

ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *Exfo IQ-5523-ST-89* at our website: ***Click HERE***

IQ-5500 — IQ-2123BP

PMD Multi-Analyzer

Instruction Manual

June 1999
P/N: MAN-116-I .4ACE

Fourth Edition

CE

If the equipment described herein bears the CE *symbol, the said equipment complies with the European Community Directive and Standards found in the Declaration of Conformity.*

If the equipment described herein bears an **FCC** *statement, the said equipment complies with the relevant Federal Communications Commission standards.*

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of EXFO Electro-Optical Engineering, Inc. (EXFO).

Information provided by EXFO is believed to be accurate and reliable. However, no responsibility is assumed by EXFO for its use nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent rights of EXFO.

EXFO's Commerce And Government Entities (CAGE) code under the North Atlantic Treaty Organization (NATO) is 0L8C3.

The information contained in this document is subject to change without notice.

© 1999 EXFO Electro-Optical Engineering, Inc.

Words which we consider as trademarks have been identified as such. However, neither the presence nor absence of such identification affects the legal status of any trademark.

Dieses Handbuch ist ebenso auf deutsch erhältlich.

CONTENTS

Certification Information vii

1 INTRODUCTION 1-1

1.1 IQ-200 Optical Test System Product Line 1-1
1.2 Unpacking and Inspection 1-2
1.3 Safety Conventions 1-2
1.4 Transportation and Storage 1-3
1.5 Getting Help 1-3

2 HARDWARE INFORMATION 2-1

2.1 IQ-5500 Front Panel Description 2-1
2.2 IQ-2123BP Front Panel Description 2-2
2.3 LED Push Button 2-3
2.4 Module Insertion 2-3
2.5 Optical Connections 2-4
2.6 Module Removal 2-7

3 OVERVIEW 3-1

4 SOFTWARE DESCRIPTION 4-1

4.1 Loading the Application Software 4-1
4.2 IQ-5500 PMD Multi-Analyzer Software Description 4-2
4.3 IQ-2123BP Light Source Software Description 4-8
4.4 Status Bar 4-12
4.5 Monitor Window 4-13
4.6 Exiting the Application Software 4-15

5 OPERATION 5-1

5.1 Source Activation/Deactivation 5-1
5.2 Source Setup 5-1
5.3 Preparing for Measurements 5-3
5.4 Entering User Information 5-5
5.5 Entering DUT Information 5-6
5.6 Setting Acquisition Parameters 5-8
5.7 Acquiring a Trace 5-12
5.8 Viewing Acquisition Results 5-13
5.9 Selecting Views with the Zoom 5-14
5.10 Selecting a Trace to View 5-15
5.11 Viewing Statistics 5-18

5.12 Viewing Acquisition Information 5-19
5.13 Customizing Acquisitions 5-23

6 MANAGING DATA 6-1

6.1 Generating a Results Table from the File Menu 6-1
6.2 Saving and Retrieving Files 6-1
6.3 Opening and Saving Configuration Files 6-2
6.4 Opening and Saving Templates 6-3
6.5 Printing Data 6-4

7 THE GPIB INTERFACE 7-1

7.1 Command Structure 7-1
7.2 Common Commands 7-2
7.3 System Commands 7-8
7.4 Quick Reference Command Trees 7-29
7.5 GPIB Error Messages 7-33

8 TECHNICAL SPECIFICATIONS 8-1

8.1 IQ-5500 PMD Analyzer 8-1
8.2 IQ-2123BP Light Source 8-2

9 MAINTENANCE AND TROUBLESHOOTING 9-1

9.1 Module Maintenance 9-1
9.2 Cleaning Fiber Ends 9-1
9.3 Cleaning Optical Ports 9-1
9.4 Troubleshooting 9-2

10 WARRANTY 10-1

10.1 General Information 10-1
10.2 Liability 10-2
10.3 Exclusions 10-2
10.4 Certification 10-2
10.5 Service and Repairs 10-2

APPENDIX A – PMD THEORY A-1

GLOSSARY GLOSSARY-1

INDEX INDEX-1

FIGURES

Figure 2-1. Module Nameplate 2-1
Figure 2-2. Front Panel of the IQ-5500 PMD Analyzer Module 2-1
Figure 2-3. Front Panel of the IQ-2123BP Light Source Module 2-2
Figure 2-4. EUI Base Plate Options 2-5
Figure 2-5. EUI Connector Adaptor 2-5
Figure 2-6. Mounting EUI Connector Adaptor 2-6
Figure 2-7. Removing an IQ Module 2-7
Figure 4-1. IQ-5500 PMD Main Window 4-2
Figure 4-2. PMD Graph Axes Description 4-6
Figure 4-3. IQ-2123BP Light Source Main Window 4-8
Figure 4-4. IQ-5500 Monitor Window 4-13
Figure 4-5. IQ-2123BP Monitor Window 4-14
Figure 5-1. Light Source Activation/Deactivation Buttons and Status Box 5-1
Figure 5-2. Increase/Decrease Buttons and Attenuation Edit Box 5-2
Figure 5-3. Modulation List Box 5-2
Figure 5-4. Wavelength Button and Box 5-3
Figure 5-5. PMD Measurement Setup with an IQ-2123BP Light Source Module 5-4
Figure 5-6. User Information Window 5-5
Figure 5-7. DUT Page 5-6
Figure 5-8. Weak Mode Coupling Fiber Measured with Strong Coupling Settings 5-7
Figure 5-9. Measurement Page 5-8
Figure 5-10. Multiple Measurement Dialog 5-10
Figure 5-11. Manual Scan Dialog 5-11
Figure 5-12. Timed Scan Dialog 5-11
Figure 5-13. PMD Results Graph 5-13
Figure 5-14. Results Page 5-13
Figure 5-15. Zoom Page 5-14
Figure 5-16. Selection Page 5-15
Figure 5-17. Statistics Page 5-18
Figure 5-18. Measurement Information Window 5-20
Figure 5-19. Measurement Information Window 5-22
Figure 5-20. Option Page 5-23
Figure 5-21. Browse Path Dialog 5-24
Figure 5-22. File Name Page 5-25
Figure 5-23. Module Page 5-26
Figure 5-24. Graphic Page 5-28
Figure 5-25. Table Page 5-31
Figure 7-1. GPIB Error Message Format 7-33
Figure A-1. PMD Delay in Perfect and Birefringent Fiber A-2

TABLES

Table 4-1.	IQ-5500 Main Window Drop-Down Menus	4-3
Table 4-2.	IQ-5500 Function Buttons Description	4-5
Table 4-3.	Status Bar Information Description	4-7
Table 4-4.	IQ-2123BP Main Window Drop-Down Menus	4-9
Table 4-5.	IQ-2123BP Function Buttons	4-10
Table 4-6.	Data Display Boxes	4-11
Table 4-7.	Module Control Status	4-12
Table 5-1.	Available Scanning Ranges According to Device Type	5-9
Table 5-2.	Zoom Functions	5-14
Table 5-3.	Information Availability Indicators	5-16
Table 5-4.	Information Available in the Selection Page	5-16
Table 5-5.	Information Available in the Statistics Page	5-18
Table 5-6.	Threshold Correspondance	5-27
Table 5-7.	Table Report Column Headings	5-32
Table 7-1	Command Commands Summary	7-2
Table 7-2.	IQ-5500 PMD Analyzer Command Tree	7-29
Table 7-3.	IQ-2100 Light Source Command Tree	7-33
Table 7-4.	IQ-5500 PMD Analyzer Error Messages	7-34
Table 7-5.	IQ-2100 Light Source Error Messages	7-36
Table 9-1.	Problems, Causes, and Recommended Actions	9-2

CERTIFICATION INFORMATION

F.C.C. INFORMATION TO USER

The IQ-5500 PMD Analyzer has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the unit is operated in a commercial environment. This unit generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this unit in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

The IQ-2123BP Light Source has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the unit is operated in a commercial environment. This unit generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this unit in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

WARNING

Changes or modifications not expressly approved by EXFO Electro-Optical Engineering could void the user's authority to operate the unit.

INDEPENDENT LABORATORY TESTING

These units have undergone extensive CE certification testing both internally, at EXFO, and externally, at an independent, qualified laboratory. All pre-qualification tests were performed at EXFO while all final tests were performed at UltraTech Engineering Labs Inc., a renowned test laboratory from Mississauga, Canada. This guarantees the unerring objectivity and authoritative compliance of all test results.

CE INFORMATION TO USER

The IQ-5500 PMD Analyzer has been tested and found to comply with the limits for a Class A digital device. Please refer to the Declaration of Conformity.

The IQ-2123BP Light Source has been tested and found to comply with the limits for a Class A digital device. Please refer to the Declaration of Conformity.

1 INTRODUCTION

EXFO Electro-Optical Engineering, Inc. (EXFO) is pleased to introduce the IQ-5500 Polarization Mode Dispersion Analyzer and the IQ-2123BP Light Source as part of the IQ-200 Optical Test System product line.

EXFO's commitment to superior design in all its fiber-optic instrumentation is respected throughout the industry and is based on the following four goals:

- reliable and accurate performance
- simple operation
- extensive features
- dedicated interest in customer needs

The PMD Multi-Analyzer will provide many years of reliable operation. To benefit fully from the many features offered by the equipment, it is important to read the following instructions thoroughly.

1.1 IQ-200 Optical Test System Product Line

The IQ-200 Optical Test System product line is a modular optical test system designed for laboratory applications. Thanks to the Windows™ compatible IQ Software, the IQ-200 Optical Test System combines power, performance, and flexibility with a user-friendly interface. The main components of the system are the IQ-203 Mainframe, which can house three modules, and the IQ-206 Expansion Unit, which can house six modules. It is also possible to control one or several IQ-206 Expansion Units with an IQ-206 PC Expansion Card.

For more information on the IQ-200 Optical Test System and the IQ Software, please refer to the *IQ-200 Optical Test System Instruction Manual*.

1.2 Unpacking and Inspection

The IQ-5500 module is delivered with the following items:

- IQ-2123BP Light Source module
- instruction manual
- Certificate of Quality
- Declaration of Conformity
- accessory kit (optional)

The equipment has been thoroughly inspected before shipment. If any damage has occurred during transportation or if any item is missing, please notify EXFO immediately. Keep the original packing material in case you need to return the equipment.

1.3 Safety Conventions

The following conventions should be understood before operating the unit:

WARNING	Refers to a potential *personal* hazard. It requires a procedure which, if not correctly followed, may result in bodily harm or injury. Do not proceed beyond a **WARNING** unless the required conditions are fully understood and met.
CAUTION	Refers to a potential *product* hazard. It requires a procedure which, if not correctly followed, may result in component damage. Do not proceed beyond a **CAUTION** unless the required conditions are fully understood and met.
IMPORTANT	Refers to any information regarding the operation of the product which should not be overlooked.

1.4 Transportation and Storage

Maintain a temperature range within specifications when transporting or storing the unit. Transportation damage can occur from improper handling. The following steps are recommended to minimize the possibility of damage:

- Pack the unit in the original packing material when shipping.
- Store unit at room temperature in a clean and dry area. Avoid high humidity or large temperature fluctuations.
- Keep the unit out of direct sunlight.
- Avoid unnecessary shock and vibration.

1.5 Getting Help

If any difficulty is encountered while operating the unit, please call EXFO at one of the offices listed below. The Customer Service Group is available from 7:30 a.m. to 8:00 p.m. eastern time, Monday to Friday.

EXFO Electro-Optical Engineering (Corporate Headquarters) 465 Godin Avenue Vanier QC G1M 3G7 Canada	1 800 663-3936 (USA and Canada) Tel.: (418) 683-0211 Fax: (418) 683-2170 support@exfo.com www.exfo.com
EXFO Europe Centre d'Affaires Les Metz 100, rue Albert Calmette 78353 Jouy-en-Josas, France	 Tel.: 33-1 34 63 00 20 Fax: 33-1 34 65 90 93

This page intentionally left blank.

2 HARDWARE INFORMATION

The product nameplate is located on a side panel near the rear of the module.

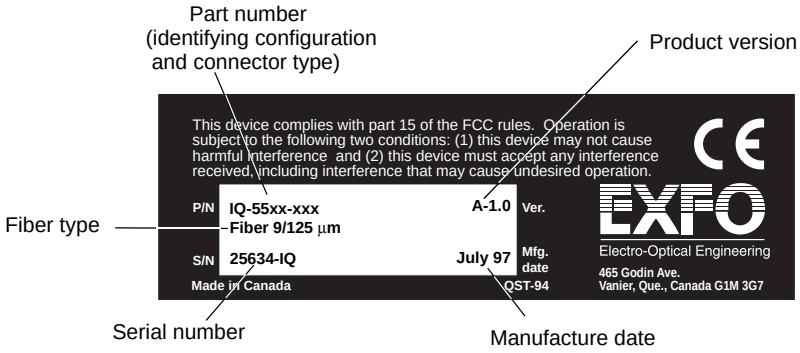


Figure 2-1. Module Nameplate

Note: *The information found on the nameplate will differ according to the module configuration.*

2.1 IQ-5500 Front Panel Description

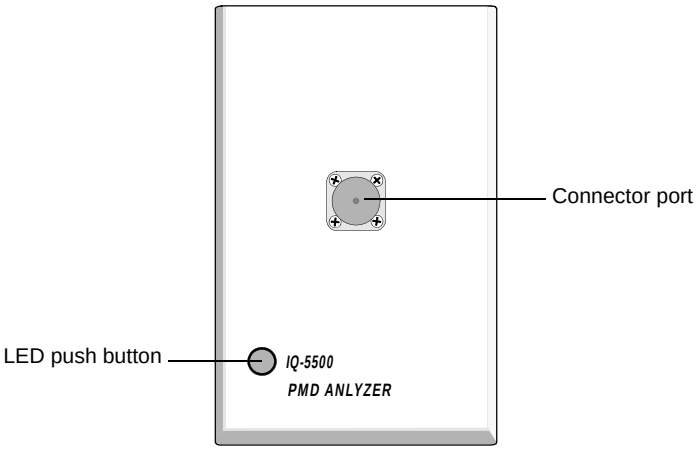


Figure 2-2. Front Panel of the IQ-5500 PMD Analyzer Module

2.2 IQ-2123BP Front Panel Description

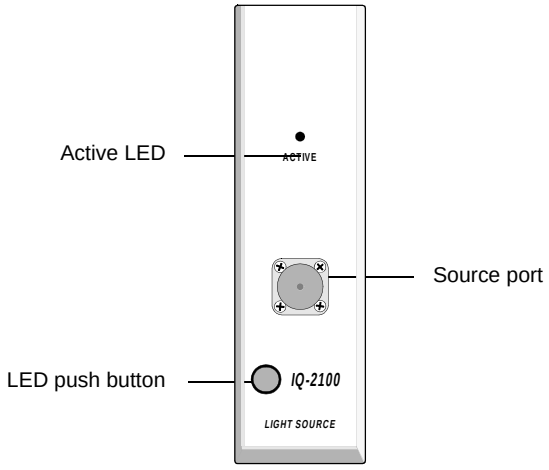


Figure 2-3. Front Panel of the IQ-2123BP Light Source Module

2.2.1 Active LED

When lit, the active LED indicates that an optical signal is being emitted from the source port.

2.2.2 Source Port

IMPORTANT

It is very important to keep optical ports clean. The protective caps, provided with each module, should always be installed when the module is not being used.

2.3 LED Push Button

The LED push button on the front panel has the following three functions:

- When system power is on, the LED push button illuminates.
- Pressing the LED push button activates the main window.
- Pressing the LED push button when the main window is open activates the monitor window.

Note: *The monitor window is a compact window displaying basic data and is fully described in Monitor Window, on page 4-13.*

2.4 Module Insertion

CAUTION

Never insert or remove any module when the IQ-203 Mainframe or the IQ-206 Expansion Units are in operation. This may result in immediate irreparable damage to the module and the IQ-203/IQ-206.

To insert the module,

1. Turn off the IQ-203/IQ-206.

2. Insert the IQ module into any available slot. The IQ-203/IQ-206 will automatically recognize the selected slot on power up.

IMPORTANT

Be sure to insert the module all the way to the back of the IQ-203/IQ-206 to ensure that the backplane connectors are properly mated. The module is correctly inserted when the module front panel is flush with the IQ-203/IQ-206 front panel.

2.5 Optical Connections

The fiber ends should always be cleaned before connecting them to the modules to ensure optimum performance and avoid erroneous readings.

2.5.1 Fiber Connections

To clean the fiber end

1. Gently wipe the end with a lint-free swab dipped in isopropyl alcohol.
2. Dry using clean compressed air.

To connect the fiber to the modules

1. Remove the connector cap.
2. Screw a fiber-optic adapter to the detector housing (if not already installed).
3. Ensure that the connector is clean and dry.
4. Align the fiber connector and detector port to avoid the fiber end touching the outside of the port or rubbing against other surfaces.
5. Connect the fiber to the fiber-optic adapter. Do not overtighten.

2.5.2 EXFO Universal Interface (EUI)

The EUI fixed base plate is available for connectors with angled (APC) or non angled (UPC) polishing. A green dot in the top left corner of the base plate indicates that it is for APC type connectors as shown in Figure 2-4.

