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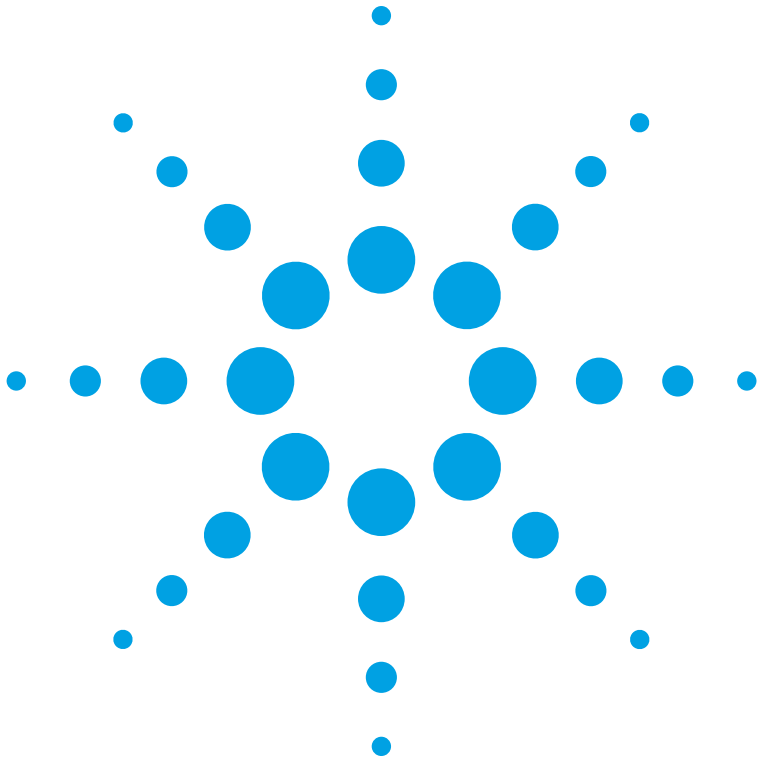
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Agilent 81591B , 81594B , 81595B
Optical Switches
User's Guide



Agilent Technologies

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Warnings and Notices

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

WARNING **Under no circumstances look into the end of an optical output or an optical cable attached to the optical outputs of the device when a connected laser source is operational. The laser radiation can seriously damage your eyesight.**

WARNING **Read and understand the Laser safety information of any Laser source which is connected to the optical switch.**

WARNING **Refer servicing only to qualified and authorized personnel.**

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Japan:	0120 421 345 0120 421 678 (FAX)
Latin America	+55 11 4197 3600 +55 11 4197 3800 (FAX)
Australia:	1 800 629 485 1 800 142 134 (FAX)
Asia-Pacific:	(852) 3197 7889 (852) 2506 9233 (FAX)

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1
Getting Started

This chapter contains an introductory description of the modules and aims to make the modules familair to you.

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Introduction

The optical switch module allows you to fully automate your signal routing during tests. By operating the switch you can change the optical routes during a test without having to disconnect and reconnect fibers, this can greatly reduce the test duration and helps to reduce contamination of fibers and connectors. This means for instance, that you can select one of several sources, you can select one of several measurement instruments, you can switch between devices being tested, or quickly change from a calibration path to a measurement path.

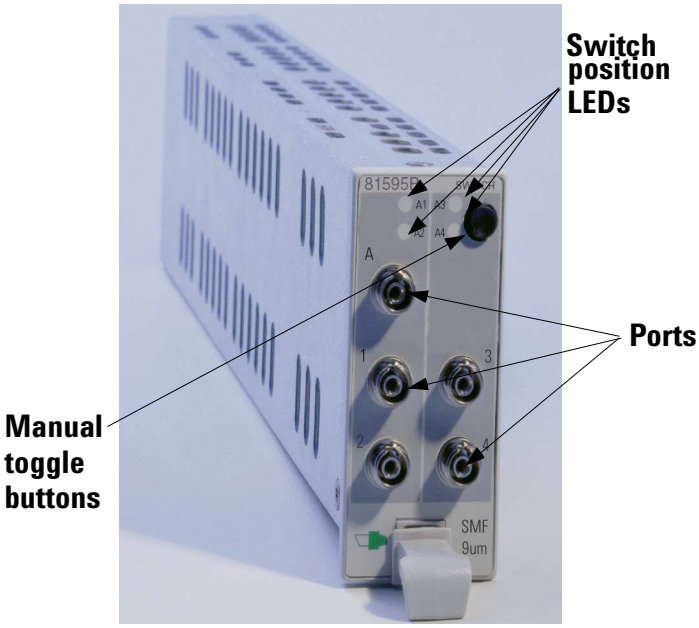


Figure 1 Front View of Switch Module

There are 3 different switch types (1x2, 2x2 and 1x4) available and each of these are supplied in versions for either single mode with angled FC/APC - R (narrow keying) connectors or multimode with straight FC/PC connectors. For all switch modules the signal paths are bi-directional.

