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User Manual

Tektronix

TFP2A FiberMaster
Optical Time-Domain Reflectometer

070-9189-03

This document applies to firmware version T1.2E and above. Earlier instruments may not include all features described in this manual. Refer to appendix E.

First Printing : November1998

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declare under sole responsibility that the

TFP2A FiberMaster

meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the official Journal of the European Communities:

EN 50081-1 Emissions

EN 55022	Radiated, Class B
IEC 1000-3-2	Mains Current Harmonics

EN 50082-1 Immunity:

IEC 1000-4-2	Electrostatic Discharge
IEC 1000-4-3	RF Radiated
IEC 1000-4-4	Fast Transients
IEC 1000-4-5	Surge
IEC 1000-4-11	Dropout

Australia / New Zealand Declaration of Conformity

EMC Complies with EMC provision of Radiocommunications per the following standard(s): AN/NZS 2064. 1/2 Industrial, Scientific, and Medical Equipment: 1992

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Safety Information

The general safety information in these pages is for both operating and servicing personnel. In addition, specific warnings and cautions appear throughout the manual where they apply.

Definition of Terms and Symbols

In this manual, a **CAUTION** flag identifies a potential for equipment or other property damage.

A **WARNING** flag identifies a potential for personal injury or property damage.

A **DANGER** flag identifies an immediate hazard to personal safety or property.

Symbols that may be marked on the equipment indicate the following:



DANGER—High Voltage



ATTENTION—refer to manual



Protective ground (earth) terminal

Power Source

This product is designed to operate from a power source that will not apply more than 250 volts RMS between the supply conductors or between the supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Instrument

The instrument is grounded through the grounding conductor of the power cord. To avoid electric shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals.

Danger Arising from Loss of Ground

If you lose the protective ground connection, all accessible conductive parts (including knobs and controls that appear to be insulating) can render an electric shock.

Use the Proper Power Cord

Use only the power cord and connector specified for your product. Use only a power cord in good condition. Refer cord and connector changes to qualified service personnel.

Use the Proper Fuse

To avoid fire hazard, use only a fuse of the correct type, voltage rating, and current rating as specified in the parts list for your product. Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers or panel properly installed.

Laser Radiation

Avoid eye exposure to the laser output and open-ended fibers by covering the end or directing the output at a non-reflective surface. FiberMaster has been classified as a Class 1 laser product under the Radiation Control and Health Safety Act of 1968.

Repair

Refer all repair problems to qualified service personnel.

1 Introduction: the FiberMaster OTDR

ATTENTION! *Read the Safety Information section located at the front of this manual before operating FiberMaster.*

This manual applies to the TFP2A firmware shown on the title page of this manual. For a list of firmware releases and major features, refer to appendix E. The information in this appendix will help you use this manual with earlier TFP2 firmware versions.

If you have questions about using FiberMaster, or have special application problems, in the U.S. and Canada call our toll-free help line, **1-800-TEK-WIDE ext. 24***, or contact your local Tektronix representative.*

Product Description

The TEKTRONIX TFP2A FiberMaster Optical Time-Domain Reflectometer (OTDR) is an optical-fiber test instrument capable of measuring loss characteristics and displaying faults, splices, and other fiber events in singlemode and multimode optical fibers.

FiberMaster applies pulses of light to the fiber under test via the optical output connector. As the pulses travel through the fiber, some light is reflected back to the instrument. These reflections are processed to display a visual representation of the fiber on FiberMaster's cathode ray tube (CRT), where you can make distance and loss measurements on the fiber under test.

The CRT display is a time plot, read from left to right. The trace starts with the outgoing pulse, and the time difference is converted to distance in the measurement process. When you view a typical fiber display, events that are further down the fiber appear to the right (later in time). Loss is measured on the CRT's vertical scale.

NOTE *This manual explains how to use the TFP2A FiberMaster product line, which includes mainframe models TFP2A (color monitor) and TFP2AM (monochrome monitor), configured with various options. (Refer to appendix A,* Accessories and Options*.) In this manual, the instrument is referred to generically as "FiberMaster" or "TFP2A," to refer to both the TFP2A and TFP2AM models.*

With the exception of a parameter on the System Settings menu used to set the color on color monitors, the operation of the two mainframes is identical.

This manual is also compatible with TFP2/TFP2M instruments. Refer to appendix E for a list of the firmware features that apply to earlier FiberMaster models.

Modular, Plug-In Laser Sources

- ❏ The FiberMaster OTDR was designed using a modular approach that allows you to choose options that answer your specific test and measurement applications. You can easily upgrade your instrument configuration as your system requirements change. FiberMaster can accommodate 850-nanometer (nm) multimode, 1300-nm multimode, 1310-nm singlemode, and 1550-nm singlemode laser sources in one or two plug-in modules. The modules can contain either two singlemode or two multimode lasers, or any single laser, allowing the instrument to be configured with from one to all four wavelengths.
- ❏ Temperature-controlled laser light sources ensure stable wavelength and optical output for highly accurate measurements.

Accurate, High-Speed Data Acquisition and Measurement

- ❏ The internal 32-bit microprocessor performs up to 16 million high-speed averages per acquisition, maximizing the signal-to-noise ratio, giving a clear display of fiber events.
- ❏ FiberMaster measures a specific fiber feature, with single-keystroke convenience. In addition, manual adjustments provide extended flexibility in interpreting the fiber data.
- ❏ An expand function allows you to magnify any portion or feature on the displayed fiber acquisition.
- ❏ FiberMaster's high-density acquisition capability offers extended expansion capacity and highly accurate measurements.
- ❏ A masking function can be performed automatically, or you can set manual masks to eliminate detector saturation caused by large Fresnel reflections, improving measurement linearity.

Automatic and Manual Event Marking

- ❏ The instrument's event-marking function automatically locates and measures events on the fiber under test that have splice losses above a user-specified threshold, or you can also mark events manually.
- ❏ An event table is compiled displaying the measurements for each marked event. You can edit and print out this table, plus enter notes and mapping information about each event.

Extended Memory and Storage Capacity

- ❏ FiberMaster offers both a current memory, containing the current data acquisition, and a reference memory, for previously acquired fiber waveform data. A dual-trace mode makes it possible to display the contents of both current and reference memory simultaneously, allowing you to compare a current optical-fiber acquisition to historical data.
- ❏ Mass-storage devices (the standard floppy-disk drive and optional internal RAM) permit unlimited storage of waveform and settings data on both removable and internal media.

Hardcopy Options

- ❏ You can choose the optional high-speed internal thermal printer, or use FiberMaster with either an IEEE 488 general-purpose interface bus (GPIB) external plotter or printer, or an RS232 external plotter or printer. One press of a button on the instrument's front panel provides a 15-second hard copy of the displayed waveform and instrument settings on the internal printer.

Remote Control Capability

- ❏ The FiberMaster OTDR can be operated under the remote control of an instrument controller or a computer with a GPIB interface, using an IEEE 488 general-purpose interface bus, or via the RS-232 serial interface.

Additional Features

- ❏ An easy-to-use menu system simplifies setting instrument measurement parameters.
- ❏ You can upload and download waveform and settings data using the RS232 interface and XModem protocol.
- ❏ The 7-inch diagonal, high-resolution color or monochrome CRT provides a comprehensive on-screen readout of waveform and measurement data, and instrument settings.
- ❏ Online help displays context-sensitive operator assistance at the press of a button.
- ❏ Rugged, portable construction is also lightweight—under 35 pounds (15 kilograms).

General Waveform Analysis

Figure 1-1 shows an optical fiber waveform acquisition typical of the data you might see on the FiberMaster CRT. The horizontal axis shows the distance from FiberMaster's front-panel connector to points along the fiber under test. The vertical axis measures reflected light detected by the OTDR, and represents transmission loss along the fiber length.

The leftmost spike is a reflection caused by the front-panel connector. The sloping waveform is backscattered light (light reflected back towards its source) that shows fiber characteristics. The slope of the waveform represents the optical fiber loss. A low-loss, homogeneous fiber will show a gradually sloping waveform.

Any breaks or connections along the fiber appear on the display as either reflective or nonreflective discontinuities in the waveform, as shown in figure 1-1. These discontinuities, or "events," indicate locations along the fiber where you might find a splice, connector, bend, break, or other anomaly in the cable.

Use the data displayed on the OTDR's screen to determine the physical locations of these types of optical-fiber faults, to help analyze their probable causes, and to measure cable transmission loss.

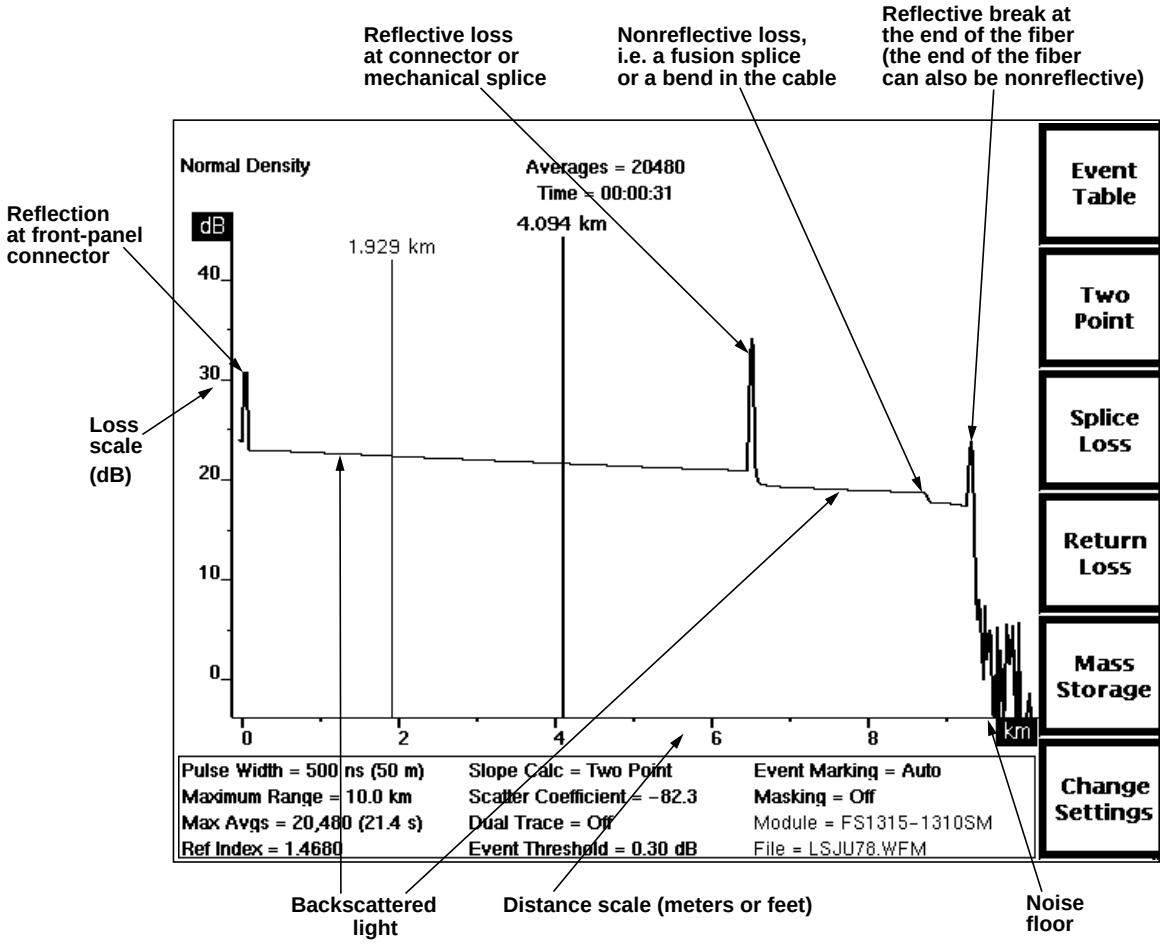


Figure 1-1. General Waveform Analysis

Overview of FiberMaster Operation

Start data acquisition on a fiber-optic cable under test by simply connecting the cable to the appropriate front-panel connector, and pressing the **START/STOP** button. An averaged waveform appears on the screen, and you can make measurements immediately.

The FiberMaster OTDR provides five measurement modes for viewing faults and measuring transmission loss, fusion-splice loss, connection loss, return loss, and other characteristics of fiber-optic cable. These are Preview, Two Point, Splice Loss, and two Return Loss modes.

- ❏ Preview mode gives a clear overview of the fiber. Scan fiber features and measure distances in Preview mode.
- ❏ Two Point mode allows you to measure loss between any two points on the fiber.
- ❏ Splice Loss mode gives loss measurements at splice points along the fiber.
- ❏ Link Return Loss mode lets you measure the return loss of a fiber link.
- ❏ Event Return Loss shows the return loss for a particular event on the fiber.

Enter each measurement mode by pressing a front-panel softkey. Two-point, splice-loss, and return-loss measurements can be made automatically. Front-panel controls permit manual adjustment to automatic measurements.

Automatic and manual event-marking modes locate and perform measurements on all events on the fiber under test. An online table is compiled that contains two-point, splice-loss, return-loss, and distance measurements for each event. You can adjust measurement values on the table, and enter and edit notes for each event.

A general-purpose interface bus (GPIB) and the RS-232 serial interface allow remote control of the instrument.

Advanced Functions

FiberMaster's automatic measurements provide adequate data for many applications. If you require more in-depth fiber analysis, however, the instrument's advanced functions offer extended flexibility in acquiring and interpreting fiber data. These functions include:

- ❏ High-density data acquisition
- ❏ A dual-waveform display, for comparing two waveforms
- ❏ Manipulation of the expansion window
- ❏ Real-time acquisition
- ❏ Manual-masking capabilities

Instrument Configuration

Instrument configuration and measurement settings are set through a menu system, accessed by pressing a front-panel softkey. You can set parameters using various front-panel controls to enter the data, or you can connect an optional IBM-AT-compatible keyboard to FiberMaster for data entry.

Mass Storage

The mass-storage system is also entered through a front-panel softkey, for storing waveform and settings data on floppy disks or an optional internal RAM. Data is saved in MS-DOS-compatible files.

The Acquisition Screen

The acquisition screen displays fiber test data and measurement information, and is used for all fiber-evaluation activity. Other than instrument setup, event marking, and mass-storage operations, most of your work with FiberMaster will be on the acquisition screen.

The acquisition screen displays either data acquisition in progress or a completed acquisition, including all measurements on the fiber under test. Distance and loss cursors display on this screen, depending on the measurement mode, and can be manipulated to perform manual measurements on the fiber.

The acquisition screen includes:

- ❏ A horizontal distance scale and a vertical loss scale.
- ❏ One or two distance cursors, and one or two loss cursors, depending on the measurement mode.

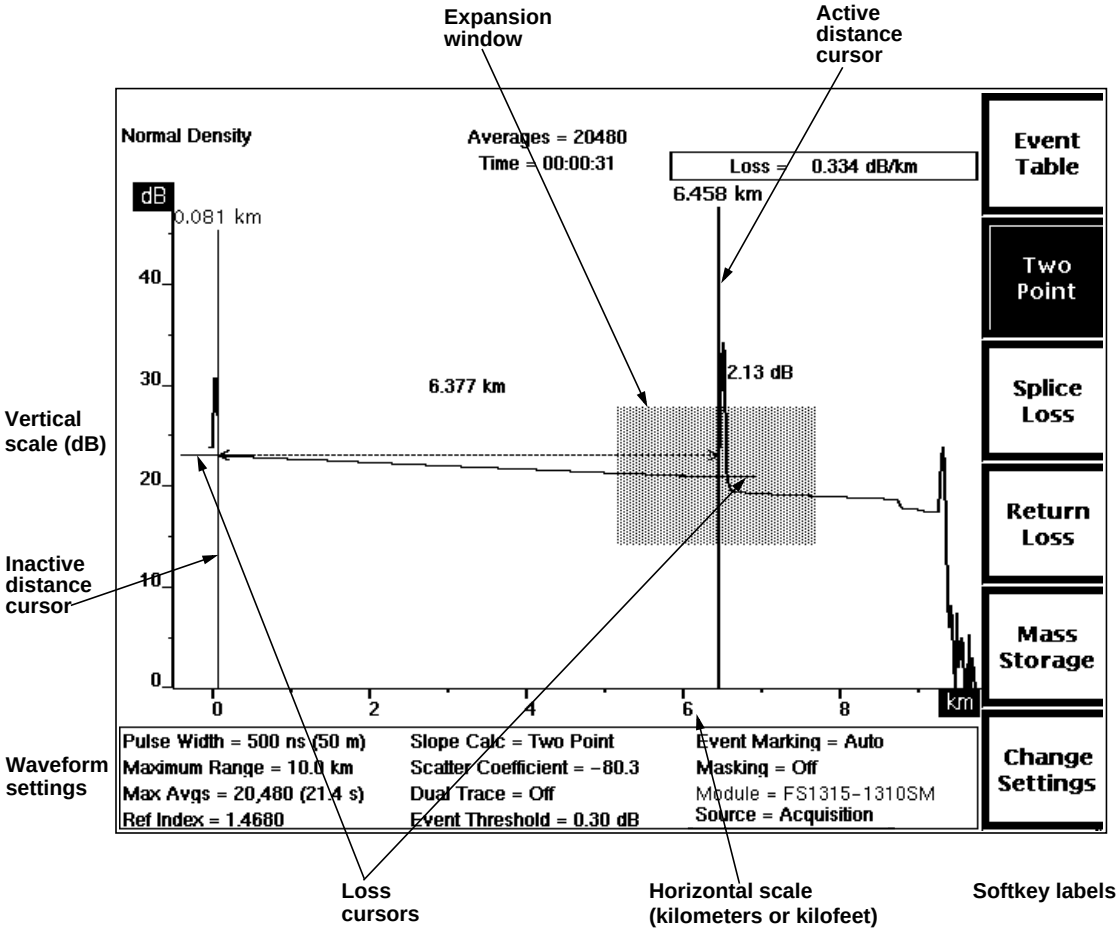


Figure 1-2. Features on the Acquisition Screen

- An expansion window. Pressing the **EXPAND** button on the front panel switches between expanded view and overview. In expanded view, the area within the expansion window is magnified to fill the display, allowing closer examination of the fiber. See figure 1-3.

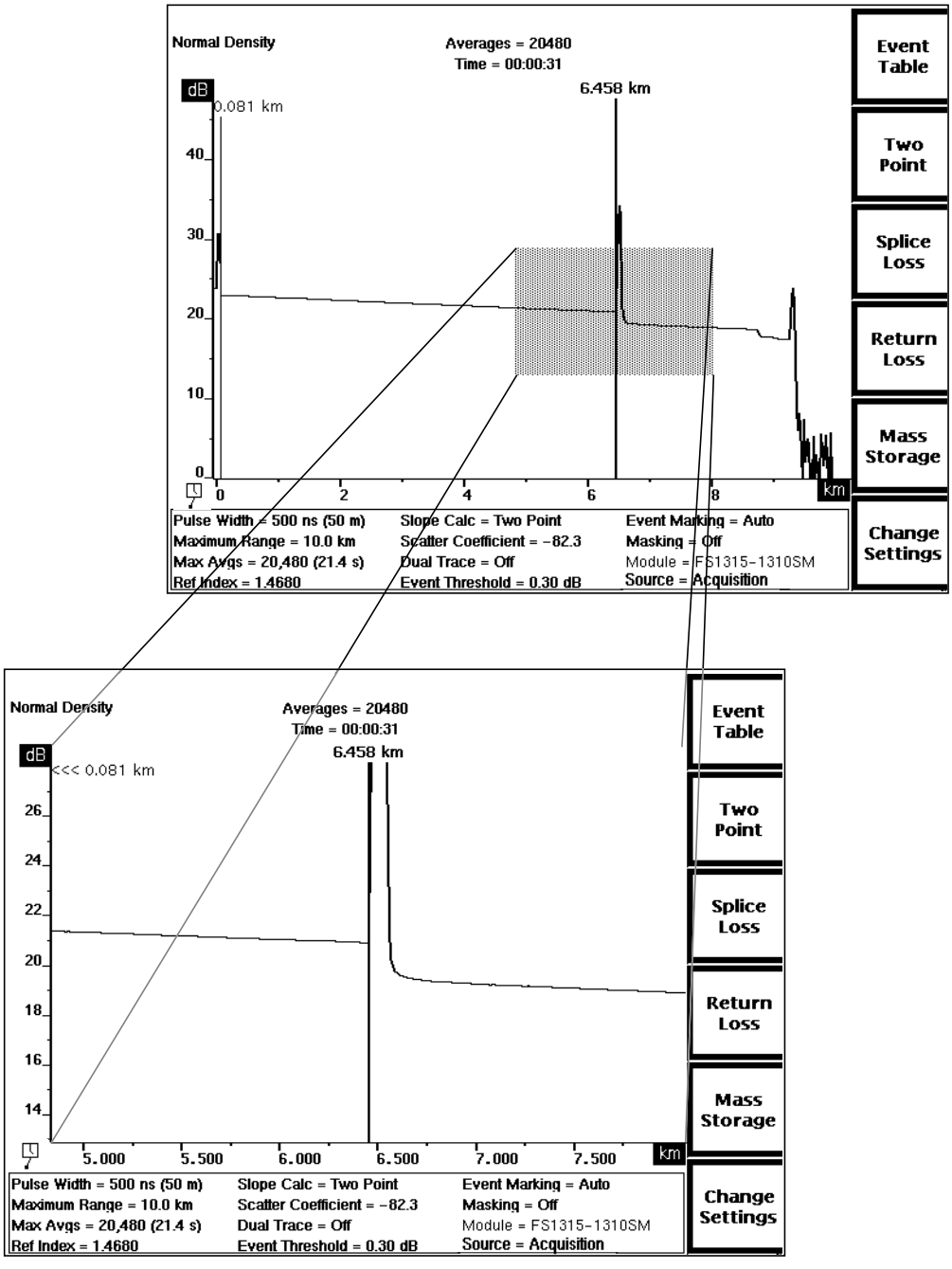


Figure 1-3. Acquisition Screen Expansion—Overview (top), and Expanded View (bottom)

- Waveform and measurement data. Distance and loss measurements are displayed on the screen near the waveform. In Two Point mode and both return-loss modes, the slope calculation and return loss, respectively, appears in the upper right-hand corner of the screen. The message **User Adjusted Measurement** displays in the upper left-hand corner of the screen for all manually adjusted measurements. The actual number of averages that were performed on the waveform, and the actual elapsed averaging time are shown in the upper center screen. If an acquisition is in progress, the number of averages and the time elapsed are seen increasing.

  During an acquisition, the display also contains an acquisition-active indicator in the lower-left corner of the waveform area. This indicator provides a quick way to check whether an acquisition is still in progress. When data acquisition is complete, and calculations are still in progress, the indicator changes to show a clock with a swinging pendulum.

  When event-marking mode is turned on, events on the fiber are marked and numbered at the bottom of the acquisition screen. In addition, when the active distance cursor is on an event marker, a field below the horizontal distance scale displays measurements for that event.

- On color monitors, the waveform area of the acquisition screen is color coded for easier interpretation of data and measurements. Waveform data, including the active waveform (except for high-density data), the number of averages, elapsed time, and the **Normal Density** or **High Density** message, is green. The user-adjustable elements—distance and loss cursors, and the **User Adjusted Measurement** message—are displayed in red. Measurement values such as the two-point distance and loss, splice loss, fiber loss, and return loss figures are shown in yellow. Event markers are also displayed in yellow.

- All waveform settings used for the acquisition are displayed at the bottom of the screen. These user-defined settings are selected on the Waveform Settings menu, reached by pressing the **Change Settings** softkey on the acquisition screen. Refer to chapter 3, *Getting Started*, for information on configuring your instrument and setting parameters.

  A **Module** parameter in the list of settings indicates which laser source is currently selected. The type of module is shown, plus the currently selected wavelength. For example, **FS1315-1310SM** indicates that the 1310-nm wavelength of a dual-wavelength singlemode FS-type optical module is currently selected. If the active module is different from the one that was used to acquire the current waveform, the module parameter is highlighted.

  The module parameter may include alphabetical characters to indicate the modification level of the module, and whether the module has an internal fiber with a non-standard core diameter. This information is appended to the wavelength. Lower-case letters indicate the modification level of the module, and upper-case letters stand for a non-standard core diameter. For example:

  FS1315-1310SM — standard module with standard core diameter
  FS1315-1310SMaA — modified module with non-standard core diameter
  FS1315-1310SMA — standard module with non-standard core diameter
  FS1315-1310SMa — modified module with standard core diameter

  For more information on module modifications and internal fiber core diameters, in the U.S. and Canada, call 1-800-833-9200, or contact your local Tektronix representative.

  The **Source** parameter shows where the current waveform data originated. The data could be the result of an acquisition, a data transfer, or from a mass-storage file. For an acquisition, the parameter displays as **Source = Acquisition**. If the waveform was loaded from mass storage, the parameter reads **File = <FILE_NAME>** where **<FILE_NAME>** is the name of the mass-storage file. If the waveform data was received via an XModem data transfer, the parameter reads **Source = XModem**.

- Softkey labels display along the right-hand edge of the screen. On the acquisition screen, the softkeys allow you to switch measurement modes, view the event table, enter the menu system, and access mass-storage functions.

About this Manual

The FiberMaster User Manual consists of seven chapters and six appendices, containing the following information:

- Chapter 1, *Introduction*, provides a description of the FiberMaster OTDR, unpacking and repacking instructions, instrument specifications, and user maintenance.
- Chapter 2, *Controls, Indicators, and Connectors*, describes the functions of each of the front- and rear-panel controls and connectors.
- Chapter 3, *Getting Started*, explains how to use the online help function, lists settings defaults, and describes the menu system used to configure the instrument and set measurement parameters.
- Chapter 4, *Making Optical Fiber Measurements*, describes each of the measurement modes—Preview, Two Point, Splice Loss, Link Return Loss, and Event Return Loss—and how to make automatic and manual measurements on a fiber in these modes.
- Chapter 5, *Event Marking,* explains the process of locating, measuring, and documenting events on the fiber under test. Events can be marked either automatically or manually. An event table of measurements is compiled, based on the locations of the event markers.
- Chapter 6, *Advanced Operating Functions*, outlines advanced aspects of some of FiberMaster's features, including details on the expansion window, high-density data acquisition, dual waveform operation, and real-time mode.
- Chapter 7, *Mass Storage*, explains how to use the mass-storage device(s) (floppy disk drive, internal RAM) to store and retrieve waveform and settings data.
- Chapter 8, *Remote Control*, contains the remote-control command set and instructions on how to use the instrument under remote control via GPIB and RS-232.
- Appendices contain information that applies to general operation of the instrument. They include a list of options and accessories available for use with the FiberMaster OTDR, a description of the instrument's data output, a list of keyboard sequences recognized by the instrument, how to run the instrument's diagnostic self tests, a list of firmware versions, a list of start-up error codes, and instructions on how to upgrade software via floppy disk.

Conventions Used in this Manual

In the text of this manual, references to front-panel controls and softkeys appear in boldface type, for example:

Press the **START/STOP** button.

Change instrument settings by pressing the **Change Settings** softkey.

Remote-control commands and messages as sent and received by the instrument are shown indented and in upper-case, boldface type:

ACQUIRE 10.0,START,NORMAL;*OPC?

Change and History Information

Change information that involves manual corrections and additional data is located at the back of this manual in the *Change Information* section. History information with the updated data is integrated into the text or diagrams when a page is updated.

Unpacking and Preparation for Use

Before unpacking FiberMaster from its shipping container or carton, inspect for signs of external damage. If the carton is damaged, notify the carrier. The shipping carton contains the instrument and its standard and optional accessories.

If the contents of the shipping container are incomplete, if there is mechanical damage or defects, or if the instrument does not meet operational check requirements, contact your local Tektronix Field Office or representative. If the shipping container is damaged, notify the carrier as well as Tektronix.

The instrument was inspected both mechanically and electrically before shipment. It should be free of mechanical damage and meet or exceed all electrical specifications. Functional and operational self tests are performed at power-on. If your instrument fails to perform satisfactorily, contact your Tektronix representative immediately, or in the U.S. and Canada, telephone toll free **1-800-TEK-WIDE ext. 2400**.

Preparation for Use

Use FiberMaster's front cover to protect the front panel when storing and transporting the instrument. Remove the cover by pulling out on the sides and lifting off. Replace the cover by pressing it over the front panel until the cover snaps in place. The instrument's accessories are stored in the soft carrying case.

You can position FiberMaster's handle to serve as a tilt stand, or you can move it to the front of the instrument, so the instrument can be stacked or carried. To position the handle, press in at both pivot points and rotate to the desired position.

Power Source and Power Requirements

FiberMaster is intended to be operated from a power source that does not apply more than 250V RMS between the supply conductors, or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

The AC power connector is a three-wide, polarized plug with the ground (earth) lead connected directly to the instrument frame to provide electrical shock protection. If the unit is connected to any other power source, the unit frame must be connected to an earth ground.

CAUTION *To avoid electric shock, the power cord protective grounding conductor must be connected to ground.*

Power and voltage requirements are printed on the back panel. With the DC power option (option 17), FiberMaster can be operated from 11 to 16 VDC, or from 90 to 250 VAC nominal line voltage at 47 to 73 Hz. AC-only instruments can be operated from 90 to 250 VAC, 47 to 73 Hz.; or from 90 to 130 VAC, 47 to 440 Hz. In AC-only instruments, power-source selection is made automatically when the unit is plugged in.

Installing the Optical Module(s)

Your TFP2A mainframe may be shipped with optical module(s) installed. If you order modules separately, you may have to install them at your site. Install one or two optical modules into the mainframe as follows:

1. Detach the left-hand side of the mainframe back panel by unscrewing four black quick-release screws in each corner of the back-panel assembly (see figure 1-4). Pull the back-panel assembly off the mainframe using the handle provided, disconnecting the control and module support boards from the interconnect board, which is attached to the inside of the back panel.

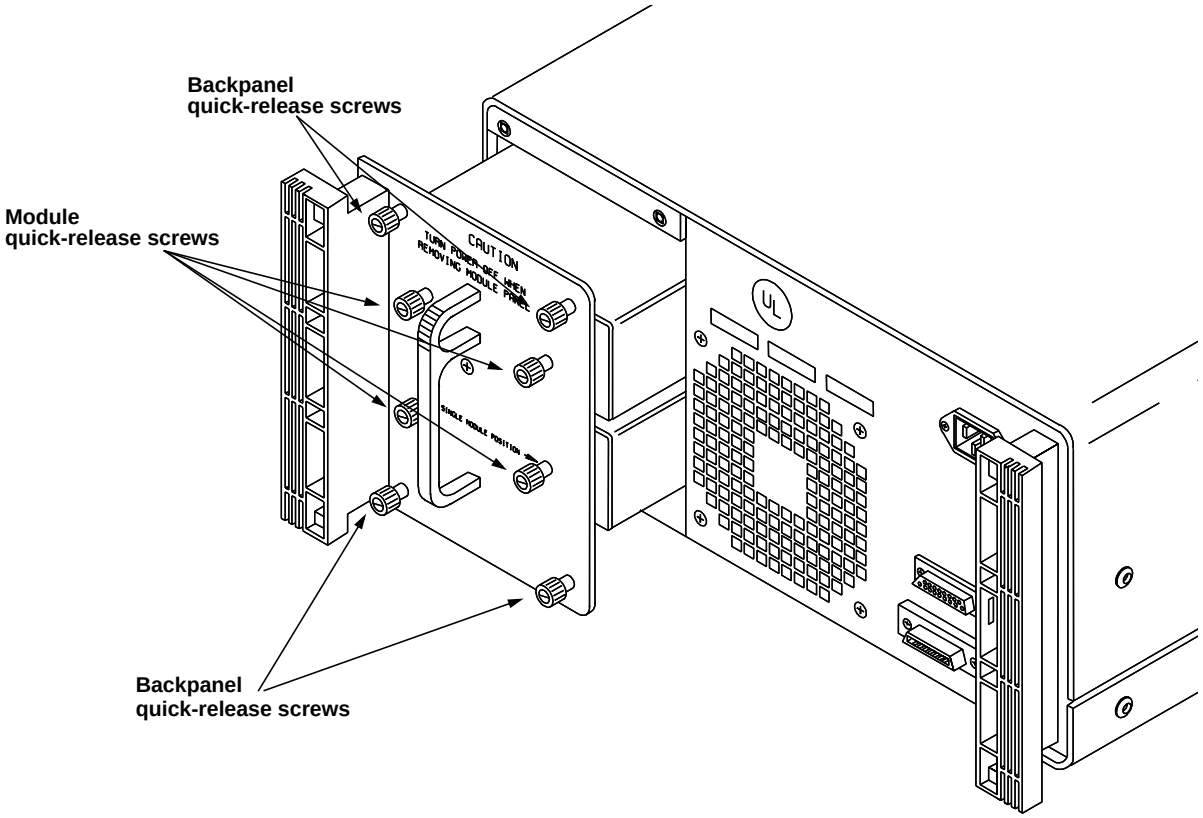


Figure 1-4. Installing Optical Modules

2. Plug one module into the bottom set of module connectors on the interconnect board, inserting the module's screwholes through the back-panel assembly. (See figure 1-5.)
3. Secure the module to the back-panel assembly by tightening the two back-panel quick-release screws into the module's screwholes.
4. If you have a second module, plug it into the top set of module connectors on the interconnect board.

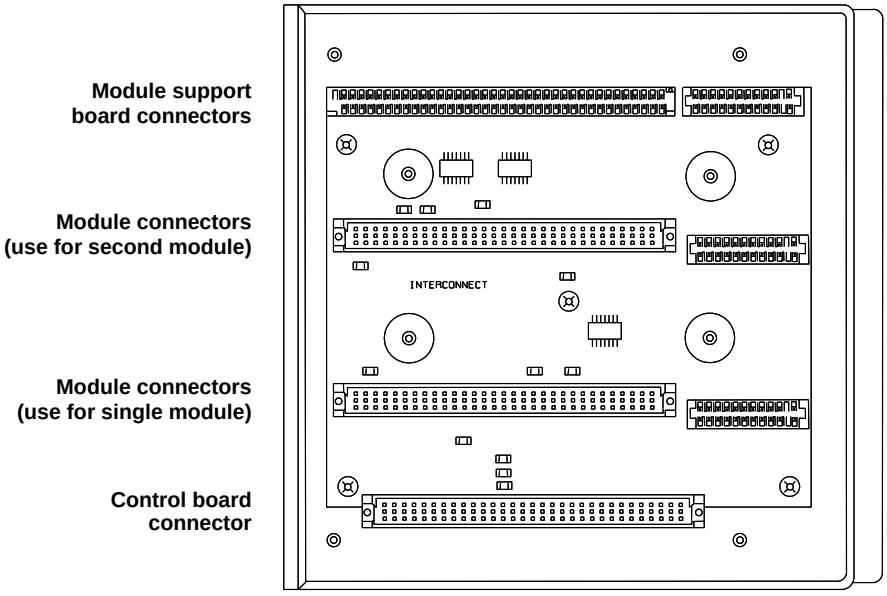


Figure 1-5. Interconnect Circuit Board Connectors

5. Secure the second module to the back-panel assembly by tightening the two quick-release screws into the module's screwholes.

6. If you are installing two modules, snap the spacer between the modules as shown in figure 1-6, into the holes provided .

7. Place the modules inside the mainframe, lining up the fiber connectors with the openings in the front panel, and reconnecting the control and module support boards to the interconnect board.

NOTE *Align the connectors on the interconnect board correctly to ensure complete connections with the module support board, optical module(s), and control board. If connections are not made properly, the instrument will not work.*

8. Reattach the back-panel assembly to the mainframe by tightening the four black quick-release screws. All the screws in the back-panel assembly can be tightened further using a screwdriver, if necessary.

To take the modules out of the TFP2A mainframe, reverse this procedure.

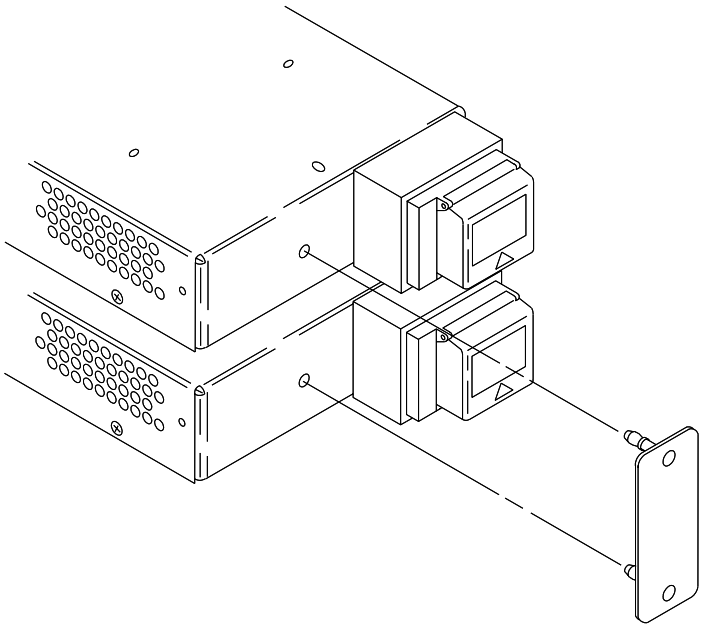


Figure 1-6. Installing the Module Spacer: Two-Module Configuration

Front-Panel Covers

If your instrument includes one optical module, the top module slot on the front panel is unused. If your instrument is not configured with a floppy-disk drive, the drive slot is unused. Unused option slots are covered before the instrument is shipped from the factory. If you change your instrument's configuration, however, you may need to remove or install these covers, as shown in figure 1-7.

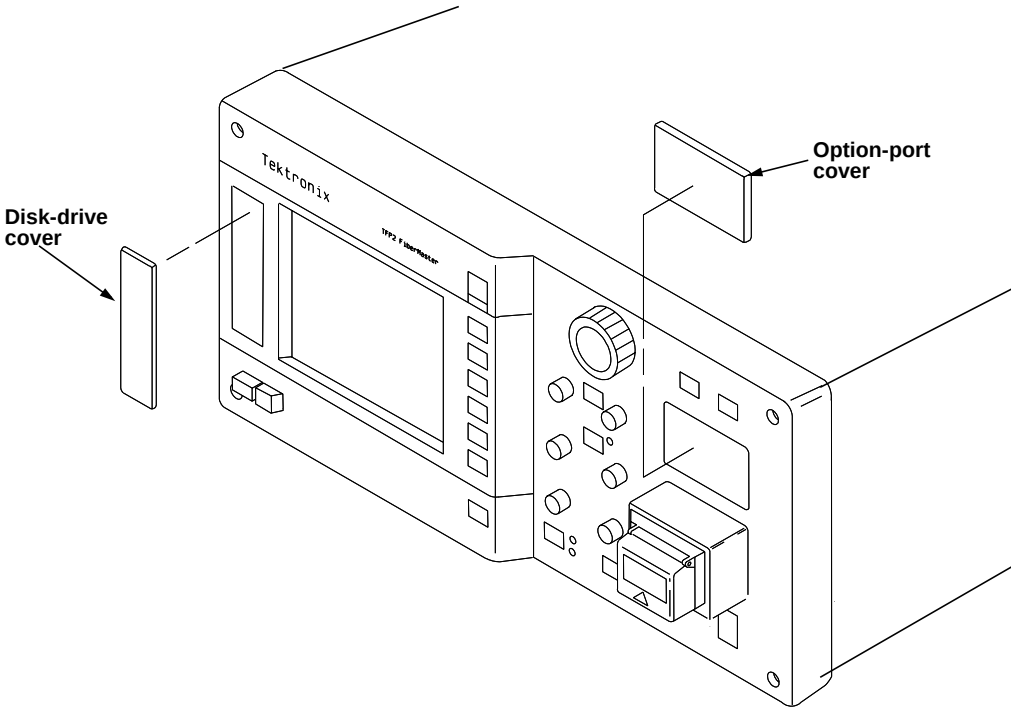


Figure 1-7. Front-Panel Option Covers

Loading Paper into the Internal Printer

To load paper into the internal thermal printer, follow these steps:

1. Slide the printer cover back.
2. Lift out the old paper roll and remove the black disks from either end.
3. Insert the disks into the ends of the new paper roll.
4. Place the new roll into the printer, with the end of the paper coming out from under the roll towards the front of the instrument.
5. Push the paper tension lever down, and hold it down for step 6.
6. Feed the paper into the slot in the paper guide, until it comes out in front of the aluminum paper guide. See figure 1-8. The arrows indicate the direction in which to feed the paper.
7. Release the tension lever.

When the printer is in use, slide the printer cover closed until it reaches the stops provided for the paper opening. Use the serrated edge of the cover as a guide to tear the paper off. After printing, tear off any remaining paper and slide the cover completely closed over the printer.

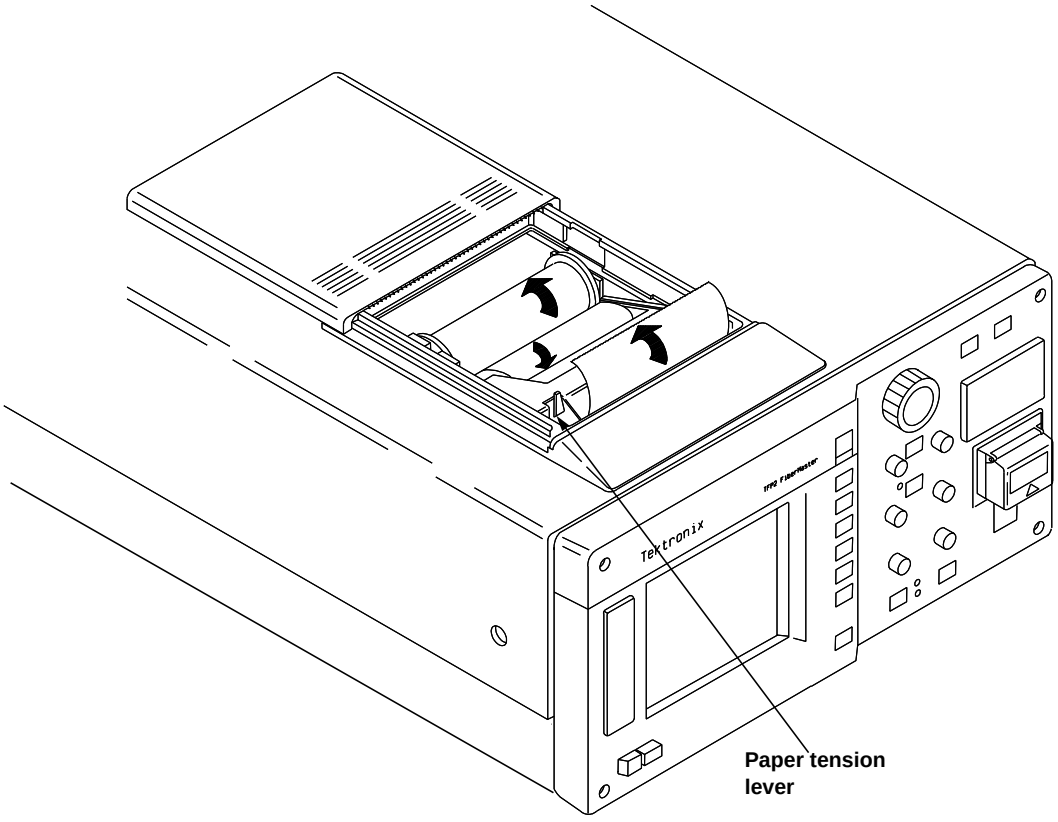


Figure 1-8. Loading Paper into the Internal Printer

Laser Output

FiberMaster is equipped with low-energy lasers and does not output continuous energy unless you have started data acquisition (by pressing the **START/STOP** button).

WARNING *The TFP2A FiberMaster has been classified as a Class 1 laser product under the Radiation Control and Health Safety Act of 1968.*

Although output from a Class 1 laser is not considered hazardous, it is good practice not to allow eye exposure from direct or reflected laser light. This can be avoided by covering the end of the fiber or directing the output at a non-reflective surface.

It is important to set up and operate the instrument as instructed in this manual. Use of controls or adjustments for performance of procedures other than those specified herein may result in hazardous radiation exposure.

Repacking for Shipment

When packing an instrument for shipping to a Tektronix Service Center for service or repair, attach a tag showing the name and address of the owner, name of the individual at your firm to contact, complete serial number, and a description of the service required. If the original packaging is not available, repackage the instrument as follows:

1. Install the front cover on the OTDR.
2. Position the handle over the front cover, and wrap the instrument in polyethylene sheeting to protect the finish.
3. Cushion the instrument on all sides with packing material or urethane foam between the carton and the sides of the instrument.
4. Seal the carton using shipping tape.

No special handling is required to prepare the floppy-disk drive for shipping.

A shipping carton and packing material can be obtained through your local Tektronix field office or representative, if necessary.

If you have any questions, contact your local Tektronix field office or representative or in the U.S. and Canada call toll free **1-800-TEK-WIDE ext. 2400**.G

Specifications

Electrical Characteristics

The following characteristics and features apply to the FiberMaster OTDR after a warmup period of at least 20 minutes. All loss numbers reflect one-way measurements unless otherwise specified.

Table 1-1. Display Range—Vertical System

Vertical range	1 dB to 50 dB, overview 1 dB to 100 dB, expanded view
Loss measurements Loss readout resolution	0.001 dB to 0.01 dB
Accuracy Two point, splice loss, and LSA fiber loss:	
FM/FS/FG series	±0.05 dB/dB, from 7 dB above the RMS noise floor (SNR = 1) to 30 dB on the screen. Maximum error of ±0.2 dB from +7 dB above the RMS noise floor to top of backscatter.
FL series	±0.02 dB/dB, from 15 dB to 35 dB on the screen.

Table 1-2. Display Range—Horizontal System

Distance range	1 m to 200 km
Distance measurements Cursor resolution (min) FM/FS/FG series: 850 nm MM 1300 nm MM/ 1310 nm SM/ 1550 nm SM FL series: 1310 SM/ 1550 SM Index of refraction range Distance measurement accuracy	 5 cm to 2 m, normal density; 1 cm to 50 cm, high density 20 cm to10 m, normal density; 10 cm to 2 m, high density 2 m to 10 m, normal density; no high density 1.4000 to 1.6000 ±0.001%, ±minimum cursor resolution ±uncertainty in index of refraction
Number of displayed waveform points	>16,000 maximum for each normal and high density

Table 1-3. Display

Size	7 inches (17.5 cm) diagonal
Resolution	640 by 480 pixels
Display type Color Monochrome	 Two-color system giving three colors, with five levels each Five-level gray scale

Table 1-4. Keyboard

Connector	5-pin RJ11
Compatibility	Compatible with IBM AT keyboards (input only), but complete compatibility can be guarenteed only with Tektronix keyboard Option 19

Table 1-5. Hardcopy

Internal printer Resolution Print dimensions	High-speed, high-resolution dot matrix, thermal 150 dots/in vertical and horizontal 4 in by 5 in (10.2 cm by 12.7 cm)
External plotter	HP-GL compatible (Tektronix HC100): GPIB and RS232 connections
External printer	Epson FX-compatible: RS232 connection Hewlett-Packard ThinkJet/LaserJet-compatible: GPIB and RS232 connections PostScript-compatible: RS232 connection

Table 1-6. Mass Storage

Floppy disk drive Size Capacity Format	 3.5 in (8.9 cm) 1.44 Mbyte or 720 Kbyte MS-DOS compatible
Internal RAM Capacity Battery life	 1 Mbyte 1 year

Operational Characteristics

Table 1-7. Operational Characteristics

Power requirements AC operation (AC only)	 90 - 130 VAC, 47 - 440Hz 180 - 250 VAC, 47 - 73Hz (auto select)
AC operation (AC with DC option)	90 - 130 VAC, 47 - 73 Hz 180 - 250 VAC, 47 - 73 Hz
DC operation	11 - 16 VDC
Power supply rating AC operation	 250 watts max. 315 VA max.
DC operation	200 VA max. (watts)
Module capacity	Two dual-wavelength modules maximum, for a total of four wavelengths
Safety	UL 1244, UL 3111-1 CSA: CAN/CSA C22.2 No. 231 CAN/CSA -C22.2 No. 1010.192 IEC 1010-1 EN 61010-1

Physical Characteristics

Table 1-8. Physical Characteristics

Weight	33 lbs (15 kg), mainframe configured with floppy-disk drive, internal printer, and one optical module
Dimensions	Overall dimensions, including front cover, handle, and feet: Length, 25 in (63.7 cm); width, 18 in (46 cm); height, 7 in (18 cm)

Environmental Characteristics

Table 1-9. Environmental Characteristics

Temperature	
Mainframe	Operating: +5˚ to +50˚ C Non-operating: -40˚ to +60˚ C
With internal printer	Operating: +5˚ to +40˚ C Non-operating: -20˚ to +60˚ C
Without floppy-disk drive	Operating: -10˚ to +55˚ C Non-operating: -40˚ to +70˚ C
Humidity (operating)	
Mainframe	8% to 75% (+5%, -0%), noncondensing
With internal printer	35% to 75% (+5%, -0%), noncondensing
Without floppy-disk drive	5% to 90% (+5%, -0%), noncondensing
Altitude (maximum)	
Operating	15,000 ft (4.6 km)
Non-operating	50,000 ft (15.2 km)
	Tek 062-2847-00, Class 3 (exceeds MIL-T-28800E)
Sine vibration	
Operating	Frequency sweep: 10 to 55 Hz Loading: 0.5G, maximum
Disk drive non-operating	Frequency sweep: 10 to 55 Hz Loading: 2.0G, maximum
Shock (maximum)	
Operating	5G
Disk drive non-operating	30G
Bench handling	MIL-T-28800E
Transit drop	MIL-T-28800E
Water resistance	Drip proof, tested with front cover on
Fungus resistance	Enclosure and electronics are fungus inert by design

Table 1-9. Environmental Characteristics, cont.

Electromagnetic compatibility	EC Council Directive 89/336/EEC
Emissions:	EN 50081-1
Radiated emissions	FCC Part 15, Subpart J, Class A EN55022, Class B
Mains Current Harmonics	IEC 1000-3-2
Conducted emissions	FCC Part 15, Subpart J, Class A EN55022, Class B
Magnetic emissions	EN60555-2 Vfg 243, Class B
Immunity:	EN 50082-1
IEC 1000-4-2 IEC 1000-4-3 IEC 1000-4-4 IEC 1000-4-5 IEC 1000-4-11	Electrostatic Discharge RF Radiated Fast Transients Surge Dropout

FS1300 Singlemode Optical Module

Table 1-10. FS1300 Singlemode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
10 µs/1000 m	29.5	38.0	1080	1050
4000 ns/400 m	27.5	38.0	480	420
2000 ns/200 m	23.5	38.0	240	220
1000 ns/100 m	22.0	38.0	140	110
500 ns/50 m	20.5	38.0	70	55
200 ns/20 m	18.5	38.0	40	25
100 ns/10 m	17.0	38.0	25	12
50 ns/5 m	15.5	38.0	20	7
50 ns/5 m HR	12.0	34.0	15	7
20 ns/2 m HR	10.5	34.0	NA	5
10 ns/1 m HR	9.0	34.0	NA	3

Operating wavelength: 1310 nm ± 20 nm

Masking: menu selectable

- ❏ Auto-QuickMask
- ❏ Auto-AccuMask
- ❏ Manual-QuickMask
- ❏ Manual-AccuMask

Full-screen display range: 50 m to 200 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FS1500 Singlemode Optical Module

Table 1-11. FS1500 Singlemode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
10 µs/1000 m	26.5	36.0	1080	1050
4000 ns/400 m	24.5	36.0	480	420
2000 ns/200 m	20.5	36.0	240	220
1000 ns/100 m	19.0	36.0	140	110
500 ns/50 m	17.5	36.0	70	55
200 ns/20 m	15.5	36.0	40	25
100 ns/10 m	14.0	36.0	25	12
50 ns/5 m	12.5	36.0	20	7
50 ns/5 m HR	9.0	33.0	18	7
20 ns/2 m HR	7.5	33.0	NA	5
10 ns/1 m HR	5.0	33.0	NA	3

Operating wavelength: 1550 nm ± 20 nm

Masking: menu selectable

- ❏ Auto-QuickMask
- ❏ Auto-AccuMask
- ❏ Manual-QuickMask
- ❏ Manual-AccuMask

Full-screen display range: 50 m to 200 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FS1315 Singlemode Optical Module

Table 1-12. FS1315 Singlemode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
10 µs/1000 m	29.5/26.5	38.0/36.0	1080	1050
4000 ns/400 m	27.5/24.5	38.0/36.0	480	420
2000 ns/200 m	23.5/20.5	38.0/36.0	240	220
1000 ns/100 m	22.0/19.0	38.0/36.0	140	110
500 ns/50 m	20.5/17.5	38.0/36.0	70	55
200 ns/20 m	18.5/15.5	38.0/36.0	40	25
100 ns/10 m	17.0/14.0	38.0/36.0	25	12
50 ns/5 m	15.5/12.5	38.0/36.0	20	7
50 ns/5 m HR	12.0/9.0	34.0/33.0	15/18	7
20 ns/2 m HR	10.5/7.5	34.0/33.0	NA	5
10 ns/1 m HR	9.0/5.0	34.0/33.0	NA	3

Operating wavelengths: 1310/1550 nm ± 20 nm

Masking: menu selectable

- ❏ Auto-QuickMask
- ❏ Auto-AccuMask
- ❏ Manual-QuickMask
- ❏ Manual-AccuMask

Full-screen display range: 50 m to 200 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FG1300 Singlemode Optical Module

Table 1-13. FG1300 Singlemode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
10 µs/1000 m	31.0	38.0	1150	1150
4000 ns/400 m	28.5	38.0	550	475
2000 ns/200 m	25.5	38.0	250	225
1000 ns/100 m	24.0	38.0	150	110
500 ns/50 m	21.5	38.0	80	55
200 ns/20 m	19.5	38.0	55	25
100 ns/10 m	18.0	38.0	50	12
50 ns/5 m	16.5	38.0	45	10
50 ns/5 m HR	13.5	34.0	30	7
20 ns/2 m HR	11.5	34.0	25	5
10 ns/1 m HR	9.5	34.0	N/A	4

Operating wavelength: 1310 nm ± 20 nm

Masking: not applicable

Full-screen display range: 50 m to 200 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -30˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter. Specifications are based on reflections not to exceed a return loss of 40 dB.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

Performance specifications are at 25˚ C.

FG1315 Singlemode Optical Module

Table 1-14. FG1315 Singlemode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
10 µs/1000 m	31.0/29.0	38.0/36.0	1150	1150
4000 ns/400 m	28.5/26.5	38.0/36.0	550	475
2000 ns/200 m	25.5/23.5	38.0/36.0	250	225
1000 ns/100 m	24.0/22.0	38.0/36.0	150	110
500 ns/50 m	21.5/19.5	38.0/36.0	80/85	55
200 ns/20 m	19.5/17.5	38.0/36.0	55/60	25
100 ns/10 m	18.0/16.0	38.0/36.0	50/55	12
50 ns/5 m	16.5/14.5	38.0/36.0	45/55	10
50 ns/5 m HR	13.5/11.5	34.0/33.0	30/35	7
20 ns/2 m HR	11.5/9.5	34.0/33.0	25/30	5
10 ns/1 m HR	9.5/7.5	34.0/33.0	N/A	4

Operating wavelengths: 1310/1550 nm ± 20 nm

Masking: not applicable

Full-screen display range: 50 m to 200 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -30˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter. Specifications are based on reflections not to exceed a return loss of 40 dB.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

Performance specifications are at 25˚ C.

FL1300 Singlemode Optical Module

Table 1-15. FL1300 Singlemode Optical Module

Pulse	Dynamic Range[1]		Dead Zone	
	SNR = 1 (dB)[2]	End Detect (dB)[3]	Meas. (m)[4]	Event (m)[5]
20 µs/2000 m	37.5	46.0	2375	2100
10 µs/1000 m	36.0	46.0	1270	1050
4000 ns/400 m	33.5	45.5	670	440
2000 ns/200 m	31.0	44.5	395	220
1000 ns/100 m	29.5	44.5	280	120
500 ns/50 m	27.5	44.0	150	60
200 ns/20 m	25.5	44.0	125	35
100 ns/10 m	24.0	44.0	125	25

Operating wavelength: 1310 nm ± 20 nm

Masking: not applicable

Full-screen display range: 50 m to 320 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 262,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FL1500 Singlemode Optical Module

Table 1-16. FL1500 Singlemode Optical Module

Pulse	Dynamic Range[1]		Dead Zone	
	SNR = 1 (dB)[2]	End Detect (dB)[3]	Meas. (m)[4]	Event (m)[5]
20 µs/2000 m	37.0	46.5	2375	2100
10 µs/1000 m	35.0	46.0	1270	1050
4000 ns/400 m	33.0	46.0	670	440
2000 ns/200 m	30.5	45.0	395	220
1000 ns/100 m	29.0	45.0	280	120
500 ns/50 m	27.0	44.5	150	60
200 ns/20 m	25.0	44.5	195	35
100 ns/10 m	23.0	44.0	170	25

Operating wavelength: 1550 nm ± 20 nm

Masking: not applicable

Full-screen display range: 50 m to 320 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 262,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FL1315 Singlemode Optical Module

Table 1-17. FL1315 Singlemode Optical Module

Pulse	Dynamic Range[1]		Dead Zone	
	SNR = 1 (dB)[2]	End Detect (dB)[3]	Meas. (m)[4]	Event (m)[5]
20 µs/2000 m	37.5/37.0	46.0/46.5	2375	2100
10 µs/1000 m	36.0/35.0	46.0/46.0	1270	1050
4000 ns/400 m	33.5/33.0	45.5/46.0	670	440
2000 ns/200 m	31.0/30.5	44.5/45.0	395	220
1000 ns/100 m	29.5/29.0	44.5/45.0	280	120
500 ns/50 m	27.5/27.0	44.0/44.5	150	60
200 ns/20 m	25.5/25.0	44.0/44.5	125/195	35
100 ns/10 m	24.0/23.0	44.0/44.0	125/170	25

Operating wavelength: 1310/1550 nm ± 20 nm

Masking: not applicable

Full-screen display range: 50 m to 320 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 262,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FM8500 Multimode Optical Module

Table 1-18. FM8500 Multimode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
100 ns/10 m	27.0	36.0	13.0	10.5
50 ns/5 m	25.5	36.0	8.5	5.5
20 ns/2 m	23.5	36.0	6.0	3.0
8 ns/80 cm	20.5	36.0	4.5	1.0
3 ns/30 cm	16.5	35.0	3.5	0.5
1 ns/10 cm	14.0	35.0	2.5	0.2

Operating wavelength: 850 nm ± 25 nm

Masking: not applicable

Full-screen display range: 5 m to 20 km

Laser safety: Class 1, 21 CFR 1040

Temperature: 0˚ to +50˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FM1300 Multimode Optical Module

Table 1-19. FM1300 Multimode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
1000 ns/100 m	26.5	38.0	125	110
500 ns/50 m	23.5	38.0	65	55
200 ns/20 m	21.5	38.0	35	25
100 ns/10 m	20.0	38.0	30	12
50 ns/5 m	18.5	38.0	25	7
50 ns/5 m HR	15.0	35.0	20	7
20 ns/2 m HR	13.0	35.0	18	5
10 ns/1 m HR	15.0	35.0	14	3

Operating wavelength: 1300 nm ± 30 nm

Masking: not applicable

Full-screen display range: 50 m to 100 km

Laser safety: Class 1, 21 CFR 1040

Temperature: 0˚ to +50˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FM8513 Multimode Optical Module

Table 1-20. FM8513 Multimode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
850 nm:				
100 ns/10 m	27.0	36.0	13.0	10.5
50 ns/5 m	25.5	36.0	8.5	5.5
20 ns/2 m	23.5	36.0	6.0	3.0
8 ns/80 cm	20.5	36.0	4.5	1.0
3 ns/30 cm	16.5	35.0	3.5	0.5
1 ns/10 cm	14.0	35.0	2.5	0.2
1300 nm:				
1000 ns/100 m	26.5	38.0	125	110
500 ns/50 m	23.5	38.0	65	55
200 ns/20 m	21.5	38.0	35	25
100 ns/10 m	20.0	38.0	30	12
50 ns/5 m	18.5	38.0	25	7
50 ns/5 m HR	15.0	35.0	20	7
20 ns/2 m HR	13.0	35.0	18	5
10 ns/1 m HR	15.0	35.0	14	3

Operating wavelengths: 850 nm ± 25 nm, 1300 nm ± 30 nm

Masking: not applicable

Full-screen display range: 850 nm—5 m to 20 km; 1300 nm—50 m to 100 km

Laser safety: Class 1, 21 CFR 1040

Temperature: 0˚ to +50˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

Inspection, Cleaning, and Maintenance

FiberMaster's cabinet minimizes dust accumulation inside the instrument. Never operate the OTDR without the cabinet installed. When storing or transporting the instrument, make sure the front cover is on to protect the front panel and display from dust and damage.

Inspect and clean your FiberMaster OTDR as often as operating conditions require. For example, under average conditions (laboratory use), inspect and clean your instrument after every 1000 hours of operation. When using FiberMaster extensively in the field, inspect and clean it after every 500 hours of operation. Dirt acts as a thermal insulator and can cause overheating and component breakdown. It also provides an electrical conduction path that could cause instrument failure, especially under high-humidity conditions.

External inspection and cleaning procedures are included in this section. Internal inspection and cleaning are beyond the scope of the user manual, and are included in the *FiberMaster Module-Level Service Manual*. Refer to this manual for assembly and disassembly procedures and instructions on inspecting and cleaning the interior of the instrument.

Exterior Inspection

Inspect the outside of the OTDR for damage, wear, and missing parts, using table 1-19 as a guide. OTDRs that appear to have been dropped or otherwise abused should be checked thoroughly to verify correct operation and performance.

Table 1-21. External Inspection Checklist

Item	Inspect For	Repair Action
Cabinet, front panel cover, handle	Cracks, scratches, deformations, damaged hardware or gaskets, proper operation of handle	Replace defective module.
Front-panel knobs	Missing, damaged, or loose knobs	Repair or replace missing or damaged knobs.
Connectors	Broken shells, cracked insulation, deformed contacts. Dirt in connectors.	Replace defective modules. Clear or wash out dirt.
Accessories	Missing items or parts of items, bent pins, broken or frayed cables, and damaged connectors.	Replace damaged or missing items, frayed cables, and defective modules.

Exterior Cleaning

CAUTION *To prevent getting moisture inside the OTDR during external cleaning, use only enough liquid to dampen the cloth or applicator.*

1. Remove dust from the outside of the instrument by wiping with a lint-free cloth or brushing the surface with a small brush. Use the brush to remove dust from around the front-panel controls.
2. Clean remaining dirt with a lint-free cloth dampened in a general-purpose detergent-and-water solution. Do not use abrasive cleaners.
3. Clean the monitor screen with a lint-free cloth dampened with isopropyl alcohol.

Optical-Fiber Cleaning

As a rule, clean any fiber before connecting it to FiberMaster's front panel, or at any time you think it may be contaminated. Clean the connector using electronics-grade isopropyl alcohol on a lint-free swab, then blow dry with clean, canned air. If you know the connector is clean, blowing with air should be sufficient.

CAUTION *Never use any abrasive material to clean the fiber. Damage to the fiber results in deteriorated performance.*

Cleaning and Changing the Front-Panel Connector

Newer FiberMaster optical modules have cleanable, universal front-panel connectors, while older modules do not. The universal connector system is identified by the nomenclature FREE and LOCK printed on the adapter plate inside the door of the optical connector assembly. Clean both types of connectors before connecting a fiber, and when changing connector adapters on the universal connectors.

Clean FiberMaster's old-style front-panel connector with electronics-grade isopropyl alcohol and a small lint-free swab. Insert the end of the swab into the connector, roll it gently, then blow dry using canned air.

Clean or change the universal connector system following the steps below. The tools you will need are:

- ❏ Flat-blade screwdriver
- ❏ Lint-free swab
- ❏ Pipe cleaner
- ❏ Electronics-grade isopropyl alcohol
- ❏ Optical-grade canned air

1. Lift the door of the optical connector assembly.
2. Using the flat-blade screwdriver, rotate the FREE-LOCK screw in either direction until it is aligned vertically with the FREE position, then rotate it back to the LOCK position. This releases the connector from the universal interface assembly.

3. Unscrew the connector by holding it around the connector knurling and turning it counterclockwise until it rotates freely. Remove the connector.
4. Dampen the pipe cleaner with alcohol and draw it through the connector barrel.
5. Dampen a lint-free swab with alcohol and swab the ferrule. The ferrule must be clean, otherwise it can deposit dirt into the optical connector.
6. Blow dry the connector barrel and the ferrule with canned air.
7. Dampen a second lint-free swab with alcohol and gently roll it over the end of the fiber. Do not scrub; this can scratch the polished end.
8. Gently blow dry the fiber end with canned air.
9. Replace the connector over the universal interface. Applying light pressure, rotate the connector barrel (the end of the connector) until it locks in the keyed position.
10. Screw the connector back in by holding it around the connector knurling and turning it clockwise until finger tight.
11. Using the screwdriver, turn the FREE-LOCK screw to align it vertically with the FREE position.
12. Push the connector assembly into the module until it stops. While holding the connector in, rotate the FREE-LOCK screw back to the LOCK position. Release the connector.

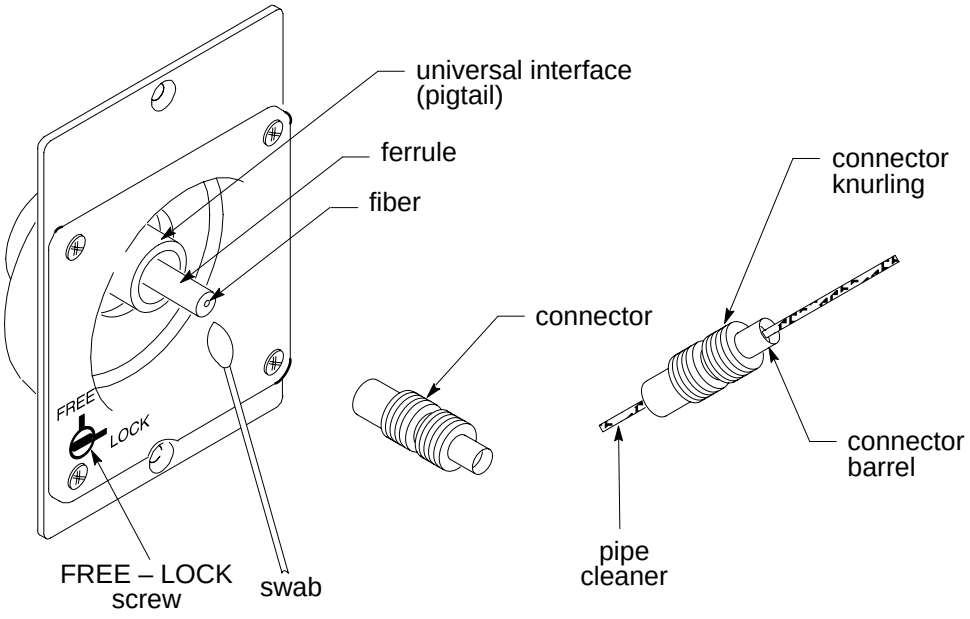


Figure 1-9. Cleaning and Changing the Universal Connector

Fuses, Filters, and Batteries

There are no fuses, filters, or batteries in the FiberMaster that can be changed or maintained by the user.

2 Controls, Indicators, and Connectors

The functions of FiberMaster's controls, indicators, and connectors are described in this chapter. Figures 2-1 and 2-2 illustrate their locations.

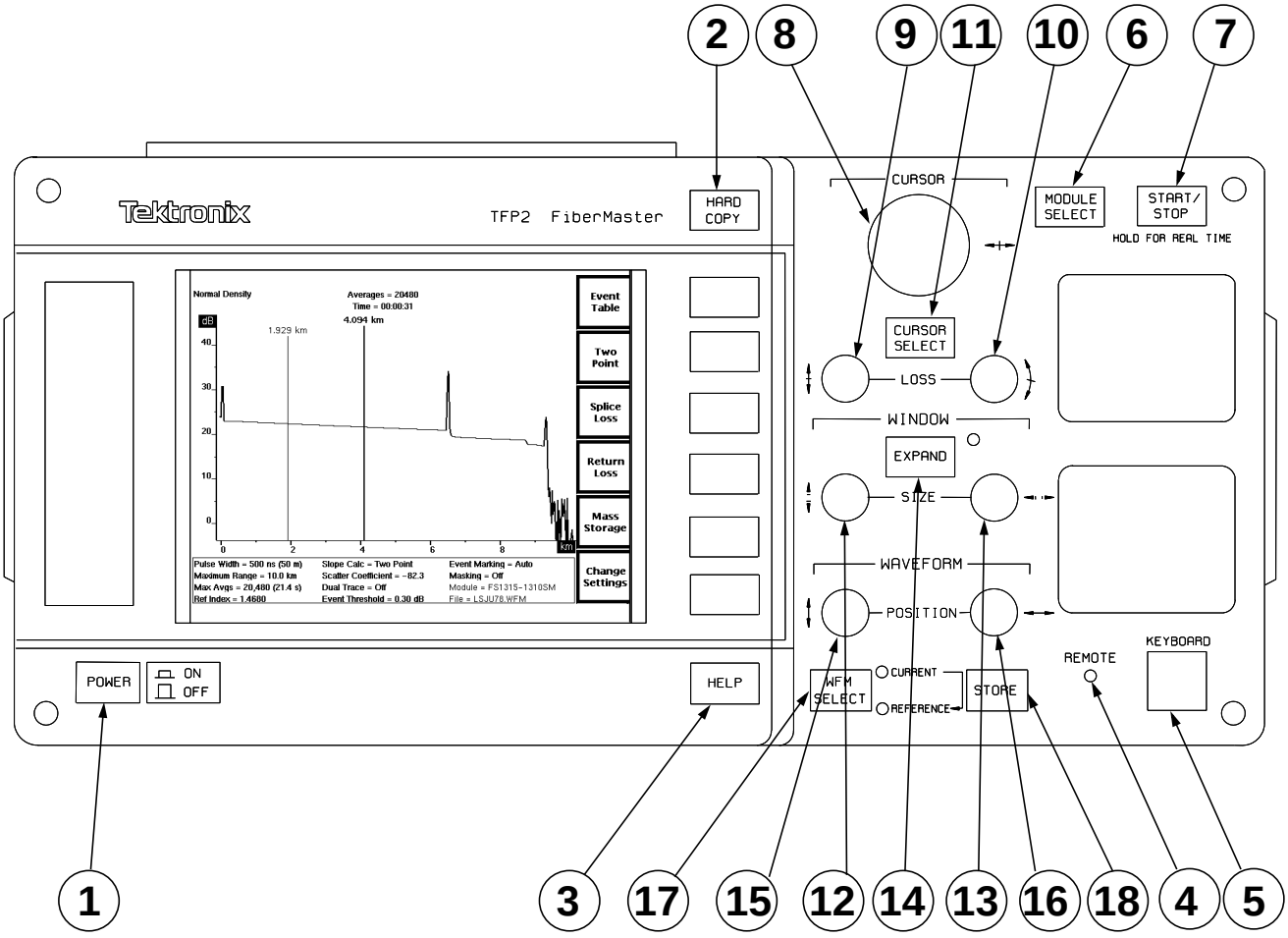


Figure 2-1. FiberMaster Front-Panel Controls, Indicators, and Connectors

General Controls, Indicators, and Connectors

(1) **POWER** - Pushing this button in turns on FiberMaster and starts the power-on sequence of self tests and displays. (The power-on sequence is described in chapter 3, *Getting Started*.) Pushing the **POWER** button a second time turns off power to the FiberMaster.

To quick-start the instrument, push the **POWER** button while holding down the **START/STOP** button. Release the **START/STOP** button after you see the message **Starting operating system...** on the instrument screen. Quick-start makes the instrument bypass the power-on diagnostics, causing the start-up screen to appear faster.

Do not quick-start your instrument every time it is powered on. Allow the instrument to run the power-on diagnostics periodically to detect any malfunctions that might have occurred.

(2) **HARD COPY** - When you push this button, the current contents of the display are printed on the printer selected on FiberMaster's System Settings menu. This device could be, for example, the internal printer, an external GPIB plotter, a serial plotter, or a serial printer. (Refer to chapter 3, *Getting Started*, for instructions on using FiberMaster's menu system.)

A printer (either internal or external) produces waveform prints when an acquisition is displayed on the screen and you press the **HARDCOPY** button. When any other screen is displayed (i.e., a menu screen), the printer produces a hard copy of the screen.

The external plotters (RS232 or GPIB) only produce waveform plots. If you press the **HARDCOPY** button when any screen *other* than an acquisition screen is displayed, a beep sounds to indicate that no plot will be made.

If you use an external GPIB plotter or printer, pressing the **HARDCOPY** button causes the instrument's GPIB status to reset temporarily to talk only, for the duration of the plot. When the hard copy finishes, the instrument automatically switches back to the original GPIB status setting. (Refer to chapter 3, *Getting Started*, for information on setting GPIB settings.)

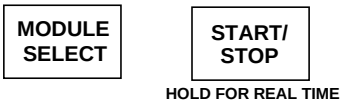
Waveform prints include the date and time the acquisition was started, the measurement mode used, and the current instrument settings. If the acquisition screen was in dual trace mode, instrument settings for both waveforms are printed. Whether the screen includes user-adjusted measurements or high-density data is also noted on the printout, as well as the actual number of averages performed and the elapsed acquisition time. The fiber ID, notes, and operator's name are also printed, as entered on the Operator Settings menu.

③ **HELP** - Push the **HELP** button to read help information on the current operation being performed by FiberMaster. For example, if the instrument is in Splice Loss mode, pressing the **HELP** button lets you read explanations on splice-loss measurement and the functions of the front-panel controls in Splice Loss mode. In the menu system, pressing the **HELP** button displays information about the currently selected setting.

④ **REMOTE** - When lighted, this indicator shows that FiberMaster is under remote control via GPIB.

⑤ **KEYBOARD** - Connector for an optional keyboard. Connect any IBM-AT-compatible keyboard to FiberMaster to duplicate the front-panel controls. Keyboard sequences recognized by the instrument are listed in appendix B. The keyboard must be plugged into the instrument before you turn on the power.

Optical Output Controls



6 **MODULE SELECT** - Pushing this button selects the laser source. On the power-on screen, press this button to cycle through all available optical modules. On the acquisition screen, however, when you press the **MODULE SELECT** button, the following message displays:

Press START/STOP to acquire new data.

Press **MODULE SELECT** to cycle through all installed modules until you reach the desired wavelength. Each time you push the button, the next available laser source is selected, wrapping from the bottom laser to the top. The corresponding indicator lights up to show which laser is currently selected. After making your selection, press the **START/STOP** button. A new acquisition is started, using the new wavelength.

The module parameter in the list of settings at the bottom of the acquisition screen shows which laser source is selected. The type of module is shown, plus the current wavelength. For example, **FS1315-1310SM** indicates that the 1310-nm wavelength of a dual-wavelength singlemode FS-type optical module is currently selected. If the active module is different from the one used to acquire the current waveform, the module parameter is highlighted until you start a new acquisition.

The module parameter may include alphabetical characters to indicate the modification level of the module, and whether the module has an internal fiber with a non-standard core diameter. This information is appended to the wavelength. Lower-case letters indicate the modification level of the module, and upper-case letters stand for a non-standard core diameter. For example:

FS1315-1310SM — standard module with standard core diameter
FS1315-1310SMaA — modified module with non-standard core diameter
FS1315-1310SMA — standard module with non-standard core diameter
FS1315-1310SMa — modified module with standard core diameter

For more information on module modifications and internal fiber core diameters, in the U.S. and Canada, call 1-800-833-9200, or contact your local Tektronix representative.

Five settings are specific to each laser source. These are pulse width, maximum range, refractive index, scattering coefficient, and masking type (refer to the following chapter for details on instrument settings and configuration). When you change laser sources, the values of these settings last used with the selected laser are recalled. The power-on defaults for the selected laser are used if no other parameter values have been specified.

The power-on defaults for these five settings remain in effect until changed on the User Defaults menu, or if you install a different type of optical module. When you install a new optical module, the factory defaults for each laser are used, unless the new module is the same type as the module that was removed. In this case, the previously defined defaults are retained and recalled for the new module's laser(s).

If the pulse width, maximum range, or masking type changes when you change laser sources, the parameter is highlighted in the list of waveform settings at the bottom of the acquisition screen. This indicates that the new value of the setting is different from the one used to acquire the current waveform. When you press **START/STOP** to acquire data using the new laser selection, the highlighted setting values are used and the highlighting is cleared. The refractive index and scattering coefficient do not require a new acquisition in order to take effect.

7 **START/STOP** - Pressing this button once begins an averaged waveform acquisition in current memory. The acquisition is for the complete fiber as defined by the current maximum-range setting.

If the active distance cursor is on the waveform when a new acquisition is started, the new acquisition has the same starting point as the previous acquisition. If the active distance cursor is not on the waveform when the **START/STOP** button is pressed, the waveform is centered around the active distance cursor, unless limited by the maximum range. (In these cases, the waveform is acquired against either the rightmost or leftmost limit of the maximum range.)

An averaged acquisition stops when the selected number of averages is complete. If an acquisition is in progress, pushing the **START/STOP** button stops it.

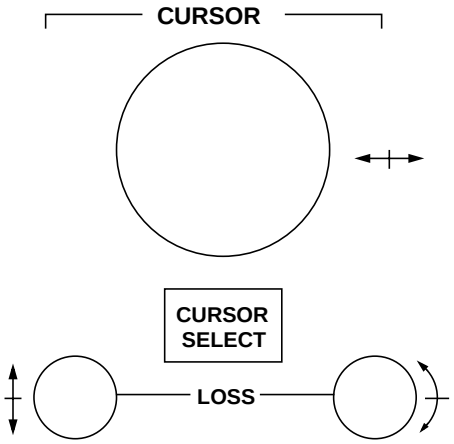
(The maximum-range setting and averaging time are selected on the Waveform Settings menu. Refer to chapter 3, *Getting Started*, for information on setting parameters.)

If you expand a waveform so that only 100 data points are displayed (by pressing the **EXPAND** button, or turning the horizontal **SIZE** knob), pressing the **STOP/START** button starts a high-density acquisition.

Pushing and holding the **START/STOP** button for two seconds starts a real-time acquisition. In real time, the maximum-averages parameter is ignored, and waveforms are acquired and displayed as rapidly as possible. To stop a real-time acquisition, press the **START/STOP** button again. In real time, the instrument automatically enters Two Point mode.

(Refer to chapter 6, *Advanced Operating Functions*, for more information on high-density and real-time acquisitions.)

Cursor Controls



8 **CURSOR** - Turn the **CURSOR** knob to move the active distance cursor along the displayed waveform to any point where you want a measurement. One distance cursor is displayed in Splice Loss and Event Return Loss modes, and two in Preview, Two Point, and Link Return Loss modes. The distance from FiberMaster's front panel is shown at the top of each cursor. (When two distance cursors are displayed, the **CURSOR SELECT** button allows you to choose which one is active.)

In the menu system, use the **CURSOR** knob to select parameter values, and to enter alphanumeric characters.

9 Vertical **LOSS** - This knob (the left-hand **LOSS** knob) is active in Two Point, Splice Loss, Link Return Loss, and Event Return Loss modes, and allows you to adjust loss measurements manually. Turning the vertical **LOSS** knob moves the active loss cursor up and down. When you turn the knob, the active loss cursor is automatically elongated to make manual adjustments easier in the noise (except when using LSA slope calculation method).

To adjust a loss cursor in noise, move it until there are an equal number of noise spikes above and below the cursor. Use the slope **LOSS** knob to match the cursor slope to the signal slope.

When using the LSA slope-calculation method, the vertical **LOSS** knob vertically positions the loss cursor, maintaining the same slope.

In Two Point mode (using the two-point slope-calculation method) and in Link Return Loss mode, the active loss cursor is the one on the active distance cursor, selected using the **CURSOR SELECT** button. In Splice Loss and Link Return Loss modes, there is one distance cursor and two loss cursors. Select the active loss cursor using the **CURSOR SELECT** button.

10 Slope **LOSS** - This knob (the right-hand **LOSS** knob) is active in Two Point, Splice Loss, Link Return Loss, and Event Return Loss modes, and allows you to rotate the active loss cursor manually to match the slope of the signal.

When you turn the slope **LOSS** knob, the active loss cursor is automatically elongated to make manual adjustments easier (except when using the LSA slope calculation method).

When using the LSA slope calculation method, the slope **LOSS** knob rotates the LSA loss cursor around the point where it touches the active distance cursor.

In Two Point mode (using the two-point slope-calculation method) and Link Return Loss mode, the active loss cursor is the one on the active distance cursor, selected using the **CURSOR SELECT** button. In Splice Loss and Event Return Loss modes, there is one distance cursor and two loss cursors. Select the active loss cursor using the **CURSOR SELECT** button.

Refer to chapter 3, *Getting Started* for information on selecting the type of slope calculation used in Two Point mode.

11 **CURSOR SELECT** - Push this button to select the active cursor. You can control the active cursor using the cursor-control knobs. The active cursor is also displayed at higher intensity to differentiate it from the inactive cursor.

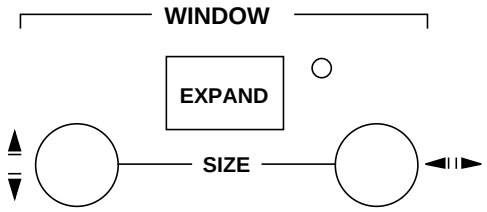
In Preview, Two Point, and Link Return Loss modes, which have two distance cursors, the **CURSOR SELECT** button controls which of two distance cursors is active.

In Preview, Two Point, and Link Return Loss modes, the **CURSOR SELECT** button also offers a “join cursors” function. Press and hold the **CURSOR SELECT** button to move the inactive cursor to the same location as the active cursor.

In Splice Loss and Event Return Loss modes, there is one distance cursor and two loss cursors. The **CURSOR SELECT** button selects which loss cursor is controlled by the **LOSS** and **SLOPE** adjustment knobs. Pressing and holding the **CURSOR SELECT** button in Splice Loss and Event Return Loss modes joins the loss cursors—the inactive loss cursor is placed at the same vertical position and extends along the same slope as the active cursor.

In both overview and expanded view, if the inactive cursor is off the screen when you press **CURSOR SELECT**, the view switches to show both cursors on the screen if possible. If the cursors are not close enough to each other to display both, the view is centered around the new active cursor.

Window Controls and Indicators



12 Vertical **SIZE** - In overview, turn this knob to expand and contract the expansion window vertically. In expanded view, the area defined by the expansion window fills the waveform viewing area—in this mode turning the vertical **SIZE** knob expands and contracts the waveform itself vertically.

In expanded view, dual-trace mode, the vertical **SIZE** knob operates on both the current and the reference waveforms simultaneously. Each waveform expands and contracts around the point where it intersects the active distance cursor.

13 Horizontal **SIZE** - In overview, turn this knob to expand and contract the expansion window horizontally. In expanded view, the area defined by the expansion window fills the waveform viewing area—in this mode turning the horizontal **SIZE** knob expands and contracts the waveform itself horizontally.

If the waveform is expanded to display only 100 data points, you are prompted to press the **START/STOP** button to obtain high-density data. Refer to chapter 6, *Advanced Operating Functions*, for details on using the expansion window with high-density data acquisition.

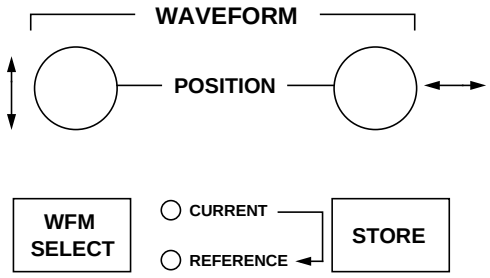
In expanded view, dual-trace mode, the horizontal **SIZE** knob operates on both the current and the reference waveforms simultaneously. Each waveform expands and contracts around the point where it intersects the active distance cursor.

⑭ **EXPAND** - Pressing this button switches between expanded view and overview display modes. Overview displays the complete waveform as defined by the maximum range setting, which is set on the Waveform Settings menu. The amount of expansion displayed in expanded view is defined by the dimensions of the expansion window, which is adjusted using the **SIZE** knobs, as described above. The indicator next to the **EXPAND** button lights when the display is in expanded view.

If the waveform is expanded to display only 100 data points, you are prompted to press the **START/STOP** button to obtain a higher sample density. Refer to chapter 6, *Advanced Operating Functions*, for details on using the expansion window with high-density data acquisition.

Note: in expanded view, expanding the waveform using the **SIZE** knobs has the effect of shrinking the expansion window. Shrinking the waveform in expanded view is the same as enlarging the expansion window. The effect on the size of the expansion window can be seen when you return to overview.

Waveform Controls and Indicators



15 Vertical **POSITION** - Turn the left-hand **POSITION** knob to move the active waveform up and down on the display.

When dual-trace mode is on, the vertical **POSITION** knob operates only on the active waveform.

16 Horizontal **POSITION** - Turn the right-hand **POSITION** knob to move the active waveform right and left on the display.

In both overview and expanded view, horizontal movement is limited to half the maximum range in either direction.

When dual-trace mode is on, the horizontal **POSITION** knob operates on both the current and the reference waveforms simultaneously.

17 **WFM SELECT** - Press this button to select which of two waveforms displays. The two waveforms are the current acquisition from current memory, and the reference waveform from reference memory.

When dual trace is on, both waveforms display at once. The active waveform is highlighted, and can be moved and used for measurements. If you turn dual trace off, the active waveform is the only one displayed. The indicator light next to the **WFM SELECT** button shows which waveform is currently active.

For information on setting the dual-trace parameter, refer to chapter 3, *Getting Started*. Details on using dual trace are given in chapter 6, *Advanced Operating Functions*.

When dual trace is on and both the current and reference waveforms are displayed, the dB scale is that of the active waveform. The difference between the scales of the active and inactive waveforms is displayed at the top of the vertical scale. To align the two waveforms vertically, press and hold the **WFM SELECT** button. The inactive

waveform moves to the same scale as the active waveform, and the difference in the scales displays as 0 dB.

When dual trace is off, and the view is in overview, pressing and holding the **WFM SELECT** button zeros the waveform's position—it is moved so that 0 dB is at the bottom of the vertical scale and 0 kilometers (or kilofeet) is at the left of the horizontal scale.

18 **STORE** - Press this button to store the current waveform and associated instrument settings into reference memory. The previous contents of reference memory are overwritten. In addition to instrument settings, the date and time the acquisition was started, the actual elapsed acquisition time and number of averages, high-density data, and any user-adjusted measurements are saved into reference memory.

Connectors

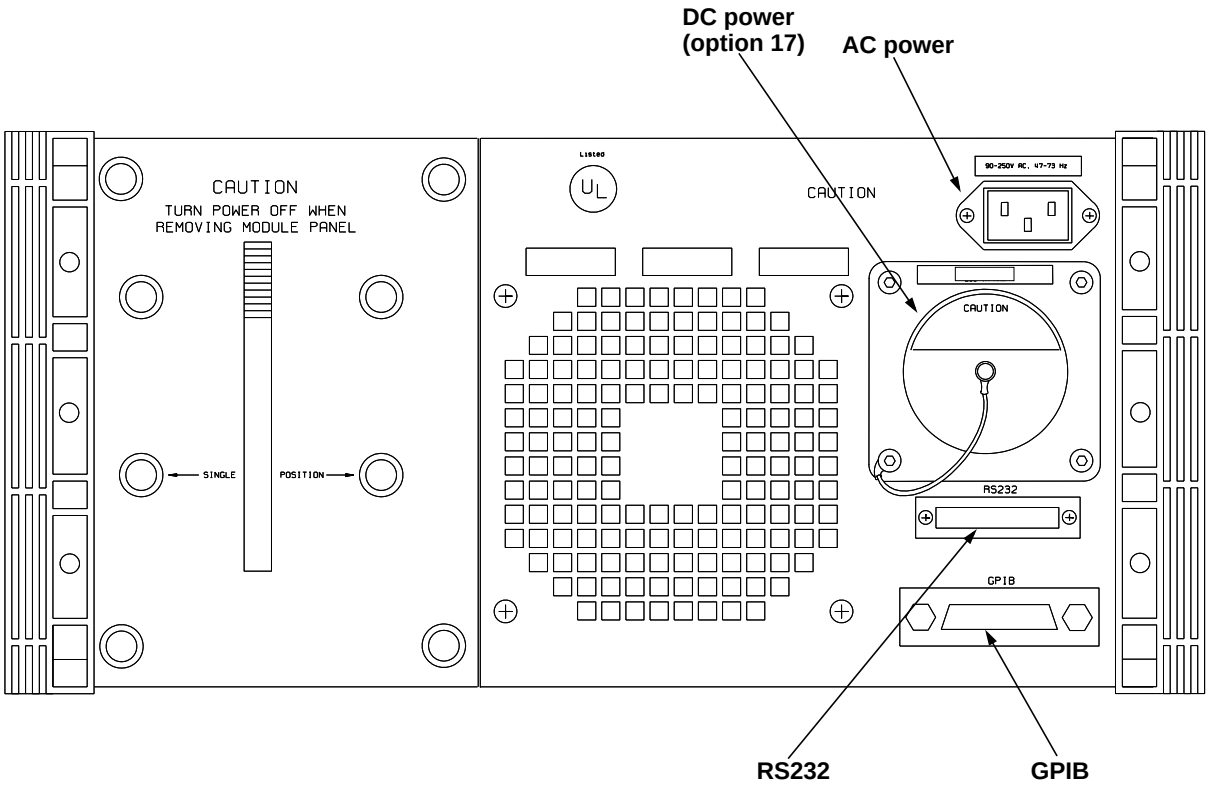


Figure 2-2. FiberMaster Rear-Panel Connectors

3 Getting Started

This chapter describes how to get started using the FiberMaster OTDR, including how to display the online help available in the instrument, and how to set up the instrument to your specifications. Power-on default settings are also listed in this chapter.

Powering On FiberMaster and Connecting a Fiber

Turn on the instrument by pressing the **POWER** button. A brief initialization period follows, during which the following sequence occurs:

1. The Tektronix logo and name of the instrument are displayed on the screen, indicating that the display processor is working properly.
2. The display processor and the main processor perform self-tests on ROM, RAM, and major circuits.
3. The start-up screen appears. The options installed in the instrument are listed on the start-up screen. The instrument's firmware version is displayed in the upper right-hand corner. If any power-on self tests fail, the results are displayed on the screen, and a **Self Test** softkey displays. This softkey allows access to a Diagnostics menu that gives more information on the power-on test that failed. (The Diagnostics menu is described in appendix D).

NOTE *If any power-on self tests fail, the start-up screen fails to display, or the instrument does not power on, contact your Tektronix representative, or telephone toll-free in the U.S. and Canada* **1-800-TEK-WIDE ext. 2400***.*

4. Press the **MODULE SELECT** button to select a laser source if more than one laser source is available on your instrument.
5. The instrument's waveform settings are displayed at the bottom of the start-up screen. You can change setting values from those displayed by pressing the **Change Settings** softkey. Instructions on configuring your instrument are given in this chapter. If you enter the menu system from the start-up screen, the acquisition screen displays when you exit the menus.
6. Connect a fiber to FiberMaster in one of two ways: 1) directly, using a mating connector plug to match the front-panel connector, or 2) indirectly via an optical interface cable.
7. Start an acquisition by pushing the **START/STOP** button. When you press **START/STOP**, the start-up screen is replaced by the acquisition screen.

