

Keysight 8160xx Series Tunable Laser Family

Getting Started
Guide

Notices

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CAUTION

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

WARNING

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

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1 Getting Started

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This chapter describes the Keysight 8160xx Series Tunable Laser Family.

General 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.

Safety Symbols



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



Hazardous laser radiation.

Initial Inspection

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

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

WARNING

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

WARNING

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

Line Power Requirements

All Keysight 8160xx Series Tunable Laser Family modules operate when installed in the 8164B Lightwave Measurement System mainframe.

Keysight 81600B Tunable Laser modules operate when installed in either the 8164A or the 8164B Lightwave Measurement System mainframe.

Operating Environment

The safety information in the 8164A/B Lightwave Multimeter (and the 8163A/B Lightwave Measurement System, & 8166A/B Lightwave Multichannel System) User's Guide summarizes the operating ranges for the Keysight 8160xx Series Tunable Laser Family modules. In order for these modules to meet specifications, the operating environment must be within the limits specified for your mainframe.

Input/Output Signals

CAUTION

There are two BNC connectors on the front panel of the Keysight 81600B and on 8160xA; a BNC input connector and a BNC output connector.

An absolute maximum of ± 6 V can be applied as an external voltage to any BNC connector.

Storage and Shipment

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

Initial Safety Information for Keysight 8160xx Family Modules

The laser sources specified by this user's guide are classified according to IEC 60825-1.

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

Table 1 Laser Source Specification

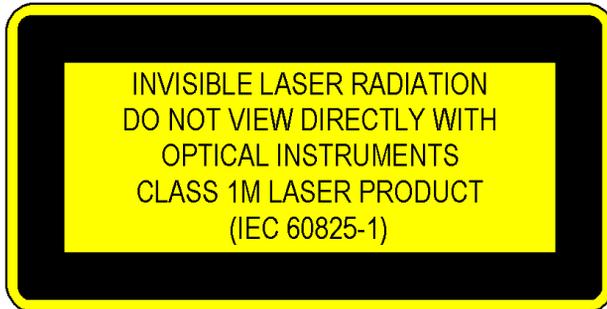
	81600B #201	81600B #200	81600B #160	81600B #150	81600B #140	81600B #130	81600B #142	81600B #132
Laser Type	EC-Laser InGaAsP							
Wavelength range	1455 - 1640 nm	1440 - 1640 nm	1495 - 1640 nm	1450 - 1590 nm	1370 - 1495 nm	1260 - 1375 nm	1370 - 1495 nm	1260 - 1375 nm
Max. CW output power	<15 mW							
Beam waist diameter	9 μm							
Numerical aperture	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Laser Class according to IEC 60825-1 (2007)	1M							
Max. permissible CW output power	163 mW	163 mW	163 mW	163 mW	52 mW	52 mW	52 mW	52 mW
* Max. CW output power is defined as the highest possible optical power that the laser source can produce at its output connector.								

Table 2 Laser Source Specification

	81606A #216 81608A #216 81609A #216	81606A #116 81607A #116 81608A #116 81609A #116	81602A #013	81606A #113 81608A #113 81609A #113	81606A #114 81608A #114 81609A #114
Laser type	EC-Laser InGaAsP	EC-Laser InGaAsP	EC-Laser InGaAsP	EC-Laser InGaAsP	EC-Laser InGaAsP
Wavelength range	1450 – 1650 nm	1490 – 1650 nm	1250 - 1370 nm	1240 - 1380 nm	1340 - 1495 nm
Max. CW output power	< 25 mW	< 25 mW	< 80 mW	< 30 mW	< 60 mW
Beam waist diameter	9 μ m	9 μ m	9 μ m	9 μ m	9 μ m
Numerical aperture	0.1	0.1	0.1	0.1	0.1
Laser class according to IEC 60825-1 (2014)	1M	1M	3B	1M	1M
Max. permissible CW output power	163 mW	163 mW	500 mW	55 - 500 mW	163 - 500 mW
* Max. CW output power is defined as the highest possible optical power that the laser source can produce at its output connector.					