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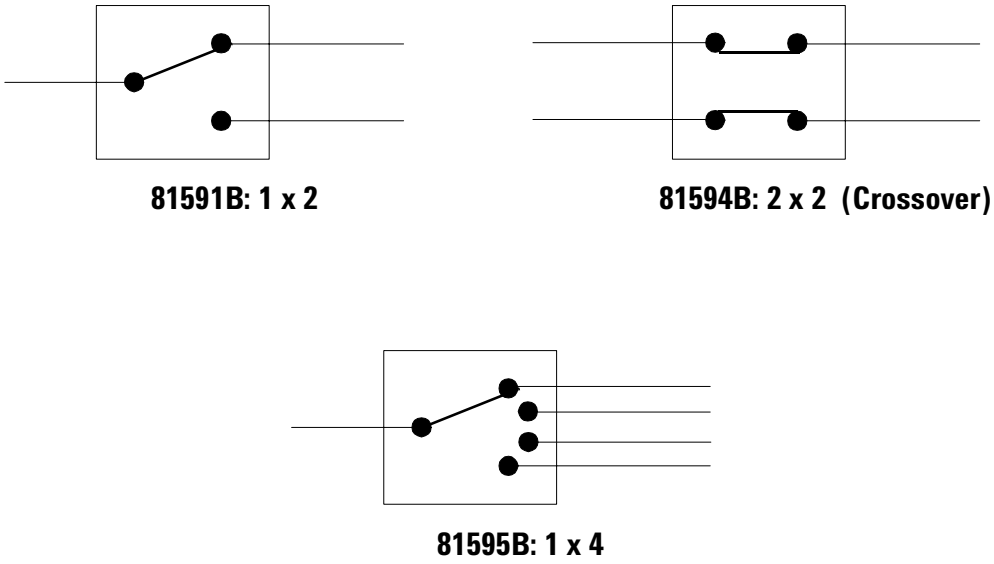


Figure 2 Switch Module Configurations

How to Toggle the Switch Path

You can use [Toggle] softkey in the mainframe User Interface, or the *Toggle* button located on the Optical Switch module front panel, to select each of the available routes for a channel in turn.

NOTE

The route selected between port A and another numbered port is indicated in the user interface and by two lit green LEDs on the front panel of the Optical Switch module.

The route selected between port B, if present, and another numbered port is indicated in the user interface and by two lit amber LEDs on the front panel of the Optical Switch module.

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Typical Applications

The following section shows just a few of the possibilities available for use of the switch modules to achieve better test automation, and test repeatability.

1 x 2 Switch

Select one of two different sources (different wavelengths) as the input to the DUT.

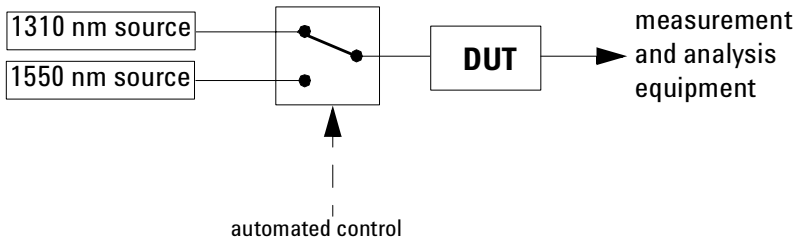


Figure 3 Laser source selection

Select different measurement and analysis paths. In the following diagram the switch is used to select between the measurement path and the calibration path.

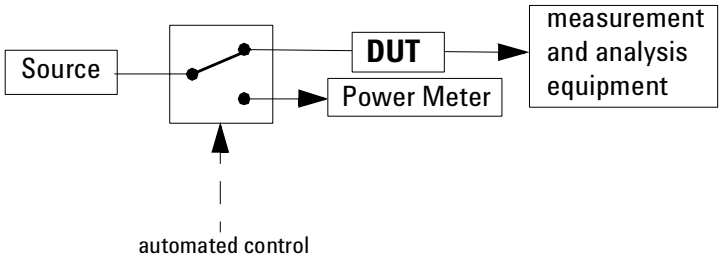


Figure 4 Measurement path selection

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2 x 2 Switch

Select an optional optical path, in the case shown here it is a fiber spool.

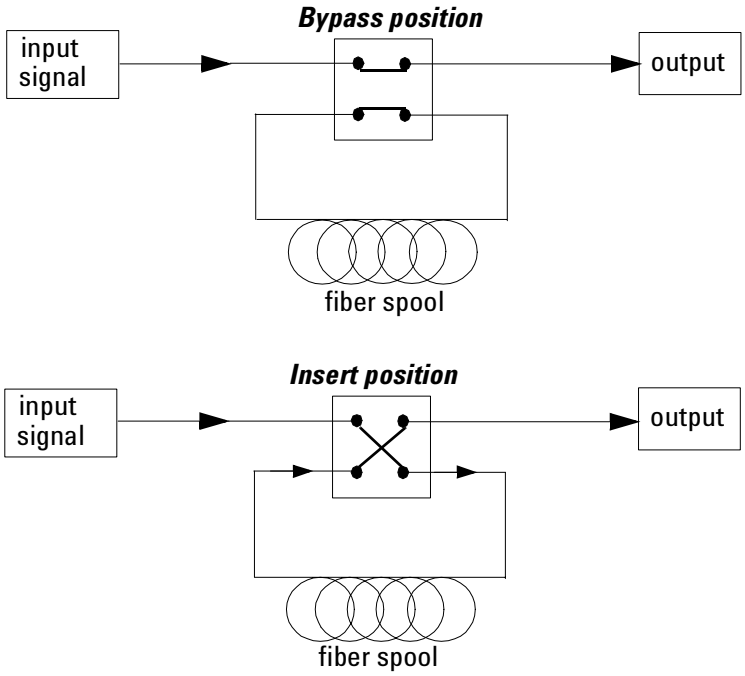


Figure 5 Circuit selection with crossover switch
(for example in dispersion penalty test setup)

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1 x 4 Switch

Select one from several test objects in parallel test setups, as shown in the following diagram.

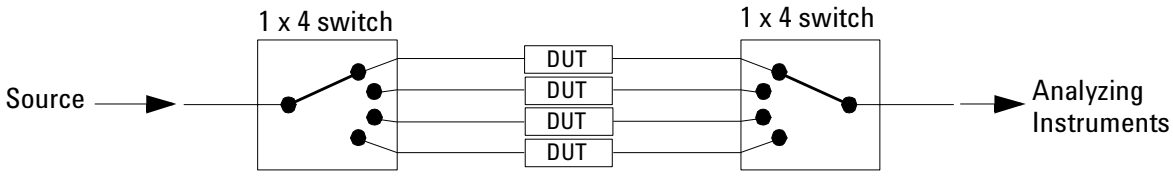


Figure 6 Selection of one from several DUTs in parallel test setups

Alternatively this switch can be used to automatically select one from up to four different analyzing instruments. Once again there are advantages to be gained through the speed in changing the test setup, and the repeatability of measurements.