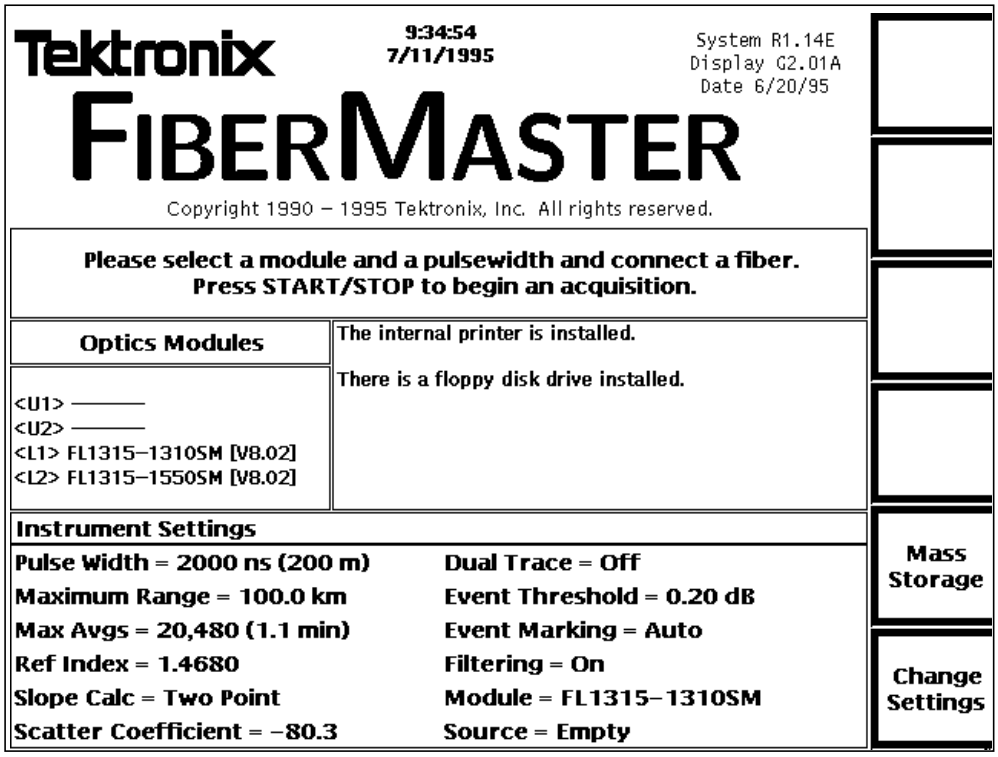


Figure 3-1. FiberMaster Start-Up Screen

WARNING *Avoid eye exposure to laser output and open-ended fibers by covering the end or directing the output at a non-reflective surface.*

The TFP2A FiberMaster has been classified as a Class 1 laser product under the Radiation Control and Health Safety Act of 1968.

CAUTION *Keep the optical output connectors and the connector plugs clean at all times. Dust and dirt affect the optical output power. Cover the connectors when not in use.*

Quick Start

You can shorten the power-on process using the quick-start feature. Quick-start your instrument by holding down the **START/STOP** button while you press the **POWER** button. This makes the instrument to bypass power-on diagnostics, causing the start-up screen to come up faster.

NOTES *When quick-starting your instrument, release the **START/STOP** button as soon as you see the message **Starting operating system...**. If you are still holding down **START/STOP** at the time the start-up screen appears, an acquisition is started and the laser starts firing.*

Do not quick-start your instrument every time it is powered on. Allow the instrument to run the power-on diagnostics periodically to detect any malfunctions that might have occurred.

Mass Storage

A **Mass Storage** softkey displays on the start-up screen. Press this key to go into the mass-storage menu system, if you want to load waveform and settings files into the instrument from floppy disk (or the optional internal RAM). You can also perform save, delete, and format operations in the mass-storage system. Refer to chapter 7, *Mass Storage*, for instructions on how to use this system. If you enter the mass-storage system from the start-up screen, the acquisition screen displays when you exit.

Power-On Defaults

FiberMaster's factory-set power-on settings are as follows:

❑ Display mode*	Overview
❑ Measurement mode*	Preview
❑ Wavelength	Top laser in bottom module
❑ Expansion window size*	20% of screen width (limited by waveform length) and 50% of screen height
❑ Pulse width	850 MM = 2 m; 1300 MM = 50 m; 1310 SM = 200 m; 1550 SM = 200 m
❑ Maximum range	850 MM = 4 km; 1300 MM = 10 km; FS/FG series: 1310 SM = 50 km; 1550 SM = 50 km; FL series: 1310 and 1550 SM = 100 km
❑ Maximum no. of averages	20,480
❑ Refractive index	850 MM (62.5 µm core diameter) = 1.4776; 1300 MM (62.5 µm core diameter) = 1.4719; 1310 SM = 1.4680; 1550 SM = 1.4685
❑ Slope calculation*	Two point
❑ Scattering coefficient	850 MM (62.5 µm core diameter) = -62.3; 1300 MM (62.5 µm core diameter) = -69.7; 1310 SM = -80.3; 1550 SM = -82.3
❑ Dual trace*	Off
❑ Event threshold	0.20 dB
❑ Event marking	Auto
❑ Masking type	Off (applicable only to FS-series 1310 nm SM and 1550 nm SM modules)
❑ Filtering	On (applicable only to FL-series modules)
❑ Fiber ID*	Blank
❑ Operator*	Blank
❑ Fiber notes*	Blank
❑ Language[1]	English
❑ Display intensity	Medium
❑ Display color	Color
❑ Sound	On
❑ Date format	M/D/Y
❑ Units	Metric
❑ Keyboard translation	USA
❑ File format	TFP2
❑ Hardcopy device	Internal if printer option installed. If not, RS232 Epson
❑ GPIB status*	Online
❑ GPIB address[2]	7
❑ RS232 baud rate	9600 bits per second
❑ RS232 parity	None
❑ RS232 stop bits	1
❑ RS232 data bits	8
❑ RS232 flow control	XON/XOFF

* The settings marked with an asterisk are always reset to the initial factory-set values at power on. For example, every time you turn on the instrument, it enters Preview mode. User-selected power-on defaults can be defined for the remaining settings (except GPIB address) via the User Defaults menu, described later in this chapter. Until you specify a user-defined default, the factory default is used as the power-on default.

[1] When you change languages, the newly selected language is automatically saved as the power-on default.

[2] The GPIB address is factory set to 7. The power-on default is always the value last used.

Using FiberMaster's Online Help

FiberMaster's online help system consists of pop-up windows that overlay the screen when you press the **HELP** button. These windows provide brief information on the current display.

When you are making measurements on a fiber, the current measurement mode is described on the screen that appears when you press the **HELP** button. You can also read help on how the controls function in the current mode by turning the knobs and pushing the buttons. Each action brings up an additional help screen that describes the function of that control.

When you are working in the menu system to configure the instrument, or to change measurement settings, the help screens describe the operation of each parameter.

Some help screens consist of multiple pages. Turn the **CURSOR** knob to scroll from page to page on mutiple-page help screens.

From any help screen, to end the help function and return to the original display, press the **HELP** button again.

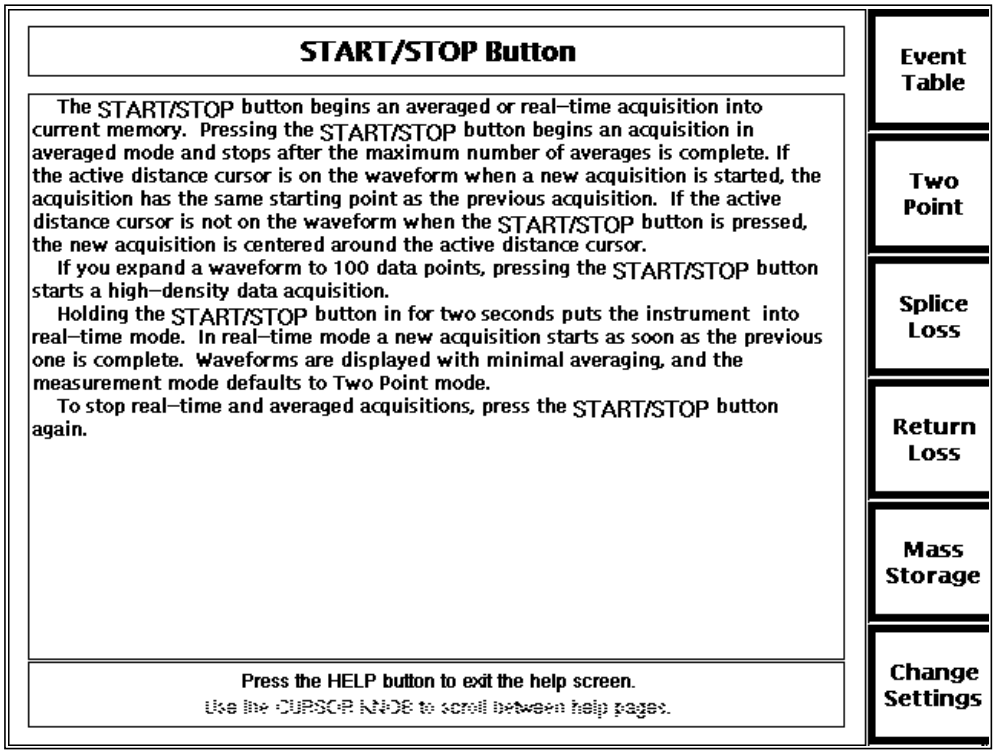


Figure 3-2. Sample Help Screen

Setting up the System

FiberMaster's operating parameters and measurement settings are controlled through a system of menus, accessed by pressing the **Change Settings** softkey from the acquisition screen. These menus and their functions are as follows:

- ❏ Waveform Settings menu - the Waveform Settings menu displays a series of pop-up selection windows used to set values for operating parameters. FiberMaster uses these settings for waveform acquisition and making measurements. They include, for example, the maximum range, pulse width, number of averages, slope calculation, and other settings.
- ❏ Operator Settings menu - allows you to enter a fiber identification string, notes, and operator identification. This information prints with the waveform when you press the **HARD COPY** button, and is saved in mass storage with the waveform or settings file.
- ❏ System Settings menu - the System Settings menu displays a series of pop-up selection windows used to set several input/output characteristics, such as RS232 and GPIB settings, and the hardcopy device. In addition, this menu allows you to set the language used, the system time and date, and display intensity and color.
- ❏ User Defaults menu - use this menu to set power-on defaults for the instrument parameters that accept user-defined defaults.
- ❏ Remote menu - the Remote menu allows serial-port data transfers. The operations available from this menu are to send, receive, and stop an XModem data transfer. Status messages display on the Remote screen during data transfers to keep you informed of operation status.

In addition to the configuration menus, if a mass-storage device or devices (floppy disk and internal RAM) are installed in your instrument, a softkey allows access to the Mass Storage menu system:

- ❏ Use the Mass Storage menu system to write and read waveform and settings data to and from disk. This system is described in detail in chapter 7, *Mass Storage*.

Entering the Menu System

To enter the menu system, from the start-up screen or from any acquisition screen, press the **Change Settings** softkey. In the menus, the softkeys are redefined and the front-panel controls function as follows:

Function	Control
Print a hard copy of the screen contents on the printer (if installed).	**HARD COPY**
Read online help**.**	**HELP**
Select parameter value, or enter numeric and alphanumeric data.	**CURSOR** knob
Begin a new acquisition or start real-time mode without exiting the current menu. (Waveform Settings menu only)	**START/STOP**
Position the waveform on the display. (Waveform Settings menu only)	**POSITION** knobs

All front-panel controls besides those listed here are not functional in the menu system.

NOTE *If you are using a keyboard to enter data on FiberMaster's configuration menus, refer to appendix B,* Keyboard Definitions*, for a list of the key sequences that duplicate front-panel controls. For the parameters that require character entry, the keyboard offers additional editing functions not available via the front-panel controls.*

Selecting Waveform Settings

Press the **Change Settings** softkey to enter the configuration menus. The Waveform Settings menu screen appears, showing the first pop-up selection window, Pulse Width. Notice that the softkeys are redefined**.** These keys let you move around within the menu system, as follows:

Next Menu - go to the next menu. For example, when working on the Waveform Settings menu, pressing the **Next Menu** softkey displays the Operator Settings menu.

Next Param - go to the next pop-up selection window. For example, after setting the pulse width, press this softkey to display the Maximum Range pop-up window. The highlighted bar on the Waveform Settings menu moves to indicate the current parameter.

Prev Param - go back to the previous parameter's pop-up selection window.

Exit - return to the acquisition screen.

The **Next Menu**, **Next Param**, and **Prev Param** softkeys repeat when held down.

When you first enter the menu system after powering on the instrument, the Pulse Width parameter on the Waveform Settings menu is the first pop-up selection window displayed. If you exit the menus, then re-enter by pressing the **Change Settings** softkey again, the instrument brings up the last Waveform Settings window that you viewed before exiting the menus.

The settings you can define on the Waveform Settings menu are:

- ❏ Pulse width
- ❏ Maximum range
- ❏ Maximum number of averages
- ❏ Refractive index
- ❏ Slope calculation
- ❏ Scattering coefficient
- ❏ Dual trace
- ❏ Event threshold
- ❏ Event marking mode
- ❏ Masking type and manual masks (if supported by the laser source—FS-series 1310 nm SM and 1550 nm SM)
- ❏ Software filtering (available only when an FL-series module is selected)

Pulse Width

Press the **Change Settings** softkey to enter the menu system. When you initially enter the menu system after power-on, the first Waveform Settings pop-up selection window, Pulse Width, displays. If the Pulse Width window is not displayed upon entering the menu system, press **Next Param** or **Prev Param** until the pulse-width parameter is highlighted on the Waveform Settings menu.

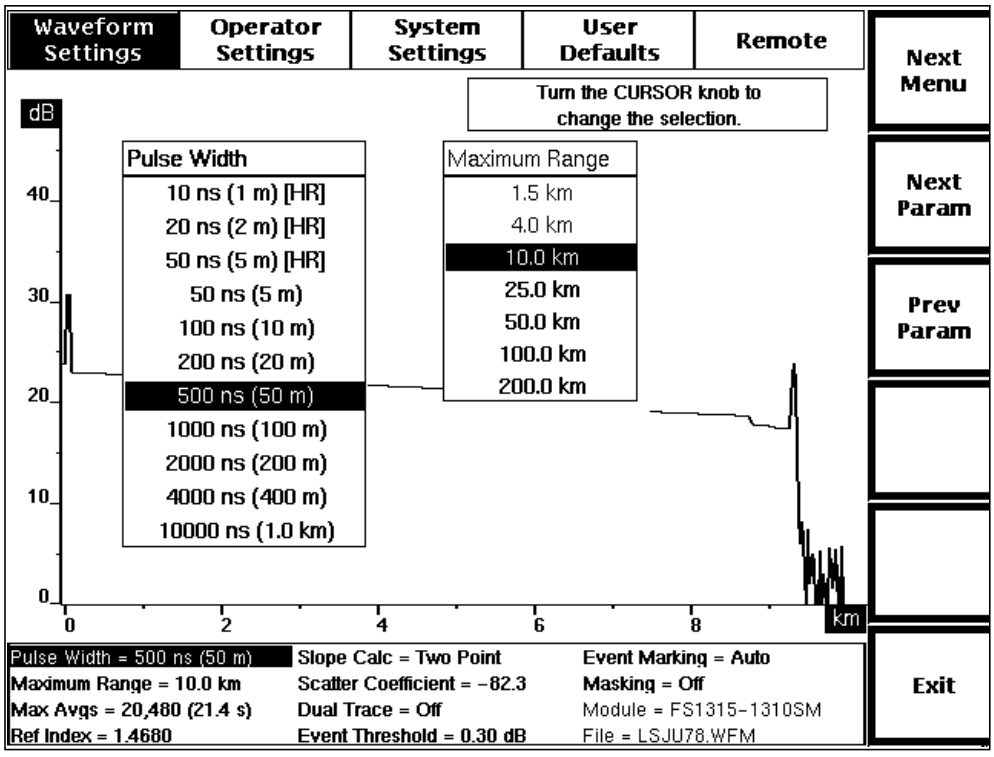


Figure 3-3. Pulse Width Pop-Up Selection Window, Waveform Settings Menu

The pulse width is the length of time the laser is on during each sampling acquisition, also measured in distance units. (A sampling acquisition is the acquisition of one set of data points on the waveform.) The current pulse-width setting is highlighted in the window. The number of pulse-width selections is defined by the laser source selected, and may change when the laser source is changed.

Pulse-width selections are also dependent on the current maximum-range setting, and vice versa. Because the two parameters are interdependent, the Maximum Range pop-up window displays next to the Pulse Width window to show the maximum-range settings that are available with the current pulse-width selection. If you change the pulse width and the current maximum-range selection is unavailable for the new pulse width, the closest available maximum-range setting is automatically selected.

Short pulse widths permit more detail to be seen over a shorter range. Use long pulse widths when you want to see more fiber, at lower resolution. The default pulse width

depends on the laser source selected: 2 meters for 850 nm MM, 50 meters for 1300 nm MM, and 200 meters for the singlemode lasers.

For the FM- and FS-series optical modules, the 1300 MM, 1310 SM, and 1550 SM modules have three high-resolution pulse widths available. They are 10 ns, 20 ns, and 50 ns pulse widths, denoted as high resolution on the menu by **[HR]**. These pulse widths offer increased distance measurement accuracy at short ranges.

Change the pulse width by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The selection of a new pulse width requires a new acquisition in order to take effect. When you press the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkey to exit the Pulse Width parameter, the pulse-width setting at the bottom of the screen is highlighted to indicate that the current setting does not match acquisition data. When you exit the menu system, the following message displays:

Press START/STOP
to acquire
new data.

Press **START/STOP** to start an acquisition using the new pulse width. The highlighting is cleared when new data is acquired, because the pulse-width setting now corresponds to the displayed waveform data. You can press **START/STOP** to start a new acquisition without exiting the menu system.

NOTE *You may notice that the acquisition range shifts when you change pulse widths. If you change from a long to a short pulse width, the range of the new acquisition may not extend from the start of the current range to the location of the active distance cursor. In this case, the new acquisition is centered around the active distance cursor.*

Maximum Range

To display the Maximum Range pop-up window, from the acquisition screen press **Change Settings**, then press **Next Param** or **Prev Param** until the maximum-range parameter is highlighted on the Waveform Settings menu.

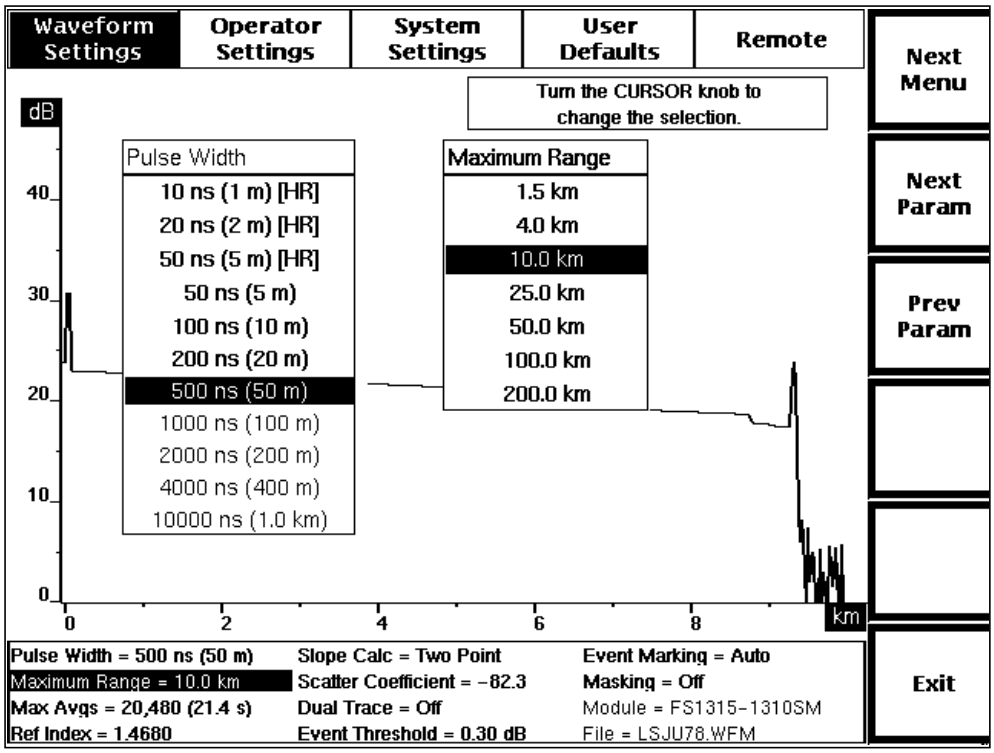


Figure 3-4. Maximum Range Pop-Up Selection Window, Waveform Settings Menu

Use the Maximum Range selection window to specify the maximum distance over which data may be acquired. The maximum range chosen is displayed as the full width of the overview acquisition screen. The available range settings are determined by the laser source you selected. This distance represents the maximum range that the acquisition can be moved down the fiber, and usually is set to the length of the fiber.

NOTE *Set the maximum range at least as long as the fiber under test, to avoid ghosting. A ghost is a reflection received from the previous sampling acquisition, caused by an event on the fiber past the end of the maximum range. The light reflected from such an event reaches the instrument's detector during the following sampling acquisition, and the reflection is averaged into the valid waveform data within the maximum range. When event marking is on, any ghosts on the waveform are marked and measured as events.*

The range selections change when you select a new laser source. The default maximum range depends on the laser source selected:

- ❏ 4 km for 850 nm MM
- ❏ 10 km for 1300 nm MM
- ❏ 50 km for 1310 and 1550 nm SM, FS-series modules
- ❏ 100 km for 1310 and 1550 nm SM, FL-series modules

The maximum-range selections are also dependent on the current pulse-width setting, and vice versa. Because these two parameters are interdependent, the Pulse Width pop-up window displays next to the Maximum Range window to show the pulse-width settings that are available with the current maximum-range selection. If you change the maximum range, and the current pulse width is unavailable for the new range, the closest available pulse-width setting is automatically selected.

Change the maximum-range setting by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

Spacing between data points changes for the longest maximum range settings. When the maximum range is set to 160 km or less, data points are spaced up to 10 meters apart. For maximum ranges of 200 km and above, the spacing between data points is 20 meters.

The selection of a new maximum range requires a new acquisition in order to take effect. When you press the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkey to exit the Maximum Range parameter, the maximum-range setting at the bottom of the screen is highlighted to indicate that the current setting does not match acquisition data. When you exit the menu system, the following message displays:

Press START/STOP
to acquire
new data.

Press **START/STOP** to start an acquisition using the new maximum range. The highlighting is cleared when new data is acquired, because the maximum-range setting now corresponds to the displayed waveform data. You can press **START/STOP** to start a new acquisition without exiting the menu system.

Maximum Averages

To display the Maximum Averages pop-up window, from the acquisition screen press **Change Settings**, then press **Next Param** or **Prev Param** until the maximum-averages parameter is highlighted on the Waveform Settings menu.

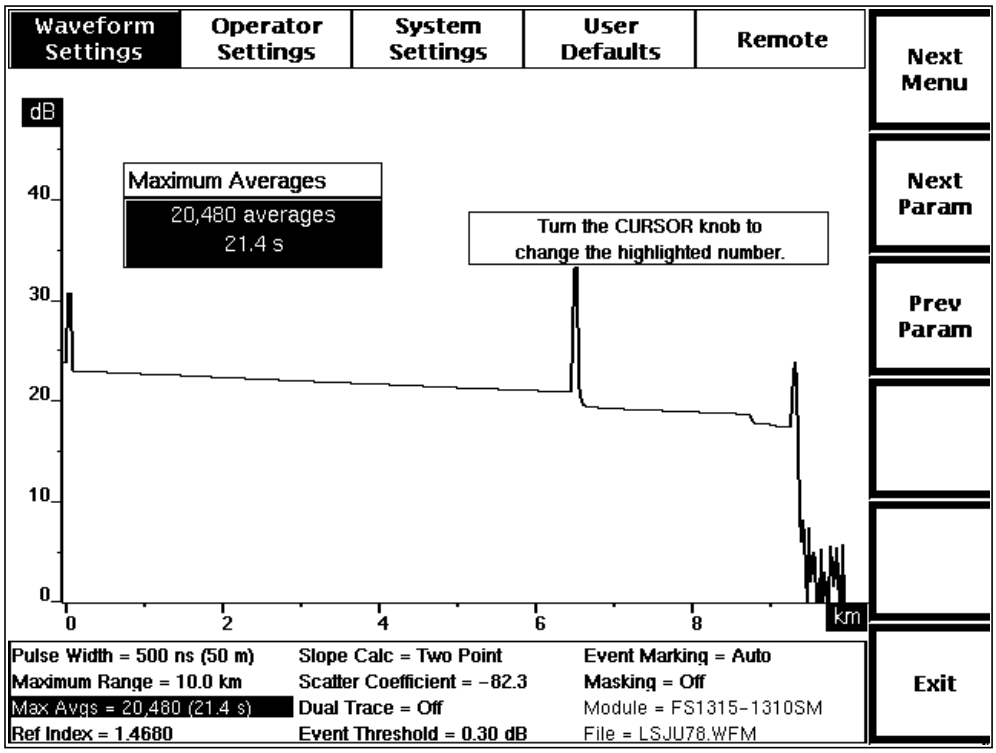


Figure 3-5. Maximum Averages Pop-Up Selection Window, Waveform Settings Menu

Use the Maximum Averages window to set the number of sampling acquisitions the instrument averages before stopping an acquisition. A sampling acquisition is the acquisition of one set of data points on the waveform, and is the same as the waveform data that would be acquired if you set the number of averages to 1.

Higher averages produce better signal to noise, but take longer to complete an acquisition. Lower averages result in faster acquisitions, but typically include more noise.

The approximate length of time required for the number of averages you select is also displayed on the menu. The time for a certain number of averages will vary, depending on the pulse-width, maximum-range, and masking-type settings. The characteristics of the fiber under test also affect the time it takes to acquire and process the waveform data.

The maximum number of averages possible is 16,777,216. The minimum is 256.

The factory-default number of averages is 20,480. You can change the power-on default using the User Defaults menu, described later in this chapter.

NOTE *The time shown is for normal-density data; a high-density acquisition would take approximately three to five times longer.*

Select the number of averages using the **CURSOR** knob. Turning the knob clockwise increases the number in minimum increments of 256. Turning the knob counterclockwise decreases the number. If you have the optional keyboard, you can use the cursor keys to do this.

The new setting is saved when you exit the Maximum Averages window by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys. If the number of averages for an acquisition in progress is greater than the new setting, the acquisition stops. Otherwise, acquisition continues until the new maximum number of averages is reached. If no acquisition is in progress, the new setting takes effect with the next acquisition.

On the acquisition screen, the actual number of averages and the elapsed acquisition time are shown at the top of the screen. These numbers are saved with the waveform when it is written to reference memory or mass storage.

Refractive Index

To display the Refractive Index pop-up window, from the acquisition screen press **Change Settings**, then press **Next Param** or **Prev Param** until the refractive-index parameter is highlighted on the Waveform Settings menu.

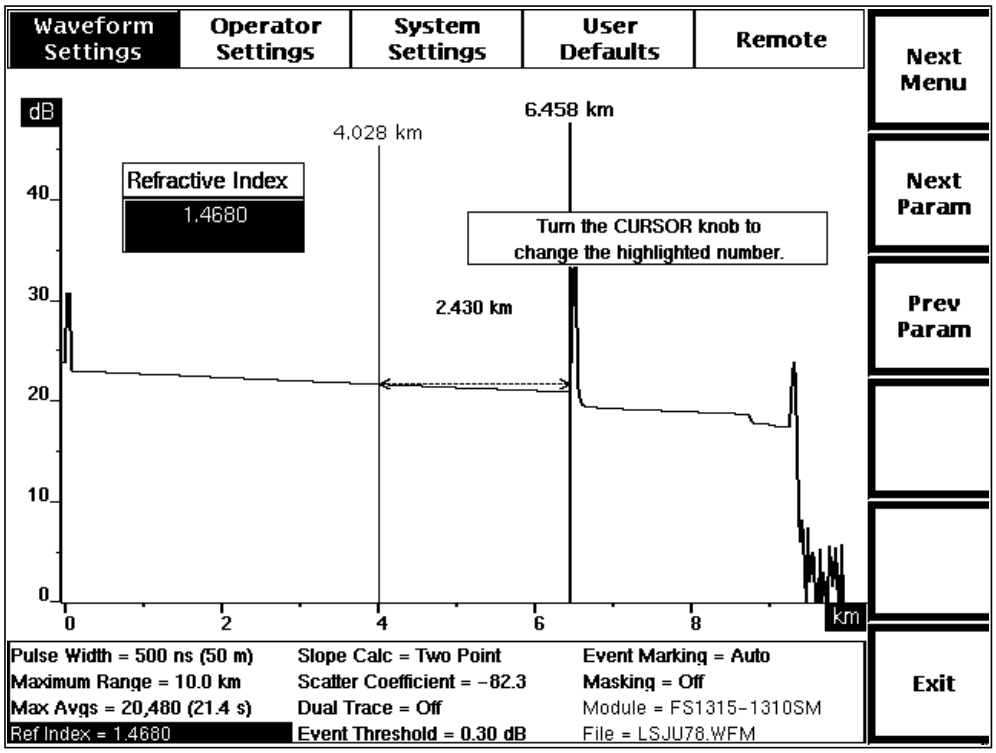


Figure 3-6. Refractive Index Pop-Up Selection Window, Waveform Settings Menu

Use the Refractive Index window to specify the refractive index of the fiber under test. You can set the refractive index to any value from 1.4000 to 1.6000, inclusive. This value is characteristic of the fiber, and can vary from fiber to fiber. The refractive index can be obtained from the fiber manufacturer. The factory-default refractive index values depend on the laser source as follows:

- ❏ 850 nm MM - 1.4776
- ❏ 1300 nm MM - 1.4719
- ❏ 1310 nm SM - 1.4680
- ❏ 1550 nm SM - 1.4685

You can set a different power-on refractive index for the currently selected laser source using the User Defaults menu, described later in this chapter.

Turn the **CURSOR** knob to increase and decrease the refractive index, in increments of the least significant digit (ten thousandths). You can also use the optional keyboard to enter the refractive index. As you type in digits from the keyboard, they are shifted to the left.

A change to the refractive index affects the distance scale and measurements. The new refractive index setting takes effect immediately, rescaling the distance measurements as you adjust the refractive index value.

Calibrating the Refractive Index

If you do not know the refractive index of the fiber under test, you can calibrate the index using a known length of fiber, or a known distance to a fiber feature. To do this, on the acquisition screen, place the active distance cursor at the end of the fiber or on the feature. Enter the Waveform Settings menu, and display the Refractive Index window. Adjust the refractive index. As the index changes, the distance measurement is rescaled. When the distance measurement matches the known distance to the fiber feature, the refractive index setting is correct.

Slope Calculation

To display the Slope Calculation pop-up window, from the acquisition screen press **Change Settings**, then press **Next Param** or **Prev Param** until the slope-calculation parameter is highlighted on the Waveform Settings menu.

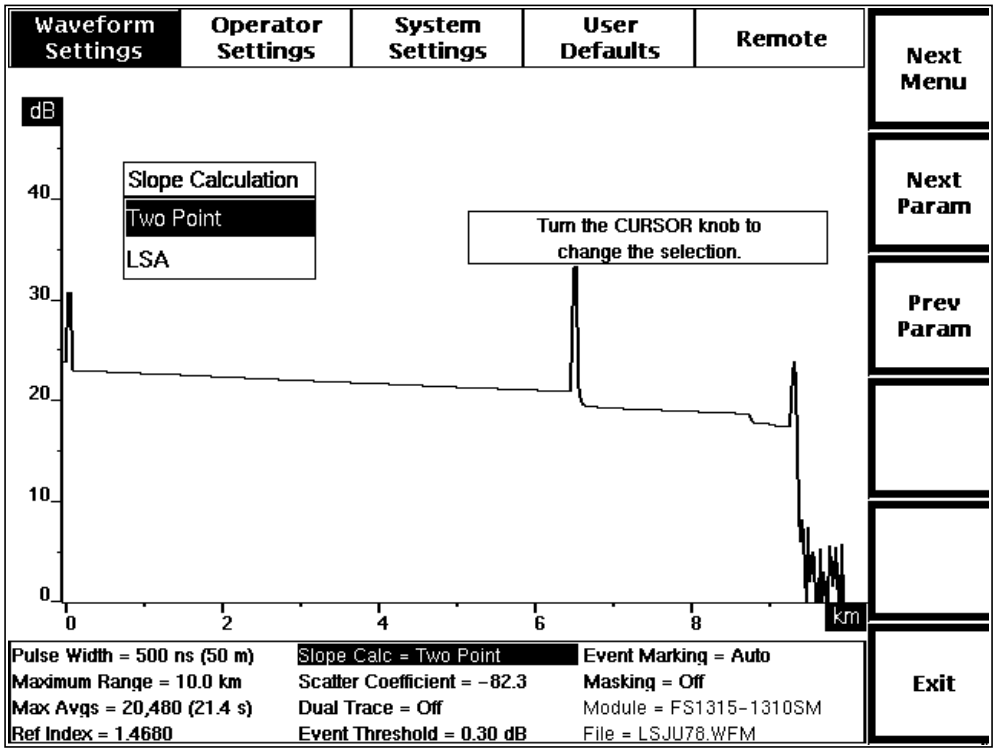


Figure 3-7. Slope Calculation Pop-Up Selection Window, Waveform Settings Menu

Use the Slope Calculation window to select the type of slope (loss per distance unit) calculation done in Two Point Mode. The **Two Point** slope setting calculates the average slope using the two-point loss and two-point distance values. The **LSA** setting fits a straight line to the data between two distance cursors using the least squares average (LSA) algorithm.

NOTE *Use the LSA slope calculation method for measuring fiber loss on featureless sections of backscatter, and the two-point method for most other two-point measurements.*

Change the slope calculation by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The new slope calculation takes effect when you exit the parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys. If the instrument was in Two Point mode before you entered the menu system, and there were no previous manual adjustments to two-point measurements, the slope is recalculated using the new method.

If two-point measurements included manual adjustments, the method of slope calculation changes, but the slope is not recalculated. The new loss cursor(s) are fitted to the existing points where the old loss cursor(s) intersected the distance cursors. In this case, you can restart two-point measurements using the new method by pressing the **Two Point** softkey.

Scattering Coefficient

To display the Scattering Coefficient pop-up window, from the acquisition screen press **Change Settings**, then press **Next Param** or **Prev Param** until the scattering-coefficient parameter is highlighted on the Waveform Settings menu.

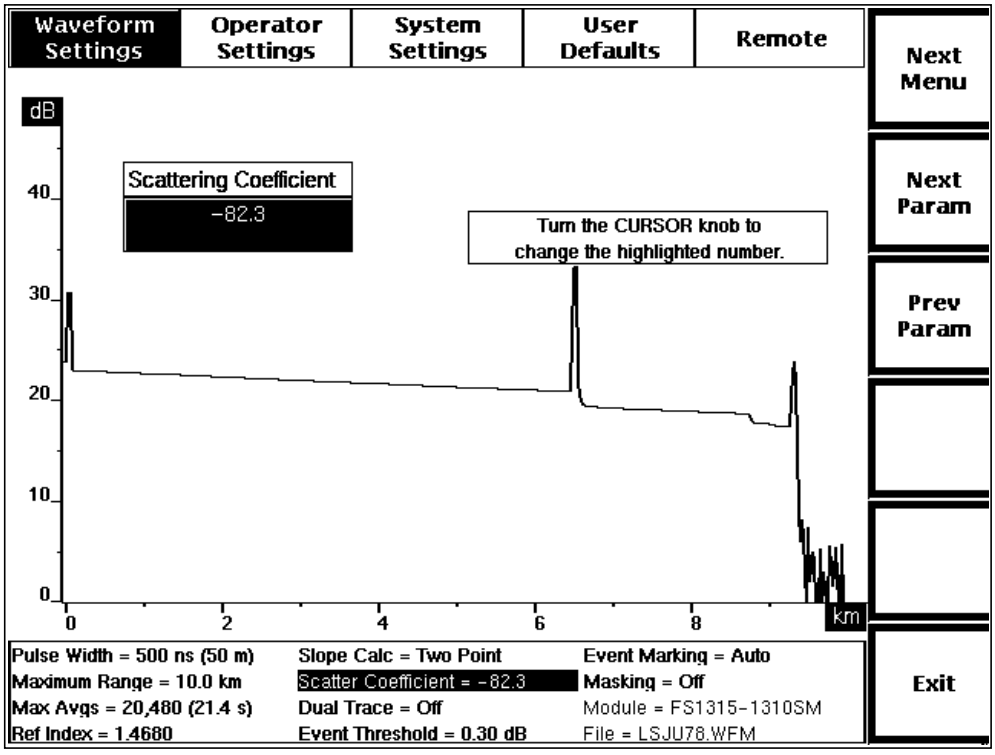


Figure 3-8. Scattering Coefficient Pop-Up Selection Window, Waveform Settings Menu

The scattering coefficient represents the amount of backscatter reflected by a particular fiber. Use the scattering coefficient to account for differences between fibers, for more accurate return-loss measurements. The scattering coefficient is a characteristic of the fiber under test and, similar to the refractive index, can vary from fiber to fiber. It is a negative number indicating the dB level of the backscattered light relative to the light entering the fiber.

NOTE *The scattering-coefficient setting applies only to return-loss measurements, and has no effect on measurements in any of the other modes.*

The scattering coefficient is based on a pulse width of 1 nanosecond, and is automatically adjusted to correspond to the pulse width used in acquiring the waveform being measured.

Use the Scattering Coefficient window to specify the scattering coefficient of the fiber under test. You can set this number to any value from -100 to -40 dB, inclusive. Turn the **CURSOR** knob to increase and decrease the scattering coefficient, in increments of the least significant digit, one-tenth dB. You can also use the optional keyboard to

enter the scattering coefficient. As you type in digits from the keyboard, they are shifted to the left.

The scattering coefficient for a particular fiber can usually be obtained from the fiber manufacturer. If you do not know the scattering coefficient, however, it is recommended that you use the factory-default values, which depend on the laser source as follows:

- ❏ 850 nm MM (62.5 μm core diameter) = -62.3 dB
- ❏ 1300 nm MM (62.5 μm core diameter) = -69.7 dB
- ❏ 1310 nm SM = -80.3 dB
- ❏ 1550 nm SM = -82.3 dB

If you do not know the scattering coefficient of a particular fiber, but the fiber includes a reflection for which the return loss is known, you can adjust the scattering coefficient by performing an event return-loss measurement on the reflection and adjusting the scattering coefficient until the return-loss value is correct.

When comparing a return-loss measurement to any previous return-loss measurements made on the same event, be sure to use the same scattering coefficient value that was used for the previous measurement.

You can set a different power-on scattering coefficient for the currently selected laser source using the User Defaults menu, described later in this chapter.

Dual Trace

To display the Dual Trace pop-up window, from the acquisition screen press **Change Settings**, then press **Next Param** or **Prev Param** until the dual-trace parameter is highlighted on the Waveform Settings menu.

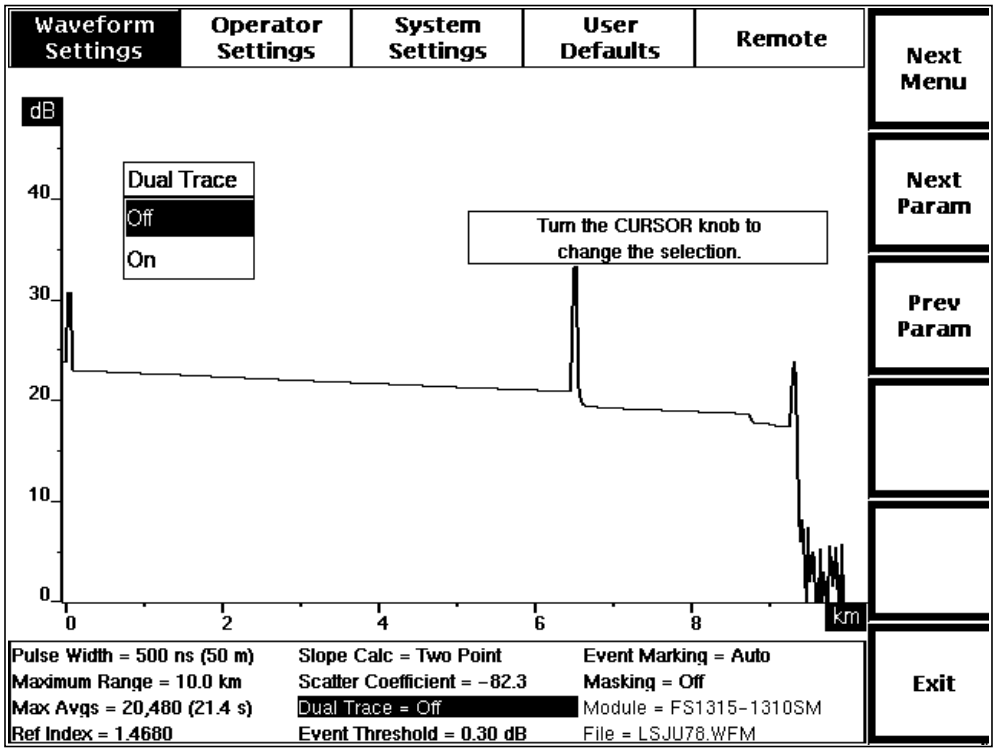


Figure 3-9. Dual Trace Pop-Up Selection Window, Waveform Settings Menu

Use the Dual Trace window to turn dual-trace mode on and off. When dual trace is on, both the current waveform and the reference waveform are displayed at the same time. The active waveform is displayed at a brighter intensity than the inactive waveform. When dual trace is off, the active waveform (selected using the **WFM SELECT** button on the front panel) is the only trace displayed. The default dual-trace setting is off.

Turn dual trace on or off by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The new display mode takes effect when you exit the dual-trace parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys.

Using dual-trace mode is discussed in more detail in chapter 6, *Advanced Operating Functions*.

Event Threshold

To display the Event Threshold pop-up window, from the acquisition screen press **Change Settings**, then press **Next Param** or **Prev Param** until the event-threshold parameter is highlighted on the Waveform Settings menu.

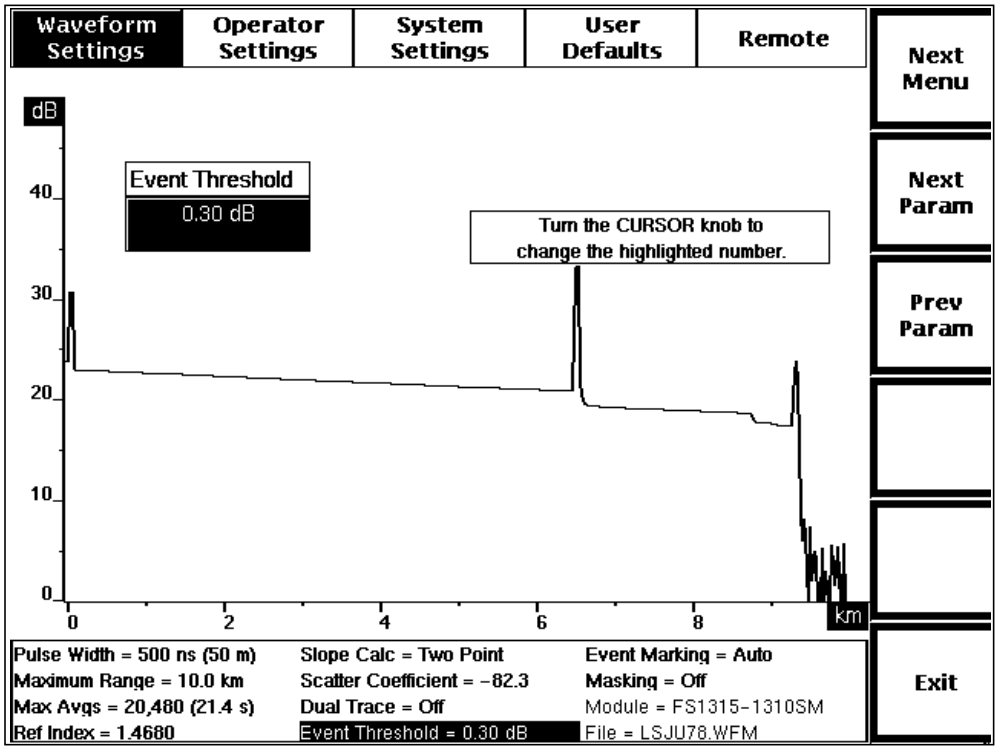


Figure 3-10. Event Threshold Pop-Up Selection Window, Waveform Settings Menu

Use the Event Threshold window to set the threshold for events that are marked when Event Marking mode is on. Only those events with splice-loss measurements that meet or exceed the threshold are included, both on the acquisition screen and on the event table.

The factory-default event threshold is 0.20 dB. You can set a different power-on event threshold using the User Defaults menu, described later in this chapter.

Turn the **CURSOR** knob clockwise or counterclockwise to increase or decrease the event threshold. The value changes in increments of one one-hundredth of a dB between 0.03 and 0.20 dB, then by five one-hundredths to a maximum value of 5.00 dB.

Event threshold minimums depend on the currently selected pulse width, as follows:

Pulse Width (meters)	Event Threshold Minimum (dB)
>400	.07
200 to 400	.05
<200	.03

Although the event threshold can be set to .03 dB, for pulse widths 200 meters or longer, the minimum threshold used is actually .05 or .07 dB.

The new setting is saved when you exit the Event Threshold window by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys. All events with splice losses that meet or exceed the new threshold are displayed, including both automatically and manually marked events.

If the new threshold is lower than the previous setting, additional event markers may be displayed on the acquisition screen and on the event table. If the new threshold is higher than the previous setting, event markers may be deleted from the acquisition screen and the event table when the new setting takes effect. In these cases, the displayed events are also renumbered.

NOTE *All marked events are displayed on the Place Event Markers screen, regardless of the event-threshold setting. The Place Event Markers screen is accessible from the Event Marking parameter window when event marking is set to* ***Manual****. In addition, all manually placed event markers are displayed regardless of the event-threshold setting, both on the acquisition screen and in the event table.*

For information on using event marking and the Place Event Markers screen, refer to chapter 5, *Event Marking*.

Event Marking

To display the Event Marking pop-up window, from the acquisition screen press **Change Settings**, then press **Next Param** or **Prev Param** until the event-marking parameter is highlighted on the Waveform Settings menu.

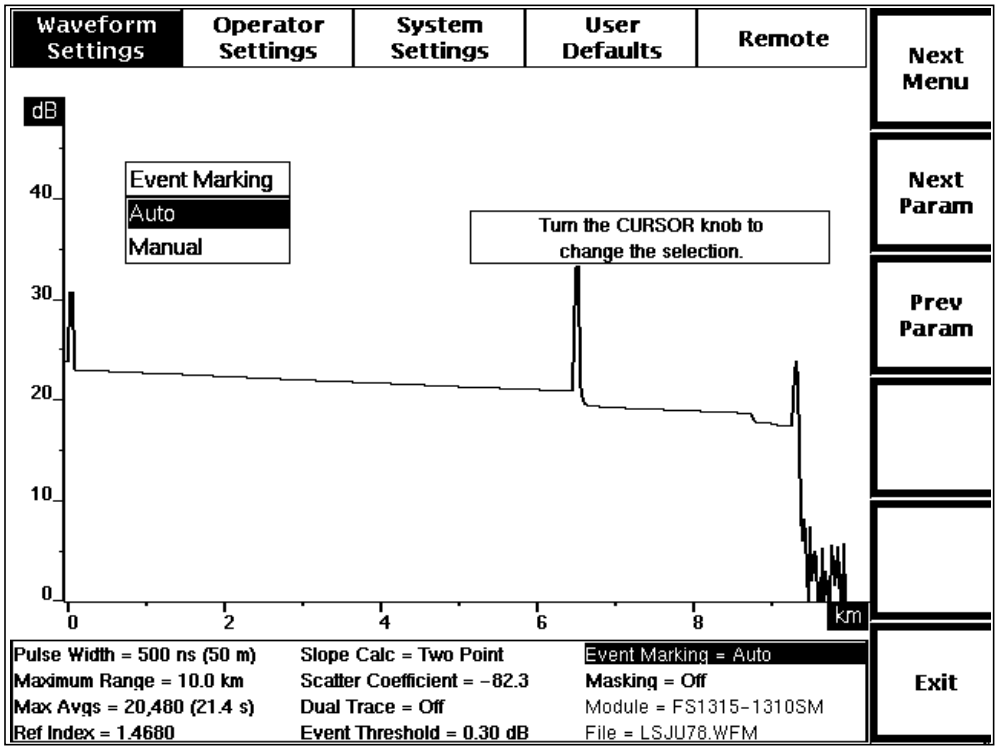


Figure 3-11. Event Marking Pop-Up Selection Window, Waveform Settings Menu

Use the Event Marking window to choose whether events on a fiber under test are automatically marked. The factory-default event-marking setting is **Auto**. You can use the User Defaults menu, described later in this chapter, to choose a different power-on default.

When event marking is set to **Auto**, all events with splice-loss measurements that meet or exceed the event threshold are automatically marked and measured on the acquisition screen and the measurements used to compile the event table. Event markers are recalculated and redisplayed with each new acquisition.

The **Manual** setting allows you to set and adjust the event markers using the Place Event Markers screen. When the manual setting is selected, an additional softkey displays on the Waveform Settings menu, **Place Markers**. This softkey gives you direct access to the Place Event Markers screen, where you can add, move, and delete event markers manually.

The **Manual** setting prevents the system from automatically locating events, but does not delete any existing markers. The markers indicate where measurements are recalculated for the event table with each new acquisition. If the new splice-loss

measurement at an existing marker is less than the current event-threshold setting, the marker is deleted from the acquisition screen and the event table, but not from the Place Event Markers screen.

When event marking is set to **Manual** and a new acquisition does not extend to all event marker locations, the event table indicates there is no data for those markers outside the acquisition range.

Instructions on placing manual event markers are given in chapter 5, *Event Marking*.

Masking Type

To display the Masking Type pop-up window, from the acquisition screen press **Change Settings**, then press **Next Param** or **Prev Param** until the masking-type parameter is highlighted on the Waveform Settings menu. This parameter is available only if the currently selected wavelength supports masking (FS-series 1310 nm SM and 1550 nm SM).

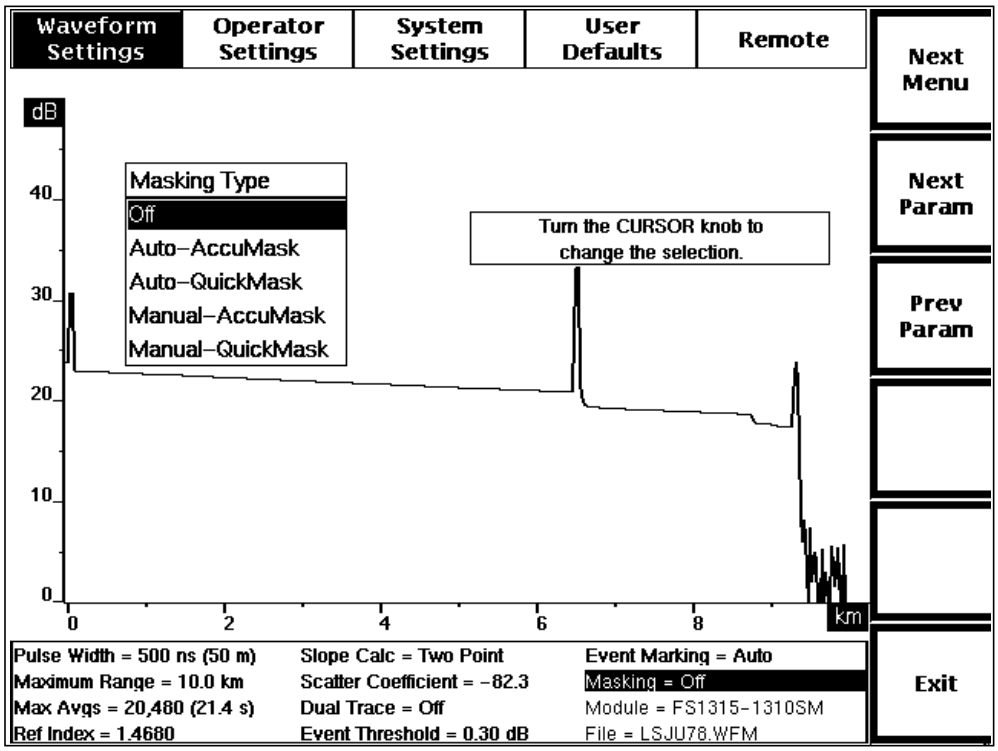


Figure 3-12. Masking Type Pop-Up Selection Window, Waveform Settings Menu

Use the Masking Type window to specify whether the reflections detected along a fiber under test are automatically masked. The factory-default masking-type setting is **Off**. You can use the User Defaults menu, described later in this chapter, to choose a different power-on default.

With **Auto** masking, the system calculates mask locations automatically.

The **Manual** masking setting allows you to set and adjust masks using the Manual Masking screen.

When one of the manual settings is selected, an additional softkey displays on the Waveform Settings menu, **Place Masks**. This softkey allows you direct access to the 7Place Manual Masks screen. In manual-masking mode, any existing masks remain unchanged from acquisition to acquisition unless adjusted or removed manually, including any automatically calculated masks from a previous **Auto** setting. (Refer to chapter 6, *Advanced Operating Functions*, for instructions on how to place masks manually.)

NOTE *The Place Manual Masks screen is available only if one of the two manual settings is selected on the Masking Type window.*

The **Off** setting turns off the masking function so no masking is done. Resetting the masking-type parameter to off and starting a new acquisition clears all masks, whether they were set automatically or manually.

You can also choose between **AccuMask** and **QuickMask** masking types, either of which can be set manually or automatically.

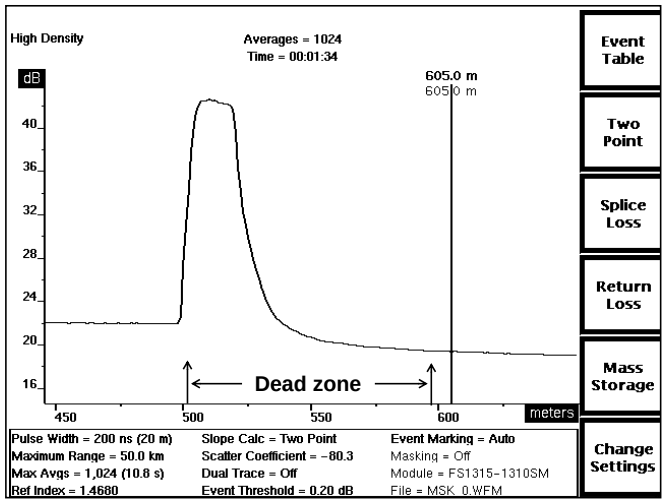


Figure 3-13. Unmasked Reflection

An example of an unmasked reflection is shown in figure 3-13 (masking type set to off). The optics hardware requires a recovery time following the reflection, resulting in "tail" following the reflection before the backscatter level is re-established.

Using QuickMask, tail is eliminated by masking the reflection. QuickMask offers higher averaging speeds; however, a loss of data before the reflection makes it more difficult to locate the event precisely (figure 3-14).

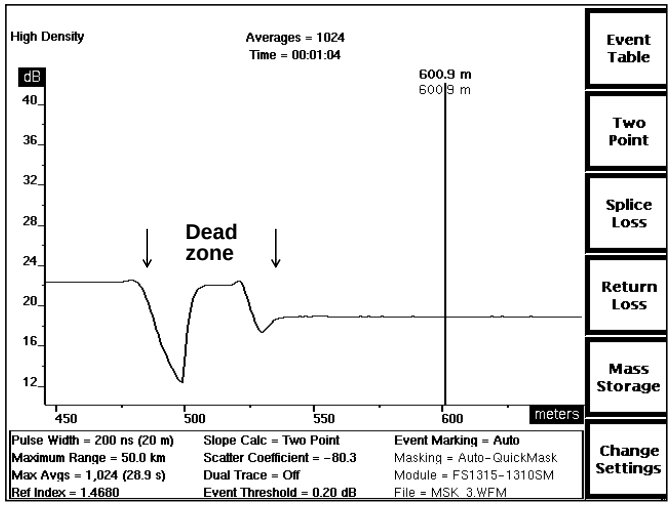


Figure 3-14. QuickMask

AccuMask reconstructs the reflection, retaining the leading edge of the reflection in addition to removing the tail, minimizing dead zone (figure 3-15). Dead zone is defined as areas where the waveform deviates ±0.5 dB from backscatter levels.

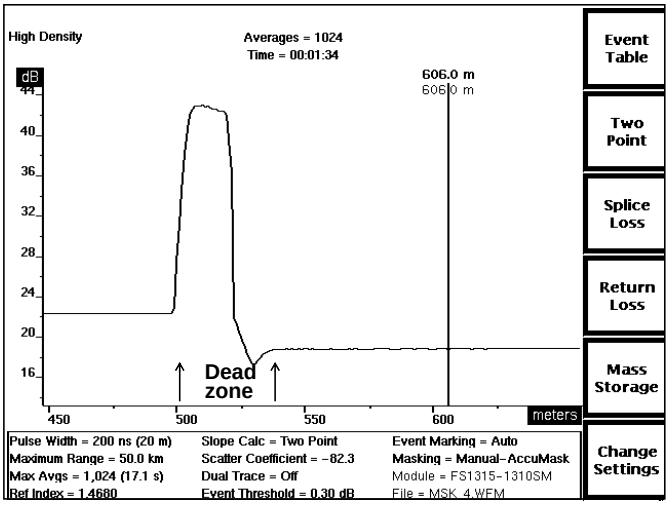


Figure 3-15. AccuMask

Make your masking-type selection by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The selection of a new masking type requires a new acquisition in order to take effect. When you press the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkey to exit the Masking Type parameter, the masking-type setting at the bottom of the screen is highlighted to indicate that the current setting does not match acquisition data. When you exit the menu system, the following message displays:

Press START/STOP to acquire new data.

Press **START/STOP** to start an acquisition using the new masking type. The highlighting is cleared when new data is acquired, because the masking-type setting now corresponds to the displayed waveform. You can press **START/STOP** to start a new acquisition without exiting the menu system.

Filtering

To display the Filtering pop-up window, from the acquisition screen press **Change Settings**, then press **Next Param** or **Prev Param** until the filtering parameter is highlighted on the Waveform Settings menu.

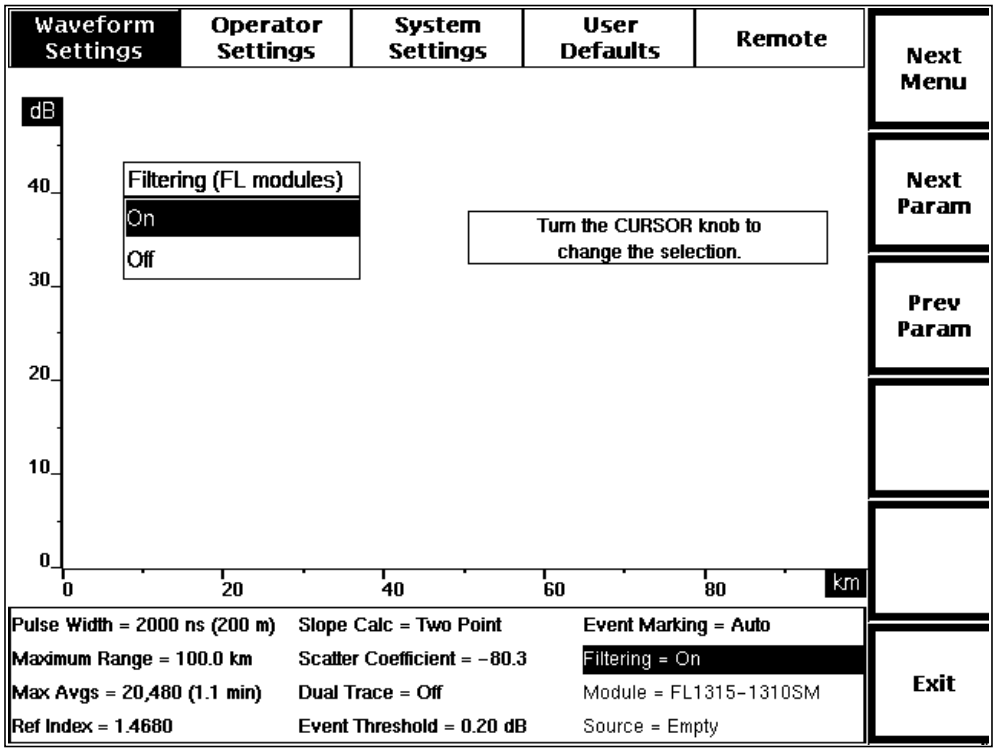


Figure 3-16. Filtering Pop-Up Selection Window, Waveform Settings Menu

Use the Filtering window to turn software filtering on and off. This parameter is available only when an FL-type optical module is selected. With an FL module selected, the filtering parameter replaces the masking-type parameter on the Waveform Settings menu and on the list of parameters at the bottom of the acquisition screen.

On FL modules, software filtering decreases noise and improves dynamic range, but it can cause a delay in locating automatic event markers for non-reflective events. For example, this delay can cause the event marker for a non-reflective splice to be located farther out on a waveform than the marker for a reflective connector at the same physical location. Turning software filtering off reduces the delay and increases the distance accuracy of automatic event detection for non-reflective events. (Refer to chapter 5, *Event Marking*.)

NOTE *Loading settings from a waveform or settings file does not change the setting of the filtering parameter. This parameter must be changed on the Waveform Settings menu.*

Turn filtering on or off by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this. The new filtering setting takes effect with the next acquisition.

The factory-default filtering setting is on. You can set the power-on filtering setting to off using the User Defaults menu, described later in this chapter.

Entering Operator Settings

The Operator Settings menu allows you to enter information that identifies the instrument operator and the fiber. This information prints with the waveform when you press the **HARD COPY** button, and is stored with the waveform when it is moved to reference memory, or written to mass storage.

Go to the Operator Settings menu from the acquisition screen by pressing the **Change Settings** softkey, then the **Next Menu** softkey.

When you first enter the Operator Settings menu after powering on the instrument, Fiber ID is the first pop-up window displayed. If you exit the menu system, then re-enter the Operator Settings menu, the last pop-up window you viewed before exiting the menus is displayed.

You can enter the following information on the Operator Settings menu:

- ❏ Fiber ID - up to 20 alphanumeric characters identifying the fiber under test.
- ❏ Fiber Notes - up to 150 characters of fiber notes as optional documentation.
- ❏ Operator - the operator's name or other identification, up to 25 characters.

The fiber ID, notes, and operator fields are blank at power on. If you load a waveform from mass storage into either current or reference memory, the fiber ID, notes, and operator information for that waveform display on the Operator Settings menu when the waveform is active. When you acquire new data, any operator settings for the

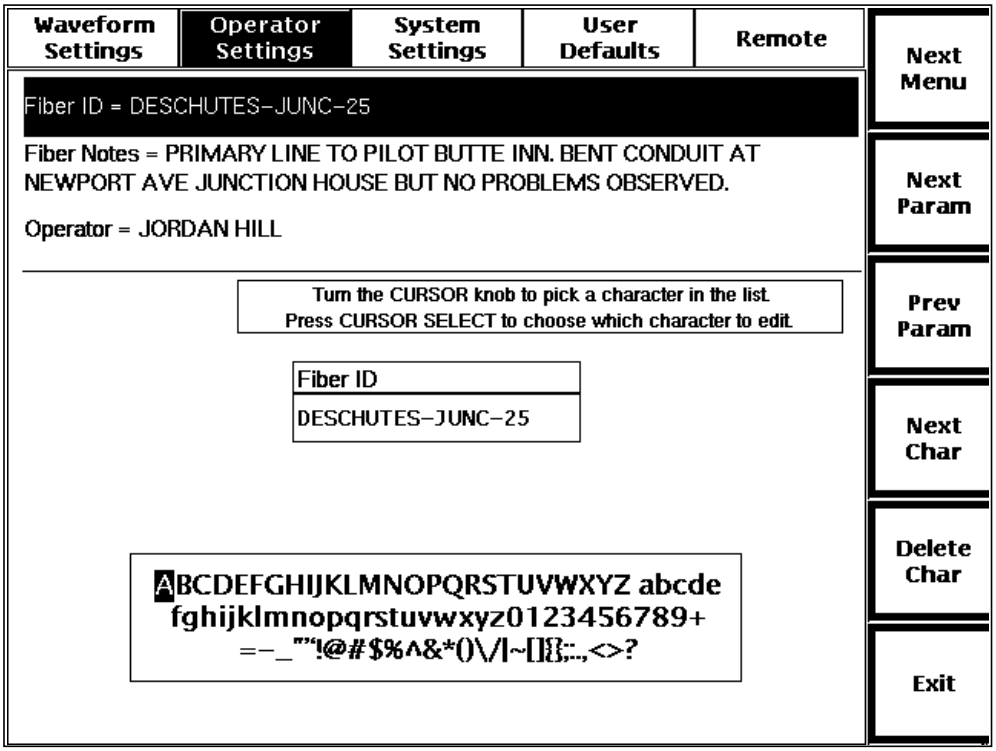


Figure 3-17. Operator Settings Menu

previous current waveform are saved with the new data, unless you change the fields on the Operator Settings menu.

Each of these parameters is a character string. Enter each the same way, using a combination of the **CURSOR** knob and softkeys.

The following softkeys appear on the Operator Settings menu:

Next Menu - save the current operator-settings parameter and go to the next menu. Pressing this softkey from the Operator Settings menu displays the System Settings menu.

Next Param - save the current parameter and display the pop-up window for the next parameter on the Operator Settings menu. For example, after entering the fiber ID, press this softkey to save the new fiber ID and display the Fiber Notes pop-up window. The highlighting bar on the menu moves to indicate the current parameter.

Prev Param - save the current parameter and display the pop-up window for the previous parameter on the Operator Settings menu.

Next Char - used for character entry, as described below.

Delete Char - used to correct characters, as described below.

Exit - save the current operator-settings parameter and return to the acquisition screen.

All the softkeys except for **Exit** repeat when held down.

Enter data in each field, as described for the fiber ID:

1. When you select the field to enter or edit, the cursor is on the next available character position. To enter a character, turn the **CURSOR** knob until the desired character is highlighted in the character set shown. The letter under the cursor in the fiber ID changes to correspond with the highlighted letter in the character set.

2. Press the **Next Char** softkey to accept the selected letter. The cursor advances to the next available character.

Press the **CURSOR SELECT** button to move the character-selecting cursor to the fiber ID. You can then turn the **CURSOR** knob to go directly to the character in the fiber ID that you wish to edit. Pressing **CURSOR SELECT** again moves the character-selecting cursor back to the character set, and turning the **CURSOR** knob selects a new letter for the character in the fiber ID being edited.

The **Delete Char** softkey deletes the character under the cursor. If the cursor is on the next available character position, which is blank, the character to the left of the cursor is deleted. To insert characters to the left of the cursor, press **Delete Char** to move backwards, then re-enter the character string.

If you have a keyboard, you can type the information. Refer to appendix B, *Keyboard Definitions*, for a list of key sequences that duplicate front-panel controls in the menu system. The keyboard also offers more editing functions than those available via front-panel controls.

The new character string takes effect when you exit the field by pressing **Next Param**, **Prev Param**, **Next Menu**, or **Exit**.

Selecting System Settings

The System Settings menu allows you to define general operating characteristics of your instrument, such as communications parameters, display intensity, and system date and time.

Go into the System Settings menu from the acquisition screen by pressing the **Change Settings** softkey, then press the **Next Menu** softkey twice. Notice that the softkeys are redefined in the menu system.

The following softkeys appear on the System Settings menu:

Next Menu - go to the next menu. From the System Settings menu, pressing this softkey displays the User Defaults menu.

Next Param - display the pop-up window for the next parameter on the System Settings menu. For example, after selecting the display intensity, press this softkey to display the Sound pop-up selection window. The highlighting bar on the System Settings menu moves to indicate the current parameter.

Prev Param - display the pop-up window for the previous parameter on the menu.

Exit - return to the acquisition screen.

The **Next Menu**, **Next Param**, and **Prev Param** softkeys repeat when held down.

When you first enter the System Settings screen after powering on the instrument, the intensity parameter is the first pop-up selection window displayed. If you exit the menu system, then re-enter the System Settings menu before turning off the instrument, the last pop-up selection window viewed before exiting the menus is redisplayed.

The settings you can define using the System Settings menu are:

- ❏ Language
- ❏ Display intensity
- ❏ Display color
- ❏ Sound
- ❏ System time
- ❏ System date
- ❏ Date format
- ❏ Units
- ❏ File format
- ❏ Keyboard translation
- ❏ Hardcopy device
- ❏ GPIB status
- ❏ GPIB address
- ❏ RS232 baud rate
- ❏ RS232 parity
- ❏ RS232 stop bits
- ❏ RS232 data bits
- ❏ RS232 flow control

Language

The Language selection window is the first pop-up window displayed when you first enter the System Settings menu after power-on. If the Language window is not displayed upon entering the menu, press **Next Param** or **Prev Param** until the Language parameter is highlighted on the menu.

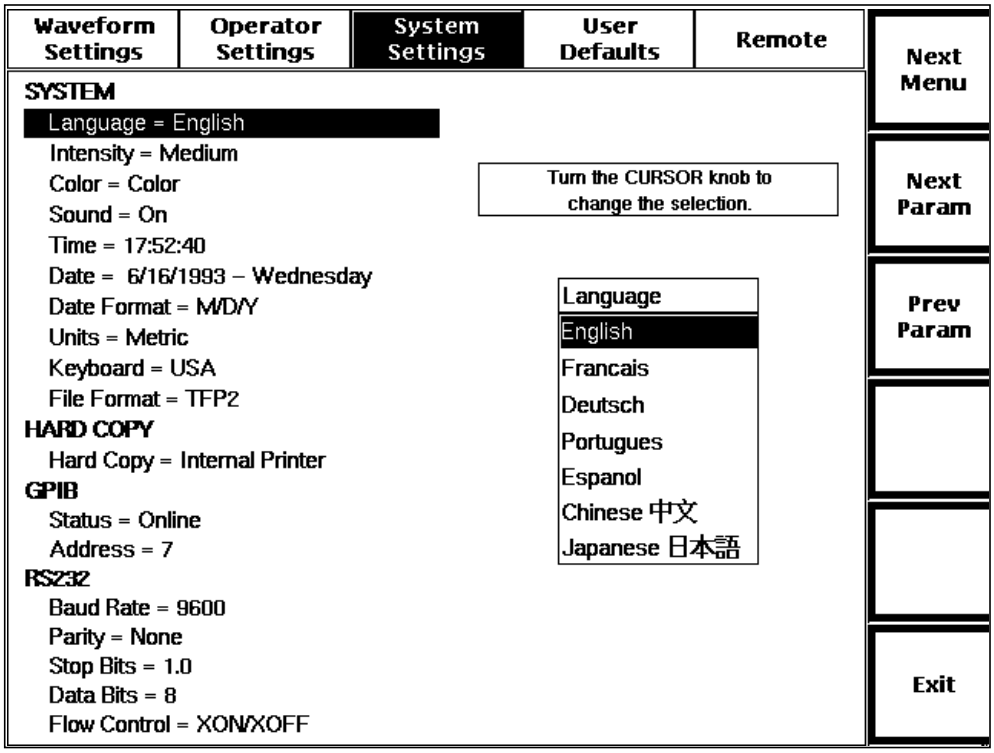


Figure 3-18. Language Pop-Up Selection Window, System Settings Menu

Use the Language window to select the new language used by the instrument. When you change languages, in most cases, the acquisition screen, help screens, menus, and softkey labels appear in the new language.

To change the language, turn the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The new language setting takes effect when you exit the parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys. A prompt appears to confirm the change to the new language. Changing to a new language requires the instrument to be restarted. When you confirm the new language selection, the instrument automatically restarts, using a quick start (no diagnostics are performed). The start-up screen reappears, in the selected language. The new language is saved as the power-on default.

If you cancel the new language selection when the prompt appears, the language is not changed and the instrument is not restarted.

NOTE *If you change the language to a language that you cannot read, you can go to the Language pop-up window from the start-up screen simply by pressing the following keys:*

Softkey 6 (bottom softkey)
Softkey 1 (top softkey)
Softkey 1
The Language menu displays. Turn the ***cursor*** *knob to select another language.*
Softkey 6
Softkey 2 (second softkey from top)

This sequence causes the instrument to quick start using the new language.

Display Intensity

To display the Intensity pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the intensity parameter is highlighted on the menu.

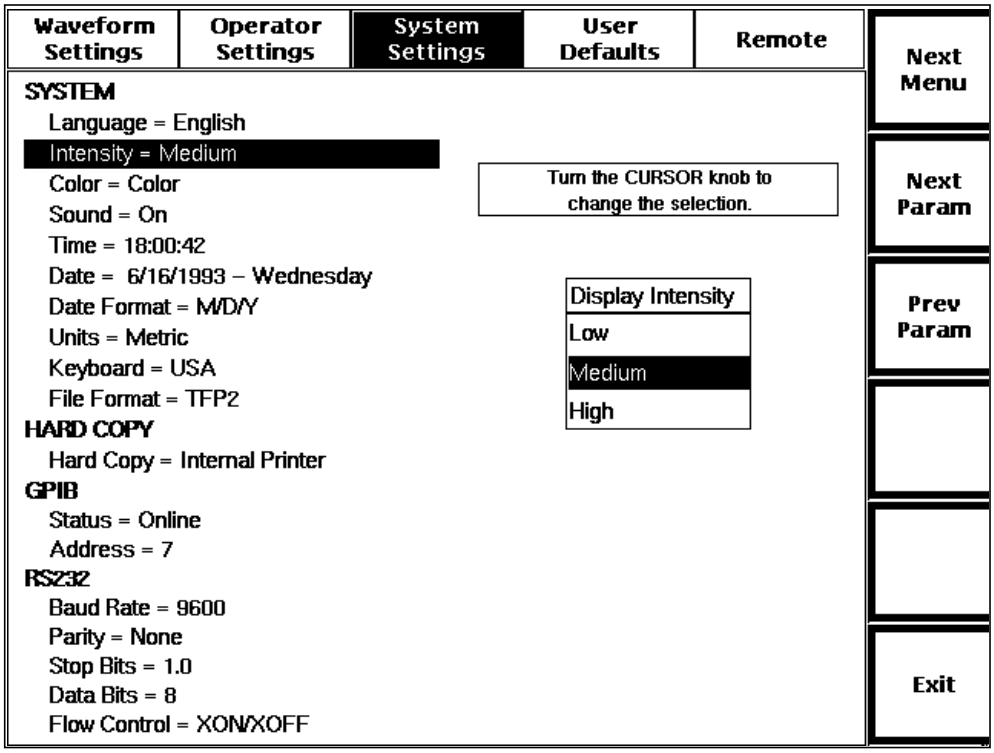


Figure 3-19. Display Intensity Pop-Up Selection Window, System Settings Menu

Use the Intensity window to control the display intensity for easiest viewing. The **High** setting is suited for viewing the display under bright light, the **Medium** is for normal external lighting, and the **Low** setting is for darker viewing conditions. The factory default intensity setting is **Medium**. You can choose a different power-on default using the User Defaults menu, described later in this chapter.

To set the intensity, turn the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The setting is effective immediately, allowing you to see the new intensity level on the screen before leaving the intensity parameter.

Display Color (color monitors only)

To display the Display Color pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the color parameter is highlighted.

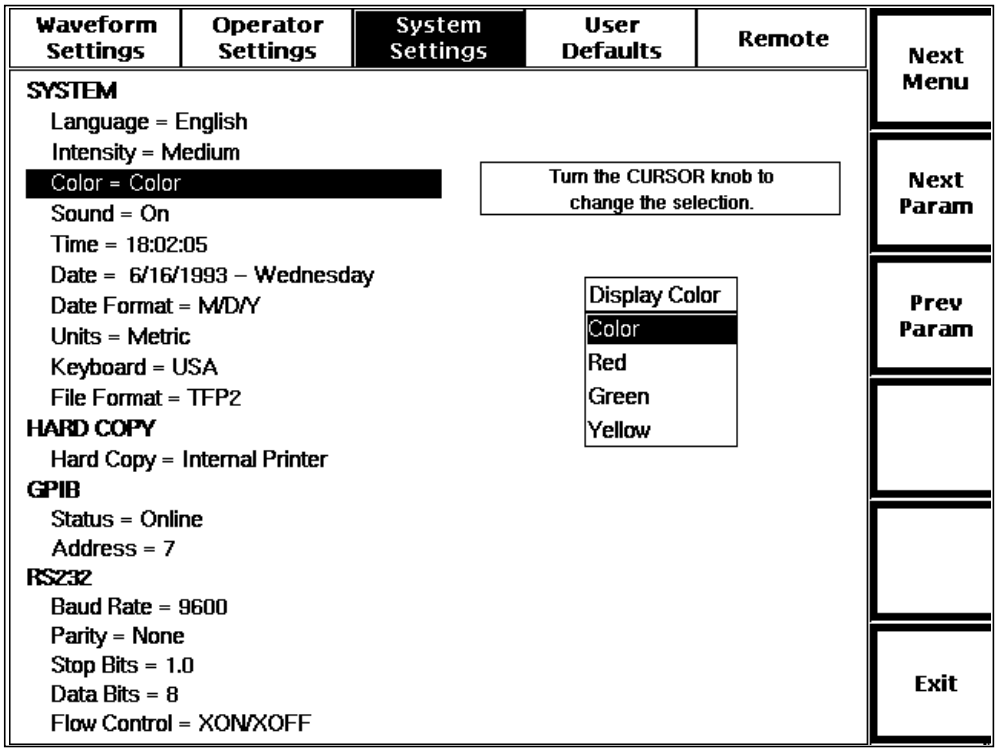


Figure 3-20. Display Color Pop-Up Selection Window, System Settings Menu

Use the Display Color window to select the color or colors used on the instrument's display. The default setting is **Color**, which uses the full range of colors available for display. A selection of monochromatic colors is also available.

Turn the **CURSOR** knob to highlight your selection. If you have the optional keyboard, you can use the cursor keys to do this.

The color setting takes effect as you change the selection, allowing you to see the new display color immediately.

Sound

To display the Sound pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the sound parameter is highlighted.

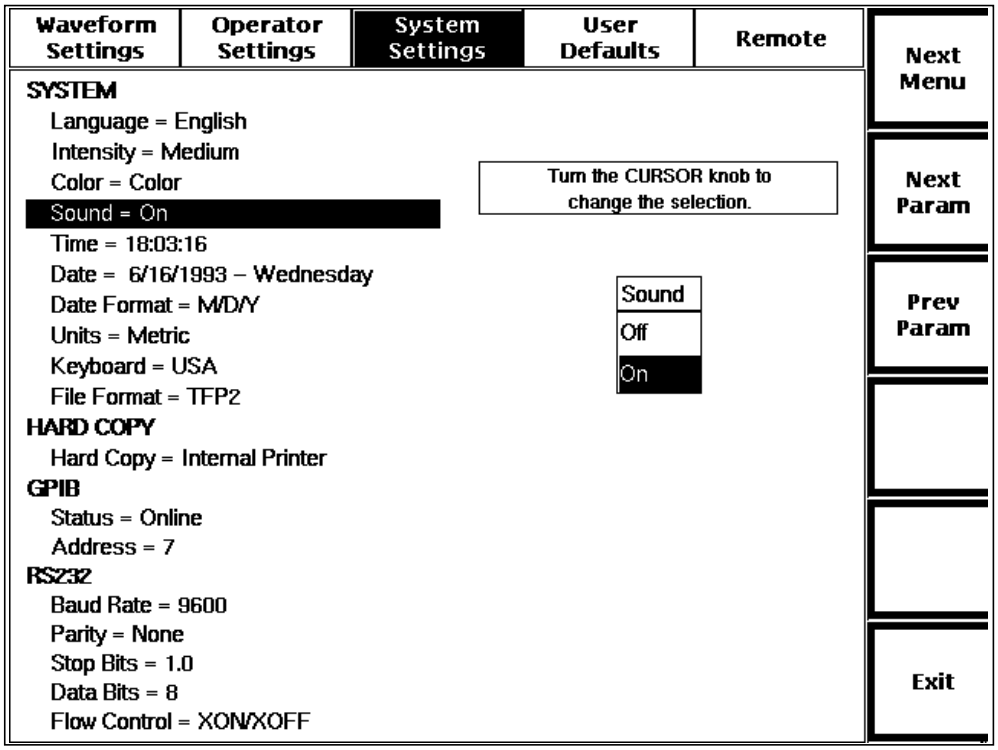


Figure 3-21. Sound Pop-Up Selection Window, System Settings Menu

FiberMaster's front-panel controls beep to indicate they are not functioning in the current instrument mode, and the cursor knob clicks when used in the menu system. Use the Sound window to turn these sounds and any alert beeps on and off. The default setting is **On**. You can choose off as the power-on default using the User Defaults menu, described later in this chapter.

Turn the **CURSOR** knob to highlight your selection. If you have the optional keyboard, you can use the cursor keys to do this.

The new sound setting takes effect when you exit the parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys.

System Time

To display the Time pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the time parameter is highlighted.

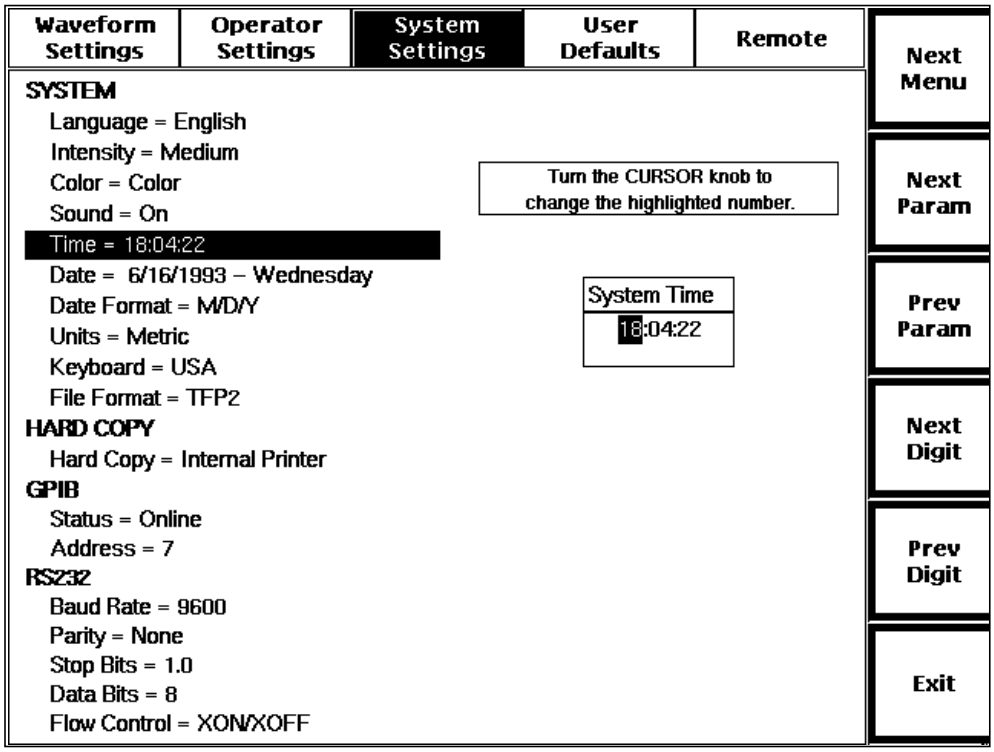


Figure 3-22. System Time Pop-Up Selection Window, System Settings Menu

Use the Time window to set the system time. This time is used to time stamp all acquisitions and disk files, on a 24-hour-clock basis.

Use the **CURSOR** knob to increase and decrease the hours, minutes, and seconds. The highlighted portion of the time is affected when you turn the **CURSOR** knob. Turning the knob clockwise increases the highlighted number; turning the knob counterclockwise decreases it. Pressing the **Next Digit** softkey causes the next portion of the time to be highlighted. Pressing the **Prev Digit** softkey highlights the previous portion of the time.

You can also use the optional keyboard to type in the time. Enter two digits each for the hours, minutes, and seconds. Use the colon (**:**) key in place of the **Next Digit** softkey.

The new time setting takes effect when you exit the parameter by pressing one of the **Next Param**, **Prev Param, Next Menu**, or **Exit** softkeys.

System Date

To display the Date pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the date parameter is highlighted.

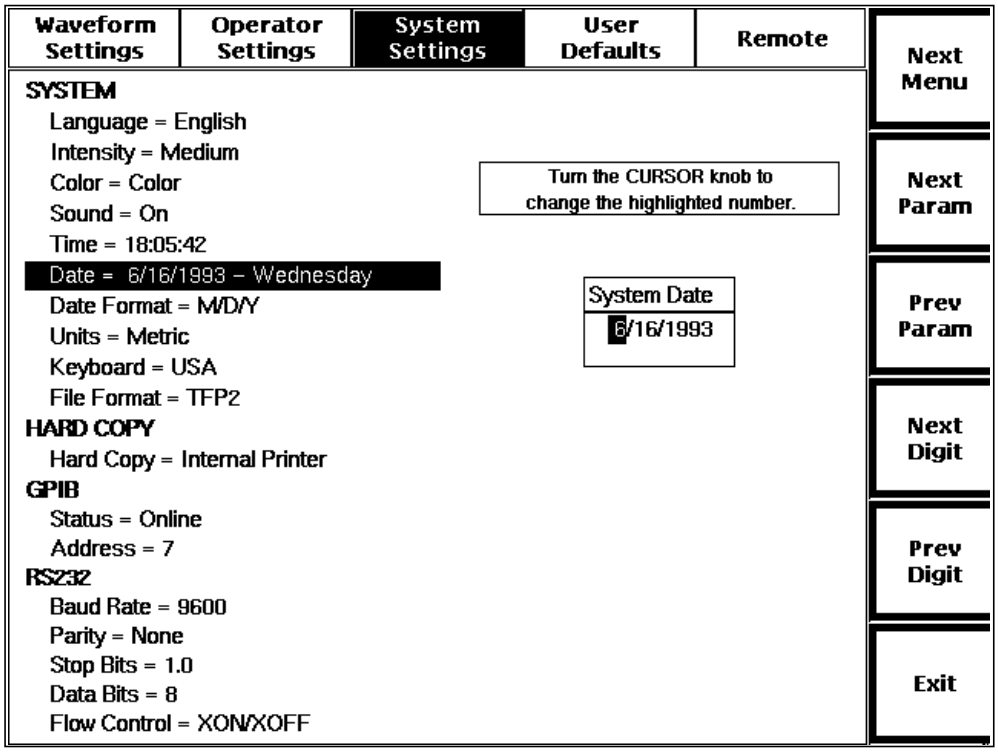


Figure 3-23. System Date Pop-Up Selection Window, System Settings Menu

Use the Date window to set the system date. This date is used to date stamp all disk files and acquisitions.

Use the **CURSOR** knob to increase and decrease the day, month, and year. The highlighted portion of the date is affected when you turn the **CURSOR** knob. Turning the knob clockwise increases the highlighted number; turning the knob counterclockwise decreases it. Pressing the **Next Digit** softkey causes the next portion of the date to be highlighted. Pressing the **Prev Digit** softkey highlights the previous portion of the date.

You can use the optional keyboard to type in the date. Enter two digits each for the day, month, and year. Use the slash (*/*) key in place of the **Next Digit** softkey.

The new date setting takes effect when you exit the parameter by pressing one of the **Next Param**, **Prev Param, Next Menu**, or **Exit** softkeys.

Date Format

To display the Date Format pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the date-format parameter is highlighted.

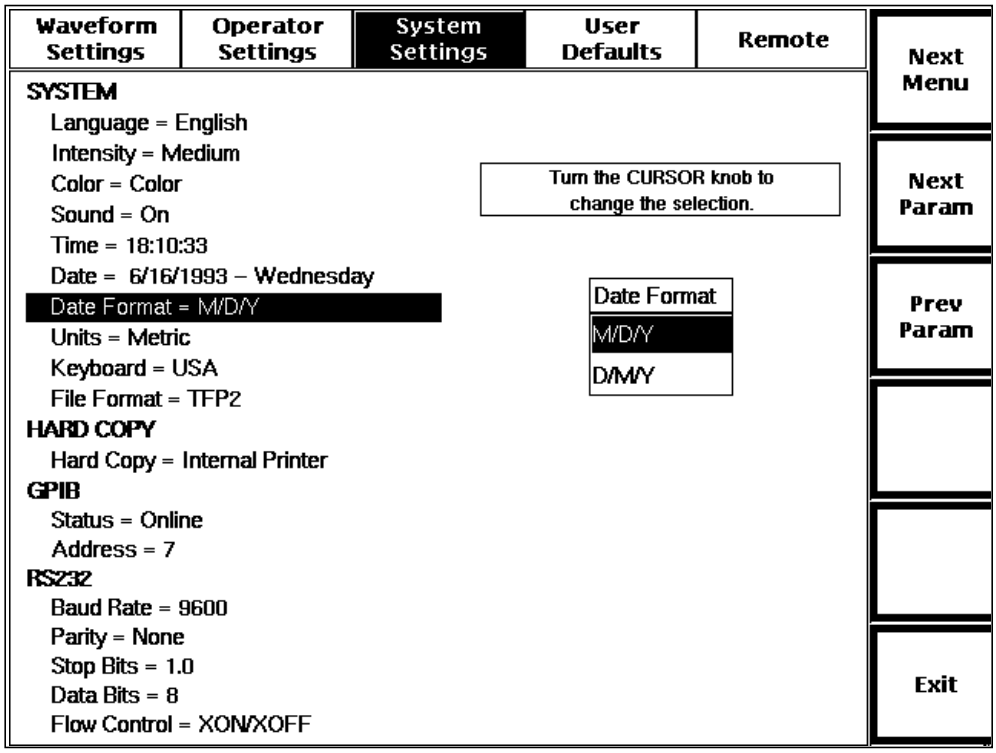


Figure 3-24. Date Format Pop-Up Selection Window, System Settings Menu

Use the Date Format window to select the system-date format. The choices are the U.S. month/day/year format (**M/D/Y**), or the non-U.S. day/month/year format (**D/M/Y**). The factory-default setting is **M/D/Y**. You can set D/M/Y as the power-on default using the User Defaults menu, described later in this chapter.

To select the date format, turn the **CURSOR** knob to highlight your selection. If you have the optional keyboard, you can use the cursor keys to do this.

The new date-format setting takes effect when you exit the parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys.

Units

To display the Units pop-up window, from the acquisition screen press **Change Settings**, then Next Menu twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the units parameter is highlighted.