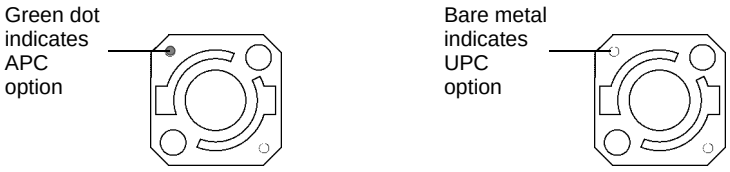


Figure 2-4. EUI Base Plate Options

To mount an EUI connector adaptor to the EUI base plate

1. Hold the EUI connector adaptor so the dust cap opens downwards as depicted in Figure 2-5 below.

2. Close the dust cap in order to hold the connector adaptor more firmly.

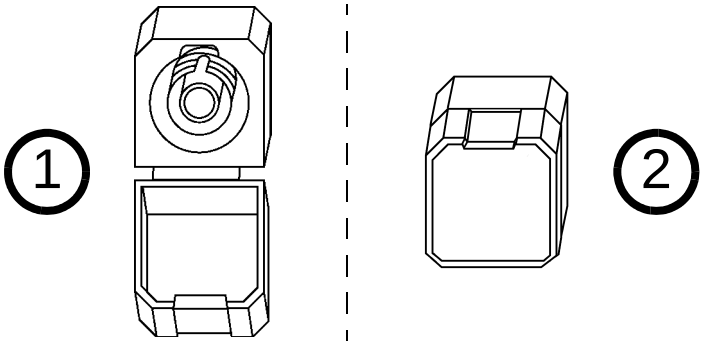


Figure 2-5. EUI Connector Adaptor

3. Insert the connector adaptor into the base plate.
4. Turn the connector adaptor clockwise to lock it in place.

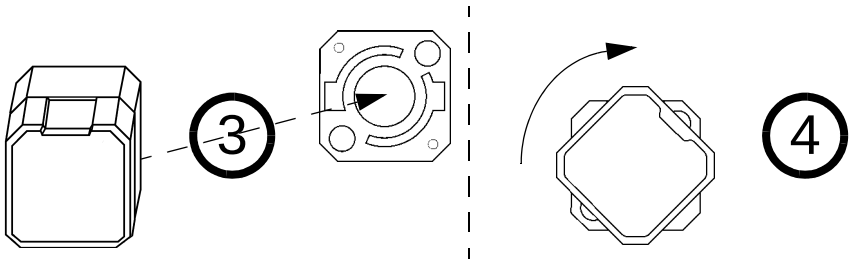


Figure 2-6. Mounting EUI Connector Adaptor

2.6 Module Removal

CAUTION

Never insert or remove any module when the IQ-203 Mainframe or the IQ-206 Expansion Unit is powered on. This will result in immediate irreparable damage to the module and IQ-203/IQ-206.

To remove module from IQ-203/IQ-206

1. Make sure the IQ-203 /IQ-206 is powered off.

2. If your module has a locking mechanism, push up the locking mechanism under the front panel of the module, as shown in Figure 2-7. Otherwise, simply place your fingers under the front panel of the module.

3. Firmly pull the module outward.

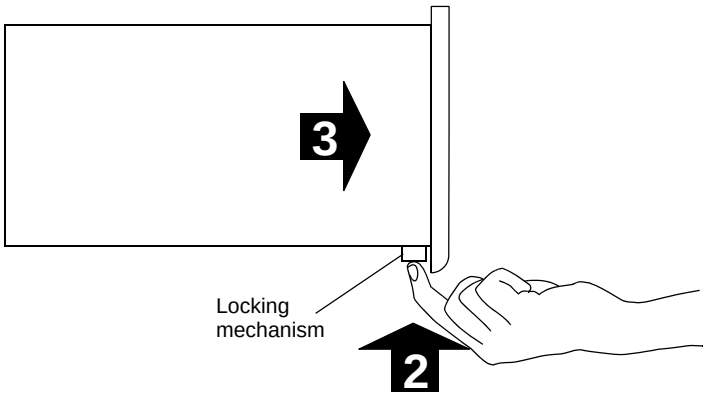


Figure 2-7. Removing an IQ Module

4. Put one of the supplied protective covers over the empty slot to prevent dust from entering the module housing.

This page intentionally left blank.

3 OVERVIEW

The IQ-5500 is a complete PMD analyzer system. It measures PMD using the internationally recognized interferometric method. The IQ-5500 averages PMD over the complete source wavelength range without any filtering, leaving all the source power for PMD measurement. The full dynamic range remains available to test long fiber spans. The IQ-5500 does not require any special environmental setup to perform reliable measurements.

The IQ-5500 PMD Analyzer measures PMD values from 0.1 to 35 ps while the IQ-5500ER Extended Range PMD Analyzer option (referred to as ERPMD) allows measurements up to 115 ps in strong mode coupling.

Note: *When in a context that applies to both, "PMD Multi-Analyzer" refers to both the IQ-5500 PMD Analyzer and the IQ-5500ER Extended Range PMD Analyzer.*

A modular source such as the IQ-2123BP singlemode polarized LED is best suited for PMD measurements. A source such as the M2100BP EELED is ideal for high dynamic range PMD measurements.

Fast test results

Obtain a complete PMD diagnosis, with delay and coefficient, in less than 15 seconds (typically). The PMD Multi-Analyzer features a powerful PC for ultrafast computation and analysis.

Repeated measurements and statistical analysis

The system performs automatic and repeated PMD measurements to accelerate qualification testing and lower production costs, and provides statistical analysis such as average and standard deviation values over a repeated number of measurements.

Validity diagnostics in the field

To save time and money, the user-defined threshold and scanning range features enable you to validate PMD results in the field and make corrections immediately.

Full documentation capability

Add notes and comments to measurements and document results for future reference. Produce detailed reports in compliance with ISO 9000 quality assurance standards.

Computer-assisted testing

View PMD distribution at a glance using the interferogram. The software takes care of the Gaussian curve fitting for added convenience.

User-friendly software

Access functions and commands through buttons. Step-by-step instructions make testing easy and virtually error-free. Thanks to the simple-to-use interface software, novice and advanced users can obtain fast, accurate, and efficient PMD measurements with little training.

Step-by-step instructions

This brief introduction has given you an overview of PMD Multi-Analyzer Application Software. The rest of this manual supplies the details. Chapter four thoroughly describes the graphical interface. Chapter five explains essentials such as how to begin an acquisition, and contains step-by-step instructions on how to characterize strong and weak mode coupling fibers and components. Chapter six explains how to manage test results.

4 SOFTWARE DESCRIPTION

The many features of the PMD Multi-Analyzer are controlled using the Windows-compatible IQ Software. Please refer to the *IQ-200 Optical Test System Instruction Manual* for information regarding the IQ-200 Optical Test System, IQ-203 Mainframe, and IQ Software conventions.

4.1 Loading the Application Software

There are two ways to load the application software:

- Push the LED push button on the front panel.
- Double-click on the corresponding icon (IQ-5500 or IQ-2123BP) in the IQ-200 Optical Test System main window.

Note: *Pushing the LED push button does not activate the source.*

Once the IQ application software for a specific module is loaded, the corresponding main window opens. The main window contains all the necessary commands to control the module. Once open, the main window appears. The software interface for each module is described in the following sections.

4.2 IQ-5500 PMD Multi-Analyzer Software Description

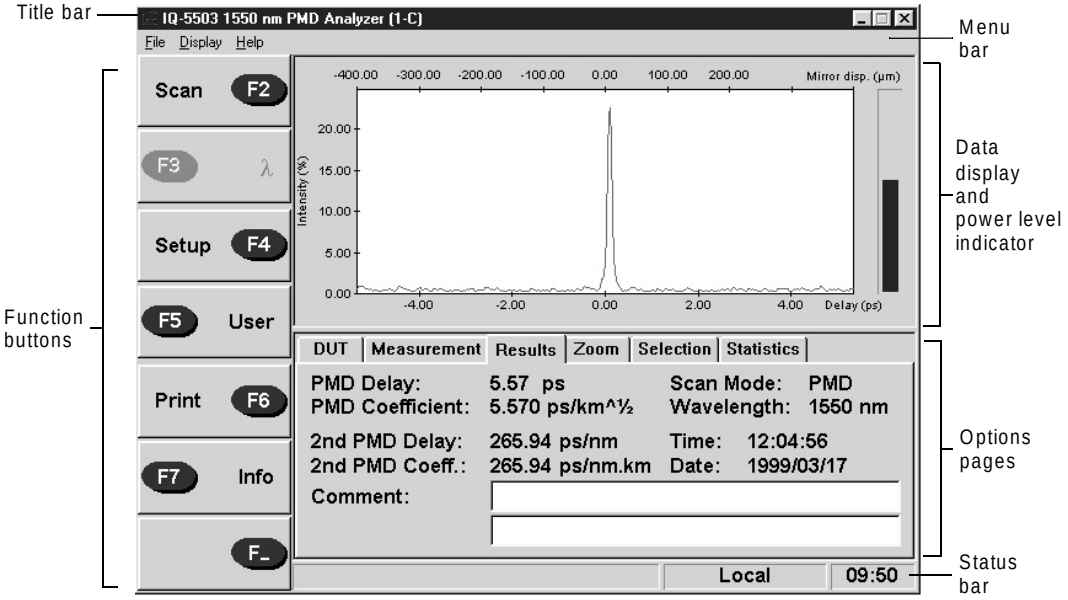


Figure 4-1. IQ-5500 PMD Main Window

The main window can be divided into five sections:

- title bar and menu bar
- function buttons
- data display and power level indicator
- options pages
- status bar

A split bar divides the data display and the options pages; it can be moved up or down to adjust the sizes of both sections.

4.2.1 Title Bar and Menu Bar

The title and menu bars are at the top of the main window. The title bar indicates the name of the application, while the menu bar contains three menus, which are described in Table 4-1.

Menu	Option	Function
File	**Open Config...**	Opens a previous configuration file. See *Opening and Saving Configuration Files*, on page 6-2. Keyboard shortcut: Ctrl + N
	Save Config...	Saves actual configuration setup to be used in following testing sessions. See *Opening and Saving Configuration Files*, on page 6-2. Keyboard shortcut: Ctrl + O
	Open Graph...	Opens a trace file. See *Saving and Retrieving Files*, on page 6-1. Keyboard shortcut: Ctrl + G
	Save Graph...	Saves a trace file. See *Saving and Retrieving Files*, on page 6-1. Keyboard shortcut: Ctrl + R
	Build Table...	Generates a data table from selected trace files. See *Generating a Results Table from the File Menu*, on page 6-1. Keyboard shortcut: Ctrl + B
	Stop Build	When **Build Table** is selected, **Stop Build** replaces **Build Table**. Selecting **Stop Build** stops table generation. The application displays the traces that were loaded before activating the **Stop Build** command. Keyboard shortcut: Ctrl + Break

Table 4-1. IQ-5500 Main Window Drop-Down Menus (Part 1 of 2)

Menu	Option	Function
File	**Open Table...**	Opens a generated table and all associated traces. See *Saving and Retrieving Files*, on page 6-1. Keyboard shortcut: Ctrl + T
	Stop Load	When **Open Table** is selected, **Stop Load** replaces **Open Table**. Selecting **Stop Load** stops file retrieval.
	Save Table...	Saves a generated table. See *Saving and Retrieving Files*, on page 6-1. Keyboard shortcut: Ctrl + A
	Exit	Closes the application.
Display	**Monitor**	Focuses the shell window associated with the PMD module. See *Monitor Window*, on page 4-13. Keyboard shortcut: Ctrl + M
Help	**Online Manual...**	Opens the contents of the present instruction manual. Keyboard shortcut: F1
	Hardware...	Displays hardware information. Keyboard shortcut: Ctrl + H
	About...	Opens a window providing the following information: • name and version of the application • Customer Support phone numbers • EXFO web site and e-mail address • system information

Table 4-1. IQ-5500 Main Window Drop-Down Menus (Part 2 of 2)

4.2.2 Function Buttons

Button	Description
	Starts PMD scanning according to specified setup. This button reads **Stop** when scanning is in progress. See *Acquiring a Trace*, on page 5-12. Keyboard shortcut: F2
	Changes the wavelength and initiates a scanning session. Keyboard shortcut: F3
	Opens the *Setup* dialog box where you can specify and set acquisition parameters and data management options. Keyboard shortcut: F4
	Opens the *User Information* dialog asking for your name and the company name. This information will appear on printed reports. Keyboard shortcut: F5
	Opens the *Print* dialog box that allows you to setup and print a PMD report and change printer settings. Keyboard shortcut: F6
	Opens the *Measurement Information* dialog box that displays complete information about the fiber, the acquisition, and results. See *Viewing Acquisition Information*, on page 5-19. Keyboard shortcut: F7
	Transfers control to the IQ-203 front panel function keys. Refer to the *IQ-200 Optical Test System Instruction Manual*. Keyboard shortcut: F12

Table 4-2. IQ-5500 Function Buttons Description

4.2.3 Data Display and Power Level Indicator

The data display section shows a signal intensity trace as a function of time or distance. The bottom x axis represents time delay in picoseconds. The top x axis represents mirror displacement in micrometers. The y axis represents signal intensity in percentage.

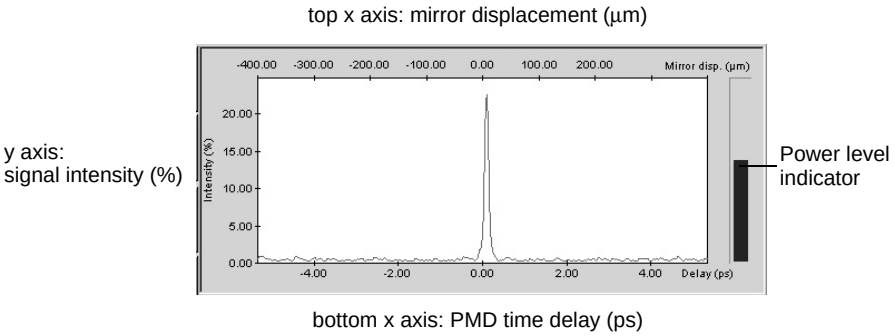


Figure 4-2. PMD Graph Axes Description

The trace will be displayed in this graph form, with a Gaussian fit drawn over the trace. Two vertical cursors, one on each side of the peak will help determine the peak limits, a horizontal cursor will help determine the noise level and another vertical cursor will indicate the peak center. Display of Gaussian fit and cursors is user-selectable. The center cursor is only displayed if the trace in the graph window is the most recent acquisition and if the active page is the **Measurement** page.

The progress bar to the right of the trace display is the power level indicator. This bar is a visual aid to estimate the intensity of the incoming signal. You can toggle the bar display on or off in the **Module** page. For more information, see *Module Page*, on page 5-26.

4.2.4 Options Pages

The options pages at the bottom of the screen are made active by selecting the corresponding tab. Six pages are available: **DUT**, **Measurement**, **Results**, **Zoom**, **Selection**, and **Statistics**. These pages will be detailed in Section 5, *Operation*.

4.2.5 Status Bar

The status bar displays the current analyzer status.

Information	Description
Scanning in progress...	The progress bar indicates the percentage value of the achieved data acquisition process.
Scanning x/total...	The progress bar indicates the percentage of achieved acquisition, while the message indicates how many scans out of a multiple acquisition have been done.
Waiting...	The module is waiting for the next acquisition to start. Depending on your preferences, an acquisition may start manually, or automatically after a certain time. For more information, see *Configuring Multiple Measurement Acquisitions*, on page 5-10.
Scan cancelled...	You clicked the **Stop** button on the main screen, or **Cancel** in the *Waiting for Next Acquisition* dialog box, thus interrupting the scanning.
Initializing	The application is setting the initial configuration or initiating communication with other modules.
Done	Initialization is finished.
Analyzing...	The module is performing calculations on acquisition data to obtain PMD value.

Table 4-3. Status Bar Information Description

4.3 IQ-2123BP Light Source Software Description

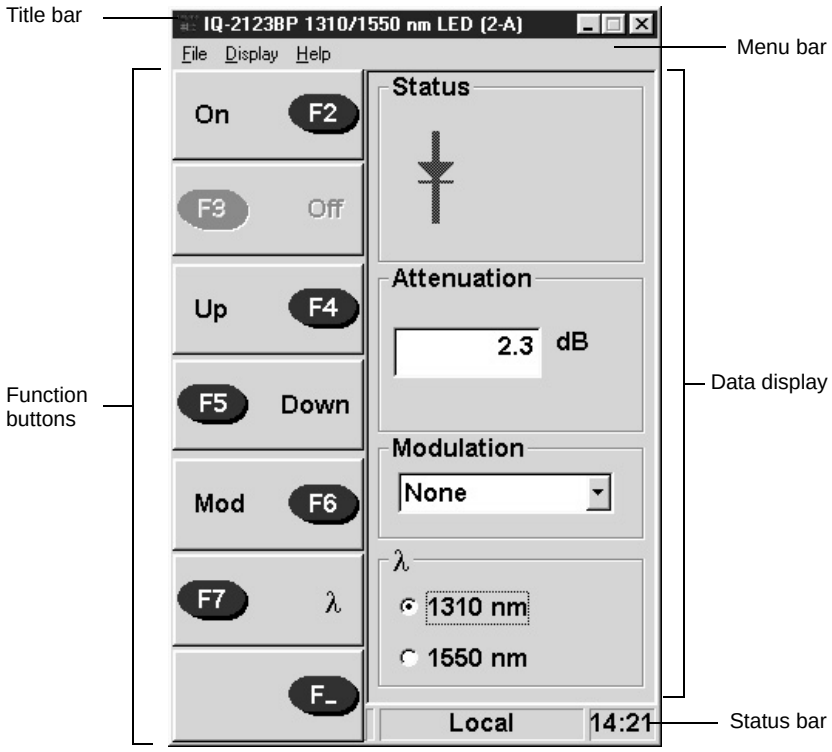


Figure 4-3. IQ-2123BP Light Source Main Window

The main window shown in Figure 4-3 can be divided into four sections:

- title bar and menu bar
- function buttons
- data display
- status bar

4.3.1 Title Bar and Menu Bar

The title bar and menu bar are at the top of the main window (see Figure 4-3). The title bar indicates the wavelength, LED/laser specifications, and operating conditions. The menu bar contains three drop-down menus that are explained in Table 4-4.

Menu	Option	Function
File	**Open Config...**	Opens a previously saved configuration.
	Save Config...	Saves the current configuration.
	Exit	Closes the application.
Display	**Monitor**	Opens the monitor window that displays basic source data (refer to *Monitor Window*, on page 4-13 for detailed information).
Help	**Online Manual**	Opens the application Help file, which contains an electronic version of the present instruction manual.
	About...	Opens a window providing the following information: • name and version of the application • Customer Support phone numbers • EXFO web site and e-mail address • system information

Table 4-4. IQ-2123BP Main Window Drop-Down Menus

4.3.2 Function Buttons

The function buttons are used for immediate control of the light source. Table 4-5 provides a quick reference guide to these controls.

Function Button	Description
	Activates light emission(see *Source Activation/Deactivation*, on page 5-1).
	Deactivates light emission (see *Source Activation/Deactivation*, on page 5-1).
	Increases attenuation (see *Attenuation Setting*, on page 5-2).
	Decreases attenuation (see *Attenuation Setting*, on page 5-2).
	Selects the modulation state (see *Modulation State*, on page 5-2).
	Selects the wavelength (see *Wavelength Selection*, on page 5-3).

Table 4-5. IQ-2123BP Function Buttons (Part 1 of 2)

Function Button	Description
	Transfers control between software function buttons and IQ-203 front panel hardware function keys (refer to *IQ-200 Optical Test System Instruction Manual*). When software function buttons are disabled, they will be grayed out.

