Agilent 81560A, 61A, 70A, 71A, 73A, 75A Variable Optical Attenuator Modules, and Agilent 81566A, 67A, 76A, 77A Variable Optical Attenuator Modules with Power Control

User's Guide

Agilent Technologies

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81560-90A14

Fourth Edition:
81560-90A14: January 31, 2003

Third Edition:
81560-90A13: October 29, 2002

Second Edition:
81560-90A12: August 04, 2002

First Edition:
81560-90A11: November 2001

Safety Summary

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

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

WARNING

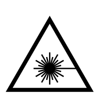
The WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

Optical power levels above 100 mW applied to single-mode connectors can easily damage the connector if it is not perfectly clean. Also, scratched or poorly cleaned connectors can destroy optical connectors mechanically. Always make sure that your optical connectors are properly cleaned and unscratched before connection. Refer to chapter "Cleaning Information" on page 91 on appropriate procedures for connector cleaning and inspection. However, Agilent Technologies Deutschland GmbH assumes no responsibility in case of an operation that is not compliance with the safety instructions as stated above.

Safety Symbols

The apparatus will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the apparatus against damage.



Hazardous laser radiation.

Initial Inspection

Inspect the shipping container for damage. If there is damage to the container or cushioning, keep them until you have checked the contents of the shipment for completeness and verified the instrument both mechanically and electrically.

The Performance Tests give procedures for checking the operation of the instrument. If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator's checks, notify the nearest Agilent Technologies Sales/Service Office.

WARNING **To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, etc.).**

WARNING **You *MUST* return instruments with malfunctioning laser modules to an Agilent Technologies Sales/Service Center for repair and calibration.**

Line Power Requirements

The Agilent 81560A, 61A, 70A, 71A, 73A, 75A Variable Optical Attenuator modules and Agilent 81566A, 67A, 76A, 77A Variable Optical Attenuator modules with Power Control operate when installed in the Agilent 8163A and B Lightwave Multimeters, the Agilent 8164A and B Lightwave Measurement Systems, or the Agilent 8166A and B Lightwave Multichannel Systems.

Within this User's Guide, these instruments are collectively referred to as 'mainframes'.

Operating Environment

The safety information in your mainframe's User's Guide summarizes the operating ranges for the Agilent 81560A, 61A, 70A, 71A, 73A, 75A Variable Optical Attenuator modules and Agilent 81566A, 67A, 76A, 77A Variable Optical Attenuator modules with Power Control. In order for these modules to meet specifications, the operating environment must be within the limits specified for your mainframe.

Storage and Shipment

Agilent 81560A, 61A, 70A, 71A, 73A, 75A Variable Optical Attenuator modules and Agilent 81566A, 67A, 76A, 77A Variable Optical Attenuator modules with Power Control can be stored or shipped at temperatures between

–40°C and +70°C.

Protect the module from temperature extremes that may cause condensation within it.

Firmware Prerequisites

For Agilent 8156x modules with a particular firmware revision to operate correctly, your Agilent 8163A/B, 8164A/B, or 8166A/B mainframe must have a V3.5, or later, firmware revision installed.

For Agilent 8157x modules with a particular firmware revision to operate correctly, your Agilent 8163A/B, 8164A/B, or 8166A/B mainframe must have a V4.0, or later, firmware revision installed.

Firmware files are provided on the OCT Support CD-ROM supplied with the instrument, and the latest firmware revisions can also be downloaded via www.Agilent.com/comms/comp-test

The firmware for A and B versions of our mainframes is not binary compatible. Make sure you select the appropriate firmware for your instrument.

NOTE

- Updating mainframe firmware does not require you to update the firmware in every hosted module. New revisions of mainframe firmware are backwards compatible with older module firmware.
- You may find it advantageous to update module firmware. To help you determine which module firmware to update, a readme file is provided with the firmware file detailing its revision history.
- If the serial number of your HP 8164A Lightwave Measurement System is DExxxxx339 or below, problems with writing files to the floppy disk drive may occur in rare cases. If this is the case, please contact your nearest Agilent Technologies Sales / Service Office.

Checking your Current Firmware Revision

8163A/B Lightwave Multimeter, 8164A/B Lightwave Measurement System, or 8166A/B Lightwave Multichannel System

To check your 8163A/B Lightwave Multimeter, 8164A/B Lightwave Measurement System, or 8166A/B Lightwave Multichannel System's firmware revision:

1 Press the Config hardkey.

2 Move to the <About Mainframe> menu option and press Enter.

3 The manufacturer, part number, instrument number, and firmware revision are listed. If the firmware revision number is less than V3.5 for 8156x modules, or is less than V4.0 for 8157x modules, follow the Update Procedure described in the readme.txt in the root directory of the OCT Support CD-ROM supplied with the instrument to install a later firmware revision.

8156x Series and 8157x Modules

To check an 8156x series, or 8157x series, module's firmware revision:

1 Press the Config hardkey.

2 Move to the <About Modules> menu option and press Enter. You see a box displaying the slots that have a module installed.

3 Move to the appropriate slot using the cursor key and press Enter.

4 The part number, module number, and firmware revision of the chosen module are displayed. If the firmware revision number is less than V3.5 for 8156x modules, or is less than V4.0 for 8157x modules, follow the Update Procedure described in the readme.txt in the root directory of the OCT Support CD-ROM supplied with the instrument to install a later firmware revision.

The Structure of this Manual

This manual is divided into two parts:

- Getting Started
  This section gives an introduction to the attenuator modules and aims to make these modules familiar to you:
  - *"Getting Started with Attenuator Modules" on page 17*.
- Additional Information
  This is supporting information of a non-operational nature, concerning accessories, specifications, and performance tests:
  - *"Accessories" on page 29*,
  - *"Specifications" on page 35*, and
  - *"Performance Tests" on page 53*.

Conventions used in this manual

- Hardkeys are indicated by italics, for example, *Config*, or *Channel*.
- Softkeys are indicated by normal text enclosed in square brackets, for example, [Zoom] or [Cancel].
- Parameters are indicated by italics enclosed by square brackets, for example, [*Range Mode*], or [*MinMax Mode*].
- Menu items are indicated by italics enclosed in brackets, for example, <*MinMax*>, or <*Continuous*>.

Table of Contents

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Getting Started with Attenuator Modules

This chapter describes the:

- Agilent 81560A and 81561A Variable Optical Attenuator (VOA) modules;
- Agilent 81566A and 81567A VOA modules with power control;
- Agilent 81570A, 81571A, 81573A and 81575A VOA modules for high-power applications; and the
- Agilent 81576A and 81577A VOA modules with power control for high-power applications.

CAUTION

Optical power levels above 100 mW applied to single-mode connectors can easily damage the connector if it is not perfectly clean. Also, scratched or poorly cleaned connectors can destroy optical connectors mechanically. Always make sure that your optical connectors are properly cleaned and unscratched before connection. Refer to chapter “Cleaning Information” on page 91 on appropriate procedures for connector cleaning and inspection. However, Agilent Technologies Deutschland GmbH assumes no responsibility in case of an operation that is not compliance with the safety instructions as stated above.

What is an Attenuator?

Agilent 8156xA and 8157x Variable Optical Attenuators attenuate and control the optical power of light in single-mode optical fibers. They allow you to set the attenuation factor and/or power level manually, or via the host instrument's GPIB interface.

Agilent 81566A, 81567A, 81576A and 81577A attenuators include power control functionality that allows you to set the output power level of the attenuator. When power control mode is enabled, the module automatically corrects for power changes at the input so that the output power level set by the user is maintained. See Figure 1 on page 19.

Installation

Agilent 8156xA and 8157xA Variable Optical Attenuators are front-loadable modules for the Agilent 8163A/B Lightwave Multimeter, 8164A/B Lightwave Measurement System, and 8166A/B Lightwave Multichannel System, collectively referred to as 'mainframes'.

An Agilent 81560A, 61A, 70A, 71A, 73A or 75A module occupies one slot, while an Agilent 81566A, 67A, 76A or 77A module occupies two slots.

For a description of how to install your module, refer to "How to Fit and Remove Modules" in the Installation and Maintenance chapter of your mainframe's User's Guide.

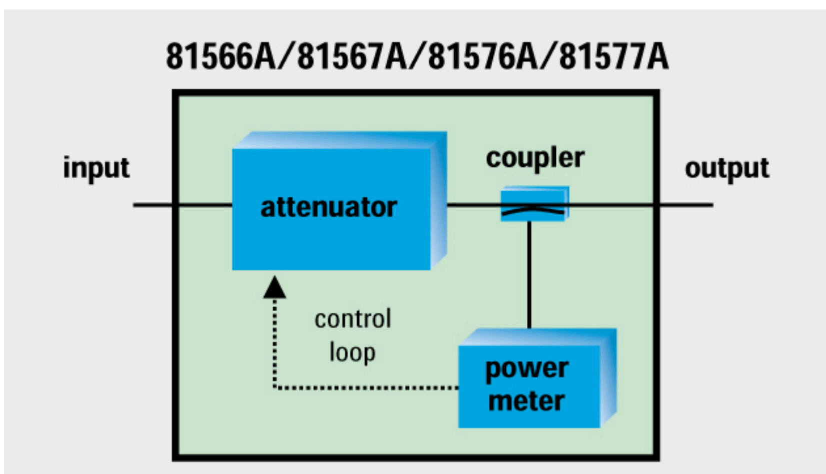


Figure 1 Agilent 81566A/67A/76A/77A Optical Attenuators with Power Control

Variable Optical Attenuator Front Panels

Agilent 81560A

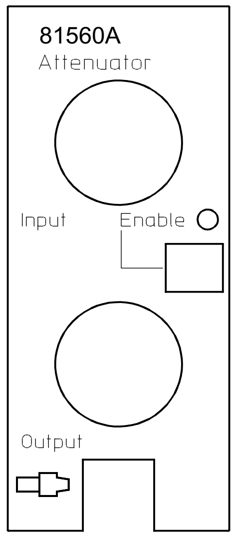


Figure 2 Agilent 81560A Attenuator with Straight Connector

Agilent 81561A

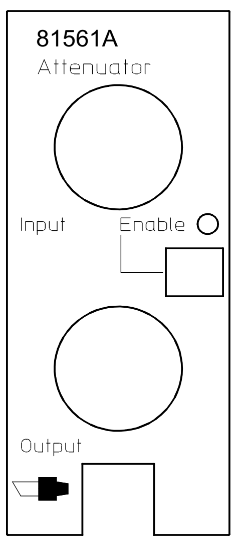


Figure 3 Agilent 81561A Attenuator with Angled Connector

Agilent 81570A

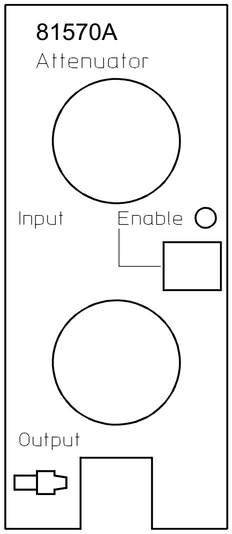


Figure 4 Agilent 81570A High-power Attenuator with Straight Connector

Agilent 81571A

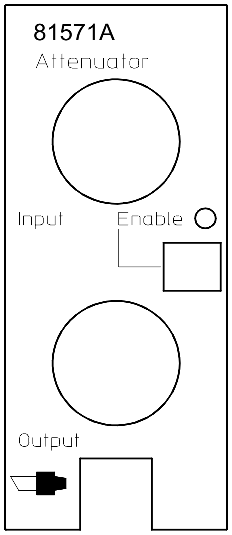


Figure 5 Agilent 81571A High-power Attenuator with Angled Connector

Agilent 81573A

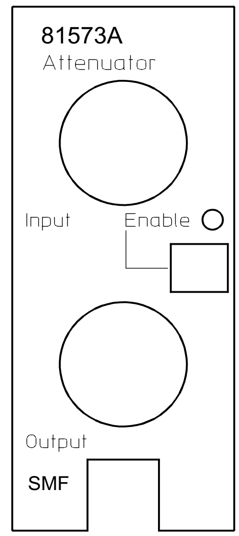


Figure 6 Agilent 81573A High Power Attenuator with SMF pigtail

Agilent 81575A

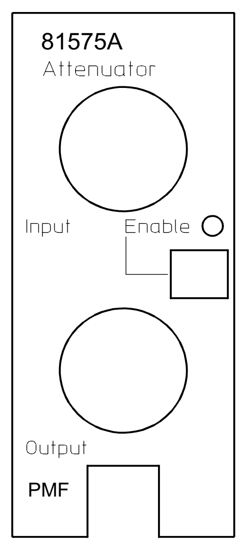


Figure 7 Agilent 81575A High Power Attenuator with PMF pigtail

Agilent 81566A

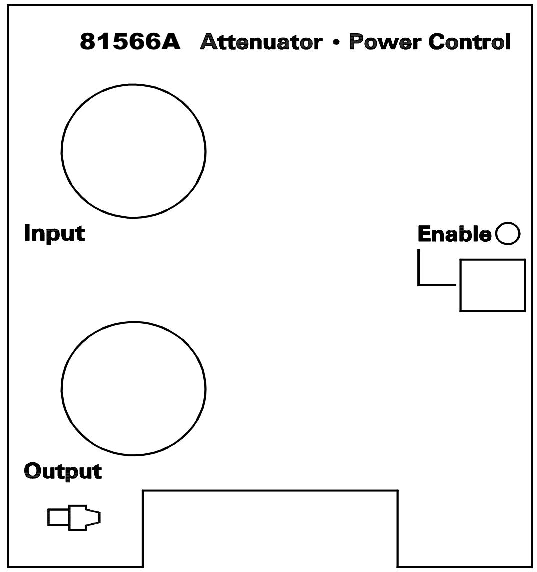


Figure 8 Agilent 81566A Attenuator with Power Control and Straight Connector

Agilent 81567A

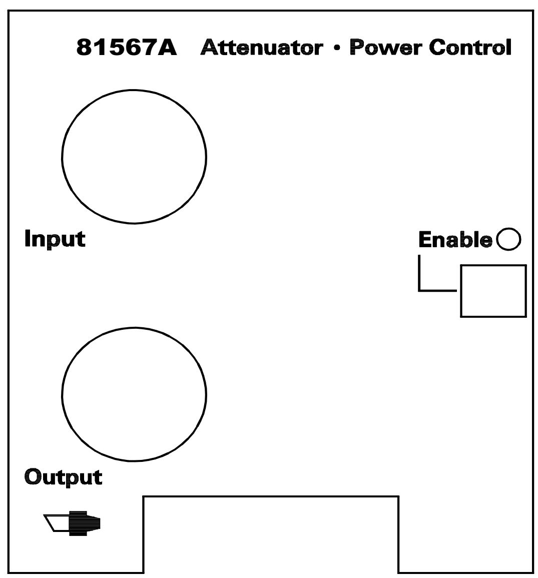
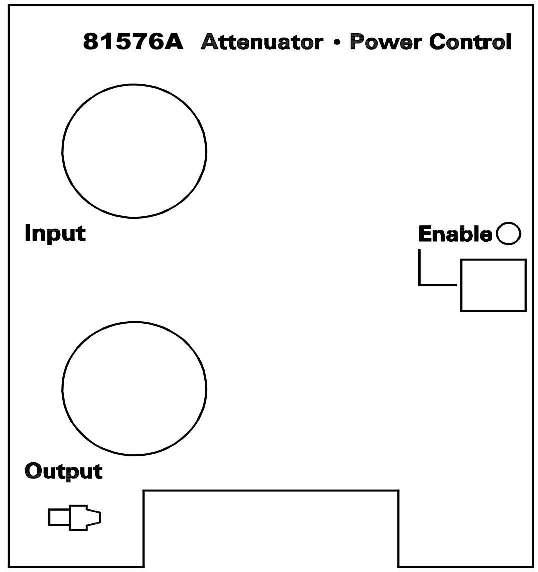


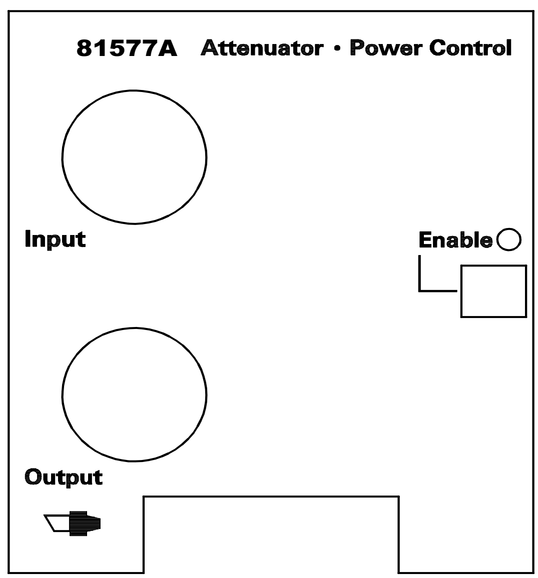
Figure 9 Agilent 81567A Attentuator with Power Control and Angled Connector

Agilent 81576A



Agilent 81576A High-power Attenuator with Power Control and Straight Connector

Agilent 81577A



Agilent 81577A High-power Attenuator with Power Control and Angled Connector

Front Panel Controls and Indicators

The front panel contains a push button to switch the shutter open/closed, and a LED that indicates the state of the shutter. If the shutter is “open”, the LED shows “enable”, and light can pass through the instrument.