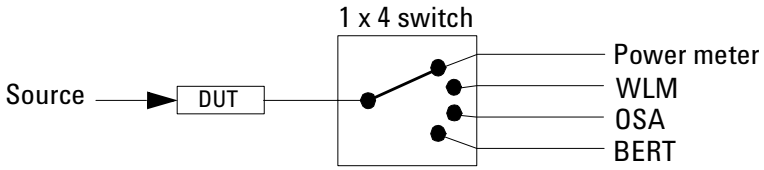


Figure 7 Selection of one from several analyzing instruments

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2
Accessories

The Agilent 81591B, 81594B and 81595B optical switch modules are available in option addressing single mode and multimode applications.

This chapter provides information on the available options.

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Modules and Options

Figure 8 shows all the options that are available for all optical switch modules and the instruments that support these modules.

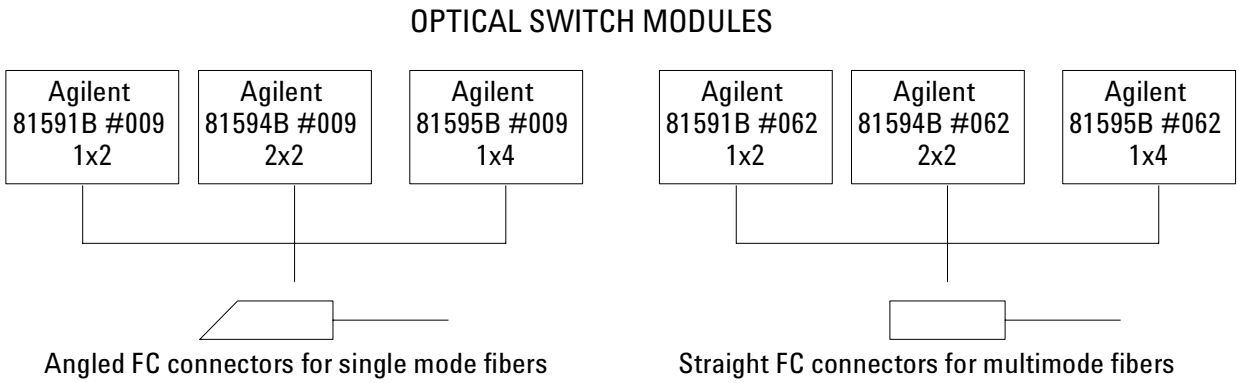


Figure 8 Optical Switch Modules and Options

Modules

The Optical Switch modules are available in the types shown in the table below.

Table 1 Optical Switch Modules

Optical Switch Modules	
Model Number	**Description**
Agilent 81591B	Optical Switch 1 x 2
Agilent 81594B	Optical Switch 2 x 2 (crossover)
Agilent 81595B	Optical Switch 1 x 4

Options

The following options are available with the optical switch modules.

Option 009 For the 8159xB modules, the optical switch comes with fixed FC/APC - R (narrow key) angled connectors for single mode optical fiber interface.

Option 062 For the 8159xB modules, the optical switch comes with fixed FC/PC straight connectors for multimode optical fiber interfaces.

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3
Specifications

Agilent 81591B, 81594B, 81595B optical switch modules are produced to the ISO 9001 international quality system standard as part of Agilent's commitment to continually increasing customer satisfaction through improved quality control.

Specifications describe the modules warranted performance. Supplementary performance characteristics describe the modules non-warranted typical performance.

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

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Definition of Terms

This section defines terms that are used both in this chapter and in "Performance Tests" on page 23.

Specification: describes a guaranteed product performance that is valid under the specified conditions. (The confidence level used is 95%, as recommended by the ISO standard).

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

Actuation Cycle

A consecutive transition through all switch-states.

Crosstalk

The maximum ratio between the power on a non-selected output port and the incident power on any input port, expressed in dB.

The cross talk x_i for any output port i is calculated from:

$$x_i\,[\mathrm{dB}] \quad = \quad \mathrm{MAX}\{P_i\,[\mathrm{dBm}] - P_a\,[\mathrm{dBm}]\}$$

where:

P_a = power measured at the end of the two patch cords (see drawing)

P_j = power measured at the switch output port.

MAX{} is the maximum value over all non-transmitting switch positions and all input ports.

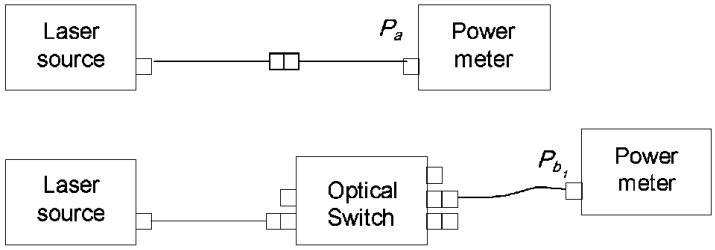


Figure 9 Crosstalk measurement Setup

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Insertion loss (IL)

The change of power level after inserting the optical switch set to transmission between two connectorized patchcords, expressed in dB. The insertion loss from input port i to output port j is calculated from:

$$\mathrm{IL}_{i,j}[\mathrm{dB}] = P_a[\mathrm{dBm}] - P_{i,j}[\mathrm{dBm}]$$

where:

P_a = ower measured at the end of the two connected patch cords (see drawing).

$P_{bi,j}$ = power measured at the switch output port j.