Table 4-5. IQ-2123BP Function Buttons (Part 2 of 2)

Note: *The software function buttons are also available in monitor window mode.*

4.3.3 Data Display

The data display boxes, located on the right side of the main window (Figure 4-3, on page 4-8) indicate the result of F button actions.

Table 4-6 provides a quick reference guide to these boxes. For further information on operation of the IQ-2123BP/BH using the data display boxes, see *Source Activation/Deactivation*, on page 5-1.

Display Box	Description
	Indicates light source status.

Table 4-6. Data Display Boxes (Part 1 of 2)

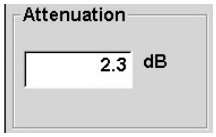
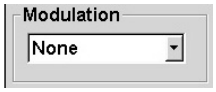
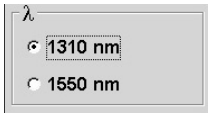
Display Box	Description
	Indicates the current attenuation level. Edit the attenuation value displayed. (see *Attenuation Setting*, on page 5-2)
	Indicates the current modulation state. Choose a modulation state from the drop-down list. (see *Modulation State*, on page 5-2)
	Indicates the current wavelength(s). Select a wavelength with the radio button. (see *Wavelength Selection*, on page 5-3)

Table 4-6. Data Display Boxes (Part 2 of 2)

4.4 Status Bar

In the status bar, you may also find the inscriptions **Local**, **Remote**, or **Lockout**, which indicate if the selected module is controlled locally or through a GPIB, OCX, DDE, or RS-232 link. Table 4-7 explains the meaning of these inscriptions. For more information on how to control the different IQ modules through a GPIB link, refer to the *GPIB and Application Development Guide*. The status bar also displays the time.

Indication	Meaning
Local	The unit is controlled locally.
Remote	The unit is controlled through a GPIB, OCX, DDG, or RS-232 link, but local commands can still be used.

Table 4-7. Module Control Status

Indication	Meaning
Lockout	The unit is exclusively controlled through a GPIB, OCX, DDG, or RS-232 link.

Table 4-7. Module Control Status

4.5 Monitor Window

The monitor window displays basic status data. Using the monitor window in conjunction with other module monitor windows allows the creation of an integrated data display screen (refer to the *IQ-200 Optical Test System Instruction Manual*). The size and position of the monitor window can be customized.

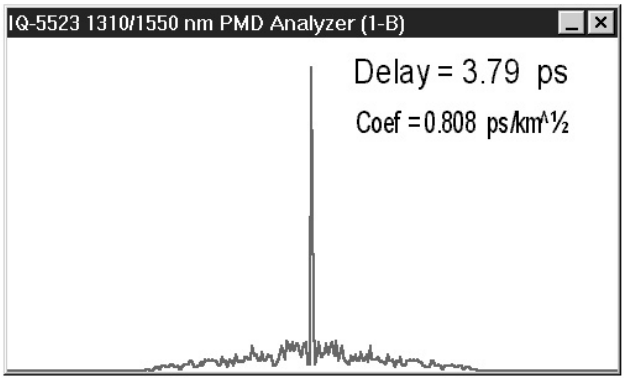


Figure 4-4. IQ-5500 Monitor Window

The IQ-2123BP Light Source Monitor window (Figure 4-5) displays the current wavelength, source status, and current attenuation.

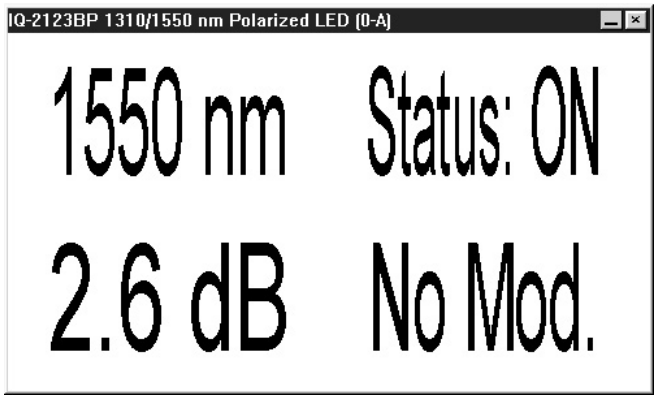


Figure 4-5. IQ-2123BP Monitor Window

4.5.1 Opening the Monitor Window

There are three ways to open the monitor window:

- In the main window, choose **Monitor** from the *Display* menu.
- In the main window, click on the bar icon in the upper right corner.
- Push the LED push button on the front panel of the module.

4.5.2 Closing the Monitor Window

There are two ways to close the monitor window and return to the main window:

- Double-click anywhere in the monitor window.
- Push the LED push button on the front panel of the module.

Note: *By positioning the cursor inside the monitor window and right-clicking, the function buttons will appear to the left of the monitor window.*

4.6 Exiting the Application Software

Closing any application software that is not in use is a good way to free system memory. The application software can be closed either from the main window or monitor window.

4.6.1 From the Main Window

There are three ways to exit the application software from the main window:

- Click on the **x** in the top right corner of the main window.
- Choose Exit from the File menu.
- Click on the module icon (in the top left corner of the main window) and select Close.

4.6.2 From the Monitor Window

To exit the application software from the monitor window, click on the x in the top right corner of the monitor window.

This page intentionally left blank.

5 OPERATION

5.1 Source Activation/Deactivation

The following section describes how to power on the light source.

- Choose **ON** to activate the light emission. The active LED on the module front panel will then light up, indicating that the source is active.

Two red right-pointing arrows will then appear in the Status box, as shown in Figure 5-1, indicating that the source is on.

- Choose **OFF** to deactivate the light emission. The active LED on the module front panel will then turn off, indicating that the source is off.

The two right-pointing arrows will disappear from the **Status** box indicating that the source has been deactivated. The symbol will also return to its original grayed-out color.

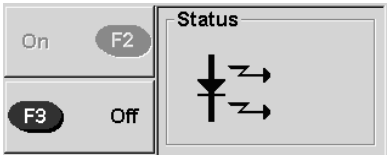


Figure 5-1. Light Source Activation/Deactivation Buttons and Status Box

Note: *To obtain optimum stability, a laser source should be allowed to warm up for a period of 30 minutes.*

5.2 Source Setup

The source is operated and controlled from within the main window. The following operations are available:

- attenuation setting
- wavelength selection

5.2.1 Attenuation Setting

The **Attenuation** edit box indicates the current attenuation. The attenuation range is up to 6 dB for LEDs and 9.9 dB for lasers (subject to change). To set the source attenuation,

- Enter an attenuation value directly in the **Attenuation** edit box, or
- Use **UP** or **DOWN** to increase or lower the attenuation by increments of 0.1 dB

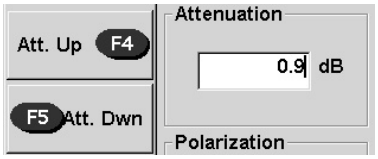


Figure 5-2. Increase/Decrease Buttons and Attenuation Edit Box

Note: *To obtain maximum output power, the attenuation should be set to 0.0 dB and modulation should be set to none.*

5.2.2 Modulation State

To set the modulation state,

- Select a modulation state from the **Modulation** list box, or
- Choose **MOD** to scroll through the available modulation frequencies

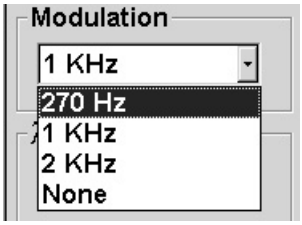


Figure 5-3. Modulation List Box

Note: *The internal modulation is full on/off modulation at a 50% duty cycle. To obtain maximum output power, modulation should be set to none and attenuation set to 0.0 dB.*

5.2.3 Wavelength Selection

To set the source wavelength (if the source is dual-wavelength),

- Choose λ, or
- Click the radio button of the desired wavelength in the **Wavelength (λ)** box

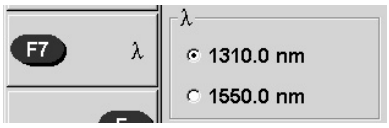


Figure 5-4. Wavelength Button and Box

A **Performing laser stabilization** information window will appear to indicate a successful wavelength selection (only if the source is a laser and the laser is active).

Note: *The wavelengths specified in the* **Wavelength (λ)** *box are the measured wavelengths of the optical sources; to the nearest 1 nm for FP lasers; to the nearest 0.1 nm for DFB lasers; and to the nearest 10 nm for LED sources for attenuation settings of 0.0 dB.*

5.3 Preparing for Measurements

Before an acquisition session,

1. Clean and verify the quality of the connectors used.
2. Connect the device under test according to test requirements.

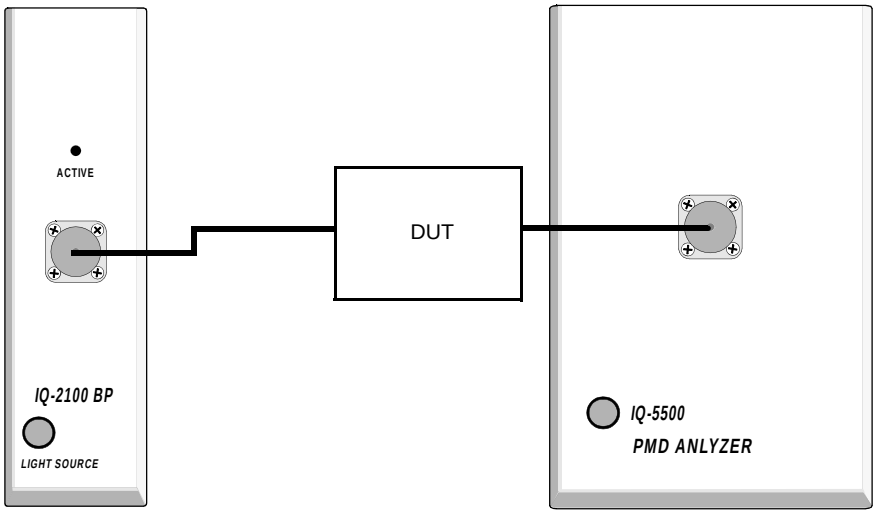


Figure 5-5. PMD Measurement Setup with an IQ-2123BP Light Source Module

Figure 5-5 shows the setup required to measure PMD with an IQ-2123BP source module. The method used to measure PMD in this case is the interferometric method.

3. Turn on the mainframe unit.

4. Load the PMD Analyzer application software.

Default values allow plug-and-play PMD acquisition. It is not necessary to modify these parameters before starting an acquisition.

5.4 Entering User Information

The **User** button opens a window where the operator may enter information about the person who will work with the PMD Multi-Analyzer.

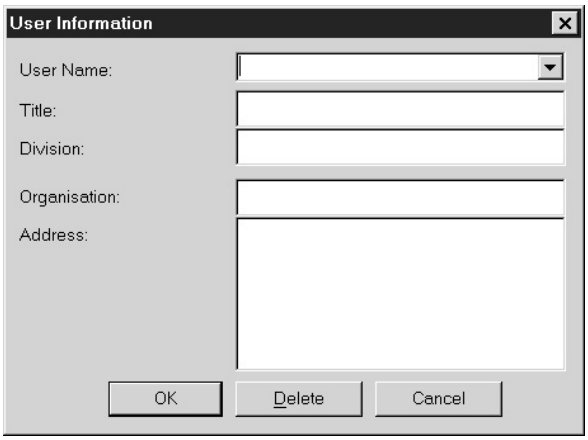


Figure 5-6. User Information Window

Every time a new name is entered in this window, it will be saved and made available in the list for future use. To delete a name from the **User Name** list, simply select it and delete it. The information supplied will be used for reports.

5.5 Entering DUT Information

DUT information is entered in the **DUT** page. This information will be available for the reports, information dialogs, etc.

Note: *The information in the* **Fiber ID** *and* **Comment** *text fields is saved with the configuration in the template.*

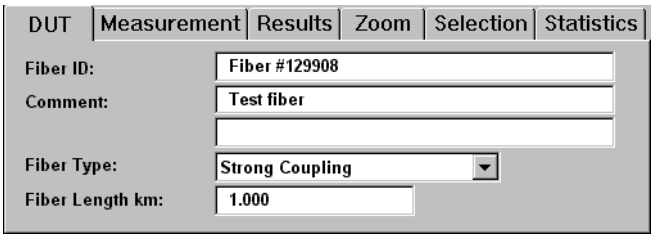


Figure 5-7. DUT Page

5.5.1 Identifying the Device Under Test

The name—or identification code of the device—is entered on **Fiber ID** line. Enter a name that properly identifies the fiber or device under test.

5.5.2 Entering Comments About the Acquisition

General comments about the device under test can be entered on the **Comment** lines. These comments will appear on reports and information windows.

5.5.3 Selecting Device Type

The **Type** drop-down list has the choice of devices necessary for PMD characterization. If the device type selected is **Strong Coupling** or **Weak Coupling**, the **Fiber Length** field will be active to type in the length, in kilometers, of the fiber under test. If **Component** is chosen, this field will not be available. The **Weak Coupling** option allows you to perform PMD measurements on fibers with very low or no polarization mode coupling, also known as weak mode coupling fibers, or HiBi (high birefringence) fibers. The **Component** option adjusts the system to measure the low PMD values of passive components.

If you do not know whether your fiber has weak polarization mode coupling, you should start by making a single acquisition using **Strong Coupling** measurement parameters. If the resulting trace has a wide main peak with one peak on each side, as in Figure 5-8, it is very likely that you are testing a weak mode coupling fiber. You should then make new a measurement in weak mode coupling to obtain a realistic PMD value.

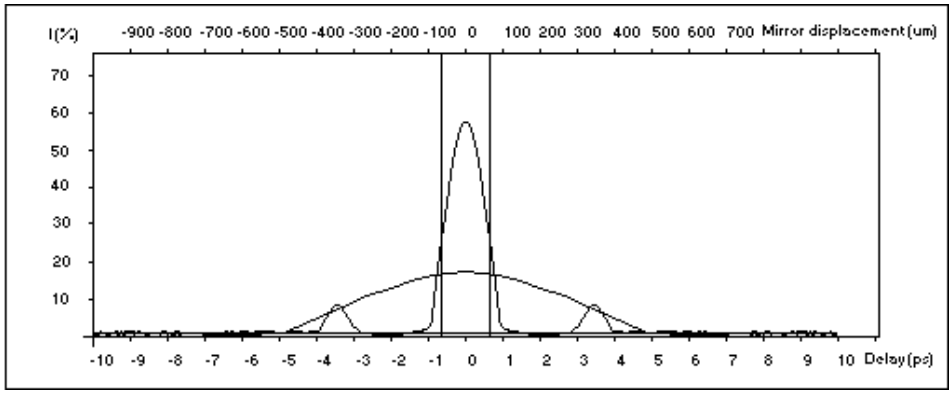


Figure 5-8. Weak Mode Coupling Fiber Measured with Strong Coupling Settings

5.5.4 Specifying Fiber Length

PMD is a function of the distance a signal travels. The fiber length parameter is compulsory since it will be used for PMD coefficient calculations. The entered value must be equal to or greater than 0.001 km (1.0 m).

5.6 Setting Acquisition Parameters

Acquisition parameters are set in the **Measurement** page, where we can find a list of scanning ranges, available wavelengths, and AC gain factors. This page also allows you to modify the scanning center, configure multiple acquisitions, save the actual parameter settings as a template, or recall an acquisition parameter file.

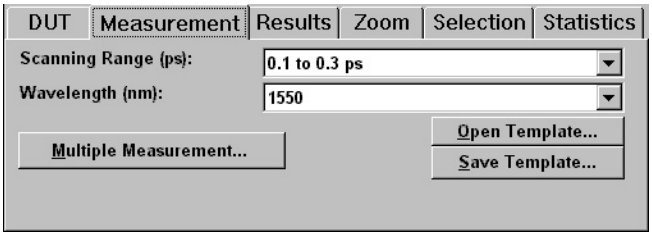


Figure 5-9. Measurement Page

5.6.1 Scanning Range

The scanning range is related to the scan width around the main peak obtained by the analyzer during a measurement and needs to be set according to the PMD being measured. When you first measure a fiber and do not know its PMD, choose an intermediate range, like 0.4–1.2 ps, or 1.0–3.0 ps. Once a measurement is made, it is important to enter a more precise scanning range corresponding to the PMD calculated for the first measurement.

If the PMD value is above the upper limit of the selected range, a message will appear suggesting a higher scanning range be chosen. If the PMD value is below the lower limit of the selected range, a message will appear suggesting you choose a scanning range that contains the obtained PMD value.

The Automatic Mode option allows you to make measurements when the expected PMD value is unknown. This option is only available in Strong Mode Coupling and if all the scanning ranges are available.

Note: *Care must be taken when using Automatic Mode. In certain conditions, the proper scanning range may not be identified in this mode. Also, automatic mode may take more time to obtain results due to the selection sequence of the scanning ranges.*

Strong Mode Coupling Device		Weak Mode Coupling Device and Component	
ps	**µm**	**ps**	**µm**
0.1 to 0.3	±100	0.1 to 1.0	±100
0.2 to 0.6	±200	1.0 to 2.2	±200
0.4 to 1.2	±400	2.0 to 4.8	±400
1.0 to 3.0	±1000	4.0 to 12.0	±1000
2.0 to 6.0	±2000	10.0 to 24.0	±2000
4.0 to 12.0	±4000	20.0 to 48.0	±4000
10.0 to 35.0	- 4000 to + 10,000	40.0 to 120.0	- 4000 to + 10,000
10.0 to 30.0 (FAST)	±4000		
10.0 to 50.0 (ERPMD)	- 4000 to +7000		
10.0 to 115.0 (ERPMD)	-4000 to +16,000		
(Automatic Mode)			

Table 5-1. Available Scanning Ranges According to Device Type

Note: *You will notice that the higher scanning ranges are shifted to the left. This is normal and does not indicate a problem with your module.*

The **Scanning Range** list box has all the scanning ranges available for the module in use. These values change depending on module configuration and on selected device type. For example, ERPMD scanning ranges are available only if you have an IQ-5500ER Extended Range PMD Analyzer.

Note: *Fast Scan measurement allows quicker results but with lesser accuracy than the regular 10.0 - 35.0 ps range, in the high end of the range.*

5.6.2 Selecting Wavelength

The **Wavelength** list box allows you to select the acquisition wavelength. These values depend on the module configuration.

Note: *If you are using an external polarized source, it must be set to the same wavelength used by the PMD program.*

When using an IQ-5500 module in conjunction with the recommended 1310 nm/1550 nm dual-wavelength light source module IQ-2123BP, the source wavelength will be adjusted automatically according to the selection made in the application software.

