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Keysight 81650A/1A/4A/5A/6A/7A Laser Source Modules

KEYSIGHT TECHNOLOGIES

User's Guide

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NOTICE: This document contains references to Agilent Technologies. Agilent's former Test and Measurement business has become Keysight Technologies. For more information, go to **www.keysight.com.**

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

WARNING

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

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

http://www.keysight.com/find/lightwave

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

United States:	1 800 829 4444 1 800 829 4433 (FAX)
Canada:	1 877 894 4414 1 800 746 4866(FAX)
Europe:	+31 20 547 2111 +31 20 547 2190 (FAX)
Japan:	120 421 345 120 421 678 (FAX)
Mexico	(52 55) 5081 9469 (52 55) 5081 9467 (FAX)
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1
Getting Started with Laser Source Modules

This chapter introduces the features of the Keysight 8165xA Fabry-Perot laser source modules.

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Safety Considerations

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

Before operation, review the instrument and manual, including the 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.**

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 Keysight 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.).**

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WARNING **You *MUST* return instruments with malfunctioning laser modules to a Keysight Technologies Service Center for repair and calibration.**

Line Power Requirements

The Keysight 81650A/1A/2A/4A/5A/6A/7A Laser Source Modules operate when installed in the 8163A/B Lightwave Multimeter, 8164A/B Lightwave Measurement System, and 8166A/B Lightwave Multichannel System.

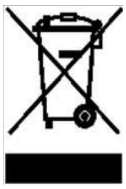
Operating Environment

The safety information in the 8163A/B Lightwave Multimeter, 8164A/B Lightwave Measurement System, and 8166A/B Lightwave Multichannel System User's Guide summarizes the operating ranges for the 81650A/1A/2A/4A/5A/6A/7A Laser Source Modules. In order for these modules to meet specifications, the operating environment must be within the limits specified for the 8163A/B, 8164A/B, and 8166A/B.

Storage and Shipment

This module 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.

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 Keysight office, or see
http://about.keysight.com/en/companyinfo/environment/takeback.shtml
for more information.

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Initial Safety Information for Laser Source Modules

The laser sources specified by this user guide are classified according to IEC 60825-1 (2007)

The laser sources comply with 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50, dated 2007-June-24

Table 1 Standard Laser Source Modules Laser Safety Information

	Keysight 81650A	**Keysight 81651A**	**Keysight 81654A**
Laser type	FP-Laser InGaAsP	FP-Laser InGaAsP	FP-Laser InGaAsP
Wavelength (±15nm)	1310 nm	1550 nm	1310/1550 nm
Max. CW output power*	<1.8 mW	<1.8 mW	<1.8 mW
Beam waist diameter	9 µm	9 µm	9 µm
Numerical aperture	0.1	0.1	0.1
Laser Class according to IEC 60825-1 (2007)	1	1	1
Max. permissible CW output power	15.6 mW	10 mW	15.6 mW/10 mW
* *Max. CW output power* is defined as the highest possible optical power that the laser source can produce at its output connector.			

Table 2 High Power Laser Source Modules Laser Safety Information

	Keysight 81655A	**Keysight 81656A**	**Keysight 81657A**
Laser Type	FP-Laser InGaAsP	FP-Laser InGaAsP	FP-Laser InGaAsP
Wavelength (±15nm)	1310 nm	1550 nm	1310/1550 nm
Max. CW output power*	<28 mW	<28 mW	<28 mW
Beam waist diameter	9 µm	9 µm	9 µm
Numerical aperture	0.1	0.1	0.1
Laser Class according to IEC 60825-1 (2007)	1M	1M	1M
Max. permissible CW output power	52 mW	163 mW	52 mW/163 mW
* *Max. CW output power* is defined as the highest possible optical power that the laser source can produce at its output connector.			

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Laser Safety Labels

Laser class 1M label



Figure 1 Class 1M Safety Label - Keysight 81655A/6A/7A

A sheet of laser safety labels is included with the laser module as required. In order to meet the requirements of IEC 60825-1 we recommend that you stick the laser safety labels, in your language, onto a suitable location on the outside of the instrument where they are clearly visible to anyone using the instrument

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What is a Laser Source Module ?

A laser source module is a laser source that emits radiation at a specific optical wavelength. The specific range of fixed wavelength for each of the Keysight Technologies laser source modules can be found in the Specifications chapter of the relevant module's User's Guide.

A Description of the Front Panel

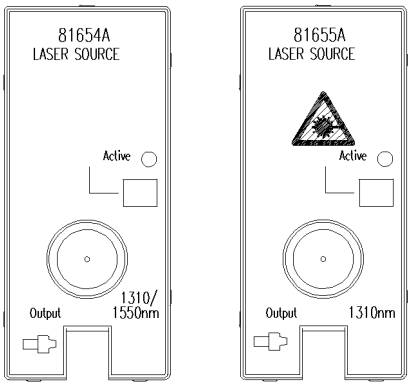


Figure 2 Front Panel of Low Power and High Power Laser Source Modules

To insert these modules into your mainframe see your mainframe's User's Guide.