Typical Use Models

Brief description

Agilent's 8156xA and 8157xA Variable Optical Attenuators are instruments that attenuate and control the optical power level of light in single mode optical fibers. As plug-in modules for Agilent's Lightwave Multichannel platform (8163A/B, 8164A/B, 8166A/B) they allow you to set the attenuation factor and/or power level manually, or remotely via a common computer interface. Their high accuracy combined with their flexibility make them ideal as test and measurement equipment for the modern telecommunication industry.

Modular Design for Multichannel Platform

Agilent's 8156xA and 8157A variable optical attenuators are a family of plug-in modules for Agilent's Lightwave Multichannel Platform 8163A/B, 8164A/B and 8166A/B. The attenuator modules 81560A, 81561A, 81570A, 81571A, 81573A and 81575A occupy one slot, while modules 81566A, 81567A, 81576A and 81577A occupy two slots. The Agilent 8166A/B Lightwave Multichannel System with its 17 slots can host up to 17 single slot modules (such as the 81560A or 81571A attenuators) or up to 8 dual slot modules, (such as the 81566A and 81577A attenuators).

Variable Optical Attenuators

Agilent's 81560A and 81561A are small and cost effective attenuator modules with high resolution for single-wavelength applications. Once you have entered the operating wavelength, the instrument automatically applies the appropriate corrections. Various calibration features allow you to set a reference power so that both the attenuation and the power level, relative to the reference power, can be set and displayed in the user interface. An integrated shutter can be used for protection purposes or to simulate channel drops.

Agilent's 81570A and 81571A have excellent wavelength flatness and can handle high input power levels. These features, combined with low insertion loss, allow you to use these modules for characterizing EDFAs and Raman amplifiers, as well for other multi-wavelength applications such as DWDM transmission system testing. Like the 81560A and 81561A, they include the reference power functionality and an integrated shutter.

Agilent’s 81573A is a pigtail version of the 81571A with SMF LP fiber, which you can splice into your set up in order to optimize insertion loss, polarization dependent loss, and return loss.

The 81575A is also a pigtail version, but with polarization maintaining fiber.

Attenuators with Power Control

Agilent's 81566A and 81567A attenuators feature power control functionality that allows you to set the output power level of the attenuator. The attenuator module firmware uses the feedback signal from a photo diode after a monitor coupler, both integrated in the module, to set the desired power level at the output of the module. When the power control mode is enabled, the module automatically corrects power changes at the input to maintain your set output level. After an initial calibration for the uncertainties at connector interfaces, absolute power levels can be set with high accuracy. The absolute accuracy of these power levels depends on the accuracy of the reference powermeter used for calibration.

High-power Attenuators with Power Control

Agilent's 81576A and 81577A attenuators have the power control functionality of the 81566A and 81567A attenuators, but also have the high-power handling capability and excellent wavelength flatness required for DWDM applications.

To set the the total power level of a multi-wavelength signal, it is necessary to determine the convolution of the signal’s spectrum against the sensitivity of the photodiode over wavelength. An enhanced calibration feature allows you to set the integrated power of the DWDM signal against a known spectrum.

Calibration Processes

Comprehensive offset functionality in the firmware enhances the calibration of the optical path in various test set-ups. There is an offset for the attenuation factor, and an independent offset for the output power level, to calibrate for losses due to the patch cords and connectors. Additionally, wavelength and offset value pairs can be stored in a table to compensate for wavelength dependent effects in the optical path of the set-up. This allows you to set the optical power level at your Device Under Test.

Calibration is even easier and more convenient if the reference powermeter and the attenuator are hosted by the same mainframe: All power related offsets can be determined by a firmware function that reads a value from the reference powermeter. The difference between the power value read by the reference powermeter and the actual value of the attenuator is automatically stored as the offset.

Optical Output

Angled and Straight Contact Connectors

Angled contact connectors are available for Agilent 81561A and 81571A Variable Optical Attenuator modules, and for the Agilent 81567A and 81577A Variable Optical Attenuator modules with Power Control.

The Agilent 81573A is delivered with an angled (FC/APC) connector attached to the end of a 2 m single-mode fiber (SMF) cable.

The Agilent 81575A is delivered with an angled (SC/APC) connector attached to the end of a 2 m polarization maintaining fiber (PMF) cable.

The inclusion of an angled contact connector is not optionable, and depends on the module part number.

Angled contact connectors help you to control return loss, since reflected light tends to reflect into the cladding, reducing the amount of light that reflects back to the source.

CAUTION If the contact connector on your instrument is angled, you can only use cables with angled connectors with the instrument.

Figure 10 Angled and Straight Contact Connector Symbols

Figure 10 shows the symbols that tell you whether the contact connector of your attenuator module is angled or straight. The angled contact connector symbol is colored green.

You should connect straight contact fiber end connectors with neutral sleeves to straight contact connectors, or connect angled contact fiber end connectors with green sleeves to angled contact connectors.

NOTE You cannot connect angled non-contact fiber end connectors with orange sleeves directly to the instrument.

See *“Accessories” on page 29* for further details on connector interfaces and accessories.

Accessories

Agilent 8156xA and Agilent 8157xA Variable Optical Attenuator modules are available in various configurations for the best possible match to the most common applications.

This chapter describes the options and accessolries available for the:

- Agilent 81560A and 81561A Variable Optical Attenuator (VOA) modules;
- Agilent 81566A and 81567A VOA modules with power control;
- Agilent 81570A, 81571A, 81573A and 81575A VOA modules for high-power applications; and the
- Agilent 81576A and 81576A VOA modules with power control for high-power applications.

Modules and Options

Figure 11 shows all the options that are available for Agilent 8156xA and Agilent 8157xA Variable Optical Attenuator modules, and the instruments that support these modules.

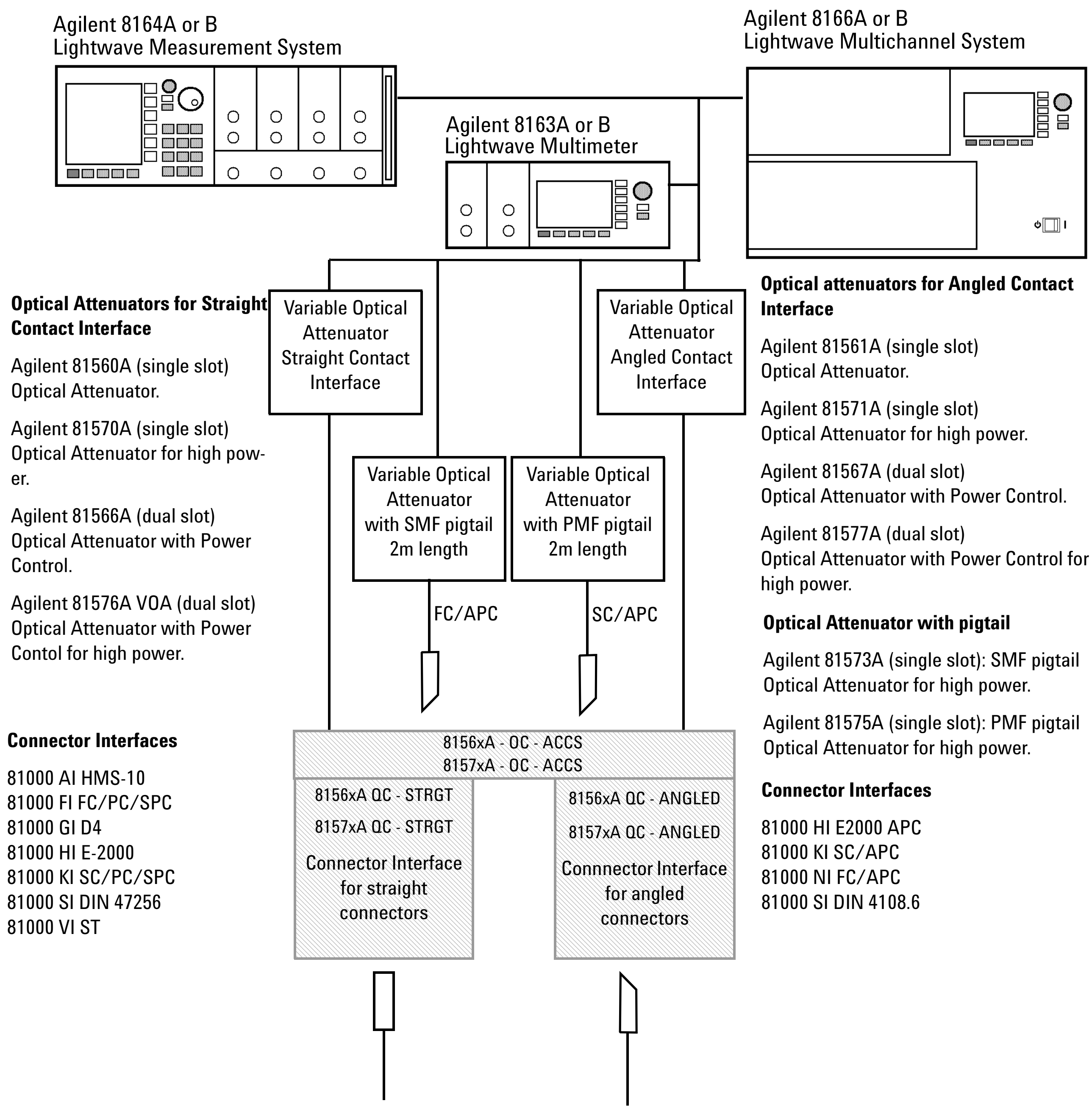


Figure 11 Mainframes, Variable Optical Attenuator Modules, and Options

Modules

Agilent 81560A, 61A, 70A, 71A, 73A, 75A Variable Optical Attenuator modules and Agilent 81566A, 67A, 76A, 77A Variable Optical Attenuator modules with Power Control can be hosted by:

- Agilent 8163A and Agilent 8163B Lightwave Multimeters,
- Agilent 8164A and Agilent 8164B Lightwave Measurement Systems,
- Agilent 8166A and Agilent 8166B Lightwave Multichannel Systems.

User's Guides

User's Guides	
Description	**Part No.**
Agilent 81560A, 61A, 70A, 71A, 73A, 75A Variable Optical Attenuator modules and Agilent 81566A, 67A, 76A, 77A Variable Optical Attenuator modules with Power Control User's Guide (English).	81560-90A14
Agilent 81560A, 61A, 70A, 71A, 73A Variable Optical Attenuator modules and Agilent 81566A, 67A, 76A, 77A Variable Optical Attenuator modules with Power Control User's Guide (French).	81560-92A12
Agilent 81560A, 61A, 70A, 71A, 73A Variable Optical Attenuator modules and Agilent 81566A, 67A, 76A, 77A Variable Optical Attenuator modules with Power Control User's Guide (Japanese).	81560-95A12
Agilent 81560A, 61A, 70A, 71A, 73A Variable Optical Attenuator modules and Agilent 81566A, 67A, 76A, 77A Variable Optical Attenuator modules with Power Control User's Guide (Simplified Chinese - China).	81560-96A12
Agilent 81560A, 61A Variable Optical Attenuator modules and Agilent 81566A, 67A Variable Optical Attenuator modules with Power Control User's Guide (Traditional Chinese - Taiwan).	81560-97A11
Agilent 81560A, 61A Variable Optical Attenuator modules and Agilent 81566A, 67A Variable Optical Attenuator modules with Power Control User's Guide (Korean).	81560-98A11

User's Guides	
Description	**Part No.**
Agilent 8163A/B Lightwave Multimeter, Agilent 8164A/B Lightwave Measurement System, & Agilent 8166A/B Lightwave Multichannel System User's Guide.	08164-90B14
Agilent 8163A/B Lightwave Multimeter, Agilent 8164A/B Lightwave Measurement System, & Agilent 8166A/B Lightwave Multichannel System Programming Guide.	08164-90B63

Connector Interfaces and Other Accessories

CAUTION

Optical power levels above 100 mW applied to single-mode connectors can easily damage the connector if it is not perfectly clean. Also, scratched or poorly cleaned connectors can destroy optical connectors mechanically. Always make sure that your optical connectors are properly cleaned and unscratched before connection. Refer to chapter "Cleaning Information" on page 91 on appropriate procedures for connector cleaning and inspection. However, Agilent Technologies Deutschland GmbH assumes no responsibility in case of an operation that is not compliace with the safety instructions as stated above.

81560A , 81566A, 81570A and 81576A VOA Modules

If you want to use straight connectors (such as FC/PC, Diamond HMS-10, DIN, Biconic, SC, ST or D4) to connect to the instrument, you must do the following:

1. Attach your connector interface to the interface adapter.

   See Figure 11 for a list of the available connector interfaces.

2. Connect your cable.

81561A, 81567, 81571A and 81577A VOA Modules

If you want to use angled connectors (such as FC/APC, Diamond HRL-10, or SC/APC) to connect to the instrument, you must do the following:

1. Attach your connector interface to the interface adapter.

   See Figure 11 for a list of the available connector interfaces.