5.6.3 Configuring Multiple Measurement Acquisitions

The **Multiple Measurement** button opens a window where multiple acquisition parameters can be set.

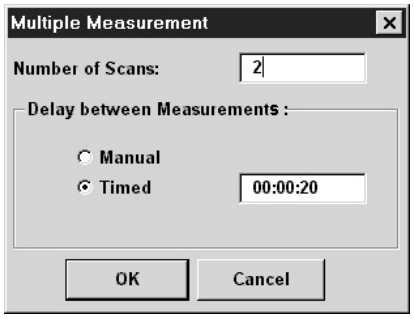


Figure 5-10. Multiple Measurement Dialog

You may indicate the number of measurements you wish to make and the delay between each measurement. Click **OK** to accept the choices and close this window. Click **Cancel** to exit this window without making any changes.

The delay between each measurement is determined in seconds. If you wish to manually determine when an acquisition should start, check the **Manual** radio button. A dialog box will open between each measurement where you click **Start Next** whenever you want the next acquisition to start. You may also change the wavelength for the next acquisition by selecting the wavelength from the list box or cancel all subsequent acquisitions by choosing **Cancel**.

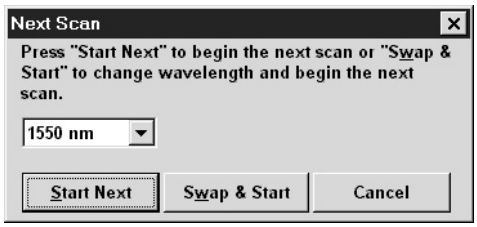


Figure 5-11. Manual Scan Dialog

If you select the timed acquisition, you must specify the delay between each acquisition in the edit box to the right of the radio button. After each acquisition the following dialog box will open:

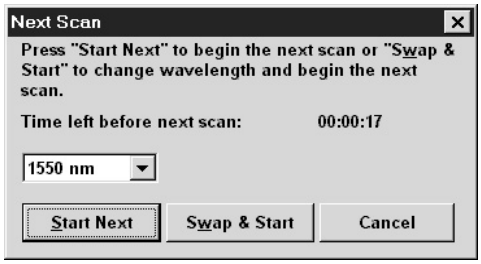


Figure 5-12. Timed Scan Dialog

The dialog box counts down the time left for the next acquisition to start. To start the acquisition before the time, click **Start Next**. You may also change the wavelength for the next acquisition by selecting the wavelength from the list box. Click **Cancel** to stop the acquisition process and the message **Scan cancelled** appears in the status bar.

Note: *Multiple measurement mode is used for making multiple acquisitions on the same fiber. Do not change the test fiber between two acquisitions of a multiple measurement mode test since parameters set for a specific fiber may not apply to all fibers.*

When using multiple measurement mode, results are saved using auto-naming values. A message window lets you choose between overwriting existing files and changing the file names. For information on auto-naming, see *File Name Page*, on page 5-25.

5.6.4 Opening and Saving Templates

The **Open Template** and **Save Template** buttons allow users to recall a previously saved acquisition parameters file and save the current settings as a template, respectively. Such template files are saved with the *tpl* extension in the directory of your choice.

5.7 Acquiring a Trace

To start an acquisition,

1. Set acquisition parameters as described in *Setting Acquisition Parameters*, on page 5-8.

2. Verify that the DUT is properly connected, that the setup is appropriate and that the source is activated.

3. Click **Scan** to begin a measurement sequence.

When the measurement is complete, the PMD results graph is displayed.

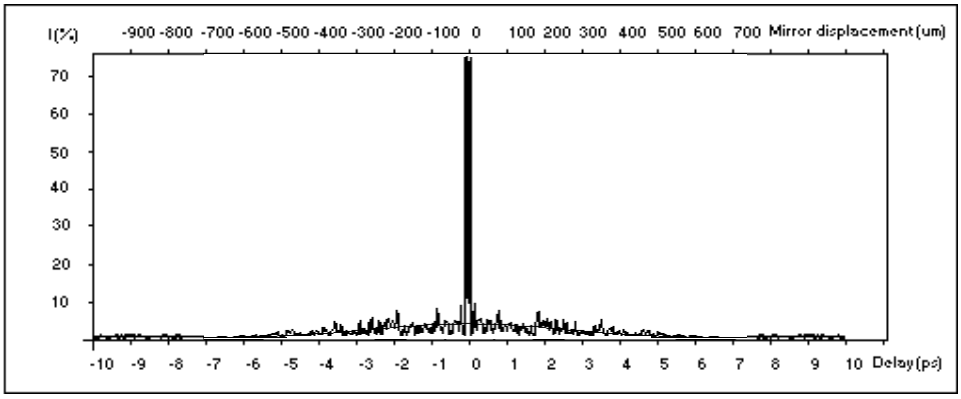


Figure 5-13. PMD Results Graph

5.8 Viewing Acquisition Results

Note: *When there is no trace, the* **Results**, **Zoom**, **Selection** *and* **Statistics** *pages are not activated.*

The **Results** page displays basic information about the recent acquisition. If there is no trace on-screen, this page is not available. After a single acquisition, this page becomes active by default to give a quick overview of the results.

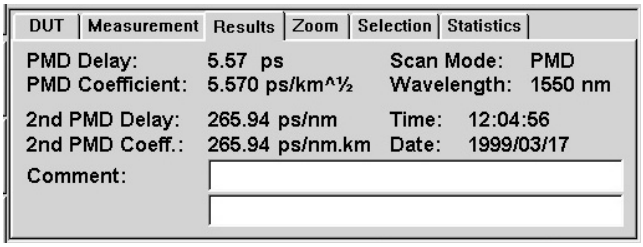


Figure 5-14. Results Page

The information in the **Comment** lines comes from the **DUT** page. This information can be modified from this page and automatically updated throughout the system.

5.9 Selecting Views with the Zoom

The **Zoom** page controls the views by increasing or diminishing the axes scales.

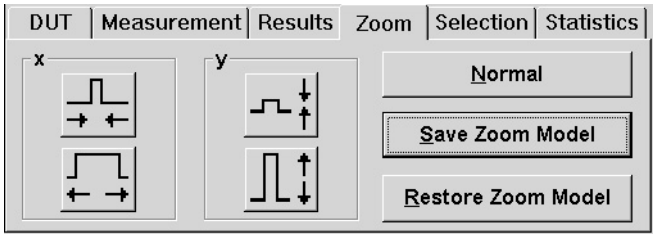


Figure 5-15. Zoom Page

The following table explains how zoom functions affect trace display.

Button	Function
	Enlarges horizontal scale. Reduces trace horizontally.
	Reduces horizontal scale. Enlarges trace horizontally.
	Enlarges vertical scale. Reduces trace vertically.
	Reduces vertical scale. Enlarges trace vertically.

Table 5-2. Zoom Functions (Part 1 of 2)

Button	Function
Normal	Sets normal trace view.
Save Zoom Model	Saves current trace view.
Restore Zoom Model	Sets the trace view as it was last saved.

Table 5-2. Zoom Functions (Part 2 of 2)

The **Save** and **Restore** buttons enable you to save and recall the trace view preferences. Using this function, you can save time when analyzing traces, especially when doing multiple acquisitions of the same fiber span over time or when analyzing multiple fiber spans simultaneously.

5.10 Selecting a Trace to View

The **Selection** page lists all acquisition results. Each acquisition takes up a line on the table. Use the scroll bars to see all the information.

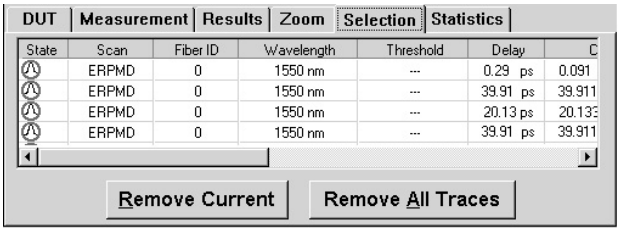


Figure 5-16. Selection Page

A multiple acquisition adds a line of information for each acquisition. Every retrieved trace adds a line to the table. The **Build Table** option — in the *File* menu — creates a new table for the selected traces. Four different icons may appear in the first column to indicate the status of the information.

Icon	Meaning
	A trace is not available for this acquisition.
	A trace is available for this acquisition. Selecting the information line will display the trace.
	A trace is available for this acquisition, but the values cannot be used for analysis, or the PMD value is valid but exceeds the threshold.
	A trace is not available for this acquisition, and the values cannot be used for analysis, or the PMD value is valid but exceeds the threshold.

Table 5-3. Information Availability Indicators

To find out why  or  appears in the state column of an acquisition, select the acquisition and click the left mouse button. The status bar displays a message explaining the problem. For example, if the PMD value is meaningful but exceeds the threshold, a  appears in the state column and the problem is identified in the status bar.

The **Selection** page contains the following information:

Column Title	Description
State	An icon indicates whether a trace is available or not, and the usefulness of the values.
Scan	Scan type used (PMD or ERPMD).

Table 5-4. Information Available in the Selection Page (Part 1 of 2)

Column Title	Description
Fiber ID	Fiber identification, as entered in the **DUT** page.
Wavelength	Wavelength used for the acquisition.
Threshold	Sets user-defined maximum tolerated PMD value.
Delay	PMD delay value.
Coeff.	PMD coefficient.
2nd Delay	2nd order PMD delay value.
2nd Coeff.	2nd order PMD coefficient.
Length	Fiber length, as entered in the **DUT** page.
Type	DUT type: weak coupling, strong coupling, or component.
Date	Acquisition date.
Time	Acquisition time.
File Name	Name of the acquisition file.
Comment 1 **Comment 2**	Comments about the acquisition, as entered in the **DUT** page.

Table 5-4. Information Available in the Selection Page (Part 2 of 2)

Highlighted information can be deleted from the table by clicking **Remove Current Trace**. If the information has never been saved or has been modified, a warning message will appear to indicate that the trace or changes will be lost if they are not saved. If you save a trace that has never been saved, a *Save* window will open. Selecting **Remove All Traces** erases the contents of the whole table.

5.11 Viewing Statistics

The **Statistics** page shows statistical results for the current trace table. These values are automatically updated whenever the table information changes.

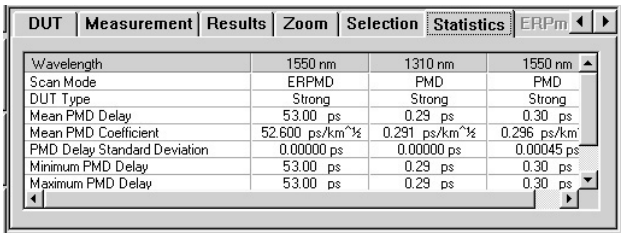


Figure 5-17. Statistics Page

Table 5-5 describes each entry in the statistics table.

Row	Description
Wavelength	Lists all wavelengths found in the trace table.
Scan Mode	Indicates the selected acquisition mode: PMD, FASTSCAN, or ERPMD.
DUT Type	Type of device: strong coupling, weak coupling, or component.
Mean PMD Delay	Mean PMD Delay value for the corresponding wavelength.
Mean PMD Coefficient	Mean PMD Coefficient value for the corresponding wavelength.
PMD Delay Standard Deviation	PMD Delay Standard Deviation for the corresponding wavelength.
PMD Coefficient Standard Deviation	PMD Coefficient Standard Deviation for the corresponding wavelength

Table 5-5. Information Available in the Statistics Page (Part 1 of 2)

Row	Description
Maximum PMD Delay	Highest PMD value found on the trace table.
Minimum PMD Delay	Lowest PMD value found on the trace table.
Maximum PMD Coefficient	Highest PMD coefficient.
Minimum PMD Coefficient	Lowest PMD coefficient.
DUT Count	Number of acquisitions considered for calculations.

Table 5-5. Information Available in the Statistics Page (Part 2 of 2)

Only meaningful results are used to calculate statistics, that is, those having one of the following symbols in the **State** column of the **Selection** page.



5.12 Viewing Acquisition Information

After you have measured a fiber, and a graph has been displayed, you are able to verify and change information about the fiber. To display the *Measurement Information* window, select the **Info** function button. For more information, see *Setting Acquisition Parameters*, on page 5-8.

Click on the appropriate field and type the new information. Acquisition results and system information are displayed on the lower section of the window. These values cannot be modified.

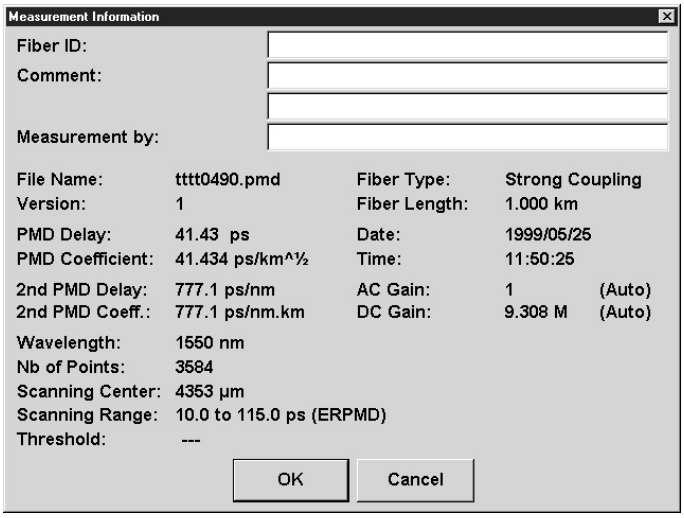


Figure 5-18. Measurement Information Window

File Name
Name assigned to the trace in the **File** page, on the *Setup* window. For more information, see *File Name Page*, on page 5-25.

Version
Version of the mathematical formulas used to make the acquisition.

PMD Delay
Resulting PMD delay value for the measured fiber length. For more details, see *Units and Measurements*, on page A-2.

PMD Coefficient
Calculated PMD coefficient for the analyzed fiber length. For more details, see *Units and Measurements*, on page A-2. This information is not available when the **Fiber Type** field contains **Component**.

2nd Order PMD Delay
Resulting second order PMD delay value with respect to wavelength for the measured fiber length.

2nd Order PMD Coeff.
Calculated second order PMD coefficient for the analyzed fiber length. This information is not available when the **Fiber Type** field contains **Component.**

Fiber Type
Indicates the device under test, as selected in the **DUT** page. For more information on this parameter, see *Selecting Device Type*, on page 5-6.

Fiber Length
As indicated in the **DUT** page. For more information on this parameter, see *Specifying Fiber Length*, on page 5-7. This information is not available when the **Fiber Type** field contains **Component**.

Scanning Center
Interferometer position relative to its mechanical reference position, measured in μm.

Scanning Range
Acquisition scanning range, as selected in the *Measurement Parameters* window and specified in ps and μm.

Threshold
Threshold value, as selected in the **Module** page of the *Setup* window.

Wavelength
Acquisition wavelength, as selected in the *Measurement Parameters* window, see *Selecting Wavelength*, on page 5-10.

Date
Acquisition date.

Time
Acquisition time.

Points
Individual acquisition sample points used to calculate PMD values. The number of points is usually higher than the number of points used to display the trace on screen.

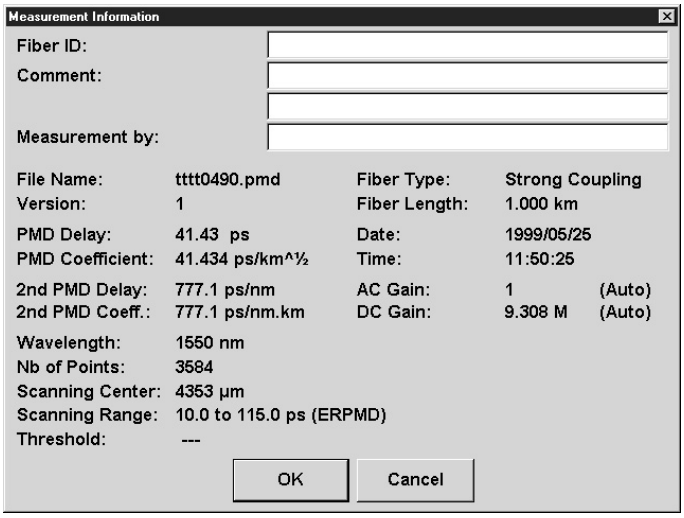


Figure 5-19. Measurement Information Window

AC Gain

Internal AC gain factor determined automatically by the application according to the signal input. In particular, it represents the amplitude of the detected interference fringes, for which the rms value is displayed on the screen following each scan.

DC Gain

Internal DC gain scale value (of the first-stage amplifier) determined automatically by the application. It represents the highest gain setting which does not saturate the detected optical signal, comprised of the AC fringe pattern superimposed on a DC level.

5.13 Customizing Acquisitions

Acquisition procedures are customized to simplify analysis in the *Setup* window. Click the **Setup** function button to open the *Setup* window. This window is composed of six pages where you can select different options to customize acquisition procedures, data saving parameters, hardware setup, graph layout, and results table layout. Once all the settings have been selected, click **OK** on the bottom of the window to accept the changes. **Cancel** exits without making any changes. **Default** ignores the changes and sets the selections back to EXFO default settings.

5.13.1 Option Page

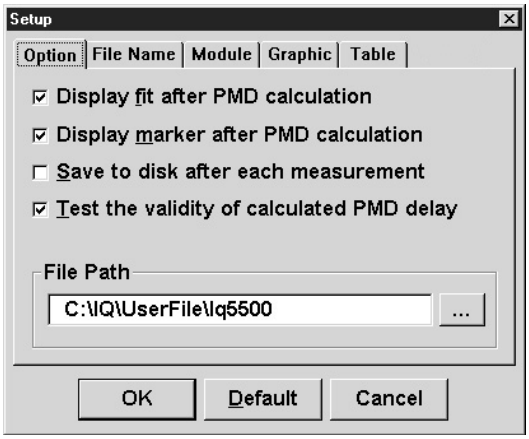


Figure 5-20. Option Page

Display fit after PMD calculation
For strong mode coupling, PMD has a theoretical Gaussian distribution. In normal mode, this option will automatically display the Gaussian curve — or fit — for each trace after acquisition.

Display marker after PMD calculation
Delimiting cursor lines will automatically be displayed for each trace after acquisition.

Save to disk after each measurement

When you choose this option, every acquisition will be saved automatically. This function is particularly useful when making multiple measurements. By choosing this option, traces will be saved before closing. If you deactivate this option, multiple acquisitions will be closed without being saved and only the information in the results table will be available.

