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THORLABS

BL1465-PAG500 - January 17, 2020

Item # BL1465-PAG500 was discontinued on January 17, 2020. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

FIBER-BRAGG-GRATING (FBG) STABILIZED LASER DIODES, PIGTAILED BUTTERFLY PACKAGE

- **FBG-Stabilized Laser Diodes with Output Powers Between 300 mW and 900 mW**
- **Center Wavelengths from 976 nm to 1465 nm**
- **Integrated TEC Element and Thermistor**
- **SM or PM Fiber Pigtailed with FC/APC Connector**

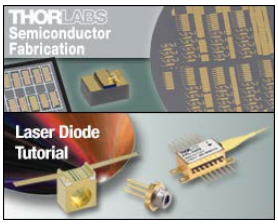
BL976-SAG300
976 nm, 300 mW, SM Pigtail

BL1465-PAG500
1465 nm, 500 mW, PM Pigtail

Hide Overview

OVERVIEW

Features



- Wavelength Stabilized by a Fiber Bragg Grating
- 976 nm Center Wavelength with Output Powers from 300 to 900 mW
- 1425 to 1465 nm Center Wavelengths with 500 mW Output Power
- Integrated Thermoelectric Cooler (TEC) and Thermistor
- Spectral Bandwidth <2 nm
- 14-Pin, Hermetically Sealed Butterfly Package
- Pigtailed Single Mode or Polarization-Maintaining Optical Fiber with FC/APC Connector (2.0 mm Narrow Key)
- Telcordia GR-468 CORE Qualified

Applications

- Core Pumping Erbium-Doped Fiber Devices:
  - Low-Noise CW Lasers
  - Mode-Locked Oscillators
  - Erbium-Doped Fiber Amplifiers (EDFA)
- Optical Tweezer Systems

Laser Diode Selection Guide[a]
Shop by Package / Type
TO Can (Ø3.8, Ø5.6, Ø9, Ø9.5 mm, and TO-46)
TO Can Pigtail (SM)
TO Can Pigtail (PM)
TO Can Pigtail (MM)
Fabry-Perot Butterfly Package
FBG-Stabilized Butterfly Package
MIR Fabry-Perot QCL, TO Can
MIR Fabry-Perot QCL, Two-Tab C-Mount
MIR Fabry-Perot QCL, D-Mount
Chip on Submount
Single-Frequency Lasers
DFB TO Can Pigtail (SM)
VHG-Stabilized TO Can or Pigtail (SM)
VHG-Stabilized Butterfly Package
ECL Butterfly Package
DBR Butterfly Package
MIR DFB QCL, Two-Tab C-Mount
MIR DFB QCL, D-Mount

- Raman Amplification

Thorlabs' Fiber-Bragg-Grating- (FBG) Stabilized Lasers are compact laser diodes designed for use as pump lasers. The butterfly packages contain an integrated thermoelectric cooler (TEC) and thermistor. The region of the fiber marked by a pair of black bands contains a grating etched into the fiber, which acts as a Bragg reflector to provide feedback to the laser. The FBG-stabilized design produces an output that is spectrally broadened by satellite modes. A FBG-stabilized laser is not a single longitudinal mode laser; while it is stabilized in terms of frequency, the gain curve will contain many different modes. Additionally, these Bragg gratings are relatively insensitive to temperature (<0.02 nm/°C). It should be noted that for the SM-pigtailed laser (item # BL976-SAG300), stress-induced birefingence on the fiber may change the output spectrum of the laser diode. Due to the properties of the fiber, the PM-pigtailed lasers will not be affected.

MIR DFB QCL, High Heat Load

Shop By Wavelength

- Our complete selection of laser diodes is available on the *LD Selection Guide* tab above.

Webpage Features

Clicking this icon opens a window that contains specifications, mechanical drawings, and performance graphs.

The 976 nm FBG lasers produce a stable output of ≥300 mW with a single mode fiber pigtail or between 500 and 900 mW with a polarization-maintaining fiber pigtail. With a spectral bandwidth of <1 nm, they are well suited for core pumping of Erbium-doped fibers, such as in Erbium-doped fiber amplifiers, mode-locked oscillators, and CW lasers.

The FBG lasers with wavelengths between 1425 and 1465 nm produce a stable output of 500 mW with a polarization-maintaining fiber pigtail. These laser diodes are designed for Raman amplification and can be used for other applications that require a stabilized, high-power laser source.