2. Connect your cable.

81573A VOA Modules Connect the FC/APC connector at the end of the pigtail to your setup, or cut the connector off and splice the pigtail into your setup.

81575A VOA Modules Connect the SC/APC connector at the end of the pigtail to your setup, or cut the connector off and splice the pigtail into your setup.

Specifications

Agilent 81560A and 81561A Variable Optical Attenuator (VOA) modules; Agilent 81566A and 81567A VOA modules with power control; Agilent 81570A, 81571A, 81573A and 81575A VOA modules for high-power applications; and Agilent 8176A and 81576A VOA modules with power control for high-power applications, are all produced to the ISO 9001 international quality system standard as part of Agilent Technologies' commitment to continually increasing customer satisfaction through improved quality control.

Specification: describes a guaranteed product performance that is valid under the specified conditions.

Typical value: a characteristic describing the product performance that is usually met but that is not guaranteed.

Because of the modular nature of the instrument, these performance specifications apply to these modules rather than the mainframe unit.

CAUTION

Optical power levels above 100 mW applied to single-mode connectors can easily damage the connector if it is not perfectly clean. Also, scratched or poorly cleaned connectors can destroy optical connectors mechanically. Always make sure that your optical connectors are properly cleaned and unscratched before connection. Refer to chapter "Cleaning Information" on page 91 on appropriate procedures for connector cleaning and inspection. However, Agilent Technologies Deutschland GmbH assumes no responsibility in case of an operation that is not compliace with the safety instructions as stated above.

Definition of Terms

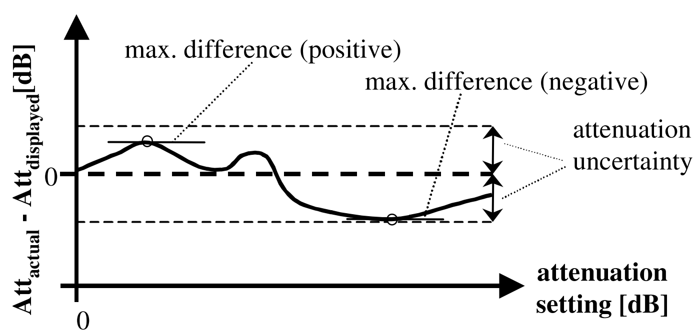
This section defines terms that are used both in this chapter and *"Performance Tests" on page 53*.

Generally, all specifications apply for the given environmental conditions and after warm-up time.

Measurement principles are indicated. Alternative measurement principles of equal value are also acceptable.

Accuracy (uncertainty)

The maximum possible difference (in dB) between the displayed *Attenuation* and actual *Attenuation*.



Conditions: Attenuator set to the wavelength of the source, source polarization condition as in the Specifications, constant temperature, excluding wavelengths of water absorption lines.

Other conditions, such as for *Attenuation correction (applicable to 8156x modules)*, as in the Specifications.

Measurement: With Fabry-Pérot laser source of applicable wavelength, polarization scrambler (if applicable), and optical power meter.

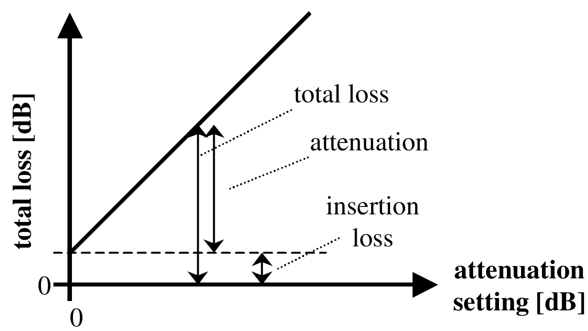
NOTE When using a polarized source, obtain the Accuracy by adding half the PDL to the Accuracy given in the Specifications *(applicable to unpolarized conditions in the Specifications)*.

Agilent reference connector

FC connector with perfect optical and mechanical quality. Depending on the case, straight or angled.

Attenuation

Difference (in dB) between *Total loss* and "total loss for a displayed attenuation of 0 dB", that is *Insertion loss*.

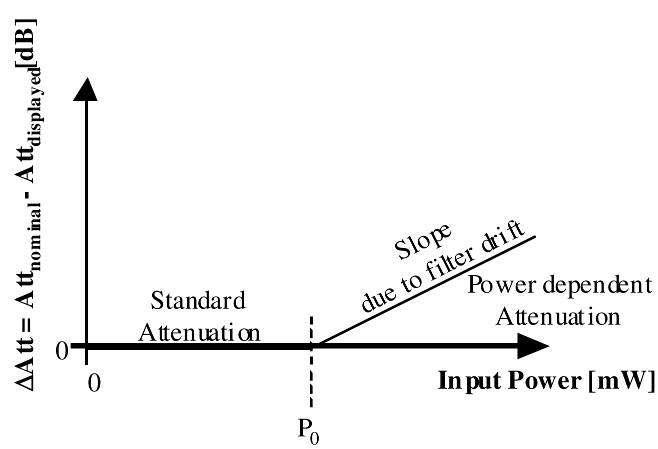


NOTE For a displayed attenuation of 0 dB the actual attenuation is 0 dB by definition.

Attenuation correction (applicable to 8156x modules)

The filter has a power-dependent attenuation because of warming effects. The displayed attenuation is valid up to a power P_0 , as in the Specifications.

For higher power levels, the nominal attenuation must be corrected using the given formula. The *Accuracy (uncertainty)* is then applicable for the entire power and wavelength range given in the Specifications.

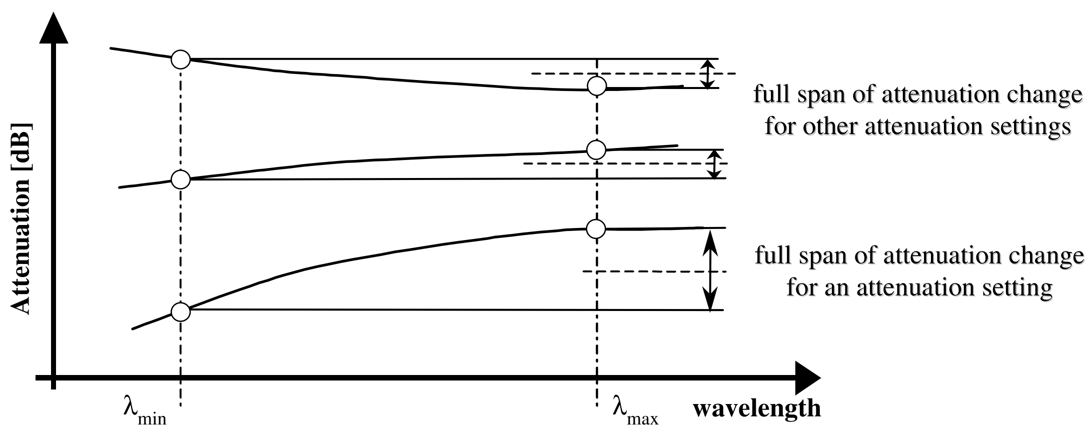


Measurement: with an Erbium-Doped Fiber Amplifier to apply the necessary input power, tunable laser source, and optical power meter to probe the wavelength dependence of the attenuation drift.

Attenuation flatness

The change of the *Attenuation* over wavelength at any arbitrary but fixed displayed attenuation and fixed wavelength setting of the attenuator. The attenuation flatness is ± half the maximum span over wavelength, expressed in dB.

Attenuation flatness does not include *Spectral ripple*.



Conditions: input power level, temperature, humidity, and displayed attenuation constant; source polarization condition, source wavelength range, constant wavelength setting of the attenuator, and attenuation range as in the Specifications.

Measurement: with tunable laser source, polarization scrambler (if applicable), and optical power meter.

NOTE This parameter does not include *Insertion loss flatness* because *Attenuation flatness* is referenced to the 0 dB setting so its value is not influenced by connectors.

Attenuation setting (applicable to attenuators with power control)

When changing the displayed attenuation, the module behaves like a pure attenuator.

NOTE Alternatively, the attenuator can be operated in *Power setting (applicable to attenuators with power control)*.

Attenuation range

Range of displayed attenuation for which the Specifications apply.

Insertion loss

Total loss at a displayed attenuation of 0 dB

Conditions: attenuator set to 0 dB and to the wavelength of the source, with *Agilent reference connector*s, source polarization condition and other conditions as in the Specifications.

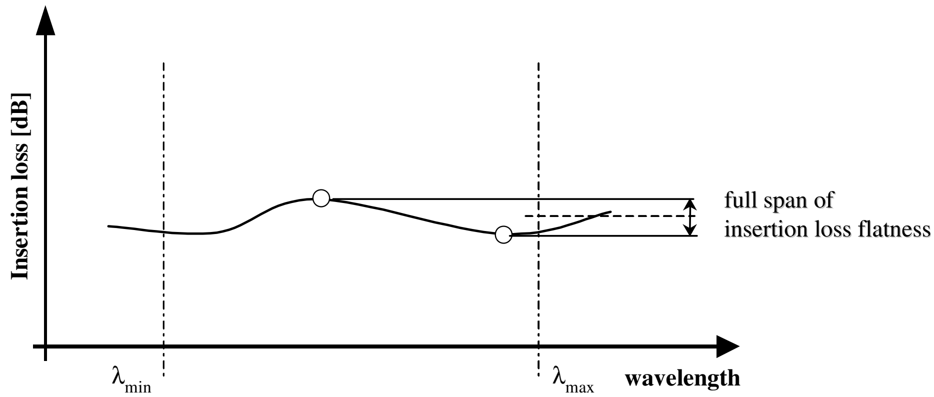
Measurement: with Fabry-Pérot laser source, polarization controller (if applicable) and optical power meter.

NOTE Insertion loss includes the loss of one connector pair, see test set up for *Total loss*. For pigtailed modules, excluding the connector assumes a perfect splice. For connectorized modules, excluding connectors means attaching connectors with perfect matching.

Insertion loss flatness

The change of the *Insertion loss* over wavelength, at a fixed wavelength setting of the attenuator. The insertion loss flatness is ± half the span between the maximum and minimum value, expressed in dB.

Insertion Loss flatness does not include *Spectral ripple*.



Conditions: input power level, wavelength setting of the attenuator, and temperature constant; attenuator set to 0 dB; source polarization condition and source wavelength range as in the Specifications; excluding wavelengths of water absorption lines.

Measurement: with tunable laser source, polarization scrambler (if applicable), power meter, and *Agilent reference connector*s.

Maximum Input Power

The maximum input power level that can be applied to the attenuator without permanent change to its characteristics.

Conditions: clean connectors

Operating temperature

The range of ambient temperatures of the mainframe hosting the attenuator module for which the Specifications apply.

Polarization Dependent Loss (PDL)

The dependence of the *Total loss* on the input polarization state, expressed as the difference (in dB) between the highest and the lowest total loss (peak to peak).

Conditions: polarized light, polarization-independent power, generation of all polarization states (covering the entire Poincaré sphere), source wavelength constant and as in the Specifications; jumper cables with *Agilent reference connector*s.

Measurement: either with fiber-loop type polarization scrambler using polarization scanning method or waveplate-type polarization controller using Mueller method.

Polarization Extinction Ratio(PER)

The ratio of optical power in the slow axis of the polarization maintaining fiber to the optical power in the fast axis.

Conditions: input power level; temperature, humidity constant; other conditions as in the Specifications; polarized light with TE mode injected in the slow axis of the polarization maintaining fiber of the attenuator.

Measurement: with ASE source and crossed-polarizer method.

Power setting (applicable to attenuators with power control)

When changing the displayed power, the attenuation will be controlled by the integrated power meter to set the output power to the displayed power.

Conditions: zeroing prior to measurement.

Relative power meter uncertainty (applicable to attenuators with power control)

When changing the output power of the attenuator, the relative power meter uncertainty is the maximum error of the displayed output power ratio to the actual output power ratio. This uncertainty is caused by the internal power meter's nonlinearity and noise and by errors in the sensing hardware, expressed as ± half the span of all possible errors with an offset due to the noise level of the power meter. Symbol *RU*.

Conditions: reference power level 1mW, wavelength and polarization state constant; power limitations as in the Specifications; zeroing prior to measurement.

Measurement: The nonlinearity is calculated using the displayed power ratio *D2 / D1* and the corresponding actual power ratio *P2 /P1*:

$$N_{dB}(1,2) \quad = \quad 10 \cdot \log\left(\frac{D_2 / D_1}{P_2 / P_1}\right)$$

The relative power meter uncertainty is then calculated using:

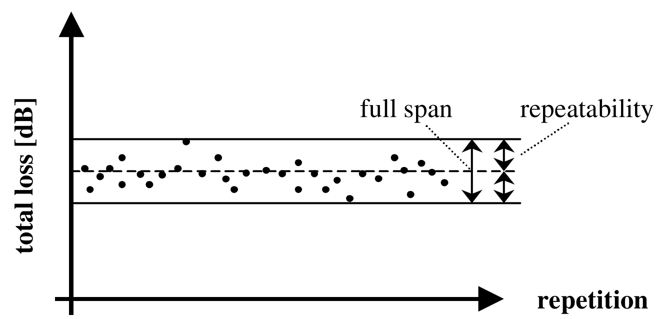
$$RU_{dB} = \pm \frac{\max |N_{dB}(1,2)|}{2}$$

RU is then expressed in dB and the offset is expressed in pW.

NOTE Absolute power accuracy attainable with the help of an external optical power meter.

Repeatability

The uncertainty in reproducing the *Total loss* after randomly changing and re-setting the attenuation. The repeatability is ± half the span between the maximum and the minimum total loss, expressed in dB.



Conditions: Uninterrupted line voltage; temperature, humidity, wavelength, input power level, and polarization state constant. For attenuators with power control, measuring the Repeatability when using power setting requires zeroing prior to measurement.

Measurement: with Fabry-Pérot laser source of applicable wavelength and optical power meter.

Resolution

The minimum addressable and displayable attenuation steps.

Return Loss

Minimum ratio between incident power and reflected power, expressed in dB. Applicable to both attenuator ports, with the respective second port terminated (zero reflectance).

Conditions: jumper cables with *Agilent reference connector*s on both attenuator ports.

Measurement: with return loss meter and non-coherent source of applicable wavelength.

NOTE The measurement result includes internal reflections in the attenuator, such as reflections from both attenuator ports and, if the shutter is closed, reflection from the shutter.

Settling Time

Maximum time needed to change the attenuation by a step defined in the Specifications, from the beginning until the end of the change.

Measurement: with optical oscilloscope or transient recorder.

NOTE Settling time excludes the time needed for the interpretation of the command and for the internal communication between the mainframe and the attenuator module.

Shutter Isolation

Ratio between transmitted powers with open and with closed shutter, at a displayed attenuation of 0 dB, expressed in dB.