Test the validity of calculated PMD delay

This feature compares the estimated PMD range value and the value given by the calculations. If the acquired PMD value is outside of the selected scanning range, a message will appear suggesting that the range be modified.

File Path

From this edit box, you may choose a directory where measurements will be automatically saved when the **Save to disk after each measurement** option is selected. Clicking the button at the end of the line opens a window showing the current directory tree.

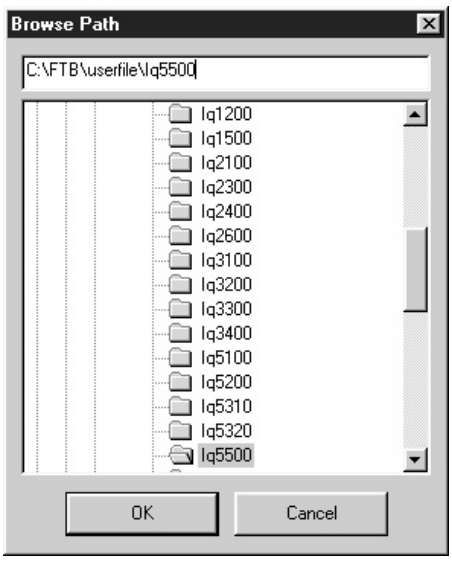


Figure 5-21. Browse Path Dialog

5.13.2 File Name Page

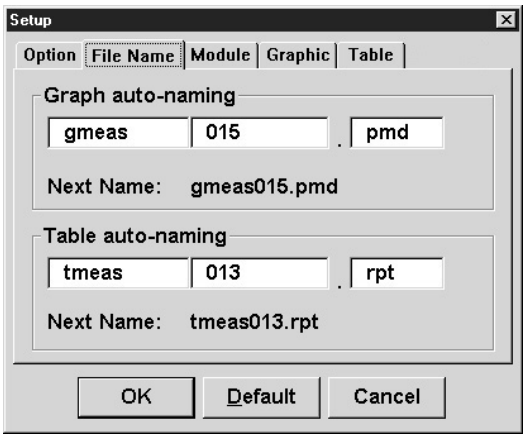


Figure 5-22. File Name Page

Graph auto-naming

By setting the default name and number of the first saved trace, all subsequent traces will be saved with the same name and an incremental number structure. The file name can be up to eight characters long. It is highly recommended to write names as short as possible, especially when using the incremental number structure.

Table auto-naming

By setting the default name and number of the first table to be saved, all subsequent tables will be saved with the same name and an incremental number structure. The file name can be up to eight characters long. It is highly recommended to write names as short as possible, especially when using the incremental number structure.

IMPORTANT

When using the incremental number structure, make sure that the number of acquisitions does not overflow the character pool. Otherwise, you will not be able to save the acquisition with a name longer than eight characters. If the Save to disk after each measurement ***option is chosen for a***

multiple acquisition without changing the name, the program will overwrite the previous acquisitions, beginning with the first ones, unless you select "no" in the message box. If you do not choose to save automatically after each acquisition, traces will not be saved and only the acquisition information will be available.

5.13.3 Module Page

The parameters controlled with this page affect the hardware-software interface.

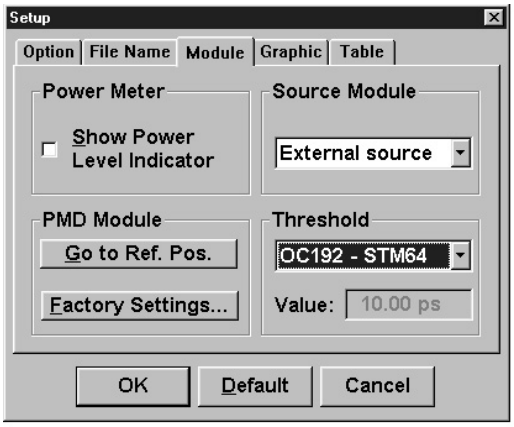


Figure 5-23. Module Page

The option to show or hide the power level indicator is available in the **Power Meter** box. The power level indicator is displayed as a level bar to the right of the data display. This level bar gives an idea of the incoming signal's intensity as detected at the input port. To display the power level indicator, select the **Show Power Level Indicator** check box.

To move the mirror to the mechanical reference position, select the **Go to Ref. Pos.** button to eliminate mechanical shifts.

The **Factory Setting** button changes the measurement parameters back to factory default settings. You should only select the **Factory Setting** button as a last resort before repair.

The **Source Module** list box allows you to choose the source employed, whether it is an IQ module (specify module position within the IQ system) or an external source.

To set a threshold for the PMD value, select the appropriate range from the **Threshold** list box. If you select OTHER, the **Value** text field will become active and you must enter the maximum PMD value you wish to use as threshold.

The following table displays the maximum accepted PMD value, which depends on the bit rate of the system under test. If the PMD value is meaningful but exceeds the user-defined threshold, a ▽ appears in the state column or the **Selection** page. For more information, see *Selecting a Trace to View*, on page 5-15.

You will be asked if you want to replace the failed measurement with a new acquisition. If so , the new measurement will overwrite the old one.

Bit Rate (Gb/s)	Maximum PMD (ps)
2.5 (OC 48 - STM16)	40
10 (OC 192 -STM64)	10
40 (OC 768 -STM256)	2,5
20 (OC48; Submarine cable)	5

Table 5-6. Threshold Correspondance

5.13.4 Graphic Page

To print a graph report, select the information that should appear in the **Graphic** page. The information order may also be determined by selecting the items in the order they should be printed.

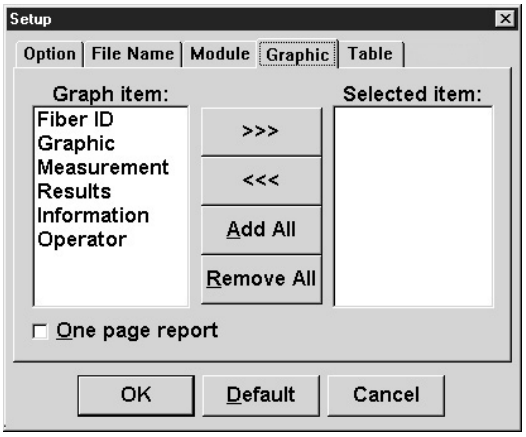


Figure 5-24. Graphic Page

To select the information to print,

1. Highlight the desired item in the **Graph item** list.
2. Click the right arrow to transfer the item to the **Selected item** list.

To print all the available information, click **Add All**.

To remove information,

1. Highlight the item to delete in the **Selected item** list.
2. Click the left arrow to transfer the item to the **Graph item** list.

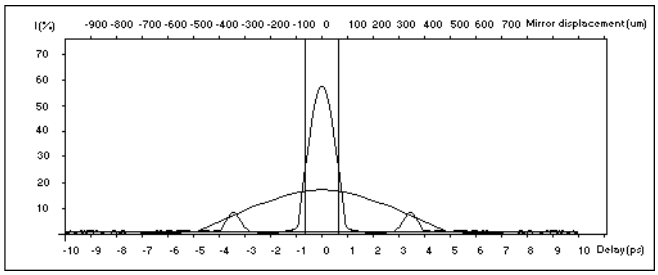
To empty the **Selected item** list, click **Remove All**.

The following list displays the information provided by each selected item.

Fiber ID

Fiber ID:	
Fiber Type:	Fiber Length:
Comment:	

Graphic



Measurement

Scanning Range:	Threshold
Scanning Center:	Wavelength:

Results

PMD Value:	Date:
PMD Coeff.:	Time:
2nd Order PMD Value:	
2nd Order PMD Coeff.:	

Information

Version:	File:
AC Gain:	Power Level:
DC Gain:	Points:

Operator

User Name:	Title:
Organization:	Division:

Markers

Left Marker:	Noise Marker:
Right Marker:	Delta Marker:

Note: *The* **Markers** *option is not available in ERPMD mode.*

To reduce line spacing to print the whole report on only one page, check the **One page report** option.

5.13.5 Table

To print a table report, you must select the information that should appear in the **Table** page. The information order may also be determined by selecting the items in the order they should print.

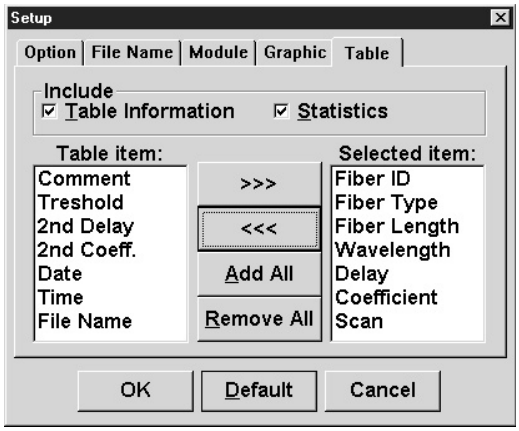


Figure 5-25. Table Page

You may include table information and statistics. **Table Information** gives the table file path. **Statistics** include calculations made from the files that compose the table.

To select the information to print,

1. Highlight the desired item in the **Table item** list.

2. Click the right arrow to transfer the item to the **Selected item** list.

To print all the available information, click **Add All**.

To remove information,

1. Highlight the item to delete in the **Selected item** list.

2. Click the left arrow to transfer the item to the **Table item** list.

To empty the **Selected item** list, click **Remove All**.

The following list gives the information provided by each selected item.

Table Information

Path:

Statistics

	Wavelength	Wavelength	...
Scan Mode			
DUT Type			
Mean PMD Delay	...	...	...
Mean PMD Coefficient	...	...	...
PMD Delay Standard Deviation			
PMD Coefficient Standard Deviation			
Maximum PMD Delay			
Minimum PMD Delay			

Table with selected items as column headings

Selected Item	Description
Number	Trace number as it appears in the trace table.
Fiber ID	Fiber or DUT identification.
Scan	Acquisition type.
Fiber Type	Strong coupling, weak coupling, or component.

Table 5-7. Table Report Column Headings (Part 1 of 2)

Selected Item	Description
Fiber Length	Length of analyzed fiber.
Comment	Comment about the acquisition.
Wavelength	Acquisition wavelength.
Threshold	User-defined maximum tolerated PMD value.
Delay	PMD delay value.
Coefficient	PMD coefficient.
2nd Delay	2nd order PMD delay value
2nd Coefficient	2nd order PMD coefficient
Date	Acquisition date.
Time	Acquisition time.

Table 5-7. Table Report Column Headings (Part 2 of 2)

This page intentionally left blank.

6 MANAGING DATA

6.1 Generating a Results Table from the File Menu

You can display your PMD mean delay and coefficient values in table form for easy analysis. You can choose all your files, or limit table data to one file type in particular. To set up a multiple file table, you must

1. Select **Build Table...** in the *File* menu.

2. Select the desired trace files to be added to the table.

3. Click **Open**.

Note: *If the trace or the trace information is not valid, a warning message will appear.*

All selected traces will be open and an entry will be added for each selected trace in the results table. See Figure 5-15, on page 5-14.

6.2 Saving and Retrieving Files

This section summarizes procedures that involve file saving and retrieval.

Choose **Save Graph** from the *File* menu to store the onscreen measurement. The file will bear the default file name entered in the **File Name** page (in the *Setup* dialog box) with the default *.prnd* file extension or the last extension used by the operator.

It is always a good idea to save your files regularly. To do so,

1. Open the *File* menu.

2. Choose **Save Graph** or **Save Table**.

3. Choose a name for your file, using the *.prnd* or *.rpt* file extension or any other extension.

4. Select the directory in which you want to save the file. The default directory is \userfile\IQ5500. This path can be modified. (See *File Path*, on page 5-24.)

5. Click **Save**.

Note: *If the file name ends with a number, the PMD program will automatically increase the number by one when you take a new measurement.*

To recall a graph or a table,

1. Open the *File* menu.

2. Select **Open Graph** or **Open Table**.

3. Select the path and file name in the dialog box. The default directory is \userfile\IQ5500. This path can be modified. (See *File Path*, on page 5-24.)

4. Double-click on the name or click **Open**.

6.3 Opening and Saving Configuration Files

A configuration file contains the parameters selected during the last testing session. Upon closing the application, the last parameters will be kept in memory for the next testing session. However, to save a configuration to be used in a special case, or if there are two or more operators with different working preferences or needs, configurations can be saved and recalled when needed. These parameters include the setup, user information, source type, and DUT configuration. To save a configuration,

1. Open the *File* menu.

2. Select **Save Config**.

3. Select the file path in the dialog box.

4. Type a file name using the *.cfg* extension (preferably).

5. Click **Save**.

Note: *The default configuration directory is* \userfile\Iq5500 *and the default name is* default.cfg.

To recall a configuration,

1. Open the *File* menu.
2. Select **Open Config**.
3. Select the path and file name in the dialog box.
4. Double-click on the name or click **Open**.

6.4 Opening and Saving Templates

The **Measurement** page actual parameter settings can be saved as a template for future acquisitions. See *Setting Acquisition Parameters*, on page 5-8.

The **Open Template** and **Save Template** buttons respectively allow you to recall a previously saved acquisition parameters file and save the current settings as a template, respectively. Such template files are saved with the *.tpl* extension in the directory of your choice.

To save a template,

1. Select the desired measuring parameters.
2. Click **Save Template**.
3. Select the desired path.

Note: *The default template directory is* \userfile\Iq5500 *and the default name is* default.tpl.

4. Type a file name using the *.tpl* extension (preferably).
5. Click **Save**.

To recall a template,

1. Click **Open Template**.

2. Select the desired template from the directory where it is saved.

Note: *The default template directory is* \userfile\Iq5500 *and the default name is* default.tpl.

3. Double-click the name of the file to open, or click **Open**.

Opening a template will replace the information contained in the **Measurement** page.

6.5 Printing Data

Once all acquisitions have been completed and analyzed, traces and generated tables can be printed. The current printer is indicated at the top of the *Print* dialog box.

Note: *The* **Print** *button is only available if a printer is connected and configured.*

The **Printer Setup** option gives you access to Window's *Print Manager* parameters, where a default printer and general printing options such as paper size and page orientation are chosen.

Note: *Whenever you wish to print a table, select the* **Landscape** *paper orientation.*

7 THE GPIB INTERFACE

7.1 Command Structure

The GPIB commands follow the guidelines determined by the Standard-Commands-for-Programmable-Interface (SCPI) consortium. For example, the command syntax

FORM(0..26):READ[:DATA]<space><digit>

is used to change the measurement display resolution (number of digits after the decimal point) of a given module.

In this particular example,

- FORM identifies that the command is a part of the SCPI FORMat subset of commands
- (0..26) is a whole number between 0 and 26 that identifies the module
- READ and DATA are keywords that define the function of the command
- [ ] indicates that a keyword or a parameter is optional
- <space> is included to indicate that a space is required
- <digit> is the command parameter

All keywords must be CAPITAL characters separated by a colon. A typical command would be

FORM4:READ:DATA 1

This command instructs the module, to display a power measurement with 1 digit after the decimal point.

7.2 Common Commands

The IQ-5500 recognizes all of the common commands identified as mandatory by IEEE-488.2. These commands, as well as some optional common commands, are summarized in Table 7-1.

Command	Function
*CLS	Clear status command
*ESE	Standard event status enable command
*ESE?	Standard event status enable query
*ESR?	Standard event status register query
*IDN?	Identification query
*LOK	Set Remote Lockout programming state
*OPC	Operation complete command
*OPC?	Operation complete query
*REM	Set Remote programming state
*RST	Reset command
*SRE	Service request enable command
*SRE?	Service request enable query
*STB?	Read status byte query
*TRG	Trigger Command (Not supported)
*TST?	Self test query
*WAI	Wait to Continue Command (Not supported)

Table 7-1 Command Commands Summary

The common commands are fully explained on the following pages.

*CLS

Description This command sets the contents of the Standard Event Register (ESR), the Status Byte Register (STB), and the Error Queue (ERR) to zero. This command is commonly used to clear the status registers before enabling SRQ. Note that the output queue, the Standard Event Status Enable Register (ESE), and the Service Request Enable Register (SRE) are not affected.

Syntax *CLS

*ESE

Description This command is used to set bits in the Standard Events Status Enable Register (ESE) to a new value (initial value is 255). The contents of the ESE register are logically ANDed with the ESR register. A non zero result will set the Event Summary Bit (ESB) of the Status Byte register (STB). This command is useful for selecting which events may generate an SRQ.

Syntax *ESE<space><value>

Parameters The <value> parameter must be between 0 and 255.

*ESE?

Description This query reads the contents of the Events Status Register.

Syntax *ESE?

Response A binary integer with a value between 0 and 255.

*ESR?

Description This query reads the contents of the Standard Event Status Register (ESR).

Syntax *ESR?

Response A binary integer with a value between 0 and 255.

*IDN?

Description This query reads the IQ-5500 identification string.

Syntax *IDN?

Response “EXFO E.O. Engineering IQ-5500 Vxx.xx” where xx.xx is the current product version.

*LOK

Description This command is used to set the Lockout programming state.

Syntax *LOK

*OPC

Description This command will cause the SCPI Manager to generate the operation complete message in the Standard Event Status Register (ESR) when all pending selected SCPI Manager’s operations have been completed.

Syntax *OPC

Example *OPC;*IDN?

*OPC?

Description This query puts an ASCII 1 in the output queue when the content of the input queue has been processed. This query is useful to prevent another command from processing until the current command is complete.

Syntax *OPC?

Response “1”

*REM

Description This command is used to set the Remote programming state.

Syntax *REM

*RST

Description This command empties the step response list. It is only seen when it is part of another multiple command. In the example below, by adding this command after *IDN?, you will not be able to access the answer. The *RST, in this instance, erases the identification string. In addition, this command performs the following operations:

1. Return to initial state before command was sent, and not necessarily to previous settings.
2. Force the device to enter into an Operation Complete Command Idle State (OCIS).
3. Force the device to enter into an Operation Complete Query Active State (OQAS).
4. Initialize previous responses unless there has been a program message terminator preceded by an *RST.

Syntax *RST

Example *IDN?;*RST<NL>

*SRE

Description This command sets bits in the Service Request Enable Register (SRE; initial value is 255), and enables the corresponding bit in the Status Byte Register (STB). The command can be used to select which events can initiate a service request.

Syntax *SRE<space><value>

Parameter The <value> parameter must be between 0 and 255.

*SRE?

Description This query returns the contents of the Service Request Enable Register (SRE).

Syntax *SRE?

Response A binary integer between 0 and 255.

*STB?

Description This query returns the contents of the Status Byte Register (STB).

Syntax *STB?