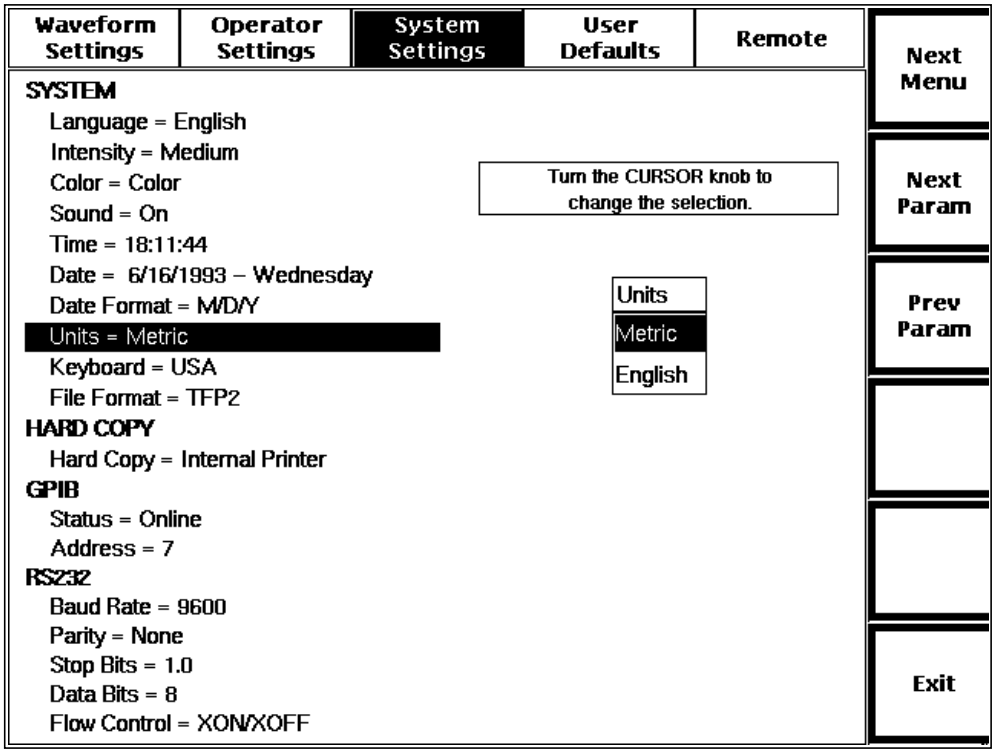


Figure 3-25. Units Pop-Up Selection Window, System Settings Menu

Use the Units window to select metric or English units of measure for distance measurements and range settings. Metric units are kilometers; English units are kilofeet. The factory default is **Metric**, but you can set the power-on default to English using the User Defaults menu, described later in this chapter.

Select metric or English by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The new units setting takes effect when you exit this parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys.

Keyboard Translation

To display the Keyboard Translation pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the keyboard-translation parameter is highlighted.

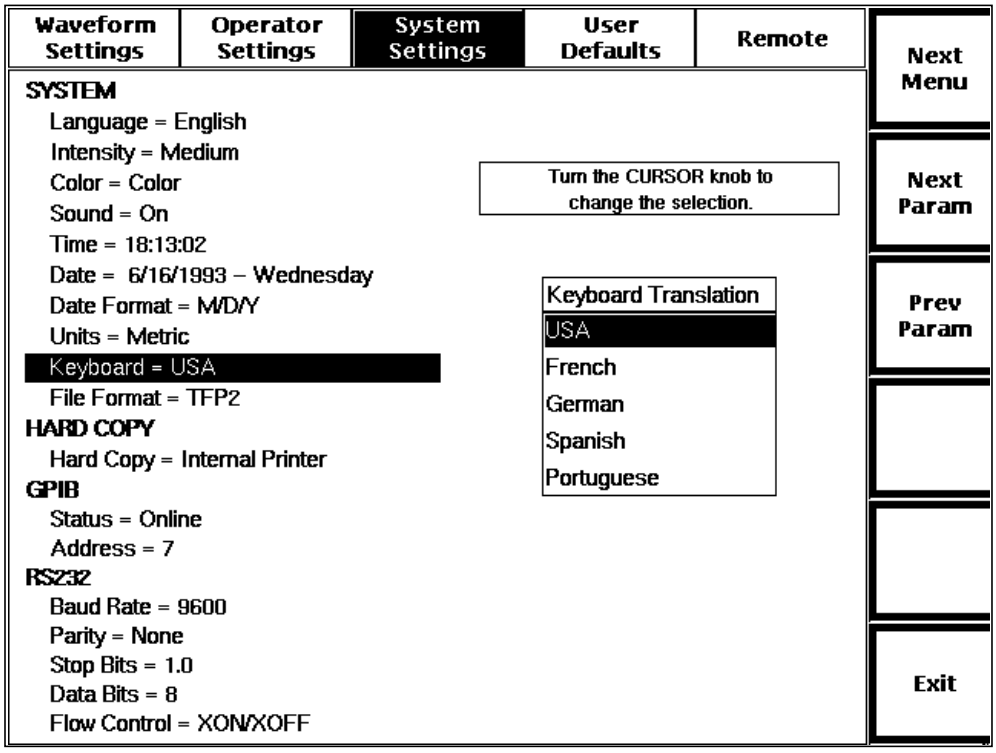


Figure 3-26. Keyboard Translation Pop-Up Selection Window, System Settings Menu

Use the Keyboard Translation window to select the type of keyboard to be used with your instrument. The factory default setting is **USA**, but you can select another language as the power-on default using the User Defaults menu.

To select the keyboard translation, turn the **CURSOR** knob to highlight your selection. If you have an optional keyboard, you can use the cursor keys to do this.

The new keyboard-translation setting takes effect when you exit the parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys.

File Format

To display the File Format pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the file-format parameter is highlighted.

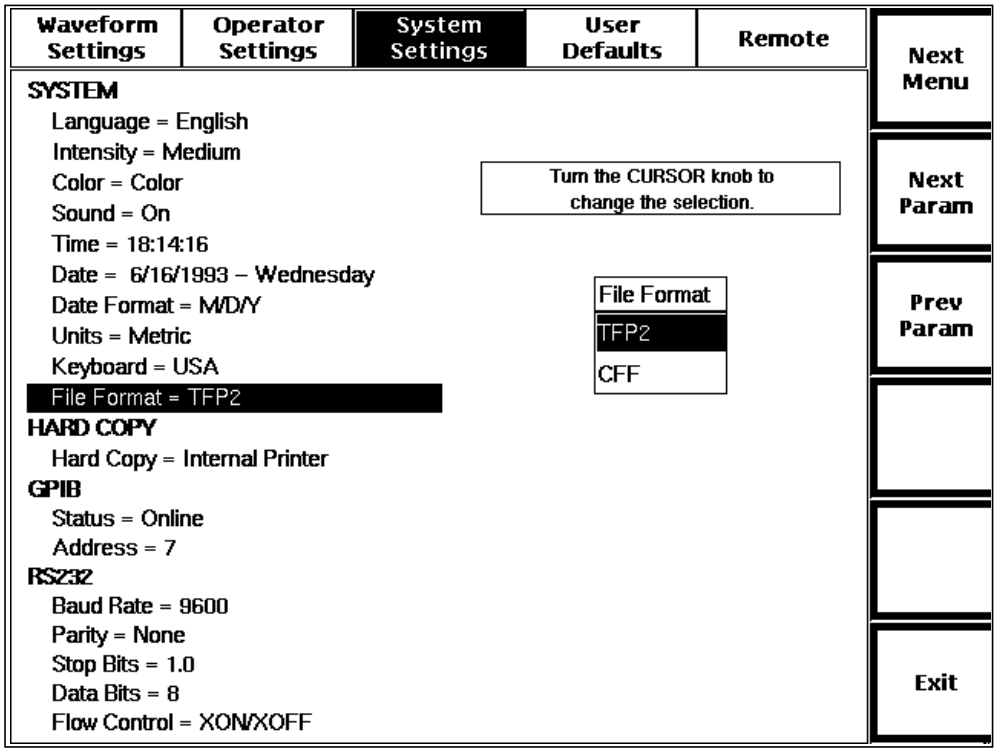


Figure 3-27. File Format Pop-Up Selection Window, System Settings Menu

Use the File Format window to select the file format used for mass-storage save operations when you save waveform data.

The two available file formats are TFP2 and CFF (common file format). TFP2 format is the one used by previous versions of the FiberMaster OTDR. It allows TFP2A waveforms to be backward compatible with the TFP2. CFF is the common file format used by the TFP2A and other newer Tektronix OTDR-related products produced in 1995 and after. CFF waveform files can be loaded, viewed, and measured using the TFP2A or other Tektronix OTDR-related products that read and write CFF data, regardless of which instrument was used to acquire the data.

Select the file format by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The file-format setting is saved when you exit the parameter by pressing **Next Menu**, **Next Param**, **Prev Param**, or **Exit**. The next time you save a waveform to mass storage, the file-format selection is used.

NOTE *When settings only are saved, the TFP2 file format is used regardless of the File Format selection on the System Settings menu.*

The factory-set default is **TFP2**. You can select CFF as the power-on default using the User Defaults menu described later in this chapter.

Hard Copy Device

To display the Hard Copy Device pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the hardcopy-device parameter is highlighted.

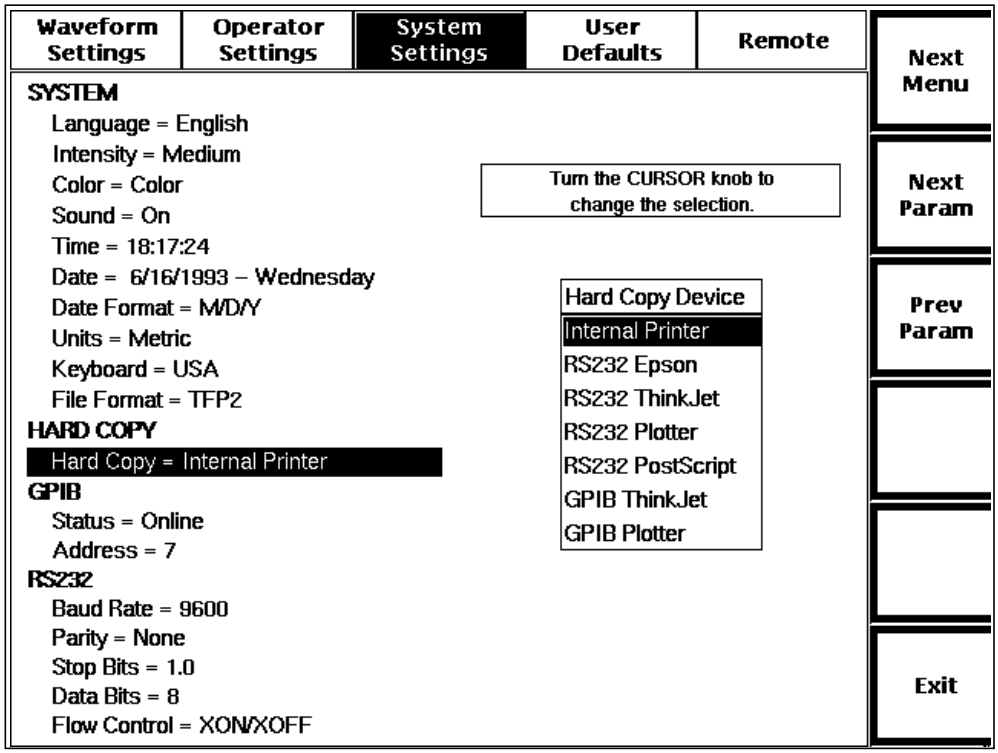


Figure 3-28. Hardcopy Device Pop-Up Selection Window, System Settings Menu

Use the Hard Copy Device window to choose which device will be used for printing when you press the **HARD COPY** button on the instrument's front panel. The internal printer is the built-in thermal printer, the GPIB plotter is an HP-GL-compatible color GPIB plotter, and the RS232 plotter is an HP-GL-compatible color serial plotter. The factory default setting is **Internal Printer**, if installed, or **RS232 Epson** if not. You can specify a different power-on default using the User Defaults menu, described later in this chapter.

Select the hardcopy device by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this. The internal-printer selection does not display if the printer is not installed in your instrument.

NOTE *When using the TFP2A with a Hewlett-Packard LaserJet printer, select the RS232 ThinkJet option on the Hard Copy Device menu.*

The hardcopy-device setting takes effect when you exit the parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys.

Any of the printer selections produces a waveform print when you press the **HARD COPY** button while an acquisition screen is on the display, and prints the contents of the screen when any other display is current (i.e., a menu or help screen). The external plotters produce only waveform plots. If you select a plotter as the hardcopy device and press the **HARD COPY** button when any display *other* than an acquisition screen is current, a beep sounds and the plotter does not produce a plot.

If you select a GPIB device as the hardcopy device, GPIB status is temporarily set to talk only when the **HARD COPY** button is pressed. When the plotter or printer finishes the hard copy, the setting reverts to its original value (online or offline).

GPIB Status

To display the GPIB Status pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the GPIB-status parameter is highlighted.

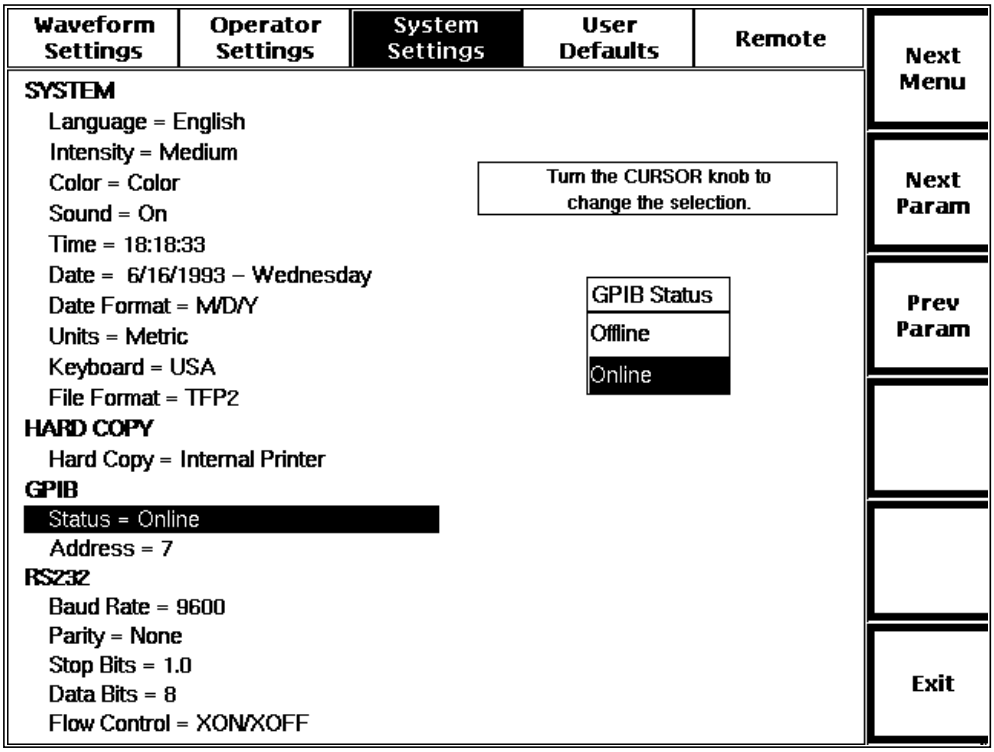


Figure 3-29. GPIB Status Pop-Up Selection Window, System Settings Menu

Use the GPIB-status setting to place the instrument online or offline. When the instrument is online, it accepts commands and generates data in response to a GPIB controller. When the instrument is offline, it does not accept commands on the bus, but can be used to drive a GPIB plotter or printer in talk-only mode. The default GPIB-status setting is **Online**.

When using a GPIB device as the hardcopy device, GPIB status is temporarily set to talk-only when the **HARD COPY** button is pressed. When the plotter or printer finishes the hard copy, the setting automatically reverts to its original value.

To select the GPIB-status setting, turn the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The GPIB-status setting takes effect when you exit this parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys.

GPIB Address

To display the GPIB Address pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the GPIB-address parameter is highlighted.

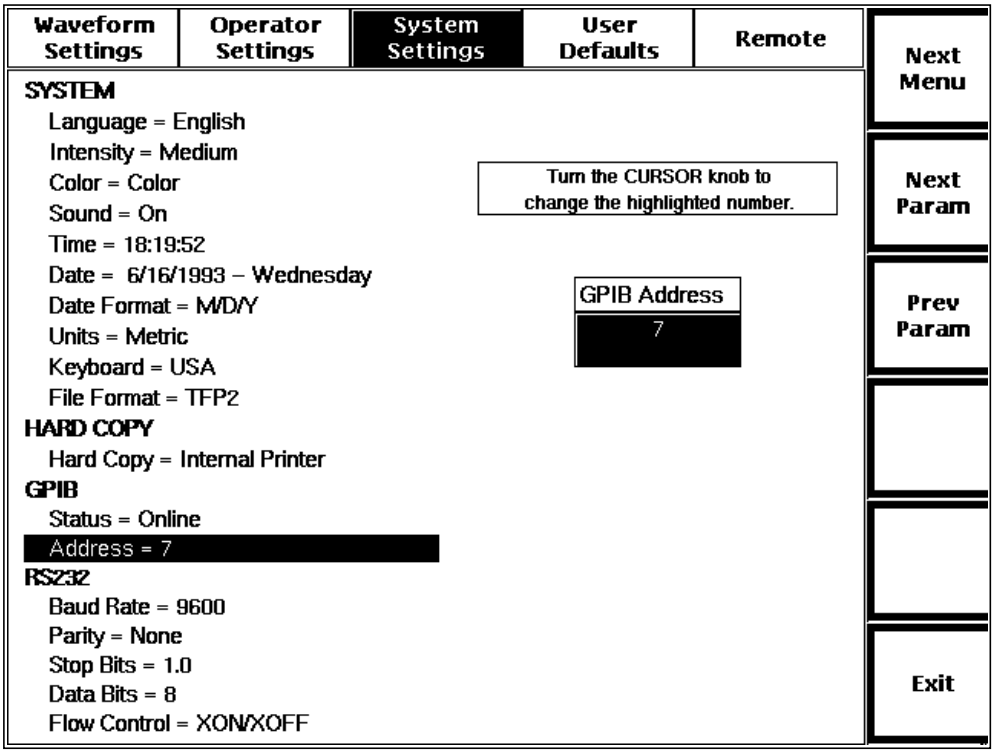


Figure 3-30. GPIB Address Pop-Up Selection Window, System Settings Menu

Use the GPIB Address window to set the talker and listener address for use in GPIB communications. You can set the address to any value from 0 to 30, inclusive. The default address is **7**. The power-on default value is the address last used.

To set the address, turn the **CURSOR** knob clockwise to increase the number, and counterclockwise to decrease it. If you have a keyboard, you can use the cursor keys to do this.

The new GPIB address takes effect when you exit this parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys.

RS232 Baud Rate

To display the RS232 Baud Rate pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the baud-rate parameter is highlighted.

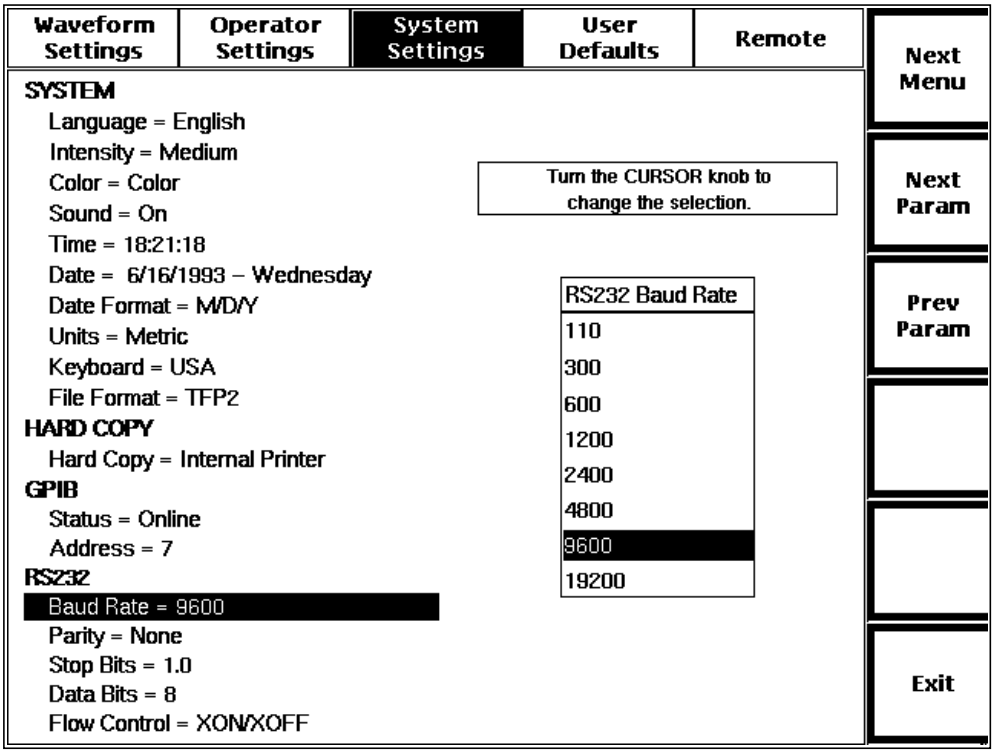


Figure 3-31. RS232 Baud Rate Pop-Up Selection Window, System Settings Menu

Use the RS232 Baud Rate window to select the baud rate used by the RS232 serial port. The baud rate is used for both serial plotter and printer hardcopy, and XModem data transfers. The factory-default baud rate is **9600** bits per second. You can set a different power-on default using the User Defaults menu, described later in this chapter.

Change the baud rate by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The new baud rate takes effect when you exit the parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys.

RS232 Parity

To display the RS232 Parity pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the RS232 parity parameter is highlighted.

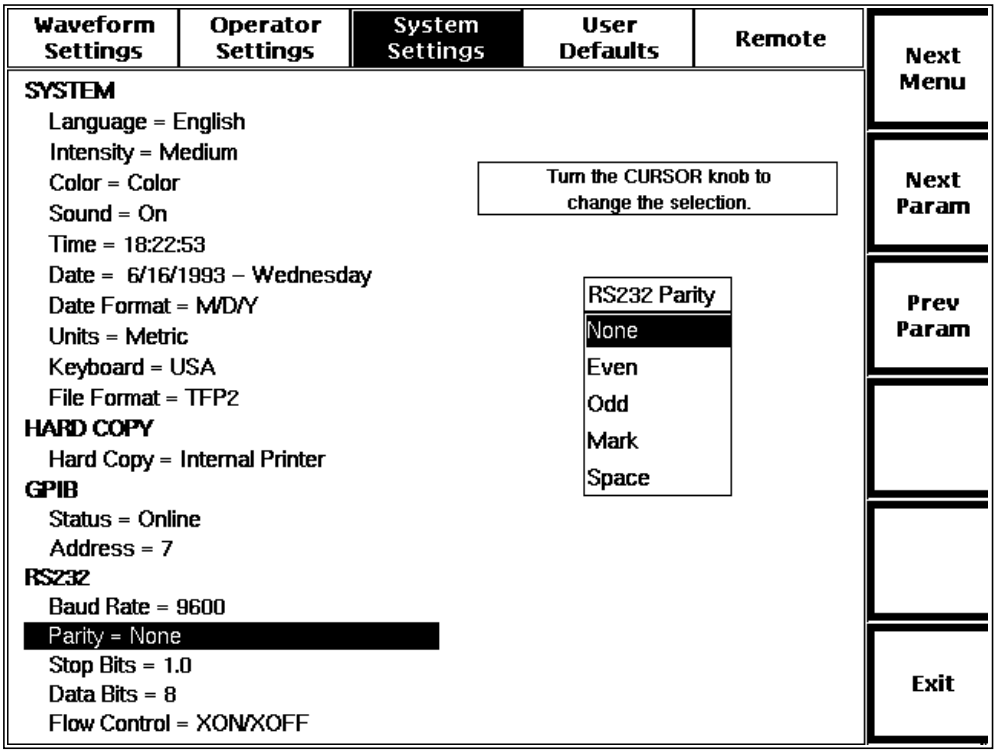


Figure 3-32. RS232 Parity Pop-Up Selection Window, System Settings Menu

Use the Parity window to set the RS232 serial port parity. The parity is used for serial-plotter and serial-printer hardcopy. (During XModem data transfers, parity is temporarily set to none automatically, regardless of the menu setting.) The factory-default parity setting is **None**. You can set a different power-on default using the User Defaults menu, described later in this chapter.

Change the parity selection by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The new parity setting takes effect when you exit the Parity parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** keys.

RS232 Stop Bits

To display the RS232 Stop Bits pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the stop-bits parameter is highlighted.

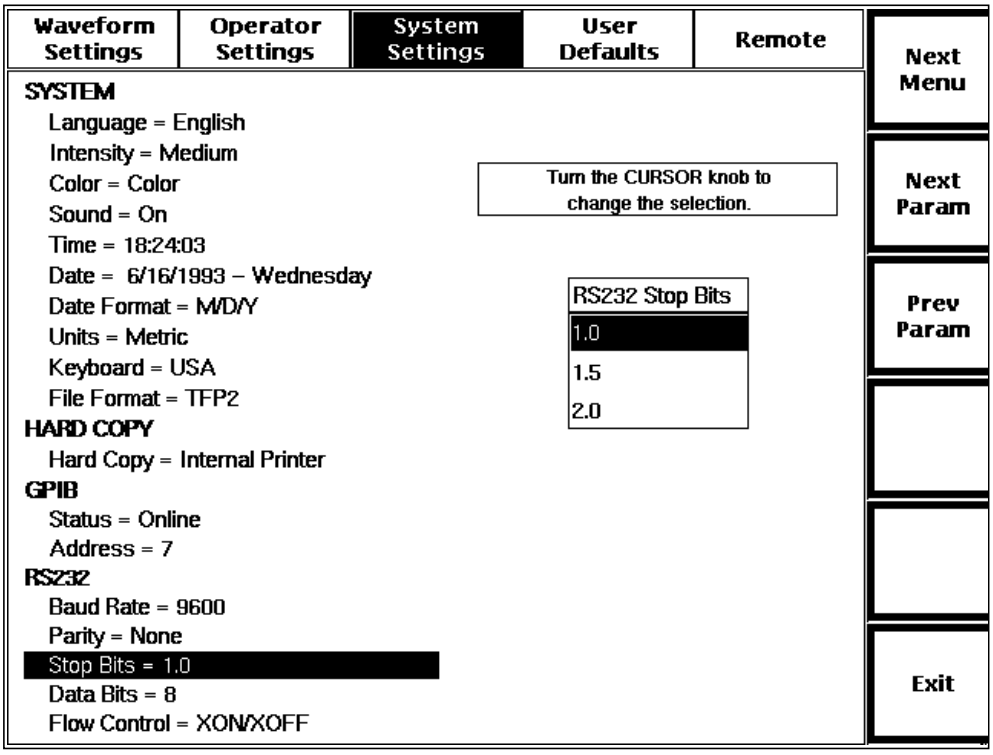


Figure 3-33. RS232 Stop Bits Pop-Up Selection Window, System Settings Menu

Use the RS232 Stop Bits window to select the number of stop bits used for serial-plotter and serial-printer hardcopy. (During XModem data transfers, the stop-bits setting is temporarily set to 1 automatically, regardless of the menu setting.) The factory-default stop bits setting is **1**. You can set a different power-on default using the User Defaults menu, described later in this chapter.

Change the number of stop bits by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The new stop-bits setting takes effect when you exit the parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys.

RS232 Data Bits

To display the RS232 Data Bits pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the data-bits parameter is highlighted.

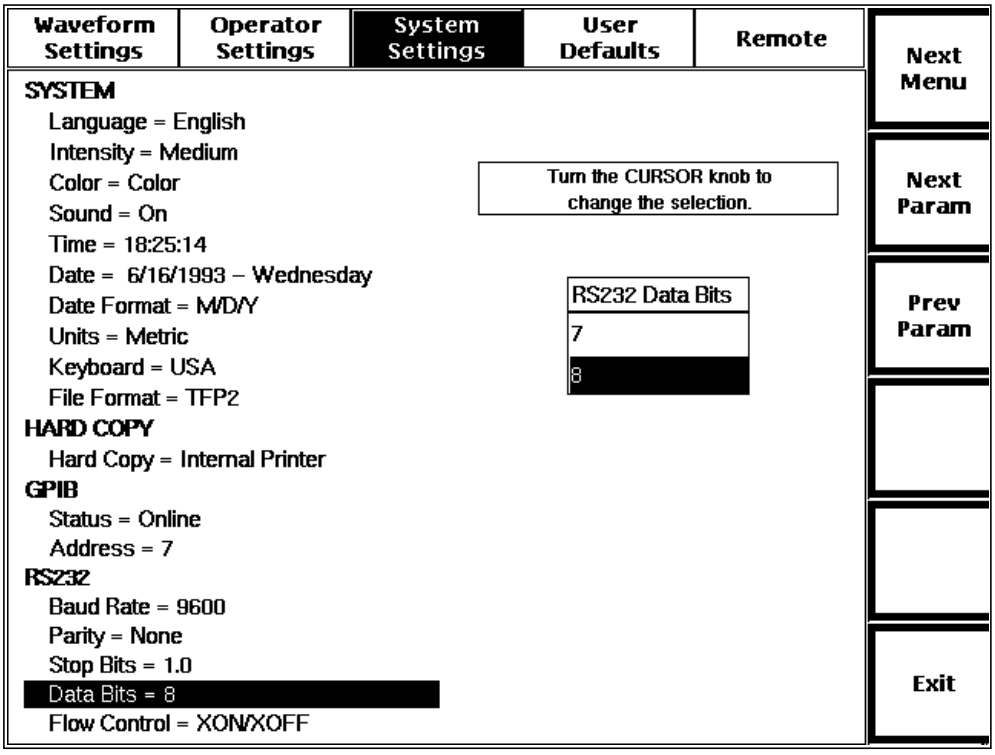


Figure 3-34. RS232 Data Bits Pop-Up Selection Window, System Settings Menu

Use the RS232 Data Bits window to specify the number of data bits used per character during serial-plotter and serial-printer hardcopy. (During XModem data transfers, data bits per character is temporarily set to 8 automatically, regardless of the menu setting.) The number of data bits does not include the parity bit. The factory-default data-bits setting is **8**. You can specify a different power-on default using the User Defaults menu, described later in this chapter.

Select 7 or 8 bits per character by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The selected setting takes effect when you exit the parameter by pressing one of the **Next Param**, **Prev Param**, **Next Menu**, or **Exit** softkeys.

RS232 Flow Control

To display the RS232 Flow Control pop-up window, from the acquisition screen press **Change Settings**, then **Next Menu** twice to reach the System Settings menu. Then press **Next Param** or **Prev Param** until the flow-control parameter is highlighted.

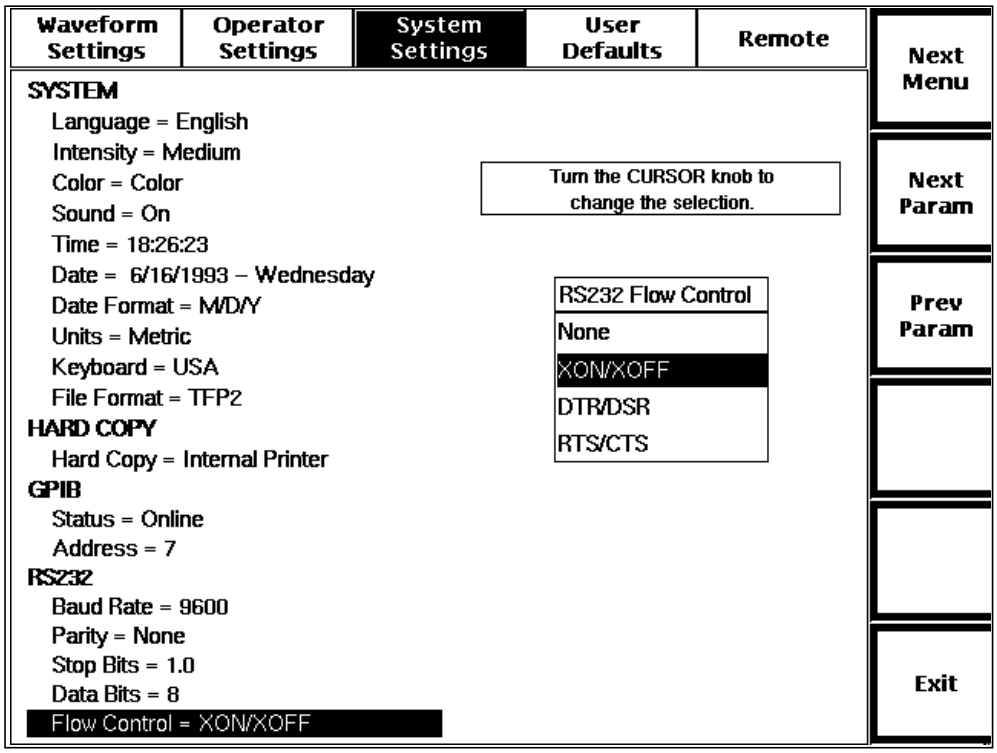


Figure 3-35. RS232 Flow Control Pop-Up Selection Window, System Settings Menu

Use the RS232 Flow Control window to set the type of flow control used during serial-plotter and serial-printer hardcopy. Flow control is used to prevent data loss if the receiving device cannot accept data as fast as it is sent. The factory-default flow-control setting is **XON/XOFF**. You can specify a different power-on default using the User Defaults menu, described later in this chapter.

Select the flow control by turning the **CURSOR** knob to highlight your selection. If you have a keyboard, you can use the cursor keys to do this.

The flow-control setting is saved when you exit the parameter by pressing **Next Menu**, **Next Param**, **Prev Param**, or **Exit**. It takes effect with the next data transfer, and does not affect any print operation or XModem transfer in progress.

Setting User Defaults

The User Defaults menu is the fourth configuration menu available on FiberMaster. Go to this menu from the acquisition screen by pressing the **Change Settings** softkey, then pressing the **Next Menu** softkey three times.

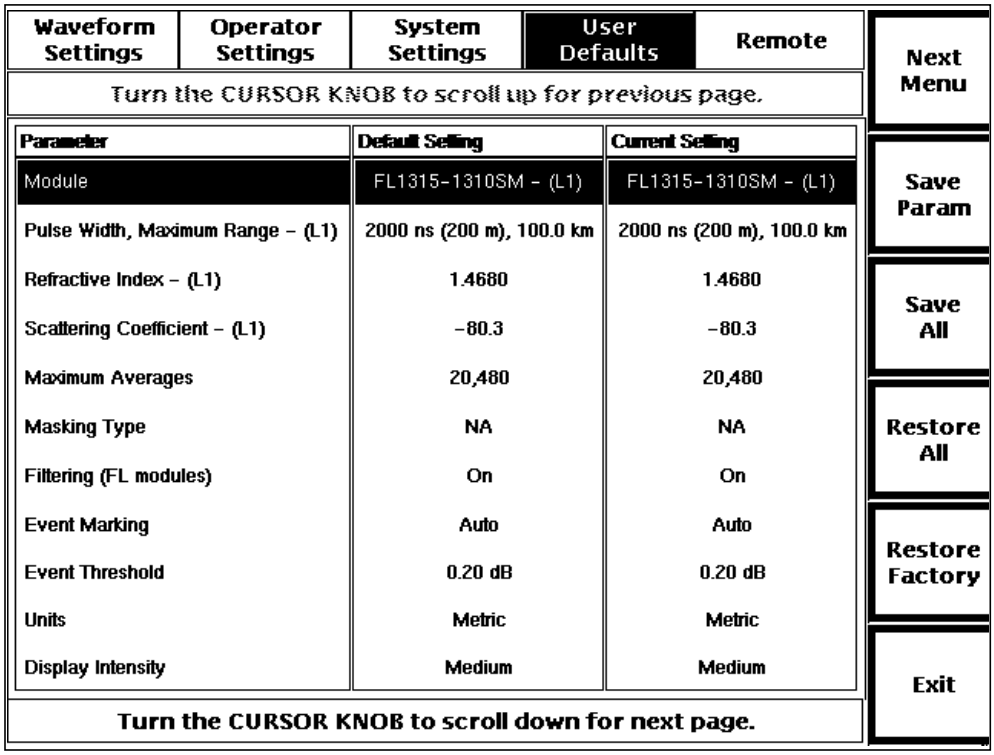


Figure 3-36. User Defaults Menu, Page 1

Use the User Defaults menu to define power-on defaults for instrument parameters that accept user-definable defaults. These parameters are listed on the User Defaults menu screen, along with their current default values, and their current settings.

The Default Setting column lists the power-on default settings. Note that the pulse width/maximum range, refractive index, scattering coefficient, and masking type shown in the Default Setting column apply to the *currently selected* optical module, shown in the Current Setting column. The optical modules are designated by position on the User Defaults menu. The laser locations are referred to as U1, U2, L1, and L2, and designate the two possible lasers in the upper and lower modules. If a single-laser module is located in either position, the laser location is U1 or L1. In the example above, the power-on default module is the 850-nm laser in position L1, while the currently selected module is the 1310-nm laser in position U1. The defaults that apply to the current optical module are in the Default Setting column, and designated by the (U1) notation. The remaining defaults apply to instrument operation in general.

The softkeys on the menu allow you to save the current setting as the default value for a selected parameter, to save the current settings as default values for all user-definable defaults, to reset the current settings to their power-on default values, and

to restore all settings to their factory defaults. Turning the **CURSOR** knob causes each successive parameter to be highlighted, wrapping from bottom to top.

The User Defaults menu is two pages long. To scroll to the second page, turn the **CURSOR** knob so the highlighting moves past the bottom parameter on the first page. To return to the first page, turn the **CURSOR** knob to move the highlight up past the top parameter on the second page.

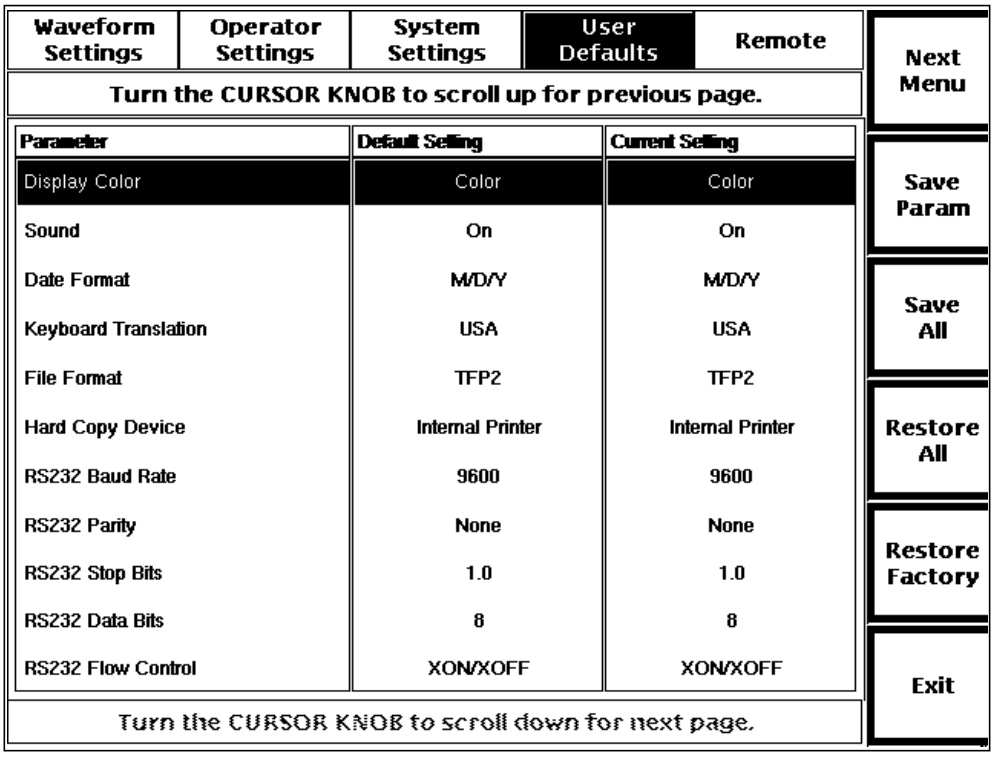


Figure 3-37. User Defaults Menu, Page 2

The softkeys perform the following functions:

Next Menu - go to the Remote menu.

Save Param - save the current setting of the highlighted parameter as the power-on default.

Save All - save the current settings of all the parameters listed on the User Defaults menu as power-on defaults. Note that this saves the current settings of the five module-dependent settings (pulse width, maximum range, refractive index, scattering coefficient, and masking type) as defaults for the active laser source, and saves the active laser source as the power-on default.

Restore All - restore settings for all the parameters listed to their current power-on default values.

Restore Factory - restore settings for all parameters listed to their factory defaults.

NOTE *The module-dependent settings for each laser source in the instrument are reset when **Restore All** and **Restore Factory** are pressed, not just the settings for the currently selected module. These settings include the pulse width, maximum range, refractive index, scattering coefficient, and masking type.*

Exit - return to the acquisition screen.

Until you use the User Defaults menu to define power-on defaults for instrument parameters, the factory-set defaults remain in effect. The factory-set power-on defaults are listed earlier in this chapter.

Remote Menu

The Remote menu, shown below, allows you to perform a number of XModem data-transfer operations. Go to the Remote menu from the acquisition screen by pressing the **Change Settings** softkey, then pressing **Next Menu** four times.

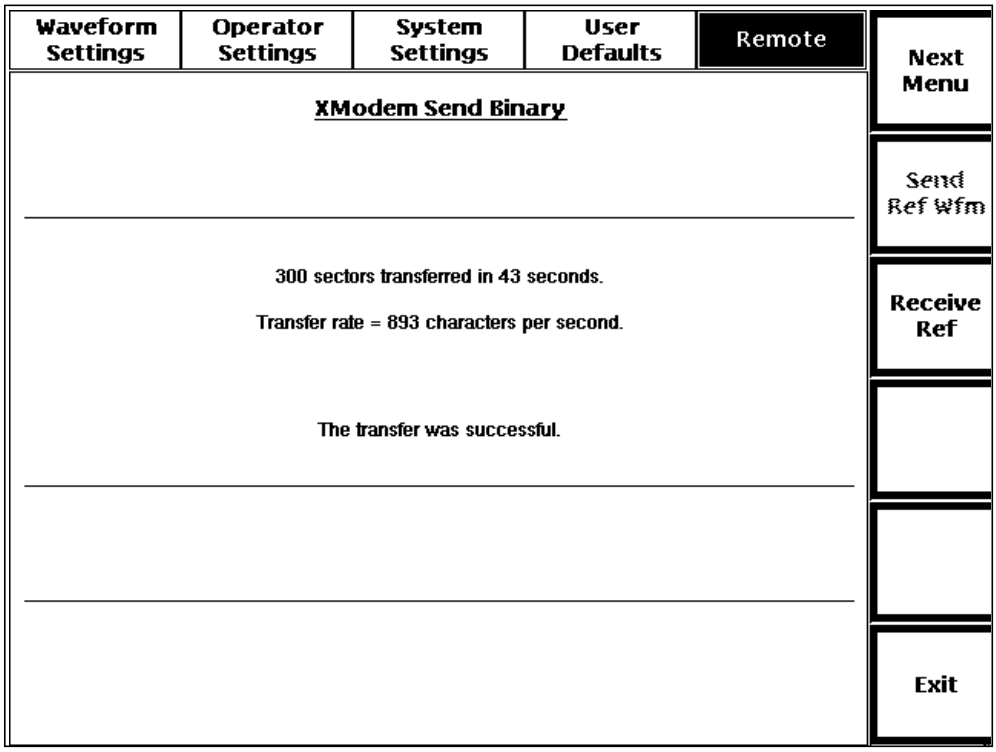


Figure 3-38. Remote Menu

Perform XModem operations by pressing the appropriate softkey on the menu. During data transfers, status information displays on the menu screen. The softkeys perform the following functions:

Next Menu - go to the next menu. From the Remote menu, pressing the **Next Menu** softkey displays the Waveform Settings menu.

Send Ref Wfm - send the contents of reference memory—the reference waveform and associated settings. This softkey does not function if reference memory is empty.

Receive Ref Wfm - receive a waveform file. The file is stored in reference memory, replacing any waveform data already residing in reference memory.

Abort Transfer - stop an XModem data transfer that is in progress. This softkey is not shown when there is no data transfer in progress.

Exit Menus - return to the acquisition screen.

During XModem data transfers, the only RS232 parameter used is baud rate. The other serial-port parameters are temporarily defaulted to the settings required by XModem. When an XModem transfer is complete, the settings revert to their original values. Refer to the System Settings menu descriptions in this chapter for information on setting RS232 parameters.

NOTE *The XModem function supports only long packets when using the Send function.*

4 Making Optical Fiber Measurements

The FiberMaster OTDR offers the following five modes of optical-fiber measurement:

1. Preview - displays an overview of the fiber. Preview is the default mode entered at power on, and provides a clear view of the fiber under test. Use Preview mode to measured fiber length and distances to events on the fiber. (Unlike the other measurement modes, Preview mode does not have its own softkey. Turn on Preview mode by turning off the other measurement modes.)
2. Two Point - the loss and distance are shown for a section of the waveform between the two distance cursors. Use Two Point mode to measure end-to-end distance and loss, and fiber loss.
3. Splice Loss - the splice loss (or gain) at the distance cursor is displayed. Use Splice Loss mode to measure the loss caused by a splice, connector, or other fiber feature.
4. Link Return Loss - the return loss of a fiber link is shown. Link return loss measures the amount of transmission energy lost over a fiber link due to light being reflected back towards its source. Link return loss is expressed as a ratio of the light entering the link to the total light reflected by the link, and allows you to characterize the performance of a fiber link without having to measure each reflective event in the link.
5. Event Return Loss - displays the return loss for a particular reflective event on the fiber. The event return loss is given as a ratio of the light entering the event to the light reflected by the event, and measures the transmission energy lost due to light reflected by a particular connector.

You can make measurements at any time, including during an active acquisition. By pressing softkeys, you can easily move from mode to mode, as various types of measurements are required. And you can manually adjust automatic two-point, splice-loss, and return-loss measurements, if necessary.

This chapter describes measurements in each mode of operation and how to make manual adjustments to two-point, splice-loss, and return-loss fiber measurements.

You can locate, measure, and document faults using FiberMaster's event-marking and event-table features, described in the following chapter, *Event Marking*.

In addition to the basic optical-fiber measurements described in this chapter, FiberMaster offers extended fiber-analysis capabilities, such as high-density data acquisition, real-time mode, and a dual-trace display. These functions are covered in the chapter 6, *Advanced Operating Functions*.

General Guidelines

When making measurements, observe these general principles:

Refractive Index - before making distance measurements, check that the refractive index setting is correct for the fiber under test. The refractive index setting can affect distance-measurement accuracy. If you do not know the refractive index for the fiber, you can calibrate it using a known length of fiber or known distance to an event on the fiber. Refer to chapter 3 for instructions on how to set and calibrate the refractive index.

Event Location - to measure the distance to an event on a waveform, use the **CURSOR** knob to move the active distance cursor to the leading edge (the left edge) of the event. The left edge is the actual location of the event, which may be a reflective loss caused by a mechanical splice, connector, or break; or a nonreflective loss caused by a fusion splice or bend in the cable.

Preview Mode

The instrument automatically enters Preview mode at power on. At other times, enter Preview mode by turning off the current measurement mode. The highlighted softkey indicates the current measurement mode. Press and hold the highlighted softkey for two seconds to turn off the current mode and enter Preview mode. In Preview mode, no softkeys are highlighted.

Preview mode displays an uncluttered waveform for the fiber under test. There are two distance cursors in Preview mode. At power on, the inactive cursor is at the zero distance point of the waveform, and the active distance cursor is two pulse widths to the right.

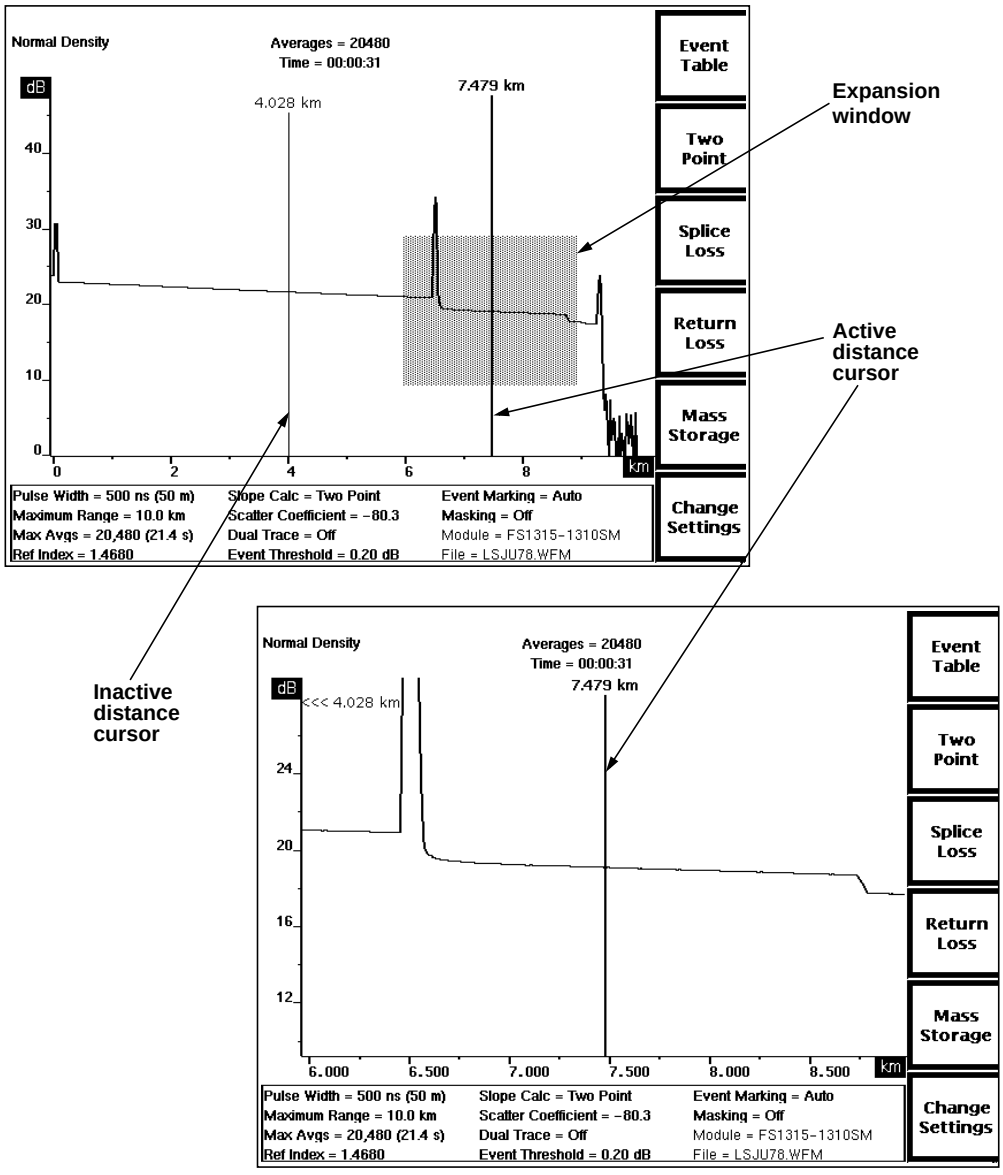


Figure 4-1. Preview Mode, Overview (top) and Expanded View (bottom)

Front Panel Controls - Preview Mode

When in Preview mode, use the front-panel controls to perform the following functions:

Event Table softkey — Exit the acquisition screen and display the event table for the fiber under test. Pressing and holding the **Event Table** softkey for two seconds turns event markers on and off without exiting the acquisition screen. Refer to chapter 5, *Event Marking*, for instructions on using event tables.

Two Point softkey — This softkey is available in Preview mode when return loss is off (refer to the description of the **Exit Return Loss** softkey, below). Press the **Two Point** softkey to exit Preview mode and enter Two Point mode. The existing cursor positions are used for two-point measurements. From Two Point mode, press and hold the **Two Point** softkey for two seconds to exit Two Point mode and enter Preview mode.

Splice Loss softkey — This softkey is available in Preview mode when return loss is off (refer to the description of the **Exit Return Loss** softkey, below). Press the **Splice Loss** softkey to exit Preview mode and enter Splice Loss mode. The existing active distance cursor location is used for splice-loss calculations. To return to Preview mode, press and hold the **Splice Loss** softkey for two seconds.

Link Return Loss softkey — This softkey is available in Preview mode when return loss is on (refer to the description of the **Return Loss** softkey, below). Press the **Link Return Loss** softkey to exit Preview mode and enter Link Return Loss mode. The existing cursor positions are used for link return-loss measurements. To return to Preview mode, press and hold the **Link Return Loss** softkey for two seconds.

Event Return Loss softkey — This softkey is available in Preview mode when return loss is on (refer to the description of the **Return Loss** softkey, below). Press the **Event Return Loss** softkey to exit Preview mode and enter Event Return Loss mode. The existing active distance cursor position is used for event return-loss measurements. To return to Preview mode, press and hold the **Event Return Loss** softkey for two seconds.

Return Loss softkey — This softkey is available only when return loss is off. Pressing **Return Loss** turns the return-loss measurement modes on. When return loss is on, the **Two Point** softkey is replaced by the **Link Return Loss** softkey, and the **Splice Loss** softkey is replaced by the **Event Return Loss** softkey. The **Return Loss** softkey is replaced by the **Exit Return Loss** softkey. Pressing **Exit Return Loss** turns off the return-loss modes, the softkeys revert to **Two Point** and **Splice Loss**, and the instrument returns to Preview mode.

Exit Return Loss softkey — This softkey is available only when return loss is on. Pressing **Exit Return Loss** turns the return loss modes off. The **Link Return Loss** softkey is replaced by the **Two Point** softkey, and the **Event Return Loss** softkey is replaced by the **Splice Loss** softkey. **Exit Return Loss** reverts to **Return Loss**.

Mass Storage softkey — Enter the mass-storage system, allowing you to store waveform and settings data on floppy disk or internal RAM, if installed. Refer to chapter 7, *Mass Storage*, for details on how to use this system.

Change Settings softkey — Enter the Waveform Settings menu, allowing you to change instrument settings, and giving access to additional configuration menus. Refer to chapter 3, *Getting Started*, for details on how to use these menus.

CURSOR knob — Move the active distance cursor along the waveform. Distance measurements are the only type of measurement you can make in Preview mode.

CURSOR SELECT knob — Pick which distance cursor is controlled by the **CURSOR** knob. The active cursor is displayed at a brighter intensity to differentiate it from the inactive cursor.

The **CURSOR SELECT** button also offers a "join cursors" function, useful when the inactive cursor is not on the screen. Press and hold the **CURSOR SELECT** button to move the inactive cursor to the same location as the active cursor.

EXPAND button — Switch between overview and expanded view. Expanded-view distance measurements may be at higher resolution. Using the expansion window and working with high-density data are explained in more detail in chapter 6, *Advanced Operating Functions*.

Vertical **SIZE** knob — In overview, expand and contract the expansion window vertically. In expanded view, the vertical **SIZE** knob expands and contracts the waveform itself vertically.

When dual-trace mode is on in expanded view, the vertical **SIZE** knob operates on both waveforms simultaneously. Each waveform expands and contracts around the point where it intersects the active distance cursor.

Horizontal **SIZE** knob — In overview, expand and contract the expansion window horizontally. In expanded view, the horizontal **SIZE** knob expands and contracts the waveform itself horizontally. This does not affect distance measurements, unless you expand into or out of high-density data.

When dual-trace mode is on in expanded view, the horizontal **SIZE** knob operates on both waveforms simultaneously. Each waveform expands and contracts around the point where it intersects the active distance cursor.

Vertical **POSITION** knob — Move the active waveform up and down on the display. It is possible to move the waveform off the display.

When dual-trace mode is on, the vertical **POSITION** knob operates only on the active waveform.

Horizontal **POSITION** knob

Move the waveform right and left on the display. In both overview and expanded view, horizontal movement is limited to half the maximum range in either direction.

When dual-trace mode is on, the horizontal **POSITION** knob operates on both waveforms simultaneously.

WFM SELECT button

Pick whether the current waveform or the reference waveform is active. The indicator next to the **WFM SELECT** button lights to show which waveform is active. In single-trace mode, the active waveform is the only one displayed.

When dual trace is on and both the current and reference waveforms are displayed, the dB scale is that of the active waveform, which is displayed at a higher intensity. You can make measurements on the active waveform. The difference between the scales of the active and inactive waveforms is shown at the top of the vertical scale. To align the two waveforms vertically, press and hold the **WFM SELECT** button. The inactive waveform moves to the same scale as the active waveform, and the difference in the scales displays as 0 dB.

When dual trace is off, and the view is in overview, pressing and holding the **WFM SELECT** button zeros the waveform's position—it is moved so that 0 dB is at the bottom of the vertical scale and 0 kilometers (or kilofeet) is at the left of the horizontal scale.

STORE button

Store the current waveform into reference memory. Any prior contents of reference memory are erased.

MODULE SELECT button

Select the next available laser. Changing the laser source requires a new acquisition. When you press the **MODULE SELECT** button, a message displays instructing you to press **START/STOP** to acquire new data using the new laser. In addition, any waveform parameters that change when you change laser sources are highlighted to show that these parameters no longer match the displayed waveform data. The highlighting is cleared when new data is acquired.

START/STOP button

Start a new acquisition. If an acquisition is already in progress, pressing the **START/STOP** button stops it.

Pressing and holding the **START/STOP** button starts a real-time acquisition. The measurement mode automatically switches to Two Point during a real-time acquisition.

The **LOSS** knobs have no effect in Preview mode.

Preview Mode Measurements—Examples

Use Preview mode to measure fiber length and distances to events on the fiber, as shown in these examples:

1. Turn the **CURSOR** knob to move the active distance cursor to the leading edge of the event. In the example below, the cursor is on the reflection caused by the end of the fiber.

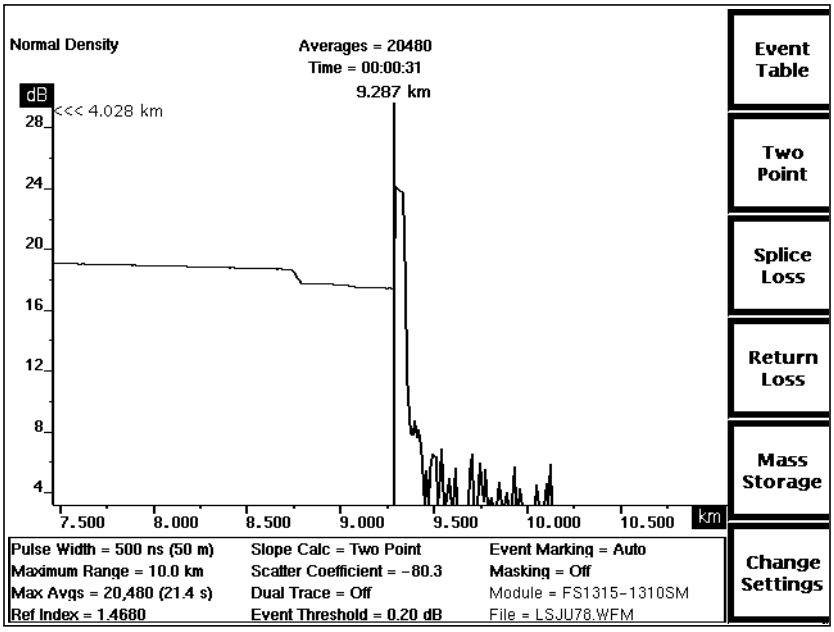


Figure 4-2. Preview Mode, Measuring Distance to End of Fiber

2. Press the **EXPAND** button to expand the view of the event if you need more accurate cursor positioning. The example below shows the distance cursor on the leading edge of a nonreflective loss caused by a fusion splice.

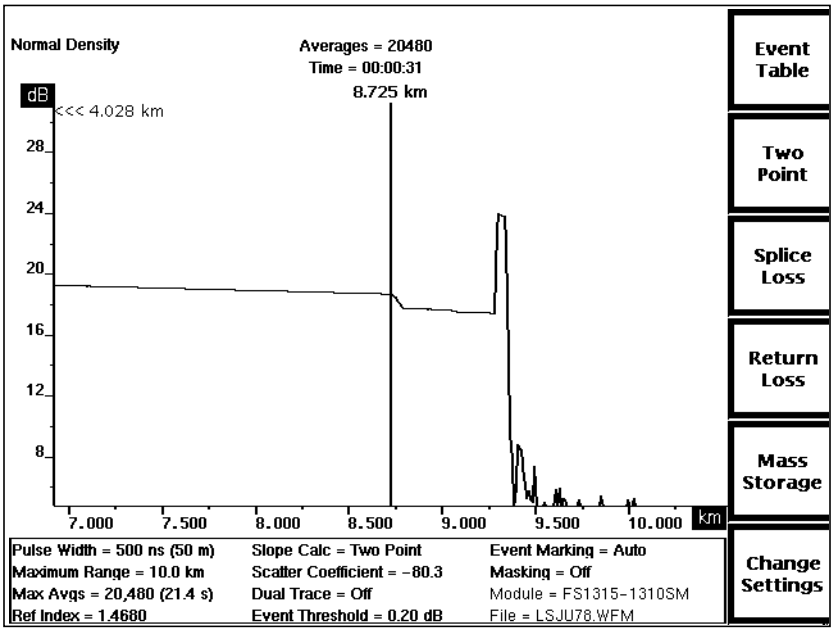


Figure 4-3. Preview Mode, Measuring Distance to Fusion Splice

3. The reading at the cursor is the distance from FiberMaster's front-panel connector to the event. In these examples, the end of the fiber is 9.287 km from the front panel, and the fusion splice is 8.725 km away.

Two Point Mode

Enter Two Point mode by pressing the **Two Point** softkey on the acquisition screen. The softkey is highlighted to show the current measurement mode. Use Two Point mode to make measurements between two points on a fiber, including end-to-end distance and loss and fiber loss measurements.

NOTE *If return loss is on, the **Two Point** softkey is replaced by the **Link Return Loss** softkey. In this case you must first press the **Exit Return Loss** softkey to turn off return loss and redisplay the **Two Point** softkey.*

Automatic Two-Point Measurements

Two distance cursors and two loss cursors define two-point measurements. When you enter Two Point mode the distance cursors are in the same locations as they were in the previous measurement mode. You can then move the distance cursors to make additional two-point measurements at other locations along the waveform. New automatic two-point measurements are made at each new position of the active distance cursor, if you have not made any manual adjustments.

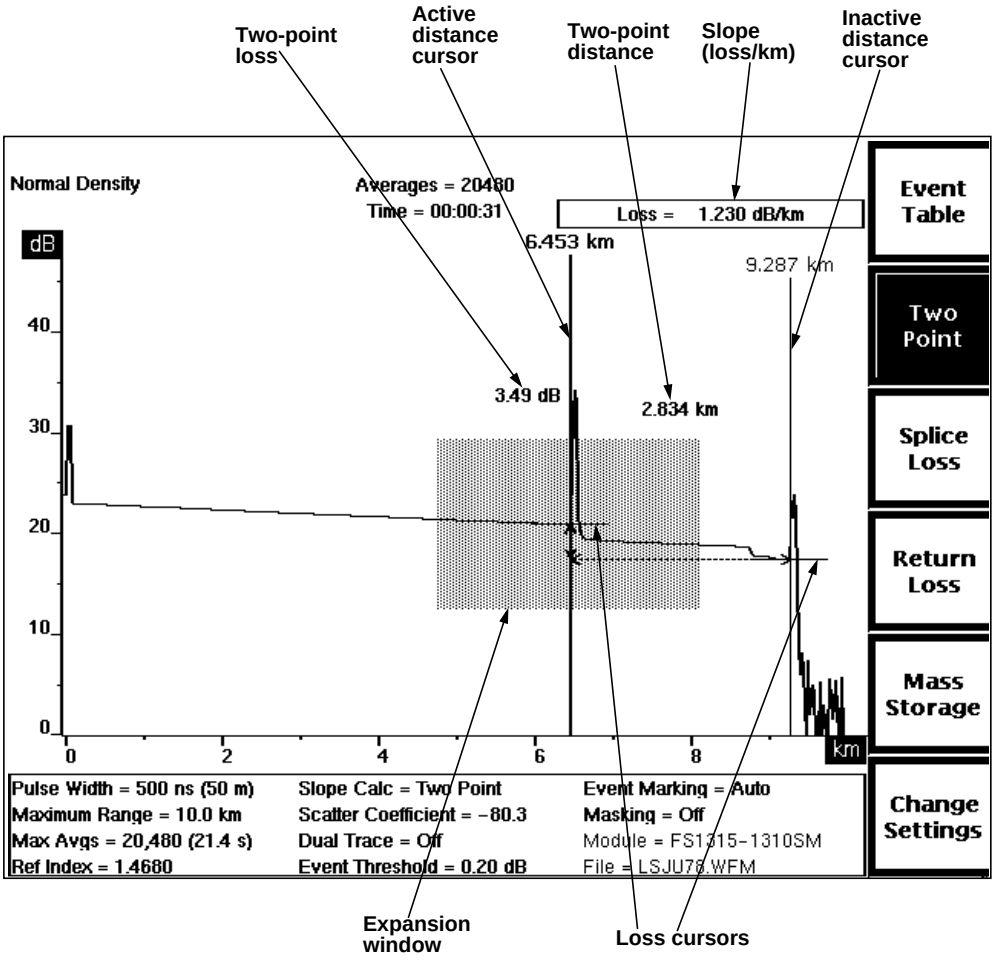


Figure 4-4. Two Point Mode (Two-Point Slope Calculation)

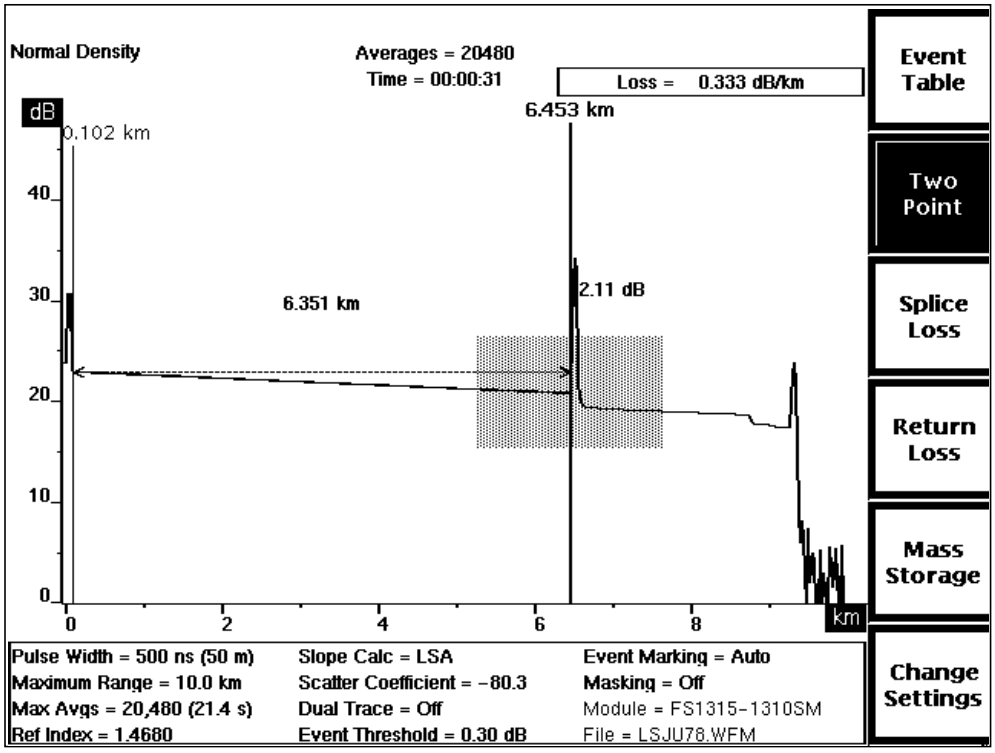


Figure 4-5. Two Point Mode (LSA Slope Calculation)

The loss cursors are located on the distance cursors, positioned at the intersection of each distance cursor and the waveform. The loss cursors move horizontally as the distance cursors are moved, and move vertically automatically with the slope of the waveform.

The two-point distance is the distance between the distance cursors. Two-point distance is shown graphically as a dashed line between the two distance cursors. The two-point loss is the difference between the decibel level of the waveform at the right loss cursor and the decibel level at the left cursor, regardless of which distance cursor is active. The loss is shown graphically as a dashed portion of the active distance cursor. The numeric loss and distance values are displayed near the dashed lines.

The loss per distance unit, or slope of the waveform between the two cursors, is calculated and displayed in the upper right-hand corner of the screen. The method of calculation is determined by the slope-calculation parameter setting. (Refer to chapter 3, *Getting Started*, for details on setting instrument parameters.)

The two slope calculation methods are two point and least squares average (LSA). In two-point slope calculations, the two-point loss is divided by the two-point distance, using the data point at each intersection between the loss cursors and the waveform. In LSA slope calculations, the data points on the waveform between the distance cursors are used to determine the best-fitting straight line using the least squares average algorithm.

NOTE *Use the LSA slope calculation method for measuring fiber loss on featureless sections of backscatter, and the two-point method for most other two-point measurements.*

Figure 4-4 shows an example of Two Point mode measurements, using the two-point slope calculation. Figure 4-5 shows an LSA slope calculation, which displays a straight line fitted between the points where the distance cursors intersect the waveform.

Manual Two-Point Measurements

Make manual adjustments to two-point measurements by adjusting the slopes and vertical positions of the loss cursors. When they are manually adjusted, two-point loss cursors elongate (extending from the opposite distance cursor to the edge of the display), to aid in aligning the cursors with the waveform. Loss cursor positions then maintain the same two-point loss (or gain) when you move the active distance cursor—the amplitude of the point where the loss cursor intersects the distance cursor remains constant as the distance cursor moves. The loss per distance unit is recalculated at each new distance-cursor position.

Manual adjustments are retained until you restart automatic two-point measurements by pressing the **Two Point** softkey. An automatic two-point measurement is made using the current distance-cursor locations.

NOTE *Link Return Loss mode is a variation of Two Point mode. If you turn on return loss, manual adjustments made in Two Point mode are retained and displayed in Link Return Loss mode. If you restart automatic link return-loss measurements, or if you make further manual adjustments in Link Return Loss mode, these changes are retained when you re-enter Two Point mode. Measurements you make in any other mode do not affect manual two-point measurements, and vice versa.*

Front-Panel Controls—Two Point Mode

When in Two Point Mode, use the front-panel controls to perform the following functions:

Event Table softkey — Exit the acquisition screen and display the event table for the fiber under test. Pressing and holding the **Event Table** softkey for two seconds turns event markers on and off without exiting the acquisition screen. Refer to chapter 5, *Event Marking*, for instructions on using event tables.

Two Point softkey — Restart two-point measurements using the current distance-cursor locations. You can manually adjust a two-point measurement using the vertical and slope **LOSS** knobs, as described for these controls. Any manual adjustments made in Two Point mode are retained until you press the **Two Point** softkey again.

If you exit Two Point mode after making manual adjustments, the adjustments are retained and displayed when you re-enter Two Point mode (unless you make changes in the related return-loss mode, Link Return Loss— see note on previous page). In this case, press the **Two Point** softkey again to clear user-adjusted measurements and make new two-point measurements using the current distance-cursor positions.

From Two Point mode, press and hold the **Two Point** softkey for two seconds to exit Two Point mode and enter Preview mode.

Splice Loss softkey — Exit Two Point mode and enter Splice Loss mode. The active distance-cursor location is used for splice-loss measurements.

Return Loss softkey — This softkey is available only when return loss is off. Pressing **Return Loss** turns the return-loss measurement modes on. When return loss is on, the **Two Point** softkey is replaced by the **Link Return Loss** softkey, and the **Splice Loss** softkey is replaced by the **Event Return Loss** softkey. The **Return Loss** softkey is replaced by the **Exit Return Loss** softkey. Pressing **Exit Return Loss** turns off the return-loss modes, the softkeys revert to **Two Point** and **Splice Loss**, and the instrument returns to Two Point mode.

Mass Storage softkey — Enter the mass-storage menu system, allowing you to store waveform and settings data on floppy disk or internal RAM, if installed. Refer to chapter 7, *Mass Storage*, for details on how to use this system.

Change Settings softkey — Enter the Waveform Settings menu, allowing you to change instrument settings, and giving access to additional configuration menus. Refer to chapter 3, *Getting Started*, for details on how to use these menus.

CURSOR knob — Move the active distance and loss cursors along the waveform. New two-point measurements are made at the new position.

CURSOR SELECT button

Pick which distance cursor is controlled by the **CURSOR** knob. The active cursor is displayed at a brighter intensity.

The **CURSOR SELECT** button also offers a "join cursors" function, useful when the inactive cursor is not on the screen. Press and hold the **CURSOR SELECT** button to move the inactive distance and loss cursors to the same location as the active cursors.

Vertical **LOSS** knob

For two-point slope calculations: move the loss cursor on the active distance cursor up and down. Use this knob to manually adjust the two-point loss value. The loss cursor elongates to make accurate positioning easier. Moving the loss cursor vertically affects two-point slope calculations.

For LSA slope calculations: the vertical **LOSS** knob vertically positions the loss cursor, but maintains the same slope. Unlike two-point slope calculations, LSA slope calculations are not affected by the vertical repositioning of the loss cursor.

Any manual adjustment to the position of the loss cursor causes the message **User Adjusted Measurement** to appear in the top left corner of the screen.

Slope **LOSS** knob

For two-point slope calculations: rotate the loss cursor at the active distance cursor. When you are making manual two-point loss adjustments, this allows you to align the slope of the cursor with the waveform. The cursor elongates to make accurate positioning easier. This adjustment does not affect measurement values.

For LSA slope calculations: rotate the LSA loss cursor around the point where it touches the active distance cursor. This function changes the slope value.

Any manual adjustment to the automatically placed loss cursor causes the message **User Adjusted Measurement** to appear at the top left of the display.

EXPAND button

Switch between overview and expanded view. Unless expanded view includes high-density data, there is no difference in measurement values, except that expanded-view measurements may be at higher resolution. With high-density data, there may be slight variations in loss measurements. (Using the expansion window and working with high-density data are explained in chapter 6, *Advanced Operating Functions*.)

Vertical **SIZE** knob	In overview, expand and contract the expansion window vertically. In expanded view, the vertical **SIZE** knob expands and contracts the waveform itself vertically. When dual-trace mode is on in expanded view, the vertical **SIZE** knob operates on both waveforms simultaneously. Each waveform expands and contracts around the point where it intersects the active distance cursor.
Horizontal **SIZE** knob	In overview, expand and contract the expansion window horizontally. In expanded view, the horizontal **SIZE** knob expands and contracts the waveform itself horizontally. This does not affect measurements, unless you expand into or out of high-density data. When dual-trace mode is on in expanded view, the horizontal **SIZE** knob operates on both waveforms simultaneously. Each waveform expands and contracts around the point where it intersects the active distance cursor.
Vertical **POSITION** knob	Move the active waveform up and down on the display. It is possible to move the waveform off the display. When dual-trace mode is on, the vertical **POSITION** knob operates only on the active waveform.
Horizontal **POSITION** knob	Move the waveform right and left on the display. In both overview and expanded view, horizontal movement is limited to half the maximum range in either direction. When dual-trace mode is on, the horizontal **POSITION** knob operates on both waveforms simultaneously.

WFM SELECT button

Pick whether the current waveform or the reference waveform is active. The active waveform is the only one on which you can make measurements, and is displayed at a brighter intensity than the inactive waveform. In single-trace mode, the active waveform is the only one displayed. The indicator next to the **WFM SELECT** button lights to show which waveform is active.

When dual trace is on and both the current and reference waveforms are displayed, the dB scale is that of the active waveform. The difference between the scales of the active and inactive waveforms is displayed at the top of the vertical scale. To align the two waveforms vertically, press and hold the **WFM SELECT** button. The inactive waveform moves to the same scale as the active waveform, and the difference in the scales displays as 0 dB.

When dual trace is off, and the view is in overview, pressing and holding the **WFM SELECT** button zeros the waveform's position—it is moved so that 0 dB is at the bottom of the vertical scale and 0 kilometers (or kilofeet) is at the left of the horizontal scale.

STORE button

Store the current waveform into reference memory. Any prior contents of reference memory are erased.

MODULE SELECT button

Select the next available laser. Changing the laser source requires a new acquisition. When you press the **MODULE SELECT** button, a message displays instructing you to press **START/STOP** to acquire new data using the new laser. In addition, any waveform parameters that change when you change laser sources are highlighted to show that these parameters no longer match the displayed waveform data. The highlighting is cleared when new data is acquired.

START/STOP button

Start a new acquisition. Any manually adjusted measurements are retained until you press the **Two Point** softkey to restart measurements. If an acquisition is already in progress, pressing the **START/STOP** button stops the acquisition. Pressing and holding the **START/STOP** button starts a real-time acquisition.

Two Point Measurements—Examples

Use Two Point mode to make two-point, end-to-end distance and loss measurements, and to measure fiber loss (loss per distance unit).

Two-Point End-to-End Measurements

To measure distance and loss between any two points on a fiber, follow the steps described below. In this example, the slope calculation setting used was two point, the recommended setting for end-to-end measurements.

1. Turn the **CURSOR** knob to place the active distance cursor on the leading edge of the first event. As you move the distance cursor, the loss cursor follows the slope of the waveform.

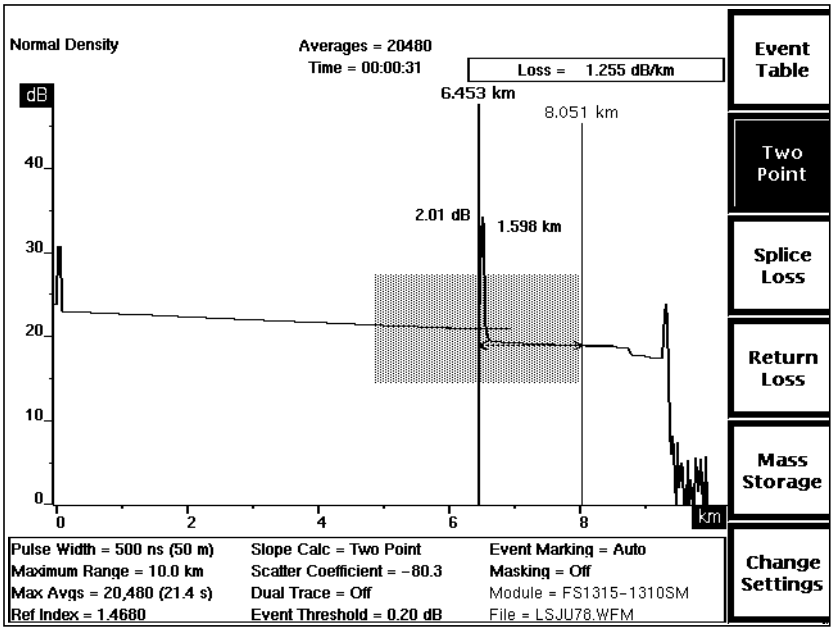


Figure 4-6. Automatic Two-Point Measurement—Positioning the First Distance Cursor

2. Press the **EXPAND** button to expand the view of the event, if necessary for precise cursor placement. (If both cursors are not on the screen in expanded view, you may want to press **EXPAND** again to return to overview before going to the next step).

3. Press **CURSOR SELECT** to switch active cursors.

4. Place the second cursor on the leading edge of the second event, expanding the view if necessary. An automatic two-point measurement is made, using the points where the distance and loss cursors intersect the waveform. See the example, below. Two-point distance and loss figures are shown near the waveform, and loss per unit of distance is displayed in the upper right corner of the screen.

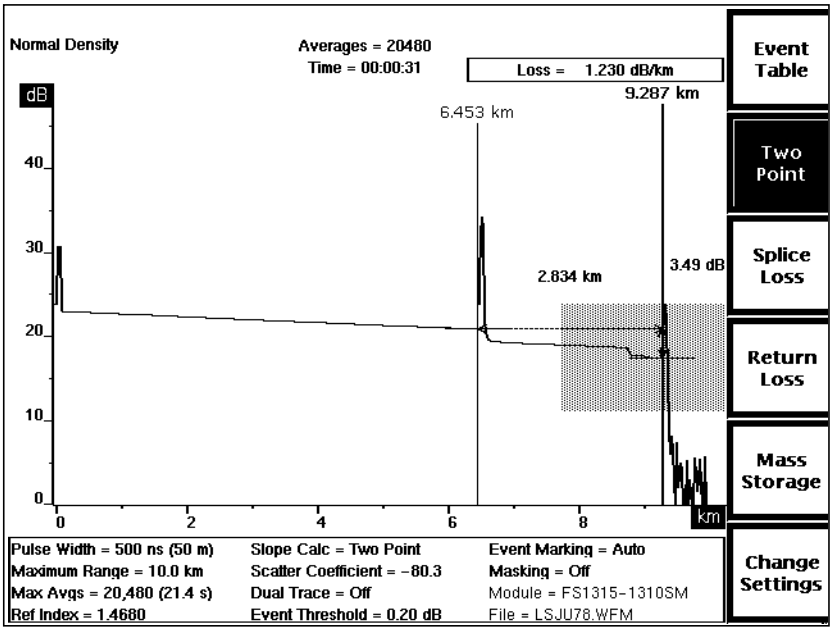


Figure 4-7. Automatic Two-Point Measurement—Positioning the Second Distance Cursor

5. To make manual adjustments to automatic measurements, use the vertical and slope **LOSS** knobs to adjust the active loss cursor so it is aligned with the waveform. The cursor extends from the opposite distance cursor to the edge of the display, as shown below in expanded view. Fit the cursor so there is an equal number of noise spikes above and below it.

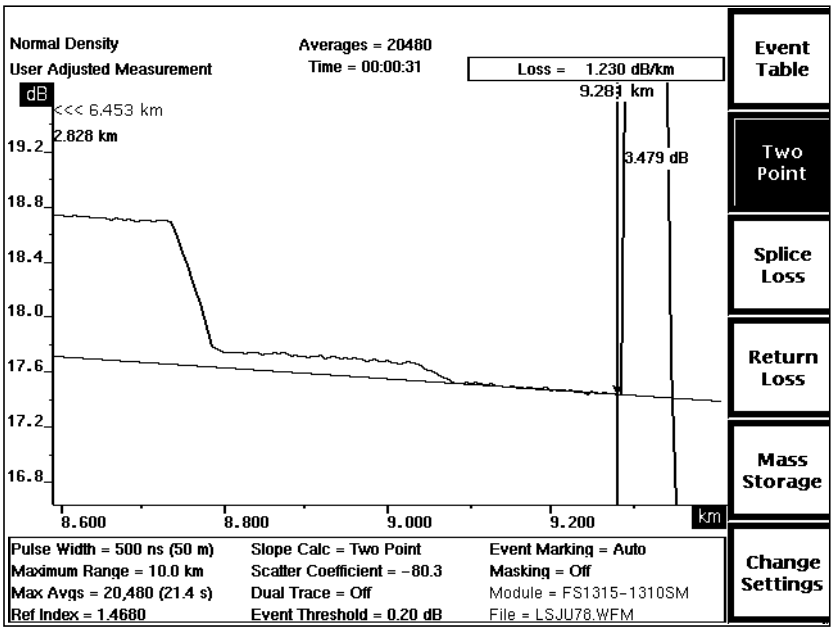


Figure 4-8. User-Adjusted Two-Point Measurement—Adjusting the Active Loss Cursor

6. Press **CURSOR SELECT** to switch active cursors.

7. Use the vertical and slope **LOSS** knobs to adjust the second loss cursor to the slope of the waveform, as shown below in expanded view.

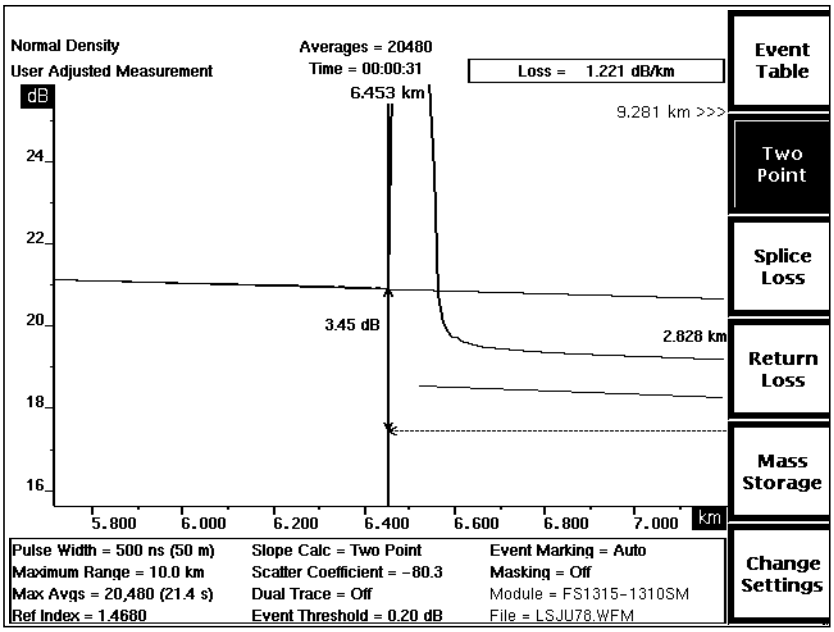


Figure 4-9. User-Adjusted Two-Point Measurement—Adjusting the Loss Cursor in Expanded View

8. The user-adjusted two-point measurement is shown in overview below. Two-point distance and loss between the distance cursors are shown on the acquisition screen near the waveform. In this example, the two-point distance is 2.828 km, and the two-point loss is 3.45 dB. The loss per distance unit for the same section of fiber is calculated and displayed in the upper right corner of the screen.

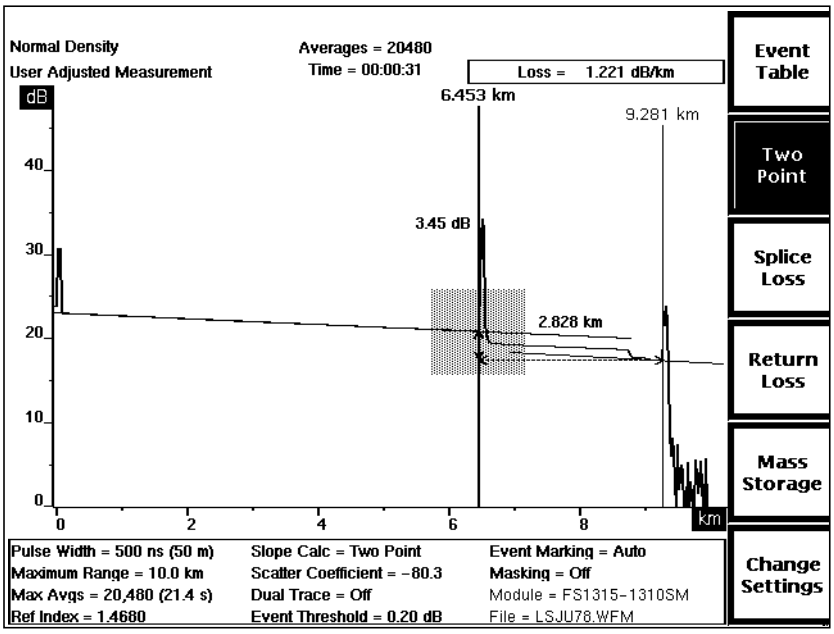


Figure 4-10. User-Adjusted Two-Point Measurement

Fiber Loss Measurements

Measure fiber loss on a featureless section of backscatter, using the LSA method of slope calculation.

1. Enter the menu system and select LSA as the slope calculation method. The display shows one loss cursor, fitted as a straight line along the waveform between the distance cursors.

2. Using the **CURSOR** knob, place the active distance cursor at the starting point of the section of fiber used for loss measurement, beyond the tail caused by any previous reflection. Press the **EXPAND** button to expand the view, if necessary for precise cursor placement. In the example, below, the cursor is placed just past the front-panel connector reflection.

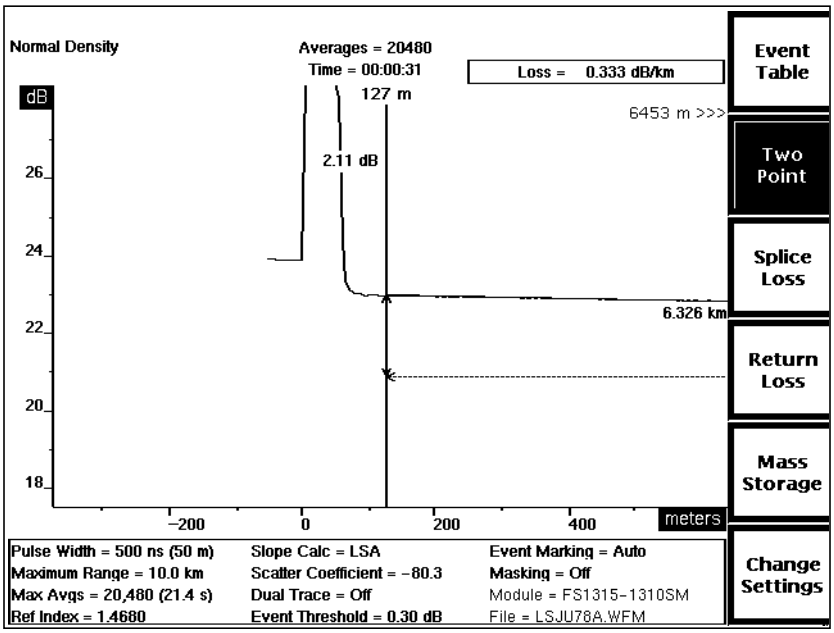


Figure 4-11. Automatic Fiber Loss Measurement—Placing the First Cursor

3. Press **CURSOR SELECT** to switch active cursors.

4. Move the second distance cursor to the end of the section of fiber being measured. In the example below, the second cursor is placed where the reflection indicates a connector at the end of this section of fiber. Automatic two-point measurements are made. In the example, the fiber loss between the distance cursors is 0.333 dB per km.

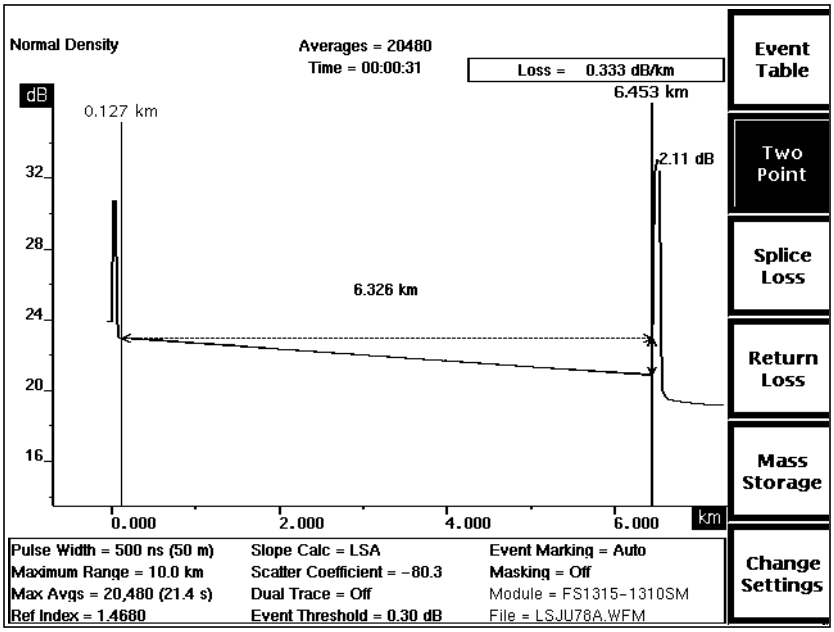


Figure 4-12. Automatic Fiber-Loss Measurement—Placing the Second Cursor

5. You can make adjustments to the automatic measurement, if necessary, by using the vertical and slope **LOSS** knobs to adjust the LSA cursor. The vertical **LOSS** knob moves the cursor up and down, and the slope **LOSS** knob rotates the cursor around the active distance cursor.

Splice Loss Mode

Enter Splice Loss mode by pressing the **Splice Loss** softkey on the acquisition screen. The softkey is highlighted to show the current measurement mode. Use Splice Loss mode to measure loss caused by a particular fiber feature, for example a connector or splice.

