Agilent 81910A
Photonic All-Parameter Analyzer

User's Guide

Agilent Technologies

Notices

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CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Warnings and Notices

WARNING

The Optical Test Head is heavy and requires two people to lift or carry it. Do not attempt to lift or carry it on your own.
Make sure you use the help of a colleague to unpack or move the Optical Test Head.

WARNING

To avoid the possibility of injury or death, you must observe the following precautions before switching on the instrument.
Insert the power cable plug only into a socket outlet provided with a protective earth contact. Do not negate this protective action by the using an extension cord without a protective conductor.

WARNING

Never look directly into the end of a fiber or a connector, unless you are absolutely certain that there is no signal in the fiber.

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For more information about Agilent Technologies test and measurement products, applications, services, and for a current sales office listing, viesit our web site:

http://www.agilent.com/comms/lightwave

You can also contact one of the following centers and ask for a test and measurement sales representative.

United States:	1 800 829 4444 1 800 829 4433 (FAX)
Canada:	1 877 894 4414 1 905 282 6495 (FAX)
Europe:	+31 20 547 2111 +31 20 547 2190 (FAX)
Japan:	120 421 345 120 421 678 (FAX)
Mexico	(52 55) 5081 9469 (52 55) 5081 9467 (FAX)
Australia:	800 629 485 800 142 134 (FAX)
Asia-Pacific:	+852 800 930 871 +852 2 506 9233(FAX)
Latin America	+55 11 4197 3600 +55 11 4197 3800 (FAX)

In This Guide...

This User's Guide contains information about installing and using the Photonic All-Parameter Analyzer and Photonic Analysis Toolbox (PAT).

Table of Contents

List of Figures

1

Installing the Photonic All-Parameter Analyzer

This chapter describes how to install your hardware and software.

The chapter starts with a brief description of the Photonic All-Parameter Analyzer system.
Then there is a list of the components that you receive, or supply yourself to make up the system.
This is followed by instructions on how to prepare the site for the test system, and how to connect the hardware and install the software.

Safety Information

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument.

Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

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

Safety Summary

The Agilent 81910A Photonic All-Parameter Analyzer is a Safety Class 1 instrument.

This product is intended for indoor use only. To prevent potential fire or electric shock hazard, do not expose to rain or other excessive moisture.

The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

Before applying power

... comply with the chapter **“Installing the Photonic All-Parameter Analyzer”** .

... verify that the product is set to match the available line voltage, and all safety precautions are taken.

AC Line Power Supply Requirements

The Agilent 81910A Photonic All-Parameter Analyzer operates from a single phase AC power source that supplies between 100 V and 240 V at a frequency in the range of 50 to 60 Hz to the System Controller.

The maximum power consumption is 200VA with all options installed.

AC Line Power Cable

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

The type of power cable shipped with each instrument depends on the country of destination. Refer to the diagram below for the part numbers of the power cables available.

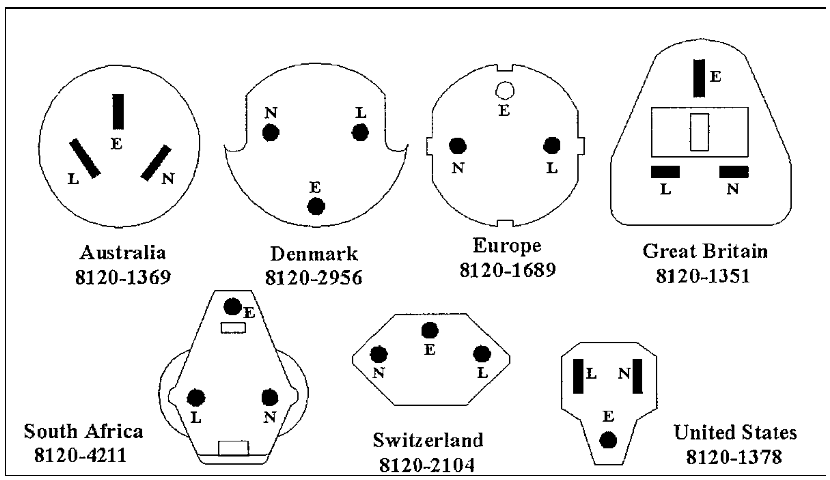


Figure 1 Line power cables – plug identification

WARNING

To avoid the possibility of injury or death, you must observe the following precautions before switching on the instrument.
Insert the power cable plug only into a socket outlet provided with a protective earth contact. Do not negate this protective action by the using an extension cord without a protective conductor.

Additional Safety Requirements

- In case of hazard the power cable inlet of the controller serves as device to disconnect from the mains.
  The controller must be positioned that the operator can easily access the power cable inlet.
  In case of rack-mounted controller the rack must be provided with an easily accessible mains switch.
- Do not interrupt the protective earth connection intentionally.
- Do not operate the instrument in the presence of flammable gases or fumes
- Operating personnel must not remove instrument covers.
- There is no user-replaceable fuse in the instrument.
- Component replacement and internal adjustments must be made only by qualified service personnel.
- Instruments that appear damaged or defective must be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

Safety Symbols

This symbol denotes a general hazard and indicates that you need to read and understand the User’s Guide before proceeding.

This symbol denotes a magnet. Caution for persons with pacemakers.

Operating and Storage Environment

The following summarizes the Photonic All-Parameter Analyzer operating environment ranges.

Temperature and humidity

The Agilent 81910A Photonic All-Parameter Analyzer can be operated between 5°C and 45°C (within specifications at a temperature of 23°C ± 5K) and a humidity between 15% and 80%.

The Agilent 81910A Photonic All-Parameter Analyzer can be stored or shipped at temperatures between -40°C and +50°C. It shall be protected from temperature extremes and changes in temperature that may cause condensation within it.

Altitude

The Agilent 81910A Photonic All-Parameter Analyzer can be used up to 2000m (6500ft.)

Measurement (Overvoltage) category and Pollution

The Agilent 81910A Photonic All-Parameter Analyzer Analyzer complies with measurement category II and is designed for pollution degree 2 (IEC 60664-1).

Declaration of Conformity

Agilent Technologies	**DECLARATION OF CONFORMITY** According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014	CE

Manufacturer's Name: Agilent Technologies International sarl
Manufacturer's Address: Rue de la Gare 29
CH - 1110 Morges
Switzerland

Declares under sole responsibility that the product as originally delivered

Product Name: **rAPTor Photonic All-parameter Analyzer**
Product Number: **81910A**
Product Options: *This declaration covers all options of the above product.*

complies with the essential requirements of the following applicable European Directives, and carries the CE marking accordingly:

- The Low Voltage Directive 73/23/EEC, amended by 93/68/EEC
- The EMC Directive 89/336/EEC, amended by 93/68/EEC

and conforms with the following product standards:

	Standard	**Limit**
EMC	IEC 61326:1997+A1:1998+A2:2000 / EN 61326:1997+A1:1998+A2:2001	
	CISPR 11:1997+A1:1999 / EN 55011:1998+A1:1999	Group 1 Class A
	IEC 61000-4-2:2001 / EN 61000-4-2:1995+A1:1998+A2:2001	4 kV CD, 8 kV AD
	IEC 61000-4-3:2002 / EN 61000-4-3:2002	3 V/m, 80-1000 MHz
	IEC 61000-4-4:2001 / EN 61000-4-4:1995+A1:2001+A2:2001	0.5 kV signal lines, 1 kV power lines
	IEC 61000-4-5:2001 / EN 61000-4-5:1995+A1:2001	0.5 kV line-line, 1 kV line-ground
	IEC 61000-4-6:1995+A1:2000 / EN 61000-4-6:1996+A1:2001	3 V, 0.15-80 MHz
	IEC 61000-4-8:2001 / EN 61000-4-8:1993+A1:2001	30 A/m
	IEC 61000-4-11:1994+A1:2000 / EN 61000-4-11:1994+A1:2001	1 cycle/100%
	Canada: ICES-001:1998	
	Australia/New Zealand: AS/NZS 2064.1	
Safety	IEC 61010-1:2001 / EN 61010-1:2001	
	Canada: CSA C22.2 No. 1010.1:1992	
	USA: UL 3111-1:1994	

Supplementary Information:

The product was tested in a typical configuration with Agilent Technologies test systems.

This DoC applies to above-listed products placed on the EU market after:

2004-August-01
Date

Hans-Martin Fischer
Name

Product Regulations Representative PMD, DVS
Agilent Technologies
Title

For further information, please contact your local Agilent Technologies sales office, agent or distributor.

Revision: D Issue Date: 2004-August-01

Regulatory Compliance Notes

EMC Australia/New Zealand

N 10149

EMC/CEM Canada

These ISM devices comply with Canadian ICES-001.

Ces appareils ISM sont conformes ŕ la norme NMB-001 du Canada.

An Overview of your Photonic All-Parameter Analyzer

The Photonic All-Parameter Analyzer consists of a number of major components that are connected optically and electronically.

Alternative Hardware Configurations

There are three alternative hardware configurations.

Single PC Configuration

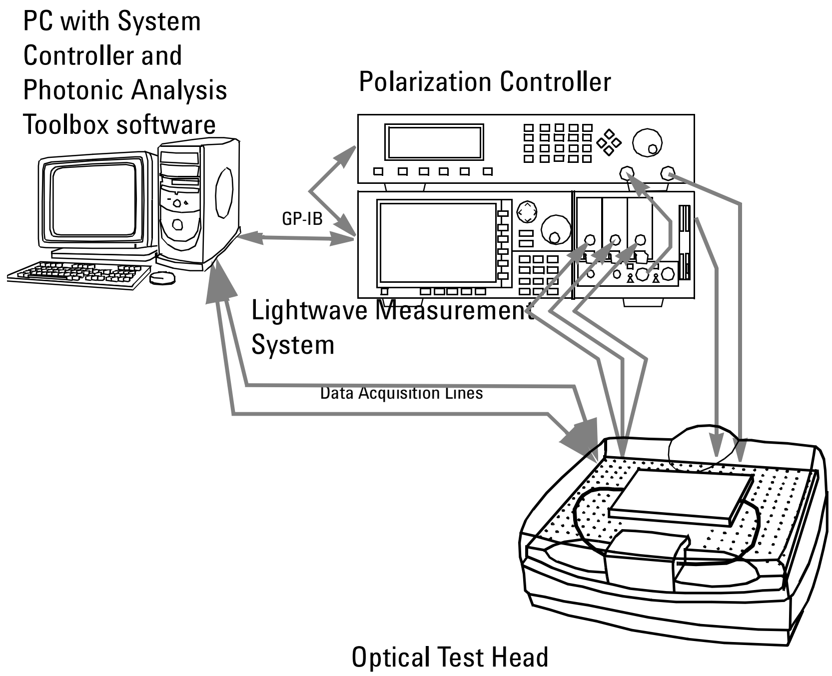


Figure 2 Overview of the Single PC Configuration

In this case all of the software and connections are on the PC supplied with the All-Parameter Analyzer, including

- the Photonic Analysis Toolbox and Photonic Foundation Library (API) software
- the GP-IB card
- the Plug and Play drivers
- the Agilent VISA drivers, and
- the System Controller software (data acquisition from and control of the Optical Test Head)

The PC is connected to the Polarization Controller and Lightwave Measurement System over GP-IB, and to the Optical Test Head over the Data Acquisition lines.

This is the configuration described in detail this this manual.

Two PC setup with GP-IB Connection to the User’s PC

NOTE

This was the hardware configuration used for the first release of the All-Parameter Analyzer.

How to set up this configuration is not described explicitly, in this manual.

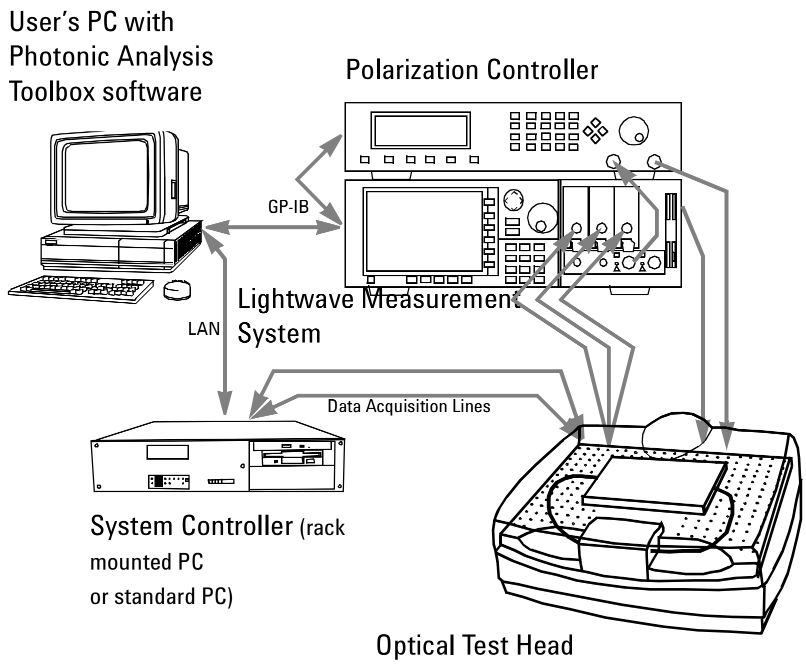


Figure 3 Overview of the Two PC setup with GP-IB Connection to the User’s PC

In this case the user’s PC contains:

- the Photonic Analysis Toolbox and Photonic Foundation Library (API) software
- the GP-IB card
- the Plug and Play drivers
- the Agilent VISA drivers, and

The user’s PC is connected to the Polarization Controller and Lightwave Measurement System over GP-IB.

The System Controller PC contains:

- the System Controller software (data acquisition from and control of the Optical Test Head).

The System Controller PC is connected to the Optical Test Head over the Data Acquisition lines.

The user’s PC is connected to the System Controller PC via LAN.

Two PC setup with using the System Controller PC’s GP-IB Connection via LAN server.

NOTE How to set up this configuration is not described explicitly, in this manual.

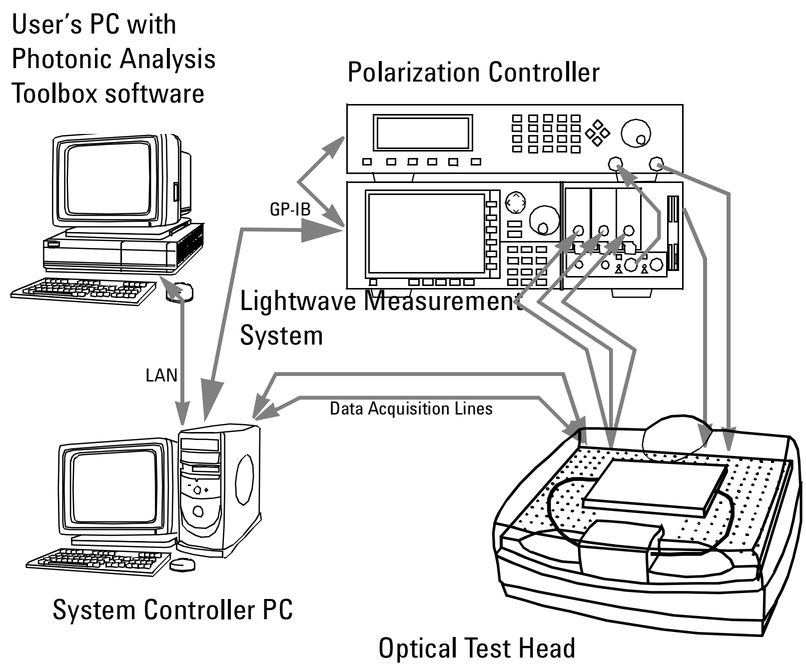


Figure 4 Overview of the Two PC setup with GP-IB Connection to the System Controller PC

In this case the user’s PC contains:

- the Photonic Analysis Toolbox and Photonic Foundation Library (API) software
- the Agilent VISA LAN Client software, and

The System Controller PC contains:

- the GP-IB card
- the Plug and Play drivers
- the Agilent VISA drivers
- the Agilent VISA LAN Server software, and
- the System Controller software (data acquisition from and control of the Optical Test Head).

The System Controller PC is connected to the Polarization Controller and Lightwave Measurement System over GP-IB, and to the Optical Test Head over the Data Acquisition lines.

The user's PC is connected to the System Controller PC via LAN. The connection from the Photonic Analysis Toolbox to the Polarization Controller and Lightwave Measurement System is accomplished usingAgilent VISA LAN Client/Server.

Hardware Description

The test signal originates from the Tunable Laser Source Module in the Lightwave Measurement System. This is routed, via the Polarization Controller, to the Optical Test Head, and to the device under test.

The light transmitted and reflected by the device under test (DUT) is measured at various points within the Optical Test Head by the Power Sensor Modules in the Lightwave Measurement System, and by internal power sensors within the Optical Test Head. The readings from the internal power sensors are polled by the System Controller software.

The Lightwave Measurement System, the Polarization Controller and the System Controller software are controlled by the Photonic Analysis Toolbox software. The Photonic Analysis Toolbox software also collects the measurement data from the Power Sensor Modules and the System Controller software. This measurement data is then processed to produce tabular and graphical results.

Checking for Updates

Before you begin installing your All-Parameter Analyzer, we recommend that you check the support website for details of any changes or updates. The All-Parameter Analyzer support website is at http://www.agilent.com/comms/allparameter
=> Choose “Technical Support”.

Unpacking the Photonic All-Parameter Analyzer

Each Photonic All-Parameter Analyzer contains.

- 1 Agilent 8164B Lightwave Measurement System (Mainframe)
  The Lightwave Measurement System is not supplied if you ordered option 002 or option 004.
- User's guide for the 8164B Lightwave Measurement System (not supplied if you ordered option 002 or option 004)
- Programmer's guide for the 8164B Lightwave Measurement System (not supplied if you ordered option 002 or option 004)
- 1 Agilent 81640B or 81600B option 200 or 160
  Tunable Laser Source Module
  If you ordered option 002 or option 004, this is the refurbished, fully calibrated Tunable Laser Source Module in exchange for the module that you previously sent to Agilent.
- User's guide for the Agilent 81640B or 81600B Tunable Laser Source Module
- 3 Agilent 81634B Power Sensor Modules
- User's guide for the Agilent 81634B Power Sensor Module
- Serial cable assembly (not supplied if you ordered option 002 or option 004)

- 1 Agilent 8169A Polarization Controller
- User's guide for the Agilent 8169A Polarization Controller

- 1 System Controller PC
  used to run/control the system.
- 1 Keyboard Kit
- 2 Data Acquisition cards
  used to control/acquire data from the Optical Test Head.
- 1 Ribbon Cable
  used to connect the two data acquisition cards.

- 1 Agilent 81910TH Optical Test Head
  used as an optical bench and for connecting to the device under test.

- 1 Optical Test Head Hood
  used to optimize measurement performance by protecting the DUT and the fibers from air currents.
- 1 DUT Holder
  optionally used to hold the DUT on the optical bench.
- 1 Mounting Kit
  contains
  20 optical bench mounting plugs so you can configure your own optical setup.
  1 Allen key for the screws used to attach the Optical Test Head Hood to the Optical Test Head.
  1 Allen key for removing the cover of the adapter patchcords in the optical workbench.
  1 Termination Rod for use in making terminations.
- 1 Accessories Kit
  contains
  4 fiber rails to keep fibers in defined and fixed positions.
  2 fiber holders, to keep the fibers in a defined position for best possible measurements.
- 2 rail kits and 2 rack mount kits for mounting the Polarization Controller and the Lightwave Measurement System in a rack.

- 2 GPIB cables
- 2 data acquisition cables, 3m
  used to transfer data between the System Controller PC and the Optical Test Head.
- 1 BNC cable, 3m
  used as a trigger cable between the Tunable Laser Source Module and the Optical Test Head.
- 1 LAN cable

- 1 Semi-Rigid Patchcord, 0.3m, with two HMS-10 connectors.
  used to connect the output of the Tunable Laser Source Module to the input of the Polarization Controller.
- 1 Protected Patchcord, 3m, with two HMS-10 connectors.
  used to connect the output of the Polarization Controller to the input of the Optical Test Head.

- 2 adapter patchcords, E2000 to bare fiber
  to adapt the Optical Test Head for operation with DUTs using bare fiber connections.
- 2 adapter patchcords, E2000 to straight
  to adapt the Optical Test Head for operation with DUTs using straight connectors.

- 3 HMS-10 interface adapters for connecting to the power sensor modules.
- 2 81000FI interface adapter
- 2 81000NI interface adapter

- 1 box containing 2 reference patchcords with straight connectors used for reference measurements for systems using straight connectors.
- 1 box containing 2 reference patchcords and 2 performance verification patchcords with angled connectors used for reference measurements for systems using angled connectors.
- 1 box containing 2 reference patchcords with bare fiber ends used for reference measurements for systems using bare fiber connections.

- UK6 Verification Report
- Support CD-ROM
- 2 or 3 power cords, according to the option ordered, used for the Lightwave Measurement System, Polarization Controller, and System Controller PC.
- 1 CD containing the Photonic Analysis Toolbox software
  for installation on your PC.
- This User’s Guide

Specification of the User's PC

If the Photonic Analysis Toolbox software is to run on a separate PC (see "Alternative Hardware Configurations" on page 22 for information on possible configurations), this should satisfy the following *minimum* specification:

Processor:	500 MHz *Note:* Do not use dual processors unless they are supported by your VISA library.
Main Memory:	192 Mbyte
Display Resolution:	SVGA (1024 x 768)
Colors:	16 or 24 bit
Operating System:	Windows NT 4 SP 6 or SP 6a or Windows 2000 SP2 or Windows XP
OS Language option:	English (US) or Japanese
Internet Explorer:	Version 4 or higher
VISA Library:	National Instruments Version 2.0 or higher (not 2.6! but 2.6.1) or Agilent J 2.0 or higher
GPIB-Card:[a]	Any type compatible with your VISA Library

[a] Only required for the Two PC Setup with GP-IB Connection to the User's PC

Setting Up the Photonic All-Parameter Analyzer

Setting up your Photonic All-Parameter Analyzer consists of three major steps:

- Preparing the site
- Setting up the hardware, which includes preparing the equipment and allowing it to acclimatize, setting up the Lightwave Measurement System, making the optical connections, making the signal connections, connecting the power, and connecting the system to your PC.
- Installing the software.

Preparing the Installation

Requirements and Constraints

Before you begin installing your Photonic All-Parameter Analyzer, make sure

- the site you have chosen meets the environmental conditions listed in “Performance Specifications” on page 216, and “Operating and Storage Environment” on page 19.
  Please also check the environmental conditions and site preparation information in the documentation supplied with the Lightwave Measurement System, the Polarization Controller and the System Controller PC.
- a robust bench or table is available for the Optical Test Head. This should be away from strong airflows or any kind of vibrations.
- there are enough AC-power outlets (you will need 1 each for the Lightwave Measurement System, the Polarization Controller, and the System Controller PC).

The Lightwave Measurement System, the Polarization Controller need to be positioned together, but not more than 2 m from the Optical Test Head. The System Controller PC must also be positioned within 2 m of the Optical Test Head.

NOTE DO NOT place the Optical Test Head on top of the Lightwave Measurement System, the Polarization Controller or the System Controller PC

Updating Your Lightwave Measurement System (option 002 or 004)

If you ordered your Photonic All-Parameter Analyzer as an upgrade (option 002), you must ensure that the Lightwave Measurement System has the most recent software.

The Support CD-ROM contains the most recent software, and is contained in your shipment.

NOTE This section is only necessary if you need to upgrade your existing Lightwave Measurement System. If you received a Lightwave Measurement System as part of your delivery, you do not need to perform this upgrade.

In addition to your PC, you require a null-modem serial cable, such as is supplied with your 8164B Lightwave Measurement System mainframe.

To upgrade the Lightwave Measurement System firmware:

NOTE This section describes the upgrade procedure for the 8164B. If you are using an 8164A, the procedure is different. Please follow the instructions of your 8164A/B User's Guide. Instructions and downloads are also available at **www.agilent.com\comms\octfirmware**.

1 Insert the Support CD-ROM into your PC.
2 Copy the Firmware\8164B folder from the Support CD-ROM to a folder on your PC.
  This folder contains the update tool ATTools_v1_23.exe and a firmware image file named 64B_V*xxx*.Z
  where *xxx* refers to the firmware version. For example, 64B_V402.Z is firmware version 4.02 for the 8164BLightwave Measurement System.
3 Connect your Lightwave Measurement System to your PC with the serial cable.
4 Read all of this step before you begin. You will need to prepare to perform this step easily.
  Turn on the Lightwave Measurement System and wait until the Agilent screen appears.
  Quickly:
  a Press, but do not hold the **Aux** hardkey
  b Press the **Appl** hardkey.

If you were successful, the instrument displays: “Instrument Maintenance Mode”.
Otherwise, turn off the power and try again.

1 At your PC, click on ATTools_v1_23.exe to start the update tool.
Click **OK** to confirm that you have completed steps the preceding steps.

When the serial connection has been established, which can take up to 30 seconds, the ATTools user interface is displayed.

2 Select the firmware image (file type .Z) in the file selection box, then click the **Update Firmware** button.
Click **OK** to confirm your choice of firmware upgrade.

3 The firmware upgrade is tracked by a progress bar in the ATTools user interface.
When the update is complete, a confirmation message is displayed. Click **OK**.

4 Click **Exit** to terminate ATTools.
Your Lightwave Measurement System reboots automatically.

Installing the Data Acquisition Cards into the System Controller PC

The data acquisition cards are removed from the System Controller PC after the system has completed the final factory test, and are shipped separately to avoid any damage in transport. These cards must be reinstalled before you continue with the installation.

NOTE All of the drivers and applications required by the All-Parameter Analyzer are pre-installed on the System Controller PC. The only modification necessary is the installation of the two cards.

- You do not require any special tools for the installation.
- Please read the 'Setup and Quick Reference Guide' supplied with the PC, especially the sections 'CAUTION: Safety Instructions' and 'When Using Your Computer'.

WARNING **Disconnect any cables to avoid any potential hazard of electrical shock.**

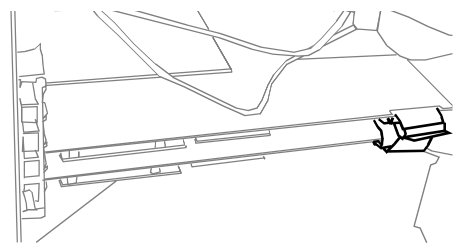
CAUTION

Observe all precautions for handling electrostatic discharge sensitive devices.

Handle the boards with care, don't touch the circuits, use the edge of the board for handling.

Make sure that the manual voltage selection switch is set for the voltage that most closely matches the AC power available in your location (e.g. 115-V position for Japans 100-V AC power).

1 Open the PC case, according to the instructions supplied with the PC.
2 Open the board locking device.
3 Remove the two screws.
4 Insert the data acquisition card marked “Port 1” into the slot corresponding to Port 1 on the rear of the System Controller PC casing.
5 Insert the data acquisition card marked “Port 2” into the slot corresponding to Port 2 on the rear of the System Controller PC casing.
6 Connect the two cards together with the ribbon cable.
7 Fix the two cards with the screws removed in step 3.
8 Close the board locking device.
9 Close the case of the System Controller PC.



- Check the intrusion switch assembly (please refer to the documentation for the PC for further information).
- If necessary, lift the data acquisition card slightly to accommodate the intrusion switch assembly.

Connecting the Hardware Together

Before you begin

WARNING

The Optical Test Head is heavy and requires two people to lift or carry.
Do not attempt to lift or carry it on your own.
Make sure you use the help of a colleague to unpack or move the Optical Test Head.

1 Remove the Optical Test Head, the test equipment, and all of the patchcords and electrical cables from the packaging.

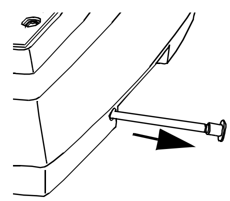
2 Make sure you have received everything before you proceed. If anything is missing, contact your local Agilent representative.

3 Place the equipment in its final position.

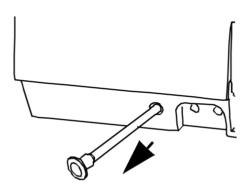
- You will need regular access to the PC with the Photonic Analysis Toolbox software, to control the system, and the Optical Test Head to attach and remove the components for test.
- Make sure the System Controller PC has adequate clearance for ventilation.

4 Remove the 4 fixing bolts from the Optical Test Head.
These bolts prevent the suspension of the Optical Test Head from being damaged in shipment.

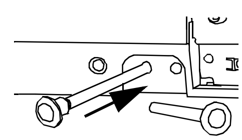
- There is one fixing bolt on each side of the Optical Test Head.



- There are two fixing bolts at the back of the Optical Test Head, to the left and right of the connector area.



- Store the fixing bolts in the holes provided at the back of the Optical Test Head, on the left and right of the connector area.



CAUTION

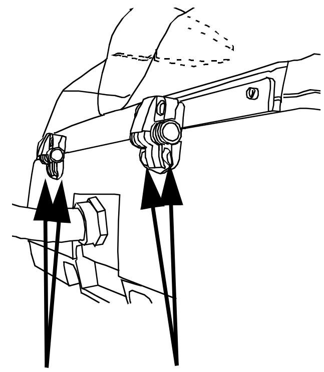
Reinsert the fixing bolts if you are moving or shipping the Optical Test Head.

To reinsert the bolts, you will need to press the optical bench down by a few millimeters (a few 100ths of an inch).

5 If the Optical Test Head is placed in a location where air currents could cause movement of patchcords or optical components, we recommend that you attach the Optical Test Head Hood.

  a Place the Optical Test Head Hood on the Optical Test Head.

  b Use the 4 screws to attach the hinges into the back of the Optical Test Head.



NOTE

Four fiber rails are provided to prevent fibers getting caught under the hood when closing it. See “Fixing the Fiber Rails” on page 48 for information on how to fix the fiber rails to the optical bench.

6 If the equipment, cords and cables have not been stored at the temperature of the room where they are being installed, leave them for an hour or so to make sure they reach room temperature. This will prevent unwanted condensation.

Setting up the Lightwave Measurement System

Please refer to the User Guide for your Lightwave Measurement System for detailed instructions on inserting modules.

1 Insert the Tunable Laser Source Module into the Lightwave Measurement System.

2 Insert the three Power Sensor Modules into slots 1, 2 and 3 of the Lightwave Measurement System.

3 Use a blanking plate to cover slot 4 of the Lightwave Measurement System.

Making the Optical Connections

NOTE

These instructions assume that you are installing the Photonic All-Parameter Analyzer for the first time, using hardware delivered from Agilent Technologies.

If you are re-installing the hardware, or reusing existing hardware, please make sure that all of your optical connectors are clean before proceeding.

1 Screw the Interface Adapters onto

- the inputs of the Power Sensor Modules
- the output 1 (Low SSE) of the Tunable Laser Source Module
- the input and output of the Polarization Controller
- the input on the rear of the Optical Test Head

CAUTION

Take care when inserting the connectors of the Semi-Rigid Patchcord.
The stiffness of the Semi-Rigid Patchcord requires caution to insert it into the connector adapter.

Before each connection, it is strongly recommended to clean each optical connector and bushing. Refer to"Cleaning" on page 270 for information on cleaning connectors. Also, refer to "Do not touch the ferrule of the three patchcords in the tubing from the back of the Optical Test Head." on page 40 before handling the patchcords from the Optical Test Head.

The quality of the optical connection between the Tunable Laser Source Module, the Polarization Controller and the Optical Test Head is vital to the overall performance of the Photonic All-Parameter Analyzer. A connection with high loss can easily occur if mechanical stress is applied on the connector, or more commonly if the connectors are either dirty or damaged.

The tests indicated for these connections can be performed either for a new optical connection, or if the diagnostic tool indicates failure. We recommend you use an optical power measurement head to make the measurements indicated, but it is possible to use one of the Power Sensor Modules of the Photonic All-Parameter Analyzer.

2 Use the Semi-Rigid Patchcord, to connect the Tunable Laser Source Module to the Polarization Controller

   a Unscrew the protective cover and connect one side of the Semi-Rigid Patchcord to the Tunable Laser Source Module output. While the connector is being screwed onto the bushing, try to avoid any transverse resistance by holding the metal casing of the patchcord perpendicular to the TLS front panel.

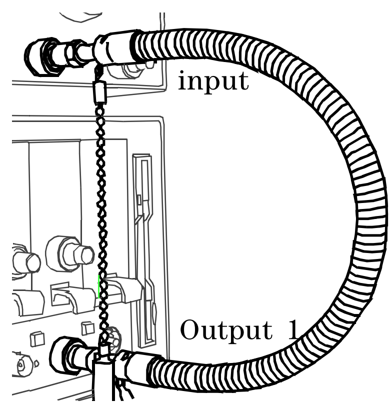
b Unscrew the protective cover and connect the other side of the Semi-Rigid Patchcord to the power meter.

c Set the Tunable Laser Source Module to a wavelength of 1570 nm and laser power to -10 dBm.
Set the power meter to a wavelength of 1570 nm.

d The power measured by the power meter must be between -10.8 dBm and -9 dBm.

If the power is not within these limits, then clean the power meter connector, and the connector of the Semi-Rigid Patchcord that is connecting to the power meter and repeat the measurement.
If, after cleaning, the power is still not within the limits, disconnect, clean and reconnect the Semi-Rigid Patchcord to the Tunable Laser Source Module, avoiding transverse stress on the connector as much as possible, as described above.
If the power is still not within the limits, please contact your local Agilent representative.

e Disconnect the Semi-Rigid Patchcord from the power meter. Without disconnecting the Semi-Rigid Patchcord from the Tunable Laser Source Module and taking care not to strain the front connectors, connect the other side of the Semi-Rigid Patchcord to the input of the Polarization Controller.



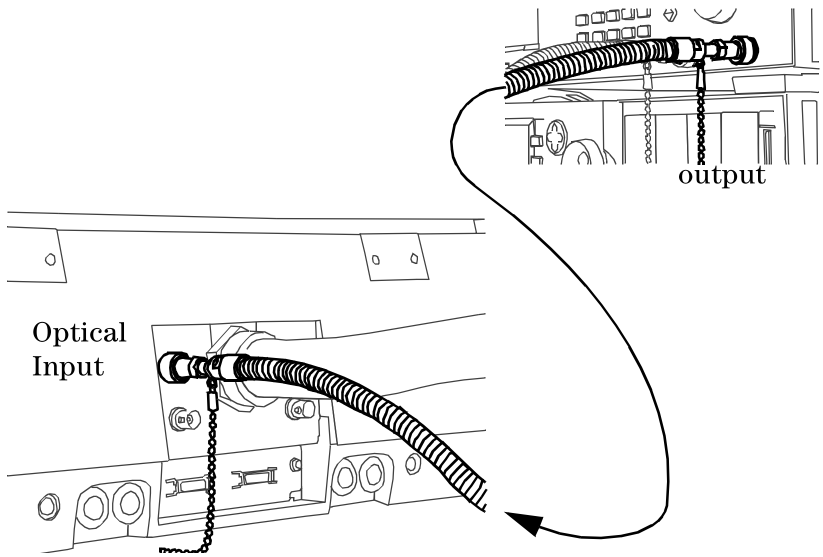
3 Using the Protected Patchcord, unscrew the protective covers and connect the output of the Polarization Controller to the power meter.

a The polarizer plate in the Polarization Controller is not aligned with the state of polarization of the incident light, so set the polarizer angle manually from the front panel of the Polarization Controller to get the maximum power on the power meter.
Use 10 degree steps first, then 1 degree steps to locate the maximum.
When the maximum is obtained, lock the polarizer angle by pressing “enter”.

b The power measured by the power meter at the maximum must be between -14.5 dBm and -10.5 dBm.

If the power is not within these limits, then clean the power meter connector, and the connector of the Protected Patchcord that is connecting to the power meter and repeat the measurement.
If the power is still not within the limits, then clean the Polarization Controller output connector, and the connector of the Protected Patchcord that is connecting to the Polarization Controller and repeat the measurement.
If, after cleaning, the power is still not within the limits, and taking care not to strain the front connectors, disconnect, clean and reconnect the Semi-Rigid Patchcord to the Polarization Controller.
If the power is still not within the limits, please contact your local Agilent representative.

c Disconnect the Protected Patchcord from the power meter, and connect it to the Optical Test Head.



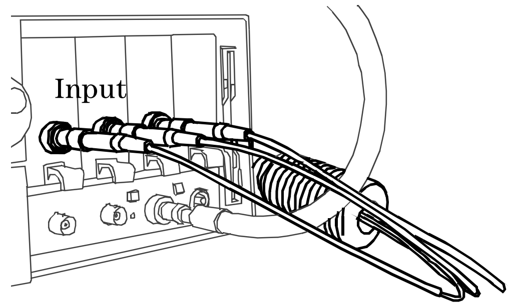
CAUTION

Do not touch the ferrule of the three patchcords in the tubing from the back of the Optical Test Head.

Take care when connecting these patchcords. The fronts of the connectors are specially treated, and scratches or dirt will affect the accuracy of your measurements.

These connectors should only be cleaned with clean, compressed air.
The specially treated surfaces can be damaged by normal contact cleaning methods or by the use of alcohol or other liquids, affecting the accuracy of measurements.

4 Connect the three patchcords in the tubing from the back of the Optical Test Head to the Power Sensor Modules. The patchcords are labelled according to the slot of the Power Sensor Module to which they should be connected.



That is, the patchcord labelled PM Slot 1 should be connected to the Power Sensor Module in slot 1, and so on.

NOTE

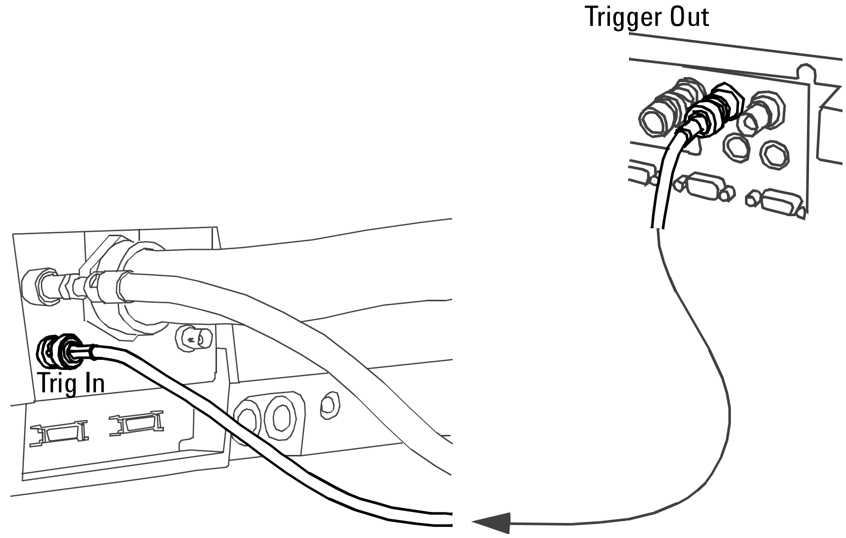
The Photonic All-Parameter Analyzer is supplied ready to use with devices that have angled connections.

Adapter patchcords are also provided for use with straight or bare fiber connections.

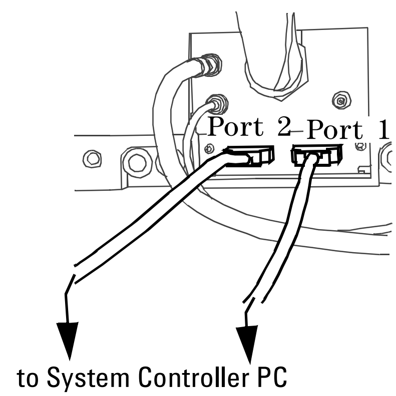
If you are testing devices with straight or bare fiber connections, see “Replacing the Optical Test Head Adapter Patchcord” on page 285 for information on how to change the adapter patchcords in the Optical Test Head.

Making the Signal Connection

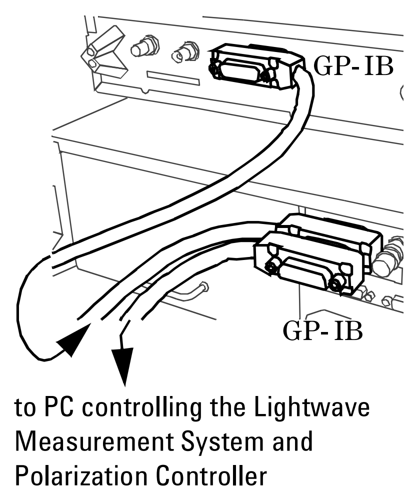
1 Using the Coax cable, connect the Trigger Output from the rear of the Lightwave Measurement System to the Trig In input on the rear of the Optical Test Head.



2 Using the two data acquisition cables, connect from the port 1 on the rear of the System Controller to port 1 on the rear of the Optical Test Head, and from the port 2 on the rear of the System Controller PC to port 2 on the rear of the Optical Test Head.



3 Using the GPIB cables, connect the PC to the Lightwave Measurement System, and then to the Polarization Controller.



Connecting the Power

1 Connect the Lightwave Measurement System, Polarization Controller and System Controller PC to the ac power source.
The circuitry in the Optical Test Head is powered via the data acquisition cables.

Installing the Software

NOTE

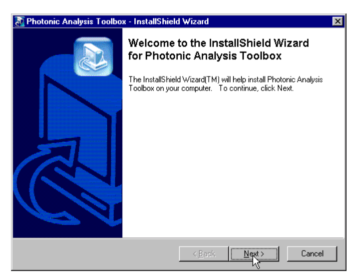
o not need to install the software if you are using the Photonic Analysis Toolbox on the PC supplied with the system.

The following instructions only apply if you are using the Photonic Analysis Toolbox softw

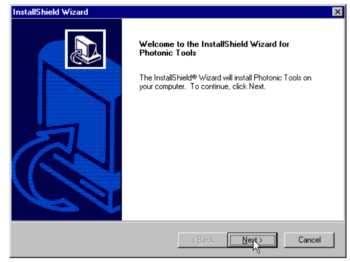
NOTE

Before you install the Photonic Analysis Toolbox software, make sure that you have already installed the Agilent I/O Libraries.
These libraries are delivered with your instruments, and are also available from the Agilent website (**http://www.agilent.com**), under the heading Test & Measurement, sub-heading Technical Support.

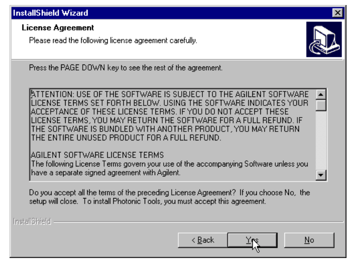
1 Insert the Photonic Analysis Toolbox software CD into the CD-ROM drive on your PC.
2 Open the file explorer.
3 Change to the root directory (****) on the CD-ROM.
4 Double-click on the program **PAT.exe**.
5 Click on the **Next >** button to start the installation process.
The Installation files are extracted.



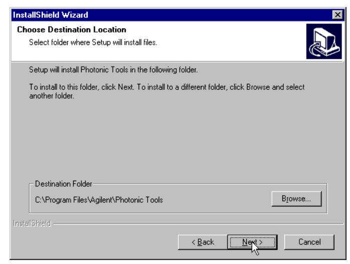
6 Click on the **Next >** button to start the installation of the software.



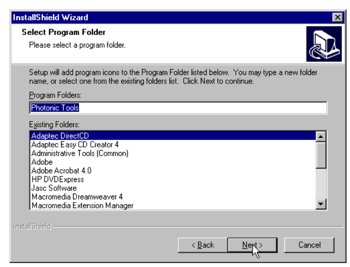
7 Click on the **Yes** button to accept the terms of the license agreement.



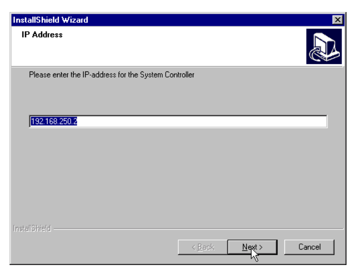
8 If you want to install the program to a different directory, click on the **Browse...** button and select the directory you want to use.
When you agree with the directory indicated, click on the **Next >** button



9 If you want the program icons to the installed in a particular program folder, select this folder, or enter the folder name.
When you are satisfied with the program folder, click on the **Next >** button.
The files are installed.

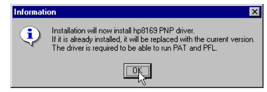


10 You are now asked to enter the IP address of the System Controller PC. The default address of the System Controller PC is given. Please check with your IT Department if you should use a different fixed IP address for the System Controller. If your System Controller is using a different address, enter this address.
When you have made sure that the correct IP address has been entered, click on the **Next >** button.



The Photonic Analysis Toolbox uses the plug-and-play (PNP) drivers for the Agilent 8169. These are added to your system as part of the installation. These will replace any existing Agilent or HP 8169 PNP drivers on your system.

11 Click on the **OK** button to continue with the installation of the Agilent 8169 plug-and-play drivers.

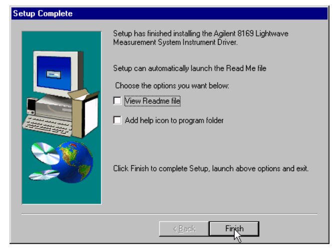


Follow the instructions of the installer.

Select to install the VISA files, if necessary.

Select the **Typical** configuration, unless you have specific requirements for other instruments being used from this PC.

When the driver has been installed, click on the **Finish** button.



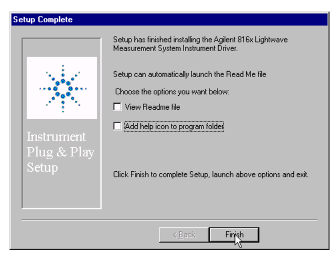
The Photonic Analysis Toolbox uses the plug-and-play (PNP) drivers for the Agilent 816x. These are added to your system as part of the installation. These will replace any existing Agilent or HP 816x PNP drivers on your system.

12 Click on the OK button to continue with the installation of the Agilent 816x plug-and-play drivers.
Follow the instructions of the installer.

Select to install the VISA files, if necessary.

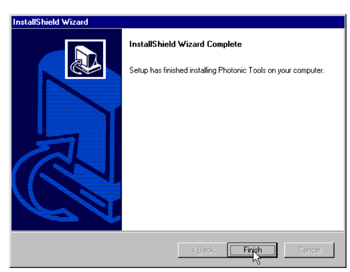
Select the **Complete** configuration, unless you have specific requirements for other instruments being used from this PC.

When the driver has been installed, click on the **Finish** button.



13 The installation of the software has now completed. Click on the **Finish** button.

The software is now ready to run.



Making Sure Everything Works

When you first start the System Controller PC, check in the Measurement and Automation Explorer (under Devices and Interfaces) of the System Controller software, that the two data acquisition (DAQ) cards are listed.

Use the test described in “Operational Verification Test” on page 222, to ensure the system is running correctly.

2
Getting Started

Getting started covers how you fix components to the optical bench on the Optical Test Head, how you attach a test device, starting the system, setting up measurement parameters, and running a measurement.

Fixing Components to the Optical Bench

CAUTION The optical bench can take a maximum weight of 10 kg (22 lbs.).

NOTE When fixing components to the optical bench, distribute the weight evenly to ensure the optimal operation of the suspension.

Fiber rails, clamps and a DUT (device under test) holder are provided to help you set up efficient tests.

Fixing the Fiber Rails

Four fiber rails are provided to prevent fibers getting caught under the hood as you close it. These are pressed into the holes in the optical bench close to the edge.

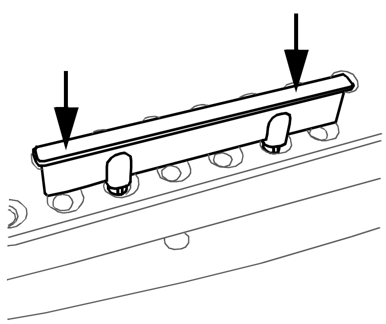


Figure 5 Inserting a fiber rail into the optical bench

To remove the fiber rails, pull them out of the optical bench.

Using the Fiber Clamps

1 At both sides of the body of the fiber clamp, pull the dust covers up off the two studs onto which they are wedged.

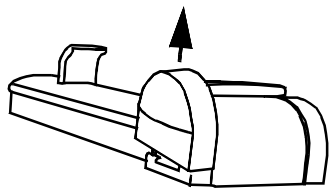


Figure 6 Removing the dust cover from a fiber clamp

2 Put the fixing bolts of the DUT holder into the mounting plugs.

3 Tighten the mounting plugs slightly so they start to bulge.

4 Insert the mounting plugs attached to the fiber clamp into the optical bench.

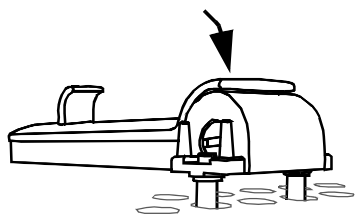


Figure 7 Inserting the fiber clamp into the optical bench

5 Use the hexagonal key to tighten the fixing bolts.

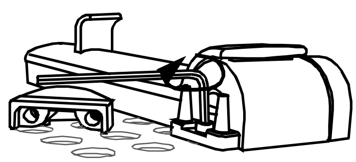


Figure 8 Tightening the fiber clamp into the optical bench

If the bolts and mounting plugs rotate in the holes of the optical bench, remove the fiber clamp from the optical bench, tighten the mounting plugs so they bulge a little more and try again.