How to Enable/Disable Laser Output

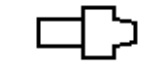
This indicates whether the module is emitting radiation. If the State parameter is On, the green LED on the front panel of the module is lit indicating the laser is active. If the State parameter is Off, green LED on the front panel of the module is unlit indicating the laser is inactive. You can switch the module by pressing the Active button on the front panel of the module.

Optical Output

Angled Contact Connectors

The Keysight Fabry-Perot laser sources are equipped with a straight contact optical output connector as standard.

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Straight Contact
Connector Symbol

Figure 3 Straight Contact Connector Symbols

Figure 3 shows the symbol for straight contact connectors.

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1 Getting Started with Laser Source Modules

What is a Laser Source Module ?

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2
Accessories

The Keysight 81650A/1A/2A/4A/5A/6A/7A Laser Source Modules are available in various configurations for the best possible match to the most common applications.

This chapter provides information on the available options and accessories.

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Modules and Options

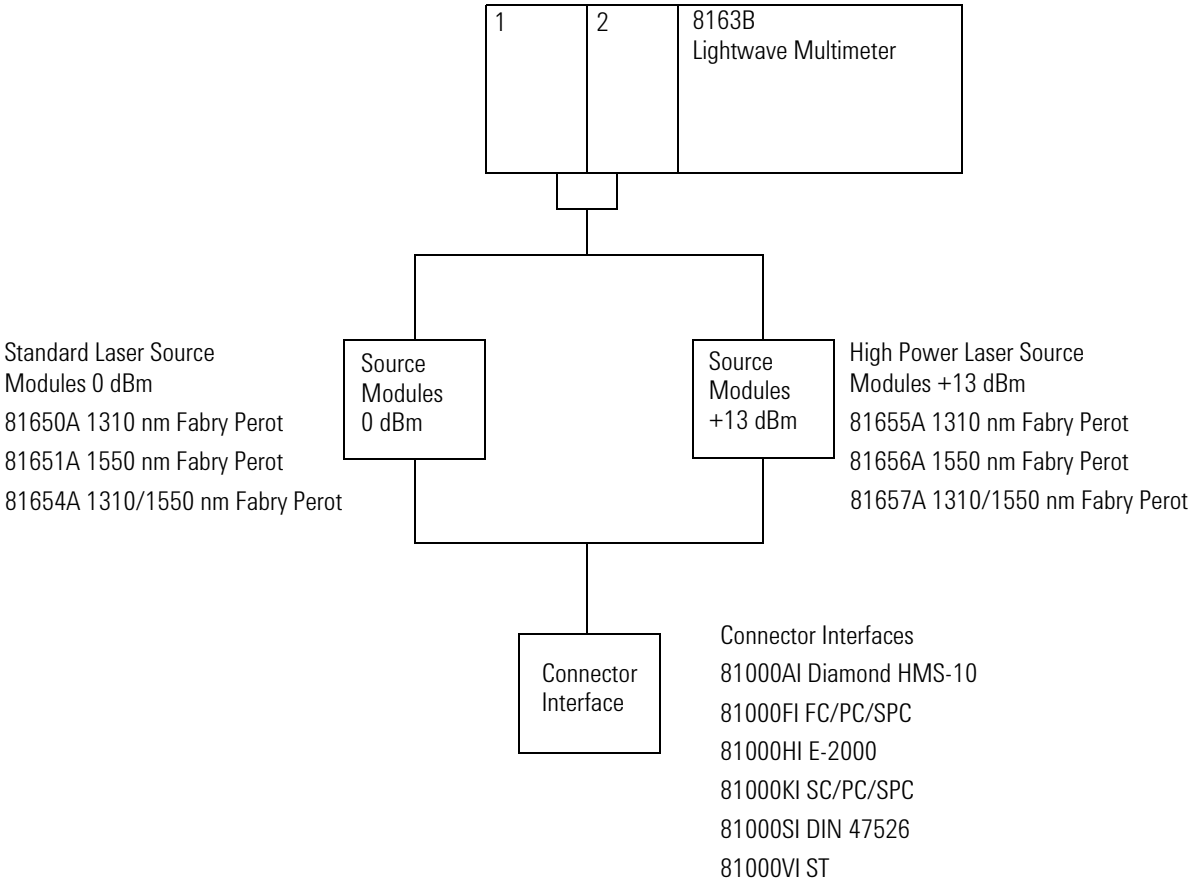


Figure 4 Recommended Connector Interfaces

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3
Specifications

The Keysight 81650A/1A/2A/4A/5A/6A/7A Laser Source Modules are produced to the ISO 9001 international quality system standard as part of Keysight Technologies's commitment to continually increasing customer satisfaction through improved quality control.

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

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

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Definition of Terms

This section defines terms that are used both in this chapter and *"Performance Tests" on page 25*.

Generally, all specifications apply for the given environmental conditions and after warmup time.