Specifications for each item can be found in the tables below and by clicking on the blue icons ( ) below. These specifications are typical values; the performance of a particular unit varies slightly between devices. Each FBG-stabilized laser diode is serialized and shipped with individual test data; click here for a sample data sheet.

These FBG laser diodes are compatible with Thorlabs' line of laser diode drivers and temperature controllers in combination with a butterfly mount. To achieve the narrowest possible linewidth, we recommend using a driver with low drive current noise, such as our LDC series of drivers. When securing a laser diode to a mount or heatsink, be sure not to exceed the 150 mN·m torque limit on the screws holding the butterfly package.

We recommend cleaning the fiber connector before each use in case any dust or other contaminants have been deposited on the surface. The laser intensity at the center of the fiber tip can be very high and may burn the tip of the fiber if contaminants are present. While the connector is cleaned and capped before shipping, we cannot guarantee that it will remain free of contamination after it is removed from the package. We also recommend that the laser is turned off when connecting or disconnecting the device from other fibers.

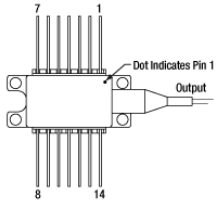
Our FBG-Stabilized Lasers are available for purchase in volume orders. Additionally, custom configurations such as unterminated fiber leads or different FBG center wavelengths are available. Please contact Tech Support for more information and quotation.

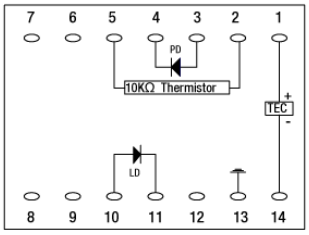
For warranty information, please refer to the *LD Operation* tab.

Hide Pin Diagrams

PIN DIAGRAMS

976 nm FBG-Stabilized Laser Diodes Pin Diagram

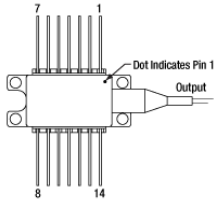


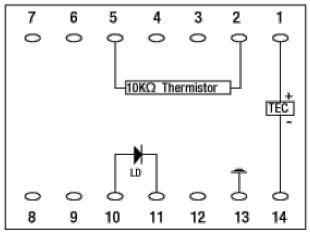


Pin Identification			
Pin	**Assignment**	**Pin**	**Assignment**
1	TEC (+)	14	TEC (-)
2	Thermistor	13	Case
3	PD Anode	12	-
4	PD Cathode	11	LD Cathode

5	Thermistor	10	LD Anode
6	-	9	-
7	-	8	-

1425 - 1465 nm FBG-Stabilized Laser Diodes Pin Diagram





Pin Identification			
Pin	**Assignment**	**Pin**	**Assignment**
1	TEC (+)	14	TEC (-)
2	Thermistor	13	Case
3	-	12	-
4	-	11	LD Cathode
5	Thermistor	10	LD Anode
6	-	9	-
7	-	8	-

Hide Laser Safety

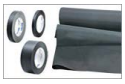
LASER SAFETY

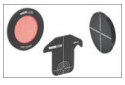
Laser Safety and Classification

Safe practices and proper usage of safety equipment should be taken into consideration when operating lasers. The eye is susceptible to injury, even from very low levels of laser light. Thorlabs offers a range of laser safety accessories that can be used to reduce the risk of accidents or injuries. Laser emission in the visible and near infrared spectral ranges has the greatest potential for retinal injury, as the cornea and lens are transparent to those wavelengths, and the lens can focus the laser energy onto the retina.

Safe Practices and Light Safety Accessories

- Thorlabs recommends the use of safety eyewear whenever working with laser beams with non-negligible powers (i.e., > Class 1) since metallic tools such as screwdrivers can accidentally redirect a beam.
- Laser goggles designed for specific wavelengths should be clearly available near laser setups to protect the wearer from unintentional laser reflections.
- Goggles are marked with the wavelength range over which protection is afforded and the minimum optical density within that range.
- Laser Safety Curtains and Laser Safety Fabric shield other parts of the lab from high energy lasers.
- Blackout Materials can prevent direct or reflected light from leaving the experimental setup area.
- Thorlabs' Enclosure Systems can be used to





contain optical setups to isolate or minimize laser hazards.