6 Replace the dust caps on both sides, pressing them down on the studs.

To remove the fiber clamp from the optical bench, perform the procedure above in reverse.

To clamp a fiber:

7 Raise the arm of the fiber clamp.

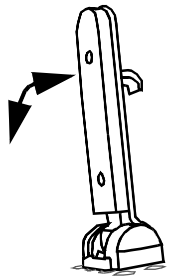


Figure 9 Raising and lowering the fiber clamp

8 Arrange the fibers on the optical bench.

9 Lower the arm of the fiber clamp.

Using the Termination Rod

1 Screw the termination rod into the mounting plug.

2 Tighten the mounting plug slightly so it starts to bulge.

3 Insert the mounting plug attached to the termination rod into the optical bench.

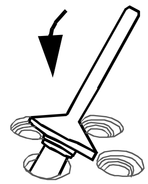


Figure 10 Inserting the termination rod into the optical bench

4 Rotate the termination rod to tighten it.

   If the rod and mounting plug rotate in the hole of the optical bench, remove the termination rod from the optical bench, tighten the mounting plug so it bulges a little more and try again.

To remove the termination rod from the optical bench, perform the procedure above in reverse.

Making a Termination

To make a termination, wrap a length of the fiber around the rod 5 times. Fix the wrapped fiber (using adhesive tape, or an elastic band).

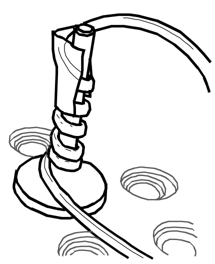


Figure 11 Creating a termination using the termination rod

Using the DUT Holder

CAUTION

Caution for persons with pacemakers.

Do not use the DUT holder with devices that are sensitive to magnetic fields.

The DUT Holder uses a magnetic clamp to hold the DUT.

1 Screw the fixing bolts of the DUT holder into the mounting plugs.
2 Tighten the mounting plugs slightly so they start to bulge.
3 Insert the mounting plugs attached to the DUT Holder into the optical bench.

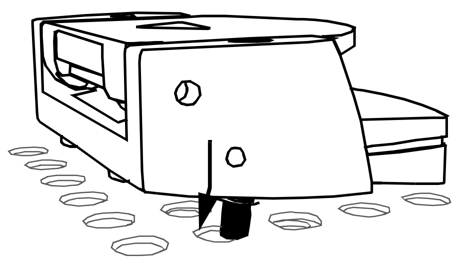


Figure 12 Inserting the DUT holder into the optical bench

4 Use the hexagonal key to tighten the fixing bolts.

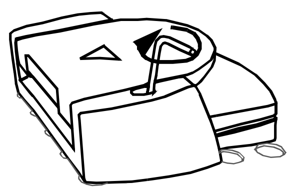


Figure 13 Tightening the DUT holder into the optical bench

If the bolts and mounting plugs rotate in the holes of the optical bench, remove the DUT holder from the optical bench, tighten the mounting plugs so they bulge a little more and try again.

To remove the DUT holder from the optical bench, perform the procedure above in reverse.

To put a DUT into the holder:

5 Raise the flap at the top.

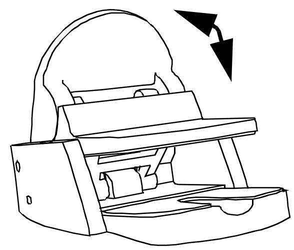


Figure 14 Opening and closing the DUT holder

6 Put the DUT into the opening.

7 Lower the flap to clamp the DUT in place.

Fixing Other Objects to the Optical Bench

A number of standard optical bench mounting plugs and fixing bolts are supplied with your Photonic All-Parameter Analyzer. These plugs are threaded on the inside.

To fix an object to the optical bench:

1 Insert fixing bolts through the fixing holes of the object, and screw them into the mounting plugs.

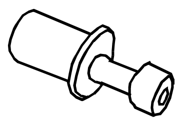


Figure 15 Inserting a fixing bolt into a mounting plug

2 Tighten the mounting plugs slightly so they start to bulge.

3 Insert the mounting plugs attached to the object into the optical bench.

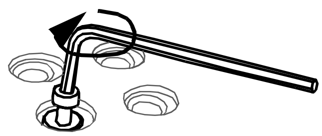


Figure 16 Tightening the fixing bold into the optical bench

4 Use the hexagonal key to tighten the fixing bolts.

   If the bolts and mounting plugs rotate in the holes of the optical bench, remove the object from the optical bench, tighten the mounting plugs so they bulge a little more and try again.

To remove the object from the optical bench, perform the procedure above in reverse.

Starting the System

To make sure the Tunable Laser Source Module can perform as specified, it needs to warm up for an hour. Therefore you should power up the Lightwave Measurement System at least an hour before you intend to start measuring.

When you power up the Lightwave Measurement System, you will need to manually unlock it by entering the number “1234” on the keypad.

When you are ready to make your measurements, and if you have not already done so, power up the Polarization Controller and System Controller PC with the Photonic Analysis Toolbox software.
The Optical Test Head is powered by the System Controller PC, and does not need to be powered up separately. The Controller Engine software should start automatically.

After the hardware is powered up, run the Photonic Analysis Toolbox software by

- double-clicking on the icon that was added to your desktop during the installation or
- clicking on the Windows **Start** button, selecting **Programs**, then the **Photonic Tools** folder, and clicking on **Photonic Analysis Toolbox**.

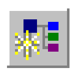
The software runs, and the Photonic Analysis Toolbox software automatically detects the hardware connected over the GP-IB.

Making a First Measurement

Before you begin to make your first measurement, attach your Interface Adapters to the input and output of the Optical Test Head.

To Set Up a New Measurement

WARNING **Never look directly into the end of a fiber or a connector, unless you are absolutely certain that there is no signal in the fiber.**

1 Click on 

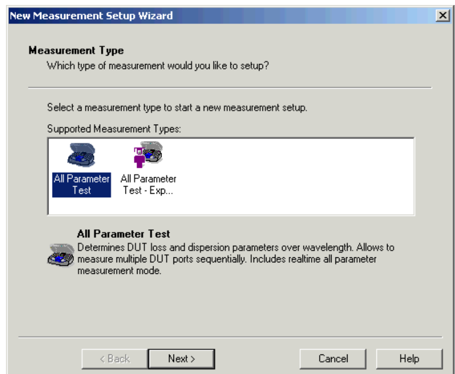
2 Select the measurement mode you want to use.
The software can be used in two modes: the "All Parameter mode" and the "Expert mode".

- All Parameter mode is recommend for general use.
All Parameter mode includes the realtime and full-performance measurements. This allows you to check and adjust the setup with a realtime measurement (updated every 1 to 2 seconds) and then do a full performance specified measurement — or continue with realtime measurements for continued adjustments of the Device under Test.

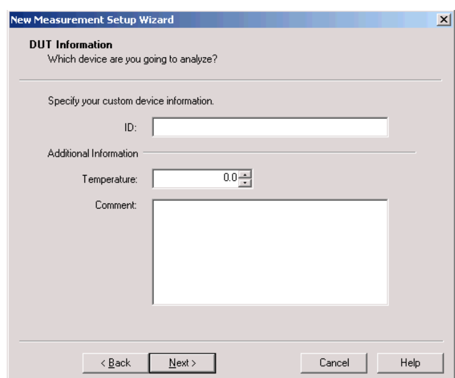
  Only selected combinations of measurements are possible in standard All Parameter Test mode. The permitted combinations are Fast GD, Fast IL, Fast GD and Fast IL, DGD/GD, PDL/IL, DGD/GD and PDL/IL. The start, stop and wavelength parameters for both loss and dispersion measurements must be the same.
  If both transmission and reflection measurements are being made, the same combination of measurements must be made in both directions.

NOTE Realtime measurements are made using interferometry:
Fast IL results are derived from the interferogram and PDL/IL results are calculated using a Jones Matrix.

- Expert mode allows full freedom in the selection of parameters, any combination of loss and dispersion measurements, and seperate configuration of measurement parameters for loss measurements and dispersion measurements. It also supports measurements over 50 nm with the highest resolution.
  Expert mode does not support real-time measurements.



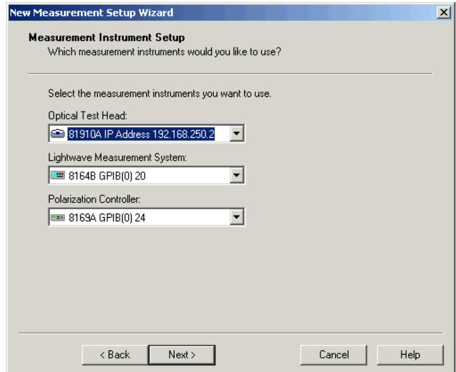
3 Enter the information about your device under test (DUT), if desired.



This includes

ID	The identification of the DUT
DUT Temperature	The temperature of the DUT during the measurement. This is used for documentation purposes only. It is not used in any calculations.The temperature range at which the Photonic All-Parameter Analyzer meets its specifications is given in “Performance Specifications” on page 216
Comment	Space to add comments on the DUT and the measurement.

4 If you have more than one setup hardware, select the hardware to be used for the measurement from the pull-down menus.



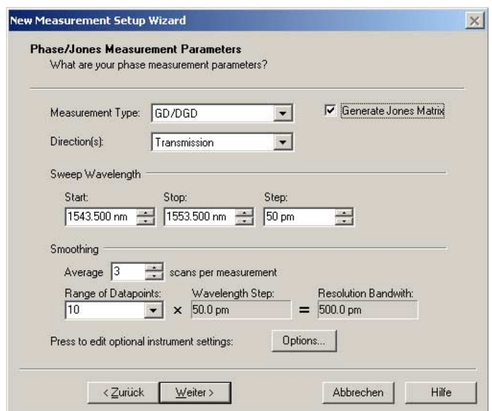
Click on the **Next >** button.

To Set the Parameters for a Measurement in Expert Mode

NOTE Parameters for Expert-Mode measurements cannot be used to make realtime measurements.

NOTE You can select DGD measurements even if DGD and PMD measurements are not possible on your All-Parameter Analyzer (option #005). However the DGD measurement will not be carried out, and the PMD analysis is not possible.

1 Set the measurement parameters for the phase measurements.



a Select the measurement

Fast GD	To make just a group delay measurement, using a single polarization state. Reference measurements are optional for the Fast GD measurement.
GD/DGD	To make both group delay and differential group delay measurements, using two polarization states. Reference measurements are required.
No Phase Measurement	To skip the measurement of group delay and differential group delay

b Select the light path

Transmission	To measure in the transmission path only.
Reflection	To measure in the reflection path only.
Transmission + Reflection	To measure in both transmission and reflection paths.

c If you are running a GD/DGD measurement, you can also select to generate a Jones Matrix for export as an ASCII file.
The Jones matrix can only be generated during a measurement. It cannot be generated from existing measurement data. Once generated, the Jones Matrix is saved with your measurement data, increasing the size of a measurement file by approximately 50%.

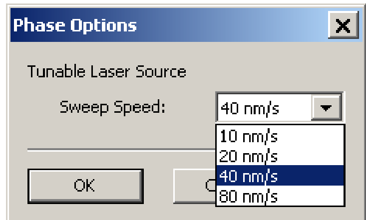
d Set the start and stop wavelengths, and the step size for the sweep.
The step size of the wavelength sweep limits the possible resolution bandwidth of the results for the group delay and differential group delay, as well as the resolution bandwidth of the chromatic dispersion analysis.
For phase measurements, the maximum step size is 100pm.
The maximum wavelength span depends on the sweep speed of the tunable laser source. The dependency between span and sweep speed is given in “Dispersion Measurement Specifications” on page 218.

e Select the number of scans. The result is averaged across the selected number of scans.
Increasing the number of scans reduces the noise floor, but increases the measurement time.
Graphs of uncertainty as a function of the spectral averaging time and the number of averages are given in “Supplementary dispersion measurement characteristicsa” on page 219.

f Set the Resolution Bandwidth of the group delay and differential group delay results, by entering the size factor of the sliding window for the calculation of the group delay and differential group delay. The sliding window is of Gaussian shape, centered on the current wavelength.
The resolution bandwidth is the 2σ value of the sliding window and is the product of the size factor and the step size for the sweep.
The resolution bandwidth of the chromatic dispersion analysis is

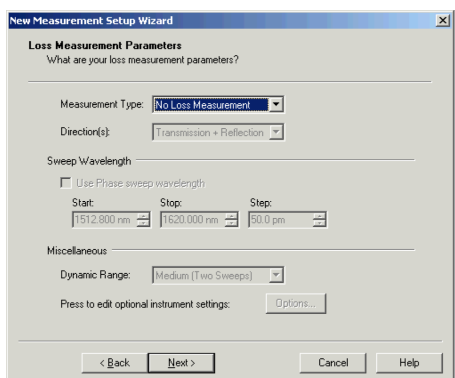
described in “Setting up the Auto-Analysis of Results” on page 152 and “Analyzing Chromatic Dispersion” on page 178.

g Set the sweep speed of the tunable laser by opening "Options..." and selecting the proper speed in "Phase Options":



The higher the sweep speed the lower is the impact of environmental disturbances. Increasing sweep speed improves phase measurement accuracy. The maximum usable sweep speed depends on the device length to be tested. The dependency between sweep speed and device length is given in “Dispersion Measurement Specifications” on page 218.

2 Set the measurement parameters for the loss and polarization dependent loss measurements



a Select the measurement

Fast Loss	To make just a loss measurement, using a single polarization state Reference measurements are optional for the Fast Loss measurement.
Loss/PDL	To make both loss and polarization dependent loss measurements, using four polarization states. Reference measurements are required.
No Loss Measurement	To skip the measurement of loss and polarization dependent loss.

b Select the light path

Transmission	To measure in the transmission path only.
Reflection	To measure in the reflection path only.
Transmission + Reflection	To measure in both transmission and reflection paths.

c Set the start and stop wavelengths, and the step size for the sweep. If you want to use the same values as you entered for the phase measurement, click in the box beside **Use Phase sweep wavelength** to make sure it has a check mark.
For loss measurements, the maximum step size is 200 pm.

d Select the Number of Sweeps to use for the measurement.
Each sweep is performed at a different power sensor range, and the results are combined to provide an increased dynamic range.
A single sweep provides a dynamic range of 35 dB (typical), two sweeps provides a dynamic range of 50 dB (typical), three sweeps provides the specified dynamic range of over 55 dB in the transmission path and over 45 dB in the reflection path.
Increasing the number of sweeps increases the measurement time.

e To set the start of the power sensor range for your measurement, please refer to “Setting the Start Range for the Power Sensor” on page 149.

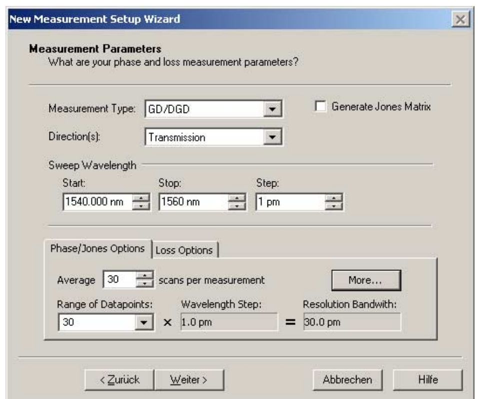
f To set the start of the coherence control for the Tunable Laser Source Module, please refer to “Controlling the Quality of the Laser Signal” on page 149.

To Set the Parameters for a Measurement in All Parameter Mode

1 Set the measurement parameters

NOTE

You can select DGD measurements even if DGD and PMD measurements are not possible on your All-Parameter Analyzer (option #005). However the DGD measurement will not be carried out, and the PMD analysis is not possible.



a Select the measurement

Fast GD	To make just a group delay measurement, using a single polarization state. Reference measurements are optional for the Fast GD measurement.
Fast Loss	To make just a loss measurement, using a single polarization state Reference measurements are optional for the Fast Loss measurement.
Fast GD and Fast Loss	To make just a group delay and a loss measurement, using a single polarization state for the Fast GD, and a second single polarization state for the Fast Loss measurement. Reference measurements are optional for the Fast GD and Fast Loss measurements.
GD/DGD	To make both group delay and differential group delay measurements, using two polarization states. Reference measurements are required.
Loss/PDL	To make both loss and polarization dependent loss measurements, using four polarization states. Reference measurements are required.
GD/DGD and Loss/PDL	To make group delay, differential group delay, loss and polarization dependent loss measurements, using two polarization states for the GD/DGD measurement and four polarization states for the Loss/PDL measurement. Reference measurements are required.

b Select the light path

Transmission	To measure in the transmission path only.
Reflection	To measure in the reflection path only.
Transmission + Reflection	To measure in both transmission and reflection paths.

c If you are running a GD/DGD measurement, you can also select to generate a Jones Matrix for Export as an ASCII file.
The Jones matrix can only be generated during a measurement. It cannot be generated from existing measurement data. Once generated, the Jones Matrix is saved with your measurement data, increasing the size of a measurement file by approximately 50%.

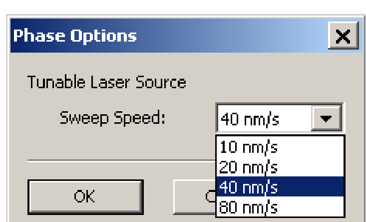
d Set the start and stop wavelengths, and the step size for the sweep.
The step size of the wavelength sweep limits the possible resolution bandwidth of the results for the group delay and differential group delay, as well as the resolution bandwidth of the chromatic dispersion analysis.
For measurements in All Parameter mode, the maximum step size is 100 pm.

2 Set the measurement parameters for the phase measurements
Click on the Phase Options tab to select this configuration if it is not already shown.

a Select the number of scans. The result is averaged across the selected number of scans.
Increasing the number of scans reduces the noise floor, but increases the measurement time.
Graphs of uncertainty as a function of the spectral averaging time and the number of averages are given in “Supplementary dispersion measurement characteristicsa” on page 219.

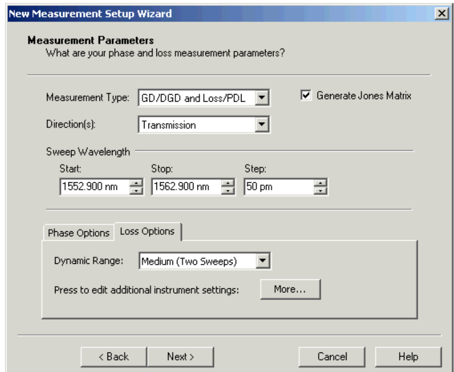
b Set the Resolution Bandwidth of the group delay and differential group delay results, by entering the size factor of the sliding window for the calculation of the group delay and differential group delay.
The sliding window is of Gaussian shape, centered on the current wavelength.
The resolution bandwidth is the 2σ value of the sliding window and is the product of the size factor and the step size for the sweep.
The resolution bandwidth of the chromatic dispersion analysis is described in “Setting up the Auto-Analysis of Results” on page 152 and “Analyzing Chromatic Dispersion” on page 178.

c Set the sweep speed of the tunable laser by opening "Options..." and selecting the proper speed in "Phase Options":



The higher the sweep speed the lower is the impact of environmental disturbances. Increasing sweep speed improves phase measurement accuracy. The maximum usable sweep speed depends on the device length to be tested. The dependency between sweep speed and device length is given in “Dispersion Measurement Specifications” on page 218

3 Set the measurement parameters for the loss and polarization dependent loss measurements



Click on the Loss Options tab to select this configuration if it is not already shown.

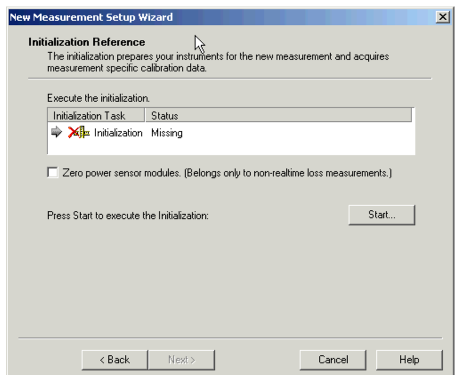
a Select the Number of Sweeps to use for the measurement.
Each sweep is performed at a different power sensor range, and the results are combined to provide an increased dynamic range.
A single sweep provides a dynamic range of 35 dB (typical), two sweeps provides a dynamic range of
50 dB (typical), three sweeps provides the specified dynamic range of over 55 dB in the transmission path and over 45 dB in the reflection path.
Increasing the number of sweeps increases the measurement time.
To set the start of the power sensor range for your measurement, please refer to “Setting the Start Range for the Power Sensor” on page 149.
To set the start of the coherence control for the Tunable Laser Source Module, please refer to “Controlling the Quality of the Laser Signal” on page 149.

To Perform the Reference Measurements

When you have set all the parameters for the measurement, you must perform a reference measurement.

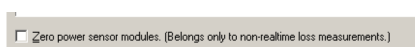
WARNING **Do not look directly into the Optical Test Headconnector, unless you are absolutely certain that there is no signal.**

4 You are prompted to start the Initialization Reference.



- If the system has been initialized recently and the hardware and measurement setup has not been changed, click on the **Next >** button to skip the Initialization Reference.

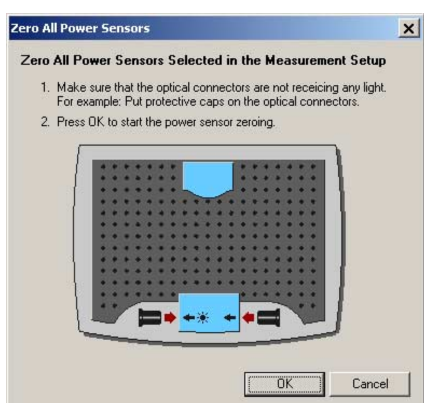
  a It is recommended that you zero the power sensors before beginning the reference measurement.



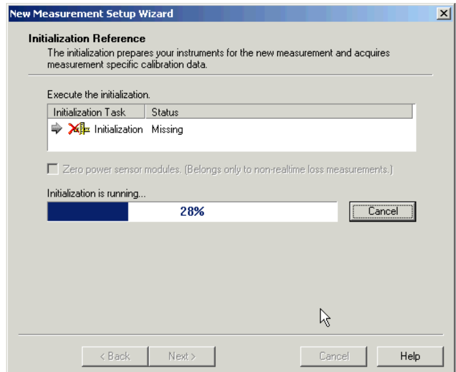
  If the power sensors have been zeroed recently and the setup has not be changed, click on the box to remove the check mark.

  b If you have changed the setup, or if you want to ensure meeting the specifications, click on the **Start...** button.

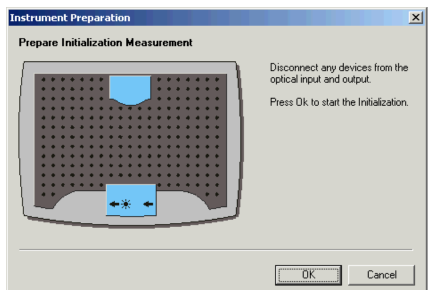
- If you are zeroing the power meters, you are prompted to set up the Optical Test Head for the Initialization Measurement by disconnecting



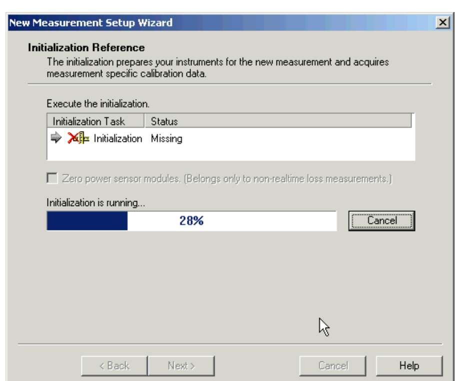
any fibers and putting protective caps on the input and output of the Optical Test Head.
Click on the **OK** button.
The power sensors are zeroed and the initialization reference is made.



c If you are not zeroing the power meters, you are prompted to set up the Optical Test Head for the Initialization Measurement by



disconnecting any fibers from the input and the output of the Optical Test Head.
Click on the **OK** button.
The Initialization Reference runs.



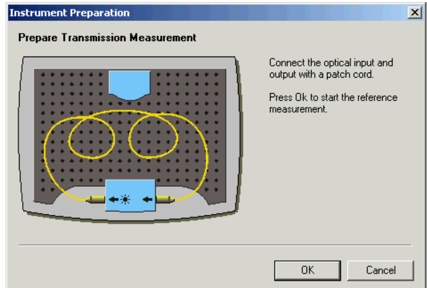
5 When the Initialization Reference finishes, you are prompted to set up the Optical Test Head for the Reference Measurement.

a Select the type of reference measurement you want to perform.

Transmission	To measure a reference in the transmission path only. This option is only available if your measurement parameters specify only a measurement in the transmission path.
Reflection	To measure a reference in the reflection path only using a reflective reference device. This option is only available if your measurement parameters specify only a measurement in the reflection path.
Terminated Reflection	To measure a reference in the reflection path using a reflective reference device and include a reference with a termination device. This option is only available if your measurement parameters specify only a measurement in the reflection path. The measurement of the terminated reflection reference extends the time for the reference measurement, but adds to the overall accuracy of the results.
Transmission and Reflection	To measure a reference in both transmission and reflection paths.
Transmission and Terminated Reflection	To measure a reference in both transmission and reflection paths, including a termination reference. The measurement of the terminated reflection reference extends the time for the reference measurement, but adds to the overall accuracy of the results.

b Click on the **Start...** button.

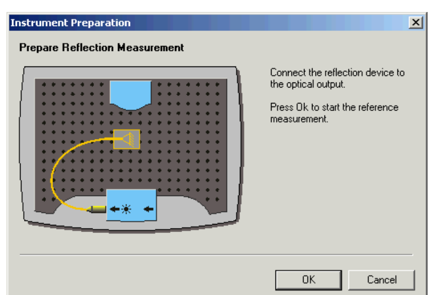
6 If you have selected a transmission reference measurement, you are prompted to set up the Optical Test Head for this measurement.



NOTE Please make sure that any optical connectors that you are using are clean before making a connection.

a. Connect or splice the Transmission Reference Fiber from the input to the output of the Optical Test Head.
   Place the Transmission Reference Fiber on the optical bench of the Optical Test Head.
b. Click on the **OK** button.
   The reference transmission measurement runs in one or two cycles, depending on the measurements selected, to calibrate the transmission path for the Loss/PDL measurements and then for the GD/DGD measurements.
c. Disconnect the Transmission Reference Fiber from the Optical Test Head.
d. If there are other reference measurement tasks to be done, click on the *Start...* button.

7. If you have selected a reflection reference measurement, you are prompted to set up the Optical Test Head for this measurement..



NOTE Please make sure that any optical connectors that you are using are clean before making a connection.

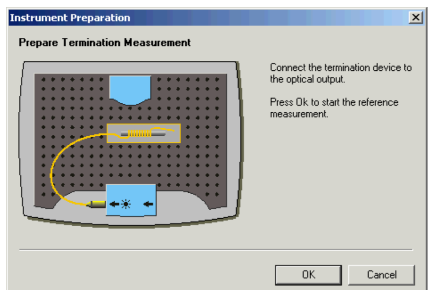
a Connect or splice the Reflectance Reference Device to the output of the Optical Test Head.

b Place the Reflectance Reference Fiber on the optical bench of the Optical Test Head.

c Click on the **OK** button.
The reference reflection measurement runs in one or two cycles, depending on the measurements selected, to calibrate the reflection path for the Loss/PDL measurements and for the GD/DGD measurements.

d If there are other reference measurement tasks to be done, click on the *Start...* button.

8 If you have selected a terminated reflection reference measurement, you are prompted to set up the Optical Test Head for this measurement.



NOTE Please make sure that any optical connectors that you are using are clean before making a connection.

a Connect or splice a fiber to the output of the Optical Test Head.

b Place the termination rod in the optical bench of the Optical Test Head, and wrap a length of the fiber around the rod 5 times. Fix the wrapped fiber (using adhesive tape, or an elastic band). Fix the fiber using the fiber clamps. See “Using the Termination Rod” on page 51 and “Using the Fiber Clamps” on page 49 for more information on making a termination and fixing the fiber.

c Click on the **OK** button.
The reference termination measurement runs.

d If there are other reference measurement tasks to be done, click on the *Start...* button.

9 Disconnect the fiber from the Optical Test Head.

10 Click on the **Finish** button.

Making an Expert Mode Measurement

After you have completed the reference measurement, you can parameterize your devices.

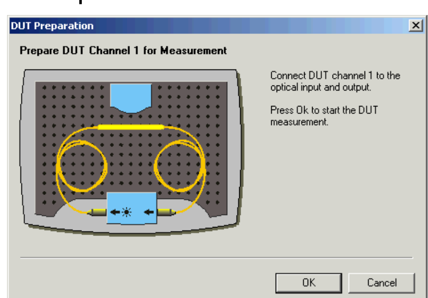
WARNING **Never look directly into the end of a fiber or a connector, unless you are absolutely certain that there is no signal in the fiber.**

NOTE Please make sure that any optical connectors that you are using are clean before making a connection.

11 Click on 
OR
From the **Measurement** menu, select **Start DUT Measurement.**

12 Click on 

in the port-selection menu bar..



13 Connect or splice the DUT from the input to the output of the Optical Test Head.
Fix the DUT on the optical bench of the Optical Test Head, and fix the input and output fibers, using the fiber clamps. See “Using the DUT Holder” on page 52 and “Using the Fiber Clamps” on page 49 for more information on fixing the DUT and the fibers.

The measurement runs, showing the measurement status as it progresses.
When the measurement finishes, the results are shown.

14 If you want to measure the transmission characteristic of another output of a multiport device, click on , and repeat step 12 to step 13.

If you want to abort the measurement of a port, click on 

. This will affect only the port that is currently being measured.

15 When you have finished measuring all the ports of your device, click on 

.

To measure further devices, click on , and repeat step 12 to step 15.

Making a Real-time Measurement in All Parameter Mode

After you have completed the reference measurement, you can parameterize your devices.

WARNING **Never look directly into the end of a fiber or a connector, unless you are absolutely certain that there is no signal in the fiber.**

NOTE Please make sure that any optical connectors that you are using are clean before making a connection.

NOTE You can only make measurements with realtime support if all-parameter mode has been selected as part of the setup of the new measurement.

16 Connect or splice the DUT from the input to the output of the Optical Test Head.
Fix the DUT on the optical bench of the Optical Test Head, and fix the input and output fibers, using the fiber clamps. See “Using the DUT Holder” on page 52 and “Using the Fiber Clamps” on page 49 for more information on fixing the DUT and the fibers.

17 Click on 
OR
From the **Measurement** menu, select **Start Realtime Measurement**.

The measurement runs.
As each measurement finishes, the results are shown. The results are updated once a second.

18 If you want to pause the measurement, click on 
OR
From the **Measurement** menu, select **Pause Realtime Measurement**.

To restart the measurement, click on 
OR
From the **Measurement** menu, select **Start Realtime Measurement**.

19 When you have finished measuring, click on 
OR
From the **Measurement** menu, select **Stop Realtime Measurement**.

3
The Photonic Analysis Toolbox Reference

This chapter provides reference information on the menus, toolbars and other functions of the Photonic Analysis Toolbox application.

The chapter starts with a description of each menu and all its items. This is followed by a description of the context menus that are available.
The chapter finishes with a description of the icons used by the software.

The File Menu

Open Opens a file browser window to select and load a measurement result and any analysis data that is available from a file (*.omr).

The same function is available

- on “The Standard Toolbar” using , or
- from the keyboard by holding down the CTRL key and pressing the “O” key (CTRL+O).

Save All Saves all the opened measurements to files (*.omr).
The measurements are saved with their current name, as shown in the Measurement View tab of the Workspace window. See “The View Menu” on page 95 for information on how to view the Workspace window.

The same function is available

- on “The Standard Toolbar” using .

Close All

NOTE Make sure you have saved any new measurements, or measurements for which you have changed the analysis parameters before you close all the measurements.

All the opened measurements are removed from memory.

Save Active Measurement Saves the active measurement to a file (*.omr).
The measurements is saved with its current name, as shown in the Measurement View tab of the Workspace window.

The same function is available

- on “The Standard Toolbar” using , or
- from the keyboard by holding down the CTRL key and pressing the “S” key (CTRL+S).

To save the active measurement or any of the non-active measurements that are open, use **Save** in “The Measurement View Context Menu” .

Save Active Measurement As...

Saves the active measurement to a file (*.omr) with a name you specify.

1 Enter the name for the file and click on the **Save** button.

The measurement is saved.

To save the active measurement or any of the non-active measurements that are open to a different file, in the Measurement View tab of the Workspace use **Save As** in “The Measurement View Context Menu” .

Close Active Measurement

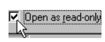
The active measurement is removed from memory.

To close the active measurement or any of the non-active measurements that are open, use **Close** in “The Measurement View Context Menu” .

Open Measurement Setup

Opens a file browser window to select and load a measurement setup from file (*.omr).

If you want to protect the measurement setup from alteration, check the “Open as read-only” box at the bottom of the file browser window.



You will be able to alter the measurement setup, but you will not be able to overwrite the original file.
You can save the altered measurement setup to a different file using “Save Measurement Setup As...” in the **File** menu.

Save Measurement Setup

Saves the current measurement setup to a file (*.omr).
The measurements is saved with its current name, as shown in the Setup View tab of the Workspace window. See “The View Menu” on page 95 for information on how to view the Workspace window.

Save Measurement Setup As...

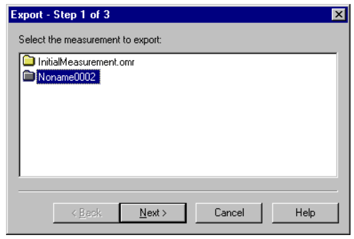
Opens a file browser window to name the file (*.omr) to which the current measurement setup is to be saved.

Enter the name for the file and click on the **Save** button.

The current measurement setup is saved.

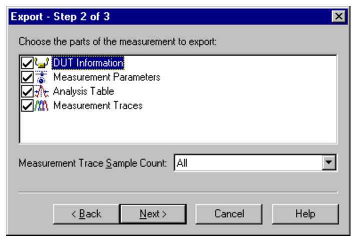
ASCII Export... Opens a measurement selection window to select the measurement for which the results are to be exported.

1 Click on the measurement for which you want to export results.



2 Click on the **Next** button.

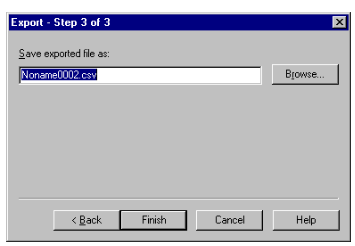
3 Make sure the only boxes checked are beside the parts of the measurement you want to export.



4 Select the number of samples you want to export for each curve.
If you select “All”, all of the samples used to draw the measurement curve will be exported.
If you select a number, that number of equally spaced samples will be exported. This makes it easier for you to compare curves, to generate consistent curves in an external application, or to reduce the quantity of data for post-processing by other applications.

5 Click on the **Next** button.

6 Enter the name for the file and click on the **Finish** button.



The selected results are exported to an ASCII text file using comma (,) separated values (.csv).

The format of the .csv file is described in “Exporting Trace Data” on page 207.

ASCII Export Mueller Matrix... Opens a file browser window to name the file (*.txt) to which the Mueller matrix from the current measurement setup is to be saved.

Enter the name for the file and click on the **Save** button.

The format of the .csv file is described in “Exporting the Mueller Matrix” on page 211.

ASCII Export Jones Matrix... Opens a file browser window to name the file (*.txt) to which the Jones matrix from the current measurement setup is to be saved.

Enter the name for the file and click on the **Save** button.

The format of the .csv file is described in “Exporting the Jones Matrix” on page 210.

Print Prints the measurement and analysis setup, any graphs which contain one or more curves (including such graphs that are currently minimized on the screen) and the tables for the active measurement result or analysis.

In the Print window, select the printer you want to use, and press the **OK** button.

The same function is available

- on “The Standard Toolbar” using, or
- from the keyboard by holding down the CTRL key and pressing the “P” key (CTRL+P).

Print Setup Configures the printer to be used for printing measurement results and analyses, and graphs.

Print Preview Shows a preview of the printout of the active measurement results or analysis.

The same function is available

- on “The Standard Toolbar” using .

Exit Ends the Photonic Analysis Toolbox application.

The Instruments Menu

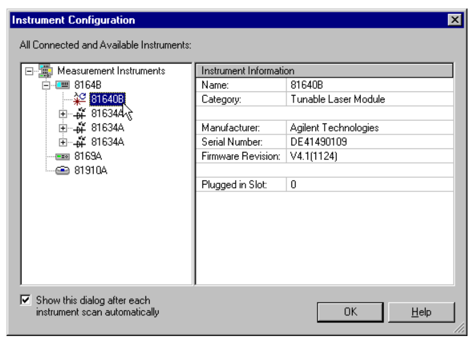
Scan for Instruments

NOTE

If you scan the GPIB, or change the hardware selection, the current measurement setup is discarded. You will need to create a new measurement, including the setting of the measurement parameters, and the making of a reference measurement, before you can make further measurements.

Scans the GPIB and the network bus for available measurement instruments.

The Photonic Analysis Toolbox scans the GPIB and the network on startup. If you add or remove an instrument, use Scan for Instruments to update the list of instruments.

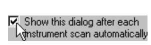


If the list of instruments is not shown automatically after the scan has completed, use **Show Instruments...** in the **Instruments** menu.

To show the list of instruments automatically after each scan,

1 In the **Instruments** menu, select **Show Instruments...**.

2 Click on the box beside “Show this dialog after each instrument scan automatically” until it is checked.

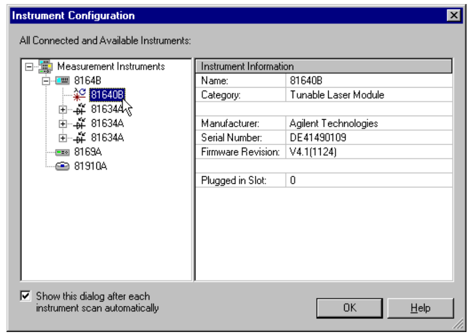


The same function is available

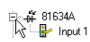
- in “The Instrument Toolbar” , select .

Show Instruments... Lists the measurement instruments recognized by the Photonic Analysis Toolbox.

- Click on an instrument to see its details.



- Click on beside an instrument or module to see its modules or connections.



Use **Scan for Instruments** in the **Instruments** menu option to scan the bus again and update the list.

The same function is available

- in “The Instrument Toolbar” , select .

Zero All Power Sensors

NOTE

Make sure the three patchcords in the tubing from the back of the Optical Test Head are connected to the inputs of the power sensors before you zero them.

Zeros the three power sensors in the Lightwave Measurement System.

You may want to zero the power meters manually before making a reference measurement, if you load existing reference data from a file, or to ensure the best possible performance.

The same function is available

- in “The Instrument Toolbar” , select .

The Measurement Menu

The measurement menu provides access to the control for setting up and performing measurements.

The Measurement Setup Submenu

New This starts a new measurement, including setting up the hardware, measurement parameters, making a reference, and measuring a device, as described in "Making a First Measurement" on page 56.

The same function is available

- on "The Measurement Toolbar" using , or
- from the keyboard by holding down the CTRL key and pressing the "N" key (CTRL+N).

Edit Parameters...

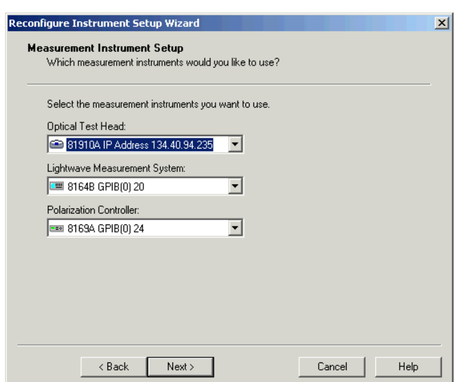
NOTE If you change the measurement parameters, you may have to make a reference measurement before you can make further measurements.

Allows examination and individual adjustment of the measurement parameters that will be used for the next measurement.

The same function is available

- on "The Measurement Toolbar" using , or
- by double clicking on the Measurement Parameters element of the current measurement in the Setup View tab of the Workspace window. See "The View Menu" on page 95 for information on how to view the Workspace window.

Reconfigure Instrument Setup... Select the hardware to be used for the measurement from the pull-down menus.

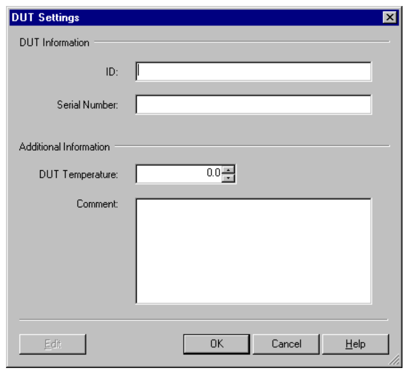


The same function is available

- on “The Measurement Toolbar” using .

After you have selected the hardware, you will automatically be required to check or change the measurement parameters.
Click on the **Next >** button.

DUT Information Provides a boilerplate for you to add information about the device under test (DUT).
Click on the **Edit** button to change the information.



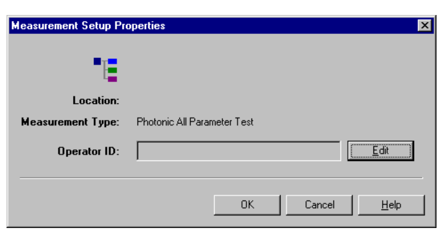
This includes

ID	The identification of the DUT
Serial Number	The serial number of the DUT
DUT Temperature	The temperature of the DUT during the measurement. This is used for documentation purposes only. It is not used in any calculations. The temperature range at which the Photonic All-Parameter Analyzer meets its specifications is given in “Performance Specifications” on page 216
Comment	Space to add comments on the DUT and the measurement.

The same function is available

- on “The Measurement Toolbar” using

Properties... Shows the measurement information.



If you want to change the operator ID, click on the **Edit** button.

Other Items in the Measurement Menu

Set as Active Measurement

Click on the measurement from the submenu that you want to set as the active measurement.

The same function is available

- using **Set as Active Measurement** in “The Measurement View Context Menu” .
- using **Set as Active Measurement** in “The Curve View Context Menu” .

Create Setup from Active Measurement

NOTE If you change the measurement parameters, you may have to make a reference measurement before you can make further measurements.

Use the measurement setup from the current active measurement for following measurements.

The same function is available

- using **Create Setup from Measurement** in **Ò The Measurement View Context Menu Ó** .

Start Reference

Starts the reference measurement.

The same function is available

- on “The Measurement Toolbar” using , or
- from the keyboard by holding down the SHIFT key and pressing the “F5” key (SHIFT+F5).

Start DUT Measurement

Starts the measurement.

The same function is available

- on “The Measurement Toolbar” using , or
- from the keyboard by pressing the “F5” key.

On completion, the results are displayed in the Graph window, in the Analysis Table window and the measurement is added to the Measurement View in the Workspace window.

The completed measurement becomes the current active measurement.

Until saved, results have the default filename Noname001, Noname002, and so on.

Start Realtime Measurement

Starts a measurement with fast update rate[a] for checking device connections and measurement parameters, or as a prelude to measuring dispersion properties for devices such as Dispersion Compensating Gratings.

NOTE

The results of the realtime measurement are only intended for verification or making adjustments.
The results are derived from a single sweep and do not provide as high an accuracy as the normal DUT measurement (as specified in "System Specifications" on page 215).

The same function is available

- on "The Measurement Toolbar" using , or
- from the keyboard by pressing the "F7" key.

The results are displayed in the Graph window and the measurement is added as the Current Measurement to the Measurement View in the Workspace window.

Pause Realtime Measurement

Pauses a realtime measurement.

The same function is available

- on "The Measurement Toolbar" using , or
- from the keyboard by pressing the "PAUSE" key.

Restart the measurement by selecting Start Realtime Measurement.

Stop Realtime Measurement

Stops a realtime measurement, and clears the realtime traces.

The same function is available

- on "The Measurement Toolbar" using , or
- from the keyboard by pressing the "Ctrl-F7" key.

[a] The update rate of the realitme measurement depends on the sweep range, but is typically 1Hz for a filter-type device.

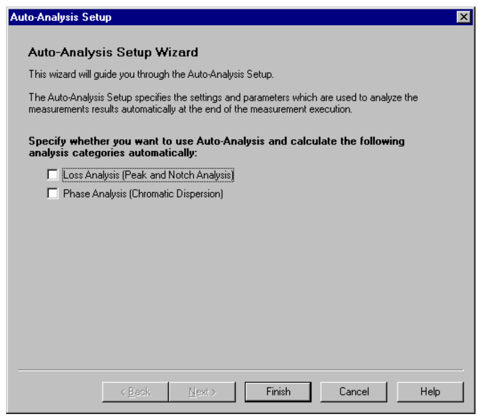
The Analysis Menu

Auto-Analysis Setup...

Sets the automatic analysis of results after they have been measured.

The results of the peak and notch analyses are shown in the Analysis Table window. The Chromatic Dispersion is shown in its own graph window.

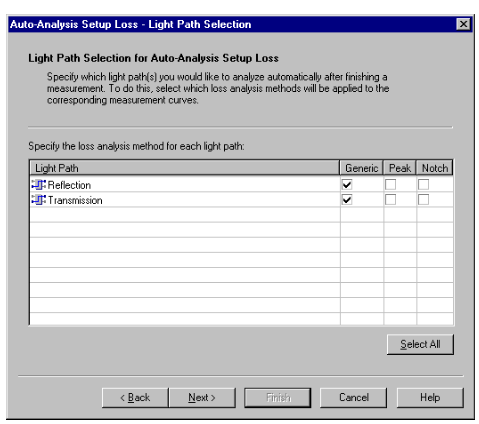
NOTE The parameters for chromatic dispersion must be configured here if you want to view chromatic dispersion using a real-time measurement.



The same function is available

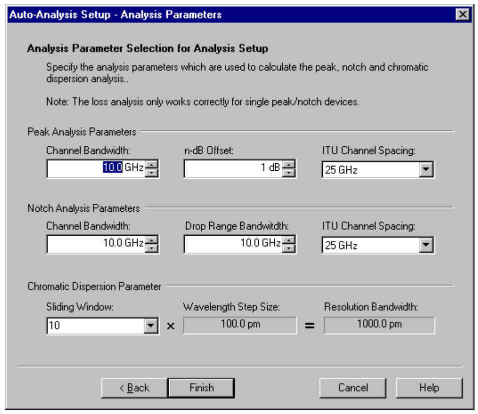
- on "The Measurement Toolbar" using .

1 Click on the boxes to set a check mark beside Loss Analysis or Phase Analysis, depending on which auto-analysis you want to perform. Click on the **Next >** button.



2 If you selected loss analysis.

a Click on the boxes to set a check mark in the row and column corresponding to the loss analyses you want to perform (generic, peak and notch analyses, in the transmission and reflection paths). Click on the **Next >** button.



b If you selected peak analysis, enter the values for the Channel Bandwidth, NdB Offset, and the ITU Channel Spacing.
For more information on these parameters and what effect they have, see “Reanalyzing the Generic, Peak and Notch Loss” on page 196.

c If you selected notch analysis, enter the values for the Channel Bandwidth, Drop Range Bandwidth, and the ITU Channel Spacing.
For more information on these parameters and what effect they have, see “Reanalyzing the Generic, Peak and Notch Loss” on page 196.

3 If you selected phase analysis, set the Resolution Bandwidth of the Chromatic Dispersion analysis by entering the number of adjacent samples used in the sliding window for the calculation.
The sliding window is centered on the current wavelength.
The resolution bandwidth is the product of the number of samples and the step size used for the wavelength sweep of the original measurement.

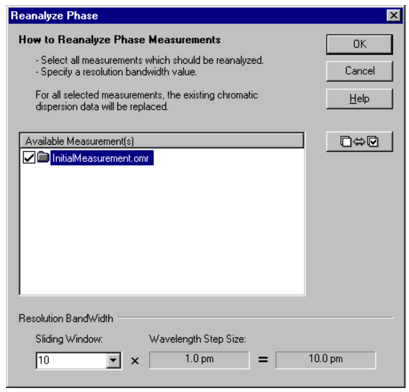
4 Click on the **Finish** button.