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

Center wavelength

The center wavelength is defined as the spectral center of gravity. For a Fabry-Perot type laser source with discrete longitudinal modes, this definition can be expressed as:

where:

$$\lambda_C = \frac{\sum P_i \lambda_i}{\sum P_i}$$

P_i=power levels of the individual longitudinal lines

λ_i=wavelengths of the individual longitudinal lines

Spectral width

The spectral width of an optical source is defined as the source's full-width half-maximum (FWHM) spectral width, $\Delta\lambda_{FWHM}$. For a non-continuous spectrum, e.g., the spectrum of a Fabry-Perot type laser diode, the spectral width is defined as the FWHM of the spectral envelope, to be calculated from the RMS spectral width, $\Delta\lambda_{RMS}$:

$$\Delta\lambda_{RMS} = \left(\frac{\Sigma P_i \lambda_i^2}{P_{total}} - \lambda_{center}^2 \right)^{1/2}$$

and

$$\Delta\lambda_{FWHM} = M \Delta\lambda_{RMS}$$

where: λ_{center}=center wavelength of laser diode in vacuum

$P_{total} = \Sigma P_i$ = total power, in watts

P_i=power of i th longitudinal mode

λ_i=wavelength of i th longitudinal mode, in vacuum

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M=multiplication factor; for a source with a gaussian envelope
M = 2.35; for other types of spectra, use M = 2.35 as well

Output power

The maximum output power at the specified center wavelength.

Conditions: Temperature within operating temperature range. Measurement with power meter at the end of specified patchcord.

CW power stability

The change of the power level during given time span, expressed as ± half the span of power changes relative to the mean power.

Conditions: uninterrupted line voltage, constant power level setting, operating temperature change not more than $\pm\Delta T$ as specified.

CW power stability due to backreflection

The change of the power level, expressed as ± half the span of power changes relative to the mean power caused by variable backreflection within given limits.

Conditions: uninterrupted line voltage, constant power level setting, CW operation, operating temperature change within specified limits, minimum return loss as pecified, all polarization states of backreflection included.

Measurement: The change of the output power is monitored while the source's susceptibility to backreflection is tested by disturbing the laser oscillation with power reflected back into the laser, P_{back}. The backreflection sensitivity depends on the absolute power level of P_{back} and on the polarization state of P_{back}.

At fixed power levels of P_{back}, backreflection sensitivity has its maximum when the states of polarization (SOP) of P_{back} and P_{in} (the source's output power) are identical. To achieve this condition a polarization controller generates all SOPs of P_{back}. Thus the measured CW stability is a worst case value with respect to the SOP. The test should be done at various power levels of P_{back} to address the fact that the CW

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stability is specified for a range of backreflectances. However, the highest backreflection is the most critical by experience.

NOTE

Power reflected back from the radiating fiber end in general creates instability in the laser cavity (mode jumps) resulting in output power instability. The ratio of the incident optical power P_{in} to the reflected optical power P_{back} of an optical component is called return loss, symbol *RL*:

$$RL = 10 \log \left(\frac{P_{in}}{P_{back}} \right)$$

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Laser Source Module Specifications

Laser Source Module Specifications (Standard modules, 0 dBm)

Specifications apply to the end of a 2-meter long fiber cable (as specified under fiber type). All specifications are valid for an attenuation setting of 0.0 dB.

All modules require straight output connectors.

Table 3 Standard Laser Source Module Specifications

	81650A	**81651A**	**81654A**
Laser Type	Fabry-Perot Laser Diode		
Center Wavelength [1]	1310 nm ±15 nm	1550 nm ±15 nm	1310/1550nm ±15 nm
Fiber Type	single-mode 9/125 µm		
Spectral width (rms) [1, 2]	< 3.5 nm	< 4.5 nm	< 3.5 / 4.5 nm
Output power	> 0 dBm (1 mW)		
CW power stability [3, 4] short term (15 min) long term (24 h) to backreflection (RL ≥ 14 dB)	 < ± 0.005 dB typ. < ± 0.003 dB with coherence control active typ. ± 0.03 dB typ. ± 0.003 dB		
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8" x 1.3" x 13.2")		
Weight	0.5 kg		
Recalibration Period	2 years		
Operating Temperature	0°C to +45°C		
Humidity	Non-condensing		
Warm-up time[3]	60 minutes		

1 Central wavelength is shown on display

2 rms: root mean square

3 Warm-up time 20 minutes, if previously stored at the same temperature

4 Constant temperature ΔT = ± 1°C

Supplementary Performance Characteristics

Internal digital modulation mode: 270 Hz, 330 Hz, 1 kHz, 2 kHz, and free selection 200 Hz to 10 kHz.

All outputs are pulse shaped, duty cycle 50%.

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Improved coherence control for linewidth broadening.

Output attenuation: The output power of all source modules can be attenuated from 0 dB to 6 dB in steps of 0.1 dB.

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Laser Source Module Specifications (High Power, 13 dBm)

Specifications apply to the end of a 2-meter long fiber cable (as specified under fiber type). All specifications are valid for an attenuation setting of 0.0 dB.

All modules require straight output connectors.

Table 4 High Power Laser Source Module Specifications

	Keysight 81655A	Keysight 81656A	Keysight 81657A
Laser Type	Fabry-Perot Laser Diode		
Center Wavelength [1]	1310 nm ± 15 nm	1550 nm ± 15 nm	1310/1550nm ± 15 nm
Fiber Type	single-mode 9/125 µm		
Spectral width (rms) [1, 2]	< 5.5 nm	< 7.5 nm	< 5.5 / 7.5 nm
Output power	> +13 dBm (20 mW)		
CW power stability [3, 4] short term (15 min) long term (24 h) to backreflection (RL ≥ 14 dB)	 < ± 0.005 dB typ. < ± 0.003 dB with coherence control active typ. ± 0.03 dB typ. ± 0.003 dB		
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8" x 1.3" x 13.2")		
Weight	0.5 kg		
Recalibration Period	2 years		
Operating Temperature	0°C to +45°C		
Humidity	Non-condensing		
Warm-up time [3]	60 minutes		

1 Central wavelength is shown on display

2 rms: root mean square

3 Warm-up time 20 minutes, if previously stored at the same temperature

4 Constant temperature $\Delta T = \pm 1°C$

Supplementary Performance Characteristics

Internal digital modulation mode: 270 Hz, 330 Hz, 1 kHz, 2 kHz, and free selection 200 Hz to 10 kHz.

All outputs are pulse shaped, duty cycle 50%.

Internal coherence control for linewidth broadening.

Output attenuation: The output power of all source modules can be attenuated from 0 dB to 6 dB in steps of 0.1 dB.

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4
Performance Tests

The procedures in this section test the optical performance of the instrument. The complete specifications to which the Keysight 81650A/1A/4A/5A/6A/7A Laser Source module is tested are given in *"Performance Tests" on page 25*. All tests can be performed without access to the interior of the instrument.

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Equipment Required

Equipment required for the performance test is listed below.

Table 5 Required Equipment

Instrument/Accessory	Recommended Model	81650A – 81657A	Required Characteristics	Alternative Models
Multimeter Mainframe	8163A	x		Keysight 8163B, 8164B
Power Meter Standard	81533B Optical Head Interface Module and 81525A Reference Optical Head	x		Keysight 81618A and Keysight 81626B
Optical Spectrum Analyzer	71452B	x		86142B
Singlemode Fibers	81101AC	x		
	81113PC	x		
Connector Adapters	81000SA	x		
Connector Interfaces	81000AI (2 ea)	x		
	81000FI	x		
Plastic Cap	5040-9351	x		

Legend:

- \- not applicable
- x necessary
- o optional

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 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 Keysight Technologies.

Test Failure

If the Keysight 81650A/1A/4A/5A/6A/7A Laser Source module fails any performance test, return the instrument to the nearest Keysight Technologies Sales/Service Office for repair.

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Instrument Specification

Specifications are the performance characteristics of the instrument that is certified. These specifications, listed in "Specifications" on page 17, are the performance standards or limits against which the Keysight Technologies 81650A/1A/4A/5A/6A/7A Laser Source module can be tested. "Specifications" on page 17 also lists some supplemental characteristics of the Keysight Technologies 81650A/1A/4A/5A/6A/7A Laser Source module and should be considered as additional information.

Any changes in the specifications due to manufacturing changes, design, or traceability to the National Institute of Standards and Technology (NIST), will be covered in a manual change supplement, or revised manual. Such specifications supercede any that were previously published.

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Performance Test

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

NOTE

Make sure that all optical connections of the test setups given in the procedure are dry and clean. DO NOT USE INDEX MATCHING OIL. For cleaning, use the cleaning instructions given in *"Cleaning Instructions" on page 51*.

The ambient temperature must be constant (±1K) during the test. The power meter must be zeroed before the measurement.

Tip: The full sequence of tests should be performed first at 1310 nm and again at 1550 nm if using a dual wavelength source. Performing all the tests for one wavelength together provides the warm-up time for the stability test.

Center Wavelength and Spectral Bandwidth Test

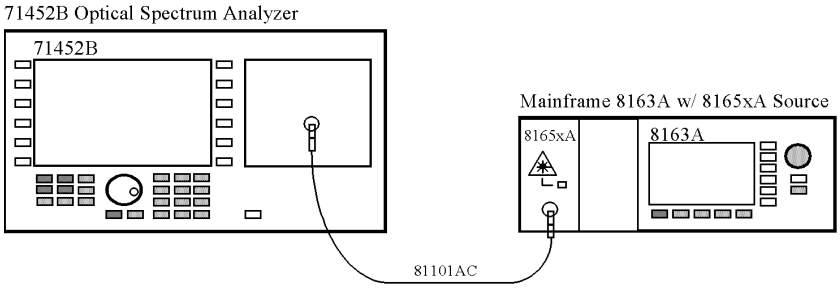


Figure 5 Measurement Setup for Center Wavelength and Spectral Bandwidth

1. Make sure that cable connector, detectors and adapters are clean.
2. Setup the equipment as shown in Figure 5.
3. Switch the Keysight 8165xA Laser Source module on.
4. Press the green button *InstrPreset* on the 71452B front panel to reset the optical spectrum analyzer.
5. Start the auto measurement by pressing the yellow button *AutoMeas*.
6. Adjust the Optical Spectrum Analyzer (OSA) for use with Fabry-Perot laser sources (the Keysight 8165xA DUTs are Fabry-Perot laser sources):

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a Press the *User* hardkey.

b Press the [FP] softkey.

7 Set up the spectrum analyzer:

a Press Menu.

b Press the [Amptd] softkey.

c Press the [Linear] softkey.

d Press the *User* hardkey.

e Press the [SingleSweep] softkey.

8 In the field given at the top of the screen, the Fabry-Perot laser test results are shown. Note the mean wavelength and the rms bandwidth (sigma) in the test record.

Example for Keysight Technologies 81650A

Parameter	Min Spec	Result	Max Spec
Mean wavelength	1295.0 nm	1309,46 nm	1325.0 nm
rms bandwidth		2,87 nm	< 3.5 nm

Output Power and Stability Test

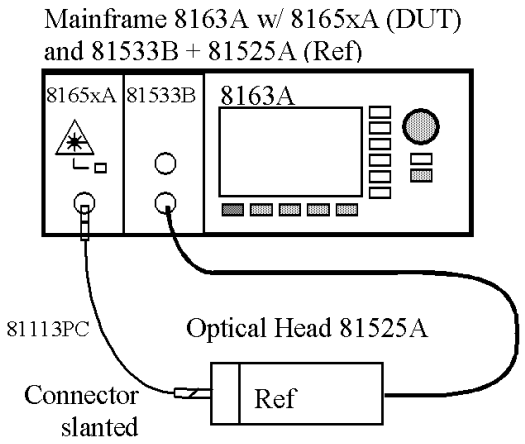


Figure 6 Measurement Setup for Output Power and Stability Test

Output Power Test

1 Make absolutly sure that cable connectors and detector windows are clean.

2 Enable the laser output of the Keysight 8165xA and allow instruments to warm up for at least 20 minutes.

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3 On the power meter:
   a Set the wavelength of the power sensor exactly to the wavelength of the laser source.
   b Ensure that the [Cal] parameter on the powermeter is set to zero.
   c With the connector adapter on the optical head, covered with a plastic cap, zero the powermeter.
   d Set the averaging time to 500 ms.
4 Connect the equipment as shown in figure D-2.
5 On the Keysight 8163A with the module under test (DUT):
   a Ensure that the laser source is in CW mode.
   b Ensure that the attenuation for the measured wavelength is set to zero.
6 Measure the output power and note the result in the test record.

Stability Test

1 Make sure the laser source Keysight 8165xA has warmed up for 20 minutes.
2 Select the channel with the source.
   a Ensure that the modulation of the source is switched off.
   b Make sure that the attenuation of the source is set to zero.
3 Using the Keysight 81113PC cable, connect the output of the source to the input of the sensor. Make sure that the cable is fixed and that it cannot be moved during the measurement.
4 On the mainframe, press Appl and select the Stability application.
5 Press Parameter and set the Total time to 15:00 minutes.
6 Edit the averaging time to 1s and make sure that the maximum number of samples exceeds 900.
7 Set the wavelength of the sensor to the wavelength of the source.
8 Select as Range mode 'Auto'.
9 Start the stability measurement by pressing 'Measure'. Do not touch the cables while the measurement is running.

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10 When the stability test has completed, press 'Analysis', select as unit [dB] and press more.

11 Note the result ΔP in the test record.

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Performance Test for the Keysight 81650A

Page 1 of 3

Model	Keysight 81650A Laser Source Module (1310 nm)	Date	_____
Serial No.	_____	Ambient Temperature	_____°C
Options	_____	Relative Humidity	_____ %
Firmware Rev.	_____	Line Frequency	_____ Hz
Test Facility	_____	Customer _____	
Performed by	_____	Report No _____	

Special Notes _____

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Performance Test for the Keysight 81650A **Test Equipment Used**

Page 2 of 3

	Description	Model No.	Trace No	Cal. Due Date
1a	Lightwave Multimeter (Std.)	8163A	_____	_____
1b	TLS Mainframe	8164A	_____	_____
2a	Opt. Head Interface Module	81533B	_____	_____
2b	Opt. Head Interface Module	Keysight 81618A	_____	_____
3a	Optical Head	81525A	_____	_____
3b	Optical Head	Keysight 81626B	_____	_____
4	Optical Spectrum Analyzer	71452B	_____	_____
5	_____	_____	_____	_____
6	_____	_____	_____	_____
7	_____	_____	_____	_____
8	_____	_____	_____	_____
9	_____	_____	_____	_____
10	_____	_____	_____	_____
11	_____	_____	_____	_____
12	_____	_____	_____	_____

Accessories	#	Product	#	Product	#	Product
Connector Adapters	1	81000AA				
Backreflector Kit	1	8156A #203				
Connector Adapters	1	81000AA				

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Performance Test for the Keysight 81650A

Page 3 of 3

Model Keysight 81650A Sensor Module **Report No._____** **Date _____**

Test No.	Center Wavelength	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
I	**Accuracy Test**		[nm]		
	measured at _____ nm (1310nm)	1295 nm	_____	1325 nm	
II	**Spectral Bandwidth (rms)**		[nm]		
	measured at _____ nm (1310 nm)		_____	< 3.5 nm	
III	**Output Power**		[dBm]		
	measured at _____ nm (1310 nm)	0 dBm <	_____		
IV	**Power Stability**		[dB]	[dB]	
	measured at _____ nm (1310 nm)		_____	< 0.01	

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Performance Test for the Keysight 81651A

Page 1 of 3

Model	Keysight 81651A Laser Source Module (1550 nm)	Date	_____
Serial No.	_____	Ambient Temperature	_____°C
Options	_____	Relative Humidity	_____ %
Firmware Rev.	_____	Line Frequency	_____ Hz
Test Facility	_____	Customer _____	
Performed by	_____	Report No _____	

Special Notes _____

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Performance Test for the Keysight 81651A **Test Equipment Used**

Page 2 of 3

	Description	Model No.	Trace No	Cal. Due Date
1a	Lightwave Multimeter (Std.)	8163A	_____	_____
1b	TLS Mainframe	8164A	_____	_____
2a	Opt. Head Interface Module	81533B	_____	_____
2b	Opt. Head Interface Module	Keysight 81618A	_____	_____
3a	Optical Head	81525A	_____	_____
3b	Optical Head	Keysight 81626B	_____	_____
4	Optical Spectrum Analyzer	71452B	_____	_____
5	_____	_____	_____	_____
6	_____	_____	_____	_____
7	_____	_____	_____	_____
8	_____	_____	_____	_____
9	_____	_____	_____	_____
10	_____	_____	_____	_____
11	_____	_____	_____	_____
12	_____	_____	_____	_____

Accessories	#	Product	#	Product	#	Product
Connector Adapters	1	81000AA				
Backreflector Kit	1	8156A #203				
Connector Adapters	1	81000AA				

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Performance Test for the Keysight 81651A

Page 3 of 3

Model Keysight 81651A Sensor Module **Report No._____** **Date _____**

Test No.	Center Wavelength	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
I	**Accuracy Test**		[nm]		
	measured at _____ nm (1550nm)	1535 nm	_____	1565 nm	
II	**Spectral Bandwidth (rms)**		[nm]		
	measured at _____ nm (1550 nm)		_____	< 4.5 nm	
III	**Output Power**		[dBm]		
	measured at _____ nm (1550 nm)	0 dBm <	_____		
IV	**Power Stability**		[dB]	[dB]	
	measured at _____ nm (1550 nm)		_____	< 0.01	

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Performance Test for the Keysight 81654A

Page 1 of 3

Model	Keysight 81654A Laser Source Module (1310/1550 nm)	Date	_____
Serial No.	_____	Ambient Temperature	_____°C
Options	_____	Relative Humidity	_____ %
Firmware Rev.	_____	Line Frequency	_____ Hz
Test Facility	_____	Customer _____	
Performed by	_____	Report No _____	

Special Notes _____

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Performance Test for the Keysight 81654A **Test Equipment Used**

Page 2 of 3

	Description	Model No.	Trace No	Cal. Due Date
1a	Lightwave Multimeter (Std.)	8163A	_____	_____
1b	TLS Mainframe	8164A	_____	_____
2a	Opt. Head Interface Module	81533B	_____	_____
2b	Opt. Head Interface Module	Keysight 81618A	_____	_____
3a	Optical Head	81525A	_____	_____
3b	Optical Head	Keysight 81626B	_____	_____
4	Optical Spectrum Analyzer	71452B	_____	_____
5	_____	_____	_____	_____
6	_____	_____	_____	_____
7	_____	_____	_____	_____
8	_____	_____	_____	_____
9	_____	_____	_____	_____
10	_____	_____	_____	_____
11	_____	_____	_____	_____
12	_____	_____	_____	_____

Accessories	#	Product	#	Product	#	Product
Connector Adapters	1	81000AA				
Backreflector Kit	1	8156A #203				
Connector Adapters	1	81000AA				

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Performance Test for the Keysight 81654A

Page 3 of 3

Model Keysight 81654A Sensor Module Report No._____ Date _____

Test No.	Center Wavelength	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
I	**Accuracy Test**		[nm]		
	measured at _____ nm (1310 nm)	1295 nm	_____	1325 nm	
	measured at _____ nm (1550 nm)	1535 nm	_____	1565 nm	
II	**Spectral Bandwidth (rms)**		[nm]		
	measured at _____ nm (1310 nm)		_____	< 3.5 nm	
	measured at _____ nm (1550 nm)		_____	< 4.5 nm	
III	**Output Power**		[dBm]		
	measured at _____ nm (1310 nm)	0 dBm <	_____		
	measured at _____ nm (1550 nm)	0 dBm <	_____		
IV	**Power Stability**		[dB]	[dB]	
	measured at _____ nm (1310 nm)		_____	< 0.01	
	measured at _____ nm (1550 nm)		_____	< 0.01	

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Performance Test for the Keysight 81655A

Page 1 of 3

Model	Keysight 81655A Laser Source Module (1310 nm)	Date	_____
Serial No.	_____	Ambient Temperature	_____°C
Options	_____	Relative Humidity	_____ %
Firmware Rev.	_____	Line Frequency	_____ Hz
Test Facility	_____	Customer _____	
Performed by	_____	Report No _____	

Special Notes _____

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Performance Test for the Keysight 81655A **Test Equipment Used**

Page 2 of 3

	Description	Model No.	Trace No	Cal. Due Date
1a	Lightwave Multimeter (Std.)	8163A	_____	_____
1b	TLS Mainframe	8164A	_____	_____
2a	Opt. Head Interface Module	81533B	_____	_____
2b	Opt. Head Interface Module	Keysight 81618A	_____	_____
3a	Optical Head	81525A	_____	_____
3b	Optical Head	Keysight 81626B	_____	_____
4	Optical Spectrum Analyzer	71452B	_____	_____
5	_____	_____	_____	_____
6	_____	_____	_____	_____
7	_____	_____	_____	_____
8	_____	_____	_____	_____
9	_____	_____	_____	_____
10	_____	_____	_____	_____
11	_____	_____	_____	_____
12	_____	_____	_____	_____

Accessories	#	Product	#	Product	#	Product
Connector Adapters	1	81000AA				
Backreflector Kit	1	8156A #203				
Connector Adapters	1	81000AA				

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Performance Test for the Keysight 81655A

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Model Keysight 81655A Sensor Module Report No._____ Date _____

Test No.	Center Wavelength	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
I	**Accuracy Test**		[nm]		
	measured at _____ nm (1310nm)	1295 nm	_____	1325 nm	
II	**Spectral Bandwidth (rms)**		[nm]		
	measured at _____ nm (1310 nm)		_____	< 5.5 nm	
III	**Output Power**		[dBm]		
	measured at _____ nm (1310 nm)	13 dBm <	_____		
IV	**Power Stability**		[dB]	[dB]	
	measured at _____ nm (1310 nm)		_____	< 0.01	

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Performance Test for the Keysight 81656A

Page 1 of 3

Model	Keysight 81656A Laser Source Module (1550 nm)	Date	_____
Serial No.	_____	Ambient Temperature	_____°C
Options	_____	Relative Humidity	_____ %
Firmware Rev.	_____	Line Frequency	_____ Hz
Test Facility	_____	Customer _____	
Performed by	_____	Report No _____	

Special Notes _____

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Performance Test for the Keysight 81656A **Test Equipment Used**

Page 2 of 3

	Description	Model No.	Trace No	Cal. Due Date
1a	Lightwave Multimeter (Std.)	8163A	_____	_____
1b	TLS Mainframe	8164A	_____	_____
2a	Opt. Head Interface Module	81533B	_____	_____
2b	Opt. Head Interface Module	Keysight 81618A	_____	_____
3a	Optical Head	81525A	_____	_____
3b	Optical Head	Keysight 81626B	_____	_____
4	Optical Spectrum Analyzer	71452B	_____	_____
5	_____	_____	_____	_____
6	_____	_____	_____	_____
7	_____	_____	_____	_____
8	_____	_____	_____	_____
9	_____	_____	_____	_____
10	_____	_____	_____	_____
11	_____	_____	_____	_____
12	_____	_____	_____	_____

Accessories	#	Product	#	Product	#	Product
Connector Adapters	1	81000AA				
Backreflector Kit	1	8156A #203				
Connector Adapters	1	81000AA				

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Performance Test for the Keysight 81656A

Page 3 of 3

Model Keysight 81656A Sensor Module Report No._____ Date _____

Test No.	Center Wavelength	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
I	**Accuracy Test**		[nm]		
	measured at _____ nm (1550nm)	1535 nm	_____	1565 nm	
II	**Spectral Bandwidth (rms)**		[nm]		
	measured at _____ nm (1550 nm)		_____	< 7.5 nm	
III	**Output Power**		[dBm]		
	measured at _____ nm (1550 nm)	13 dBm <	_____		
IV	**Power Stability**		[dB]	[dB]	
	measured at _____ nm (1550 nm)		_____	< 0.01	

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Performance Test for the Keysight 81657A

Page 1 of 3

Model	Keysight 81657A Laser Source Module (1310/1550 nm)	Date	_____
Serial No.	_____	Ambient Temperature	_____°C
Options	_____	Relative Humidity	_____ %
Firmware Rev.	_____	Line Frequency	_____ Hz
Test Facility	_____	Customer _____	
Performed by	_____	Report No _____	

Special Notes _____

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Performance Test for the Keysight 81657A **Test Equipment Used**

Page 2 of 3

	Description	Model No.	Trace No	Cal. Due Date
1a	Lightwave Multimeter (Std.)	8163A	_____	_____
1b	TLS Mainframe	8164A	_____	_____
2a	Opt. Head Interface Module	81533B	_____	_____
2b	Opt. Head Interface Module	Keysight 81618A	_____	_____
3a	Optical Head	81525A	_____	_____
3b	Optical Head	Keysight 81626B	_____	_____
4	Optical Spectrum Analyzer	71452B	_____	_____
5	_____	_____	_____	_____
6	_____	_____	_____	_____
7	_____	_____	_____	_____
8	_____	_____	_____	_____
9	_____	_____	_____	_____
10	_____	_____	_____	_____
11	_____	_____	_____	_____
12	_____	_____	_____	_____

Accessories	#	Product	#	Product	#	Product
Connector Adapters	1	81000AA				
Backreflector Kit	1	8156A #203				
Connector Adapters	1	81000AA				

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Performance Test for the Keysight 81657A

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Model Keysight 81657A Sensor Module Report No._____ Date _____

Test No.	Center Wavelength	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
I	**Accuracy Test**		[nm]		
	measured at _____ nm (1310 nm)	1295 nm	_____	1325 nm	
	measured at _____ nm (1550 nm)	1535 nm	_____	1565 nm	
II	**Spectral Bandwidth (rms)**		[nm]		
	measured at _____ nm (1310 nm)		_____	< 5.5 nm	
	measured at _____ nm (1550 nm)		_____	< 7.5 nm	
III	**Output Power**		[dBm]		
	measured at _____ nm (1310 nm)	13 dBm <	_____		
	measured at _____ nm (1550 nm)	13 dBm <	_____		
IV	**Power Stability**		[dB]	[dB]	
	measured at _____ nm (1310 nm)		_____	< 0.01	
	measured at _____ nm (1550 nm)		_____	< 0.01	

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5
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.

Keysight Technologies assume no liability for the customer's failure to comply with these requirements.

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Cleaning Instructions for this Instrument

The Cleaning Instructions apply to a number of different types of Optical Equipment. Table 6 lists the sections that are relevant to the various modules that can be installed in this instrument.

Table 6 Cleaning Instructions for Modules

Modules	Instruction
Optical Heads	"How to clean instruments with an optical glass plate" on page 70
Laser Source Modules	"How to clean instruments with a physical contact interface" on page 71
Tunable Laser Modules	"How to clean instruments with a physical contact interface" on page 71
Return Loss Modules	"How to clean instruments with a physical contact interface" on page 71
LED Source Modules	"How to clean instruments with a physical contact interface" on page 71
Keysight 81633A/4A Power Sensor Modules	If you must clean these modules, please refer the module to the skilled personnel of Keysight's service team.
All other Power Sensor Modules	"How to clean instruments with a recessed lens interface" on page 72

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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 mm (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 Keysight 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 Keysight 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.

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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 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.

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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.

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.

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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 damage.

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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 Keysight 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 Keysight 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.

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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 Instrument" on page 52* 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 mm. 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.

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 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.

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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 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.

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 particularly 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.

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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.

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.

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How to clean lenses

Some lenses have special coatings that are sensitive to solvents, grease, liquid and mechanical abrasion. Take extra care when cleaning lenses with these coatings.

Lens assemblies consisting of several lenses are not normally sealed. Therefore, use as little alcohol as possible, as it can get between the lenses and in doing so can change the properties of projection.

Preferred Procedure

Use the following procedure on most occasions.

1 Clean the lens by rubbing a new, dry cotton-swab over the surface using a small circular movement.

2 Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly 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.

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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 Keysight's service team.

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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How to clean instruments with an optical glass plate

Some instruments, for example, the optical heads from Keysight Technologies have an optical glass plate to protect the sensor. Clean this glass plate in the same way as optical lenses (see "How to clean lenses" on page 68).

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How to clean instruments with a physical contact interface

Remove any connector interfaces from the optical output of the instrument before you start the cleaning procedure.

Cleaning interfaces is difficult as the core diameter of a single-mode fiber is only about 9 mm. 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 project onto the card and becomes visible as a small circular spot.

Preferred Procedure

Use the following procedure on most occasions.

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

Procedure for Stubborn Dirt

Use this procedure particularly 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.

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How to clean instruments with a recessed lens interface

WARNING

For instruments with a deeply recessed lens interface (for example the Keysight 81633A and 81634A Power Sensors) do NOT follow ths 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 Keysight'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
2. 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, and using the procedure for light dirt is not sufficient. Using isopropyl alcohol should be your last choice for recessed lens interfaces because of the difficulty of cleaning out any dirt that is washed to the edge of the interface:

1. Moisten a new cotton-swab with isopropyl alcohol.
2. Clean the interface by rubbing the cotton-swab over the surface using a small circular movement.
3. Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4. Blow away any remaining lint with compressed air.

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How to clean optical devices which are sensitive to mechanical stress and pressure

Some optical devices, such as the Keysight 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 anything to 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.

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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 particularly 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.

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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.

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 particularly when there is greasy dirt on the lens:

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CAUTION

Only use water if you are sure that your device does not corrode. Do not use hot water as this can lead to mechanical stress, which can damage your device.

Make sure that your liquid soap has no abrasive properties or perfume in it, because they can scratch and damage your device. Do not use normal washing-up liquid as sometimes an iridescent film remains.

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.

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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 Keysight 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 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

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.

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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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