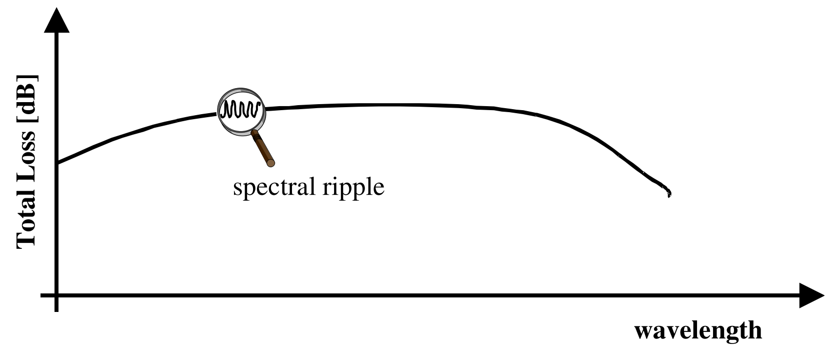
Measurement: with Fabry-Pérot laser source and optical power meter.

NOTE For another displayed attenuation, the isolation is increased by the attenuation.

Spectral ripple

Spectral ripple is a periodic change of the *Total loss* over wavelength when using a coherent light source. It results from interference between the passing wave and spurious internal reflections. The spectral ripple is ± half the span between the maximum and the minimum total loss, expressed in dB.

Spectral ripple does not include either *Attenuation flatness* or *Insertion loss flatness*.



Conditions: input power level, temperature, humidity, and input polarization constant; linewidth as in the Specifications.

Measurement: with tunable laser source and optical power meter.

Total loss

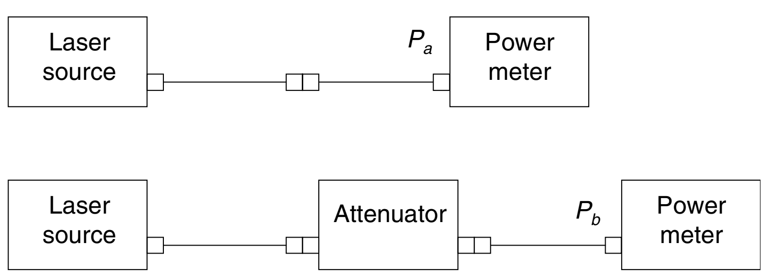
Change of power level after inserting the attenuator between two connectorized patchcords, at an arbitrary attenuation setting, expressed in dB. It can be calculated from:

$$A_{TL}[dB] = 10\log\frac{P_a}{P_b} = P_a[dBm] - P_b[dBm]$$

where:

P_a = power measured at the end of the two patchcords.

P_b = power measured after the insertion of the attenuator.



Conditions: Jumper cables with *Agilent reference connector*s on both attenuator ports.

NOTE Total loss includes the loss of one additional connector pair.

Transition speed

Specifies the settable rate of change for attenuation.

Wavelength Range

Usable wavelength range.

Specifications

The following Specifications tables are provided:

- "Variable Optical Attenuator Modules" on page 49, which describes the Agilent 81560A and Agilent 81561A.
- "Variable Optical Attenuator Modules with Power Control" on page 50, which describes the Agilent 81566A and Agilent 81567A.
- "Variable Optical Attenuator Modules for high-power applications" on page 51, which describes the Agilent 81570A, Agilent 81571A, Agilent 81573A and Agilent 81575A.
- "Variable Optical Attenuator Modules with Power Control for high-power applications" on page 52, which describes the Agilent 81576A and Agilent 81577A.

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Variable Optical Attenuator Modules		6.0
	Agilent 81560A	**Agilent 81561A**
Connectivity [1]	straight connector	angled connector
Fiber type	9/125 µm SMF28	9/125 µm SMF28
Wavelength range	1200-1700 nm	1200-1700 nm
Attentuation range	0-60 dB	0-60 dB
Resolution	0.001 dB	0.001 dB
Repeatability [2]	±0.01 dB	±0.01 dB
Accuracy (uncertainty) [3]	±0.1 dB [4]	±0.1 dB [4]
Settling time [5]	typ. 100 ms	typ. 100 ms
Insertion loss [6]	typ. 1.7 dB	typ. 1.7 dB
Polarization dependent loss [6, 7]	< 0.05 dBpp	< 0.05 dBpp
Return loss [6]	typ. 45 dB	typ. 60 dB
Maximum input power [8]	+ 22 dBm	+ 22 dBm
Shutter isolation	typ. 100 dB	typ. 100 dB
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8" x 1.3" x 13.2")	
Weight	0.9 kg	
Recommended recalibration period	2 years	
Operating temperature	10 °C - 45 °C	
Humidity	Non-condensing	
Warm-up time	30 min.	

[1] For Agilent's versatile optical connector interfaces

[2] At constant wavelength, temperature

[3] Unpolarized; temperature constant and within 23 °C ± 5 K;

For input power ≤ +10 dBm $\text{attenuation}_{nominal} = \text{attenuation}_{display}$

For input power > 10 mW and 1500 nm < λ < 1600 nm apply correction:
$\text{attenuation}_{nominal} = \text{attenuation}_{display}\ (1+0.0002 \cdot (P[mW] - 10) \cdot (\lambda[\mu m] - 1.5))$

[4] For λ= 1550 nm ± 15 nm and for input power ≤ +10 dBm; typically ± 0.1 dB for 1250 nm < λ < 1650 nm

[5] Stepsize < 1 dB; for full range typically 6 s

[6] For λ = 1550 nm ± 15 nm with Agilent reference connectors

[7] Temperature constant and within 23 °C ± 5 K

[8] Exposure time < 2h

Variable Optical Attenuator Modules with Power Control				6.0
	Agilent 81566A		Agilent 81567A	
Connectivity [1]	straight connector		angled connector	
Fiber type	9/125 µm SMF28		9/125 µm SMF28	
Wavelength range	1250-1650 nm		1250-1650 nm	
Attentuation range	0-60 dB		0-60 dB	
Resolution	0.001 dB		0.001 dB	
	Attenuation Setting	Power Setting	Attenuation Setting	Power Setting
Repeatability [2]	±0.01 dB	±0.015 dB [3]	±0.01 dB	±0.015 dB [3]
Accuracy (uncertainty) [4]	±0.1 dB [5]		±0.1 dB [5]	
Settling time [6]	typ. 100 ms	typ. 300 ms	typ. 100 ms	typ. 300 ms
Relative power meter uncertainty [7]	± 0.03 dB ± 20 pW		± 0.03 dB ± 20 pW	
Insertion loss [8]	typ. 2.2 dB		typ. 2.2 dB	
Polarization dependent loss [8, 9]	< 0.08 dBpp		< 0.08 dBpp	
Return loss[8]	typ. 45 dB		typ. 60 dB	
Maximum input power [10]	+ 22 dBm		+ 22 dBm	
Shutter isolation	typ. 100 dB		typ. 100 dB	
Weight	1.3 kg			
Dimensions (H x W x D)	75 mm x 64 mm x 335 mm (2.8" x 2.6" x 13.2")			
Recommended recalibration period	2 years			
Operating temperature	10 °C - 45 °C			
Humidity	Non-condensing			
Warm-up time	30 min.			

[1] For Agilent's versatile optical connector interfaces

[2] At constant wavelength, temperature

[3] Output power > - 50 dBm, input power < +17 dBm, for input power > +17 dBm add typically ±0.01 dB

[4] Unpolarized; temperature constant and within 23 °C ± 5 K

For input power ≤ +10 dBm $\text{attenuation}_{nominal} = \text{attenuation}_{display}$

For input power > 10 mW and 1500 nm < λ < 1600 nm apply correction:
$\text{attenuation}_{nominal} = \text{attenuation}_{display} (1+0.0002 \cdot (P[mW] - 10) \cdot (\lambda[\mu m] - 1.5))$

[5] For λ = 1550 nm ± 15 nm and for input power < +10 dBm; typically ± 0.1 dB for 1250 nm < λ < 1650 nm

[6] Stepsize < 1 dB; for full range typically 6 s

[7] For λ < 1630 nm and constant wavelength; SOP constant; temperature constant and within 23 °C ± 5 °C, input power < +17 dBm, for input power > +17 dBm add ±0.02 dB

[8] For λ = 1550 nm ± 15 nm with Agilent reference connectors

[9] Temperature constant and within 23 °C ± 5 K

[10] Exposure time < 2h

Variable Optical Attenuator Modules for high-power applications 5.6

	81570A	81571A	81573A	81575A
Connectivity	**straight connector versatile interface**	**angled connector versatile interface**	**SMF pigtail FC/APC termination**	**PMF pigtail SC/APC termination**
Fiber type	9/125 µm SMF28	9/125 µm SMF28	9/125 µm SMF28	Fujikura PANDA 8/125 cutoff < 1400 nm
Wavelength range	1200-1700 nm			
Attentuation range	0-60 dB			
Resolution	0.001 dB			
Repeatability [1]	±0.01 dB			
Accuracy (uncertainty) [1, 2, 3, 4]	±0.1 dB			±0.2 dB
Settling time [5]	typ. 100 ms			
Transition speed	typ. 0.1 ... 12 dB/s			
Attenuation flatness [1, 4, 6]	< ±0.07 dB (typ. ±0.05 dB) for 1520 nm < λ < 1620 nm [8] typ. ±0.10 dB for 1420 nm < λ < 1640 nm [8]			
Spectral ripple [7]	typ. ±0.003 dB			
Insertion loss [2, 4, 9, 10]	typ. 0.7 dB excluding connectors < 1.6 dB (typ. 1.0 dB) including connectors [11]			typ. 0.7 dB excl. connectors typ. 1.2 dB incl. connectors [11]
Insertion loss flatness [1, 11]	typ. ±0.1 dB for 1420 nm < λ <1615 nm [4]			
Polarization dependent loss [2, 9, 11]	< 0.08 dBpp (typ. 0.03 dBpp)			N/A
Polarization extinction ratio	N/A			typ. 20 dB [1, 2, 12]
Return loss [9, 11]	typ. 45 dB	typ. 57 dB	typ. 57 dB	typ. 57 dB
Maximum input power [13]	+ 33 dBm			
Shutter isolation	typ. 100 dB			
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8" x 1.3" x 13.2")			
Weight	0.9 kg			
Recommended recalibration period	2 years			
Operating temperature	10 °C - 45 °C			
Humidity	Non-condensing			
Warm-up time	30 min.			

[1] At constant temperature

[2] Temperature within 23 °C ± 5 K

[3] Input power < +30 dBm; λ= 1550 nm ± 15 nm; typical for 1250 nm < λ < 1650 nm

[4] For unpolarized light (SMF versions), or polarized light with TE mode injected in the slow axis (PMF version)

[5] Stepsize < 1 dB; for full range: typ. 6 s

[6] Relative to reference at 0 dB attenuation

[7] Linewidth of source ≥ 100 MHz

[8] λ_{disp} set to 1550 nm; attenuation ≤ 20 dB; for attenuation > 20 dB:
add typ. 0.01 dB (α [db] - 20) for 1520 nm < λ < 1620 nm
add typ. 0.02 dB (α [db] - 20) for 1420 nm < λ < 1640 nm

[9] For λ = 1550 nm ± 15 nm

[10] Add typ. 0.1 dB for λ = 1310 nm ± 15 nm

[11] Measured with Agilent reference connectors

[12] Excluding connectors, measured with a broadband source.

[13] Agilent Technologies Deutschland GmbH assumes no responsibility for damages caused by scratched or poorly cleaned connectors.

Variable Optical Attenuator Modules with Power Control for high-power applications 5.6				
	81576A		**81577A**	
Connectivity	straight connector, versatile interface		angled connector, versatile interface	
Fiber type	9/125 µm SMF			
Wavelength range	1250-1650 nm			
Attentuation range	0-60 dB			
Resolution	0.001 dB			
	Attenuation Setting	**Power Setting**	**Attenuation Setting**	**Power Setting**
Repeatability [1]	±0.010 dB	±0.015 dB [2]	±0.010 dB	±0.015 dB [2]
Accuracy (uncertainty) [1, 3, 4, 5]	±0.1 dB		±0.1 dB	
Settling time [6]	typ. 100 ms	typ. 300 ms	typ. 100 ms	typ. 300 ms
Transition speed	typ. 0.1 ... 12 dB/s			
Relative power meter uncertainty [7]	± 0.03 dB ± 200 pW [8]			
Attenuation flatness [1, 5, 9]	< ±0.07 dB (typ. ±0.05 dB) for 1520 nm < λ < 1620 nm [10] typ. ±0.10 dB for 1420 nm < λ < 1640 nm [10]			
Spectral ripple [11]	typ. ±0.003 dB			
Insertion loss [3, 5, 12, 13]	typ. 0.9 dB excluding connectors < 1.8 dB (typ. 1.2 dB) including connectors [14]			
Insertion loss flatness [1, 14]	typ. ±0.1 dB for 1420 nm < λ < 1615 nm [5]			
Polarization dependent loss [3, 12, 14]	< 0.10 dBpp (typ. 0.05 dBpp)			
Return loss [12, 14]	typ. 45 dB		typ. 57 dB	
Maximum input power [15]	+ 33 dBm			
Shutter isolation	typ. 100 dB			
Dimensions (H x W x D)	75 mm x 64 mm x 335 mm (2.8" x 2.6" x 13.2")			
Weight	1.3 kg			
Recommended recalibration period	2 years			
Operating temperature	10 °C - 45 °C			
Humidity	Non-condensing			
Warm-up time	30 min.			

[1] At constant temperature

[2] Output power > - 40 dBm, input power < +27 dBm, for input power > +27 dBm add typically ±0.01 dB

[3] Temperature within 23 °C ± 5 K,

[4] Input power < + 30 dBm; λ = 1550 nm ± 15 nm; typical for 1250 nm < λ < 1650 nm

[5] For unpolarized light

[6] Stepsize < 1 dB; for full range: typ. 6 s

[7] Wavelength and SOP constant; temperature constant and between 23 °C ± 5 K; λ < 1630 nm

[8] Input power ≤ + 27 dBm, for input power > +27 dBm add ± 0.02 dB

[9] Relative to reference at 0 dB attenuation

[10] λ_{disp} set to 1550 nm; attenuation ≤ 20 dB;
for attenuation > 20 dB:
add typ. 0.01 dB (α [db] - 20) for 1520 nm < λ < 1620 nm
add typ. 0.02 dB (α [db] - 20) for 1420 nm < λ < 1640 nm

[11] Linewidth of source ≥ 100 MHz

[12] For λ = 1550 nm ± 15 nm

[13] Add typ. 0.1 dB for λ = 1310 nm ± 15 nm

[14] Measured with Agilent reference connectors

[15] Agilent Technologies Deutschland GmbH assumes no responsibility for damages caused by scratched or poorly cleaned connectors.

Performance Tests

The procedures in this section test the optical performance of the Agilent 8156xA Variable Optical Attenuator modules and the 8157xA High-Power Variable Optical Attenuator modules. The complete specifications to which the instrument is tested are given in *“Specifications” on page 35*.

All tests can be performed without access to the interior of the instrument. The performance tests refer specifically to tests using reference connectors. See *Agilent reference connectors*.

CAUTION

Optical power levels above 100 mW applied to single-mode connectors can easily damage the connector if it is not perfectly clean. Also, scratched or poorly cleaned connectors can destroy optical connectors mechanically. Always make sure that your optical connectors are properly cleaned and unscratched before connection. Refer to chapter “Cleaning Information” on page 91 on appropriate procedures for connector cleaning and inspection. However, Agilent Technologies Deutschland GmbH assumes no responsibility in case of an operation that is not compliace with the safety instructions as stated above.