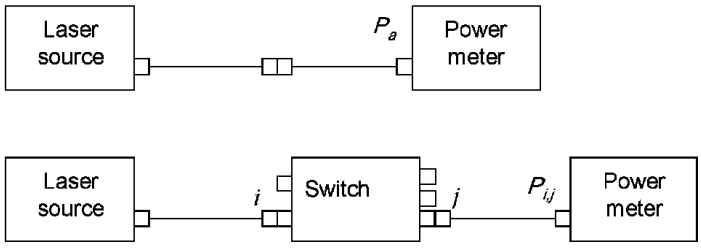


Figure 10 Insertion Loss Test Setup

Conditions: Wavelength as specified. Using patchcords with high quality connectors in perfect optical condition.

NOTE Insertion loss includes the loss of one additional connection.

Maximum Input power

The input power level for which the specifications apply and that can be applied to the optical switch without permanent change of its characteristics.

CAUTION Applying more than the specified maximum input power may damage the device!

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Operating Temperature

TThe range of ambient temperatures for which the specifications apply.

NOTE

For a device mounted in a rack the environmental conditions within the rack apply.

Polarization dependent loss (PDL)

The dependence of the Insertion loss (IL) on the input polarization state, expressed as the difference (in dB) between the lowest and highest insertion loss (peak-to-peak).

Reference Connector

Connector with perfect optical quality. Depending on the option, straight or angled FC.

Repeatability

The uncertainty in reproducing the Insertion loss (IL) after repeated Actuation Cycle. The repeatability is ± half the span between the maximum and the minimum values, expressed in dB.

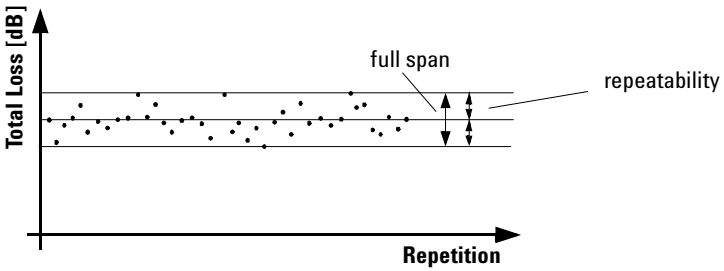


Figure 11 Repeatability

Conditions: Number of repetitions as specified. Uninterrupted line voltage, constant temperature, constant humidity, constant wavelength, constant input power level, and constant polarization state.

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Return loss

Minimum ratio between incident power and reflected power over all switch states, expressed in dB. The return loss RL for any input port is calculated from:

$$RL\left[\mathrm{dB}\right] = \mathrm{MIN}_{\mathrm{s}}\left\{P_{\mathrm{inc}}\left[\mathrm{dBm}\right] - P_{\mathrm{ref}}\left[\mathrm{dBm}\right]\right\}$$

Where Pinc is the incident power, P,ref is the reflected power and MINs{} is the minimum over all switch states.

Conditions: Termination patchcords with high quality connectors connected to the output ports. All optical connectors in perfect optical condition.

Switching Time

Maximum time needed to stabilize the optical output power when switching. This is applicable for all input-output combinations and for risetime and falltime, as described in the figure below.

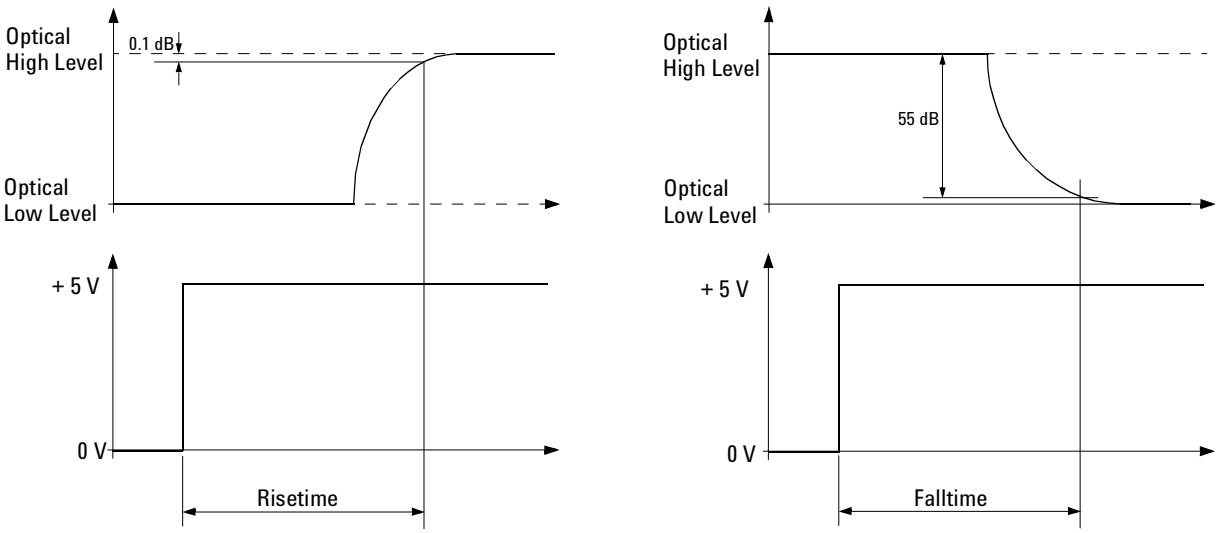


Figure 12 Switching Time

NOTE Switching time excludes the time needed for the interpretation of the command and for the internal communication between the mainframe and the optical switch module.

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Wavelength range

Specifies the wavelength range for which the specifications apply (if not differently stated).