Laser Safety Labels

Laser class 1M label



Laser class 3B label



Figure 1 Class 3B Safety Label - Keysight 81602A

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

WARNING

Please pay attention to the following laser safety warning:

- The laser output can be controlled by GUI, GPIB state command and the front panel button. The built in laser diode is active whenever the instrument is powered on, therefore disabling the output is not sufficient to establish eye safe conditions.
Note: The remote interlock function interrupts the laser current when the connector is open.
 - Do not switch on the instrument when there is no termination to the optical output connector, to the optical fiber or to the attached device.
 - The laser radiation can seriously damage your eyesight.
 - The use of optical instruments with this product will increase eye hazard.
 - Refer servicing only to qualified and authorized personnel.
-

For Class 3B lasers**WARNING**

The built-in laser diode is active whenever the instrument is powered on, therefore disabling the output is not sufficient to establish eye and skin safe conditions.

CAUTION

Protect your extra-high power tunable laser from damage:

- Clean the instrument's output connector and all interfaces of attached fibers and termination devices to avoid burning-in dust and other residue!
 - Do not leave plastic caps on the output connector or on the end of a connected fiber when you activate the laser – you risk damaging the connector surface with deposit from hot plastic!
 - Make sure the optical path is terminated properly and confirm that the termination can cope with an optical power level of over +18.5 dBm or 70 mW!
 - Use a metal cap to cover the laser outputs when open. Terminate open patchcord ends with a commercially available “fiber optic light trap”.
-

What is a Tunable Laser?

A Tunable Laser is a laser source for which the wavelength can be varied through a specified range. The Keysight Technologies range of tunable laser modules also allow you to set the output power, and to choose between continuous wave or modulated power.

Installation

Every Keysight 8160xx Series Tunable Laser Family module is backloadable into Slot 0 of a 8164B mainframe. In addition, Keysight 81600B Tunable Laser modules operate in the 8164A mainframe; see “How to Fit and Remove Modules” in the 8163A/B Lightwave Multimeter, 8164A/B, Lightwave Measurement System, & 8166A/B Lightwave Multichannel System User’s Guide.

Front Panels

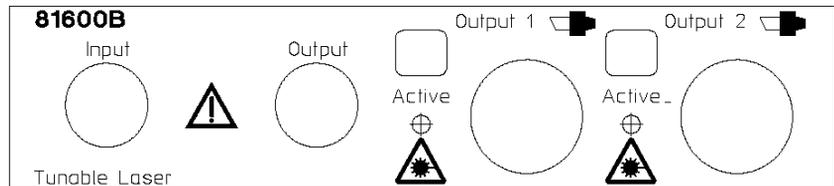


Figure 2 Keysight 81600B Tunable Laser Source Family modules (dual output, angled contact connectors)

Figure 2 illustrates a typical front panel for a dual-output Keysight 81600B Tunable Laser Source Family module, such as options #201, #200, #160, #150, #140 or #130. In this case, angled contact interfaces (81600B-072) are indicated. The two large circles indicate the optical ports, while the two smaller circles at the left are BNC connectors.

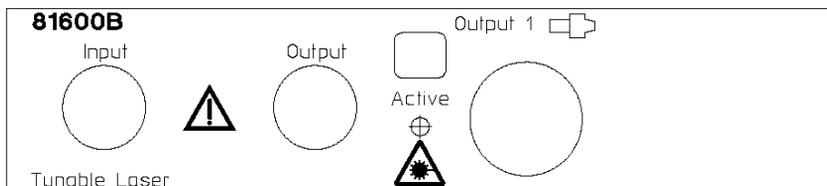


Figure 3 Keysight 81600B Tunable Laser Source Family module (single output, straight contact connectors)

Figure 3 illustrates a typical front panel for a single-output Keysight 81600B Tunable Laser Source Family module, such as options #142 or #132. In this case, straight contact interfaces (81600B#071) are indicated. The large circle indicates the optical port, while the two smaller circles at the left are BNC connectors.