- A fiber-pigtailed laser should always be turned off before connecting it to or disconnecting it from another fiber, especially when the laser is at power levels above 10 mW.
- All beams should be terminated at the edge of the table, and laboratory doors should be closed whenever a laser is in use.
- Do not place laser beams at eye level.
- Carry out experiments on an optical table such that all laser beams travel horizontally.
- Remove unnecessary reflective items such as reflective jewelry (e.g., rings, watches, etc.) while working near the beam path.
- Be aware that lenses and other optical devices may reflect a portion of the incident beam from the front or rear surface.
- Operate a laser at the minimum power necessary for any operation.
- If possible, reduce the output power of a laser during alignment procedures.
- Use beam shutters and filters to reduce the beam power.
- Post appropriate warning signs or labels near laser setups or rooms.
- Use a laser sign with a lightbox if operating Class 3R or 4 lasers (i.e., lasers requiring the use of a safety interlock).
- Do not use Laser Viewing Cards in place of a proper Beam Trap.

Laser Classification

Lasers are categorized into different classes according to their ability to cause eye and other damage. The International Electrotechnical Commission (IEC) is a global organization that prepares and publishes international standards for all electrical, electronic, and related technologies. The IEC document 60825-1 outlines the safety of laser products. A description of each class of laser is given below:

Class	Description	Warning Label
1	This class of laser is safe under all conditions of normal use, including use with optical instruments for intrabeam viewing. Lasers in this class do not emit radiation at levels that may cause injury during normal operation, and therefore the maximum permissible exposure (MPE) cannot be exceeded. Class 1 lasers can also include enclosed, high-power lasers where exposure to the radiation is not possible without opening or shutting down the laser.	
1M	Class 1M lasers are safe except when used in conjunction with optical components such as telescopes and microscopes. Lasers belonging to this class emit large-diameter or divergent beams, and the MPE cannot normally be exceeded unless focusing or imaging optics are used to narrow the beam. However, if the beam is refocused, the hazard may be increased and the class may be changed accordingly.	
2	Class 2 lasers, which are limited to 1 mW of visible continuous-wave radiation, are safe because the blink reflex will limit the exposure in the eye to 0.25 seconds. This category only applies to visible radiation (400 - 700 nm).	
2M	Because of the blink reflex, this class of laser is classified as safe as long as the beam is not viewed through optical instruments. This laser class also applies to larger-diameter or diverging laser beams.	
3R	Lasers in this class are considered safe as long as they are handled with restricted beam viewing. The MPE can be exceeded with this class of laser, however, this presents a low risk level to injury. Visible, continuous-wave lasers are limited to 5 mW of output power in this class.	
3B	Class 3B lasers are hazardous to the eye if exposed directly. However, diffuse reflections are not harmful. Safe handling of devices in this class includes wearing protective eyewear where direct viewing of the laser beam may occur. In addition, laser safety signs lightboxes should be used with lasers that require a safety interlock so that the laser cannot be used without the safety light turning on. Class-3B lasers must be equipped with a key switch and a safety interlock.	
4	This class of laser may cause damage to the skin, and also to the eye, even from the viewing of diffuse reflections. These hazards may also apply to indirect or non-specular reflections of the beam, even from apparently matte surfaces. Great care must be taken when handling these lasers. They also represent a fire risk, because they may ignite combustible material. Class 4 lasers must be equipped with a key switch and a safety interlock.	
All class 2 lasers (and higher) must display, in addition to the corresponding sign above, this triangular warning sign		

Hide LD Operation

LD OPERATION

Laser Diode and Laser Diode Pigtail Warranty

When operated within their specifications, laser diodes have extremely long lifetimes. Most failures occur from mishandling or operating the lasers beyond their maximum ratings. Laser Diodes are among the most static-sensitive devices currently made. Proper ESD Protection should be worn whenever handling a laser diode. Due to their extreme electrostatic sensitivity, laser diodes cannot be returned after their sealed package has been open. Laser diodes in their original sealed package can be returned for a full refund or credit.

Handling and Storage Precautions

Due to their extreme susceptibility to damage from electrostatic discharge (ESD), care should be taken whenever handling and operating laser diodes:

- Wrist Straps: Use grounded anti-static wrist straps whenever handling diodes.
- Anti-Static Mats: Always work on grounded anti-static mats.
- Laser Diode Storage: When not in use, short the leads of the laser together to protect against ESD damage.