Response A binary integer between 0 and 255.

*TRG

Description Not supported

Syntax *TRG

*TST?

Description This query initiates an internal self test, and returns a binary value indicating the results of the test.

Syntax *TST?

Response A binary value:
"0"-test is complete with no errors
"1"-test is complete with errors

*WAI

Description Not supported

Syntax *WAI

7.3 System Commands

7.3.1 IQ-5500 PMD Analyzer Commands

ABORt	
Description	This command stops any acquisition in progress.
Syntax	ABOR(0..26)
Example	ABOR3

DISPlay**:FIT**	
Description	This command shows or hides gaussian display.
Syntax	DISP(0..26):FIT<space><0|1>.
Example	DISP3:FIT 1

DISPlay**:FIT?**	
Description	This query indicates whether gaussian is showing or hiding.
Syntax	DISP(0..26):FIT?
Response	Returns “FALSE” if gaussian is hidden, and “TRUE” if gaussian is showing.
Example	DISP3:FIT 1

DISPlay:MARKer

Description This command shows or hides markers.

Syntax DISP(0..26):MARK<space><0|1>.

Example DISP3:MARK 1

DISPlay:MARKer?

Description This query indicates whether marker is showing or hiding.

Syntax DISP(0..26):MARK?

Response Returns “FALSE” if marker is hidden, and “TRUE” if marker is showing.

Example DISP3:MARK?

DISPlay:SCALe

Description This command shows or hides sensitivity scale.

Syntax DISP(0..26):SCAL<space><0|1>.

Example DISP3:SCAL 1

DISPlay:SCALe?

Description This query indicates whether sensitivity scale is showing or hiding.

Syntax DISP(0..26):SCAL?

Response Returns “FALSE” if sensitivity scale is hidden, and “TRUE” if sensitivity scale is showing.

Example DISP3:SCAL?

FETCh?

Description This query returns the PMD delay and coefficient values stored into the stack.

Syntax FETC(0..26)?

Response Two values in the format “99.999,99.999”. The first value is the PMD delay and the second value is the PMD coefficient.

Example FETC3?

See also INIT:CONT, INIT:CONT?, and INIT:IMM

FETCh:SENSitivity?

Description This query returns the power of the signal as currently read on a sensitivity scale from 0 to 5. This command is only available in PMD mode.

Syntax FETC(0..26)SENS?

Response A value between 0 and 5 in the format “9.999”.

Example FETC3:SENS?

FETCh:STATe?

Description This query returns the validity of an acquired trace.

Syntax FETC(0..26):STAT?

Response A boolean value:
“TRUE” -the trace is valid
“FALSE” -the trace is not valid

Note To store measurements into the stack, use the command INIT:CONT or INIT:IMM.

Example FETC3:STAT?

INITiate**:CONT**inuous

Description This command starts one or more acquisitions, depending on how the commands SENS:POW:COUN and SENS:POW:DEL have been set.

Syntax INIT(0..26):CONT<space><state>

Parameters The <state> parameter is a boolean value:
"1" -start acquisitions
"0" -stop acquisitions

Example INIT3:CONT 1

See also INIT:CONT?, INIT:IMM, SENS:POW:COUN, and SENS:POW:DEL

INITiate**:CONT**inuous**?**

Description This query returns a value indicating whether an acquisition is in progress.

Syntax INIT(0..26):CONT?

Response A boolean value:
"1" -acquisition in progress
"0" -acquisition not in progress

Example INIT3:CONT?

See also INIT:CONT, INIT:IMM, and FETC?

INITiate[**:IMM**ediate]

Description This command starts a single acquisition.

Syntax INIT(0..26)[:IMM]

Example INIT3:IMM

See also INIT:CONT, INIT:CONT?, and FETC?

INSTrument:CATalog?

Description This query returns a list of light sources available in the IQ system as it is currently configured.

Syntax INST(0..26):CAT?<space>[moduleType],[mode]

Parameters The <moduleType> parameter is optional and represents the type of module for which you want to have a list:
"SRC" -to have a list of light source modules
If you are asking for a list of light source modules, use the <mode> parameter (which is optional) to be even more specific on the type of source you are looking for:
"0" -to ask for sources to be used in PMD mode

Note If no value is entered for the <moduleType> parameter, it will be considered as "SRC". If no value is entered for the <mode> parameter, it will be considered as "0". If the <moduleType> parameter is absent, the <mode> parameter must not be present.

Response The list of light sources available in the IQ system in the format "99,99,99...". Return values represent slots in the IQ system.

Examples INST3:CAT? (to obtain a list of sources to be used in PMD mode)

See also INST:SEL and INST:SEL?

INSTrument[**:SEL**ect]

Description This command selects a source.

Syntax INST(0..26)[:SEL]<space><slot>[,moduleType][,mode]

Parameters The <slot> parameter specifies the location of the selected source. It represents a slot number in the IQ system in the format “99”.
The <moduleType> parameter is optional and represents the type of the selected module:
“SRC” -light source module
If you are selecting a light source module, you can use the <mode> parameter (which is optional) to be even more specific on the type of source you are selecting:
“0” -source to be used in PMD mode
“-1” -external source

Note If no value is entered for the <moduleType> parameter, it will be considered as “SRC”. If no value is entered for the <mode> parameter, it will be considered as “0”. If the <moduleType> parameter is absent, the <mode> parameter must not be present.

Example INST3:SEL 4,SRC,2

See also INST:CAT? and INST:SEL?

INSTrument:**SEL**ect?

Description This query returns the location of the source currently selected in the IQ system.

Syntax INST(0..26)SEL?<space>[moduleType],[mode]

Parameters The <moduleType> parameter is optional and represents the type of module that you are looking for:
"SRC" -to look for a light source module
If you are looking for the light source module, use the <mode> parameter (which is optional) to be even more specific on the type of source you are looking for:
"0" -to ask for the source to be used in PMD mode

Note If no value is entered for the <moduleType> parameter, it will be considered as "SRC". If no value is entered for the <mode> parameter, it will be considered as "0". If the <moduleType> parameter is absent, the <mode> parameter must not be present.

Response The list of light sources available in the IQ system in the format "99,99,99...". Return values represent slots in the IQ system.

Examples INST3:SEL? (to look for the source to be used in PMD mode)

See also INST:CAT? and INST:SEL

MEMory:**CLEA**r

Description This command clears all the traces from the Selection page.

Syntax MEM(0..26):CLEA

Note This command does not erase the trace from the storage device.

Example MEM3:CLEA

MEMory:DATA

Description This command changes the entries in the DUT, Comment 1, and Comment 2 fields.

Syntax MEM(0..26):DATA<space><field>,<data>

Parameters The <field> parameter identifies the field to be edited:
"DUT" -to edit the DUT field
"Comment1" -to edit the Comment 1 field
"Comment2" -to edit the Comment 2 field
The <data> parameter is the information to be entered in a 60-character field.

Example MEM3:DATA DUT,This DUT was pinched.

MEMory:DATA?

Description This query returns the contents of the DUT, Comment 1, or Comment 2 fields.

Syntax MEM(0..26):DATA?<space><field>

Parameters The <field> parameter identifies the field whose contents will be returned:
"DUT" -to fetch the contents of the DUT field
"Comment1" -to fetch the contents of the Comment 1 field
"Comment2" -to fetch the contents of the Comment 2 field

Response The contents of specified field (60 characters maximum).

Example MEM3:DATA? Comment1

MEMory:DELete

Description This command clears the trace currently open from the screen and erases it from the storage device.

Syntax MEM(0..26):DEL

Example MEM3:DEL

MEMory:FILE

Description This command saves the currently open trace.

Syntax MEM(0..26):FILE<space><fileName>

Parameters The <fileName> parameter corresponds to the complete DOS path and file name under which the PMD trace will be saved. If only a file name is entered, the trace will be saved to the default location (C:\IQ\USERFILE\IQ5500\).

Note For easier management, file names should be limited to eight characters and the extension ".PMD" should be given to PMD trace files.

Example MEM3:FILE C:\TRACES\PMD\DUT12345.PMD

MEMory:FILE?

Description This query returns the file name of the currently open trace.

Syntax MEM(0..26):FILE?

Response The complete DOS path and file name of the currently open PMD trace in the format "C:\TRACES\PMD\DUT12345.PMD".

Example MEM3:FILE?

MEMory:LENgth

Description This command is used to specify the length of the fiber under test. This command is only available for weak mode coupling and strong mode coupling fiber types.

Syntax MEM(0..26):LEN<space><length>

Parameters The <length> parameter represents the length of the fiber under test (in kilometers) in the format “9999.999”. Accepted values are between 0.001 and 9999.999.

Example MEM3:LEN 1324.465

MEMory:LENgth?

Description This query returns the length currently set for the fiber under test. This query is only available for weak mode coupling and strong mode coupling fiber types.

Syntax MEM(0..26):LEN?

Response The length currently set for the fiber under test (in kilometers) in the format “9999.999”.

Example MEM3:LEN?

MEMory:TABLe:CURRent:DATA?

Description PMD acquisition data is used to plot a PMD trace. This command returns the coordinates of every point on the current PMD trace.

Syntax MEM(0..26):TABL:CURR:DATA?

Response The coordinates of every point on the current PMD trace. PMD acquisitions provide an (x,y) reading: "±99.999,99.999;±99.999,99.999;±99.999,99.999..."

Example MEM3:TABL:CURR:DATA?

MEMory:TABLe:CURRent:MAGNitude:POINts?

Description This query returns the total number of points that compose the current PMD trace.

Syntax MEM(0..26):TABL:CURR:MAGN:POIN?

Response The total number of points that compose the current PMD trace in the format "9999".

Example MEM3:TABL:CURR:MAGN:POIN?

MEMory:TYPE

Description This command selects the type of the fiber under test.

Syntax MEM(0..26):TYPE<space><type>

Parameters The <type> parameter represents the type of the fiber under test:

"Strong"	-for strong coupling mode fibers
"Weak"	-for weak coupling mode fibers
"Component"	-to measure the low PMD values of passive components

Note If you do not know whether or not your fiber has weak polarization mode coupling, you should start by making a single acquisition using the strong coupling setting. If the resulting trace has a wide main peak with one peak on each side, it is very likely that you are testing a weak mode coupling fiber.

Example MEM3:TYPE Weak

MEMory:TYPE?

Description This query returns the type currently set for the fiber under test (Strong, Weak, Component).

Syntax MEM(0..26):TYPE?

Response A text string representing the type currently set for the fiber under test:

"Strong"	-for strong coupling mode fibers
"Weak"	-for weak coupling mode fibers
"Component"	-to measure the low PMD values of passive components

Example MEM3:TYPE?

MEMory:USER

Description This command changes the user name as currently set in the IQ system. Any alphanumeric character is allowed (max. 60).

Syntax MEM(0..26):USER<space><name>

Parameter The <name> parameter is the name of the person that will operate the IQ-5500 PMD Multi-Analyzer.

Example MEM3:USER John Smith

MEMory:USER?

Description This query returns the user name as currently set in the IQ system.

Syntax MEM(0..26):USER?

Response The user name as currently set in the IQ system.

Example MEM3:USER?

SENSe:POWer:COUNt

Description This command specifies the number of scans to be performed.

Syntax SENS(0..26):POW:COUN<space><scan>

Parameters The <scan> parameter indicates the number of scans to be performed. Accepted values are integers between 0 and 9999, in the format “9999”.

Example SENS3:POW:COUN 2419

SENSe:POWer:COUNt?

Description This query returns the number of scans to be performed.

Syntax SENS(0..26):POW:COUN?

Response The number of scans to be performed, in the format “9999”.

Example SENS3:POW:COUN?

SENSe:POWer:DELay

Description This command specifies the delay between scans.

Syntax SENS(0..26):POW:DEL<space><time>

Parameters The <time> parameter indicates the delay between scans (in seconds) in the format “99999”. Accepted values are integers between 2 and 86399.

Example SENS3:POW:DEL 36200

SENSe:POWer:DELay?

Description This query returns the current delay between scans.

Syntax SENS(0..26):POW:DEL?

Response The current delay between scans (in seconds) in the format “99999”.

Example SENS3:POW:DEL?

SENSe:POWer:MODE?

Description This query returns the current scanning mode.

Syntax SENS(0..26):POW:MODE?

Response A value representing the current scanning mode:
"PMD" -to indicate regular PMD mode
"FAST" -to indicate Fast Scan PMD mode
"ERPMD" -to indicate extended range PMD mode
"AUTOPMD"-to indicate automatic mode

Example SENS3:POW:MODE?

SENSe:POWer:RANGe

Description The total scanning range of the IQ-5500 is divided into 7 sub-ranges, each being assigned with an index. To obtain the range attributed to each index, use the query SENS:POW:RANG?:LIST?. The SENS:POW RANG command selects a scanning range index.

Syntax SENS(0..26):POW:RANG<space><index>[,mode]

Parameters The <index> parameter represents the index of the new scanning range in the format "9". In PMD scanning mode, valid values are from 1 to 7. In FAST, ERPMD, and AUTOPMD scanning modes, the only valid value is 1.
The <mode> parameter is optional and represents the mode to which the new scanning range will apply:
"PMD" -to indicate regular PMD mode
"FAST" -to indicate Fast Scan PMD mode
"ERPMD" -to indicate extended range PMD mode
"AUTOPMD"-to indicate automatic mode
If the mode is not specified, the new scanning range index will apply to PMD mode.

Example SENS3:POW:RANG 1,PMD

SENSe:POWer:RANGe

See also SENS:POW:RANG? and SENS:POW:RANG?:LIST?

SENSe:POWer:RANGe?

Description This query returns the current scanning range index.

Syntax SENS(0..26):POW:RANG?

Response The index of the current scanning range in the format “9”. In PMD scanning mode, return values will be from 1 to 7. In FAST, and AUTOPMD scanning modes, the only possible return value is 1. In ERPMD scanning modes, the possible return values are 2 and 3.

Example SENS3:POW:RANG?

See also SENS:POW:RANG and SENS:POW:RANG?:LIST?

SENSe:POWer:RANGe?:LIST?

Description The total scanning range of the IQ-5500 is divided into 7 sub-ranges, each being assigned with an index (1 to 7). This query returns the range attributed to each index.

Syntax SENS(0..26):POW:RANG?:LIST?<space>[mode]

Parameters The <mode> parameter is optional and specifies the mode for which the scanning range indexes will be returned:
“PMD” -regular PMD mode
“FAST” -Fast Scan mode
“ERPMD” -extended range PMD mode
“AUTOPMD”-automatic mode

SENSe:POWer:RANGe?:LIST?

Response A list with all the available indexes with their corresponding scanning ranges.
In PMD scanning mode, the list will include 7 indexes in the format "1: 1.0 to 2.0 ps (±20 0 μm)".
In FAST scanning mode, the list will include 1 index in the format "1: 10.0 to 32.0 ps (±4 000 μm)".
In ERPMD scanning mode, the list will include 1 index in the format "1: 27.0 to 80.0 ps (±10 000 μm)".
In AUTOPMD scanning mode, the list will only include 1 index in the format ''1: 1.0 to 2.0 ps (±400 μm)".

Example SENS3:POW:RANG:LIST?

See also SENS:POW:RANG and SENS:POW:RANG?

SENSe:POWer:WAVElength

Description This command changes the wavelength on the IQ-5500.

Syntax SENS(0..26):POW:WAVE<space><wavelength>[NM]

Parameters The <wavelength> parameter represents the new wavelength (in nm) in the format "9999". The units (NM) are optional.

Example SENS3:POW:WAVE 1310NM

SENSe:POWer:WAVElength?

Description This query returns the current wavelength.

Syntax SENS(0..26):POW:WAVE?

Response The current wavelength (in nm) in the format "9999".

Example SENS3:POW:WAVE?

7.3.2 IQ-2100 Light Source Commands

SOURce:AM[:INTernal]:FREQuency

Description This command selects the internal modulation frequency. The internal modulation is 50 % duty cycle at the selected frequency.

Syntax SOUR(0..26):AM[:INT]:FREQ<space><value>
[<space><units>]

Parameters The <value> parameter represents the new modulation frequency: 270 Hz, 1000 Hz, 2000 Hz, or CW (or 0) for no modulation.
The <units> parameter is optional and can be HZ or KHZ.

Example SOUR3AM:INT:FREQ 270 HZ -(set modulation to 270 Hz)
or
SOUR3:AM:INT:FREQ CW -(set modulation to none)

SOURce:AM[:INTernal]:FREQuency?

Description This query returns a value indicating the current internal modulation frequency. If the source is in CW mode, the function will return “0”.

Syntax SOUR(0..26):AM[:INT:]FREQ?

Response A four-digit integer identifying the frequency (in Hz) in the format “9999”. If the source is in CW mode, the return value is “0”.

Example SOUR3:AM:FREQ?

SOURce:POWer:ATTenuation

Description This command changes the source internal attenuation. The source power is at its maximum when the attenuation is set to 0.0 dB.

Syntax SOUR(0..26):POW:ATT<space><value>[<space><units>]

Parameters The <value> parameter is between 0.0 and 10.0 for laser sources and between 0.0 and 6.0 for LED sources. The attenuation is a positive value in dB.
The <units> parameter is DB and is optional.

Example SOUR3:POW:ATT 5.2 DB

SOURce:POWer:ATTenuation?

Description This query returns the internal source power attenuation value.

Syntax SOUR(0..26):POW:ATT?

Response A value between 0.0 and 10.0 (in dB) in the format “99.9”.

Example SOUR3:POW:ATT?

SOURce:POWer:STATe

Description This command turns on or off the optical source. When the source is on, the red LED (Active) on the front of the module illuminates.

Syntax SOUR(0..26):POW:STAT<space><state>

Parameters The state parameter is a boolean VALUE:
"0" or "OFF" -turn off the source
"1" or "ON" -turn on the source

Example SOUR3:POW:STAT ON

SOURce:POWer:STATe?

Description This query returns a value indicating the state of the optical source (on or off).

Syntax SOUR(0..26):POW:STAT?

Response "0" -the source is off
"1" -the source is on

Example SOUR3:POW:STAT?

SOURce:POWer:WAVElength

Description This command selects a wavelength when using a dual-wavelength source module.

Syntax SOUR(0..26):POW:WAVE<space><value>

Parameters The <value> parameter can be:
"UPP" -switch to the highest wavelength
"LOW" -switch to the lowest wavelength

Example SOUR3:POW:WAVE UPP

SOURce:POWer:WAVElength?

Description This query returns a value indicating which wavelength is currently selected.

Syntax SOUR(0..26):POW:WAVE?