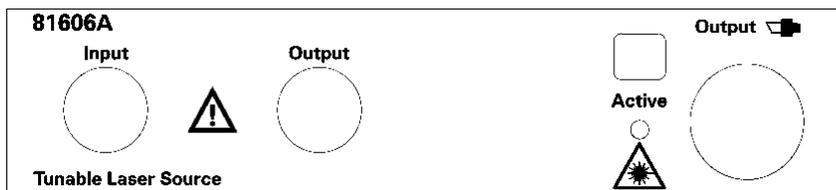


Figure 4 Keysight 81606A Tunable Laser Source module

Figure 4 illustrates the front panel for the Keysight 81606A Tunable Laser Source module, options #216, #116, #114 and #113. Angled contact interfaces (81606A-072) are mandatory for this module. The large circle indicates the optical port, while the two smaller circles at the left are BNC connectors.

Front Panel Controls and Indicators

Switch the laser output on or off using the button on its front panel, using the [State] parameter in the instrument's Graphical User Interface, or remotely using GPIB commands. When the 'Active' LED is lit the output is enabled. When the active LED is not lit, the output is disabled.

Typical Use Models

The Keysight 8160xx Family of Tunable Laser Sources offers the full wavelength range from 1240 nm to 1650 nm with no wavelength gaps. All 8160xx Tunable Laser Sources are modules for the bottom slot of the Keysight 8164B Lightwave Measurement System mainframe. This provides test instrumentation with maximum flexibility.

81606A #216, #116, #114 and #113

The 81606A Top Line Tunable Laser Source is the new flagship model, featuring fast, two-way sweeping up to 200 nm/s, and an outstanding dynamic wavelength accuracy and repeatability. The excellent low-SSE performance of better than 80 dB/nm signal-to-source spontaneous emission ratio (signal-to-SSE ratio) and the high signal power of >+12 dBm permit measurements of wavelength isolation to 100 dB, most often limited by power meter sensitivity.

The 81606A option 216 offers a wide tuning range of 200 nm, option 116 covers a range of 150 nm, option 114 covers 155 nm in the E-band, and option 113 tunes across 140 nm in the O-band.

81607A #116, 81608A #216, #116, #114 and #113

The new 81607A Value Line Tunable Laser Source complements the Top Line 81606A model at a more moderate output power. With a typical wavelength repeatability of ± 1 pm even during two-way sweeps with up to 200 nm/s, it is ideal for high-throughput test and automated adjustment of passive optical components.

The new 81608A, another member of the Value Line Tunable Laser sources, offers a peak output power of >+12 dBm, at least 75 dB/nm above its spontaneous emission level. It features a typical wavelength repeatability of ± 1.5 pm at two-way sweeps up to 200 nm/s. The laser's balance of features, performance and price makes it suitable for both coherent transmission experiments and cost-effective manufacturing-floor component testing.

81609A #216, #116, #114 and #113

The new 81609A Basic Line module can step within 300 milliseconds to discrete wavelengths with a resolution of 0.1 pm and a typical wavelength repeatability of ± 3 pm, making it ideal for cost-effective testing of broadband optical devices. Like the other modules in the family, it delivers >+12 dBm peak output power with low spontaneous emission levels. At ± 0.01 dB power stability over an hour, it can also serve as a static local oscillator with a wide tuning range for receiver testing or transmission experiments.

E-band model for CWDM8 component testing

The new 8160xA option 114 covers the wavelength range from 1340 nm to 1495 nm. Combined with the other options, this allows measurements over all CWDM channels, such as for CWDM8 devices. Components for Raman amplification also use this wavelength range.

81602A #013 The new 81602A Extra High Power Tunable Laser Source reaches an optical power level of over +18 dBm (63 mW). The high output power helps compensate for the coupling loss of optical surface probes or the insertion loss of external modulators during the verification of integrated photonic designs. This allows testing photonic devices at relevant signal levels and wavelengths. With a tuning range of 1250 nm to 1370 nm, the laser addresses the latest silicon photonics research. It shares the same excellent power flatness, repeatability and stability, the outstanding wavelength accuracy and the fast repetition rate with the 8160xA Family of Tunable Laser Sources.