The use of reference grade optical connectors is recommended for high power applications.

Equipment Required

The equipment required for the performance test is listed in Table 1. Any equipment that satisfies the critical specifications of the equipment given in Table 1 may be substituted for the recommended models

Table 1 Equipment Required

Instrument/ Accessory	Model	81560A/70A	81561A/71A	81573A	81575A	81566A/76A	81567A/77A	Required Characteristics	Alternative Models
Lightwave Multimeter	Agilent 8163A/B	x	x	o	o	x	x		
Lightwave Measurement System*	Agilent 8164A/B	x	x	x	x	x	x		
Tunable Laser Source*	Agilent 81640A/B #072	x	x	x	x	x	x	1520 nm to 1620 nm	81642A/B
Laser Source Module	Agilent 81654A	x	x	x	-	x	x		81657A
Interface Module	Agilent 81618A	x	x	x	x	x	x		81619A
Optical Head	Agilent 81624B	x	x	x	x	x	x	low PDL	81626B
Depolarizing Filter	Agilent 81000DF	o	o	o	o	o	o		
FC/PC Optical Head Adapter	Agilent 81000FA	x	x	x	x	x	x		
Variable Optical Attenuator	Agilent 81561A	-	-	-	-	x	x		8156A #201/#221
Polarization Controller	Agilent 11896A #022	x	x	x	-	x	x		11896A #025
Return Loss Module	Agilent 81612A	x	x	x	x	x	x		
Reference Cable	Agilent 81610CC	x	x	x	x	x	x		
FC/PC Connector Interface	Agilent 81000FI	x	x	x	x	x	x	N-key, 2.20 mm	
FC/PCConnector Interface	Agilent 81000NI	x	x	x	x	x	x	R-key, 2.00 mm	
SC Connector Interface	Agilent 81000KI	-	-	-	x	-	-		
FC/PC Feedthrough Adapter	Agilent 1005-0256	x	x	x	x	x	x		
SC/PC Feedthrough Adapter	112-301-901V002**	-	-	-	x	-	-		
Reference Cable FC/APC	182-182-120L001**	-	x	x	-	-	x		
Reference Cable FC/APC - FC/SPC	179-182-120L001**	x	x	x	x	x	x		
Reference Cable FC/SPC	179-179-120L001**	x	-	-	-	x	-		
Reference Cable SC/APC - FC/APC	155-182-120L001**	-	-	-	x	-	-		
Reference Cable SC/APC - FC/APC	155-179-120L001**	-	-	-	x	-	-		
SMF Cable FC/APC - FC/APC	183-183-004L002	x	x	x	-	x	x		

Legend:

x : necessary
- : not applicable
o : optional
* : required for 8157xA only
** : manufactured by Diamond.

NOTE Reference cables are manufacturer selected and calibrated to mechanical dimensions, that is for a minimum specified excentricity of the fiber’s core. The optical connectors of reference cables are designed according to internal standards to achieve particular loss and repeatability characteristics.

Test Record

Results of the performance test may be tabulated in the Test Record provided at the end of the test procedures. It is recommended that you fill out the Test Record and refer to it while doing the test. Since the test limits and setup information are printed on the Test Record for easy reference, the record can also be used as an abbreviated test procedure (if you are already familiar with the test procedures). The Test Record can also be used as a permanent record and may be reproduced without written permission from Agilent Technologies.

Test Failure

If the Agilent 81560/61A/66A/67A Attenuator module,
or Agilent 81570A/71A/73A/75A/76A/77A Attenuator module, fails any performance test, return the instrument to the nearest Agilent Technologies Sales/ Service Office for repair.

Instrument Specification

Specifications are the performance characteristics of the instrument that is certified. These specifications, listed in *“Specifications” on page 35* are the performance standards or limits against which the Agilent 81560A/61A/66A/67A Attenuator module
or Agilent 81570A/71A/73A/75A/76A/77A Attenuator module can be tested.

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.

Performance Test Instructions

The performance tests given in this section apply to Agilent 81560A, 81561A, 81566A, and 81567A Attenuator modules; and to 81570A, 81571A, 81573A, 81575A, 81576A and 81577A high power Attenuator modules. The tests described include the Attenuation Repeatability Test. Perform each step in the order given, using the corresponding test equipment.

Operate an Agilent 81566A, 81567A, 81576A or 81577A Attenuator module as an attenuator and switch the power control loop off if not otherwise mentioned.

NOTE: Make sure that all optical connections of the test setup given in the procedure are dry and clean. DO NOT USE INDEX MATCHING OIL. Make sure that all optical connectors are undamaged.

For cleaning, use the cleaning instructions given in *"Cleaning Information" on page 91*.

Make sure that all optical cables of the test setup are fixed to the table so that they won't move during measurements.

Movement of the fibers during the test procedures and the quality of optical connectors affect the result of power measurements.

The environmental conditions (temperature and relative humidity) must remain constant during the test.

Insertion Loss Test

Carry out the following Insertion Loss Test with reference fibers using the equipment listed in Table 1, “Equipment Required,” on page 55. To adapt for the straight or angled contact versions of the attenuator use the patchcords with appropriate connectors and the adequate connector interfaces.

Perform the test at 1550 nm for 8157xA High Power Attenuator modules and additionally at 1310 nm for 8156xA modules.

1. Turn the instruments on and allow the devices to warm up (20..30min).
2. Make sure that all your connectors are clean and undamaged.
3. Connect the equipment as shown in Figure 12 or Figure 13.

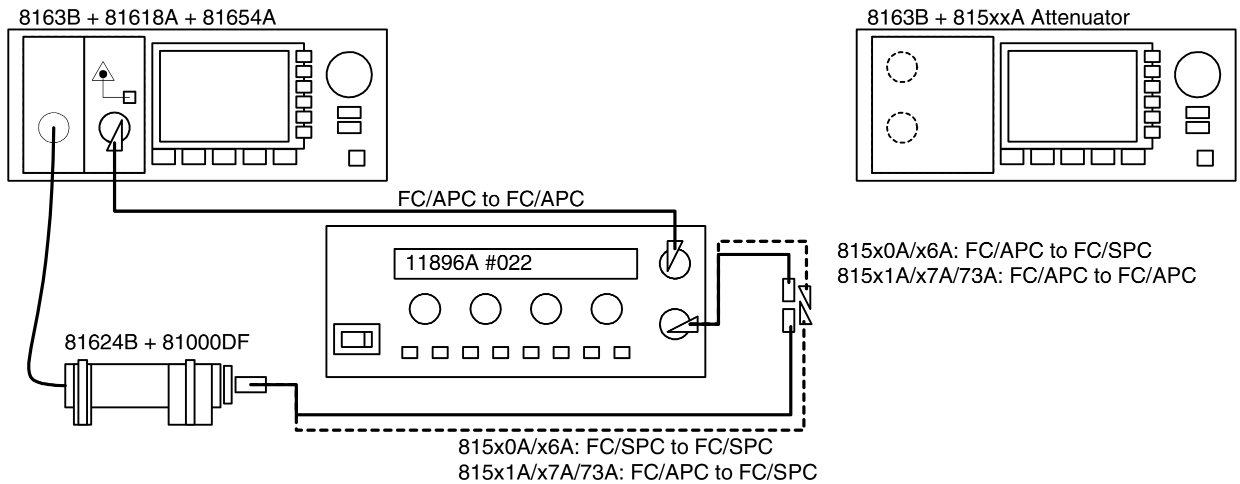

Figure 12 Insertion Loss Reference Setup (SMF-Attenuators)

NOTE The patchcords to and from the polarization controller and the attenuator must not move during and between all measurements. Use tape to fix the fibers to the the table.

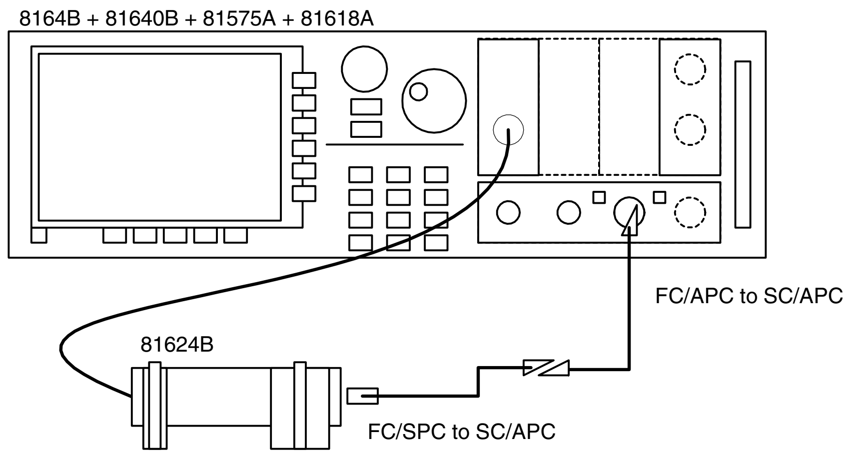

Figure 13 Insertion Loss Reference Setup (81575A)

NOTE The patchcords must not move during and between all measurements. Use tape to fix the fibers to the the table.

4 Set the attenuator to the actual wavelength of the laser source.

5 Enable the laser source.

6 Choose the power meter Stability Application and set the following parameters:.

Power Unit	=	dBm
Total Time	=	25 seconds
Averaging Time	=	50 ms
Wavelength	=	Source wavelength
Range Mode	=	auto

7 For SMF Attenuators only:

- Set the 11896A Polarization Controller's scan rate = 4, then press [Autoscan] to start polarization scrambling.
- Press Measure at the power meter to start PDL scrambling.

8 After the measurement press [Analaysis] to display the power readings.

9 Note the average power reading from the statistics table.

10 Connect the equipment as shown in Figure 14 or Figure 15.

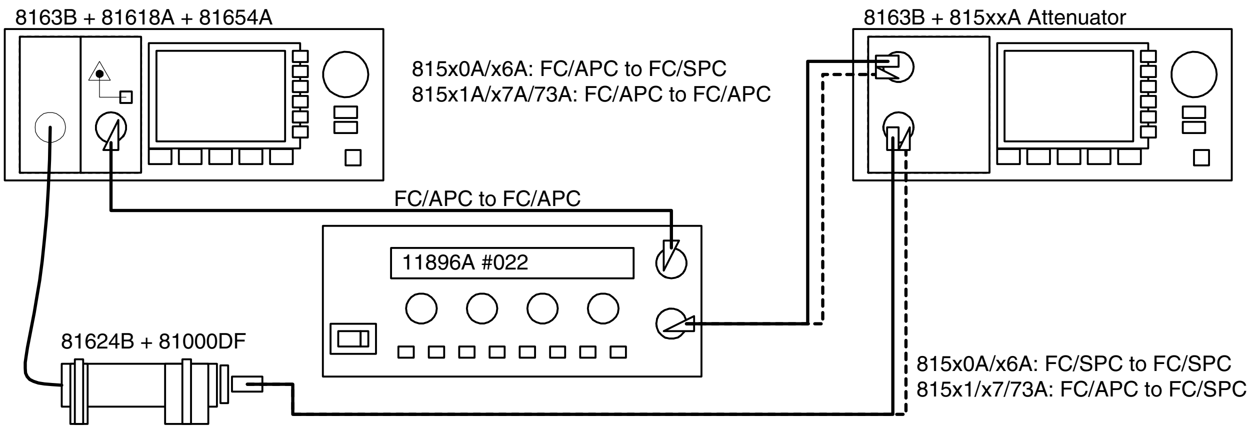

Figure 14 **Insertion Loss Test Setup (SMF Attenuators)**

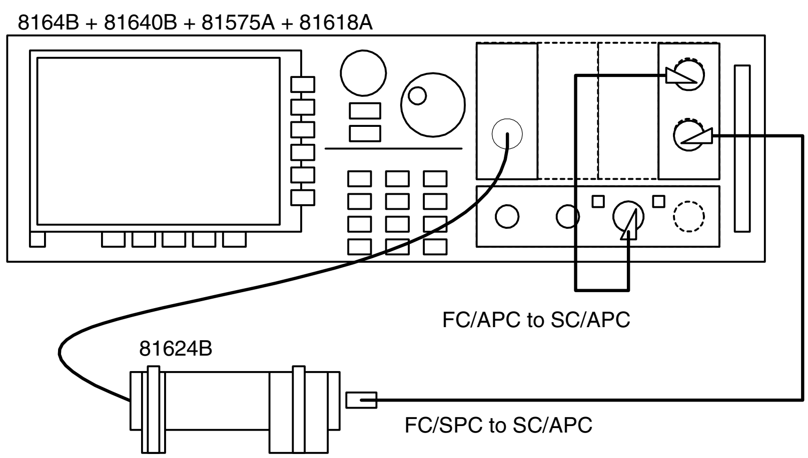

Figure 15 **Insertion Loss Test Setup (81575A)**

11 Set attenuation [α] to 0dB and open the shutter.

12 Repeat step 6 to step 8 with the Attenuator as DUT.

13 Note the average power reading.

14 Subtract the the average power readings (in dBm) at step 9 and step 13 to obtain the insertion loss of the attenuator.

15 Record the insertion loss (in dB) in the Test Record.

Accuracy Test - 8156xA modules

Use the same equipment and test setup as used in Figure 14 on page 60.

NOTE: With a laser source with output power < +10dBm it is not necessary to recalculate the real attenuation.

1 Turn the instruments on and allow the devices to warm up (20..30min).
2 Make sure that all your connectors are clean and undamaged.
3 Set the attenuator and the power meter to the actual wavelength of the laser source.
4 Disable the laser source, zero the power meter and select Autorange. Display [dB].
5 Enable the laser source, open the shutter and set attenuation [α] to 0 dB.
6 Set Display to Reference on the power meter.
7 Set the attenuation [α] to each value listed below and note the power meter reading in the Test Record.

1 db	2 dB	3 dB	4 dB	5 dB
6 dB	7 dB	8 dB	9 dB	10 dB
11 dB	12 dB	13 dB	14 dB	15 dB
25 dB	35 dB	45 dB	55 dB	60 dB

Accuracy Test - 8157xA modules

Use the same equipment and test setup as used in Figure 14 on page 60.

For the 81575A PMF attenuator, use the equipment and setup as used in Figure 15 on page 60, but remove the SC/APC-FC/PC patchcords and connect the 81575A PMF pigtails directly to the laser source and the power meter.

1 Turn the instruments on and allow the devices to warm up (20..30min).

2 Make sure that all your connectors are clean and undamaged.

3 Set the attenuator and the power meter to the actual wavelength of the laser source.

4 Disable the laser source, zero the power meter and select Autorange.

5 Choose the power meter Stability Application and set the following parameters:

Power unit	=	dBm
Total Time	=	25 seconds
Averaging Time	=	50 ms
Wavelength	=	Source Wavelength
Range mode	=	auto

6 Enable the laser source, open the shutter and set attenuation [α] to 0 dB.

7 For SMF Attenuators only:

- Set the 11896A Polarization Controller's scan rate = 4, then press [AutoScan] to start polarization scrambling.
- Press [Measure] at the power meter to start PDL Scanning.