Operating and Safety Precautions

Use an Appropriate Driver:
Laser diodes require precise control of operating current and voltage to avoid overdriving the laser diode. In addition, the laser driver should provide protection against power supply transients. Select a laser driver appropriate for your application. Do not use a voltage supply with a current limiting resistor since it does not provide sufficient regulation to protect the laser.

Power Meters:
When setting up and calibrating a laser diode with its driver, use a NIST-traceable power meter to precisely measure the laser output. It is usually safest to measure the laser output directly before placing the laser in an optical system. If this is not possible, be sure to take all optical losses (transmissive, aperture stopping, etc.) into consideration when determining the total output of the laser.

Reflections:
Flat surfaces in the optical system in front of a laser diode can cause some of the laser energy to reflect back onto the laser's monitor photodiode giving an erroneously high photodiode current. If optical components are moved within the system and energy is no longer reflected onto the monitor photodiode, a constant power feedback loop will sense the drop in photodiode current and try to compensate by increasing the laser drive current and possibly overdriving the laser. Back reflections can also cause other malfunctions or damage to laser diodes. To avoid this, be sure that all surfaces are angled 5-10°, and when necessary, use optical isolators to attenuate direct feedback into the laser.

Heat Sinks:
Laser diode lifetime is inversely proportional to operating temperature. Always mount the laser in a suitable heat sink to remove excess heat from the laser package.

Voltage and Current Overdrive:
Be careful not to exceed the maximum voltage and drive current listed on the specification sheet with each laser diode, even momentarily. Also, reverse voltages as little as 3 V can damage a laser diode.

ESD Sensitive Device:
Currently operating lasers are susceptible to ESD damage. This is particularly aggravated by using long interface cables between the laser diode and its driver due to the inductance that the cable presents. Avoid exposing the laser or its mounting apparatus to ESDs at all times.

ON/OFF and Power Supply Coupled Transients:
Due to their fast response times, laser diodes can be easily damaged by transients less than 1 µs. High current devices such as soldering irons, vacuum pumps, and fluorescent lamps can cause large momentary transients. Thus, always use surge-protected outlets.

If you have any questions regarding laser diodes, please call your local Thorlabs Technical Support office for assistance.

Hide FBG-Stabilized Laser Diodes, 976 nm

FBG-Stabilized Laser Diodes, 976 nm

Item #	Info	Wavelength (nm)	Power (mW)[a]	Typical Drive Current (mA)[a]	Package	Pin Code	Monitor Photodiode	Wavelength Tested
						b		

BL976-SAG300		976	300	470	SM-Pigtailed Butterfly	14-Pin Type 1	Yes	Yes
BL976-PAG500		976	500	830	PM-Pigtailed Butterfly	14-Pin Type 1[b]	Yes	Yes
BL976-PAG700		976	700	1090	PM-Pigtailed Butterfly	14-Pin Type 1[b]	Yes	Yes
BL976-PAG900		976	900	1480	PM-Pigtailed Butterfly	14-Pin Type 1[b]	Yes	Yes

- a. Do not exceed the maximum optical power or maximum drive current, whichever occurs first.
- b. See the *Pin Diagram* Tab for Pin Configuration

Part Number	Description	Price	Availability
BL976-SAG300	**976 nm, 300 mW, Butterfly FBG-Stabilized Laser, SM Fiber, FC/APC**	**$729.34 Volume Pricing Available**	**Today**
BL976-PAG500	**976 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC**	**$1,527.95**	**Today**
BL976-PAG700	**976 nm, 700 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC**	**$1,803.89**	**Today**
BL976-PAG900	**976 nm, 900 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC**	**$2,313.57**	**Today**