81600B #201 and #200 The 81600B options 200 and 201 feature a wide tuning range of up to 200 nm and a 70 dB/nm signal-to-SSE ratio. The excellent low-SSE performance typically allows crosstalk measurements of better than 70 dB for an 8 channel CWDM multiplexer.

81600B #160, 150, 140, 130 The 81600B option 160, 150, 140 and 130 Tunable Laser Sources offer other wavelength ranges and are equipped with two optical outputs, like the option 200. By selecting the port, high power or low-SSE can be obtained.

81600B #142, 132 The 81600B option 142 and 132 Tunable Laser Sources have a single high power output port. The 81600B option 132 covers the wavelength range from 1260 nm to 1375 nm.

Realize the cost efficiency and performance benefits in WDM component tests

The testing of optical filters and multiplexers is based on a generic principle, namely the stimulus response test. The state-of-the-art approach uses a tunable laser source that is capable of fast and precise sweeps across the entire wavelength range with one or more optical power meters to simultaneously measure all output ports of the component.

For DWDM components, high wavelength accuracy and dynamic range are critical. For CWDM and PON components, a wide wavelength range, dynamic range and tight costing are key targets. If the investment in the test solution can be shared among many different types of filters, the contribution to each individual filter is minimized. In this way, cost targets for CWDM and PON components can be met without sacrificing accuracy.

Investing in the Keysight 8160xx TLS family can realize both the cost efficiency and performance benefits required.

Integrated solutions for swept-wavelength spectral measurements

The 8160xA family is supported with the N7700A software suite for spectral measurements of insertion loss, polarization dependent loss and polarization mode dispersion in combination with Keysight power meters and polarization instruments. These provide optimal measurement performance and quick time-to-measurement by simplifying system integration. The N7700A software suite has a measurement engine for

IL and PDL that can combine the sweeps of up to 3 tunable laser wavelength ranges. See the N7700A brochure for details.

www.keysight.com/find/n7700

Swept Measurements

As manufacturing yield expectations becomes more and more stringent, it is important that all instruments deliver optimum performance under all measurement conditions. The Keysight 81602A, 81606A, 81607A and 81608A Tunable Laser Sources can sweep as fast as 200 nm/s in both directions with specified accuracy during the sweep.

High Dynamic Range

The low SSE output port of 81606A, 81607A, 81608A and 81609A delivers a signal with ultra-low source spontaneous emission. It enables accurate crosstalk measurement of DWDM and CWDM wavelength filtering components by producing light only at the desired wavelength.

For example, you can characterize steep notch filters such as Fiber Bragg Gratings by using the low SSE output and a power sensor module.

High Power

The Keysight 81602A offers the highest output power in the 8160xx product family with more than +17 dBm, 50dB/nm above its spontaneous emission level. The Keysight 81606A, 81608A and 81609A feature a single optical output power with over +12 dBm output power. At 80 dB/nm signal-to-SSE level, they combine the lowest SSE level in the 8160xx family with high output power. The 81607A offers >+8 dBm output power. For all 8160xA lasers, the output power can be reduced to 0 dBm by the user.

For Keysight 81600B options 200, 160, 150,140 and 130, the second output port provides high optical power, adjustable over a power range of more than 60 dB via a built-in optical attenuator.

The Keysight 81600B options 142 and 132 simply provide an output port with high stimulus power for applications where the SSE level is not critical. The 81600B option 142 can also be equipped with a built-in optical attenuator (option #003), to provide an adjustable power range of 60 dB.

Precision

The Keysight 8160xx Family of Tunable Laser Sources includes a built-in real time wavelength meter which realizes the family's excellent absolute and relative wavelength accuracy, and delivers wavelength logging data after each sweep.

The new Keysight 81602A, 81606A, 81607A, 81608A and 81609A take this concept even further by adding a gas cell for long-term stability and absolute referencing. The wavelength reference unit's fast response and fine wavelength resolution enable the 81602A and 81606A to sweep with

sub-picometer repeatability. It is the key to their superior accuracy and temperature stability, and it enables a greater degree of self-diagnosis than previously possible.