NOTE *If return loss is on, the **Splice Loss** softkey is replaced by the **Event Return Loss** softkey. In this case you must first press the **Return Loss** softkey to turn off return loss and redisplay the **Splice Loss** softkey.*

Automatic Splice-Loss Measurements

In Splice Loss mode there is only one distance cursor. There are two loss cursors, matched to the waveform on either side of the distance cursor. The loss cursors move horizontally as the distance cursor is moved. When you move the distance cursor using the **CURSOR** knob, an automatic splice-loss measurement is made at the new cursor position (unless there are previous manual adjustments). The splice loss (or gain) value is displayed to the left of the distance cursor, and is shown graphically as a dashed portion of the distance cursor.

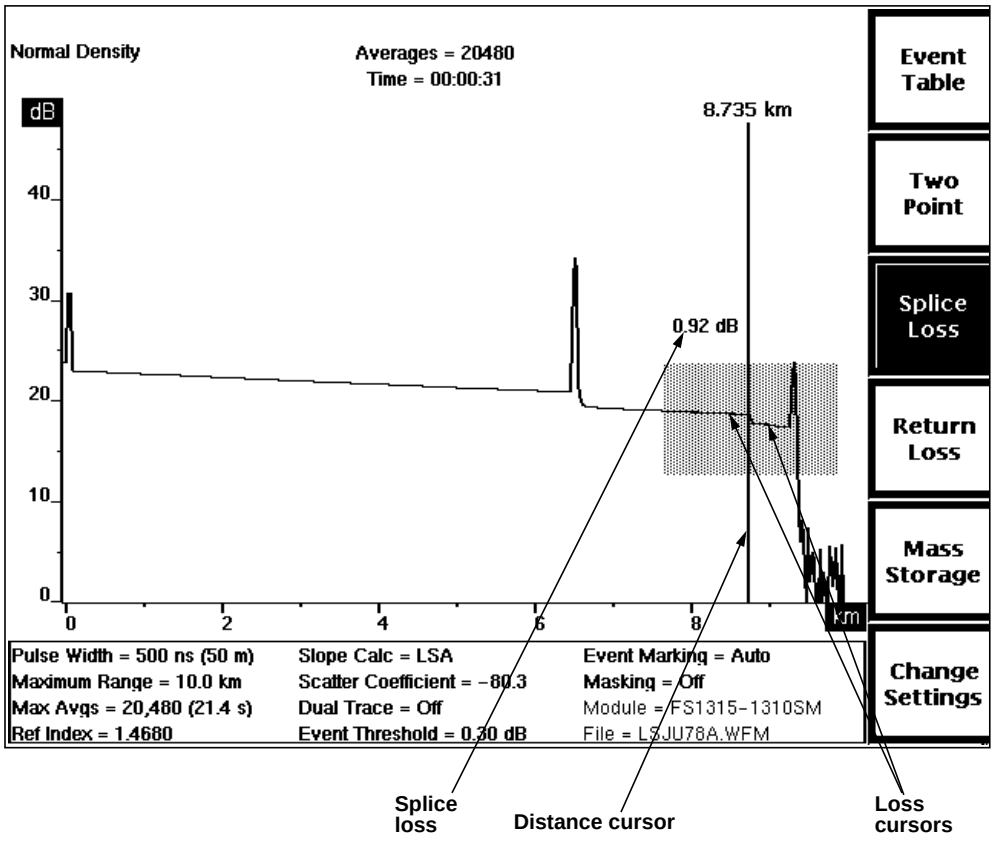


Figure 4-13. Splice Loss Mode

Automatic measurements are calculated by fitting loss cursors to waveform data points. The lengths of the loss cursors indicate the sections of the waveform used in the measurement. The width of the expansion window determines the lengths of the loss cursors, which extend from the distance cursor to the edges of the expansion window. When making splice-loss measurements, you can select the waveform data used in the measurements by adjusting the size of the expansion window. You can include or exclude specific fiber features from your measurements this way. The cursors may be automatically limited, however, to exclude features from the splice-loss measurement, such as large reflections. Automatic measurements also exclude the splice or event itself. Dashed portions of the loss cursors indicate the excluded segments of the waveform.

In addition, you can use the masking function to control the data used when positioning loss cursors in Splice Loss mode. The portions of the waveform that are masked are not used in measurement calculations. The availability of the masking function depends on the laser source—only the FM/FS-series 1300 nm MM, 1310 nm SM, and 1550 nm SM modules support masking.

Manual Splice-Loss Measurements

To adjust measurements, select the active loss cursor using the **CURSOR SELECT** button. You can adjust the active loss cursor using the vertical and slope **LOSS** knobs. Manually adjusted loss cursors extend along the slope of the waveform to the edges of the display to help you make accurate adjustments. As you move the distance cursor, the loss cursors maintain the same slopes and vertical positions, and splice loss is recalculated.

Manual adjustments are retained until you restart automatic splice-loss measurements, by pressing the **Splice Loss** softkey. An automatic splice-loss measurement is made at the current distance-cursor position.

NOTE *Event Return Loss mode is a variation of Splice Loss mode. If you turn on return loss, manual adjustments made in Splice Loss mode are retained and displayed in Event Return Loss mode. If you restart automatic event return-loss measurements, or if you make further manual adjustments in Event Return Loss mode, these changes are retained when you re-enter Splice Loss mode. Measurements you make in any other mode do not affect manual splice-loss measurements, and vice versa.*

Splice Loss and Event Marking

In Splice Loss mode, when event marking is turned on and you move the distance cursor anywhere onto an event marker or an event, the cursor automatically snaps to the location of the event. You can then move the cursor on the event. If you then press the **Splice Loss** softkey, the cursor snaps onto the event again.

Front Panel Controls – Splice Loss Mode

When in Splice Loss mode, use the front-panel controls to perform the following functions. Make manual adjustments to splice-loss measurements using the **CURSOR SELECT**, vertical **LOSS**, and slope **LOSS** knobs, as described below for each of these controls.

Event Table softkey — Exit the acquisition screen and display the event table for the fiber under test. Pressing and holding the **Event Table** softkey for two seconds turns event markers on and off without exiting the acquisition screen. Refer to chapter 5, *Event Marking*, for instructions on using event tables.

Two Point softkey — Exit Splice Loss mode and enter Two Point mode. The distance cursor where the last splice-loss measurement was made becomes the active distance cursor.

Splice Loss softkey — Restart automatic splice-loss measurements and clear any previous manual adjustments. You can manually adjust a splice-loss measurement using the **CURSOR SELECT** button and the vertical and slope **LOSS** knobs, as described for these controls. Any manual adjustments made in Splice Loss mode are retained until you press the **Splice Loss** softkey again.

If you leave Splice Loss mode after making manual adjustments, the adjustments are saved and redisplayed when you re-enter Splice Loss mode (unless you make changes in the related return-loss mode, Event Return Loss—see note on previous page). In this case, press the **Splice Loss** softkey again to clear user-adjusted measurements and make a new splice-loss measurement using the current distance-cursor position.

From Splice Loss mode, press and hold the **Splice Loss** softkey for two seconds to exit Splice Loss mode and enter Preview mode.

Return Loss softkey — This softkey is available only when return loss is off. Pressing **Return Loss** turns the return-loss measurement modes on. When return loss is on, the **Two Point** softkey is replaced by the **Link Return Loss** softkey, and the **Splice Loss** softkey is replaced by the **Event Return Loss** softkey. The **Return Loss** softkey is replaced by the **Exit Return Loss** softkey. Pressing **Exit Return Loss** turns off the return-loss modes, the softkeys revert to **Two Point** and **Splice Loss**, and the instrument returns to Splice Loss mode.

Mass Storage softkey — Enter the mass-storage menu system, allowing you to store waveform and settings data on floppy disk or internal RAM drive, if installed. Refer to chapter 7, *Mass Storage*, for details on using this system.

Change Settings softkey — Enter the instrument's Waveform Settings menu, allowing you to change instrument settings, and allowing access to additional configuration menus. Refer to chapter 3, *Getting Started*, for details on using these menus.

CURSOR knob — Move the distance cursor along the waveform. A new splice-loss measurement is made at the new position. When event marking is turned on and you move the distance cursor anywhere onto an event marker or an event, the cursor automatically snaps to the location of the event. You can then move the cursor on the event. If you move the cursor off the event and back on, or if you press the **Splice Loss** softkey, the cursor snaps onto the event again.

CURSOR SELECT knob — Pick the active loss cursor. The active loss cursor is displayed at a brighter intensity than the inactive cursor.

Pressing and holding the **CURSOR SELECT** button in Splice Loss mode joins the loss cursors—the inactive loss cursor is placed at the same vertical position and extends along the same slope as the active cursor.

Vertical **LOSS** knob — Move the active loss cursor up and down. Use this control to manually match the amplitude of the cursor to the waveform. The splice-loss value changes as you move the cursor vertically.

Any manual adjustment to the position of the loss cursor causes the message **User Adjusted Measurement** to appear in the top left corner of the screen.

Slope **LOSS** knob — Rotate the active loss cursor. Use this control to align the loss cursor with the slope of the waveform. This adjustment does not affect the splice-loss value.

Any manual adjustment to the position of the loss cursor causes the message **User Adjusted Measurement** to appear in the top left corner of the screen.

EXPAND button — Switch between overview and expanded view. Unless expanded view includes high-density data, there is no difference in measurement values, except that expanded-view measurements may be at higher resolution. With high-density data, slight variations in splice-loss measurements may occur. (Using the expansion window and working with high-density data are explained in more detail in chapter 6, *Advanced Operating Functions*.)

Vertical **SIZE** knob — In overview, expand and contract the expansion window vertically. In expanded view, the vertical **SIZE** knob expands and contracts the waveform itself vertically.

When dual-trace mode is on in expanded view, the vertical **SIZE** knob operates on both waveforms simultaneously. Each waveform expands and contracts around the point where it intersects the active distance cursor.

Horizontal **SIZE** knob — In overview, expand and contract the expansion window horizontally. In expanded view, the horizontal **SIZE** knob expands and contracts the waveform itself horizontally. This does not affect distance measurements, unless you expand into or out of high-density data.

When dual-trace mode is on in expanded view, the horizontal **SIZE** knob operates on both waveforms simultaneously. Each waveform expands and contracts around the point where it intersects the active distance cursor.

Vertical **POSITION** knob

Move the active waveform up and down on the display. It is possible to move the waveform off the display.

When dual-trace mode is on, the vertical **POSITION** knob operates only on the active waveform.

Horizontal **POSITION** knob

Move the waveform right and left on the display. In both overview and expanded view, horizontal movement is limited to half the maximum range in either direction.

When dual-trace mode is on, the horizontal **POSITION** knob operates on both waveforms simultaneously.

WFM SELECT button

Pick whether the current waveform or the reference waveform is active. The active waveform is the only one on which you can make measurements, and is displayed at a brighter intensity than the inactive waveform. In single-trace mode, the active waveform is the only one displayed. The indicator next to the **WFM SELECT** button lights to show which waveform is active.

When dual trace is on and both the current and reference waveforms are displayed, the dB scale is that of the active waveform. The difference between the scales of the active and inactive waveforms is displayed at the top of the vertical scale. To align the two waveforms vertically, press and hold the **WFM SELECT** button. The inactive waveform moves to the same scale as the active waveform, and the difference in the scales displays as 0 dB.

When dual trace is off, and the view is in overview, pressing and holding the **WFM SELECT** button zeros the waveform's position—it is moved so that 0 dB is at the bottom of the vertical scale and 0 kilometers (or kilofeet) is at the left of the horizontal scale.

STORE button

Store the current waveform into reference memory. Any previous contents of reference memory are erased.

MODULE SELECT button

Select the next available laser source. Changing the laser source requires a new acquisition. When you press the **MODULE SELECT** button, a message displays instructing you to press **START/STOP** to acquire new data using the new laser. In addition, any waveform parameters that change when you change laser sources are highlighted, indicating that these parameters no longer match the displayed waveform data. The highlighting is cleared when new data is acquired.

START/STOP button

Start a new acquisition. Any manually adjusted measurements are retained until you press the **Splice Loss** softkey to restart measurements. If an acquisition is currently in progress, pressing the **START/STOP** button stops it.

Holding the **START/STOP** button down for two seconds starts a real-time acquisition. The measurement mode automatically switches to Two Point mode during a real-time acquisition.

Splice-Loss Measurements—Examples

Use Splice Loss mode to measure the loss caused by a particular fiber feature.

1. Turn the **CURSOR** knob to move the distance cursor to the leading edge of the event to be measured. Use the expand function if necessary for precise cursor placement.
2. An automatic splice-loss measurement is made, and the loss is displayed on the screen next to the event. The example below shows an expanded-view, automatic splice-loss measurement made at the location of a fusion splice in the cable. The automatic measurement is made by fitting the loss cursors to the waveform on either side of the event being measured.

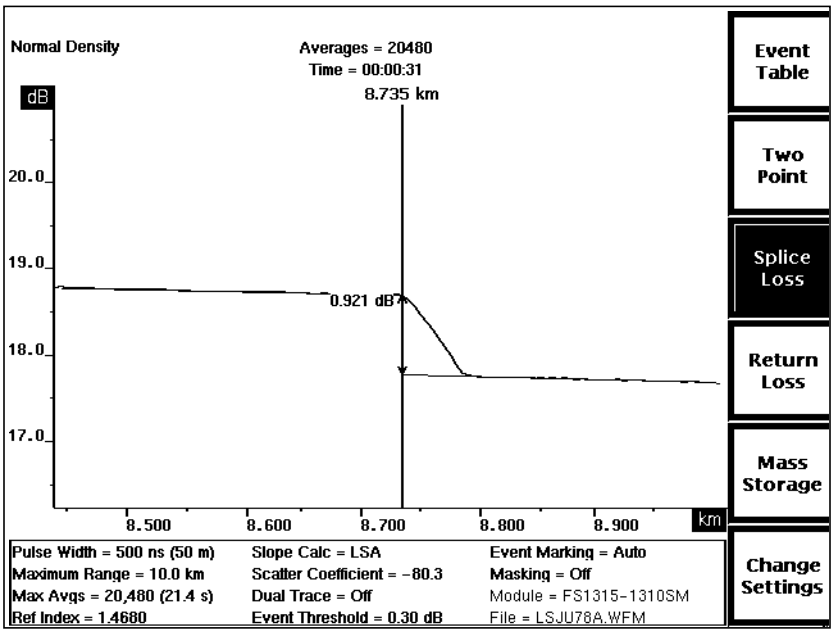


Figure 4-14. Automatic Splice-Loss Measurement

NOTE *In Splice Loss mode, automatic measurements are made by fitting loss cursors to waveform data points. The lengths of the loss cursors indicates the portion of the waveform used for measurement, and are determined by the width of the expansion window, in both overview and expanded view. The size of the expansion window, therefore, may cause automatic loss figures to vary. You can vary the width of the expansion window to control the number of data points used to perform the automatic splice-loss measurement.*

3. To make manual adjustments to automatic measurements, use the slope and vertical **LOSS** knobs to rotate the active loss cursor and move it vertically. The cursor elongates automatically, extending from the distance cursor to the edge of the display, to make it easier to fit to the waveform.

   Press **CURSOR SELECT** to activate the second loss cursor. Adjust the second cursor using the **LOSS** knobs. As you adjust the loss cursors, the splice loss is recalculated. The example below shows a manually adjusted splice loss measurement at the location of a connector.

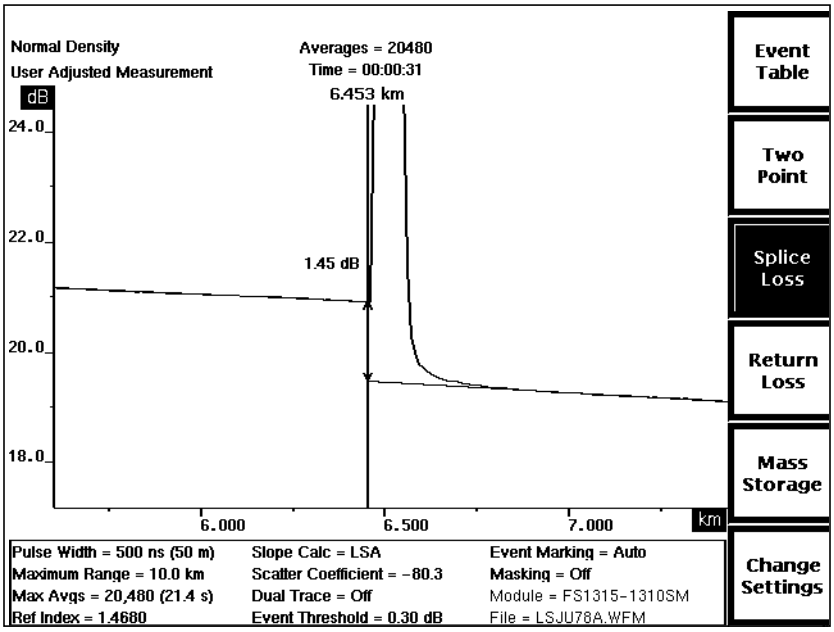


Figure 4-15. User-Adjusted Splice-Loss Measurement

Link Return Loss Mode

When FiberMaster is first turned on, the softkeys allow entry into Two Point, and Splice Loss modes. Two additional return-loss measurement modes are available via the **Return Loss** softkey. When you press **Return Loss** softkey, the **Two Point** and **Splice Loss** softkeys are replaced by the **Link Return Loss** and **Event Return Loss** softkeys

Enter Link Return Loss mode from Two Point mode simply by pressing the **Return Loss** softkey. From Preview and Splice Loss modes, enter Link Return Loss mode by pressing the **Return Loss** softkey, then the **Link Return Loss** softkey.

Use Link Return Loss mode to measure the transmission energy lost due to the total light reflected by the link.

Scattering Coefficient

The scattering coefficient is a parameter on the Waveform Settings menu that represents the amount of backscatter reflected by a particular fiber, and is used in return-loss calculations in Link Return Loss mode. The scattering coefficient is a characteristic of the fiber under test, and can vary from fiber to fiber. Before performing link return-loss measurements, check that the scattering coefficient is set to the correct value for the fiber being tested. The scattering coefficient for a particular fiber can usually be obtained from the fiber manufacturer. If you do not know the correct value, however, it is recommended that you use the factory-default values, which depend on the laser source. For more information on the scattering coefficient parameter, and how to set it, refer to chapter 3, *Getting Started*.

Automatic Link Return-Loss Measurements

Two distance cursors and one loss cursor define link return-loss measurements. When you enter Link Return Loss mode the distance cursors are in the same locations as they were in the previous measurement mode. You can then move the distance cursors to make measurements at other locations along the waveform. New automatic link return-loss measurements are made at each new position of the active distance cursor, if you have not made any manual adjustments.

The single loss cursor is located at the left-hand distance cursor, positioned at the intersection of the distance cursor and the waveform. The loss cursor moves horizontally as the distance cursor moves, and is automatically fitted to the slope of the waveform. This cursor is used to establish the backscatter level before the link, and can be adjusted manually.

The length of the loss cursor indicates the section of the waveform data used to determine the backscatter level. The width of the expansion window determines the length of the loss cursor. The loss cursor extends from the left distance cursor to the left edge of the expansion window. You can vary the length of the loss cursor (and thus the waveform data used for measurement) by adjusting the size of the expansion window (in overview) or by positioning the waveform horizontally (in

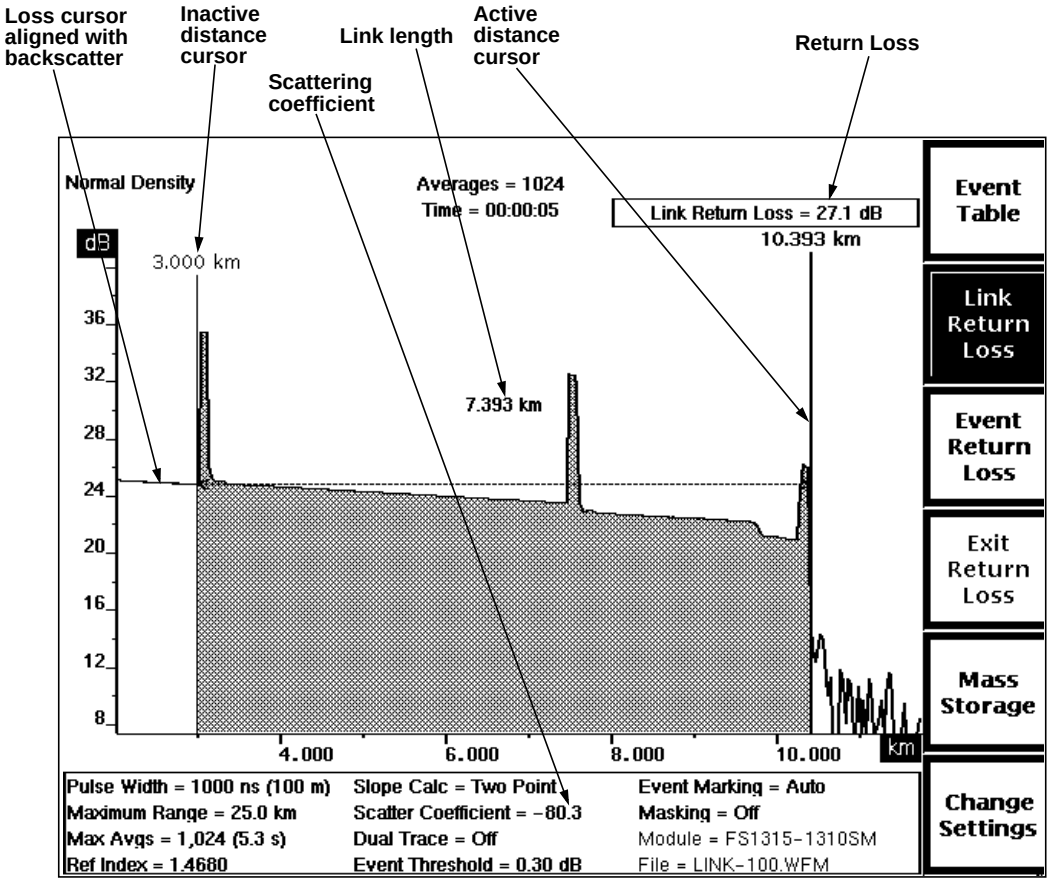


Figure 4-16. Link Return Loss Mode

expanded view). The cursor may be automatically limited, however, to exclude features from the link return-loss measurement, such as large reflections.

When the left edge of the expansion window does not extend beyond the left distance cursor, the loss cursor is fixed at a minimum length.

The distance between the two distance cursors is shown graphically as a dashed line between the cursors. The numeric distance value is displayed near the dashed line.

The return loss for the link specified by the distance cursors is calculated and displayed in the upper right-hand corner of the screen.

NOTE *Link return-loss measurements yield the most accurate results with masking off; however, you can perform link return-loss measurements when reflections have been masked using the AccuMask masking type. Link return-loss measurements on fiber links with reflections that have been masked using the QuickMask masking type are not accurate.*

Manual Link Return-Loss Measurements

Make manual adjustments to link return-loss measurements by adjusting the slope and vertical position of the loss cursor. When it is manually adjusted, the loss cursor extends to the edge of the display, to help in aligning the cursor with the backscatter. The loss cursor then maintains the same angle and vertical position when you move the active distance cursor—the amplitude of the point where the loss cursor intersects the distance cursor remains constant as the distance cursor moves. The link return loss is recalculated at each new distance-cursor position.

Manual adjustments are retained until you restart automatic link return-loss measurements by pressing the **Link Return Loss** softkey. An automatic link return-loss measurement is made using the current distance-cursor locations.

NOTE *Link Return Loss mode is a variation of Two Point mode. If you turn off return loss, manual adjustments made in Link Return Loss mode are retained and displayed in Two Point mode. If you restart automatic two-point measurements, or if you make further manual adjustments in Two Point mode, these changes are retained when you re-enter Link Return Loss mode. Measurements you make in any other mode do not affect manual link return-loss measurements, and vice versa.*

Front-Panel Controls—Link Return Loss Mode

When in Link Return Loss Mode, use the front-panel controls to perform the following functions:

Event Table softkey — Exit the acquisition screen and display the event table for the fiber under test. Pressing and holding the **Event Table** softkey for two seconds turns event markers on and off without exiting the acquisition screen. Refer to chapter 5, *Event Marking*, for instructions on using event tables.

Link Return Loss softkey — Restart link return-loss measurements using the current distance-cursor locations. You can manually adjust a link return-loss measurement using the vertical and slope **LOSS** knobs, as described for these controls. Any manual adjustments made in Link Return Loss mode are retained until you press the **Link Return Loss** softkey again.

If you exit Link Return Loss mode after making manual adjustments, the adjustments are retained and displayed when you re-enter Link Return Loss mode (unless you make changes in the related Two Point mode—see note on the previous page). In this case, press the **Link Return Loss** softkey again to clear user-adjusted measurements and make new link return-loss measurements using the current distance cursor positions.

Pressing and holding the **Link Return Loss** softkey for two seconds exits LInk Return Loss mode and enters Preview mode.

Event Return Loss softkey — Exit Link Return Loss mode and enter Event Return Loss mode. The active distance-cursor location is used for event return-loss measurements.

Exit Return Loss softkey — This softkey is available only when return loss is on. Pressing **Exit Return Loss** turns the return loss modes off. The **Link Return Loss** softkey is replaced by the **Two Point** softkey, the **Event Return Loss** softkey is replaced by the **Splice Loss** softkey, and the instrument enters Two Point mode. **Exit Return Loss** reverts to **Return Loss**.

Mass Storage softkey — Enter the mass-storage menu system, allowing you to store waveform and settings data on floppy disk or internal RAM, if installed. Refer to chapter 7, *Mass Storage*, for details on how to use this system.

Change Settings softkey — Enter the Waveform Settings menu, allowing you to change instrument settings, and giving access to additional configuration menus. Refer to chapter 3, *Getting Started*, for details on how to use these menus.

CURSOR knob — Move the active distance and loss cursors along the waveform. New link return-loss measurements are made at the new position.

CURSOR SELECT knob

Pick which distance cursor is controlled by the **CURSOR** knob. The active cursor is displayed at a brighter intensity to differentiate it from the inactive cursor.

The **CURSOR SELECT** button also offers a "join cursors" function, useful when the inactive cursor is not on the screen. Press and hold the **CURSOR SELECT** button to move the inactive distance cursor to the same location as the active cursor.

Vertical **LOSS** knob

Move the loss cursor up and down. (Note that the left-hand distance cursor must be active in order to adjust the loss cursor.) Use this knob to manually adjust the link return-loss value by adjusting the vertical position of the loss cursor to match the backscatter. The loss cursor elongates to make accurate positioning easier. Moving the loss cursor vertically affects link return-loss calculations.

Any manual adjustment to the position of the loss cursor causes the message **User Adjusted Measurement** to appear in the top left corner of the screen.

Slope **LOSS** knob

Rotate the loss cursor around the point where it meets the distance cursor. (Note that the left-hand distance cursor must be active in order to adjust the loss cursor.) When you are making manual link return-loss measurements, this allows you to match the slope of the cursor with the backscatter before the link. The cursor elongates to make accurate positioning easier. This adjustment does not affect measurement values.

Any manual adjustment to the automatically placed loss cursor causes the message **User Adjusted Measurement** to appear at the top left of the display.

EXPAND button

Switch between overview and expanded view. Unless expanded view includes high-density data, there is no difference in measurement values, except that expanded-view measurements may be at higher resolution. With high-density data, there may be slight variations in loss measurements. (Using the expansion window and working with high-density data are explained in chapter 6, *Advanced Operating Functions*.)

Vertical **SIZE** knob

In overview, expand and contract the expansion window vertically. In expanded view, the vertical **SIZE** knob expands and contracts the waveform itself vertically.

When dual-trace mode is on in expanded view, the vertical **SIZE** knob operates on both waveforms simultaneously. Each waveform expands and contracts around the point where it intersects the active distance cursor.

Horizontal **SIZE** knob

In overview, expand and contract the expansion window horizontally. In expanded view, the horizontal **SIZE** knob expands and contracts the waveform itself horizontally. This does not affect distance measurements, unless you expand into or out of high-density data.

When dual-trace mode is on in expanded view, the horizontal **SIZE** knob operates on both waveforms simultaneously. Each waveform expands and contracts around the point where it intersects the active distance cursor.

Vertical **POSITION** knob

Move the active waveform up and down on the display. It is possible to move the waveform off the display.

When dual-trace mode is on, the vertical **POSITION** knob operates only on the active waveform.

Horizontal **POSITION** knob

Move the waveform right and left on the display. In both overview and expanded view, horizontal movement is limited to half the maximum range in either direction.

When dual-trace mode is on, the horizontal **POSITION** knob operates on both waveforms simultaneously.

WFM SELECT button

Pick whether the current waveform or the reference waveform is active. The active waveform is the only one on which you can make measurements, and is displayed at a brighter intensity than the inactive waveform. In single-trace mode, the active waveform is the only one displayed. The indicator next to the **WFM SELECT** button lights to show which waveform is active.

When dual trace is on and both the current and reference waveforms are displayed, the dB scale is that of the active waveform. The difference between the scales of the active and inactive waveforms is displayed at the top of the vertical scale. To align the two waveforms vertically, press and hold the **WFM SELECT** button. The inactive waveform moves to the same scale as the active waveform, and the difference in the scales displays as 0 dB.

When dual trace is off, and the view is in overview, pressing and holding the **WFM SELECT** button zeros the waveform's position—it is moved so that 0 dB is at the bottom of the vertical scale and 0 kilometers (or kilofeet) is at the left of the horizontal scale.

STORE button

Store the current waveform into reference memory. Any prior contents of reference memory are erased.

MODULE SELECT button

Select the next available laser. Changing the laser source requires a new acquisition. When you press the **MODULE SELECT** button, a message displays instructing you to press **START/STOP** to acquire new data using the new laser. In addition, any waveform parameters that change when you change laser sources are highlighted to show that these parameters no longer match the displayed waveform data. The highlighting is cleared when new data is acquired.

START/STOP button

Start a new acquisition. Any manually adjusted measurements are retained until you press the **Link Return Loss** softkey to restart measurements. If an acquisition is already in progress, pressing the **START/STOP** button stops the acquisition. Pressing and holding the **START/STOP** button starts a real-time acquisition. During a real-time acquisition, the return-loss measurement modes are not available, and the instrument automatically enters Two Point mode.

Link Return-Loss Measurements—Examples

Use Link Return Loss mode to measure the return loss of a fiber link. The return loss of the link is expressed in dB, and gives the ratio of the total light entering the link to the total light reflected by the link.

1. Turn the **CURSOR** knob to place the active distance cursor on the first event in the link. As you move the left distance cursor, the loss cursor follows the backscatter level, and is fit to the slope of the waveform data under the loss cursor.

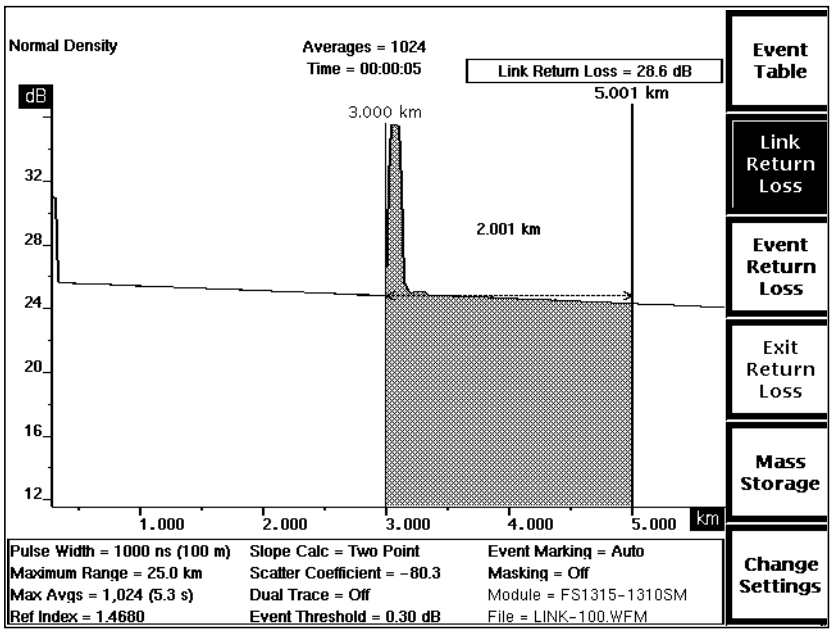


Figure 4-17. Automatic Link Return-Loss Measurement—Placing the First Cursor at the Start of the Link

2. Press the **EXPAND** button to expand the view of the event, if necessary for precise cursor placement. (If both cursors are not on the screen in expanded view, you may want to press **EXPAND** again to return to overview before going to the next step).

3. Press **CURSOR SELECT** to switch active cursors.

4. Place the second cursor at the link's end reflection, expanding the view if necessary. The fiber segment used for the measurement is shaded, as shown in these examples. An automatic link return-loss measurement is made. The length of the link being measured is displayed near the waveform, and the link return loss is shown in the upper right-hand corner of the screen. In this example, the return loss of the fiber link shown is 27.1 dB.

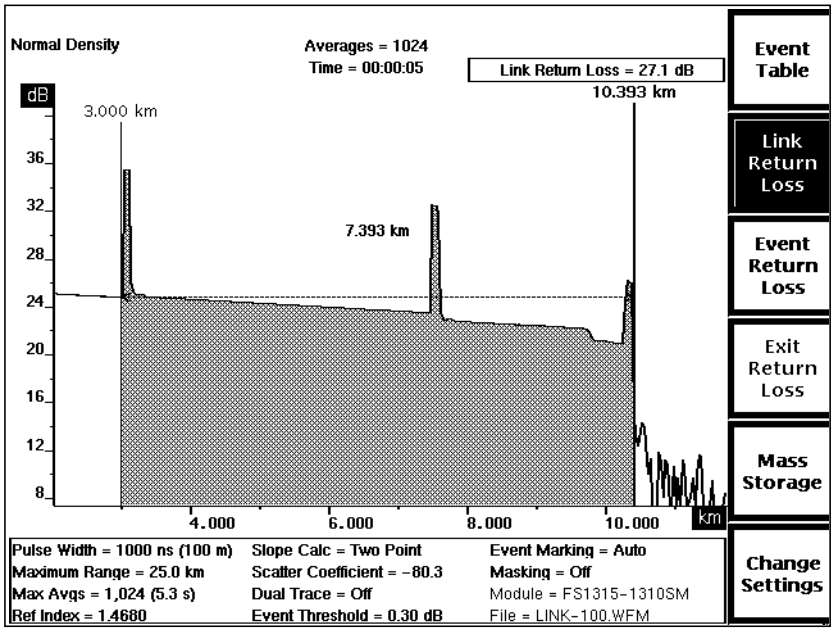


Figure 4-18. Automatic Link Return-Loss Measurement—Placing the Second Cursor at the End of the Link

5. To make manual adjustments to automatic measurements, press **CURSOR SELECT** to activate the left-hand distance cursor. Then use the vertical and slope **LOSS** knobs to adjust the loss cursor so it is aligned with the section of backscatter in front of the fiber link being measured.

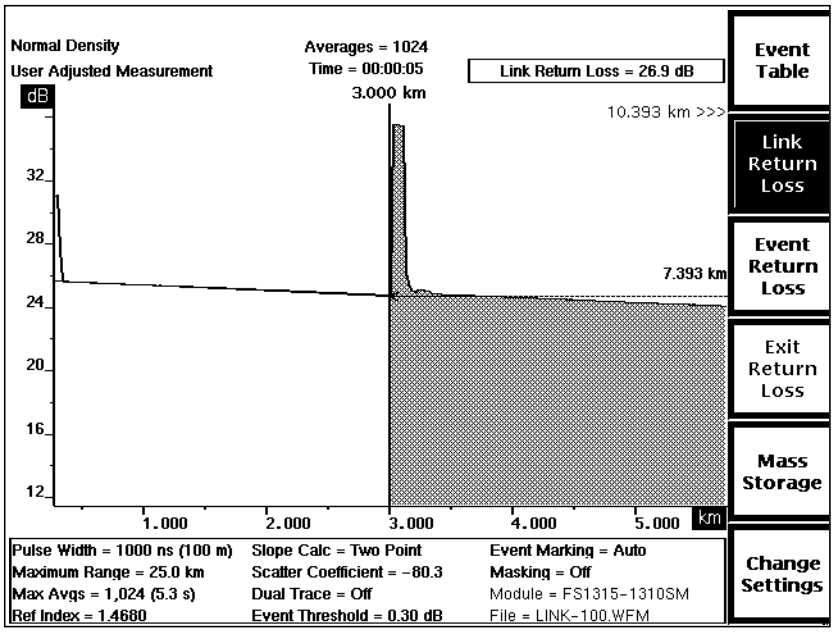


Figure 4-19. User-Adjusted Link Return-Loss Measurement

Notice that when you adjust the loss cursor manually, the message **User Adjusted Measurement** appears in the upper left-hand corner of the screen.

Event Return Loss Mode

When FiberMaster is first turned on, softkeys allow entry into Two Point, and Splice Loss modes. Two additional return-loss measurement modes are available via the **Return Loss** softkey. When you press the **Return Loss** softkey, the **Two Point** and **Splice Loss** softkeys are replaced by the **Link Return Loss** and **Event Return Loss** softkeys.

Enter Event Return Loss mode from Splice Loss mode simply by pressing the **Return Loss** softkey. From Preview and Two Point modes, enter Event Return Loss mode by pressing the **Return Loss** softkey, then the **Event Return Loss** softkey.

Use Event Return Loss to measure the transmission loss due to light reflected by a particular fiber feature, such as a connector or splice.

Scattering Coefficient

The scattering coefficient is a parameter on the Waveform Settings menu that represents the amount of backscatter reflected by a particular fiber, and is used in return-loss calculations in Event Return Loss mode. The scattering coefficient is a characteristic of the fiber under test, and can vary from fiber to fiber. Before performing event return-loss measurements, check that the scattering coefficient is set to the correct value for the fiber being tested. The scattering coefficient for a particular fiber can usually be obtained from the fiber manufacturer. If you do not know the correct value, however, it is recommended that you use the factory-default values, which depend on the laser source. For more information on the scattering coefficient parameter, and how to set it, refer to chapter 3, *Getting Started*.

Automatic Event Return-Loss Measurements

In Event Return Loss mode there is one distance cursor. There are two loss cursors, matched to the waveform on either side of the distance cursor. When you enter Event Return Loss mode, the active distance cursor is in the same location as it was in the previous measurement mode. The loss cursors move horizontally as the distance cursor is moved. An automatic event return-loss measurement is made at each new position of the distance cursor, if you have not made any manual adjustments. The event return loss is displayed in the upper right-hand corner of the screen.

The left loss cursor is fitted to a segment of waveform data to establish the backscatter level before the reflection being measured. This cursor extends from the distance cursor to the left edge of the expansion window, so you can control its length by adjusting the width of the expansion window (in overview) or by positioning the waveform horizontally (in expanded view). The cursor may be automatically limited, however, to exclude features from the event return-loss measurement, such as large reflections. The right loss cursor is used to mark the top of the reflection being measured, and extends slightly more than a pulse width to the right of the distance cursor.

The dB difference between the two loss cursors is shown graphically as a dashed line between the cursors. The numeric gain (or loss) value is displayed near the dashed line.

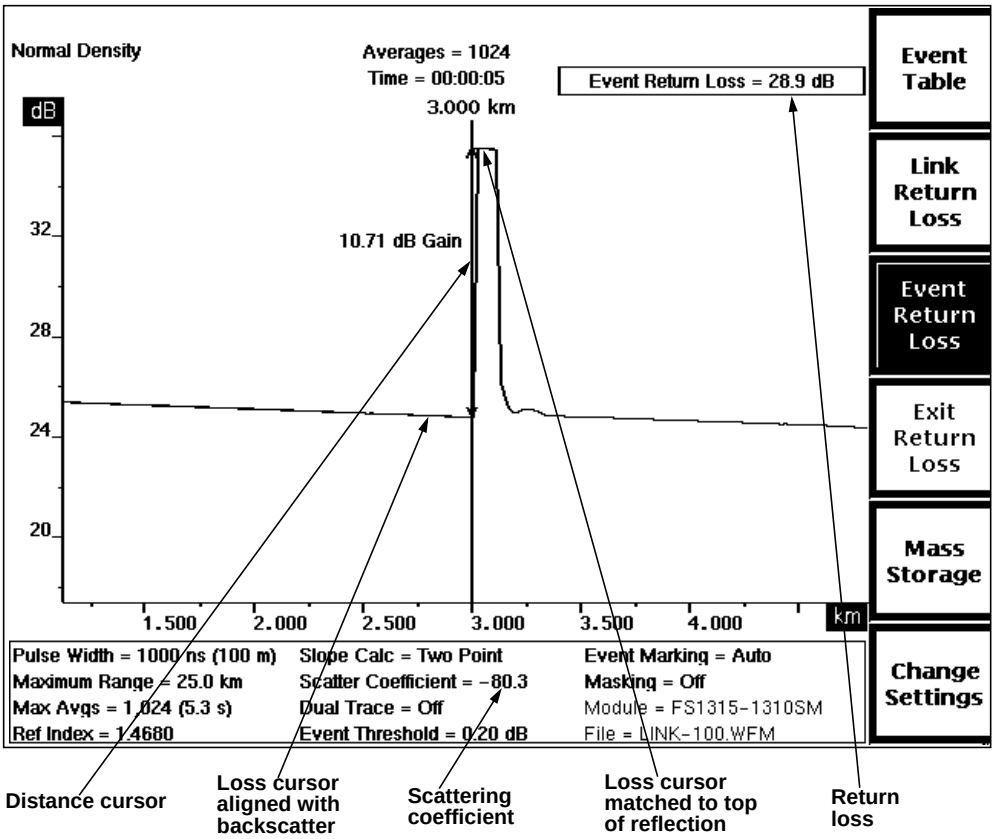


Figure 4-20. Event Return Loss Mode

NOTE *Event return-loss measurements on a reflective event yield the most accurate results with masking off; however, you can perform event return-loss measurements on reflections that have been masked using the AccuMask masking type. Event return-loss measurements on reflections that have been masked using the QuickMask masking type are not accurate.*

Manual Event Return-Loss Measurements

To adjust measurements, select the active loss cursor using the **CURSOR SELECT** button. You can adjust the active loss cursor using the vertical and slope **LOSS** knobs. Manually adjusted loss cursors extend to the edges of the display to help you make accurate adjustments. As you move the distance cursor, the loss cursors maintain the same slopes and vertical positions, and event return loss is recalculated.

Manual adjustments are retained until you restart automatic event return-loss measurements, by pressing the **Event Return Loss** softkey. An automatic event return-loss measurement is made at the current distance-cursor position.

NOTE *Event Return Loss mode is a variation of Splice Loss mode. If you turn off return loss, manual adjustments made in Event Return Loss mode are retained and displayed in Splice Loss mode. If you restart automatic splice-loss measurements, or if you make further manual adjustments in Splice Loss mode, these changes are retained when you re-enter Event Return Loss mode. Measurements you make in any other mode do not affect manual event return-loss measurements, and vice versa.*

Event Return Loss and Event Marking

In Event Return Loss mode, when event marking is turned on and you move the distance cursor anywhere onto an event marker or an event, the cursor automatically snaps to the location of the event. You can then move the cursor on the event. If you then press the **Event Return Loss** softkey, the cursor snaps onto the event again.

Front Panel Controls – Event Return Loss Mode

When in Event Return Loss mode, use the front-panel controls to perform the following functions. Make manual adjustments using the **CURSOR SELECT**, vertical **LOSS**, and slope **LOSS** knobs, as described below for each of these controls.

Event Table softkey — Exit the acquisition screen and display the event table for the fiber under test. Pressing and holding the **Event Table** softkey for two seconds turns event markers on and off without exiting the acquisition screen. Refer to chapter 5, *Event Marking*, for instructions on using event tables.

Link Return Loss softkey — Exit Event Return Loss mode and enter Link Return Loss mode.

Event Return Loss softkey — Restart automatic event return-loss measurements and clear any previous manual adjustments. You can manually adjust an event return-loss measurement using the **CURSOR SELECT** button and the vertical and slope **LOSS** knobs, as described for these controls. Any manual adjustments made in Event Return Loss mode are retained until you press the **Event Return Loss** softkey again.

If you leave Event Return Loss mode after making manual adjustments, the adjustments are saved and redisplayed when you re-enter Event Return Loss mode (unless you make changes in the related Splice Loss mode—see note on previous page). In this case, press the **Event Return Loss** softkey again to clear user-adjusted measurements and make a new event return-loss measurement using the current distance-cursor position.

Pressing and holding the Event Return Loss softkey for two seconds exits Event Return Loss mode and enters Preview mode.

Exit Return Loss softkey — This softkey is available only when return loss is on. Pressing **Exit Return Loss** turns the return loss modes off. The **Event Return Loss** softkey is replaced by the **Splice Loss** softkey, the **Link Return Loss** softkey is replaced by the **Two Point** softkey, and the instrument enters Splice Loss mode. **Exit Return Loss** reverts to **Return Loss**.

Mass Storage softkey — Enter the mass-storage menu system, allowing you to store waveform and settings data on floppy disk or internal RAM drive, if installed. Refer to chapter 7, *Mass Storage*, for details on using this system.

Change Settings softkey — Enter the instrument's Waveform Settings menu, allowing you to change instrument settings, and allowing access to additional configuration menus. Refer to chapter 3, *Getting Started*, for details on using these menus.

CURSOR knob — Move the distance cursor along the waveform. A new event return-loss measurement is made at the new position. When event marking is turned on and you move the distance cursor anywhere onto an event marker or an event, the cursor automatically snaps to the location of the event. You can then move the cursor on the event. If you move the cursor off the event and back on, or if you press the **Event Return Loss** softkey, the cursor snaps onto the event again.

CURSOR SELECT knob — Pick the active loss cursor. The active loss cursor is displayed at a brighter intensity than the inactive cursor.

Pressing and holding the **CURSOR SELECT** button in Event Return Loss mode joins the loss cursors—the inactive loss cursor is placed at the same vertical position and extends along the same slope as the active cursor.

Vertical **LOSS** knob — Move the active loss cursor up and down. Use this control to manually match the amplitude of the cursor to the waveform. The event return-loss value changes as you move the cursor vertically.

Any manual adjustment to the position of the loss cursor causes the message **User Adjusted Measurement** to appear in the top left corner of the screen.

Slope **LOSS** knob — Rotate the active loss cursor. Use this control to align the loss cursor with the slope of the waveform. This adjustment does not affect the event return-loss value.

Any manual adjustment to the position of the loss cursor causes the message **User Adjusted Measurement** to appear in the top left corner of the screen.

EXPAND button — Switch between overview and expanded view. Unless expanded view includes high-density data, there is no difference in measurement values, except that expanded-view measurements may be at higher resolution. With high-density data, slight variations in event return-loss measurements may occur. (Using the expansion window and working with high-density data are explained in more detail in chapter 6, *Advanced Operating Functions*.)

Vertical **SIZE** knob — In overview, expand and contract the expansion window vertically. In expanded view, the vertical **SIZE** knob expands and contracts the waveform itself vertically.

When dual-trace mode is on in expanded view, the vertical **SIZE** knob operates on both waveforms simultaneously. Each waveform expands and contracts around the point where it intersects the active distance cursor.

Horizontal **SIZE** knob — In overview, expand and contract the expansion window horizontally. In expanded view, the horizontal **SIZE** knob expands and contracts the waveform itself horizontally. This does not affect distance measurements, unless you expand into or out of high-density data.

When dual-trace mode is on in expanded view, the horizontal **SIZE** knob operates on both waveforms simultaneously. Each waveform expands and contracts around the point where it intersects the active distance cursor.

Vertical **POSITION** knob — Move the active waveform up and down on the display. It is possible to move the waveform off the display.

When dual-trace mode is on, the vertical **POSITION** knob operates only on the active waveform.

Horizontal **POSITION** knob

Move the waveform right and left on the display. In both overview and expanded view, horizontal movement is limited to half the maximum range in either direction.

When dual-trace mode is on, the horizontal **POSITION** knob operates on both waveforms simultaneously.

WFM SELECT button

Pick whether the current waveform or the reference waveform is active. The active waveform is the only one on which you can make measurements, and is displayed at a brighter intensity than the inactive waveform. In single-trace mode, the active waveform is the only one displayed. The indicator next to the **WFM SELECT** button lights to show which waveform is active.

When dual trace is on and both the current and reference waveforms are displayed, the dB scale is that of the active waveform. The difference between the scales of the active and inactive waveforms is displayed at the top of the vertical scale. To align the two waveforms vertically, press and hold the **WFM SELECT** button. The inactive waveform moves to the same scale as the active waveform, and the difference in the scales displays as 0 dB.

When dual trace is off, and the view is in overview, pressing and holding the **WFM SELECT** button zeros the waveform's position—it is moved so that 0 dB is at the bottom of the vertical scale and 0 kilometers (or kilofeet) is at the left of the horizontal scale.

STORE button

Store the current waveform into reference memory. Any previous contents of reference memory are erased.

MODULE SELECT button

Select the next available laser source. Changing the laser source requires a new acquisition. When you press the **MODULE SELECT** button, a message displays instructing you to press **START/STOP** to acquire new data using the new laser. In addition, any waveform parameters that change when you change laser sources are highlighted, indicating that these parameters no longer match the displayed waveform data. The highlighting is cleared when new data is acquired.

START/STOP button

Start a new acquisition. Any manually adjusted measurements are retained until you press the **Event Return Loss** softkey to restart measurements. If an acquisition is currently in progress, pressing the **START/STOP** button stops it.

Holding the **START/STOP** button down for two seconds starts a real-time acquisition. During a real-time acquisition, the return-loss modes are not available, and the instrument automatically enters Two-Point mode.

Event Return-Loss Measurements—Examples

Use Event Return Loss mode to measure the return loss of any reflective fiber feature, for example, a connector. The return loss of the feature is expressed in dB, and gives the ratio of the light entering the connector to the light reflected by it.

1. Turn the **CURSOR** knob to move the distance cursor to the leading edge of the event to be measured. Use the expand function if necessary for precise cursor placement.

2. An automatic event return-loss measurement is made, and the return loss is displayed in the upper right-hand corner of the screen. The example below shows in expanded-view, an automatic event return-loss measurement made at the location of a connector in the cable. The automatic measurement is made by fitting the left loss cursor to the backscatter before the reflection, and the right loss cursor to the top of the reflection.

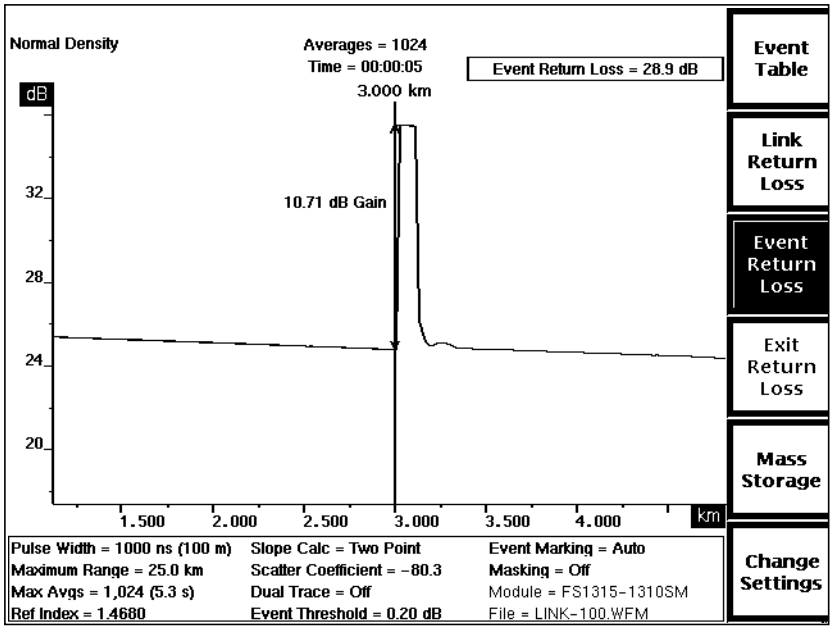


Figure 4-21. Automatic Event Return-Loss Measurement

NOTE *In Event Return Loss mode, automatic measurements use the length of the left loss cursor to determine how much waveform data is used in establishing the backscatter level before the reflection. The length of the left loss cursor is determined by the width of the expansion window, in both overview and expanded view. This may cause the automatic loss figures to vary, depending on size of the expansion window. You can vary the width of the expansion window to control the number of data points used to perform the automatic event return-loss measurement.*

3. To make manual adjustments to automatic measurements, use the slope and vertical **LOSS** knobs to rotate the active loss cursor and move it vertically. The active loss cursor is displayed at a brighter intensity. When adjusted, the cursor elongates automatically, extending from the distance cursor to the edge of the display, to make it easier to fit to the waveform.

   Press **CURSOR SELECT** to activate the second loss cursor. Adjust the second cursor using the **LOSS** knobs. As you adjust the loss cursors, the event return loss is recalculated. The example below shows a manually adjusted event return-loss measurement at the location of a connector.

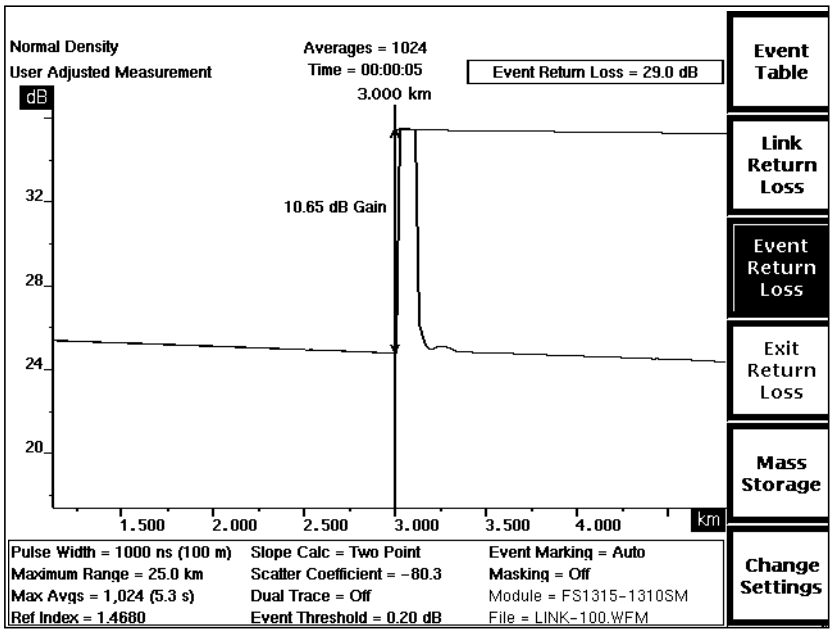


Figure 4-22. User-Adjusted Event Return-Loss Measurement

5 Event Marking

The previous chapter describes FiberMaster's measurement modes, how to make automatic measurements on a fiber, and how to make manual adjustments to the automatic measurements on the acquisition screen. FiberMaster's event-marking feature detects fiber features and performs these measurements automatically, and combines them into a tabular format for each fiber under test.

When you turn event-marking on, FiberMaster automatically locates every event on the fiber above a defined threshold, identifies these events on the acquisition screen, and compiles a table containing several distance and loss measurements for each event detected.

In addition to its fully automatic mode, the event-marking feature includes provisions for manually entering measurements into the table, and manually moving, deleting, and adding event markers on the acquisition screen. The locations of the event markers determine where measurements are calculated for inclusion in the event table.

Up to 50 event markers can be placed either automatically by the instrument, or manually by the user.

An additional event notes screen allows you to read and record up to 79 characters of notes for each event marked. This function can be used for mapping the fiber under test.

Overview

Automatic event marking scans the waveform for events, starting at the front panel. When you turn on event marking mode, a triangular marker is displayed under each event detected, along with an additional field of measurement information shown above the parameter settings. This field displays measurement information about the current marker. A marker is current when the active distance cursor is located on that marker.

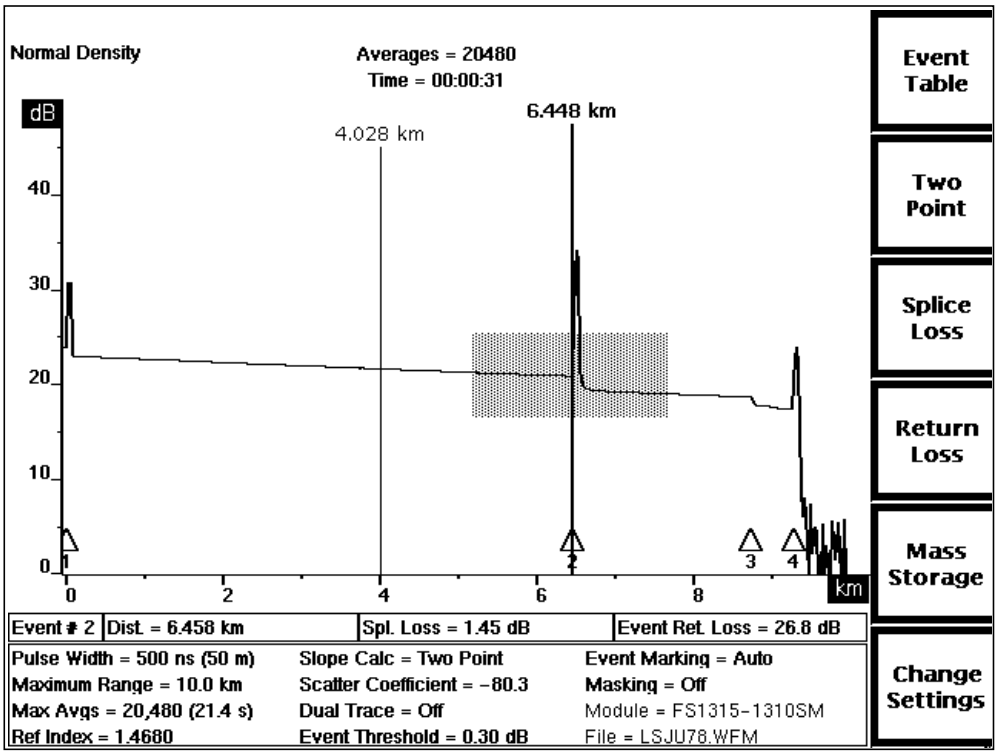


Figure 5-1. Event Marking

Automatic event marking stops looking for events when one of the following occurs:

- ❏ a splice loss greater than 10.00 dB is detected, indicating a break or the end of the fiber,
- ❏ the noise floor is reached (waveform amplitude drops below 0 dB on the acquisition screen), or
- ❏ the end of the data is reached.

A softkey on the acquisition screen allows access to the Event Table screen. This table lists several distance and loss measurements for each event on the waveform. The event table is compiled automatically, but you can adjust the measurements if necessary. From the Event Table screen, additional softkeys allow you to read and record notes about each event listed in the table.

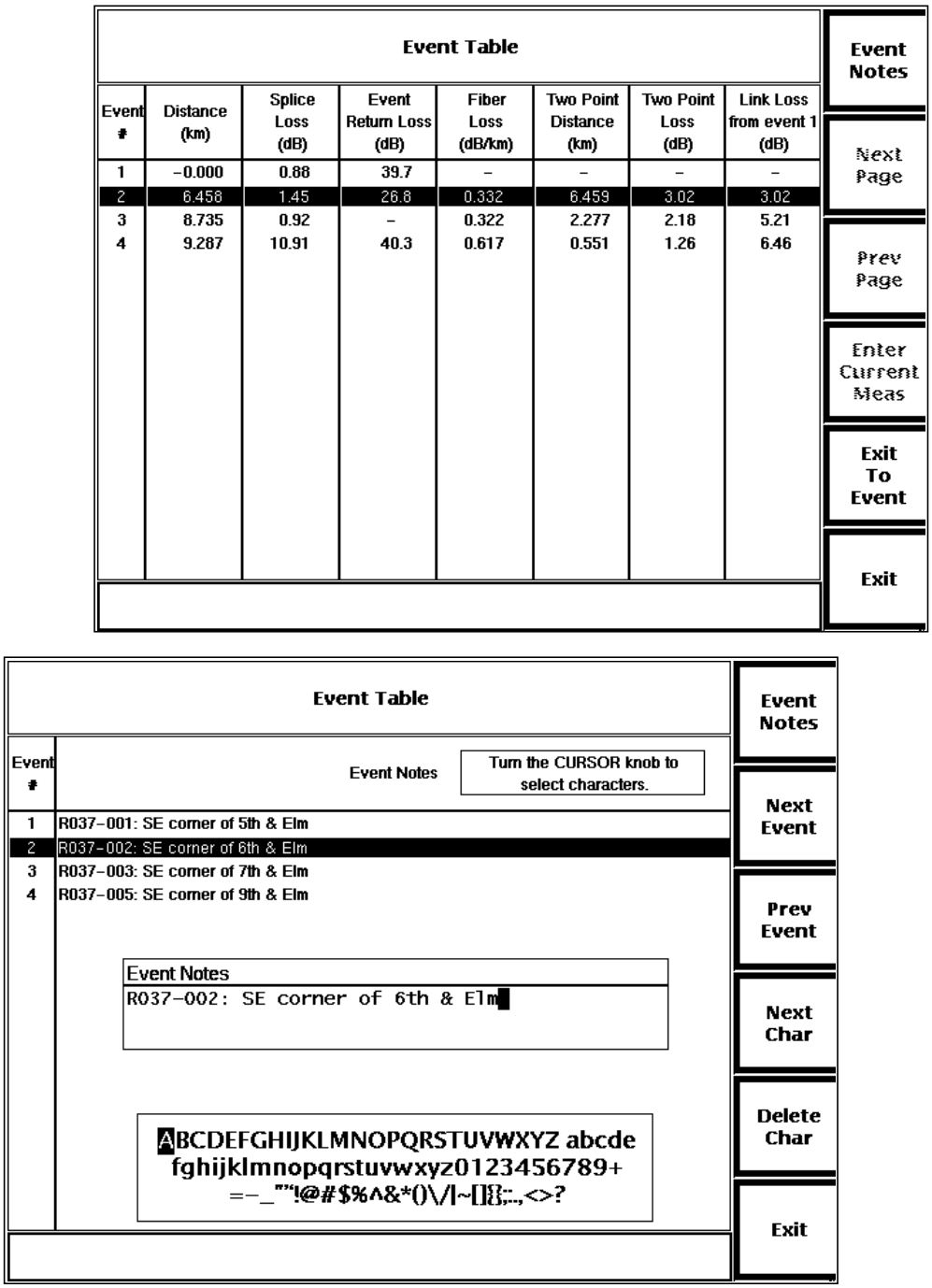


Figure 5-2. Event Table (above) and Event Notes (below)

Two Waveform Setting parameters affect event marking. The **Event Threshold** has a factory default of 0.20 dB. This means that when event marking is on, all automatically marked events with splice losses of 0.20 dB or greater are displayed on the acquisition screen and included in the event table. You can change this threshold on the Waveform Settings menu, and you can select a different power-on default on the User Defaults menu.

All manually placed event markers are displayed regardless of the event-threshold setting, both on the acquisition screen and in the event table.

The **Event Marking** parameter allows you to select either automatic or manual event marking. The factory default setting is **Auto**, which causes events to be automatically located for each acquisition. You can change this setting to **Manual** on the Waveform Settings menu. When the manual setting is selected, the Place Event Markers screen is accessible from the Waveform Settings menu. This screen lets you add, delete, and move event markers. The markers you add on this screen are not changed with a new acquisition, as long as the event-marking parameter is set to **Manual**.

Refer to chapter 3, *Getting Started*, for information on the event-threshold and event-marking parameters and how to set them.

This section describes FiberMaster's event-marking features—how to locate events automatically and manually, edit the event table, and add event notes.

Turning on Event Marking

When FiberMaster is turned on and a waveform is acquired, the instrument defaults to Preview mode with event markers turned off. To view the event markers in Preview mode (or any other current measurement mode), press and hold the **Event Table** softkey for two seconds. The event-marking parameter defaults to **Auto**. All events that meet or exceed the event threshold are automatically marked with a triangle, and numbered consecutively from left to right.

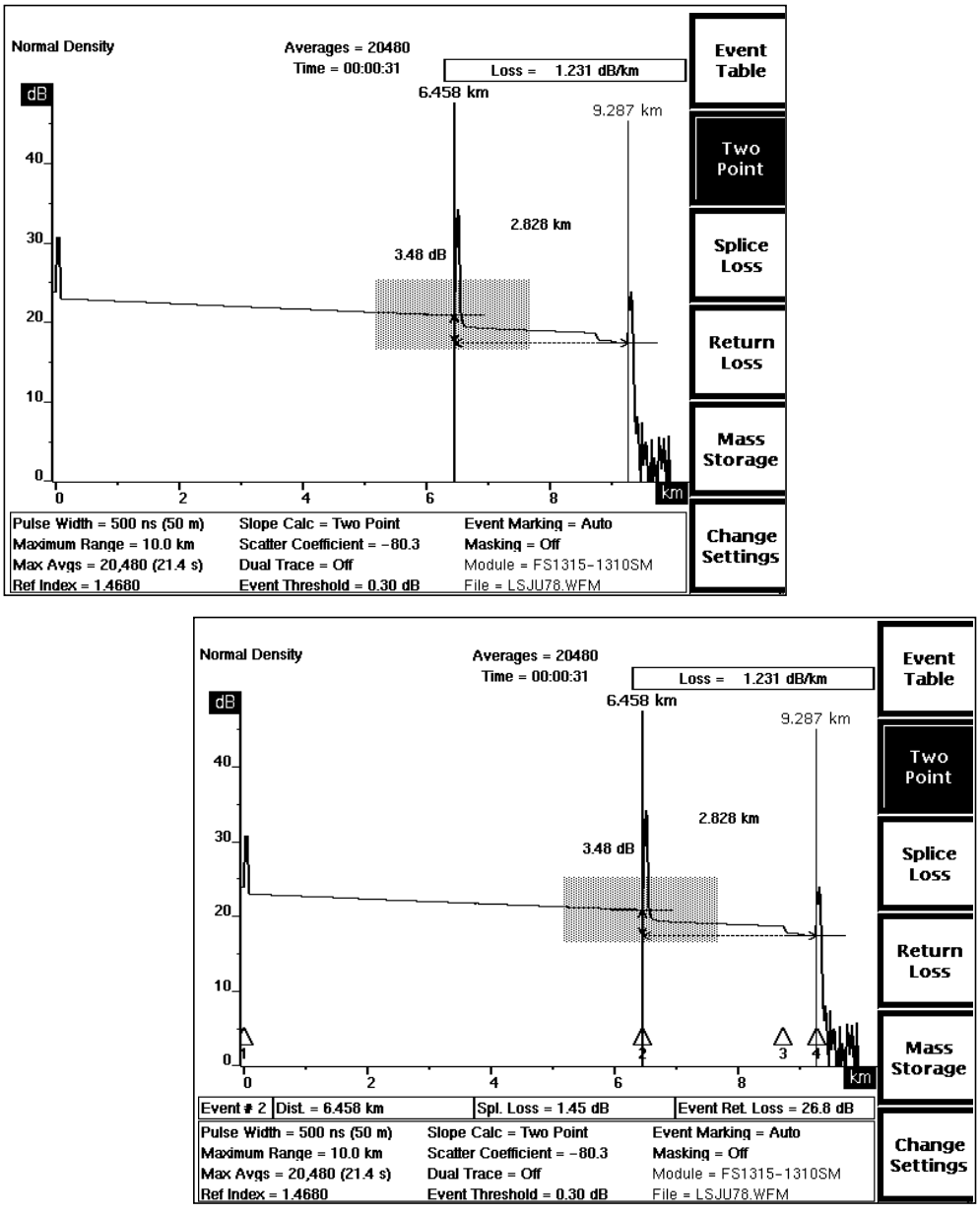


Figure 5-3. Turning on Event Marking

When you move the active distance cursor onto an event marker, the distance from the front panel to the event, the splice loss of the event, and the event return loss are displayed in a field under the waveform, above the parameter area of the acquisition screen. When the distance cursor is not on an event marker, this field is blank.

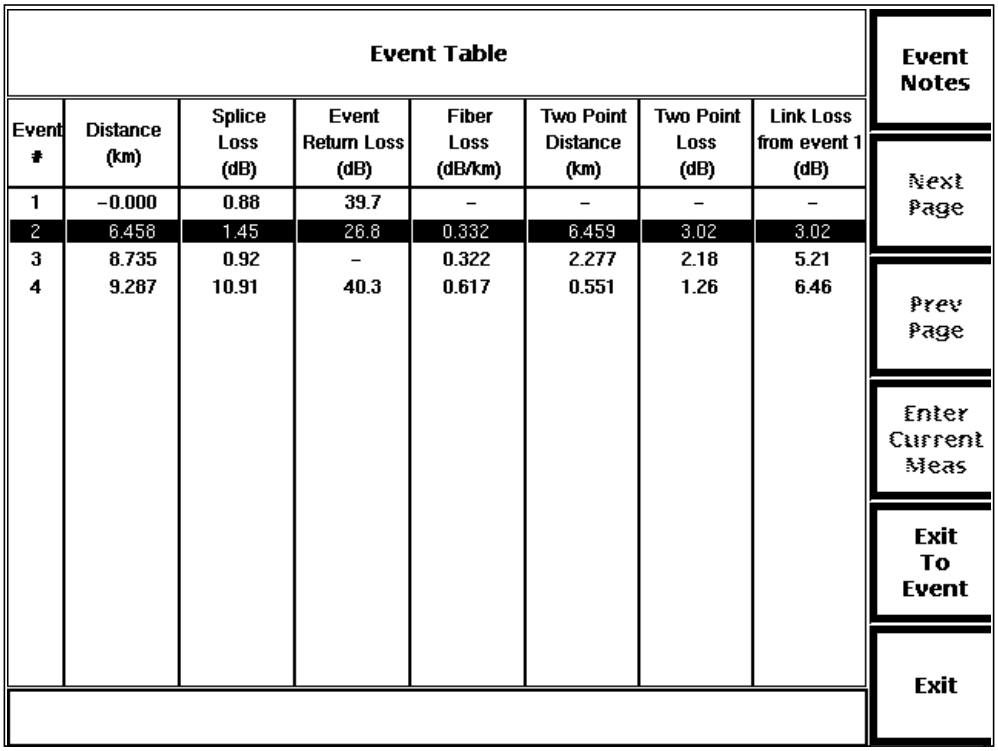
After turning on event marking, you can move between measurement modes, and the event markers stay visible on the acquisition screen, and on the Waveform Settings menu.

In any measurement mode, pressing the **Event Table** softkey to display the event table, then exiting back to the acquisition screen is another way to turn on event marking. You can turn event marking off by pressing and holding the **Event Table** softkey for two seconds. Turning event markers on and off does not affect measurements in the current measurement mode.

The Event Table

The Event Table screen contains measurement information for all events marked on the acquisition screen, including:

- ❏ distance from the front panel to the event
- ❏ splice loss at the event
- ❏ return loss at the event, if it is a reflective event
- ❏ fiber loss between the event and the preceding event
- ❏ two-point distance between the event and the preceding event
- ❏ two-point loss between the event and the preceding event
- ❏ cumulative link loss to the event from the first marked event



Event #	Distance (km)	Splice Loss (dB)	Event Return Loss (dB)	Fiber Loss (dB/km)	Two Point Distance (km)	Two Point Loss (dB)	Link Loss from event 1 (dB)
1	–0.000	0.88	39.7	–	–	–	–
2	6.458	1.45	26.8	0.332	6.459	3.02	3.02
3	8.735	0.92	–	0.322	2.277	2.18	5.21
4	9.287	10.91	40.3	0.617	0.551	1.26	6.46

Figure 5-4. The Event Table

The distance, splice loss, return loss, and two-point distance and loss measurements correspond to measurements on the acquisition screen. The fiber loss is the loss per kilometer for the fiber between events, starting after the previous event and up to the current event. The link loss is the cumulative total of the two-point loss measurements. Two-point loss includes both the splice loss of the previous event as well as the fiber loss between events. Two-point loss divided by two-point distance, therefore, does not equal the fiber loss.

The event table is automatically compiled for all marked events. The splice loss and event return loss measurements can be adjusted manually, if necessary.

Turning the **CURSOR** knob causes each event to be highlighted in succession.

NOTE

Loss measurements on the event table may vary slightly from the same automatic measurements made on the acquisition screen. For splice-loss and event return-loss measurements, measurements on the event table are made by fitting lines to the data between the current event and the adjacent events, while measurements on the acquisition screen use the data within the expansion window. For two-point loss measurements, event-table measurements fit lines using all data points between events, while acquisition-screen measurements are calculated using the two points where the distance cursors intersect the waveform.

Two-point distance measurements on the event table should correspond with those seen on the acquisition screen, if the distance cursors are positioned precisely on the events on the acquisition screen.

On the Event Table screen, the softkeys perform the following functions:

Event Notes - display notes for the marked events. From the Event Notes screen, you can press another softkey that allows you to enter and edit the notes.

Next Page and **Prev Page** - if there are more events on the fiber than fit on one page, use the **Next Page** and **Prev Page** softkeys to scan through the events, or scroll through the events using the **CURSOR** knob.

Enter Current Meas - allows you to make manual entries to the event table, as follows:

1. On the acquisition screen, move the distance cursor to an event marker, and make either a splice-loss or event return-loss measurement. For example, you can adjust the expansion window to optimize the automatic measurement, or you can manually adjust the loss cursors.
2. From the acquisition screen, press the **Event Table** softkey to enter the Event Table screen. Because you have made or changed a splice-loss measurement or an event return-loss measurement for the current event, the **Enter Current Meas** softkey is now available.

NOTE *The **Enter Current Meas** softkey is not available on the Event Table screen unless you make an automatic splice-loss or event return-loss measurement, or you make manual adjustments to either measurement for the event currently highlighted on the event table.*

3. At the bottom of the screen, a message informs you of the value, type, and location of the current measurement. To replace the existing event-table measurement with the new value, press the **Enter Current Meas** softkey. The new measurement is entered into the event table, and an asterisk indicates that it was entered manually.

NOTE *For automatically placed event markers, if a new splice-loss measurement is below the current event-threshold setting, the event is deleted from the event table when you press the **Enter Current Meas** softkey. Manually placed event markers are displayed regardless of the event threshold.*

Exit to Event - exit the Event Table screen and return to the acquisition screen with the active distance cursor located at the currently highlighted event.

Exit - exit the Event Table screen and return to the acquisition screen with the active distance cursor located where it was when you entered the Event Table screen.

Reverting to Automatic Measurements

After entering manually adjusted measurements into the event table, there may be occasions when you want to restore the original value. For an individual measurement, you can do this as follows:

1. On the acquisition screen, place the distance cursor on the event and perform the automatic measurement. (To perform an automatic measurement after manual adjustments have been made, make sure you are in the appropriate measurement mode, Splice Loss or Event Return Loss, then press the **Splice Loss** or **Event Return Loss** softkey again.)
2. Press the **Event Table** softkey to go to the Event Table screen.
3. Press the **Enter Current Meas** softkey to enter the automatic measurement into the event table. The automatic measurement replaces the previous value, with an asterisk to indicate that it was entered into the event table manually.

To re-enter all automatic measurements for a particular event, you can repeat the steps above for both the splice-loss and the event return-loss measurements. Or you can go to the Place Event Markers screen and move or remove and replace the marker manually. Automatic measurements are performed for all new and moved event markers. Details on moving, adding, and deleting event markers manually on the Place Event Markers screen are given later in this section.

To repeat automatic measurements for event markers, do one of the following:

- ❏ With the event-marking parameter set to **Manual**, press the **START/STOP** button to start a new acquisition. New data triggers automatic measurements at all event markers, using the existing event-marker locations. Event notes are retained.
- ❏ With the event-marking parameter set to **Manual**, go to the Place Event Markers screen and press the **Auto Mark Events** softkey. This replaces all markers with automatically located markers, and measurements are recalculated. Event notes are erased.
- ❏ With the event-marking parameter set to **Auto**, press the **START/STOP** button to start a new acquisition. This also replaces all markers with automatically located markers, and recalculates measurements. Event notes are erased.

Printing the Event Table

With the Event Table screen displayed, press the **HARD COPY** button to print the event table, including event notes.

NOTE *You can print the event table only when the hardcopy device selected is the internal printer or one of the supported external printers. The external plotters produce only waveform plots. If you select a plotter as the hardcopy device and press the* **HARD COPY** *button when any display* other *than an acquisition screen is current, a beep sounds and the plotter does not produce a plot.*

Refer to chapter 3, Getting Started*, for instructions on selecting the hardcopy device.*

Event Notes

From the Event Table screen, press the **Event Notes** softkey to display notes or mapping information for each marked event. If no notes have been entered yet, the screen is blank, with the event numbers listed in the left-hand column.

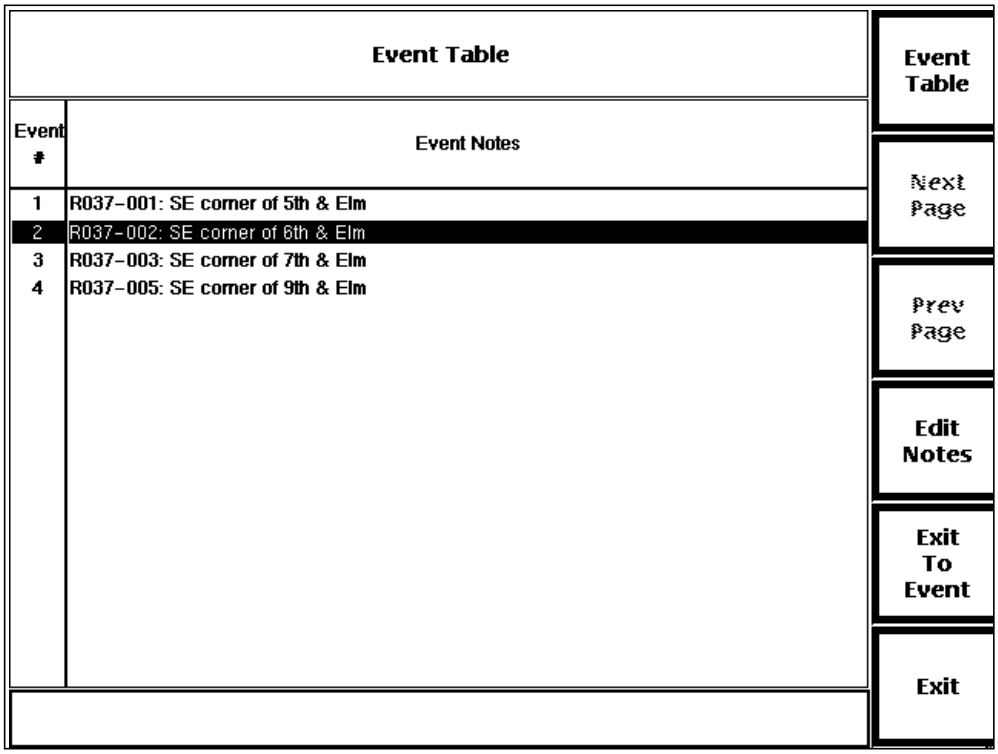


Figure 5-5. Event Notes

The softkeys on the Event Notes screen work as follows:

Event Table - return to the Event Table screen. The same event highlighted on the Event Notes screen is highlighted on the event table. On the Event Table screen, the top softkey becomes **Event Notes**, so you can press this softkey to switch between the Event Table and Event Notes screens.

Next Page and **Prev Page** - if there are more notes than fit on one page, use the **Next Page** and **Prev Page** softkeys to scan through the notes, or scroll through them using the **CURSOR** knob.

Edit Notes - go to a second Event Notes screen where you can enter new notes or edit existing notes. Entering and editing notes is described on the following page.

Exit to Event - Exit the Event Notes screen and return to the acquisition screen with the active distance cursor located at the currently highlighted event.

Exit - Exit the Event Notes screen and return to the acquisition screen with the active distance cursor located where it was when you entered the Event Table screen.

Entering and Editing Event Notes

From the Event Table screen, press the **Event Notes** softkey, then the **Edit Notes** softkey to go to a screen that allows you to enter and edit notes for each marked event on the fiber.

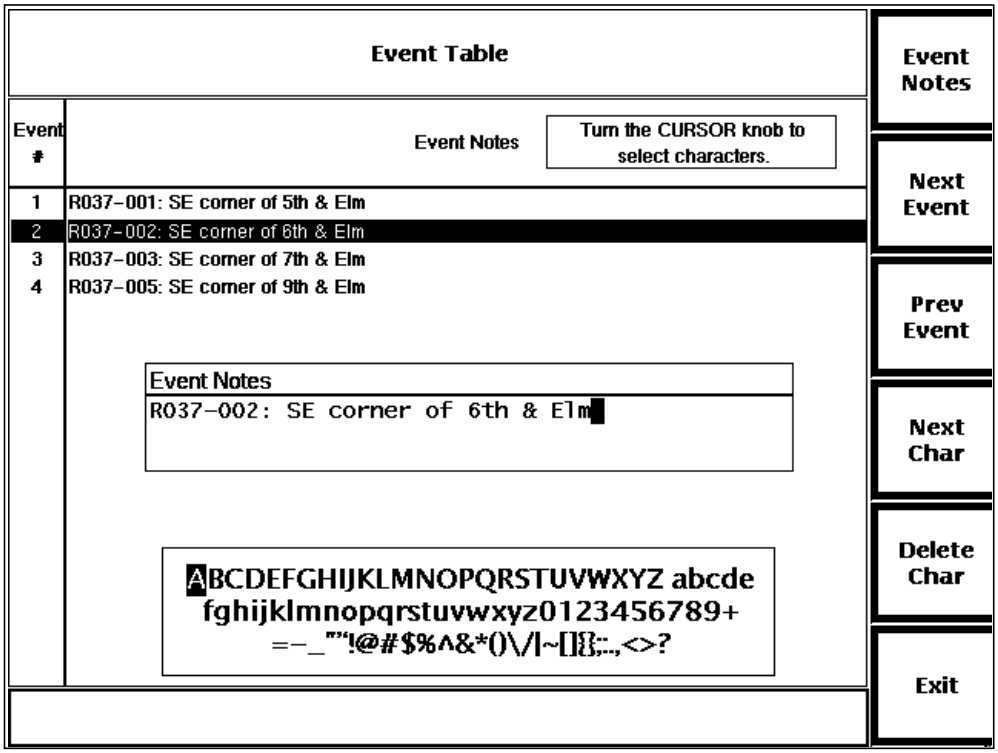


Figure 5-6. Editing Event Notes

The current event is highlighted, and any existing notes for that event appear in the Event Notes window for editing. You can enter up to 79 characters of annotation for each event. Use either a keyboard to type in the information, or enter the notes using a combination of softkeys and the **CURSOR** knob.

If you are using a keyboard, refer to appendix B, *Keyboard Definitions*, for a list of key sequences that duplicate front-panel controls. The keyboard also offers more editing functions than those available via front-panel controls.

The softkeys function as follows:

Event Notes - save the current note and return to the previous Event Notes screen.

Next Event - save the current note and highlight the next event. If a note has already been entered for the next event, this note appears in the Event Notes window for editing.

Prev Event - save the current note and highlight the previous event. If a note has already been entered for the previous event, this note appears in the Event Notes window for editing.

Next Char - used for character entry, as described below.

Delete Char - used to correct characters, as described below.

Exit - save the current note and return to the acquisition screen.

Enter notes for each event using softkeys and the **CURSOR** knob as follows:

1. When you select the note to enter or edit, the cursor is on the next available character position. To enter a character, turn the **CURSOR** knob until the desired character is highlighted in the character set shown. The letter under the cursor in the Event Notes window changes to correspond with the highlighted letter in the character set.
2. Press the **Next Char** softkey to accept the selected letter. The cursor advances to the next available character position.

The **Delete Char** softkey deletes the character under the cursor. If the cursor is on the next available character position, which is blank, the character to the left of the cursor is deleted. To correct characters to the left of the cursor, press **Delete Char** to move backwards, then re-enter the note.

The new note takes effect when you exit the field by pressing **Next Event** or **Previous Event**, or when you exit the screen by pressing **Event Notes** or **Exit**.

NOTE *Event notes are erased with a new acquisition when the event-marking parameter is set to **Auto**. Event notes are also erased when you press the **Auto Mark Events** softkey on the Place Event Markers screen.*

Manual Event Marking

Automatic event-marking keeps track of the noise level on the waveform under test in order to avoid marking noise spikes as events. However, you may still see an occasional noise spike labeled with an event marker. Or a large echo might be marked as an event. On the other hand, automatic event marking may miss a non-reflective event when the splice loss is small or the waveform is noisy. In these cases, you can use FiberMaster's manual event-marking feature to add or remove event markers when necessary.

The Place Event Markers screen is available via a softkey on the Waveform Settings menu, when the Event Marking pop-up window is displayed and the parameter is set to **Manual**. Use this screen to add, delete, and move event markers manually. When the event-marking parameter is set to **Auto**, the Place Event Markers screen is not accessible.

When you start a new acquisition, the manual setting prevents the system from automatically locating events, and does not delete any existing markers. All manually placed event markers are displayed regardless of the event-threshold setting, both on the acquisition screen and in the event table.

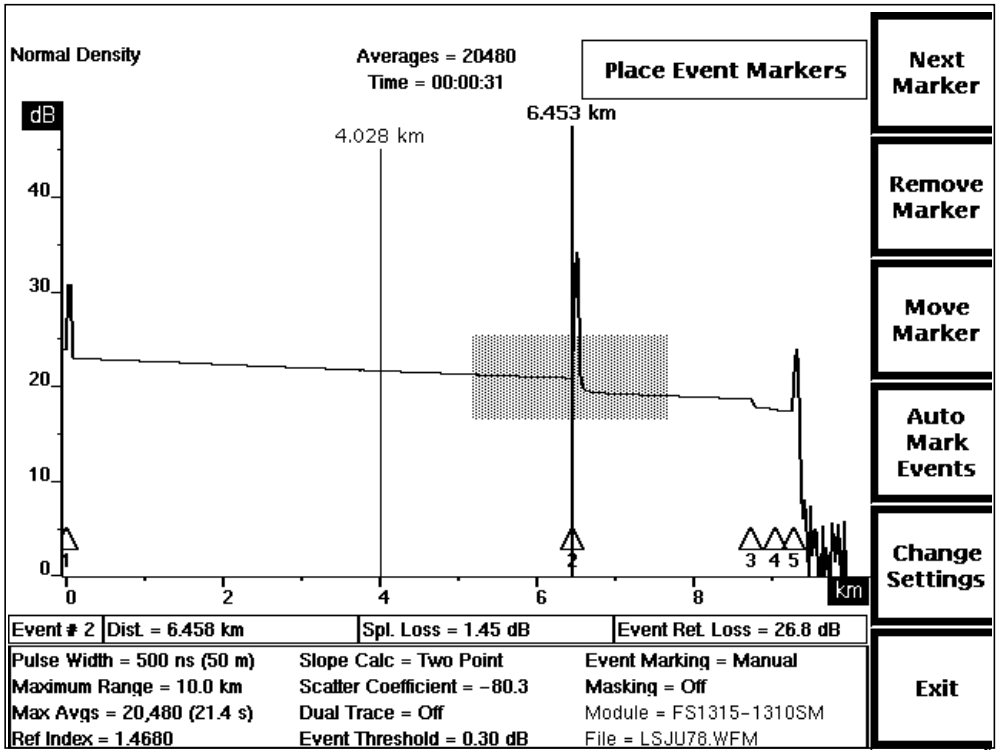


Figure 5-7. The Place Event Markers Screen (Cursor on Event Marker)

When event marking is set to **Manual** and a new acquisition does not extend to all event marker locations, the event table indicates there is no data for those markers outside the acquisition range.

Entering the Place Event Markers Screen

Enter the Place Event Markers screen from the acquisition screen as follows:

1. Press the **Change Settings** softkey to enter the Waveform Settings menu.
2. Press the **Next Param** or **Prev Param** softkey until the Event Marking pop-up window displays.
3. Set event marking to **Manual**.
4. The **Place Markers** softkey displays when event marking is set to **Manual**. Press this softkey. The Place Event Markers screen displays.

NOTE *All marked events are displayed on the Place Event Markers screen, regardless of the event-threshold setting.*

When working on the Place Event Markers screen, you can use the expansion window to magnify portions of the waveform for precise marker placement. Use the horizontal and vertical **SIZE** knobs to size the waveform for this purpose. The waveform **POSITION** knobs also function when working on the Place Event Markers screen. You can also press **START/STOP** to start a new acquisition without exiting the Place Markers screen.

Placing Event Markers

Use softkeys to add, remove, and move markers. Use the distance cursor to identify the marker to be moved or removed:

Next Marker - advance the distance cursor to the next marker. Pressing **Next Marker** selects the marker to the right of the current cursor position, and wraps to the first marker on the waveform from the last one.

Remove Marker (appears only when the cursor is located on an existing marker, see figures 5-7 and 5-9) - remove the current marker and renumber the markers. After the marker is removed, this softkey changes to **Add Marker** until you either add a marker or move the cursor to another marker.

Add Marker (appears only when the cursor is not located on an existing marker, see figure 5-8) - add a marker at the current cursor position and renumber the markers. After the marker is added, the softkey changes to **Remove Marker**.

Move Marker (appears only when the cursor is located on an existing marker, see figure 5-7) - attach the marker to the distance cursor so the marker moves with the cursor when you turn the **CURSOR** knob. If you move the marker past other markers, the markers are renumbered to reflect their new order. After the marker is attached to the cursor, this softkey changes to **Leave Marker**.

Leave Marker (appears only after pressing **Move Marker** to attach a marker to the distance cursor, see figure 5-9) - detaches the marker from the distance cursor to place it at its new location. After pressing **Leave Marker**, the softkey changes back to **Move Marker**. You can turn the **CURSOR** knob to move the distance cursor, and the marker stays in its new location.

NOTE *Pressing any other softkey when **Leave Marker** is active drops the marker before performing the function of that softkey.*

Auto Mark Events - replace all markers with automatically located markers. Markers are located and measurements calculated as if the event-marking parameter were set to **Auto** and a new acquisition started. This allows you to reset markers without having to reacquire data. When you press this softkey, manual markers are replaced, and event notes are erased.

Change Settings - return to the Event Marking parameter screen on the Waveform Settings menu.

Exit - exit the menu system and return to the acquisition screen.