Literature

[1] ***Fiber optic test and measurement***, Hewlett Packard Professional Books, edited by Prentice Hall,
ISBN 0-13-534330-5

[2] ***GR -1073-CORE***, Generic Requirements for Single Mode Fiber Optic Switches
(Issue 1, January 2001, Telcordia Technologies)

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Specifications

Table 2 Optical Switch Module Specifications

Product Number	81591B		81594B		81595B	
Switch type	1 x 2		2 x 2		1 x 4	
Fiber interface	#009 single mode	#062 multimode	#009 single mode	#062 multimode	#009 single mode	#062 multimode
Fiber Type	9/125 µm SMF	62.5/125 µm MMF	9/125 µm SMF	62.5/125 µm MMF	9/125 µm SMF	62.5/125 µm MMF
Connectivity	FC/APC - R angled	FC/PC straight	FC/APC - R angled	FC/PC straight	FC/APC - R angled	FC/PC straight
Wavelength range	1270 - 1670nm	700 -1400nm	1270 - 1670nm	700 -1400nm	1270 - 1670nm	700 -1400nm
Insertion loss (incl. connectors)	< 1.0 dB [3]	< 1.0 dB [1]	< 1.5 dB [3]	< 1.0 dB [1]	< 2.0 dB [4]	< 2.0 dB [1]
Polarization dependent loss	typ. 0.05 dB_{pp}	NA	typ. 0.05 dB_{pp}	NA	typ. 0.07 dB_{pp}	NA
Repeatability [2]	± 0.02 dB	± 0.02 dB [1]	± 0.02 dB	± 0.02 dB [1]	± 0.03 dB	± 0.03 dB [1]
Return loss	typ. 55 dB	typ. 20 dB	typ. 50 dB	typ. 20 dB	typ. 55 dB	typ. 20 dB
Crosstalk	typ. -70 dB	typ. -70 dB	typ. -70 dB	typ. -70 dB	typ. -70 dB	typ. -70 dB
Switching time	< 10 ms					
Lifetime	> 10 million cycles					
Maximum input power	+ 20 dBm					
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.9" x 1.3" x 13.2")					
Weight	0.5 kg					
Operating temperature	10°C - 45°C					
Storage temperature [5]	-40°C - 70°C					
Humidity	non-condensing					
Warm-up time	30 min.					

[1] Specification is typical with 50/125 µm multimode fiber

[2] Worst case measurement deviation over 10,000 random switching cycles

[3] For l = 1550 nm; for 1270 nm < l < 1670 nm add 0.3dB

[4] For l = 1550 nm; for 1270 nm < l < 1670 nm add 0.6dB

[5] Allow minimum acclimatization of 2 hours if previously stored outside operating temperature range before turning on the module

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Ordering Information:

Modules for single mode fiber interface: #009

Modules for multimode fiber interface: #062

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4
Performance Tests

The performance tests in this section test the optical performance of the Agilent 8159xB optical switches modules. The complete specifications to which the instrument is tested are given in “Specifications” on page 15.

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

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Required Test Equipment

The equipment required for the performance test is listed in Table 3. Any equipment that satisfies the critical specifications of the equipment given in Table 3 may be substituted for the recommended models.

Table 3 Equipment Required

Instrument/Accessory	Model	81591B #009	81594B #009	81595B #009	81591B #062	81594B #062	81595B #062	Required Characteristics	Alternative Models
Lightwave Multimeter	Agilent 8163A/B	2	2	2	2	2	2		1 ea 8164A/B
Laser Source Module FP	Agilent 81654A	1	1	1	-	-	-	1310 nm/1550 nm	81657A
Laser Source Module FP MM 850nm	Agilent 81655A #E01	-	-	-	1	1	1	850 nm, MM	
Interface Module	Agilent 81618A	1	1	1	1	1	1		81619A
Optical Head	Agilent 81624B	1	1	1	-	-	-		81626B
Optical Head, 850nm MM	Agilent 81623B #C01	-	-	-	1	1	1	Optical Head Standard, Ge	
Single Mode Fiber	Diamond 117-183-003L002	1	1	1	-	-	-	FC/SPC to FC/APC-R	
Single Mode Fiber	Diamond 183-183-003L002	1	1	1	-	-	-	FC/APC - R to FC/APC - R	
Mode Conditioner	(1)	-	-	-	1	1	1		
Mode stripping fiber, 62.5 µm	81578-63203 (2)	-	-	-	1	1	1		
Connector interface	81000AI	-	-	-	1	1	1		
Connector interface	81000FI	1	1	1	2	2	2		
Connector adapter	81001FA	1	1	1	1	1	1		
Connector adapter	81001AA	-	-	-	1	1	1		
Adapter, feedthrough, FC	1005-0256	1	1	1	-	-	-		DIAMOND 110-301-903V001
HMS10 Universal adapter	81000UM	-	-	-	1	1	1		

1. Diamond AMCB-180-00V062

2. Service tool. For use in Agilent Technologies Service Center only. Buffered Reference Fiber 62.5µm

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Legend:

1,2,3	necessary quantity
-	not applicable
o	optional
APC	angled physical contact
SPC	straight physical connector
FC/xPC-R	FC/xPC connector with R-type narrow keying
FC/xPC	FC/xPC connector

Test Record

Results of the performance test may be tabulated on 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 executing 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 procedure). 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 8159xB Modular Optical Switch 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 “Optical Switch Module Specifications” on page 21 are the performance standards or limits against which the Agilent 8159xB can be tested.

Any changes in the specification 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.

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Performance Test Procedures

The performance tests given in this section includes the Repeatability Test. Perform each step in the order given, using the corresponding test equipment.

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 35.

Make sure that all optical cables of the test setup are fixed to the table so that they cannot 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.

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Insertion Loss Test

Carry out the following Insertion Loss Test for 8159xB #009 at 1310 nm and 1550 nm, and for 8159xB #062 at 850nm and 1310nm using the equipment listed in Table 3 on page 24. To adapt for the straight or angled contact versions of the optical switch use patch cords with appropriate connectors and suitable connector interfaces.

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

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

3 On the laser source, select the first wavelength as listed in the Test Record.
From the 8163A/B menu, set the laser source to Coherence Ctrl ON.