Reanalyze Phase... Replaces the existing or nonexisting Chromatic Dispersion analysis for the selected measurements with an analysis based on the new value for the resolution bandwidth.

The chromatic dispersion is shown as a graph for the available light paths for the measurement. See “The Transmission Graph Submenu” on page 92 and “The Reflection Graph Submenu” on page 93 for details on how to display the chromatic dispersion graph.

To reanalyze the chromatic dispersion for the active measurement, use **Reanalyze Phase** in “The Measurement View Context Menu” .

1 Click on the boxes to set a check mark beside the measurements you want to reanalyze.



2 Set the Resolution Bandwidth of the Chromatic Dispersion analysis by entering the number of adjacent samples used in the sliding window for the calculation.
The sliding window is centered on the current wavelength.
The resolution bandwidth is the product of the number of samples and the step size used for the wavelength sweep of the original measurement.

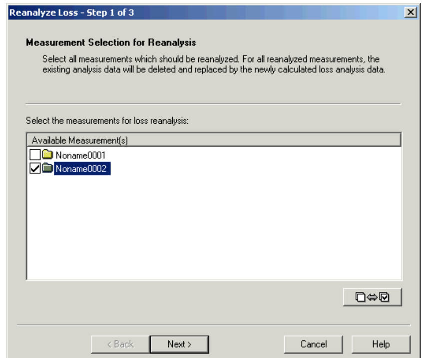
3 Click on the **OK** button.

Reanalyze Loss... Replaces existing or nonexisting peak or notch loss analyses for the selected measurements with analyses based on the new values for the analysis parameters.

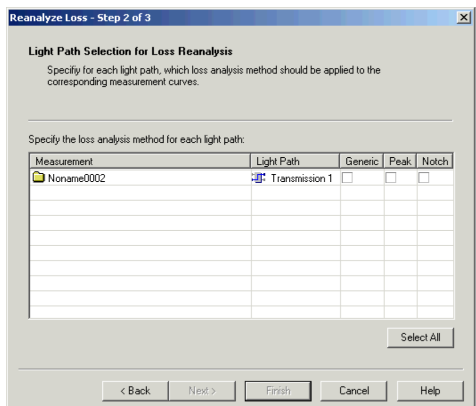
The loss analyses are shown in the Analysis Table window. See “The View Menu” on page 95 for details on how to display the Analysis Table window.

To reanalyze the peak or notch, use **Reanalyze Loss** in "The Measurement View Context Menu" .

1 Click on the boxes to set a check mark beside the measurements you want to reanalyze.

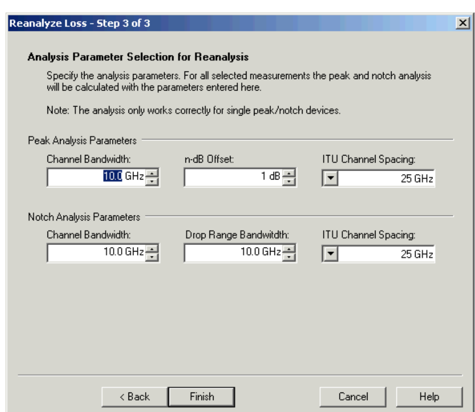


2 Click on the boxes to set a check mark beside the measurements you want to reanalyze.



Click on the **Next >** button.

3 If you selected peak analyses, enter the values for the Channel Bandwidth, NdB Offset, and the ITU Channel Spacing.



For more information on these parameters and what effect they have, see “Reanalyzing the Generic, Peak and Notch Loss” on page 196.

4 If you selected notch analyses, enter the values for the Channel Bandwidth, Drop Range Bandwidth, and the ITU Channel Spacing. For more information on these parameters and what effect they have, see “Reanalyzing the Generic, Peak and Notch Loss” on page 196.

5 Click on the **Finish** button.

Compare Loss Analysis with Active Measurement...

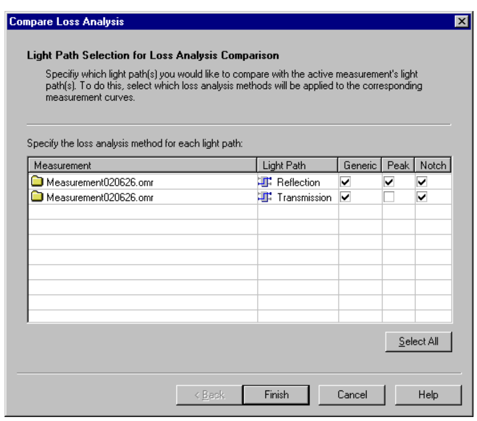
Temporarily reanalyzes the generic, peak and notch loss analyses for the selected measurements with analyses based on the analysis parameters of the active measurement, and adds the resulting analyses to the analysis tables.

The analyses and analysis parameters for the selected measurements are not altered in the file or the measurement. If you change the active measurement, the analyses for the comparison are deleted.
To change the analyses for a measurement, “Reanalyze Loss...” on page 89.

The loss analyses of the active measurement and the measurements selected for comparison are shown in the Analysis Table window.
See “The View Menu” on page 95 for details on how to display the Analysis Table window.

To compare the loss analyses for any individual non-active measurement that is open with the active measurement, use **Compare Loss Analysis with Active Measurement** in the “The Measurement View Context Menu”
.

1 Click on the boxes to set a check mark beside in the row and column corresponding to the loss analyses you want to compare with the active measurement (generic, peak and notch analyses, in the transmission and reflection paths).



2 Click on the **Finish** button.

The Graph Menu

The graph menu lets you select which graphs are displayed, and control of the universal display possibilities

The Transmission Graph Submenu

There are five transmission graph windows:

- Loss (Loss)
- Polarization Dependent Loss (PDL)
- Group Delay (GD)
- Differential Group Delay (DGD)
- Chromatic Dispersion (CD)

In each case the graph window displays the selected curves of the measurement results over wavelength (nm).

Select **Loss**, **PDL**, **GD**, **DGD,** or **CD** in the Transmission Graph submenu to activate any individual graph window or combination of these graph windows.

You can select which curves are selected in the Curve View tab of the Workspace window. See “The View Menu” on page 95 for information on how to view the Workspace window.

Bring to Front Bring any transmission graphs that are active to the front. Any active reflection graphs will be minimized.

The same function is available

- on “The Graph Toolbar” using .

The Reflection Graph Submenu

There are five reflection graphs:

- Loss (Loss)
- Polarization Dependent Loss (PDL)
- Group Delay (GD)
- Differential Group Delay (DGD)
- Chromatic Dispersion (CD)

In each case the graph window displays the selected curves of the measurement results over wavelength (nm).

Select **Loss**, **PDL**, **GD**, **DGD** or **CD** in the Reflection Graph submenu to activate any individual graph window or combination of these graph windows.

You can select which curves are selected in the Curve View tab of the Workspace window. See “The View Menu” on page 95 for information on how to view the Workspace window.

Bring to Front Bring any reflection graphs that are active to the front. Any active transmission graphs will be minimized.

The same function is available

- on “The Graph Toolbar” using .

Other Items in the Graph Menu

Noise Suppression...

Specifies the Noise Suppression Threshold. Enter the value for the threshold and click on the **OK** button.

The Loss Measurement curve, in the measurement path of the currently active graph, is examined for sections with signal strength less than the threshold.
Any areas below the threshold are removed from the display of the other curves in the measurement path.
The display of the loss curve is not affected.
Graphs which did not use the same measurement parameters as the loss measurement are not affected.

Zoom Out All

Zoom out to view the full curves in all the graph windows.

The same function is available

- on “The Graph Toolbar” using .

Double-click in a graph window to zoom out to view the full curves in that window.

Show Markers

Select this to show or hide all markers in the graph windows.

The same function is available

- on “The Graph Toolbar” using .

Use the graph context menu in a particular graph window to show or hide the markers in that window. See “The Graph Context Menu” on page 107 for more information.

Show Orientation Curves

Select this to show or hide all the orientation curves in the graph windows. If orientation curves are selected, the loss average curve is shown in the background of each curve. This provides a visual reference to help you correlate between different curves of the same measurement.

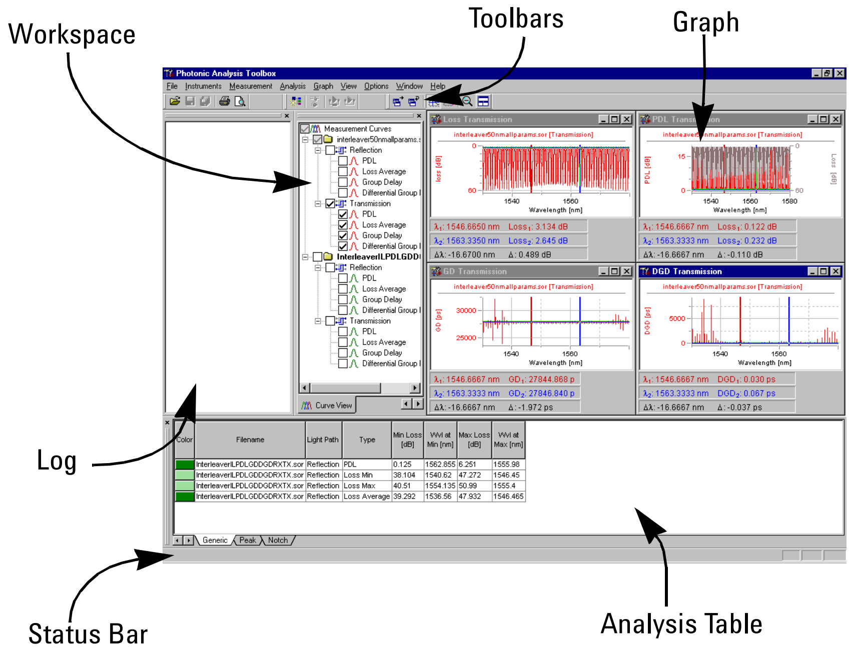
The same function is available

- on “The Graph Toolbar” using .

Use the graph context menu in a particular graph window to show or hide the orientation curves for that window. See “The Graph Context Menu” on page 107 for more information.

The View Menu

The Photonic Analysis Toolkbox's View menu allows you to enable and disable the different on-screen areas of the Photonic Analysis Toolbox.



The layout of the graphs in the Graph window is controlled from the Window menu, see “The Window Menu” on page 104.

The workspace, analysis table and log windows and the toolbars can be “detached” from the Photonic Analysis Toolbox window and placed anywhere on your PCs screen:

1 Double-click on the header or sidebar ( ).

2 Click in the window title bar and drag it to the new position.

To re-attach the Workspace, Log or Analysis Table window, double click in the window title bar.

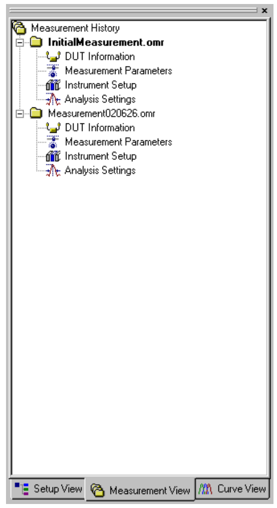
Resizing and closing any window is done according to the normal Windows conventions.

Workspace If Workspace is selected, you can view the setup and history of the measurements made in the current session.

- The Setup View shows the current preparations for measurements: Click on the **Setup View** tab at the bottom of the Workspace window to see it.

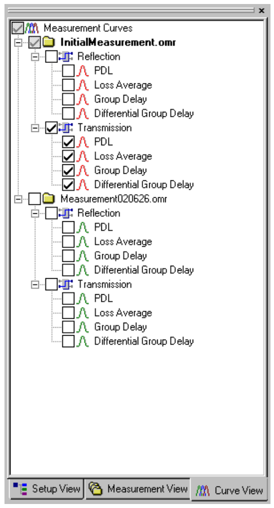
  - Click with the right mouse button on **Current Measurement Setup** to access "The Setup View Root Context Menu" (see page 112).
  - Double-click on **DUT Information** to view or edit the ID, serial number, temperature information or comments for the next DUT to be measured. See "DUT Information" on page 84.
  - Double-click on **Measurement Parameters** to view or edit the parameters for the next measurement. See "Checking or Setting the Measurement Parameters" on page 139.
  - Double-click on **Instrument Setup** to view or reconfigure the instruments in use for the next measurement. See "Show Instruments..." on page 81.
    Click on the Reconfigure button at the bottom left of this box to reconfigure the instruments. See "Reconfigure Instrument Setup..." on page 83.
  - Double-click on **Analysis Settings** to edit the automatic analysis settings applied after the measurement. See "Auto-Analysis Setup..." on page 87.
  - A red X ( ) beside the text **No reference data available**, indicates that the reference data is no longer valid.
    A green check mark ( ) beside the text **All reference data available**, indicates that the current reference data is valid.

- The Measurement View shows all of the measurements currently in memory - Click on the **Measurement View** tab at the bottom of the Workspace window to see it.



- Click with the right mouse button on **Measurement History** to access "The Measurement View Root Context Menu" (see page 113).
- Click on ⊞ to see the DUT, measurement and instrument settings for a measurement.
  Click on ⊟ to hide the DUT, measurement and instrument settings for a measurement.
- Double-click on **DUT Information** to view the ID, serial number, temperature information or comments for the DUT.
- Double-click on **Measurement Parameters** to view the parameters for the measurement.
- Double-click on **Instrument Setup** to view the instruments used for the measurement.
- Double-click on **Analysis Settings** to view the parameters used for the analysis.
- Click with the right mouse button on a measurement name to access "The Measurement View Context Menu" (see page 114).

- The Curve View lists all the available curves of the measurements currently in memory. Click on the **Curve View** tab at the bottom of the Workspace window to see it.



- Click with the right mouse button on **Measurement Curves** to access "The Curve View Root Context Menu" (see page 119).
- Click with the right mouse button on a measurement name to access "The Curve View Context Menu" (see page 119).
- Click on ⊞ beside a measurement name to see which results are available.
  Click on ⊟ beside a measurement name to hide the results that are available for it.
- Click on the check box beside a measurement name to toggle between show (☑) and hide (☐) for all the results for that measurement.
  If the corresponding Graph windows are not already open, they are opened automatically.
- Click on the check box beside a measurement path to toggle between show (☑) and hide (☐) for all the results for that measurement path.
  If the corresponding Graph windows are not already open, they are opened automatically.
- Click on the check box beside a result to toggle between show (☑) and hide (☐) for the result.
  If the corresponding Graph window is not already open, it is opened automatically.
- Double-click on a result to show the curve and open the graph window for this result.

Analysis Table If Analysis Table is selected, the analysis table is shown. Click on the Generic, Peak or Notch tab at the bottom of the Analysis Table window to see each of these three tables for the current measurement results or analysis.

One row of data is displayed per curve.

The first column shows the color of the curve, as used in the analysis Graph window.

The appearance of the cursor changes to indicate its current function:

cursor to select all the values in a column	
cursor to reposition column in the table click on a column to select it, then click and drag the column to its new position	
cursor to resize a column click on the division between column headers and drag to resize the column to the left of the cursor.	
cursor to resize a row click on the division between row headers and drag to resize the row above the cursor.	
cursor to resize a hidden column click on the division between column headers where the hidden column is, and drag to resize the hidden column	

Log If Log is selected, the log window is shown. This window records events and errors. You can set what is recorded in the Log menu, see “The Log Submenu” on page 102.

Standard Toolbar If Standard Toolbar is selected, the file and print icons ( )will be displayed at the top of the Photonic Analysis Toolbox window.

This toolbar is described in “The Standard Toolbar” on page 122.

Instrument Toolbar If Instrument toolbar is selected, the instrument icons ( ) will be displayed at the top of the Photonic Analysis Toolbox window.

This toolbar is described in “The Instrument Toolbar” on page 123.

Measurement Toolbar If Measurement Toolbar is selected, the measurement icons ( ) will be displayed at the top of the Photonic Analysis Toolbox window.

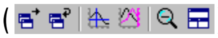
This toolbar is described in “The Measurement Toolbar” on page 125.

Realtime Measurement Toolbar

If Realtime Measurement Toolbar is selected, the realtime measurement icons () will be displayed at the top of the Photonic Analysis Toolbox window.

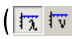
This toolbar is described in “The Realtime Measurement Toolbar” on page 129.

Graph Toolbar

If Graph Toolbar is selected, the graph icons ()will be displayed at the top of the Photonic Analysis Toolbox window.

This toolbar is described in “The Graph Toolbar” on page 130.

X-Axes Dimension Toolbar

If X-Axes Dimension Toolbar is selected, the X-Axes Dimension icons () will be displayed at the top of the Photonic Analysis Toolbox window.

This toolbar is described in “The X-Axes Dimension Toolbar” on page 132.

Statusbar

If Statusbar is selected, status messages and short help texts will be displayed at the bottom of the Photonic Analysis Toolbox window.

The Options Menu

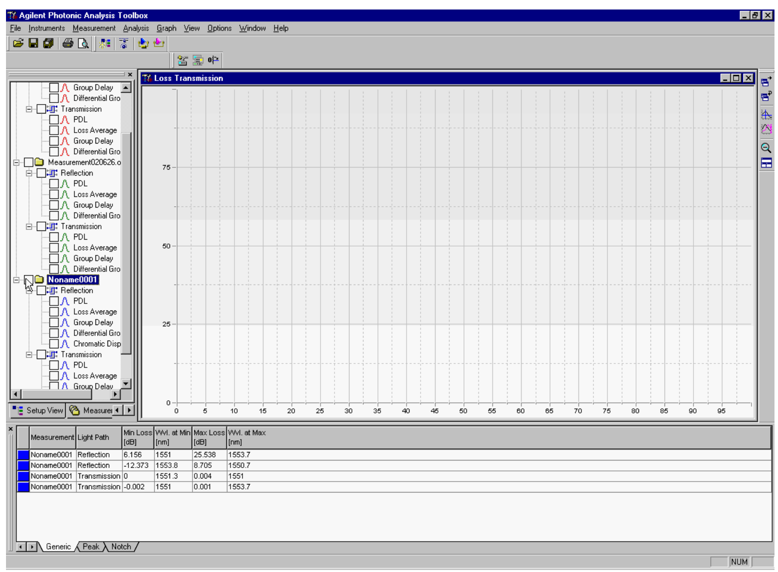
The options menu lets you control the layout of the windows on the screen, and which events are logged.

The Layout Submenu

Select **Layout 1**, **Layout 2** or **Layout 3** from the Layout submenu to select one of these three pre-configured layouts.
Each layout contains settings for the appearance of the Photonic Analysis Toolbox on the screen.

The current appearance is saved to the currently selected layout when you exit the Photonic Analysis Toolbox.

Reset to Default Restores the factory default layout (with the workspace window at the left, the analysis table at the bottom, and the Loss Transmission window open).



The Log Submenu

The Photonic Analysis Toolbox's Log menu allows you to set the severity of events and errors that should be logged in the Log window; and to save, or clear, the current log.

Save... Opens a file browser window to name the file to which the log is to be saved.

Enter the name for the file and click on the **Save** button.

The log is saved.

Clear Clears the current log entries.

Show Latest Entries Automatically scrolls the log window so that the most recent entries are shown.

Event are classed as errors, warnings, or hints.
Only one of the following three levels of logging can be selected:

Log Errors Only Errors are logged. Warnings, and hints are not logged.

Log Errors and Warnings Errors and warnings are logged. Hints are not logged.

Complete Logging Errors, warnings, and hints are logged.

X-Axes Dimension Submenu

Wavelength

- The X-Axes of all graphs are scaled in nm.
- The vertical marker position and the distance between the vertical markers are given nm.
- The position values in the Analysis Table are given in nm.

The same function is available

- on “The X-Axes Dimension Toolbar” using .

Frequency

- The X-Axes of all measurements are scaled in THz.
- The vertical marker position and the distance between the vertical markers are given THz.
- The position values in the Analysis Table are given in THz.

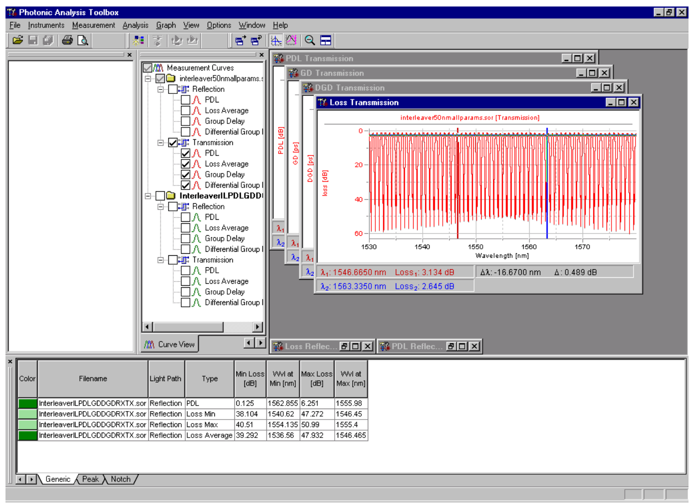
The same function is available

- on “The X-Axes Dimension Toolbar” using .

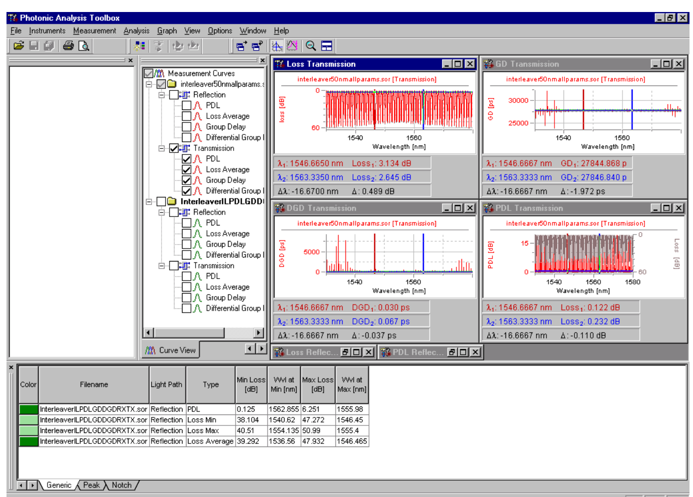
The Window Menu

The Graph windows are opened in the Window menu (see “The Transmission Graph Submenu” on page 92 and “The Reflection Graph Submenu” on page 93).

Cascade Arranges the graph windows one behind the other in the Photonic Analysis Toolbox window:

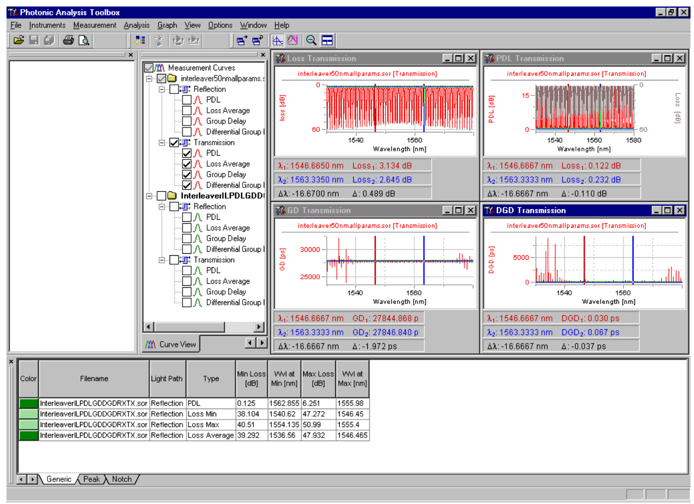


Tile Arranges the graph windows beside one other in the Photonic Analysis Toolbox window:



Arrange Icons Arranges the icons for the minimized graph windows.
This is particularly useful if you have changed the size of the area used by the graph windows, and some of the icons for your minimized graph windows are hidden.

Arrange Window Arranges all the open graph windows to fill the Photonic Analysis Toolbox Graph window.



The same function is available

- on “The Graph Toolbar” using .

Close All Closes all of the graph windows.

The further entries in the Window menu depend on the graph windows that are open.
Select a graph window to highlight it. This can shorten the time it takes to find a particular graph window.

The Help Menu

Contents Displays the contents of the online Help.

About Photonic Analysis Toolbox Displays version information for the Photonic Analysis Toolbox, and version information for the plug and play drivers and the VISA library.

The Graph Context Menu

The appearance of the cursor changes to indicate its current function:

cursor for zooming	
cursor for scrolling the curve left/right	
cursor for scrolling the curve up/down	
cursor for moving a wavelength marker left/right	
cursor for moving the loss, GD or DGD marker up/down (only if the markers are free, as described in “Free” on page 109)	
cursor for positioning the horizontal and vertical markers at the indicated point on the curve. See “The Marker Context Menu” on page 111 for more details.	

Click with the right mouse button on the graph window away from the curve - when you are away from the curve the , , , or cursor is shown.

The Zoom Submenu

Main Curves Zooming operations are based on the main curve. That is zooming affects both amplitude and wavelength.

Orientation Curve Zooming operations are based on the orientation curve. That is zooming only affects the amplitude.

Zoom out Select the zooming.

To zoom in: Click at one corner of the area of interest, drag to the second diagonally opposite corner of the area of interest, then release the mouse button. The curve is displayed in the range defined by the first and second points.

To zoom out: Double-click anywhere on the graph to return to the previous zooming. If you double-click on the graph twice the full curve is shown.

Scrolling a zoomed curve: To view another section of a zoomed curve, click and drag the scale of the X or Y axis.

The Marker Submenu

The λ/ν and Loss/Delay/Dispersion markers can be dragged into position using the mouse. The marker position, and the difference between the marker positions, is displayed at the bottom of the Graph window.

Free To move the markers freely in the graph window. The λ/ν_1, λ/ν_2, $Loss/Delay/Dispersion_1$ and $Loss/Delay/Dispersion_2$ markers move independently.

Locked to Curve Lock the markers to the currently selected curve. The λ/ν_1, and $Loss/Delay/Dispersion_1$ markers are locked together, and the λ/ν_2 and $Loss/Delay/Dispersion_2$ markers are locked together. This means that as you move the λ/ν marker on the curve, the loss marker shows the corresponding loss measurement at that wavelength or frequency.

Locked to Sample Lock the markers to the measurement samples. The λ/ν_1, and $Loss/Delay/Dispersion_1$ markers are locked together, and the λ/ν_2 and $Loss/Delay/Dispersion_2$ markers are locked together. This means that as you move the λ/ν marker from sample to sample, the loss marker shows the corresponding loss measurement at that sample.

Averaging/PMD Window If Averaging/PMD Window is selected, the average loss, display or dispersion for the area between the λ/ν markers is shown at the bottom of the window (the area used for the calculation is highlighted).
In the Differential Group Delay window, the value of PMD for the area between the λ/ν markers is shown at the bottom of the window.

Off Switch off the markers in this graph window.

Other Items in the Graph Context Menu

Loss Orientation Curve If this is selected, the loss orientation curve for this light path will be shown in the graph window, as a common visual element to help you correlate the results in different graphs.

Synchronize X Axis Zooms the X-axis for all open graph windows so that the wavelength range in the window where you select this item, is used for all graph windows that are open.

The zooming in Y-axis is unaffected.

Copy to Clipboard Copy the contents of the graph window to the clipboard, for pasting into other applications.

Print Graph Prints the current graph window.

Print Preview Shows a preview of the printout of the current graph window.

The Marker Context Menu

Click with the right mouse button on the graph window on the curve - when you are on the curve the cursor is shown.

NOTE The markers have to be in Locked to Curve or Locked to sample mode (in the "The Marker Submenu" on page 109) for either of the following items to work.

Lock Marker AC Positions the λ/ν_1, and Loss/Delay/Dispersion$_1$ marker at the point where you clicked.

Lock Marker BD Positions the λ/ν_2, and Loss/Delay/Dispersion$_2$ marker at the point where you clicked.

Apply Averaging/PMD Window If the Averaging/PMD Window is enabled (see "Averaging/PMD Window" on page 109), and more than one curve is currently open in the graph window, select **Apply Averaging/PMD Window** to display the average or PMD value for the selected curve.

The Setup View Root Context Menu

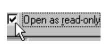
New... This starts a new measurement, including setting up the hardware, measurement parameters, making a reference, and measuring a device, as described in “Making a First Measurement” on page 56.

The same function is available

- in the **Measurement** menu, in the **Measurement Setup** menu, using **New...**.
- on “The Measurement Toolbar” using , or
- from the keyboard by holding down the CTRL key and pressing the “N” key (CTRL+N).

Open... Opens a file browser window to select and load a measurement setup from file (*.omr).

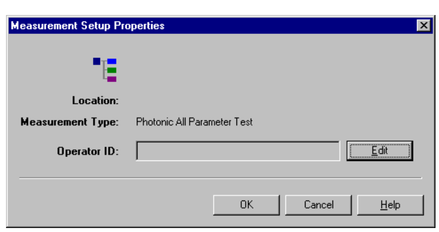
If you want to protect the measurement setup from alteration, check the “Open as read-only” box at the bottom of the file browser window.



You will be able to alter the measurement setup, but you will not be able to overwrite the original file.
You can save the altered measurement setup to a different file using “Save Measurement Setup As...” in the **File** menu.

Save Saves the current measurement setup to a file (*.omr).
The measurements is saved with its current name, as shown in the Setup View tab of the Workspace window.

Properties Shows the measurement information.



If you want to change the operator identification for the following measurements, click on the **Edit** button.

The Measurement View Root Context Menu

Click with the right mouse button on **Measurement History** in the Measurement View tab of the Workspace window to open the **Measurement View Root** context menu. See “The View Menu” on page 95 for information on how to view the Workspace window.

Open... Opens a file browser window to select and load a measurement result and any analysis data that is available from file (*.omr).

The same function is available

- from the **File** menu, **Open...** item
- on “The Standard Toolbar” using , or
- from the keyboard by holding down the CTRL key and pressing the “O” key (CTRL+O).

Close All

NOTE Make sure you have saved any new measurements, or measurements for which you have changed the analysis parameters before you close all the measurements.

All the opened measurements are removed from memory.

The Measurement View Context Menu

Click with the right mouse button on a measurement name in the Measurement View tab of the Workspace window to open the **Measurement View** context menu. See “The View Menu” on page 95 for information on how to view the Workspace window.

Show Analysis and Measurement Data

Opens all the graphs and analysis tables for the measurement.

This menu item is only available for the active measurement.

Set as Active Measurement

Sets the measurement you have just clicked on as the active measurement.

This menu item is only available for non-active measurements.

The same function is available

- in the Measurement menu, select **Set as Active Measurement**.
- in the Curve View tab of the Workspace window by using **Set as Active Measurement** in “The Curve View Context Menu” .

Create Setup from Measurement

NOTE If you change the measurement parameters, you may have to make a reference measurement before you can make further measurements.

Use the measurement setup from the measurement you have just clicked on for following measurements.

The same function is available for the active measurement

- in the **Measurement** menu, select **Create Setup from Active Measurement**.

Close

The measurement you just clicked on is removed from memory.

To close the active measurement, in the **File** menu, select **Close Active Measurement**.

To close all the currently open measurements, in the **File** menu, select **Close All**.

Save Saves the measurement you just clicked on to a file (*.omr).
The measurements is saved with its current name.

The same function is available for the active measurement

- on “The Standard Toolbar” using , or
- from the keyboard by holding down the CTRL key and pressing the “S” key (CTRL+S).
- in the **File** menu, select **Save Active Measurement**.

The same function is available for all the currently open measurement

- in the **File** menu, select **Save All**.

Save As... Saves the measurement you just clicked on to a file (*.omr) with a name you specify.

1 Enter the name for the file and click on the **Save** button.

The measurement is saved.

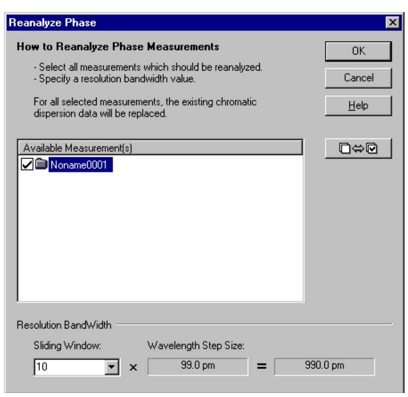
The same function is available for the active measurement

- in the **File** menu, select **Save Active Measurement As...**.

Reanalyze Phase... Replaces the existing or nonexisting Chromatic Dispersion analysis for the measurement you just clicked on with an analysis based on the new value for the resolution bandwidth.

The chromatic dispersion is shown as a graph for the available light paths for the measurement. See “The Transmission Graph Submenu” on page 92 and “The Reflection Graph Submenu” on page 93 for details on how to display the chromatic dispersion graph.

1 Set the Resolution Bandwidth of the Chromatic Dispersion analysis by entering the number of adjacent samples used in the sliding window for the calculation.
The sliding window is centered on the current wavelength.
The resolution bandwidth is the product of the number of samples and the step size used for the wavelength sweep of the original measurement.



2 Click on the **OK** button.

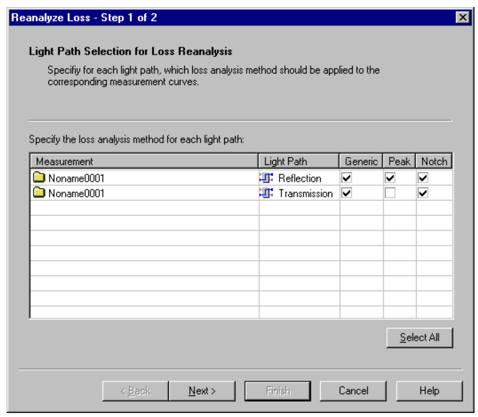
The same function is available for the one or more measurements

- in the **Analysis** menu, select **Reanalyze Phase...**.

Reanalyze Loss... Replaces existing or nonexisting peak or notch loss analyses for the measurement you just clicked on with analyses based on the new values for the analysis parameters.

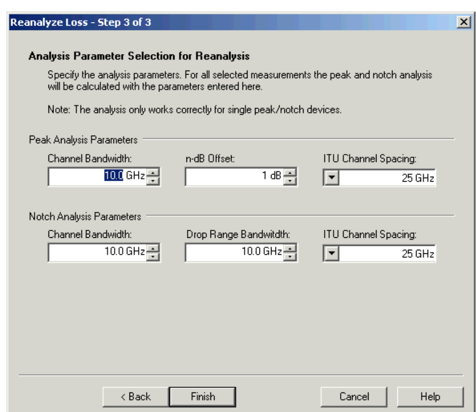
The loss analyses are shown in the Analysis Table window. See “The View Menu” on page 95 for details on how to display the Analysis Table window.

1 Click on the boxes to set a check mark in the row and column corresponding to the loss analyses you want to perform (generic, peak and notch analyses, in the transmission and reflection paths).



Click on the **Next >** button.

2 If you selected peak analyses, enter the values for the Channel Bandwidth, NdB Offset, and the ITU Channel Spacing.



For more information on these parameters and what effect they have, see “Reanalyzing the Generic, Peak and Notch Loss” on page 196.

3 If you selected notch analyses, enter the values for the Channel Bandwidth, Drop Range Bandwidth, and the ITU Channel Spacing. For more information on these parameters and what effect they have, see “Reanalyzing the Generic, Peak and Notch Loss” on page 196.

4 Click on the **Finish** button.

The same function is available for the one or more measurements

- in the **Analysis** menu, select **Reanalyze Loss...**.

Compare Loss Analysis with Active Measurement...

Temporarily replaces the existing generic, peak and notch loss analyses for the measurement you just clicked on with analyses based on the analysis parameters of the active measurement.

This menu item is only available for non-active measurements.

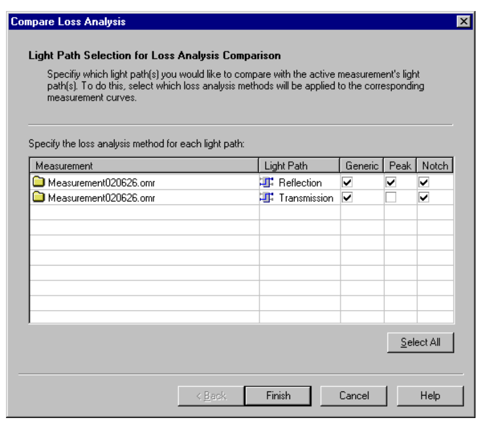
The analysis and analysis parameters for the measurement are not altered in the file or the measurement. If you change the active measurement, the analyses for the comparison are deleted.
To change the analyses for a measurement, use **Reanalyze Phase...** and **Reanalyze Loss...**.

The loss analyses of the active measurement and the measurements selected for comparison are shown in the Analysis Table window.
See “The View Menu” on page 95 for details on how to display the Analysis Table window.

To compare the loss analyses for a number of measurements

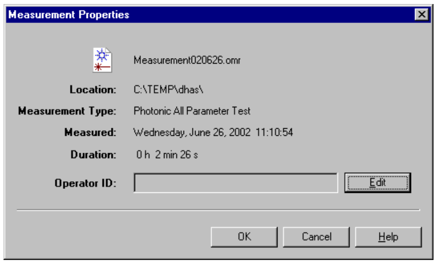
- in the **Measurement** menu, select **Compare Loss Analysis with Active Measurement...**.

1 Click on the boxes to set a check mark beside in the row and column corresponding to the loss analyses you want to compare with the active measurement (generic, peak and notch analyses, in the transmission and reflection paths).



2 Click on the **Finish** button.

Properties Shows information about the file, measurement, and the operator.



The Curve View Root Context Menu

Click with the right mouse button on **Measurement Curves** in the Curve View tab of the Workspace window to open the **Curve View Root** context menu.

Show Min/Max Loss Curves Select this to make the Loss Min and Loss Max curves available for display, in addition to the Loss Average curve which is normally displayed.

Show PDL Calculation Curves Select this to make the Loss: Linear Horizontal, Loss: Linear +45°, Loss: Linear -45°, and Loss: Right Circular available for display.

The Linear Horizontal, Linear +45, Linear -45 and Right Circular are the measured curves. The Min, Max, Average and PDL curves are calculated from them.

The Curve View Context Menu

Click with the right mouse button on a measurement name in the Curve View tab of the Workspace window to open the **Curve View** context menu.

Set as Active Measurement

Sets the measurement you have just clicked on as the active measurement.

This menu item is only available for non-active measurements.

The same function is available

- in the Measurement menu, select **Set as Active Measurement**.
- using **Set as Active Measurement** in "The Measurement View Context Menu" .

The Curve View Result Context Menu

Click with the right mouse button on a result in the Curve View tab of the Workspace window to open the **Curve View Result** context menu.

Activate Selects the curve and opens the corresponding graph window.

The Standard Toolbar

Opens a file browser window to select and load a measurement result and any analysis data that is available from a file (*.omr).

The same function is available

- in the **File** menu, select **Open**.
- from the keyboard by holding down the CTRL key and pressing the “O” key (CTRL+O).

Saves the active measurement to a file (*.omr).
The measurements is saved with its current name, as shown in the Measurement View tab of the Workspace window.

The same function is available

- in the **File** menu, select **Save Active Measurement**.
- from the keyboard by holding down the CTRL key and pressing the “S” key (CTRL+S).

To save the active measurement or any of the non-active measurements that are open, use **Save** in “The Measurement View Context Menu” .

Saves all the opened measurements to files (*.omr).
The measurements are saved with their current name, as shown in the Measurement View tab of the Workspace window. See “The View Menu” on page 95 for information on how to view the Workspace window.

The same function is available

- in the **File** menu, select **Save All**.

Prints the measurement and analysis setup, any graphs which contain one or more curves (including such graphs that are currently minimized on the screen) and the tables for the active measurement result or analysis.

In the Print window, select the printer you want to use, and press the **OK** button.

The same function is available

- in the **File** menu, select **Print**.
- from the keyboard by holding down the CTRL key and pressing the “P” key (CTRL+P).

Shows a preview of the printout of the active measurement results or analysis.

The same function is available

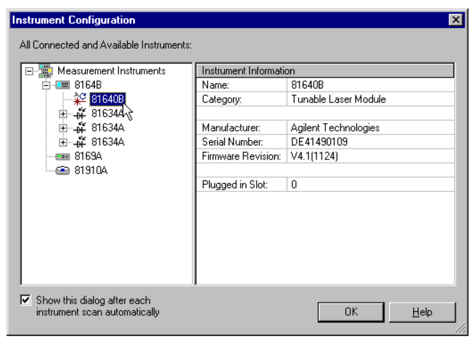
- in the **File** menu, select **Print Preview**.

The Instrument Toolbar

 Scans the GPIB and the network bus for available measurement instruments.

NOTE If you scan the GPIB, or change the hardware selection, it automatically starts a new measurement procedure which has to be completed (including the setting of the measurement parameters, and the making of a reference measurement) before you can make further measurements.

The Photonic Analysis Toolbox scans the GPIB and the network on startup. If you add or remove an instrument, use Scan for Instruments to update the list of instruments.

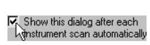


If the list of instruments is not shown automatically after the scan has completed, use .

To show the list of instruments automatically after each scan,

1 In the Instrument toolbar, select .

2 Click on the box beside “Show this dialog after each instrument scan automatically” until it is checked.

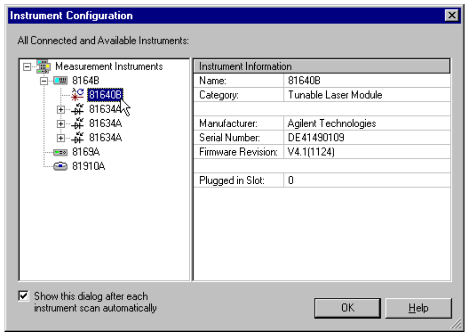


The same function is available

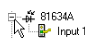
- in the **Instruments** menu, select **Scan for Instruments**.

 Lists the measurement instruments recognized by the Photonic Analysis Toolbox.

- Click on an instrument to see its details.



- Click on [+] beside an instrument or module to see its modules or connections.



Use [scan icon] to scan the bus again and update the list.

The same function is available

- in the **Instruments** menu, select **Show Instruments...**.

Zeros the three power sensors in the Lightwave Measurement System.

NOTE Make sure the three patchcords in the tubing from the back of the Optical Test Head are connected to the inputs of the power sensors before you zero them.

You may want to zero the power meters manually before making a reference measurement, if you load existing reference data from a file, or to ensure the best possible performance.

The same function is available

- in the **Instruments** menu, select **Zero all Power Sensors**.

The Measurement Toolbar

This starts a new measurement, including setting up the hardware, measurement parameters, making a reference, and measuring a device, as described in “Making a First Measurement” on page 56.

The same function is available

- in the **Measurement** menu, in the **Measurement Setup** submenu, select **New**.
- from the keyboard by holding down the CTRL key and pressing the “N” key (CTRL+N).

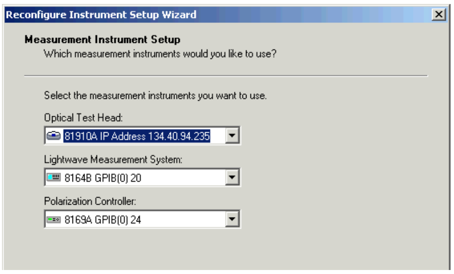
Allows examination and individual adjustment of the measurement parameters that will be used for the next measurement.

NOTE If you change the measurement parameters, you may have to make a reference measurement before you can make further measurements.

The same function is available

- in the **Measurement** menu, in the **Measurement Setup** submenu, select **Edit Parameters...**.
- by double clicking on the Measurement Parameters element of the current measurement in the Setup View tab of the Workspace window. See “The View Menu” on page 95 for information on how to view the Workspace window.

Select the hardware to be used for the measurement from the pull-down menus.

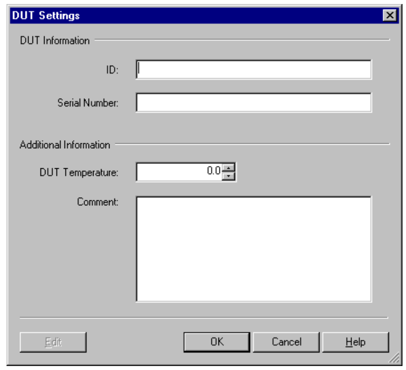


The same function is available

- in the **Measurement** menu, select **Reconfigure Instrument Setup**.

After you have selected the hardware, you will automatically be required to check or change the measurement parameters.
Click on the **Next >** button.

Provides a boilerplate for you to add information about the device under test (DUT).
Click on the **Edit** button to change the information.



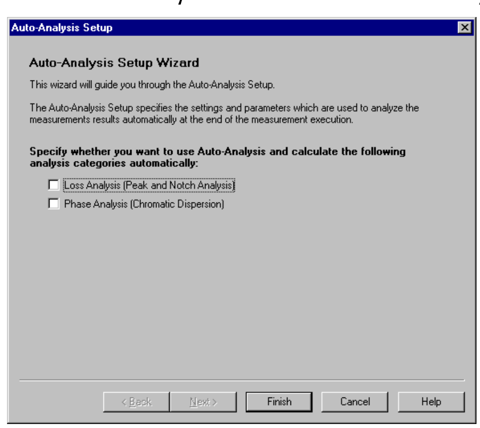
This includes

ID	The identification of the DUT
Serial Number	The serial number of the DUT
DUT Temperature	The temperature of the DUT during the measurement. This is used for documentation purposes only. It is not used in any calculations. The temperature range at which the Photonic All-Parameter Analyzer meets its specifications is given in “Performance Specifications” on page 216
Comment	Space to add comments on the DUT and the measurement.

The same function is available

- in the **Measurement** menu, select **DUT Information**.

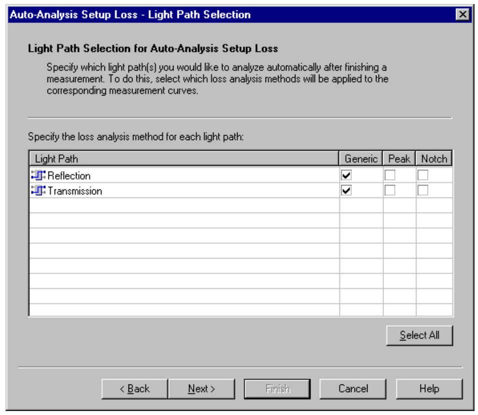
Sets the automatic analysis of results after they have been measured. The results of the analysis are shown in the Analysis Table window.



The same function is available

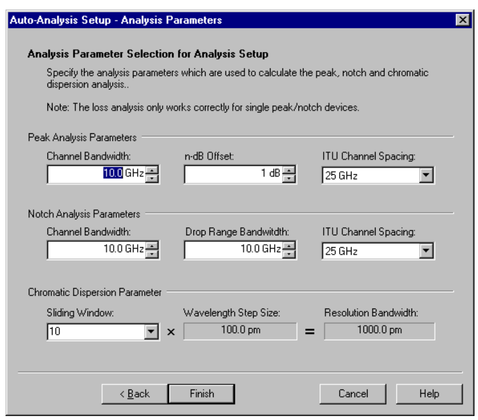
- in the **Analysis** menu, select **Auto-Analysis Setup**.

1 Click on the boxes to set a check mark beside Loss Analysis or Phase Analysis, depending on which auto-analyses you want to perform. Click on the **Next >** button.



2 If you selected loss analyses.

a Click on the boxes to set a check mark in the row and column corresponding to the loss analyses you want to perform (generic, peak and notch analyses, in the transmission and reflection paths). Click on the **Next >** button.



b If you selected peak analyses, enter the values for the Channel Bandwidth, NdB Offset, and the ITU Channel Spacing.
For more information on these parameters and what effect they have, see “Reanalyzing the Generic, Peak and Notch Loss” on page 196.

c If you selected notch analyses, enter the values for the Channel Bandwidth, Drop Range Bandwidth, and the ITU Channel Spacing.
For more information on these parameters and what effect they have, see “Reanalyzing the Generic, Peak and Notch Loss” on page 196.

3 If you selected phase analyses, set the Resolution Bandwidth of the Chromatic Dispersion analysis by entering the number of adjacent samples used in the sliding window for the calculation.
The sliding window is centered on the current wavelength.
The resolution bandwidth is the product of the number of samples and the step size used for the wavelength sweep of the original measurement.

4 Click on the **Finish** button.

Starts the measurement.

The same function is available

- in the **Measurement** menu, select **Start DUT Measurement**.
- from the keyboard by pressing the “F5” key.

On completion, the results are displayed in the Graph window, in the Analysis Table window and the measurement is added to the Measurement View in the Workspace window.

The completed measurement becomes the current active measurement.

Until saved, results have the default filename Noname001, Noname002, and so on.

Starts the reference measurement.

The same function is available

- in the **Measurement** menu, select **Start Reference**.
- from the keyboard by holding down the SHIFT key and pressing the “F5” key (SHIFT+F5).

The Realtime Measurement Toolbar

Starts a measurement with fast[a] update rate for checking device connections and measurement parameters, or as a prelude to measuring dispersion properties for devices such as Dispersion Compensating Gratings.