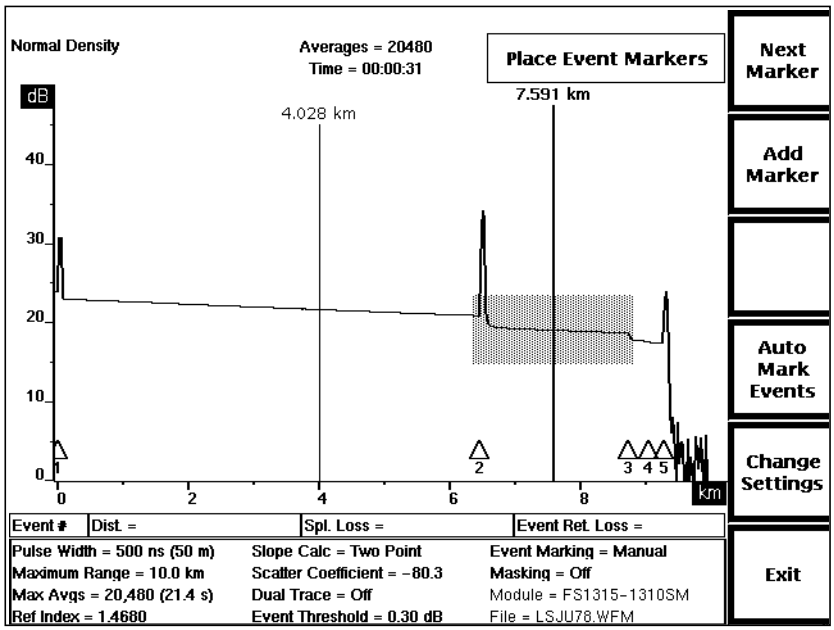


Figure 5-8. The Place Event Markers Screen (Cursor off Event Marker)

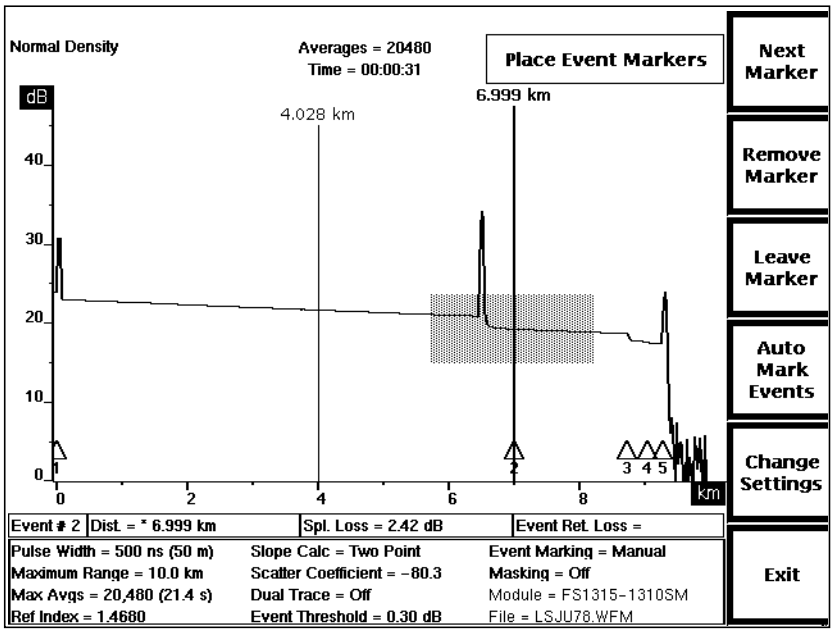


Figure 5-9. The Place Event Markers Screen (Moving Event Marker)

Examples

Moving a marker:

1. Press **Next Marker** until the distance cursor is located on the marker you want to move.
2. Press **Move Marker**.
3. Turn the **CURSOR** knob to move the distance cursor and the marker to the new location. Press **EXPAND** to expand the view if necessary for precise marker placement.
4. Press **Leave Marker**.

Adding a marker:

1. Turn the **CURSOR** knob to move the distance cursor to the leading edge of the event where you want a new marker. Press **EXPAND** to expand the view if necessary.
2. Press **Add Marker**.

Deleting a marker:

1. Press **Next Marker** until the distance cursor is located on the marker you want to delete.
2. Press **Remove Marker**.

Automatic Measurements with Manually Placed Markers

The measurements for an event marker depend on the locations of the adjacent event markers to determine how much data is used. Adding, moving, and removing a marker, therefore, requires that some measurements be recalculated, as follows:

- ❑ Adding or moving a marker recalculates all event measurements for that marker, as well as automatically entered measurements for both markers to its left and right. Manually entered measurements for neighboring markers are not recalculated.
- ❑ Removing a marker recalculates the automatically entered measurements for both neighboring markers, but not any manually entered ones.

Storing and Retrieving Event Markers

Event-marker locations and event-table measurements are stored to disk along with instrument settings information. You can save event markers and later retrieve and reuse them by saving the waveform and associated settings, or by saving the instrument settings alone. When you reload the waveform or settings file to current memory, the event marker information is also reloaded. By setting the event-marking parameter to **Manual**, the loaded marker locations are used to determine where measurements are made for subsequent acquisitions. This way, you can use one set of markers to build an event table for each fiber bundled within a cable. For example:

Generate and save event markers for the first fiber:

1. Connect the first fiber to FiberMaster, and press the **START/STOP** button to start an acquisition, with the event-marking parameter set to **Auto**. Event markers are located, measurements are made, and an event table is compiled automatically.
2. Press the **HARD COPY** button to document the waveform.
3. Press the **Event Table** softkey to go to the Event Table screen. If necessary, enter notes about the events marked on the fiber.
4. Press the **HARD COPY** button to print the event table and notes for the current fiber.
5. Press the **Mass Storage** softkey to enter the mass-storage system, and save the current instrument settings into a disk file. You now have a set of event markers saved on disk for use in building event tables for each fiber in the cable.

Recall event markers and use them for subsequent data acquisition:

1. Press the **Mass Storage** softkey to enter the mass-storage system, and reload the settings file saved in step 5, above.
2. Press the **Change Settings** softkey to go to the Waveform Settings menu, and change the event-marking parameter to **Manual**.
3. Connect the second fiber from the cable to FiberMaster's front panel. Press **START/STOP** to start a new acquisition. The original event markers are used for measurements, and an event table is compiled for the second fiber.
4. Press **HARD COPY** to print the waveform.
5. Press the **Event Table** softkey to go to the Event Table screen. Enter new notes about the second fiber.
6. Press **HARD COPY** to print the event table and notes for the second fiber.
7. Repeat steps 3 through 6 for each fiber in the cable, until each fiber is documented.

Operational Details of Automatic Event Marking

The following paragraphs describe how automatic event marking handles certain special cases.

Front-Panel Reflections

Automatic event marking treats the front-panel reflection as a normal reflective event, and makes a return-loss measurement on the reflection.

Nonreflective Gains

Nonreflective gains (caused by mismatched fibers) are treated in the same way as reflective events, and are marked as events. Both splice-loss and return-loss measurements are made on nonreflective gains.

Event Markers and High-Density Data

When high-density data is acquired, the measurements at any markers located within the high-density data are remeasured using the high-density data, although the locations of the markers (the distance measurement on the event table) are determined using normal-density data. The event table indicates which markers fall within high-density data.

Grouped Events

In certain cases, two or more events may be closer together than the resolving power of the event-marking method can measure accurately. Events may not be separated by measurable backscatter, or by just a few data samples. In these cases, for FM-, FS-, and FG-series optical modules, FiberMaster marks the first event in the group, and then any reflections that occur after the first event:

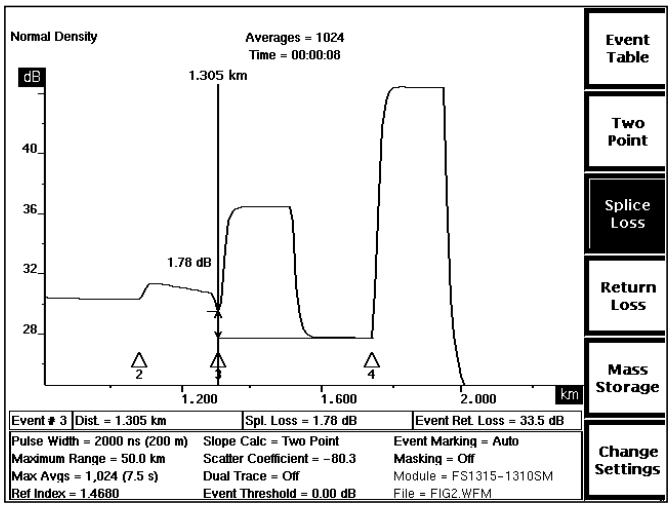


Figure 5-10. Event Marking and Grouped Reflective Events

For FL-series modules, only the first event in the group is marked, and the splice loss is calculated by combining the loss from all events in the group.

When there are no reflections found after the first event in a group, or when any event in the group is masked, only the first event is marked. The combined splice loss of all events in the group is measured and reported on the event table.

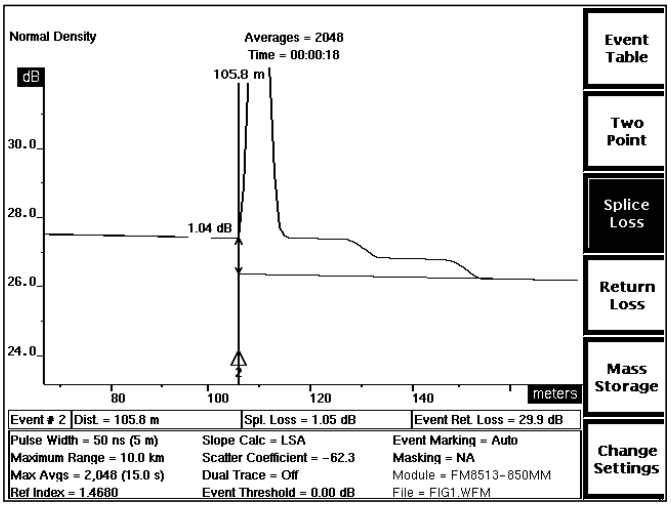


Figure 5-11. Event Marking and Grouped Non-Reflective Events

With two closely spaced events, the tail of one reflection may extend to the second reflective event. Both reflections are marked, but the splice-loss measurements may not be accurate. In this case, you can use a shorter pulse width to improve resolution.

Effects of Masking

If one or more reflections in a group of events is masked, the splice loss is calculated by combining the loss from all events in the group. This is done to exclude any event-like signatures that may be produced from waveform reconstruction. Figure 5-12 below shows two unmasked reflections, individually marked and measured. After masking, only the first reflection is marked, and the combined splice loss is measured, as shown in figure 5-13.

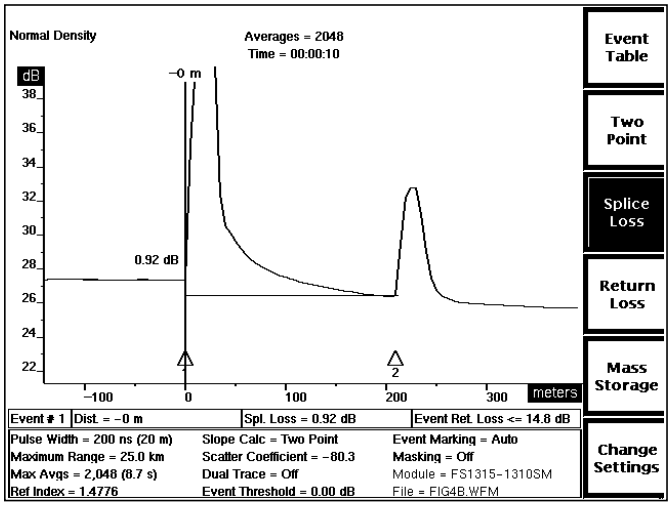


Figure 5-12. Event Marking and Unmasked Grouped Events

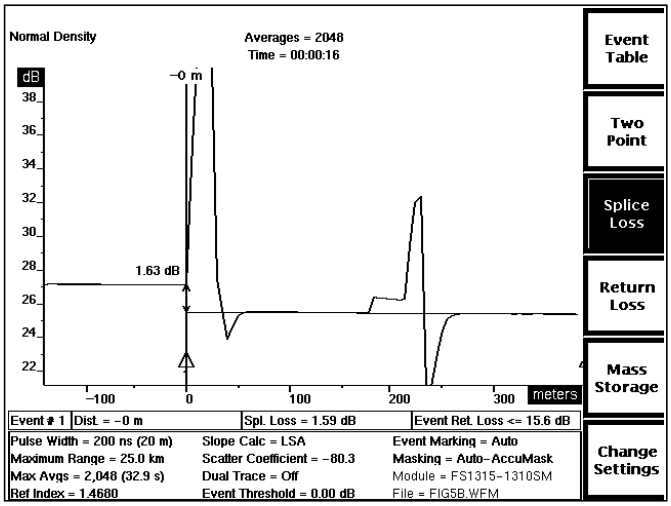


Figure 5-13. Event Marking and Masked Grouped Events

A nonreflective event or a section of backscatter that has been manually masked is marked as a nonreflective event, to avoid the waveform signature produced by the mask when calculating splice loss measurements for any adjacent events.

There are two cases when automatic return-loss measurements are not made for masked events:

1. When waveform reconstruction produces a nonreflective gain just before the reflection:

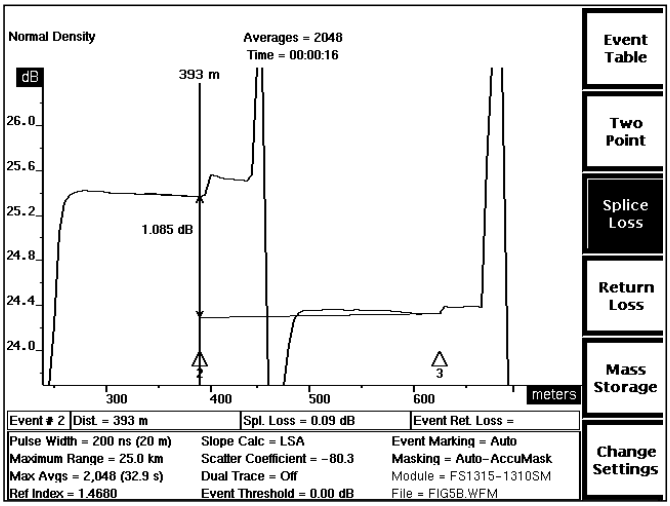


Figure 5-14. Event Marking and Nonreflective Gain Produced by Waveform Reconstruction

In this case, gain is not high enough to be treated as a reflection, so the gain and the reflection following are measured together as a nonreflective event.

2. When incorrect mask placement causes undershoot before the reflection. In this case, the event is considered nonreflective.

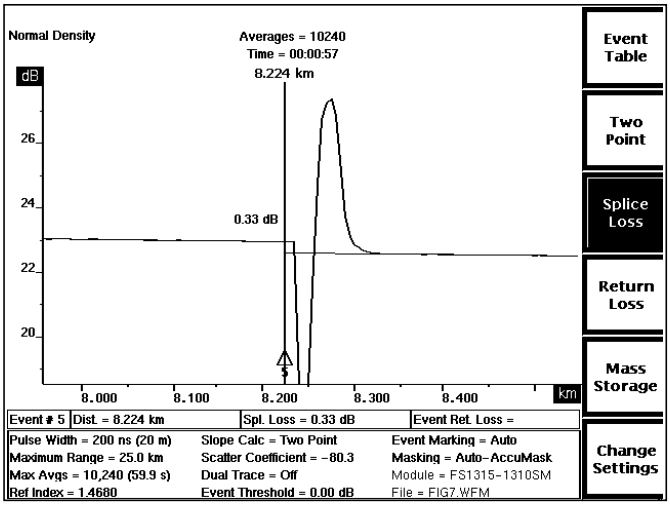


Figure 5-15. Event Marking and Incorrect Mask Placement

Event-Marking Examples

The following examples show how to use event marking, along with some of FiberMaster's other operating capabilities, to locate and measure events on a fiber.

Example 1

Figure 5-16 shows a waveform with a fusion splice between two other marked events. The fusion splice is shown as a slight nonreflective loss between events 5 and 6. Event marking is being done automatically (the event-marking parameter is set to **Auto**), and the fusion splice was not marked.

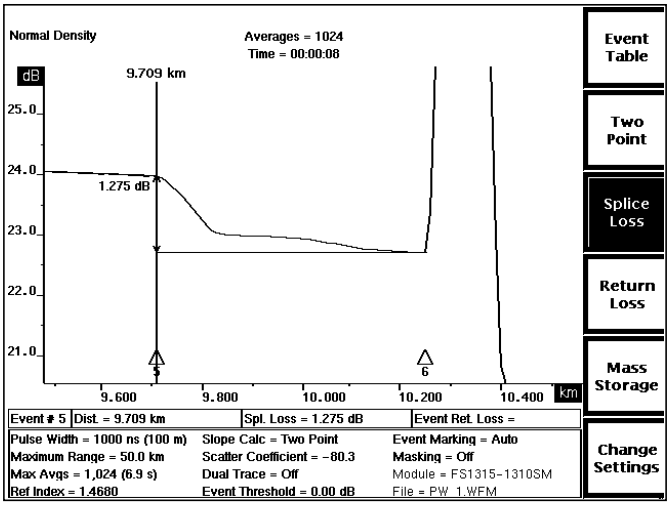


Figure 5-16. Unmarked Fusion Splice

FiberMaster grouped events 5 and 6 together and did not mark the fusion splice because the 1000-ns pulse width did not produce enough resolution. Since the fusion splice was not marked, no measurements were performed at that event. There are two ways to mark and measure the fusion splice. One possibility is to set event marking to **Manual** and mark the fusion splice manually on the Place Event Markers screen. Measurements are then made at the location of the new marker, the event is added to the event table, and the adjacent events are adjusted accordingly.

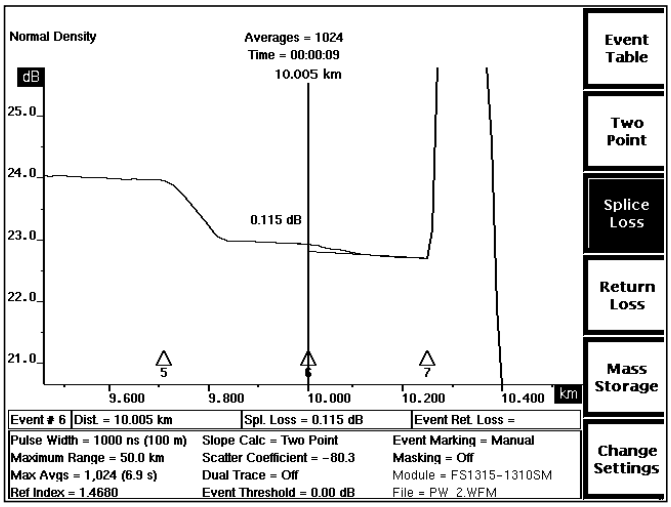


Figure 5-17. Manually Marked Fusion Splice

An alternative to marking the splice manually is to decrease the pulse width to obtain higher resolution on the waveform. When we did this on our test fiber, changing the pulse width from 1000 ns to 500 ns, FiberMaster located and marked the fusion splice automatically, as shown in figure 5-18.

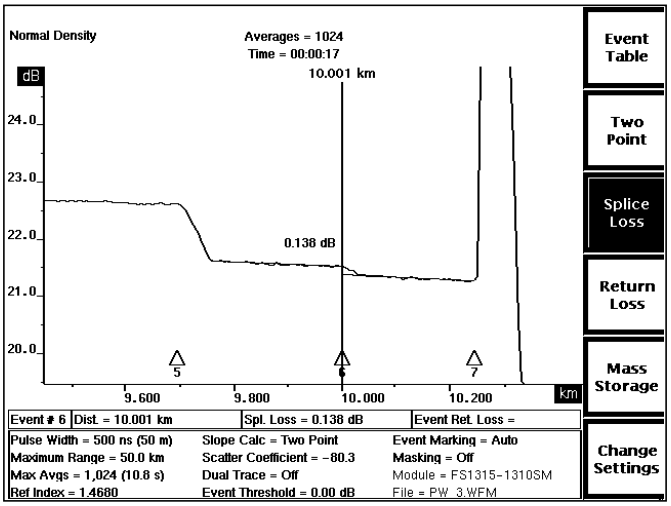


Figure 5-18. Automatically Marked Fusion Splice

Example 2

This example shows how you can use FiberMaster's maximum averages parameter to improve event-marking accuracy. Figure 5-19 shows a noisy waveform for a fiber that has a fusion splice at about 6.75 km. The splice was not marked because of the noise in the waveform.

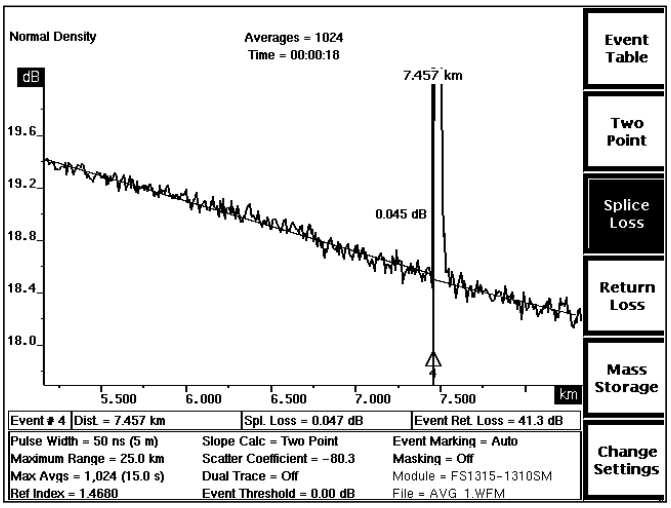


Figure 5-19. Fusion Splice Undetected in Noise

By increasing the number of averages FiberMaster does during data acquisition and reacquiring the waveform, we can improve the signal-to-noise ratio of the waveform and reduce the effects of noise. In this case, we increased the number of averages from 1024 to 5120, which improved the signal-to-noise ratio enough so the automatic event-marking function was able to locate the fusion splice, as shown in figure 5-20:

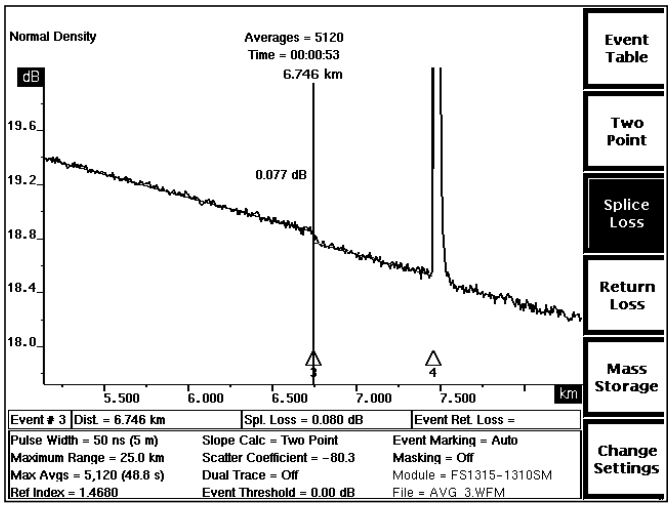


Figure 5-20. Fusion Splice Automatically Detected in Noise

6 Advanced Operating Functions

The previous chapters describe FiberMaster's measurement modes, how to make automatic optical-fiber measurements, and how to make basic manual adjustments to the automatic measurements. In many applications, automatic measurements provide all necessary data.

If you require more in-depth fiber analysis, however, you can use FiberMaster's additional features, which offer extended flexibility in acquiring and interpreting fiber data. These functions include, for example, acquiring high-density data for more accurate measurements, and comparing two waveforms by displaying them simultaneously.

This chapter explains the following:

- ❏ Details on the expansion function
- ❏ Extending the acquisition range
- ❏ High-density data acquisition
- ❏ Dual-trace mode
- ❏ Real-time data acquisition
- ❏ Manual masking

The Expansion Window

The **EXPAND** button on FiberMaster's front panel allows you to magnify a selected area of the active waveform. The magnified area is defined by the expansion window, a rectangle visible on the acquisition screen at the active distance cursor. The default size for this rectangle is one-fifth of the width and one-half the height of the overview

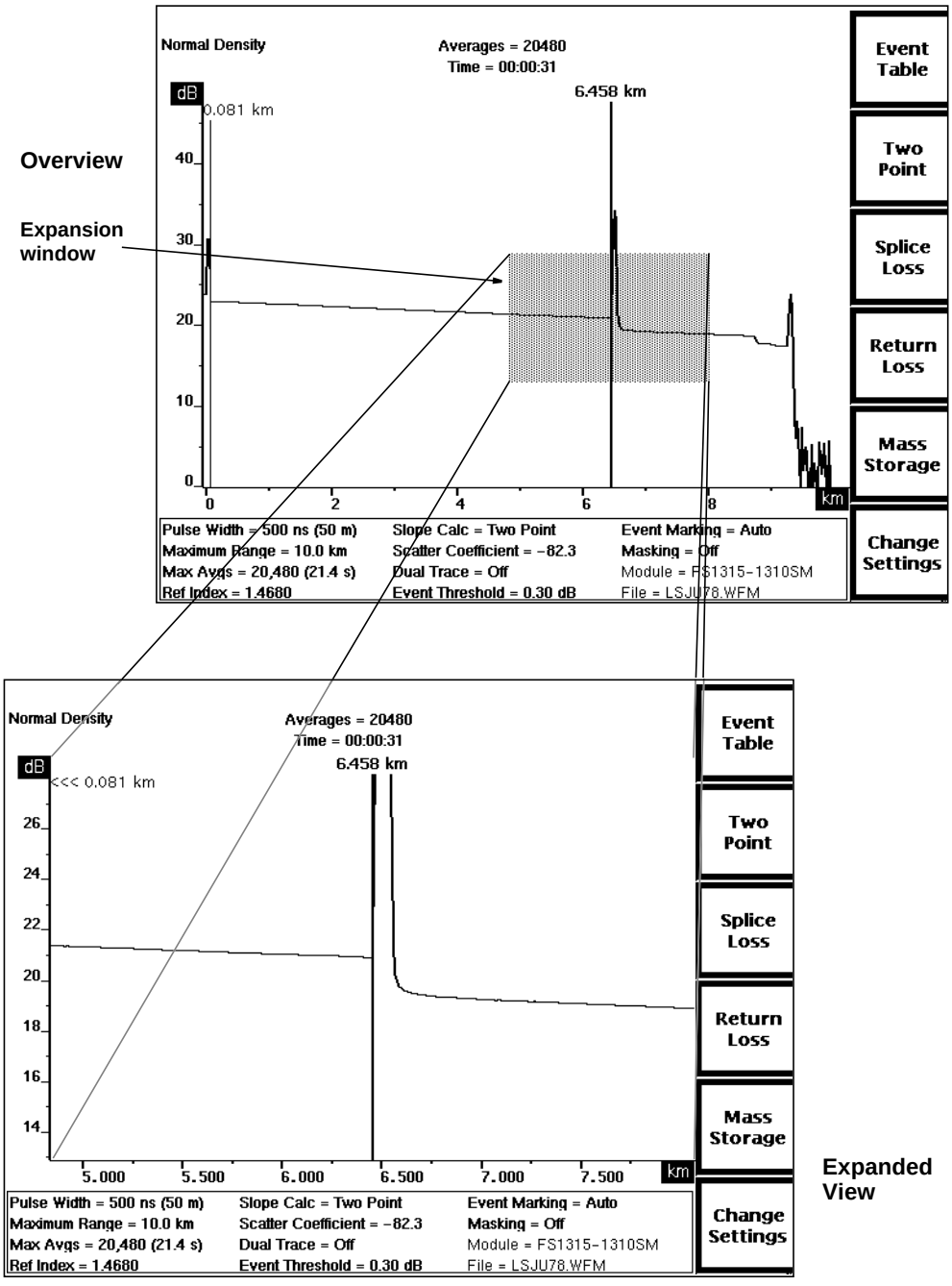


Figure 6-1. The Expansion Window

display. When you press the **EXPAND** button, the area of the waveform defined by the expansion window expands to fill the display.

In overview, you can move the expansion window along the waveform by moving the active distance cursor. The expansion window stays centered around the intersection of the cursor and the waveform. If you move the cursor off either the beginning or the end of the waveform, the expansion window remains centered around the vertical position of the last data point the cursor was on.

The only exception to this positioning occurs when re-entering overview from expanded view after moving the cursor or the waveform in expanded view. In this case, the expansion window may no longer be centered around the cursor/waveform intersection. However, when you turn the **CURSOR** knob, the window moves to center around the distance cursor and the waveform again.

You can also change the size of the window—the smaller the window, the more magnification results when you enter expanded view.

Refer to the following sections in this chapter for details on using the expansion window with high-density data, and in dual-trace mode. The expansion window is also available during real-time acquisition, and when setting manual masks.

Use these front-panel controls to manipulate the expansion window:

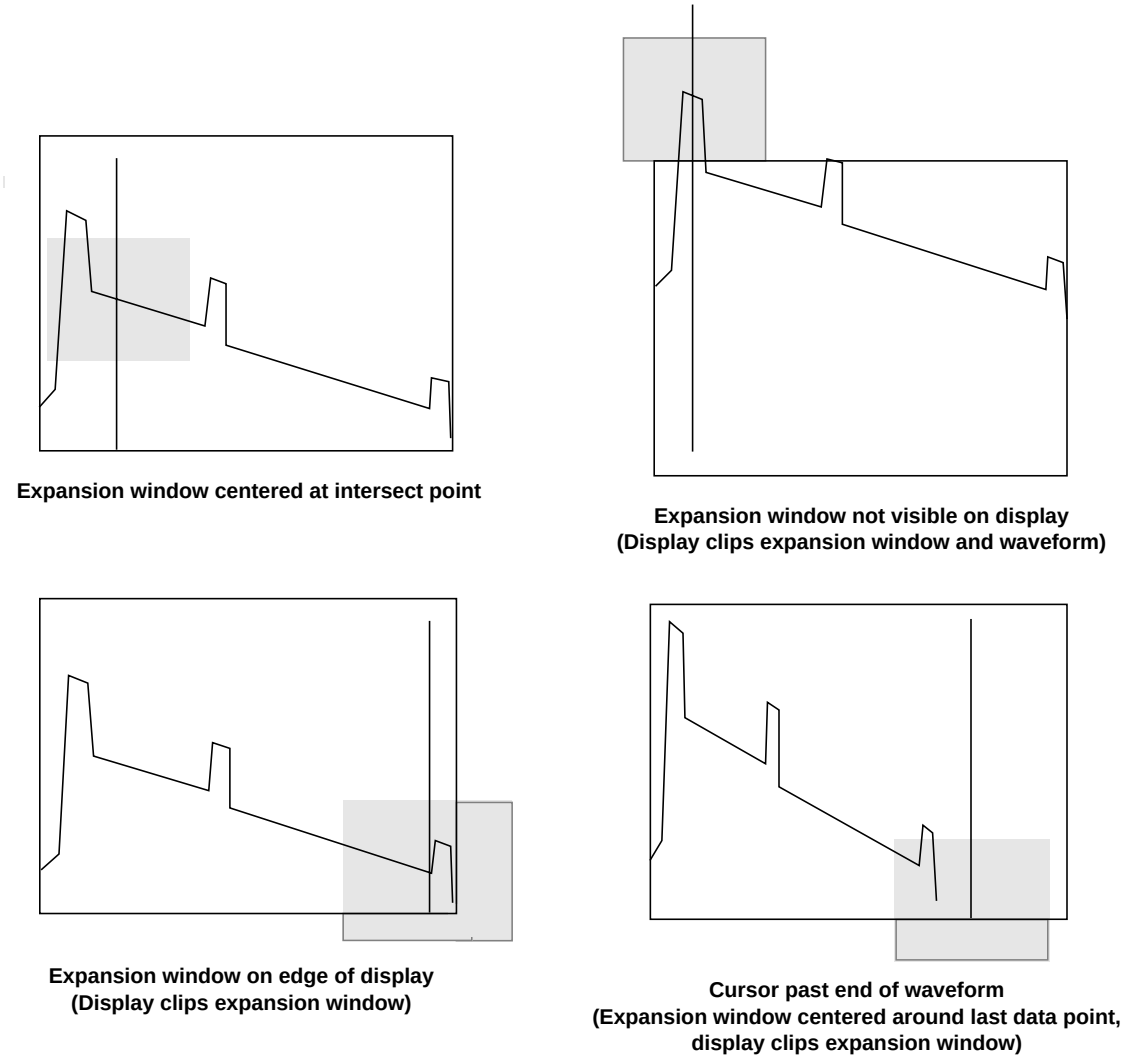
Vertical SIZE Knob

In overview, turning this knob causes the expansion window to expand and shrink vertically. Turn the knob clockwise to increase the height of the rectangle, and counterclockwise to decrease it.

You cannot expand the window larger than the overview vertical dimension, and you cannot reduce the window vertically to less than ten pixels on the display.

In expanded view, the frame of reference is the waveform and not the expansion window, which now fills the display. Even if you shrink the expansion window down to the 10-pixel limit in overview, you can increase vertical expansion further in expanded view using the vertical **SIZE** knob. When you expand the waveform to the point where the dB scale spans 1 dB, no further vertical expansion is possible.

Note that expanding the waveform vertically in expanded view has the same effect as shrinking the expansion window vertically in overview. Shrinking the waveform in expanded view is the same as enlarging the expansion window in overview. You can see the effects of these actions on the height of the expansion window when you return to overview.



Expansion window centered at intersect point

Expansion window not visible on display
(Display clips expansion window and waveform)

Expansion window on edge of display
(Display clips expansion window)

Cursor past end of waveform
(Expansion window centered around last data point,
display clips expansion window)

Figure 6-2. Moving the Expansion Window

Horizontal SIZE Knob

Turning this knob causes the expansion window to expand and shrink horizontally. Turn the knob clockwise to increase the width of the rectangle, and counterclockwise to decrease it.

You cannot expand the window larger than the overview horizontal dimension, or reduce it to include fewer than 100 data points, or 10 pixels, whichever is reached first.

In expanded view, the frame of reference for this control is the waveform itself and not the expansion window, which now fills the display. You can reduce the expansion window to 10 pixels on the display, but in expanded view you may be able to expand the waveform further, until 100 data points are left on the display. (In this case, the 100 data points may span a smaller distance than the 10-pixel width of the expansion window in overview.)

Note that expanding the waveform horizontally in expanded view has the same effect as shrinking the expansion window horizontally in overview. Shrinking the waveform in expanded view is the same as enlarging the expansion window in overview. You can see the effects of these actions on the width of the expansion window when you return to overview.

If you expand the waveform horizontally such that 100 data points are displayed, you may be prompted to push the **START/STOP** button to obtain high-density data. Refer to the next section in this chapter for a discussion of high-density data.

Distance CURSOR Knob

In overview, the expansion window is centered around the intersect point between the active distance cursor and the active waveform. When you move the distance cursor, the window follows along the waveform. If you move the distance cursor off the waveform, the expansion window stays centered around the distance cursor and the vertical position of the last data point on the waveform.

In expanded view, you can move the distance cursor within the expansion window. When you move the cursor past the right or left edge of the display, the cursor continues scrolling along the waveform, dragging the expansion window with it. (The waveform appears to move in the opposite direction.) In some cases, you may be able to drag the expansion window off the waveform.

In expanded view, the vertical positions of the waveform and the expansion window are not affected by moving the distance cursor. When you return to overview after moving the distance cursor in expanded view, the expansion window does not change location with reference to the cursor and the waveform. However, as soon as you turn the **CURSOR** knob, the window moves to center around the intersection of the cursor and the waveform again.

CURSOR SELECT Button

In Preview, Two Point, and Link Return Loss modes, in both overview and expanded view, the **CURSOR SELECT** button switches the active distance cursor, and moves the expansion window so it is centered around the intersection of the waveform and new active cursor. If the inactive cursor is off the screen when you press **CURSOR SELECT**, the view switches to show both cursors on the screen if possible. If the cursors are not close enough to each other to display both, the view is centered around the new active cursor.

If both points where the waveform intersects the two distance cursors can be contained within the height of the expansion window, the vertical position of the window is adjusted to do so, even if both distance cursors are not visible on the screen. If the intersect points between the waveform and the cursors are separated vertically by more than the height of the expansion window, the window centers around the new active distance cursor and the waveform.

In Splice Loss and Event Return Loss modes, the function of the **CURSOR SELECT** button does not affect the expansion window.

Extending the Acquisition Range

The maximum range specified on the Waveform Settings menu should be approximately the same as the length of the fiber being tested. If you select a short pulse width for the acquisition, the resulting waveform may span only a fraction of the maximum range and the screen, as shown below. You can extend the acquisition

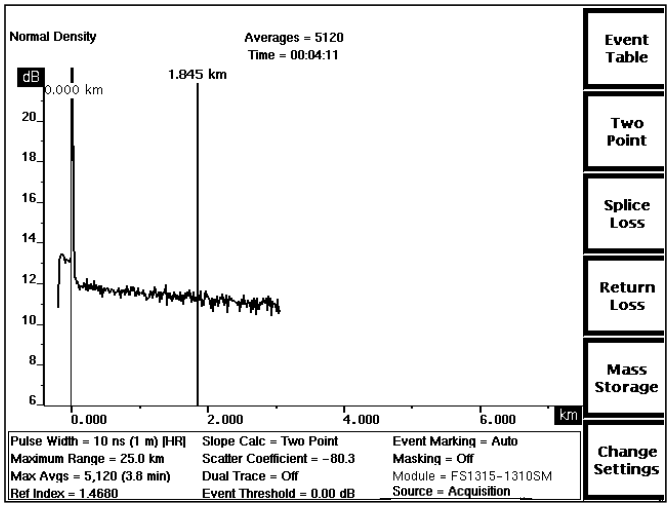


Figure 6-3. Short Acquisition Range

range up or down the fiber by moving the distance cursor to the left or right off the waveform. When the cursor passes the end of the waveform, the following prompt displays on the screen:

Press START/STOP to extend the acquisition

NOTE *Extended data acquisition is not necessary when using long pulse widths, and unavailable with the long-range FL-series modules. In these cases, this prompt does not appear.*

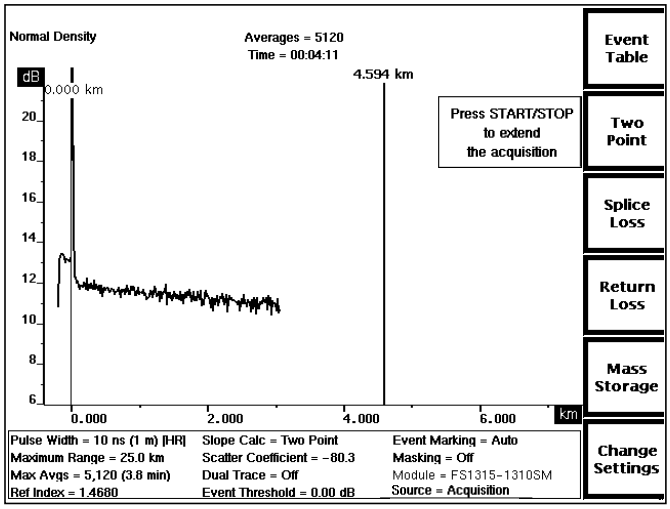


Figure 6-4. Cursor Past Acquisition Range and Resulting Prompt

When you press **START/STOP**, a new acquisition starts, centered around the active distance cursor.

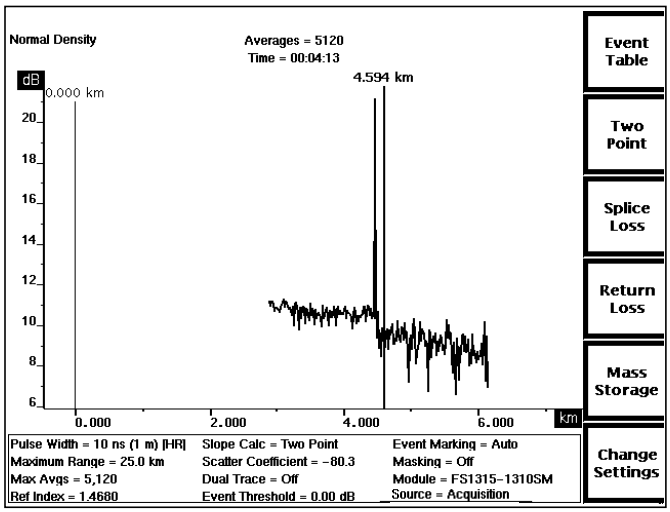


Figure 6-5. Extended Acquisition

If you know the location of a fiber feature that is not included within the current acquisition range, you can move the cursor past the end of the waveform, directly to the location of the event. When you press **START/STOP**, new data is acquired with the acquisition range centered around the event of interest.

NOTE *You may also notice the acquisition range shift when changing pulse widths. If you change from a long to a short pulse width, the range of the new acquisition may not extend from the start of the current range to the location of the active*

distance cursor. In this case, the new acquisition is centered around the active distance cursor.

High-Density Data Acquisition

When you expand a waveform (either by turning the horizontal **SIZE** knob in expanded view, or by pressing the **EXPAND** button in overview), the number of data samples visible on the display can be reduced to 100. In this case, a prompt may appear telling you to press the **START/STOP** button to acquire high-density data. You do not have to press **START/STOP** when you see this prompt, but you cannot expand the waveform to fewer than 100 displayed data samples.

NOTE *High-density data acquisition is not available with the FL-series optical modules and may not be possible with other modules for waveforms with short pulse widths and long maximum ranges. In these cases, the high-density prompt does not appear.*

When you press **START/STOP**, new data is acquired at a sample density up to five times the normal sample density. The high-density data is displayed in a different color and at higher intensity than normal-density data. It resides in its own memory and does not overwrite normal-density data.

NOTE *On the acquisition screen, the time shown for the maximum number of averages selected is for normal-density data only. A high-density acquisition takes approximately three to five times longer.*

After acquiring high-density data, you can return to normal density by turning the horizontal **SIZE** knob counterclockwise, past the point that produced the high-density prompt. You can then redisplay the previously acquired high-density data by expanding the waveform to fewer than 100 samples again. Since the high-density data has already been acquired, the prompt does not display. Instead, the high-density data appears automatically when the waveform is expanded to fewer than 100 data points.

High-Density Data Measurements

You can see high-density data as a dashed zone of the waveform on the overview display. If the high-density data spans at least half the expansion window, when you expand on this area the high-density data is displayed and used in all measurement calculations. When high-density data is being viewed or used in measurements, the message **High Density** appears in the upper left corner of the display. If high density is not being viewed, the message **Normal Density** displays.

Parameter Settings and High-Density Data Acquisition

You cannot change parameter settings specifically for high-density data acquisition. Settings for high-density data must match those of the corresponding normal-density data. Any setting changes you make while viewing high-density data also apply to the normal-density data.

Changes to the pulse width, maximum range, and laser source require a new acquisition to take effect. A message appears instructing you to press **START/STOP** to acquire data using the new settings. The new acquisition is normal density, the acquisition screen returns to overview, and the previously acquired high-density data is lost.

Exceptions occur, however, to allow manual adjustments to masks for high-density data without requiring a new normal-density acquisition. You can change the masking type setting and make manual changes to masks specifically for high-density data.

For example, when viewing high-density data you can switch from an automatic to a manual masking-type setting. In this case, when you press **START/STOP** to implement the new masking type, high-density data is reacquired without affecting the normal-density data. You can press **START/STOP** either after returning to the acquisition screen, or on the Place Manual Masks screen after adjusting masks.

If you change the masking type or adjust manual masks for high-density data, when you return to overview, the Masking Type parameter is highlighted to indicate that the current setting does not match the overview waveform data. A prompt appears informing you to press **START/STOP** to reacquire normal-density data using the new masking parameters. When you reacquire normal-density data, the high-density data is discarded.

When a new acquisition is started and high-density data is *not* being viewed, any existing high-density data is erased from current memory.

Storing High-Density Data

When you copy a waveform from current acquisition memory to reference memory (by pressing the **STORE** button), any associated high-density data is copied along with the overview data and parameter settings.

The Save menu in the mass-storage system accommodates saving and recalling high-density data. When you want to save a waveform that has high-density data associated with it, a prompt displays asking if you want to include the high-density data in the save function. Any waveform that is saved with high-density data is automatically recalled with that data.

Dual-Trace Mode

Dual-trace mode displays two waveforms on the screen at once. You can turn dual-trace mode on or off using the Waveform Settings menu. (Refer to chapter 3, *Getting Started*, for details on setting instrument parameters.) When dual-trace mode is on, one waveform is displayed from current memory and a second is displayed from reference memory. When dual-trace mode is off, only the active waveform displays.

Making Measurements

In dual-trace mode, you can perform measurements on the active waveform. The **WFM SELECT** button on the front panel selects the active waveform. Pressing **WFM SELECT** alternately selects the current and the reference waveform as the active waveform. One of the indicators next to the **WFM SELECT** button lights to show which waveform is active. The active waveform is displayed at a brighter intensity to differentiate it from the inactive waveform.

Each waveform is independent from the other, and has its own set of waveform settings. Measurement operation is the same as in single-trace mode, as described in chapter 4, *Making Optical Fiber Measurements*. The front-panel controls operate on the active waveform, except for the horizontal **POSITION** knob and the **SIZE** knobs (in expanded view), which operate on both waveforms simultaneously.

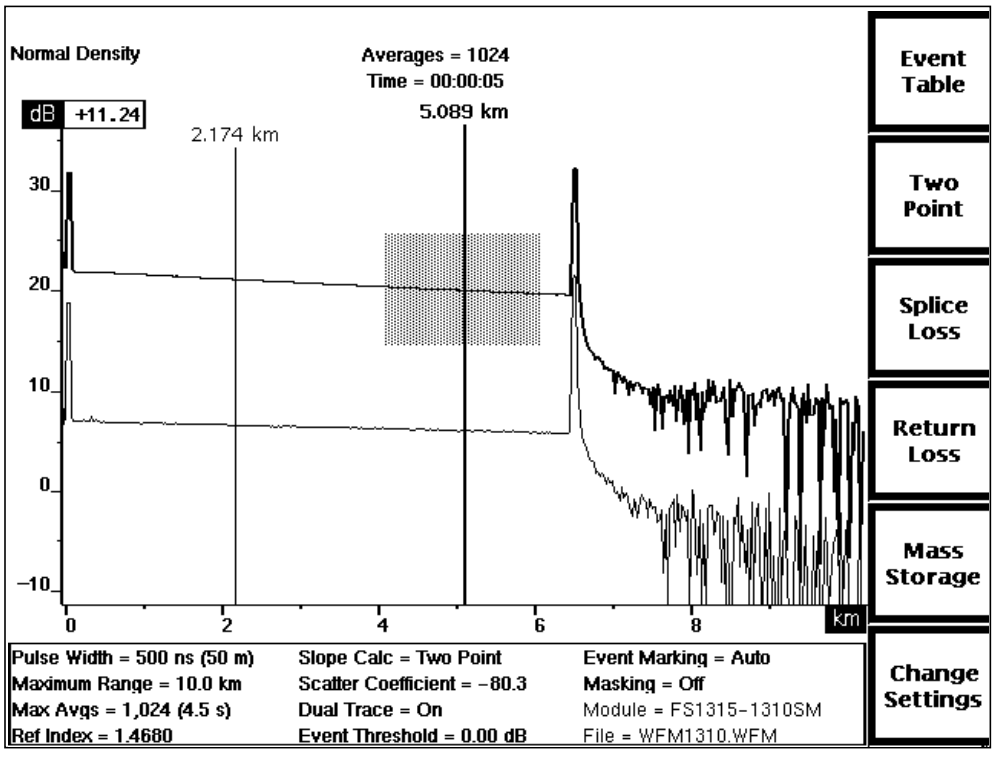


Figure 6-6. Dual Waveform Display

Aligning Waveform Scales

In dual-trace mode, the current and reference waveforms are displayed on the same distance scale. The horizontal **SIZE** and **POSITION** knobs operate simultaneously on both waveforms to maintain distance alignment. The vertical **SIZE** knob operates on both waveforms to maintain equal vertical expansion. To separate the waveforms vertically, however, the vertical **POSITION** knob controls only the active waveform. The dB scale displayed is that of the active waveform. The difference between the scales of the active and inactive waveforms is shown at the top of the vertical scale.

You can align the two vertical scales by pressing and holding the **WFM SELECT** button. The inactive waveform moves to the same scale as the active waveform, and the difference in the scales displays as 0 dB.

Changing Instrument Settings

The waveform-parameter area at the bottom of the acquisition screen shows the settings of the instrument when the active waveform was acquired. For the reference waveform, these settings are static. For the current waveform, you can change these settings, which reflect the current state of the instrument.

You can change waveform settings for the current waveform at any time. Any setting change that affects how the waveform data is acquired (pulse width, maximum range, or masking type) causes a prompt to display instructing you to press **START/STOP** to acquire new data. The changed settings are highlighted to show that they do not correspond to the waveform data currently displayed. When new data is acquired using the new settings, the highlighting is cleared.

The Expansion Window

When dual trace is on, pressing the **EXPAND** button expands both the active waveform and the inactive waveform. However, if the inactive waveform is outside the expansion window in overview, only the active waveform is visible in expanded view. In this case, you can use the vertical **POSITION** knob to move the active waveform and bring the inactive waveform into view.

High-Density Data Acquisition

If the current waveform is active, you may be able to acquire high-density data for the active waveform. You can expand the active waveform as long as the inactive (in this case, the reference) waveform still has more than 100 data points on the screen. If this limitation lets you expand the active waveform to 100 data points, a prompt appears telling you to press the **START/STOP** button to acquire high-density data for the active waveform.

You can then expand the high-density data as long as the inactive waveform still has more than 100 data points on the screen. If the inactive waveform has high-density data in the same region, expanded view shows high-density data for both waveforms.

If you reach the 100-point minimum for the inactive waveform, you cannot expand the active waveform any further. To expand the active waveform further, you must turn dual trace off.

Real-Time Acquisition

In real-time acquisition, data is acquired as fast as possible and new acquisitions are continually displayed on the screen. (The acquisition rate varies for different wavelength, maximum-range, and pulse-width settings.) The data is averaged minimally, so changes appear on the display almost immediately. Real-time acquisition is useful for adjusting fiber connections and making splices.

To start a real-time acquisition, press and hold the **START/STOP** button for two seconds. When you put the instrument into real-time mode, the maximum-averages and masking-type settings may no longer apply to the acquisition. The settings displayed at the bottom of the acquisition screen for these parameters change to indicate the actual values used for real-time mode. When you stop real-time mode, the settings revert to their previous values.

The masking types allowed during a real-time acquisition are **Off**, **Auto-QuickMask**, and **Manual-QuickMask**. If AccuMask is on, the masking type parameter switches to the appropriate QuickMask setting (auto or manual) for the duration of real-time mode.

During a real-time acquisition, the elapsed time displayed at the top of the acquisition screen changes to read **Time = Real Time**, and the acquisition-active indicator displays at the lower left of the waveform area.

The only measurements possible in real-time mode are two-point measurements. When you start a real-time acquisition, the instrument automatically enters Two Point mode. These measurements require very little calculation and, except for automatic two-point loss, remain unchanged by the constant input of new data unless you turn the distance **CURSOR** knob.

When you start a real-time acquisition with return loss on, the **Link Return Loss** and **Event Return Loss** softkeys are replaced by the **Two Point** and **Splice Loss** softkeys, the **Exit Return Loss** softkey changes to **Return Loss**, and the instrument enters Two Point mode. When the real-time acquisition is stopped, return loss is turned back on.

You cannot enter the mass-storage menus during a real-time acquisition. In order to enter mass storage, first stop the acquisition.

To stop a real-time acquisition, press the **START/STOP** button again. Real-time acquisition also stops when you press a softkey to exit Two Point mode.

Setting Manual Masks

The Place Manual Masks screen is available via a softkey on the Waveform Settings menu, when the Masking Type pop-up window is displayed. Use this screen to make manual adjustments to automatically set masks, or to set masks independently. Manual masking is available only if supported by the currently selected laser, and if the masking-type parameter is set to one of the manual settings. (Masking is supported on the FS-series 1310 nm SM and 1550 nm SM modules.)

The masking-type parameter allows you to specify **Auto** or **Manual** masking. The **Auto** settings cause the system to calculate masks automatically. When the masking type is set to **Auto**, the Place Manual Masks screen is not accessible.

The **Manual** settings prevent the system from automatically setting masks, but do not delete any existing masks. Existing masks can be moved, removed, or resized manually.

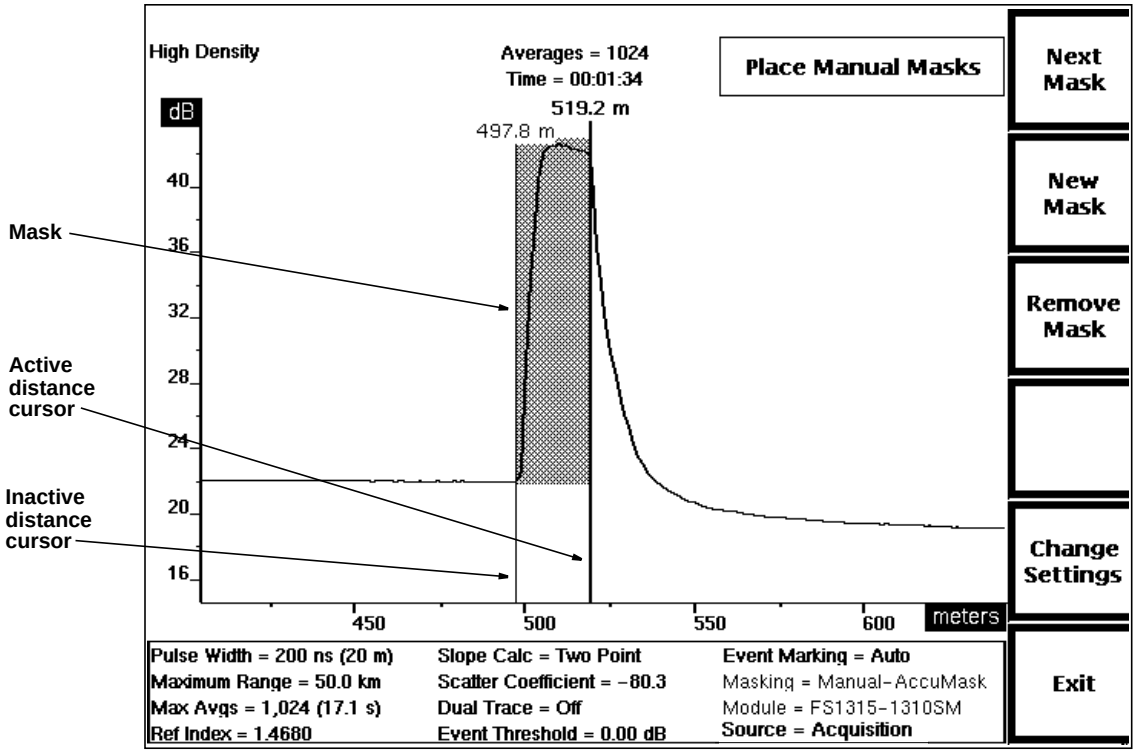


Figure 6-7. Place Manual Masks Screen

Entering the Place Manual Masks Screen

Enter the Place Manual Masks screen from the acquisition screen as follows:

1. Press the **Change Settings** softkey to enter the Waveform Settings screen.
2. Press the **Next Param** softkey until the Masking Type pop-up window displays.
3. Set the masking type to one of the two manual selections.
4. The **Place Masks** softkey displays when the masking type is set to manual. Press this softkey. The Place Manual Masks screen displays.

Masks are identified by shaded rectangular areas that cover the portions of the waveform that are excluded from acquisition averaging. When there are no masks, a blank mask appears as an outlined rectangle between the two distance cursors. Moving the active distance cursor enables this mask, which you can then move and resize as needed.

When working on the Place Manual Masks screen, you can use the expansion window to magnify portions of the waveform for precise mask placement. Use the horizontal and vertical **SIZE** knobs and the **EXPAND** button to size the waveform for this purpose. The waveform **POSITION** knobs also function when working on the Place Manual Masks screen.

Adjusting Masks

To mask a reflection manually, position the left side of the mask on the rising edge of the reflection. Place the right side of the mask on the down-turning point of the right side of the reflection. After placing masks, press **START/STOP** to acquire new data using the new mask without exiting the Place Manual Masks screen. If necessary, you can then readjust masks to further minimize dead zone. The following paragraphs describe how to move, add, adjust, and remove masks manually.

NOTE *If reflections are too close together, tail from the first reflection can interfere with the second one. To see data between two closely spaced reflections, mask the first reflection, but not the second one.*

Manual Masking Softkeys

The masking operation uses softkeys and two distance cursors to modify the masks. Use the distance cursors to specify the mask to be modified and the softkeys to make the modification, as follows:

Next Mask - advance the distance cursors to the next mask. A cursor is placed on either side of the mask. Pressing **Next Mask** selects the mask to the right of the current cursor positions, and wraps to the first mask on the waveform from the last one. The selected mask is highlighted.

New Mask - create a new mask that you can move to any point on the waveform.

Remove Mask - delete the mask on which the distance cursors are located.

Change Settings - return to the Masking Type parameter on the Waveform Settings menu.

Exit - exit the menu system and return to the acquisition screen.

Moving a Mask

You can move a mask in the direction of the inactive distance cursor. For example, to move a mask to the right along the waveform, follow these steps:

1. Using the **Next Mask** softkey, place the distance cursors on the mask to be moved.
2. Press the **CURSOR SELECT** button to select the left-hand distance cursor as the active cursor.
3. Turn the **CURSOR** knob clockwise to move the distance cursor to the right. Move the active cursor, pushing the inactive cursor, until you reach the location along the waveform where you want to place the mask.
4. Place the cursors on the right-hand point of the mask, then move the active cursor to the left-hand point. When you move the active cursor left, the inactive cursor stays stationary, and you can adjust the mask size.

Move a mask to the left in the same way, selecting the right-hand distance cursor as the active cursor.

Adding a Mask

1. Press **Next Mask** to position the distance cursors at the nearest existing mask.
2. Press the **Add Mask** softkey. The new mask is added next to the existing one, on the right side (unless the existing mask is at the end of the waveform, then the new mask is added to the left). If you are working in overview, the new mask is one-twentieth the width of the waveform. If you are in expanded view, the new mask is one pulsewidth wide.
3. Move the new mask to another location, and resize it using the distance **CURSOR** knob.

Adjusting Mask Width

1. Adjust mask width by pressing **Next Mask** to place the distance cursors on the mask to be adjusted.
2. Use the distance **CURSOR** knob to move the active distance cursor to the desired position. The mask point at the inactive distance cursor remains stationary as you move the active cursor.
3. To adjust the opposite side of the mask, press the **CURSOR SELECT** button to select the other distance cursor.

Removing a Mask

Remove a mask by selecting the mask using the **Next Mask** softkey, then pressing the **Remove Mask** softkey. The mask is removed, and the distance cursors advance to the next mask. If you remove the last mask, the distance cursors remain at their current positions and the mask between them is blanked, appearing as an outlined rectangle. The blank mask is not enabled.

Implementing Manual Masks

Any manual changes to masks require a new acquisition to see the effects of the changes. You can start a new acquisition while on the Place Manual Masks screen by pressing the **START/STOP** button.

When working with high-density data on the Place Manual Masks screen, you can reacquire high-density data without affecting the corresponding normal-density data.

If you change the masking type or adjust manual masks for high-density data, when you return to overview, the Masking Type parameter is highlighted to indicate that current masking parameters do not match the overview waveform data. A prompt appears informing you to press **START/STOP** to reacquire normal-density data using the new masking parameters. When you reacquire normal-density data, the high-density data is discarded.

For more information on changing parameters for high-density data, refer to the section in this chapter, *High-Density Data Acquisition*.

Clearing and Replacing Manual Masks

You can clear the Place Manual Masks screen simply by removing each mask manually. Otherwise, all masks are cleared when the masking-type parameter on the Waveform Settings menu is set to **Off** and new data is acquired.

Masks are replaced under the following circumstances:

- When you change the masking-type parameter on the Waveform Settings menu to one of the **Auto** settings, masks are recalculated with each new acquisition.
- When the masking-type parameter on the Waveform Settings menu is set to one of the **Manual** settings, masks are replaced when you switch optical modules by the masks last used with the new module. For example, when you switch from 1300 nm MM to 1310 nm SM, the set of masks last used with the singlemode module is recalled.

  Manual masks are *not* replaced when switching optical modules in the same plug-in unit.

Exiting the Place Manual Masks Screen

Press **Change Settings** to return to the Waveform Settings screen, or **Exit** to return to the acquisition screen.

When you set manual masks, a new acquisition is required in order to see the effects of the changes. When you press the **Next Param, Prev Param, Next Menu,** or **Exit** softkey to exit the masking-type parameter, the masking-type setting at the bottom of the screen is highlighted to indicate that the current masking data does not match the acquisition data.

Press **START/STOP** to acquire new data using the new masking parameters. The highlighting is cleared, because the masks now correspond to the waveform.

7 Mass Storage

Mass-storage menus are available from the start-up screen and from the acquisition screen. These menus allow you to save and recall waveform data and instrument settings on removable floppy disks and optional fixed internal RAM. The data is saved in MS-DOS-compatible files.

Instrument Configuration

FiberMaster can be configured with one or two mass-storage devices. Your instrument can have a floppy-disk drive alone, or a floppy-disk drive plus internal RAM. The mass-storage menus vary depending on whether your instrument has one or two mass-storage devices. The illustrations in this chapter show examples of mass-storage menus for both single- and dual-drive instruments.

Entering the Mass Storage Menus

Enter the mass-storage menus from the power-on screen or the acquisition screen by pressing the **Mass Storage** softkey. The first menu displayed is the Load from Disk menu. Each menu in the system includes a list of mass-storage menus across the top of the display. The current menu is highlighted. Each menu provides a specific mass-storage function, including:

- ❏ Load from Disk
- ❏ Save to Disk
- ❏ Format
- ❏ Delete
- ❏ Copy (available only on dual-drive instruments)

If an acquisition is in progress when you enter the mass-storage menus, it stops until you exit. When you exit mass storage, the acquisition resumes, unless you have performed an operation that affects current memory. For example, if you load a waveform from disk to current memory, the previous acquisition data is overwritten. If you load a settings file into current memory, the previous acquisition does not resume when you exit mass storage. You must press the **START/STOP** button to start a new acquisition using the new settings.

If a real-time acquisition is in progress, you must stop it before you can enter the mass storage menus.

A status line displays at the bottom of each mass-storage menu to inform you how to perform each function, and to show the status of any current operation.

The Load from Disk menu is always the first menu displayed when you enter mass storage.

FiberMaster File Types

FiberMaster uses data files containing waveform data and associated settings and event markers, and files containing instrument settings and event markers only. When you create a file by saving waveform or settings data in mass storage a three-character suffix is automatically appended to the file name, unless you specify the suffix. The suffix that is added automatically depends on which type of data the file contains. The suffix WFM is added to waveform file names, and the suffix SET is added to settings file names.

Waveform files can be in one of two formats, depending on how they were saved. The formats are TFP2 and CFF (common file format). The TFP2 format is backward compatible with older TFP2 instruments. The CFF format is common to Tektronix OTDR-type products produced in 1995 and after.

The File Type field on the Load From Disk and Delete menus shows which type of file is currently selected. For waveform files, the file type shows **TFP2** or **CFF**, depending on the format that was used to save the file. The File Type field shows **Settings** for settings-only files, and **Non-OTDR** for all other file types.

The File Type field shown on the Save to Disk menu shows the file format that will be used when waveform files are saved. This is the current setting of the file format parameter, which is selected on the System Settings menu.

Loading and Saving Other OTDR Files

You can load waveform files acquired using other Tektronix OTDR-type products. All Tektronix OTDR products produced in 1995 and after use the common file format, and any CFF file can be loaded into the FiberMaster.

After loading a non-FiberMaster CFF file, you can change the fiber notes, operator name, fiber ID, scattering coefficient, index of refraction, units of measurement, fault threshold, and event notes.Saving the file on the FiberMaster saves the changes without affecting any other data in the file.

NOTE *If a non-FiberMaster file is loaded into current memory and you push the* ***START/STOP*** *button to start a new acquisition, all non-FiberMaster data is discarded. All data used by FiberMaster (listed in appendix c,* FiberMaster Data Format*) is retained, but all data specific to the instrument that originated the file is discarded.*

Media Capacity

The number of waveform and settings files that you can store on mass media varies, depending on the type of media you use, and the type of data you are storing. A typical normal-density waveform file can range from 4 or 5 Kbytes to over 30 Kbytes, and a waveform that has been stored with high-density and masking data can be over 50 Kbytes in size. Using a conservative estimate of about 35 Kbytes per file, a 1.4-Mbyte floppy disk can store about 40 waveform files.

Load from Disk

Use the Load from Disk menu to load a waveform or instrument settings from a disk file or internal RAM to the instrument. If the file is a waveform file, you can load the data into current or reference memory. You can load settings files into current memory only.

The Load from Disk menu (figure 7-1) is the first one displayed when you enter the mass-storage system. From any other mass-storage menu, go to the Load from Disk menu by pressing the **Next Menu** softkey until the menu displays and is highlighted at the top of the screen.

Selecting a File to Load

The disk's directory is shown on the lower half of the screen. The selected file in the directory is highlighted. The file-specification fields display data for the highlighted file. Turn the distance **CURSOR** knob to select other files in the directory. When the cursor is stationary, file data is read from the disk and the file-specification fields are updated for the highlighted file.

If the directory is longer than one page, use the **Next Page** and **Previous Page** softkeys to scan through the files, or scroll through the directory using the distance **CURSOR** knob.

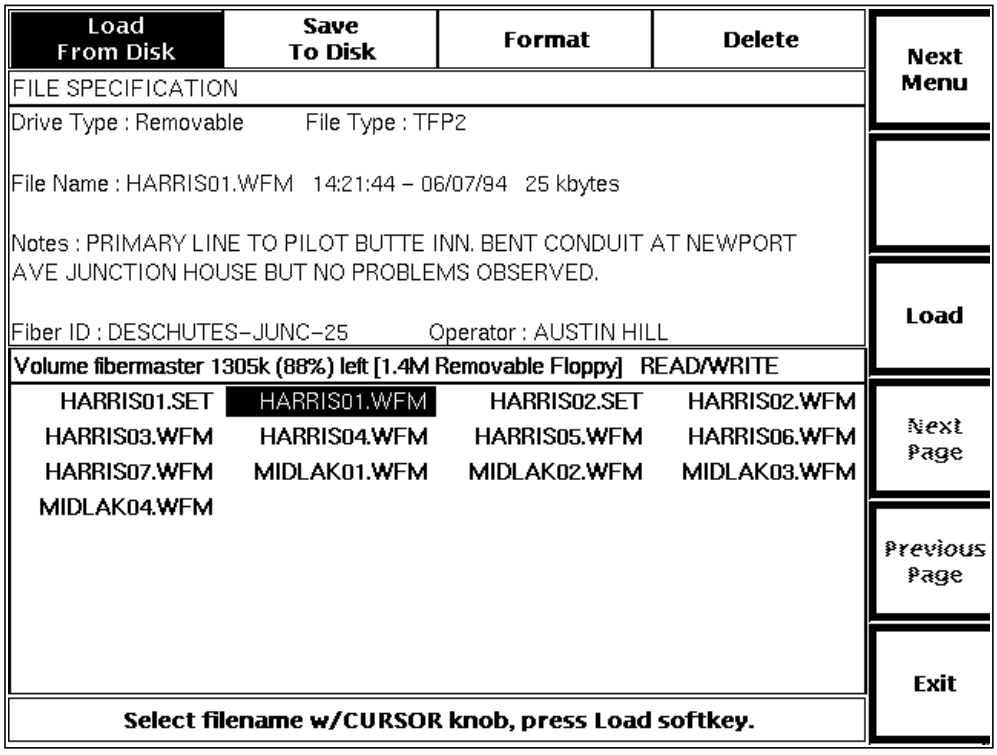


Figure 7-1. Load from Disk Menu: Single-Drive Instrument

If your instrument has both internal RAM and a floppy-disk drive, an additional softkey on this menu allows you to select which drive to use for the load operation (figure 7-2). The directory lists the contents of the currently active drive. Pressing the **Switch Drives** softkey lets you view the directory of the other drive. The Drive Type field in the file-specification area of the screen indicates which drive is active. You can then select the file to load from the active drive's directory.

For dual-drive instruments, if there is a disk in the floppy-disk drive when you turn on the instrument, that drive is the active drive. If there is no floppy disk present, the internal RAM is the default drive type. After power-on, each time you enter the mass-storage menus the active drive type is the one last used.

After choosing the file to load, press the **Load** softkey to load the waveform or settings data.

Only waveform and settings files may be loaded. If you select a file to load that is another type of file, the file type is displayed as **Non-OTDR**, and the following message displays:

Only Waveform or Settings files may be loaded.

Loading a Waveform File

When you press the **Load** softkey to load a waveform file, the softkeys are redrawn to show the following options:

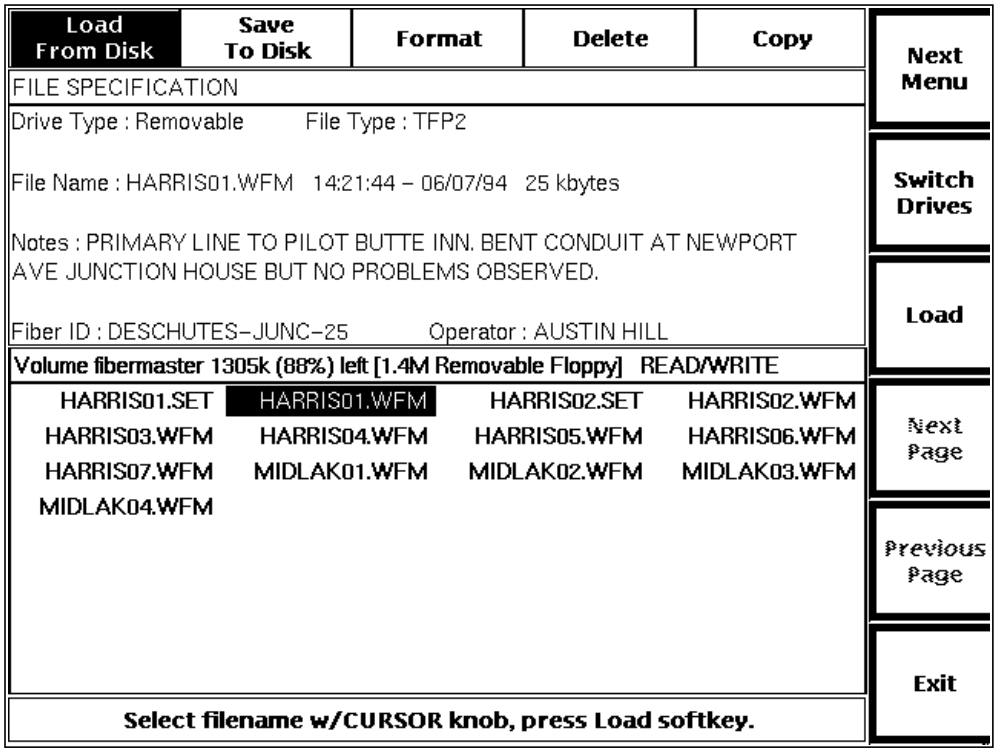


Figure 7-2. Load Menu: Dual-Drive Instrument

Curr Memory - load the waveform and settings data to current memory. Any existing acquisition data in current memory is overwritten.

Ref Memory - load the waveform and settings data to reference memory. Any existing data in reference memory is overwritten.

Cancel - cancel the operation and return to the Load from Disk menu.

NOTE *If you load a waveform file into current memory, any partial or complete acquisition data is overwritten.*

Loading a Settings File

When you press the **Load** softkey to load a settings file, the following message displays on the screen: **Load settings to current?** Two additional softkeys are provided, **Yes** and **No**.

Yes - load the new settings into current memory.

No - cancel the operation and return to the Load from Disk menu. The original settings are retained.

NOTE *If an acquisition was in progress when you entered the mass-storage menus, it stops until you exit. When you exit mass storage, the acquisition resumes, unless you load a waveform or settings file into current memory. If you load a settings file into current memory, the waveform data is not overwritten, but the acquisition does not resume. The settings shown at the bottom of the acquisition screen are those just loaded from disk, and may not match the settings used to acquire the waveform displayed. Any settings that do not match acquisition data are highlighted. You must then press the* ***START/STOP*** *button to start a new acquisition using the settings just loaded. When waveform data is acquired using the new settings, the highlighting is cleared.*

Quick Load

The Quick Load function allows you to load waveform and settings files with a minimum of button pressing. From the acquisition screen, access the Quick Load function as follows:

1. Press the **Mass Storage** softkey. The Load from Disk menu displays.
2. For dual-drive instruments, select the drive to use for the load operation by pressing the **Switch Drives** softkey.
3. Press the **WFM SELECT** button.

The softkeys are redrawn with file names from mass storage. The first five settings file names appear on the top five softkeys. If five settings files are not found on the active drive, the remaining keys show the first available waveform file names.

To load one of the files, press the corresponding softkey. When you press a softkey, the following operations happen automatically:

- ❏ The file is loaded into current memory.
- ❏ You are returned to the acquisition screen.
- ❏ A new acquisition is started.

If the file being loaded is a waveform file, the file is loaded into both current and reference memories before starting the new acquisition. This way, the file's settings are used for the new acquisition in current memory, and you can also view the original waveform data in reference memory.

Press the **Exit** softkey to cancel the Quick Load operation and return to the acquisition screen.

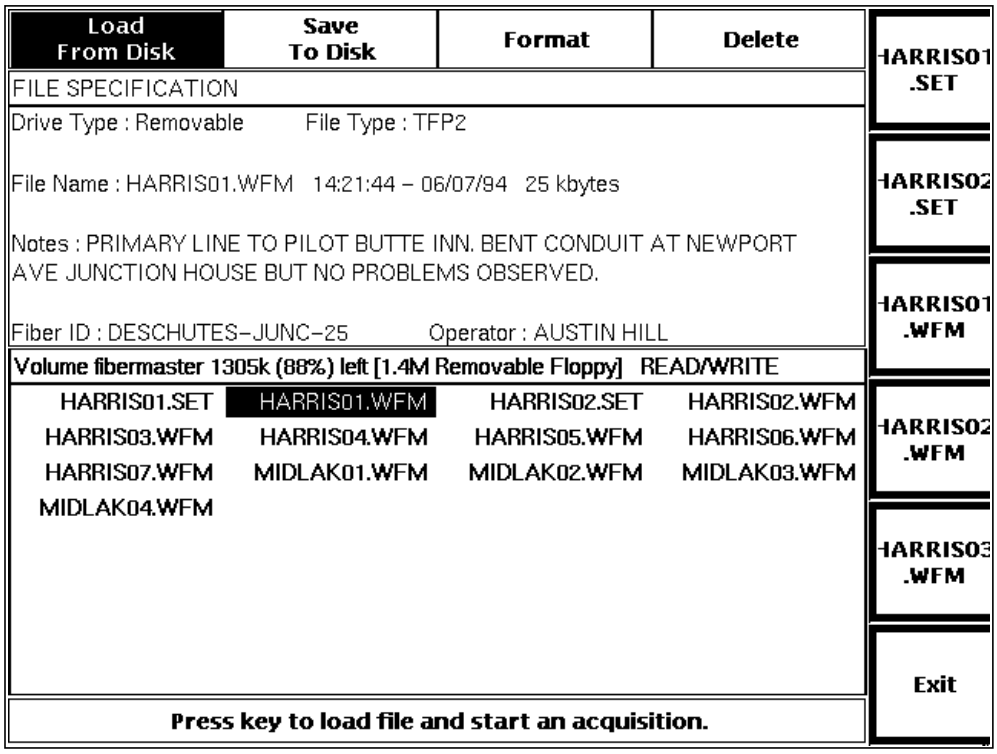


Figure 7-3. Quick Load

Exiting the Load from Disk Menu

To go to the Save to Disk menu, press the **Next Menu** softkey.

To return to the acquisition screen, press **Exit**.

Save to Disk

Use the Save to Disk menu to save the current waveform and associated instrument settings into a disk file. You can also save instrument settings only. From the acquisition screen, display the Save to Disk menu by pressing the **Mass Storage** softkey, then press the **Next Menu** softkey once.

NOTE *All save functions save data as unformatted (binary) data only. The data is saved in MS-DOS-compatible files.*

File Format

You can select one of two file formats to use when waveforms are saved to disk. The formats are TFP2 and CFF (common file format). TFP2 format is the one used by previous versions of the FiberMaster OTDR. It allows TFP2A waveforms to be backward compatible with the TFP2. CFF is the common file format used by the TFP2A and other newer Tektronix OTDR-related products produced in 1995 and after. CFF waveform files can be loaded, viewed, and measured using the TFP2A or other Tektronix OTDR-related products that read and write CFF data, regardless of which instrument was used to acquire the data.

Select the file format on the System Settings menu. All subsequent mass-storage save operations will use the selected file format.

The currently selected file format, which will be used for the next save operation, is displayed below the drive type when you enter the Save to Disk menu. If you want to change the file format before saving the waveform, exit the mass-storage system and press the **Change Settings** softkey to go to the menu system.

Refer to chapter 3, *Getting Started*, for instructions on how to select the file format to be used for saving waveform files.

NOTE *When settings only are saved, the TFP2 file format is used regardless of the File Format selection on the System Settings menu.*

File Specifications

When you enter the Save to Disk menu, the file-specification area of the screen shows the active drive, the file format that will be used for saving waveforms (TFP2 or CFF), and the file name of the currently selected file. Select the drive type (dual-drive instruments only) and enter the file name for the current save operation as follows.

Select the Drive

If your instrument is equipped with both a fixed internal RAM drive and a floppy-disk drive, you can select which drive to use for the save operation. Select the drive by pressing the **Switch Drives** softkey to display the directory of the other drive (see figure 7-4). The current drive is indicated in the drive-type field in the file-specification area of the display. **Fixed** refers to the internal RAM. **Removable** refers to the front-panel floppy-disk drive. This device is then used for the next save operation.

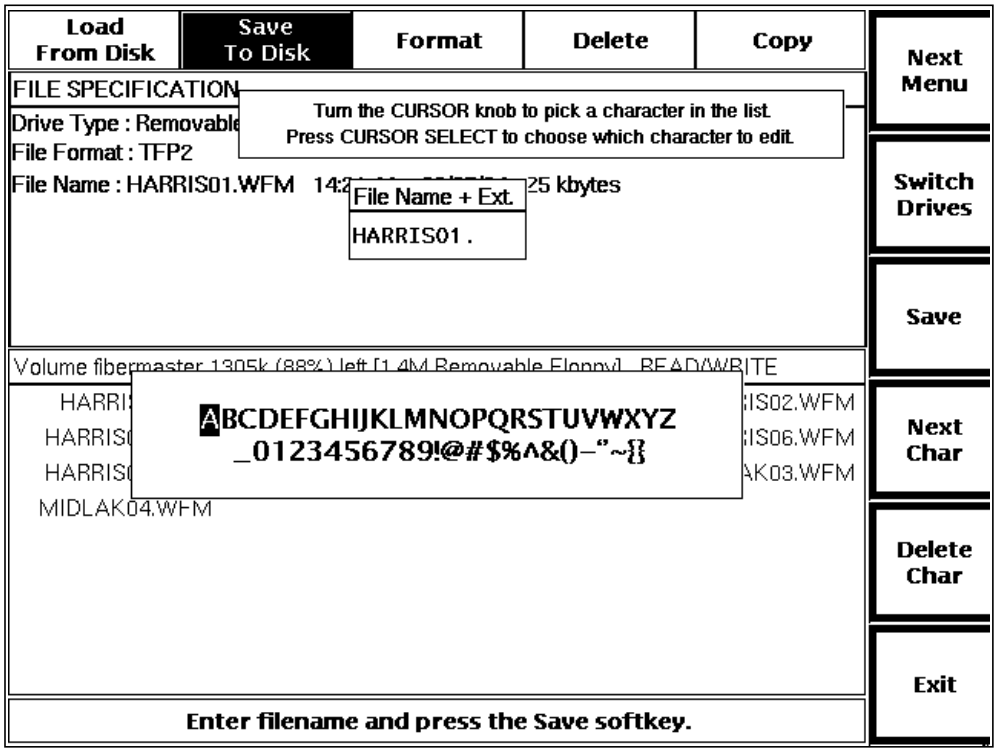


Figure 7-4. Save Menu: Dual-Drive Instrument

For dual-drive instruments, if there is a disk in the floppy-disk drive when you turn on the instrument, that drive is the active drive. If there is no floppy disk present, the internal RAM is the default drive type. After power-on, each time you enter the mass-storage menus the active drive type is the one last used.

File Name

The file name is the name that identifies the waveform or settings file on the disk. This name appears on the disk directory. You can specify a file name up to eight characters in length, with an additional optional three-character extension.

If you enter more than eight characters, a period is shown as the only legal ninth character, and must be entered as part of the file name. You can then go on to specify up to three more characters as the optional filename extension.

If you enter eight or fewer characters in the file name, .WFM is automatically appended to waveform files and .SET is automatically appended to settings files during the save operation.

The file name can include any combination of numbers and letters. In addition, the following characters are allowed in the file name: ! @ # $ % ^ & ( ) - _ ‘ ’ ~ { }.

Enter the file name as follows:

1. When you first enter the File Name window, the file name of the last file saved or selected is displayed. The cursor is on the next available character position. To enter a character, turn the **CURSOR** knob until the desired character is highlighted in the character set shown. The letter under the cursor in the file name changes to correspond with the highlighted letter in the character set.

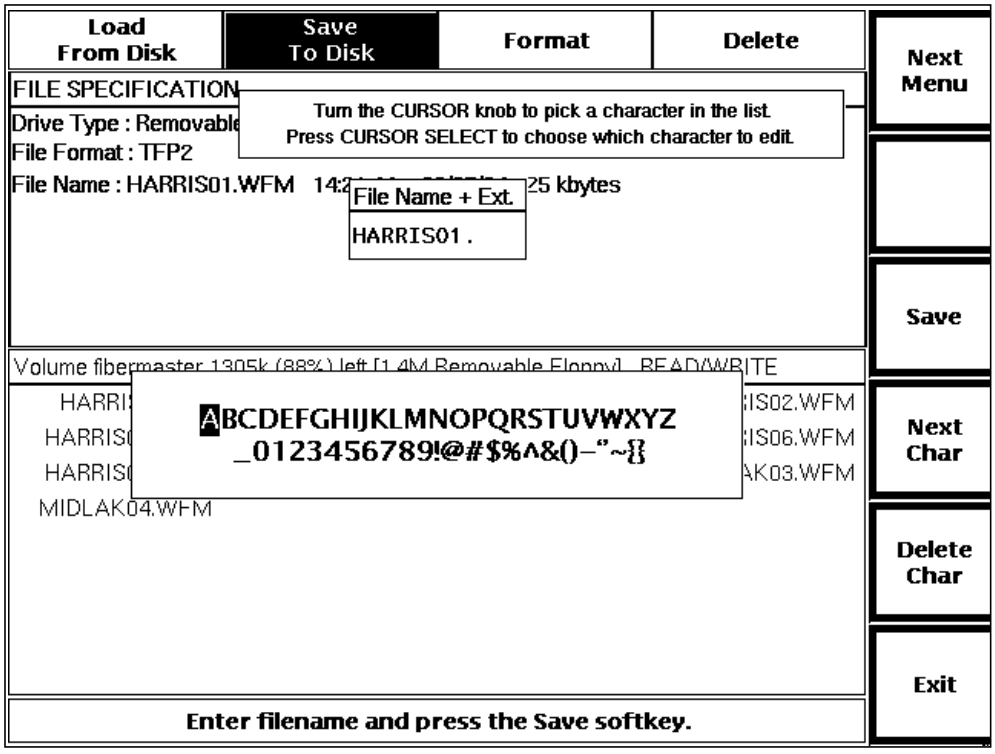


Figure 7-5. Save Menu: Single-Drive Instrument

2. Press the **Next Char** softkey to accept the selected letter. The cursor advances to the next available character position.

Press the **CURSOR SELECT** button to move the character-selecting cursor to the file name. You can then turn the **CURSOR** knob to go directly to the character in the file name that you wish to edit. Pressing **CURSOR SELECT** again moves the character-selecting cursor back to the character set, and turning the **CURSOR** knob selects a new letter for the character in the file name being edited.

Use the **Delete Char** softkey to delete the character under the cursor. If the cursor is blank (indicating the next available character position), the character to the left of the cursor is deleted. To change characters to the left of the cursor, either

1. Press **Delete Char** to move backwards, then re-enter the character string, or
2. Press **CURSOR SELECT** to move the character-selecting cursor to the file name, then turn the **CURSOR** knob counterclockwise to select the character to edit.

If you have the optional keyboard, you can type in the file name. Refer to appendix B for a list of keyboard editing functions, and key sequences that duplicate front-panel controls in the mass-storage menus.

Date and Time

The date and time fields are automatically set by the instrument's internal clock. Files are date and time stamped when saved. You cannot change the system date and time on the mass-storage menus. To reset the system date or time, go to the System Settings menu by pressing the **Change Settings** softkey from the acquisition screen.

Fiber ID, Notes, and Operator

The fiber ID, notes, and operator are optional information, entered on the Operator Settings menu and saved with the waveform. If you have not entered the fiber ID, notes, or operator since powering on the instrument, these fields are blank. On the mass-storage menus these fields are shown for information only on the Load, Delete, and Copy menus, and cannot be edited. To change these fields before saving a file, go to the Operator Settings menu, by pressing the **Change Settings** softkey from the acquisition screen.

Refer to chapter 3, *Getting Started*, for instructions on how to set the system date and time, and how to enter information on the Operator Settings menu.

Saving the File

If you choose to save waveform data, the save function saves the current or the reference waveform, measurement information, and instrument settings into a disk file on the currently selected drive (fixed or removable, if both are installed). If there is high-density data associated with the waveform, you are prompted whether the high-density data should also be saved with the other waveform data.

If you choose to save settings data, only the current instrument settings are saved into a disk file.

If you try to save a current acquisition that is still in progress, the following message displays: **There is an acquisition in progress. It must be stopped before saving.** Acquisitions in progress are paused upon entry to the mass-storage menus, and resumed when you exit the menus. When you see this message, you must exit the mass-storage system and press **START/STOP** to stop the acquisition. You can then return to the Save menu and continue the save operation.

Save waveform or settings data by pressing the **Save** softkey. The softkeys are redrawn to show your choices:

Curr Wfm & Settings - saves the current waveform and instrument settings.

Ref Wfm & Settings - saves the reference waveform and settings.

Curr Settings - saves the current instrument settings only.

Cancel - returns to the Save menu without saving any data.

Waveform files are saved using the currently selected file format (TFP2 or CFF). The file format is selected on the System Settings menu, described in chapter 3. Settings files are saved in TFP2 format only, regardless of which format is selected on the System Settings menu.

Quick Save

The Quick Save function allows you to save waveform files with a minimum of button pressing and text entry. Quick Save lets you to save multiple waveform files, automatically incrementing the file name and fiber ID. For example, you can save a waveform into a file called FIBER01.WFM, then use the Quick Save function to save successive waveforms in FIBER02.WFM, FIBER03.WFM, FIBER04.WFM, etc. These file names are automatically provided by the Quick Save function, and the save operation is performed by one button press. The fiber ID is incremented automatically as well, for example, FIBERA9 becomes FIBERB0.

The incrementing is based on both alpha and numeric characters. It starts with the last character in the file name, and moves left as characters are incremented from 9 to 0 or from Z to A. The incrementing stops when a non-alphanumeric character is found. For example:

FIBER_01.WFM becomes FIBER_02.WFM
FIBER_99.WFM becomes FIBER_00.WFM
FIBER99.WFM becomes FIBES00.WFM

FIBERA.WFM becomes FIBERB.WFM
FIBERZ.WFM becomes FIBESA.WFM

The fiber ID is incremented using the same method.

From the acquisition screen, access the Quick Save function as follows:

1. Press the **Mass Storage** softkey. The Load from Disk menu displays.
2. For dual-drive instruments, select the drive to use for the save operation by pressing the **Switch Drives** softkey.
3. Turn the **CURSOR** knob to select the starting waveform file. The first waveform file to be quick-saved will have a file name based on the current file.
4. Press the **STORE** button.

When you press the **STORE** button, the following operations happen automatically:

- ❏ The file name of the highlighted file is incremented.
- ❏ Current waveform and settings are saved into the new file.
- ❏ The new file is selected on the Load from Disk menu.
- ❏ You are returned to the acquisition screen.

You can now repeat the Quick Save operation, omitting step 3. The name of the last file saved is incremented with the next waveform saved. This allows you to save successive waveforms into incremented files simply by pressing the **Mass Storage** softkey, followed by the **STORE** button each time.

CAUTION *If the first file you select in the Quick Save operation is one of an already existing series of file names, the succeeding files are overwritten with new waveform data. Take care when selecting the starting waveform file that you do not unintentionally overwrite waveform data.*

If the file name you select for a Quick Save operation is a settings file, that file name is incremented and a .WFM extension is appended. The current waveform and settings data is saved in the file.

Exiting the Save to Disk Menu

To go to the Format menu, press the **Next Menu** softkey.

To return to the acquisition screen, press **Exit**.

Format

From the acquisition screen, display the Format menu by pressing the **Mass Storage** softkey, then press the **Next Menu** softkey twice. The format function formats the media in the selected drive, depending on which mass-storage device(s) are installed in your instrument. MS-DOS format is used.

For instruments with only one mass-storage device (figure 7-6), pressing the **Format** softkey formats a floppy disk or the internal RAM drive. For a floppy disk, the disk

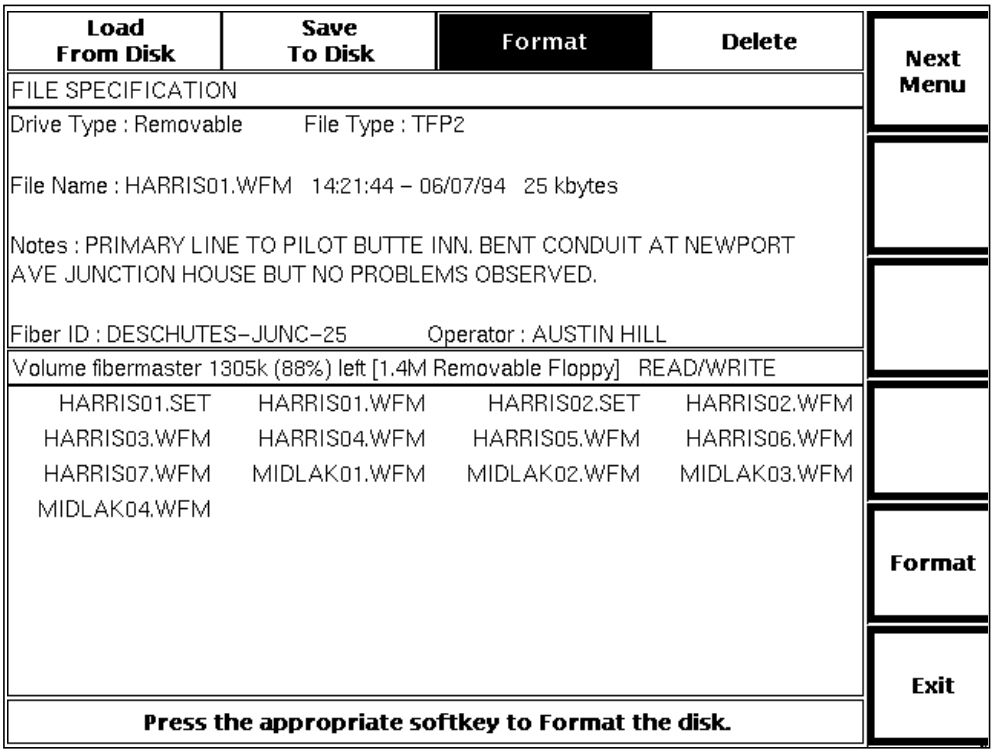


Figure 7-6. Format Menu: Single-Drive Instrument

must be in the drive before pressing the softkey. A pop-up window displays asking you to confirm the format operation. Two softkeys display, **Yes** and **No**:

Yes - formats the disk and returns to the Format menu.

No - returns to the Format menu without formatting the disk.

CAUTION *Be careful when formatting both removable and fixed media. Any data already on the media is erased.*

Selecting the Drive

For instruments equipped with both internal RAM and a floppy-disk drive (figure 7-7), softkeys allow you to specify which drive to format, **Format Fixed** and **Format Removable**. Pressing **Format Fixed** formats the internal RAM. Pressing **Format Removable** formats a floppy disk. In both cases, you are asked to confirm the operation, and two softkeys display, **Yes** and **No**. Pressing **Yes** formats the selected device. Pressing **No** cancels the operation.