4 Connect the equipment as shown in Figure 13.

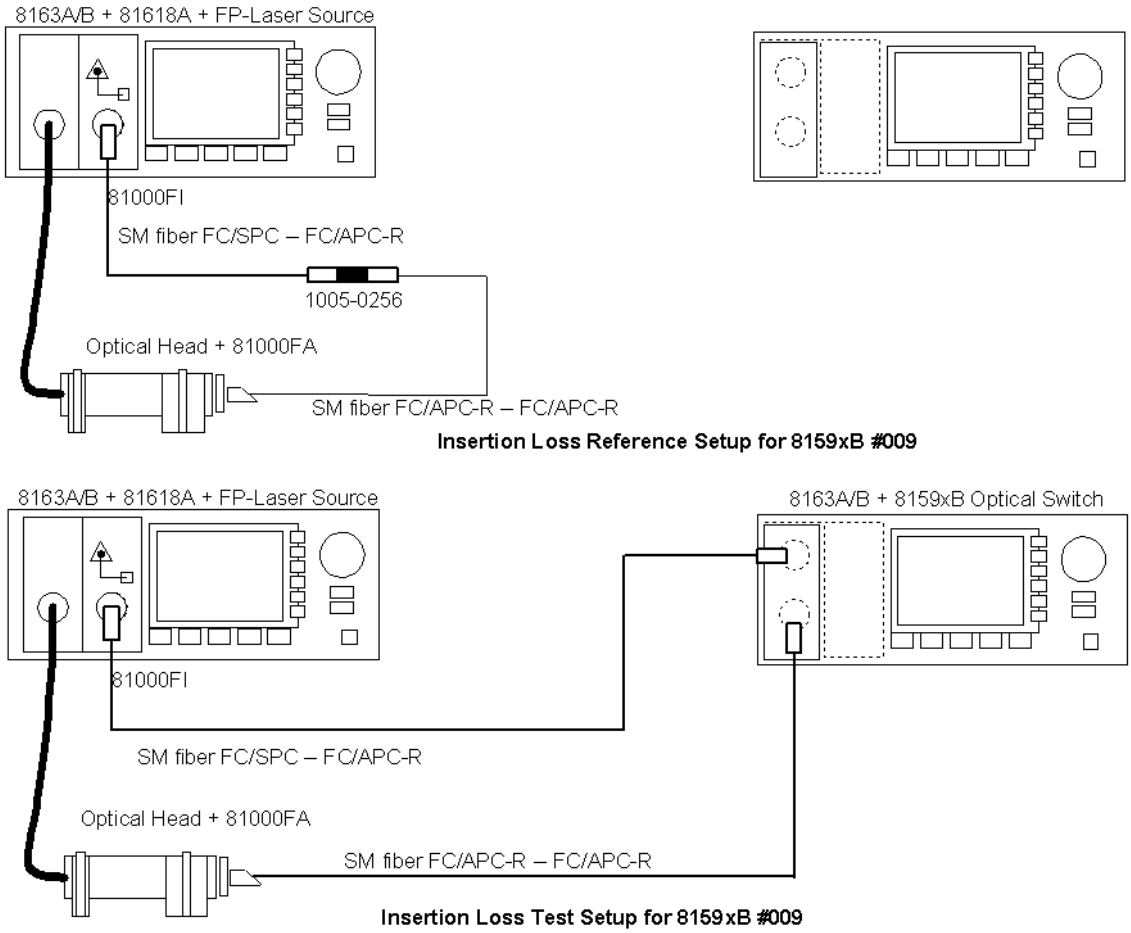


Figure 13 Insertion Loss Reference Setup

5 Set the power meter to the actual wavelength of the laser source.

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

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Insertion Loss Measurement

7 Set the power meter averaging time to 200ms

8 Enable the laser source and set <Display to Reference> on the power meter

9 Connect the equipment as shown in Figure 14. For 81594B, connect the laser source to input A, first.

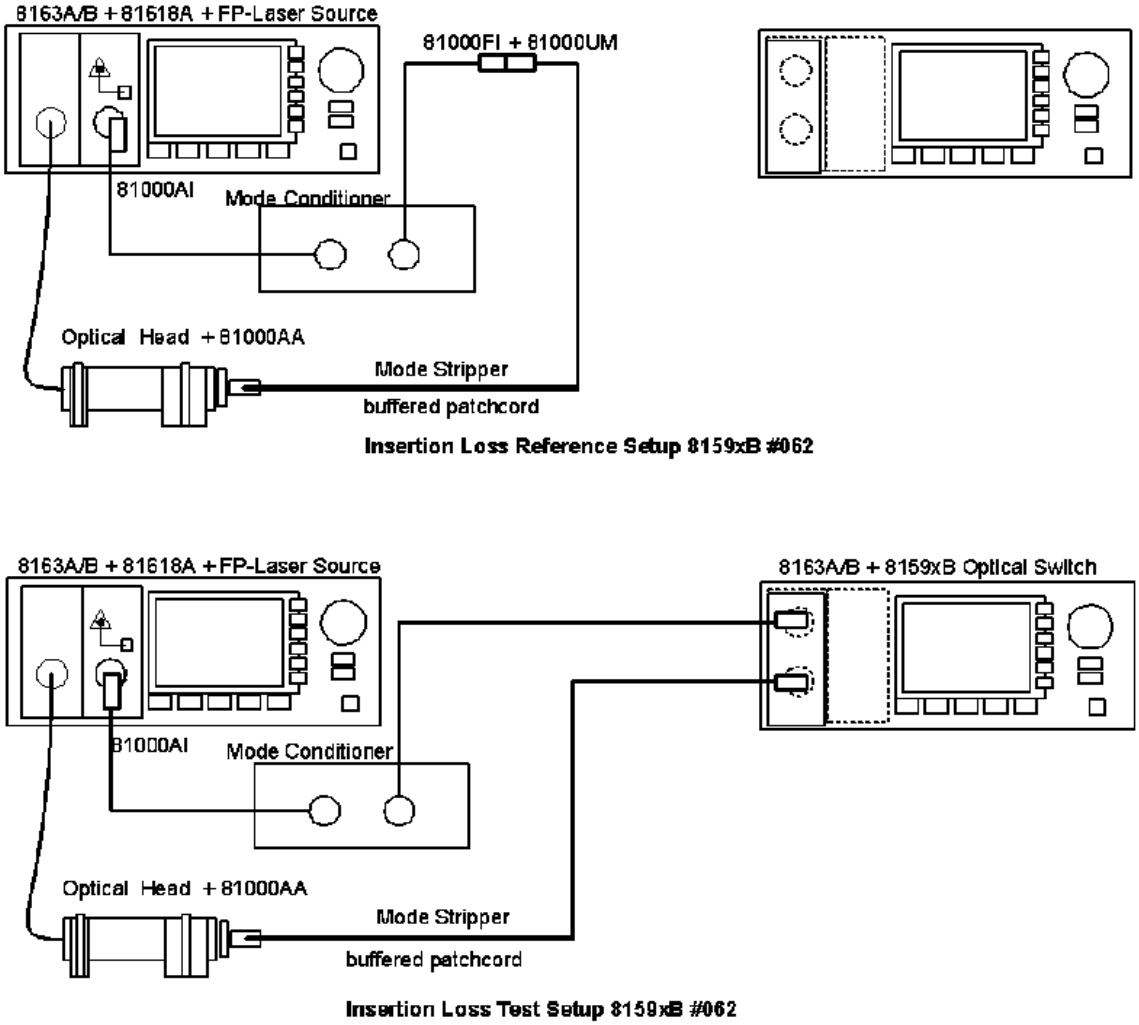


Figure 14 Insertion Loss Test Setup

10 Select the switch port which is connected to the power meter.

11 Note the power meter reading (in dB) as Insertion Loss in the Test Record.

12 Repeat step 10 to step 11 for the other switch output ports.

13 With 81594B, connect the laser source to input B, then measure both output ports as listed in step 9 to step 10

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NOTE This test should be completed within 15 minutes because of stability and drift reasons. Else a new reference measurement has to be performed.

14 On the laser source, select the second wavelength as listed in the Test Record

15 Repeat step 4 to step 11

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Repeatability Test

Carry out the following Repeatability Test for 8159xB #009 at 1550 nm, and for 8159xB #062 at 850nm using the equipment listed in Table 3 on page 24.

1. Use the same equipment and test set up as used in Figure 14 on page 28.
2. Turn the instruments on and allow the devices to warm up (30 min).
3. Make sure that all your connectors are clean and undamaged.
4. Set the laser source to the wavelength given in the Test Record. Set the power meter to the same wavelength as the laser source.
5. Disable the laser source, zero the power meter and select Autorange. Display [dB].
6. Select the switch port which is connected to the power meter and enable the laser source.
7. Set Display to Reference on the power meter.
8. Cycle the switch away and back to the connected port.
9. Note the power meter reading in the Test Record.
10. Repeat step 8 and step 9 ten times.