Response A four-digit number identifying the current wavelength (in nm) in the format “9999”.

Example SOUR3:POW:WAVE?

SOURce:POWer:WAVElength:COUNt?

Description This query returns the number of available sources on the module.

Syntax SOUR(0..26):POW:WAVE:COUN?

Response A value representing the number of sources:
“1” -one wavelength available
“2” -two wavelengths available

Example SOUR3:POW:WAVE:COUN?

7.4 Quick Reference Command Trees

7.4.1 IQ-5500 Command Tree

Command		Parameter/ Response	Description
ABOR		—	Stop measurement
DISP	FIT	<0|1>	Show/hide gaussian
	FIT?	(TRUE|FALSE)	Gaussian showing
	MARK	<0|1>	Show/hide marker
	MARK?	(TRUE|FALSE)	Marker showing
	SCAL	<0|1>	Show/hide scale
	SCAL?	(TRUE|FALSE)	Scale showing
FETC?		(99.999,99.999)	Get delay and coefficient values
FETC	SENS?	(99.999)	Get current power
	STAT?	(TRUE|FALSE)	Get trace validity
INIT	CONT	<0|1>	Start acquisitions
	CONT?	(0|1)	Acquisitions in progress?
	[IMM]	—	Start single measurement

Table 7-2. IQ-5500 PMD Analyzer Command Tree (Part 1 of 4)

Command		Parameter/ Response	Description
INST	CAT?	[SRC],[9]	Get list of sources
	[SEL]	<99>,[SRC],[9]	Get source
	SEL?	[SRC],[9]	Get current source
MEM	CLEA	—	Clear Selection page

Table 7-2. IQ-5500 PMD Analyzer Command Tree (Part 2 of 4)

Command				Parameter/ Response	Description
	DATA			<field>,<data>	Set entries in DUT, Comment 1, and Comment 2 fields
	DATA?			<field>/(data)	Get entries in DUT, Comment 1, and Comment 2 fields
	DEL			—	Erase current trace
	FILE			<file>	Set trace file name
	FILE?			(file)	Get trace file name
	LEN			<9999.999>	Set fiber length
	LEN?			(9999.999)	Get fiber length
	TABL	CURR	DATA?	(±99.999,99.999)	Get trace data in tabular form
			MAGN POIN?	(9999)	Get number of acquisition points
	TYPE			<STRONG|WEAK| COMPONENT>	Set fiber type
	TYPE?			(STRONG|WEAK| COMPONENT)	Get fiber type
	USER			<name>	Set operator's name
	USER?			(name)	Get operator's name
SENS	POW	COUN		<9999>	Set number of scans

Table 7-2. IQ-5500 PMD Analyzer Command Tree (Part 3 of 4)

Command			Parameter/ Response	Description
SENS	POW	COUN?	(9999)	Get number of scans
		DEL	<99999> max. 86399	Set time delay between scans
		DEL?	(99999)	Get time delay between scans
		MODE?	(PMD|FAST|ERPMD| AUTOPMD)	Get scan mode
		RANG	<9>,[PMD|FAST|ERPMD |AUTOPMD]	Set power range
		RANG?	(9)	Get power range
		LIST?	[PMD|FAST|ERPMD| AUTOPMD] / (1:0.1 to 1.0; etc.)	Get range list
		WAVE	<9999>[NM]	Set wavelength
		WAVE?	(9999)	Get wavelength

Table 7-2. IQ-5500 PMD Analyzer Command Tree (Part 4 of 4)

7.4.2 IQ-2123 Command Tree

Command			Parameter/ Response	Description
SOUR	AM	[INT] FREQ	<value>[HZ|KHZ]|CW|0	Set internal modulation
		FREQ?	(9999)	Get internal modulation
	POW	ATT	<value>[0..10][DB]	Set attenuation
		ATT?	(99.9)	Get attenuation
		STAT	<1|0|ON|OFF>	Turn source on or off
		STAT?	(0|1)	Source active?
		WAVE	<UPP|LOW>	Set wavelength
		WAVE?	(9999)	Get wavelength
		WAVE COUN?	(1|2)	Get number of available sources

Table 7-3. IQ-2100 Light Source Command Tree

7.5 GPIB Error Messages

7.5.1 Error Message Format

System and device specific errors are managed by the SCPI Manager. The generic format for error messages is illustrated in Figure 7-1.



Figure 7-1. GPIB Error Message Format

As shown in the above figure, the message contains three parts; the error number, the error description, and device dependent information. All error messages are stacked in a FIFO buffer. When there is at least one message in the buffer, bit 2 of the Status Byte Register is set to 1. Use the command **SYST:ERR?** , **ERR?**, or **LERR?** to read the most recent message. The error message buffer is initialized when starting the IQ-5500, when executing the command ***CLS**, or by reading the last message stored in the buffer.

7.5.2 IQ-5500 Error Messages

Error Number	Description	Probable Cause
1	"Unknown command."	The module has received a command that it does not recognize.
602	"Bad unit selection."	The selected units do not correspond to the parameter being analyzed.
603	"Scanning already running."	An acquisition is already in progress.
604	"Scanning not running."	The acquisition is not in progress.
605	"Invalid source."	The selected light source is not compatible with the tests to be performed.
606	"Invalid data name."	The name you wish to assign to the data file is not valid.
607	"Invalid fiber type."	The specified fiber type is not valid ("Weak", "Strong" or "Component").
608	"Invalid wavelength."	The selected wavelength is out of range or is not a valid wavelength value.

Table 7-4. IQ-5500 PMD Analyzer Error Messages (Part 1 of 2)

Error Number	Description	Probable Cause
609	“Invalid range.”	The selected scanning range is not compatible with the test to be performed.
610	“Invalid curve size.”	Buffer overflow of trace information.
611	“Invalid scan count.”	The selected scan count is out of range or is not a scan count value.
612	“Invalid delay.”	The selected time delay between acquisitions is out of range or is not a valid selection.
613	“Invalid curve.”	The selected trace is not a PMD file.
616	“Invalid length.”	The specified fiber length is out of range.
618	“Invalid scan type.”	The type of scan is not available for the test you wish to perform.
619	“Invalid instrument.”	The selected unit is not available or not compatible.
620	“Invalid PMD module.”	The selected PMD module is not available or is incompatible.
621	“Invalid scan mode.”	The selected scan mode is not available.

Table 7-4. IQ-5500 PMD Analyzer Error Messages (Part 2 of 2)

7.5.3 IQ-2123 Error Messages

Error Number	Description	Probable Cause
402	“Illegal parameter value.”	An illegal data parameter has been received.
403	“Attenuation out of range.”	A command has attempted to set the internal attenuation to a an unsupported value.

Table 7-5. IQ-2100 Light Source Error Messages

8 TECHNICAL SPECIFICATIONS

8.1 IQ-5500 PMD Analyzer

Optical Specifications				
Model		**IQ-5502**	**IQ-5503**	**IQ-5523**
Wavelength (nm)		1310	1550	1310/1550
Measurement range (ps) (PMD)		0.1 to 35	0.1 to 35	0.1 to 35
Fast measurement range (ps) (FAST)		10 to 30	10 to 30	10 to 30
Extended measurement range (ps) (ERPMD option)		0.1 to 115	0.1 to 115	0.1 to 115
Dynamic range[a] (dB)		45 (50)[b]	40 (48)[b]	32 (40)[b]

a. With a power source of -20 dBm at 1550 nm and -16 dBm at 1310 nm (power at the output of the polarized source) for the range 0.1 ps ≤ PMD ≤ 1 ps.
b. With our M2100 Broadband Light Source.

Mechanical Specifications		
Model		**IQ-55XX**
Temperature	operating	0° to 40°C/32° to 104°F
	storage	-40° to 50°C/-40° to 122°F
Relative Humidity (%)		0 to 80% non-condensing
Dimension (H X W X D)		12 × 7.5 × 26.2 cm 4.75 × 3 × 10.25 in.
Weight		2.18 kg 4..75 lb
CE		Compliant Class B

Specifications are subject to change without notice.

8.2 IQ-2123BP Light Source

Specifications apply to a 2-m fiber output (specified type) with FC/SPC (singlemode) and FC/PC (multimode) connectors, and are valid for a 0.0 dB attenuation.

Source	IQ-2123BP
Wavelength (nm)	1310 ±25
	1550 +10/-40
Spectral width (FWHM)	≥45/65
Power output (dBm)	≥-17/-21
Stability (dB)	
15 min. (T=constant)	±0.005/±0.04
8 hr (T=0° to 40°C ±1°)	±0.03
Modulation	270 Hz, 1 kHz, 2 kHz (50% duty cycle)
Temperature stability (dB)	≤±0.4

Operating Environment	
Operating temperature	10° to 40°C/50° to 104°F
Storage temperature	-35° to 70°C/-31° to 158°F
Relative humidity	0 to 95% non-condensing

Specifications are subject to change without notice.

9 MAINTENANCE AND TROUBLESHOOTING

9.1 Module Maintenance

The IQ modules have been designed to require a minimum of maintenance and provide reliable operation for many years. To help ensure long, trouble-free operation

- keep the IQ modules free of dust,
- clean the IQ modules with a cloth slightly dampened with water.

CAUTION

During cleaning, handle the module cautiously and be careful not to damage the connector pins.

9.2 Cleaning Fiber Ends

Prior to testing, it is important that the fiber ends connected to the optical ports of the module be clean. Always cleaning connectors before plugging them to the module is also a good way to prevent dust and dirt from entering the port housing. To clean the fiber ends,

1. Make sure the fiber is not active.
2. Remove the protective caps.
3. Gently wipe the fiber end with a lint-free pad dipped in isopropyl alcohol (98% pure or more).
4. Dry using clean compressed air.

9.3 Cleaning Optical Ports

Dirty ports may affect the performance of the IQ module. To prevent dust and dirt from entering the port housing, always put back the protective caps on the optical ports when the IQ module is not in use and make sure the connectors are clean before plugging them to the ports. To clean the optical ports,

1. Make sure ports are inactive.

2. Remove the protective caps.

3. Gently wipe the ports with a lint-free swab dipped in isopropyl alcohol (98% pure or more).

4. Dry using compressed air.

9.4 Troubleshooting

Problem	Probable Cause	Recommended Action
LED push button does not illuminate	Power is not on.	Check AC power cord and power on the IQ system.
		Refer to IQ-200 manual to locate and verify fuse.
	Module is not properly inserted.	Power off the IQ system, remove and reinstall the module.
	Computer is locked up.	Reboot the IQ system.
	LED is burnt.	Call EXFO.
Pushing the LED push button does not open the main window	Computer is locked up.	Reboot the IQ system.

Table 9-1. Problems, Causes, and Recommended Actions (Part 1 of 2)

Problem	Probable Cause	Recommended Action
Questionable PMD measurements	Optical connectors are dirty.	Clean all optical connections.
	Improper wavelength is selected.	Switch to the correct wavelength on all instruments being used.
	Optical source is unstable.	Wait for source to stabilize.
	There are loops in the test jumper.	Remove loops.
	Improper fiber type is selected.	Select proper fiber type.

Table 9-1. Problems, Causes, and Recommended Actions (Part 2 of 2)

In all cases, if problem persists after performing recommended action, call EXFO.

This page intentionally left blank.

10 WARRANTY

10.1 General Information

EXFO Electro-Optical Engineering, Inc. (EXFO) warrants this equipment against defects in material and workmanship for a period of two years from the date of original shipment. EXFO also warrants that this equipment will meet applicable specifications under normal use.

During the warranty period, EXFO will, at its discretion, repair, replace, or issue credit for any defective product. This warranty also covers recalibration during two years if the equipment is repaired or if the original calibration is erroneous.

IMPORTANT

The warranty can become null and void if

- ***the equipment has been tampered with, repaired, or worked upon by unauthorized individuals or non-EXFO personnel,***
- ***the warranty sticker has been removed,***
- ***case screws have been removed,***
- ***the case has been opened,***
- ***the equipment serial number has been altered, erased, or removed,***
- ***the equipment has been misused, neglected, or damaged by accident.***

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED, IMPLIED OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL EXFO BE LIABLE FOR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

10.2 Liability

EXFO shall not be liable for damages resulting from the use of the purchased product, nor shall be responsible for any failure in the performance of other items to which the purchased product is connected or the operation of any system of which the purchased product may be a part.

10.3 Exclusions

EXFO reserves the right to make changes in the design or construction of any of its products at any time without incurring any obligation to make changes whatsoever on units purchased. Accessories, including but not limited to fuses, pilot lamps and batteries used with EXFO's products are not covered by this warranty.

10.4 Certification

EXFO certifies that this equipment met its published specifications at the time of shipment from the factory.

10.5 Service and Repairs

To obtain service or repair for any equipment, follow the procedure below.

1. Call EXFO Customer Service Group. Support personnel will determine if the equipment requires service, repair, or calibration.

2. If the equipment must be returned to EXFO or an authorized service center, support personnel will issue a Return Merchandise Authorization (RMA) and an address for return.

3. If the unit has an internal storage device, do a backup of your data before sending the unit for repairs.

4. Pack the equipment in its original shipping material. Be sure to include a statement or report fully detailing the defect and the conditions under which it was observed.

IMPORTANT

Never send any unit or accessory back to EXFO without a Return Merchandise Authorization (RMA).

5. Return the equipment, prepaid, to the address given by the support personnel. Be sure to write the RMA on the shipping slip. EXFO will refuse and return any package which does not bear an RMA.

Note: *A test setup fee will apply to any returned unit which, after test, is found to meet the applicable specifications.*

After repair, the equipment will be returned with a repair report. If the equipment is not under warranty, the customer will be invoiced for the cost appearing on this report. Return-to-customer shipping costs will be paid by EXFO for equipment under warranty. Shipping insurance is at the customer's expense.

This page intentionally left blank.

APPENDIX A – PMD THEORY

Introduction

The performance of optical fiber and cable has a major influence on fiber-optic communication networks capabilities. Transmission range and rate are the two main optical link parameters that system designer seek to maximize. Range is a function of emitter output power, receiver sensibility, and loss in the fiber. Rate is limited by emitter and receiver frequency response as well as dispersion in the fiber. Although other types of dispersion can be corrected and fairly well controlled, there is no known practical way of controlling PMD. PMD adversely affects signal transmission rates of an optical fiber network.

Definition

Simply put, PMD arises when the propagation time of a light pulse in an optical fiber depends upon its initial polarization state. This polarization-dependent variation in the optical path length of the fiber is caused by birefringence, a phenomenon whereby the effective index of refraction changes as a function of input polarization state, either locally or distributed along the length of the fiber.

Birefringence is frequently the consequence of small defects in the manufacturing process, bends and other mechanical stresses that may affect the circular fiber geometry. The magnitude of this effect at any given point in standard telecom fiber is usually quite small, and its orientation (the axes of the birefringence) normally varies along the length.

The polarization state of a light pulse can always be decomposed into orthogonal polarization modes. Any small segment of birefringent fiber will decompose the incident light into polarization modes corresponding to the axes of birefringence[1] (assuming this light is not already polarized along one of the principal axes), and as a consequence, a propagation delay will result as the pulse passes through. In fact, this decomposition of the pulse into two pulses (corresponding to each polarization mode) is the general effect when the birefringent axes remain invariant along the full length of the fiber, as is the case with so-called HiBi or polarization-maintaining fiber. (See Figure A-1). However, in the case of standard telecommunication fiber, there is a cumulative effect of

many, randomly-oriented birefringent segments, leading to a mixing (and partial depolarization) of the polarization states. As a consequence, instead of being split into two distinct output pulses, the output pulse is broadened in time. The magnitude of this broadening is highly sensitive to the slightest environmental perturbation, and hence is a stochastic phenomenon that can only be determined from a series of statistically-averaged measurements.

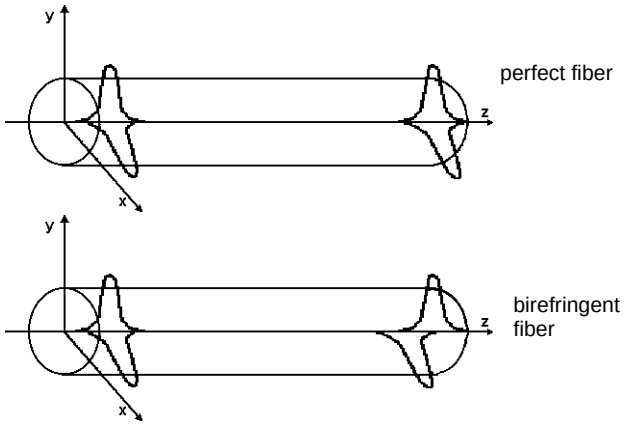


Figure A-1. PMD Delay in Perfect and Birefringent Fiber

Units and Measurements

The PMD delay is usually expressed in picoseconds (ps = 10^{-12} seconds), which for a cable or fiber can be given as a coefficient over a known fiber or cable length (in km). If the mode coupling is weak, the PMD is expressed in ps for discrete components, and in terms of a PMD coefficient in ps/km for HiBi fiber. In the case of strong mode coupling, this coefficient is expressed in ps/km$^{1/2}$.

1. There is frequent confusion between the terms “axes of birefringence” and “input (and output) principal states of polarization (PSP)”. The former refers to a local orientation of the fast and slow axes in the fiber, based upon the physical geometry of the fiber. The latter refers to the two (generally orthogonal) states of polarization of a (monochromatic) input light pulse which pass through a birefringent medium, including a concatenation of randomly-oriented birefringent elements, without spreading. The two corresponding states of polarization of such a pulse as it exits the medium are referred to as the “output PSPs”, which are, in general, different from those of the input PSPs. For a constant birefringence medium (e.g. high birefringence fiber), the axes of birefringence and the PSPs are the same, but for a complicated medium having local birefringence which changes along its length (e.g. concatenated high birefringence fibers), the input and output PSPs in general do not correspond to the axes of birefringence (anywhere along the fiber).

For a polarization-maintaining fiber, a short length of singlemode fiber, an isolator, or a coupler, mode coupling is weak and the PMD delay is usually small, typically 0.5 ps or less (except for isolators, some of which exhibit PMD values over 0.5 ps).

For long cable lengths, mode coupling is usually strong. This is fortunate, since it means that for most fibers the PMD grows only as the square root of the cable length.

Second order PMD is the first-order variation of DGD (Differential Group Delay, symbolized by $\delta\tau$) and PSPs (Principal States of Polarization) with a change in optical frequency.

Applications

PMD measurement applications can be divided into five levels.