NOTE The results of the realtime measurement do not provide as high an accuracy as the DUT measurement.

The same function is available

- in the **Measurement** menu, select **Start Realtime Measurement**, or
- from the keyboard by pressing the “F7” key.

The results are displayed in the Graph window and the measurement is added as the Current Measurement to the Measurement View in the Workspace window.

Pauses a realtime measurement.

The same function is available

- in the **Measurement** menu, select **Paise Realtime Measurement**, or
- from the keyboard by pressing the “PAUSE” key.

Restart the measurement by selecting .

Stops a realtime measurement, and clears the realtime traces.

The same function is available

- in the **Measurement** menu, select **Stop Realtime Measurement**, or
- from the keyboard by pressing the “Ctrl-F7” key.

[a] The update rate of the realitme measurement depends on the sweep range, but is typically 1Hz for a filter-type device.

The Graph Toolbar

Bring any transmission graphs that are active to the front. Any active reflection graphs will be minimized.

The same function is available

- in the **Graph** menu, in the **Transmission Graph** submenu, select **Bring to Front**.

Bring any reflection graphs that are active to the front. Any active transmission graphs will be minimized.

The same function is available

- in the **Graph** menu, in the **Reflection Graph** submenu, select **Bring to Front**.

Select this to show or hide all markers in the graph windows.

The same function is available

- in the **Graph** menu, select **Show Markers**.

Use the graph context menu in a particular graph window to show or hide the markers in that window. See “The Graph Context Menu” on page 107 for more information.

Select this to show or hide all the orientation curves in the graph windows. If orientation curves are selected, the loss average curve is shown in the background of each curve. This provides a visual reference to help you correlate between different curves of the same measurement.

The same function is available

- in the **Graph** menu, select **Show Orientation Curves**.

Use the graph context menu in a particular graph window to show or hide the orientation curves for that window. See “The Graph Context Menu” on page 107 for more information.

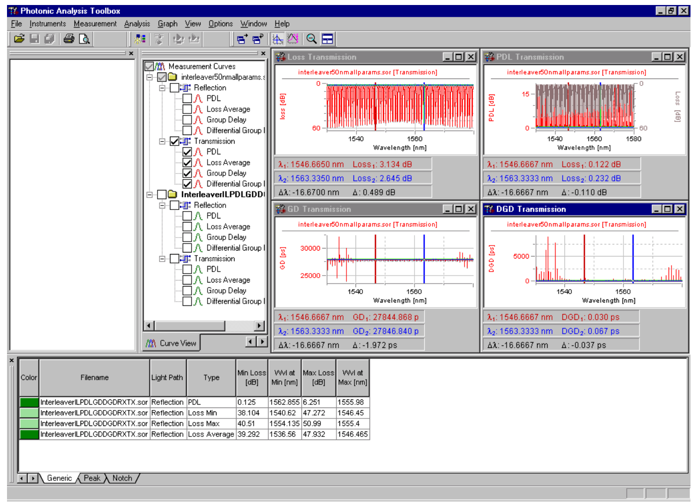
Zoom out to view the full curves in all the graph windows.

The same function is available

- in the **Graph** menu, select **Zoom Out All**.

Double-click in a graph window to zoom out to view the full curves in that window.

 Arranges all the open graph windows to fill the Photonic Analysis Toolbox Graph window.



The same function is available

- in the **Window** menu, select **Arrange Windows**.

The X-Axes Dimension Toolbar

- The X-Axes of all graphs are scaled in nm.
- The vertical marker position and the distance between the vertical markers are given nm.
- The position values in the Analysis Table are given in nm.

The same function is available

- in the **Options** menu, in the **X-Axes Dimension** submenu, select **Wavelength**.

- The X-Axes of all measurements are scaled in THz.
- The vertical marker position and the distance between the vertical markers are given THz.
- The position values in the Analysis Table are given in THz.

The same function is available

- in the **Options** menu, in the **X-Axes Dimension** submenu, select **Frequency**.

4

Making Measurements

This chapter describes how to make measurements.

The chapter starts with selecting hardware and setting the parameters for the measurement and the auto-analysis of results.
This is followed by a description of how to make a reference measurement.
The chapter ends with performing measurements.

Starting a New Measurement

To start the complete new measurement procedure

- Click on .

Or.

- In the **Measurement** menu, in the **Measurement Setup** menu, select **New...**.

If the current measurement setup is new or has been changed since it was opened, you will be asked if you want to save it before you proceed.
Click on **Yes** to save it before you proceed.
Click on **No** to continue without saving the measurement setup.
Click on **Cancel** to abort starting a new measurement.

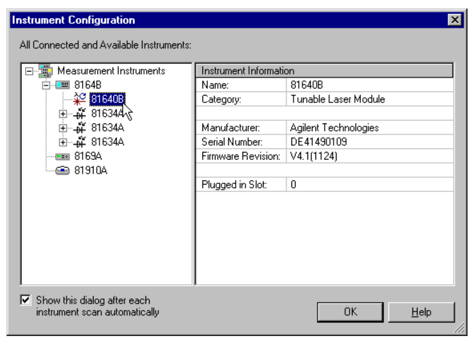
Making a new measurement is described in “Making a First Measurement” on page 56.

Checking or Selecting the Hardware for a Measurement

NOTE If you scan the GPIB, or change the hardware selection, you will need to start a new measurement (including the setting of the measurement parameters, and the making of a reference measurement) before you can make further measurements.

If you do not intend to change the currently selected hardware, you can view it by:

1 In the Instrument toolbar, select ,
OR
in the **Instruments** menu, select **Show Instruments...**,



- Click on an instrument to see its details.
- Click on [+] beside an instrument or module to see its modules or connections.

Identifying Which Hardware is Available

If you have changed some of your hardware while the Photonic Analysis Toolbox has been running, or if you have added hardware, you can scan the instrument bus.

- In the Instrument toolbar, select ,
  OR
  in the **Instruments** menu, select **Scan for Instruments**.

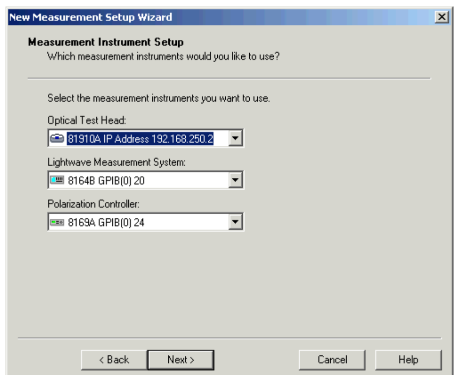
The current measurement setup will be invalid if you scan for instruments. You are asked if you want to save it before you proceed.
Click on **Yes** to save it before you proceed.
Click on **No** to continue without saving the measurement setup.
Click on **Cancel** to abort the scan for instruments.

Selecting Specific Instruments

NOTE If you change the instrument selection, you may have to confirm the measurement parameters and make a reference measurement before you can make further measurements.

If your measurement setup has more than one Optical Test Head, Lightwave Measurement System or Polarization Controller, you can select which is to be used for your measurements by:

1 In the Measurement toolbar, select
OR
In the **Measurement** menu, in the **Measurement Setup** submenu, select **Reconfigure Instrument Setup...**.



2 Select the instruments you want to use from the pull-down menus - the instruments are identified by their IP or GPIB addresses.

3 When you have finished, click on the **Next >** button.

Checking or Setting the Measurement Parameters

Selecting Measurement Parameters for Accuracy and Resolution

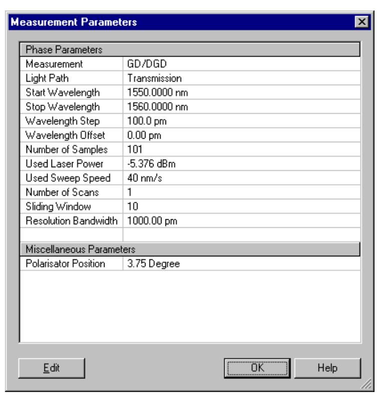
Graphs of uncertainty as a function of the spectral averaging time and the number of averages are given in "Supplementary dispersion measurement characteristicsa" on page 219.

The total time for each measurement cycle is closely related to the product of the spectral averaging time and the number of averages. You can optimize your measurement time by selecting the combination of spectral averaging time and number of averages that minimizes the test time, while producing results that are within the allowable measurement uncertainty for your test device.

Checking the Measurement Parameters

In the Workspace window, in the Setup View tab, double-click on **Measurement Parameters**.

The measurement parameters are shown.



If you want to edit the parameters

1 Click on the **Edit** button.

Setting the Measurement Parameters for All Parameter Mode

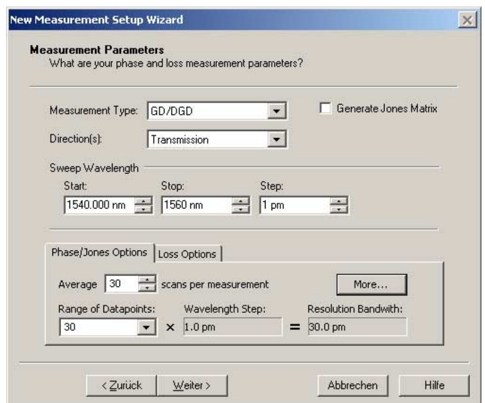
If you are not already editing the measurement parameters,

- Click on .

Or

- In the **Measurement** menu, in the **Measurement Setup** submenu, select **Edit Parameters...**.

If your measurement was initially setup in All Parameter mode, you will see the following window:



Please note that this single window has tabs in the lower half for the Phase and Loss options.
If this window is not shown, you will need to start a New measurement, as described in “Starting a New Measurement” on page 135.

NOTE

You can select DGD measurements even if DGD and PMD measurements are not possible on your All-Parameter Analyzer (option #005). However the DGD measurement will not be carried out, and the PMD analysis is not possible.

1 Select the measurements

Fast GD	To make just a group delay measurement, using a single polarization state. Reference measurements are optional for the Fast GD measurement.
Fast Loss	To make just a loss measurement, using a single polarization state Reference measurements are optional for the Fast Loss measurement..
Fast GD and Fast Loss	To make just a group delay and a loss measurement, using a single polarization state for the Fast GD, and a second single polarization state for the Fast Loss measurement. Reference measurements are optional for the Fast GD and Fast Loss measurements.
GD/DGD	To make both group delay and differential group delay measurements, using two polarization states. Reference measurements are required.
Loss/PDL	To make both loss and polarization dependent loss measurements, using four polarization states. Reference measurements are required.
GD/DGD and Loss/PDL	To make group delay, differential group delay, loss and polarization dependent loss measurements, using two polarization states for the GD/DGD measurement and four polarization states for the Loss/PDL measurement. Reference measurements are required.

2 Select the light path

Transmission	To measure in the transmission path only.
Reflection	To measure in the reflection path only.
Transmission + Reflection	To measure in both transmission and reflection paths.

3 If you are running a GD/DGD measurement, you can also select to generate a Jones Matrix.
The Jones matrix can only be generated during a measurement. It cannot later be generated from existing measurement data. Once generated, the Jones Matrix is saved with your measurement data, increasing the size of a measurement file by approximately 50%.

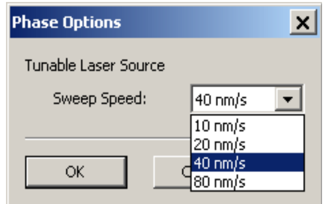
4 Set the start and stop wavelengths, and the step size for the sweep.
The step size of the wavelength sweep limits the possible resolution bandwidth of the results for the group delay and differential group delay, as well as the resolution bandwidth of the chromatic dispersion analysis.
For measurements in All Parameter mode, the maximum step size is 100 pm.
The maximum wavelength span depends on the sweep speed of the tunable laser source. The dependency between span and sweep speed is given in “Dispersion Measurement Specifications” on page 218.

5 Set the measurement parameters for the phase measurements
Click on the Phase Options tab to select this configuration if it is not already shown.

   a Select the number of scans. The measurement result that is displayed is averaged across the selected number of scans. Increasing the number of scans reduces the noise floor, but increases the measurement time.
   Graphs of uncertainty as a function of the spectral averaging time and the number of averages are given in “Supplementary dispersion measurement characteristicsa” on page 219.

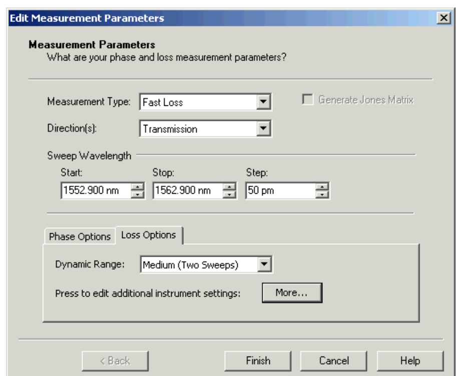
   b Set the Resolution Bandwidth of the group delay and differential group delay results, by entering the size factor of the sliding window for the calculation of the group delay and differential group delay.
   The sliding window is of Gaussian shape, centered on the current wavelength.
   The resolution bandwidth is the 2σ value of the sliding window and is the product of the size factor and the step size for the sweep.
   The resolution bandwidth of the chromatic dispersion analysis is described in “Setting up the Auto-Analysis of Results” on page 152 and “Analyzing Chromatic Dispersion” on page 178.

6 Set the sweep speed of the tunable laser by opening "Options..." and selecting the proper speed in "Phase Options":



The higher the sweep speed the lower is the impact of environmental disturbances. Increasing sweep speed improves phase measurement accuracy. The maximum usable sweep speed depends on the device length to be tested. The dependency between sweep speed and device length is given in “Dispersion Measurement Specifications” on page 218.

7 Set the measurement parameters for the loss and polarization dependent loss measurements



Click on the Loss Options tab to select this configuration if it is not already shown.

a Select the Number of Sweeps to use for the measurement.
Each sweep is performed at a different power sensor range, and the results are stitched together to provide an increased dynamic range. A single sweep provides a dynamic range of 35 dB (typical), two sweeps provides a dynamic range of 50 dB (typical), three sweeps provides the specified dynamic range of over 55 dB in the transmission path and over 45 dB in the reflection path.
Increasing the number of sweeps increases the measurement time.
To set the start of the power sensor range for your measurement, please refer to “Setting the Start Range for the Power Sensor” on page 149.
To set the start of the coherence control for the Tunable Laser Source Module, please refer to “Controlling the Quality of the Laser Signal” on page 149.

Setting the Measurement Parameters in Expert Mode

NOTE

Certain changes will invalidate the current reference data (see "Changing Parameters Without Invalidating Reference Data" on page 148).

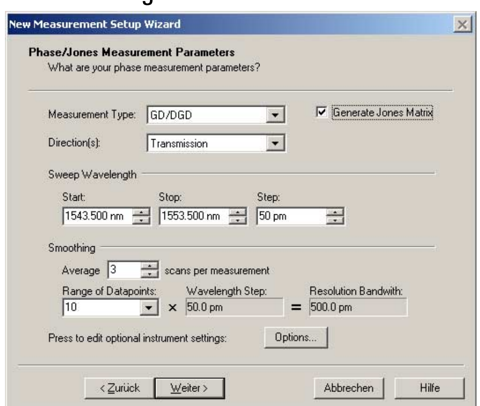
If the reference data has been invalidated, you must perform a new reference measurement before you can make further measurements.

If you are not already setting the measurement parameters

- Click on .

Or

- In the **Measurement** menu, select **Edit Parameters...**.
- If your measurement was initially setup in Expert mode, you will see the following window:



Please note that this window is one of two. The first offers the full set of parameters for phase measurements, the second offers the full set of parameters for loss measurements.
If these window are not shown, you will need to start a New measurement, as described in "Starting a New Measurement" on page 135.

NOTE

You can select DGD measurements even if DGD and PMD measurements are not possible on your All-Parameter Analyzer (option #005). However the DGD measurement will not be carried out, and the PMD analysis is not possible.

---

1 For the phase measurement

a Select the measurement

Fast GD	To make just a group delay measurement, using a single polarization state. Reference measurements are optional for the Fast GD measurement.
GD/DGD	To make both group delay and differential group delay measurements, using two polarization states. Reference measurements are required.
Off	To skip the measurement of group delay and differential group delay

b Select the light path

Transmission	To measure in the transmission path only.
Reflection	To measure in the reflection path only.
Both	To measure in both transmission and reflection paths.

c If you are running a GD/DGD measurement, you can also select to generate a Jones Matrix.
The Jones matrix can only be generated during a measurement. It cannot be generated from existing measurement data. Once generated, the Jones Matrix is saved with your measurement data, increasing the size of a measurement file by approximately 50%.

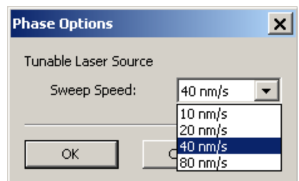
d Set the start and stop wavelengths, and the step size for the sweep.
The step size of the wavelength sweep limits the possible resolution bandwidth of the results for the group delay and differential group delay, as well as the resolution bandwidth of the chromatic dispersion analysis.
For phase measurements, the maximum step size is 100 pm.
The maximum wavelength span depends on the sweep speed of the tunable laser source. The dependency between span and sweep speed is given in “Dispersion Measurement Specifications” on page 218.

e Set the Resolution Bandwidth of the group delay and differential group delay results, by entering the size factor of the sliding window for the calculation of the group delay and differential group delay.
The sliding window is of Gaussian shape, centered on the current wavelength.
The resolution bandwidth is the 2σ value of the sliding window and

is the product of the size factor and the step size for the sweep. The resolution bandwidth of the chromatic dispersion analysis is described in “Setting up the Auto-Analysis of Results” on page 152 and “Analyzing Chromatic Dispersion” on page 178.

f Select the number of scans. The measurement result that is displayed is averaged across the selected number of scans. Increasing the number of scans reduces the noise floor, but increases the measurement time.

g Set the sweep speed of the tunable laser by opening "Options..." and selecting the proper speed in "Phase Options":

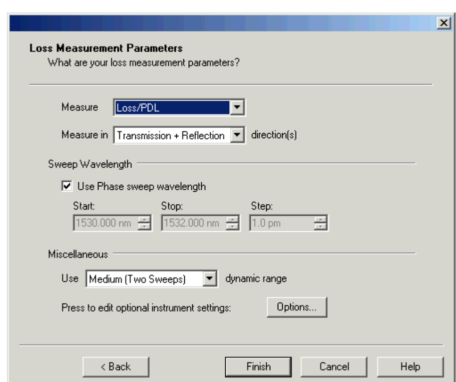


The higher the sweep speed the lower is the impact of environmental disturbances. Increasing sweep speed improves phase measurement accuracy. The maximum usable sweep speed depends on the device length to be tested. The dependency between sweep speed and device length is given in “Dispersion Measurement Specifications” on page 218.

2 If you have finished setting all the measurement parameters, click on the **Next>** button.

Certain changes will invalidate the current reference data (see “Changing Parameters Without Invalidating Reference Data” on page 148).
If the reference data has been invalidated, you must perform a new reference measurement before you can make further measurements.

3 Set up the Loss measurements.



a Select the Measurement

Fast Loss	To make just a loss measurement, using a single polarization state Reference measurements are optional for the Fast Loss measurement.
Loss/PDL	To make both loss and polarization dependent loss measurements, using four polarization states. Reference measurements are required.
Off	To skip the measurement of loss and polarization dependent loss

b Select the light path

Transmission	To measure in the transmission path only.
Reflection	To measure in the reflection path only.
Both	To measure in both transmission and reflection paths.

c If you have set a phase measurement, select **Use Phase settings** to reuse the start and stop wavelengths, and the step size for the sweep that you set for the phase measurement.
Or, set the start and stop wavelengths, and the step size for the sweep.
For loss measurements, the maximum step size is 200pm.

d Select the Number of Sweeps to use for the measurement.
Each sweep is performed at a different power sensor range, and the results are stitched together to provide an increased dynamic range.
A single sweep provides a dynamic range of 35dB (typical), two sweeps provides a dynamic range of 50dB (typical), three sweeps provides the specified dynamic range of over 55dB in the transmission path and over 45dB in the reflection path.
Increasing the number of sweeps increases the measurement time.
To set the start of the power sensor range for your measurement, please refer to “Setting the Start Range for the Power Sensor” on page 149.

4 If you have finished setting all the measurement parameters, click on **Finish**.

Click on **Yes** to change the parameters.
Click on **No** to preserve the current parameters.

Certain changes will invalidate the current reference data (see “Changing Parameters Without Invalidating Reference Data” on page 148).
If the reference data has been invalidated, you must perform a new reference measurement before you can make further measurements.

Changing Parameters Without Invalidating Reference Data

The reference data remain valid when you:

- increase the start wavelength or reduce the stop wavelength by any multiple of the step wavelength. (The grid of the measured data points is not affected), or
- switch from Both transmission and reflection to either Transmission or Reflection only.

For loss measurement parameters, the reference data remain valid when you:

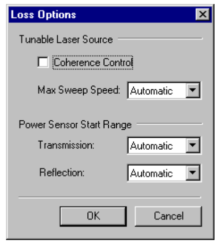
- change the PWM start range,
- change the number of sweeps, or
- switch from IL/PDL to Fast IL.

For phase measurement parameters, the reference data remain valid when you:

- change the number of averages, or
- change the number of data points for averaging, as long as the resulting resolution bandwidth is below 200pm.
  If the resulting resolution bandwidth is larger than 200pm, the resolution bandwidth of the reference measurement and the DUT measurement have to match.

Setting the Start Range for the Power Sensor

1 Click on the Options button.

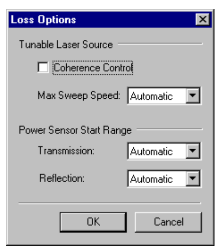


2 Select the start range for the power sensor for the Transmission path. The default value is Automatic, in which case the start range is chosen for a DUT with zero-loss.

3 Select the start range for the power sensor for the Reflection path. The default value is Automatic, in which case the start range is chosen for a DUT with zero-loss.

Controlling the Quality of the Laser Signal

1 Click on the Options button.

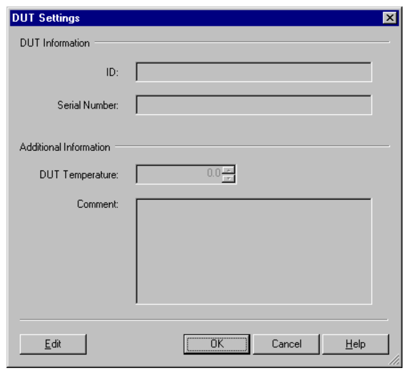


2 Click beside Coherence Control to switch this on and off. Coherence Control has no effect on the time taken to make a measurement.

3 Select the maximum sweep speed.
A faster sweep speed reduces the time taken for the measurement. A slower speed assists measuring devices with very steep spectral features or allow the instrument to use longer averaging times to reduce noise for weak signals from a high-loss DUT.
The default value is Automatic.

Entering Information for the DUT

1 In the Measurement toolbar, select .
OR
In the **Measurement** menu, in the **Measurement Setup** submenu, select **DUT Information...**.
The DUT information is displayed.



2 Click on the **Edit** button.

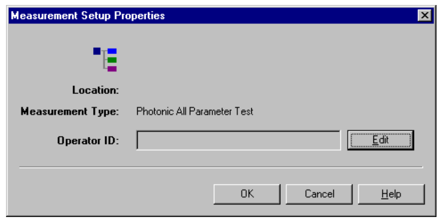
3 Enter the DUT identification and serial number.

4 If it is known, add the temperature of the DUT, and any additional comments you may have.

5 Click on the **OK** button.

Entering the Operator ID

1 In the **Measurement** menu, in the **Measurement Setup** submenu, select **Properties...**.
The measurement information is displayed.



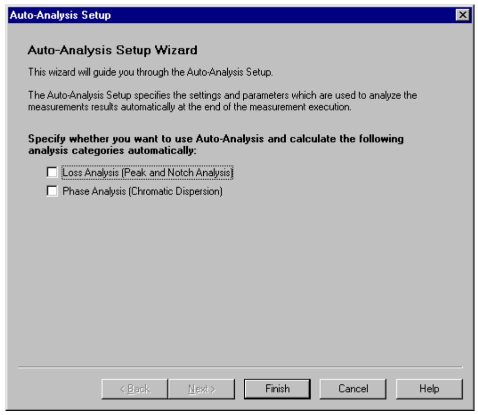
2 Click on the **Edit** button.

3 Enter the operator identification.

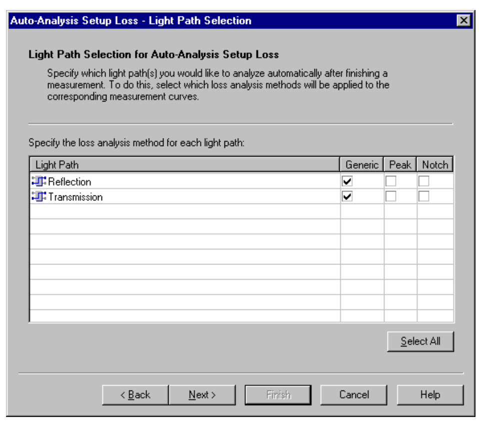
4 Click on the **OK** button.

Setting up the Auto-Analysis of Results

1 In the Measurement toolbar, select
OR
In the **Analysis** menu, select **Auto-Analysis Setup...**.

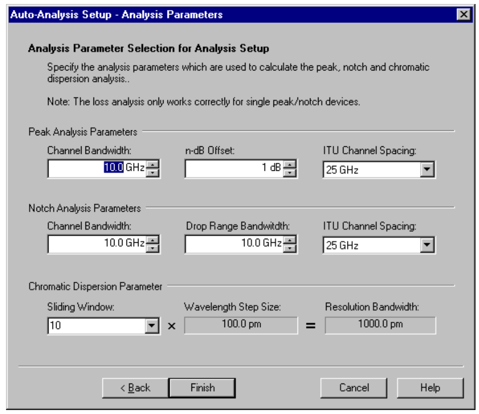


2 Click on the boxes to set a check mark beside Loss Analysis or Phase Analysis, depending on which auto-analyses you want to perform. Click on the **Next >** button.



3 If you selected Loss Analysis.

a Click on the boxes to set a check mark in the row and column corresponding to the loss analyses you want to perform (generic, peak and notch analyses, in the transmission and reflection paths). Click on the **Next >** button.



b If you selected Peak Analysis, enter the values for the Channel Bandwidth, NdB Offset, and the ITU Channel Spacing. These parameters are described in greater detail in “Reanalyze Loss...” on page 89.

c If you selected notch analyses, enter the values for the Channel Bandwidth, Drop Range Bandwidth, and the ITU Channel Spacing. These parameters are described in greater detail in “Reanalyze Loss...” on page 89.

4 If you selected phase analyses, set the Resolution Bandwidth of the Chromatic Dispersion analysis by entering the number of adjacent samples used in the sliding window for the calculation.
The resolution bandwidth is the product of the number of samples and the step size used for the wavelength sweep of the original measurement.

5 Click on the **Finish** button.

Saving the Current Measurement Setup

The measurement setup saved to disk includes the current hardware setup, the measurement parameters and the results of the reference measurements.

To save the measurement setup with the current name

1 In the **File** menu, select **Save Measurement Setup**.

Saving a Measurement Setup with a Different Name

1 In the **File** menu, select **Save Measurement Setup As...**.
2 Enter the name for the file.
3 Click on the **Save** button.

Repeating Earlier Measurements

There are two ways of repeating an earlier measurement for the same or a different DUT, either by

- "Loading an Existing Measurement Setup" , or by
- "Using the Measurement Setup from a Previous Measurement" that is already opened.

Loading an Existing Measurement Setup

NOTE If you load a measurement setup from another Photonic All-Parameter Analyzer, or a measurement setup that is more than 24 hours old, you should make a new reference measurement, to ensure the system performs according to its specifications, before you make further measurements.

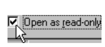
The measurement setup loaded from disk includes the hardware setup, the measurement parameters and the results of the reference measurements.

1 In the **File** menu, select **Open Measurement Setup**.

   If the current measurement setup is new or has been changed since it was opened, you will be asked if you want to save it before you proceed.
   Click on **Yes** to save it before you proceed.
   Click on **No** to continue without saving the measurement setup.
   Click on **Cancel** to abort loading an existing measurement setup.

2 Select the file from which the measurement setup is to be loaded.

3 If you want to make sure the file cannot be overwritten, make sure the box beside Open As Read Only is checked.

4 Press on the **OK** button.

Using the Measurement Setup from a Previous Measurement

NOTE

If you use a measurement setup from a measurement made on another Photonic All-Parameter Analyzer, or a measurement setup that is more than 24 hours old, you should make a new reference measurement, to ensure the system performs according to its specifications, before you make further measurements.

---

1 Make sure the measurement from which you want to use the measurement setup is open (see “Viewing Curves for New and Previous Measurements” on page 174) and that it is selected as the current measurement:

   a In the **Measurement** menu, select **Set as Active Measurement**.

   b Click on the measurement from the submenu that you want to set as the active measurement.

2 In the **Measurement** menu, select **Create Setup from Active Measurement**.

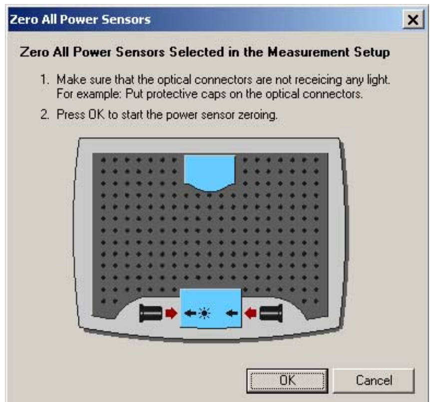
   If the current measurement setup is new or has been changed since it was opened, you will be asked if you want to save it before you proceed.
   Click on **Yes** to save it before you proceed.
   Click on **No** to continue without saving the measurement setup.
   Click on **Cancel** to abort creating the measurement setup from an previous measurement.

Zeroing the Power Sensors

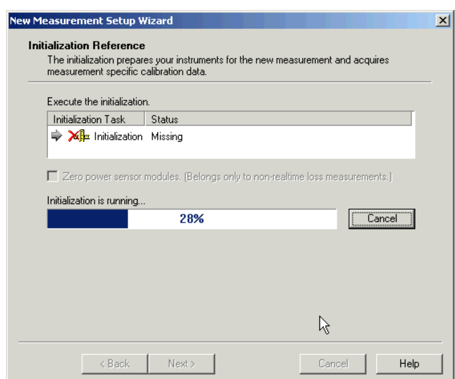
- Click on .

Or

- In the **Instruments** menu, select **Zero all Power Sensors**.



Disconnect any fibers and put protective caps on the input and output of the Optical Test Head.
Click on the **Ok >** button.
The power sensors are zeroed.



Performing a Realtime Measurement

The realtime measurement lets you check that your test device, and other components are connected correctly, and lets you confirm measurement parameters, such as the wavelength range. This can be particularly useful when measuring dispersion properties for devices such as Dispersion Compensating Gratings.

WARNING **Never look directly into the end of a fiber or a connector, unless you are absolutely certain that there is no signal in the fiber.**

NOTE Please make sure that any optical connectors that you are using are clean before making a connection.

---

1 If they are not already attached, attach patchcords to the input and output of the Optical Test Head.
2 Connect or splice the DUT from the input to the output of the Optical Test Head.
Fix the DUT on the optical bench of the Optical Test Head, and fix the input and output fibers, using the fiber clamps.
3 Click on .
Or
In the **Measurement** menu, select **Start Realtime Measurement**.

After a delay the first results are shown, and are then updated frequently (typically once a second, depending on the sweep range).

Pausing a Realtime Measurement

Click on .
Or
In the **Measurement** menu, select **Pause Realtime Measurement**.

You can now adjust your measurement setup.

Restarting a Paused Realtime Measurement

Click on .
Or
In the **Measurement** menu, select **Start Realtime Measurement**.

Stopping a Realtime Measurement

Click on .
Or
In the **Measurement** menu, select **Stop Realtime Measurement**.

Performing a Reference Measurement

NOTE

To meet the full Loss and PDL specifications, please zero the power sensors before you perform a reference measurement. See “Zeroing the Power Sensors” on page 157 for information on how to zero the power sensors.

- Click on .

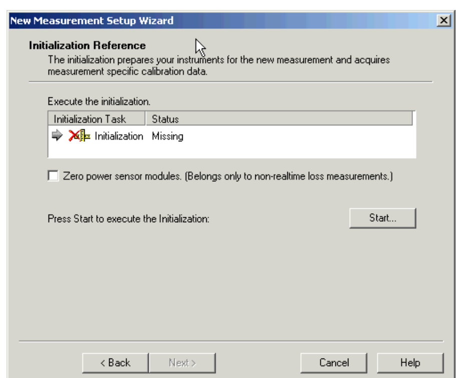
Or

- In the **Measurement** menu, select **Start Reference**.

WARNING

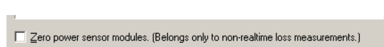
Never look directly into a connector, unless you are absolutely certain that there is no signal.

1 You are prompted to start the Initialization Reference.



- If the system has been initialized recently and the hardware and measurement setup has not been changed, click on the **Next >** button to skip the Initialization Reference.

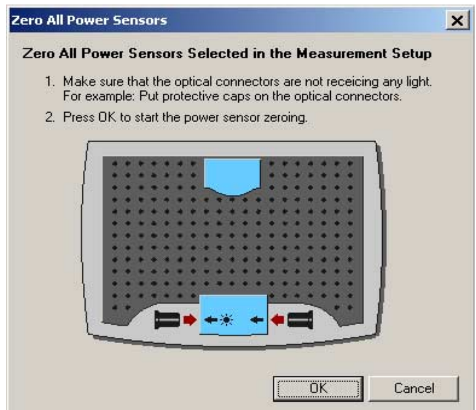
a It is recommended that you zero the power sensors before beginning the reference measurement.



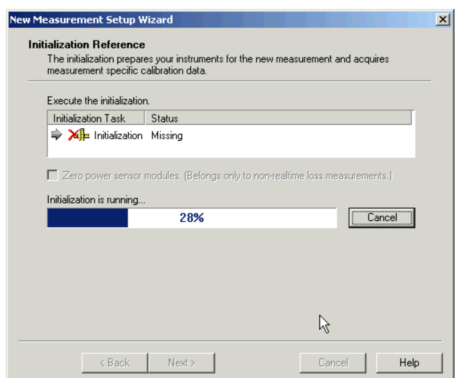
If the power sensors have been zeroed recently and the setup has not be changed, click on the box to remove the check mark.

b If you have changed the setup, or if you want to ensure meeting the specifications, click on the **Start...** button.

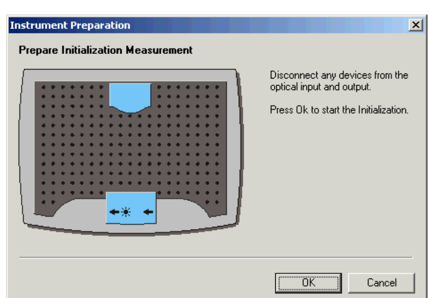
- If you are zeroing the power meters, you are prompted to set up the Optical Test Head for the Initialization Measurement by disconnecting any fibers and putting protective caps on the input and output of the Optical Test Head.



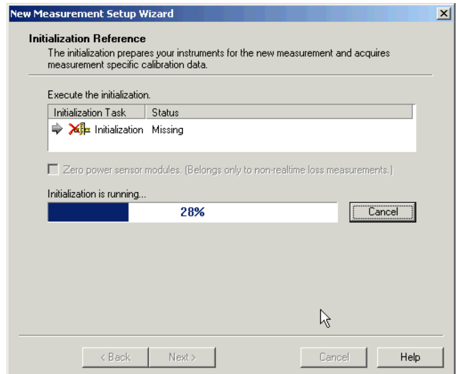
Click on the **OK** button.
The power sensors are zeroed and the initialization reference is made.



c If you are not zeroing the power meters, you are prompted to set up the Optical Test Head for the Initialization Measurement by disconnecting any fibers from the input and the output of the Optical Test Head.



Click on the **OK** button.
The Initialization Reference runs.

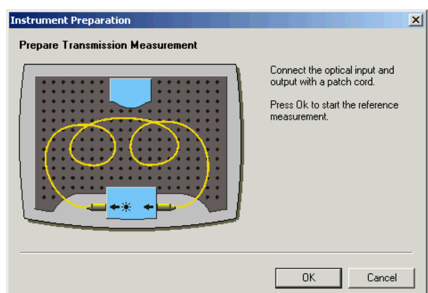


2 When the Initialization Reference finishes, press the **Next** button. You are prompted to set up the Optical Test Head for the Reference Measurement.

   a Select the type of reference measurement you want to perform.

   b Click on the **Start...** button.

3 If you have selected a transmission reference measurement, you are prompted to set up the Optical Test Head for this measurement.



   a Connect or splice the Transmission Reference Fiber from the input to the output of the Optical Test Head.
   Place the Transmission Reference Fiber on the optical bench of the Optical Test Head.

   b Click on the **OK** button.
   The reference transmission measurement runs in one or two cycles, depending on the measurements selected, to calibrate the transmission path for the Loss/PDL measurements and then for the GD/DGD measurements.

   c Disconnect the Transmission Reference Fiber from the Optical Test Head.

   d If there are other reference measurement tasks to be done, click on the *Start...* button.

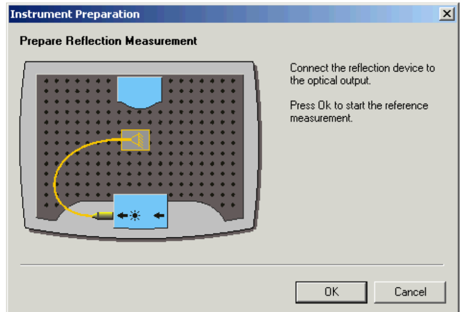
Transmission	To measure a reference in the transmission path only. This option is only available if your measurement parameters specify only a measurement in the transmission path.
Reflection	To measure a reference in the reflection path only using a reflective reference device. This option is only available if your measurement parameters specify only a measurement in the reflection path.
Terminated Reflection	To measure a reference in the reflection path using a reflective reference device and include a reference with a termination device. This option is only available if your measurement parameters specify only a measurement in the reflection path. The measurement of the terminated reflection reference extends the time for the reference measurement, but adds to the overall accuracy of the results.
Transmission and Reflection	To measure a reference in both transmission and reflection paths.
Transmission and Terminated Reflection	To measure a reference in both transmission and reflection paths, including a termination reference. The measurement of the terminated reflection reference extends the time for the reference measurement, but adds to the overall accuracy of the results.

NOTE Please make sure that any optical connectors that you are using are clean before making a connection.

4 If you have selected a reflection reference measurement, you are prompted to set up the Optical Test Head for this measurement.

NOTE Please make sure that any optical connectors that you are using are clean before making a connection.

5 Connect or splice the Reflectance Reference Device



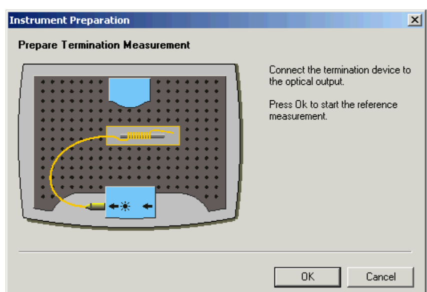
a to the output of the Optical Test Head.

b Place the Reflectance Reference Fiber on the optical bench of the Optical Test Head. Fix the fiber using the fiber clamps.

c Click on the **OK** button.
The reference reflection measurement runs in one or two cycles, depending on the measurements selected, to calibrate the reflection path for the Loss/PDL measurements and for the GD/DGD measurements.

d If there are other reference measurement tasks to be done, click on the *Start...* button.

6 If you have selected a terminated reflection reference measurement, you are prompted to set up the Optical Test Head for this measurement.



NOTE Please make sure that any optical connectors that you are using are clean before making a connection.

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a Connect or splice a termination to the output of the Optical Test Head.
You can make a termination as described in “Making a Termination” on page 51, or you can use any termination with a return loss greater than 70dB.

b Place the termination in the optical bench of the Optical Test Head. Fix the fiber using the fiber clamps. See “Using the Termination Rod” on page 51 and “Using the Fiber Clamps” on page 49 for more information on making a termination and fixing the fiber.

c Click on the **OK** button.
The reference termination measurement runs.

d If there are other reference measurement tasks to be done, click on the *Start...* button.

7 Disconnect the fiber from the Optical Test Head.

8 Click on the **Finish** button.

Performing a Two-Port DUT Measurement

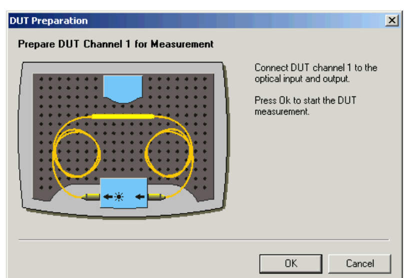
WARNING **Never look directly into the end of a fiber or a connector, unless you are absolutely certain that there is no signal in the fiber.**

NOTE Please make sure that any optical connectors that you are using are clean before making a connection.

1 If they are not already attached, attach patchcords to the input and output of the Optical Test Head.

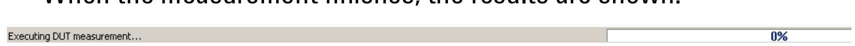
2 Click on 
OR
From the **Measurement** menu, select **Start DUT Measurement**.

3 Click on  .in the "DUT Measurement Control" panel.



4 Connect or splice the DUT from the input to the output of the Optical Test Head.
Fix the DUT on the optical bench of the Optical Test Head, and fix the input and output fibers, using the fiber clamps. See "Using the DUT Holder" on page 52 and "Using the Fiber Clamps" on page 49 for more information on fixing the DUT and the fibers.

The measurement runs, showing the measurement status as it progresses.
When the measurement finishes, the results are shown.



5 When you have finished measuring your device, click on  in the "DUT Measurement Control" panel.

To measure further devices, click on , and repeat step 3 to step 5.

Performing a Multi-Port DUT Measurement

WARNING

Never look directly into the end of a fiber or a connector, unless you are absolutely certain that there is no signal in the fiber.

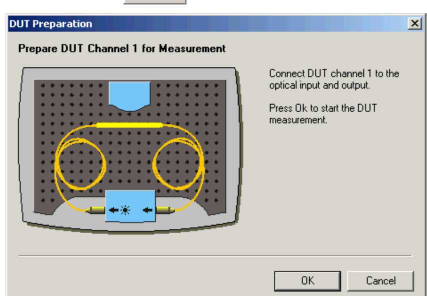
NOTE

Please make sure that any optical connectors that you are using are clean before making a connection.

1 If they are not already attached, attach patchcords to the input and output of the Optical Test Head.

2 Click on
OR
From the **Measurement** menu, select **Start DUT Measurement**.

3 Click on Start.



4 Connect or splice the DUT from the input to the output of the Optical Test Head.
Fix the DUT on the optical bench of the Optical Test Head, and fix the input and output fibers, using the fiber clamps. See "Using the DUT Holder" on page 52 and "Using the Fiber Clamps" on page 49 for more information on fixing the DUT and the fibers.

The measurement runs, showing the measurement status as it progresses.
When the measurement finishes, the results are shown.

5 Click on Add Port, and repeat step 3 to step 4 for the next output port.

If you want to abort the measurement of a port, click on Cancel.
This will affect only the port that is currently being measured.

6 When you have finished measuring all the ports of your device, click on Close.

To measure further devices, click on , and repeat step 3 to step 6.

Cancelling a Reference or DUT Measurement

To cancel the current reference or DUT measurement click the **Cancel** button in the measurement status box.

The cancellation of the measurement can take several seconds.

Saving and Closing Measurements

If you want to use a measurement for further reference or analysis, you should save it.

When you have finished analyzing a measurement, you should close it to remove it from memory.

Saving a Measurement

1 In the Measurement View tab of the Workspace window click with the right mouse button on the measurement name, select **Save**.

You can also save the active measurement, in the **File** menu, by selecting **Save Active Measurement**.

Saving a Measurement with a Different Name

1 In the Measurement View tab of the Workspace window click with the right mouse button on the measurement name, select **Save As...**.
2 Enter the name for the file.
3 Click on the **Save** button.

You can also save the active measurement with a Different Name

1 In the **File** menu, select **Save Active Measurement As...**.
2 Enter the name for the file.
3 Click on the **Save** button.

Saving All Measurements

1 In the **File** menu, select **Save All**.

Closing Measurements

1 In the Measurement View tab of the Workspace window click with the right mouse button on the measurement name, select **Close**.

You can also save the active measurement, in the **File** menu, by selecting **Close Active Measurement**.

Closing All Measurements

1 In the **File** menu, select **Close All**.

5
Analyzing Results

This chapter describes how to analyze recently measured and previously stored results.

This includes configuring and analyzing graphical and tabular results, and how to export results for further analysis and save them.

Opening a Previous Measurement for Analysis

If you want to open one or more previous measurements

- in the **File** menu, select **Open**
- on "The Standard Toolbar" use , or
- press CTRL+O on the keyboard

to open a file browser window to select and load measurement results or analyses from files (*.omr).

To open a single file:

1 Click on the file.

2 Click on the **Open** button.

To open a number of files:

- If the files are listed one after the other,
  - **a** Click on the first file.
  - **b** Press SHIFT and click on the last file.
  - **c** Click on the **Open** button.
- If the files are not listed one after the other,
  - **a** Click on the first file.
  - **b** Press CTRL and click on the next file.
  - **c** Repeat step b until all of the files you want to open are highlighted.
  - **d** Click on the **Open** button.

The last measurement you open automatically becomes the active measurement.

Viewing Curves for New and Previous Measurements

The curves that are displayed depend on two factors:

- which curves are selected for display, and
- which graph windows are open.

Selecting the Curves to Display

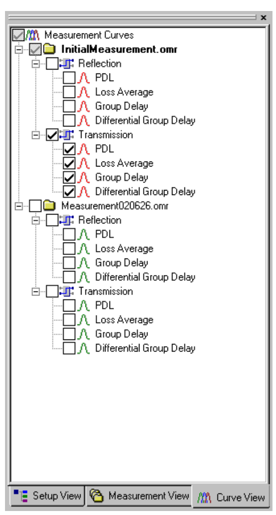
Loading a new measurement, or changing the active measurement, automatically displays all the curves and analysis tables associated with the new active measurement. Any curves or analysis tables for the previous active measurement are deselected.

To view all the curves for the active measurement

1 In the Measurement View tab of the Workspace window click with the right mouse button on the active measurement name, select **Show Analysis and Measurement Data**.

To select a particular set of curves from the active and non-active measurements.

1 In the Workspace window, select the **Curve View** tab.



2 Click on ⊞ beside a measurement name to see which results are available.

Click on ⊟ beside a measurement name to hide the results that are available for it.

- Click on the check box beside a measurement name to toggle between show (☑) and hide (☐) for all the results for that measurement.
  If the corresponding graph windows are not already open, they are opened automatically.
- Click on the check box beside a measurement path to toggle between show (☑) and hide (☐) for all the results for that measurement path.
  If the corresponding graph windows are not already open, they are opened automatically.
- Click on the check box beside a result to toggle between show (☑) and hide (☐) for the result.
  If the corresponding graph window is not already open, it is opened automatically.

NOTE If a graph window is empty, it probably indicates the measured results for the DUT were outside the specified range of the All-Parameter Analyzer. For example, if you were to specify a reflection loss measurement for a patchcord, the resulting Loss Reflection graph window would be empty.

See “Opening and Closing Graph Windows” on page 176 for information on how to open or close graph windows to display the curves you have selected, or to close empty graph windows.

For information on the measurements, see “Examining the Measurement Conditions” on page 177.

Showing the Calculation Curves for Loss and PDL

- To view the minimum and maximum loss curves,
  click with the right mouse button on **Measurement Curves** in the Curve View tab of the Workspace window to open the **Curve View Root** context menu.
- Select **Show Min/Max Loss Curves** to make the Loss Min and Loss Max curves available for display, in addition to the Loss Average curve which is normally displayed.
  You can now select these curves for display, as described above.
  The curves are displayed in the Loss graph window.
- To view the calculation loss curves used to calculate PDL,
  Select **Show PDL Calculation Loss Curves** to make the Loss: Linear Horizontal, Loss: Linear +45°, Loss: Linear -45°, and Loss: Right Circular available for display.
  The Linear Horizontal, Linear +45, Linear -45 and Right Circular are the measured loss curves. The Min, Max, Average and PDL curves are calculated from them.

- You can now select the linear horizontal, linear +45°, linear -45°, and right-hand circular polarization loss curves for display, as described above.
  The curves are displayed in the Loss graph window.

Opening and Closing Graph Windows

Any combination of Graph windows can be selected.
The selected curves are displayed in the windows that are open. See “Selecting the Curves to Display” on page 174 for information on how to select curves.