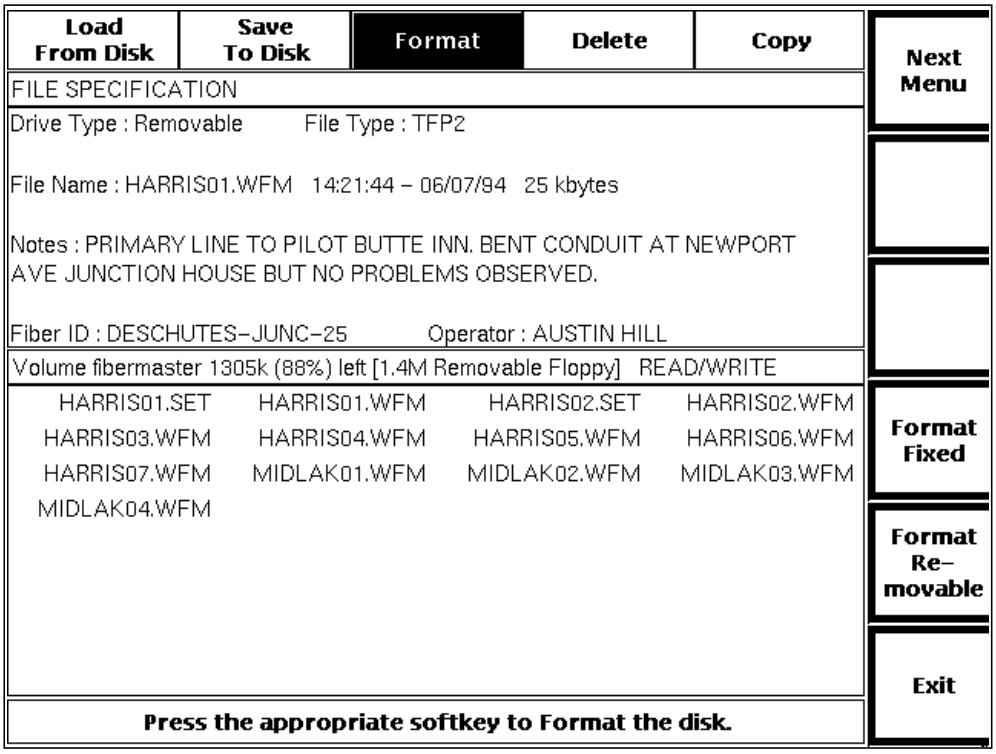


Figure 7-7. Format Menu: Dual-Drive Instrument

For dual-drive instruments, if there is a disk in the floppy-disk drive when you turn on the instrument, that drive is the active drive. If there is no floppy disk present, the internal RAM is the default drive type. After power-on, each time you enter the mass-storage menus the active drive type is the one last used.

Exiting the Format Menu

To go to the Delete menu, press the **Next Menu** softkey.

To return to the acquisition screen, press **Exit**.

Delete

Use the Delete menu to remove a file from the selected mass-storage device. From the acquisition screen, display the Delete menu by pressing the **Mass Storage** softkey, then the **Next Menu** softkey three times.

Selecting a File to Delete

The disk's directory is displayed on the lower half of the screen (figure 7-8). The selected file in the disk directory is highlighted. The file-specification fields display data for the highlighted file. Turn the distance **CURSOR** knob to select other files from the directory. After the cursor is stationary, file data is read from the disk and the file-specification fields are updated for the currently selected file.

If the directory is longer than one page, use the **Next Page** and **Previous Page** softkeys to move through the directory, or use the distance **CURSOR** knob to scroll through the directory.

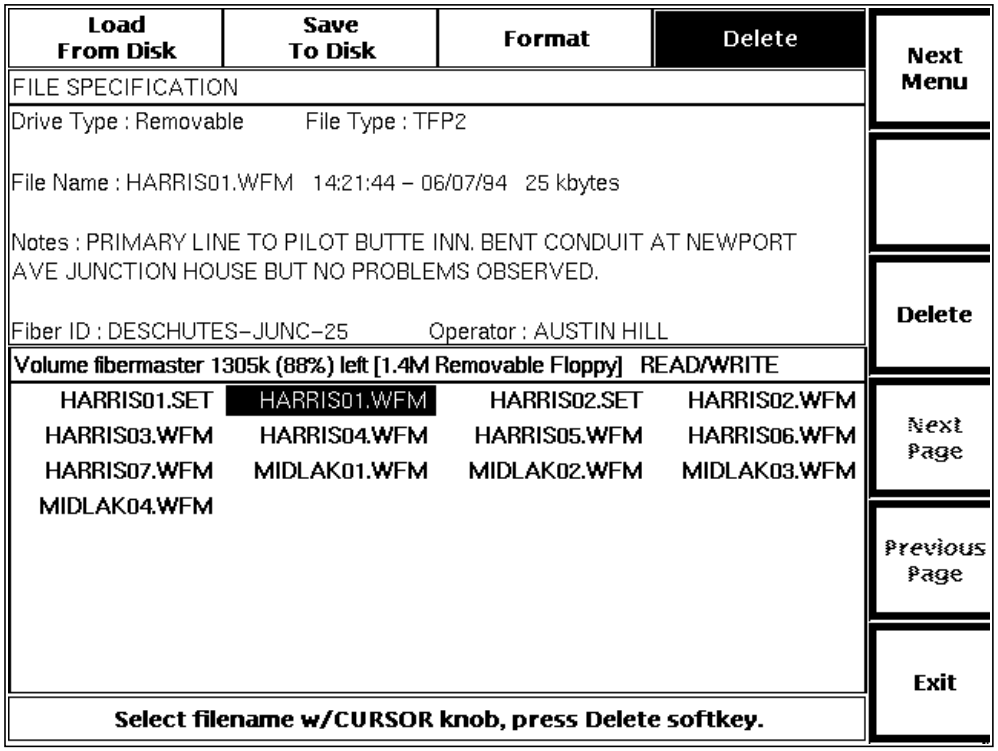


Figure 7-8. Delete Menu: Single-Drive Instrument

If your instrument includes both internal RAM and a floppy-disk drive, a **Switch Drives** softkey displays, allowing you to select which device to use for the delete operation (figure 7-9). The directory area of the Delete menu (the lower half of the display) lists the contents of the currently active drive.

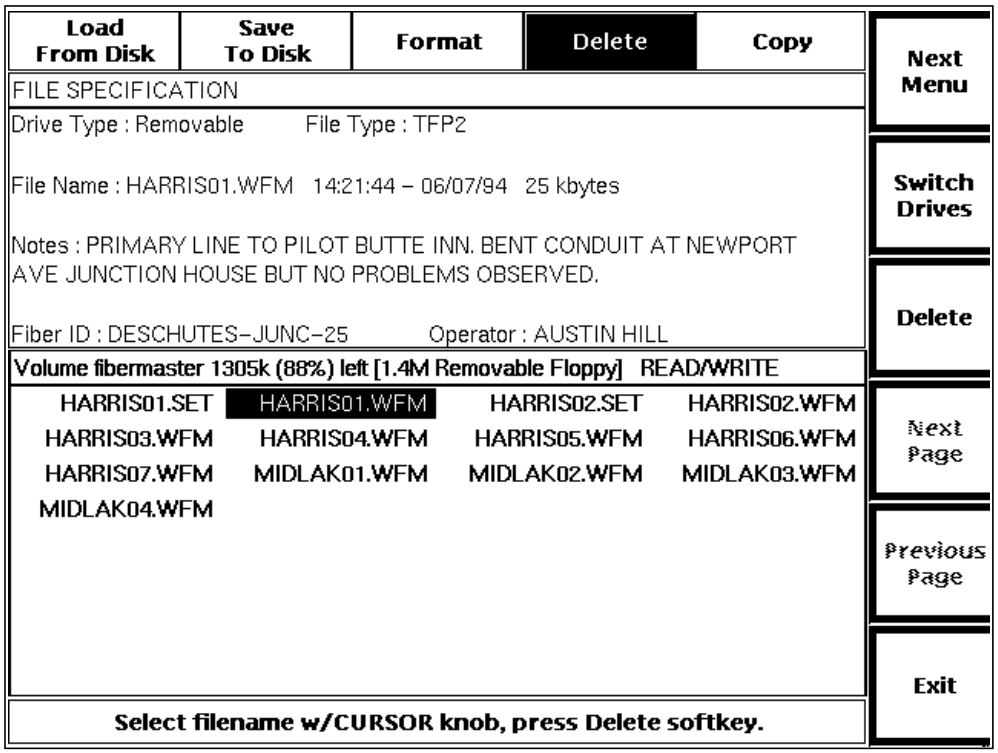


Figure 7-9. Delete Menu: Dual-Drive Instrument

Pressing the **Switch Drives** softkey allows you to view the directory of the other drive. The Drive Type field in the file-specification area of the screen indicates which drive is active. **Fixed** refers to the internal RAM, and **Removable** refers to the floppy-disk drive. You can then select the file to delete from the active drive's directory.

For dual-drive instruments, if there is a disk in the floppy-disk drive when you turn on the instrument, that drive is the active drive. If there is no floppy disk present, the internal RAM is the default drive type. After power-on, each time you enter the mass-storage menus the active drive type is the one last used.

After you have selected the file to delete, press the **Delete** softkey. A message displays to confirm the deletion, and two softkeys are provided, **Yes** and **No**. Pressing **Yes** deletes the file and returns to the Delete menu. Pressing **No** returns to the Delete menu without deleting the file.

Exiting the Delete Menu

Press the **Next Menu** softkey to go to the Load from Disk menu (single-drive instruments), or the Copy menu (dual-drive instruments).

Press **Exit** to return to the acquisition screen.

Copy

The Copy menu is available only if your instrument is configured with internal RAM, in addition to a floppy-disk drive. The Copy menu allows you to copy files from the active drive to the inactive drive. From the acquisition screen, display the Copy menu by pressing the **Mass Storage** softkey, then the **Next Menu** softkey four times.

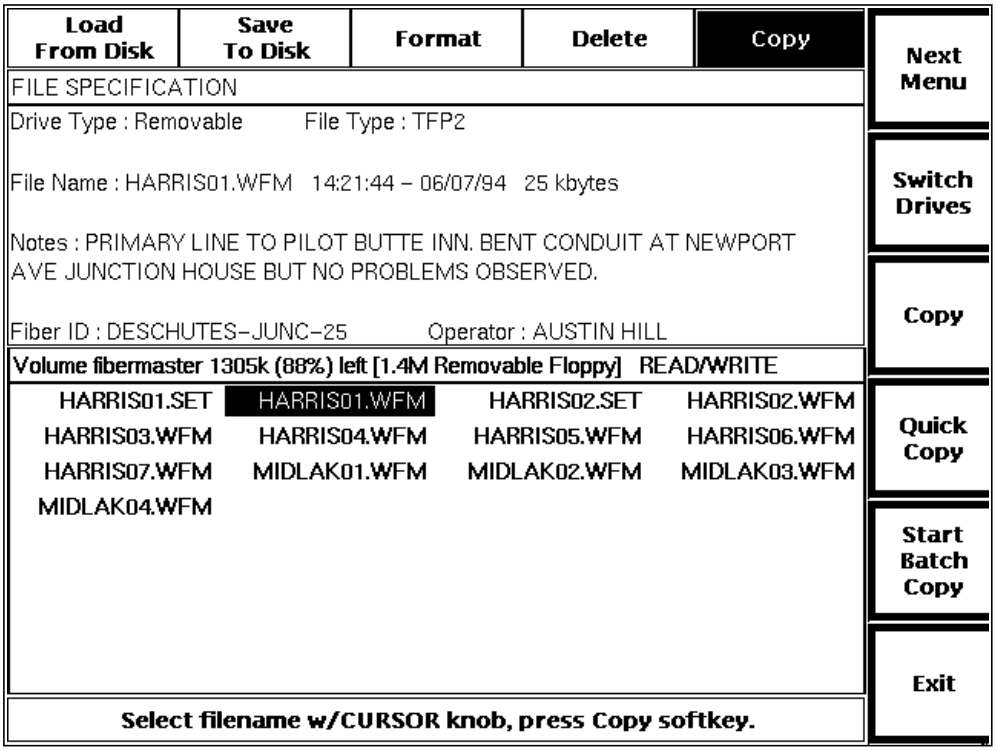


Figure 7-10. Copy Menu: Dual-Drive Instrument

The directory area of the Copy menu lists the contents of the active drive. Pressing the **Switch Drives** softkey displays the directory of the other drive. The Drive Type field in the file-specification area of the screen indicates which drive is active. **Fixed** refers to the internal RAM, and **Removable** refers to the floppy-disk drive. You can then select the file to copy from the active drive's directory.

For dual-drive instruments, if there is a disk in the floppy-disk drive when you turn on the instrument, that drive is the active drive. If there is no floppy disk present, the internal RAM is the default drive type. After power-on, each time you enter the mass-storage menus the active drive type is the one last used.

Select a file by turning the **CURSOR** knob to highlight the file name. After the cursor is stationary, the file-specification fields are updated to show data for the currently selected file.

Perform the copy operation by pressing the **Copy** softkey. A pop-up window displays asking you to confirm the copy. Two softkeys are shown, **Yes** and **No**. Pressing **Yes**

copies the highlighted file from the active drive to the inactive drive. Pressing **No** cancels the operation and returns to the Copy menu.

Quick Copy

The **Quick Copy** softkey provides a way to copy several files in succession quickly. Press **Quick Copy** to copy the highlighted file from the active drive to the inactive drive immediately (bypassing the confirmation). The next file is then highlighted.

Batch Copy

The **Start Batch Copy** softkey lets you copy some or all the files on the disk by pressing one softkey. When you press **Start Batch Copy**, files from the active drive are copied to the inactive drive, starting with the currently selected file and ending when the end of the directory is reached. For example, to copy all the files from one drive to the other, select the first file in the directory and press the **Start Batch Copy** softkey.

After you press **Start Batch Copy**, the softkey changes to **Stop Batch Copy**. Press the softkey again to stop the batch copy operation. When the operation is stopped, the softkey reverts to **Start Batch Copy**.

Exiting the Copy Menu

Press the **Next Menu** softkey to go to the Load from Disk menu.

Press **Exit** to exit the mass-storage system and return to the acquisition screen.

8 Remote Control

The FiberMaster OTDR operates directly from front-panel controls, or under the remote control of an instrument controller. This chapter tells you how to configure and operate FiberMaster in remote mode.

The instrument can be controlled through the IEEE 488.1 general-purpose interface bus (GPIB) or the RS-232 serial interface. The command language used is the same for both physical interfaces. The following sections describe the GPIB and RS-232 interfaces, and the second half of the chapter includes a list of remote-control commands and queries.

GPIB System

The GPIB interface is designed in compliance with IEEE standards 488.1 and 488.2. The bus uses eight data lines, five control lines, and three handshake lines. Information is transferred bit-parallel by an asynchronous handshake. This allows instruments with different transfer rates to operate together if they conform to the handshake state diagrams and other protocols defined in the IEEE standard.

You can connect a GPIB system in either a star or linear configuration (see figure 8-1), or a combination of the two. When designing the system, you must observe the following rules:

1. No more than 15 devices can be connected to a single GPIB.
2. The length of all cable used must be less than or equal to two meters times the number of devices, not to exceed a maximum of 20 meters total. For example, use a maximum cable length of six meters for a system that includes three devices. The maximum separation between any two devices in a system is four meters.

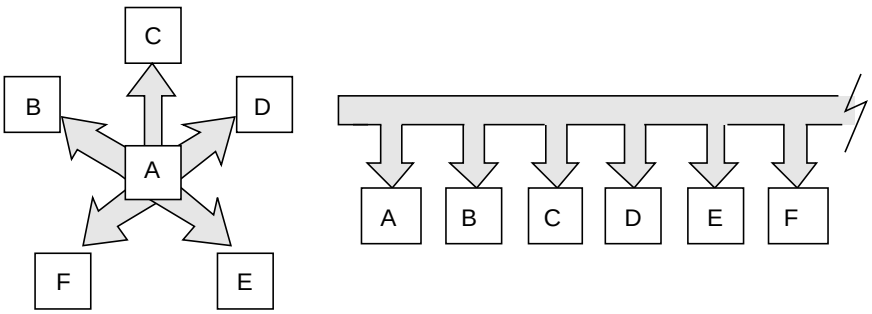


Figure 8-1. Standard and Linear Bus Configurations

A typical system (see figure 8-2) could include a controller, a talker, such as a counter or digital multimeter, and a listener, such as a plotter or signal generator. More than one function can be combined in a single instrument. For example, FiberMaster has both a listener/talker function and a talker-only function.

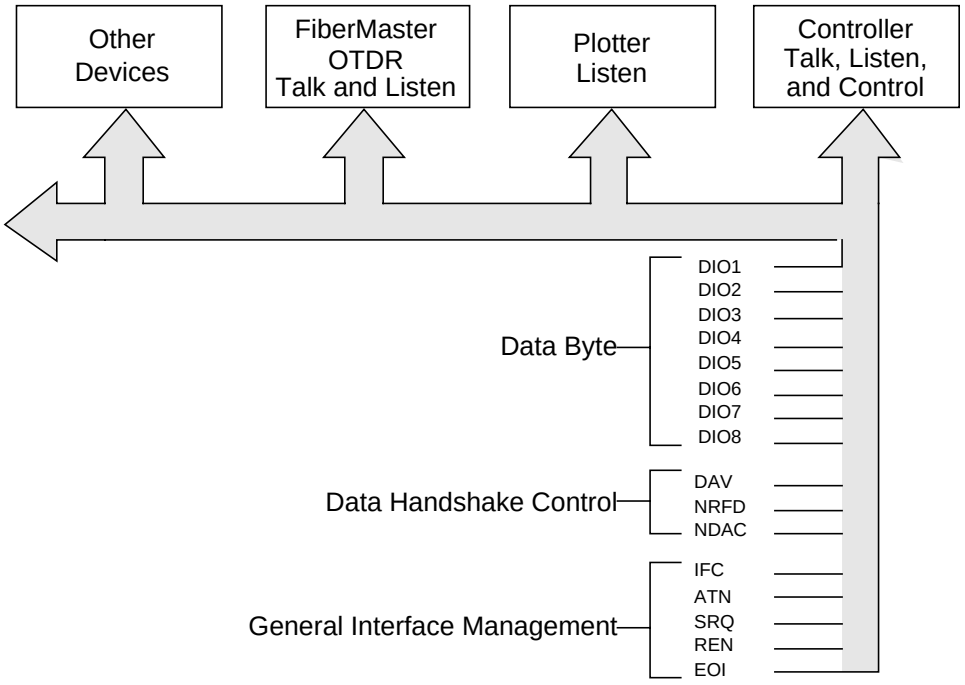


Figure 8-2. Sample GPIB IEEE 488 System

GPIB Signal Lines

The GPIB contains three groups of signal lines: data, handshake, and control. Eight lines, DIO1 through DIO8, are used to carry data (message) bytes on the bus. The asynchronous, three-wire handshake is controlled by these lines:

DAV (Data Valid): asserted by the transmitting device.

NRFD (Not Ready For Data): asserted by the receiving device.

NDAC (Not Data Accepted): asserted by the receiving device.

Five interface lines are used for the control functions:

ATN (Attention): specifies how data on the DIO lines is to be interpreted—as interface messages when ATN is asserted, or as device-dependent messages when ATN is unasserted.

IFC (Interface Clear): used to initialize the interface functions of all instruments.

SRQ (Service Request): asserted to request service from the controller in charge.

REN (Remote Enable): allows remote control of devices on the bus.

EOI (End Or Identify): indicates the last byte of a message, or when asserted with ATN, polls devices connected to the bus. EOI is only used as a message terminator on FiberMaster, and will be referred to in this manual as END.

Refer to ANSI/IEEE standards 488.1-1987, *IEEE Standard Digital Interface for Programmable Instrumentation*, and 488.2-1987, *IEEE Standard Codes, Formats, Protocols, and Common Commands* for full definitions of these lines and protocol for use.

GPIB Interface Functions

The following GPIB interface functions are implemented in FiberMaster:

Table 8-1. FiberMaster GPIB Interface Functions

Function	Description
SH1	Source message transfer capability
AH1	Accept message capability
T5	Basic talker, serial poll, talk-only mode, unaddress if MLA
L4	Basic listener, no listen-only mode, unaddress if MTA
SR1	Ability to request service via SRQ line
RL1	Ability to enable/disable local control
PP0	No parallel poll function
DC1	Device clear capability
DT0	No device trigger function
C0	No controller function
E2	Tri-state drivers

GPIB Addressing

Each GPIB device has at least one talk or listen address. Device addresses are sent by the controller to specify who talks and who listens. FiberMaster's address is set by pressing the **Change Settings** softkey on the front panel to enter the menu system. The GPIB address menu is found on the System Settings menu screen. You can set the GPIB address to any value from 0 to 30, inclusive. The factory default setting is 7. The power-on default is the value last used. (Refer to Chapter 3, *Getting Started*, for details on using the menu system.)

You can make changes to the GPIB address only while the instrument is in local state (LOCS) or local with lockout state (LWLS). User-initiated address changes are recognized immediately by the instrument. If a GPIB address change is requested while the instrument is exchanging messages with the controller, the instrument stops scanning an incoming message or stops sending a response message, and becomes ready to receive a new message whenever it receives its new listen address from the controller.

In addition to a GPIB address setting, the System Settings menu includes a GPIB status setting. The instrument can be set online or offline. When online, FiberMaster accepts commands and generates data in response to queries from a GPIB controller. When offline, the instrument does not participate in message transfer over the bus.

If the hardcopy device selected is an external GPIB plotter or printer, FiberMaster automatically switches temporarily to talk-only status when the user presses the **HARDCOPY** button. When the plotter is finished, the status is reset to its previous value (online or offline). Address and status-change requests are not allowed when the instrument is in talk-only mode and sending data to a GPIB plotter or printer.

GPIB Communications

Communication between the controller and FiberMaster takes place using interface messages defined by IEEE 488.1, common commands defined by IEEE 488.2, and device-dependent messages.

IEEE 488.1 Interface Messages

Interface messages control the operation of the 488.1 bus only, and do not control device operations. There are two types of interface messages, uniline and multiline.

Uniline messages are sent by asserting one of the general interface management lines. They include IFC, ATN, REN, SRQ, and END. IFC, ATN, and REN are sent from the controller to the instrument. SRQ is sent by the instrument to the controller to request service. END is sent by either the controller or the instrument to terminate a program or response message, respectively.

A multiline message is transferred on the GPIB DIO lines while ATN is asserted. These messages are used for control functions such as device addressing, serial polling, clearing the instrument I/O, front-panel lockout, and returning the instrument to local control. Multiline messages fall into three categories:

- *Universal messages* affect all devices on the bus, and include LLO, DCL, SPE, SPD.
- *Addressed messages* affect all devices on the bus that are addressed to listen, and include GTL and SDC.
- *Addresses* address a device to talk or to listen, unaddress all devices to talk, or unaddress all devices to listen. They include MTA, MLA, OTA, UNT, UNL.

The IEEE 488.1 interface messages are listed in the following tables.

Table 8-2. Uniline Interface Messages

Message	Description
ATN	Attention Notifies the instrument that a data byte sent concurrently is an interface message.
END	End Notifies the instrument or controller that a data byte sent concurrently is the last byte of a message.
IFC	Interface Clear Resets interface functions by unaddressing the instrument to talk or listen, and disabling serial poll.
REN	Remote Enable Enables remote programming of instrument settings and controls if the instrument is addressed as a listener while REN is true.
SRQ	Service Request Instrument request for service from the controller.

Table 8-3. Multiline Universal Interface Messages

Message	Description
DCL	Device Clear Places the instrument's remote-message handler into an idle state, ready to receive a new command or query. Does not affect any operation in progress or device status.
LLO	Local Lock Out Disables return to local from front panel.
SPD	Serial Poll Disable Exits serial-poll state. Return to normal talker status.
SPE	Serial Poll Enable Enters serial-poll state; allows sending status byte. The status byte, not device-dependent data, will be sent when the device is addressed to talk.

Table 8-4. Multiline Addressed Interface Messages

Message	Description
GTL	Go to Local Re-enables local control of device.
SDC	Selected Device Clear Same actions as DCL if addressed as a listener.

Table 8-5. Multiline Address Interface Messages

Message	Description
MLA	My Listen Address Instrument becomes addressed to listen.
MTA	My Talk Address Instrument becomes addressed to talk.
OTA	Other Talk Address Instrument becomes unaddressed to talk (do not put data on the bus).
UNL	Unlisten If instrument is addressed to listen, becomes unaddressed.
UNT	Untalk If instrument is addressed to talk, becomes unaddressed.

The following interface messages are ignored by FiberMaster: GET, IDY, MSA, TCT, PPC, PPE, PPD, PPRn, and PPU.

Common Commands and Queries

FiberMaster recognizes a subset of the common commands and queries defined in IEEE 488.2. Each common command is identified by an asterisk. The commands implemented in FiberMaster include the following (for descriptions of these commands, refer to the *Commands and Queries* section in this chapter): *IDN?, *LRN?, *RST, *CLS, *ESE, *SRE, *ESE?, *ESR?, *SRE?, *STB, *OPC, *WAI, *OPC?, *TST?.

Device-Dependent Messages and Program Messages

Device-dependent messages transfer information directly between FiberMaster and the controller. They include commands that cause an action to take place in the instrument, queries requesting information from the instrument, command and query data elements, and query responses.

Some commands and queries start device operations such as acquisitions, measurements, and disk-drive operations. Other commands perform interface-related functions such as setting status registers and allowing controller and instrument synchronization. Queries also read instrument settings, status, and configuration information. Device-dependent commands and queries are listed in the *Commands and Queries* section of this chapter.

A sequence of one or more device-dependent commands and queries is called a program message. The FiberMaster is programmed by sending it one or more program messages from the controller. A program message that contains a query is called a query message.

For explanations of the formats of commands, queries, and program messages, refer to the *Commands and Queries* section of this chapter.

Modes of Operation

Front-panel controls allow you to set GPIB status online or offline. When online, the instrument accepts commands and generates data in response to a GPIB controller. When offline, the instrument does not respond to interface messages or device-dependent commands sent by the controller.

The power-on GPIB status setting is online and the address is the factory default of 7 or the last user-selected address.

You can operate FiberMaster using the front-panel controls as described in chapters 2 through 7, or remotely using a remote controller. In addition to these local and remote states, the controller can place the instrument in a local lockout condition at any time. This combination yields four possible operating states:

- **Local State (LOCS)** - FiberMaster responds to front-panel control and to remote messages that do not affect instrument settings, data memory, or start device operations.
- **Local with Lockout State (LWLS)** - This state is transitional, as the instrument always enters RWLS from LWLS when it receives its listen address (for example, before receiving a program message).
- **Remote State (REMS)** - In REMS the controller can change instrument settings, and start acquisitions and other device operations. In this state, a **Return to Local** softkey displays, allowing the operator to return the instrument to local control.
- **Remote with Lockout State (RWLS)** - RWLS is similar to REMS, except the **Return to Local** softkey does not display.

Remote/Local State Transitions

FiberMaster enters LOCS when the REN line is released in any other local or remote state, when the **Return to Local** key is pressed (in REMS), when the instrument receives the Go to Local (GTL) interface message (in REMS), and at power-on.

The instrument enters LWLS from LOCS when it receives the Local Lockout (LLO) interface message with REN asserted, and from RWLS when it is addressed to listen and receives the GTL interface message.

REMS is entered from LOCS when the instrument is addressed to listen while REN is asserted.

FiberMaster enters RWLS from REMS when the LLO message is received, and from LWLS when the instrument receives its listen address. REMS cannot be directly entered from RWLS.

Local-to-Remote Transition

When the instrument changes from local to remote operation, the following occurs:

- ❏ Any currently executing device operation that was initiated from the front panel is aborted, with the exception of a mass-storage operation.
- ❏ When the state change is made, the full set of GPIB commands is now available for execution, rather than the limited subset available in the local state.
- ❏ The **REMOTE** indicator on the front panel lights up.
- ❏ The instrument remains in the current measurement mode, with any previously acquired waveform displayed. Instrument settings are not affected.
- ❏ All front-panel controls are disabled. The only exception is the softkey that displays only in REMS, **Return to Local**. The **Return to Local** softkey returns the instrument to local control.

The acquisition screen is updated during remote control to show any setting changes, measurement-mode changed, new acquisitions, cursor movement, and expansion-window changes that occur as a result of GPIB commands. Menu screens are not displayed.

Remote-to-Local Transition

When the instrument returns to local from remote operation, the following occurs:

- ❏ All front-panel controls and softkeys are enabled.
- ❏ The **REMOTE** indicator on the front panel is turned off.

The acquisition data and instrument settings displayed during remote control remain on the screen after the transition to local. Instrument settings and acquired waveform data are not affected.

GPIB remote message processing continues in the local state, but any commands and queries that affect instrument settings, data memory, or start device operations

are not executed. In response to such a command or query, an execution error is logged in the Event Queue, and an execution error is flagged in the Standard Event Status Register. If previously enabled by the host, the instrument asserts the SRQ line. (For more details on error reporting, refer to the *Status Reporting and Error Handling* section, later in this chapter.)

Using a GPIB Plotter or Printer

Data displayed on FiberMaster's screen can be plotted or printed on an external GPIB plotter or printer, both when the instrument is under local and remote control. The ThinkJet printer and HPGL-compatible plotters are supported. Refer to chapter 3, *Getting Started*, for hardcopy-device-selection details.

GPIB Hardcopy under Local Control

To use FiberMaster with a GPIB plotter or printer under local control, configure the hardcopy device for listen-only mode. To start the hard copy, press the **HARDCOPY** button. Press **HARDCOPY** a second time to stop a plot or print in progress.

NOTE *When using an external plotter, the* **HARDCOPY** *button functions only when the acquisition screen is displayed. If you press* **HARDCOPY** *when any other screen is current (i.e., a menu or help screen), a beep sounds and a plot operation is not started.*

Before starting a hardcopy operation, the instrument enters talk-only mode. When the hardcopy finishes, GPIB status is automatically reset to its previous value (online or offline).

When the instrument is in talk-only mode, its listener function is disabled, so it cannot process commands sent by a GPIB controller. If a controller is on the bus and sends an interface message that unaddresses the instrument to talk (OTA, UNT, or IFC), the instrument readdresses itself to talk. If the controller sends an interface clear message (IFC), the instrument waits for the IFC line to be released, then continues sending data to the hardcopy device. In this case, the device may lose data, depending on how it responds to interface clear.

In configurations with a controller on the bus, contention for the bus may occur between the controller and the instrument (operating in talk-only mode). Prevent this contention by putting the controller on standby (488.1 Controller Standby State), so it releases the ATN line.

GPIB Hardcopy under Remote Control

When using a GPIB plotter or printer under remote control, configure the device as a talker/listener. To start a hardcopy, the controller application program should go through the following steps:

1. Send the HCTYPE command to select the output data format.
2. Send the GPLTSCREEN? or GPLTTEXT? query, as appropriate, followed by a program message terminator. (Refer to the *Commands and Queries* section of this chapter for descriptions of these queries.)

3. Send the listen address of the plotter or printer.
4. Send the talk address of the instrument.
5. When the instrument asserts the END line indicating that all data was sent to the plotter, unaddress the plotter or printer.

You may need to send the UNL interface command before step 2 if there are other devices on the bus that should not receive the hardcopy data.

GPIB Status Reporting and Error Handling

The GPIB controller has access to five FiberMaster status and status-enable registers. These registers control status and error reporting for all device events, as illustrated in figure 8-3. The functions of each register are explained in the following pages. Table 8-6 summarizes the status registers and their corresponding commands and queries.

Table 8-6. GPIB Status Register Summary

Register/Queue	Write with	Clear with	Read with
Device Event Status Enable Register (DESER)	DESE	DESE	DESE?
Standard Event Status Register (SESR)	none	*CLS, *ESR?	*ESR?
Standard Event Status Enable Register (SESER)	*ESE	*ESE	*ESE?
Status Byte Register (STB)	none	*CLS	*STB,Serial Poll
Service Request Enable Register (SRER)	*SRE	*SRE	*SRE?

Device Event Status Enable Register

The Device Event Status Enable Register (DESER) is an eight-bit register with bit definitions corresponding to the IEEE 488.2-defined Standard Event Status Register (SESR). The purpose of the DESER is to enable the reporting of events in the SESR and the Event Queue. (Refer to the descriptions of the Standard Event Status Register and the Status Byte Register, in the following pages.

When an event enabled by the DESER occurs, the corresponding bit in the SESR is set, and a code and corresponding message explaining the event are stored in the Event Queue. Event codes and their meanings are listed in the section *GPIB Event Codes and Messages*, later in this chapter.

The DESER defaults to an ASCII value of 255 (all bits on), meaning that all types of events will be logged in the SESR and Event Queue. To disable the logging of selected event types, set the value of the register to the appropriate bit mask by using the DESE command.

For definitions of the bits in the DESER, refer to the description of the SESR, in the following paragraphs.

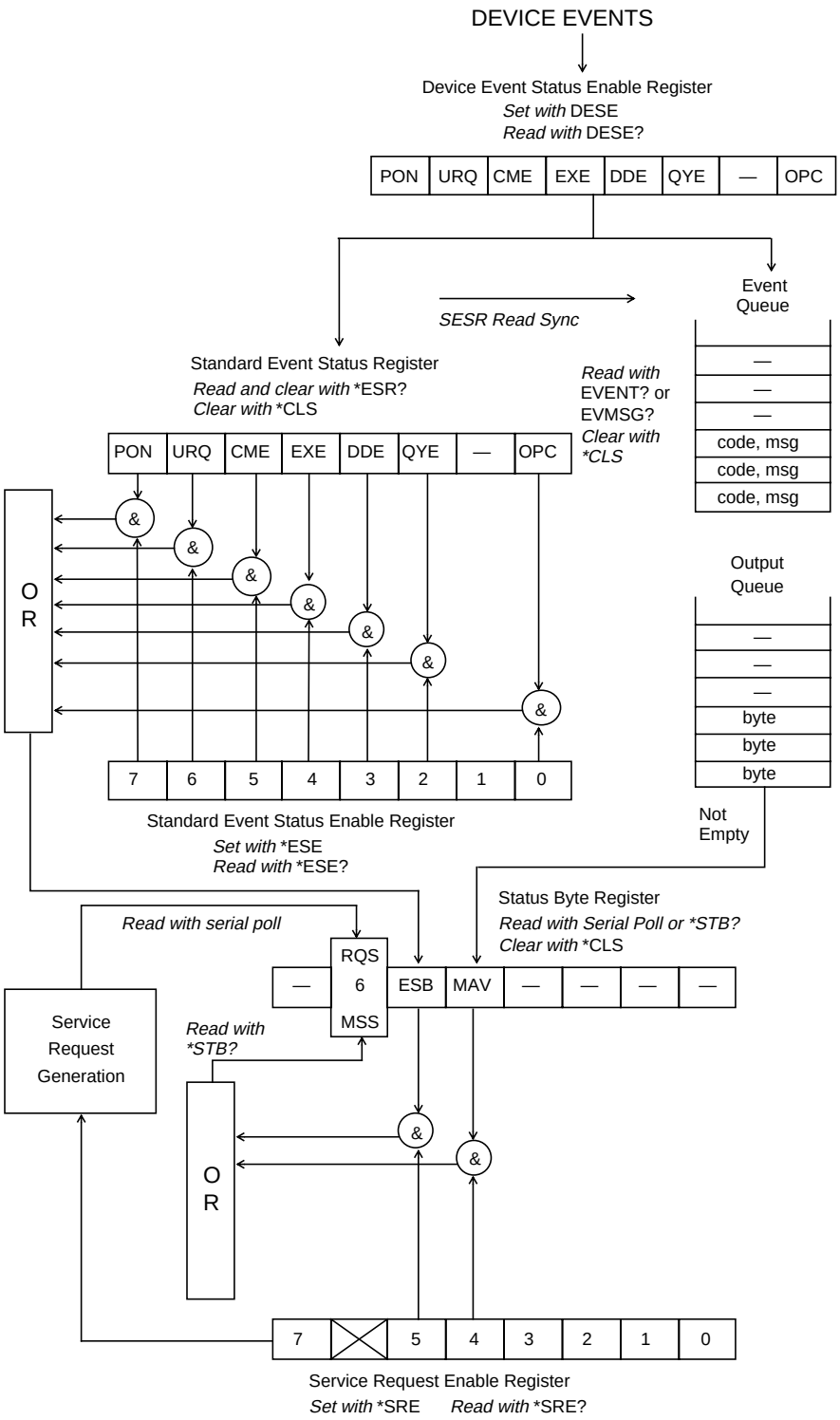


Figure 8-3. GPIB Status Reporting and Error Handling

Standard Event Status Register

The eight bits of the Standard Event Status Register (SESR) log individual events occurring in the instrument. The SESR is cleared (set to 0) when the power is turned on, after being read by sending the *ESR? query, and when the *CLS command is issued. The bit definitions of the SESR are listed below. When a defined event occurs and is enabled by the DESER, the corresponding bit is turned on in the SESR, and an event code and message pair is logged in the Event Queue.

Bit 7: Power On (PON)
When set to 1, the power-on bit indicates that the instrument has been turned off and then turned on since the last time the SESR was read.

Bit 6: User Request (URQ)
When the URQ bit is set to 1, it indicates that the user has pressed a softkey programmed using the SOFTKEY command. Read the Event Queue entry for this event to determine which key was pressed.

Bit 5: Command Error (CME)
The CME bit is turned on when the instrument detects a command error. Command errors can be caused by: 1) command or query syntax errors; and 2) semantic errors. For example an unimplemented or incorrectly spelled command or query will generate a command error.

Bit 4: Execution Error (EXE)
The EXE bit is turned on when FiberMaster detects an error during the execution of a command. Execution errors can occur when command parameters are outside the legal range for the instrument or are inconsistent with a current instrument mode or operation.

Bit 3: Device-Dependent Error (DDE)
A device-dependent error occurs when a device operation does not complete due to some internal condition of the instrument.

Bit 2: Query Error (QYE)
The QYE bit indicates that 1) the controller made an attempt to read a response from the instrument before sending a terminated query message (UNTERMINATED error); 2) the controller sent part of another program message to the instrument before reading the entire response for a previous query message (INTERRUPTED error); or 3) both the Input Buffer and Output Queue are full and another data byte was received (DEADLOCK error).

Bit 1: Not Used

Bit 0: Operation Complete (OPC)
This bit is generated in response to the Operation Complete (*OPC) command.

Event Queue

Device events that are enabled by the DESER are logged in the SESR. At the same time, a code and message identifying the event are written to the Event Queue. The queue is written and read on a first-in, first-out basis, and has a capacity of eight events. The Event Queue can be read using the EVENT? or EVMSG? queries. Clear the Event Queue using the *CLS command.

The reading of the Event Queue is synchronized with the reading of the SESR. The *ESR? query reads and clears the SESR. Each time an *ESR? query is issued, the contents of the Event Queue that were logged up to the time the query is issued are enabled for reading. If the data is not read, it remains in the queue until the next time the *ESR? query is received. At that time, events logged *prior to* the last *ESR? query are deleted, and events logged *since* the last query and before the current query are enabled to be read.

EVENT? returns only the code for the oldest enabled event in the queue and removes the event from the queue. EVMSG? returns the code *and message* for the oldest enabled event in the queue and removes the event from the queue. In three cases, EVENT? and EVMSG? do not return and remove an item from the queue, but indicate the current state of the queue: 1) event 0 is returned when the queue is empty, 2) event 1 is returned when *ESR? must be sent to enable events in the queue for reading, and 3) event 350 is returned when the queue has overflowed.

Standard Event Status Enable Register

The Standard Event Status Enable Register (SESER) allows the host to program which bits of the SESR, when set, will set the event-summary bit in the Status Byte Register. The eight bits of the SESER correspond to the bits in the SESR.

Set the SESER register using the *ESE command. Read the register using the *ESE? query.

Status Byte Register

The Status Byte Register (STB) is used to summarize FiberMaster's internal states and to indicate to the controller if FiberMaster has originated a service request. The STB is read during a serial poll, and using the *STB? query. It is cleared using the *CLS command. Three bits in the STB are defined:

Bit 4: Message Available (MAV)
The MAV bit is turned on when FiberMaster has response data in the Output Queue.

Bit 5: Event Status Bit (ESB)
The ESB is turned on when an enabled standard event has occurred and has been logged in the SESR.

Bit 6: Master Summary Status Bit (MSS)
The MSS bit indicates that the instrument has at least one reason to request service—one or both of the ESB and MAV bits is set in the STB *and* in the Service Request Enable Register. The MSS bit is sent in response to the *STB? query, but not in response to the serial poll. It is not considered part of the IEEE 488.1 Status Byte.

Bit 6: Request Service Bit (RQS)
Bit 6 also functions as the RQS bit, which is turned on when the instrument raises the SRQ line to request service. SRQ is raised when an enabled bit (ESB or MAV) is set in the Status Byte Register. When SRQ is raised, the controller typically starts a serial poll to determine which device requested service. The instrument sends the Status Byte in response to the serial poll, then clears the RQS bit.

Service Request Enable Register

The Service Request Enable Register (SRER) determines which bits in the Status Byte Register generate a service request to the controller. Bits 4 and 5 of the SRER enable service-request generation when the MAV and ESB bits of the Status Byte Register are set, respectively.

Input Buffer

FiberMaster has an input buffer used to store incoming program messages. It has a capacity of 512 bytes. Whenever the input buffer fills, the GPIB handshake line NRFD (Not Ready For Data) is asserted to prevent the controller from sending another byte. In this case, NRFD is released whenever the instrument reads the next byte from the input buffer, or a device-clear message (SDC or DCL) causes the input buffer to be cleared.

Output Queue

FiberMaster logs query response data in the Output Queue, which has a capacity of 512 bytes. When this queue is not empty, the MAV bit in the STB is turned on. If enabled by the SRER, this condition turns on the RQS bit and generates a service request.

A buffer deadlock condition can arise if the input buffer overflows from an incoming query message while the instrument has filled the Output Queue with a response message. This condition can be avoided by not sending a long query message (greater than 512 bytes). If this condition occurs, event 430 is logged in the Event Queue, and all data in the output queue is lost.

GPIB Softkeys

As described previously, when FiberMaster is in REMS, the **Return to Local** softkey appears on the display. In addition, the remaining five softkeys can be programmed to generate a user-request event. These softkeys function as follows:

Return to Local

Pressing the **Return to Local** softkey causes the instrument to return to LOCS. If you press **Return to Local** during the receipt of a program message from the controller, execution errors occur for any commands or queries that are remote executable only and are received after the transition from REMS to LOCS.

Programmable Softkeys

You can use the SOFTKEY command to program a softkey to generate a user-request event (URQ) in the Standard Event Status Register and the Event Queue (if enabled by the DESER). The topmost softkey is **Return to Local** (not programmable, does not generate a URQ event). The programmable softkeys are identified as 1 through 5. The two bottom softkeys (4 and 5) are not available for programming when status information is being displayed. The status display is enabled and disabled using the GSTATUS command.

When softkey *n* has been programmed and is subsequently pressed, the user-request event 4030 + n is generated in the Event Queue. For example, pressing softkey 1 causes the following Event Queue entry:

4031, "User request; Softkey 1 actuation"

The controller can be asynchronously notified of the actuation of a softkey by programming the instrument to request service when the corresponding URQ event occurs. Using the SOFTKEY command with the MESSAGE command allows an interactive dialog between the instrument operator and the controller during remote operation of the instrument.

When the instrument returns to local control, programmable softkey definitions are retained. When the instrument returns to remote control again, the previously programmed softkeys are redisplayed and re-enabled.

Refer to the *Commands and Queries* section in this chapter for full descriptions of the SOFTKEY, GSTATUS, and MESSAGE commands.

The use of programmable softkeys is not available in RWLS (remote with local lockout state).

Error- and Event-Detection Summary

The power-on setting of the DESER to 255 causes all errors and events detected by FiberMaster to set a bit in the SESR and generate an entry in the Event Queue.

Errors are summarized on bits 2 through 5 of the SESR. The SESR is read and cleared using the *ESR? query. Further detail about errors summarized in the SESR can be obtained by sending the EVENT? or EVMSG? query *after* sending the *ESR? query.

You can program FiberMaster to request service whenever an error or event is detected by setting the appropriate bits in the DESER and SESER and setting the event-summary bit (ESB) in the SRER.

For example, to cause FiberMaster to request service when any type of error occurs (command, execution, device-dependent or query error), but not when other types of events occur, send the program message:

***ESE 60 ; *SRE 32**

The *ESE command sets the CME, EXE, DDE, and QYE bits in the SESER (60 = 32 + 16 + 8 + 4), enabling the corresponding errors to be summarized in the ESB bit of the STB. The *SRE command enables a service request whenever the ESB bit of the STB is set.

Refer to the *Commands and Queries* section later in this chapter for complete descriptions of GPIB commands.

GPIB System Errors, Events, and Warnings

Certain categories of errors and events detected by the instrument are recorded in the Standard Event Status Register and the Event Queue, as described in the previous section on status reporting and error handling.

Logged events are categorized by their numeric codes as shown in the following table:

Table 8-7. GPIB Event Code Categories

Code Range	Event Category	SESR Bit
100 - 199	Command error	CME
200 - 299	Execution error	EXE
2000 - 2999	Execution error	EXE
300 - 399	Internal error	DDE
3000 - 3999	Internal error	DDE
400 - 499	System event	PON, OPC URQ, QYE
500 - 599	Execution warning	EXE
600 - 699	Internal warning	DDE

The specific codes and messages used by FiberMaster are listed in the section *GPIB Event Codes and Messages*, later in this chapter.

Command Errors

A command error is a syntax or semantic error in a program message. A syntax error occurs when a program message contains a combination of syntactic elements that FiberMaster does not recognize. A semantic error occurs when the instrument receives an unrecognized command or query header, or detects a length or type error in a program data element.

Execution Errors

An execution error occurs when a program data element is invalid or out of legal range, or when the current state of the instrument prevents the execution of a command or query. Execution errors in the range from 2000 to 2999 are specific to FiberMaster.

Internal Errors

An internal error is logged when a serious system or hardware failure occurs, either during the power-on sequence or during the execution of a command or query. Internal errors in the range from 3000 to 3999 indicate errors specific to FiberMaster.

NOTE *Event 350, which indicates an Event Queue overflow, does not set the DDE bit in the SESR.*

System Events

There are four types of system events:

1. The power-on event, PON.
2. The operation-complete event, OPC. (Refer to the description of the *OPC command in the *Commands and Queries* section later in this chapter.)
3. The user-request event, URQ, which occurs when you press a softkey programmed by the SOFTKEY command while the instrument is in REMS.
4. Query errors, QYE. (Refer to the following section on message-exchange protocol.)

Execution Warnings

An execution warning occurs when 1) a command or query parameter is adjusted to the nearest legal value, or 2) a command refers to data that is not currently stored in the instrument.

Internal Warnings

An internal warning is caused by a command or query execution failure, but does not indicate as serious a failure as an internal error. For example, an internal warning would occur in response to a timeout on a data transfer to an external device (such as a plotter), or a printer-out-of-paper error.

Event Code and Message Formats

In response to the EVENT? and EVMSG? queries, event codes are formatted as unsigned decimal integers. Event messages are returned as string response data, up to 256 characters in total length. (Refer to the EVENT? and EVMSG? query descriptions in the *Commands and Queries* section of this chapter.)

Event messages may be in one of nine formats:

1. "<message>"
2. "<message>; <specifics>"
3. "<message>; Header: <header>"
4. "<message>; Header: <header> / Parameter: <param>"
5. "<message>; Header: <header> / Parameter 1: <param1>/ Parameter 2: <param2>"
6. "<message>; <specifics> (Header: <header>)"
7. "<message>; <specifics> (Header: <header> / Parameter: <param>"
8. "<message>; <specifics> (Header: <header> / Parameter 1: <param1> / Parameter 2: <param2>)"

The message elements are defined as follows:

<message>	a basic description of the error or event,
<specifics>	further detail about the error or event,
<header>	the header of the command or query that caused the error, and
<param>	the text of an invalid parameter or parameters received
<param1>	with a command or query.
<param2>	

Formats 3 through 8 are used when an error can be attributed directly to a particular command or query, or to one or more parameters of a particular command or query.

GPIB Message-Exchange Protocol

The way the controller sends query messages to FiberMaster and reads response messages must conform to the following rules:

1. The controller should wait until it has sent a query message plus a program-message terminator before it attempts to read the corresponding response message.

   If the instrument detects a violation of this rule, event 420 (query UNTERMINATED error) is logged in the Event Queue and bit 2 (QYE) is set in the SESR, if enabled by the DESER. The Output Queue is cleared, and any command or query currently being parsed by FiberMaster is discarded. The instrument then becomes ready to parse a new command or query.

2. The controller should wait until it has read an entire response message, including the response-message terminator, before sending a new program message to FiberMaster.

   If FiberMaster detects a violation of this rule, event 410 (query INTERRUPTED error) is logged in the Event Queue and bit 2 (QYE) is set in the SESR, if enabled by the DESER. The Output Queue is cleared and FiberMaster stops sending the current response so it can read and process the new program information.

Rules 1 and 2 can be summarized in the following sequence:

1. Controller sends query message.
2. Controller sends program-message terminator.
3. Controller reads response message.
4. Controller reads response-message terminator.
5. Controller sends next program message.

3. If the controller expects a lengthy response from a particular query (at least 512 characters), it should limit the length of the query message to less than 512 characters, including the program-message terminator. If the length were not limited, both the Input Buffer and the Output Queue would fill during the receipt and execution of the query message. The controller, since it must observe rule 1, above, would not be able to read the response from the full Output Queue because the Input Buffer would not be able to hold the program-message terminator.

   If the instrument detects a violation of this rule, event 430 (query DEADLOCKED error) is logged in the Event Queue and bit 2 (QYE) is set in the SESR, if enabled by the DESER. The Output Queue is cleared and FiberMaster does not generate a response for any query in the current program message. When the instrument sees the program-message terminator, it again becomes ready to generate responses to query messages.

If the controller violates any of these rules, it may timeout waiting for a query response that the instrument has aborted. Status queries (such as *ESR? and EVENT?) can then be sent to determine the nature of the error.

GPIB Controller and Instrument Synchronization

FiberMaster executes all commands and queries *sequentially*, which means that any device operation initiated by a command or query must be complete before the next command or query is executed.

FiberMaster provides the controller with a means of determining when the instrument has completed a device operation, and allowing the controller to exchange messages with other devices on the bus in the meantime. The controller can send the *OPC command or *OPC? query after a command or query that starts a device operation. (Refer to the *Commands and Queries* section of this chapter for complete descriptions of FiberMaster's GPIB commands and queries.)

Responses to individual queries are generated at the time FiberMaster detects the query, not when the controller reads the query. The message-available bit (MAV in the Status Byte Register) indicates when query response data is available.

When used in conjunction with FiberMaster's service-request capability, the *OPC command, *OPC? query, and MAV bit allow the controller to be notified when FiberMaster completes a device operation.

The following examples illustrate these synchronization techniques:

Example 1:

1. The controller sends the query message

   ACQUIRE 10.0,START,NORMAL;*OPC?

   followed by the talk address of the instrument.

2. FiberMaster starts an acquisition. When the acquisition is complete, the instrument detects the *OPC? query and sends the response

   1<NL>^<END>

3. Upon reading the response message from *OPC?, the controller knows the acquisition is complete. Note that this method does not allow the controller to exchange messages with other devices, since it must wait for a response from FiberMaster.

Example 2:

1. The controller sends the program message

   ***ESE 1**

   enabling the setting of the event-summary bit (ESB) in the STB when the *OPC command is executed. (The 1 indicates the operation-complete bit, or OPC, in the SESR.) **Note**: bit 1 of the DESER must be set to enable the logging of the operation-complete event. The factory-default setting of the DESER is all bits set.

2. The controller sends the program message

   ***SRE 32**

   enabling FiberMaster to request service when the event-summary bit (ESB) is set in the STB.

3. The controller sends the program message

   ACQUIRE 10.0,START,NORMAL;*OPC

4. When the acquisition is complete, the instrument detects and executes the *OPC command. The OPC bit is set in the SESR and summarized in the ESB bit in the STB. When the ESB bit is set, the instrument asserts the GPIB service-request line (SRQ). The controller may conduct a serial-poll sequence to determine that FiberMaster is the device requesting service, and that the ESB bit is set in the STB.

5. To read and clear the SESR, the controller sends the program message

   ***ESR?**

6. The instrument sends the response message

   1<NL>^<END>

   where the 1 indicates the operation-complete event.

Example 3:

1. The controller sends the program message

   ***SRE 16**

   enabling the device to request service when the message-available bit (MAV) is set in the STB.

2. The controller sends the program message

   ACQUIRE 10.0,START,NORMAL;CURVE?

   to cause FiberMaster to make an acquisition, and return the waveform data.

3. When FiberMaster completes the acquisition, it places the CURVE? query response data in the Output Queue and sets the MAV bit in the STB, generating a service request. The controller may conduct a serial-poll sequence to determine that FiberMaster is the device requesting service, and that the MAV bit is set in the STB.

4. The controller reads the CURVE? query response data.

Examples 2 and 3 allow the controller to exchange messages with other devices while FiberMaster is acquiring data.

GPIB Device Initialization

In addition to power-on initialization, FiberMaster has three types of reset via GPIB, accomplished through the DCL/SDC interface messages, the *RST command, and the *CLS command.

Power-On Initialization

Instrument parameters with factory-set power-on defaults are reset to their factory-set values at power-on. Parameters with user-definable power-on defaults are reset to the user-programmed values at power-on. The GPIB-related power-on defaults are as follows:

GPIB address - defaults to the last-used value. The factory default is 7.

GPIB status - GPIB status is always online after power-on.

Status-enable registers - the status-enable registers include the Device Event Status Enable Register (DESER), the Standard Event Status Enable Register, (SESER), and the Service Request Enable Register (SRER). The power-on values of these registers are:

DESER: 255
SESER: 0
SRER: 0

Standard Event Status Register (SESR) - the power-on value is 128 (decimal), which indicates the power-on event.

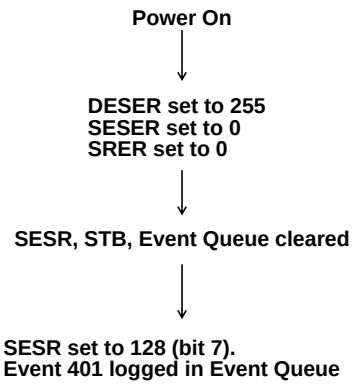
Status Byte Register (STB) - the power-on value is 0.

Event Queue - power-on value is to queue a single event (power-on, event 401).

Response header enabling - power-on value is ON.

Waveform encoding - power-on value is BINARY.

The sequence of events at power-on is illustrated in the following diagram.



Device-Clear Messages

A second type of initialization is performed by device-clear messages, DCL and SDC. A DCL or SDC forces the instrument's message handler into an idle state, ready to receive and execute program messages, but does not affect any device operation in progress.

A device-clear message causes the instrument to:

1. Clear the Input Buffer and the Output Queue.
2. Abort any query response currently being sent.
3. Clear the MAV (message-available) bit in the SESR.
4. Reset the message-exchange-protocol state.

A device clear does *not*:

1. Change instrument settings or stored waveform data.
2. Affect instrument front-panel operation or change the remote/local state.
3. Affect status or status-enable registers, with the exception of clearing the MAV (message-available) bit in the STB.
4. Change the bus address or GPIB status of the instrument.
5. Unaddress the instrument to talk or listen.

Reset

The *RST command resets all instrument settings to factory defaults and clears any acquired waveforms from data memory and instrument display (refer to the description of the *RST command in the following section). If the *RST command is preceded by a device-clear message, it also aborts any current device operation started by the execution of a command or query, with the exception of mass-storage operations, which are allowed to complete.

Clear Status Registers

The *CLS command clears the SESR, the STB (except for the MAV bit), and the Event Queue. If the instrument is currently requesting service, it releases the SRQ line and clears the RQS bit in the STB.

RS-232 System

The only two devices allowed on the RS-232 link are the controller (typically a host computer) and the FiberMaster. These devices can be connected directly or over a telephone line, as shown in figure 8-4.

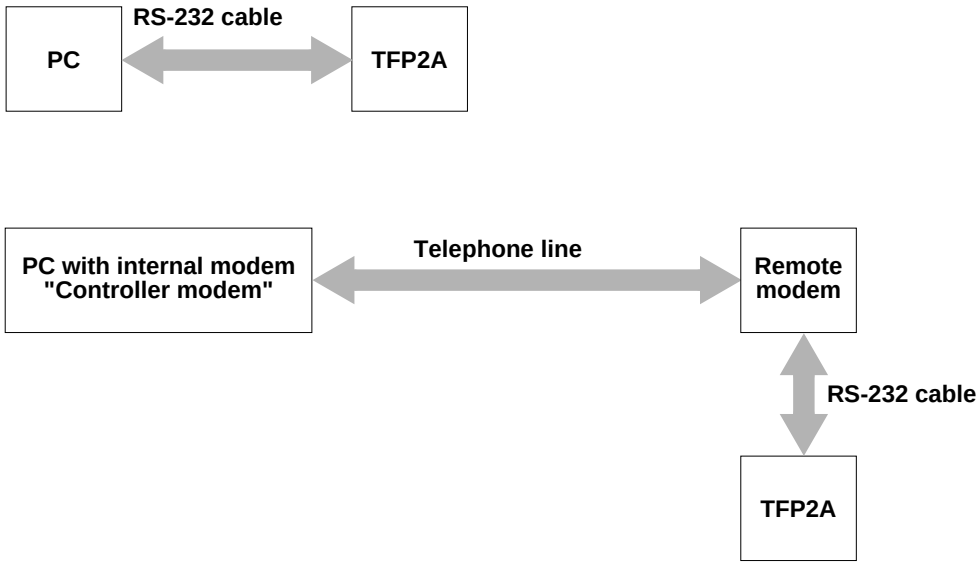


Figure 8-4. RS-232 Direct Connection and Connection over Telephone Line

Multidrop configurations or addressing schemes are not supported. Half-duplex and synchronous RS-232 links are not supported.

Similar to the GPIB interface, FiberMaster functions as a talker and listener—it does not have controller capability. For example, it cannot control another FiberMaster or configure a modem. (An RS-232 terminal can be used to configure a modem before the modem is connected to FiberMaster, as shown in figure 8-4.)

NOTE

*Operation of the TFP2A under RS-232 remote control cannot be mixed with XModem file transfers or GPIB remote control. You must cycle power to the instrument (press **POWER** once to turn the TFP2A off, then press **POWER** again to turn it on and reinitialize the instrument) under the following conditions:*

1. *After using XModem if RS-232 remote control is desired, or if hard copy to an RS-232 printer is desired.*
2. *After using RS-232 remote control if GPIB remote control is desired.*
3. *After using GPIB remote control if RS-232 remote control is desired.*

RS-232 Signal Lines

FiberMaster is configured as Data Communication Equipment (DCE). Table 8-8 shows the subset of RS-232 signal lines (interface circuits) that are pertinent to the remote control of FiberMaster.

Table 8-8. RS-232 Signal Lines

Line	Name	Explanation
--	Protective Ground	Connected to equipment chassis
--	Signal Ground	Common ground reference for all other lines except Protective ground
TD	Transmitted Data	Controller transmits data to FiberMaster on this line
RD	Received Data	FiberMaster transmits data to controller on this line
RTS	Request to Send	Indicates controller is ready to exchange data (when RTS/CTS flow control enabled)
CTS	Clear to Send	Indicates FiberMaster is ready to exchange data (when RTS/CTS flow control enabled)
DTR	Data Terminal Ready	Indicates controller ready to exchange data (when DTR/DSR flow control enabled)
DSR	Data Set Ready	Indicates FiberMaster is ready to exchange data (when DTR/DSR flow control enabled)
DCD	Data Carrier Detect	Continuously asserted by FiberMaster after power-on.

The minimum set of required lines for remote control are the ground circuits, TD and RD. However, this does not allow the use of hardware flow control (or hardware handshaking). It is recommended that both RTS and CTS or both DTR and DSR be used to allow for hardware flow control. If modems are to be used, the RTS and CTS lines should be used for hardware flow control.

NOTES

FiberMaster always asserts the CTS and DSR lines after power-on, even if hardware flow control is not enabled. If hardware flow control is selected (RTS/CTS or DTR/DSR), one of these lines (CTS or DSR, respectively) is dropped whenever FiberMaster is not ready to receive data.

DCD is asserted continuously after power-on and not dropped under any condition.

RS-232 System Setup

Set the RS-232 parameters on FiberMaster's System Settings Menu to match those of the controller being used. These parameters include:

- ❏ Baud rate
- ❏ Parity
- ❏ Stop bits
- ❏ Data bits
- ❏ Flow control

These parameter settings can be saved as power-on user defaults, using the User Defaults menu.

If binary waveform or settings transfers are used, set the number of data bits to 8 and the flow control to RTS/CTS or DTR/DSR. Use RTS/CTS if you are connecting FiberMaster to a modem and the modem supports RTS/CTS flow control.

Do not change FiberMaster RS-232 parameters while I/O with a controller is in progress. This could result in a lockup of communications between the controller and FiberMaster, as well as in lost data. In the event that this happens, however, communications can be restored by doing the following:

1. Restore FiberMaster parameter settings to match those of the controller.
2. Send a BREAK signal to FiberMaster to ready the instrument to receive new commands.

Cabling

It is recommended that only shielded cables be used.

Table 8-9 shows the recommended wiring for a cable used to connect FiberMaster to a host computer that is configured as Data Terminal Equipment and has a 25-pin RS-232 connector (DB-25). In this case a standard RS-232 "straight cable" with all 25 pins wired can be used.

Table 8-9. FiberMaster-to-DTE Wiring

DTE (Host)		DCE (FiberMaster)	
	DB-25	DB-25	
Line	Pin #	Pin #	Line
PG	1	1	PG
TD	2	2	TD
RD	3	3	RD
RTS	4	4	RTS
CTS	5	5	CTS
DSR	6	6	DSR
SG	7	7	SG
DTR	20	20	DTR

Table 8-10 shows the recommended wiring for a cable used to connect FiberMaster to a modem (DCE) that has a 25-pin RS-232 connector (DB-25). In this case, the transmit and receive lines, as well as the flow-control lines, must be swapped since both devices are DCE.

Table 8-10. FiberMaster-to-DCE Wiring

DCE (Modem) DB-25		DCE (FiberMaster) DB-25	
Line	**Pin #**	**Pin #**	**Line**
PG	1	1	PG
TD	2	3	RD
RD	3	2	TD
RTS	4	5	CTS
CTS	5	4	RTS
DSR	6	20	DTR
SG	7	7	SG
DTR	20	6	DSR

Table 8-11 shows the recommended wiring for a cable used to connect FiberMaster to an IBM PC/AT-compatible COM port that has a DB-9 connector.

Table 8-11. FiberMaster-to-DTE Wiring

DTE (PC) DB-9		DCE (FiberMaster) DB-25	
Line	**Pin #**	**Pin #**	**Line**
RD	2	3	RD
TD	3	2	TD
DTR	4	20	DTR
SG	5	7	SG
DSR	6	6	DSR
RTS	7	4	RTS
CTS	8	5	CTS

Modem Configuration

FiberMaster can be controlled remotely by a PC, using a telephone line and a modem, as illustrated in figure 8-4. The term “controller modem” describes the modem connected to the controller, and the term “remote modem” describes a stand-alone modem connected to FiberMaster. When configuring a remote-controlled FiberMaster this way, be aware of the following:

- ❏ FiberMaster does not use software error correction, so both controller and remote modems should support a compatible mode of error correction, such as V.42 or MNP.
- ❏ The modem connected to FiberMaster must have an auto-answer capability, since the controller originates the connection used for remote control. FiberMaster does not originate the connection or have the ability to configure a modem.

Table 8-12 shows settings used with two Hayes Accura modems to establish a connection between a controller PC and a FiberMaster. Each modem was configured by connecting a terminal and entering the configuration commands for that modem. These settings were used for a 9600-baud, V.42-LAPM connection over a dial-up line. The PC originated the call with its internal modem. The remote modem answered the call and transferred commands to FiberMaster.

Local RTS/CTS flow control was used between FiberMaster and the remote modem, and between the PC and controller modem. The Hayes factory default settings for both modems were used, with the following exceptions:

Controller modem:

Destructive break signalling (ATS82=7 command)
Command echo turned off (ATE0 command)
Speaker off (ATM0)
Basic call progress return codes (ATX1)

Remote modem:

Auto-answer on one ring (ATS0=1 command)
Destructive break signalling (ATS82=7 command)
Command echo turned off (ATE0 command)
Speaker off (ATM0)
Basic call progress return codes (ATX1)

The modem commands and/or settings needed may be different for other types of connections, or for other types of modems. Settings that apply only to synchronous transmission have been omitted.

An asterisk in the second column indicates that settings for both modems are identical.

Table 8-12. Hayes Accura Modem Settings for FiberMaster Remote Control

Modem Setting		
Controller	**Remote**	
B16	*	Use U.S. domestic industry standard 103 when dialing at 300 bps.
B1	*	Use U.S. domestic industry standard 212A when dialing at 1200 bps.
E0	*	Command echo off.
L2	*	Medium speaker volume.
M0	*	Speaker off.
N1	*	Negotiation of handshake options when modem speeds differ.
Q0	*	Result codes enabled.
V1	*	Result codes displayed as words.
W0	*	CONNECT code reports DTE speed.
X1	*	Provide basic call progress result codes and connect speed.
Y0	*	Disable long space (extended break signal) disconnect.
&A0	*	Connect as answering modem when auto-answering.
&C0	*	Assume presence of carrier detect signal.
&D0	*	When &Q5 in effect, DCD on at all times.
&G0	*	Guard tones disabled.
&J0	*	Auxiliary relay never closed (appropriate for RJ-11 phone jack)
&K3	*	Enable RTS/CTS flow control with DTE.
&L0	*	Select dial-up line operation (use &L1 for leased line).
&Q5	*	Enable error-correction protocol.
&S0	*	DSR circuit always on.
&T4	*	Grant remote digital loopback requests.
&U0	*	Enable Trellis coding for V.32 connections.
&Y0	*	Select stored profile 0 at power-on.
S00:000	S00:001	000=disable auto-answer, 001=auto-answer after 1 ring.
S01:000	*	Ring count register.
S02:043	*	Use plus sign (+) as escape-sequence character.
S03:013	*	ASCII value of carriage-return character.
S04:010	*	ASCII value of newline character.
S05:008	*	ASCII value of backspace character.
S06:002	*	Delay (seconds) between going offhook and dialing.
S07:050	S07:060	Max wait (seconds) between connection and carrier detect.
S08:002	*	Delay (seconds) due to comma (,) dial modifier.
S09:006	*	Carrier detect response time (1/10-second units).
S10:014	*	Delay (seconds) between lost carrier and hang-up.
S11:095	S11:055	Duration and spacing of tones in multi-frequency tone dialing (msec).
S12:050	*	Escape sequence guard time (1/50-second units).
S18:000	*	Disable modem test timer.
S25:005	*	DTR change detect time (1/100-second units).
S30:000	*	Disable inactivity timer.

Table 8-12. Hayes Accura Modem Settings for FiberMaster Remote Control (cont.)

Modem Setting		
Controller	**Remote**	
S36:007	*	Attempt MNP protocol if V.42 negotiation fails.
S37:000	*	Desired DCE line speed (0=use highest line speed not exceeding that of last AT command issued.
S38:020	*	Delay (seconds) between hang-up command and disconnect.
S43:009	*	DCE speed of last carrier established (9=9600 bps).
S46:002	*	Error-control protocol selection (2=LAPM with compression).
S48:007	*	Enable feature negotiation between modems.
S63:000	*	Leased line carrier level adjustment.
S82:007	*	Break signalling technique (7=destructive).
S86:004	S86:000	Cause of last connection failure.
S95:000	*	Error-control negotiation message options.
S97:030	*	V.32 automode V.22 probe timing (1/10-second units).
S108:001	*	V.32 signal-quality requirement (1=low quality).
S109:062	*	V.32bis carrier-speed selector.
S110:002	*	V.32bis and auto rate re-negotiation selected.

Port-Select Sequence

At power-on, Fibermaster is enabled by default for GPIB (IEEE 488) remote control. In order to enable RS-232 remote control, send the following sequence of ASCII characters to FiberMaster's RS-232 port:

REQCTRL<NL>

<NL> is the ASCII newline character (0A hex). No spaces or other characters are allowed between the REQCTRL and terminating <NL> character. The letters in the word REQCTRL can be upper, lower, or mixed case.

This sequence selects FiberMaster's RS-232 port as the remote-control port, and takes the GPIB interface offline. All subsequent data received by FiberMaster's RS-232 interface is interpreted as commands or queries (described in the *Commands and Queries* section later in this chapter.

To bring the GPIB interface back online, cycle power to the FiberMaster.

The port-select sequence only enables the RS-232 port as the remote-control port; it does not put the instrument into remote mode or affect any instrument mode or operation in progress. (Refer to the descriptions of the REMOTE, REMLOCK, and LOCAL commands in the *Commands and Queries* section for information on switching between local and remote modes of instrument operation.) If the port-select sequence is received when the RS-232 port is already enabled for remote control, it is ignored.

The following example shows a typical sequence used to initiate RS-232 remote control:

REQCTRL<NL>	Send RS-232 port-select sequence.
REMOTE<NL>	Put instrument in remote control.
***RST<NL>**	Reset instrument settings to factory defaults.
***CLS<NL>**	Clear instrument status registers and event queue.
***IDN?<NL>**	Query instrument for identification string.

The RS-232 port is disabled as the remote-control port whenever any of the following occurs:

1. Instrument power is cycled.
2. An XMODEM transfer is initiated from the Remote menu.
3. A hardcopy operation to an RS-232 printer or plotter is started.

In each of these cases, the port-select sequence must be reissued to re-enable the RS-232 port for remote control.

Input Buffer

FiberMaster has an input buffer used to store incoming commands and queries. It has a capacity of 2048 bytes. If flow control is selected, FiberMaster requests the controller to stop transmitting data when the number of characters in the buffer reaches 1536 (refer to the section on flow control, below). This threshold is referred to as the “high-water mark.” When the number of characters in the input buffer subsequently drops to below 512 characters, FiberMaster requests the controller to resume transmitting data. This threshold is referred to as the “low-water mark.”

Data-Bit Settings

FiberMaster and controller data-bit settings should both be set to eight bits per character if binary data transfers are to be used.

Flow Control

Flow control should always be enabled when using RS-232 remote control. If not, data can be lost, especially during data transfers between the controller and FiberMaster. RTS/CTS is the recommended method of flow control.

FiberMaster supports bidirectional flow control during remote control. In other words, FiberMaster 1) responds to controller requests to stop the flow of data to the controller when the controller is not ready, and 2) requests the controller to stop the flow of data from the controller when FiberMaster is not ready.

Three methods of flow control are available for selection via FiberMaster’s System Settings menu:

XON/XOFF

XON/XOFF flow control is not recommended since it cannot be used with binary data transfers. The flow-control character could occur as part of the data itself.

When XON/SOFF flow control is selected and FiberMaster receives an XOFF character (13 hex) from the controller, it does not transmit data to the controller until it receives an XON character (11 hex). FiberMaster sends an XOFF character to the controller when its input buffer reaches the high-water mark. It sends an XON character to the controller when its input buffer drops to the low-water mark.

RTS/CTS

RTS/CTS is the recommended method of flow control since it can be used with binary data and is supported by V.42-compliant modems.

When RTS/CTS flow control is selected and the controller drops the RTS signal, FiberMaster does not transmit data to the controller until RTS is reasserted. FiberMaster drops the CTS signal when its input buffer reaches the high-water mark. It reasserts CTS when its input buffer drops to the low-water mark.

DTR/DSR

DTR/DSR flow control should only be used with direct connections since many modems have reserved uses for these signals.

When DTR/DSR flow control is selected and the controller drops the DTR signal, FiberMaster does not transmit data to the controller until DTR is reasserted. FiberMaster drops the DSR signal when its input buffer reaches the high-water mark. It reasserts DSR when its input buffer drops to the low-water mark.

RS-232 Communications

Common Commands and Queries

Under RS-232 remote control, FiberMaster recognizes a subset of the common commands and queries defined in IEEE 488.2. Each common command is identified by an asterisk. The commands implemented in FiberMaster include the following (for descriptions of these commands, refer to the *Commands and Queries* section in this chapter): *IDN?, *LRN?, *RST, *CLS, *ESE, *SRE, *ESE?, *ESR?, *SRE?, *STB, *OPC, *WAI, *OPC?, *TST?.

Device-Dependent Messages and Program Messages

Device-dependent messages transfer information directly between FiberMaster and the controller. They include commands that cause an action to take place in the instrument, queries requesting information from the instrument, command and query data elements, and query responses.

Some commands and queries start device operations such as acquisitions, measurements, and disk-drive operations. Other commands perform interface-related functions such as setting status registers and allowing controller and instrument synchronization. Queries also read instrument settings, status, and configuration information. Device-dependent commands and queries are listed in the *Commands and Queries* section of this chapter.

A sequence of one or more device-dependent commands and queries is called a program message. The FiberMaster is programmed by sending it one or more program messages from the controller. A program message that contains a query is called a query message.

For explanations of the formats of commands, queries, and program messages, refer to the *Commands and Queries* section of this chapter.

Modes of Operation

You can operate FiberMaster using the front-panel controls as described in chapters 2 through 7, or remotely using a remote controller. In addition to these local and remote states, the controller can place the instrument in a local lockout condition at any time. This combination yields three possible operating states:

- **Local State (LOCS)** - FiberMaster responds to front-panel control and to remote messages that do not affect instrument settings, data memory, or start device operations.
- **Remote State (REMS)** - In REMS the controller can change instrument settings, and start acquisitions and other device operations. In this state, a **Return to Local** softkey displays, allowing the operator to return the instrument to local control.
- **Remote with Lockout State (RWLS)** - RWLS is similar to REMS, except the **Return to Local** softkey does not display.

Remote/Local State Transitions

REMS is entered from LOCS or RWLS when FiberMaster receives the REMOTE command.

LOCS is entered from REMS or RWLS when FiberMaster receives the LOCAL command. LOCS is also entered at power-on, and when FiberMaster is in REMS and the **Return to Local** softkey is pressed.

RWLS is entered from LOCS or REMS when FiberMaster receives the REMLOCK command.

In all cases the port-select sequence, REQCTRL<NL>, must have been sent at some time prior to sending the REMOTE, LOCAL, or REMLOCK commands.

Local-to-Remote Transition

When the instrument changes from local to remote operation, the following occurs:

- ❏ Any currently executing device operation that was initiated from the front panel is aborted, with the exception of a mass-storage operation.
- ❏ When the state change is made, the full set of remote commands is now available for execution, rather than the limited subset available in the local state.
- ❏ The **REMOTE** indicator on the front panel lights up.
- ❏ The instrument remains in the current measurement mode, with any previously acquired waveform displayed. Instrument settings are not affected.
- ❏ All front-panel controls are disabled. The only exception is the softkey that displays only in REMS, **Return to Local**. The **Return to Local** softkey returns the instrument to local control.

The acquisition screen is updated during remote control to show any setting changes, measurement-mode changed, new acquisitions, cursor movement, and expansion-window changes that occur as a result of remote commands. Menu screens are not displayed.

Remote-to-Local Transition

When the instrument returns to local from remote operation, the following occurs:

- ❏ All front-panel controls and softkeys are enabled.
- ❏ The **REMOTE** indicator on the front panel is turned off.

The acquisition data and instrument settings displayed during remote control remain on the screen after the transition to local. Instrument settings and acquired waveform data are not affected.

Message processing continues in the local state, but any commands and queries that affect instrument settings, data memory, or start device operations are not executed. In response to such a command or query, an execution error is logged in the Event Queue, and an execution error is flagged in the Standard Event Status Register. (For

more details on error reporting, refer to the *Status Reporting and Error Handling* section, later in this chapter.)

Using a GPIB Plotter or Printer

Data displayed on FiberMaster's screen can be plotted or printed on an external GPIB plotter or printer, when the instrument is under RS-232 remote control. The ThinkJet printer and HPGL-compatible plotters are supported. Refer to chapter 3, *Getting Started*, for hardcopy-device-selection details.

When using a GPIB plotter or printer under RS-232 remote control, configure the device as listen only. To start a hard copy, send the GPLTSCREEN or GPLTTEXT command. Details on using these commands are given in the *Commands and Queries* section later in this chapter.

RS-232 Communications and Mass Storage

Serial communications are ignored during mass-storage operations. Data can be lost if a mass-storage operation is started via RS-232 and then another RS-232 command is sent before the mass-storage operation is complete.

To avoid this problem, send only one mass-storage command in an RS-232 program message, and terminate the message with the operation complete query (*OPC?). Then wait for the response to be returned before sending another command or query.

For example, to save the current waveform to the file TEST.WFM, send the following message:

SAVECUR "TEST";*OPC?^NL

FiberMaster sends the response to the *OPC? query (1^NL) when the SAVECUR command is complete.

In general, the recommended form for sending an RS-232 mass-storage command is as follows:

<command>;*OPC?^NL

The controller should read the *OPC? response (1^NL) from FiberMaster after sending this type of message.

There is no need to terminate a mass-storage query with *OPC?, but use only one mass-storage query in a program message. For example, to obtain a directory of the currently selected drive, send:

DIRECTORY?^NL

The recommended form for sending a mass-storage query is as follows:

<query>^NL

RS-232 Status Reporting and Error Handling

The RS-232 controller has access to two FiberMaster status and status-enable registers. These registers control status and error reporting for all device events, as illustrated in figure 8-5. The functions of each register are explained in the following pages. Table 8-13 summarizes the status registers and their corresponding commands and queries.

Table 8-13. RS-232 Status Register Summary

Register/Queue	Write with	Clear with	Read with
Device Event Status Enable Register (DESER)	DESE	DESE	DESE?
Standard Event Status Register (SESR)	none	*CLS, *ESR?	*ESR?

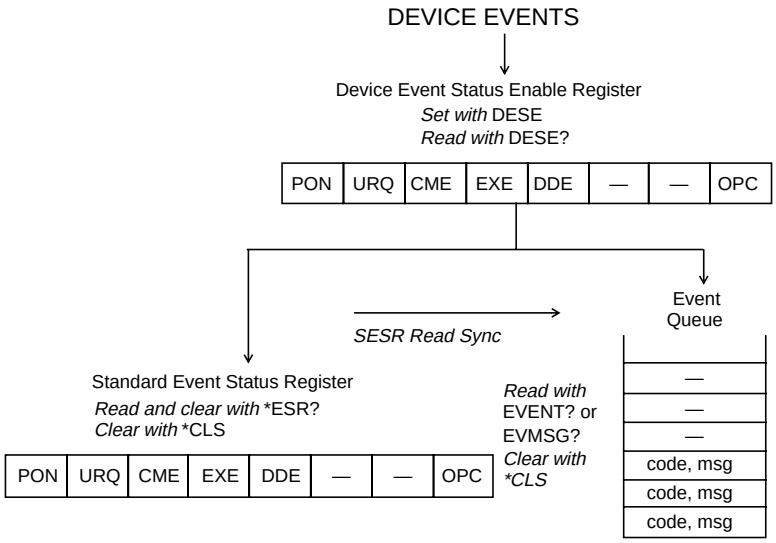


Figure 8-5. RS-232 Status Reporting and Error Handling

Device Event Status Enable Register

The Device Event Status Enable Register (DESER) is an eight-bit register with bit definitions corresponding to the IEEE 488.2-defined Standard Event Status Register (SESR). The purpose of the DESER is to enable the reporting of events in the SESR and the Event Queue. (Refer to the descriptions of the Standard Event Status Register and the Status Byte Register, in the following pages.

When an event enabled by the DESER occurs, the corresponding bit in the SESR is set, and a code and corresponding message explaining the event are stored in the

Event Queue. Event codes and their meanings are listed in the section *RS-232 Event Codes and Messages*, later in this chapter.

The DESER defaults to an ASCII value of 255 (all bits on), meaning that all types of events will be logged in the SESR and Event Queue. To disable the logging of selected event types, set the value of the register to the appropriate bit mask by using the DESE command.

For definitions of the bits in the DESER, refer to the description of the SESR, in the following paragraphs.

Standard Event Status Register

The eight bits of the Standard Event Status Register (SESR) log individual events occurring in the instrument. The SESR is cleared (set to 0) when the power is turned on, after being read by sending the *ESR? query, and when the *CLS command is issued. The bit definitions of the SESR are listed below. When a defined event occurs and is enabled by the DESER, the corresponding bit is turned on in the SESR, and an event code and message pair is logged in the Event Queue.

Bit 7: Power On (PON)
When set to 1, the power-on bit indicates that the instrument has been turned off and then turned on since the last time the SESR was read.

Bit 6: User Request (URQ)
When the URQ bit is set to 1, it indicates that the user has pressed a softkey programmed using the SOFTKEY command. Read the Event Queue entry for this event to determine which key was pressed.

Bit 5: Command Error (CME)
The CME bit is turned on when the instrument detects a command error. Command errors can be caused by: 1) command or query syntax errors; and 2) semantic errors. For example an unimplemented or incorrectly spelled command or query will generate a command error.

Bit 4: Execution Error (EXE)
The EXE bit is turned on when FiberMaster detects an error during the execution of a command. Execution errors can occur when command parameters are outside the legal range for the instrument or are inconsistent with a current instrument mode or operation.

Bit 3: Device-Dependent Error (DDE)
A device-dependent error occurs when a device operation does not complete due to some internal condition of the instrument.

Bit 2: Not Used

Bit 1: Not Used

Bit 0: Operation Complete (OPC)
This bit is generated in response to the Operation Complete (*OPC) command.

Event Queue

Device events that are enabled by the DESER are logged in the SESR. At the same time, a code and message identifying the event are written to the Event Queue. The queue is written and read on a first-in, first-out basis, and has a capacity of eight events. The Event Queue can be read using the EVENT? or EVMSG? queries. Clear the Event Queue using the *CLS command.

The reading of the Event Queue is synchronized with the reading of the SESR. The *ESR? query reads and clears the SESR. Each time an *ESR? query is issued, the contents of the Event Queue that were logged up to the time the query is issued are enabled for reading. If the data is not read, it remains in the queue until the next time the *ESR? query is received. At that time, events logged *prior to* the last *ESR? query are deleted, and events logged *since* the last query and before the current query are enabled to be read.

EVENT? returns only the code for the oldest enabled event in the queue and removes the event from the queue. EVMSG? returns the code *and message* for the oldest enabled event in the queue and removes the event from the queue. In three cases, EVENT? and EVMSG? do not return and remove an item from the queue, but indicate the current state of the queue: 1) event 0 is returned when the queue is empty, 2) event 1 is returned when *ESR? must be sent to enable events in the queue for reading, and 3) event 350 is returned when the queue has overflowed.

Remote Softkeys

As described previously, when FiberMaster is in REMS, the **Return to Local** softkey appears on the display. In addition, the remaining five softkeys can be programmed to generate a user-request event. These softkeys function as follows:

Return to Local

Pressing the **Return to Local** softkey causes the instrument to return to LOCS. If you press **Return to Local** during the receipt of a program message from the controller, execution errors occur for any commands or queries that are remote executable only and are received after the transition from REMS to LOCS.

Programmable Softkeys

You can use the SOFTKEY command to program a softkey to generate a user-request event (URQ) in the Standard Event Status Register and the Event Queue (if enabled by the DESER). The topmost softkey is **Return to Local** (not programmable, does not generate a URQ event). The programmable softkeys are identified as 1 through 5. The two bottom softkeys (4 and 5) are not available for programming when GPIB status information is being displayed. The GPIB status display is enabled and disabled using the GSTATUS command.

When softkey *n* has been programmed and is subsequently pressed, the user-request event 4030 + n is generated in the Event Queue. For example, pressing softkey 1 causes the following Event Queue entry:

4031, "User request; Softkey 1 actuation"

The controller can subsequently use the *ESR? query to determine that the URQ bit is set in the Standard Event Status Register, and use the EVENT? or EVMSG? query to determine if a programmable softkey has been pressed.

When the instrument returns to local control, programmable softkey definitions are retained. When the instrument returns to remote control again, the previously programmed softkeys are redisplayed and re-enabled.

Refer to the *Commands and Queries* section in this chapter for full descriptions of the SOFTKEY, GSTATUS, and MESSAGE commands.

The use of programmable softkeys is not available in RWLS (remote with local lockout state).

Error- and Event-Detection Summary

The power-on setting of the DESER to 255 causes all errors and events detected by FiberMaster to set a bit in the SESR and generate an entry in the Event Queue.

Errors are summarized on bits 3 through 5 of the SESR. The SESR is read and cleared using the *ESR? query. Further detail about errors summarized in the SESR can be obtained by sending the EVENT? or EVMSG? query *after* sending the *ESR? query.

Refer to the *Commands and Queries* section later in this chapter for complete descriptions of remote commands.

RS-232 System Errors, Events, and Warnings

Certain categories of errors and events detected by the instrument are recorded in the Standard Event Status Register and the Event Queue, as described in the previous section on status reporting and error handling.

Logged events are categorized by their numeric codes as shown in the following table:

Table 8-14. RS-232 Event Code Categories

Code Range	Event Category	SESR Bit
100 - 199	Command error	CME
200 - 299	Execution error	EXE
2000 - 2999	Execution error	EXE
300 - 399	Internal error	DDE
3000 - 3999	Internal error	DDE
400 - 499	System event	PON, OPC, URQ
500 - 599	Execution warning	EXE
600 - 699	Internal warning	DDE

The specific codes and messages used by FiberMaster are listed in the section *Remote Control Event Codes and Messages*, later in this chapter.

Command Errors

A command error is a syntax or semantic error in a program message. A syntax error occurs when a program message contains a combination of syntactic elements that FiberMaster does not recognize. A semantic error occurs when the instrument receives an unrecognized command or query header, or detects a length or type error in a program data element.

Execution Errors

An execution error occurs when a program data element is invalid or out of legal range, or when the current state of the instrument prevents the execution of a command or query. Execution errors in the range from 2000 to 2999 are specific to FiberMaster.

Internal Errors

An internal error is logged when a serious system or hardware failure occurs, either during the power-on sequence or during the execution of a command or query. Internal errors in the range from 3000 to 3999 indicate errors specific to FiberMaster.

NOTE *Event 350, which indicates an Event Queue overflow, does not set the DDE bit in the SESR.*

System Events

There are three types of system events:

1. The power-on event, PON.
2. The operation-complete event, OPC. (Refer to the description of the *OPC command in the *Commands and Queries* section later in this chapter.)
3. The user-request event, URQ, which occurs when you press a softkey programmed by the SOFTKEY command while the instrument is in REMS.

Execution Warnings

An execution warning occurs when 1) a command or query parameter is adjusted to the nearest legal value, or 2) a command refers to data that is not currently stored in the instrument.

Internal Warnings

An internal warning is caused by a command or query execution failure, but does not indicate as serious a failure as an internal error. For example, an internal warning would occur in response to a timeout on a data transfer to an external device (such as a plotter), or a printer-out-of-paper error.

Event Code and Message Formats

In response to the EVENT? and EVMSG? queries, event codes are formatted as unsigned decimal integers. Event messages are returned as string response data, up to 256 characters in total length. (Refer to the EVENT? and EVMSG? query descriptions in the *Commands and Queries* section of this chapter.)

Event messages may be in one of nine formats:

1. "<message>"
2. "<message>; <specifics>"
3. "<message>; Header: <header>"
4. "<message>; Header: <header> / Parameter: <param>"
5. "<message>; Header: <header> / Parameter 1: <param1>/ Parameter 2: <param2>"
6. "<message>; <specifics> (Header: <header>)"
7. "<message>; <specifics> (Header: <header> / Parameter: <param>"
8. "<message>; <specifics> (Header: <header> / Parameter 1: <param1> / Parameter 2: <param2>)"

The message elements are defined as follows:

<message>	a basic description of the error or event,
<specifics>	further detail about the error or event,

<header>	the header of the command or query that caused the error, and
<param>	the text of an invalid parameter or parameters received
<param1>	with a command or query.
<param2>	

Formats 3 through 8 are used when an error can be attributed directly to a particular command or query, or to one or more parameters of a particular command or query.

RS-232 Controller and Instrument Synchronization

FiberMaster executes all commands and queries *sequentially*, which means that any device operation initiated by a command or query must be complete before the next command or query is executed.

The *OPC? query can be appended to a command to determine when the operation started by that command is complete.

The following example illustrates this synchronization technique:

1. The controller sends the query message

   ACQUIRE 10.0,START,NORMAL;*OPC?

2. FiberMaster starts an acquisition. When the acquisition is complete, the instrument detects the *OPC? query and sends the response

   1<NL>

3. Upon reading the response message from *OPC?, the controller knows the acquisition is complete.

RS-232 Device Initialization

In addition to power-on initialization, FiberMaster has three types of reset via RS-232 control, accomplished through the BREAK signal, the *RST command, and the *CLS command.

Power-On Initialization

Instrument parameters with factory-set power-on defaults are reset to their factory-set values at power-on. Parameters with user-definable power-on defaults are reset to the user-programmed values at power-on. The RS-232 factory power-on defaults are as follows:

Baud rate - 9600

Parity - none

Stop bits - 1

Data bits - 8

Flow control - XON/XOFF

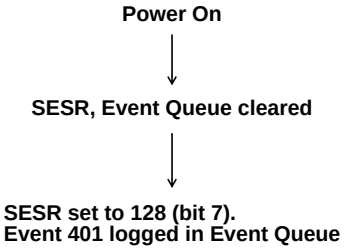
Standard Event Status Register (SESR) - the power-on value is 128 (decimal), which indicates the power-on event.

Event Queue - power-on value is to queue a single event (power-on, event 401).

Response header enabling - power-on value is ON.

Waveform encoding - power-on value is BINARY.

The sequence of events at power-on is illustrated in the following diagram.



BREAK Signal

A second type of initialization is performed by the RS-232 BREAK signal. Sending a BREAK signal forces the instrument's message handler into an idle state, ready to receive and execute program messages, but does not affect any device operation in progress.

A BREAK signal causes the instrument to:

1. Clear the Input Buffer and the Output Queue.

2. Abort any query response currently being sent.
3. Assert CTS.
4. Assert DSR.
5. If XON/XOFF flow control is in effect and FiberMaster has sent a prior XOFF character to the controller (indicating it is not ready to receive data), FiberMaster sends an XON character to the controller to indicate it is now ready to receive.

A BREAK signal does *not*:

1. Change instrument settings or stored waveform data.
2. Affect instrument front-panel operation or change the remote/local state.
3. Affect status or status-enable registers.
4. Cause FiberMaster to assume the controller is ready to receive data. If transmission to the controller has been suspended because the controller used flow control to stop transmission prior to the BREAK, the controller must use flow control to indicate it is again ready to receive data. For XON/XOFF flow control, the controller must send an XON character. For RTS/CTS flow control, the controller must assert RTS. For DTR/DSR flow control, the controller must assert DTR.

Reset

The *RST command resets all instrument settings (except RS-232 settings) to factory defaults and clears any acquired waveforms from data memory and instrument display (refer to the description of the *RST command in the following section). If the *RST command is preceded by a BREAK signal, it also aborts any current device operation started by the execution of a command or query, with the exception of mass-storage operations, which are allowed to complete.

Clear Status Registers

The *CLS command clears the SESR and the Event Queue.

Similarities and Differences between GPIB and RS-232 Remote Control

Aside from the differences necessitated by the different physical interfaces, GPIB and RS-232 operate much the same at the command and query level. Under both forms of remote control the controller sends commands to select options, change settings values, and start device operations. The controller also sends queries to the instrument to obtain settings, waveform and settings files, and other information. With some minor exceptions, the command language, command and query argument types, and the effect of commands or queries issuable through either interface are the same.