NOTE IThe step 7 to step 10 should be completed within 15 minutes because of stability and drift reasons. Else a new reference measurement has to be performed.

11. Repeat the Test with step 7 to step 10 for the other switch ports.
12. With 81954B, connect the laser source to input B, then measure both output ports as listed in step 7 to step 11.

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Test Record

Agilent Modular Optical Switch Performance Test Page 1 of 4

Test Facility:

	Report No.:		
	Date:		
	Customer:		
	Tested By:		
Model: Agilent Modular Optical Switch	Product Number:	#	
Serial No.	Ambient temperature	°C	
Firmware Rev.	Relative humidity	%	
	Line frequency	Hz	

Special Notes:

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Agilent Modular Optical Switch Performance Test Page 2 of 4

Agilent Modular Optical Switch Report No. Date:

Test Equipment

#	Description	Model No.	Trace No.	Cal. due date
1	Mainframe			N/A
2	Power Meter			/ /
3	Laser Source			/ /
4	Mode Conditioner			N/A
5	Mode Stripping Fiber			N/A
6				/ /
7				/ /
8				/ /
9				/ /
10				/ /
11				/ /
12				/ /
13				/ /
14				/ /
15				/ /
16				/ /
17				/ /
18				/ /
19				/ /
20				/ /

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Agilent Modular Optical Switch Performance Test

Agilent Modular Optical Switch Report No. _____ Date _____

Insertion Loss Test

Product	81591B #009		81594B #009		81595B #009	
Wavelength	1310 nm	1550 nm	1310 nm	1550 nm	1310 nm	1550 nm
Measurement	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Upper Test Limit	1.3 dB	1.0 dB	1.8 dB	1.5 dB	2.6 dB	2.0 dB

Product	81591B #062		81594B #062		81595B #062	
Wavelength	850 nm	1310 nm	850 nm	1310 nm	850 nm	1310 nm
Measurement	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Upper Test Limit	1.0 dB	1.0 dB	1.0 dB	1.0 dB	2.0 dB	2.0 dB

Repeatability test

Product	81591B #009	81591B #062
Wavelength	1550 nm	850 nm
Cycle 1 Deviation	_____ dB	_____ dB
Cycle 2 Deviation	_____ dB	_____ dB
Cycle 3 Deviation	_____ dB	_____ dB
Cycle 4 Deviation	_____ dB	_____ dB
Cycle 5 Deviation	_____ dB	_____ dB
Cycle 6 Deviation	_____ dB	_____ dB
Cycle 7 Deviation	_____ dB	_____ dB
Cycle 8 Deviation	_____ dB	_____ dB
Cycle 9 Deviation	_____ dB	_____ dB
Cycle 10 Deviation	_____ dB	_____ dB
Upper Test Limit	+ 0.02 dB	+ 0.02 dB
Lower Test Limit	- 0.02 dB	- 0.02 dB