In the **Graph** menu, in the **Transmission** or **Reflection** submenu, select the graphs you want to view.

- Select **Loss**, **PDL**, **GD**, **DGD,** or **CD** in the submenu to activate any individual graph or combination of these graphs.

If you want to view a particular curve immediately,

- In the Curve View tab of the Workspace window,
  - double-click on the result, or
  - click with the right mouse button on the result, select **Activate**.

The curve is selected (if it is not already selected), and the graph window is opened.

Eliminating Noisy Sections from the Displayed Graphs

By defining a noise threshold, sections of the curves that contain no useful information can be suppressed on the screen.

The Loss curve in the measurement path for the currently active graph is compared with the threshold that you enter. For any wavelength on the Loss curve that has a signal strength below the noise threshold the curve is eliminated in the all corresponding graph windows for the measurement path.
Noise suppression can only be applied to measurements that use the same parameters as the loss measurement.
The full Loss curve continues to be displayed.

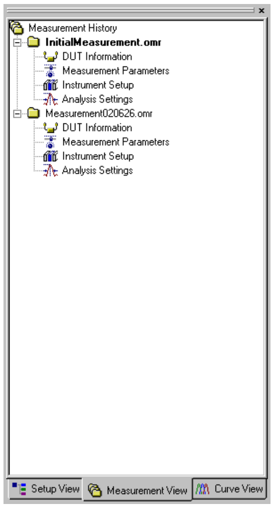
1. Identify the lowest signal level of interest on the loss curve.
2. In the **Graph** menu, select **Noise Suppression...**.
3. Enter the value for the threshold and click on the **OK** button.

Examining the Measurement Conditions

To examine the DUT information, the measurement parameters or the instrument setup,

1 In the Workspace window, click on the Measurement View tab.

2 Make sure the measurement you want to examine is expanded (click on ⊞, if necessary)



3 Double-click on **DUT Information** to see, or edit, the information about the device under test.
Double-click on **Measurement Parameters** to see the parameters used for the measurement.
Double-click on **Instrument Setup** to see the setup used for the measurement.

Analyzing Chromatic Dispersion

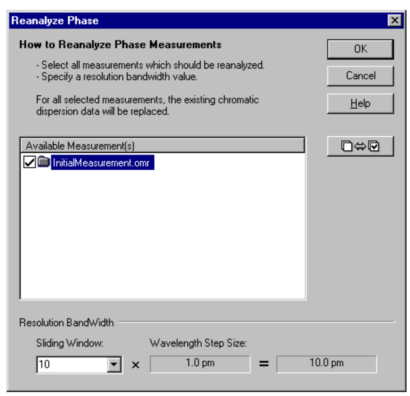
The initial curve for chromatic dispersion (CD) is determined by how you configured the automatic phase analysis. See “Setting up the Auto-Analysis of Results” on page 152 for information on setting up the automatic analysis.

Reanalyzing the CD

If you did not configure a phase analysis, or if you would like to reanalyze the chromatic dispersion, or to apply the same analysis to a number of measurements so you can compare them:

1 In the **Analysis** menu, select **Reanalyze Phase...**.

2 Click on the boxes to set a check mark beside the measurements you want to reanalyze.



3 Set the Resolution Bandwidth of the Chromatic Dispersion analysis by entering the number of adjacent samples used in the sliding window for the calculation.
The resolution bandwidth is the product of the number of samples and the step size used for the wavelength sweep of the original measurement.

4 Click on the **OK** button.

Reanalyzing CD for the Active Measurement

This is an alternative to reanalyzing CD when you just want to change the analysis for the active measurement.

1 In the Measurement View tab of the Workspace window click with the right mouse button on the measurement name, select **Reanalyze Phase**.

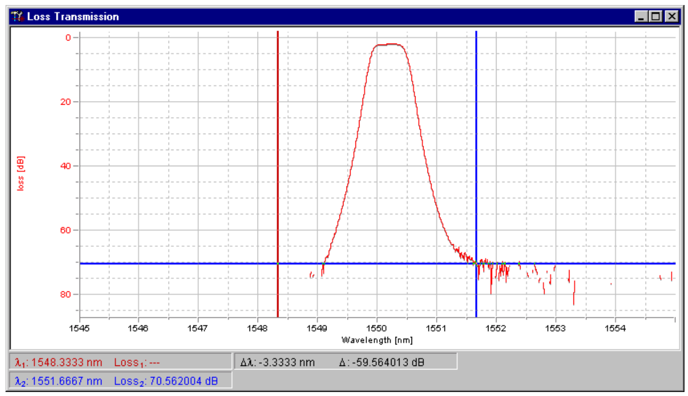
2 Set the Resolution Bandwidth of the Chromatic Dispersion analysis by entering the number of adjacent samples used in the sliding window for the calculation.
The resolution bandwidth is the product of the number of samples and the step size used for the wavelength sweep of the original measurement.

3 Click on the **OK** button.

The chromatic dispersion is shown as a graph for the available light paths for the measurement. See “Viewing Curves for New and Previous Measurements” on page 174 for details on how to display the chromatic dispersion curve.

Analyzing a Curve in the Graph Window

The Graph window lets you view the detail on the curves, and position markers on the curves to measure values and differences.



Changing between Wavelength and Frequency

To change the position values on the graph to wavelength (nm):

- In the X-Axes Dimension toolbar, select
  OR
  in the **Options** menu, in the **X-Axes Dimension** submenu, select **Wavelength**.

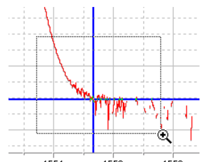
To change the position values on the graph to frequency (THz):

- In the X-Axes Dimension toolbar, select
  OR
  in the **Options** menu, in the **X-Axes Dimension** submenu, select **Frequency**.

Zooming In and Out

Zooming In on the Curves in a Graph Window

1 Click on one corner of the area of interest and, holding down the left mouse button, drag a rectangle to the opposite corner of the area of interest.



2 Release the mouse button.

If you can only zoom along the y-axis, check that the zoom is selected for the main curves (see “Zooming on the Orientation Curve” on page 187 for information on returning to normal zooming).

Returning to the Previous Zoom for a Graph Window

Double-click anywhere in the graph window.

Zooming All Graphs Identically

If you have zoomed in on an area of interest in one graph window, and want to compare the same wavelength range for all the graph windows:

1 Click with the right mouse button on the graph window away from the curve - when you are away from the curve the , , , or cursor is shown.

2 Click on **Synchronize X Axis**.

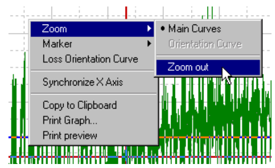
The X-axis of all open graph windows is synchronized.

The zooming in the Y-axis is unaffected.
If you want to zoom in the Y-axis, you should do this before synchronizing the X-axis.

Zooming Out Fully for a Graph Window

1 Click with the right mouse button on the graph window away from the curve - when you are away from the curve the , , , , or cursor is shown.

2 Click on **Zoom**.



3 Select **Zoom Out**.

The same function is available by double-clicking twice in the graph window.

Zooming Out Fully for All Graph Windows

- Click on the icon.

OR

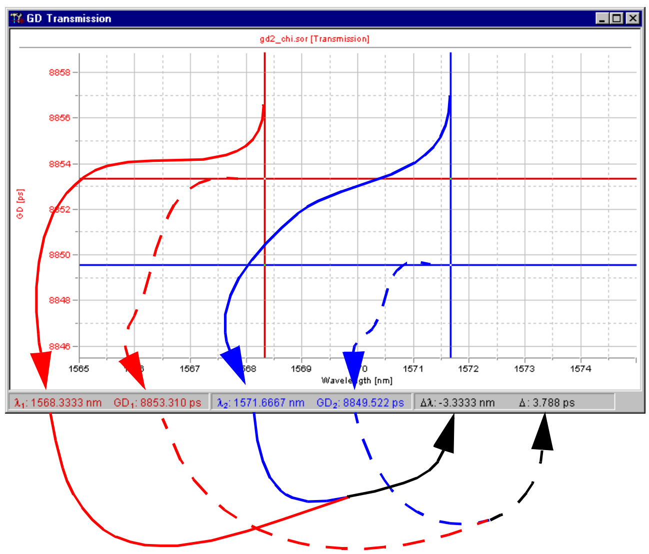
- In the **Graph** menu, select **Zoom Out All**.

Using Markers to Analyze Curves

Four markers are provided.

- Use the two vertical markers, λ/ν_1 and λ/ν_2, to determine wavelength or frequency on the curves.
- Use the two horizontal markers, like (**Loss**$_1$ and **Loss**$_2$, **GD**$_1$ and **GD**$_2$, or **DGD**$_1$ and **DGD**$_2$, depending on the graph window) to determine loss, GD, DGD, etc. on the curves.

The positions of the markers are given at the bottom of the Graph window.



The third pair of values shows the difference in wavelength or frequency, $\Delta\lambda/\Delta\nu$, between the positions of the vertical markers, and the difference in loss, GD, DGD or CD, Δ, between the horizontal markers.

Moving Vertical Markers

1 Move the cursor over the vertical marker.
When the cursor is over the marker it changes to .

2 Click on the marker and drag it to the new position.

If the markers are locked together, the horizontal marker corresponding to the vertical marker you have moved will move to the point where the vertical marker intersects the curve of the active measurement. See “Locking the λ/ν and Loss/Delay/Dispersion Markers Together” on page 183 for information on locking the vertical and horizontal markers together.

Moving Horizontal Markers

1 Make sure the marker is free (see “Positioning the Four Markers Freely” on page 184).
If the horizontal markers are not free, you can only position them by moving the corresponding vertical marker, as described in “Moving Vertical Markers” on page 183.

2 Move the cursor over the horizontal marker.
When the cursor is over the marker it changes to .

3 Click on the marker and drag it to the new position.

Positioning Both Markers on the Curve

1 Make sure the markers are locked together (see “Locking the λ/ν and Loss/Delay/Dispersion Markers Together” on page 183).

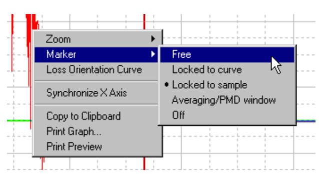
2 Click with the right mouse button on the graph window on the curve at the point where you want to position the markers - when you are on the curve the cursor is shown.

- Select **Lock Marker AC** to position the λ/ν_1, and Loss/Delay/Dispersion$_1$ marker at the point where you clicked.
- Select **Lock Marker BD** to position the λ/ν_2, and Loss/Delay/Dispersion$_2$ marker at the point where you clicked.

Positioning the Four Markers Freely

1 Click with the right mouse button on the graph window away from the curve - when you are away from the curve the , , , , or cursor is shown.

2 Click on **Marker**.



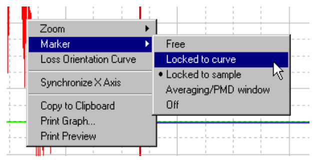
3 Select **Free**.

You can now position the vertical and horizontal markers independently.

Locking the λ/ν and Loss/Delay/Dispersion Markers Together

1 Click with the right mouse button on the graph window away from the curve - when you are away from the curve the , , , , or cursor is shown.

2 Click on **Marker**.



- Select **Locked to Curve** so that as you move the λ/ν marker it moves smoothly along the curve. The corresponding Loss/Delay/Dispersion marker will show the loss, GD, DGD or CD on the curve.
- Select **Locked to sample** so that as you move the λ/ν marker it steps from measurement sample to measurement sample. The corresponding Loss/Delay/Dispersion marker will show the loss, GD, DGD or CD on the curve.

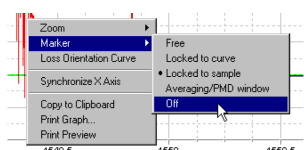
Switching the Markers Off

Click on the icon.

OR

1 Click with the right mouse button on the graph window away from the curve - when you are away from the curve the , , , , or cursor is shown.

2 Click on **Marker**.



3 Select **Off**.

To turn the markers back on again:

- Click on the icon again.

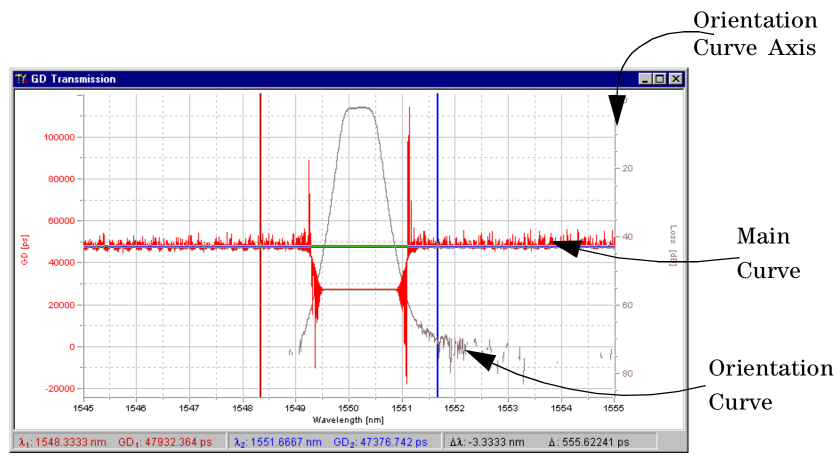
OR

- In the **Graph** menu, select **Show Markers**.

Using the Orientation Curve

The Orientation Curve puts the Loss Average curve for the measurement path in the background of the graph window to give you a common element to help comparisons between different curves.

The axis for the orientation curve is shown at the right side of the graph.



Turning On the Orientation Curve in All Graph Windows

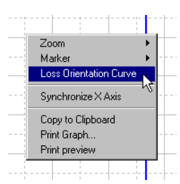
- Click on the  icon.

OR

- In the **Graph** menu, select **Show Orientation Curves**.

Turning On or Off the Orientation Curve in a Graph Window

1. Click with the right mouse button on the graph window away from the curve - when you are away from the curve the , , , , or cursor is shown.
2. Select **Loss Orientation Curve**.

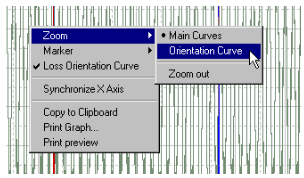


Zooming on the Orientation Curve

If you need to see more detail on the Orientation Curve to correlate information from two different graph windows:

1 Click with the right mouse button on the graph window away from the curve - when you are away from the curve the , , , , or cursor is shown.

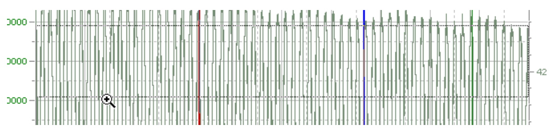
2 Click on Zoom.



3 Select **Orientation Curve**.

You can now zoom on the orientation curve:

1 Click at the top of the area of interest and, holding down the left mouse button, drag to the bottom of the area of interest.



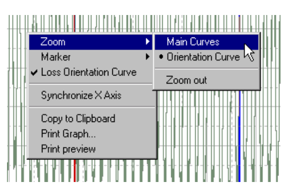
2 Release the mouse button.

The Orientation Curve will be zoomed in the y-axis only. The main curve and the zooming in the x-axis are unaffected.

To return to normal zooming

1 Click with the right mouse button on the graph window away from the curve - when you are away from the curve the , , , , or cursor is shown.

2 Click on Zoom.



3 Select **Main Curves**.

Analyzing PMD, or Average Loss, Group Delay or Chromatic Dispersion Over Passband

In many cases you are interested in

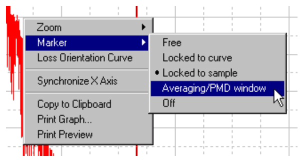
- “Analyzing PMD Over Passband”
- or “Analyzing Average Loss, Group Delay or Chromatic Dispersion Over Passband” .

Analyzing PMD Over Passband

The PMD over passband can only be measured on the Differential Group Delay curve, as the wavelength-averaged DGD.

1 Click with the right mouse button on the DGD graph window away from the curve - when you are away from the curve the , , , , or cursor is shown.

2 Click on **Marker**.



3 Select **Averaging/PMD Window**

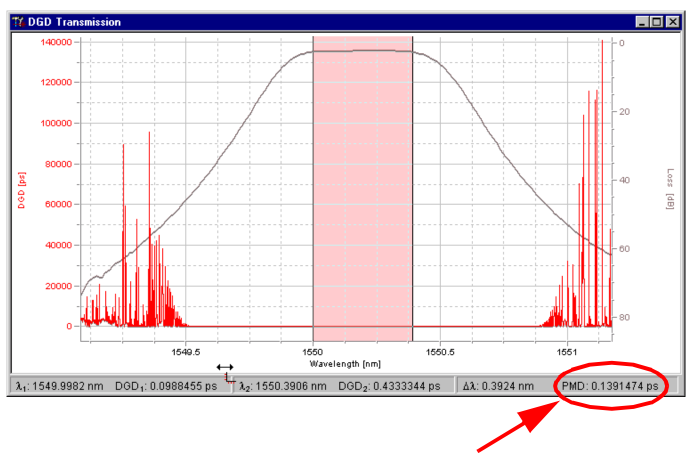
4 If it is not already being displayed, select the Loss Orientation Curve (as described in Using the Orientation Curve 186).

5 Position the two markers at the lower and upper wavelengths or frequencies of the passband:

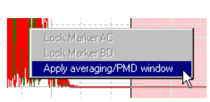
a Move the cursor over the vertical marker.
When the cursor is over the marker it changes to .

b Click on the marker and drag it to the new position.

When both of the markers are positioned, the value for the PMD as averaged DGD in the highlighted passband is shown below the graph.



If there is more than one curve in the window, right click on the curve - when you are on the curve the cursor is shown - and select **Apply Averaging/PMD Window**.

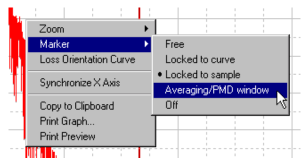


Analyzing Average Loss, Group Delay or Chromatic Dispersion Over Passband

The average can be measured on the PDL or Loss Average, Group Delay or Chromatic Dispersion curve.

1 Click with the right mouse button on the graph window away from the curve - when you are away from the curve the , , , , or cursor is shown.

2 Click on **Marker**.



3 Select **Averaging/PMD Window**.

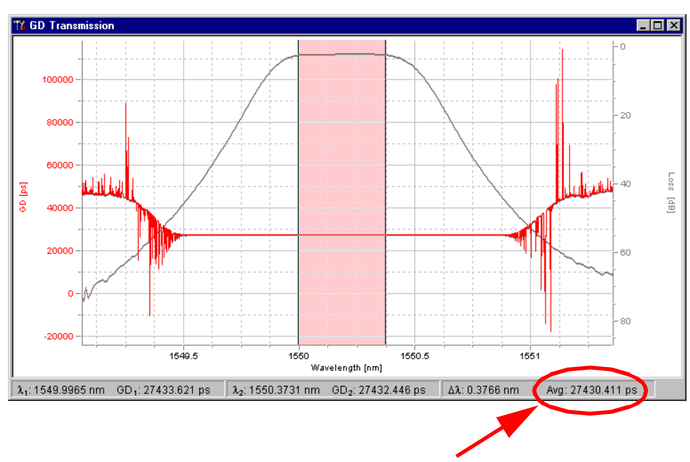
4 If it is not already being displayed, select the Loss Orientation Curve (as described in Using the Orientation Curve 186).

5 Position the two markers at the lower and upper wavelengths or frequencies of the passband:

   a Move the cursor over the vertical marker.
   When the cursor is over the marker it changes to .

   b Click on the marker and drag it to the new position.

When both of the markers are positioned, the value for the average in the highlighted passband is shown below the graph.



Using Results in Your Documentation

You can print graphs, or paste the contents of the graph windows into your other documents.

For information on using tabular results in your documentation, see “Exporting Data for Further Processing” on page 207.

Copying Graphs into Documentation

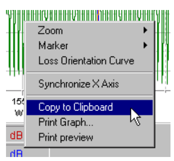
Before you start to copy a graph for use in a documentation, make sure the graph is displayed on the screen as you want to use it in your documentation.
That is

- Make sure the correct area is zoomed.
- Make sure the markers are positioned correctly.
- Make sure the orientation curve is selected or deselected, as required.
- Make sure the size and aspect ratio of the graph are more or less correct for use in your documentation.
  You can adjust these in most word processing packages, but large adjustments can mean that the axis labelling becomes illegible, or that the resolution is insufficient.

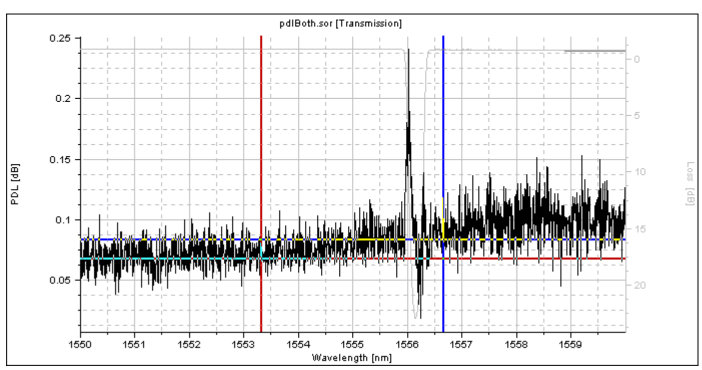
NOTE Choosing a small size increases the relative label size.

1 Click with the right mouse button on the graph window away from the curve - when you are away from the curve the , , , , or cursor is shown.

2 Select **Copy to Clipboard**.



You can now paste the graph into your document (assuming this is supported by the application you are using to generate your documentation).



Printing Graphs

Setting up the Printer

Before you print any graphs, make sure the printer is set up correctly. To do this you

- In the **File** menu, select **Printer Setup...**

The rest of the procedure is specific to your printer, but the graph will be formatted to fit the size and orientation of the selected paper, so in particular make sure the correct size of paper and the correct orientation (Portrait or Landscape) is selected.

Printing Individual Graphs

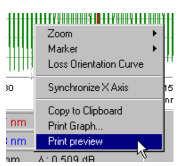
Before you print a graph, make sure it is displayed on the screen as you want to print it.
That is

- Make sure the correct area is zoomed.
- Make sure the markers are positioned correctly.
- Make sure the orientation curve is selected or deselected, as required.

1 Click with the right mouse button on the graph window away from the curve - when you are away from the curve the , , , , or cursor is shown.

- If you want to check your graph before you print it,

a select **Print Preview**.



b If the layout is correct, click on the **Print** button.
If the layout is not correct, click on the **Close** button, make the necessary adjustments and repeat the procedure.

- If you just want to print the graph, select **Print Graph...**.

2 Make sure the correct printer is selected, and the settings of your printer driver are okay.

3 Click on the **OK** button.

Printing Results

A printout of the results of a measurement includes

- the measurement and analysis setup
- any graphs which contain one or more curves (including such graphs that are currently minimized on the screen), and
- the tables for the active measurement result or analysis.

Before you print a result, make sure any graphs in the result are displayed on the screen as you want to print them.
That is

- Make sure correct area is zoomed.
- Make sure the markers are positioned correctly.
- Make sure the orientation curve is selected or deselected, as required.

1 If you want to check your printout before you print it:
   a In the **File** menu, select **Print Preview**.
   b If the layout is correct, click on the **Print** button.
   If the layout is not correct, click on the **Close** button, make the necessary adjustments and repeat the procedure.

   If you just want to print the result:

   In the **File** menu, select **Print**.

2 Make sure the correct printer is selected, and the settings of your printer driver are okay.

3 Click on the **OK** button.

Selecting the Results Displayed in the Analysis Table

Loading a new measurement, or changing the active measurement, automatically displays all the curves and analysis tables associated with the new active measurement. Any curves or analysis tables for the previous active measurement are deselected.

To display the results of more than one measurement in the analysis tables, the analyses must be equivalent. This is described in "Comparing Loss Analyses for Several Measurements" on page 205.

The initial values in the peak and notch loss analysis tables are determined by how you configured the automatic loss analysis. See "Setting up the Auto-Analysis of Results" on page 152 for information on setting up the automatic analysis.

Changing between Wavelength and Frequency

To change the position values in the table to wavelength (nm):

- In the X-Axes Dimension toolbar, select
  OR
  in the **Options** menu, in the **X-Axes Dimension** submenu, select **Wavelength**.

To change the position values in the table to frequency (THz):

- In the X-Axes Dimension toolbar, select
  OR
  in the **Options** menu, in the **X-Axes Dimension** submenu, select **Frequency**.

Reanalyzing the Generic, Peak and Notch Loss

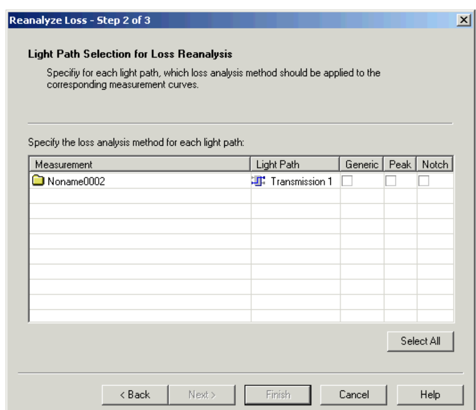
NOTE If you want to compare a number of different loss analyses, see "Comparing Loss Analyses for Several Measurements" on page 205.

NOTE Meaningful results for Peak and Notch analyses are only possible for measurements of devices with peak or notch characteristics.

If you did not configure an automatic loss analysis, or if you would like to reanalyze the generic, peak or notch loss, or to apply the same analysis to a number of measurements to make the data comparable in external applications:

1 In the **Analysis** menu, select **Reanalyze Loss...**.

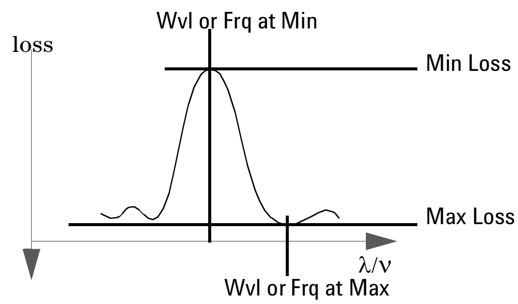
2 Click on the boxes to set a check mark beside the measurements you want to reanalyze.



Click on the **Next >** button.

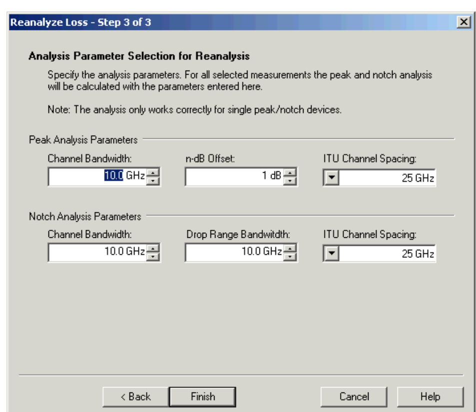
The results of the generic analysis are shown on the **Generic** tab of the Analysis table window. The columns displayed are:

Color	Indicates the color of the corresponding graph
Measurement	The name of the file in which the measurement is stored.
Light Path	Whether the measurement was made in the transmission or reflection light path
Curve	The type of measurement (PDL, Loss,...).



Min Loss [dB]	The minimum loss measured.
Wvl at Min [nm] Frq at Min [THz]	The wavelength or frequency at which the minimum loss was measured
Max Loss [dB]	The maximum loss measured.
Wvl at Max [nm] Frq at Max [THz]	The wavelength or frequency at which the maximum loss was measured

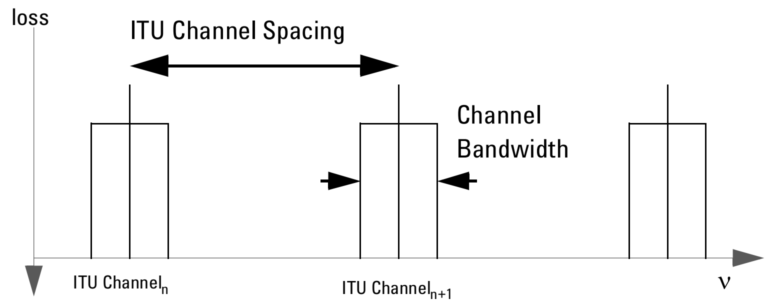
3 If you selected peak analysis, enter the values for the Channel Bandwidth, NdB Offset, and the ITU Channel Spacing.



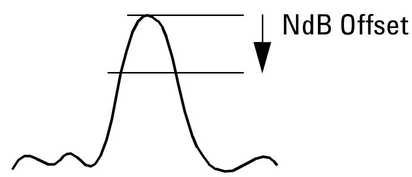
The ITU Channel Spacing (in the frequency domain) defines which of the channels, as defined by the International Telecommunication Union (ITU), are being used.

NOTE The Photonic All-Parameter Analyzer uses 193.1 THz as the ITU Channel 0 frequency.

The Channel Bandwidth is the nominal value of the width of each channel, centered around the ITU channel frequency.

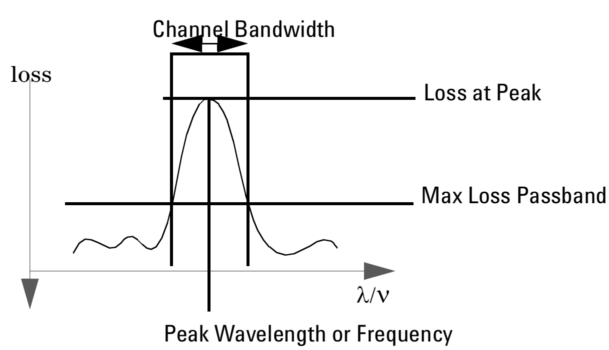


The NdB Offset defines a change in signal loss indicating the effective width of the channel. For example, for a 3dB bandwidth, the value for NdB Offset should be set to “3”.

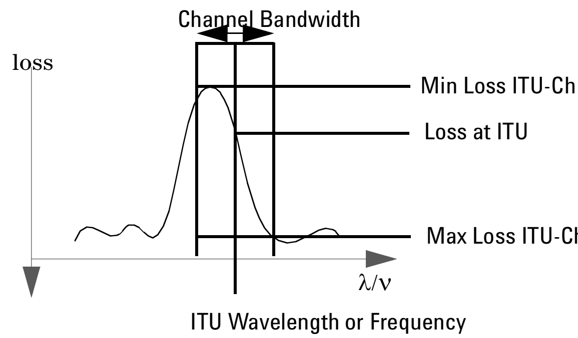


The results of the peak analysis are shown on the peak tab of the Analysis table window. The columns displayed are:

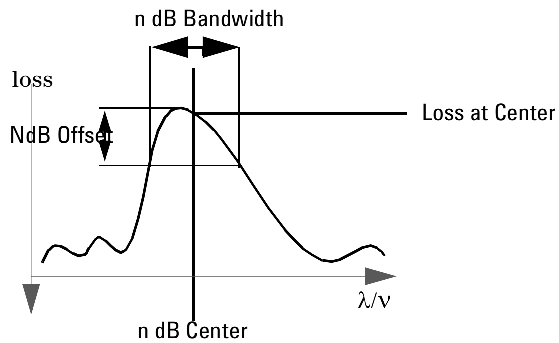
Color	Indicates the color of the corresponding graph
Measurement	The name of the file in which the measurement is stored.
Light Path	Whether the measurement was made in the transmission or reflection light path
Curve	The type of measurement (PDL, Loss,...).



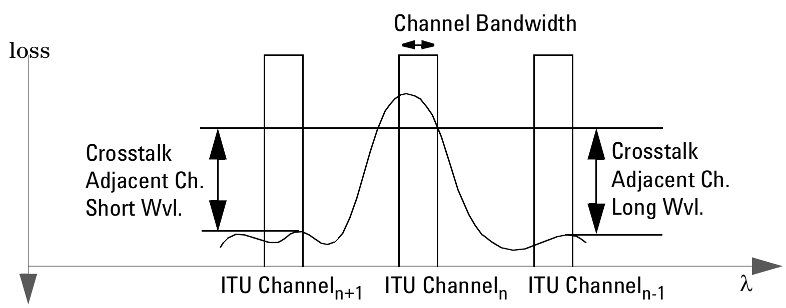
Peak Wavelength [nm] Peak Frequency [THz]	The wavelength or frequency at which the minimum loss was measured.
Max Loss Passband [dB]	The maximum loss measured in the passband centered at the peak wavelength or frequency with the specified channel bandwidth.
Loss at Peak [dB]	The value of the minimum loss.

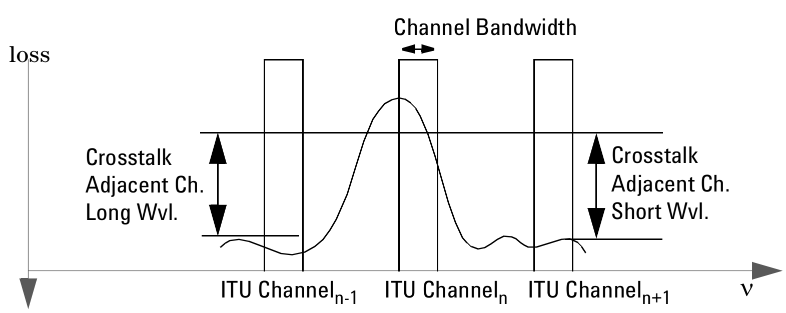


ITU-Ch	The number of the ITU Channel closest to the peak wavelength or frequency
ITU Wavelength [nm] ITU Frequency [THz]	The center wavelength or frequency of the ITU Channel
Loss at ITU [dB]	The loss at the ITU center wavelength or frequency
Min Loss ITU-Ch [dB]	The minimum loss in the ITU Channel centered at the ITU wavelength or frequency, with the specified channel bandwidth.
Max Loss ITU-Ch [dB]	The maximum loss in the ITU Channel centered at the ITU wavelength or frequency, with the specified channel bandwidth.



n dB Center [nm] n dB Center [THz]	The wavelength or frequency half way between the points on either side of the peak that are offset from the peak loss by the value specified for NdB Offset.
Loss at Center [dB]	The loss at the wavelength or frequency half way between the two NdB points.
n dB Bandwidth [nm] n dB Bandwidth [THz]	The bandwidth between the two NdB points.





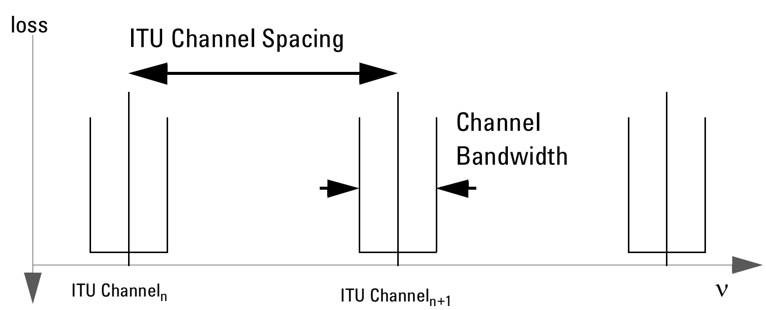
Crosstalk Adjacent Ch. Short Wvl. [dB]	The difference between the maximum loss in the ITU channel, and the minimum loss in the next ITU channel at a shorter wavelength/longer frequency.
Crosstalk Adjacent Ch. Long Wvl. [dB]	The difference between the maximum loss in the ITU channel, and the minimum loss in the next ITU channel at a longer wavelength/lower frequency.

4 If you selected notch analysis, enter the values for the Channel Bandwidth, Drop Range Bandwidth, and the ITU Channel Spacing.

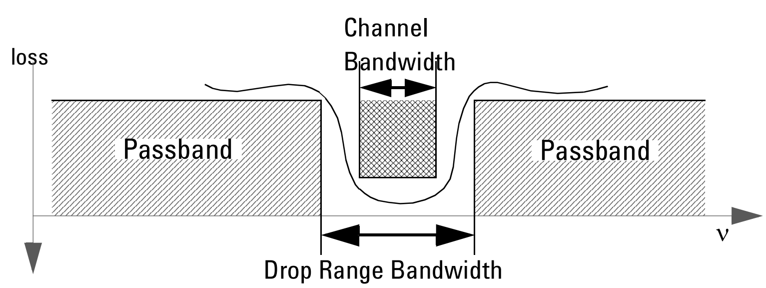
The ITU Channel Spacing (in the frequency domain) defines which of the channels, as defined by the International Telecommunication Union (ITU), are being used.

NOTE The Photonic All-Parameter Analyzer uses 193.1 THz as the ITU Channel 0 frequency.

The Channel Bandwidth is the nominal value of the width of each channel, centered around the ITU channel frequency.

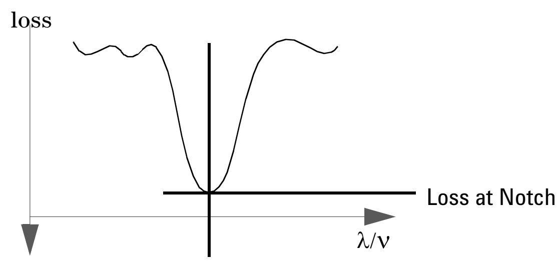


The Drop Range Bandwidth is the bandwidth to the edges of the passband.

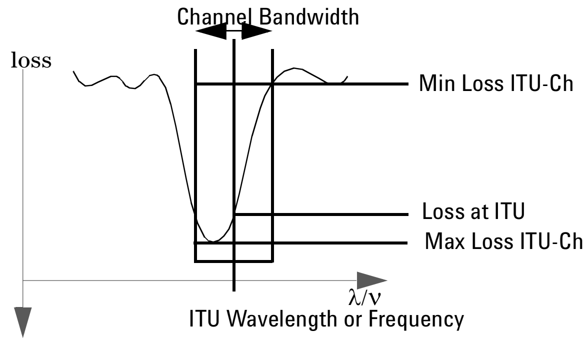


The results of the notch analysis are shown on the notch tab of the Analysis table window. The columns displayed are:

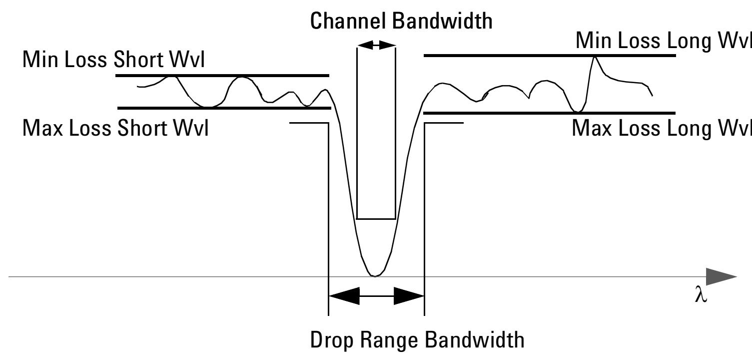
Color	Indicates the color of the corresponding graph
Measurement	The name of the file in which the measurement is stored.
Light Path	Whether the measurement was made in the transmission or reflection light path
Curve	The type of measurement (PDL, Loss,...).

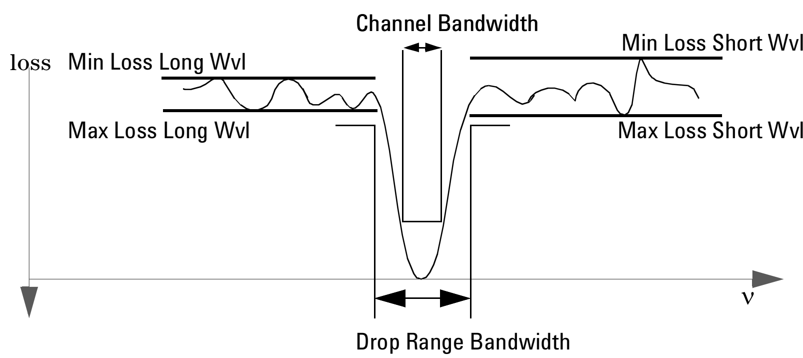


Notch Wavelength [nm] Notch Frequency [THz]	The wavelength or frequency at which the maximum loss was measured
Loss at Notch [dB]	The value of the maximum loss.



ITU-Ch	The number of the ITU Channel closest to the notch wavelength or frequency
ITU Wavelength [nm] ITU Frequency [THz]	The center wavelength or frequency of the ITU Channel
Loss at ITU [dB]	The loss at the ITU center wavelength or frequency
Min Loss ITU-Ch [dB]	The minimum loss in the ITU Channel centered at the ITU wavelength or frequency, with the specified channel bandwidth.
Max Loss ITU-Ch [dB]	The maximum loss in the ITU Channel centered at the ITU wavelength or frequency, with the specified channel bandwidth.





Min Loss Short Wvl Passband [dB]	The minimum loss measured at shorter wavelengths/higher frequencies, outside the drop range.
Max Loss Short Wvl Passband [dB]	The maximum loss measured at shorter wavelengths/higher frequencies, outside the drop range.
Min Loss Long Wvl Passband [dB]	The minimum loss measured at longer wavelengths/lower frequencies, outside the drop range.
Max Loss Long Wvl Passband [dB]	The maximum loss measured at longer wavelengths/lower frequencies, outside the drop range.

5 Click on the **Finish** button.

Reanalyzing the Generic, Peak and Notch Loss for the Active Measurement

1 in the Measurement View tab of the Workspace window click with the right mouse button on the measurement name, select **Reanalyze Loss**.

2 Click on the boxes to set a check mark in the row and column corresponding to the loss analyses you want to perform (generic, peak and notch analyses, in the transmission and reflection paths).
Click on the **Next >** button.

3 If you selected peak analyses, enter the values for the Channel Bandwidth, NdB Offset, and the ITU Channel Spacing.

4 If you selected notch analyses, enter the values for the Channel Bandwidth, Drop Range Bandwidth, and the ITU Channel Spacing.

5 Click on the **Finish** button.

The loss analyses are shown in the Analysis Table window. See “The View Menu” on page 95 for details on how to display the Analysis Table window.

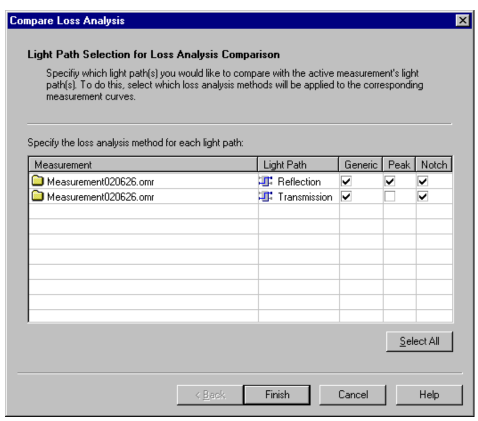
Comparing Loss Analyses for Several Measurements

Comparing the loss analyses for several measurements temporarily reanalyzes the generic, peak and notch loss analyses for the selected measurements with analyses based on the analysis parameters of the active measurement, and adds the resulting analyses to the analysis tables.

The analyses and analysis parameters for the selected measurements are not altered in the file or the measurement.
If you change the active measurement, the analyses for the comparison are deleted.
To change the analyses for a measurement, see “Reanalyzing the Generic, Peak and Notch Loss” on page 196.

1 In the **Analysis** menu, select **Compare Loss Analysis with Active Measurement...**.
   To compare the loss analyses for any individual non-active measurement with the active measurement, in the Measurement View tab of the Workspace window click with the right mouse button on the measurement name, use **Compare Loss Analysis with Active Measurement**.

2 Click on the boxes to set a check mark beside in the row and column corresponding to the loss analyses you want to compare with the active measurement (generic, peak and notch analyses, in the transmission and reflection paths).



3 Click on the **Finish** button.

The loss analyses of the active measurement and the measurements selected for comparison are shown in the Analysis Table window.
See “The View Menu” on page 95 for details on how to display the Analysis Table window.

Arranging the Analysis Table

Reordering the Table

You can reorder the table according to the data in any column by double-clicking on the header for that column.

For example, after you have first opened a file, double-clicking on **Min Loss [dB]** will sort the table in the order of ASCENDING minimum losses. Double clicking on **Min Loss [dB]** a second time will sort the table in the order of DESCENDING minimum losses.

Rearranging Columns in the Table

You can rearrange the columns in the table by clicking once on the header, then clicking on the header and, holding down the left mouse button, dragging the column to its new position.

While you are dragging the column, the cursor changes to . The position where the column will be reinserted into the table is shown as a red line.

Resizing and Hiding Columns

You can resize a column by clicking on the division between this column and the column to its right. The cursor changes to  when you are over the division between columns.
Hold down the mouse button and drag the column to the new width.

You can hide a column by reducing its width to zero.

You can resize a hidden column by moving over the gap between columns where the hidden column is, until the cursor changes to .
Hold down the mouse button and drag the column to the new width.

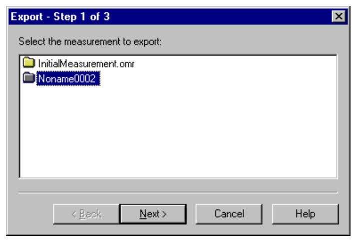
Exporting Data for Further Processing

Exporting Trace Data

To export the trace data for the active measurement as a **comma-delimited** ASCII text file:

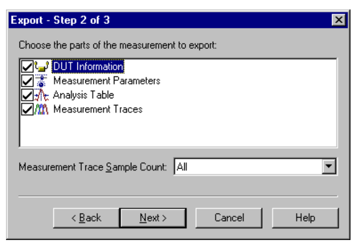
1 In the **File** menu, select **ASCII Export...**.

2 Click on the measurement for which you want to export results.



3 Click on the **Next** button.

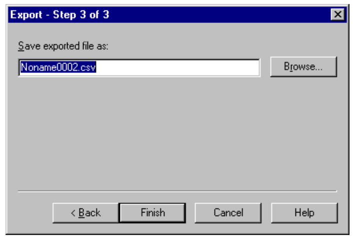
4 Make sure the only boxes checked are beside the parts of the measurement you want to export.



5 Select the number of samples you want to export for each curve.
If you select “All”, all of the samples used to draw the measurement curve will be exported.
If you select a number, that number of equally spaced samples will be exported. This makes it easier for you to compare curves, to generate consistent curves in an external application, or to reduce the quantity of data for post-processing by other applications.

6 Click on the **Next** button.

7 Enter the name for the file and click on the **Finish** button.



The selected results are exported to an ASCII text file using comma (,) separated values (.csv).

The Trace Data Export File

- The file starts with three lines listing the name and revision of the library and software used.
- Each section of the file starts with an empty line followed by a section header in angled brackets, for example:

  <Measurement parameters>.

The remaining sections are repeated for each measurement selected for export.

- The sections for DUT Settings and Measurement parameters, are followed by a number of lines, each starting with a label, followed by the parameter corresponding to that label, separated by commas. Some of the labels are indented (the line starts with a comma), such as the loss parameters, for example:

  <Measurement parameters>
  Loss measurement,Pdl
  ,Measure transmission,On
  ,Measure reflection,On
  ,Start wavelength [nm],1535
  ,Stop wavelength [nm],1575
  ,Wavelength step [nm],0.005
  ,Coherence control,Off
  ...

- The section for the Instrument setup has
  - The first line contains the labels for the data columns (Resource, Serial number, Software version), separated by commas.
  - The following rows contain the instrument setup data, separated by commas, for example:

  <Instrument setup>
  Resource,Serial number,Software version
  GPIB0::24::INSTR[POL(8169A)],3425G00857,V2.0
  GPIB0::30::INSTR[8164A],DE38200050,V3.50(87702)
  ...

- The remaining sections contain the Measurement traces. For each trace:
  - The first line contains information on the number of samples that follow (the number of rows of data).
  - The next line contains the labels for the data columns, separated by commas.
  - The following rows contain the trace data, separated by commas, for example:

```
<Measurement traces>
<DATA_ 201 samples>
Lambda[nm],DGD Ch.1 Tx[s],GD Ch.1 Tx[s],
1552.9,2.94033368261844e-014,8.21228823385218e-008,
1552.95,2.9039955403708e-014,8.21228953115737e-008,
1553,2.83575259191074e-014,8.21229085668691e-008,
1553.05,2.75106681223847e-014,8.21229222722829e-008,
1553.1,2.65939957128623e-014,8.21229365245315e-008,
1553.15,2.55078013585895e-014,8.21229513412002e-008,
1553.2,2.50851464762884e-014,8.21229666754103e-008,
1553.25, ...
```

Exporting the Jones Matrix

NOTE

You can only export the Jones Matrix for GD and DGD measurements where this matrix was generated at the time that the measurement was made.
See “Setting the Measurement Parameters for All Parameter Mode” on page 140, and “Setting the Measurement Parameters in Expert Mode” on page 144 for information on generating the Jones Matrix.

To export the Jones Matrix for the active measurement as a **comma - delimited** ASCII text file:

1 In the **File** menu, select **ASCII Export Jones Matrix...**.
2 Enter the name for the file and click on the **Save** button.

The selected results are exported to an ASCII text file (.txt) using comma separated values.