- Fiber manufacturing process
- R&D and new fiber and process qualification
- Cable manufacturing
- Cable installation evaluation
- Existing network upgrade evaluation

The first three levels take place at the plant and concern the fiber manufacturer. PMD in singlemode fiber is caused by asymmetry introduced into the optical fiber during its fabrication, and monitoring this parameter allows the manufacturer to improve or better characterize the fiber-drawing process in order to reduce undesirable birefringence and mode-coupling effects. During the assembly process, even if the individual fibers present low PMD, additional PMD may be induced through stress. It has been demonstrated that, in a large cable, inner fibers have higher PMD delays than outer fibers.

The fourth and fifth levels take place in the field. After cable installation, and in order to upgrade network systems to operate at higher bit rates, PMD measurement is advisable. Fibers that have never been tested for PMD may have extremely high PMD delays.

Conclusion

PMD is now an important consideration in high-speed digital and analog networks. It has to be measured not only after manufacturing but also after cabling and installation, since mechanical bends and pressure points can change the mode coupling and birefringence and thus affect the PMD. With the use of EDFAs (Erbium-Doped Fiber Amplifiers) to increase fiber span, all sources of dispersion must be minimized and controlled, otherwise the improvement in range will be undermined by the bandwidth limitation.

GLOSSARY

AC	Alternating current
adapter	A device for coupling two connectors.
amplitude	The distance between high and low points of a waveform or signal.
ASCII	American Standard Code for Information Interchange. A system used to represent letters, numbers, symbols, and punctuation as bytes of binary signals.
attenuation	The diminution of average optical power. Attenuation results from absorption, scattering, and other radiation losses. Attenuation is generally expressed in dB without a negative sign.
attenuation coefficient	A factor expressing attenuation per unit length, expressed in dB/km.
attenuator	An optical device, either fixed or adjustable, that reduces the intensity of light propagating through it.
axis of birefringence	One of two generally orthogonal orientations transverse to the fiber core corresponding to fast and slow propagation of the group velocity of a light beam. In general, these orientations are elliptical and the orientation and amplitude of vary along the fiber. In the special case of a HiBi fiber, the axes are linear and constant along the length of the fiber.
backscattering	That portion of scattered light that returns in a direction generally opposite to the direction of propagation.
baud rate	Measurement of data transmission speed, expressed in bits per second or bps.
beat length	In a reasonably uniform, birefringent medium, the distance over which a light wave propagating along the slow axis will accumulate a phase lag of one wavelength (2π) with respect to light propagating along the fast axis. As a rule, the shorter

	the beat length, the higher the fiber birefringence. Typical HiBi fibers have a beat length of 3 mm at 1550 nm.
Bellcore	Bell Communications Research, an organization that contains much of the former Bell labs. It specializes in telephone network technology, standards, and interfaces.
BER	Bit error rate. On a transmission link, the number of digital "highs" that are interpreted as "lows," and vice versa, divided by the total number of bits received. In modern networks, BERs much better than 10^{-9} are expected.
birefringence	The property whereby the effective propagation speed of a light wave in a medium depends upon the orientation of the electric field (state of polarization) of the light.
c	Velocity of light in a vacuum = 2.997925 x 10^8 m/s.
°C	Degree Celsius. To convert to Fahrenheit: $F = \frac{9}{5}C + 32$.
CFR	Code of Federal Regulations
chromatic dispersion	A phenomenon caused by the wavelength dependence of the group velocity in an optical fiber. Since any practical light source has a certain spectral width, chromatic dispersion results in pulse broadening. The coefficient describing chromatic dispersion per unit length is generally given in units of ps/nm·km.
coherence	A phenomenon whereby the phases of the photons (or constituent wavetrains) of a light beam maintain a definite relationship with each other. A narrow-linewidth laser is said to exhibit a high "degree of coherence".
connector	A junction that allows an optical fiber or cable to be repeatedly connected or disconnected to a device such as a source or detector.
core eccentricity	A measure of the displacement of the core center relative to the cladding center.
core ellipticity (non-circularity)	A measure of the departure of the core from roundness.

coupler	A device whose purpose is to distribute optical power among two or more ports or to combine optical power from two or more fibers into a single port.
coupling ratio	Value obtained by measuring the power at both output ports and providing the output ratio between them. Also, CR.
cutoff wavelength	For a singlemode fiber, the wavelength above which the fiber can only support the propagation of the lowest order transverse mode.
CW	Abbreviation for continuous wave. Refers to non-modulated, constant-intensity light.
CR	Coupling ratio
dB	Decibel
dBm	Decibel referenced to a milliwatt.
DC	Direct current
decibel (dB)	The standard unit used to express gain or loss of optical power. A standard logarithmic unit for the ratio of two powers.
directivity	In a 3-port optical circulator, the ratio of power launched into port 1 that exits via port 2 vs. the fraction that exits via port 3.
DUT	Device under test
dynamic range	For an optical instrument, generally defined as the ratio (in dB) of the smallest signal that can be observed (at a specified wavelength separation) in the presence of a strong, nearly saturating signal.
EDFFA	Erbium doped fluoride fiber amplifier
EDFSA	Erbium doped silica fiber amplifier
EIA	Electronics Industries Association
EL	Excess loss

electromagnetic interference	Any electrical or electromagnetic interference that causes degradation, failure in electronic equipment, or undesirable response. Optical fibers neither emit nor receive EMI.
EMI	Electromagnetic interference
excess loss (EL)	In relation to multiport components, the excess loss is a measure of the insertion loss over and above that induced by the splitting ratio.Excess loss is normally defined (in dB units) as the ratio of the input power divided by the sum of the powers in the output ports.
f	Abbreviation for femto, which indicates 10^{-15} units.
f	Frequency, often also designated by ν.
FCC	Federal Communications Commission. A U.S. government body overseeing and regulating national electrical and radio communications. The FCC, formed in 1934, also deals with licences, tariffs, and limitations. The members of the commission are appointed by the U.S. president.
frequency	The number of cycles per unit of time, denoted by hertz (Hz).
G	Abbreviation for giga, which indicates 10^{9} units.
Ge	Germanium
GeX	High power germanium
HiBi	High birefringence (fiber)
h	Mode coupling parameter, normally given in units of meters. A characteristic length over which there is a significant transfer of energy from the light component aligned with one axis of birefringence to the other axis of birefringence, and vice versa. For long fibers, the overall PMD is lowered if h is relatively short (<10 m), on the order of the fiber beat length.
hr	Hour
Hz	Hertz. Denotes number of cycles per second.

IEC	International Electrotechnical Commission. A standardization body at the same level as ISO.
IEE	Institute of Electronics Engineering. A professional body covering all aspects of electronic engineering, including software, network, and computer engineering.
IEEE	Institute of Electrical and Electronics Engineering. The institute is very active, among other things, in many fiber-optic and opto-electronic related fields.
IL	Insertion loss
index matching material	A material, often a liquid or a cement, whose refractive index is nearly equal to the core index, used to reduce Fresnel reflections from a fiber's endface.
index of refraction	The ratio of the group velocity of light in a vacuum to the group velocity of light in a given medium.
index profile	The refractive index as a function of radius of an optical fiber.
InGaAs	Indium gallium arsenide, a popular detector material.
insertion loss	The ratio of input power to output power in dB units (for a given output port) for an optical component such as a connector, splice, or coupler. For a multiport device, the insertion loss includes the splitting ratio and the excess loss.
ISO	International Organization for Standardization. Commonly believed to stand for International Standards Organization. In fact, ISO is not an abbreviation—it is intended to signify uniformity (derived from the Greek *iso* meaning "equal"). ISO is responsible for many standards including those for data communications and computing.
ITU	International Telecommunications Union. The ruling body for telecommunications and the source of many network standards.
jumper	Fiber-optic cable that has connectors terminated on both ends. Used to connect two pieces of equipment, modules, or components.

LoBi	Low birefringence (fiber)
LD	Laser diode
LED	Light emitting diode
loopback	Type of diagnostic test in which the transmitted signal is returned to the sending device after passing through a communications link or network.
M	Abbreviation for mega, 10^{6} units.
m	Abbreviation for milli, 10^{-3} units.
min	Minute
MFD	Mode field diameter (singlemode fiber).
modal dispersion	Generally used to designate multimode dispersion, which is pulse broadening due to optical power propagating via different waveguide modes. Modal dispersion is the main limitation on the bandwidth of multimode fibers.
mode coupling	The exchange of power among modes.
mode field diameter	The effective diameter of optical energy in a singlemode fiber. Because the mode field diameter is greater than the core diameter, mode field diameter frequently replaces core diameter as a practical parameter.
n	Abbreviation for nano, 10^{-9} units.
n	Refractive index. For the silica glass used in optical fibers, $n \approx 1.465$.
NA	Numerical aperture
NIST	National Institute of Standards and Technology. U.S. governmental body that provides the assistance in developing standards. It was formerly the National Bureau of Standards.
noise figure	A measure of the quality of an amplifier, defined as the ratio of output to input SNRs.

numerical aperture (NA)	It is the sine of half the maximum angle of acceptance.
optical rejection ratio	Another commonly used term for “dynamic range” in an optical system.
optical return loss (ORL)	The ratio (expressed in units of dB) of optical power, reflected by a component or an assembly, to the optical power incident on a component or assembly that is introduced into a link or system.
p	Abbreviation for pico, 10^{-12} units.
P	Power
PC	In optical schematics, used to designate a polarization controller.
PCS	Plastic-clad silica (fiber)
PDCR	Polarization dependent coupling ratio
PDEL	Polarization dependent excess loss
PDG	Polarization dependent gain
PDL	Polarization dependent loss
PMF	Polarization maintaining fiber
Poincaré sphere	A three-dimensional graphical representation of the state of polarization of a light beam.
polarization controller	Instrument used to control the polarization state of the light. This type of equipment can produce different polarization states of the input light.
polarization dependent loss	A transmission loss that varies with input polarization state. Normally defined as T_{max}(dB) - T_{min}(dB).
polarization mode dispersion (PMD)	Pulse spreading in a singlemode fiber that arises on account of the different group velocities associated with each of the two principal states of polarization of the fiber.
polarizer	Component used to polarize light.

principal states of polarization (PSP)	The two generally orthogonal states of polarization of a monochromatic light beam launched into a fiber (input PSP) that will propagate through the fiber without spreading or distortion. The SOP of this light beam as it exits the fiber will be in one of two, generally orthogonal, output PSPs. In general, the output PSPs are not the same as the input PSPs, and the orientation of these PSPs changes with wavelength. Not to be confused with axes of birefringence. Only in the spectral case of a single HiBi fiber are the PSPs and the axes of birefringence the same.
RMA	Return merchandise authorization
RNF	Refracted near field
s	Second
sensitivity	For an optical instrument, the smallest signal that can be detected in the absence of any other signal.
Si	Silicon
SNR	Signal-to-noise ratio. Also written S/N. The ratio of the received optical power, divided by the noise floor for the optical system.
state of polarization (SOP)	The orientation of the electric field vector of a propagating optical wave. In general, this vector will trace an ellipse as it propagates. In special cases, it will remain oriented in one direction (linear polarization) or will trace out a circle (left or right circular polarization).
t	Time
T	Abbreviation for tera, 10^{12} units.
V	volt
VA	volt-ampere
W	watt
waveguide dispersion	An important constituent of chromatic dispersion in optical fibers. It is determined by the fiber cladding/core geometry and refractive index profile.

wavelength	For monochromatic light, the distance between two successive peaks (or troughs) of the sinusoidally-varying electric-field amplitude. Note that, unlike frequency, the wavelength of light is inversely proportional to the refractive index of the medium through which it propagates. It is for this reason that accurate wavelength measurements are generally specified as being determined in “air” or in “vacuum.”
λ	lambda. Greek letter used to denote wavelength.
μ	Abbreviation for micro, 10^{-6} units.
ν	nu. Greek letter used to denote frequency. Traditionally, the physics community uses “ν” to denote frequency whereas the engineering community uses “*f*.”

This page intentionally left blank.

INDEX

A

abbreviations Glossary-1
AC gain 5-8
acquisition
  multiple 5-10
  PMD 5-12
  points 5-21
  setup 5-8
  wavelength 5-10
active LED 2-2
after sales service 10-2
application software
  exiting 4-15
  loading 4-1
attenuation 5-2
  level 4-12
  setting 4-10
auto-naming 5-25

B

birefringence A-1

C

caps, protective 2-2
caution of product hazard 1-2
certification
  information vii
  warranty 10-2
cleaning
  fiber ends 9-1
  module casing 9-1
  optical ports 9-1
closing application 4-15
comment, parameters 5-6
connecting fiber to detector port 2-4
contacting EXFO 1-3
control
  status 4-12
  transfer 4-5, 4-11
cursor display 5-23
customizing acquisitions 5-23

D

data
  display 4-6, 4-11
  management 6-1
  printing 6-4
DC gain 5-22
description of module front panel 2-1, 2-2
device type 5-6
display
  cursor after PMD calculation 5-23
  data 4-6
  fit after PMD calculation 5-23
  trace 4-6
display menu
  IQ-2123BP/BH 4-9
  IQ-5500 4-4
DUT information 5-6

E

equipment returns 10-3
error messages
  format 7-33
  IQ-2123 7-36
  IQ-5500 7-34
estimated PMD value 5-24
EUI
  base plate 2-5
  connector adaptor 2-5
  dust cap 2-5
EXFO Universal Interface (EUI) 2-5
exiting the application 4-15

F

factory default settings 5-26
fiber
HiBi 5-6, A-2
ID 5-6
length 5-7
polarization-maintaining A-3
fiber ends, cleaning 9-1
file menu
IQ-2123BP 4-9
IQ-5500 4-4
fit display 5-23
frequency 5-2
front panel description
IQ-2123BP 2-2
IQ-5500 2-1
function buttons
in monitor window 4-14
light source 4-10
PMD analyzer 4-5

G

Gaussian fit 4-6
generating a results table 6-1
getting help 1-3
glossary Glossary-1
GPIB
command structure 7-1
control 7-1–7-34
error message format 7-33
IQ-2123 command tree 7-33
IQ-2123 error messages 7-36
IQ-5500 command tree 7-29
IQ-5500 error messages 7-34
link 4-12
graph report 5-27

H

hardware identification 2-1
hardware-software interface 5-26
help menu
IQ-2123BP 4-9
IQ-5500 4-4
HiBi fiber 5-6, A-2

I

index of refraction A-1
information
fiber 5-19
status indicators 5-15
window 5-19
inserting the module 2-3
inspection upon receipt 1-2
installing the module 2-3
IQ Software 1-1
IQ-2123BP brief description 3-1
IQ-5500 brief description 3-1

L

launching the application 4-1
LED push button 2-3
local 4-12
lockout 4-12

M

maintenance
cleaning fiber ends 9-1
cleaning module casing 9-1
cleaning optical ports 9-1
managing data 6-1
measurement
information 5-8
information window 5-19
parameters 5-8
preparation 5-3
procedure 5-12
mechanical shifts 5-26
menu
display 4-4, 4-9
file 4-4, 4-9

help....4-4, 4-9
menu bar
IQ-2123BP....4-9
IQ-5500....4-3
mirror displacement....5-26
modulation
list box....5-2
state....4-12, 5-2
module
insertion....2-3
installation....2-3
maintenance....9-1
nameplate....2-1
removal....2-7
monitor window
closing....4-14
description....4-13
opening....4-14
mounting EUI connector adaptor....2-5
multiple
acquisitions....5-8
measurements....5-10

N

nameplate....2-1
number of points....5-21

O

operation....5-1
optical connections....2-4

P

parameters
comment....5-6
custom....5-23
fiber ID....5-6
fiber length....5-7
scanning range....5-8
wavelength....5-10
picoseconds....A-2
PMD....A-1
acquisition....5-12
data display....4-6
definition....A-1
fit....4-6
Gaussian fit....4-6
graph axes description....4-6
measurement applications....A-3
measurements....A-2
module description....2-1
second order....5-20
trace display....4-6
units....A-2
polarization
modes....A-1
state....A-1
polarization-maintaining fiber....A-3
port cleaning....9-1
power level indicator
description....4-6
showing or hiding....5-26
preparing for measurement....5-3
printing....6-4
printing reports....5-28, 5-31
product nameplate....2-1
protective caps....2-2

Q

quick reference for GPIB commands
IQ-2123....7-33
IQ-5500....7-29

R

range....A-1
rate....A-1
remote....4-12
removing the module....2-7
results table....5-15, 6-1
return merchandise authorization *see* RMA
RMA....10-3

S

safety
- caution ... 1-2
- important ... 1-2
- warning ... 1-2

save
- as ... 6-1
- to disk after each measurement ... 5-24

saving ... 6-1
scanning
- range ... 5-8

second order PMD ... 5-20
service, after sales ... 10-2
setting
- source attenuation ... 5-2
- views with the zoom ... 5-15

setup
- acquisition ... 5-8
- attenuation ... 5-2
- source ... 5-1
- source wavelength ... 5-3

shipping to EXFO ... 10-3
signal intensity ... 4-6, 5-26
software
- exiting ... 4-15
- loading ... 4-1

source
- activation/deactivation ... 4-10, 5-1
- attenuation ... 5-2
- IQ-2123BP ... 3-1
- modulation ... 5-2
- port ... 2-2
- setup ... 5-1
- status ... 4-11
- warm up period ... 5-1
- wavelength ... 5-10

starting PMD acquisition ... 5-12
statistical results ... 5-18
status, source ... 4-11
storage temperature ... 1-3
symbols ... Glossary-1

T

table ... 6-1
table report ... 5-31
taking measurements ... 5-12
technical specifications
- IQ-2123BP ... 8-2
- IQ-5500 ... 8-1

temperature for storage ... 1-3
template ... 5-8
test setup ... 5-4
threshold, user-defined ... 5-27
title bar
- IQ-2123BP ... 4-9
- IQ-5500 ... 4-3

trace
- display ... 4-6
- view preferences ... 5-15

transportation requirements ... 1-3
troubleshooting ... 9-2

U

UltraTech Engineering Labs Inc. ... vii
user information ... 5-5

V

view preferences ... 5-15
viewing table ... 6-1

W

warm up period ... 5-1
warning of personal hazard ... 1-2
warranty
- certification ... 10-2
- exclusions ... 10-2
- general ... 10-1
- liability ... 10-2
- null and void ... 10-1

wavelength
- available ... 5-8
- parameters ... 5-10

selection 4-10, 4-12, 5-3
weak polarization mode coupling 5-7
window, measurement information 5-19

Z

zoom 5-14, 5-15

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP