

# Keysight 81618A/9A Optical Head Interface Modules and Keysight 81620B/3B/4B/6B/8B Optical Heads

User's Guide

# Notices

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## Safety Notices

### CAUTION

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

### WARNING

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

## Safety Summary

### General Safety Precautions

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. For safe operation the general safety precautions for the M9502A and M9505A AXIe chassis, must be followed.

See: <http://www.keysight.com/find/M9505A>

Keysight Technologies Inc. assumes no liability for the customer's failure to comply with these requirements. Before operation, review the instrument and manual for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe condition.

### 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.).

### General

This product is a Safety Class 3 instrument. The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

### Environment Conditions

This instrument is intended for indoor use in an installation category II, pollution degree 2 environment. It is designed to operate within a temperature range of 0 °C – 40 °C (32 °F – 105 °F) at a maximum relative humidity of 80% and at altitudes of up to 2000 meters.

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.

### Ground the Instrument

To minimize shock hazard, the instrument chassis and cover must be connected to an electrical protective earth ground. The instrument must be connected to the ac power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

### Before Applying Power

Verify that all safety precautions are taken including those defined for the mainframe. The power cable inlet of the instrument serves as a device to disconnect from the mains in case of hazard. The instrument must be positioned so that the operator can easily access the power cable inlet. When the instrument is rack mounted the rack must be provided with an easily accessible mains switch.

Line Power Requirements	The Keysight M8292A/M8296A operates when installed in an Keysight AXIe mainframe.
Do Not Operate in an Explosive Atmosphere	Do not operate the instrument in the presence of flammable gases or fumes.
Do Not Remove the Instrument Cover	Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified personnel. Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

# General Safety Considerations

## Intended Use

This instrument is intended to use in an office or laboratory environment, under the environmental conditions listed in the specifications.

## Safety Symbols

### CAUTION

The caution sign denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in damage to or destruction of the product. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.

---




### WARNING








The warning sign denotes a hazard. It calls attention to a procedure 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.

---

## Instrument Markings


Table 1 Instrument Markings

Symbol	Description
	Indicates warning or caution. If you see this symbol on a product, you must refer to the manuals for specific Warning or Caution information to avoid personal injury or damage to the product.
	The laser radiation symbol. This warning symbol is marked on products which have a laser output.
	The electrostatic discharge symbol. This warning symbol is marked on products which have components that can be damaged by an electrostatic discharge.

Symbol	Description
	Indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.
	The C-Tick mark is the certification mark of the Australian Communications Authority.
	The RCM Mark is a compliance mark to the ACMA (Australian Spectrum Management Agency). This indicates compliance with all Australian EMC regulatory information.
	CSA is the Canadian certification mark to demonstrate compliance with the Safety requirements.
	The earthing symbol marks a connection that is connected, through the instrument, to the earth of the line power.
	CE compliance marking to the EU Safety and EMC Directives. ISM GRP-1A classification according to the international EMC standard. ICES/NMB-001 compliance marking to the Canadian EMC standard.
	This symbol on all primary and secondary packaging indicates compliance to China standard GB 18455-2001.

# Compliance and Environmental Information

**Table 2 Compliance and Environmental Information**

Safety Symbol	Description
	<p>This product complies with WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste.</p> <p>Product Category: With reference to the equipment types in WEEE Directive Annex I, this product is classed as a “Monitoring and Control instrumentation” product.</p> <p>Do not dispose in domestic household waste.</p> <p>To return unwanted products, contact your local Keysight office, or see <a href="http://about.keysight.com/en/companyinfo/environment/takeback.shtml">http://about.keysight.com/en/companyinfo/environment/takeback.shtml</a> for more information.</p>





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# 1

# Getting Started with Optical Heads

This chapter introduces the features of the Keysight 81623B/4B/6B/8B Optical Heads.

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

### WARNING

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

---

### CAUTION

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.

---

#### 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.



Caution - hot surface



Magnetic fields - may interfere with a pacemaker.

## Input Power Limitations

### **WARNING**

Applicable to Keysight 81628B only.

Operation above 34 dBm (2.51 W) is at your own risk.

Operation at a continuous optical power, or an average optical power, greater than 34 dBm causes, in the specified operating temperature range, the metal parts (connector adapters, screws) to become hotter than the required limit (55°C) of the safety standard IEC 61010- 1.

Keysight Technologies Deutschland GmbH will not be liable for any damage caused by operation above 34 dBm.

---

## 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.).

---

## Line Power Requirements

The Keysight 81618A and Keysight 81619A Optical Head Interface Modules operate when installed in the 8163B Lightwave Multimeter, 8164B Lightwave Measurement System, and 8166B Lightwave Multichannel System.

### Operating Environment

The safety information in the Keysight 8163B Lightwave Multimeter, Keysight 8164B Lightwave Measurement System, and 8166B Lightwave Multichannel System User's Guide summarizes the operating ranges for the Keysight 81618A and Keysight 81619A Optical Head Interface Modules. In order for these modules to meet specifications, the operating environment must be within the limits specified for the Keysight 8163B Lightwave Multimeter, Keysight 8164B Lightwave Measurement System, and 8166B Lightwave Multichannel System.

### Storage and Shipment

This module can be stored or shipped at temperatures between  $-40\text{ }^{\circ}\text{C}$  and  $+70\text{ }^{\circ}\text{C}$ . Protect the module from temperature extremes that may cause condensation within it.



# What is an Optical Head?

An optical head measures the power emitted from a connected single-mode or multi-mode fiber or the power applied in an open parallel beam (with max. 5 mm diameter). The wavelength and power range depends on the sensor element.

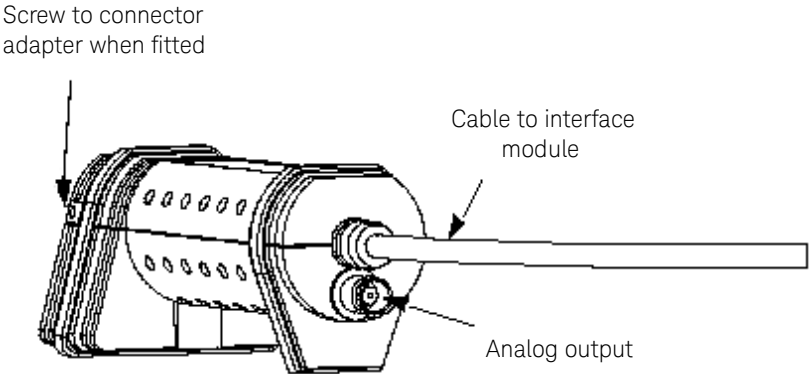


Figure 1 Rear view of an Optical Head with Analog Output

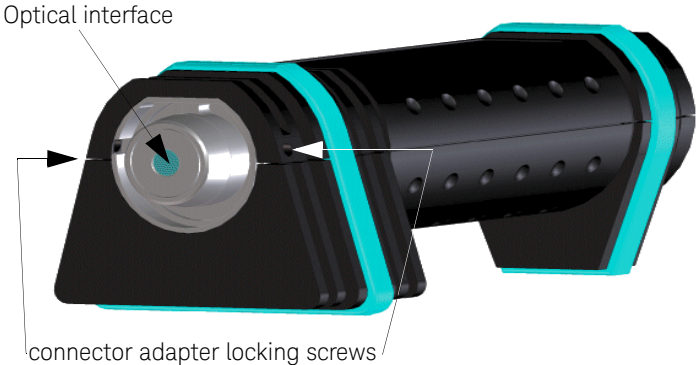


Figure 2 Front View of Optical Head without Adapter

Figure 1 on page -17 and Figure 2 on page -17 show views of a typical optical head.

Figure 3 on page -18 shows two types of adapter that are available for connecting the input fiber to an optical head as well as the 81624DD adapter ring that is used with threaded adapters.



Threaded connector adapter:  
81000xA, 81000BT



D-shape-to-threaded adapter:  
81624DD



D-type magnetic connector adapter:  
(preferred)  
81003xx  
81001xx  
81000BC

Figure 3 Connector adapters

**NOTE**

The optical heads are shipped including a mounted 81624DD adapter ring. To use D-type magnetic connector adapters, this ring should be removed by loosening the locking screws shown in Figure 2 with a 1.5mm hex key.

Analog Output

The analog output is the BNC connector on the back of the optical head. It outputs a voltage directly proportional to the strength of the optical signal at the optical input in the current range. The analog signal is always in the range between 0 and 2V, 2V corresponding to a full power input signal in the current range, 0V corresponding to no input signal.

During autoranging, the level to which 2V corresponds changes. You should disable autoranging when using the analog output.

### Disabling Autoranging

Select the best range for the application using the mainframes user interface. Select <Menu>, <Range Mode>, <Manual> and then choose from the list of ranges.

### Applications

Possible applications for the analog output are:

- to close the feedback loop controlling the current supplied to a laser
- to aid positioning the system for fiber alignment tasks
- to monitor optical power on an oscilloscope

The analog signal reacts instantaneously to the input signal, whereas the power shown on the display is subject to averaging.

### Optical input

The optical input to the optical head requires a connector adapter to match the connector type (or bare fiber) to the optical head interface.

The optical head interface can be either threaded or a D-type magnetic interface depending on the model of optical head (81628B is only available with a threaded interface). See [Accessories](#) on page 25 for details of the connector adapters available.

When a connector adapter is fitted it should be locked in place by tightening the locking screws located either side of the main optical head housing.

### Heat Sink for 81628B optical Head

The 81628B optical head has a heat sink that allows an extended operating power range. This heat sink must be mounted on the integrating sphere for operation from 34 dBm to 38 dBm.

## Attaching the heat sink to the 81628B Optical Head

### NOTE

Always attach the heat sink and rubber ring to the 81628B if operating at an optical power higher than 34dBm!

---

### Applicable adapters

Keysight adapters types 81000xx, 81000BT are applicable to the 81628B with the heat sink attached (without the heat sink and up to 34 dBm the 81000BT bare fiber adapter may be attached). Bare fibers are not intended to be used in high power applications.

### NOTE

If shipping the 81628B high power optical head please detach the heat sink from the optical head to avoid damage during transportation.

---

### Mounting Instructions

- 1 Check that the blue rubber ring is correctly attached to the integrating sphere and covers the metallic screws as shown in [Figure 4](#) on page -20.



Figure 4 Attaching the Rubber Ring

- 2 The heat sink consists of two conical metal parts, the bottom part (smallest diameter at the bottom), and the top part (largest diameter at top). Slide the bottom part of the heat sink over the throat of the integrating sphere with the smallest diameter facing to the sphere. Then screw on the desired adapter (81000xx series) to the sphere as shown in [Figure 5](#) on page -21.



Figure 5 Attaching the Bottom Part of the Heat Sink

- 3 Attach the upper part of the heat sink to the integrating sphere. Slide the upper part over the connector adapter with the largest diameter facing opposite to the sphere. Tighten the screws with the Allen key enclosed in the Heat Sink Kit (see [Figure 6](#) on page -22).

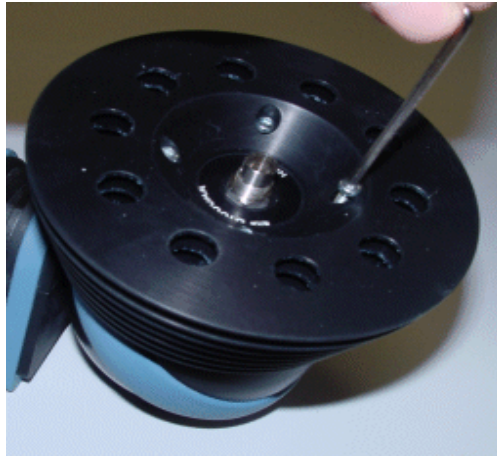


Figure 6 Attaching the Upper Part of the Heat Sink

## Operation

For operating instructions, please refer to the User's Guide and Programming Guide for the 816x mainframe.





# 2 Accessories

The Keysight 81618A/9A Optical Head Interface Modules and Keysight 81623B/4B/6B/8B Optical Heads 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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[Optical Heads \(5mm Sensors\)](#) / 26

[High Power Optical Head \(with integrating sphere\)](#) / 27

[Connector Adapters - Reference List](#) / 28

# Modules and Options

## Optical Heads (5mm Sensors)

### Optical Heads (5mm Sensors)

OPTIONAL



For advanced accuracy see "Special Calibration" options C01/02 and C85/86

#### Accessories

- 81624CE 4 m extension cable
- 81624DD additional D-shape quick change adapter
- 81624RM Half-rack Mount Kit for 2 Heads
- 81625RM Rack Mount Kit for 4 Heads

#### Interface Module

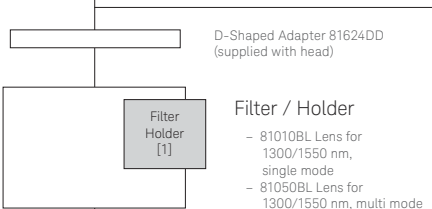
#### Interface Modules

- 81618A Single-Head Interface Module
- 81619A Dual-Head Interface Module

#### Optical Heads for: Connectorized Fiber, Bare Fiber and Open beam NA $\leq 0.3$

#### Optical Heads

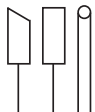
- 81620B Si: +10 dBm to -90 dBm, 450 - 1020 nm
- 81623B Ge: +10 dBm to -90 dBm, 750 - 1800 nm
- 81624B InGaAs: +10 dBm to -90 dBm, 800 - 1700 nm
- 81626B InGaAs: +27 dBm to -70 dBm, 850 - 1650 nm



#### Connector Adapters (threaded)

- 81000BT Bare Fiber Connectivity Set (Threaded)
- 81000FA FC/PC/APC
- 81000KA SC/PC/APC
- 81000VA ST
- 81003LA LC
- 81000PA E-2000

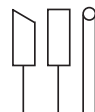
#### Connector Adapters (threaded)



#### Connector Adapters (with integral D-Shape)

- 81000BC Bare Fiber Connectivity Set (D-shaped)
- 81001FA FC
- 81001KA SC
- 81001LA LC
- 81001MA MU
- 81001PA E-2000
- 81001ZA BLANK Adapter

#### Integral D-Shaped Adapters



High Power Optical Head (with integrating sphere)

**High Power Optical Head (with integrating sphere)**

OPTIONAL



Interface Module

**Interface Modules**

- 81618A Single-Head Interface Module
- 81619A Dual-Head Interface Module

**Accessories**

- 81624CE 4 m extension cable

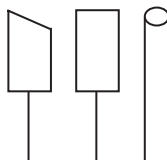
High Power Optical Head for:  
Connectorized Fiber,  
Bare Fiber and  
Open beam  $NA \leq 0.3$

81628B InGaAs  
+40 dBm to -60 dBm

Connector Adapters  
(threaded)

**Connector Adapters (threaded)**

- 81000BT Bare Fiber Connectivity Set (Threaded)
- 81000FA FC/PC/APC
- 81000KA SC/PC/APC
- 81000VA ST
- 81003LA LC
- 81000PA E-2000



## Connector Adapters - Reference List

**Table 3 Connector Adapters**

Connector Type	Threaded Version	Preferred Adapters
		Integral D-shape for 5 mm optical heads
Barefiber	81000BT	81000BC
FC/PC	81000FA	81001FA
SC/PC	81000KA	81001KA
MU		81001MA
E-2000	81000PA	81001PA
ST	81000VA	
blank		81001ZA
LC	81003LA	81001LA
MTP(ribbon)		81003TD

# 3 Specifications

The Keysight 81618A/9A Optical Head Interface Modules and Keysight 81623B/4B/6B/8B Optical Heads are produced to the ISO 9001 international quality system standard as part of Keysight Technologies' 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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[Optical Head Specifications](#) / 35

[Supplementary Performance Characteristics](#) / 39

[Maximum Safe Input Power](#) / 40

## Definition of Terms

This section defines terms that are used both in this chapter and **Performance Tests** on page 41.

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

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

### Averaging Time

Time defining the period during which the power meter takes readings for averaging. At the end of the averaging time the average of the readings is available (display- or memory-update). Symbol  $T_{avg}$ .

### Linearity

Specifies the relative difference between the displayed power ratio,  $D_x/D_0$ , and the actual (true) power ratio  $P_x/P_0$  caused by changing the displayed power level from the reference level,  $D_0$ , to an arbitrary displayed level,  $D_x$ . Excluding noise and offset. Powers expressed in Watts.

if expressed in %

$$Linearity = \left( \frac{D_x/D_0}{P_x/P_0} - 1 \right) X(100)$$

if expressed in dB

$$Linearity_{dB} = 10 \log \left( \frac{D_x/D_0}{P_x/P_0} \right)$$

*Conditions:* reference level 10  $\mu$ W. Power range and range setting as specified.

Note 1: Ideally Linearity is 0%, or 0 dB respectively.

Note 2: The power-dependent nonlinearity,  $N(P_x)$ , can alternatively be expressed by the following formula:

$$N(P_x) = \frac{r(P_x) - r(P_0)}{r(P_0)}$$

where  $r(P)$  is the power-dependent responsivity (for a power meter, the responsivity is defined as the ratio of displayed power to actual input power).

#### Linewidth

FWHM spectral bandwidth. The 3 dB width of the optical spectrum, expressed in Hertz. Symbol:  $\Delta f$ .

#### Noise

The peak-to-peak change of displayed power level with zero input power level (dark).

*Conditions:* Zero prior to measurement, averaging time and observation time as specified, lowest power range selected and wavelength range as specified.

*Measurement:* the measurement result is obtained by:

$Noise = P_{max} - P_{min}$  expressed as peak-to-peak within the given time span. Any offset is automatically excluded this way.

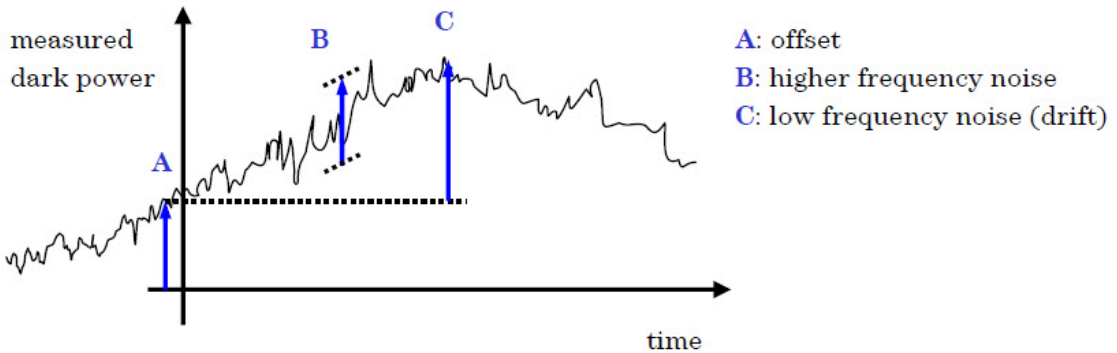
#### Power range

The power range is defined from the highest specified input power level to the smallest input power level that causes a noticeable change of displayed power level.

*Conditions:* wavelength, averaging time as specified.

#### Offset

The average power reading without incident optical power (dark).

**NOTE**

The power meter is adjusted to zero offset by doing a zero operation with darkened power meter.

## Reference conditions

The specified conditions during the spectral responsivity calibration, or conditions which are extrapolated from the conditions during calibration.

*Conditions:* power level, beam diameter or fiber type, numerical aperture, wavelength, spectral width, ambient temperature as specified, at the day of calibration. Noise and drift observed over a specified observation time, with a temperature change of not more than  $\pm\Delta T$ .

## Relative uncertainty due to polarization

Also termed polarization-dependent responsivity (PDR), the relative uncertainty due to polarization is the uncertainty of the displayed power level on the input polarization state, expressed as the difference between the highest and the lowest displayed power. Uncertainty figures are based upon a 95% confidence level.

*Conditions:* laser source with variable polarization state, generation of all possible polarization states (covering the entire Poincaré sphere), constant wavelength, constant power level, angled connector as specified, temperature as specified.



Relative uncertainty due to speckle noise

### NOTE

**Spectral ripple is measured by stepping the source wavelength over the wavelength range specified.**

Specifies the uncertainty of the power reading caused by optical interference (see the note) between different optical paths within the power meters optical assembly when using a coherent source.

*Conditions:* constant wavelength, constant power level, angled connector as specified, linewidth of source as specified, temperature as specified.

### NOTE

**Incoming light to the integrating sphere undergoes numerous internal reflections (as many as several hundred) prior to hitting the detector. If the source is sufficiently coherent, a complicated interference pattern (speckle pattern) appears spread over the whole sphere volume. Slight changes of the ambient conditions (temperature, vibration, shock) affect particular optical paths which consequently changes the speckle pattern and results in an instability of the head power reading (speckle noise).**

### NOTE

**Changes in the source wavelength have a similar effect on speckle noise as environmental changes, because they cause fluctuations in the interference pattern. If the source coherence length is small compared to the effective path length, the interference pattern disappears and relative uncertainty due to speckle noise becomes negligible.**

*Measurement:* In contrast to the spectral ripple definition the source wavelength isn't stepped when measuring speckle noise.

Relative uncertainty (spectral ripple) due to interference

Uncertainty of power reading when using a coherent source, due to a wavelength-dependent periodic change of the power meter's responsivity caused by optical interference [1] between reflective interfaces within the power meter's optical assembly.

*Conditions:* constant wavelength, constant power level, angled connector as specified, linewidth of source <100 MHz, temperature as specified.

#### Return loss

The ratio of the incident power to the reflected power expressed in dB.  
Symbol: *RL*.

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

*Conditions:* the return loss excludes any reflections from the fiber end used as radiation source.

#### Spectral width of optical source

Full width at half maximum. The 3 dB width of the optical spectrum, expressed in nm. Symbol: *FWHM*.

#### Total uncertainty

The uncertainty for a specified set of operating conditions, including noise and drift.

*Conditions:* power level, beam diameter or fiber type, numerical aperture, wavelength, spectral width, ambient temperature, re-calibration period as specified. Noise and drift observed over a specified observation time, with a temperature change of not more than  $\pm\Delta T$ .

#### Uncertainty at reference conditions

The uncertainty for the specified set of reference conditions, including all uncertainties in the calibration chain from the national laboratory to the test meter.

#### Wavelength range

The range of wavelengths for which the power meter is calibrated.

Note: Selectable wavelength setting of the power meter for useful power measurements (operating wavelength range).

#### Literature

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

## Optical Head Specifications

All optical heads have to be operated with the single (Keysight 81618A) or dual (Keysight 81619A) Interface Modules.

**Table 4 Keysight 81620B Optical Head Specifications**

Silicon optical head	Keysight 81620B
Sensor element	Si, Ø 5 mm
Wavelength range	450 nm to 1020 nm
Power range	-90 dBm to +10 dBm
Applicable fiber type	Standard SM and MM max 100 µm core size, NA ≤0.3
Open beam	Parallel beam max Ø 4 mm
Uncertainty (accuracy) at reference conditions <sup>1</sup>	±2.2% (600 nm to 1020 nm)
Total uncertainty <sup>2</sup>	±4.0% ±0.5 pW (600 nm to 1020 nm)
Linearity (power): <sup>3,5</sup> at 23 °C ±5 °C at operating temp. range	(CW -70 dBm to +10 dBm) < ±0.04 dB < ±0.15 dB
Noise (peak to peak) <sup>4</sup>	< 0.5 pW (700 nm to 900 nm)
Averaging time (minimal)	100 µs
Analog output	Included
Maximum safe input power	+16 dBm
Dimensions (H x W x D)	57 mm x 66 mm x 156 mm
Weight	0.5 kg
Recommended recalibration period	2 years
Operating temperature	0 °C to 40 °C
Humidity	Non-condensing
Warm-up time	40 min

1. Reference Conditions:

- Power level 10 µW (-20 dBm), continuous wave (CW)
- Parallel beam, 3 mm spot diameter on the center of the detector
- Ambient temperature 23 °C ±5 °C
- On day of calibration (add ±0.3% for aging over one year, add ±0.6% over two years)
- Spectral width of source <10 nm (FWHM)
- Wavelength setting at power sensor corresponding to source wavelength ±0.4 nm

2. Operating Conditions:

- Parallel beam, 3 mm spot diameter on the center of the detector or connectorized fiber with NA ≤0.2 (straight connector)
- For NA > 0.2 add 1%
- Averaging time 1 s
- Within one year after calibration; add 0.3% for second year
- Spectral width of source <10 nm (FWHM)
- Wavelength setting at power sensor corresponding to source wavelength ±0.4 nm

3. Does not include noise; zeroing required;

for wavelength <1000 nm applies for -50 dBm to +10 dBm

4. Averaging time 1 s, T = 23 °C ±5 °C, ΔT ±1 °C, observation time 300 s
5. For input power > 2 mW add ±0.004 dB/mW; zeroing required

**Table 5 Keysight 81623B Optical Head Specifications**

Ge optical head	Keysight 81623B	Keysight 81623B Calibration option C85	Keysight 81623B Calibration option C01
Sensor element	Ge, Ø 5 mm		
Wavelength range	750 nm to 1800 nm		
Power range	- 80 dBm to +10 dBm		
Applicable fiber type	Standard SM and MM max 100 µm core size, NA ≤0.3		
Open beam	Parallel beam max Ø 4 mm		
Uncertainty (accuracy) at reference conditions <sup>1</sup>	±2.2% (1000 nm to 1650 nm) ±3.0% typ. (800 nm to 1000 nm)	±2.2% (1000 nm to 1650 nm) ±2.5% (800 nm to 1000 nm)	±1.7% (1000 nm to 1650 nm) ±3.0% typ. (800 nm to 1000 nm)
Total uncertainty <sup>2,9</sup>	±3.5% ±100 pW (1000 nm to 1650 nm) ±4.0% typ. ±250 pW (800 nm to 1000 nm)	±3.5% ±100 pW (1000 nm to 1650 nm) ±3.7% ±250 pW (800 nm to 1000 nm)	±3.0% ±100 pW (1000 nm to 1650 nm) ±4.0% typ. ±250 pW (800 nm to 1000 nm)
Relative uncertainty: - due to polarization <sup>3</sup> - spectral ripple (due to interference) <sup>4</sup>	< ±0.01 dB <sup>10</sup> (typ. < ±0.005 dB) < ±0.006 dB (typ. < ±0.003 dB)		
Linearity (power): <sup>5</sup> at 23 °C ±5 °C at operating temp. range	(CW - 60 dBm to +10 dBm) <sup>9</sup> < ±0.025 dB < ±0.05 dB		
Return loss <sup>7</sup>	> 50 dB, typ. > 55 dB <sup>8</sup>		> 56 dB
Noise (peak to peak) <sup>6</sup>	< 100 pW (1200 nm to 1630 nm) < 400 pW (800 nm to 1200 nm)		
Averaging time (minimal)	100 µs		
Analog Output	Included		
Maximum safe input power	+16 dBm		
Dimensions (H x W x D)	57 mm x 66 mm x 156 mm		
Weight	0.5 kg		
Recommended recalibration period	2 years		
Operating temperature	0 °C to 40 °C		
Humidity	Non-condensing		
Warm-up time	40 min		

- Reference Conditions:
  - Power level 10 µW (-20 dBm), continuous wave (CW)
  - Parallel beam, 3 mm spot diameter on the center of the detector
  - Ambient temperature 23 °C ±5 °C
  - On day of calibration (add ±0.3% for aging over one year, add ±0.6% over two years)
  - Spectral width of source <10 nm (FWHM)
  - Wavelength setting at power sensor corresponding to source wavelength ±0.4 nm
- Operating Conditions:
  - Parallel beam, 3 mm spot diameter on the center of the detector or connectorized fiber with NA ≤0.2 (straight connector; option C01 also with angled connector ≤8 °)
  - For NA >0.2 add 1%
- All states of polarization at constant wavelength (1550 nm ±30 nm) and constant power, straight connector, T = 23 °C ±5 °C. For angled connector (8 °) add ±0.01 dB typ.
- Conditions:
  - Wavelength 1550 nm ±30 nm, fixed state of polarization, constant power,
  - Temperature 23 °C ±5 °C
  - Linewidth of source ≥100 MHz
  - Angled connector 8 °
- Does not include noise; for wavelength < 1000 nm applies for -50 dBm to +10 dBm
- Averaging time 1 s, T = 23 °C ±5 °C, ΔT ±1 °C, observation time 300 s.
- Conditions:
  - Wavelength 1550 nm ±30 nm
  - Standard single mode fiber
  - Angled connector min 8 °
- With D-shape adapter 81001xx return loss > 60 dB typical
- For input power > 2 mW add ±0.004 dB/mW (not for C01); zeroing required
- Specification valid for optical heads with S/N starting with "DE413..." and higher (shipping began April 1, 2001)

**Table 6 Keysight 81624B & 81626B High Power Optical Head Specification**

High performance and high power optical heads	Keysight 81624B	Keysight 81624B Calibration option C01	Keysight 81626B	Keysight 81626B Calibration option C01
Sensor element	InGaAs, Ø 5 mm			
Wavelength range	800 nm to 1700 nm		850 nm to 1650 nm	
Power range	-90 dBm to +10 dBm		-70 dBm to +27 dBm (1250 nm to 1650 nm) -70 dBm to +23 dBm (850 nm to 1650 nm)	
Applicable fiber type	Standard SM and MM max 100 µm core size, NA ≤0.3			
Open beam	Parallel beam max Ø 4 mm			
Uncertainty (accuracy) at reference conditions <sup>1</sup>	±2.2% (1000 nm to 1630 nm)	±1.5% (970 nm to 1630 nm)	±3.0% (950 nm to 1630 nm)	±2.5% (950 nm to 1630 nm)
Total uncertainty <sup>2</sup>	±3.5% ±5 pW (1000 nm to 1630 nm)	±2.8% ±5 pW (970 nm to 1630 nm)	±5.0% ±500 pW <sup>8</sup> (950 nm to 1630 nm)	±4.5% ±500 pW <sup>8</sup> (950 to 1250 nm max +23 dBm) (1250 to 1630 nm max +27 dBm)
Relative uncertainty:				
- due to polarization <sup>3</sup>	≤±0.005 dB (typ. ≤ ±0.002 dB)		≤±0.005 dB (typ. ≤ ±0.002 dB)	
- spectral ripple (due to interference) <sup>4</sup>	≤±0.005 dB (typ. ≤ ±0.002 dB)		≤±0.005 dB (typ. ≤ ±0.002 dB)	
Linearity (power): <sup>5</sup>	CW -70 dBm to +10 dBm, 1000 nm to 1630 nm		CW - 50 dBm to + 27dBm, 950 nm to 1630 nm	
- at 23 °C ±5 °C	< ±0.02 dB		< ±0.04 dB <sup>8</sup>	
- at operat. temp. range	< ±0.05 dB		< ±0.15 dB <sup>8</sup>	
Return loss	typ. 60 dB <sup>7</sup>		> 45 dB	> 47 dB
Noise (peak to peak) <sup>6</sup>	< 5 pW		< 500 pW	
Averaging time (min.)	100 µs			
Analog Output	Included			
Maximum safe input power	+16 dBm		+23.5 dBm (850 nm to 1650 nm) +27.5 dBm (1250 nm to 1650 nm)	
Dimensions (H x W x D)	57 mm x 66 mm x 156 mm			
Weight	0.5 kg			
Recommended recalibration period	2 years			
Operating temperature	0 °C to 40 °C		0 °C to +35 °C <sup>9</sup>	
Humidity	Non-condensing			
Warm-up time	40 min			

- Reference Conditions:
  - Power level 10 µW (-20 dBm), continuous wave (CW)
  - Parallel beam, 3 mm spot diameter on the center of the detector
  - Ambient temperature 23 °C ±5 °C
  - On day of calibration (add ±0.3% for aging over one year, add ±0.6% over two years)
  - Spectral width of source ≤10 nm (FWHM)
  - Wavelength setting at power sensor corresponding to source wavelength ≤±0.4 nm
- Operating Conditions:
  - Parallel beam, 3mm spot diameter on the center of the detector or connectorized fiber with NA ≤0.2 (straight connector, option C01 also with angled connector ≤8 °)
  - For NA > 0.2 add 1%.
- All states of polarization at constant wavelength (1550 nm ±30 nm) and constant power, straight connector, T = 23 °C ±5 °C. For angled connector (8 °) add ±0.01 dB typ.
- Conditions:
  - Wavelength 1550 nm ±30 nm, fixed state of polarization, constant power
  - Temperature 23 °C ±5 °C
  - Linewidth of source ≥100 MHz
  - Angled connector 8 °
- Does not include noise; zeroing required
- Averaging time 1 s, T = 23 °C ±5 °C, ΔT ±1 °C, observation time 300 s. Wavelength range 1200 nm to 1630 nm
- Conditions:
  - Wavelengths 1550 nm ±30 nm
  - Standard single mode fiber, angled connector min 8 °
  - With D-shape adapter 81001xx return loss > 60 dB typical
- For input power >10 mW:
  - Add typ. ±0.0016 dB/mW, or in case of option C01 for wavelength ≤1550 nm add ±0.0006 dB/mW (guaranteed) using adaptor 81000AF.
  - In case of decreasing power, allow time for stabilization of the reading (about 5 s per dB change).
  - In case of decreasing power by more than 50 dB, allow recovery time of 3 minutes.
- Max 30 °C above + 20 dBm input power

**Table 7** Keysight 81628B High Power Optical Head Specification

High power optical head	Keysight 81628B with integrating sphere
Sensor element	InGaAs
Wavelength range	800 nm to 1700 nm
Power range	-60 dBm to +40 dBm (800 nm to 1700 nm) For operation higher than +34 dBm see safety note
Damage Power	+40.5 dBm
Applicable fiber type	Single mode NA $\leq 0.2$ , Multimode NA $\leq 0.4$
Open beam	$\varnothing \leq 3$ mm center of sphere
Uncertainty (accuracy) at reference conditions <sup>1,8</sup>	$\pm 3.0\%$ (970 nm to 1630 nm)
Total uncertainty <sup>2,8</sup>	(970 nm to 1630 nm)
$\leq 10$ dBm	$\pm 4.0\% \pm 5$ nW
$>10$ dBm to $\leq 20$ dBm	$\pm 4.5\%$
$>20$ dBm to $\leq 38$ dBm	$\pm 5\%$
Relative uncertainty:	
- due to polarization <sup>3</sup>	typ. $\leq \pm 0.006$ dB
- due to speckle noise at source linewidth: <sup>4</sup>	
0.1 $\mu$ m to 100 $\mu$ m	typ. $\leq \pm 0.02$ dB
$>100$ $\mu$ m	typ. $\leq \pm 0.002$ dB
Linearity (power): <sup>5,8</sup>	(CW -40 dBm to +38 dBm, 970 nm to 1630 nm)
$\leq 10$ dBm	$\leq \pm 0.03$ dB
$>10$ dBm to $\leq 20$ dBm	$\leq \pm 0.06$ dB
$>20$ dBm to $\leq 37$ dBm	$\leq \pm 0.09$ dB
$>37$ dBm to $\leq 38$ dBm	$\leq \pm 0.10$ dB at 23 °C $\pm 5$ °C, for operating temperature range add $\pm 0.03$ dB
Return loss	typ. $> 75$ dB
Noise (peak to peak) <sup>6</sup>	$< 5$ nW
Averaging time (minimal)	100 $\mu$ s
Analog Output	Included
Dimensions (H x W x D)	55 mm x 80 mm x 250 mm
Weight	0.9 kg (without heat sink)
Recommended recalibration period	2 years
Operating temperature <sup>7</sup>	0 °C to +40 °C
Humidity	Non-condensing
Warm-up time	40 min

**Safety Note:**

For optical power higher than +34 dBm the attached heat sink MUST be used!

For continuous optical power or average optical power higher than +38 dBm the connector adapters will get warmer than permitted according to the safety standard IEC 61010-1.

The 81628B Optical Head can handle optical power up to +40 dBm, however, operation above +38 dBm is at the operators own risk.

Keysight Technologies Deutschland GmbH will not be liable for any damages caused by an operation above +38 dBm.

- Reference Conditions:
  - Power level 10  $\mu$ W (-20 dBm), continuous wave (CW)
  - Averaging time 1 s
  - Parallel beam, 3 mm, center of sphere input
  - Ambient temperature 23 °C  $\pm 5$  °C
  - On day of calibration (add  $\pm 0.3\%$  for aging over one year, add  $\pm 0.6\%$  over two years)
  - Spectral width of source  $< 10$  nm (FWHM)
  - Wavelength setting at power sensor must correspond to source wavelength  $\leq \pm 0.4$  nm
  - Humidity 50%  $\pm 10\%$
- Operating Conditions:
  - Parallel beam,  $\varnothing 3$  mm, center of sphere input, or connectorized fiber with NA  $\leq 0.2$  (straight connector)
  - For NA  $> 0.2$ : add 1%
  - Within one year after calibration, add  $\pm 0.3\%$  for second year
  - Operating temperature range as specified, humidity  $< 80\%$  and non-condensing
  - Zeroing required
- All states of polarization at constant wavelength (1550 nm  $\pm 30$  nm) and constant power.
- Conditions:
  - Wavelength 1550 nm  $\pm 30$  nm, fixed state of polarization, constant power
  - Temperature 23 °C  $\pm 5$  °C
  - Measurement time  $\leq 3$  min
- Does not include noise; zeroing required
- Averaging time 1 s, T = 23 °C  $\pm 5$  °C,  $\Delta T \pm 1$  °C, observation time 300 s, wavelength range 970 nm to 1630 nm; thermal drift at +38 dBm, exposure time 30 min:
  - Recovery time 10 min:  $\leq 30$  nW
  - 30 min:  $\leq 10$  nW
- For input power  $> 30$  dBm the maximal operating temperature is limited to 35 °C
- Wavelength must not be equal to any water absorption line

## Supplementary Performance Characteristics

### Analog Output

Bandwidth  $\geq$ DC,  $\leq$ 300 to 5000 Hz depending on range and optical head.  
 Output voltage 0 to 2 V non-terminated  
 Output impedance 600 Ohm typ.  
 Max. input voltage  $\pm$ 10V

Range	Band width 81620B	Band width 81622B/3B	Band width 81624B/6B/7B	Band width 81628B
+40 dBm	N/A	N/A	N/A	3.5 kHz
+30 dBm	N/A	N/A	N/A	3.5 kHz
+20 dBm	N/A	N/A	N/A	3.5 kHz
+10 dBm	5.0 kHz	5.0 kHz	5.0 kHz	3.5 kHz
0 dBm	5.0 kHz	5.0 kHz	5.0 kHz	1.8 kHz
-10 dBm	5.0 kHz	5.0 kHz	5.0 kHz	1.8 kHz
-20 dBm	5.0 kHz	5.0 kHz	5.0 kHz	0.12 kHz
-30 dBm	0.5 kHz	0.5 kHz	1.8 kHz	0.12 kHz
-40 dBm	0.5 kHz	0.5 kHz *	1.8 kHz	N/A
-50 dBm	0.05 kHz	0.05 kHz *	0.12 kHz †	N/A
-60 dBm	0.05 kHz	0.05 kHz *	0.12 kHz †	N/A

\* Not applicable for 81622B

† Not applicable for 81626B

## Maximum Safe Input Power

Model	Maximum Safe Input Power
81620B	+16 dBm
81623B	+16 dBm
81624B	+16 dBm
81626B	+23.5 dBm (850 nm to 1650 nm) +27.5 dBm (1250 nm to 1650 nm)
81628B	+40.5 dBm



# 4 Performance Tests

The procedures in this section test the performance of the instrument. The complete specifications to which Keysight 81623B/4B/6B/8B Optical Heads are tested are given in “[Specifications](#) on page 29”. All tests can be performed without access to the interior of the instrument. The test equipment given corresponds to tests carried out with Diamond HMS-10 connectors.

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## Equipment Required

Equipment required for the performance test is listed in the table below. Any equipment that satisfies the critical specifications of the equipment given in the table may be substituted for the recommended models.

**Table 8 Equipment Required for Performance Test**

Instrument/Accessory	Recommended Model	Interface		Optical Head				Required Characteristics	Alternative Models
		81618A	81619A	81623B	81624B	81626B	81628B		
Multimeter Mainframe	8163A/B	1 ea	1 ea	2 ea	2 ea	2 ea	2 ea	8164A/B  Keysight 81619A    Keysight 81657A	
Interface Module	Keysight 81618A	-	-	x	x	x	x		
Optical Head	8162x	1 ea	2 ea	-	-	-	-		
CW Laser Module	Keysight 81657A	-	-	x	x	x	x		
CW Laser Module	81654A	-	-	x	x	x	x		
Power Meter Standard	Keysight 81618A Optical Head Interface Module with Keysight 81623B #C01	-	-	x	-	-	-		
Power Meter Standard	Keysight 81618A Optical Head Interface Module with Keysight 81624B #C01	-	-	-	x	x	x		
Power Sensor Module	Keysight 81634B	-	-	x	x	x	x		
Optical Attenuator	8156A #221	-	-	x	x	x	x		
Optical Attenuator	8156A #101	-	-	x	x	x	x		
Return Loss Reference Cable	Keysight 81610CC	-	-	x	x	x	x		
Return Loss Module	Keysight 81613A	-	-	x	x	x	x		
Kit, Performance Test	81628-68705	-	-	-	-	-	x		
Tunable Laser Source	8164A and 81680A #022	-	-	-	0	0	0		
Polarization Controller	11896A #025	-	-	-	0	0	0		

Instrument/Accessory	Recommended Model	Interface		Optical Head				Required Characteristics	Alternative Models
		81618A	81619A	81623B	81624B	81626B	81628B		
Wavelength Independent Coupler (3 dB)	Special Tool	-	-	-	o	o	o		
Best IF Adapter	Special Tool	-	-	-	o	o	o		
Worst IF Adapter	Special Tool	-	-	-	o	o	o		
Singlemode Fiber	81101AC (2/1* ea)	-	-	x	x	x	x		
Connector Adapters	81101PC (1 ea)	-	-	-	-	-	-		
	81102SC (1 ea)	-	-	-	-	-	x		
	81113PC (3 ea)	-	-	x	x	x	x		
	81113SC (1 ea)	-	-	x	x	x	x		
	81000AA (2 ea)	-	-	x	x	x	x		
	81000SA (1 ea)	-	-	x	x	x	x		
	81001SA (1 ea)	-	-	-	-	-	-		
	81000FA (1/2*ea)	-	-	x	x	x	x		
Connector Interfaces	81001FA (1 ea)	-	-	-	-	-	-		
	81000AI (3 ea)	-	-	x	x	x	x		
	81000FI (3 ea)	-	-	x	x	x	x		
	81000SI (4 ea)	-	-	x	x	x	x		
Plastic Cap	PN 5040-9351	-	-	x	x	x	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 81618A/19A Interface module or Keysight 81623B/4B/6B/8B Optical Head fails any performance test, return the instrument to the nearest Keysight Technologies Sales / Service Office for repair.

## Instrument Specification

Specifications are the performance characteristics of the instrument that is certified. These specifications, listed in [Specifications](#) on page 29, are the performance standards or limits against which the Keysight 81623B/4B/6B/8B Optical Head can be tested. [Specifications](#) on page 29 also lists some supplemental characteristics of the Keysight 81623B/4B/6B/8B Optical Head. Supplemental characteristics should be considered as additional information.

Keysight 81618A/19A Interface Modules are tested for functionality only.

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.

## Functional Tests

The functional test applies to the Keysight 81618A/19A Interface modules.

Mainframe 8163A/B with  
8161xA Interface Module as DUT

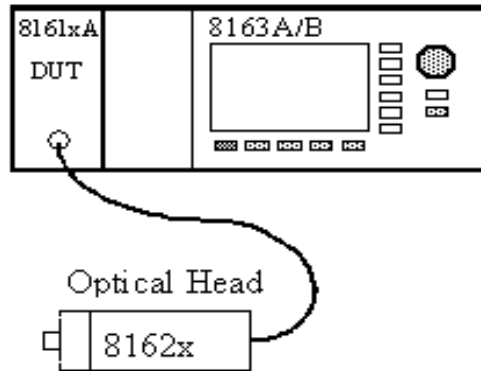


Figure 7 Functional Test Setup

- 1 Set up the equipment as shown in [Figure 7](#) on page -47
- 2 If you are using a Keysight 81619A Interface module connect one optical head to channel 1 and the other to channel 2
- 3 Power up the mainframe.

If the Keysight 81618A/19A passes all self-tests, the module is considered fully functional.

## Performance Tests

The performance tests given in this section includes the Accuracy Test, the Linearity Test, the Return Loss Test (for the 81623B/26B) and the Noise Test. The performance tests for the Keysight 81624B/6B also include – as optional tests – the Relative Polarization Uncertainty and the Relative Interference Uncertainty Test. Perform each step in the order given, using the corresponding test equipment.

### NOTE

**Make sure that all optical connections are dry and clean. DO NOT USE INDEX MATCHING OIL. For cleaning, use the cleaning instructions given in [Cleaning Information](#) on page 87.**

The optical cables from the laser source to the 8156A Attenuator and from there to the power meter must be fixed to the table to ensure minimum cable movement during the tests.

For 81628B only

The performance test for the 81628B High Power Head does not differ from the test procedure for an optical head without an integrating sphere, except for the linearity test. The integrating sphere of the 81628B has to be disconnected for testing the linearity of the head alone. A special adapter and a disconnecting tool are necessary for disconnection. These tools are included in the Performance Test Kit (order P/N 81628-68705).

If the integrating sphere is disconnected the performance of the 81628B has to be verified. If performing a performance test on the 81628B that includes the linearity test, it is necessary to start the procedure with the linearity test and then perform the accuracy and noise tests afterwards.

The non-linearity of the 81628B is not normally tested up to the specified power level of +38 dBm. The linearity test only verifies the linearity of the head without the integrating sphere up to 10 dBm (equivalent to 40 dBm with the integrating sphere). The attenuation of the integrating sphere is typically  $31 \pm 1$  dB, hence the maximum input power for the photodiode is in the range 6 - 8 dBm and so the test described below covers this input power range of the photodiode. The contribution of the sphere to the non-linearity is caused by the heating of the sphere due to applied power  $> 30$  dBm. These linearity characteristics are determined by sample testing of the 81628B in OCMD's metrology lab.



The thermal characteristics of the sphere do not change from device to device, or during the product lifetime. If a head without the sphere passes the linearity test within the specifications given on the Test Record Sheet, then the whole system – sphere and head – is within the product specification.

The head and the integrating sphere of the 81628B are adjusted and serialized together, therefore the specifications of the 81628B are only valid for that given combination of head and integrating sphere.

The disconnecting and connecting of the integrating sphere may change the performance verification data slightly.

#### Accuracy Test

This performance test applies to Keysight 81623B/4B/6B/8B Optical Heads.

#### NOTE

The linearity test must only be performed at either 1310 nm or 1550 nm. The accuracy test must be performed in the - 20 dBm range at 10.0  $\mu$ W at both 1310 nm and 1550 nm.

---

## Test Setup

- 1 Make sure that cable connector, detectors and adapters are clean.
- 2 Connect the equipment as shown in Figure 8.

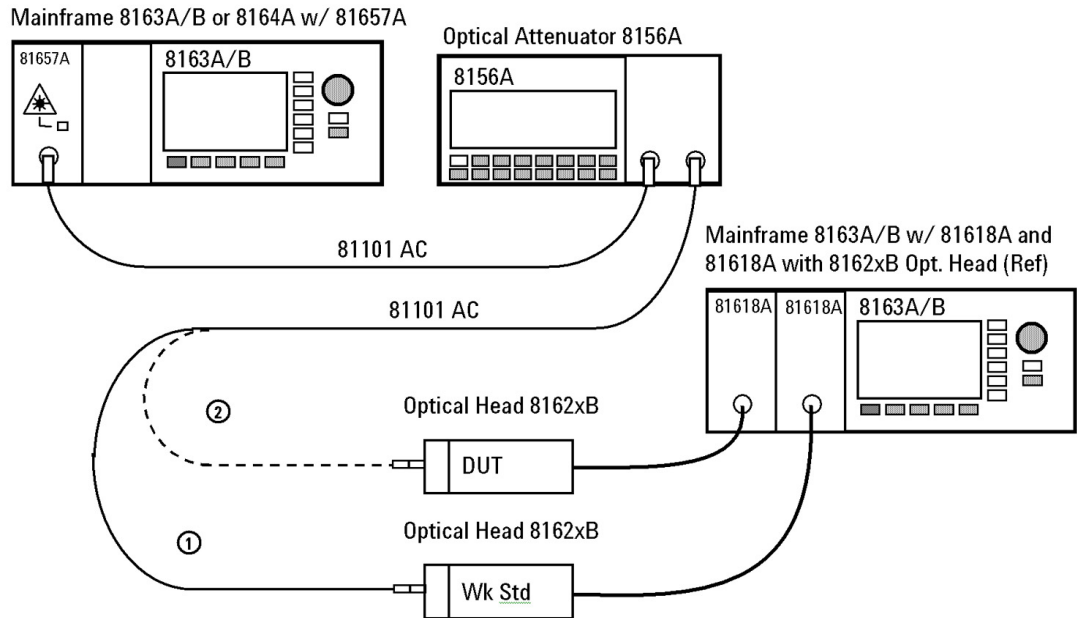


Figure 8 Accuracy Test Setup

**NOTE**

Make sure that the cables to and from the attenuator are fixed on the table and that both the optical head and the DUT are close together so that minimum cable movement is required when connecting the cable to the head or to the DUT.

Use 81101PC patchcord for measurement path and 81001FA connector adapter (for the DUT) and 81000FA connector adapter (for reference power meter) instead.

- 3 Move to the Laser Source channel, move to the wavelength parameter, [ $\lambda$ ], press *Enter*, select the lower wavelength source, and press *Enter*.

- 4 If you are using a Keysight 81657A Laser Source make sure you initialize the Keysight 8156A Optical Attenuator with 30 dB attenuation.
- 5 Turn the instruments on, enable the laser source and allow the instruments to warm up for at least 20 minutes.
- 6 Perform the following sub-procedure for both Power Meters:
  - a Move to the Power Meter channel.
  - b Move to the wavelength parameter, [ $\lambda$ ], press *Enter*, enter the wavelength of the laser source, and press *Enter*.
  - c Move to the calibration parameter, [*CAL*], press *Enter*, set the calibration parameter to zero, and press *Enter*.
  - d Move to the averaging time parameter, [*AvgTime*], press *Enter*, move to <500 ms>, and press *Enter*.
  - e Move to the power parameter, [*P*], press [Pwr unit], move to <Watt>, and press *Enter*.
- 7 Make sure the optical input of the Device Under Test (DUT), 8162xA/B, is not receiving any light by placing a plastic cap over the input. Move to the DUT Power Meter channel, press [Menu], move to <Zero>, press *Enter*.
- 8 Ensure that the Keysight 8156A output is disabled. Move to the reference Power Meter channel that uses the Keysight 8162xB Optical Head and Keysight 81618A Optical Head Interface module, press [Menu], move to <Zero>, press *Enter*.
- 9 Enable the Keysight 8156A output and change the attenuation until the reference Power Meter displays 10.00 mW.
- 10 Connect the attenuator output cable to the DUT Power Meter. Note the power value returned from the DUT, [*P*], from the display and note the result in the test record.
- 11 Move to the Laser Source channel, move to the wavelength parameter, [ $\lambda$ ], press *Enter*; select the longer wavelength source, and press *Enter*.
- 12 Repeat steps step 4 to step 10 at the second wavelength with the corresponding source.

### Linearity Test

This performance test applies to Keysight 81623B/4B/6B/8B Optical Heads.

**NOTE**

81628B only:

You have to disconnect the integrating sphere of the 81628B head to verify the linearity. Use the 81102SC high return loss patchcord to connect the DUT to the attenuator.

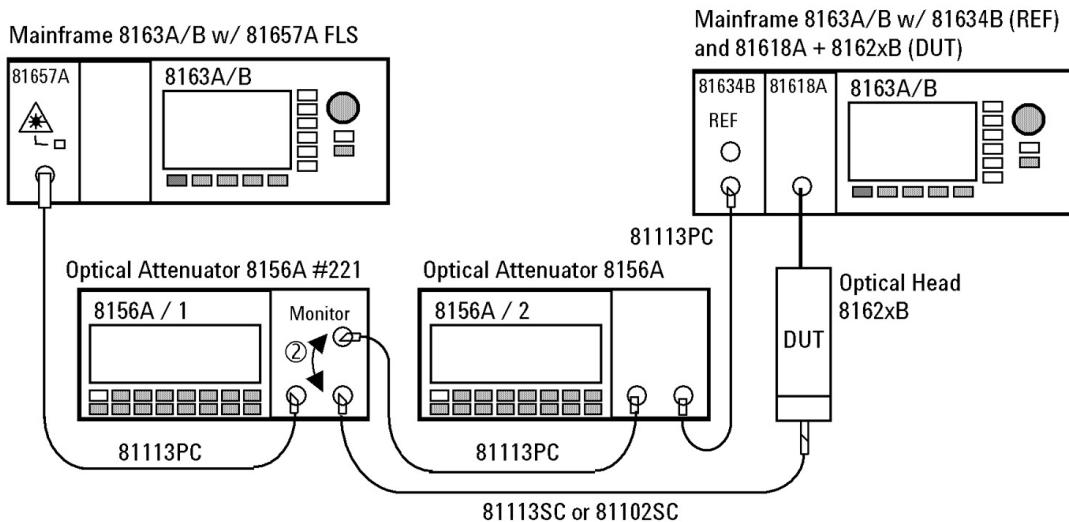


Figure 9 Measurement Setup for Power Linearity

### Test Setup

**NOTE**

- Do not turn the laser off during the measurement!
- Clean all connectors carefully before you start with the measurement!

**NOTE**

The linearity test checks the in- range linearity as well as the range discontinuity. Therefore, two values are measured at the same power but within different power ranges (range discontinuity) and two different power values, one on the lower and the other on the upper limit of the power range, are measured within the same power range (in- range linearity).

Perform the test until the power reading of the DUT shows:

- for 81623B: -47.x dBm
- for 81624B: -57.x dBm
- for 81626B: -37.x dBm
- for 81628B: -57.x dBm (without sphere)

- 1 Make sure that cable connector, detectors and adapters are clean.
- 2 Make sure that you perform this test in a temperature-controlled environment with temperature fluctuations less than  $\pm 1^{\circ}\text{C}$ .
- 3 Setup the equipment as shown in Figure 9. Disable both attenuators and enable the laser source, where the source wavelength is chosen to 1550 nm. If you are using the 81657A, move to the wavelength parameter, [I], press *Enter*, select the longer wavelength source (1550 nm nominally), and press *Enter*.
- 4 Set the wavelength of both attenuators to the same wavelength as the laser source.
- 5 Perform the following sub-procedure for both Power Meters:
  - a Move to the Power Meter channel.
  - b Move to the wavelength parameter, [I], press *Enter*, enter the wavelength of the laser source, and press *Enter*.
  - c Move to the calibration parameter, [CAL], press *Enter*, set the calibration parameter to zero, and press *Enter*.
  - d Move to the averaging time parameter, [AvgTime], press *Enter*, move to <100 ms>, and press *Enter*.
  - e Move to the power parameter, [P], press [Pwr unit], move to <dBm>, and press *Enter*.
  - f Press the [Menu] softkey and move to <Number of digits>, press *Enter*, move to <3>, press *Enter* and press [Close].

**NOTE**

Always include at least three digits after the decimal point when you note a power reading.

- 6 Initialize the two attenuators as follows:
  - a Set the attenuation of the 8156A #221 with Monitor Output (referred to as Atty1) to 0 dB.
  - b Set the attenuation of the other 8156A (referred to as Atty2) to 35 dB.
- 7 Wait at least 15 minutes until the laser source has stabilized.
- 8 Perform the following sub-procedure for the reference Power Meter, 81634B:
  - a Press [Menu], move to <Range mode>, move to <Manual>, and press *Enter*.
  - b Move to <Range>, press *Enter*, move to <-50 dBm>, press *Enter*, and press [Close].
- 9 Perform the following sub-procedure for the DUT, 8162xB:
  - a Press [Menu], move to <Range mode>, move to <Manual>, and press *Enter*.
  - b Move to <Range>, press *Enter*, move to <10 dBm>(40 dBm for 81628B), and press *Enter*.
  - c Zero both Power Meters. Move to <Zero all> and press *Enter*.
- 10 Enable both attenuators.
- 11 Adjust the attenuation of Atty2 in order to achieve -47.2 dBm on the reference Power Meter.

**NOTE****For 81628B:**

Before starting the measurement move to the DUT channel and enter a calibration factor of 31 dB. This simulates the disconnected integrating sphere. If the power at the DUT overflows when switching to the lower range decrease the calibration factor (e.g. to 30 dB) and start the linearity test again.

---

**+10 dBm Range (equivalent to +40 dBm range for 81628B)**

- 1 Applies to the 81626B only:  
Switch to the 20 dBm range and note both power readings as n=0 in the test record, which is given at the end of the test descriptions (#0, that is n=0). Switch back to the 10 dBm range.
- 2 Note both power readings as the first value (n=1) in the test record, which is given at the end of the test descriptions (#1).
- 3 Increase the attenuation of Atty1 until the power reading of the DUT shows about +2.8 dBm.
- 4 Note the InRange-values in the test record (#2)
- 5 At the DUT, 8162xB, move to <Range>, press *Enter*, move to <0 dBm> (30 dBm for 81628B), and press *Enter*.
- 6 Adjust the attenuation of Atty2 in order to be on the upper limit of the -50 dBm range at the reference power meter (i.e. -47.2 dBm).

**0 dBm Range (equivalent to +30 dBm range for 81628B)**

- 1 Disable Atty1.
- 2 Zero both Power Meters. On the 8163A/B with two installed power meters, press [Menu], move to <Zero all>, and press *Enter*.
- 3 Enable Atty1.
- 4 Switch one range up to the +10 dBm range (+40dBm for 81628).
- 5 Note both power readings (#3).
- 6 Switch down to the previous range (0 dBm, 30 dBm for the 81628B) and note the values again (#4).
- 7 Increase Atty1 by 10 dB and note the results in the test record (#5).
- 8 At the DUT, 8162xB, press [Menu], move to <Range>, press *Enter*, move to <-10 dBm>(20 dBm for the 81628B), press *Enter*; and press [Close].
- 9 If necessary, adjust the attenuation of Atty1 in order to be on the upper limit of the range (i.e. -x7.y dBm).
- 10 Decrease the attenuation of Atty2 by 10 dB in order to be on the upper limit of the -50 dBm range at the reference power meter.

**-10 dBm Range (equivalent to +20 dBm range for 81628B)**

- 1 Disable Atty1
- 2 Zero both Power Meters. On the 8163A/B with two installed power meters, press [Menu], move to <Zero all>, and press *Enter*.
- 3 Enable Atty1.
- 4 Switch one range up to the 0 dBm range (30 dBm for the 81628B) and note the power readings (#6).

- 5 Switch down to the previous range (-10 dBm, 20 dBm for the 81628B) and note the values again (#7).
- 6 Increase the attenuation of Atty1 by 10 dB and note the results in the test record (#8).
- 7 At the DUT, 8162xB, press [Menu], move to <Range>, press *Enter*, move to <-20 dBm>(10 dBm for the 81628B), press *Enter* and press [Close].
- 8 If necessary, adjust the attenuation of Atty1 in order to be on the upper limit of the range (i.e. -x7.y dBm).
- 9 Decrease the attenuation of Atty2 to 10 dB in order to be on the upper limit of the -50 dBm range at the reference power meter.

#### **-20 dBm Range (equivalent to +10 dBm range for 81628B)**

- 1 Disable Atty1.
- 2 Zero both Power Meters. On the 8163A/B with two installed power meters, press [Menu], move to <Zero all>, and press *Enter*.
- 3 Enable Atty1.
- 4 Switch one range up to the -10 dBm (20 dBm for the 81628B) range and note the power readings (#9).
- 5 Switch down to the previous (-20 dBm, 10 dBm for the 81628B) and note the power readings again (#10).
- 6 Increase the attenuation of Atty1 by 10 dB and note the results in the test record (#11).
- 7 On the DUT switch one range down to the -30 dBm (0 dBm for the 81628B) range.
- 8 If necessary, adjust the attenuation of Atty1 in order to be on the upper limit of the range (i.e. -x7.y dBm).
- 9 Decrease the attenuation of Atty2 by 10 dB in order to be on the upper limit of the -50 dBm range.

#### **-30 dBm Range (equivalent to 0 dBm range for 81628B)**

- 1 Disable Atty1.
- 2 Zero both power meters. On the 8163A/B with two installed power meters, press [Menu], move to <Zero all>, and press *Enter*.
- 3 Enable Atty1.
- 4 Switch one range up to the -20 dBm range (10 dBm for the 81628B) and note the power readings (#12).
- 5 Switch down to the previous range (-30 dBm, 0 dBm for the 81628B) and note the values again (#13).



- 6 Increase the attenuation of Atty1 by 10 dB and note the results in the test record (#14).
- 7 On the DUT switch one range down to the -40 dBm (-10 for 81628B) range.

#### Change Setup

- 1 Disable Atty1 and switch the output with the monitor output.
- 2 Set the attenuation of Atty1 to 35 dB and of Atty2 to 25 dB.
- 3 Enable Atty1 again.
- 4 Adjust the attenuation of both attenuators in the following order:
  - a Atty1: DUT Power Meter shows a reading of -37.2 dBm.
  - b Atty2: the REF Power Meter shows a reading of -47.2 dBm.

#### -40 dBm Range (equivalent to -10 dBm range for 81628B)

- 1 Disable Atty1.
- 2 Zero both Power Meters. On the 8163A/B with two installed power meters, press [Menu], move to <Zero all>, and press Enter.
- 3 Enable Atty1.
- 4 Switch one range up to the -30 dBm (0 dBm for the 81628B) range and note the power readings (#15).
- 5 Switch one range down (-40 dBm, -10 dBm for the 81628B) and note the power readings again (#16).
- 6 Increase the attenuation of Atty1 by 10 dB and note the results in the test record (#17).
- 7 On the DUT switch one range down to the -50 dBm range (-20 dBm for the 81628B).
- 8 If necessary, adjust the attenuation of Atty1 in order to be on the upper limit of the range (i.e. -x7.y dBm).
- 9 Decrease the attenuation of Atty2 by 10 dB in order to be on the upper limit of the -50dBm range at the reference power meter.

#### -50 dBm Range (equivalent to -20 dBm range for 81628B)

- 1 Disable Atty1.
- 2 Zero both power meters. On the 8163A/B with two installed power meters, press [Menu], move to <Zero all>, and press Enter.
- 3 Enable Atty1.
- 4 Switch one range up to the -40 dBm (-10 dBm for the 81628B) range and note the power readings (#18).

- 5 Switch one range down (-50 dBm, -20 dBm for the 81628B)) and note the power readings (#19).
- 6 Increase the attenuation of Atty1 by 10 dB and note the results in the test record (#20).

**Calculation**

- 1 Calculate the non-linearity using the formulas given in the test record.

## Example: Measurement Results

Information only				Your Entries		Notes
n	Atty1 / #221 [dB]	Atty2 / #100 [dB]	DUT Range [dBm]	REF Power [dBm]	DUT Power [dBm]	
1	0	42	10	-47,1915	9,4273	1. Value
2	6,6	42	10	-53,769	2,8467	InRange
3	6,6	35,5	10	-47,262	2,8524	RangeDisc / lower limit
4	6,6	35,5	0	-47,2605	2,8543	RangeDisc / upper limit
5	16,6	35,5	0	-57,2304	-7,1141	InRange
6	16,6	25,5	0	-47,2363	-7,1118	RangeDisc / lower limit
7	16,6	25,5	-10	-47,2347	-7,1097	RangeDisc / upper limit
8	26,6	25,5	-10	-57,2345	-17,111	InRange
9	26,6	15,5	-10	-47,2411	,17,106	RangeDisc / lower limit
10	26,6	15,5	-20	-47,2382	-17,1054	RangeDisc / upper limit
11	36,6	15,5	-20	-57,228	-27,0942	InRange
12	36,6	5,5	-20	-47,2317	-27,0864	RangeDisc / lower limit
13	36,6	5,5	-30	-47,2318	-27,0873	RangeDisc / upper limit
14	46,6	5,5	-30	-57,2336	-37,089	InRange
15	35,5	17,6	-30	-47,219	-37,253	RangeDisc / lower limit
16	35,5	17,6	-40	-47,2195	-37,22538	RangeDisc / upper limit
17	45,5	17,6	-40	-57,1333	-47,166	InRange
18	45,5	7,6	-40	-47,1411	-47,164	RangeDisc / lower limit
19	41,2	11,3	-50	-47,1355	-47,1664	RangeDisc / upper limit
20	51,2	11,3	-50	-57,134	-57,163	InRange

### Calculations

	Conversion [dBm] @ [mW]		Calculation as given			Calculation as given	
n	REF Power [mW] (Rn)	DUT Power [mW] (Dn)	Relation 1 (An)		Relation 2 (Bn)		Non-Linearity $= A_n * B_n^{*(NL_{n\pm 1} + 1)} - 1$ [%]
1	1,90919E-05	8,76455761	0,2199125	$= R_{n+1}/R_n$	4,5505092	$= D_n/D_{n+1}$	0,1
2	4,19856E-06	1,926060834					
3	1,87845E-05	1,928590397	1,0003454		0,9995626		0,03
4	1,8791E-05	1,929434323	0,1006955		9,9275024		0,04
5	1,89217E-06	0,194352441					
6	1,8896E-05	0,194455396	1,0003685		0,9995166		0,08
7	1,8903E-05	0,194549447	0,1000046		10,002994		0,09
8	1,89038E-06	0,019449122					
9	1,88751E-05	0,019471526	1,000668		0,9998619		0,05
10	1,88877E-05	0,019474217	Reference Level			0,00	
11	1,89322E-06	0,00195245	9,9765412	$= R_{n-1}/R_n$	0,1002582	$= D_n/D_{n-1}$	0,02
12	1,8916E-05	0,00195596					
13	1,89156E-05	0,001955555	1,000023		0,9997928		0,01
14	1,89078E-06	0,000195479	10,004146		0,0999609		0,01
15	1,89714E-05	0,000188235					
16	1,89692E-05	0,0001882	1,0001151		0,99981581		0,00
17	1,93495E-06	1,92044E-05	9,803474		0,1013767		0,03
18	1,93593E-05	1,92132E-05					
19	1,93997E-05	1,92026E-05	1,001013651		0,9994475		0,08
20	1,93464E-06	1,92176E-06	9,996546719		0,1000783		0,13

**NOTE**

The Nonlinearity is calculated recursively using  $n=10$  as reference point. The formula is:

$$NL_n = \begin{cases} A_n * B_n \cdot (NL_{n+1} + 1) - 1 & \text{for } n < 10 \\ A_n * B_n \cdot (NL_{n-1} + 1) - 1 & \text{for } n > 10 \end{cases}$$

where  $NL_{n+1}$  or  $NL_{n-1}$  is the previously calculated nonlinearity value. For  $n=1, 4, 7$  the values are  $NL_{n+2}$ , while they are  $NL_{n-2}$  for  $n=13, 16, 19$ .

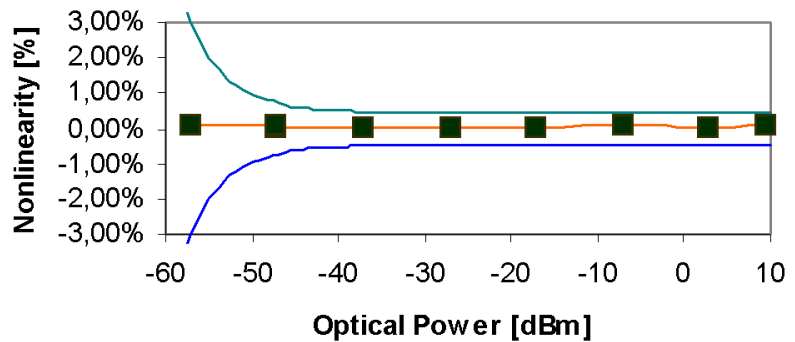
**Linearity of 81624B**

Figure 10 Example of Linearity Test Result

## Noise Test

This performance test applies to Keysight 81623B/4B/6B/8B Optical Heads.

**NOTE**

**You must insert a module or a blank panel in the second channel position of the Keysight 8163A/B Lightwave Multimeter before you perform the noise measurement.**

- 1 Insert a Keysight 81618A or a Keysight 81619A Optical Head Interface module into one slot of the Keysight 8163A/B Lightwave Multimeter and connect the device under test, an 8162xA/B Optical Head, to the Optical Head Interface module.
- 2 Make sure the optical input of the Device Under Test (DUT), an 8162xA/B Optical Head, is not receiving any light by placing a plastic cap over the input adapter. Move to the DUT Power Meter channel, press [Menu], move to <Zero>, and press *Enter*.
- 3 Press *Appl*, move to <Stability>, and press *Enter*. The Stability Setup Screen appears.
- 4 Ensure that the correct channel is selected in the upcoming Module Selection box.
- 5 Press [Menu] to access the Logging application menu screen.
- 6 Move to <Pwr unit>, press *Enter*, move to <W>, and press *Enter*.
- 7 Move to <AvgTime>, press *Enter*, move to <1 s>, and press *Enter*.
- 8 Move to <Range mode>, press *Enter*, move to <Auto>, and press *Enter*, and press [Close].
- 9 Press the [Parameter] softkey, move to [TotalTime], press *Enter*, set the total time to 00:05:00, which is 5 minutes, and press *Enter*.
- 10 Press the [Measure] softkey to start the measurement.
- 11 After the stability application has finished, press the [Analysis] softkey, press the [more] softkey, and note [DP] as the noise value in the test record.

## Return Loss Test

This performance test applies to Keysight 81623B/4B/6B/Optical Heads.

- 1 Make sure that all connectors are clean.
- 2 Connect the equipment as shown in Figure 11.
- 3 Press [*Preset*] on the mainframe

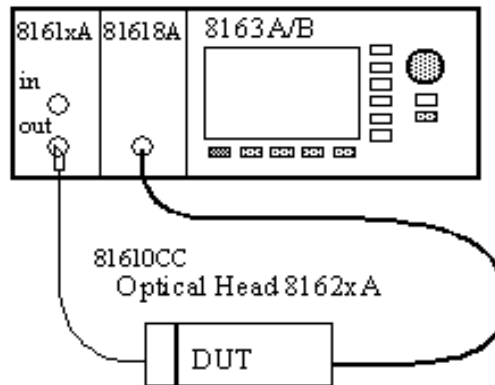


Figure 11 Return Loss Reference Setup

**NOTE**

To ensure traceability, use the 81610CC Reference Cable for calibration measurements. Do not use the 81610CC Reference Cable for measurements on a Device Under Test. Instead, use a measurement patchcord.