8 After the measurement, press [Analysis] to get the power readings.

9 Note the average power reading AVG[α] from the statistics table.

10 Set the attenuation [α] to each value listed below and repeat step 5 to step 9.

1 db	2 dB	3 dB	4 dB	5 dB
6 dB	7 dB	8 dB	9 dB	10 dB
11 dB	12 dB	13 dB	14 dB	15 dB
35 dB	40 dB	45 dB	55 dB	60 dB

11 Calculate the accuracy at the given attenuation [α]
Accuracy [α] = AVG[α] - [α] - AVG[α = 0dB]

12 Record the accuracy in the Test Record.

Repeatability Test

For the SMF Attenuators, use the equipment and test setup shown in Figure 14 on page 60 but without the Agilent 11896A Polarization Controller.
For the 81575A use the same equipment and setup as used for the Accuracy Test - 8157xA modules.

The performance test can be performed at other wavelengths than 1550 nm.

1 Turn the instruments on and allow the devices to warm up (20..30min).

2 Make sure that all your connectors are clean and undamaged.

3 Set the attenuator and the power meter to the actual wavelength of the laser source.

4 Disable the laser source, zero the power meter and select Autorange. Display [dB].

5 Enable the laser source and open the shutter.

6 Set attenuation [α] to 1 dB, wait until it settles and set Display to Reference on the power meter.

7 Set the attenuation [α] to any other value, such as 21 dB, and wait until it settles at this value.

8 Change the attenuation [α] back to the previous value and note the deviation in the Test Record.

9 Repeat the steps 6 to 8 for the following attenuation settings:

7 dB	15 dB	24 dB	32 dB
40 dB	48 dB	54 dB	60 dB

Power Setting Repeatability Test - Attenuator modules with Power Control

Use the same equipment and test setup as used in Figure 14 on page 60 without the Agilent 11896A Polarization Controller.

The performance test can be performed at wavelengths other than 1550 nm.

This test applies only to the Agilent 81566A/67A and Agilent 81576A/77A Attenuators with power control.

1 Turn the instruments on and allow the devices to warm up (20..30min).
2 Make sure that all your connectors are clean and undamaged.
3 Set the attenuator to the actual wavelength of the laser source and set the averaging time to 1s.
4 Zero the attenuator power meter, disable the power control and display [dBm].
5 Enable the laser source and open the shutter.
6 Set [P_{SET}] to 0 dBm and wait for stabilizing. Note the reading of [P_{ACT}] in the Test Record.
7 Set [P_{SET}] to any other value and wait until settling.
8 Change [P_{SET}] back to the previous value and note the deviation of [P_{ACT}] in the Test Record.
9 Repeat the steps 6 to 8 for [P_{SET}] = - 25 dBm and [P_{SET}] = - 50 dBm.

Attentuation Flatness Test - 8157xA modules

Carry out the following Attenuation Flatness Test with single mode fibers using the equipment listed in Table 1, “Equipment Required,” on page 55. To adapt for the straight or angled contact versions of the attenuator use the patchcords with appropriate connectors and the adequate connector interfaces.

Outline The Attenuation Flatness Test measures the attenuation of the 8157xA at six wavelength points for a constant attenuation and a constant wavelength setting of the attenuator.

To account for the PDL uncertainty, the attenuation is measured as an average over all polarization states. To allow for the contribution of spectral ripple, the attenuation measurement is averaged over a wavalenght span of ± 0.5 nm arond the nominal wavelength point setting.

NOTE It is strongly recommended that the Attenuation Flatness Test is performed automatically utilizing Agilent 816x VXI Plug&Play drivers.

Procedure

1 Turn the instruments on and allow the devices to warm up (20..30min).

2 Make sure that all your connectors are clean and undamaged.

3 For the SMF Attenuators, connect the equipment as shown below in Figure 16.

   For the 81575A use the same equipment and setup as used for the Accuracy Test - 8157xA modules.

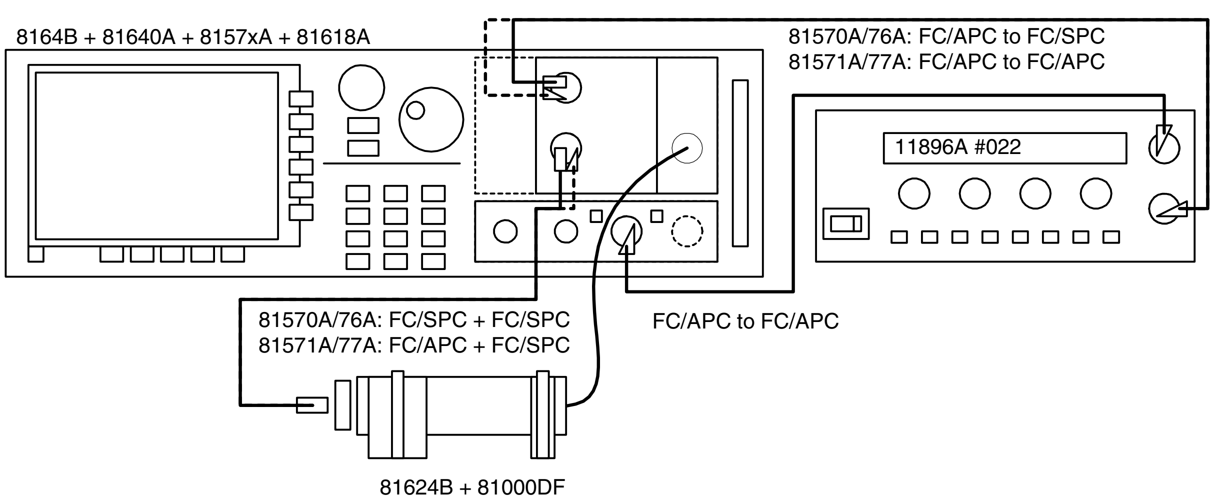

Figure 16 **Attenuation Flatness Test Setup - 8157xA VOAs**

4 Configure a wavelength sweep measurement for each of the following wavelength points:

λ_i	λ_1	λ_2	λ_3	λ_4	λ_5	λ_6
Wavelength	1520.0 nm	1540.0 nm	1560.0 nm	1580.0 nm	1600.0 nm	1620.0 nm

Set the following parameters:

TLS, λ_Start	=	λ_i - 0.5 nm
TLS, λ_Start	=	λ_i + 0.5 nm
TLS, Sweep Mode	=	continuous
TLS, Repeat Mode	=	two-way
TLS, Cycles	=	100
TLS, Output Power	=	0.0 dBm
Power meter, Averaging Time	=	2 ms
Power meter, Data points	=	12500

5 Set the attenuator to 0 dB and open the shutter.

6 For SMF Attenuators only:

- Set the 11896A Polarization Controller to its fastest scan rate, then press [AutoScan] to start polarization scrambling.

7 Perform the reference sweep.

8 Set the attenuation to to 10 dB and perform the measurement sweep.

9 Using the data obtained by the reference sweep and the measurement sweep, calculate the loss for each nominal wavelength point λ_i .

10 Note the difference between the maximum loss and the minimim loss in the test record.

11 Repeat step 8 to step 10 but for an attenuator setting of 20 dB.

Return Loss Test

Carry out the following Return Loss Test at 1550 nm with single mode fibers using the equipment listed in Table 1, “Equipment Required,” on page 55. To adapt for the straight or angled contact versions of the attenuator use the patchcords with appropriate connectors and the adequate connector interfaces.

1 Turn the instruments on and allow the devices to warm up (20..30min).

2 Make sure that all your connectors are clean and undamaged.

3 Connect the equipment as shown below in Figure 17.

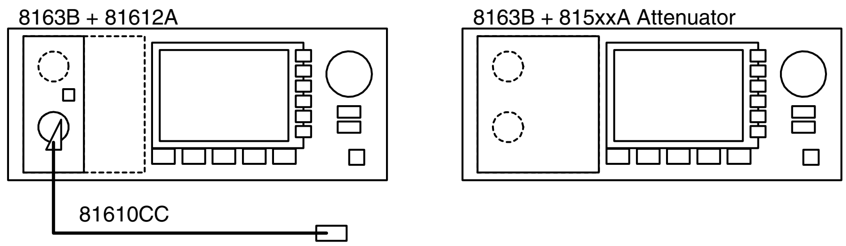

Figure 17 Return Loss Reference Setup

4 Set the attenuator and the power meter to the actual wavelength of internal laser source of the return loss meter.

5 Disable the internal laser source, cover the end of the reference cable and zero the return loss meter.

6 Uncover and clean the end of the reference cable and enable the laser source.

7 Select the CAL REF parameter and set the reflection reference R to 14.7 dB, the default value for the return loss of the Agilent 81610CC Reference Reflector cable.

8 Set Display to Reference. The value read should now be 14.7 dB, the same as the value entered for reflection reference R.

9 Select the REF AUX parameter and terminate the reference cable by wrapping the fiber several times around a pencil or the shaft of a screwdriver.

10 Set Display to Reference toset the termination parameter.

11 Remove the reference cable and connect the equipment as shown in Figure 18.

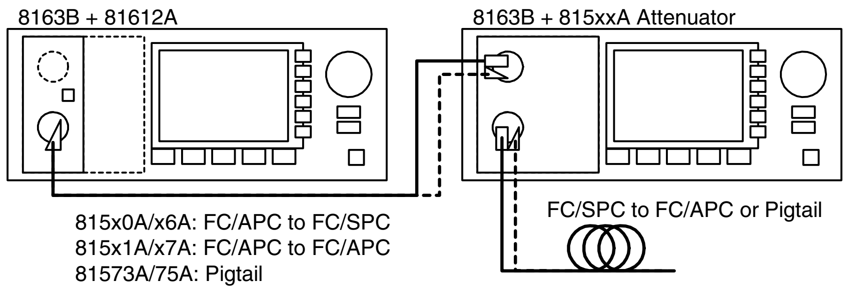

Figure 18 Return Loss Test Setup

12 Terminate the patchcord on the attenuator output by wrapping the fiber several times around a pencil or the shaft of a screwdriver. Do the same for the monitor output if applicable.

13 Set the attenuation [α] to 0 dB and note the input return loss in the Test Record.

14 Open the shutter and record the return loss in the Test Record.

15 Connect the return loss meter to the attenuator output port and terminate the input port as described in step 12.

16 You may measure the output return loss for open and closed shutter or for other arbitrary attenuation settings as described in step 13 to step 14.

Polarization Dependent Loss (PDL) Test, Scanning method - SMF Attentuator modules

Use the same test equipment and test setup as used in Figure 14 on page 60.

NOTE This test method is recommended if the fiber-loop type 11869A Polarization Controller is used. If the plate-type 8169A Polarization Controller is used, refer to “Polarization Dependent Loss (PDL) Test, Scanning method - SMF Attentuator modules” on page 69.

1 Turn the instruments on and allow the devices to warm up (20..30 min).

2 Make sure that all your connectors are clean and undamaged.

3 Set the attenuator to the wavelength of the laser source.

4 Enable the laser source and open the shutter of the attenuator.

5 Display [dB] at the power meter and set Display to Reference.

6 Choose the power meter Stability Application and set parameters:

Total Time	=	25 seconds
Averaging Time	=	50 ms
Wavelength	=	Source Wavelength
Range mode	=	auto

7 Set the 11896A Polarization Controller scan rate = 4 and press [AutoScan] to start Polarization Scrambling.

8 Press Measure at the power meter to start PDL Scanning.

9 After the measurement press [Analysis] and [More] to get the power readings.

10 Note the results in the Test Record.

Polarization Dependent Loss (PDL) Test, Mueller method - SMF Attenuator modules

Carry out the following PDL Test at 1550 nm with single mode fibers using the equipment listed in Table 1, “Equipment Required,” on page 55. To adapt for the straight or angled contact versions of the attenuator use the patchcords with appropriate connectors and the adequate connector interfaces. Use the operation mode "Attenuation Set".

NOTE Perform this test with the plate-type 8169A Polarization Controller.

1 Turn the instruments on and allow the devices to warm up (20..30 min).

2 Make sure that all your connectors are clean and undamaged.

3 Connect the equipment as shown in Figure 19.

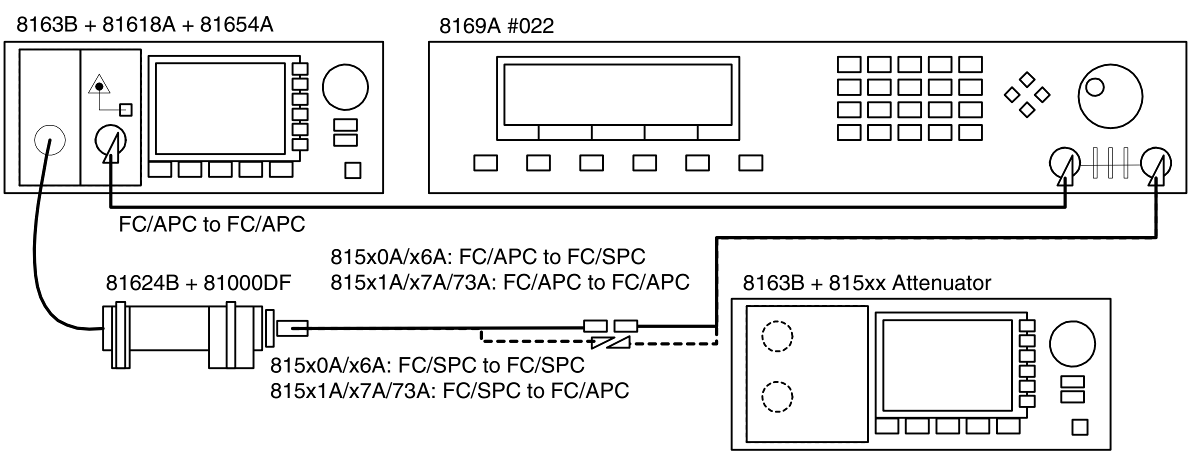

Figure 19 PDL Reference Setup

NOTE The patchcords to and from the polarization controller and the attenuator must not move during and between all measurements. Use tape to fix the fibers to the table.

4 Zero the power meter. Display [W].

5 Set the attenuator and the power meter to the actual wavelength of the source.

6 Enable the laser source and allow 5 minutes for the laser to settle.

7 Reset the polarization controller.

8 Set the polarization filter of the 8169A to maximize the signal.

9 Note the diplayed angle of the polarization filter as "Linear Horizontal Setting".

Set plates for Horizontal polarization. For the following steps the polarizer is kept constant.

10 Set the λ/4 Retarder Plate to the same angle as the polarization filter.

11 Note the angle as "λ/4, Linear Horizontal Polarization".

12 Set the λ/2 Retarder Plate to the same angle as the polarization filter.

13 Note the angle as "λ/2, Linear Horizontal Polarization".

Determine settings for Linear Vertical, Linear Diagonal and Right Hand Circular Polarization.

NOTE In order to get the required polarization, the λ/2 and λ/4 retarder plates need to be set to the appropriate values. The corrected positions of the polarizer plates depend on the actual wavelength and have to be taken from Table 2, “Retarder Settings,” on page 73. In the case of Linear Horizontal polarized light no correction is to be done. The table lists corrections for every 20 nm step. For wavelengths between listed values, a linear approximation should be used.