Under both interfaces the controller must initiate control of FiberMaster by sending appropriate commands to put the instrument into remote state. FiberMaster itself does not act as a controller under either physical interface and does not initiate remote control or have the ability to control other devices.

Differences between GPIB and RS-232 Remote Control

This section summarizes some differences between GPIB and RS-232 remote control. For specific details on setting up for remote control, refer to the sections *GPIB System Overview* and *RS-232 System Overview*, earlier in this chapter.

Physical Setup

For GPIB remote control, FiberMaster conforms to both the 488.1 and 488.2 standards, and is suitable for use in a GPIB-based instrumentation system, with a controller and possibly multiple talkers and listeners.

Under RS-232 remote control, FiberMaster operates strictly in a point-to-point mode with a controller that is typically a host computer. No multidrop or addressing schemes are supported.

Cabling

Under GPIB remote control, a standard GPIB cable is all that is needed to connect FiberMaster to a controller or to other devices in a linear configuration.

Under RS-232 remote control, there are a variety of cabling schemes that are dictated by different applications. For example, the same cable cannot be used to connect FiberMaster to a DTE-configured host computer and also a DCE-configured modem.

Distance between Controller and FiberMaster

GPIB supports a maximum distance of four meters between the controller and the instrument, but greater distances can be achieved with RS-232. For direct connections, the RS-232C standard provides for up to 15 meters between two devices. Greater distances can be achieved, depending on the baud rate, cable quality, and ambient conditions. The use of modems allows for locating the controller

and FiberMaster at greater distances from one another by using the telephone lines for communication.

Port Selection

The GPIB interface goes online after power-on when the start-up screen appears and becomes ready to receive commands from a controller. In contrast, a special sequence of characters, called a “port-select sequence” must be received by FiberMaster’s RS-232 interface in order for RS-232 control to be enabled.

Remote/Local Changes

The method of making transitions between various remote and local states (local, remote, remote with local lockout) differs between the GPIB and RS-232 interfaces. The GPIB interface uses dedicated interface messages as defined in IEEE 488.1. RS-232 remote control uses ASCII commands (LOCAL, REMOTE, and REMLOCK) to achieve remote/local state changes.

Message-Exchange Protocol/Query Errors

GPIB uses a half-duplex protocol for exchanging messages between devices (488.2 message-exchange protocol). Since RS-232 remote control is supported only in full-duplex configuration, 488.2 message-exchange protocol does not apply.

Status Reporting

The GPIB SRQ message is not emulated under FiberMaster RS-232 remote control. (Compare figures 8-3, GPIB, and 8-5, RS-232.) The service-request generation part of the status reporting is removed for RS-232 remote control.

Message Termination

Under GPIB remote control, the controller must send one of

<data byte>^<END>,
<NL^<END>, or
<NL>

to terminate a program message. FiberMaster always terminates a response message by

<NL>^<END>

Under RS-232 remote control, <NL> serves as the sole terminator for both program and response messages.

Buffer Sizes

The following table gives the FiberMaster buffer sizes (in bytes) used for remote control:

	GPIB	RS-232
Input Buffer	512	2048
Output Queue	512	2048

External Hardcopy

Under GPIB remote control, the commands SPLTSCREEN and SPLTTEXT can be used to generate hardcopy on an RS-232 printer or plotter connected to FiberMaster's RS-232 port. The GPLTSCREEN? and GPLTTEXT? queries are used to send data to a GPIB plotter or printer on the GPIB bus. The controller is required to address the plotter or printer to listen before sending the GPLTSCREEN? or GPLTTEXT? query to FiberMaster. These commands and queries are GPIB-only and not available under RS-232 remote control.

Under RS-232 remote control, the commands GPLTSCREEN and GPLTTEXT can be used to generate hardcopy on a GPIB plotter or printer connected to FiberMaster's GPIB port. The plotter or printer must be configured for listen-only mode. Since RS-232 remote control does not support multidrop configurations, SPLTSCREEN and SPLTTEXT are unavailable.

Binary Data

Since the GPIB bus is a parallel interface with eight dedicated data lines, no special provision must be made for handling eight-bit binary data.

However, for the serial RS-232 interface, the number of data bits must be set to 8 (on both the FiberMaster and the controller). The method of flow control used should be either RTS/CTS or DTR/DSR and not XON/XOFF.

Command Set

A small number of commands and queries in the TFP2A command set are designated "GPIB-only" or "RS-232-only" meaning that they are only valid under the interface specified. These commands are indicated as such both on the tables listing the commands and in the command descriptions.

Differences in Command Execution

All FiberMaster remote-control commands that are allowed from both GPIB and RS-232 interfaces (with the following exceptions) have the same effect, regardless of the interface on with they are received. The exceptions are listed below:

*RST (reset command)
Under GPIB remote control, FiberMaster RS-232 parameters are reset to factory defaults. Under RS-232 remote control, these parameters are not changed.

*TST? (selftest query)
Under GPIB remote control, FiberMaster includes a test of the RS-232 interface as part of the execution of the *TST? query. Under RS-232 remote control, this test is not run.

*ESE (event status enable)
*SRE (service request enable)
Under GPIB remote control, these commands enable certain events to generate a service request. Service requests are not emulated under RS-232 remote control, so these commands function as no-ops.

*STB? (status byte query)
The GPIB interface conforms to IEEE 488.2 requirements for the implementation of this query. Under RS-232 remote control, the MAV (message available) bit in the status byte is always 0.

RS-232 Emulation of IEEE 488.1 Interface Messages

The 488.1 interface messages that are recognized or generated by FiberMaster under GPIB remote control are listed below:

ACG Addressed command group
ATN Attention
DAB Data byte
DAC Data accepted
DAV Data valid
DCL Device clear
END End of message
GTL Go to local
LAG Listen address group
LLO Local lockout
MLA My listen address
MTA My talk address
NUL Null byte
OTA Other talk address
PCG Primary address group
REN Remote enable
RFD Ready for data
RQS Request service
SDC Selected device clear
SPD Serial poll disable
SPE Serial poll enable
SRQ Service request
TAG Talk address group
UCG Universal command group
UNL Unlisten
UNT Untalk

The following are not emulated under the RS-232 interface. They are GPIB addressing messages and do not apply to RS-232 point-to-point communications:

ACG
LAG
MLA
MTA
OTA
PCG
TAG
UCG
UNL
UNT

The following list indicates how or if each of the remaining messages are emulated under the RS-232 interface:

ATN Attention
Indicates on the 488.1 interface that the DIO lines contain a multiline interface message rather than a data byte. No equivalent under RS-232. Not emulated.

DAB Data byte
FiberMaster RS-232 remote control supports seven- and eight-bit data bytes, depending on the RS-232 settings for data byte length.

DAC Data accepted
Part of IEEE “3-wire handshake.” No RS-232 hardware equivalent, although the RS-232 remote control interface supports XON/XOFF, CTS/RTS, and DTR/DSR flow control as described in the *RS-232 System Overview* section.

DAV Data valid
Part of IEEE “3-wire handshake.” No RS-232 hardware equivalent, although the RS-232 remote control interface supports XON/XOFF, CTS/RTS, and DTR/DSR flow control as described in the *RS-232 System Overview* section.

DCL Device clear
Emulated by sending an RS-232 BREAK to the TFP2A.

END End of message
Emulated by requiring that all program messages from host to TFP2A to be terminated by ASCII newline character (0A hex). The TFP2A terminates all response messages sent to the host with the ASCII newline character.

GTL Go to local
Emulated by sending the LOCAL command, which causes the TFP2A to enter the LOCS state from any other remote or local state.

LLO Local lockout
Emulated by sending the REMLOCK command, which causes the TFP2A to enter the RWLS state from any other remote or local state.

NUL Null byte
The null byte (0 hex) is treated as white space when it occurs in program messages. This is the same as GPIB remote control.

REN Remote enable
Emulated by sending the REMOTE command, which causes the TFP2A to enter the REMS state from any other remote or local state.

RFD Ready for data
Part of IEEE “3-wire handshake.” No RS-232 hardware equivalent, although the RS-232 remote control interface supports XON/XOFF, CTS/RTS, and DTR/DSR flow control as described in the *RS-232 System Overview* section.

RQS Request service
Not emulated. Error conditions in the TFP2A that require host and/or operator intervention can be ascertained by querying the TFP2A’s event queue with the *ESR? and EVMSG? queries.

SDC Selected device clear
Emulated by sending an RS-232 BREAK to the TFP2A.

SPD Serial poll disable
SPE Serial poll enable
Not emulated. Refer to RQS, above.

SRQ Service request
Not emulated. Refer to RQS, above.

Remote Control Data Formats

Remote control data formats are explained in this section.

The following notational conventions are used in the format definitions, as well as in the command and query descriptions in the following section:

Symbol	Definition
<>	Defined element
::=	Is defined as
()	Explanatory material
{ }	Grouping
[ ]	Optional, may be omitted
...	Preceding element may be repeated
|	Exclusive OR

Program Messages

Program messages are device-dependent messages used to program FiberMaster via GPIB or RS-232. They consist of a sequence of one or more commands or queries. A program message that contains a query is called a query message.

Each program message sent to FiberMaster must be terminated in one of the following ways:

GPIB:

1. Assert the IEEE 488.1 END line concurrently with the last data byte sent,
2. Send an ASCII newline character (0A hex) as the last data byte of the message, or
3. Send an ASCII newline character as the last data byte of the message concurrently with asserting the END line.

RS-232:

1. Send an ASCII newline character as the last data byte of the message.

White space can be freely used within a program message, with the following exceptions:

- ❏ It cannot be embedded within the text of a command or query header, or character program data (<CPD>) element.
- ❏ It cannot be embedded within a signed or unsigned integer that is part of a decimal numeric program data (<DNPD>) element.
- ❏ It cannot appear within the string program data (<SPD>) elements used for the TIME and DATE commands.

White space is required between a command or query header and a following data element. It consists of a sequence of one or more ASCII characters in the range 0 to 9 hex or 0B to 20 hex (all ASCII control characters and space, but excluding the newline character).

A program message is defined as

<prog msg unit>[;<prog msg unit>] ...

The **<prog msg unit>** is a command or query defined as

header [<data>[,<data>]...]

where the **<header>** is the full or abbreviated command or query name as shown in the descriptions in this section, and **<data>** is a program data element. These elements are described in the following pages. For example,

ACQUIRE 12.5,CENTER,0.1;CURVE?

is a query message.

The message

UNITS METRIC;AVERAGES 256 <NL>

is a terminated program message, where **<NL>** is the ASCII newline character.

In addition, using GPIB the following messages

UNITS METRIC;AVERAGES 256 <NL>^<END>
UNITS METRIC;AVERAGES 256^<END>

are terminated program messages, where **^<END>** indicates that the GPIB END line is asserted concurrently with the transmission of the immediately preceding data byte.

Command and Query Headers

Valid command and query headers are given in the command descriptions this section. Although they are shown in upper case in this manual, command and query headers can be sent in all lower case or mixed upper and lower case without affecting their interpretation by FiberMaster.

All commands and queries can be abbreviated to a minimum of three characters, as long as the abbreviation is unique to that command or query. To maintain a unique abbreviation, you can add characters. For example, the STORE command can be abbreviated to STO, because STORE is the only command that begins with those three characters. However, the WFMSELECT and WFMINT commands must be abbreviated to WFMS and WFMI.

You can abbreviate query headers the same way, but the last character of any query header abbreviation must be the ASCII question mark.

Command and Query Argument Formats

The following paragraphs describe conventions used in specifying arguments for GPIB and RS-232 device-dependent commands and queries listed in this section. These conventions correspond to Device Listening Formats defined in IEEE standard 488.2.

<CPD> = <Character Program Data> Command and query data descriptions specify <CPD> elements in upper-case letters, but FiberMaster also recognizes lower case and mixed upper and lower case. A <CPD> element starts with any upper- or lower-case ASCII character, and can contain any combination of alphanumeric characters and the ASCII underscore character. A <CPD> element is a non-quoted mnemonic or symbol, such as REFERENCE, XON_XOFF, and WFM1A. <CPD> elements for a particular command or query can be abbreviated to the minimum number of characters required to make them unique for that command or query.

<DNPD> = <Decimal Numeric Program Data>, defined as follows:

<DNPD> ::= <mantissa>[<whitespace>][<exponent>]

where

<mantissa> ::= [+|-] {<floatnum>|<integer>}

<floatnum> ::= {<integer>.[<integer>]} |
{[<integer>].<integer>}

<integer> ::= sequence of one or more ASCII digits 0 - 9

<exponent> ::=
E|e [<whitespace>][+|-]<integer>

<whitespace> ::= sequence of one or more ASCII characters in the range 0 - 9 hex or 0B - 20 hex.

The mantissa may not contain more than 255 characters, excluding leading zeros. The exponent must be in the range from -32,000 through 32,000.

<DNPD> specifies that the argument is an integer or floating-point number with or without an exponent, such as 755, 755., 755.1, .1, 0.1, 755E5, and 0.1E-3.

<SPD> = <String Program Data> Specifies a quoted string, defined as follows:

"<character_sequence>"|'<character_sequence>'

where <character_sequence> is any sequence of ASCII characters. To include the delimiting quote character (" or ') within the string, enter it twice as shown in the examples below:

<SPD> Entered As:	**String Interpreted As:**
"FIBER X-1-A"	FIBER X-1-A
'FIBER X-1-A'	FIBER X-I-A
"FIBER 'X-1-A'"	FIBER 'X-1-A'
'FIBER "X-1-A"'	FIBER "X-1-A"
"FIBER ""X-1-A"""	FIBER "X-1-A"
'FIBER ''X-1-A'''	FIBER 'X-1-A'

<ABPD> = <Arbitrary Block Program Data> Used for the FILNORM, FILHIGH, FILSET, PUT_WFM, and PUT_SET commands, and defined in the descriptions of these commands

Query Response Argument Formats

For each valid query message sent to FiberMaster, the instrument returns a response message. Each response message consists of one or more response-message units, and is terminated by the ASCII newline character (RS-232), or the ASCII newline character sent concurrently with the GPIB END line asserted (GPIB). Responses to single queries within a query message are sent in the order in which each query was received.

Most queries return a single response-message unit in the following format:

[<header>]<data>[,<data>]...

The exceptions are *LRN?, SET?, and WFMPRE?, which return multiple response message units. Most queries return a fixed number of **<data>** elements. Exceptions are MASKOPTION?, MODLOWER?, MODUPPER?, MEASURE?, EVNTINFO?, PULSELIST?, RANGELIST?, DENSITYLIST?, and CURVE? (when ASCII waveform encoding is used), which return a variable number of data elements.

The **<header>** portion of the response is the unabbreviated upper-case header of the corresponding query without the trailing question mark. The header may or may not be sent in the query response, depending on the setting of the header-enable option (refer to the HEADER command description). Response headers are never sent for IEEE 488.2 common queries, or for the SET?, GPLTSCREEN?, and GPLTTEXT? queries.

With exceptions noted in the command and query descriptions, the only occurrence of white space in a response message is a single ASCII space between a response header and an immediately following data element.

The **<data>** element of the response message can be sent in any of the following formats:

<CRD> = <Character Response Data> Defined the same as the <CPD> format, except that any alpha characters in a <CRD> element are always sent in upper case, and abbreviations are not used.

<NR1> = <NR1 Numeric Response Data> Specifies an optionally signed integer (ASCII format), such as 775 or -3:

[+|-]<integer>

<NR2> = <NR2 Numeric Response Data> Specifies an optionally signed whole number with a fraction (ASCII format), as follows:

[+|-]<integer>.<integer>

for example, 77.1, 77.0, 0.99, -32.0. An <NR2> element contains both a whole number *and* a fraction. Numbers such as 77., .23, and 77 are not returned.

<NR3> = <NR3 Numeric Response Data> Specifies an <NR2> element followed by an exponent (ASCII format). There is no white space between the <NR2> element and the exponent, and the exponent is in the form **E+|-<integer>**. Exponent examples are E-07 and E+15.

<SRD> = <String Response Data> Specifies a quoted string using **"** as the quote character. Embedded quotes are returned in pairs ("").

<DLABRD> = <Definite Length Arbitrary Block Response Data> Used for the CURVE? and FILE? query responses, and defined in the descriptions of these queries in the *Commands and Queries* section of this chapter.

<ILABRD> = <Indefinite Length Arbitrary Block Response Data> Used for the GPLTTEXT?, GPLTSCREEN?, GET_SET?, and GET_WFM? queries, and defined in the descriptions of these queries in the *Commands and Queries* section of this chapter.

<AARD> = <Arbitrary ASCII Response Data> Used for the *IDN? query, and defined in the description of this query in the *Commands and Queries* section of this chapter.

Response Message Terminator

A terminated response message is sent in response to a terminated query message. A response-message terminator consists of the following:

RS-232: the ASCII newline character

GPIB: the ASCII newline character sent concurrently with the IEEE 488.1 END message.

These are illustrated in the following examples:

The terminated RS-232 query message

UNITS?<NL>

would generate a terminated response message in the format

UNITS ENGLISH<NL>

The terminated GPIB query message

DATE?;ACQUIRE 12.5,CENTER,NORMAL;HEADER?<NL>

would generate a terminated response message in the format

DATE"1993-11-10";HEADER 1<NL>^<END>

If response headers were disabled using the HEADER command, the response would be

"1993-11-10";1<NL>^<END>

Responses to Queries that Generate Errors

If FiberMaster receives a valid query, but the query causes a command, execution, or device-dependent error, the response contains the single <Character Response Data> element:

NULL

to indicate that the requested response could not be generated. For example, the query

AVETIME? 0.0

returns the response

AVETIME NULL

since the AVETIME? query expects a <CPD> argument (NORMAL or HD1). (Note that if response headers were not enabled, the response would be only NULL.)

If a query is received that is not in FiberMaster's command set, no response at all is generated. In this case, the controller may time out waiting for a response.

In either case above, the controller should issue status queries to determine the cause of the error.

Commands and Queries

The remote-control commands and queries defined for FiberMaster are listed in this section. The following tables list the commands and queries according to function. The page numbers in the tables indicate the page on which each command description can be found.

Any commands or queries that change instrument settings, affect data memory, or start device operations are not executable when the instrument is under front-panel control (LOCS or LWLS), and are identified as *remote only*. If one is received while the instrument is under local control, an error message is logged in the Event Queue, and an execution error is indicated in the Standard Event Status Register.

GPIB-Only and RS-232-Only Commands and Queries

Most FiberMaster commands are valid when received through either the GPIB or RS-232 interfaces. However, some commands are valid only with a specific interface.

GPIB-only commands include the following:

BAUD
PARITY
NCHARBITS
NSTOPBITS
FLOW
SPLTSCREEN
SPLTTEXT
PUT_WFM (binary encoding only)
PUT_SET (binary encoding only)

If any of these commands is sent to FiberMaster under RS-232 remote control, the following error is generated:

2006, "Instrument state error; command accepted only under 488 remote control."

GPIB-only queries include the following:

GPLTSCREEN?
GPLTTEXT?
GET_WFM? (binary encoding only)
GET_SET? (binary encoding only)

If any of these queries is sent to FiberMaster under RS-232 remote control, the following error is generated:

2007, "Instrument state error; query accepted only under 488 remote control."

RS-232-only commands include the following:

GPLTSCREEN
GPLTTEXT
LOCAL
REMOTE
REMLOCK

If any of these commands is sent to FiberMaster under GPIB remote control, the following error is generated:

2008, "Instrument state error; command accepted only under RS-232 remote control."

NOTE *Binary-encoded versions of the commands and queries PUT_WFM, PUT_SET, GET_WFM?, and GET_SET? are not allowed under RS-232 remote control. ASCII-encoded versions are available and described in the following section. Waveform encoding is selected using the ENCDG command.*

Table 8-15. Remote/Local Commands and Queries

Commands	Remote only (Y/N)	Page
LOCAL (RS-232 only)	N	8-71
REMLOCK (RS-232 only)	N	8-71
REMOTE (RS-232 only)	N	8-71
Queries		
LOCAL?	N	8-71
REMLOCK?	N	8-71
REMOTE?	N	8-72

Table 8-16. Module-Independent Settings Commands and Queries

Commands	Remote only (Y/N)	Page
AVERAGES	Y	8-73
CALCSLOPE	Y	8-73
DATE	Y	8-74
FIBERID	Y	8-74
FIBERNOTE	Y	8-74
OPERATOR	Y	8-75
REFINDEX	Y	8-75
SCATTERCOEFF	Y	8-75
TIME	Y	8-76
TRACE	Y	8-76
UNITS	Y	8-76
Queries		
AVERAGES?	N	8-77
CALCSLOPE?	N	8-77
DATE?	N	8-77
FIBERID?	N	8-78
FIBERNOTE?	N	8-78
OPERATOR?	N	8-78
REFINDEX?	N	8-78
SCATTERCOEFF?	N	8-78
TIME?	N	8-79
TRACE?	N	8-79
UNITS?	N	8-79

Table 8-17. Module-Dependent Settings Commands and Queries

Commands	Remote only (Y/N)	Page
MASKSET	Y	8-80
MODSELECT	Y	8-81
PULSRNG	Y	8-82
Queries		
MASKSET?	N	8-83
MODINFO?	N	8-84
MODSELECT?	N	8-85
PULSRNG?	N	8-85

Table 8-18. Module Information Queries

Queries	Remote only (Y/N)	Page
AVETIME?	N	8-86
MASKOPTION?	N	8-86
MODLOWER?	N	8-86
MODUPPER?	N	8-87
PULSELIST?	N	8-87
RANGELIST?	N	8-88
DENSITYLIST?	N	8-88

Table 8-19. Serial Port Settings Commands and Queries

Commands	Remote only (Y/N)	Page
BAUD (GPIB only)	Y	8-89
FLOW (GPIB only)	Y	8-89
NCHARBITS (GPIB only)	Y	8-89
NSTOPBITS (GPIB only)	Y	8-89
PARITY (GPIB only)	Y	8-89
Queries		
BAUD?	N	8-90
FLOW?	N	8-90
NCHARBITS?	N	8-90
NSTOPBITS?	N	8-90
PARITY?	N	8-90

Table 8-20. RS-232 Remote-Control Command

Commands	Remote only (Y/N)	Page
NLTRANS	Y	8-91

Table 8-21. Acquisition Commands

Commands	Remote only (Y/N)	Page
ACQUIRE	Y	8-92
REALTIME	Y	8-93

Table 8-22. Cursor Movement Command and Query

Command	Remote only (Y/N)	Page
CURSOR	Y	8-94
Query		
CURSOR?	N	8-94

Table 8-23. Expansion Commands and Queries

Command	Remote only (Y/N)	Page
EXPAND	Y	8-95
WINCURSOR	Y	8-95
WINDISTANCE	Y	8-96
WINDOW	Y	8-96
Queries		
EXPAND?	N	8-97
WINDOW?	N	8-97

Table 8-24. Measurement Command and Queries

Command	Remote only (Y/N)	Page
MEASMODE	Y	8-98
Queries		
EVNTRTNLOSS?	Y	8-99
LINKRTNLOSS?	Y	8-100
MEASMODE?	N	8-101
MEASURE?	Y	8-101
SPLICELOSS?	Y	8-101
TWOPOINT?	Y	8-102

Table 8-25. Event Marking and Event Table Commands and Queries

Commands	Remote only (Y/N)	Page
EVNTAUTOMARK	Y	8-103
EVNTMARKING	Y	8-103
EVNTMEAS	Y	8-103
EVNTNOTES	Y	8-103
EVNTTHRESH	Y	8-104
IPRNEVENTS	Y	8-104
Queries		
EVNTCOUNT?	N	8-104
EVNTINFO?	N	8-104
EVNTMARKING?	N	8-107
EVNTNOTES?	N	8-107
EVNTTHRESH?	N	8-107

Table 8-26. Event Marker Commands and Queries

Commands	Remote only (Y/N)	Page
ADDMARKER	Y	8-108
DELMARKDIST	Y	8-108
DELMARKNUM	Y	8-108
SHOWMARKERS	Y	8-109
Queries		
MARKERDIST?	N	8-109
NUMMARKERS?	N	8-109
SHOWMARKERS?	N	8-110

Table 8-27. Waveform Selection and Storage Commands and Queries

Commands	Remote only (Y/N)	Page
STORE	Y	8-111
WFMSELECT	Y	8-111
Queries		
WFMSELECT?	N	8-111
WFMSOURCE?	N	8-112

Table 8-28. Waveform Data Command and Queries

Commands	Remote only (Y/N)	Page
WFMINT	Y	8-113
Queries		
CURVE?	Y	8-114
NR_PT?	Y	8-115
PT_OFF?	Y	8-115
WFID?	Y	8-115
WFMINT?	Y	8-115
WFMPRE?	Y	8-116
XINCR?	Y	8-116
XZERO?	Y	8-117
YMULT?	Y	8-117
YOFF?	Y	8-117
YZERO?	Y	8-117

Table 8-29. Response Formatting Commands and Queries

Commands	Remote only (Y/N)	Page
ENCDG	N	8-118
HEADER	N	8-118
Queries		
ENCDG?	N	8-119
HEADER?	N	8-119

Table 8-30. Waveform Transfer Commands and Queries

Commands	Remote only (Y/N)	Page
PUT_SET (binary)*	Y	8-120
PUT_WFM (binary)*	Y	8-120
PUT_SET (ASCII)	Y	8-121
PUT_WFM (ASCII)	Y	8-121
FILHIGH	Y	8-122
FILNORM	Y	8-122
FILSET	Y	8-122
Queries		
FILE?	Y	8-124
GET_SET? (binary)*	Y	8-126
GET_WFM? (binary)*	Y	8-126
GET_SET? (ASCII)	Y	8-127
GET_WFM? (ASCII)	Y	8-127

* GPIB only for binary encoding; ASCII-encoded versions available for both GPIB and RS-232.

Table 8-31. Mass-Storage Commands and Queries

Commands	Remote only (Y/N)	Page
BATCHCOPY	Y	8-129
COPYFILE	Y	8-130
COPYSET	Y	8-130
COPYWFM	Y	8-130
DELETE	Y	8-130
DELSET	Y	8-131
DELWFM	Y	8-131
DRIVESELECT	Y	8-131
FORMAT	Y	8-131
LOADCUR	Y	8-132
LOADREF	Y	8-132
LOADRFS	Y	8-132
LOADSET	Y	8-132
MSFORMAT	Y	8-132
SAVECUR	Y	8-133
SAVEREF	Y	8-133
SAVESET	Y	8-133
Queries		
DIRECTORY?	Y	8-134
DIRSET?	Y	8-135
DIRWFM?	Y	8-135
DRIVEBAT?	Y	8-135
DRIVESELECT?	Y	8-136
FETCHID?	Y	8-136
FETCHNOTE?	Y	8-136
FETCHOPER?	Y	8-137
MSFORMAT?	Y	8-137
TYPEFILE?	Y	8-137

Table 8-32. Hardcopy Commands and Queries

Commands	Remote only (Y/N)	Page
GPLTSCREEN	Y	8-138
GPLTTEXT	Y	8-138
HCTYPE	Y	8-139
IPRNSCREEN	Y	8-139
IPRNTEXT	Y	8-140
SPLTSCREEN (GPIB only)	Y	8-140
SPLTTEXT (GPIB only)	Y	8-140
Queries		
GPLTSCREEN? (GPIB only)	Y	8-141
GPLTTEXT? (GPIB only)	Y	8-142
HCTYPE?	Y	8-142

Table 8-33. Display-Related Commands and Query

Commands	Remote only (Y/N)	Page
GSTATUS	Y	8-143
MESSAGE	Y	8-144
SOFTKEY	Y	8-145
Query		
GSTATUS?	Y	8-145

Table 8-34. Identification Query

Query	Remote only (Y/N)	Page
*IDN?	N	8-146

Table 8-35. Learn Settings Queries

Queries	Remote only (Y/N)	Page
*LRN?	N	8-147
SET?	N	8-147

Table 8-36. Reset and Stop Commands

Command	Remote only (Y/N)	Page
*RST	Y	8-149
STOP	Y	8-149

Table 8-37. Status and Error Reporting Commands and Queries

Commands	Remote only (Y/N))	Page
*CLS	N	8-150
DESE	N	8-150
*ESE	N	8-150
*SRE	N	8-150
Queries		
DESE?	N	8-151
*ESE?	N	8-151
*ESR?	N	8-151
EVENT?	N	8-151
EVMSG?	N	8-152
*SRE?	N	8-152
*STB?	N	8-152

Table 8-38. Device Synchronization Commands and Query

Commands	Remote only (Y/N)	Page
*OPC	N	8-153
*WAI	N	8-153
Query		
*OPC?	N	8-153

Table 8-39. Selftest Queries

Queries	Remote only (Y/N)	Page
*TST?	Y	8-154
TSTRESULT?	Y	8-154

Remote/Local Commands and Queries

LOCAL

Places the instrument in local control (LOCS) from any other remote/local state. *RS-232 only.*

Command Syntax: **LOCAL**

REMLOCK

Places the instrument in remote control with local lockout (RWLS) from any other remote/local state. *RS-232 only.*

Command Syntax: **REMLOCK**

REMOTE

Places the instrument in remote control (REMS) from any other remote/local state. *RS-232 only.*

Command Syntax: **REMOTE**

LOCAL?

Determines if the instrument is in local control (LOCS).

Query Syntax: **LOCAL?**

Response Syntax: LOCAL <option>

Response Data: <option> ::= <NR1>
0 instrument is not in LOCS
1 instrument is in LOCS

REMLOCK?

Determines if the instrument is in remote control with local lockout (RWLS).

Query Syntax: **REMLOCK?**

Response Syntax: REMLOCK <option>

Response Data: <option> ::= <NR1>
0 instrument is not in RWLS
1 instrument is in RWLS

REMOTE?

Determines if instrument is in remote control (REMS).

Query Syntax: **REMOTE?**

Response Syntax: REMOTE <option>

Response Data: <option> ::= <NR1>
0 instrument is not in REMS
1 instrument is in REMS

Module-Independent Settings Commands

NOTE *Commands that change instrument settings do not save the new settings as power-on defaults. To save instrument settings, use the SET or *LRN? query. These queries both generate response data in the form of resendable commands that you can use to set the instrument back to its current configuration.*

AVERAGES

Select the number of sampling acquisitions the instrument averages before stopping an acquisition. *Remote only.*

Command Syntax: **AVERAGES** <numavg>

Command Data: <numavg> ::= <DNPD> and specifies the number of averages. If not a positive multiple of 256, will be set to the nearest positive multiple of 256.

Example(s): AVE 500 (adjusted to 512 by the instrument)

Factory Default: 1024 averages

Discussion: The new number of averages takes effect immediately, and is used for the next acquisition. The command is executed even if the reference waveform is currently selected.

CALCSLOPE

Change method of calculating slope. *Remote only.*

Command Syntax: **CALCSLOPE** <calc>

Command Data: <calc> ::= <CPD> and specifies the type of slope calculation. Possible values are:

TWOPOINT	Use the Two Point method to calculate slope
LSA	Use the Least Squares Average method to calculate slope

Example(s): CALC TWOP

Factory Default: TWOPOINT

Discussion: The new slope calculation takes effect with the active waveform.

DATE

Set real-time clock date. *Remote only.*

Command Syntax:	**DATE** <date>
Command Data:	<date> ::= <SPD>, of the form "YYYY-MM-DD" where YYYY = year, MM = month, DD = day
Example(s):	DAT "1988-01-22" DAT '1988-12-25'

FIBERID

Set the system fiber ID parameter which is used to identify a waveform. *Remote only.*

Command Syntax:	**FIBERID** <idstring>
Command Data:	<idstring> ::= <SPD> and specifies a string 1-20 characters long. Only the first 20 characters are stored.
Example(s):	FIBERI "FIBERONE" FIBERID 'ALPHAX2S'
Discussion:	The fiber ID string is used by the next SAVECUR or SAVEREF operation (waveform or settings) and is printed on hard copies. The new fiber ID takes effect with the active waveform.
Power-On Value:	Null string.

FIBERNOTE

Enter notes on cable or front-panel settings. *Remote only.*

Command Syntax:	**FIBERNOTE** <fibernote>
Command Data:	<fibernote> ::= <SPD> and specifies a string up to 150 characters long. Only the first 150 characters are stored.
Example(s):	FIBERN "REFERENCE CABLE"
Discussion:	Used to supply additional notes about the fiber under test. The string is used by the next SAVECUR or SAVEREF operation (waveform or settings) and is printed on hard copies. The new fiber notes take effect with the active waveform.
Factory Default:	Null string.

OPERATOR

Store the name of the instrument operator. *Remote only.*

Command Syntax: **OPERATOR** <operator>

Command Data: <operator> ::= <SPD> and specifies a string 1-25 characters long. Only the first 25 characters are stored.

Discussion: The operator string takes effect with the active waveform, and is used by the next SAVECUR or SAVEREF operation (waveform or settings) and is printed on hard copies.

REFINDEX

Set the refractive index. The setting should match the fiber being tested in order to obtain best measurement results. *Remote only.*

Command Syntax: **REFINDEX** <index>

Command Data: <index> ::= <DNPD> and specifies the refractive index. Allowable values are from 1.4000 and 1.6000, inclusive. Values are rounded internally to the nearest 0.0001.

Example(s): REF 1.4000

Factory Default: 850 nm MM - 1.4776
1300 nm MM - 1.4719
1310 nm SM/1550 nm SM - 1.4680

Discussion: The new refractive index takes effect with the active waveform.

SCATTERCOEFF

Set the scattering coefficient. For best results in return-loss measurements, the value should match the scattering coefficient given by the fiber manufacturer. *Remote only.*

Command Syntax: **SCATTERCOEFF** <coeff>

Command Data: <coeff> ::= <DNPD> and specifies the scattering coefficient, in dB. Allowable values are from -100.0 dB to -40.0 dB, inclusive.

Example(s): SCA -80.3

Factory Default: 850 nm MM (62.5 μm core diameter) = -62.3
1300 nm MM (62.5 μm core diameter) = -69.7
1310 nm SM= -80.3
1550 nm SM = -82.3

Discussion: The new scattering coefficient takes effect with the active waveform.

TIME

Set system clock. *Remote only.*

Command Syntax:	**TIME** <time>
Command Data:	<time> ::= <SPD> A quoted string in the format "HH:MM:SS", where HH = hour, MM = minute, SS = seconds
Example(s):	TIM "12:22:01" TIM '12:22:09'

TRACE

Select dual- or single-trace display. *Remote only.*

Command Syntax:	**TRACE** <mode>
Command Data:	<mode> ::= <CPD> and specifies single- or dual-trace display. Possible values are SINGLE | DUAL.
Example(s):	TRA DUAL
Discussion:	Dual-trace mode shows both current and reference waveforms using a default separation. Single-trace mode shows the active waveform only.
Power-On Value:	SINGLE

UNITS

Select distance measurement units for the horizontal axis of display. *Remote only.*

Command Syntax:	**UNITS** <units>
Command Data:	<units> ::= <CPD> and specifies the units of measurement. Possible values are METRIC | ENGLISH (kilometers or kilofeet)
Example(s):	UNI METRIC
Factory Default:	METRIC
Discussion:	The setting of the UNITS command also determines the units used in all query responses that return distances.

Module-Independent Settings Queries

AVERAGES?

Return the number of sampling acquisitions the instrument averages before stopping an acquisition.

Query Syntax:	**AVERAGES?**
Response Syntax:	AVERAGES <numavg>
Response Data:	<numavg> ::= <NR1> and specifies the number of waveforms the instrument will average during an acquisition.
Discussion:	The AVERAGES? query returns the number of averages that will be used for the next acquisition, if the current waveform is active. If the reference waveform is active, the response is the number of averages that was used to acquire the reference waveform.

CALCSLOPE?

Return method used in calculating slope for the active waveform.

Query Syntax:	**CALCSLOPE?**
Response Syntax:	CALCSLOPE <calc>
Response Data:	<calc> ::= <CRD> and specifies the current slope calculation method. Possible values are TWOPOINT | LSA.

DATE?

Return the system date.

Query Syntax:	**DATE?**
Response Syntax:	DATE <date>
Response Data:	<date> ::= <SRD>, and specifies the current date setting of the instrument's real-time clock, in the form "YYYY-MM-DD" where YYYY = year, MM = month, DD = day.

FIBERID?

Return the fiber ID for the active waveform.

Query Syntax: **FIBERID?**

Response Syntax: FIBERID <idstring>

Response Data: <idstring> ::= <SRD> and specifies the fiber ID string, up to 20 characters.

FIBERNOTE?

Return the fiber notes for the active waveform.

Query Syntax: **FIBERNOTE?**

Response Syntax: FIBERNOTE <fibernote>

Response Data: <fibernote> ::= <SRD> and consists of a quoted string up to 150 characters long.

OPERATOR?

Return the operator name for the active waveform.

Query Syntax: **OPERATOR?**

Response Syntax: OPERATOR <operator>

Response Data: <operator> ::= <SRD> and specifies the name of the instrument operator, up to 25 characters.

REFINDEX?

Return the refractive index for the active waveform.

Query Syntax: **REFINDEX?**

Response Syntax: REFINDEX <index>

Response Data: <index> ::= <NR2>, and specifies the refractive index of the fiber under test.

SCATTERCOEFF?

Return the scattering coefficient for the active waveform.

Query Syntax: **SCATTERCOEFF?**

Response Syntax: SCATTERCOEFF <coeff>

Response Data: <coeff> ::= <NR2>, and specifies the scattering coefficient of the fiber under test, in dB.

TIME?

Return the system time.

Query Syntax:	**TIME?**
Response Syntax:	TIME <time>
Response Data:	<time> ::= <SRD> in the format "HH:MM:SS" where HH = hours, MM = minutes, and SS = seconds.

TRACE?

Return whether dual or single-trace mode is selected.

Query Syntax:	**TRACE?**
Response Syntax:	TRACE <mode>
Response Data:	<mode> ::= <CRD> and specifies the current display mode. Possible responses are SINGLE | DUAL.

UNITS?

Return the currently selected distance measurement unit.

Query Syntax:	**UNITS?**
Response Syntax:	UNITS <units>
Response Data:	<units> ::= <CRD> and specifies the units used for distance measurement along the horizontal axis. Possible responses are METRIC | ENGLISH (kilometers or kilofeet)

Module-Dependent Settings Commands

NOTE *GPIB commands that change instrument settings do not save the new settings as power-on defaults. To save instrument settings, use the SET or *LRN? query. These queries both generate response data in the form of resendable GPIB commands that you can use to set the instrument back to its current configuration.*

Acceptable parameters for these commands depend on which optics module is currently selected. Valid settings for these parameters can be obtained by sending module-information queries (described in the following pages). Execution errors are generated if settings commands specify options or values not available for the currently selected optics module.

MASKSET

Select automatic masking type. This command is available only if the currently selected laser source supports masking. Manual masking is not selectable under remote control. *Remote only.*

Command Syntax: **MASKSET** <masktype>

Command Data: <masktype> ::= <CPD> and specifies the type of automatic masking. Possible values are
OFF | QUICK | ACCU

OFF	Disable masking
QUICK	Enable QuickMask masking
ACCU	Enable AccuMask masking

Power-On Value: ACCU (if supported by optics module, otherwise OFF)

Discussion: Refer to chapter 3, *Getting Started* for descriptions of the various masking types.

The new masking type takes effect immediately, and is used for the next acquisition. The command is executed even if the reference waveform is currently selected.

MODSELECT

Select a front-panel optical module and wavelength. *Remote only.*

Command Syntax: **MODSELECT** <slot>,<module>

Command Data: <slot> ::= <CPD>

UPPER	Selects a wavelength in the upper module.
LOWER	Selects a wavelength in the lower module.

<module> ::= <CPD> and specifies a wavelength, as returned by the MODUPPER? or MODLOWER? query.

Example(s): MODS UPPER,MM1300

Power-On Value: Uppermost available front-panel wavelength.

Discussion: The new module selection takes effect immediately, and is used for the next acquisition. The command is executed even if the reference waveform is currently selected.

PULSRNG

Set both pulse width and range for the currently selected optics module. *Remote only.*

Command Syntax: **PULSRNG** <pulse width>,<range>

Command Data: <pulse width> ::= <DNPD> and specifies an available pulse width returned by the PULSELIST? query.

<range> ::= <DNPD> and specifies an available range returned by the RANGELIST? query.

Example(s): PULSR 100,10 (pulse width = 100 ns, range =10 km)

Discussion: Specify the pulse width in nanoseconds, and the range in units specified by the last UNITS command (kilometers or kilofeet).

To select a high-resolution pulse width (10 ns, 20 ns, and 50 ns only), enter a negative pulse-width value. For example, to select a 10-ns HR pulse width, use the command

PULSRNG –10,4

This selects the 10-ns HR pulse width and a 4-km range.

If you select a high-resolution pulse width when none is available for a given pulse width (i.e., PULSRNG -2000,100), FiberMaster sets the pulse width to the same width, but at the normal-resolution setting (i.e., as if you had sent the command PULSRNG 2000,100).

If you select a normal-resolution pulse width when is none is available for a given pulse width (i.e., PULSRNG 10,4), FiberMaster sets the pulse width to the same width, but at the high-resolution setting (i.e., as if you had sent the command PULSRNG -10,4).

The new pulse width and range take effect immediately, and are used for the next acquisition. The command is executed even if the reference waveform is currently selected.

Module-Dependent Settings Queries

MASKSET?

Determine whether automatic masking is enabled for the currently selected module.

NOTE *Although manual masking is not selectable under remote control, this query may return a response to indicate that manual masking is still in effect, having been enabled under local control.*

Query Syntax: **MASKSET?**

Response Syntax: MASKSET <masktype>

Response Data: <masktype> ::= <CRD> and specifies the current automatic masking setting. Possible responses are:

OFF	Masking disabled.
QUICK	QuickMask masking enabled
ACCU	AccuMask masking enabled
MANACCU	Manual masking still in effect
MANQUICK	from local control.

Discussion: Refer to chapter 3, *Getting Started* for descriptions of the various masking types.

The MASKSET? query returns the masking setting that will be used for the next acquisition, if the current waveform is active. If the reference waveform is active, the response is the masking setting that was used to acquire the reference waveform.

MODINFO?

Return the serial number, part number, wavelength, and fiber mode of an optics module.

Query Syntax:	**MODINFO?** <slot>
Query Data:	<slot> ::= <CPD> Possible values are UPPER and LOWER, specifying the upper and lower module positions in the TFP2A.
Response Syntax:	MODINFO <serial_number>,<laser1>,<laser2>
Response Data:	<serial_number> ::= <SRD>, serial number of module <laser1> ::= <SRD>, laser 1 information <laser 2> ::= <SRD>, laser 2 information
Discussion:	The query returns a single data field ("NONE") if no plug-in is in the specified slot. If the module is a single-wavelength type, two fields are returned, serial number and laser type. If the module is a dual-wavelength type, three fields are returned, serial number and two laser types.
Example(s):	MODINFO? UPPER (query) MODINFO "NONE" (response) Indicates no module installed in upper slot. MODINFO? UPPER (query) MODINFO "b040007","FS1300-1310SM" (response) Indicates the optical module in the upper slot of the TFP2A has the serial number B040007, part number FS1300, and one singlemode wavelength of 1310 nm. MODINFO? LOWER (query) MODINFO "b010008","FL1315-1310SM","FL1315-1550SM" (response) Indicates the optical module in the lower slot of the TFP2A has the serial number B010008, part number FL1315, and two singlemode wavelengths of 1310 and 1550 nm. MODINFO? UPPER (query) MODINFO "b010007","FL1500-1550SM" (response) Indicates the optical module in the upper slot of the TFP2A has the serial number B010007, part number FL1500, and one singlemode wavelength of 1550 nm.

MODSELECT?

Determine which front-panel module is selected.

Query Syntax:	**MODSELECT?**
Response Syntax:	MODSELECT <slot>,<module>
Response Data:	<slot> ::= <CRD> and equals UPPER or LOWER depending on whether a wavelength in the upper or lower module slot is selected. <module> ::= <CRD> and is a module type returned by the MODUPPER or MODLOWER query.
Discussion:	The MODSELECT? query returns the module that will be used for the next acquisition, if the current waveform is active. If the reference waveform is active, the response is the module that was used to acquire the reference waveform.

PULSRNG?

Determine the current pulse width and range settings.

Query Syntax:	**PULSRNG?**
Response Syntax:	PULSRNG <pulse width>,<range>
Response Data:	<pulse width> ::= <NR2> and specifies the current pulse width in nanoseconds. <range> ::= <NR2> and specifies the current range setting, in units selected by the last UNITS command (kilometers or kilofeet).
Example(s):	PULSRNG 100.0,10.0 (pulse width = 100 ns, range = 10 km)
Discussion:	The PULSRNG? query returns the pulse width and range that will be used for the next acquisition, if the current waveform is active. If the reference waveform is active, the response is the pulse width and range that were used to acquire the reference waveform.

Module Information Queries

AVETIME?

Return the approximate averaging time for an acquisition. Computed from current AVERAGES setting and required density level for the acquisition.

Query Syntax: **AVETIME?** <density_level>

Query Data: <density_level> ::= <CPD>
Possible values are NORMAL, HD1.

Response Syntax: AVETIME <minutes>

Response Data: <minutes> ::= <NR2> and specifies the maximum averaging time in minutes for an acquisition.

Discussion: Certain instrument settings, automatic event marking, automatic masking, and FL module calculations add uncertainty to the time estimates, depending on the characteristics of the fiber under test. When setting a time-out value for external computers, add an additional one to two minutes. Also see the description of the *OPC? query.

MASKOPTION?

Determine available automatic-masking options for the currently selected module.

Query Syntax: **MASKOPTION?**

Response Syntax: MASKOPTION <option>

Response Data: <option> ::= <CRD>
Possible values are:

NONE	Masking is not available for the currently selected module.
OFF	Masking is available but disabled.
QUICK	QuickMask masking is enabled.
ACCU	AccuMask masking is enabled.

Discussion: Refer to chapter 3, *Getting Started* for descriptions of the various masking types.

MODLOWER?

Determine what wavelengths (if any) are in the lower module on the front panel.

Query Syntax: **MODLOWER?**

Response Syntax: MODLOWER NONE
MODLOWER MM850,MM1300
MODLOWER SM1310,SM1550
MODLOWER MM850
MODLOWER MM1300
MODLOWER SM1310
MODLOWER SM1550

The first response indicates that no module is installed in the lower slot on the front panel. Other responses indicate that one or two wavelengths are available in the lower module.

MODUPPER?

Determine what wavelengths (if any) are in the upper module on the front panel.

Query Syntax: **MODUPPER?**

Response Syntax:
MODUPPER NONE
MODUPPER MM850,MM1300
MODUPPER SM1310,SM1550
MODUPPER MM850
MODUPPER MM1300
MODUPPER SM1310
MODUPPER SM1550

The first response indicates that no module is installed in the upper slot on the front panel. Other responses indicate that one or two wavelengths are available in the upper module.

PULSELIST?

Determine available pulse widths for the currently selected module and specified maximum range.

Query Syntax: **PULSELIST?** <maxrange>

Query Data: <maxrange> ::= <DNPD> and specifies the desired maximum range (or use a value of 0 to return all available pulse widths, regardless of the range desired).

Response Syntax:
PULSELIST 0.0
PULSELIST <pulsewidth>[,<pulsewidth>]...

The first response implies the specified range is not available. The second response returns a list of one or more <NR2> elements, each of which is an available pulse width (in nanoseconds).

Example(s): PULSELIST 20.0,100.0,200.0,500.0

RANGELIST?

Determine available maximum ranges for the currently selected module and specified pulse width.

Query Syntax: **RANGELIST?** <pulse width>

Query Data: <pulse width> ::= <DNPD> and specifies the desired pulse width (use a value of 0 to return all available ranges, regardless of the pulse width desired).

Response Syntax: RANGELIST 0.0 (or)
RANGELIST <range>[,<range>]...

The first response indicates the specified pulse width is not available. The second response returns a list of one or more <NR2> elements, each of which is an available range (in units selected by the UNITS command, kilometers or kilofeet).

Example(s): RANGELIST 0.5,1.0,2.0,5.0,10.0

Discussion: If you specify a high-resolution pulse width when none is available for a given pulse width (i.e., RANGELIST? -2000), FiberMaster returns the set of ranges compatible with the normal-resolution pulse width (i.e., as if you had sent the command RANGELIST? 2000).

If you specify a normal-resolution pulse width when none is available for a given pulse width (i.e., RANGELIST? 10), FiberMaster returns the set of ranges compatible with the high-resolution pulse width (i.e., as if you had sent the query RANGELIST? -10).

DENSITYLIST?

Return a list of densities available for averaged acquisitions made with the currently selected module, pulse width, and range.

Query Syntax: **DENSITYLIST?**

Response Syntax: DENSITYLIST <normal density>[,<hd1>]

Response Data: <normal density> ::= <NR2>
<hd1> ::= <NR2>
Response data consists of one or two <NR2> elements giving available acquisition sample densities in kilometers or kilofeet per sample point (as determined by the UNITS command setting). The first element is the normal density. The second element (if any) is the high-density acquisition sample density.

Example(s): DEN? (query)
DENSITYLIST 1.0,0.1 (response)

Serial-Port Settings Commands and Queries

NOTE *FiberMaster commands that change instrument settings do not save the new settings as power-on defaults. To save instrument settings, use the SET or *LRN? query. These queries both generate response data in the form of resendable GPIB commands that you can use to set the instrument back to its current configuration.*

Serial-port setup commands.

Set up serial-port parameters. *Remote only. GPIB only.*

Command Syntax:
BAUDRATE <baudrate>
PARITY <parity>
NSTOPBITS <stopbits>
NCHARBITS <charbits>
FLOW <flowcontrol>

Command Data:
<baudrate> ::= <DNPD>. Possible values: 300 | 1200 | 2400 | 4800 | 9600 | 19200.
<parity> ::= <CPD>. Possible values are NONE | EVEN | ODD | ZERO | ONE.
<stopbits> ::= <DNPD>. Possible values are 10 | 15 | 20 (indicating 1, 1.5 and 2 bits respectively).
<charbits> ::= <DNPD>. Possible values are 7 | 8.
<flowcontrol> ::= <CPD>. Possible values are NONE | XONXOFF | RTS_CTS.

Factory Default:
9600 baud, no parity, 1 stop bit, 8 bits/character, xon/xoff flow control.

Serial-port setup queries.

Determine individual serial-port parameters.

Query Syntax:	**BAUDRATE?** **PARITY?** **NSTOPBITS?** **NCHARBITS?** **FLOW?**
Response Syntax:	BAUD <baudrate> PARITY <parity> NSTOPBITS <stopbits> NCHARBITS <charbits> FLOW <flowcontrol>
Response Data:	<baudrate> ::= <NR1> and specifies the serial-port baud rate. <parity> ::= <CRD> and specifies the parity setting. <stopbits> ::= <NR1> and specifies the stop bits. <charbits> ::= <NR1> and specifies the bits per character. <flowcontrol> ::= <CRD> and specifies the flow-control method.
Discussion:	See previous section on "Serial-port setup commands" for an explanation of data-element formats.

RS-232 Remote-Control Command

NLTRANS

Determines translation of ASCII newline character (0A hex) returned by queries with ASCII-encoded responses. Applies only to RS-232 remote control.

Command Syntax: **NLTRANS** <char>

Command Data: <char> ::= <HNPD>

Example(s): To change translation to an asterisk character:

NLTRANS #H2A

Power-On Default: 7E hex (ASCII tilde character: ~)

Discussion: Certain queries that return ASCII data with quoted strings (such as the DIRWFM? query) contain embedded newline characters in the responses. By default, under RS-232 remote control, these newline characters are translated to tildes to prevent application software from considering the newline characters to be message terminators. If desired, such translation can be disabled by sending the following command:

NLTRANS #H0A

Acquisition Commands

ACQUIRE

Perform an averaged normal- or high-density acquisition. *Remote only.*

Command Syntax: **ACQUIRE** <distance>,<distspec>,<densityspec>

Command Data: <distance> ::= <DNPD> and specifies either the starting point or center point for the acquisition (as determined by the <distspec> parameter). The distance is from the front panel, in the currently selected distance units (set by the UNITS command).

<distspec> ::= <CPD> and specifies that the distance supplied by the <distance> parameter will be used as a starting point or center point for the acquisition. Values for <distspec> are START and CENTER. START causes the acquisition to start at the point specified by the <distance> parameter; CENTER causes it to be centered around that point.

<densityspec> ::= <CPD> Values are NORMAL for normal-density acquisition, and HD1 for high density.

Example(s): ACQ 10.0,START,NORMAL

Discussion: The acquisition is done using the optical module and wavelength specified by the MODSELECT command.

The acquisition can be stopped before completion by sending a device-clear interface message, immediately followed by a STOP command.

When a high-density acquisition is made and the instrument is then returned to local control, the display indicates that both normal and high-density data are stored. This maintains consistency with local operation of the instrument, because high-density data can only be obtained in local when normal-density data is already stored. A following WFMPRE? or CURVE? query returns data for the high-density waveform (acquired under remote control) unless a new acquisition has been made under local control.

REALTIME

Place the instrument in real-time acquisition mode. *Remote only.*

Command Syntax: **REALTIME** <distance>,<distspec>

Command Data: <distance> ::= <DNPD> and specifies either the starting distance or centering distance for the acquisition (as determined by the <distspec> parameter).

<distspec> ::= <CPD> and specifies whether the distance supplied by the <distance> parameter will be used as a starting distance or centering distance for the acquisition. Values for <distspec> are START and CENTER. START causes the acquisition to start at the point specified by the <distance> parameter; CENTER causes it to be centered around that point.

Example(s): REA 10.0,START

Discussion: Places the instrument in a mode in which data is acquired and new acquisitions are displayed continually with minimal averaging. Useful for adjusting fiber connections and making splices. Only commands and queries that do not affect the current acquisition and do not start other operations are allowed in real-time mode. The only measurement query allowed in real-time mode is TWOPOINT?. Exit real-time acquisition mode by issuing the STOP command.

The commands and queries that are allowed when the instrument is under remote control and in real-time acquisition mode are listed below. Any other command or query will generate one of the following two errors:
2003, "Instrument state error; command not accepted in real-time mode"
2004, "Instrument state error; query not accepted in real-time mode"

*CLS	BAUDRATE?	HDR	PARITY?
*ESE	CALCSLOPE?	HDR?	PULSELIST?
*ESE?	DATE	HEADER	PULSRNG?
*ESR?	DATE?	HEADER?	RANGELIST?
*IDN?	DENSITYLIST?	MASKOPTION?	REFINDEX?
*LRN?	DESE	MASKSET?	SET?
*OPC	DESE?	MESSAGE	SOFTKEY
*OPC?	ENCDG	MODINFO?	STOP
*RST	ENCDG?	MODLOWER?	TIME?
*SRE	EVENT?	MODSELECT?	TIME?
*SRE?	EVMSG?	MODUPPER?	TRACE?
*STB?	FIBERID?	NCHARBITS	TWOPOINT?
*WAI	FLOW	NCHARBITS?	UNITS?
AVERAGES?	FLOW?	NSTOPBITS	WFMSELECT?
AVETIME?	GSTATUS	NSTOPBITS?	
BAUDRATE	GSTATUS?	PARITY	

Cursor Command and Query

CURSOR

Set the position (distance) of the distance cursors. *Remote only.*

Command Syntax: **CURSOR** <cursor>,<dist>

Command Data: <cursor> ::= <CPD> and specifies which cursor is to position. Possible values are ACTIVE | INACTIVE.

<dist> ::= <DNPD> and specifies the distance where the cursor will be positioned, in distance units (kilometers or kilofeet).

<dist> need not specify the location of a data point on the waveform. The cursor is positioned at the waveform scale increment (a data point if the distance specified is on the waveform) nearest the specified distance.

Example(s): CURS ACTIVE,2.549

Discussion: If the instrument is in Splice Loss or Event Return Loss mode, the inactive distance cursor is not visible, although its position can be set.

If the active distance cursor is moved out of the expansion window, the window moves with the cursor. If the active distance cursor is moved within the expansion window, the window does not move.

CURSOR?

Return the location of one of the distance cursors.

Query Syntax: **CURSOR?** <curs>

Query Data: <curs> ::= <CPD> and specifies the cursor position to return. Possible values are ACTIVE | INACTIVE.

Response Syntax: CURSOR <dist>

Response Data: <dist> ::= <NR2> and gives the distance to the cursor in distance units (kilometers or kilofeet).

Discussion: The inactive cursor is not visible if the instrument is in Splice Loss or Event Return Loss mode; however, its position is returned in response to this query.

Expansion Commands and Queries

EXPAND

Set the expansion to on (expanded) or off (overview). *Remote only.*

Command Syntax: **EXPAND** <option>

Command Data: <option> ::= <DNPD> | <CPD> and turns waveform expansion off (overview) or on (expanded). Possible values are:
0 | OFF
1 | ON

Example(s): EXPAND 1
EXPAND OFF

WINCURSOR

Set the expansion window dimensions. The expansion window is positioned so that it is centered around the intersection of the active distance cursor and the waveform. *Remote only.*

Command Syntax: **WINCURSOR** <width>,<height>

Command Data: <width> ::= <DNPD> and specifies the width of the expansion window in distance units (kilometers or kilofeet).

<height> ::= <DNPD> and specifies the height of the expansion window in decibels.

Example(s): WINC 2,10

WINDISTANCE

Set the expansion window dimensions and center distance. The expansion window is centered vertically at the amplitude of the waveform at the given center distance. *Remote only.*

Command Syntax:	**WINDISTANCE** <width>,<height>,<dist>
Command Data:	<width> ::= <DNPD> and specifies the width of the expansion window in distance units (kilometers or kilofeet). <height> ::= <DNPD> and specifies the height of the expansion window in decibels. <dist> ::= <DNPD> and specifies the center distance for the expansion window (which need not specify the location of a data point on the waveform), in distance units.
Example(s):	WINDIST 1.5,15,3.625
Discussion:	If the expansion window is moved off the active distance cursor, the cursor moves with the expansion window.

WINDOW

Set the dimensions, center distance, and amplitude of the expansion window. *Remote only.*

Command Syntax:	**WINDOW** <width>,<height>,<dist>,<amp>
Command Data:	<width> ::= <DNPD> and specifies the width of the expansion window in distance units (kilometers or kilofeet). <height> ::= <DNPD> and specifies the height of the expansion window in decibels. <dist> ::= <DNPD> and specifies the center distance for the expansion window (which need not specify the location of a data point on the waveform), in distance units. <amp> ::= <DNPD> and specifies the center amplitude for the expansion window, in decibels.
Example(s):	WINDOW 1.5,15,3.625,23.
Discussion:	If the expansion window is moved off the active distance cursor, the cursor moves with the expansion window.

EXPAND?

Return the expansion state of the instrument.

Query Syntax: **EXPAND?**

Response Syntax: EXPAND <option>

Response Data: <option> ::= <NR1>
0 overview
1 expanded view

WINDOW?

Return the dimensions and position of the expansion window.

Query Syntax: **WINDOW?**

Response Syntax: WINDOW <width>,<height>,<dist>,<amp>

Response Data: <width> ::= <NR2> and specifies the width of the expansion window in distance units (kilometers or kilofeet).

<height> ::= <NR2> and specifies the height of the expansion window in decibels.

<dist> ::= <NR2> and specifies the center distance for the expansion window, in distance units.

<amp> ::= <NR2> and specifies the center amplitude for the expansion window in decibels.

Measurement Command and Queries

MEASMODE

Select a measurement mode for the instrument. The display and cursors are updated to indicate the selected mode. Does not initiate a measurement or cause any measurement data to be stored. *Remote only.*

Command Syntax: **MEASMODE** <mode>

Command Data: <mode> ::= <CPD> and specifies the measurement mode for the instrument to enter. Possible values are:

PREVIEW
TWOPOINT
SPLICELOSS
LINKRTNLOSS
EVNTRTNLOSS

Example(s): MEASMODE LINK

puts the instrument into Link Return Loss mode and updates the display.

After setting the measurement mode with MEASMODE, you can use the CURSOR command to position the cursor(s), and the MEASURE? query to perform a measurement at the current cursor locations. For example, the message:

MEASMODE SPL;CURSOR ACT,5;MEASURE?

puts the instrument in Splice Loss mode, moves the active distance cursor to 5 kilometers, and performs a splice-loss measurement and returns the measurement value. The response format in this case is the same as for the SPLICELOSS? query.

EVNTRTNLOSS?

Enter Event Return Loss mode and return event-return-loss data for the active waveform. *Remote only*.

Query Syntax:	**EVNTRTNLOSS?** <distance>
Query Data:	<distance> ::= <DNPD> and specifies the point on the fiber at which to make the event-return-loss measurement. <distance> need not specify an actual data point on the waveform. The measurement is made using the waveform point closest to <distance>. <dist> in the query response gives the actual location of the point.
Response Syntax:	EVNTRTNLOSS <dist>,<loss>,<height>
Response Data:	<dist> ::= <NR2> and specifies the distance of the data point nearest <distance>. <loss> ::= <NR2> and specifies the return loss at <dist>. <height> ::= <NR2> and specifies the height of the reflection at <dist>, in dB.
Discussion:	If the distance given lies within the bounds of the active waveform, the instrument enters Event Return Loss mode (unless already in that mode). If the given distance is within one pulse width of a splice, the active distance cursor is placed at the splice. If not, the active distance cursor is placed at the data point closest to the distance specified. Event 2260 is generated if the loss value reported in the query response is not accurate due to clipping of the waveform.

LINKRTNLOSS?

Enter Link Return Loss mode and return link-return-loss data for the active waveform. *Remote only*.

Query Syntax: **LINKRTNLOSS?** <distance1>,<distance2>

Query Data:

<distance1> ::= <DNPD> and specifies the starting point for link-return-loss calculations.

<distance2> ::= <DNPD> and specifies the ending point for link-return-loss calculations.

<distance1> and <distance2> need not specify locations of actual data points on the waveform. The measurement is made using the waveform point closest to <distance1> and the waveform point closest to <distance2>. <dist1> and <dist2> in the query response give the actual locations of the two points used.

Response Syntax: LINKRTNLOSS <dist1>,<dist2>,<loss>

Response Data:

<dist1> ::= <NR2> and specifies the distance to the starting waveform point from the instrument's front panel.

<dist2> ::= <NR2> and specifies the distance to the ending waveform point from the front panel.

<loss> ::= <NR2> and specifies the return loss at <dist>.

<height> ::= <NR2> and specifies the link return loss between <dist1> and <dist2>, in dB.

Discussion:

If the distance given lies within the bounds of the active waveform, the instrument enters Link Return Loss mode (unless already in that mode). The cursors are placed at <dist1> and <dist2>.

Event 2260 is generated if the loss value reported in the query response is not accurate due to clipping of the waveform.

MEASMODE?

Return the current measurement mode.

Query Syntax: **MEASMODE?**

Response Syntax: MEASMODE <mode>

Response Data: <mode> ::= <CRD> and specifies the instruments current measurement mode. Possible values are:

PREVIEW
TWOPOINT
SPLICELOSS
LINKRTNLOSS
EVNTRTNLOSS

MEASURE?

Performs a measurement using the current distance cursor location(s) and measurement mode. The cursor location and measurement mode may be set before sending this query, either under local control or using the CURSOR and MEASMODE commands. *Remote only.*

Query Syntax: **MEASURE?**

Response Syntax: The response syntax depends on the current measurement mode. Refer to the descriptions of the response syntax for the TWOPOINT?, SPLICELOSS?, LINKRTNLOSS?, and EVNTRTNLOSS? queries.

SPLICELOSS?

Enter Splice Loss mode and return splice-loss data for the active waveform. *Remote only.*

Query Syntax: **SPLICELOSS?** <distance>

Query Data: <distance> ::= <DNPD> and specifies the point at which to make the measurement.

<distance> need not specify an actual data point on the waveform. The measurement is made using the waveform point closest to <distance>. <splicedist> in the query response gives the actual location of the point.

Response Syntax: SPLICELOSS <splicedist>,<loss>

Response Data: <splicedist> ::= <NR2> and specifies the distance to the splice from the instrument's front panel.

<loss> ::= <NR2> and specifies the value of the measured splice loss in decibels.

TWOPOINT?

Enter Two Point mode and return two-point measurement for active waveform. *Remote only.*

Query Syntax:	**TWOPOINT?** <dist1>,<dist2>
Query Data:	<dist1> ::= <DNPD> and specifies the starting point for the two-point calculations <dist2> ::= <DNPD> and specifies the ending point for the two-point calculations. <dist1> and <dist2> need not specify locations of actual data points on the waveform. The measurement is made using the waveform point closest to <dist1> and the waveform point closest to <dist2>. <dist_p1> and <dist_p2> in the query response give the actual locations of the two points.
Response Syntax:	TWOPOINT <dist_p1>,<dist_p2>,<loss>,<slope>
Response Data:	<dist_p1> ::= <NR2> and specifies the distance to the starting waveform point from the instrument's front panel. <dist_p2> ::= <NR2> and specifies the distance to the ending waveform point from the front panel. <loss> ::= <NR2> and specifies the loss in decibels between points <dist_p1> and <dist_p2>. <slope> ::= <NR3> and specifies the calculated slope of the waveform between these points (using the method specified in the CALCSLOPE command).
Discussion:	On the instrument's display, the reference and active distance cursors are moved to locations <dist_p1> and <dist_p2>, respectively.

Event Marking and Event Table Commands and Queries

EVNTAUTOMARK

Mark events on the active waveform that have splice losses exceeding the current event-marking threshold. This is the same function as pressing the **Auto Mark Events** softkey on the Place Event Markers screen. *Remote only.*

Command Syntax: EVNTAUTOMARK

EVNTMARKING

Select automatic or manual event marking. *Remote only.*

Command Syntax:	**EVNTMARKING** <marking_type>
Command Data:	<marking_type> ::= <CPD>. Possible values are AUTOMATIC | MANUAL.
Factory Default:	AUTOMATIC
Discussion:	The new event-marking mode takes effect with the active waveform.

EVNTMEAS

Store the current measurement (splice loss or event-return loss) into the event table. *Remote only.*

Command Syntax:	**EVNTMEAS**
Discussion:	If the current measurement is a splice loss or event-return loss at one of the events in the event table, the measurement value is entered into the appropriate column of the table for that event, and the event table is updated.

EVNTNOTES

Store notes for a particular event into the event table. *Remote only.*

Command Syntax:	**EVNTNOTES** <eventnum>,<notes>
Command Data:	<eventnum> ::= <DNPD> and specifies the number of the event within the event table. <notes> ::= <SPD> where the number of characters within quotes must not exceed 79 characters.
Example(s):	EVNTNOTES 3,"R037-003: SE Corner of 7th & Elm" stores a note for event 3 into the event table.

EVNTTHRESH

Set a minimum event threshold for automatic event marking. All events with splice-loss measurements of equal or greater magnitude are marked and included in the event table. *Remote only.*

Command Syntax:	**EVNTTHRESH** <threshold>
Command Data:	<threshold> ::= <DNPD>. The value for the threshold must be in the range 0.0 to 5.0 decibels. Values are converted to the nearest multiple of 0.05.
Discussion:	Events with losses (or gains) below the selected threshold are not reported by the EVNTINFO? query and do not appear in the event table under local operation of the instrument. A threshold of 0 causes all events to be reported, regardless of loss. The new event threshold takes effect with the active waveform.
Factory Default:	0.20 dB

IPRNEVENTS

Print the event table for the active waveform on the TFP2A internal printer. *Remote only.*

Command Syntax: IPRNEVENTS

EVNTCOUNT?

Return the number of events stored in the event table.

Query Syntax:	**EVNTCOUNT?**
Response Syntax:	EVNTCOUNT <numevents>
Response Data:	<numevents> ::= <NR1> and specifies the number of events included in the event table.
Discussion:	When event marking is set to automatic, whether events are included in the event table depends on the current event threshold setting. Refer to the EVNTTHRESH command.

EVNTINFO?

Return information for one or all events in the event table.

Query Syntax:	**EVNTINFO?** <eventnum>,<info>

Query Data: <eventnum> ::= <DNPD> and specifies either the number of the event within the event table or 0 to return information for all events. This corresponds to a row number in the event table, as it is displayed under local operation of the instrument.

<info> ::= <CPD> and specifies the type of information to return about the event. Possible values are:

DISTANCE	return the distance at the event, in kilometers or kilofeet
SPLICELOSS	return the splice loss, in dB
RETURNLOSS	return the event return loss, in dB
FIBERLOSS	return the fiber loss as measured from the previous event in the table, in dB/km or dB/kft
TWOPTDIST	return the distance as measured from the previous event in the table, in km or kft
TWOPTLOSS	return the two-point loss as measured from the previous event in the table, in dB
LINKLOSS	return the link loss as measured from event 1, in dB
ALL	return all of the above

Response Syntax: EVNTINFO <bitmask>,<data>

Response Data: <bitmask> ::= <HNRD>
For all types of <info> except ALL and FIBERLOSS, <data> ::= <NR2>.
For ALL, <data> ::= <distance>,<spliceloss>,<returnloss>, <fiberloss>,<twoptdist>,<twoptloss>,<linkloss> where all fields in the response are in <NR2> format, except for <fiberloss>, which is in <NR3> format.
For FIBERLOSS, <data> ::= <NR3>.

Discussion: The value of <eventnum> must be between 1 and the number of events reported in the EVNTCOUNT? query response.
The <bitmask> is an eight-bit field whose bits indicate the following conditions:

#H0000	return loss normal
#H0001	return loss not accurate due to clipping (actual value is less than reported value)
#H0002	return loss not accurate because height of reflection too small (actual value is greater than reported value)
#H0003	return loss not applicable (the event is non-reflective)
#H0004	no data at this event
#H0008	this event is the first event found on the waveform (therefore no reference for

FIBERLOSS, TWOPTDIST, TWOPTLOSS, and LINKLOSS)

#H0010	manually entered splice-loss measurement
#H0020	manually entered return-loss measurement
#H0040	high-density data used for measurements

Example(s): Query/response for the number of events in the event table:

```
EVNTCOUNT?
EVNTCOUNT 5
```

Queries/responses for distance and splice loss for event 2:

```
EVNTINFO? 2,DISTANCE
EVNTINFO #H0000,2.947        (distance in km)

EVNTINFO? 2,SPLICELOSS
EVNTINFO #H0000,0.13         (loss in dB)
```

Query/response for all information for event 2:

```
EVNTINFO? 2,ALL
EVNTINFO #H0000,2.947,0.13,30.5,0.354E+00,4.360,
1.68,4.59
```

The individual fields of the response from left to right are interpreted as follows:

```
DISTANCE = 2.947 km
SPLICELOSS = 0.13 dB
RETURNLOSS = 30.5 dB
FIBERLOSS = 0.354 dB/km
TWOPTDIST = 4.360 km
TWOPTLOSS = 1.68 dB
LINKLOSS = 4.59 dB
```

Query/response for event return loss for event 3:

```
EVNTINFO? 3,RETURNLOSS
EVNTINFO #H0000,32.4
```

Query/response for event return loss for event 4:

```
EVNTINFO? 4,RETURNLOSS
EVNTINFO #H0003,0.0
```

This indicates that event 4 is a non-reflective event and return loss does not apply.

Use an <eventnum> of 0 to return all information for all events in the table. For example, to return the distance of all events:

EVENTINFO? 0,DISTANCE
EVENTINFO #H0000,0.00,#H0000,2.947,#H0000,3.45,
#H0000,6.324,#H0000,10.735

Note that the bitmask is returned with each distance value. To return the entire event table (all information fields for all events):

EVENTINFO? 0,ALL
EVNTINFO #H0008,0.0,1.0,31.5,0.354E+00,0.0,0.0,0.0,
#H0000,2.947,0.13,30.5,0.354E+00,4.360,1.68,4.59,
<event 3 info>,
<event 4 info>,
#H0000,10.735,5.5,33.5,0.354E+00,1.0,0.354.10.7

EVNTMARKING?

Determine whether automatic or manual event marking has been selected for the active waveform.

Query Syntax:	**EVNTMARKING?**
Response Syntax:	EVNTMARKING <marking_type>
Response Data:	<marking_type> ::= <CRD>. Possible values are AUTOMATIC | MANUAL.

EVNTNOTES?

Retrieve notes for a particular event from the event table.

Query Syntax:	EVNTNOTES? <eventnum>
Query Data:	<eventnum> ::= <DNPD> and specifies the number of the event within the event table.
Response Syntax:	EVNTNOTES <notes>
Response Data:	<notes> ::= <SRD>

EVNTTHRESH?

Return the setting of the event threshold for the active waveform.

Query Syntax:	**EVNTTHRESH?**
Response Syntax:	EVNTTHRESH <threshold>
Response Data:	<threshold> ::= <NR2> and specifies the current event-threshold setting, in decibels.
Response Data:	Refer to the EVNTTHRESH command description.

Event Marker Commands and Queries

The following commands and queries are available only when manual event marking is selected (refer to the EVNTMARKING command description).

ADDMARKER

Add an event marker to the Place Event Markers screen. The marked event is measured and entered into the event table. Measurements for other events in the table are updated if they are affected by the new addition. *Remote only*.

Command Syntax: **ADDMARKER** <distance>

Command Data: <distance> ::= <DNPD> and specifies the location of the new marker, in distance units (kilometers or kilofeet).

Discussion: The new marker is not added to the event table if its splice loss is not equal to or greater than the current event threshold.

DELMARKDIST

Delete an event marker from the Place Event Markers screen by specifying the location of the marker. Measurements for other events in the table are updated if they are affected by the deletion. *Remote only*.

Command Syntax: **DELMARKDIST** <distance>

Command Data: <distance> ::= <DNPD> and specifies the location of the marker in distance units (kilometers or kilofeet).

DELMARKNUM

Delete an event marker from the Place Event Markers screen by specifying the number of the marker. Measurements for other events in the table are updated if they are affected by the deletion. *Remote only*.

Command Syntax: **DELMARKNUM** <markernum>

Command Data: <markernum> ::= <DNPD> and specifies the marker number of the event as shown on the Place Event Markers screen.

Discussion: The value of <markernum> must be between 1 and the number of events reported in the NUMMARKERS? query response.

SHOWMARKERS

Set the instrument to show (or not show) the event markers on the display. *Remote only*.

Command Syntax: **SHOWMARKERS** <option>

Command Data: <option> ::= <DPND> | <CPD> and specifies that event markers are off or on. Possible values are:

0 | OFF
1 | ON

Example(s): SHOWMARKERS 1
SHOWMARKERS OFF

MARKERDIST?

Return the distance from the front panel to a marker on the Place Event Markers screen.

Query Syntax: **MARKERDIST?** <markernum>

Query Data: <markernum> ::= <DNPD> and specifies the number of the marker for which the distance is to be returned.

Response Syntax: MARKERDIST <distance>

Response Data: <distance> ::= <NR2> and gives the location of the marker in distance units (kilometers or kilofeet).

NUMMARKERS?

Return the number of markers shown on the Place Event Markers screen.

Query Syntax: **NUMMARKERS?**

Response Syntax: NUMMARKERS <nummarkers>

Response Data: <nummarkers> ::= <NR1>

Discussion: The NUMMARKERS? response includes all markers on the Place Event Markers screen. This includes all marked events, regardless of the event threshold setting.

SHOWMARKERS?

Return whether event markers are on or off on the instrument display.

Query Syntax:	SHOWMARKERS?
Response Syntax:	SHOWMARKERS <option>
Response Data:	<option> ::= <NR1> and specifies that event markers are off or on. Possible values are 0 | 1:

0 off
1 on

Waveform Selection and Storage Commands and Queries

STORE

Save the current waveform and associated settings to reference memory. *Remote only.*

Command Syntax: **STORE**

WFMSELECT

Select the active waveform (waveform used for measurements and waveform settings queries). *Remote-only.*

Command Syntax: **WFMSELECT** <waveform>

Command Data: <waveform> ::= <CPD> and specifies which waveform is active.
Possible values are CURRENT | REFERENCE.

Example(s): WFMSEL C

Power-On Value: CURRENT

WFMSELECT?

Determine whether the current or reference waveform is active.

Query Syntax: **WFMSELECT?**

Response Syntax: WFMSELECT <waveform>

Response Data: <waveform> ::= <CRD> and specifies the active waveform.
Possible responses are CURRENT | REFERENCE

WFMSOURCE?

Indicate the source of the data for the active waveform.

Query Syntax: **WFMSOURCE?**

Response Syntax: WFMSOURCE <source>

Response Data: <source> ::= <CRD> and specifies the source of the waveform, as follows:

NONE	no data is stored for the active waveform (i.e., current memory or reference memory—whichever is active—is empty)
ACQUISITION	data acquired since power-on from an installed optics module
MASS_STORAGE	data loaded from mass-storage (floppy disk or internal RAM)
XMODEM	data received from RS232 port using XMODEM protocol

Waveform Data Command and Queries

WFMINT

Select an interval of points on the stored waveform that will be returned by the CURVE? query. *Remote only.*

Command Syntax: **WFMINT** <start>,<end>

Command Data: <start> ::= <DNPD> and specifies the index of first point in the interval

<end> ::= <DNPD> and specifies the index of the last point in the interval

Example(s): If the waveform contains 10,000 total points, the command

WFMINT 1000,2500

causes the CURVE? query to return waveform points 1000 through 2500, inclusive (rather than the default of points 0 through 9999).

Discussion: Specifying -1 for both parameters (WFMINT -1,-1) resets the CURVE? query interval to the entire waveform.

The WFMPRE? and NR_PT? queries return the total number of points in the waveform. The WFMINT? query returns the current WFMINT interval selection.

The ACQUIRE, REALTIME, and *RST commands cause the waveform interval to be reset to the entire waveform.

An execution error is generated if no waveform data is currently stored, or if the interval specified does not lie entirely within 0 through the last point on the waveform.

Power-On Default: If a WFMINT command is not issued, the CURVE? query returns the entire waveform.

CURVE?

Return data for the active waveform. (See WFMPRE? query, ACQUIRE and REALTIME commands.) *Remote only.*

Query Syntax: **CURVE?**

Response Syntax: CURVE <curve_data>

Response Data: <curve_data> can be encoded in ASCII or binary, depending on ENCDG command selection (default = binary).

ASCII encoding:
<point>[,<point>]...
where <point> ::= <NR1>. Points are given in order of increasing x value. A single point of 0 is sent if no waveform data is available.

Binary encoding:
#<len>[<count>{<byteM><byteL>}...<checksum>]

The data is in <Definite Length Arbitrary Block Response Data> format, where <len> is a single digit (0-9) which specifies the number of bytes in the <NR1> element <count>. <count> specifies the number of bytes of data that follow (including the checksum). <byteM> is the most significant byte of a 16-bit data word. <byteL> is the least significant byte of a 16-bit data word. Each data word is a signed 2's complement integer. <checksum> is a single byte giving the 2's complement of the modulo 256 sum of all bytes in the response except for #.

If <len> is 0, the entire response is #10, and indicates that no waveform data is stored.

Discussion: The ENCDG command is used to determine how waveforms will be formatted. The WFMPRE? query is used to determine the number of points on an ASCII or binary waveform, the offset of the first sample point from the origin, and the sample interval. The maximum number of points per waveform is 16,000. For binary-encoded waveforms this results in a maximum block response length of 32,008 bytes, i.e., the response:

CURVE #532001<32000 data bytes><checksum>

CURVE? returns normal- or high-density data, whichever was acquired last, regardless of whether the last acquisition was made under local control (by pressing the **START/STOP** button) or remote control (by sending the ACQUIRE command).

Example(s): Sending 100 16-bit data words in binary encoding:

CURVE #3201<byte1>...<byte200><checksum>

NR_PT?

Return number of points in waveform. *Remote only.*

Query Syntax: **NR_PT?**

Response Syntax: NR_PT <points>

Response Data: <points> ::= <NR1> and specifies the number of data points in the entire waveform.

PT_OFF?

Return point offset for waveform. *Remote only.*

Query Syntax: **PT_OFF?**

Response Syntax: PT_OFF <ptoff>

Response Data: <ptoff> ::= <NR1> and specifies the point offset for the waveform (always 0).

WFID?

Return fiber ID for waveform. *Remote only.*

Query Syntax: **WFID?**

Response Syntax: WFID <fiberid>

Response Data: <fiberid> ::= <SRD> and specifies the fiber ID string as set by the FIBERID command.

WFMINT?

Return the interval of data points on the stored waveform (to be returned by CURVE?), set by the last WFMINT command or power-on default. *Remote only.*

Query Syntax: **WFMINT?**

Response Syntax: WFMINT <start>,<end>

Response Data: <start> ::= <NR1> and specifies the index of first point in the interval
<end> ::= <NR1> and specifies the index of the last point in the interval

WFMPRE?

Return size and scale information about the active waveform. (See CURVE? query). Note that each of the items returned by the WFMPRE? query can be obtained individually using the WFID?, NR_PT?, XINCR?, PT_OFF?, XZERO?, YMULT?, YZERO?, and YOFF? queries. *Remote only.*

Query Syntax: **WFMPRE?**

Response Syntax: WFMPRE WFID <fiberid>;NR_PT <points>;XINCR <xincr>;PT_OFF <ptoff>;XZERO <xzero>;YMULT <ymult>;YZERO <yzero>;YOFF <yoff>

Response Data:

<fiberid> ::= <SRD>, fiber ID as set by FIBERID command
<points> ::= <NR1>, number of points in waveform
<xincr> ::= <NR2>, distance between points in kilometers or kilofeet (units selected by the UNITS command)
<ptoff> ::= <NR1>, point offset for waveform (always 0)
<xzero> ::= <NR2>, x coordinate of first point on waveform in kilometers or kilofeet (units selected by the UNITS command)
<ymult> ::= <NR2>, scale factor for y values (conversion from CURVE? query data-point value to dBs)
<yzero> ::= <NR2>, y-value zero value (always 0.0)
<yoff> ::= <NR2>, y-value offset value (always 0.0)

NOTE *The x coordinate of the nth point on the waveform returned by CURVE? is*

<xzero> + <xincr> * (<n - <ptoff>)

where n = 0, 1, 2, ...

The y coordinate of the nth point on the waveform is:

<yzero> + <ymult> * (y_n - <yoff>)

where y_n is the nth value returned by the CURVE? query and n = 0, 1, 2, ...

XINCR?

Return the distance between data points in kilometers or kilofeet (units selected by the UNITS command). Refer to the WFMPRE? query description. *Remote only.*

Query Syntax: **XINCR?**

Response Syntax: XINCR <xincr>

Response Data: <xincr> ::= <NR2> and specifies the distance between data points on the waveform.

XZERO?

Return the x coordinate of the first point on the waveform, in kilometers or kilofeet (units selected by the UNITS command). Refer to the WFMPRE? query description. *Remote only.*

Query Syntax:	**XZERO?**
Response Syntax:	XZERO <xzero>
Response Data:	<xzero> ::= <NR2> and specifies the x coordinate of the first point on the waveform.

YMULT?

Return the y-value scale factor, used to convert CURVE? query y values to dBs. Refer to the WFMPRE? query description. *Remote only.*

Query Syntax:	**YMULT?**
Response Syntax:	YMULT <ymult>
Response Data:	<ymult> ::= <NR2> and specifies the y-value scale factor.

YOFF?

Return the y-value offset value (always 0.0). Refer to the WFMPRE? query description. *Remote only.*

Query Syntax:	**YOFF?**
Response Syntax:	YOFF <yoff>
Response Data:	<yoff> ::= <NR2> and specifies the y-value offset value (always 0.0).

YZERO?

Return the y-coordinate of the first point on the waveform (always 0.0). Refer to the WFMPRE? query description. *Remote only.*

Query Syntax:	**YZERO?**
Response Syntax:	YZERO <yzero>
Response Data:	<yzero> ::= <NR2> and specifies the y coordinate of the first point on the waveform (always 0.0).

Response Formatting Commands

ENCDG

Specify the encoding format (ASCII or BINARY) used by the following commands and queries:

CURVE?
FILE?
GET_SET?
GET_WFM?
FILNORM
FILHIGH
FILSET
PUT_SET
PUT_WFM

Command Syntax:	**ENCDG** <format>
Command Data:	<format> ::= <CPD> and specifies the data format used for waveform data. Possible values are ASCII | BINARY.
Power-On Value:	BINARY

HEADER

Enable or disable the headers returned with query responses. (Refer to the *GPIB Data Formats* section.)

Command Syntax:	**HEADER** <option>
Command Data:	<option> ::= <DNPD> | <CPD>
	0 | OFF — disable query response headers 1 | ON — enable query response headers
Example(s):	HEADER OFF
Power-On Value:	ON
Discussion:	**HDR** can be used as a synonym for HEADER.

Response Formatting Queries

ENCDG?

Return the encoding format (ASCII or BINARY) used for the following commands and queries:

CURVE?
FILE?
GET_SET?
GET_WFM?
FILNORM
FILHIGH
FILSET
PUT_SET
PUT_WFM

Query Syntax: **ENCDG?**

Response Syntax: ENCDG <format>

Response Data: <format> ::= <CRD> and specifies the data format used for waveform data. Possible responses are ASCII | BINARY.

HEADER?

Return header option setting.

Query Syntax: **HEADER?**

Response Syntax: HEADER <option>

Response Data: <option> ::= <NR1>
0 | 1 disable or enable query response headers

Discussion: **HDR?** can be used as a synonym for HEADER?.

Waveform Transfer Commands and Queries

PUT_SET, PUT_WFM (binary encoding)

Download a waveform or settings file that is in TFP2A mass-storage format from the controller to the instrument. Waveform files are loaded into current or reference memory, depending on which waveform is active. Settings files are always loaded into current memory. *Remote only. GPIB only.*

Command Syntax:

PUT_SET <filename>,#0<file_data><NL>^<END>
PUT_WFM <filename>,#0<file_data><NL>^<END>

Command Data:

<filename> ::= <SPD>, a quoted string enclosing the file name to be stored in the TFP2A's source parameter.

#0 is the header for the IEEE 488.2 Arbitrary Block Program data element, and indicates that all the data up to but not including the <NL>^<END> is a binary waveform or settings file data in TFP2A format. *Do not include white space between #0 and <file_data> and between <file_data> and the <NL> (newline) character.*

<NL>^<END> indicates that the waveform file data should be followed by an ASCII newline character (0A hex) sent with the GPIB EOI line asserted concurrently. The EOI line *must* be asserted when the newline character is sent, because this is the only way to terminate a binary data stream of unknown length.

Discussion:

An error is generated and stored in the TFP2A Event Queue if the <file_data> data stream does not conform to TFP2A waveform or settings file format. An error is also likely to occur as a result of a transmission error due to faulty cabling. It is recommended that *ESR? and EVMSG? queries be sent after the PUT_WFM and PUT_SET commands to determine if an error has occurred.

Example(s):

The commands

WFMSEL REF
PUT_WFM "test.wfm",#0<file_data><NL>^<END>
send waveform file data to reference memory and set the acquisition source to the file "test.wfm".

The command

PUT_SET "test.set",#0<file_data><NL>^<END>

sends setting data to current memory.

Note that it is not necessary to use the name of the file in the <filename> data element from which the data was read on the controller. The <filename> data element is supplied for

documentation purposes only. For example, either command

PUT_WFM "test.wfm",#0<file_data><NL>^<END>
or
PUT_WFM "",#0<file_data><NL>^<END>

would download a waveform to the TFP2A, regardless of the name of the source file on the controller's hard disk. However, the <file_data> element is still required. If it is omitted the PUT_WFM and PUT_SET commands generate an error.

PUT_SET, PUT_WFM (ASCII encoding)

NOTE *This form of the PUT_SET and PUT_WFM commands is intended for RS-232 remote-control applications when eight-bit binary data cannot be handled.*

Download a waveform or settings file that is in TFP2A mass-storage format from the controller to the instrument. Waveform files are loaded into current or reference memory, depending on which waveform is active. Settings files are always loaded into current memory. *Remote only.*

Command Syntax: **PUT_SET** <filename>,#0<data><NL>
PUT_WFM <filename>,#0<data><NL>

Command Data: <filename> ::= <SPD>, a quoted string enclosing the filename to be stored in the TFP2A's source parameter.

#0 is the header for the IEEE 488.2 Arbitrary Block Program data element, and indicates that all the data up to but not including the <NL> is waveform or settings dat*a. Do not include white space between #0 and <data> and between <data> and the <NL> (newline) character.*

Discussion: Each eight-bit byte of waveform data in <data> is encoded as two hexadecimal digits. For example, the data sent to FiberMaster when an actual waveform data byte has value 2E hex is the digit 2 (32 hex), followed by the digit E (45 hex). The most significant digit (32 hex) is sent first.

Example(s): The commands

WFMSEL REF
PUT_WFM "test.wfm",#0FEA7...2C<NL>
send waveform file data to reference memory and set the acquisition source to the file "test.wfm". The first byte of actual waveform data has the hex value FE, the second byte has the hex value A7, and the last byte has the hex value 2C.

The command

PUT_SET "test.set",#0A355...C2<NL>

sends setting data to current memory. The first byte of actual settings data has the hex value A3, the second byte has the hex value 55, and the last byte has the hex value C2.

Note that it is not necessary to use the name of the file in the <filename> data element from which the data was read on the controller. The <filename> data element is supplied for documentation purposes only (but must always be specified). <filename> can be set to "" if not needed.

FILHIGH, FILNORM, FILSET

Download a waveform file (FILNORM, FILHIGH) or settings file (FILSET) that is in TFP2A mass-storage format from the controller to the instrument. Waveform files are loaded into current or reference memory, depending on which waveform is active. Settings files are loaded into current memory. *Remote only.*

Command Syntax: **FILNORM** <file_data>
FILHIGH <file_data>
FILSET <file_data>

Command Data: <file_data> ::= #<len><count><data_byte>...<checksum>
The command data is in 488.2 Arbitrary Block Program Data format.

<len> is a single digit (0 - 9) that specifies the number of digits in the data byte count, <count>.

<count> specifies the number of data bytes that follow, including the checksum.

<checksum> gives the two's complement of the modulo 256 sum of bytes in the command data, excluding the #.

Binary encoding (selected by the ENCDG BINARY command):

<data_byte> corresponds to one eight-bit byte of waveform data and <checksum> is an eight-bit checksum.

ASCII encoding (selected by the ENCDG ASCII command):

This encoding is designed primarily for RS-232 remote-control applications in which binary data cannot be handled. In this format, each eight-bit byte of actual waveform data is encoded as two hexadecimal digits. For example, the data sent to FiberMaster when an actual waveform data byte has value 2E hex is the digit 2 (32 hex) followed by the digit E (45 hex). The most significant digit (32 hex) is sent first.

In this case, each <data_byte> is two hex-encoded digits and <checksum> is two hex-encoded digits. <count> is the count of hex-encoded digits in <data_byte>...<checksum> (twice the value of <count> for the binary encoding).

Discussion: For the binary encoding, the sequence of bytes <data_byte>..., not including the checksum, should be the contents of a FiberMaster waveform file (FILNORM and FILHIGH) or settings file (FILSET).

The data should be the same as if the user had saved the active waveform or instrument settings to a mass-storage file. The format is the same as that of the FILE? query response.

The difference between the FILNORM and FILHIGH commands is that FILNORM does not send the high-density part of the waveform to FiberMaster. FILHIGH transfers both normal and high-density parts of the waveform to FiberMaster.

Example(s): Binary encoding:

FILHIGH #548801<byte#1><byte#2>...<byte#48800><checksum byte>

#5 indicates that the next five digits, 48801, are the count of data bytes including the checksum byte. Each <byte#n> is an eight-bit waveform data byte.

ASCII encoding:

FILHIGH #597602FC55...B7A2

#5 indicates that the next five digits, 97602, are the count of all bytes to follow, including the checksum bytes. The first actual byte of waveform data has the hex value FC, the second has the hex value 55, and the last byte has the hex value B7. The checksum has the hex value A2.