**CAUTION**

It is important to maintain the quality of the straight connector end of the 81610CC Reference Cable. Never add another connector to the straight end of the 81610CC Reference Cable, since a physical connection is made. When the straight end of the 81610CC Reference Cable is connected to the 81634B Power Sensor module, no physical connection is made so there should be no degradation of connector quality.

- 4 Zero the Return Loss Module and the Optical Head
- 5 Enable the internal laser source of the Return Loss Module and allow 20 minutes for it to stabilize.

- 6 At the Power Meter:
  - a Set the averaging time [*AvTime*] to 1s
  - b Set the wavelength [ $\lambda$ ] to the wavelength of the RTL source.
  - c Set [Pwr unit] to <db>.
- 7 At the Return Loss Module:
  - a Set the averaging time [*AvTime*] to 1s.
  - b Enter the Return Loss Reference value RLref of the 81610CC reference cable for this wavelength.
  - c Press [RefCal] to calibrate the Return Loss module at reference condition.
- 8 At the Power Meter press [Disp -> Ref]. The Power Meter should now read 0.0 dB.
- 9 Disconnect the 81610CC Reference Cable from the setup and connect a 81113SC user cable to the Return Loss Module and leave the other end open as shown in Figure 14.

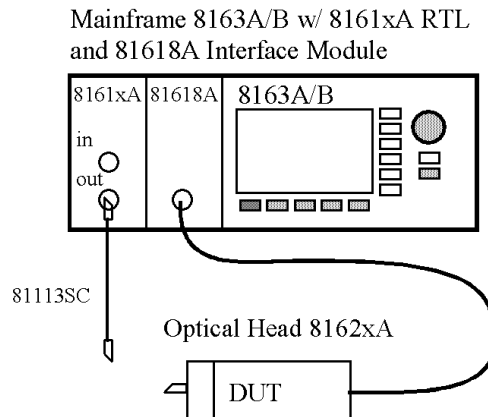


Figure 12 Return Loss Measurement Setup

- 10 At the Return Loss Module, press [TermCal] in order to calibrate the Return Loss Module at termination condition.

## NOTE

Do not wrap the cable. The termination condition is realized with the open end of the patchcord.



- 11 Now connect the open end to the optical head.
- 12 Enter the Power reading [P] on the optical head as [FPDelta] on the Return Loss Meter. Make sure you enter the sign of this value correctly.
- 13 Note the Return Loss reading as the Return Loss result into the test record.

#### Relative Uncertainty due to Polarization (Optional Test)

### NOTE

The performance test "Relative Uncertainty due to Polarization" is optional, since the polarization is given with the production of the unit by mechanical and optical cavities and is unchanged by normal use of the sensor module.

Refer to [Figure 13](#) on page -66 for a setup to verify the relative uncertainty due to polarization of the sensor module.

Generally, during this measurement procedure the tunable laser source is swept through a predefined wavelength range. After every wavelength step, a single PDL-measurement is made, where the polarization controller generates all the different polarization states. The highest PDL value is taken as the "relative uncertainty due to polarization". The low output power path of the coupler is used to monitor the power stability of the setup.

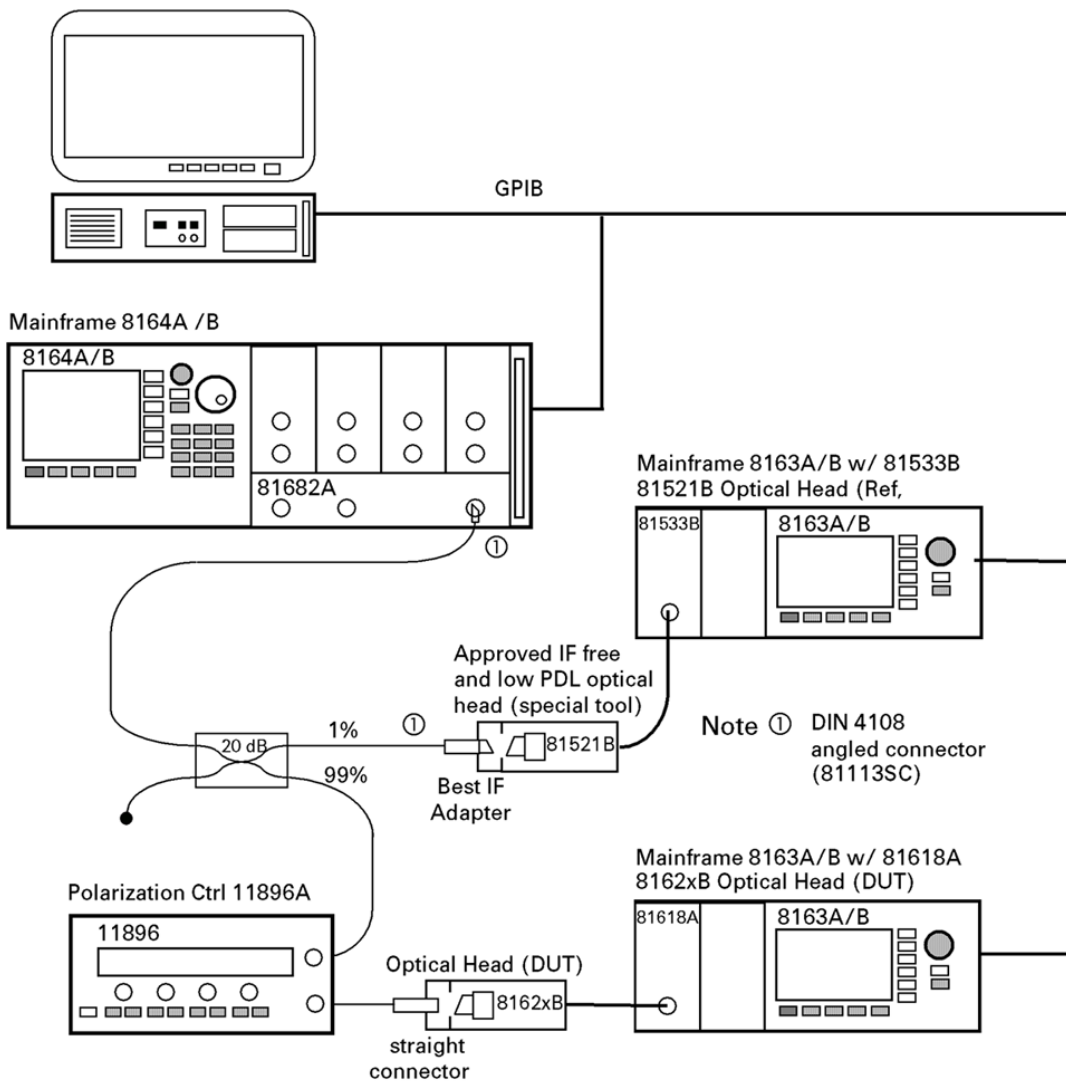


Figure 13 Measurement Setup for PDL Test

## Relative Uncertainty due to Interference (Optional Test)

**NOTE**

The performance test "Relative Uncertainty due to Interference" is optional, since the interference is given with the production of the unit by mechanical and optical cavities and is unchanged by normal use of the sensor module.

---

Refer to [Figure 14](#) on page -68 for a test setup to verify the relative uncertainty due to interference within the optical head optical assembly. In order to perform the relative uncertainty due to interference test, it is mandatory to use two mainframes, since the time difference between measurement A and B for a specific wavelength point has to be no greater than 2 ms. Due to this short measurement interval, the performance test of the Relative Uncertainty Due to Interference can only be performed under computer control.

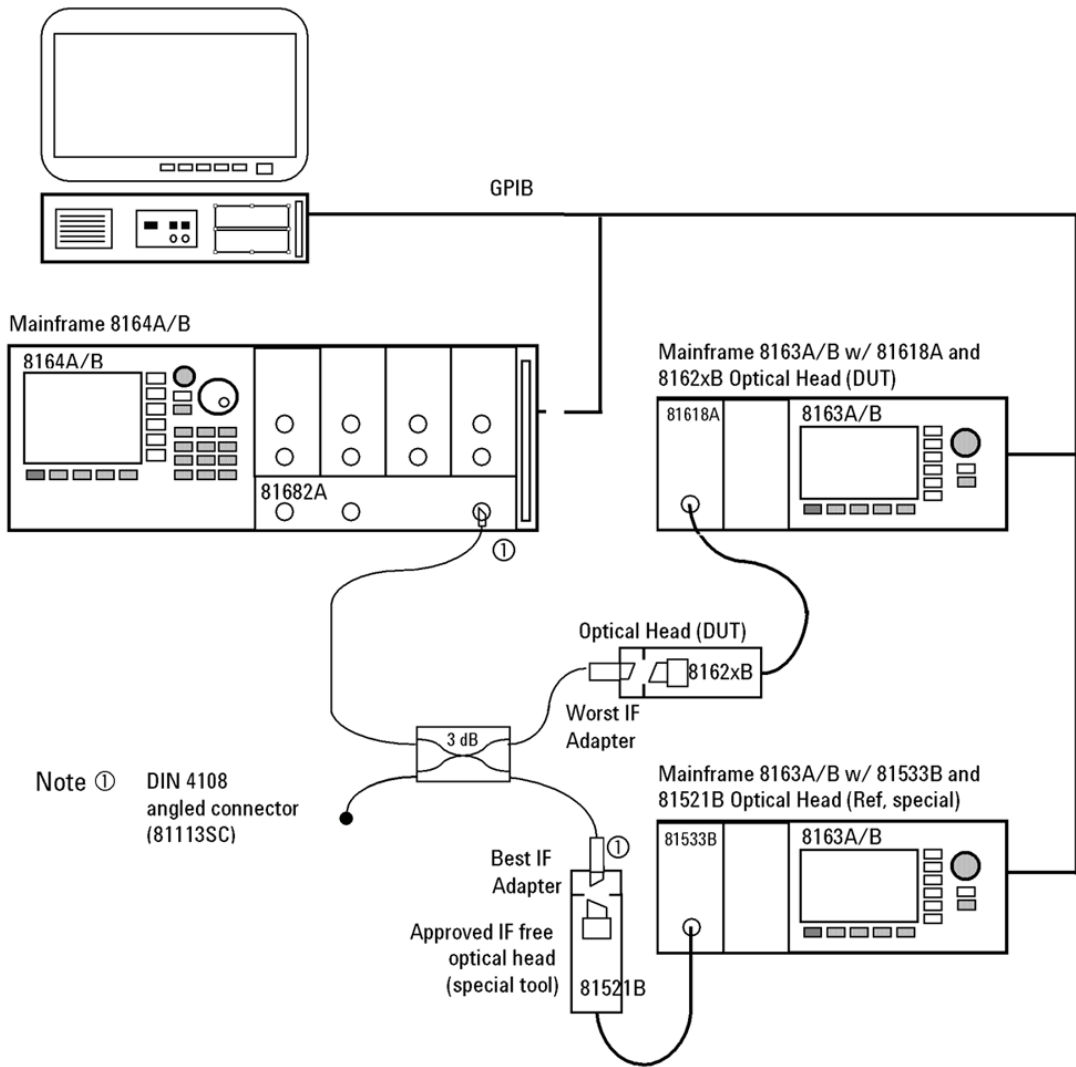


Figure 14 Setup for Relative Uncertainty due to Interference Measurement

Theoretically, both Power Meters are monitoring the power ratio over the variable wavelength in a predefined range as shown in Figure 15. Ensure that the tunable laser source is mode-hop free in the tested wavelength range.

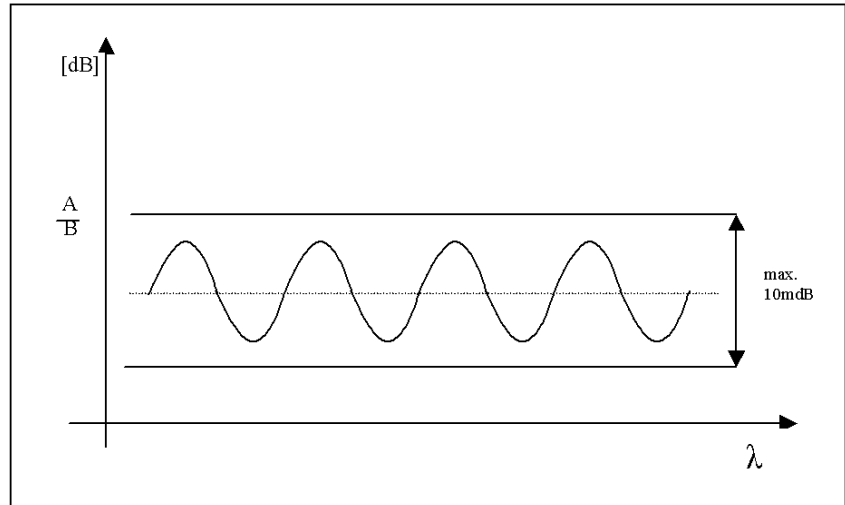


Figure 15 Interference Ripple

Performance Test for the Keysight 81623B

Page 1 of 3

Model	Keysight 81623B Optical Head_	Date	_____
Serial No.	_____	Ambient Temperature	_____ °C
Options	_____	Relative Humidity	_____ %
Firmware Rev.	_____	Line Frequency	_____ Hz
Test Facility	_____	Customer	_____
Performed by	_____	Report No	_____

Special Notes

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Performance Test for the Keysight 81623B

Test Equipment Used

Page 2 of 3

	Description	Model No.	Trace No	Cal. Due Date
1a1	Lightwave Multimeter (Std.)	8163A/B	_____	_____
1a2	Lightwave Multimeter (DUT)	8163A/B	_____	_____
1b	TLS Mainframe	8164A/B	_____	_____
2a	Interface Module	Keysight 81618A	_____	_____

2b	Interface Module	Keysight 81619A	_____	_____
3a	CW Laser Source	Keysight 81656A	_____	_____
3b	CW Laser Source	Keysight 81657A	_____	_____
4	CW Laser Source	Keysight 81654A	_____	_____
5a1	Opt. Head Interface Module	Keysight 81618A	_____	_____
5a2	Optical Head, Reference	Keysight 81623B	_____	_____
6	Sensor Module	Keysight 81634A	_____	_____
7	Optical Attenuator	8156A #221	_____	_____
8a	Optical Attenuator	8156A #101	_____	_____
9	Return Loss Module	Keysight 81613A	_____	_____
10	_____	_____	_____	_____
11	_____	_____	_____	_____
12	_____	_____	_____	_____