14 Get the values (possible by approximation) for the wavelength dependent offset positions for each type of polarization from Table 2, “Retarder Settings,” on page 73.

15 Add these values to those for Linear Horizontal polarized light.

16 Note the calculeted corrected wavelength dependent position values in the Test Record for the λ/4 Plate setting and the λ/2 Plate setting for Linear Vertical, Linear Diagonal and Right Hand Circular Polarization.

Measure the Reference Power.

17 Keep the settings from the polarizer and the λ/4 and λ/2 Retarder Plates from steps 8, 10 and 12 for Linear Horizontal polarized light.

18 Note the power reading as Reference Power P_1 in the Test Record.

19 Set the λ/4 and λ/2 Retarder Plates to the corrected wavelength dependent positions for Linear Vertical polarized light.

20 Read the power on the power meter and note is as Reference Power P_2 in the Test Record.

21 Set the λ/4 and λ/2 Retarder Plates to the corrected wavelength dependent positions for Linear Diagonal polarized light.

22 Note the power reading as Reference Power P_3 in the Test Record.

23 Set the λ/4 and λ/2 Retarder Plates to the corrected wavelength dependent positions for Right Hand Circular polarized light.

24 Note the power reading as Reference Power P_4 in the Test Record.

25 Connect the equipment as shown in Figure 20.

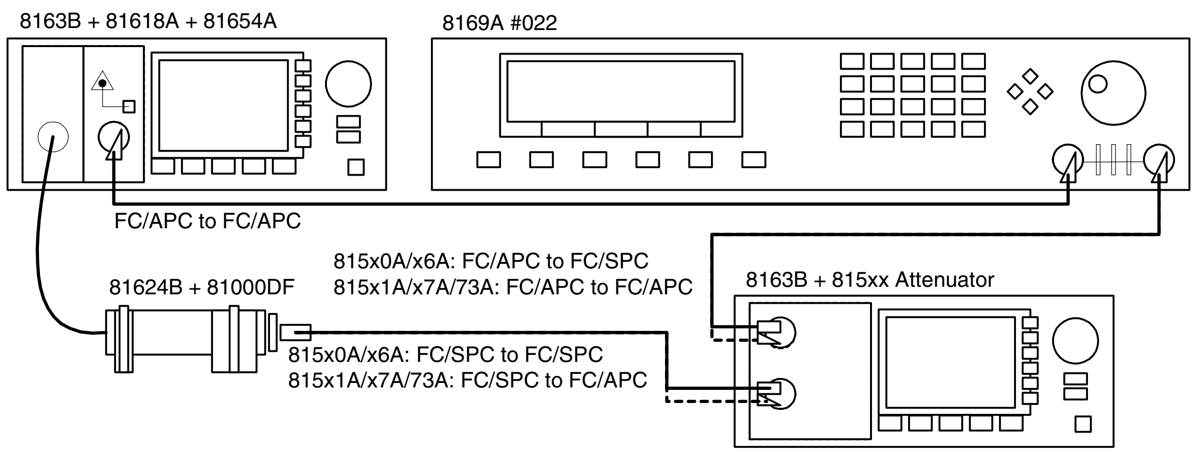

Figure 20 PDL Test Setup (Mueller Method)

NOTE The patchcords to and from the polarization controller and the attenuator must not move during and between all measurements. Use tape to fix the fibers to the table.

Measure the optical power after the Attenuator Module.

26 Open the shutter of the attenuator.

27 Set the λ/4 and λ/2 Retarder Plates for Linear Horizontal polarized light.

28 Note the power reading as DUT Power P_1 in the Test Record.

29 Set the λ/4 and λ/2 Retarder Plates to the corrected wavelength dependent positions for Linear Vertical polarized light.

30 Note the power that is displayed on the power meter as DUT Power P_2 in the Test Record.

31 Set the λ/4 and λ/2 Retarder Plates to the corrected wavelength dependent positions for Linear Diagonal polarized light.

32 Note the power reading as DUT Power P_3 in the Test Record.

33 Set the λ/4 and λ/2 Retarder Plates to the corrected wavelength dependent positions for Right Hand Circular polarized light.

34 Note the power reading as DUT Power P_4 in the Test Record.

35 Calculate the Mueller coefficients, the Minimum and Maximum transmission and finally the Polarization Dependent Loss (PDL) as described in the Test Record.

Table 2 Retarder Settings

λ/nm	Linear Vertical		Linear Diagonal		Right Hand Circular	
	λ/4 Plate	λ/2-Plate	λ/4-Plate	λ/2-Plate	λ/4-Plate	λ/2-Plate
1580	2.5°	46.2°	1.7°	23.3°	42.9°	-17.1°
1560	1.2°	45.6°	0.8°	22.9°	44.0°	-16.5°
1540	0°	45.0°	0°	22.5°	45.0°	-15.1°
1520	-1.4°	44.3°	-1.0°	22.0°	46.2°	-13.8°
1500	-2.7°	43.6°	-2.0°	21.4°	47.4°	-12.4°

Relative Power Meter Uncertainty Test

Carry out the following Power Meter Uncertainty Test at 1550 nm or another specified wavelength with single mode fibers using the equipment listed in Table 1, "Equipment Required," on page 55. To adapt for the straight or angled contact versions of the attenuator use the patchcords with appropriate connectors and the adequate connector interfaces.

This test applies only to the Agilent 81566A/76A and 81576A/77A Attenuators with power control.

NOTE Do not turn the laser off during the measurement. Clean all connectors carefully before you begin the measurement!

1 Turn the instruments on and allow the devices to warm up (20..30 min).

2 Make sure that you perform this test in a temperature-controlled environment with temperature fluctuations less than ±1°C.

3 Make sure that all your connectors are clean and undamaged.

4 Connect the equipment as shown below in Figure 21.

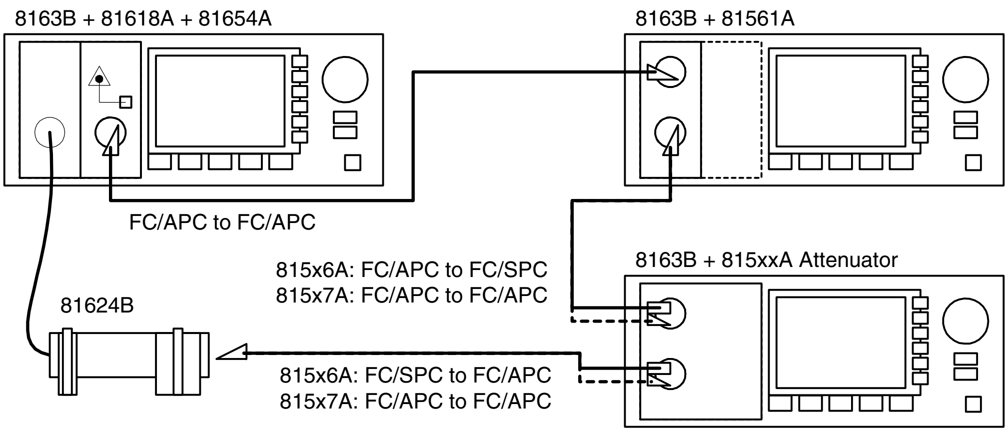

Figure 21 Relative Power Meter Uncertainty Setup

5 Set both attenuators to the wavelength of the source and disable them.

6 Set the attenuation [α] of 81561A reference attenuator to 55dB.

7 Set the attenuation [α] of the DUT attenuator to 0dB.

8 Set the averaging time of the DUT attenuator power meter to 1s.

9 Zero the reference and the attenuator power meter.

10 Enable the laser source and wait for stabilizing (>30 seconds).

11 Enable the attenuators.

12 Set the reference power meter to the wavelength of the source, set the averaging time to 1s and display [dB]. Press [Display to Reference].

13 Set the range mode of the reference power meter to [manual].

14 On the DUT attenuator edit [P Offset] until the parameter [P_{SET}] equals 0 dBm.

15 Lower [P_{SET}] and the attenuation of the reference attenuator by 5dB.

16 Note the reference power meter reading in the Test Record.

17 Repeat step 14 to step 15 until the reference attenuator shows an attenuation of 0dB.

18 Perform step 14 to step 15 upward until the reference attenuator shows 55dB.

Test Record - 8156xA modules

Agilent 8156xA Optical Attenuator Module Performance Test
Page 1 of 8

Test Facility:

________________________ Report No. ______________

________________________ Date ______________

________________________ Customer ______________

________________________ Tested By ______________

Model: Agilent Optical Attenuator Module ☐ 81560A ☐ 81561A

☐ 81566A ☐ 81567A

Model Agilent 8156xA Optical Attenuator Module Performance Test

Serial No. ________________ Ambient temperature ______ °C

Options ________________ Relative humidity ______ %

Firmware Rev. ________________ Line frequency ______ Hz

Special Notes:

____

____

____

____

____

Agilent 8156xA Optical Attenuator Module Performance Test
Page 2 of 8

Agilent 8156xA Optical Attentuator Module Report No. ________ Date_______

Test Equipment Used

Description	Model No.	Trace No.	Cal. Due Date
1. Mainframe	___________	_________	__/___/__
2. Power Meter	___________	_________	__/___/__
3. Laser Source	___________	_________	__/___/__
4. Return Loss Module	___________	_________	__/___/__
5. Connector Interface	___________	_________	__/___/__
6. Single Mode Fiber	___________	_________	__/___/__
7. __________________________	___________	_________	__/___/__
8. __________________________	___________	_________	__/___/__
9. __________________________	___________	_________	__/___/__
10. __________________________	___________	_________	__/___/__
11. __________________________	___________	_________	__/___/__
12. __________________________	___________	_________	__/___/__
13. __________________________	___________	_________	__/___/__
14. __________________________	___________	_________	__/___/__
15. __________________________	___________	_________	__/___/__
16. __________________________	___________	_________	__/___/__

Agilent 8156xA Optical Attenuator Module Performance Test
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Agilent 8156xA Optical Attentuator Module Report No. ________ Date________

Insertion Loss Test - 8156xA

Product	**81560A + 81561A**	**81566A + 81567A**
Measurement		
Specification	1.9 dB	2.2 dB

Attenuation Accuracy Test - 8156xA

Setting /dB	**Reading /dB**	**Deviation /dB**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
25		
35		
45		
55		
60		
Maximum absolute deviation		
Specification		± 0.1 dB

Agilent 8156xA Optical Attenuator Module Performance Test
Page 4 of 8

Agilent 8156xA Optical Attentuator Module Report No. ________ Date_______

Attenuation Repeatability Test - 8156xA

Setting / dB	Deviation / dB
1	
7	
15	
24	
32	
40	
48	
54	
60	
Maximum absolute deviation	
Specification	± 0.01 dB

Power Setting Repeatability Test - 8156xA

Power Setting / dB	Deviation / dB
0 dBm	
-25 dBm	
-50 dBm	
Maximum absolute deviation	
Specification	± 0.015 dB

Agilent 8156xA Optical Attenuator Module Performance Test
Page 5 of 8

Agilent 8156xA Optical Attentuator Module Report No. ________ Date_______

Return Loss Test - 8156xA

Product	81560A + 81566A	81561A + 81567A
Attenuation Setting		
Shutter State	Open Closed	Open Closed
Measurement Input Port		
Measurement Output Port		
Test Limit	42 dB	57 dB

Agilent 8156xA Optical Attenuator Module Performance Test
Page 6 of 8

Agilent 8156xA Optical Attentuator Module Report No. ________ Date________

Polarization Dependent Loss Test (Scanning Method 11896A) - 8156xA

Product	81560A +81561A	81566A +81567A
Attentuation Setting		
Polarization Dependent Loss		
Specification	< 0.05 dBpp	< 0.08 dBpp

Polarization Dependent Loss Test (Mueller Method 8169A) - 8156xA

	Polarization			
	Linear Horizontal	Linear Vertical	Linear Diagonal	Right Hand Circular
Polarizer Setting	deg	n/a	n/a	n/a
$\lambda/4$ Plate Setting	deg	n/a	n/a	n/a
$\lambda/2$ Plate Setting	deg	n/a	n/a	n/a

	Corrected Wavelength Dependent Positions			
	Linear Horizontal	Linear Vertical	Linear Diagonal	Right Hand Circular
Polarizer Setting	n/a	deg	deg	deg
$\lambda/4$ Plate Setting	n/a	deg	deg	deg

λ/2 Plate Setting	n/a	deg	deg	deg

Measurement	**P_1**	**P_2**	**P_3**	**P_4**
Reference Power	µW	µW	µW	µW
DUT Power	µW	µW	µW	µW

Mueller Coefficients				
m_{11}	=	$(P_{DUT1} / P_{REF1} + P_{DUT2} / P_{REF2})/2$	=	
m_{12}	=	$(P_{DUT1} / P_{REF1} - P_{DUT2} / P_{REF2})/2$	=	
m_{13}	=	$(P_{DUT3} / P_{REF3}) - m_{11}$	=	
m_{14}	=	$(P_{DUT4} / P_{REF4}) - m_{11}$	=	
Minimum and Maximum Transmission				
T_{max}	=	$m_{11} + \sqrt{m_{12}^2 + m_{13}^2 + m_{14}^2}$	=	
T_{max}	=	$m_{11} - \sqrt{m_{12}^2 + m_{13}^2 + m_{14}^2}$	=	

Product	**81560A + 81561A**	**81566A + 81567A**
Polarization Dependent Loss PDL = 10 lg (Tmax / Tmin) dBpp		
Specification	< 0.05 dBpp	< 0.08 dBpp

Agilent 8156xA Optical Attenuator Module Performance Test
Page 8 of 8

Agilent 8156xA Optical Attentuator Module Report No. ________ Date_______

Relative Power Meter Uncertainty Test - 8156xA

8156xA [PSET] /dBm	Reference Attenuation /dB	Reference Reading 1 /dB	Reference Reading 2 /dB
0	55	0	
-5	50		
-10	45		
-15	40		
-20	35		
-25	30		
-30	25		
-35	20		
-40	15		
-45	10		
-50	5		
-55	0		
Maximum peak-to-peak deviation			
Specification		**0.06 dBpp**	

Test Record - 8157xA modules

Agilent 8157xA High Power Optical Attenuator Module Performance Test
Page 1 of 8

Test Facility:

____________________________ Report No. _______________

____________________________ Date _______________

____________________________ Customer _______________

____________________________ Tested By _______________

Model: Agilent High Power Optical Attenuator Module ☐ 81570A ☐ 81571A ☐ 81573A

☐ 81575A ☐ 81576A ☐ 81577A

Serial No. ________________ Ambient temperature _______ °C

Options ________________ Relative humidity _______ %

Firmware Rev. ________________ Line frequency _______ Hz

Special Notes:

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Agilent 8157xA High Power Optical Attenuator Module Performance Test
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Agilent 8157xA High Power Optical Attentuator Report No. ________ Date_______