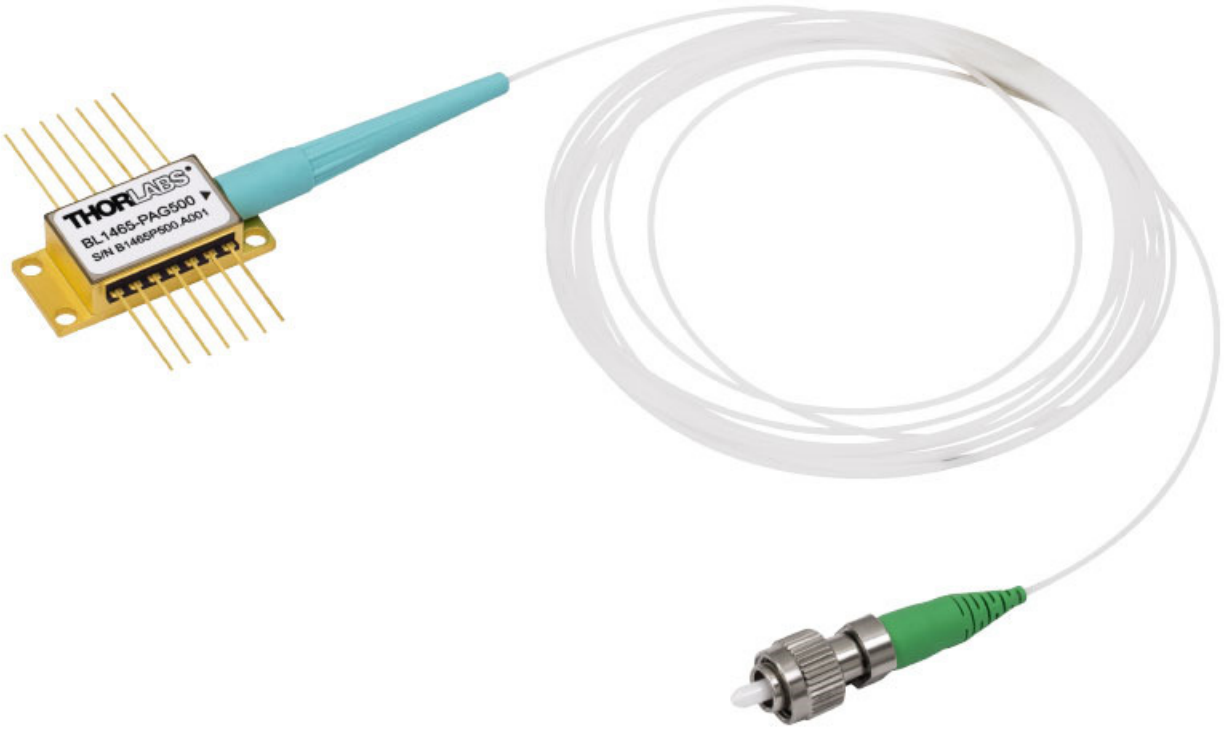
Hide FBG-Stabilized Laser Diodes, 1425 - 1465 nm

FBG-Stabilized Laser Diodes, 1425 - 1465 nm

Item #	Info	Wavelength (nm)	Power (mW)[a]	Typical Drive Current (mA)[a]	Package	Pin Code	Monitor Photodiode	Wavelength Tested
BL1425-PAG500		1425	500	1600	PM-Pigtailed Butterfly	14-Pin Type 1[b]	No	Yes
BL1436-PAG500		1436	500	1600	PM-Pigtailed Butterfly	14-Pin Type 1[b]	No	Yes
BL1456-PAG500		1456	500	1600	PM-Pigtailed Butterfly	14-Pin Type 1[b]	No	Yes
BL1465-PAG500		1465	500	1600	PM-Pigtailed Butterfly	14-Pin Type 1[b]	No	Yes

- a. Do not exceed the maximum optical power or maximum drive current, whichever occurs first.
- b. See the *Pin Diagram* Tab for Pin Configuration

Part Number	Description	Price	Availability
BL1425-PAG500	**1425 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC**	**$1,853.59**	**Today**
BL1436-PAG500	**1436 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC**	**$1,853.59**	**Today**
BL1456-PAG500	**1456 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC**	**$1,853.59**	**Today**
BL1465-PAG500	**1465 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC**	**$1,853.59**	**Lead Time**