The Jones Matrix Export File

- The first three lines start with a “%”, and contain the name and revision of the software and the labels for the data.
  - The second line contains the labels for the data columns.
    The first column for each reference or DUT measurement is the wavelength, and the following 8 columns correspond to the elements of the amplitude and phase matrices (interleaved), as indicated by the label.
  - The third line contains the label for the measurement (the channel number, whether it is in transmission or reflection, and whether it is a reference or a DUT measurement).
  - The labels are positioned in their respective columns by commas.
- The remaining lines contain the data for the matrices for each wavelength, separated by commas.
  For example:

%Wavelength	Amp(j11)	Phase(j11)	Amp(j12)	Phase(j12)	Amp(j21)	Phase(j21)	Amp(j22)	Phase(j22)	Wavelength	Amp(j11)	Phase(j11)	Amp(j12)	Phase(j12)	Amp(j21)
%Channel_1 Tx, Reference									Channel_1 Tx, Measurement					
1.5529E-06	3.766501084	76147.5383	3.476574733	76146.88745	3.471860346	76142.82206	3.79469005	76139.01697	1.5529E-06	1.000082854	0.931255012	0.0008369	1.165030736	0.000507231
1.55295E-06	3.7654402	79454.5058	3.472911739	79453.85418	3.470508503	79449.79016	3.79545003	79445.98429	1.55295E-06	1.000067942	1.77708272	0.000840848	2.014323943	0.000511528
0.000001553	3.764402215	82761.26088	3.46926922	82760.60845	3.469237545	82756.54584	3.796262512	82752.73917	0.000001553	1.000054049	2.629292755	0.000839932	2.867795708	0.000516343
1.55305E-06	3.763406068	86067.80356	3.465675793	86067.15029	3.468041161	86063.08913	3.797126643	86059.28164	1.55305E-06	1.00004185	-2.795299953	0.000833496	-2.557223957	0.000521585
1.5531E-06	3.762466917	89374.13388	3.462158388	89373.47974	3.46690168	89369.42007	3.798028316	89365.61172	1.5531E-06	1.000031917	-1.930327948	0.000821598	-1.693585887	0.000527119
1.55315E-06	3.761595781	92680.25188	3.458740447	92679.59683	3.465797338	92675.5387	3.798947405	92671.72944	1.55315E-06	1.00002468	-1.058982199	0.000804995	-0.823640201	0.000532723
1.5532E-06	3.760798959	95986.15758	3.455440012	95985.50158	3.464707807	95981.44505	3.799863427	95977.63484	1.5532E-06	1.000020473	-0.181269613	0.000784982	0.053366552	0.000538064
1.55325E-06	3.76007765	99291.85103	3.4522685	99291.19403	3.463618647	99287.13915	3.800760421	99283.32794	1.55325E-06	1.00001945	0.702803479	0.000763314	0.937945302	0.000542784
1.5533E-06	3.759428058	102597.3322	3.449229958	102596.6742	3.462522923	102592.621	3.80162898	102588.8088	1.5533E-06	1.000021533	1.593233229	0.000741903	1.830270744	0.000546568
1.55335E-06	3.758842171	105902.6013	3.446321035	105901.9421	3.461422298	105897.8907	3.802468207	105894.0773	1.55335E-06	1.000026493	2.490019374	0.000722675	2.73012954	0.000549186

Exporting the Mueller Matrix

NOTE

The Mueller Matrix information can only be generated from PDL measurements.
See “Setting the Measurement Parameters for All Parameter Mode” on page 140, and “Setting the Measurement Parameters in Expert Mode” on page 144 for information on specifying the measurement of PDL.

The Mueller Matrix information is restricted to the four first-row coefficients used in the calculation of PDL.

To export the Mueller Matrix data for the active measurement as a **comma -delimited** ASCII text file:

1 In the **File** menu, select **ASCII Export Mueller Matrix...**.

2 Enter the name for the file and click on the **Save** button.

The selected results are exported to an ASCII text file (.txt) using comma separated values.

The Mueller Matrix Export File

- The first three lines start with a “%”, and contain the name and revision of the software and the labels for the data.
  - The second line contains the labels for the data columns.
    The first column for each reference or DUT measurement is the wavelength, and the following 4 columns correspond to the elements of the matrix, as indicated by the label.
  - The third line contains the label for the measurement (the channel number, and whether it is in transmission or reflection).
  - The labels are positioned in their respective columns by commas.
- The remaining lines contain the data for the first row of the matrices for each wavelength, separated by commas.
  For example:

%Wavelength	m11	m12	m13	m14	Wavelength	m11	m12	m13	m14
%Channel_1 Rx					Channel_1 Tx				
1.4958E-06	1.000082854	0.931255012	0.0008369	1.165030736	1.4958E-06	1.000123861	-0.134815583	0.000854288	0.112897565
1.49585E-06	1.000067942	1.77708272	0.000840848	2.014323943	1.49585E-06	1.000111103	0.877271721	0.000854889	1.133575166
1.4959E-06	1.000054049	2.629292755	0.000839932	2.867795708	1.4959E-06	1.00009563	1.895769159	0.000854716	2.160287937
1.49595E-06	1.00004185	-2.795299953	0.000833496	-2.557223957	1.49595E-06	1.000078186	2.920681237	0.000854161	-3.090732712
0.000001496	1.000031917	-1.930327948	0.000821598	-1.693585887	0.000001496	1.000059709	-2.33117335	0.000853419	-2.053546169
1.49605E-06	1.00002468	-1.058982199	0.000804995	-0.823640201	1.49605E-06	1.000041227	-1.293420734	0.000852447	-1.011651514
1.4961E-06	1.000020473	-0.181269613	0.000784982	0.053366552	1.4961E-06	1.000023781	-0.24924388	0.000850988	0.034869984
1.49615E-06	1.00001945	0.702803479	0.000763314	0.937945302	1.49615E-06	1.000008346	0.801358965	0.000848749	1.086007671
1.4962E-06	1.000021533	1.593233229	0.000741903	1.830270744	1.4962E-06	0.99999573	1.858389323	0.000845432	2.141864228
1.49625E-06	1.000026493	2.490019374	0.000722675	2.73012954	1.49625E-06	0.999986491	2.921848571	0.00084096	-3.080561103

Saving and Closing Analyses

If you have changed the analysis of a measurement, you may want to save it, either replacing the original measurement, or using a different name to preserve the original analysis.

When you have finished analyzing a measurement, you should close it to remove it from memory.

Saving Measurements

- In the Measurement View tab of the Workspace window click with the right mouse button on the measurement name, select **Save**.

You can also save the active measurement, in the **File** menu, by selecting **Save Active Measurement**.

Saving a Measurement with a Different Name

- In the Measurement View tab of the Workspace window click with the right mouse button on the measurement name, select **Save As...**.
- Enter the name for the file.
- Click on the **Save** button.

You can save the active measurement with a Different Name

- In the **File** menu, select **Save Active Measurement As...**.
- Enter the name for the file.
- Click on the **Save** button.

Saving All Measurements

- In the **File** menu, select **Save All**.

Closing Measurements

- In the Measurement View tab of the Workspace window click with the right mouse button on the measurement name, select **Close**.

You can also save the active measurement, in the **File** menu, by selecting **Close Active Measurement**.

Closing All Measurements

- In the **File** menu, select **Close All**.

6
System Specifications

Performance Specifications

Guaranteed Specifications

Each 81910A is individually tested for each specification and has passed test limits which are tighter than what is displayed as specification. The test and specification process follows strict guidelines and is controlled by our metrology laboratory. The system specifications are traceable to national standards or equivalent according to Agilent guidelines. Offering a thorough data sheet backed by stringent quality control measures guarantees best performance and application fit over time.

Agilent 81910A Photonic All-parameter Analyzer Configuration for Measurement of Spectral Loss, Polarization Dependent Loss, Group Delay and Differential Group Delay

The specifications given in this section are valid after warm-up, at the stated operating conditions and measurement settings, at uninterrupted line voltage, and after a reference measurement. Constant ambient temperature ±1 K after reference measurement. All optical patchcords and fibers fixed and settled for Š 3 minutes.

	Technical Specifications
Wavelength range for warranted operation	1520 nm to 1620 nm
Operating wavelength range	1498.1 nm to 1620 nm (option #001 and #002) 1477 nm to 1620 nm (option #003 or #004)
Operating conditions	Ambient temperature 5°C to 45°C, relative humidity <80%, non-condensing conditions; environmental conditions suitable for precise optical measurements
Conditions for specified operation	Ambient temperature 23°C ±5 K, relative humidity <80%, non-condensing conditions; environmental conditions suitable for precise optical measurements
Warm-up time	1 hour
Environmental storage conditions	-40 to +50°C
Measurement time	Typically 60 seconds for a fully specified measurement of a narrow-band device, including all loss and dispersion measurements in transmission and reflection. Includes instrument initialization, measurement of device under test, data acquisition and display. Reference measurements excluded.

Loss and Polarization Dependent Loss Measurement Specifications

Loss uncertainty[a]	**Transmission**	**Reflection** [b]
loss ≤ 0.5 dB	±0.010 dB	±0.020 dB
loss ≤ 10 dB	±0.015 dB	±0.025 dB
loss ≤ 30 dB [c]	±0.025 dB	±0.040 dB
loss ≤ 40 dB [c]	±0.050 dB	
Loss range (typical)	> 55 dB	> 45 dB

Polarization dependent loss (PDL) uncertainty [d]		
loss ≤ 0.5 dB	±(0.040 dB + 3% of device PDL) typ.: ±(0.030 dB +3% of device PDL)	±(0.040 dB + 3% of device PDL) typ.: ±(0.030 dB +3% of device PDL)
loss ≤ 10 dB	±(0.050 dB + 3% of device PDL)	±(0.055 dB + 3% of device PDL)
loss ≤ 30 dB	±(0.060 dB + 3% of device PDL)	±(0.100 dB + 3% of device PDL)
Absolute wavelength uncertainty [e]	±4 pm (±1.5 pm typ.)	
Relative wavelength uncertainty [e]	±3 pm (±0.8 pm typ.)	
Wavelength repeatability (typical)	±0.3 pm	
Measurement settings as follows: 2 pm step size; ≤ 5 nm/s sweep speed; coherence control off; after zeroing of power meters. For measurements of, and around, steep slopes, choose sweep speed in nm/s ≤ 200 divided by slope in dB/nm for a device loss ≤ 10 dB, else sweep speed in nm/s ≤ 50 divided by slope in dB/nm. Device PDL ≤ 1 dB.		

[a] For polarization dependent devices, the measurement result corresponds to the loss for non polarized light. Valid for PDL ≤ 0.1 dB if loss ≤ 0.5 dB, and PDL ≤ 0.4 dB if loss ≤ 10 dB.

[b] Loss results are relative to the loss of a reference reflector (with return loss ≤ 0.3 dB) used in the reference measurement. Note: the reference gold reflector supplied with the test head has a return loss of typ. (0.16 ± 0.13) dB.

[c] Source spontaneous emission (SSE) of tunable laser sources (TLS) limits the measurable loss dynamic range of components with narrow stop band and broad transmission band (like Fiber Bragg Gratings in transmission). This means an additional loss uncertainty in the stop band depending on the amount of total SSE of the source used. The Signal-to-total-SSE ratio of the Agilent 81600B #160 TLS at wavelengths up to 1610 nm is ≥ 55 dB.

[d] Excludes the polarization dependent loss of all optical connections to the optical test head. In reflection, PDL uncertainty specifications are typical if the straight or angled reference kit has been used

[e] Valid in the wavelength range of an $H^{13}C^{14}N$ molecular gas cell (NIST SRM 2519), 1528.5 - 1561.6 nm. Outside this range add typ. ±1 pm.

Dispersion Measurement Specifications

Group Delay (GD)	Transmission	Reflection
Group Delay dynamic range (typical)	10 ns	
Group Delay loss range (typical)	30 dB	
Group Delay resolution	<0.1 fs	
Group Delay uncertainty [a] [b]		
Group Delay noise [c] [d]	< ± 50 fs (< ± 35 fs typical) [e]	
Group Delay relative uncertainty[f]	±1.5 % of device relative Group Delay	

Differential Group Delay (DGD)	Transmission	Reflection
Differential Group Delay measurement range (typical)	0.5 ns	
Differential Group Delay loss range (typical)	30 dB	
DGD resolution	<0.1 fs	
Differential Group Delay uncertainty [a]		
Differential Group Delay noise [cd]	< ± 80 fs (< ± 55 fs typical) [e]	
Polarization Mode Dispersion (PMD) uncertainty[g] (typical)	<±5.0 fs	n/a
Absolute wavelength uncertainty [h]	± 1.5 pm	
Maximum device optical path length (typical)	15 m (80 nm/s sweep speed) 30 m (40 nm/s sweep speed) 60 m (20 nm/s sweep speed) 120 m (10 nm/s sweep speed)	

[a] Any 50 nm within 1520 and 1620 nm.
[b] For polarization dependent devices, the measurement result corresponds to the GD for non polarized light.
[c] 30 measurements averaged, wavelength resolution bandwidth 30 pm, 40 nm/s sweep speed.. For a detailed relation between uncertainty, resolution, and number of averages, please refer to the supplementary dispersion measurement characteristics. This relation allows you to choose the best parameter fit for an individual application.
[d] Measuring a patch cord, made of 2 m standard single mode fiber and a 0.1 m section of polarization maintaining fiber with ~0.1 ps DGD in transmission. In reflection, measuring a patch cord, made of 1 m standard single mode fiber and a 0.1 m section of polarization maintaining fiber with ~0.1 ps DGD, terminated by a gold reflector.
[e] 30 measurements averaged, wavelength resolution bandwidth 30 pm, 80 nm/s sweep speed over full operating wavelength range.
[f] Measuring a GD peak of ~16.5 ps amplitude at wavelength 1550.515 nm of a $H^{13}C^{14}N$ molecular gas cell (NIST SRM 2519). The peak GD value is derived from spectral loss data using the Kramers-Kronig relation. Double pass of the cell in reflection. 30 measurements averaged, wavelength resolution bandwidth 10 pm.
[g] Measurement of NIST Standard Reference Material 2518 (Mode-coupled PMD artifact, 50 nm wavelength range from 1520 to 1570 nm, PMD ~300 fs).
[h] Valid in the wavelength range of an $H^{13}C^{14}N$ molecular gas cell, 1528.5 - 1561.6 nm. Outside this range uncertainty values are typical. Between 1595 nm and 1620 nm uncertainties are as given in the Loss and PDL section.

For a detailed relation between uncertainty, resolution and number of averages, please refer to the supplementary dispersion measurement characteristics allowing to choose best parameter fit for an individual application.

Supplementary dispersion measurement characteristics

Group Delay and Differential Group Delay measurement uncertainty can be customized to any application requirements in terms of accuracy, resolution, and measurement time by adjusting resolution bandwidth and number of averaged sweeps. The relation between accuracy, resolution bandwidth and averages is shown in Figure 17 and Figure 18.

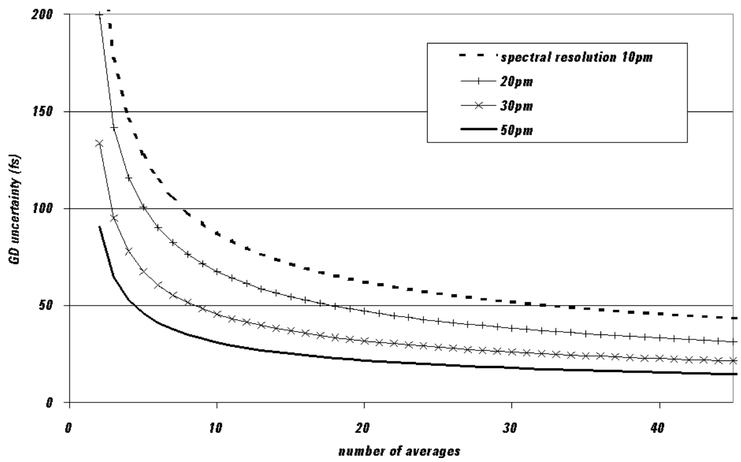


Figure 17 Group Delay noise as a function of resolution bandwidth and number of averages

NOTE Graphics depict the performance of a representative unit measured on an optical bench. Note that with 30 pm spectral averaging and 30 averages a Group Delay uncertainty of 25 fs is achieved. Valid between 1520 and 1620 nm at 40 nm/s.

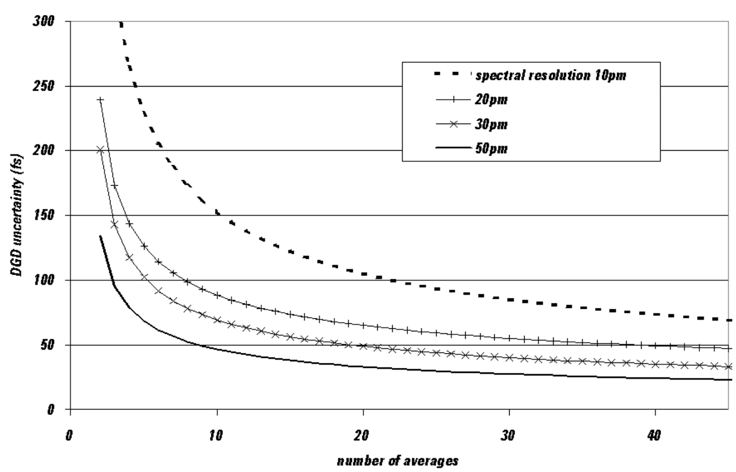


Figure 18 Differential Group Delay noise as a function of resolution bandwidth and number of averages

Ordering instructions

The Agilent 81910A Photonic All-Parameter Analyzer must be ordered with option #001 or #002, #003, or #004.
Option #005 can be combined with any of these options.

81910A #001: complete system.
Includes 81600B #160 tunable laser, 8164B mainframe, 8169A polarization controller, 81634B power meters, system controller, licensed software, three reference kits, accessories and optical test head.
Each reference kit consists of transmission fiber and pigtailed reflector equipped with straight or angled connectors or with bare fibers.
System controller may be used as host PC.

81910A #002: same as #001, but integrates a pre-owned tunable laser. Customer has to send back either one tunable laser source 81640A, 81680A/B, or 81480A/B for conversion into an 81600B #160 tunable laser and integration in the system, or a tunable laser source 81600B #160 or 81640B with option #072 (angled connector) for integration.

81910A #003: same as #001, but includes a 81600B #200 tunable laser.

81910A #004: same as #003, but integrates a pre-owned 81600B #200 tunable laser. Customer has to send back one tunable laser source 81600B #200 to Agilent Technologies for integration in the system.

81910A #005: system without DGD and PMD measurement functions. If these capabilities are required later, they can be added by ordering 81911A retrofit DGD and PMD measurement function. Every system shipped is verified for DGD and PMD measurement accuracy, whether or not #005 is ordered, to ensure upgrading is possible.

81911A: retrofit DGD and PMD measurement function to an 81910A with option #005.
The upgrade is carried out on site by an Agilent Technologies representative. Performance verification is included. Please state the 81910A system serial number when ordering.

Optional: if a second PC is used as a host, the following performance is required: PC with min. 500 MHz CPU, 192 MB RAM or more, Windows XP,

Windows 2000 or Windows NT with SP6, 200 MB free hard disk space; 2 free PCI slots; 81910A operated by a SW revision greater 2.5.

7
Performance Verification

Operational Verification Test

Purpose

Although this verification is a subset of the total process for verifying the system's conformance to specifications, this procedure can be used alone as a functional test and can be helpful in the following ways:

- It can be used at incoming inspection to check that no major degradation has occurred in the system during shipment
- It provides a means to periodically monitor measurement stability
- It can help isolate the cause of incorrect measurement results. (When the system passes the test, you will have confidence the system is operating correctly and any problem is in the setup or with the DUT)

Introduction

This chapter covers the verification procedure for the 81910A All-Parameter Analyzer.

Before running the verification procedures, turn the system on and allow it to warm up for one hour (1 h). Please close the hood of the optical test head before making any measurement.

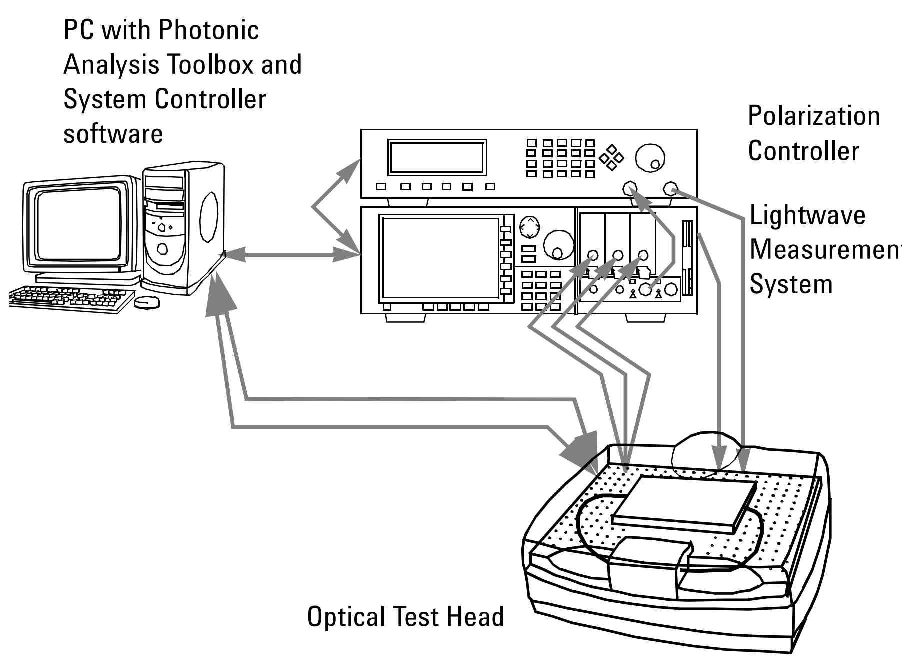


Figure 19 81910A All-parameter Analyzer Setup

Equipment Required

Required equipment to perform the operational verification test is delivered with the 81910A All-parameter Analyzer system. For reference, the additional accessories required during the operational verification test are listed in the table below.

Qty	Part Number	Part Description
1 ea	81910-88706	Reference Fiber Kit Angled, incl. • 16 m Transmission Reference Fiber • 8 m Reflection Reference Fiber with Reflector • 2.2 m SMF/PMF Mixed Fiber for Transmission • 1.1 m SMF/PMF Mixed Fiber with Reflector
2 ea	81000FI + Protective Cap	FC/PC Connector Interface

NOTE Make sure that all optical connections for the test setups given in the procedure are dry and clean. DO NOT USE INDEX MATCHING OIL. For cleaning, use the cleaning instructions given in “Cleaning” on page 270.

CAUTION DO NOT DISCONNECT AND CLEAN THE FIBERS CONNECTED TO THE THREE POWERMETERS. These fibers have a special anti-reflection (AR) coating that is removed by cleaning the connectors with anything other than clean and compressed air. Removing this coating results in performance degradation.

Fix the DUT on the bench of the Optical Test Head and fix the optical cables, using the fiber clamps, to ensure minimum cable movement during the tests.

Ensure you run the recommended tests after exchanging the Optical Test Head adapter patchcords for maintenance.

Performing Diagnostics

Before taking any measurements, make sure the system passes the diagnostics.

The Diagnostic Tool is a part of the software installed with the Photonic Analysis Toolbox application on the PC. It can be accessed through the windows start menu.

Please visit our website www.agilent.com for the latest release of the Diagnostic Tool.

The tests are performed in a hierarchical sequence, starting with general requirements and finishing with testing specific power levels in different configurations. The last step requires user interaction and the following equipment

- transmission reference fiber
- reflection reference fiber
- caps to darken optical input and output

Sequence

1 On the PC, where the Photonic Analysis Toolbox is installed, start the Diagnostic Tool.
   - Click on the Windows **Start** menu.
   - Select **Programs** and then **Photonic Tools.**
   - In **Photonic Tools** select **Diagnostic Tool.**
2 In the **Diagnose** menu, select **All**.
3 Follow the instructions as required while the program executes the Optical Layer Test.

The tests are, in detail:

- Operating System Layer
  Purpose: Verification of the system requirements to successfully run measurements
  User Interaction: none
- Software Layer
  Purpose: Check availability and revision of required libraries and licenses
  User Interaction: none
- Controller Layer
  Purpose: Triggering and verification of self-test status of the system controller
  User Interaction: none

- Instrument Layer
  Purpose: Verification of hardware test setup, check availability of required instruments
  User Interaction: none
- Optical Layer
  Purpose: Verification of instrument setup, cabling and performance of subparts
  User Interaction: yes

  The optical layer test requires following user interactions:

  a Verification that no DUT is connected to the Optical Test Head

  b Connection of reference patchcord to the Optical Test Head

  c Connection of a reference reflection to the Optical Test Head

  If the optical layer test fails, a dialog box gives further advice on how to proceed. Please follow the advise in order to resolve the issue.

  If the error cannot be resolved by following the suggestions given in the diagnostic analyzer, contact your Agilent Service representative. Please save a log of the diagnostic test.

Please find below a schematic drawing for your reference. The diagnostic tool lists the power readings according to the scheme below.

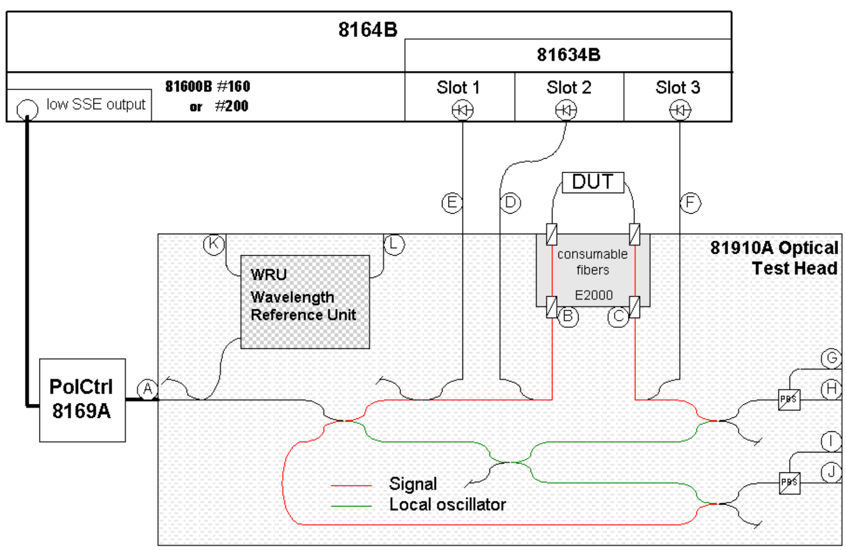


Figure 20 Schematic Drawing of the Optical Architecture

Problem Analysis and Solution

warning	**Low monitoring power**
cause	Patchcord to power module in slot 1
description	The Diagnostic Tool has found at least one expected power value within the given test limit, but the test for monitoring power failed. This indicates, the connection to the Optical Test Head is ok, but the connector or fiber to the power module in slot 1 has too much insertion loss
potentially affected components	Connection to power module in slot 1
solution	Using clean and dry air, blow clean the connection of the power module in slot 1 (fiber connector and module input lens) – but do not physically touch or otherwise clean the special treated fiber connector

warning	**Low transmission power**
cause	• Adapter patchcord on the optical input of the Optical Test Head • Patchcord used as device under test • Patchcord to power module slot 3
description	The Diagnostic Tool has found monitoring and reflection power levels are within test limits, but the transmission power is below test limit. This indicates a high insertion loss for the transmission measurement
potentially affected components	• Adapter patchcord on the input of the Optical Test Head (right connector) • Transmission device under test • Patchcord to power module in slot 3
solution	• Clean the connectors of the adapter patchcord connected to the input of the Optical Test Head and the patchcord used as device under test • Use another adapter patchcord on the optical input of the Optical Test Head • Use another patchcord as device under test • Using clean and dry air, blow clean the connection of the power module in slot 3 (fiber connector and module input lens) – but do not physically touch or otherwise clean the special treated fiber connector

warning	**Low reflection power**
cause	• Adapter patchcord on the optical output of the Optical Test Head • Reflection device under test • Patchcord to power module slot 2
description	The Diagnostic Tool has found monitoring and transmission power levels are within test limits, but the reflection power is below test limit. This indicates a high insertion loss for the reflection measurement
potentially affected components	• Adapter patchcord on the output of the Optical Test Head (left connector) • Reflection device under test • Patchcord to power module in slot 2
solution	• Clean the connectors of the adapter patchcord connected to the output of the Optical Test Head and the reflection device • Use another adapter patchcord on the optical output of the Optical Test Head • Use another reflection device • Using clean and dry air, blow clean the connection of the power module in slot 2 (fiber connector and module input lens) – but do not physically touch or otherwise clean the special treated fiber connector

warning	**Low monitoring, transmission and reflection power**
cause	• Connection TLS - Polarization Controller - Optical Test Head has a high loss • Leading fibers from Optical Test Head to power modules defect (fiber break or connector loss)
description	The Diagnostic Tool has found power values at all power modules in slot 1, 2 and 3 are below test limit; indicating an unusually high loss at the beginning of the optical path (TLS to Optical Test Head).
potentially affected components	• Short and long semi-rigid fibers • Connections on TLS, Polarization Controller and Optical Test Head
solution	• Clean the semi-rigid fibers connections and reconnect. Do not apply stress to the short semi rigid fiber. • Using clean and dry air, blow clean the connections on the 3 power modules 1, 2 and 3 (fiber connector and module input lens) – but do not physically touch or otherwise clean the special treated fiber connectors

warning	**Low transmission and reflection power**
cause	• Adapter patchcords on the optical input and output of the Optical Test Head • Reflection device used as device under test • Connection TLS - Polarization Controller - Optical Test Head has a high loss
description	The Diagnostic Tool has found low transmission and reflection power, while the monitoring power was within test limits. This may happen if either the adapter patchcords / DUT has too high a loss or if the connection to the Optical Test Head has a high insertion loss.
potentially affected components	• Adapter patchcords within Optical Test Head • Reflection / Transmission device under test • Connection TLS – Polarization Controller – Optical Test Head • Three patchcords in the tubing from the back of the Optical Test Head
solution	• Clean the connectors of the adapter patchcords and the device under test • Use another adapter patchcord on the optical output of the Optical Test Head • Clean the semi-rigid fibers connections and reconnect them

warning	**Low monitoring power, high reflection and transmission power**
cause	Patchcord to power module slot 1
description	The Diagnostic Tool has found the power value at power module in slot 1 to be below the given test limit, while the power values for slot 2 and 3 were above the upper test limit. This failure is a result of two different errors, but proceed with suggested solution first (second failure is: High transmission or reflection power)
potentially affected components	Connection to power module in slot 1
solution	Using clean and dry air, blow clean the connection of the power module in slot 1 (fiber connector and module input lens) – but do not physically touch or otherwise clean the special treated fiber connector

warning	**High monitoring power**
cause	Wrong optical connection to power module in slot 1
description	The Diagnostic Tool has found the power value at power module in slot 1 exceeds the upper limit. If this happens, the fiber optic connections are incorrect. Please refer to the installation description.
potentially affected components	• All fiber optic connections • Optical Test Head
solution	Connect the correct patchcord to the power module in slot 1

warning	**High reflection power**
cause	High reflection from input connector (normal if your connector optical output power is straight)
description	NOTE! This test will fail for all straight ended connections due to the high back reflection (low return loss). No action is needed if a bare fiber or a straight output connector is used. To run an extensive test, change the adapter patchcord to angled connections and verify whether this test passes or fails. This test may fail also, if the output connection of the Optical Test Head shows too little return loss due to wear or physical damage (scratches)
potentially affected components	Adapter patchcord at the output of the Optical Test Head (left connector)
solution	• If a straight or bare adapter patchcord is connected to the optical output of the Optical Test Head, this test is intended to fail • If an adapter patchcord with angled output connector is connected to the optical output, then **a** clean this adapter patchcord, **b** use another angled adapter patchcord at the optical output

warning	**High transmission or reflection power**
cause	Semi-rigid fiber connection
description	The Diagnostic Tool has found too much power is applied to the power modules in slot 2 and 3, leading to over ranging when starting a measurement. This failure is really rare and might only happen if the state of polarization at the input of the polarization controller is near to an ideal linear input state. Disconnecting, bending and reconnecting the semi-rigid fibers resolves this failure.
potentially affected components	Short and long semi-rigid fiber connections
solution	• Reconnect the semi-rigid fibers • Reconnect the short semi-rigid fiber with flipped connections (that is, connecting what was previously the TLS output to Polarization Controller input, and vice versa.)

warning	**The power expected in transmission and reflection are interchanged**
cause	Two patchcords to power modules have been interchanged
description	The Diagnostic Tool has found the expected power values for transmission and reflection measurements to be interchanged. This can happen if either the adapter patchcords within the Optical Test Head or the patchcords to the power module in slot 2 and 3 are interchanged.
potentially affected components	• Three patchcords in the tubing from the back of the Optical Test Head • Adapter patchcords within Optical Test Head
solution	Interchange patchcords to power module in slot 2 and 3

warning	**Transmission power equal to expected monitoring power**
cause	Two patchcords to power modules have been interchanged
description	The Diagnostic Tool has found unexpected power values applied to power module in slot 1 and 3. This can happen if either the adapter patchcords within the Optical Test Head or the patchcords to the power module in slot 1 and 3 are interchanged.
potentially affected components	• Three patchcords in the tubing from the back of the Optical Test Head • Adapter Patchcords within Optical Test Head
solution	Interchange patchcords to power module in slot 1 and 3

warning	**Reflection power equal to expected monitoring power**
cause	Two patchcords to power modules have been interchanged
description	The Diagnostic Tool has found unexpected power values applied to power module in slot 1 and 2. This can happen if either the adapter patchcords within the Optical Test Head or the patchcords to the power module in slot 1 and 2 are interchanged.
potentially affected components	• Connection to power module in slot 1, 2 and 3 • Adapter patchcords within Optical Test Head
solution	Interchange patchcords to power module in slot 1 and 2

warning	**Internal optical loss failure**
cause	WRU failure
description	The power values detected at the Optical Test Head internal wavelength reference unit (WRU) are too low
potentially affected components	Optical Test Head
solution	Contact your Agilent Service representative

warning	**Internal optical loss failure**
cause	Local oscillator failure
description	The power values at the Optical Test Head internal oscillator are too low
potentially affected components	Optical Test Head
solution	Contact your Agilent Service representative

warning	**Internal optical loss failure**
cause	WRU or local oscillator failure
description	Diagnostic has detected too much power at the Optical Test Head internal wavelength reference unit (WRU) or at the internal oscillator
potentially affected components	Optical Test Head
solution	Contact your Agilent Service representative

Verification Test

If the diagnostic tool has passed all layer tests, start testing the functionality of the system.

Transmission Measurements

Test Setup and Measurement

1 If the system has been warmed up for an hour, start the Photonic Analysis Toolbox.

2 Set up the measurement with the following parameters:

Parameters	Test Settings
Measurement	GD / DGD and Loss/PDL
Direction	Transmission
Start Wavelength	1550.0
Stop Wavelength	1555.0
Wavelength Step	1.0 pm
Number of Scans	30
Range of Data Points for Averaging	30
Dynamic Range	Low (One Sweep)
Coherence Control	Off
Maximum Sweep Speed	5 nm/s
Power Sensor Start Range, Transmission	automatic
Power Sensor Start Range, Reflection	n/a

3 Start the reference measurement

a Perform the **Initialization Reference**, including the Zero Power Sensor function, using protective caps on the connectors of the Optical Test Head to prevent light from entering the fibers.

b Connect the **transmission reference device (16 m fiber)** to the output and input of the Optical Test Head. Allow 3 min. for the fiber to settle.

c Perform the **Transmission Reference**. This will be used for the phase measurement verification (GD and DGD).

d Press **Finish**.

4 Disconnect the transmission reference device and connect the **2.2 m mixed-fiber transmission device** to the output and input of the Optical Test Head. Fix the fiber on the Test Head so that it does not move during the measurements.

5 Start the DUT Measurement. The result will be used to verify the **measurement of GD and DGD**.

6 When the measurement is finished, and particularly if the test limits are exceeded, save the measurement results to a file.
a) If not already set as active measurement, set as active measurement in the **Curve View** tab.
b) From the **File** menu, select **Save Active Measurement**.

7 Analyze the GD and DGD measurement curves to verify the phase measurements in transmission. Sample results are shown below.

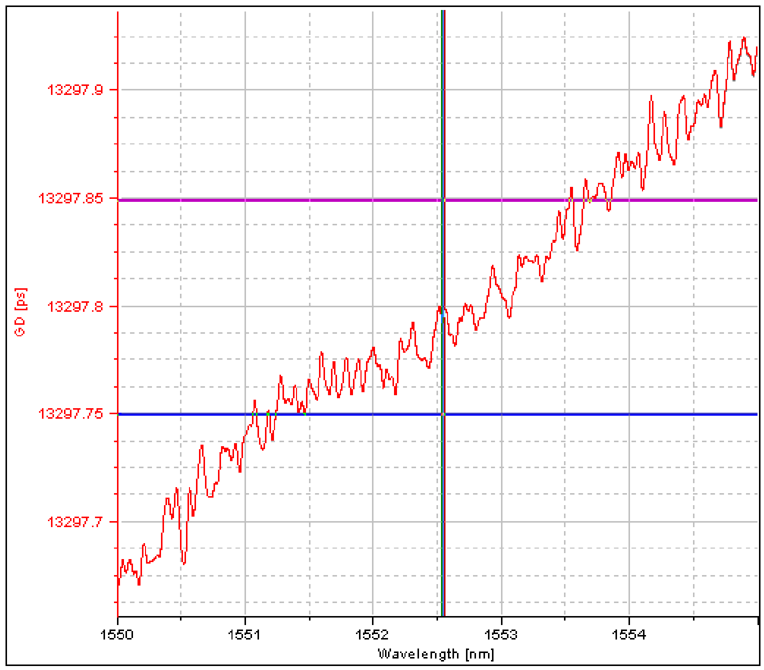


Figure 21 Group Delay (GD)

There is a linear increase of GD vs. wavelength due to fiber dispersion. The fluctuation in GD other than this increase should stay within the test limit. Test limit: ±0.05 ps around the fitted regression of the GD curve.

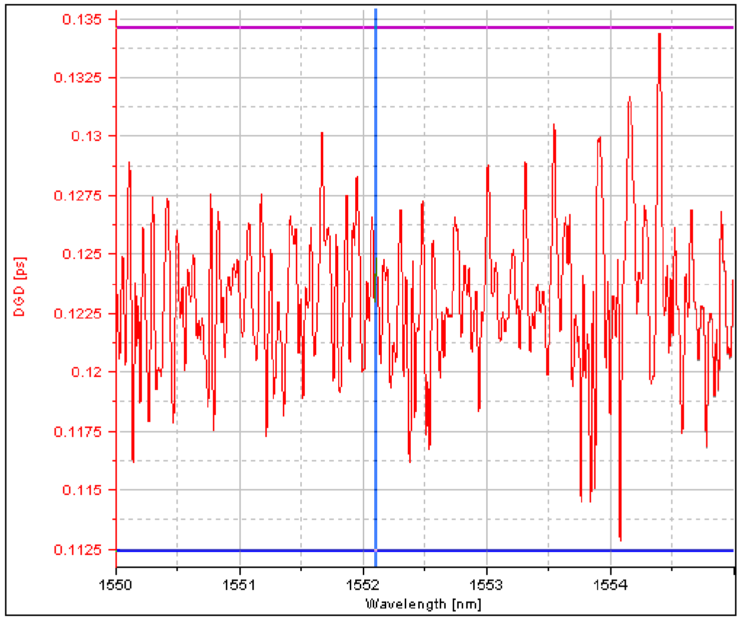


Figure 22 Differential Group Delay (DGD)

Test Limit: ± 0.08 ps around the mean of the DGD curve. The mixed test fiber provides a DGD of about 0.150 ps.

8 Leaving the mixed-fiber transmission device attached and unmoved, repeat the **Transmission Reference** measurement. It is not necessary to repeat the initialization reference.

9 Then **reposition the mixed fiber device** without disconnecting. For example flip the coils of the fiber over. The goal is to change the polarization states inside the fiber. Fix the fiber again so it does not move. Then wait 3 minutes for the fiber to settle.

10 Start the DUT measurement. The result will be used to verify the **measurement of IL and PDL**.

11 When the measurement is finished, and particularly if the test limits are exceeded, save the measurement results to a second file.

12 Analyze the IL and PDL measurement curves to verify the loss measurements in transmission. Sample results are shown below.

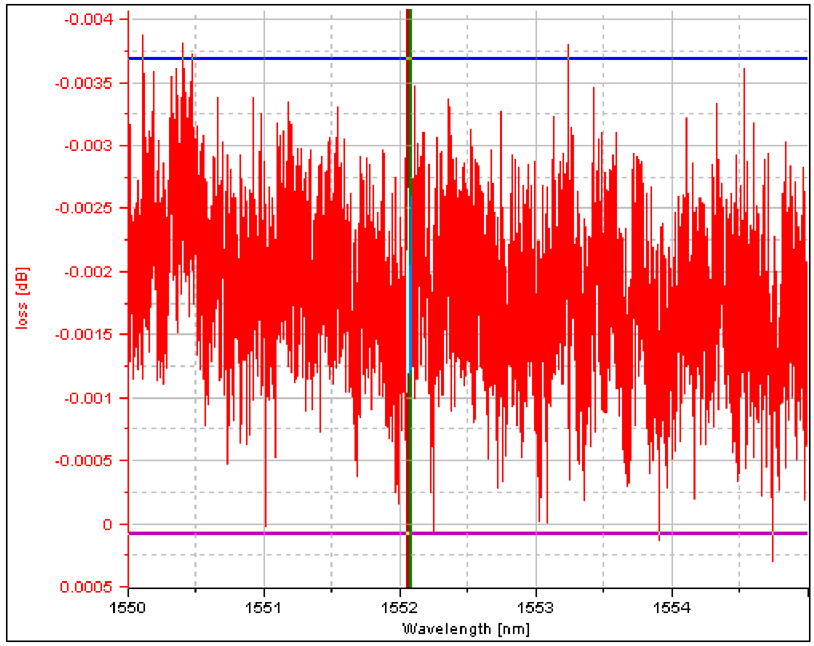


Figure 23 Insertion Loss (IL)

Test limit: ±0.010 dB

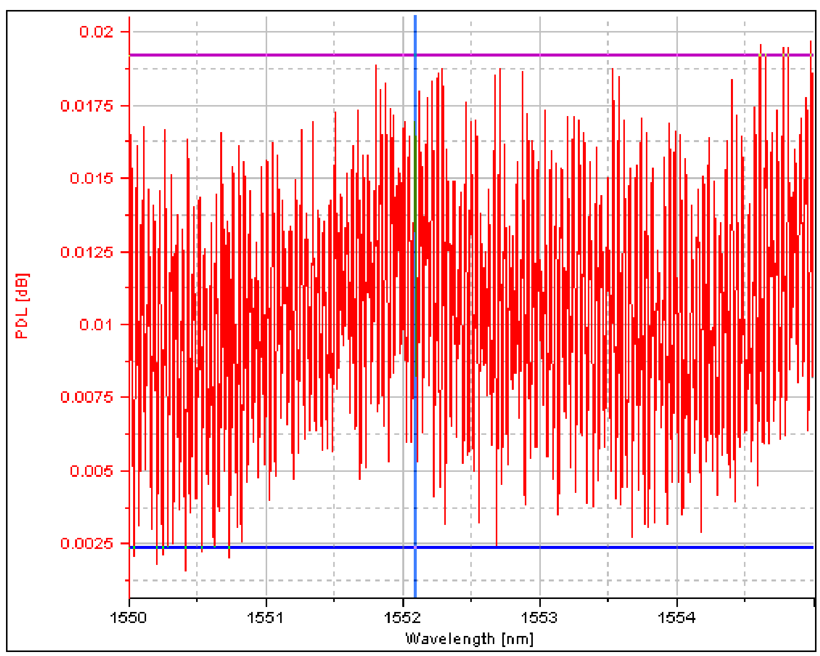


Figure 24 Polarization Dependent Loss (PDL))

Test limit: ±0.040 dB

Reflection Measurements

Test Setup and Measurement

1 If the system has been warmed up for an hour, start the Photonic Analysis Toolbox.

2 Set up the measurement with the following parameters:

Parameters	Test Settings
Measurement	GD / DGD and Loss/PDL
Direction	Reflection
Start Wavelength	1550.0
Stop Wavelength	1555.0
Wavelength Step	1.0 pm
Number of Scans	30
Range of Data Points for Averaging	30
Dynamic Range	Low (One Sweep)
Coherence Control	Off
Maximum Sweep Speed	5 nm/s
Power Sensor Start Range, Transmission	n/a
Power Sensor Start Range, Reflection	automatic

3 Start the Reference Measurement

a Perform the **Initialization Reference**, with no fibers attached to the connectors of the Optical Test Head. (If the Zero Power Sensor function was already used before the transmission measurement it does not need to be repeated.)

b Connect the r**eflection reference device (8 m fiber)** to the output of the Optical Test Head. Allow 3 min. for the fiber to settle.

c Perform the **Reflection Reference**. This will be used for the phase measurement verification (GD and DGD). (It is not necessary to make the **Termination Reference** for these verifications so select only **Reflection** from the drop-down menu on the reference tab).

d Press **Finish**.

4 Disconnect the reflection reference device and connect the **1.1 m mixed-fiber reflection device** to the output of the Optical Test Head. Fix the fiber on the Test Head so that it does not move during the measurements.

5 Start the DUT Measurement. The result will be used to verify the **measurement of GD and DGD**.

6 When the measurement is finished, and particularly if the test limits are exceeded, save the measurement results to a third file.

7 Analyze the GD and DGD measurement curves to verify the phase measurements in reflection. Sample results are shown below.

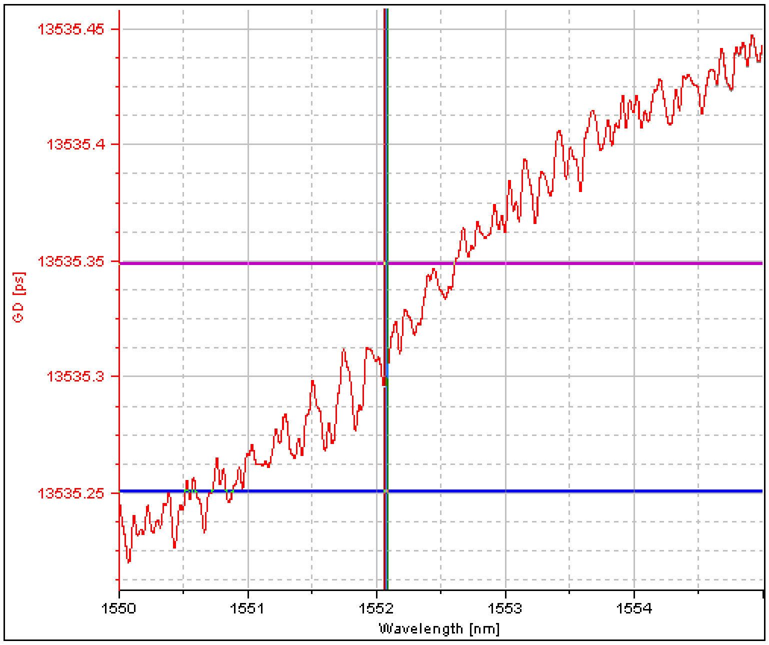


Figure 25 Group Delay (GD)

There is a linear increase of GD vs. wavelength due to fiber dispersion. The fluctuation in GD other than this increase should stay within the test limit. Test limit: ± 0.05 ps around the fitted regression of the GD curve.

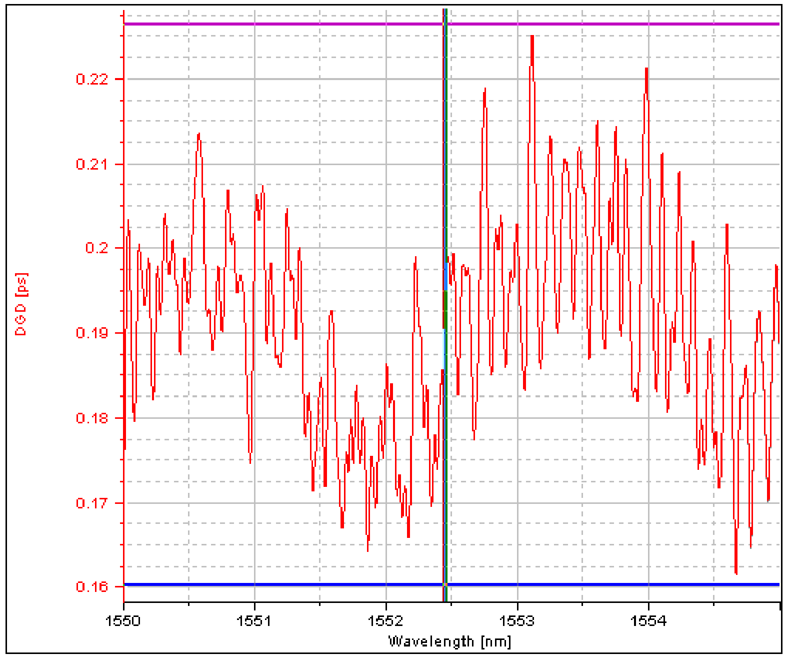


Figure 26 Differential Group Delay (DGD)

Test Limit: ± 0.08 ps around the mean of the DGD curve. The mixed test fiber provides a DGD of about 0.150 ps.