FILE?

Causes the binary data for the active waveform file or for an instrument settings file to be sent as a response. The response data contains the same stream of data contained in a FiberMaster mass-storage waveform or settings file, and can be used by the controller to write a FiberMaster-compatible waveform or settings file to the controller's disk drive. *Remote only.*

Query Syntax: **FILE?** <filetype>

Query Data: <filetype> ::= <CPD>

WFM_NORMAL	Send waveform file with normal-density data only
WFM_HIGH	Send waveform file with normal and high-density data, if any
SET	Send settings file

Response Syntax: FILE <file_data>

Response Data: <file_data> ::= #<len><count>[<data_byte> ... <checksum>]

The data is in <Definite Length Arbitrary Block Response Data> format:

<len> is a single digit (0-9) that specifies the number of bytes in the <NR1> element <count>. <count> specifies the number of bytes that follow, including the checksum.

<checksum> gives the two's complement of the modulo 256 sum of bytes in the response, excluding the #.

Binary encoding (selected by the ENCDG BINARY command):

<data_byte> corresponds to one eight-bit byte of waveform data and <checksum> is an eight-bit checksum.

ASCII encoding (selected by the ENCDG ASCII command):

This encoding is designed primarily for RS-232 remote-control applications in which binary data cannot be handled. In this format, each eight-bit byte of actual waveform data is encoded as two hexadecimal digits.

For example, the data returned by FiberMaster when an actual waveform data byte has value 2E hex is the digit 2 (32 hex) followed by the digit E (45 hex). The most significant digit (32 hex) is sent first.

In this case, each <data_byte> is two hex-encoded digits and <checksum> is two hex-encoded digits. <count> is the count of hex-encoded digits in <data_byte>...<checksum> (twice the value of <count> for the binary encoding).

Discussion: For the binary encoding, the sequence of bytes <data_byte>... , not including the checksum, is the contents of a FiberMaster waveform or settings file. This data is the same as if the user had saved the active waveform or current instrument settings to a mass-storage file. The application software can write this sequence of bytes to a disk file and subsequently read this file in a FiberMaster floppy-disk drive, or as an input file to the FMTAP application software.

If no data is available at the time of the FILE? query, the entire response data field will be #10.

Example(s): The query FILE? WFM_NORMAL might return the following response:

Binary encoding:

FILE #548801<byte #1><byte #2> ...
<byte #48000><checksum byte>

where 5 indicates the next five digits are the byte count 48801. The byte count includes the 48800 bytes of waveform file data plus the terminating checksum.

The response would be FILE #10 if no waveform data had been acquired since power-on.

ASCII encoding:

FILE #597602FC55...B7A2

#5 indicates that the next five digits 97602 are the count of all the bytes to follow, including the checksum bytes. The first actual byte of waveform data has the hex value FC, the second has the hex value 55, and the last byte has the hex value B7. The checksum has the hex value A2.

GET_WFM?, GET_SET? (binary encoding)

Upload a waveform or settings file from the TFP2A to the controller. Files are read from current or reference memory, depending on which waveform is active. *Remote only. GPIB only.*

Query Syntax: **GET_WFM?**
GET_SET?

Response Syntax: GET_WFM #0<file_data><NL>^<END>
GET_SET #0<file_data><NL>^<END>

#0 is the header for the IEEE 488.2 Indefinite Length Arbitrary Block Response Data element. It indicates that all data up to but not including the <NL>^<END> is binary waveform file data in TFP2A format. #0 and the terminating <NL> (newline) character are not parts of the data and should not be stored in the destination file by the controller.

<NL>^<END> indicates that the waveform file data is followed by an ASCII newline character (0A hex) sent with the GPIB EOI line asserted concurrently.

There is no white space between #0 and <file_data> and between <file_data> and the <NL> (newline) character.

Discussion: The FILE? query can also be used to upload a waveform or settings file from the TFP2A. The difference between the FILE? query and the GET_WFM? and GET_SET? queries is that the FILE? query response has a header containing a byte count and also transmits a checksum to be used for detecting transmission errors.

If the program message containing the GET_WFM? or GET_SET? query contains another query, it must precede the GET_WFM? or GET_SET? query. This is because GET_WFM? and GET_SET? always terminate the response message with the GPIB EOI line. For example, the message

*IDN? ; WFMSEL REF ; GET_WFM?

is valid and returns the *IDN? response followed by the GET_WFM? response. However, the message

WFMSEL REF ; GET_WFM? ; *IDN?

generates an error in the Event Queue and no response data is sent.

Example(s): The message

WFMSEL CUR ; GET_WFM?

is a query for the current waveform file data. The response is in the general form

GET_WFM #0<file_data><NL>^<END>

The response header, GET_WFM, can be disabled using the HEADER OFF command, so the response would be:

#0<file_data><NL>^<END>

GET_WFM?, GET_SET? (ASCII encoding)

NOTE *This form of the GET_WFM? and GET_SET? queries is intended for RS-232 remote-control applications when eight-bit binary data cannot be handled.*

Upload a waveform or settings file from the TFP2A to the controller. Files are read from current or reference memory, depending on which waveform is active. *Remote only.*

Query Syntax: **GET_WFM?**
GET_SET?

Response Syntax: GET_WFM #0,<data><NL>
GET_SET #0,<data><NL>

#0 is the header for the IEEE 488.2 Indefinite Length Arbitrary Block Response Data element. It indicates that all data up to but not including the <NL> is waveform or settings file data. #0 and <NL> (newline) character are not parts of the data and should not be stored in the destination file by the controller.

There is no white space between #0 and <data> and between <data> and <NL> (newline) character.

Discussion: Each eight-bit byte of waveform data in <data> is encoded as two hexadecimal digits. For example, the data sent to FiberMaster when an actual waveform data byte has value 2E hex is the digit 2 (32 hex), followed by the digit E (45 hex). The most significant digit (32 hex) is sent first.

The FILE? query (ASCII or binary encoding) can also be used to upload a waveform or settings file from the TFP2A. The difference between the FILE? query and the GET_WFM? and GET_SET? queries is that the FILE? query response has a header containing a byte count and also transmits a checksum to be used for detecting transmission errors.

Example(s): The following sequence of messages:

WFMSEL CUR
GET_WFM?

returns the response:

GET_WFM #0FEA7...2C<NL>

The first byte of actual waveform data has the hex value FE, the second byte has the hex value A7, and the last byte has the hex value 2C.

Mass-Storage Commands

NOTE *Serial communications are ignored during mass-storage operations. Data can be lost if a mass-storage operation is started via RS-232 and then another RS-232 command is sent before the mass-storage operation is complete.*

*To avoid this problem, send only one mass-storage command in an RS-232 program message, and terminate the message with the operation complete query (*OPC?). Then wait for the response to be returned before sending another command or query.*

BATCHCOPY

Copy multiple files from the internal drive to the external drive, or from the external drive to the internal drive. *Remote only.*

Command Syntax: **BATCHCOPY** <wildcard>

Command Data: <wildcard> ::= <SPD> and specifies a wildcard character that indicates the files to be copied, as follows:

Use *.* to copy all files.
Use *.SET to copy all settings files.
Use *.WFM to copy all waveform files.

The * and ? wildcard characters are supported. The * matches any sequence of characters (not including a dot), and the ? matches any single character (except a dot).

Discussion: Files are copied from the currently selected drive to the other.
Note that file name extensions must be explicitly given, as opposed to commands such as COPYSET (which assumes a .SET extension) or COPYWFM (which assumes a .WFM extension). Extensions can also be specified with wildcards, for example: FIBER05.*

Example(s): DRIVESEL FIXED (select fixed mass-storage drive)
BATCHCOPY WT*.WFM (copy all waveform files that start with the letters WT from the fixed drive to the external drive.)

DRIVESEL REMOV (select removable-media drive)
BATCHCOPY WT?.SET (copy all settings files that start with the letters WT followed by any single character, from the external drive to the fixed drive.

COPYFILE

Copy file from the currently selected drive to the second drive. The currently selected drive is selected by the DRIVESELECT command. (For instruments with both internal RAM and a floppy-disk drive.) *Remote only.*

Command Syntax: **COPYFILE** <filename>

Command Data: <filename> ::= <SPD> and specifies the file name to be copied. The full file name, including extension (if any) must be specified.

Example(s):
COPYFILE "TESTWFM"
COPYFILE "FIB090.WFM"
COPYF "FIB090.SET"
COPYF "850TEST.OBJ"

COPYSET, COPYWFM

Copy file from the currently selected drive to the second drive. The currently selected drive is selected by the DRIVESELECT command. (For instruments with both internal RAM and a floppy-disk drive.) *Remote only.*

Command Syntax: **COPYSET** <filename>
COPYWFM <filename>

Command Data: <filename> ::= <SPD> and specifies the file name to be copied.

Example(s):
COPYW "FIB090"
COPYW "FIB090.WFM"
COPYS "850TEST"
COPYS "850TEST.SET"

Discussion: If no extension is specified in <filename>, COPYSET assumes a .SET extension, and COPYWFM assumes a .WFM extension.

DELETE

Delete specified file from the floppy disk or internal RAM drive. On instruments with both types of drives, the file is deleted from the device selected by the DRIVESELECT command. *Remote only.*

Command Syntax: **DELETE** <filename>

Command Data: <filename> ::= <SPD> and specifies the file name to be deleted. The full file name, including extension (if any), must be specified.

Example(s):
DELETE "TESTWFM"
DELETE "FIB090.WFM"
DELETE "850TEST.SET"
DELETE "850TEST.OBJ"

DELSET, DELWFM

Delete waveform or settings file from the floppy disk or internal RAM drive. On instruments with both types of drive, the file is deleted from the device selected by the DRIVESELECT command. *Remote only.*

Command Syntax: **DELSET** <filename>
DELWFM <filename>

Command Data: <filename> ::= <SPD> and specifies the file name to be deleted.

Example(s):
DELW "FIB090"
DELW "FIB090.WFM"
DELS "850TEST"
DELS "850TEST.SET"

Discussion: If no extension is specified in <filename>, DELSET assumes a .SET extension, and DELWFM assumes a .WFM extension.

DRIVESELECT

Select the internal RAM or floppy-disk drive for subsequent mass-storage operations. (For instruments with internal RAM and a floppy-disk drive.) *Remote only.*

Command Syntax: **DRIVESELECT** <drive>

Command Data: <drive> ::= <CPD> and specified the drive to use for mass storage operations. Options are:

FIXED	Optional internal RAM
REMOVABLE	Floppy-disk drive

Power-On Default: FIXED, unless media is present in the REMOVABLE drive at power on, or internal RAM is not installed.

FORMAT

Format a floppy disk or internal RAM (device selected by the last DRIVESELECT command). *Remote only.*

Command Syntax: **FORMAT**

LOADCUR, LOADREF, LOADSET, LOADRFS

Load waveform or instrument settings from the currently selected device (selected by the DRIVESELECT command) to memory. *Remote only.*

Command Syntax:

LOADCUR <filename>
Load waveform and associated settings into current memory.

LOADREF <filename>
Load waveform and associated settings into reference memory.

LOADSET <filename>
Load settings only into current memory.

LOADRFS <filename>
Load waveform and settings into reference memory, and settings only into current memory.

Command Data: <filename> ::= <SPD> and specifies the file name to be loaded.

Example(s):
```
LOADREF "FIBER11A"
LOADSET "REF_SET"
LOADREF "FIBER11A.WFM"
LOADSET "REF_SET.SET"
```

Discussion: If no extension is specified, LOADCUR, LOADREF, AND LOADRFS assume a .WFM extension, and LOADSET assumes a .SET extension.

MSFORMAT

Select the data format used for waveform files returned by the FILE? and GET_WFM? queries. *Remote only.*

Command Syntax: **MSFORMAT** <msformat>

Command Data: <msformat> ::= <CPD> and specifies the format to be used:

TFP2	TFP2 native format
CFF	Common file format

Discussion: MSFORMAT does not affect the interpretation of files sent to the instrument with the FILNORM, FILHIGH, or PUT_WFM commands. Either TFP2- or CFF-format files can be sent with these commands and FiberMaster automatically determines the format of the data received.

Settings files (returned by the FILE? and GET_SET? queries) are always returned in TFP2 format.

Factory Default: TFP2

SAVECUR, SAVEREF, SAVESET

Save waveform and instrument settings to the mass-storage device selected by the DRIVESELECT command. *Remote only.*

Command Syntax:

SAVECUR <filename>
Save current waveform and associated settings.

SAVEREF <filename>
Save reference waveform and associated settings.

SAVESET <filename>
Save current settings.

Command Data: <filename> ::= <SPD> and specifies the file name to be saved.

Example(s):

```
SAVEC "FIBER221";
SAVES "REF_SET"
SAVEC "FIBER221.WFM"
SAVES "REF_SET.SET"
```

Discussion: If no extension is specified, SAVECUR and SAVEREF assume a .WFM extension, and SAVESET assumes a .SET extension.

The system FIBERID and the current value of the FIBERNOTES and OPERATOR strings, as well as the current date and time (from the realtime clock/calendar) are saved with the waveform.

If the root file name is longer than eight characters, only the first eight are used.

Mass-Storage Queries

DIRECTORY?

Obtain a list of file names stored on the device selected by the DRIVESELECT command. *Remote only.*

Query Syntax: **DIRECTORY?**

Response Syntax: DIRECTORY <list>

Response Data: <list> ::= <SRD> and consists of a quoted string that lists name, creation date, and size (in bytes) of each file on the current drive.

Example(s): Query:
DIRECTORY?

Response:

```
"TRACE.DAT      8-22-93     2345<NL>
TEST.C          4-01-94     7362<NL>
TEST.OBJ        8-21-93     97681<NL>
FIBER07.SET     4-02-94     1294<NL>
LINK.WFM        7-19-94     32984<NL>
"
```

<NL> indicates an ASCII newline within the <SRD> response.

Discussion: DIRECTORY? returns a list of all file names stored on the selected device, including FiberMaster waveform files (.WFM extension), FiberMaster settings files (.SET extension), and non-FiberMaster files. The TYPEFILE? query can be used to determine whether a particular file is a waveform or settings file.

DIRSET?, DIRWFM?

Obtain a list of file names stored on the device selected by the DRIVESELECT command. *Remote only.*

Query Syntax: **DIRSET?** (for settings files)
DIRWFM? (for waveform files)

Response Syntax: DIRSET <list>
DIRWFM<list>

Response Data: <list> ::= <SRD> and consists of a quoted string that lists name, creation date, and size (in bytes) of each file of the type requested.

Example(s): Query:
DIRW?

Response:

```
"FIBER1.WFM      8-22-89      17096<NL>
FIB010.WFM       8-21-89      20732<NL>
FIB0CT9.WFM      10-9-88      23534<NL>
"
```

<NL> indicates an ASCII newline within the <SRD> response.

Discussion: DIRSET? returns a list of files with .SET extensions. If a settings file has a different extension, it is not reported. DIRWFM? returns a list of files with .WFM extensions. If a waveform file has a different extension, it is not reported. Use the DIRECTORY? query in these cases. The TYPEFILE? query can be used to determine whether a particular file is a waveform or settings file.

DRIVEBAT?

Check status of RAM battery, if present. *Remote only.*

Query Syntax: **DRIVEBAT?** <drive>

Query Data: <drive> ::= <CPD> and specifies which device:
FIXED Internal RAM

Response Syntax: DRIVEBAT <status>

Response Data: <status> ::= <NR1>; 0 if battery is OK, 1 if battery is low

DRIVESELECT?

Return currently selected mass-storage device. (For instruments with both internal RAM and a floppy-disk drive.) *Remote only.*

Query Syntax: **DRIVESELECT?**

Response Syntax: DRIVESELECT <drive>

Response Data: <drive> ::= <CRD> and specifies which device is currently selected:

FIXED	Internal RAM drive
REMOVABLE	Floppy-disk drive

FETCHID?

Return the fiber ID stored in a waveform file on the drive currently selected by the DRIVESELECT command. *Remote only.*

Query Syntax: **FETCHID?** <filename>

Query Data: <filename> ::= <SPD>, and specifies the waveform file from which to read the fiber ID. If no extension is specified in <filename>, a .WFM extension is assumed.

Response Syntax: FETCHID <fiberid>

Response Data: <fiberid> ::= <SRD>

Discussion: Use the FIBERID command to specify a fiber ID for the fiber under test.

FETCHNOTE?

Return the fiber notes stored in a waveform file on the device currently selected by the DRIVESELECT command. *Remote only.*

Query Syntax: **FETCHNOTE?** <filename>

Query Data: <filename> ::= <SPD>, and specifies the waveform file from which to read the notes. If no extension is specified in <filename>, a .WFM extension is assumed.

Response Syntax: FETCHNOTE <fibernotes>

Response Data: <fibernotes> ::= <SRD>

Discussion: Use the FIBERNOTES command to specify fiber notes before saving the waveform file.

FETCHOPER?

Return the operator string stored in a waveform file on the drive currently selected by the DRIVESELECT command. *Remote only.*

Query Syntax: **FETCHOPER?** <filename>

Query Data: <filename> ::= <SPD>, and specifies the waveform file from which to read the operator string. If no extension is specified in <filename>, a .WFM extension is assumed.

Response Syntax: FETCHOPER <operator>

Response Data: <operator> ::= <SRD>

Discussion: Use the OPERATOR command to specify operator string for the fiber under test.

MSFORMAT?

Return the data format used for waveform files returned by the FILE? and GET_WFM? queries.

Query Syntax: **MSFORMAT?**

Response Syntax: MSFORMAT <msformat>

Response Data: <msformat> ::= <CRD> and specifies the file format:

TFP2	TFP2 native format
CFF	Common file format

TYPEFILE?

Determine if a mass-storage file is a waveform or settings file. *Remote only.*

Query Syntax: **TYPEFILE?** <file>

Query Data: <file> ::= <SPD>, and specifies the name of the file.

Response Syntax: TYPEFILE <type>

Response Data: <type> ::= <NR1> and specifies the file type:

1	settings file
2	waveform file
0	neither waveform or settings file

Example(s): The following query is sent to determine which type file unknown.xyz is:

```
TYPEFILE? "unknown.xyz"
```

The response indicates a waveform file:

```
TYPEFILE 2
```

Discussion: If the currently selected mass-storage device is unreadable for any reason, 0 is returned.

Hardcopy Commands and Queries

GPLTSCREEN

Sends printer or plotter commands to draw a representation of the acquisition screen to a GPIB printer or plotter. *Remote only. RS-232 only.*

Command Syntax: **GPLTSCREEN**

Discussion: The HCTYPE command specifies the format of the data sent to the GPIB port.

HPGL plotters only: the display is scaled to A-size (8.5 by 11 inches) on the plotter.

The printer or plotter connected to FiberMaster's GPIB port must be configured for listen-only mode.

GPLTTEXT

Sends printer or plotter commands to draw a text string on a GPIB printer or plotter. *Remote only. RS-232 only.*

Command Syntax: **GPLTTEXT** <test>,<x>,<y>

Command Data: <text> ::= <SPD> specifying the text string to print or plot (80-character maximum). The escape characters \n and \r can be used in <text> to send a newline character or a carriage return to the printer or plotter. The escape character \f can be used in <text> to send a formfeed character to a printer.

HPGL plotter: <x> and <y> ::= <DPND> specifying (in plotter coordinates) the desired location of the text string. The text string is left justified at this location. The x and y coordinates are relative to the minimum x and y hard-clip limits of the plotter.

ThinkJet printer: <x> and <y> are required arguments, but their values are ignored. The text string is printed at the current paper position.

Discussion: The HCTYPE command specifies the format of the data sent to the GPIB port.

The printer or plotter connected to FiberMaster's GPIB port must be configured for listen-only mode.

HCTYPE

Set the format of data output as a result of issuing the GPLTSCREEN? and GPLTTEXT? queries and the SPLTSCREEN and SPLTTEXT commands. *Remote only.*

Command Syntax: **HCTYPE** <hctype>

Command Data: <hctype> ::= <CPD> Options are:

PLOTTER	HPGL data
THINKJET	Data format for ThinkJet printer
EPSON	Data format for Epson printer
POSTSCRIPT	Data format for PostScript printer

Factory Default: PLOTTER

Discussion: When using the GPLTSCREEN? or GPLTTEXT? queries, the EPSON and POSTSCRIPT options are provided for the purpose of transferring Epson- or PostScript-compatible print commands via GPIB.

IPRNSCREEN

Format and send a representation of the display screen to the internal printer. *Remote only.*

Command Syntax: **IPRNSCREEN**

IPRNTEXT

Send a text string to the internal printer. *Remote only.*

Command Syntax: **IPRNTEXT** <textstring>

Command Data: <textstring> ::= <SPD> and specifies a quoted string 1 to 80 characters in length. The escape sequences **\n** and **\f** can be used in <textstring> to send a newline character or a form feed character to the printer.

SPLTSCREEN

Format waveform and associated settings and output to an external RS232 plotter or printer. *Remote only. GPIB only.*

Command Syntax: **SPLTSCREEN**

Discussion: The data format is determined by the HCTYPE command. An A-size plot (8.5" x 11") is produced.

SPLTTEXT

Print text string on an external serial plotter or printer. *Remote only. GPIB only.*

Command Syntax: **SPLTTEXT** <text>,<x>,<y>

Command Data: <text> ::= <SPD> specifying the text string to plot. (80 characters maximum.) The escape characters **\n** and **\r** can be used in <text> to send a newline character or a carriage return character to the plotter.
<x> and <y> ::= <DNPD> specifying (in plotter coordinates) the desired location of the text string.

Discussion: The HCTYPE command specifies the type of data to be printed by this command.

GPLTSCREEN?

Return printer or plotter commands to draw a representation of the acquisition screen, including waveform(s) and instrument settings. *Remote only. GPIB only.*

Query Syntax:	**GPLTSCREEN?**
Response Syntax:	<printer/plotter commands><NL>^<END>
Response Data:	<printer/plotter commands> is the sequence of printer or plotter commands needed to draw the waveform(s) and settings on a printer or plotter.
Discussion:	The HCTYPE command specifies the data format to be returned by this query. (If the format is specified as EPSON or POSTSCRIPT, the data is intended for transferring via GPIB.) A response header is never sent for this query. GPLTSCREEN? must be sent as the last or only query in a program message because it asserts the END line after the data is sent. HPGL plotters only: the display is scaled to A-size (8.5 by 11 inches) on the plotter. For more information on sending data to a GPIB hardcopy device, refer to the section *Using a GPIB Plotter or Printer*, in this chapter.

NOTE *The response for this query is not a 488.2-compatible response-data format.*

GPLTTEXT?

Return printer or plotter commands to draw a text string. *Remote only. GPIB only*

Query Syntax: **GPLTTEXT?** <text>,<x>,<y>

Query Data: <text> ::= <SPD> specifying the text string to print or plot. (80 characters maximum.) The escape characters **\n** and **\r** can be used in <text> to send a newline character or a carriage return character to the printer or plotter. The escape character **\f** can be used in <text> to send a form-feed character to a printer.

HPGL plotter: <x> and <y> ::= <DNPD> specifying (in plotter coordinates) the desired location of the text string. The text string is left justified at this location. The x and y coordinates are relative to the minimum x and y hard-clip limits of the plotter.

ThinkJet printer: <x> and <y> are required arguments, but their values are ignored. The text string is printed at the current paper position.

Response Syntax: <printer/plotter commands><NL>^<END>

Response Data: <printer/plotter commands> is the sequence of printer or plotter commands needed to draw the text string on the printer or plotter.

Discussion: The HCTYPE command specifies the type of data to be returned by this query.

A response header is never sent for this query. GPLTTEXT? must be sent as the last or only query in a program message because it asserts the END line after the data is sent.

For more information on sending data to a GPIB hardcopy device, refer to the section *Using a GPIB Plotter or Printer*, in this chapter.

NOTE *The response for this query is not a 488.2-compatible response-data format.*

HCTYPE?

Return the format of data output to the GPIB port. *Remote only.*

Query Syntax: **HCTYPE?**

Response Syntax: HCTYPE <hctype>

Response Data: <hctype> ::= <CRD>
Values are: PLOTTER (HPGL data), THINKJET, EPSON, and POSTSCRIPT.

Display-Related Commands and Query

GSTATUS

Enable or disable the display of GPIB interface status information on the instrument screen. (Status information is shown only when the instrument is under remote control.) *Remote only.*

Command Syntax: **GSTATUS** <option>

Command Data: <option> ::= <CPD>| <DNPD> Possible values are ON|OFF. (A number that rounds to an integer value of 0 can be used instead of OFF. A number that rounds to a nonzero integer value can be used instead of ON.)

Discussion: Interface status is displayed in the lower right corner of the screen when the instrument is under remote control. The following information is displayed:

MA nn	My Address; nn indicates the current bus address of the instrument.
LSTN	Addressed to listen indicator
TALK	Addressed to talk indicator
SRQ	Service request indicator; set when the service request line is asserted.

Status indicators are erased when the instrument returns to local control, and are redisplayed upon returning to remote control.

MESSAGE

Post a text message on the instrument display screen. *Remote only.*

Command Syntax: **MESSAGE** <msg_type>,<msg>

Command Data: <msg_type> ::= <CPD> Possible values are INFORM|REQUEST|ERROR.:

INFORM	Informative message
REQUEST	User request
ERROR	Error indication

The color of the message on the display depends on the message type.

<msg> ::= <SPD> and is the text of the message to display, up to a maximum of 150 characters. The display area reserved for the message is 50 characters by three lines in size. To cause text to wrap to the next line, an ASCII newline character (0A hex) can be inserted in the message.

A null string ("" or ’’) clears any message previously posted on the display using MESSAGE. In this case, the <msg_type> is ignored.

Discussion: The message is erased when the instrument returns to local control, and is redisplayed upon returning to remote control.

SOFTKEY

Program a softkey to generate a user-request event (URQ) in the Standard Event Status Register and Event Queue (if enabled by the Device Event Status Register). Available only in REMS (remote state without local lockout). *Remote only*.

Command Syntax: **SOFTKEY** <keynum>,<text>

Command Data: <keynum> ::= <DNPD> and specifies which key to program. The topmost softkey is **Return to Local**, and is not programmable. The remaining softkeys are programmable, and specified as 1 through 5. If display status has been enabled (using the GSTATUS command), softkeys 4 and 5 are not available for programming.

<text> ::= <SPD> and specifies the text to display on softkey <keynum>. A null string ("" or ''), or a string containing only ASCII blanks (20 hex) disables generation of the URQ event for that softkey, and erases the text on the softkey.

Discussion: When softkey n has been programmed and is then pressed, the user-request event 4030 + n is generated in the Event Queue. For example, pressing softkey 1 would generate this Event Queue entry: 4031, "User request; Softkey 1 actuation".

The controller can be asynchronously notified of the actuation of a softkey by programming the instrument to request service when the corresponding URQ event occurs. Use of the SOFTKEY command with the MESSAGE command allows an interactive dialog to be used between the instrument operator and the controller during remote operation.

Upon return to local control, programmable softkey definitions are retained but not enabled. When the instrument returns to remote control (without local lockout), the previously programmed softkeys are displayed and enabled.

GSTATUS?

Determine if GPIB interface status is currently shown on the instrument display. *Remote only.*

Query Syntax: **GSTATUS?**

Response Syntax: GSTATUS <option>

Response Data: <option> ::= <NR1> Possible values are 0|1 (not shown or shown).

Identification Query

*IDN?

Allows unique identification of devices over the system interface.

Query Syntax: ***IDN?**

Response Syntax: Returns four fields separated by commas in the <Arbitrary ASCII Response Data> format:

TEKTRONIX,TFP2A | TFP2AM,0,CF:89.1ST <v68020> <v34010> <vplugin1> <vplugin2> <vacqsys>

Response Data: The response elements are defined as follows:

TEKTRONIX	Manufacturer
TFP2A	Model number
0	Place holder for serial number (not used)
CF:89.1ST<SP>	Tek Codes & Formats 89.1, Flat header structure (no colons) (adapted Tek Codes and Formats 1981 waveform handling)
<v68020><SP>	<v68020>::=version number of 68020 firmware ROM
<v34010><SP>	<v34010>::=version number of 34010 ROM
<vplugin1><SP>	vplugin1>::=version number of plug-in 1 ROM
<vplugin2><SP>	<vplugin2> ::= version number of plug-in 2 ROM
<vacqsys>	<vacqsys>::=acquisition system version number

Note that each element of the fourth field is separated by an ASCII space.

If the instrument contains no plug-in modules, the response includes the string **A0.00A** instead of plug-in ROM version numbers.

Discussion: The response to the *IDN? query is terminated by asserting the END line concurrently with sending the newline character. The query must be sent as the only or last query in a program message, or event 440 is generated.

Learn Settings Queries

NOTE *GPIB commands that change instrument settings do not save the new settings as power-on defaults. To save instrument settings, use the SET or *LRN? query. These queries both generate response data in the form of resendable GPIB commands that you can use to set the instrument back to its current configuration.*

*LRN?

Learn instrument setup query.

Query Syntax: ***LRN?**

Response Syntax: See SET? query.

SET?

Learn instrument settings.

Query Syntax: **SET?**

Response Syntax: <instrument settings>

Response Data: <instrument settings> ::= concatenated settings commands, separated by semicolons.

Discussion: Response is a directly resendable set of GPIB commands, separated by semicolons, which sets the instrument to its current settings. Settings include:

MODSELECT	Select module
AVERAGES	Select number of averages used for acquisition
BAUDRATE	Set serial-port baud rate
CALCSLOPE	Select slope-calculation method
ENCDG	Specify ASCII or binary waveform encoding
EVNTMARKING	Select automatic or manual event marking
EVNTTHRESH	Set event-marking threshold
FIBERID	Specify fiber ID string
FIBERNOTES	Specify fiber notes string
FLOW	Set RS232 method of flow control
HCTYPE	Select hardcopy data format
HEADER	Enable/disable headers
MASKSET	Select masking option
NCHARBITS	Specify serial-port bits per character
NSTOPBITS	Specify serial-port number of stop bits
OPERATOR	Specify operator string
PARITY	Specify serial-port parity
PULSRNG	Select pulse width and range settings
REFINDEX	Set refractive index

SCATTERCOEFF	Set scattering coefficient
SHOWMARKER	Enable/disable display of event markers
TRACE	Select double- or single-trace display
UNITS	Select distance-measurement units
WFMSELECT	Select active waveform

Reset and Stop Commands

*RST

Reset instrument settings. *Remote only.*

Command Syntax: ***RST**

Discussion: Set instrument settings to factory and power-on defaults with the following exceptions:

(1) The GPIB address is not changed.
(2) The output queue is unaffected.
(3) The Standard Event Status Enable Register and Service Request Enable Register are unaffected.

If RS-232 remote control is active, RS-232 parameters (baud rate, parity, data bits, stop bits, and flow control) are not affected.

If a real-time acquisition is in progress, it is stopped. The display screen is updated to show an acquisition screen with cursors in power-on positions. Any previously acquired waveform(s) are cleared from data memory and from the display.

If immediately preceded by a device-clear message (SDC or DCL), *RST aborts any current device operation, with the exception of mass storage operations.

STOP

Stop operation. *Remote only.*

Command Syntax: **STOP**

Discussion: Use the STOP command to abort the following types of operations: averaged acquisitions, measurements, hardcopy operations, and diagnostic tests. To abort one of these operations, send a device-clear interface message (SDC or DCL), immediately followed by the STOP command.

The STOP command also causes the instrument to exit realtime acquisition mode. In this case, the device-clear message is not necessary.

Status and Error-Reporting Commands

CLS

GPIB: clear the Status Byte Register except for MAV bit, the Standard Event Status Register, and the Event Queue, but do not clear the Output Queue. If the instrument is currently requesting service, it releases the SRQ line and clears the RQS bit in the Status Byte Register.

RS-232: clear the Standard Event Status Register and Event Queue, but do not clear the Output Queue.

Command Syntax: ***CLS**

DESE

Device event status enable command. Specify which event types are summarized in the Standard Event Status Register and logged in the Event Queue.

Command Syntax: **DESE** <mask>

Command Data: <mask> ::= <DNPD> and sets a bit mask that indicates which types of events are summarized in the Standard Event Status Register and logged in the Event Queue. Possible values are 0 to 255, inclusive.

Power-On Default: 255 (all events enabled)

*ESE

Set the Standard Event Status Enable Register bits.

Command Syntax: ***ESE** <mask>

Command Data: <mask> ::= <DNPD> and specifies the status byte mask value. Possible values range from 0 to 255 inclusive.

Example(s): *ESE 100

Power-On Default: 0 (no events enabled)

*SRE

Set the Service Request Enable Register bits.

Command Syntax: ***SRE** <mask>

Command Data: <mask> ::= <DNPD> and specifies the byte-mask value for the Service Request Enable Register (0 through 255, inclusive).

Example(s): *SRE 100

Power-On Default: 0 (service requests disabled)

Status and Error-Reporting Queries

DESE?

Return Device Event Status Enable Register settings.

Query Syntax:	**DESE?**
Response Syntax:	DESE <mask>
Response Data:	<mask> ::= <NR1> and equals the current value of the Device Event Status Enable Register.

*ESE?

Return the current contents of the Standard Event Status Enable Register.

Query Syntax:	***ESE?**
Response Syntax:	<mask>
Response Data:	<mask> ::= <NR1>, and equals the current value of the Standard Event Status Enable Register, in the range 0 to 255.

*ESR?

Read and clear the Standard Event Status Register, and enable entries in the Event Queue to be read and removed by the EVENT? and EVMSG? queries.

Query Syntax:	***ESR?**
Response Syntax:	<mask>
Response Data:	<mask> ::= <NR1> and equals the value of the Standard Event Status Register. Possible responses are in the range from 0 to 255, inclusive.

EVENT?

Read and remove a single code from the Event Queue associated with the results of the last read of the Standard Event Status Register (*ESR?).

Query Syntax:	**EVENT?**
Response Syntax:	EVENT <eventcode>
Response Data:	<eventcode> ::= <NR1> and specifies the event code

EVMSG?

Read and remove a single code and message pair from the Event Queue associated with the results of the last read of the Standard Event Status Register (*ESR?).

Query Syntax:	**EVMSG?**
Response Syntax:	EVMSG <eventcode>,<eventmsg>
Response Data:	<eventcode> ::= <NR1> and specifies the event code <eventmsg> ::= <SRD> and specifies the event message.

**SRE?*

Return the contents of the Service Request Enable Register.

Query Syntax:	***SRE?**
Response Syntax:	<mask>
Response Data:	<mask> ::= <NR1> and equals the current value of the Service Request Enable Register.

**STB?*

Read the status byte and Master Summary Status bit. MSS is reported on bit 6.

Query Syntax:	***STB?**
Response Syntax:	<statusbyte>
Response Data:	<statusbyte> ::= <NR1> and specifies the current value of the status byte.

Device Synchronization Commands and Query

*OPC

Cause the instrument to generate the operation-complete message in the Standard Event Status Register and log event 402 in the Event Queue (if enabled in the DESER).

Command Syntax: ***OPC**

*WAI

Functions as a no-op. Provided for 488.2 compatibility.

Command Syntax: ***WAI**

*OPC?

Place a 1 in the instrument's Output Queue.

Query Syntax: ***OPC?**

Response Syntax: 1

Selftest Queries

*TST?

Perform instrument self tests. *Remote only.*

Query Syntax: ***TST?**

Response Syntax: <test_result>

Response Data: <test_result> ::= <NR1> Possible values are:
0 All self tests passed.
1 At least one self test failed.

Discussion: Instrument settings and stored data are not affected by the selftest sequence.

Detailed selftest results can be obtained by sending the TSTRESULT? query after sending *TST?. *TST? clears the results stored during the execution of any previous *TST? query.

The *TST? query takes approximately two and one-half minutes to execute.

The selftest includes tests of any installed mass-storage drive. Before sending the *TST? query, make sure that each drive contains correctly formatted, non-write-protected media.

If RS-232 remote control is active, the *TST? query does not run tests of FiberMaster's RS-232 interface.

CAUTION *Do not use media containing any data files. A failure of the tests could result in the corruption and/or loss of any or all data.*

TSTRESULT?

Obtain detailed results from last *TST? query. *Remote only.*

Query Syntax: **TSTRESULT?**

Response Syntax: TSTRESULT <results>

Response Data: <results> ::= <SRD>, and describes the results from the last *TST? .selftests

GPIB Programming Example

A hypothetical controller language is used in the following GPIB programming example. It includes the following statements:

SEND addr;"program message"
Send program message enclosed in quotes (plus a program message terminator <NL>^<END>) to the device at bus address **addr**.

RECEIVE addr;response
Read response message from device at bus address **addr**. The text of the response is placed in the variable **response** (excluding the response message terminator <NL>^<END>).

READ STATUS BYTE addr;status
Serial poll device at bus address and place contents of device's Status Byte Register in variable **status**.

WAIT_SRQ
Optionally exchange messages with other devices on the bus while waiting for a service request.

The example is as follows:

SEND 7;"HEADER OFF"

Disable response headers

SEND 7;"AVERAGE 1024;REFINDEX 1.4560;FIBERID 'ALPHA_D'"

Set number of averages and refractive index for the fiber to be tested, and store fiber ID.

SEND 7;"MODSELECT UPPER,MM850"

Select 850-nm multimode laser from module in upper front panel slot.

SEND 7;"PULSELIST? 20.0"

Determine pulse widths available when a maximum range of 20.0 km is used with the currently selected module.

RECEIVE 7;response

Sample response: **1.0,3.0,8.0,20.0,50.0**. Response data elements are available pulse widths, in nanoseconds.

SEND 7;"PULSRNG 8,20"

Set pulse width to 8 ns and maximum range to 20 km.

SEND 7;"DENSITYLIST?"

Request available sampling densities for currently selected module and with the current pulse width and maximum range settings.

RECEIVE 7:response

Sample response: **0.00020,0.00005**. Response data elements are sampling intervals in kilometers. 0.00020 is the normal-density sampling interval. 0.00005 is the high-density sampling interval.

SEND 7;"*SRE 16"

Enable a service request when data becomes available in the output queue.

SEND 7;ACQUIRE 5.0,START,HD1; *OPC?"

Run a high-density acquisition at 5.0 km.

WAIT_SRQ

Wait for a service request from FiberMaster when response data becomes available. Optionally exchange messages with other devices in the meantime.

READ STATUS BYTE 7;status

Status byte read from device at address 7 is 80 (decimal), indicating that the RQS bit (64 decimal) and the MAV bit (16 decimal) are both set.

RECEIVE 7;response

Response: **1**.

SEND;"*SRE 0"

Disable FiberMaster service requests.

SEND 7;"ENCDG BIN;WFMPRE?"

Request binary waveform encoding for the CURVE? query response, and size and scaling information for the active waveform.

RECEIVE 7;response

Sample response: **WFID "ALPHA_D"; NR_PT 16000; XINCR 0.00005; PT_OFF 0; XZERO 5.0; YMULT 0.001562; YZERO 0.0; YOFF 0.0**, indicating a waveform ID of ALPHA_D, the waveform contains 16,000 points, the sample interval is 0.00005 kilometers, x-coordinate for the nth point on the waveform is 5.0 km + n*0.00005 kilometers (n = 0, 1, ..., 15999), the y-coordinate for the nth point can be multiplied by 0.001562 to obtain a dB value.

SEND 7;"CURVE?"

Return data for the active waveform.

RECEIVE 7;response

Sample response: **#532001<wfm_y_data><checksum>** where 5 is the number of digits following, which give the number of bytes remaining in the response. <wfm_y_data> consists of 16,000 two-byte y values, and <checksum> is a one-byte, 2's-complement checksum of all preceding bytes, except the #.

SEND 7;"DIRWFM?"

Get a directory of waveform files stored on the diskette in the instrument's disk drive.

RECEIVE 7;response

Sample response:

"**ALPHA_A.WFM 07-07-89 11326**
ALPHA_B.WFM 07-06-89 20342
ALPHA_C.WFM 06-10-89 15826
"

giving the names, creation dates, and sizes of the files.

SEND 7;"LOADREF 'ALPHA_C'; TRACE DUAL;
WFMSELECT REF"

Load waveform and associated settings from the file ALPHA_C.WFM into reference memory, enable dual-trace mode, and select the reference waveform as the active one.

SEND 7;"CALCSLOPE LSA; TWOPOINT? 5.1,5.2"

Change the method of slope calculation to LSA, and perform two-point calculations between 5.1 and 5.2 km on the active waveform.

RECEIVE 7;response

Sample response: **5.1,5.2,0.101,9.3E-1**. 5.1 and 5.2 km are the data points at which the two-point measurements were made. 0.101 dB is the loss, and .93 is the waveform slope.

SEND 7;"BAUD 1200;FLOW XON"

Set RS232 port baud rate to 1200, and use XON/XOFF flow control.

SEND 7;"WFMSELECT CUR; SAVECUR "ALPHA_D"; SPLTSCREEN"

Make the current waveform the active one, and save the waveform data to disk in the file ALPHA_D.WFM. Send a waveform plot to an external serial plotter.

RS-232 Programming Example

A hypothetical controller language is used in the following RS-232 programming example. It includes the following statements:

SEND "program message"
Send program message enclosed in quotes (plus a program message terminator <NL>) to FiberMaster.

RECEIVE response
Read response message from device at bus address **addr**. The text of the response is placed in the variable **response** (excluding the response message terminator <NL>).

The example is as follows:

SEND "HEADER OFF"

Disable response headers

SEND "AVERAGE 1024;REFINDEX 1.4560;FIBERID 'ALPHA_D'"

Set number of averages and refractive index for the fiber to be tested, and store fiber ID.

SEND "MODSELECT UPPER,MM850"

Select 850-nm multimode laser from module in upper front panel slot.

SEND "PULSELIST? 20.0"

Determine pulse widths available when a maximum range of 20.0 km is used with the currently selected module.

RECEIVE response

Sample response: **1.0,3.0,8.0,20.0,50.0**. Response data elements are available pulse widths, in nanoseconds.

SEND "PULSRNG 8,20"

Set pulse width to 8 ns and maximum range to 20 km.

SEND "DENSITYLIST?"

Request available sampling densities for currently selected module and with the current pulse width and maximum range settings.

RECEIVE response

Sample response: **0.00020,0.00005**. Response data elements are sampling intervals in kilometers. 0.00020 is the normal-density sampling interval. 0.00005 is the high-density sampling interval.

SEND "ACQUIRE 5.0,START,HD1; *OPC?"

Run a high-density acquisition at 5.0 km.

RECEIVE response

Response: **1**.

SEND "ENCDG BIN;WFMPRE?"

Request binary waveform encoding for the CURVE? query response, and size and scaling information for the active waveform.

RECEIVE response

Sample response: **WFID "ALPHA_D"; NR_PT 16000; XINCR 0.00005; PT_OFF 0; XZERO 5.0; YMULT 0.001562; YZERO 0.0; YOFF 0.0**, indicating a waveform ID of ALPHA_D, the waveform contains 16,000 points, the sample interval is 0.00005 kilometers, x-coordinate for the nth point on the waveform is 5.0 km + n*0.00005 kilometers (n = 0, 1, ..., 15999), the y-coordinate for the nth point can be multiplied by 0.001562 to obtain a dB value.

SEND "CURVE?"

Return data for the active waveform.

RECEIVE response

Sample response: **#532001<wfm_y_data><checksum>** where 5 is the number of digits following, which give the number of bytes remaining in the response. <wfm_y_data> consists of 16,000 two-byte y values, and <checksum> is a one-byte, 2's-complement checksum of all preceding bytes, except the #.

SEND "DIRWFM?"

Get a directory of waveform files stored on the diskette in the instrument's disk drive.

RECEIVE response

Sample response:

"**ALPHA_A.WFM 07-07-89 11326**
ALPHA_B.WFM 07-06-89 20342
ALPHA_C.WFM 06-10-89 15826
"

giving the names, creation dates, and sizes of the files.

**SEND "LOADREF 'ALPHA_C'; TRACE DUAL;
WFMSELECT REF"**

Load waveform and associated settings from the file ALPHA_C.WFM into reference memory, enable dual-trace mode, and select the reference waveform as the active one.

SEND "CALCSLOPE LSA; TWOPOINT? 5.1,5.2"

Change the method of slope calculation to LSA, and perform two-point calculations between 5.1 and 5.2 km on the active waveform.

RECEIVE response

Sample response: **5.1,5.2,0.101,9.3E-1**. 5.1 and 5.2 km are the data points at which the two-point measurements were made. 0.101 dB is the loss, and .93 is the waveform slope.

SEND "WFMSELECT CUR; SAVECUR "ALPHA_D"; GPLTSCREEN"

Make the current waveform the active one, and save the waveform data to disk in the file ALPHA_D.WFM. Send a waveform plot to an external GPIB plotter.

Remote Control Event Codes and Messages

Queue Status Codes

0, "No events to report - queue empty"
The Event Queue is empty.

1, "No events to report - new events pending *ESR?"
The Event Queue contains events, but an *ESR? query must be issued to enable them for reading. The *ESR? response summarizes which types of events are in the queue.

350, "Too many events"
The Event Queue has overflowed. More than eight events have been written to it since the last *ESR? query. Event 350 does not log an event to the SESR.

Command Errors

Command-error codes are in the range from 100 to 199, and set the CME bit in the Standard Event Status Register.

102, "Syntax error; invalid starting character for token: [token]"
The parser has started scanning the first or next token in a program message and has determined that its first character is invalid.

102, "Syntax error; unexpected character in token: token[char]"
A character inconsistent with the definition of a token has been found while scanning a token.

NOTE *"char" is the character causing the error. If printable, it appears literally in the event message, otherwise the ASCII hexadecimal value of the character appears in the format xxH.*

102, "Syntax error; unexpected end-of-message in token: token [xxH]"
102, "Syntax error; unexpected end-of-message in token: token[END]"
An end-of-message has been detected while scanning an incomplete token. (An ASCII newline within a data element other than string program data, or the concurrent assertion of the GPIB EOI line with a data byte in an incomplete token.)

102, "Syntax error; unexpected token in message: [token]"
A token has occurred in a program message in a place that violates IEEE 488.2 device-listening format.

102, "Syntax error; token too long: [last 20 characters of token]"
A token longer than 256 characters has been detected.

104, "Data type error"
A data element sent for a command or query does not match the type of element required. For example, a <CPD> element is sent when a <DNPD> element is expected.

108, "Parameter not allowed"
Too many data elements have been sent for a command or query.

109, "Missing parameter"
A command or query is missing a required parameter.

110, "Command header error; too short"
A command or query header shorter than three characters has been received.

110, "Command header error; too long"
A command or query header longer than 12 characters has been received.

110, "Command header error; abbreviation not unique"
A command or query was abbreviated using the same characters used to abbreviate another command or query.

113, "Undefined header"
A command or query with an unrecognized header was received.

120, "Numeric data error; conversion error"
A floating-point conversion error occurred during an attempt to convert a <DNPD> element to internal representation.

123, "Numeric overflow"
A <DNPD> element was received that contained an exponent of absolute value greater than 32,000.

124, "Too many digits"
A <DNPD> element was received that contained more than 255 characters.

144, "Character data too long"
A <CPD> element longer than 12 characters was received.

150, "String data error; too long"
An <SPD> element longer than 255 characters was received.

Execution Errors

Execution-error codes are in the ranges from 200 to 299 and 2000 to 2999, and set the EXE bit in the Standard Event Status Register.

220, "Parameter error; unrecognized <CPD> element"
An invalid <CPD> element was received.

220, "Parameter error; invalid value"
A numeric data element is invalid for a reason not related to range.

220, "Parameter error; abbreviation not unique"
A non-unique abbreviation for a <CPD> element has been received.

220, "Parameter error; ON, OFF, 0 or 1 required"
Indicates that a command or query that takes an ON|OFF or 0|1 argument received an invalid argument.

220, "Parameter error; incorrect format for date"
The argument for the DATE command contained an incorrectly formatted date.

220, "Parameter error; incorrect format for time"
The argument for the TIME command contained an incorrectly formatted time.

222, "Data out of range"
Indicates that a <DNPD> element was outside the valid range.

241, "Hardware missing; printer not installed"
A command to write data to an internal printer was received, but no printer is installed.

250, "Mass storage error"
Generic mass-storage media error.

250, "Mass storage error; no waveform data stored"
An attempt was made to save the current or reference waveform to mass storage when no waveform data is stored in current or reference memory.

251, "Missing mass storage"
A mass-storage command or query was received but no disk or internal RAM is installed.

251, "Missing mass storage; no fixed RAM drive"
A command or query has requested an operation on a fixed RAM drive but no such drive is installed.

251, "Missing mass storage; no floppy-disk drive."
A command or query has requested an operation on a floppy disk drive but no such drive is installed.

252, "Missing media"
A mass storage operation was attempted with a floppy-disk drive when the media is removed.

253, "Corrupt media"
A bad sector or format error has been detected on the floppy disk.

254, "Media full"
The floppy disk is full.

255, "Directory full"
The MS-DOS directory is full.

256, "Filename not found"
A read or delete command specified a nonexisting file name.

257, "Filename error"
An invalid MS-DOS file name was specified.

258, "Media protected"
An attempt to write or delete a file or format the floppy disk was made, but the media is write protected.

2001, "Instrument state error; command accepted only in remote state"
A command was received in LOCS or LWLS that can only be executed in REMS or RWLS.

2002, "Instrument state error; query accepted only in remote state"
A query was received in LOCS or LWLS that can only be executed in REMS or RWLS.

2003, "Instrument state error; command not accepted in real-time mode"
The instrument is in real-time acquisition mode and the command received is not allowed in this mode.

2004, "Instrument state error; query not accepted in real-time mode"
The instrument is in real-time acquisition mode, and the query received is not allowed in this mode.

2006,"Instrument state error; command accepted only under 488 remote control"
A command available only under GPIB remote control was received while RS-232 remote control was active.

2007, "Instrument state error; query accepted only under 488 remote control"
A query available only under GPIB remote control was received while RS-232 remote control was active.

2008, "Instrument state error; command accepted only under RS-232 remote control"
A command available only under RS-232 remote control was received while GPIB remote control was active.

2009, "Instrument state error; query accepted only under RS-232 remote control"
A query available only under RS-232 remote control was received while GPIB remote control was active.

2010, "Instrument state error; indefinite length binary data format not allowed under RS-232 remote control"
One of the commands and queries PUT_WFM, PUT_SET, GET_WFM?, or GET_SET? was received when the waveform encoding (ENCDG command) was set to BINARY. Only the ASCII versions of these commands and queries are supported under RS-232 remote control.

2101, "Density parameter error; not available for active laser"
The specified density level is not available for the active laser.

2102, "Module selection error; no module detected in plug-in, or no plug-in"
2103, "Module selection error; requested module not present in plug-in"
The MODSELECT command was issued with parameters that do not match the instrument's optics-module configuration.

2152, "Module setting error; masking unavailable for current module"
The currently selected optics module does not support masking.

2153, "Module setting error; unavailable pulse width"
The currently selected optics module does not support the requested pulse width.

2154, "Module setting error; unavailable range"
The currently selected optics module does not support the requested maximum range.

2155, "Module setting error; unavailable pulse width and range"
The currently selected optics module does not support the requested pulse width and range.

2156, "Module setting error; unavailable combination of pulse width and range"
An invalid combination of pulse width and range was selected for the current optics module.

2251, "Measurement start error; unavailable in real-time mode"
Splice-loss measurements were attempted while the instrument was in real-time mode.

2252, "Measurement start error; distance not in acquisition range"
Invalid distance specified for splice-loss measurement.

2253, "Measurement start error; distance 1 not in acquisition range"
2254, "Measurement start error; distance 2 not in acquisition range"
2255, "Measurement start error; neither distance in acquisition range"
Invalid distance(s) specified for two-point measurement.

2260, "Return loss inaccurate; clipped reflection(s) or data out of calibration range"
Generated by the EVNTRTNLOSS? and LINKRTNLOSS? queries if the loss value reported in the query response is not accurate due to clipping of the waveform.

2271, "Cursor positioning error; distance out of range"
An attempt was made to move the cursor outside the distance range shown in overview mode.

2272, "Window sizing error; width too large"
An attempt was made to change the width of the expansion window to more than the distance range shown in overview.

2273, "Window sizing error; width too small"
An attempt was made to change the width of the expansion window to include fewer than 100 data points.

2274, "Window sizing error; height too large"
An attempt was made to change the height of the expansion window to exceed the amplitude range shown in overview.

2275, "Window sizing error; height too small"
An attempt was made to change the height of the expansion window to less than 1 dB.

2276, "Window locating error; distance out of range"
An attempt was made to center the expansion window at a location outside the distance range shown in overview.

2277, "Window locating error; amplitude out of range"
An attempt was made to center the expansion window at an amplitude outside the range from -30 to 50 dB.

2302, "Waveform setting error; attempt to change reference waveform settings"
An attempt was made to change settings while the reference waveform was active.

2401, "Display command error; attempt to program softkeys in RWLS"
An attempt to enable events from the front-panel softkeys was made during local lockout.

2402, "Display command error; attempt to program softkey 4 or 5 when GPIB status shown"
An attempt was made to program softkey 4 or 5 when they were disabled by the display of GPIB status indicators.

2501, "Waveform/settings file error; Bad file data version"
Indicates that an unrecognized waveform or file settings version number was received.

2504, "Waveform/settings file error; Miscellaneous data error"
Indicates a possible transmission error or application program error related to reading data from a waveform or settings file.

2505, "Waveform/settings file error; All data wasn't received"
Indicates that not all data needed to store the waveform and/or settings on the instrument was received. Data was lost during transmission or the application program did not send the complete data for the waveform or settings.

2508, "Waveform/file settings error; Invalid data header format"
A FILNORM, FILHIGH, or FILSET command was received that had an incorrect header format.

2509, "Waveform file/settings error; Non-hex digit in ASCII encoding"
ASCII waveform encoding (ENCDG ASCII) is in effect, and one of the commands FILNORM, FILHIGH, PUT_WFM, or PUT_SET was received that had a character other than a hexadecimal digit in the data portion of the command data argument.

2510, "Waveform file/settings error; Data header count doesn't match byte count"
The number of data bytes (including the checksum byte) received in the FILNORM, FILHIGH, or FILSET command does not match the data count encoded in the command argument header.

2511, "Waveform file/settings error; Checksum error"
The checksum received as part of the data argument of a FILNORM, FILHIGH, or FILSET command does not match that computed by FiberMaster. Either the checksum sent to FiberMaster was incorrectly computed or a transmission error has occurred.

2601, "Event marking error; Requested operation not available in automatic event marking mode"

2602, "Event marking error; Event or marker number out of range"
The event or marker number supplied to a command or query is not in the range of 1 through the current number of events in the event table.

2603, "Event marking error; Events notes too long"
An attempt was made to store event notes that exceeded 79 characters in length.

2604, "Event marking error; Marker distance not in acquisition range"
An attempt was made to add or delete an event marker at a distance that is not within the distance spanned by the active waveform.

2605, "Event marking error; No marker at the given distance"
An attempt was made to delete a marker at a distance where no marker exists.

2606, "Event marking error: No event markers stored."
An attempt was made to delete a marker but there are no markers stored.

2607, "Event marking error; Marker list full."
An attempt was made to add a marker but the list of markers is currently full.

2608, "Event marking error; Current measurement not a splice loss or event return loss."
The EVNTMEAS command can only be used to replace a splice-loss or event-return loss measurement in the event table (not two-point or link return-loss measurements).

2609, "Event marking error; Current measurement not performed at a marker."
An attempt was made to use the EVNTMEAS command to replace a measurement in the event table with a new measurement, but the cursor is not positioned at an event marker.

2610, "Event marking error; Marker already exists at given distance."
An attempt was made to add an event marker where one already exists.

2611, "Event marking error; No events stored."
An event information query was made but there are no events stored in the event table.

2904, "Selftest failure; result buffer overflow"
The internal buffer used to hold selftest results from *TST? query has overflowed. The query requesting the description receives partial information.

Internal Errors

Internal-error codes are in the ranges from 300 to 399 and 3000 to 3999, and set bit DDE in the Standard Event Status Register.

310, "System error; memory allocation failure"
310, "System error; operating system error"
These errors indicate a firmware failure within FiberMaster's multitasking system.

3200, "Display hardware failure"
A 34010 display-processor error has been detected by the 68020 CPU.

3901, "Power-on selftest failure"
The instrument has failed at least one power-up diagnostic. The event message will contain additional information on which component has failed.

3902, "Power-on selftest failure; result-buffer overflow"
The instrument has failed enough power-on diagnostics to overflow the buffer holding test-result descriptions. The event message will contain information on which components have failed, although some results will be lost. Diagnostics should be run under local control to determine the cause of the failure.

System Events

System-event codes are in the ranges from 400 to 499 and 4000 to 4999, and set bits PON, OPC, URQ, and QYE in the Standard Event Status Register.

401, "Power on"
The instrument has been powered on.

402, "Operation complete"
The instrument has received and executed the *OPC command.

410, "488.2 query INTERRUPTED error"
420, "488.2 query UNTERMINATED error"
430, "488.2 query DEADLOCKED error"
The controller has violated 488.2 protocol in exchanging messages with the instrument. Refer to the section *Message Exchange Protocol*, earlier in this chapter.

440, "488.2 query UNTERMINATED error after indefinite response"
The controller has sent *IDN?, GPLTSCREEN?, or GPLTTEXT?, but it is not the only or last query in the program message. Refer to the descriptions of query response argument formats, in the *Command and Queries* section of this chapter.

4031, "User request; Softkey 1 actuation"
4032, "User request; Softkey 2 actuation"
4033, "User request; Softkey 3 actuation"
4034, "User request; Softkey 4 actuation"
4035, "User request; Softkey 5 actuation"
One of the programmable softkeys (1 through 5) was programmed using the SOFTKEY command, and has been pressed by the operator.

Execution Warnings

Execution-warning codes are in the range from 500 to 599, and set the EXE bit in the Standard Event Status Register.

501, "WFM command warning; no waveform data stored."
Zero data points are returned for the waveform requested.

502, "WFM command warning; averages adjusted to nearest multiple of 256"
The AVERAGES command was sent with an argument not equal to a positive multiple of 256. The requested setting is being adjusted as indicated.

Internal Warnings

Internal-warning codes are in the range from 600 to 699, and set the DDE bit in the Standard Event Status Register.

610, "Internal printer error"
Generic internal-printer failure.

611, "Internal printer error; printer busy"
Attempt to print while the printer is still completing the last print request.

612, "Internal printer error; paper error"
The internal printer has a paper jam or is out of paper.

613, "Internal printer error; head disengaged"
Internal printer's head is disengaged.

620, "RS232 error"
Generic serial-port error.

621, "RS232 error; parity error"
Invalid parity in character received by serial port.

622, "RS232 error; framing error"
Invalid character framing in character received by serial port.

623, "RS232 error; overrun error"
Receiver buffer overrun detected by serial port.

624, "RS232 error; transmitter timeout"
A timeout has occurred as a result of attempting to transmit a character from the serial port.

631, "GPIB error; no acceptor on bus"
An attempt was made to place data on the GPIB when no acceptor was detected. (Both the NDAC and NRFD handshake lines were high when the GPIB source handshake became active.)

A Accessories and Options

Mainframes

Table A-1. Mainframe Options

Mainframe #	Description
TFP2A	Mainframe with color monitor
TFP2AM	Mainframe with monochrome monitor
1T	Hard case option
1R	19-inch rackmount option
L1	French language option
L3	German language option
L4	Spanish language option
1S	Mainframe with FMTAP

Accessories

Table A-2. Standard Accessories

Description	Part Number	Quantity
Power cord, standard	161-0104-00	1
User manual	070-9189-xx	1
Quick-reference card	063-2292-xx	1
Soft case	016-1037-01	1
Front-panel cover	200-3566-00	1
Option-port cover	333-3572-00	1
Plug-in spacer	386-5950-00	1
Alcohol packs / App note	006-8134-00	1
Rackmount instruction sheet	063-1691-xx	1

Table A-3. Optional Accessories

Nomenclature	Part or Option Number
Jumpers (all combinations)	
Keyboard adapter cable	174-2356-01
Keyboard	118-7637-00
External plotter	HC100 or HC100 Option 03
RS-232C cable	012-1384-00
GPIB cable (2 meter)	012-0991-00
Hard-shell transit case	016-1036-00
Module-level service manual	070-9188-xx
FiberMaster Trace Analysis Pkg.	FMTAP
FiberMaster utilities disk	063-1493-xx
TOP130 LED source 850/1300 nm w/ ST connector	2T
TOP140 laser source 1310 nm w/ FC connector	3T
TOP150 laser source 1550 nm w/ FC connector	4T
TOP200 optical power meter 850/1300/1550 nm w/ ST connector	5T
TOP300 visual fault finder 635 nm w/ FC connector	6T
TOP160 laser source 1310/1550 nm w/ FC connector	7T
French User Manual	070-9428-XX
German User Manual	070-9429-XX
Spanish User Manual	070-9430-XX
French Quick Reference Card	063-1844-XX
German Quick Reference Card	063-1982-XX
Spanish Quick Reference Card	063-1983-XX

Options

Table A-4. System Options

Opt. #	Description
14	1 Mbyte nonvolatile RAM
16	Internal printer assembly
17	DC power option
19	Keyboard and adapter cable (USA format)
A1	Universal European, 220VAC/16A, 50 Hz
A2	United Kingdom, UK, 240VAC/13A, 50 Hz
A3	Australian, 240VAC/10A, 50 Hz
A4	North American, 240VAC/12A, 60 Hz
A5	Swiss, 250VAC/6A, 50Hz

Table A-5. System Multimode Options

Opt. #	Description	Order #
01	850 nm MM acquisition module	FM8500*
02	1300 nm MM acquisition module	FM1300*
03	850/1300 nm MM acquisition module	FM8513*
20	Biconic connector, MM, 62.5 µm	119-4515-00
21	FC/PC connector, MM, 62.5 µm	119-4516-00
22	D4/PC connector, MM, 62.5 µm	119-4514-00
23	SMA 905/906 connector, MM, 62.5 µm	119-4557-00
24	ST/PC connector, MM, 62.5 µm	119-4513-00
25	DIN/PC 47256 connector, MM, 62.5 µm	119-4546-00
26	Diamond 3.5 connector, MM, 62.5 µm	119-4558-00
27	Diamond 2.5 connector, MM, 62.5 µm	119-4556-00
28	SC/PC connector, MM, 62.5 µm	119-4518-00
29	SMA 2.5 connector, MM, 62.5 µm	119-4517-00

*Use when ordering optics modules separately, for a previously purchased mainframe.

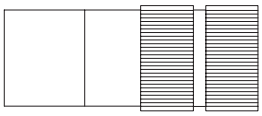
Table A-6. System Singlemode Options

Opt. #	Description	Order #
04	1310 nm SM acquisition module	FS1300*
05	1550 nm SM acquisition module	FS1500*
06	1310/1550 SM acquisition module	FS1315*
07	1310 nm SM long-range acquisition module	FL1300*
08	1310/1550 nm SM long-range acquisition module	FL1315*
09	1550 nm SM long-range acquisition module	FL1500*
10	1310 nm SM general-purpose acquisition module	FG1300*
11	1310/1550 nm SM general-purpose acquisition module	FG1315*
30	Biconic connector, SM	119-4515-00
31	FC/PC connector, SM	119-4516-00
32	D4/PC connector, SM	119-4514-00
33	SMA 905/906 connector, SM	119-4557-00
34	ST/PC connector, SM	119-4513-00
35	DIN/PC 47256 connector, SM	119-4546-00
36	Diamond 3.5 connector, SM	119-4558-00
37	Diamond 2.5 connector, SM	119-4556-00
38	SC/PC connector, SM	119-4518-00
39	SMA 2.5 connector, SM	119-4517-00
41	FC/APC connector, SM**	119-5115-00
42	SC/APC connector, SM**	119-5116-00
43	E-2000/APC connector, SM**	119-5164-00
44	ST/APC connector, SM**	119-5888-00
45	DIN/APC connector, SM**	119-5887-00

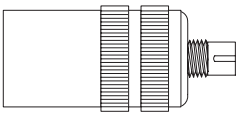
*Use when ordering optics modules separately, for a previously purchased mainframe.
**Angle polish connectors (options 41 through 45) cannot be interchanged with any of the option 2x or 3x adapters.

Table A-7. Option Accessories

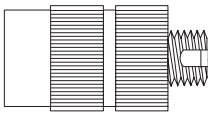
Description	Part Number	Quantity
Thermal print paper	006-7682-00	1
Thermal print paper, case	006-7682-20	50
Paper holders	386-5947-01	2
3-1/2" diskette, 1.44 MB	119-3910-00	1
Power cord, option A1	161-0104-06	1
Power cord, option A2	161-0104-07	1
Power cord, option A3	161-0104-05	1
Power cord, option A4	161-0134-00	1
Power cord, option A5	161-0167-00	1
Power cord, option 17	161-0280-01	1



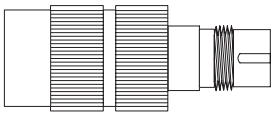
Opt. 20 Multimode
Opt. 30 Singlemode



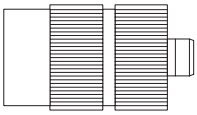
Opt. 25 Multimode
Opt. 35 Singlemode



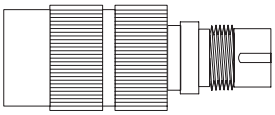
Opt. 21 Multimode
Opt. 31 Singlemode
Opt. 41 Singlemode



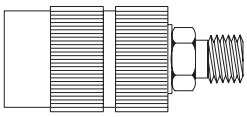
Opt. 26 Multimode
Opt. 36 Singlemode



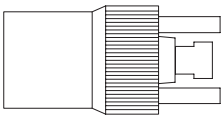
Opt. 22 Multimode
Opt. 32 Singlemode



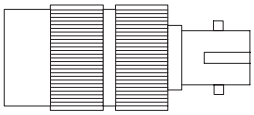
Opt. 27 Multimode
Opt. 37 Singlemode



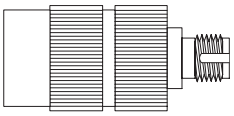
Opt. 23 Multimode
Opt. 33 Singlemode



Opt. 28 Multimode
Opt. 38 Singlemode
Opt. 42 Singlemode



Opt. 24 Multimode
Opt. 34 Singlemode



Opt. 29 Multimode
Opt. 39 Singlemode

Figure A-1. Connector Options

B Keyboard Definitions

The functions of FiberMaster's controls can be duplicated using an IBM AT-compatible keyboard connected to the front panel. Defined key sequences are as follows:

Global Functions

The following functions are available regardless of the instrument's current operating mode:

Table B-1. Global Keyboard Functions

Key	Function
F1 through **F6**	Performs the same function as the corresponding front-panel softkey, as currently labeled. **F1** corresponds to the top softkey, **F2** to the second softkey, etc.
Alt-F1	Display the diagnostics menus (available only from the startup screen).
Shift-Prt Scr	Hard copy.
Alt-? and **Alt-/**	Help.
Num Lock	Change the keypad from numeric digits to cursor functions.

Menu-System Functions

The following key sequences are available when in the menu system, including the mass-storage menus:

Table B-2. Menu-System Keyboard Functions

Key	Function
Return	Display next parameter menu.
Shift-Return	Display previous parameter menu.
Esc	Restore previous value for current parameter.
↑ ↓	For menus with selections listed: move selection up or down. For menus with numeric parameters: increase or decrease the value.

The following key sequences apply to the numeric parameters:

Table B-3. Menu-System Numeric-Parameter Keyboard Functions

Key	Function
0 through **9**	For menus with numeric parameters, including the time and date parameters: shift the typed digit in from the right.
Delete	For menus with numeric parameters: shift the rightmost digit out.
Tab	For the time and date parameters: move to the next field (hours, minutes, or seconds; or day, month, or year).
Shift-Tab	For the time and date parameters: move to the previous field.
:	For the time parameter: move to the next field (same as the **Tab** key).
/	For the date parameter: move to the next field (same as the **Tab** key).

The following key sequences apply to the character-string parameters:

Table B-4. Menu-System Alphanumeric-Parameter Keyboard Functions

Key	Function
Home	Move the cursor to the first character in the string.
End	Move the cursor to the last character in the string.
Page Down	Delete the characters from the cursor to the end of the string.
← →	Move the cursor left or right.
Delete	Delete the character before the cursor.
Del (keypad)	Delete the character that the cursor is on.

Mass-Storage Menu System Functions

The following key sequences are available on the mass-storage menus in addition to the general menu-system functions listed on the previous page.

Table B-5. Mass-Storage Keyboard Functions

Key	Function
Home	Move the directory cursor to the first file name in the directory.
End	Move the directory cursor to the last file name in the directory.
← →	Move the directory cursor left or right.
↑ ↓	Move the directory cursor up or down.

Acquisition-Screen Functions

The following key sequences are available on the acquisition screen:

Table B-6. Acquisition-Screen Keyboard Functions

Key	Function
← →	Move the distance cursor left or right.*
Alt-← →↑ ↓	Resize the expansion box or change the waveform scale.*
Ctrl-← →↑ ↓	Position the waveform.*
Alt-C	Cursor select.*
Alt-J	Join cursors.*
Alt-E	Expand.*
Alt-W	Waveform select.
Alt-A	Align waveforms (dual-trace mode).
Alt-P	Store the current waveform into reference memory.
Alt-M	Module select.
Alt-F	Turn event markers on and off.
Alt-N	Turn off current measurement mode and enter Preview mode.
Alt-R	Start a real-time acquisition
Alt-S	Start/Stop.*
7 (on keypad)	Move the left side of the active loss cursor up.
1 (on keypad)	Move the left side of the active loss cursor down.
9 (on keypad)	Move the right side of the active loss cursor up.
3 (on keypad)	Move the right side of the active loss cursor down.

* The key sequences marked with an asterisk are also available on the Place Event Markers and the Place Manual Masks screens.

C FiberMaster Data Format

FiberMaster's data transfers take place in six ways:

- ❏ Internal printer hardcopy
- ❏ GPIB plotter or printer hardcopy
- ❏ Serial plotter or printer hardcopy
- ❏ Data transfer to and from the instrument via XModem
- ❏ Data transfer from the instrument via remote control
- ❏ Data transfer to and from the instrument via floppy disk or internal RAM.

To maintain consistency, all non-hardcopy data (except GPIB and RS-232) is in the same format. This allows the user to use the same data manipulation routines, no matter how the data is acquired. Every waveform file contains the following data:

- Pulse width
- Maximum range
- Slope calculation method
- Refractive index
- Scattering coefficient
- Fiber ID
- Maximum averages
- Dual trace setting
- Event threshold
- Event marking type and event markers
- Masking type and masks
- Units
- Fiber notes
- Operator
- Measurement mode
- Wavelength
- Distance and loss cursor positions, and which are active
- User adjustments to loss cursors
- Slope calculation
- Splice loss
- Expansion window size and position
- Acquisition sample density
- Number of samples per pulse
- Distance at first data point
- Distance between data points
- Number of data points in waveform
- Waveform data points, including high-density data
- Actual number of averages used for acquisition
- Elapsed acquisition time
- Time and date the **START/STOP** button was pressed to start the acquisition

Settings-only files contain the following:

- Pulse width
- Maximum range
- Slope calculation method
- Refractive index
- Scattering coefficient
- Fiber ID
- Maximum averages
- Dual trace setting
- Event threshold
- Event marking type and event markers
- Masking type and masks
- Units
- Fiber notes
- Operator
- Wavelength

Notes: 1) When data is sent to FiberMaster via XModem, it is stored in reference memory. 2) When a waveform file is loaded from disk, you can choose to load it into current or reference memory. Settings-only files are loaded into current memory. 3) These data formats above do not apply to GPIB and RS-232 data. Refer to chapter 8 for information on GPIB and RS-232 data formats.

D Diagnostics Menus

This appendix describes how to use FiberMaster's diagnostics menus. If your instrument does not function properly, or if you have questions about the instrument, contact your local Tektronix representative, or call our toll-free help line at 1-800-833-9200. You may be asked to run tests using these diagnostics menus, in the process of troubleshooting any problems with your instrument.

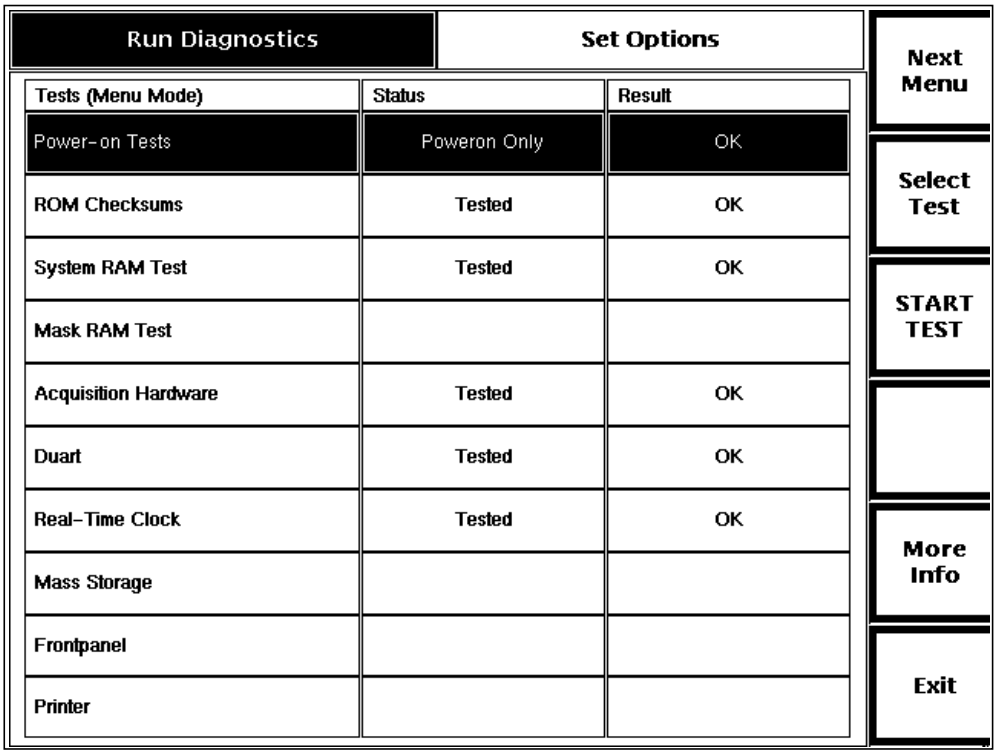


Figure D-1. Run Diagnostics Menu

Entering the Diagnostics Menus

The diagnostics menus are available from the start-up screen via a function key if diagnostic errors were detected during power-on. The menus are also available from the start-up screen by pressing the **HELP** button and softkey 6 (the bottom softkey) simultaneously.

The diagnostics menus allow the selection of various self tests for the instrument to perform. The results of the tests are reported following completion of the tests.

Reading More Information on the Highlighted Test

To read more information on the currently highlighted test, press the **More Info** softkey. A description of the test displays, along with test results from the last time the test was run.

Selecting and Clearing Tests to Run

On the Run Diagnostics menu, use the distance **CURSOR** knob to select which tests to run. As the knob is turned, each test listed on the menu is highlighted. To select the highlighted test, press the **Select Test** softkey. The test is then indicated as "Selected" in the Status column on the menu.

To clear a selected test, turn the **CURSOR** knob until the test is highlighted. Press the **Select Test** softkey again. The selection is cleared.

Setting Options for the Selected Tests

A second diagnostics menu lets you choose the number of iterations to perform of the selected tests, and whether to print the results of the tests on the internal printer. Press the **Next Menu** softkey to display the Set Options menu.

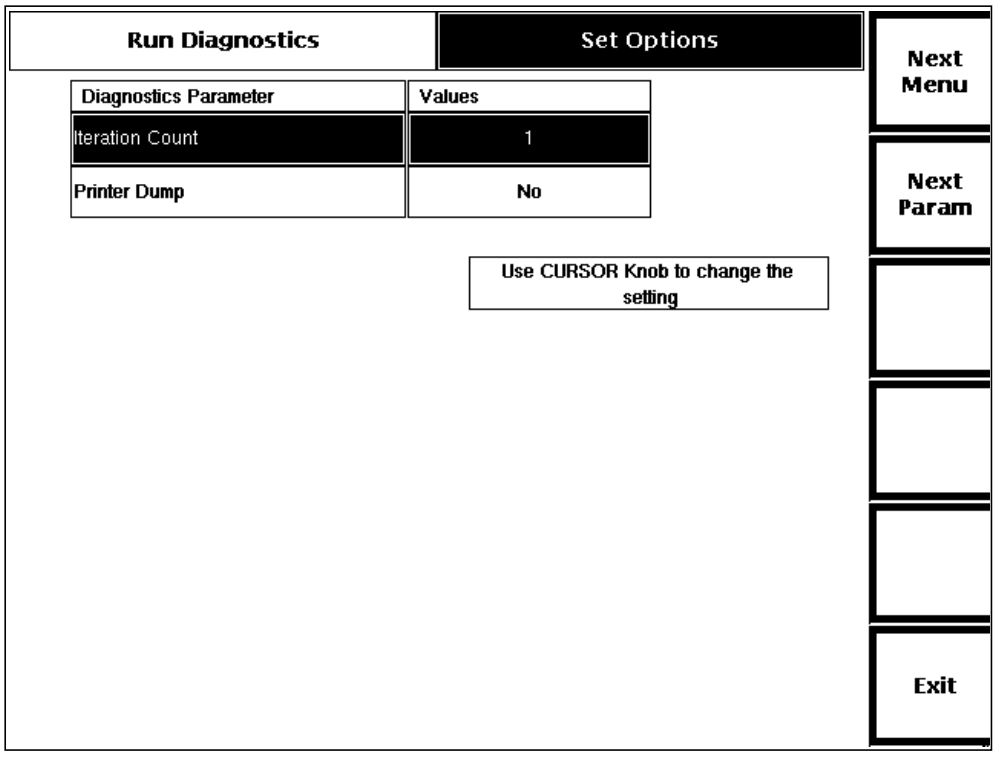


Figure D-2. Set Options Menu

Upon entry to the Set Options menu, the Iteration Count parameter is highlighted. Turn the **CURSOR** knob to increase or decrease the number of iterations, from 0 to 20. A setting for infinite iterations is also available, by turning the **CURSOR** knob counterclockwise past 0.

To set the printer dump parameter, press the **Next Param** softkey to highlight the parameter. Turn the **CURSOR** knob to choose either **No** or **Yes**. This parameter is available only when your instrument is equipped with an internal printer.

Running the Selected Tests

Run the selected tests by pressing the **Start Tests** softkey on the Run Diagnostics menu, or by pressing the **START/STOP** button on the front panel. When the tests are complete, each selected test is shown as “Tested” in the Status column on the menu. The Test Result column displays either “OK” or “ERROR.” If errors were detected, use the **More Info** function to read more information on the test results.

Exiting the Diagnostics Menus

To exit the diagnostics menus and return to the previous display, press the **Exit** softkey.

E Firmware Features

FiberMaster firmware is periodically updated to add new features and enhancements. This user manual applies to the firmware version noted on the title page of the manual, but can also be used with all TFP2A/TFP2 instruments with any prior firmware version. The differences in the user interface consist of the features and enhancements that are added to each successive firmware version.

You can identify your firmware version on the start-up screen. The version number appears in the upper right-hand corner, as shown below.

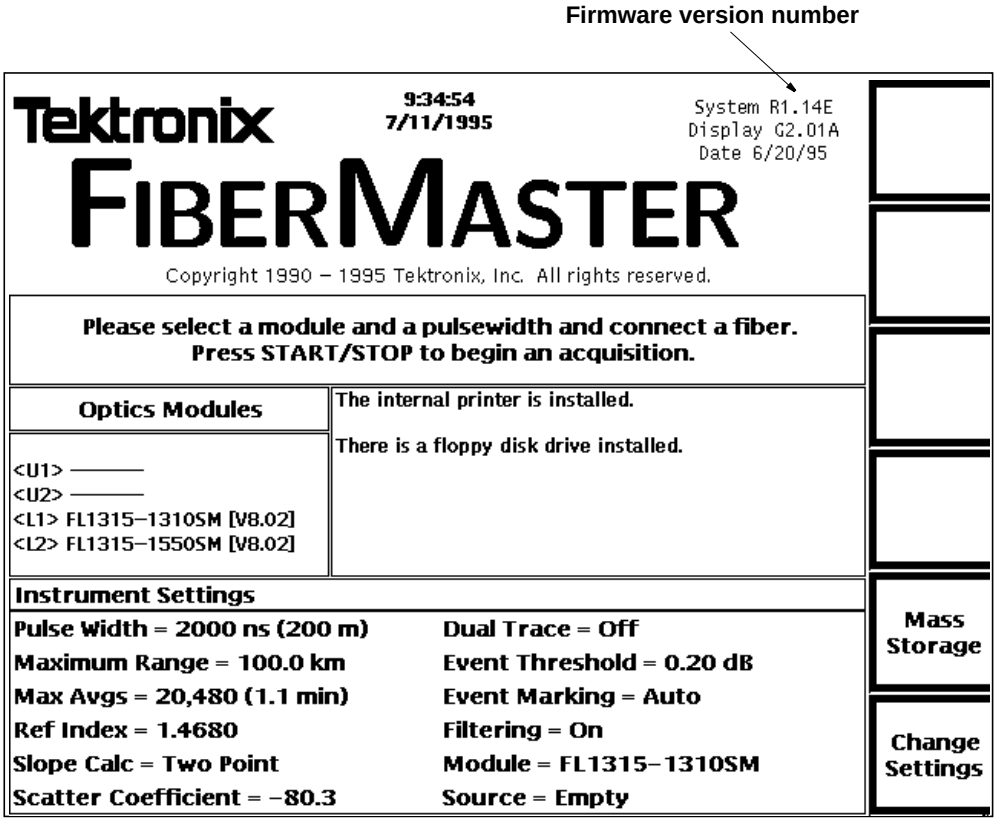


Figure E-1. Firmware Version Number on the Start-Up Screen

The table below lists the major firmware version releases, and the significant features added with each release. If your firmware is not the most current version, your instrument does not include the features listed in the table as having been added with later versions. **The sections of the user manual that cover the features added in firmware versions later than the one installed in your instrument do not apply to the operation of your instrument**.

Table E-1: Firmware Versions and Features

Firmware Version	Major Features Added
2.00	Initial TFP2 release
3.00	Link Return Loss and Event Return Loss measurement modes, scattering coefficient parameter
4.00	Event Marking, event threshold and event marking parameters, units parameter moved from Waveform Settings to System Settings menu, GPIB expansion window commands, batch copy mass-storage function, support for foreign language help
8.00	Module parameter information expanded, support for FL-series optical modules and non-standard core diameter modules, 2-km pulse width, quick load and quick save mass-storage functions, GPIB commands EVNTAUTOMARK and IPRNEVENTS, maximum averages default changed to 20,480
9.00	RS-232 remote control, mass-storage filename extensions; ASCII versions of PUT_SET, PUT_WFM, GET_SET?, and GET_WMF? remote-control commands and queries; FILHIGH, FILNORM, FILSET remote-control commands; DIRECTORY? and TYPEFILE? remote-control queries. Final TFP2 release.
1.00	Initial TFP2A release. Language and file format parameters added to the System Settings menu and to remote control instruction set (MSFORMAT and MSFORMAT?). Firmware upgrade via floppy disk. Quick start. Extended long range for FL modules.
1.20	Software filtering parameter for FL modules.

Upgrading Firmware

The TFP2A FiberMaster is shipped with firmware installed. You can upgrade your instrument's firmware when necessary via floppy disk. Contact your local Tek representative, or in the U.S. and Canada, call **1-800-TEK-WIDE ext. 2400** for information about TFP2A firmware releases.

To install the firmware into the instrument follow the steps given below. First the instrument checks the firmware disks then the firmware is loaded into the instrument, so you must insert each disk twice during this process.

1. With the power turned off to the instrument, insert TFP2A Firmware disk 1 into the floppy-disk drive.
2. Press **POWER** to turn on the instrument. The power-on diagnostics are performed.
3. The TFP2A displays the following prompts:

   To load from Floppy press the LOAD button
   To start the instrument press the START button

   Softkey 4 (the fourth softkey from the top) is labeled **LOAD**, and softkey 5 is labeled **START**.

   To start the process that loads the firmware from the floppy disk to the TFP2A's flash ROM (where the firmware resides in the instrument), press the **LOAD** softkey.

   To bypass loading the firmware from the floppy disk and start the instrument using the firmware already resident in the flash ROM, press the **START** softkey.
4. After you press the **LOAD** softkey, the instrument starts checking the floppy disk. Information is displayed about the disk (number of disks, languages being loaded, part number, firmware version, and date and time). When the instrument is finished checking the first disk, this prompt appears:

   Insert Disk 2
5. Remove disk 1 from the floppy-disk drive and insert disk 2. Disk 2 is checked, and the same information is displayed. When the disk check is complete, this prompt appears:

   Insert Disk 1
6. Remove disk 2 from the drive, and insert disk 1. The firmware on disk 1 is copied to the instrument. After the file is copied, the following prompt appears:

   Insert Disk 2
7. Remove disk 1 from the drive, and insert disk 2. The firmware on disk 2 is copied to the instrument. When the load procedure is complete, the flash ROM is checked and the instrument starts. The start-up screen displays.
8. Remove disk 2 from the disk drive, and store the firmware disk set in a safe place.

NOTES

Do not interrupt the load process. If you stop the load process before it is complete, firmware can be partially copied to flash ROM. This can cause the instrument to function improperly, or not at all. If this happens, restart the load process from the beginning.

If the load process causes errors and does not complete as expected, contact your local Tek representative for assistance or in the U.S. and Canada call ***1-800-835-9433****. Error messages that might occur while loading firmware are displayed on the instrument's screen. These messages appear on the screen in English only. For languages other than English, check appendix f,* Error Codes*, in your local language version of this manual for translated error codes.*

F Error Codes

This appendix lists file system error codes that may appear on the TFP2A display. If there is a problem with your instrument that you cannot resolve, call our toll-free help line at **1-800-TEK-WIDE ext. 2400**.

File System Error Codes

The following file system errors may occur during the process of loading new software into the TFP2A.

Table F-1: File System Error Codes

Error Code	Description
FS-1	Unable to allocate memory for file system
FS-2	File name invalid or file does not exist
FS-3	Invalid pathname
FS-4	Too many files open
FS-5	Incompatible file access, or file is not open for access
FS-6	Invalid file handle
FS-12	Invalid access mode
FS-13	Recovered error in data
FS-14	Unrecovered error in data
FS-15	Invalid device
FS-17	Incorrect device for this operation
FS-18	No more directory entries satisfy request
FS-19	Invalid file truncation
FS-20	Device or media write protected
FS-21	Invalid directory of FAT table
FS-22	Hardware error on device

Table F-1: File System Error Codes (cont.)

Error Code	Description
FS-23	Directory already exists
FS-24	Directory full
FS-25	Directory to be deleted not empty
FS-26	Invalid disk label
FS-27	Disk full
FS-28	Duplicate file/directory name
FS-29	Invalid operation on current path
FS-30	Disk I/O error abort
FS-31	Timeout on disk I/O
FS-34	Disk not formatted
FS-66	Ambiguous file name
FS-90	Permanent disk error
FS-280	Access denied
FS-281	File not found
FS-282	Invalid operation current path
FS-283	Different device numbers
FS-284	Directory not empty
FS-285	Name already exists
FS-286	File name already exists
FS-287	Invalid label
FS-288	Invalid directory path
FS-289	File truncation
FS-290	No disk to format
FS-350	Device error
FS-500	Disk removed after customer abort
FS-501	Abort after archive disk mount request
FS-607	Device abort
FS-608	Directory full
FS-609	Too many files open

Table F-1: File System Error Codes (cont.)

Error Code	Description
FS-745	Disk retry
FS-903	Disk change detected
FS-906	Mount floppy disk
FS-907	Permanent error on device X
FS-908	Restore error on file X
FS-909	Skip restoring file X
FS-910	Timeout error on device X
FS-917	Disk change detected

Flash Memory Error Codes

The following flash memory errors may occur during the process of loading new software into the TFP2A.

Table F-2: Flash Memory Error Codes

Error Code	Description
FM-2	Clear status failed for part(s) <part number list>
FM-3	VPP low detected for part(s) <part number list>
FM-4	Device timed out on write for part(s) <part number list> Device timed out on erase for part(s) <part number list>
FM-5	Data verify failed for part(s) <part number list>
FM-6	Byte write error for part(s) <part number list>
FM-7	Block erase error for part(s) <part number list>
FM-8	Erase sequence error for part(s) <part number list>
FM-9	Parallel data failure for part(s) <part number list>
FM-10	Checksum failed
FM-11	Invalid block number parameter
FM-12	Write-enable failed
FM-13	Write-disable failed
FM-14	Unexpected error

Power-On Diagnostic Error Codes

During the first phase of power-on diagnostics, the front-panel LEDs indicate which part of the test sequence is running. The LED code is flashed just prior to starting the specific test, so if the instrument halts, the pattern displayed reflects the test that failed. The pattern codes are as follows:

Table F-3: LED Error Codes

REMOTE LED	REFERENCE LED	CURRENT LED	WINDOW LED	Error Condition
Off	Off	Off	Off	Self test complete
Off	Off	Off	On	LED bus error test
Off	Off	On	Off	Unused
Off	On	On	Off	Parallel port test
Off	Off	On	On	Core RAM test
Off	On	Off	Off	Shared RAM test
Off	On	Off	On	Display processor test
Off	On	On	On	Comprehensive RAM test
On	Off	Off	Off	Floating point coprocessor test
On	Off	Off	On	Serial port test
On	Off	On	Off	Serial port test complete
On	Off	On	On	Unused
On	On	Off	Off	Status register bus error test
On	On	Off	On	Unused
On	On	On	Off	Unused
On	On	On	On	Initial LED write/read verify test
Off	Off	On	Off	Normal power-up/init complete

The following is a list of additional possible error conditions that can be reported during phase 1 power-on diagnostics.

Table F-4: Phase 1 Error Codes

Error Code	Description
D1-0001	Front-panel button bus error test failed
D1-0002	LED bus error test failed
D1-0004	LED error test failed
D1-0008	Simple core RAM test failed
D1-0010	Simple core RAM test failed (vector area)
D1-0020	Shared RAM test failed
D1-0040	Not an error. Indicates display interface untested.
D1-0080	Display interface error
D1-0100	Extended RAM test error
D1-0200	Extended RAM test refresh error
D1-0400	Extended RAM test moving inversion error
D1-0800	FPU bus error test failed
D1-1000	DUART bus error test failed
D1-2000	Parallel interface bus error test failed
D1-4000	System status register bus error test failed
D1-8000	Bus error occurred for reasons unknown

The following is a list of possible error conditions that can be reported during phase 2 power-on diagnostics.

Table F-5: Phase 2 Error Codes

Error Code	Description
D2-00001	Front-panel controller register pattern test failed
D2-00002	Printer controller registers reset value
D2-00004	Printer controller does not count down
D2-00008	Printer controller counts down when it should not
D2-00010	Serial controller register reset value
D2-00020	Serial controller loop-back error - bad data received

Table F-5: Phase 2 Error Codes (cont.)

Error Code	Description
D2-00040	Serial controller does not transmit character
D2-00080	Serial controller counter does not count down
D2-00100	Floppy controller register read error
D2-00200	Real-time clock time updates not OK
D2-00400	GPIB controller soft reset command failed [fatal]
D2-00800	Printer controller register write-read failed
D2-01000	Floppy controller drive reset interrupt
D2-02000	Serial controller loop-back error - timeout
D2-04000	Serial controller counter error - no interrupts [fatal]
D2-08000	NV memory checksum error
D2-10000	NV memory read/write error [fatal]

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