The 81607A and 81608A Value Line models, while offering more moderate wavelength accuracy levels than 81606A, benefit from the same long-term stability as the Top Line model. The 81609A Basic Line model, unlike the other models, is a step-tunable laser source with similar long-term stability.

**Testing
Integrated
Optical devices**

The 8160xx Tunable Laser Source Family's PMF output ports provide a well-defined state of polarization to ensure constant measurement conditions for waveguide devices. A PMF cable easily connects to an external optical modulator.

Optical Output

Polarization Maintaining Fiber

All Keysight 8160xx Series Tunable Laser Family modules include polarization maintaining fiber (PMF) outputs, aligned to maintain the state of polarization.

The fiber is of Panda type, with the electrical field oriented in the slow axis in line with the connector key. A well defined state of polarization ensures constant measurement conditions.

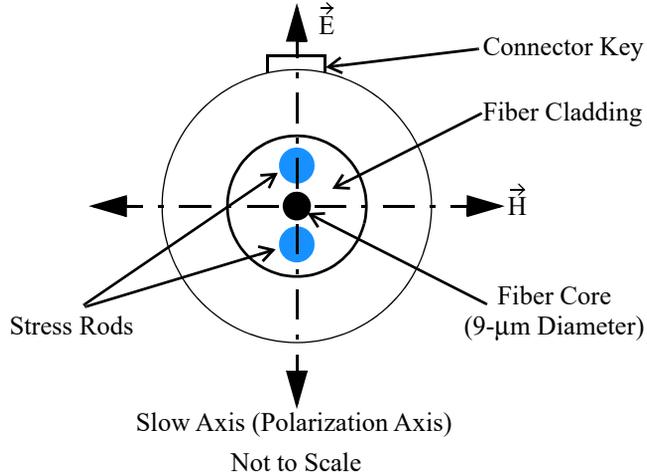


Figure 5 PMF Output Connector

Angled and Straight Contact Connectors

Angled contact connectors help you to control return loss. With angled fiber end-faces, reflected light tends to reflect into the cladding, reducing the amount of light that reflects back to the source. When reflected light remains in the fiber core at two or more locations along the optical path, such as at an open straight-polished connector output to a power meter, double reflections result in multi-path interference of the coherent light and thus power instability in the measurements.

Keysight 8160xx Series Tunable Laser modules can have the following connector interface options:

- Option 071, Polarization-maintaining fiber, Panda-type, for straight contact connectors, or
- Option 072, Polarization-maintaining fiber, Panda-type, for angled contact connectors.

Keysight 81602A, 81606A, 81607A, 81608A and 81609A Tunable Laser Sources come with Option 072.

CAUTION

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

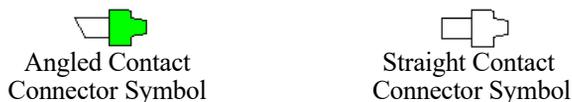


Figure 6 Angled and Straight Contact Connector Symbols

Figure 6 shows the symbols that tell you whether the contact connector of your Tunable Laser Source module is angled or straight. The angled contact connector symbol is colored green.

Figure 3 and Figure 7 show the front panel of the Keysight 81600B Family Tunable Laser Source module with straight and angled contact connectors respectively.

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

NOTE

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

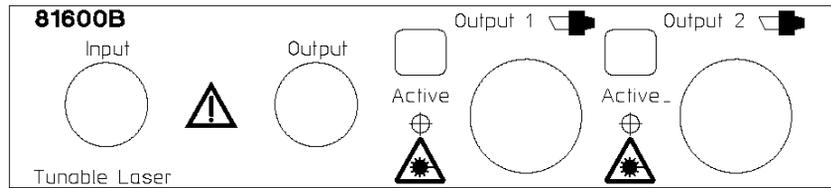


Figure 7 Keysight 81600B Tunable Laser Module (angled contact connector)

Refer to the *User Guide* for further details on connector interfaces and accessories.

Signal Input and Output

CAUTION

There are two BNC connectors on the front panel of a Keysight 8160xx Series Tunable Laser module - a BNC input connector and a BNC output connector.

An absolute maximum of ± 6 V can be applied as an external voltage to any BNC connector.