8 Leaving the mixed-fiber reflection device attached and unmoved, repeat the **Reflection Reference** measurement. It is not necessary to repeat the initialization reference.

9 Then **reposition the mixed fiber device** without disconnecting. For example flip the coils of the fiber over. The goal is to change the polarization states inside the fiber. Fix the fiber again so it does not move. Then wait 3 minutes for the fiber to settle.

10 Start the DUT measurement. The result will be used to verify the **measurement of IL (RL) and PDL**.

11 When the measurement is finished, and particularly if the test limits are exceeded, save the measurement results to a fourth file.

12 Analyze the IL and PDL measurement curves to verify the loss measurements in reflection. Sample results are shown below.

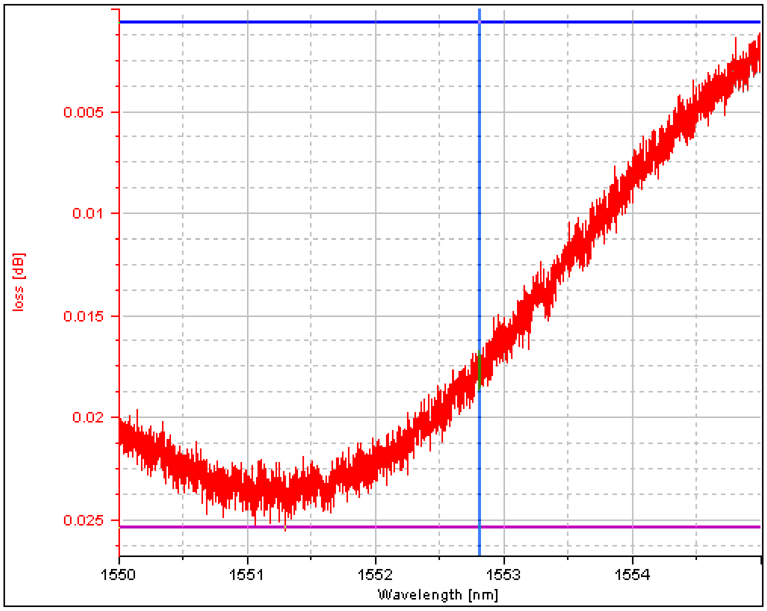


Figure 27 Insertion Loss (IL) / Return Loss (RL)

Test Limit: ± 0.020 dB.

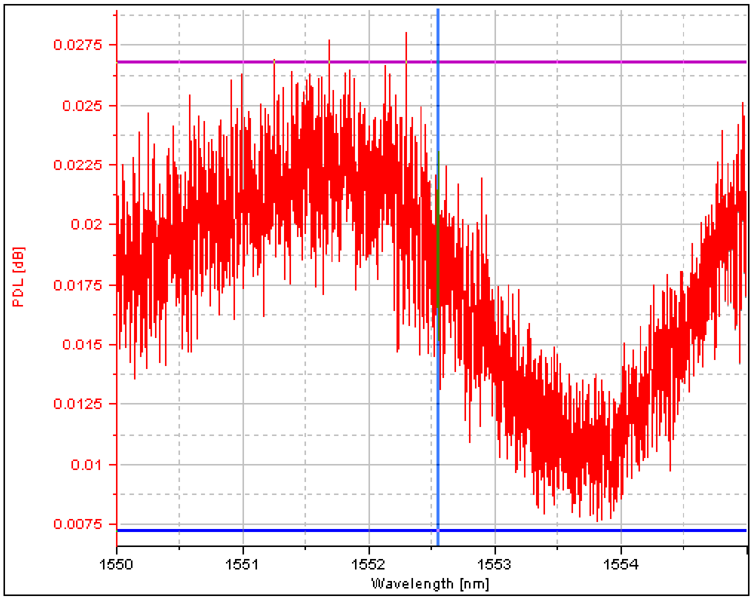


Figure 28 Polarization Dependent Loss (PDL)

Test Limit: ±0.040 dB.

Condensed Performance Verification Test

Introduction

The procedures in this section outline the performance test for the measurement system. The complete specifications to which the system is tested are given in "System Specifications" on page 215. All tests can be performed without access to the interior of the instruments.

The procedure outline in this section is intended to clarify the calibration method. The procedures require many measurements, detailed analysis and specialized equipment and are not intended to be performed manually by the user. Agilent Technologies offers a standards compliant system calibration. Contact your nearest Agilent Sales/Service Office for details.

NOTE The calibration of the 81910A All Parameter Analyzer does not require the calibration of the individual 81910A system components.

Equipment Required

Equipment required for the performance test is listed in the table below. Any equipment that satisfies the critical specifications of the equipment given in the table may be substituted for the recommended models.

Qty	Part Description
1 ea	Wavelength Reference (HCN Gas Cell)
1 ea	Polarization Scrambler Transmission (E2000 connectors)
1 ea	Polarization Scrambler Reflection (E2000 connectors)
1 ea	Polarizer (E2000 connectors)
1 ea	Short Reflection Reference Fiber
1 ea	Transmission Reference Fiber [a]
1 ea	Long Reflection Reference Fiber [a]
1 ea	GD/DGD Standard Transmission [a]
1 ea	GD/DGD Standard Reflection [a]
2 ea	81000NI and Protective Caps FC/PC Connector Interface (required for each test, not mentioned in the rest of this description)

[a] Equivalent devices are provided in the Angled Fiber Reference Kit, supplied with the 81910A

Troubleshooting

If the All-Parameter Analyzer measurement system does not perform according to specifications, please run the 'Diagnostic Tool'. This tool will help troubleshoot the failure and, in most cases, help you identify the root cause, which can usually be fixed easily.

Please visit our website www.agilent.com for the latest release of the Diagnostic Tool.

Instrument Specification

To test the overall system specification it is required that each instrument is within specification.

Specifications are the performance characteristics of the instrument that is certified. These specifications are the performance standards or limits against which the test system can be tested. This chapter also lists some supplementary performance characteristics. Supplemental performance characteristics should be considered as additional information.

Any changes in the specifications due to manufacturing changes, design, or traceability to the National Institute of Standards and Technology (NIST), will be covered in a manual change supplement, or revised manual. Such specifications supersede any that were previously published.

NOTE Make sure that all optical connections used in the test setups described are dry and clean. DO NOT USE INDEX MATCHING OIL. For cleaning, use the cleaning instructions described in “Cleaning” on page 270.

CAUTION DO NOT DISCONNECT AND CLEAN THE FIBERS CONNECTED TO THE THREE POWERMETERS. These fibers have a special anti-reflection (AR) coating which can be removed by cleaning the connectors in any other way than with clean and compressed air. The removal of this coating results in performance degradation.

Fix the DUT on the bench of the Optical Test Head and fix the optical cables, using the fiber clamps, to ensure minimum cable movement during the tests.

Make sure you run the recommended test after exchanging the adapter patchcords for maintenance.

Test Procedure

Due to the statistical nature of the measurement results the data analysis described in the test procedure is based on the post data processing of the saved measurement results. Generally, each test is divided in following sections:

- Test Equipment
  lists all additional equipment necessary to carry out the individual test
  - Test Setup
    shows the setup used during the DUT measurement
- Test Settings
  lists all measurement settings in the parameter table
- Measurement
  describes the test procedure
- Analysis
  generally describes the post data processing sequence

At the end of the performance test procedure a test record is listed for all measured and analyzed parameters. Within the test procedure, cross-references are made to the appropriate part of this test record.

Prior to first delivery, the 81910A All Parameter Analyzer is extensively tested using the procedure described here. For re-calibration, a reduced set of ranges can be used for testing. To account for both, two different settings are given in the procedure.

To eliminate repetition of some frequently used sub-procedures, these are described in the general procedures section.

General Procedures

This section describes procedures which are frequently required for the 81910A verification.

Before beginning the performance tests, you should prepare a separate folder on the PC (e.g. c:\data\81910A\) to save the measurement results.

Some performance tests must be programmed with the application programming interface (API) because they require access to unprocessed measurement data.

Photonic Analysis Toolbox Operations

Save measurement result

File – Save Active Measurement as... – Move to measurement results folder, enter the given filename and *Save*

Export measurement result

File – Export... –

1 Select the given file
2 Deselect '*Analysis Table*'
3 Move to measurement results folder, enter the given filename and *Save*

New measurement setup

Measurement – Measurement Setup – New... – Measurement Parameter menu appears

NOTE Each test provides a set of parameters which have to be entered in the Measurement Parameter menu

Edit measurement setup

Measurement – Measurement Setup – Edit Parameters... – Measurement Parameter menu appears

NOTE Each test provides a set of parameters which have to be entered in the Measurement Parameter menu

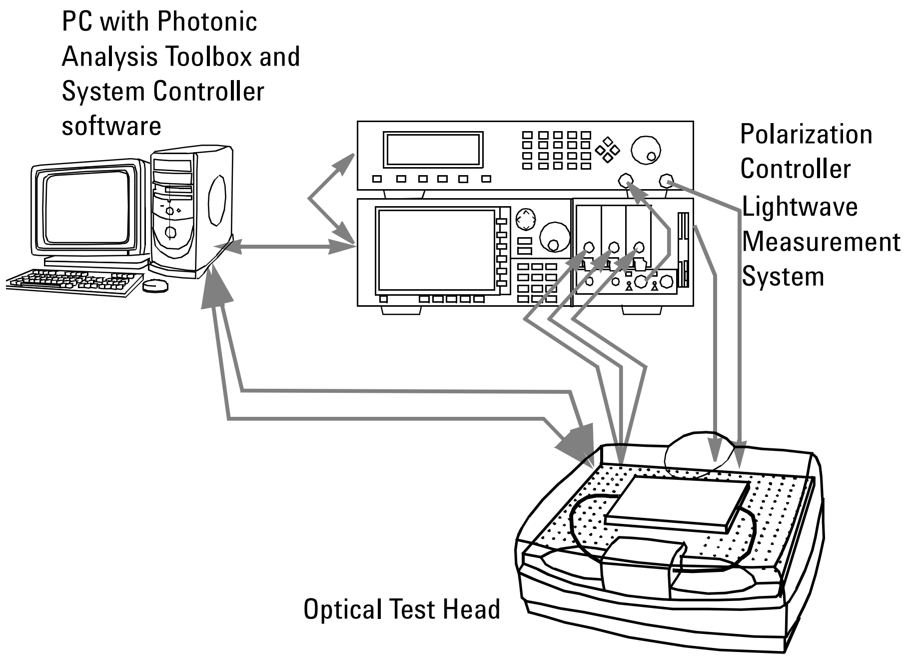
Referencing

Each DUT measurement requires a set of reference measurements. A number of measurements have a two-step initial reference measurement in common. The initial reference zeroes the power-meters and performs a referencing of the internal optical assemblies of the 81910TH:

- zeroing the power meters is necessary once after the system has warmed up and can be skipped for further measurements
- the reference measurements require reference fibers as DUT, depending on the type of measurement

Test Setup

Ensure that the hood of the 81910TH is closed before taking any measurement.



Wavelength Calibration

Parameters under test:

- Absolute Wavelength Uncertainty for Loss Specifications in Transmission and Reflection (WLA)
- Relative Wavelength Uncertainty for Loss Specifications in Transmission and Reflection (WLR)
- Absolute Wavelength Uncertainty for Dispersion Specifications in Transmission and Reflection (WPA)

The test measures the absorption lines of a HCN gas cell in the wavelength range from 1528nm to 1562nm.

Due to the limited sample points of the power meters the wavelength range is split into two sweeps which are performed consecutively.

Test Equipment

Qty	Part Description
1 ea	Wavelength Reference (HCN Gas Cell)
1 ea	Transmission Reference Fiber

Test Settings (using Expert Mode)

Phase Parameters	Initial Test	Re-calibration
Measurement	GD/DGD	GD/DGD
Light Path	Transmission	Transmission
Sweep Wavelength, Start	**a** 1528.0 **b** 1550.0	**a** 1528.0 **b** 1550.0
Sweep Wavelength, Stop	**a** 1540.0 **b** 1562.0	**a** 1540.0 **b** 1562.0
Sweep Wavelength, Step	1.0 pm	1.0 pm
Resolution Bandwidth, Sliding Window	10.0 pm	10.0 pm
Averaging, Number of Scans	10	10
Sweep Speeds	40 nm/s	40 nm/s
Loss Parameters		
Measurement	Fast Loss	Fast Loss
Light Path	Transmission	Transmission
Sweep Wavelength	Use Phase Settings	Use Phase Settings
Dynamic	Low	Low
Loss Parameters, Options		
TLS, Coherence Control	off	off
TLS, Max. Sweep Speed	5 nm/s	5 nm/s
Power Sensor Start Range, Trans.	automatic	automatic
Power Sensor Start Range, Refl.	n/a	n/a

File Name (*.omr / *.csv)	Initial Test	Re-calibration
Measurement a)	wave_r1	wave_r1
Measurement b)	wave_r2	wave_r2

Measurement

1 Start the Photonic Analysis Toolbox software.

2 Setup a new measurement according to the parameters given above.

3 Set the sweep wavelength range according to setting a)

4 Start the reference measurement

   a Zero the power meters and perform the internal reference protective caps.

   b Connect the transmission reference fiber and wait 3 min. for it to settle.

   c Perform the transmission reference measurement.

5 Connect the gas cell, wait 3 min. for the fibers to settle.

6 Perform the DUT measurement.

7 **Save** and **Export** the measurement results to wave_r1.omr / wave_r1.csv

8 Set the wavelength range to setting b), and repeat steps 3 to 8 of the test procedure.

9 **Save** and **Export** the measurement results to wave_r2.omr / wave_r2.csv

Analysis

Analysis of Amplitude Data

The basic part of the data evaluation of insertion loss and group delay data is the Lorentz-function. This includes a linear regression to ensure independence from “background” slopes, due to slight amplitude ripples in IL or fiber dispersion in GD.

1 For each file **wave_r#.csv** a Lorentz-function has to be fitted to each peak listed in Table 1, as shown below, that is, for the part of the wavelength range covered by the individual range of the file, with regard to its loss (amplitude). For the fit, use a 70% of the maximum peak value as a threshold criteria to get a selection of useful data points around each center. Parameter of interest is the center wavelength λ_c. The fit has to be applied to single peaks.

2 Calculate the absolute wavelength uncertainty in amplitude for peak k:

$$\Delta\lambda_{IL}(k) = \lambda_{c,IL}(k) - \lambda_{tab}(k)$$

where
$\Delta\lambda_{IL}(k)$ is the absolute deviation of peak *k*,
$\lambda_{c,IL}(k)$ the center wavelength from fit of peak k and
$\lambda_{tab}(k)$ the tabulated wavelength of peak *k* from Table 1.
Compare each $\Delta\lambda_{IL}(k)$ against the specification.

Test Record Reference: WLA: = $MAX_k(\Delta\lambda_{IL}(k))$

3 Calculate the relative wavelength uncertainty in amplitude:

$$WLenRelUncertAmp = \frac{1}{2} \cdot \left(MAX_k \left(\Delta\lambda_{IL}(k) \right) - MIN_k \left(\Delta\lambda_{IL}(k) \right) \right)$$

Test Record Reference: WLR: = *WLenRelUncertAmp*

Table 1 Selected peaks with very small wavelength uncertainty (0.6 pm specified by NIST used for the test.

no.(k)	λ [nm]	no.(k)	λ [nm]
1	1528.4862	9	1536.7034
2	1528.9271	10	1537.2997
3	1529.8376	11	1538.5224
4	1531.2764	12	1550.5149
5	1532.8024	13	1554.5892
6	1534.4159	14	1555.4346
7	1535.5401	15	1560.7185
8	1536.1170	16	1561.6344

Analysis of Phase Data

1 For each file **wave_r#.csv** a Lorentz-function has to be fitted to each peak listed in Table 1, that is, for that part of the wavelength range covered by the range of the individual file, with regard to its group delay (phase). The Lorentzian fit can be applied to the group delay data, regardless of the non-lorentzian shape of the complete curve. In a region that is 70% of peak height there is a strong correspondence with a Lorentzian shape and the fit easily converges, delivering the correct peak location.
Parameter of interest is the center wavelength λ_c. The fit has to be applied to single peaks.

2 Calculate the absolute wavelength uncertainty in phase for peak k:

$$\Delta\lambda_{GD}(k) = \lambda_{c,GD}(k) - \lambda_{tab}(k)$$

where
$\Delta\lambda_{GD}(k)$ is the absolute deviation of peak *k*,
$\lambda_{c,GD}(k)$ the center wavelength from fit of peak k and
$\lambda_{tab}(k)$ the tabulated wavelength of peak *k* from Table 1.
Compare each against the specification.

Test Record Reference: WPA: = $MAX_k(\Delta\lambda_{GD}(k))$

Loss and Polarization Dependent Loss Calibration

Parameters under test:

- Loss Measurement Uncertainty in Transmission and Reflection (LT0, LT1, LT2, LT3 / LR0, LR1, LR2)
- Polarization Dependent Loss (PDL) Uncertainty in Transmission and Reflection (PT0, PT1, PT2 / PR0, PR1, PR2 / PDA)

Post data processing analysis is required because the saved power values are only expressed relative to the monitoring power over wavelength. That is, the Photonic Analysis Toolbox shows data in the form of (power in transmission (reflection) / monitoring power). A special Service Center program is necessary which monitors and logs the monitoring power.

The measurement consists of four parts, with the given results:

a *Noise Power Measurement in Transmission and Reflection*

b *Zero Device Measurement of Loss and PDL in Transmission*

c *Zero Device Measurement of Loss and PDL in Reflection*

d *PDL Device Measurement*

Noise Power Measurement

Test Equipment

Qty	Part Description
1 ea	Transmission Reference Fiber
1 ea	Long Reflection Reference Fiber

Test Settings

Phase Parameters	Initial Test	Re-calibration
Measurement	Off	off
...	...	...
Loss Parameters		
Measurement	Loss / PDL	Loss / PDL
Light Path	Both	Both
Sweep Wavelength	Set manually	Set manually
Sweep Wavelength, Step	10.0 pm	10.0 pm
Sweep Wavelength, Start	1520.0	1520.0
Sweep Wavelength, Stop	1620.0	1620.0
Dynamic	**a** Low (1 sweep) **b** Medium (2 sweeps) **c** High (3 sweeps)	**a** Low (1 sweep) **b** Medium (2 sweeps) **c** High (3 sweeps)
Loss Parameters, Options		
TLS, Coherence Control	off	off
TLS, Max. Sweep Speed	40 nm/s	40 nm/s
Power Sensor Start Range, Trans.	automatic	automatic
Power Sensor Start Range, Refl.	automatic	automatic

File Name (*.omr / *.csv)	Initial Test	Re-calibration
Measurement a)	range1	range1
Measurement b)	range2	range2
Measurement c)	range3	range3
Measurement d)	monitoring.txt	monitoring.txt

Measurement

1 Start the Photonic Analysis Toolbox software.

2 Setup new measurement according to the parameters given above.

3 Set the dynamic range according to the settings for a)

4 Start the reference measurement

   a Zero the power meters and perform the internal reference with protective caps. Note that if the system is stable, the power meter zeroing need not always be repeated.

   b Unwrap the fiber and connect the fiber end to the optical input of the test head; wait 3 min. for the fiber to settle.

   c Perform the transmission reference measurement.

   d Connect the long reflection reference fiber and wait 3 min. for it to settle.

   e Perform the reflection reference calibration.

   f Connect the transmission reference fiber to the optical output and wrap the other fiber end about 8 times around a rod of about 5 mm diameter and wait 3 minutes for it to settle.

   g Perform the termination reference measurement.

5 As DUT, use the transmission reference fiber, where the fiber end is wrapped about 8 times around the termination rod.

6 Perform the DUT measurement.

7 **Save** and **Export** the results to range1.omr / range1.csv

8 Change the measurement parameters for Dynamic to b).

9 Ignore/cancel the reference warnings and start the DUT measurement.

10 **Save** and **Export** the results to range2.omr/ range2.csv

11 Change the measurement parameters for Dynamic to c).

12 Ignore/cancel the reference warnings and start the DUT measurement.

13 **Save** and **Export** the results to range3.omr/ range3.csv

14 Use the Service Center program to perform the power-monitor measurement. (Only available for the Agilent Service Center.)

15 **Save** the results of the monitor power measurement to monitoring.txt.

Zero Device Measurement in Transmission

This test measures the transmission power levels for N = 10 stochastic state of polarizations (SOP). The SOP's are generated by the Polarization Scrambler Transmission.

Test Equipment

Qty	Part Description
1 ea	Polarization Scrambler Transmission

Test Settings

Phase Parameters	Initial Test	Re-calibration
Measurement	off	off
...	...	...
Loss Parameters		
Measurement	Loss / PDL	Loss / PDL
Light Path	Transmission	Transmission
Sweep Wavelength	Set manually	Set manually
Sweep Wavelength, Start	1520.0	1520.0
Sweep Wavelength, Stop	1620.0	1620.0
Sweep Wavelength, Step	10.0 pm	10.0 pm
Dynamic	Low (1 sweep)	Low (1 sweep)
Loss Parameters, Options		
TLS, Coherence Control	off	off
TLS, Max. Sweep Speed	40 nm/s	40 nm/s
Power Sensor Start Range, Trans.	automatic	automatic
Power Sensor Start Range, Refl.	automatic	automatic

File Name (*.omr / *.csv)	Initial Test	Re-calibration
Measurement [i], $i \in [0, N-1]$, N = 10	T_LossPdl_[i]	T_LossPdl_[i]

File Names range from T_LossPdl_0.omr to T_LossPdl_9.omr

Random polarization states

The Polarization scrambler is composed of 4 fiber loops that can be rotated independently. The position of a loop is defined by a number between 0 and 999, equivalent to an angular rotation of the loop between 0 and 180°.

Each state of polarization (SOP) is achieved by setting the 4 loops at a random angle position. Measurement

1 Start the Photonic Analysis Toolbox software.
2 Setup a new measurement according to the parameters given above.
3 Start the reference measurement.
   a Zero the power meters and perform the internal reference with protective caps.
   b Connect the Polarization scrambler in transmission and set its SOP to SOP_0.
   c Perform the transmission reference measurement.

4 Repeat steps 5 to 7 for i = 0 to N-1 (N=10).

5 On the Polarization scrambler, set the SOP to SOP_i.

6 Perform the DUT measurement i.

7 **Save** and **Export** the results to T_LossPdl_[i].omr / T_LossPdl_[i].csv

Zero Device Measurement in Reflection

This test measures the reflection power levels for ten stochastic state of polarizations (SOP). The SOP's are generated by the Polarization Scrambler Reflection.

Test Equipment

Qty	Part Description
1 ea	Polarization Scrambler Reflection
1 ea	Long Reflection Reference Fiber

Test Settings

Phase Parameters	Initial Test	Re-calibration
Measurement	off	off
...	...	...
Loss Parameters		
Measurement	Loss / PDL	Loss / PDL
Light Path	Reflection	Reflection
Sweep Wavelength	Set manually	Set manually
Sweep Wavelength, Start	1520.0	1520.0
Sweep Wavelength, Stop	1620.0	1620.0
Sweep Wavelength, Step	10.0 pm	10.0 pm
Dynamic	Low (1 sweep)	Low (1 sweep)
Loss Parameters, Options		
TLS, Coherence Control	off	off
TLS, Max. Sweep Speed	40 nm/s	40 nm/s
Power Sensor Start Range, Trans.	automatic	automatic
Power Sensor Start Range, Refl.	automatic	automatic

File Name (*.omr / *.csv)	Initial Test	Re-calibration
Measurement [i], $i \in [0, N-1]$, N = 10	R_LossPDL_[i]	R_LossPDL_[i]

File Names range from R_LossPdl_0.omr to R_LossPdl_9.omr

Measurement

1 Start the Photonic Analysis Toolbox software.

2 Setup a new measurement according to the parameters given above.

3 Start the reference measurement.

   a Zero the power meters and perform the internal reference with protective caps.

   b Connect the reflection termination reference (fiber wrapped 8 times around the termination rod).

   c Perform the termination reference.

   d Connect the Polarization Scrambler Reflection and set its SOP to SOP_0.

   e Perform the reflection reference measurement.

4 Repeat steps 5 to 7 for i = 0 to N-1 (N=10).

5 On the Polarization scrambler, set the SOP to SOP_i.

6 Perform the DUT measurement i.

7 **Save** and **Export** the results to R_LossPdl_[i].omr / R_LossPdl_[i].csv

PDL Device Measurement

This test measures the 3% device PDL by using N=10 stochastic state of polarizations (SOP) - set by the polarization scrambler - which are applied to a polarizer, which accounts for device dependent PDL.

Test Equipment

Qty	Part Description
1 ea	Polarization Scrambler Transmission
1 ea	Polarizer

Test Settings

Phase Parameters	Initial Test	Re-calibration
Measurement	off	off
...	...	...
Loss Parameters		
Measurement	Loss / PDL	Loss / PDL
Light Path	Transmission	Transmission
Sweep Wavelength	Set manually	Set manually
Sweep Wavelength, Start	1520.0	1520.0
Sweep Wavelength, Stop	1620.0	1620.0
Sweep Wavelength, Step	10.0 pm	10.0 pm
Dynamic	Low (1 sweep)	Low (1 sweep)
Loss Parameters, Options		
TLS, Coherence Control	off	off
TLS, Max. Sweep Speed	40 nm/s	40 nm/s
Power Sensor Start Range, Trans.	automatic	automatic
Power Sensor Start Range, Refl.	automatic	automatic

File Names range from T_PdlDev_0.omr to T_PdlDev _9.omr

File Name (*.omr / *.csv)	Initial Test	Re-calibration
Measurement [i], i ∈ [0, N-1], N = 10	T_PdlDev_[i]	T_PdlDev_[i]

Measurement

1 Start the Photonic Analysis Toolbox software.

2 Setup a new measurement according to the parameters given above.

3 Start the reference measurement.

   a Zero the power meters and perform the internal reference with protective caps.

   b Connect the Polarization Scrambler Transmission and set its SOP to SOP_0.

   c Perform the transmission reference measurement.

4 Connect the polarizer between the Polarization scrambler and the input port (right side) of the optical test head.

5 Repeat steps 6 to 8 for i = 0 to N-1 (N=10).

6 On the Polarization scrambler, set the SOP to SOP_i.

7 Perform the DUT measurement i.

8 **Save** and **Export** the results to T_ PdlDev _[i].omr / T_ PdlDev _[i].csv

Analysis

As a result of all the measurements performed above, 2 types of data are available:

- Noise data
- Loss / PDL data
  - ZeroLossTransmission(λ,i) / ZeroPdlTransmission(λ,i)
  - ZeroLossReflection(λ,i) / ZeroPdlReflection(λ,i)
  - DevicePdlTransmission(λ,i)

where
i = 0 .. N-1 represents the ten random states of polarization set by the Polarization Scrambler and
λ is the wavelength.

The number of wavelength points is given by:

$$nb\_WL\_datapoints = \frac{\lambda_{end} - \lambda_{start}}{wavelength\ resolution} + 1$$

Noise Contribution

Reference Power Evaluation The reference power evaluation determines the quasi-statistical minimum power levels in dBm which are applied to the transmission / reflection power meters when a reference device (0 dB loss) is used.

1. From range1.omr, calculate transmission power levels for each polarization used by the Mueller by eliminating the monitoring power level.
2. From range1.omr, calculate reflection power levels for each polarization used by the Mueller by eliminating the monitoring power level.
3. Calculate the lowest power value over wavelength:
   a. Determine both the quasi-statistical minimum power levels for Transmission and Reflection over all polarizations used by the Mueller method.
   b. Convert the minimum power levels into dBm.
   for transmission: T_SP = 10 * log (1000 * T_min)
   for reflection: R_SP = 10 * log (1000 * R_min)

Noise Evaluation in Transmission Calculate the noise level T_Noise (j) for each range j, j ∈ [0, 3]):

1. From files range1.omr, range2.omr and range3.omr, calculate the transmission power levels by eliminating the monitoring power for each power range and each polarization (SOP) used by the Mueller method.

2 Calculate for each SOP and for each power range j ∈ [1, 3] the average noise over wavelength for individual SOPs and power ranges in transmission.

3 Determine the maximum average noise over all SOPs for each power range, to get the noise level in transmission, T_N (j).

4 Calculate the absolute noise level in dBm, corresponding to the noise level in Watt in power meter range 3:
T_NdBm = 10 * **LOG**(1000 * T_N(3))

5 Calculate the noise to signal ratio for each range. For

   a j = 1: T_lim_Noise(j):= 0

   b j ∈ [2, 3]:

$$T\_lim\_Noise(j) = -10 \cdot \mathrm{LOG}\left(1 - \frac{1000 \cdot T\_N(j-1)}{10^{\frac{T\_SP-(Range(j)-3dB)}{10}}}\right)$$

   c j ∈ [1, 3]:

$$T\_IL\_Noise(j) = -10 \cdot \mathrm{LOG}\left(1 - \frac{1000 \cdot T\_N(j)}{10^{\frac{(T\_SP-IL(j))}{10}}}\right)$$

   d Calculate the T_Noise (j) parameter:
   i. j = 0: T_Noise(j):= 0
   ii. j ∈ [1, 3]: T_Noise(j) = **MAX**(T_lim_Noise (j), T_IL_Noise (j))

Noise Evaluation in Reflection In the same way, determine the R_Noise (j) value by the given procedure:

1 From files range1.omr, range2.omr and range3.omr calculate the reflection power values by eliminating the monitoring power for each power range and each polarization (SOP) used by the Mueller method.

2 Calculate for each SOP and for each power range j ∈ [1, 2] the average noise over wavelength for individual SOPs and power ranges in transmission.

3 Determine for each power range j ∈ [1, 2] the maximum average noise over all SOPs to get the noise level in reflection R_N(j).

4 Calculate the absolute noise level in dBm, corresponding to the noise level in Watt in power meter range 2:
R_NdBm = 10 * **LOG**(1000 * R_N(2))

5 Calculate for each range j, j ∈ [0, 2] the noise to signal. For

a j = 1: R_lim_Noise(j):= 0

b j = 2:

$$R\_lim\_Noise(j) = -10 \cdot \mathrm{LOG}\left(1 - \frac{1000 \cdot R\_N(j-1)}{10^{\frac{R\_SP-(Range(j)-3dB)}{10}}}\right)$$

c j ∈ [1, 2]:

$$R\_IL\_Noise(j) = -10 \cdot \mathrm{LOG}\left(1 - \frac{1000 \cdot R\_N(j)}{10^{\frac{(R\_SP-IL(j))}{10}}}\right)$$

d Calculate now the R_Noise(j) parameter:
i. j = 0: R_Noise(j):= 0
ii. j ∈ [1, 2]: R_Noise(j) = **MAX**(R_lim_Noise(j), R_IL_Noise(j))

Evaluation of the Zero Loss Device Results

With the results from previous calculations and the Zero Device Loss results in transmission and reflection the Zero Device Loss Errors in transmission and reflection can be determined.

1 Divide the wavelength range of the Zero Device Loss in transmission and the Zero Device Loss in reflection into 20 equally spaced subranges.

2 For each wavelength-subrange and over all N-1 random polarization states, calculate the average Zero Device Loss Transmission and the average Zero Device Loss Reflection.

3 With the T_Noise(j) parameter, calculate the Zero Device Loss uncertainty for each range in each wavelength subrange.

4 Determine the maximum error from the previous result and compare against the specifications for each range.

Test Record Reference:

LTj: = *Zero Device Maximum Loss Error in Transmission*
LRj: = *Zero Device Maximum Loss Error in Reflection*

Evaluation of the Zero PDL Device Results

With the results from the previous calculations and the *Zero Device PDL in transmission* and *Zero Device PDL in reflection* results, the Zero Device PDL errors in transmission and reflection are determined in the same way as the calculations for zero loss error.

1 Divide the wavelength range of the Zero Device PDL Transmission and the Zero Device PDL Reflection into 20 equally spaced subranges.

2 For each wavelength-subrange and over all N-1 random polarization results, calculate the average Zero Device PDL for transmission and reflection.

3 With the T_Noise(j) parameter, calculate the PDL uncertainty for each range in each wavelength subrange.

4 Determine the maximum error in transmission and reflection from the previous result and compare it against the specifications for each range $j \in [0, 2]$.

Test Record Reference:

PTj: = *Zero Device Maximum PDL Error in Transmission*
PRj: = *Zero Device Maximum PDL Error in Reflection*

Evaluation of the Polarizer PDL Device Results

A similar approach is taken for this evaluation. The range is subdivided into 20 ranges and PDL device measurement results are transformed by removing all invalid values within the given wavelength range. This function is named here **ValidValues** and removes for example negative values given by the power meter reading.

1 Divide the wavelength range of the PDL device measurement into 20 equally spaced subranges.
2 Remove all invalid values of the PDL device measurement for each wavelength-subrange over all random polarization states.
3 For each wavelength subrange, calculate the maximum determinable PDL.
4 For each wavelength subrange calculate the average and the standard deviation of the previous result.
5 Calculate the PDL Device error
6 The measurement result of the relative PDL uncertainty test has to be converted from the “root-sum-square” (RSS) value to the “arithmetic addition value” before it can be checked against the test limit.

   This is necessary because, statistically, the specification is expressed correctly as
   RSS (0.04dB, 5.7% $\times$ *P)*
   where
   P = DUT PDL value.

   However, for convenience the specification is actually given in the form of an arithmetic addition:
   0.04dB **+** *3%* $\times$ *P”*.

   The difference in the percentage values compensates for the relation between the RSS operation and the addition.

7 Compare the maximum of the Arithmetic PDL Error against the specification of 3%

Test Record Reference:

PDA: = *Maximum Arithmetic PDL Error*

Group Delay and Differential Group Delay Calibration

Parameters under test:

- Group Delay (GD) Uncertainty with GD/DGD Standard in Transmission and Reflection (GTA, GRA)
- Differential Group Delay (DGD) Uncertainty with GD/DGD Standard in Transmission and Reflection (DTA, DRA)
- Relative Group Delay Uncertainty with Wavelength Reference in Transmission and Reflection (GTH, GRH)

Noise Calibration

Noise Calibration in Transmission

Test Equipment

Qty	Part Description
1 ea	Transmission Reference Fiber
1 ea	GD/DGD Standard Transmission

Test Settings

Phase Parameters	Initial Test	Re-calibration
Measurement	GD/DGD	GD/DGD
Light Path	Transmission	Transmission
Sweep Wavelength, Start	**a** 1520.0 **b** 1560.0 **c** 1595.0	**a** 1520.0 **b** 1560.0 **c** 1595.0
Sweep Wavelength, Stop	**a** 1560.0 **b** 1595.0 **c** 1620.0	**a** 1560.0 **b** 1595.0 **c** 1620.0
Sweep Wavelength, Step	1.0 pm	1.0 pm
Resolution Bandwidth, Sliding Window	30.0 pm	30.0 pm
Averaging, Number of Scans	30	30
Sweep Speeds	40 nm/s	40 nm/s
Loss Parameters		
Measurement	off	off

File Name (*.omr / *.csv)	Initial Test	Re-calibration
Measurement a)	fiber_s1_r1	fiber_s1_r1
Measurement b)	fiber_s1_r2	fiber_s1_r2
Measurement c)	fiber_s1_r3	n/a

Measurement

1 Start the Photonic Analysis Toolbox software.
2 Setup a new measurement according to the parameters given above.
3 Set the sweep wavelength range to setting a)
4 Perform the reference measurement.
    a Zero the power meters and perform the internal reference with protective caps.
    b Connect the Transmission Reference Fiber and wait 3 min. for it to settle.
    c Perform the transmission reference measurement.
5 Connect the GD/DGD Standard and wait 3 min. for it to settle.
6 Perform the DUT Measurement.
7 **Save** and **Export** the results to file_s1_r1.omr / fiber_s1_r1.csv
8 Repeat steps 3 to 7 for settings b) and c).

Noise Calibration in Reflection

Test Equipment

Qty	Part Description
1 ea	Long Reflection Reference Fiber
1 ea	GD/DGD Standard Reflection

Test Settings

Phase Parameters	Initial Test	Re-calibration
Measurement	GD/DGD	GD/DGD
Light Path	Reflection	Reflection
Sweep Wavelength, Start	1520.0 1560.0 1595.0	1520.0 1560.0 1595.0
Sweep Wavelength, Stop	1560.0 1595.0 1620.0	1560.0 1595.0 1620.0
Sweep Wavelength, Step	1.0 pm	1.0 pm
Resolution Bandwidth, Sliding Window	30.0 pm	30.0 pm
Averaging, Number of Scans	30	30
Sweep Speeds	40 nm/s	40 nm/s
Loss Parameters		
Measurement	off	off

File Name (*.omr / *.csv)	Initial Test	Re-calibration
Measurement a)	fiber_s2_r1	fiber_s2_r1
Measurement b)	fiber_s2_r2	fiber_s2_r2
Measurement c)	fiber_s2_r3	n/a

Measurement

1 Start the Photonic Analysis Toolbox software.

2 Setup a new measurement according to the parameters given above.

3 Set the sweep wavelength range according to setting a)

4 Perform the reference measurement

  a Zero the power meters and perform the internal reference with protective caps.

  b Connect the long reflection reference fiber and wait 3 min. for it to settle.

  c Perform the reflection reference measurement.

5 Connect the GD/DGD Standard and wait 3 min. for it to settle.

6 Perform the DUT Measurement.

7 **Save** and **Export** the results to file_s2_r1.omr / fiber_s2_r1.csv.

8 Repeat steps 3 to 7 for settings b) and c).

Analys*is*

1 In each data file **fiber_s#_r#.csv** the group delay data consists of the noise floor and an increase due to the fiber dispersion, which has to been corrected for each file individually by a 2nd order polynomial function

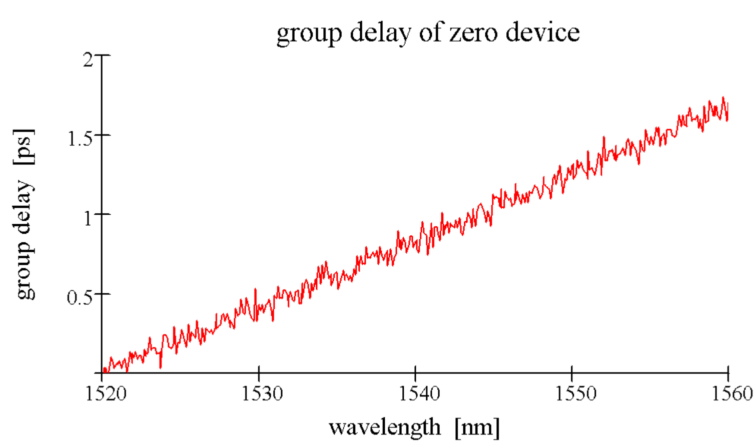


Figure 29 Expected group delay profile for T/R including fiber dispersion contribution

2 Correct the group delay with the fitted polynomial function to calculate the group delay noise floor for transmission and reflection.

3 The data arrays obtained by the different wavelength range measurements have to be concatenated to one data array for GD and DGD.

4 Divide the wavelength range of the GD noise and the DGD noise into 20 equally spaced subranges for transmission and reflection.

5 For each wavelength-subrange, calculate the standard deviation, σ, of the GD and DGD noise.

6 The uncertainties are calculated as 2σ in each wavelength subrange for transmission and reflection.

Test Record Reference:

GTA: = *Maximum GD uncertainty in transmission*
GRA: = *Maximum GD uncertainty in reflection*
DTA: = *Maximum DGD uncertainty in transmission*
DRA: = *Maximum DGD uncertainty in reflection*

HCN Gas Cell Calibration

HCN Gas Cell Calibration in Transmission

Test Equipment

Qty	Part Description
1 ea	Wavelength Reference (HCN Gas Cell)
1 ea	Transmission Reference Fiber

Test Settings

Phase Parameters	Initial Test	Re-calibration
Measurement	GD/DGD	GD/DGD
Light Path	Transmission	Transmission
Sweep Wavelength, Start	1550.0	1550.0
Sweep Wavelength, Stop	1551.0	1551.0
Sweep Wavelength, Step	1.0 pm	1.0 pm
Resolution Bandwidth, Sliding Window	10.0 pm	10.0 pm
Averaging, Number of Scans	300	300
Sweep Speeds	40 nm/s	40 nm/s
Loss Parameters		
Measurement	off	off

File Name (*.omr / *.csv)	Initial Test	Re-calibration
Measurement a)	hcn_s1	hcn_s1

Measurement

1 Start the Photonic Analysis Toolbox software.

2 Setup a new measurement according to the parameters given above.

3 Start the reference measurement.

   a Zero the power meters and perform the internal reference with protective cap.

   b Connect the transmission reference fiber and wait 3 min. for it to settle.

   c Perform the transmission reference measurement.

4 Connect the gas cell and perform the DUT measurement.

5 **Save** and **Export** the results to hcn_s1.omr / hcn_s1.csv

HCN Gas Cell Calibration in Reflection

Test Equipment

Qty	Part Description
1 ea	Wavelength Reference (HCN Gas Cell)
1 ea	Long Reflection Reference Fiber
1 ea	Short Reflection Reference Fiber (connected to output of Wavelength Reference)

Test Settings

Phase Parameters	Initial Test	Re-calibration
Measurement	GD/DGD	GD/DGD
Light Path	Reflection	Reflection
Sweep Wavelength, Start	1547.0	1547.0
Sweep Wavelength, Stop	1548.0	1548.0
Sweep Wavelength, Step	1.0 pm	1.0 pm
Resolution Bandwidth, Sliding Window	10.0 pm	10.0 pm
Averaging, Number of Scans	30	30
Sweep Speeds	40 nm/s	40 nm/s
Loss Parameters		
Measurement	off	off

File Name (*.omr / *.csv)	Initial Test	Re-calibration
Measurement	hcn_s2	hcn_s2

Measurement

1 Start the Photonic Analysis Toolbox software.

2 Setup a new measurement according to the parameters given above.

3 Start the reference measurement.

  a Zero the power meters and perform the internal reference with protective cap.

  b Connect the long reflection reference fiber and wait 3 min. for it to settle.

  c Perform the reflection reference measurement.

4 Connect the gas cell with the short reflection reference fiber and perform the DUT measurement.

5 **Save** and **Export** the results to hcn_s2.omr / hcn_s2.csv

Analysis From file hcn_s#.csv investigate the peak in more detail

1 Build the difference between the maximum and the minimum peak height of the group delay data for transmission and reflection.

2 Use the specific group delay calibration data of the gas cell for this peak in transmission and reflection to calculate the uncertainty for this specific device with serial number SN. Compare the group delay uncertainty for transmission and reflection against the specification.

Test Record Reference:

GTH: = *Group Delay uncertainty transmission*
GRH: = *Group Delay uncertainty reflection*

Performance Test for the 81910A

Page 1 of 3

Model	81910A All Parameter Analyzer	**Date**	____________
Serial No.	____________	**Ambient Temperature**	________°C
Options	____________	**Relative Humidity**	________%
Software Rev.	____________	**Line Frequency**	________ Hz
Test Facility	____________	**Customer**	____________
Performed by	____________	**Report No**	____________

Special Notes ____

Performance Test for the 81910A **Test Equipment Used**

Page 2 of 3

System Component List

	Description	Model No.	Serial No
1	Optical Test Head	81910TH	____________
2	System Controller	81910SC	____________
3	Lightwave Measurement System	8164B	____________
4	Tunable Laser Source	81600B	____________
5	Optical Power Meter	81634B	____________
6	Optical Power Meter	81634B	____________
7	Optical Power Meter	81634B	____________
8	Polarization Controller	8169A	____________
9	Optical Head, Reference	81521B	____________

Test Equipment List

	Description	Model No.	Trace No	Cal. Due Date
1	Wavelength Reference (HCN Gas Cell)		______	______
2	Polarization Scrambler Transmission		______	______
3	Polarization Scrambler Reflection		______	______
4	Polarizer		______	______
5	Short Reflection Reference Fiber with Reflector		______	______
6	Transmission Reference Fiber		______	______
7	Long Reflection Reference Fiber with Reflector		______	______
8	GD/DGD Standard Transmission		______	______
9	GD/DGD Standard Reflection		______	______

Accessories	#	Product
Connector Interfaces	2	81000FI
Protective Caps	2	5040-9351

Performance Test for the 81910A **Report No. ________________**

Page 3 of 3 **Date ________________**

Test Description	Reference	Result	Spec	Uncertainty	Reference	Result	Spec	Uncertainty
	Transmission				Reflection			
Wavelength		[pm]	[pm]					
Loss, absolute	**WLA**	_______	<± 4					
Loss, relative	**WLR**	_______	<± 3					
Phase, absolute	**WPA**	_______	<± 1.5					
Loss		[dB]	[dB]			[dB]	[dB]	
Loss < 0.5 dB	**LT0**	_______	<± 0.010		**LR0**	_______	<± 0.020	
Loss < 10 dB	**LT1**	_______	<± 0.015		**LR1**	_______	<± 0.025	
Loss < 30 dB	**LT2**	_______	<± 0.025		**LR2**	_______	<± 0.040	
Loss < 40 dB	**LT3**	_______	<± 0.050					
PDL		[dB]	[dB]			[dB]	[dB]	
Loss < 0.5 dB	**PT0**	_______	<± 0.040		**PR0**	_______	<± 0.040	
Loss < 10 dB	**PT1**	_______	<± 0.050		**PR1**	_______	<± 0.055	
Loss < 30 dB	**PT2**	_______	<± 0.060		**PR2**	_______	<± 0.100	
Device PDL	**PDA**	______%	< 3%					
Dispersion								
GD, fiber	**GTA**	______fs	<± 50 fs		**GRA**	______fs	<± 50 fs	
GD, HCN	**GTH**	______%	<± 1.5%		**GRH**	______%	<± 1.5%	
DGD, fiber	**DTA**	______fs	<± 80 fs		**DRA**	______fs	<± 80 fs	

8

Maintenance and Troubleshooting

Cleaning

Safety Precautions

The following Cleaning Instructions contain some general safety precautions, which must be observed during all phases of cleaning. Consult the manuals or guides for the Polarization Controller, Lightwave Measurement System, Power Sensor Modules, and Tunable Laser Source Module for full information on safety matters.

Please try, whenever possible, to use physically contacting connectors, and dry connections. Clean the connectors, interfaces, and bushings carefully after use.

If you are unsure of the correct cleaning procedure for your optical device, we recommend that you first try cleaning a dummy or test device.

Agilent Technologies assumes no liability for the customer is failure to comply with these requirements.

WARNING

Please follow the following safety rules.

Do not remove instrument covers when operating.

Ensure that the instrument is switched off throughout the cleaning procedures.

Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.

Make sure that you disable all sources when you are cleaning any optical interfaces.

Under no circumstances look into the end of an optical device attached to optical outputs when the device is operational. The laser radiation is not visible to the human eye, but it can seriously damage your eyesight.

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

Do not install parts or perform any unauthorized modification to optical devices.

Refer servicing only to qualified and authorized personnel.

Why is it important to clean optical devices?

In transmission links optical fiber cores are about 9 µm (0.00035“) in diameter. Dust and other particles, however, can range from tenths to hundredths of microns in diameter. Their comparative size means that they can cover a part of the end of a fiber core, and thus degrade the transmission quality. This will reduce the performance of your system.

Furthermore, the power density may burn dust into the fiber and cause additional damage (for example, 0 dBm optical power in a single mode fiber causes a power density of approximately 16 million W/m2). If this happens, measurements become inaccurate and non-repeatable.

Cleaning is, therefore, an essential yet difficult task. Unfortunately, when comparing most published cleaning recommendations, you will discover that they contain several inconsistencies. We want to suggest ways to help you clean your various optical devices, and thus significantly improve the accuracy and repeatability of your lightwave measurements.

What do I need for proper cleaning?