Product	81594B #009				81594B #062			
Wavelength	1550 nm				850 nm			
Ports	A => 1	A => 2	B => 1	B => 2	A => 1	A => 2	B => 1	B => 2
Cycle 1 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 2 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 3 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 4 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 5 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 6 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 7 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 8 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 9 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 10 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Upper Test Limit	+ 0.02 dB				+ 0.02 dB			
Lower Test Limit	- 0.02 dB				- 0.02 dB			

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Agilent Modular Optical Switch Performance Test

Agilent Modular Optical Switch Report No. _____ Date _____

Product	81595B #009				81595B #062			
Wavelength	1550 nm				850 nm			
Ports	A => 1	A => 2	A => 3	A => 4	A => 1	A => 2	A => 3	A => 4
Cycle 1 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 2 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 3 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 4 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 5 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 6 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 7 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 8 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 9 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Cycle 10 Deviation	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB	_____ dB
Upper Test Limit	+ 0.03 dB				+ 0.03 dB			
Lower Test Limit	- 0.03 dB				- 0.03 dB			

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5
Cleaning Information

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Cleaning Instructions

The following Cleaning Instructions contain 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.

Cleaning Instructions for this Module The Cleaning Instructions apply to a number of different types of Optical Equipment. If you must clean the Agilent 8159xB Optical Switch Modules, please refer the module to the skilled personnel of Agilent's service team.

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.

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Why is it important to clean optical devices ?

In transmission links optical fiber cores are about 9 µm (0.00035") in diameter. Dust and other particles, however, can range from tenths to hundredths of microns in diameter. Their comparative size means that they can cover a part of the end of a fiber core, and as a result 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 section, 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.

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What 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 protected coverings should be kept on the equipment at all times, except when your optical device is in use. Be careful when replacing dust caps after use. Do not press the bottom of the cap onto the fiber too hard, as any dust in the cap can scratch or pollute your fiber surface.

If you need further dust caps, please contact your nearest Agilent Technologies sales office.

Isopropyl alcohol

This solvent is usually available from any local pharmaceutical supplier or chemist's shop.

If you use isopropyl alcohol to clean your optical device, do not immediately dry the surface with compressed air (except when you are cleaning very sensitive optical devices). This is because the dust and the dirt is solved and will leave behind filmy deposits after the alcohol is evaporated. You should therefore first remove the alcohol and the dust with a soft tissue, and then use compressed air to blow away any remaining filaments.

If possible avoid using denatured alcohol containing additives. Instead, apply alcohol used for medical purposes.

Never try to drink this alcohol, as it may seriously damage your health.

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Do not use any other solvents, as some may damage plastic materials and cladding. 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.

There are many different kinds of pipe cleaner available from tobacco shops.

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.

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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.

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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 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 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 this card you are able to control the shape of laser light emitted. The invisible laser beam is projected onto the sensor card, then becomes visible to the normal eye as a round spot.

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.

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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.

Keep the caps on the equipment always 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

Where it is 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 voided.

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Which Cleaning Procedure should I use ?

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. Please consult “Cleaning Instructions for this Module” on page 36 for the procedure relevant for this instrument.

If you are unsure of how sensitive your device is to cleaning, please contact the manufacturer or your sales distributor

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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 the surface. To be certain of the condition of the surface of your connector and to check it after cleaning, you need a microscope.

In the case of scratches, or of dust that has been burnt onto the surface of the connector, you may have no option but to polish the connector. This depends on the degree of dirtiness, or the depth of the scratches. This is a difficult procedure and should only be performed by skilled personal, and as a last resort as it wears out your connector.

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 project onto the card and becomes visible as a small circular spot.

Preferred Procedure

Use the following procedure on most occasions.

1. Clean the connector by rubbing a new, dry cotton-swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly 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.

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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 by pushing and pulling a new, dry pipe-cleaner into the opening. Rotate the pipe-cleaner slowly as you do this.
2. Then clean the interface by rubbing a new, dry cotton-swab over the surface using a small circular movement.
3. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the interface:

1. Moisten a new pipe-cleaner with isopropyl alcohol.
2. Clean the interface by pushing and pulling the pipe-cleaner into the opening. Rotate the pipe-cleaner slowly as you do this.
3. Moisten a new cotton-swab with isopropyl alcohol.
4. Clean the interface by rubbing the cotton-swab over the surface using a small circular movement.
5. Using a new, dry pipe-cleaner, and a new, dry cotton-swab remove the alcohol, any dissolved sediment and dust.
6. Blow away any remaining lint with compressed air.

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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.

They can 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 particularly 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.

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.

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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 be misaligned.

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Additional Cleaning Information

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

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.

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Other Cleaning Hints

Selecting the correct cleaning method is an important element in maintaining your equipment and saving you time and money. This Appendix 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 appropriate the cleaning methods.

When you insert the ferrule of a patch cord 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

Note that 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

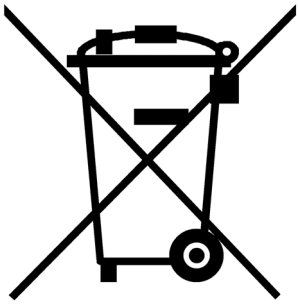
Do not use immersion oil or other index matching compounds with optical sensors equipped with recessed lenses. They are liable to dirty the detector and impair its performance. They may also alter the property of depiction of your optical device, thus rendering your measurements inaccurate.

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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Environmental Information

This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/ electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a "Monitoring and Control instrumentation" product.

Do not dispose in domestic household waste.

To return unwanted products, contact your local Agilent office, or see www.agilent.com/environment/product/ for more information.

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