Accessories	#	Product	#	Product	#	Product
Singlemode Fibers	2	81101AC	1	81113SC	3	81113PC
	1	81610CC				
Connector Interfaces	3	81000AI	3	81000FI	4	81000SI
Connector Adapters	2	81000AA	1	81000SA	1	81000FA

Performance Test for the Keysight 81623B

Page 3 of 3

Model Keysight 81623B Optical Head

Report No. \_\_\_\_\_

Date \_\_\_\_\_

Test No.	Test Description	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
----------	------------------	------------	--------	------------	-------------------------

I	Accuracy Test		$[\mu W]$	
	measured at _____ nm (1310nm) Output Power	9.72 $\mu W$	_____	10.28 $\mu W$
	measured at _____ nm (1550nm) Output Power	9.72 $\mu W$	_____	10.28 $\mu W$

II Linearity Test For Calculations you may want to use the appropriate sheet

Range	$P_{DUT}$ [dBm]	$P_{DUT}$ [dBm]	Loss [%]	
+10	+9	_____	_____	< $\pm$ 1.13 %
+10	+3	_____	_____	< $\pm$ 0.58 %
0	+3	_____	_____	< $\pm$ 0.58 %
0	-7	_____	_____	< $\pm$ 0.58 %
-10	-7	_____	_____	< $\pm$ 0.58 %
-10	-17	_____	_____	< $\pm$ 0.58 %
-20*	-17*	Reference	0.0	< $\pm$ 0.58 %
-20	-27	_____	_____	< $\pm$ 0.58 %
-30	-27	_____	_____	< $\pm$ 0.58 %
-30	-37	_____	_____	< $\pm$ 0.63 %
-40	-37	_____	_____	< $\pm$ 0.63 %
-40	-47	_____	_____	< $\pm$ 1.08 %
-50	-47	_____	_____	< $\pm$ 1.08%
-50	-57	_____	_____	< $\pm$ 5.59 %



III	Noise Test	[pW]	
		_____	< 100 pW
IV	Return Loss Test	[dB]	
		50 dB < _____	

Performance Test for the Keysight 81624B

Page 1 of 3

Model	Keysight 81624B Optical Head_	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 81624B

Test Equipment Used

Page 2 of 3

	Description	Model No.	Trace No	Cal. Due Date
1a1	Lightwave Multimeter (Std.)	8163A/B	_____	_____
1a2	Lightwave Multimeter (DUT)	8163A/B	_____	_____
1b	TLS Mainframe	8164A/B	_____	_____
2a	Interface Module	Keysight 81618A	_____	_____

2b	Interface Module	Keysight 81619A	_____	_____
3a	CW Laser Source	Keysight 81656A	_____	_____
3b	CW Laser Source	Keysight 81657A	_____	_____
4	CW Laser Source	Keysight 81654A	_____	_____
5a1	Opt. Head Interface Module	Keysight 81618A	_____	_____
5a2	Optical Head, Reference	Keysight 81624A	_____	_____
6	Sensor Module	Keysight 81634A	_____	_____
7	Optical Attenuator	8156A #221	_____	_____
8a	Optical Attenuator	8156A #101	_____	_____
9	Return Loss Module	Keysight 81613A	_____	_____
10	_____	_____	_____	_____
11	_____	_____	_____	_____
12	_____	_____	_____	_____

Accessories	#	Product	#	Product	#	Product
Singlemode Fibers	2	81101AC	1	81113SC	3	81113PC
	1	81610CC				
Connector Interfaces	3	81000AI	3	81000FI	4	81000SI
Connector Adapters	2	81000AA	1	81000SA	1	81000FA

Performance Test for the Keysight 81624B

Page 3 of 3

Model Keysight 81624B Optical Head

Report No. \_\_\_\_\_

Date \_\_\_\_\_

Test No.	Test Description	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
----------	------------------	------------	--------	------------	-------------------------

I	Accuracy Test			[ $\mu W$ ]	
	measured at _____ nm	9.72 $\mu W$	_____		10.28 $\mu W$
	(1310nm) Output Power				
	measured at _____ nm	9.72 $\mu W$	_____		10.28 $\mu W$
	(1550nm) Output Power				

II Linearity Test For Calculations you may want to use the appropriate sheet

Range	P <sub>DUT</sub> [dBm]	P <sub>DUT</sub> [dBm]	Loss [%]	
+10	+9	_____	_____	<± 0.46 %
+10	+3	_____	_____	<± 0.46 %
0	+3	_____	_____	<± 0.46 %
0	-7	_____	_____	<± 0.46 %
-10	-7	_____	_____	<± 0.46 %
-10	-17	_____	_____	<± 0.46 %
-20*	-17*	Reference	0.0	<± 0.46 %
-20	-27	_____	_____	<± 0.46 %
-30	-27	_____	_____	<± 0.46 %
-30	-37	_____	_____	<± 0.49 %
-40	-37	_____	_____	<± 0.49 %
-40	-47	_____	_____	<± 0.71 %
-50	-47	_____	_____	<± 0.71 %
-50	-57	_____	_____	<± 2.97 %

III Noise Test [pW]

IV

Return Loss Test

typ. 60 dB

\_\_\_\_\_  
[dB]  
\_\_\_\_\_

< 5 pW

Performance Test for the Keysight 81626B

Page 1 of 3

Model	Keysight 81626B Optical Head_	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 81626B

Test Equipment Used

Page 2 of 3

	Description	Model No.	Trace No	Cal. Due Date
1a1	Lightwave Multimeter (Std.)	8163A/B	_____	_____
1a2	Lightwave Multimeter (DUT)	8163A/B	_____	_____
1b	TLS Mainframe	8164A/B	_____	_____
2a	Interface Module	Keysight 81618A	_____	_____

2b	Interface Module	Keysight 81619A	_____	_____
3a	CW Laser Source	Keysight 81656A	_____	_____
3b	CW Laser Source	Keysight 81657A	_____	_____
4	CW Laser Source	Keysight 81654A	_____	_____
5a1	Opt. Head Interface Module	Keysight 81618A	_____	_____
5a2	Optical Head, Reference	Keysight 81624A	_____	_____
6	Sensor Module	Keysight 81634A	_____	_____
7	Optical Attenuator	8156A #221	_____	_____
8a	Optical Attenuator	8156A #101	_____	_____
9	Return Loss Module	Keysight 81613A	_____	_____
10	_____	_____	_____	_____
11	_____	_____	_____	_____
12	_____	_____	_____	_____

Accessories	#	Product	#	Product	#	Product
Singlemode Fibers	2	81101AC	1	81113CC	3	81113PC
	1	81610CC				
Connector Interfaces	3	81000AI	3	81000FI	4	81000SI
Connector Adapters	2	81000AA	1	81000SA	1	81000FA

Performance Test for the Keysight 81626B

Page 3 of 3

Model Keysight 81626B Optical Head

Report No. \_\_\_\_\_

Date \_\_\_\_\_

Test No.	Test Description	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
I	Accuracy Test		[ $\mu W$ ]		
	measured at _____ nm (1310nm) Output Power	9.64 $\mu W$	_____	10.36 $\mu W$	
	measured at _____ nm (1550nm) Output Power	9.64 $\mu W$	_____	10.36 $\mu W$	

II	Linearity Test	For Calculations you may want to use the appropriate sheet		
	Range	P <sub>DUT</sub> [dBm]	P <sub>DUT</sub> [dBm]	Loss [%]
	+20	+9	_____	_____ <± 1.29% <sup>[1]</sup>
	+10	+9	_____	_____ <± 0.93 %
	+10	+3	_____	_____ <± 0.93 %
	0	+3	_____	_____ <± 0.93 %
	0	-7	_____	_____ <± 0.93 %
	-10	-7	_____	_____ <± 0.93 %
	-10	-17	_____	_____ <± 0.93 %
	-20	-17	_____	_____ <± 0.93 %
	-20*	-17*	Reference	0.0 <± 0.93 %
	-20	-27	_____	_____ <± 0.95 %
	-30	-27	_____	_____ <± 0.95 %
	-30	-37	_____	_____ <± 1.18 %
	-40	-37	_____	_____ <± 1.18 %
	-40	-47	_____	_____ <± 3.43 %
III	Noise Test		[pW]	
			_____	< 500 pW
IV	Return Loss Test		[dB]	
			60 dB < _____	

[1] The 20 dB range measurement is only performed to check the functionality of the current booster. The published specification does not apply to operation in non-automode as used here to check the functionality.



**NOTE**

The nonlinearity of the 81626B is not usually tested to the specified power level of +27 dBm. Instead, limited testing up to +9 dBm is used to test the electronic circuitry of the 81626B. Above +9 dBm the largest contribution to nonlinearity is from the absorbing glass filter (which is tested on a sample basis) that does not change its linearity with time. Thus it is guaranteed by design that testing the 81626B up to +9 dBm ensures specification compliance to +27 dBm

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Performance Test for the Keysight 81628B

Page 1 of 3

Model	Keysight 81628B Optical Head_	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 81628B

Test Equipment Used

Page 2 of 3

	Description	Model No.	Trace No	Cal. Due Date
1a1	Lightwave Multimeter (Std.)	8163A/B	_____	_____
1a2	Lightwave Multimeter (DUT)	8163A/B	_____	_____
1b	TLS Mainframe	8164A/B	_____	_____
2a	Interface Module	Keysight 81618A	_____	_____
2b	Interface Module	Keysight 81619A	_____	_____

3a	CW Laser Source	Keysight 81656A	_____	_____
3b	CW Laser Source	Keysight 81657A	_____	_____
4	CW Laser Source	Keysight 81654A	_____	_____
5a1	Opt. Head Interface Module	Keysight 81618A	_____	_____
5a2	Optical Head, Reference	Keysight 81624A	_____	_____
6	Sensor Module	Keysight 81634A	_____	_____
7	Optical Attenuator	8156A #221	_____	_____
8a	Optical Attenuator	8156A #101	_____	_____
9	Return Loss Module	Keysight 81613A	_____	_____
10	_____	_____	_____	_____
11	_____	_____	_____	_____
12	_____	_____	_____	_____

Accessories	#	Product	#	Product	#	Product
Singlemode Fibers	2	81101AC	1	81113SC	3	81113PC
	1	81610CC				
Connector Interfaces	3	81000AI	3	81000FI	4	81000SI
Connector Adapters	2	81000AA	1	81000SA	1	81000FA

Performance Test for the Keysight 81628B

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Model Keysight 81628B Optical Head

Report No. \_\_\_\_\_ Date \_\_\_\_\_

Test No.	Test Description	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
----------	------------------	------------	--------	------------	-------------------------

I Linearity Test (without sphere) For Calculations you may want to use the appropriate sheet

Range	P <sub>DUT</sub> [dBm]	P <sub>DUT</sub> [dBm]	Loss [%]
+40	+9	_____	<± 0.46 %
+40	+3	_____	<± 0.46 %

4 Performance Tests

+30	+3	_____	_____	<± 0.46 %
+30	-7	_____	_____	<± 0.46 %
+20	-7	_____	_____	<± 0.46 %
+20	-17	_____	_____	<± 0.46 %
+10*	-17*	Reference	0.0	<± 0.46 %
+10	-27	_____	_____	<± 0.46 %
0	-27	_____	_____	<± 0.46 %
0	-37	_____	_____	<± 0.46 %
-10	-37	_____	_____	<± 0.46 %
-10	-47	_____	_____	<± 0.49 %
-20	-47	_____	_____	<± 0.49 %
-20	-57	_____	_____	<± 0.71 %

II	Accuracy Test (with sphere)		[ $\mu W$ ]	
	measured at _____ nm (1310nm) Output Power	9.64 $\mu W$	_____	10.36 $\mu W$
	measured at _____ nm (1550nm) Output Power	9.64 $\mu W$	_____	10.36 $\mu W$

III	Noise Test		[pW]	
			_____	< 5 nW

Calculation Sheets

**Table 9 Calculation Sheet for Linearity Measurement (81623B, 81624B, 81628B)**

n	Your Entries		Conversion [dBm] @ [mW]		Calculation as given		Calculation as given
	REF Power [dBm]	DUT Power [dBm]	Ref / R [mW]	DUT / D [mW]	Relation1 / A = $R_{n+1}/R_n$	Relation2 / B = $D_n/D_{n+1}$	Non-Linearity = $A_n * B_n (NL_{n±1+1}) - 1$ [%]
1							
2							
3							
4							
5							
6							
7							
8							
9							
10					Reference Level		0.00
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

**Table 10 Calculation Sheet for Linearity Measurement (81626B)**

Your Entries		Conversion [dBm] @ [mW]		Calculation as given			Calculation as given
n	REF Power [dBm]	DUT Power [dBm]	Ref / R [mW]	DUT / D [mW]	Relation1 / A = $R_{n+1}/R_n$	Relation2 / B = $D_n/D_{n+1}$	Non-Linearity = $A_n * B_n (NL_{n+1} + 1) - 1$ [%]
1							
2							
3							
4							
5							
6							
7							
8					= $R_{n+1}/R_n$	= $D_n/R_{n+1}$	
9							
10					Reference Level		0.00
11							
12							
13							
14							
15							
16							
17							
18							
19					= $R_{n+1}/R_n$	= $D_n/R_{n+1}$	
20							

# 5 Cleaning Information

The following Cleaning Information contains some general safety precautions, which must be observed during all phases of cleaning. Consult your specific optical device manuals or guides for full information on safety matters.

Please try, whenever possible, to use physically contacting connectors, and dry connections. Clean the connectors, interfaces, and bushings carefully after use.

If you are unsure of the correct cleaning procedure for your optical device, we recommend that you first try cleaning a dummy or test device.

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

[Cleaning Instructions for this Device](#) / 88

[Why is it important to clean optical devices?](#) / 90

[What do I need for proper cleaning?](#) / 91

[Preserving Connectors](#) / 96

[Cleaning Instrument Housings](#) / 97

[Which Cleaning Procedure should I use?](#) / 98

[Additional Cleaning Information](#) / 108

[Other Cleaning Hints](#) / 111

## Cleaning Instructions for this Device

This Cleaning Information applies to a number of different types of Optical Equipment.