THORLABS
BL1465-PAG500
S/N B1465P500.A001

BL1465-PAG500 - 1465 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC

Specifications | Fiber Specs | Drawing | Spectrum | LIV

Optical Electrical Characteristics[a]				
Characteristic	**Min**	**Typ.**	**Max**	**Unit**
Peak Wavelength[b]	1464	1465	1466	nm
Spectral Bandwidth @ -3 dB	-	1.2	2.0	nm
Output CW Operating Power	500	-	-	mW
Kink-Free Power	-	500	-	mW
Threshold Current	-	75	200	mA
Forward Current (@ Operating Power)	-	1600	2100	mA
Slope Efficiency	0.20	0.28	-	W/A
Forward Voltage	-	1.7	2.1	V
Relative Intensity Noise (100 kHz ~ 1 GHz)	-	-	-105	dB/Hz
Temp. Coefficient of FBG	-	0.01	0.02	nm/°C
Polarization Extinction Ratio	13	18	-	dB

a. $T_{CASE} = T_{FBG} = 25$ °C
b. Vacuum Wavelength

Absolute Maximum Ratings[a,b]		
Characteristic	**Value**	**Unit**
LD Reverse Voltage	2.0	V
Absolute Max Current	3000	mA
Absolute Max Power	650	mW
Max TEC Voltage, Cooler Mode	4.5	V
Max TEC Current, Cooler Mode	3.5	A
Operation Case Temperature ($T_{Submount}$ = 25 °C)	-5 to +75	°C
Storage Temperature	-40 to +85	°C
Max Tightening Torque	150	mN•m

a. Absolute Maximum Rating specifications should never be exceeded. Operating beyond these conditions can seriously damage the laser. For more information, please see the Laser Diode Tutorial.
b. T_{CHIP} = 25 °C, T_{CASE} = -5 °C to 75 °C

TEC Characteristics				
Characteristic	**Min**	**Typ.**	**Max**	**Unit**
Cooling Capacity	-	-	30	°C
Total TEC Power Consumption (P_{op} = 500 mW; T_{case} = 70 °C)	-	-	9.0	W
Thermistor B Constant	3700	-	4100	K
Thermistor Resistance	9.5	10	10.5	kOhms

General Specifications	
Characteristic	**Value**
Monitor Photodiode	No
Package	PM-Pigtailed Butterfly
Pin Code	14-Pin Type 1[a]
Spatial Mode	Single Mode
Wavelength Tested	Yes

a. See the *Pin Diagram* Tab for Pin Configuration

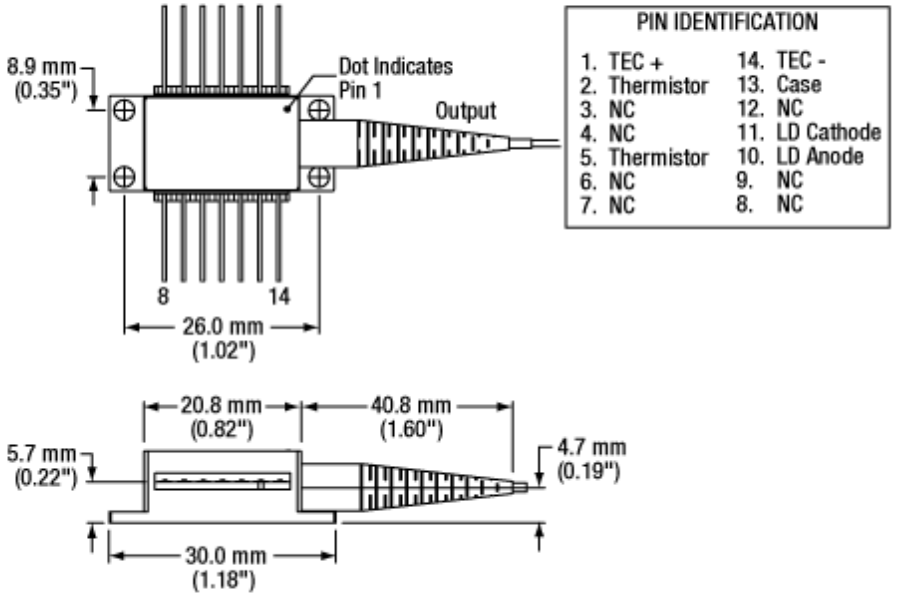
BL1465-PAG500 - 1465 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC

Specifications | **Fiber Specs** | Drawing | Spectrum | LIV

Fiber Specifications			
Characteristic	**Value**		
Fiber Type	Corning PM15-U25D		
Fiber Termination	FC/APC, 2.0 mm Narrow Key		
Key Alignment	Parallel to Slow Axis of Fiber		
Polarization	Aligned to Slow Axis of Fiber		
Protection Tubing Diameter	900 µm		
Parameter	**MIN**	**TYP**	**MAX**
Fiber Coating Diameter (Typical)	230 µm	245 µm	260 µm
FBG Recoat Diameter	260 µm	295 µm	400 µm
Fiber Bend Radius	20 mm	-	-
Distance Between FBG and Module	-	2.5 m	-
Distance Between FBG and Fiber End	0.5 m	-	-
Pigtail Length	-	3.4 m	-