Test Equipment Used

Description	Model No.	Trace No.	Cal. Due Date
1. Mainframe	___________	_________	__/___/__
2. Power Meter	___________	_________	__/___/__
3. Laser Source	___________	_________	__/___/__
4. Return Loss Module	___________	_________	__/___/__
5. Connector Interface	___________	_________	__/___/__
6. Single Mode Fiber	___________	_________	__/___/__
7. __________________________	___________	_________	__/___/__
8. __________________________	___________	_________	__/___/__
9. __________________________	___________	_________	__/___/__
10. __________________________	___________	_________	__/___/__
11. __________________________	___________	_________	__/___/__
12. __________________________	___________	_________	__/___/__
13. __________________________	___________	_________	__/___/__
14. __________________________	___________	_________	__/___/__
15. __________________________	___________	_________	__/___/__
16. __________________________	___________	_________	__/___/__

Agilent 8157xA High Power Optical Attenuator Module Performance Test
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Agilent 8157xA High Power Optical Attentuator Report No. ________ Date_______

Insertion Loss Test - 8157xA

Product	**81570A, 71A, 73A**	**81576A, 77A**	**81575A**
Measurement			
Specification / (Test Limit)	1.6 dB	1.8 dB	(1.8 dB)

Attenuation Accuracy Test - 8157xA

Setting /dB	**Reading /dB**	**Deviation /dB**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
25		
35		
45		
55		
60		
Maximum absolute deviation		
SMF Attenuator Specification		± 0.1 dB
81575A Specification		± 0.2 dB

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Agilent 8157xAHigh Power Optical Attentuator Report No. ________ Date________

Attenuation Repeatability Test - 8157xA

Setting /dB	Deviation /dB
1	
7	
15	
24	
32	
40	
48	
54	
60	
Maximum absolute deviation	
Specification	± 0.01 dB

Power Setting Repeatability Test - 8157xA

Power Setting /dB	Deviation /dB
0 dBm	
-25 dBm	
-50 dBm	
Maximum absolute deviation	
Specification	± 0.015 dB

Agilent 8157xA High Power Optical Attenuator Module Performance Test
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Agilent 8157xA High Power Optical Attentuator Report No. ________ Date_______

Attenuation Flatness Test - 8157xA modules

Wavelength	Power Reading at α = 0 dB $P_{0\,dB}$	Power Reading at α = 10 dB $P_{10\,dB}$	Attenuation at α = 10 dB $P_{0\,dB}$ - $P_{10\,dB}$	Power Reading at α = 20 dB $P_{20\,dB}$	Attenuation at α = 20 dB $P_{0\,dB}$ - $P_{20\,dB}$
1520 nm ± 0.5 nm	dBm	dBm	dBpp	dBm	dBpp
1540 nm ± 0.5 nm	dBm	dBm	dBpp	dBm	dBpp
1560 nm ± 0.5 nm	dBm	dBm	dBpp	dBm	dBpp
1580 nm ± 0.5 nm	dBm	dBm	dBpp	dBm	dBpp
1600 nm ± 0.5 nm	dBm	dBm	dBpp	dBm	dBpp
1620 nm ± 0.5 nm	dBm	dBm	dBpp	dBm	dBpp
Minimum Attenuation A_{min}			dBpp		dBpp
Maximum Attenuation A_{max}			dBpp		dBpp
Attenuation Flatness A_{max} - A_{min}			dBpp		dBpp
Maximum Deviation			dBpp		
Specification			0.14 dBpp		

Return Loss Test - 8157xA

Product	81570A + 81576A	81571A, 73A, 75A, 77A
Attenuation Setting		
Shutter State	Open Closed	Open Closed
Measurement Input Port		
Measurement Output Port		
Test Limit	42 dB	57 dB

Agilent 8157xA High Power Optical Attenuator Module Performance Test
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Agilent 8157xA High Power Optical Attentuator Report No. ________ Date________

Polarization Dependent Loss Test (Scanning Method 11896A) - 8157xA

Product	81570A/71A/73A	81576A +81577A
Attentuation Setting		
Maximum peak-to-peak Deviation		
Specification	0.08 dBpp	< 0.10 dBpp

Polarization Dependent Loss Test (Mueller Method 8169A) - 8157xA

Attenuation Setting: ________ dB

	Polarization			
	Linear Horizontal	Linear Vertical	Linear Diagonal	Right Hand Circular
Polarizer Setting	deg	n/a	n/a	n/a
$\lambda/4$ Plate Setting	deg	n/a	n/a	n/a
$\lambda/2$ Plate Setting	deg	n/a	n/a	n/a

	Corrected Wavelength Dependent Positions			
	Linear Horizontal	Linear Vertical	Linear Diagonal	Right Hand Circular
Polarizer Setting	n/a	deg	deg	deg
$\lambda/4$ Plate Setting	n/a	deg	deg	deg

$\lambda/2$ **Plate Setting**	n/a	deg	deg	deg

Measurement	**P_1**	**P_2**	**P_3**	**P_4**
Reference Power	µW	µW	µW	µW
DUT Power	µW	µW	µW	µW

Mueller Coefficients				
m_{11}	=	$(P_{DUT1} / P_{REF1} + P_{DUT2} / P_{REF2})/2$	=	
m_{12}	=	$(P_{DUT1} / P_{REF1} - P_{DUT2} / P_{REF2})/2$	=	
m_{13}	=	$(P_{DUT3} / P_{REF3}) - m_{11}$	=	
m_{14}	=	$(P_{DUT4} / P_{REF4}) - m_{11}$	=	
Minimum and Maximum Transmission				
T_{max}	=	$m_{11} + \sqrt{m_{12}^2 + m_{13}^2 + m_{14}^2}$	=	
T_{max}	=	$m_{11} - \sqrt{m_{12}^2 + m_{13}^2 + m_{14}^2}$	=	

Product	**81570A/71A/73A**	**81576A + 81577A**
Polarization Dependent Loss PDL = 10 lg (Tmax / Tmin) dBpp		
Specification	< 0.08 dBpp	< 0.10 dBpp

Agilent 8157xA High Power Optical Attenuator Module Performance Test
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Agilent 8157xA High Power Optical Attentuator Report No. ________ Date________

Relative Power Meter Uncertainty Test - 8157xA

8157xA [P_{SET}] /dBm	Reference Attenuation /dB	Reference Reading 1 /dB	Reference Reading 2 /dB
0	55	0	
-5	50		
-10	45		
-15	40		
-20	35		
-25	30		
-30	25		
-35	20		
-40	15		
-45	10		
-50	5		
-55	0		
Maximum peak-to-peak deviation			
Specification		**0.06 dBpp**	

Cleaning Information

The following Cleaning Information contains some general safety precautions, which must be observed during all phases of cleaning. Consult your specific optical device manuals or guides 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 assume no liability for the customer's failure to comply with these requirements.

Safety Precautions

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?

CAUTION

Optical power levels above 100 mW applied to single-mode connectors can easily damage the connector if it is not perfectly clean. Also, scratched or poorly cleaned connectors can destroy optical connectors mechanically. Always make sure that your optical connectors are properly cleaned and unscratched before connection. However, Agilent Technologies Deutschland GmbH assumes no responsibility in case of an operation that is not compliace with the safety instructions as stated above.

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/m^2). 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. In this chapter, 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 materials do I need for proper cleaning?

Some Standard Cleaning Equipment is necessary for cleaning your instrument. For certain cleaning procedures, you may also require certain Additional Cleaning Equipment.

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 of 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. Results will vary depending on the purity of the alcohol.

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 dissolved in the alcohol and will leave behind filmy deposits after the alcohol has 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 feed through 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
- 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 photography or 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 hot water, 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.

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 the help of this card you are able to inspect the shape of laser light emitted. The invisible laser beam is projected onto the sensor card. The light beam’s infrared wavelengths are refleted at visible wavelengths, so becoming visible to the normal eye as a round spot.

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 of 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

Use a dry and very soft cotton tissue to clean the instrument housing and the keypad. Do not open the instruments as there is a danger of electric shock, or electrostatic discharge. Opening the instrument can cause damage to sensitive components, and in addition your warranty will be invalidated.

General Cleaning Procedure

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 9 µm. This generally means you cannot see streaks or scratches on its 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.

Cleaning procedure for high-power single-mode connections

Optical single-mode connectors for high-power applications (optical power levels bove 100 mW) require careful cleaning to prevent the power density of burning dust or dirt into the fiber causing permanent damage to the devices and/or connectors. If this happens, measurements become inaccurate and unrepeatable.

The “Preferred Procedure” on page 102 or the “Procedure for Stubborn Dirt” on page 102 must be strictly followed for each part of the optical connection (connector, connector interface, and physical connector interface).

Always make sure that the fiber end-faces are properly cleaned and unscratched before connection. The fiber end faces must be visually inspected using a microscope with a magnification of at leasst 400x. For recommended fiber inspection microscopes, please refer to personnel in Agilent’s Service Team.

The connection should be made immediately after cleaning and inspection to prevent the connection (connector, connector interface, and physical connector interface) from becoming dusty or dirty again.(

Preferred Procedure

An Optical Connector Cleaner, which ressembles a VCR cleaning tape, is a device that can be used to clean grease from the surface of a connector.

1 Blow away any surface dust with compressed air..

2 Press the button on the sideof the Optical Connector Cleaner device to ensure that a fresh strip of tape is ready.

3 Position the connector interface on the tape.

4 Holding the connector interface against the tape, rotate the interface about 180 degrees, then slide it across the surface of the tape.

Alternative Procedure

Use the following procedure if an Optical Connector Cleaner is not available.

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 optical head adapters

CAUTION Some adapters have an anti-reflection coating on the back to reduce back reflection. This coating is extremely sensitive to solvents and mechanical abrasion. Extra care is needed when cleaning these adapters.

When using optical head adapters, periodically inspect the optical head's front window. Dust and metal particles can be propelled through the adapter's pinhole while inserting the connector ferrule into the receptacle. These dirt particles collect on the head's front window, which can lead to incorrect results if not removed.

Preferred Procedure

Use the following procedure on most occasions.

1. Clean the adapter 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 adapter:

1. Moisten a new cotton swab with isopropyl alcohol.
2. Clean the adapter 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 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.

Do not use pipe cleaners on optical head adapters, as the hard core of normal pipe cleaners can damage the bottom of an adapter.

Preferred Procedure

Use the following procedure on most occasions.

1 Clean the interface, when no lens is connected, 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 Using a new, dry pipe cleaner, and 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 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:

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.

CAUTION

Be careful when using pipe cleaners, as the core and the bristles of the pipe cleaner are hard and can damage the adapter.

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 and instruments with an optical glass plate

Some lenses have special coatings that are sensitive to solvents, grease, liquid and mechanical abrasion. Take extra care when cleaning lenses with these coatings. Some instruments, for example, Agilent's optical heads have an optical glass plate to protect the sensor.

CAUTION

Do not attempt to access the internal parts of an Agilent N3988A video microscope for cleaning or for any other purpose.

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.

If you are cleaning an Agilent 8162*A optical head, periodically inspect the optical head's front window for dust and other particles. Dust and particles can be propelled through the optical head adapter's pinhole while inserting a connector ferrule into the receptacle. Particles on the optical head's front window can significantly impair measurement results.

NOTE

Do not dry the lens by rubbing with with cloth or other material, which may scratch the lens surface.

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.

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 fat in the connector, please refer the instrument to the skilled personnel of Agilent’s service team.

NOTE Both the surface and the jacket of the attached connector should be completely dry and clean.

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.

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 9 µm. 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.

Optical single-mode connections for high-power applications (optical power levels above 100mW) require careful cleaning to prevent the power density of burning dust or dirt into the fiber causing permanent damage of the devices and/or connectors. If this happens, measurements become inaccurate and non-repeatable.

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.

NOTE This procedures must be strictly followed for each part of the optical connection (connector, connector interface and physical connector interface).

NOTE The connection should be made immediately after cleaning and inspection to prevent the connection (connector, connector interface and physical connector interface) from getting dusty or dirty again.

NOTE Always make sure that the fiber end faces are properly cleaned and unscratched before connection. The fiber end faces must be visually inspected using a microscope with a magnification of at least 400x. For recommended fiber inspection microscopes, please refer to Agilent 's service team personnel.

How to clean instruments with a recessed lens interface

For instruments with a *deeply* recessed lens interface (for example the Agilent 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 Agilent’s 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 preferred procedure 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 the Agilent 81000BR Reference Reflector, which has a gold plated surface, 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 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 metal filters or attenuator gratings

This kind of device is extremely fragile. A misalignment of the grating leads to inaccurate measurements. Never touch the surface of the metal filter or attenuator grating.

Be very careful when using or cleaning these devices. Do not use cotton swabs or soft tissues, as there is the danger that you cannot remove the lint and that the device will be destroyed by becoming mechanically distorted.

Preferred Procedure

Use the following procedure on most occasions.

1. Use compressed air at a distance and with low pressure to remove any dust or lint.

Procedure for Stubborn Dirt

Do not use an ultrasonic bath as this can damage your device.

Use this procedure when there is greasy dirt on the device:

1. Put the optical device into a bath of isopropyl alcohol, and wait at least 10 minutes.
2. Remove the fluid using compressed air at some distance and with low pressure. If there are any streaks or drying stains on the surface, repeat the whole cleaning procedure.

Additional Cleaning Information

The following cleaning procedures may be used with other optical equipment:

- How to clean bare fiber ends
- How to clean large area lenses and mirrors

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.

Preferred Procedure

There is an easy method for removing dust from bare fiber ends.

1. Touch the bare fiber end with adhesive tape. Any dust will be removed.

How to clean large area lenses and mirrors

Some mirrors, as those from a monochromator, are very soft and sensitive. Therefore, never touch them and do not use cleaning tools such as compressed air or polymer film.

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 liquid 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. Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt

Use this procedure when there is greasy dirt on the lens:

CAUTION

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 hot water, 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.

1 Moisten the lens or the mirror with water.
2 Put a little liquid soap on the surface and gently spread the liquid over the whole area.
3 Wash off the emulsion with water, being careful to remove it all, as any remaining streaks can impair measurement accuracy.
4 Take a new, dry soft tissue and remove the water, by rubbing gently over the surface using a small circular movement.
5 Blow away remaining lint with compressed air.

Alternative Procedure A

To clean lenses 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 B

If your lens is sensitive to water then:

1 Moisten the lens or the mirror with isopropyl alcohol.
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 remaining lint with compressed air.

Other Cleaning Hints

Selecting the correct cleaning method is an important element in maintaining your equipment and saving you time and money. This chapter highlights the main cleaning methods, but cannot address every individual circumstance.

This section contain some additional hints which we hope will help you further. For further information, please contact your local Agilent Technologies representative.

Making the connection

Before you make any connection you must ensure that all lightwave cables and connectors are clean. If not, then use the appropriate cleaning methods.

When you insert the ferrule of a patchcord into a connector or an adapter, ensure that the fiber end does not touch the outside of the mating connector or adapter. Otherwise, the fiber end will rub up against something which could scratch it and leave deposits.

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.

Immersion oil and other index matching compounds

Do not use immersion oil or other index matching compounds with optical sensors equipped with recessed lenses. They are liable to dirty the detector and impair its performance. They may also alter the property of depiction of your optical device, thus rendering your measurements inaccurate.

Cleaning the housing and the mainframe

When cleaning either the mainframe or the housing of your instrument, only use a dry and very soft cotton tissue on the surfaces and the numeric pad.

Never open the instruments as they can be damaged. Opening the instruments puts you in danger of receiving an electrical shock from your device, and renders your warranty void.

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