Sections of particular relevance to the following devices are cross-referenced below.

### 8100xA Optical Head Adapters

When using optical head adapters, periodically inspect the optical head's front window (see [How to clean connector adapters](#) on page 100 for cleaning procedures). Dust and metal particles can be propelled through the adapter's pinhole while inserting the connector ferrule into the receptacle. These dirt particles collect on the head's front window and, if not removed, can lead to incorrect measurement results.

### 8162xx Optical Power Heads

Periodically inspect the optical head's front window for dust and other particles (see [How to clean instruments with an optical glass plate](#) on page 104 for cleaning procedures). These can be propelled through the optical head adapter's pinhole while inserting a connector ferrule into the receptacle. Particles on the optical head's front window can significantly impair measurement results.

### Safety Precautions

Please follow the following safety rules:

- Do not remove instrument covers when operating.
- Ensure that the instrument is switched off throughout the cleaning procedures.
- Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.
- Make sure that you disable all sources when you are cleaning any optical interfaces.
- Under no circumstances look into the end of an optical device attached to optical outputs when the device is operational. The laser radiation is not visible to the human eye, but it can seriously damage your eyesight.
- To prevent electrical shock, disconnect the instrument from the mains before cleaning. Use a dry cloth, or one slightly dampened with water, to clean the external case parts. Do not attempt to clean internally.



- Do not install parts or perform any unauthorized modification to optical devices.
- Refer servicing only to qualified and authorized personnel.

## Why is it important to clean optical devices?

In transmission links optical fiber cores are about 9  $\mu\text{m}$  (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  $\text{W}/\text{m}^2$ ). 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.

## What do I need for proper cleaning?

Some **Standard Cleaning Equipment** on page 91 is necessary for cleaning your instrument. For certain cleaning procedures, you may also require certain **Additional Cleaning Equipment** on page 94.

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

If you need further dust caps, please contact your nearest 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.

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

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

Do not use any other solvents, as some may damage plastic materials and claddings. Acetone, for example, will dissolve the epoxy used with fiber optic connectors. To avoid damage, only use isopropyl alcohol.

### **Cotton swabs**

We recommend that you use swabs such as Q-tips or other cotton swabs normally available from local distributors of medical and hygiene products (for example, a supermarket or a chemist's shop). You may be able to obtain various sizes of swab. If this is the case, select the smallest size for your smallest devices.

Ensure that you use natural cotton swabs. Foam swabs will often leave behind filmy deposits after cleaning.

Use care when cleaning, and avoid pressing too hard onto your optical device with the swab. Too much pressure may scratch the surface, and could cause your device to become misaligned. It is advisable to rub gently over the surface using only a small circular movement.

Swabs should be used straight out of the packet, and never used twice. This is because dust and dirt in the atmosphere, or from a first cleaning, may collect on your swab and scratch the surface of your optical device.

### **Soft tissues**

These are available from most stores and distributors of medical and hygiene products such as supermarkets or chemists' shops.

We recommend that you do not use normal cotton tissues, but multi-layered soft tissues made from non-recycled cellulose. Cellulose tissues are very absorbent and softer. Consequently, they will not scratch the surface of your device over time.

Use care when cleaning, and avoid pressing on your optical device with the tissue. Pressing too hard may lead to scratches on the surface or misalignment of your device. Just rub gently over the surface using a small circular movement.

Use only clean, fresh soft tissues and never apply them twice. Any dust and dirt from the air which collects on your tissue, or which has gathered after initial cleaning, may scratch and pollute your optical device.

### Pipe cleaner

Pipe cleaners can be purchased from tobacconists, and come in various shapes and sizes. The most suitable one to select for cleaning purposes has soft bristles, which will not produce scratches.

There are many different kinds of pipe cleaner available from tobacconists.

The best way to use a pipe cleaner is to push it in and out of the device opening (for example, when cleaning an interface). While you are cleaning, you should slowly rotate the pipe cleaner.

Only use pipe cleaners on connector interfaces or on feed through adapters. Do not use them on optical head adapters, as the center of a pipe cleaner is hard metal and can damage the bottom of the adapter.

Your pipe cleaner should be new when you use it. If it has collected any dust or dirt, this can scratch or contaminate your device.

The tip and center of the pipe cleaner are made of metal. Avoid accidentally pressing these metal parts against the inside of the device, as this can cause scratches.

### Compressed air

Compressed air can be purchased from any laboratory supplier.

It is essential that your compressed air is free of dust, water and oil. Only use clean, dry air. If not, this can lead to filmy deposits or scratches on the surface of your connector. This will reduce the performance of your transmission system.

When spraying compressed air, hold the can upright. If the can is held at a slant, propellant could escape and dirty your optical device. First spray into the air, as the initial stream of compressed air could contain some condensation or propellant. Such condensation leaves behind a filmy deposit.

Please be friendly to your environment and use a CFC-free aerosol.

## Additional Cleaning Equipment

Some Cleaning Procedures need the following equipment, which is not required to clean each instrument:

- Microscope with a magnification range about 50X up to 300X
- Ultrasonic bath
- Warm water and liquid soap
- Premoistened cleaning wipes
- Polymer film
- Infrared Sensor Card

### Microscope with a magnification range about 50X up to 300X

A microscope can be found in most photography stores, or can be obtained through or specialist mail order companies. Special fiber-scopes are available from suppliers of splicing equipment.

Ideally, the light source on your microscope should be very flexible. This will allow you to examine your device closely and from different angles.

A microscope helps you to estimate the type and degree of dirt on your device. You can use a microscope to choose an appropriate cleaning method, and then to examine the results. You can also use your microscope to judge whether your optical device (such as a connector) is severely scratched and is, therefore, causing inaccurate measurements.

### Ultrasonic bath

Ultrasonic baths are also available from photography or laboratory suppliers or specialist mail order companies.

An ultrasonic bath will gently remove fat and other stubborn dirt from your optical devices. This helps increase the life span of the optical devices.

Only use isopropyl alcohol in your ultrasonic bath, as other solvents may cause damage.

### Warm water and liquid soap

Only use water if you are sure that there is no other way of cleaning your optical device without causing corrosion or damage. Do not use hot water, as this may cause mechanical stress, which can damage your optical device.

Ensure that your liquid soap has no abrasive properties or perfume in it. You should also avoid normal washing up liquid, as it can cover your device in an iridescent film after it has been air dried.

Some lenses and mirrors also have a special coating, which may be sensitive to mechanical stress, or to fat and liquids. For this reason we recommend you do not touch them.

If you are not sure how sensitive your device is to cleaning, please contact the manufacturer or your sales distributor.

### **Premoistened cleaning wipes**

Use pre-moistened cleaning wipes as described in each individual cleaning procedure. Cleaning wipes may be used in every instance where a moistened soft tissue or cotton swab is applied.

### **Polymer film**

Polymer film is available from laboratory suppliers or specialist mail order companies.

Using polymer film is a gentle method of cleaning extremely sensitive devices, such as reference reflectors and mirrors.

### **Infrared Sensor Card**

Infrared sensor cards are available from laboratory suppliers or specialist mail order companies.

With 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.

## Preserving Connectors

Listed below are some hints on how best to keep your connectors in the best possible condition.

### **Making Connections**

Before you make any connection you must ensure that all cables and connectors are clean. If they are dirty, use the appropriate cleaning procedure.

When inserting the ferrule of a patchcord into a connector or an adapter, make sure that the fiber end does not touch the outside of the mating connector or adapter. Otherwise you will rub the fiber end against an unsuitable surface, producing scratches and dirt deposits on the surface of your fiber.

### **Dust Caps and Shutter Caps**

Be careful when replacing dust caps after use. Do not press the bottom of the cap onto the fiber as any dust in the cap can scratch or dirty your fiber surface.

When you have finished cleaning, put the dust cap back on, or close the shutter cap if the equipment is not going to be used immediately.

Always keep the caps on the equipment when it is not in use.

All of 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**

Wherever possible, do not use immersion oil or other index matching compounds with your device. They are liable to impair and dirty the surface of the device. In addition, the characteristics of your device can be changed and your measurement results affected.



## Cleaning Instrument Housings

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

## 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 Device](#) on page 88 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

### How to clean connectors

Cleaning connectors is difficult as the core diameter of a single-mode fiber is only about 9  $\mu\text{m}$ . This generally means you cannot see streaks or scratches on the surface. To be certain of the condition of the surface of your connector and to check it after cleaning, you need a microscope.

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

## WARNING

**Never look into the end of an optical cable that is connected to an active source.**

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To assess the projection of the emitted light beam you can use an infrared sensor card. Hold the card approximately 5 cm from the output of the connector. The invisible emitted light is projected onto the card and becomes visible as a small circular spot.

**Preferred Procedure**

Use the following procedure on most occasions.

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

**Procedure for Stubborn Dirt**

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

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

**An Alternative Procedure**

A better, more gentle, but more expensive cleaning procedure is to use an ultrasonic bath with isopropyl alcohol.

- 1 Hold the tip of the connector in the bath for at least three minutes.
- 2 Take a new, dry soft tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
- 3 Blow away any remaining lint with compressed air.

How to clean connector 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.

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**Preferred Procedure**

Use the following procedure on most occasions.

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

**Procedure for Stubborn Dirt**

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

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

How to clean connector interfaces

**CAUTION**

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

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

---

**Preferred Procedure**

Use the following procedure on most occasions.

- 1 Clean the interface 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 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.

### How to clean bare fiber adapters

Bare fiber adapters are difficult to clean. Protect from dust unless they are in use.

#### **CAUTION**

Never use any kind of solvent when cleaning a bare fiber adapter as solvents can:

- Damage the foam inside some adapters.
  - Deposit dissolved dirt in the groove, which can then dirty the surface of an inserted fiber.
- 

#### **Preferred Procedure**

Use the following procedure on most occasions.

- 1 Blow away any dust or dirt with compressed air.

#### **Procedure for Stubborn Dirt**

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

- 1 Clean the adapter by pushing and pulling a new, dry pipe cleaner into the opening. Rotate the pipe cleaner slowly as you do this.

#### **CAUTION**

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

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

## How to clean lenses

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

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

### Preferred Procedure

Use the following procedure on most occasions.

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

### Procedure for Stubborn Dirt

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

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

## How to clean instruments with a fixed connector interface

You should only clean instruments with a fixed connector interface when it is absolutely necessary. This is because it is difficult to remove any used alcohol or filaments from the input of the optical block.

It is important, therefore, to keep dust caps on the equipment at all times, except when your optical device is in use.

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 become 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 103).

How to clean instruments with a physical contact interface

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

Cleaning interfaces is difficult as the core diameter of a single-mode fiber is only about 9  $\mu\text{m}$ . 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.

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To assess the projection of the emitted light beam you can use an infrared sensor card. Hold the card approximately 5 cm from the interface. The invisible emitted light is projected onto the card and becomes visible as a small circular spot.



**Preferred Procedure**

Use the following procedure on most occasions.

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

**Procedure for Stubborn Dirt**

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

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

How to clean instruments with a recessed lens interface

**WARNING**

For instruments with a deeply recessed lens interface (for example the Keysight 81634A Power Sensors) do NOT follow this procedure. Alcohol and compressed air could damage your lens even further.

Keep your dust and shutter caps on when your instrument is not in use. This should prevent it from getting too dirty. If you must clean such instruments, please refer the instrument to the skilled personnel of Keysight's service team.

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**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 when there is greasy dirt on the interface, and using the preferred procedure is not sufficient. Using isopropyl alcohol should be your last choice for recessed lens interfaces because of the difficulty of cleaning out any dirt that is washed to the edge of the interface:

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

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

Some optical devices, such as the 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 any part of the device.

- 1 Put the device into the bath for at least three minutes.
- 2 Blow away any remaining liquid with compressed air.

If there are any streaks or drying stains on the surface, repeat the cleaning procedure.

**How to clean metal filters or attenuator gratings**

This kind of device is extremely fragile. A misalignment of the grating leads to inaccurate measurements. Never touch the surface of the metal filter or attenuator grating. Be very careful when using or cleaning these devices. Do not use cotton swabs or soft tissues, as there is the danger that you cannot remove the lint and that the device will be destroyed by becoming mechanically distorted.

**Preferred Procedure**

Use the following procedure on most occasions.

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

**Procedure for Stubborn Dirt**

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

- 1 Use this procedure when there is greasy dirt on the device:
- 2 Put the optical device into a bath of isopropyl alcohol, and wait at least 10 minutes.

Remove the fluid using compressed air at some distance and with low pressure. If there are any streaks or drying stains on the surface, repeat the whole cleaning procedure.

## Additional Cleaning Information

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

- [How to clean bare fiber ends](#) on page 108
- [How to clean large area lenses and mirrors](#) on page 108

### 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 when there is greasy dirt on the lens:

**CAUTION**

Only use water if you are sure that there is no other way of cleaning your optical device without causing corrosion or damage.

Only use water if you are sure that there is no other way of cleaning your optical device without causing corrosion or damage. Do not use hot water, as this may cause mechanical stress, which can damage your optical device.

Ensure that your liquid soap has no abrasive properties or perfume in it. You should also avoid normal washing up liquid, as it can cover your device in an iridescent film after it has been air dried.

Some lenses and mirrors also have a special coating, which may be sensitive to mechanical stress, or to fat and liquids. For this reason we recommend you do not touch them.

If you are not sure how sensitive your device is to cleaning, please contact the manufacturer or your sales distributor.

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

**Alternative Procedure A**

To clean lenses that are extremely sensitive to mechanical stress or pressure you can also use an optical clean polymer film. This procedure is time-consuming, but you avoid scratching or destroying the surface.

- 1 Put the film on the surface and wait at least 30 minutes to make sure that the film has had enough time to dry.
- 2 Remove the film and any dirt with special adhesive tapes.

### **Alternative Procedure B**

If your lens is sensitive to water then:

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

## Other Cleaning Hints

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

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

### **Lens cleaning papers**

Some special lens cleaning papers are not suitable for cleaning optical devices like connectors, interfaces, lenses, mirrors and so on. To be absolutely certain that a cleaning paper is applicable, please ask the salesperson or the manufacturer.

### **Immersion oil and other index matching compounds**

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

### **Cleaning the housing and the mainframe**

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

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