Standard Cleaning Equipment

Before you can start your cleaning procedure you need the following standard equipment:

- Dust and shutter caps
- Isopropyl alcohol
- Cotton swabs
- Soft tissues
- Pipe cleaner
- Compressed air

Dust and shutter caps All Agilent Technologies lightwave instruments are delivered with either laser shutter caps or dust caps on the lightwave adapter. Any cables come with covers to protect the cable ends from damage or contamination.

We suggest these protective coverings should be kept on the equipment at all times, except when your optical device is in use. Be careful when replacing dust caps after use. Do not press the bottom of the cap onto the fiber too hard, as any dust in the cap can scratch or pollute your fiber surface.

If you need further dust caps, please contact your nearest Agilent Technologies sales office.

Isopropyl alcohol This solvent is usually available from any local pharmaceutical supplier or chemist’s shop.

If you use isopropyl alcohol to clean your optical device, do not immediately dry the surface with compressed air (except when you are cleaning very sensitive optical devices). This is because the dust and the dirt is solved and will leave behind filmy deposits after the alcohol is evaporated. You should therefore first remove the alcohol and the dust with a soft tissue, and then use compressed air to blow away any remaining filaments.

If possible avoid using denatured alcohol containing additives. Instead, apply alcohol used for medical purposes. Never drink this alcohol, as it may seriously damage to your health.

Do not use any other solvents, as some may damage plastic materials and claddings. Acetone, for example, will dissolve the epoxy used with fiber optic connectors. To avoid damage, only use isopropyl alcohol.

Cotton swabs We recommend that you use swabs such as Q-tips or other cotton swabs normally available from local distributors of medical and hygiene products (for example, a supermarket or a chemist’s shop). You may be able to obtain various sizes of swab. If this is the case, select the smallest size for your smallest devices.

Ensure that you use natural cotton swabs. Foam swabs will often leave behind filmy deposits after cleaning.

Use care when cleaning, and avoid pressing too hard onto your optical device with the swab. Too much pressure may scratch the surface, and could cause your device to become misaligned.

It is advisable to rub gently over the surface using only a small circular movement.

Swabs should be used straight out of the packet, and never used twice. This is because dust and dirt in the atmosphere, or from a first cleaning, may collect on your swab and scratch the surface of your optical device.

Soft tissues These are available from most stores and distributors of medical and hygiene products such as supermarkets or chemists’ shops.

We recommend that you do not use normal cotton tissues, but multi-layered soft tissues made from non-recycled cellulose. Cellulose tissues are very absorbent and softer. Consequently, they will not scratch the surface of your device over time.

Use care when cleaning, and avoid pressing on your optical device with the tissue. Pressing too hard may lead to scratches on the surface or misalignment of your device.

Just rub gently over the surface using a small circular movement.

Use only clean, fresh soft tissues and never apply them twice. Any dust and dirt from the air which collects on your tissue, or which has gathered after initial cleaning, may scratch and pollute your optical device.

Pipe cleaner Pipe cleaners can be purchased from tobacconists, and come in various shapes and sizes.The most suitable one to select for cleaning purposes has soft bristles, which will not produces scratches.

The best way to use a pipe cleaner is to push it in and out of the device opening (for example, when cleaning an interface). While you are cleaning, you should slowly rotate the pipe cleaner.

Only use pipe cleaners on connector interfaces or on feedthrough adapters. Do not use them on optical head adapters, as the center of a pipe cleaner is hard metal and can damage the bottom of the adapter.

Your pipe cleaner should be new when you use it. If it has collected any dust or dirt, this can scratch or contaminate your device.

The tip and center of the pipe cleaner are made of metal. Avoid accidentally pressing these metal parts against the inside of the device, as this can cause scratches.

Compressed air Compressed air can be purchased from any laboratory supplier.

It is essential that your compressed air is free of dust, water and oil. Only use clean, dry air. If not, this can lead to filmy deposits or scratches on the surface of your connector. This will reduce the performance of your transmission system.

When spraying compressed air, hold the can upright. If the can is held at a slant, propellant could escape and dirty your optical device. First spray into the air, as the initial stream of compressed air could contain some condensation or propellant. Such condensation leaves behind a filmy deposit.

Please be friendly to your environment and use a CFC-free aerosol.

Additional Cleaning Equipment

Some Cleaning Procedures need the following equipment, which is not required to clean each instrument:

- Microscope with a magnification range about 50X up to 300X
- Ultrasonic bath
- Warm water and liquid soap
- Premoistened cleaning wipes
- Lens papers
- Polymer film
- Infrared Sensor Card

Microscope with a magnification range about 50X up to 300X

A microscope can be found in most photography stores, or can be obtained through or specialist mail order companies.

Special fiber-scopes are available from suppliers of splicing equipment.

Ideally, the light source on your microscope should be very flexible. This will allow you to examine your device closely and from different angles.

A microscope helps you to estimate the type and degree of dirt on your device. You can use a microscope to choose an appropriate cleaning method, and then to examine the results. You can also use your microscope to judge whether your optical device (such as a connector) is severely scratched and is, therefore, causing inaccurate measurements.

Ultrasonic bath Ultrasonic baths are also available from laboratory suppliers or specialist mail order companies.

An ultrasonic bath will gently remove fat and other stubborn dirt from your optical devices. This helps increase the life span of the optical devices.

Only use isopropyl alcohol in your ultrasonic bath, as other solvents may cause damage.

Warm water and liquid soap Only use water if you are sure that there is no other way of cleaning your optical device without causing corrosion or damage. Do not use water that is too hot or too cold, as this may cause mechanical stress, which can damage your optical device.

Ensure that your liquid soap has no abrasive properties or perfume in it. You should also avoid normal washing-up liquid, as it can cover your device in an iridescent film after it has been air-dried.

Some lenses and mirrors also have a special coating, which may be sensitive to mechanical stress, or to fat and liquids. For this reason we recommend you do not touch them.

If you are not sure how sensitive your device is to cleaning, please contact the manufacturer or your sales distributor.

Premoistened cleaning wipes Use pre-moistened cleaning wipes as described in each individual cleaning procedure. Cleaning wipes may be used in every instance where a moistened soft tissue or cotton swab is applied.

Lens cleaning papers Some special lens cleaning papers are not suitable for cleaning optical devices like connectors, interfaces, lenses, mirrors and so on. To be absolutely certain that a cleaning paper is applicable, please ask the salesperson or the manufacturer.

Polymer film Polymer film is available from laboratory suppliers or specialist mail order companies.

Using polymer film is a gentle method of cleaning extremely sensitive devices, such as reference reflectors and mirrors.

Infrared Sensor Card Infrared sensor cards are available from laboratory suppliers or specialist mail order companies.

With this card you are able to control the shape of laser light emitted. The invisible laser beam is projected onto the sensor card, then becomes visible to the normal eye as a round spot.

WARNING **Take care never to look into the end of a fiber or any other optical component when they are in use. This is because the laser can seriously damage your eyes.**

Preserving Connectors

Listed below are some hints on how best to keep your connectors in the best possible condition.

Making Connections

Before you make any connection you must ensure that all cables and connectors are clean. If they are dirty, use the appropriate cleaning procedure.

When inserting the ferrule of a patchcord into a connector or an adapter, make sure that the fiber end does not touch the outside of the mating connector or adapter. Otherwise you will rub the fiber end against an unsuitable surface, producing scratches and dirt deposits on the surface of your fiber.

Dust Caps and Shutter Caps

Be careful when replacing dust caps after use. Do not press the bottom of the cap onto the fiber as any dust in the cap can scratch or dirty your fiber surface.

When you have finished cleaning, put the dust cap back on, or close the shutter cap if the equipment is not going to be used immediately.

Always keep the caps on the equipment when it is not in use.

All Agilent Technologies lightwave instruments and accessories are shipped with either laser shutter caps or dust caps. If you need additional or replacement dust caps, contact your nearest Agilent Technologies Sales/Service Office.

Immersion Oil and Other Index Matching Compounds

Wherever possible, do not use immersion oil or other index matching compounds with your device. They are liable to impair and dirty the surface of the device. In addition, the characteristics of your device can be changed and your measurement results affected.

Cleaning Instrument Housings

WARNING **Do not open the instruments as there is a danger of electric shock, or electrostatic discharge.**

CAUTION Do not open instruments. Opening the instrument can cause damage to sensitive components, and in addition your warranty will be voided.

CAUTION Do not use isopropyl alcohol to clean instrument housings.

Use a dry and very soft cotton tissue to clean the instrument housing and the keypad. In the case of heavy dirt, you can moisten the cotton tissue in water.

Which Cleaning Procedure should I use for Optical Components and Connectors?

Light dirt

If you just want to clean away light dirt, observe the following procedure for all devices.

- Use compressed air to blow away large particles.
- Clean the device with a dry cotton swab.
- Use compressed air to blow away any remaining filament left by the swab.

Heavy dirt

If the above procedure is not enough to clean your instrument, follow one of the procedures below.

If you are unsure of how sensitive your device is to cleaning, please contact the manufacturer or your sales distributor.

How to clean connectors

Cleaning connectors is difficult, as the core diameter of a single-mode fiber is only about 9µm. This generally means you cannot see streaks or scratches on the surface. To be certain of the condition of the surface of your connector and to check it after cleaning, you need a microscope.

In the case of scratches, or of dust that has been burnt onto the surface of the connector, you may have no option but to polish the connector. This depends on the degree of dirtiness, or the depth of the scratches. This is a difficult procedure and should only be performed by a skilled person, and as a last resort, as it wears out your connector.

WARNING **Never look into the end of an optical cable that is connected to an active source.**

To assess the projection of the emitted light beam you can use an infrared sensor card. Hold the card approximately 5 cm from the output of the connector. The invisible emitted light is projected onto the card and becomes visible as a small circular spot.

Preferred Procedure Use the following procedure on most occasions.

1. Clean the connector by rubbing a new, dry cotton swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt Use this procedure when there is greasy dirt on the connector.

1 Moisten a new cotton swab with isopropyl alcohol.
2 Clean the connector by rubbing the cotton swab over the surface using a small circular movement.
3 Take a new, dry soft tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4 Blow away any remaining lint with compressed air.

An Alternative Procedure A better, more gentle, but more expensive cleaning procedure is to use an ultrasonic bath with isopropyl alcohol.

1 Hold the tip of the connector in the bath for at least three minutes.
2 Take a new, dry soft tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
3 Blow away any remaining lint with compressed air.

How to clean connector interfaces

CAUTION Be careful when using pipe cleaners, as the core and the bristles of the pipe cleaner are hard and can damage the interface.

Preferred Procedure Use the following procedure on most occasions.

1 Clean the interface by pushing and pulling a new, dry pipe cleaner into the opening. Rotate the pipe cleaner slowly as you do this.
2 Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt Use this procedure when there is greasy dirt on the interface.

1 Moisten a new pipe cleaner with isopropyl alcohol.
2 Clean the interface by pushing and pulling the pipe cleaner into the opening. Rotate the pipe cleaner slowly as you do this.
3 Moisten a new cotton swab with isopropyl alcohol.
4 Using a new, dry pipe cleaner, remove the alcohol, any dissolved sediment and dust.
5 Blow away any remaining lint with compressed air.

How to clean bare fiber adapters

Bare fiber adapters are difficult to clean. Protect from dust unless they are in use.

CAUTION

Never use any kind of solvent when cleaning a bare fiber adapter as solvents can:

- damage the foam inside some adapters;
- deposit dissolved dirt in the groove, which can then dirty the surface of an inserted fiber.

Preferred Procedure Use the following procedure on most occasions.

1 Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt Use this procedure when there is greasy dirt on the adapter.

CAUTION

Be careful when using pipe cleaners, as the core and the bristles of the pipe cleaner are hard and can damage the adapter.

1 Clean the adapter by pushing and pulling a new, dry pipe cleaner into the opening. Rotate the pipe cleaner slowly as you do this.
2 Clean the adapter by rubbing a new, dry cotton swab over the surface using a small circular movement.
3 Blow away any remaining lint with compressed air.

How to clean lenses

Some lenses have special coatings that are sensitive to solvents, grease, liquid and mechanical abrasion. Take extra care when cleaning lenses with these coatings.

Lens assemblies consisting of several lenses are not normally sealed. Therefore, use as little alcohol as possible, as it can get between the lenses and in doing so can change the properties of projection.

Preferred Procedure Use the following procedure on most occasions.

1 Clean the lens by rubbing a new, dry cotton swab over the surface using a small circular movement.
2 Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt Use this procedure when there is greasy dirt on the lens.

1 Moisten a new cotton swab with isopropyl alcohol.
2 Clean the lens by rubbing the cotton swab over the surface using a small circular movement.
3 Using a new, dry cotton swab remove the alcohol, any dissolved sediment and dust.
4 Blow away any remaining lint with compressed air.

How to clean instruments with a fixed connector interface

You should only clean instruments with a fixed connector interface when it is absolutely necessary. This is because it is difficult to remove any used alcohol or filaments from the input of the optical block.

It is important, therefore, to keep dust caps on the equipment at all times, except when your optical device is in use.

CAUTION

Only use clean, dry compressed air. Make sure that the air is free of dust, water, and oil. If the air that you use is not clean and dry, this can lead to filmy deposits or scratches on the surface of your connector interface. This will degrade the performance of your transmission system.

Never try to open the instrument and clean the optical block by yourself, because it is easy to scratch optical components, and cause them to become misaligned.

If you do discover filaments or particles, the only way to clean a fixed connector interface and the input of the optical block is to use compressed air.

If there are fluids or oil in the connector, please refer the instrument to the skilled personnel of the Agilent service team.

How to clean instruments with a physical contact interface

Remove any connector interfaces from the optical output of the instrument before you begin the cleaning procedure.

Cleaning interfaces is difficult as the core diameter of a single-mode fiber is only about 9µm. This generally means you cannot see streaks or scratches on the surface. To be certain of the degree of pollution on the surface of your interface and to check whether it has been removed after cleaning, you need a microscope.

WARNING **Never look into an optical output, because this can seriously damage your eyesight.**

To assess the projection of the emitted light beam you can use an infrared sensor card. Hold the card approximately 5 cm from the interface. The invisible emitted light is projected onto the card and becomes visible as a small circular spot.

Preferred Procedure Use the following procedure on most occasions.

1 Clean the interface by rubbing a new, dry cotton swab over the surface using a small circular movement.
2 Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt Use this procedure when there is greasy dirt on the interface.

1 Moisten a new cotton swab with isopropyl alcohol.
2 Clean the interface by rubbing the cotton swab over the surface using a small circular movement.
3 Take a new, dry soft tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4 Blow away any remaining lint with compressed air.

How to clean instruments with a recessed lens interface

For instruments with a deeply recessed lens interface (for example the Agilent Technologies 81633A and 81634A Power Sensors) do NOT follow this procedure. Alcohol and compressed air could damage your lens even further.

Keep your dust and shutter caps on when your instrument is not in use. This should prevent it from getting too dirty.

If you must clean such instruments, please refer the instrument to the skilled personnel of the Agilent service team.

Preferred Procedure Use the following procedure on most occasions.

1 Blow away any dust or dirt with compressed air.

If this is not sufficient, then

   a Clean the interface by rubbing a new, dry cotton swab over the surface using a small circular movement.
   b Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt Use this procedure when there is greasy dirt on the interface, and using the procedure for light dirt is not sufficient.

Using isopropyl alcohol should be your last choice for recessed lens interfaces because of the difficulty of cleaning out any dirt that is washed to the edge of the interface.

1 Moisten a new cotton swab with isopropyl alcohol.
2 Clean the interface by rubbing the cotton swab over the surface using a small circular movement.
3 Take a new, dry soft tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4 Blow away any remaining lint with compressed air.

How to clean optical devices which are sensitive to mechanical stress and pressure

Some optical devices, such as Reference Reflectors, are very sensitive to mechanical stress or pressure. Do not use cotton swabs, soft tissues or other mechanical cleaning tools, as these can scratch or destroy the surface.

Preferred Procedure Use the following procedure on most occasions.

1 Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt To clean devices that are extremely sensitive to mechanical stress or pressure you can also use an optical clean polymer film. This procedure is time-consuming, but you avoid scratching or destroying the surface.

1 Put the film on the surface and wait at least 30 minutes to make sure that the film has had enough time to dry.
2 Remove the film and any dirt with special adhesive tapes.

Alternative Procedure For these types of optical devices you can often use an ultrasonic bath with isopropyl alcohol. Only use the ultrasonic bath if you are sure that it won't cause any damage to any part of the device.

1 Put the device into the bath for at least three minutes.
2 Blow away any remaining liquid with compressed air.

If there are any streaks or drying stains on the surface, repeat the cleaning procedure.

How to clean bare fiber ends

Bare fiber ends are often used for splices or, together with other optical components, to create a parallel beam.

The end of a fiber can often be scratched. You make a new cleave. To do this:

1. Strip off the cladding.
2. Take a new soft tissue and moisten it with isopropyl alcohol.
3. Carefully clean the bare fiber with this tissue.
4. Make your cleave and immediately insert the fiber into your bare fiber adapter in order to protect the surface from dirt.

Replacing the Optical Test Head Adapter Patchcord

The Optical Test Head adapter patchcords should be replaced every 1,000 uses, or if you suspect the connector has been damaged.

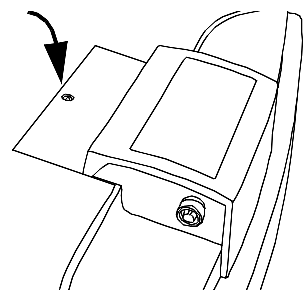
You can also replace the patchcord to accommodate the type of connection (straight, angled or bare) of your devices under test.

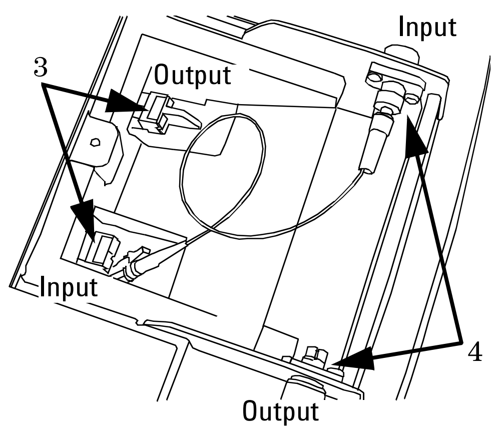
To replace the Optical Test Head patchcords you will need

- 2 replacement patchcords (Agilent part number 81910-88710 for straight connectors, 81910-88711 for angled connectors and 81910-88712 for bare fiber).
- A 3mm Allen key, (supplied as part of the Mounting Kit with the Photonic All-Parameter Analyzer).
- A Termination Reflectance Rod (supplied as part of the Mounting Kit with the Photonic All-Parameter Analyzer).

1 Using the Allen key, remove the bolt holding the patchcord cover.

2 Lift the cover up and away from the Optical Test Head.





3 Disconnect the existing patchcords from the internal connectors

4 Disconnect the existing patchcords from the external connectors.

5 Unscrew the protective cap from the new patchcord.

6 Connect the first new patchcord to the internal and external connector of the Optical Test Head **output** port.

7 Check the PDL in reflection:

a Connect or splice the reference reflector patchcord (gold reflector) to the external end of the output adapter patchcord.

b Fix the reference reflector patchcord and the output adapter patchcord so they cannot move, and let them settle (3 minutes recommended).

c Perform a PDL reference measurement in reflection over the desired wavelength range.
Set the parameters for the PDL measurement, as described in “Checking or Setting the Measurement Parameters” on page 139.

Measurement	Loss/PDL
Light Path	Reflection
Sweep Wavelength	According to the maximum wavelength range and resolution you use for your measurements.
Dynamic	3

Make sure that the phase measurement is off (see “Setting the Measurement Parameters in Expert Mode” on page 144).
Make a reference measurement, as described in “Performing a Reference Measurement” on page 160.

d Move the patchcord to change the polarization of the reflected light.
Create different loops.
No part of the fiber should be bent to tighter than a 10 cm diameter.

e Fix the reference reflector patchcord and the output adapter patchcord so they cannot move, and let them settle (3 minutes recommended).

f Perform the PDL measurement, as described in “Performing a Multi-Port DUT Measurement” on page 167.

g Check the PDL result against the specified PDL uncertainty in reflection.
See “Performance Specifications” on page 216 for the specified PDL uncertainty in reflection.
More than 95% of all results must be below the limit.

Note: This result includes the parasitic PDL of the connection (or splice) between output adapter patchcord and reference reflector patchcord.
These parasitics are not part of the system uncertainty. If they lead to a failure of the test, improve that connection (or splice) and repeat the test.

If the PDL results exceed the specified uncertainty, check and improve the internal connection, or install a new patchcord, and repeat the test.
If a second patchcord fails to satisfy the PDL uncertainty in reflection, contact your Agilent Service representative.

h For increased confidence in the PDL uncertainty in reflection, repeat steps step d to step g(10 times is recommended).

8 Connect the second new patchcord to the internal connector of the Optical Test Head **input** port.

9 Check the PDL in transmission:

a Connect or splice the external ends of the adapter patchcords together.
If the test head input patchcord is shorter than 75 cm, extend it using the transmission reference fiber.

b Fix the patchcords so they cannot move, and let them settle (3 minutes recommended).

c Change the light path for the PDL measurement to transmission, as described in “Checking or Setting the Measurement Parameters” on page 139.

Measurement	Loss/PDL
Light Path	Transmission
Sweep Wavelength	According to the maximum wavelength range and resolution you use for your measurements.
Dynamic	3

Make a reference measurement, as described in “Performing a Reference Measurement” on page 160.

d Move the input adapter patchcord (and the transmission reference fiber, if used) to change the polarization of the reflected light.
Create different loops (see diagram).
No part of the fiber should be bent to tighter than a 10 cm diameter.

e Fix the patchcords so they cannot move, and let them settle (3 minutes recommended).

f Perform the PDL measurement, as described in “Performing a Multi-Port DUT Measurement” on page 167.

g Check the PDL result against the specified PDL uncertainty in transmission.
See “Performance Specifications” on page 216 for the specified PDL uncertainty in transmission.
More than 95% of all results must be below the limit.

Note: This result also covers the parasitic PDL of the connection (or splice) between the input adapter patchcord and transmission reference patchcord (if used).
These parasitics are not part of the system uncertainty. If they lead to a failure of the test, improve the connection (or splice) and repeat the test.

If the PDL results exceed the specified uncertainty, check and improve the internal connection, or install a new patchcord, and repeat the test.
If a second patchcord fails to satisfy the PDL uncertainty in transmission, contact your Agilent Service representative.

h For increased confidence in the PDL uncertainty in transmission, repeat steps step d to step g (10 times is recommended).

10 Make sure the patchcords are looped with the largest possible radius, and are fixed to minimize stress on the patchcord and the connectors.

11 Connect the new patchcords to the external connectors.

12 Replace the patchcord cover, and return the bolt and tighten it.

Troubleshooting

If the 81910A All Parameter Analyzer does not perform according to its specifications, please perform an operational verification test, as decribed in “Operational Verification Test” on page 222. This test consists of

- system diagnostics, and a
- simplified performance verification.

If one or both of these tests fail, please make sure you save all the test results, and contact your Agilent Service representative.

Further Information

For further information, please consult the All-Parameter Analyzer support website at http://www.agilent.com/comms/allparameter; then choose “Technical Support”.

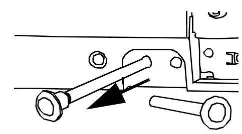
Transporting the Optical Test Head

WARNING

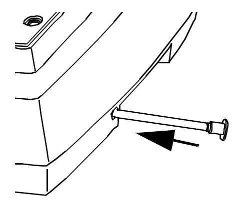
The Optical Test Head is heavy and requires two people to lift or carry.
Do not attempt to lift or carry it on your own.
Make sure you use the help of a colleague to pack, unpack or move the Optical Test Head.

If you are transporting the Optical Test Head for any reason,

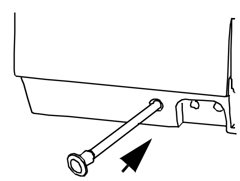
- Reinsert the 4 fixing bolts to the Optical Test Head.
  These bolts prevent suspension of the Optical Test Head from being damaged in transport.
  - Remove the fixing bolts from the holes at the back of the Optical Test Head, to the left and right of the connector area.



  - There is one fixing bolt on each side of the Optical Test Head.
    Depress the optical bench slightly to slide the bolt into position.



  - There are two fixing bolts at the back of the Optical Test Head, to the left and right of the connector area.
    Depress the optical bench slightly to slide the bolt into position.



  If necessary, secure the fixing bolts to the Optical Test Head with adhesive tape to ensure they do not slip out during transport.

- You should return the Optical Test Head to the original packing if this is available.
- Make sure the Optical Test Head is transported horizontally. If necessary mark the packaging with the correct position for transport (up/down).

9
Theory of Measurement and Operation

This chapter offers a brief explanation of the theory of measurement and operation as it applies to the Photonic All-Parameter Analyzer. For more details on the principles applied, please refer to one of the standard text books on fiber optic test. For more information on the theory of operation of the Tunable Laser Source, Polarization Controller or the other elements of the measurement system, please refer to the user documentation supplied with the individual instruments.

Theory of Operation for Basic Measurements

To measure Loss and Reflectance, the optical test head uses three power meters.

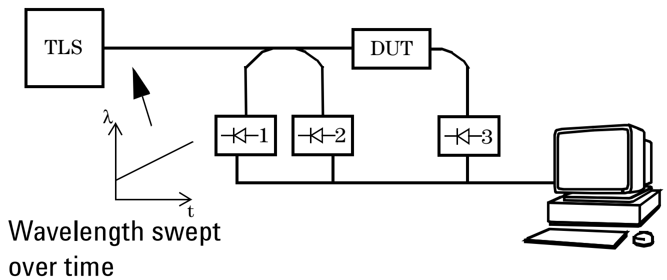


Figure 30 Configuration used to measure basic lossparameters

The loss of the DUT is measured between power meters 2 and 3.
The reflectance of the device is measured by power meters 1 and 2.

Reference measurements are used to establish the relationshipbetween the readings of the respective power meters for a device of zero-loss.

NOTE The labeling of the power meters does not correspond to the slot numbers of the instrumentation.

Theory of Operation for Polarization Dependent Loss Measurements

The Polarization Dependent Loss (PDL) is measured using the Mueller Method. For a detailed description of the Mueller method of measuring PDL, please see Agilent application note 5964-9937E.

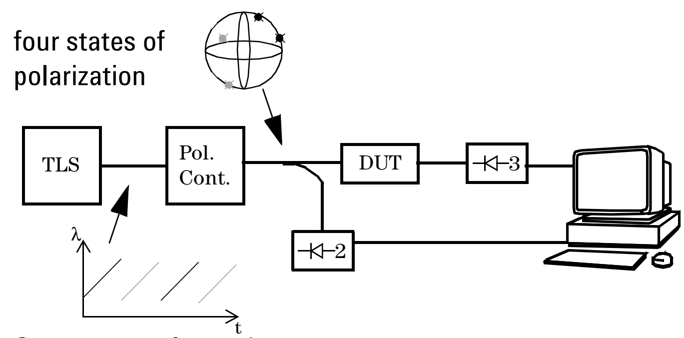


Figure 31 Configuration used to measure polarization dependent loss

A Stokes vector, S=(S0, S1, S2, S3) completely describes the power and polarization state of an optical wave.

An incident polarized wave, characterized by the Stokes vector S_{in}, interacts with the DUT, and the emerging lightwave is characterized by the Stokes vector S_{out}.
The 4 x 4 Mueller Matrix, M_{DUT}, gives the relationship between these two vectors:

The four first-row coefficients of the Mueller Matrix describe the power transmission of the DUT.

$$T = \frac{S0_{out}}{S0_{in}} = \frac{m_{11} \cdot S0_{in} + m_{12} \cdot S1_{in} + m_{13} \cdot S2_{in} + m_{14} \cdot S3_{in}}{S0_{in}}$$

From which the PDL can be calculated:

$$PDL_{dB} = 10\log\frac{T_{max}}{T_{min}} = 10\log\frac{m_{11} + \sqrt{m_{12}^2 + m_{13}^2 + m_{14}^2}}{m_{11} - \sqrt{m_{12}^2 + m_{13}^2 + m_{14}^2}}$$

Theory of Operation for Group Delay Measurements

The Group Delay of a DUT is measured using the basic principle of swept wavelength interferometry.

The Mueller Method determines PDL by measuring the DUT at four well-known states of polarization, yielding a system of linear equations that can be solved to determine the four first-row coefficients of the Mueller Matrix:

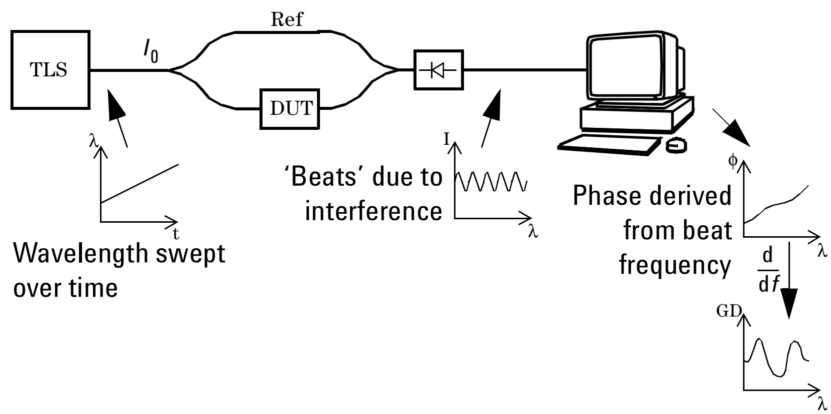


Figure 32 Interferometric measurement of the GD of a DUT

As the source wavelength is swept by the TLS (tunable laser source), the strength of the signal detected, *S*, by the power meter is given by the formula

$$S(f) = \frac{I_0}{4}(1 + T(f) + 2\sqrt{T(f)} \cdot \cos(2\pi f \cdot (\tau_{\phi_{DUT}}(f) - \tau_{\phi_{Ref}})))$$

where I_0 is the power of the laser, *T(f)* is the transmission ration of the DUT and $\tau_{\phi_{DUT}}$ and $\tau_{\phi_{Ref}}$ are, respectively, the phase delays in the DUT and reference paths.

The last term of this equation describes the beating of the output signal as the wavelength is swept. The period of the beats will depend on the difference in the phase delay between the DUT and reference paths($\tau_{\phi_{DUT}}$ - $\tau_{\phi_{Ref}}$). Given the short length of the reference path, $\tau_{\phi_{Ref}}$ can be considered as a constant.
The application on the PC separates this phase component out:

$$\Psi(f) = 2\pi f \cdot (\tau_{\phi_{DUT}}(f) - \tau_{\phi_{Ref}})$$

And differentiating this we get

$$\frac{1}{2\pi}\cdot\frac{d}{df}\Psi(f) = \tau_{\phi_{DUT}}(f) + f\frac{d}{df}\tau_{\phi_{DUT}}(f) - \tau_{\phi_{Ref}}$$

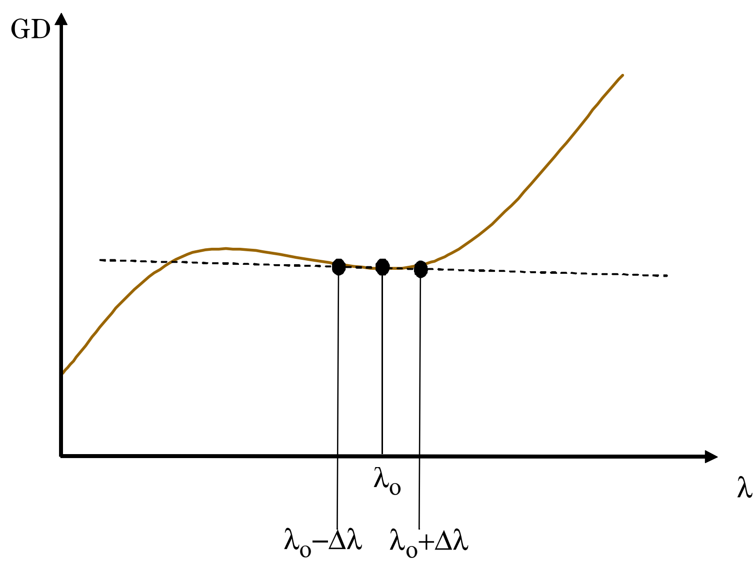
Which is equivalent to the definition of relative group delay:

$$GD(f) = \tau_{\phi} + f\frac{d\tau_{\phi}}{df} + k \quad \text{, where } k \text{ is a constant.}$$

Derivation of Chromatic Dispersion from the Group Delay

The chromatic dispersion is the derivative of the group delay.

$$CD = \frac{d}{d\lambda}GD \approx \frac{GD(\lambda_0 + \Delta\lambda) - GD(\lambda_0 - \Delta\lambda)}{(\lambda_0 + \Delta\lambda) - (\lambda_0 - \Delta\lambda)}$$



Theory of Operation for Differential Group Delay Measurements

Polarization Mode Dispersion (PMD) and Differential Group Delay (DGD) are due to any polarization dependence in the Group Delay. Measuring PMD and DGD relies on determining the maximum and minimum values for the group delay, over wavelength for the all possible polarization states.

To minimize the amount of data and the time required for the measurement, the Photonic All-Parameter Analyzer determines the values for the Jones matrix.
The Jones matrix is a 2 x 2 matrix for a device that describes the polarization-dependent, optical properties. Its Eigenstates give the states of polarization for minimum and maximum group delay. The resulting Eigenvalues give the values for maximum and minimum group delay.

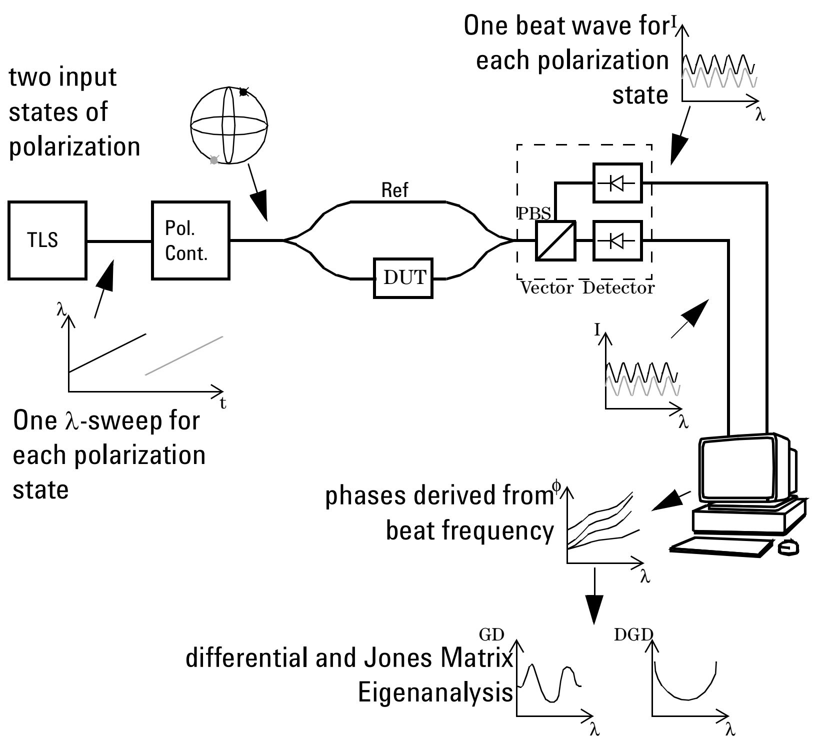


Figure 33 Interferometric measurement of the GD and DGD of a DUT

This setup extends the principle used for the basic swept wavelength interference setup described in “Theory of Operation for Group Delay Measurements” on page 294. A polarization controller has been added and vector detector (consisting of a polarization beam splitter (PBS) and two power meters). The PBS splits the light emerging from the interferometer into orthogonal components. By applying two, known states of input light (each swept over wavelength), we can solve the Jones matrix for the DUT.

Once the Jones matrix has been solved, we can use the difference of the Eigenvalues to derive the DGD, and the average of the Eigenvalues to derive the GD.

Loss and Polarization Dependent Loss Measurements Using the Jones Matrix

While in the accurate measurement mode, Insertion Loss (IL) and Polarization Dependent Loss (PDL) are determined using the Mueller Method, it is also possible to use the Jones Matrix to determine those parameters. In the fast (realtime) measurement mode, the Photonic All-Parameter Analyzer uses the Jones Matrix for all parameters including IL and PDL.

By exporting the Jones Matrix to a file after a measurement in accurate mode, it can be used for custom calculations. The Jones Matrix can deliver IL, PDL, GD, DGD traces as well as derived parameters such as CD, PMD, second order PMD, principal states of polarization (PSP), impulse response and others.

To characterize devices with a large polarization dependence or polarization extinction ratio, such as polarizers or polarizing beam splitters, the Jones Method delivers more reliable and accurate PDL measurement results than the Mueller Method. On the other hand, the Mueller Method is the most accurate way to determine small PDL values.

As uncertainty mechanisms are different for the Mueller Method and the Jones Method, there are a few things to consider:

- The maximum PDL that can be measured with the Jones Method depends on the sweep range: the narrower the sweep range is, the larger PDL values can be measured.

  Under laboratory conditions, (e.g. for polarizers) PDL values as large as 70 dB could be determined at sweep ranges of a few nanometers, however maximum polarization extinction / PDL values decrease to 29 dB at the edges of a 50 nm sweep range.
- If small PDL values are to be determined with the Jones Matrix, uncertainties can become significant and limit the minimum detectable PDL.
- These effects do not compromise the accuracy of the principal states of polarization (PSP) derived from the Jones matrix.

Generally, for optimum loss and PDL measurement accuracy, we recommend to rely on Mueller data for a PDL of less than 10 dB, and on Jones data for larger PDL values.

10
Definition of Terms

This appendix offers definitions of commonly used terms, and, where necessary, the measurement conditions associated with them.

Specification: describes a guaranteed product performance that is valid under the specified conditions. The confidence level used is 95%, as recommended by the ISO standard.

Generally, all specifications are valid at the stated operating conditions and measurement settings, at uninterrupted line voltage, for constant (as stated) ambient temperature after reference measurement, with all optical patchcords and fibers fixed and settled as stated.

Typical value: a characteristic describing the product performance that is usually met but not guaranteed.

Absolute wavelength uncertainty

Specifies the maximum difference between measured and actual wavelength.
Wavelength is defined as wavelength in vacuum.

Conditions: As specified.

Differential group delay (DGD)

The variation of *"Group delay (GD)"* of a device, in transmission or reflection, resulting from applying all possible polarization states, expressed as the difference between the maximum and the minimum group delay value.

NOTE

DGD is a peak-to-peak value. In optical fibers with their statistical nature of polarization-dependent group delay, the term "Polarization Mode Dispersion (PMD)" is normally used expressing the average of the differential group delay $<DGD>_{\lambda}$ over a specified wavelength range.

Differential group delay (DGD) loss range

"Loss" range for which the system can measure "Differential group delay (DGD)", lying between 0 dB and the specified value.

Differential group delay (DGD) measurement range

Measurable "Differential group delay (DGD)" range, lying between 0 and the specified value.

Differential group delay (DGD) noise

The maximum variation of "Differential group delay (DGD)" compared to low pass filtered (averaged) measurement curve over wavelength, for a device with wavelength-flat DGD.

Conditions: Device under test type and settings as specified. Other conditions as specified.

Differential group delay (DGD) resolution

The smallest possible "Differential group delay (DGD)" increment in the DGD measurement results.

Group delay (GD)

The optical signal delay time caused by a device, either in transmission or reflection.

NOTE

In general group delay depends on wavelength and polarization state. In some cases (for example to determine the chromatic dispersion) only the variation of the group delay over wavelength is of interest, not its absolute value. In these case the "relative group delay" can be used where an arbitrary delay value is added to the group delay values, typically to bring its minimum value to zero.

Group delay (GD) dynamic range

Specifies the maximum measurable "Group delay (GD)" change over wavelength of a test device (DUT), given as the difference between maximum and minimum group delay.

NOTE

The upper limit of the measurable group delay itself is given by the Maximum device optical path length of a fiber.

Group delay (GD) loss range

"Loss" range for which the system can measure "Group delay (GD)" , lying between 0 dB and the specified value.

Group delay (GD) noise

The variation of "Group delay (GD)" compared to the second order polynomial fit of the measured curve over wavelength for measurements of an optical fiber.

Conditions: Device under test type and settings as specified. Other conditions as specified.

Group delay (GD) relative uncertainty

When calculating the difference between measured and actual "Group delay (GD)" over a specified wavelength range and for a given polarization state, the Group delay (GD) relative uncertainty is ± half the span between maximum and minimum of all differences. This does not include an arbitrary offset of the complete GD spectrum to produce relative GD.

Conditions: Device under test type as specified. Other conditions as specified.

Measurement: The GD relative uncertainty is determined by measuring the maximum group delay change around one absorption peak of a $H^{13}C^{14}N$ be molecular gas cell at the given wavelength. The actual group delay change value is derived from the measured spectral loss curve of the gas cell using the Kramers-Kronig relation as described in [1].

Group delay (GD) resolution

The smallest possible "Group delay (GD)" increment in the group delay measurement results.

Loss

The loss of a device is the ratio between incident optical power at the input port and the optical power emerging either from the output port of the device (in transmission) or reflected back to the input port (in reflection). Loss is expressed in dB and can be calculated from:

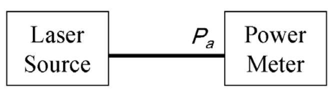
$$Loss[\mathrm{dB}] = 10\log\frac{P_a}{P_b} = P_a[\mathrm{dBm}] - P_b[\mathrm{dBm}]$$

where: P_a = input optical power, and P_b = output optical power.

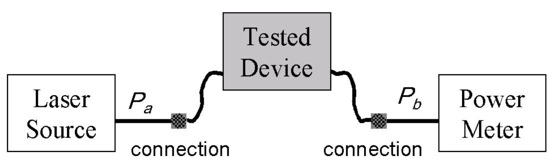
Measurement: A sequence of 1.) reference measurement and 2.) device measurement.

In transmission:

1

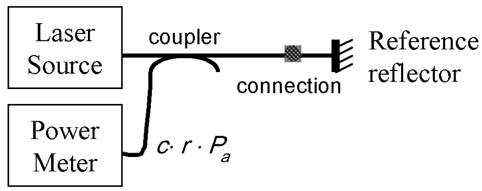


2

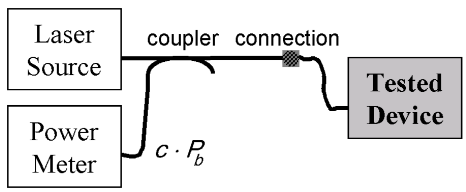


In reflection:

1



2



A constant coupling factor *c* has no effect on the result of loss in reflection. To calculate loss in reflection, the reference reflector's reflectivity *r* must be known.

NOTE

In general, loss depends on wavelength and polarization state.

NOTE

"Loss in transmission" is often also called "insertion loss". "Loss in reflection" is often also called "return loss"

Loss range

Specifies in a "Loss" measurement to the ratio between the receiver power level at a device loss of 0 dB and the receiver dark noise (RMS), expressed in dB.

Conditions: Power meter zeroing prior to measurement. Source power and power meter ranges as automatically set by the software. Other conditions as specified.

Loss uncertainty

Specifies the maximum difference between measured and actual "Loss" (in dB).

Conditions: Loss uncertainty does not include the loss of the connections (connectors or splices) between the adaptor patchcords and the reference fiber or device under test. In reflection, loss results are normalized to the used reference reflector, this means the reference reflector has per definition 0 dB loss in reflection. Other conditions specified.

Maximum device optical path length

Specifies the maximum geometric path length of a signal propagating through silica (i.e. typical single mode fiber with refractive index 1.47) for which group delay and differential group delay can be measured.

NOTE In vacuum or air the maximum geometric path length can be higher than the specified value. Generally, for a medium with refractive index n the maximum length is 1.47/n times the specified value.

Measurement time

Time needed for a test device (DUT) measurement, for transfer of the measurement data to the computer, for calculation of the measurement results and displaying or storing the result.

Condition: Reference measurements already taken. Other conditions and parameters as specified.

Operating conditions

The environmental conditions under which the specifications apply.

NOTE For a mainframe mounted in a rack the environmental conditions within the rack apply.

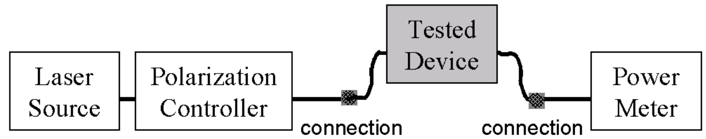
Polarization dependent loss (PDL)

The dependence of the "Loss" of a device (in transmission or reflection) on the input polarization state, expressed as the difference between maximum and minimum loss (in dB).

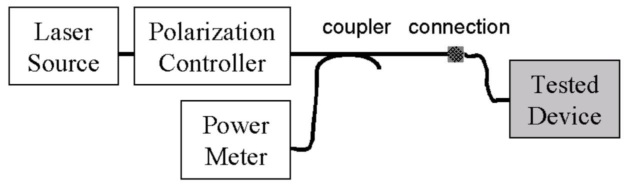
Measurement: The polarization dependent loss measurement is based on four loss measurements in four defined polarization states of the light source. The polarization states are generated by a polarization controller and are mutually orthogonal on the Poincare sphere.

The polarization dependent loss values are calculated from the loss results using the Mueller-Stokes method [2].

In transmission:



In reflection:



NOTE PDL is a peak-to-peak value. In general PDL depends on wavelength.

Polarization dependent loss (PDL) uncertainty

Specifies the uncertainty of the measurement results for "Polarization dependent loss (PDL)" , expressed as the maximum difference between the measured value and actual value (in dB).

Conditions: PDL uncertainty does not include the PDL of the connections (connectors or splices) between the adapter patchcords and the reference fiber or device under test. In reflection the uncertainty applies when using the bare fiber reflectance reference. Other conditions as specified.

Polarization Mode Dispersion (PMD)

The average of the "Differential group delay (DGD)" , $<DGD>_\lambda$ over a broad specified wavelength range.

NOTE In mode coupled devices, such as standard single mode fibers of kilometer length, the DGD has a strong wavelength dependence. The dependence of a device's DGD over wavelength performance may alter due to bending or temperature changes. It can be shown that the DGD characteristics of such devices can be described by a statistically averaged value like PMD.

Polarization mode dispersion (PMD) uncertainty

Specifies the uncertainty of the measurement results for "Polarization Mode Dispersion (PMD)" , expressed as the maximum possible difference between the measured value and actual value.

Conditions: As specified.

Relative group delay

The difference in the "Group delay (GD)" of a device at two different wavelengths.

Relative wavelength uncertainty

When calculating the difference between measured and actual wavelength over a specified wavelength range, the relative wavelength uncertainty is ± half the span between maximum and minimum of all differences. Wavelength is defined as wavelength in vacuum.

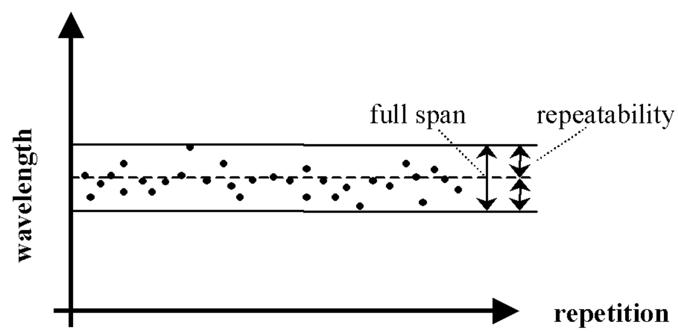
Conditions: As specified.

Wavelength range

The range of wavelength for which the specifications apply. Wavelength is defined as wavelength in a vacuum.

Wavelength repeatability

Specifies the uncertainty in reproducing a wavelength in repeated measurements. The wavelength repeatability is ± half the span between maximum and minimum actual wavelength over repetitions at any nominal wavelength.



Conditions: Repetitions performed with the same measurement settings and same wavelength offset correction. Other conditions as specified.

Wavelength resolution

The narrowest wavelength spacing between the measurement result values.

Wavelength resolution bandwidth

Specifies the 2 Sigma width (in nm) of a Gaussian filter used for numerically convolving "Group delay (GD)" or "Differential group delay (DGD)" data over wavelength.

NOTE The convolution acts as a low pass (smoothing) filter for the measured signal over wavelength. Due to the symmetry of the Gaussian filter no wavelength shift is introduced to the data.

References

[1] A. Motamedi, B. Szafraniec, P. Robrish, D.M. Baney, “Group delay reference artifact based on molecular gas absorption”, Optical Fiber Communications Conference, March 18-22, 2001, ThC8-1 (2001)

[2] IEC 61300-3-12, “Polarization dependence of attenuation of a single-mode fibre optic component: matrix calculation method”

Index

S

T

U

V

W

X

Z

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