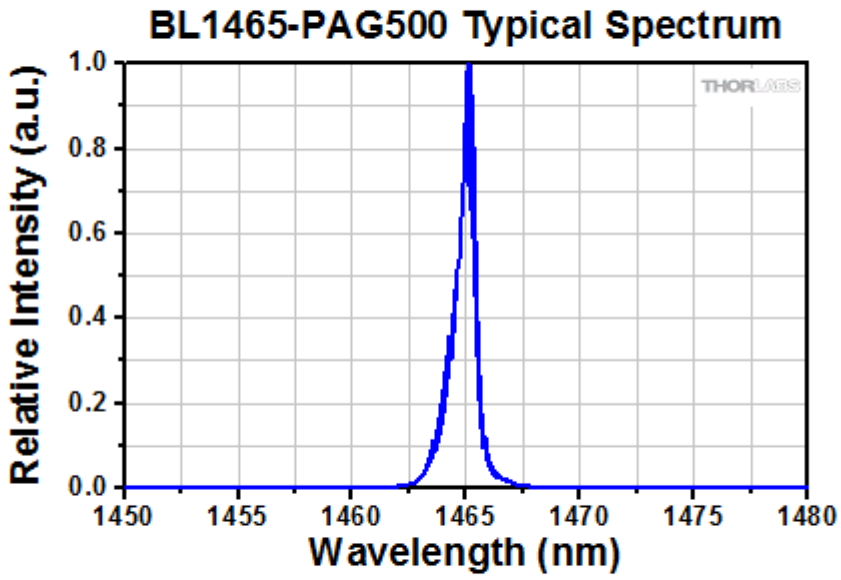
BL1465-PAG500 - 1465 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC

Specifications | Fiber Specs | **Drawing** | Spectrum | LIV



BL1465-PAG500 - 1465 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC

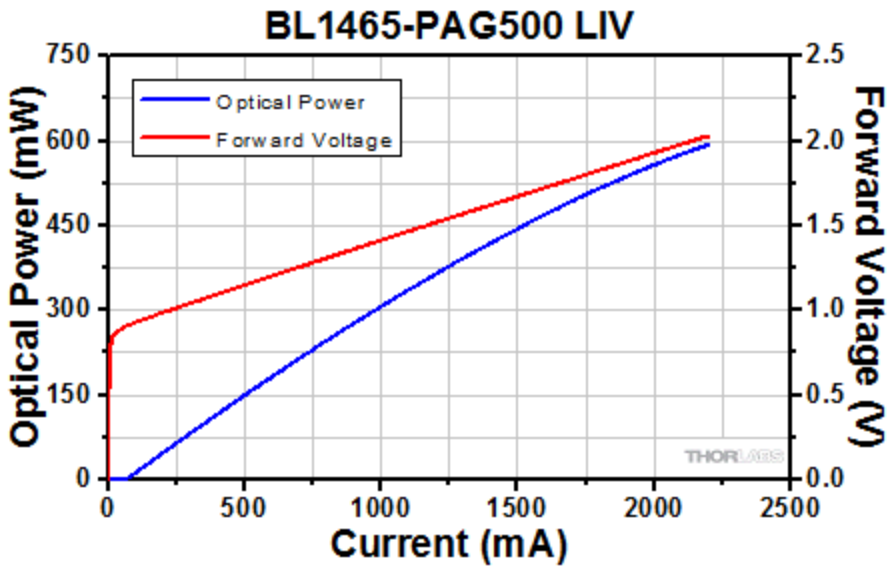
Specifications | Fiber Specs | Drawing | **Spectrum** | LIV



The typical optical spectrum is shown above. The laser diode was driven at P_{OP} (500 mW) and held at 25 °C. Performance will vary between individual lasers, serial-number-specific documentation is provided with each FBG-stabilized laser diode.

BL1465-PAG500 - 1465 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC

Specifications | Fiber Specs | Drawing | Spectrum | LIV



Note: The plot above is typical, and performance will vary between individual lasers. Serial-number-specific documentation is provided with each FBG-stabilized laser diode.