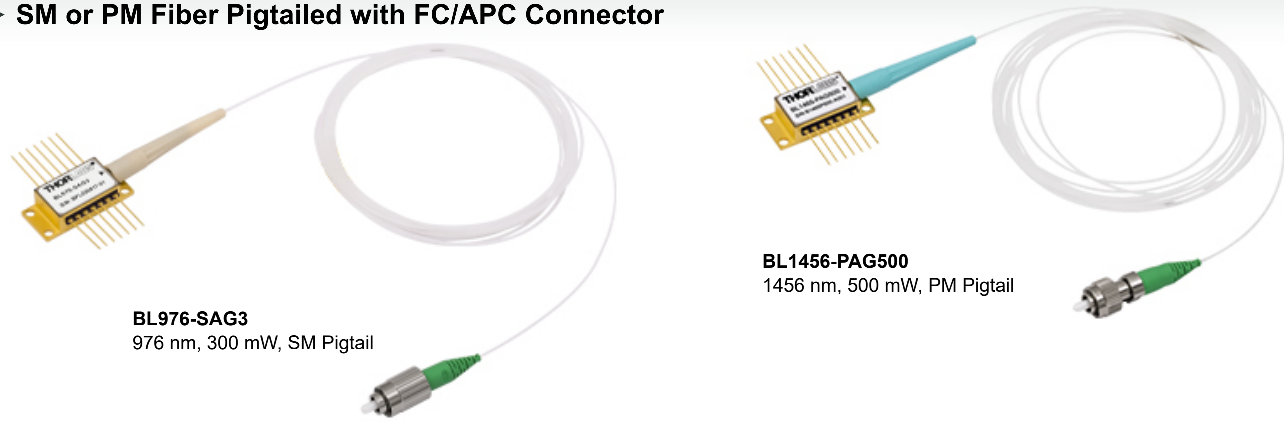
BL976-SAG300 - December 19, 2023

Item # BL976-SAG300 was discontinued on December 19, 2023. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

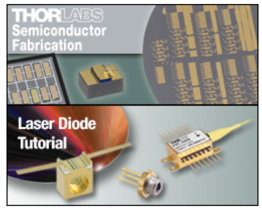
FIBER-BRAGG-GRATING (FBG) STABILIZED LASER DIODES, PIGTAILED BUTTERFLY PACKAGE

- ► **FBG-Stabilized Laser Diodes with Output Powers Between 300 mW and 900 mW**
- ► **Center Wavelengths from 976 nm to 1456 nm**
- ► **Integrated TEC Element and Thermistor**
- ► **SM or PM Fiber Pigtailed with FC/APC Connector**



OVERVIEW

Features



- Wavelength Stabilized by a Fiber Bragg Grating
- 976 nm Center Wavelength with Output Powers from 300 to 900 mW
- 1425 to 1456 nm Center Wavelengths with 500 mW Output Power
- Integrated Thermoelectric Cooler (TEC) and Thermistor
- Spectral Bandwidth: <2 nm
- 14-Pin, Type 1, 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
- Raman Amplification

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

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

Webpage Features	
(i)	Clicking this icon opens a window that contains specifications, mechanical drawings, and performance graphs.

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-SAG3), 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.

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 1456 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 (i) 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.

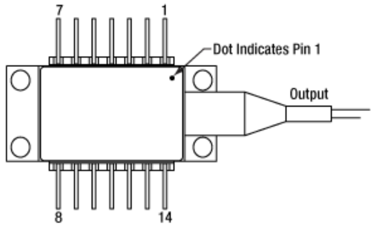
We recommend cleaning the fiber connector before each use in case any dust or other contaminants have been deposited on the surface. The laser intensity at the center of the fiber tip can be very high and may burn the tip of the fiber if contaminants are present. While the connector is cleaned and capped 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.

PIN DIAGRAMS

976 nm FBG-Stabilized Pigtailed Butterfly Laser Diodes Pin Diagram

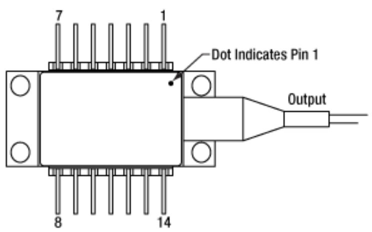


Click for Details

Pin Identification			
Pin	Assignment	Pin	Assignment
1	TEC[a] +	14	TEC -
2	Thermistor	13	Case
3	PD[b] Anode	12	NC[c]
4	PD Cathode	11	LD[d] Cathode
5	Thermistor	10	LD Anode
6	NC	9	NC
7	NC	8	NC

a. Thermoelectric Cooler (TEC)
b. Photodiode (PD)
c. Not Connected (NC)
d. Laser Diode (LD)

1425 - 1456 nm FBG-Stabilized Laser Diodes Pin Diagram



Click for Details

Pin Identification			
Pin	Assignment	Pin	Assignment
1	TEC[a] +	14	TEC -
2	Thermistor	13	Case
3	NC[b]	12	NC
4	NC	11	LD[c] Cathode
5	Thermistor	10	LD Anode
6	NC	9	NC
7	NC	8	NC

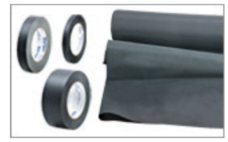
a. Thermoelectric Cooler (TEC)
b. Not Connected (NC)
c. Laser Diode (LD)

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








- Laser safety eyewear must be worn whenever working with Class 3 or 4 lasers.
- Regardless of laser class, Thorlabs recommends the use of laser safety eyewear whenever working with laser beams with non-negligible powers, 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	Class 3R lasers produce visible and invisible light that is hazardous under direct and specular-reflection viewing conditions. Eye injuries may occur if you directly view the beam, especially when using optical instruments. 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 in this class are limited to 5 mW of output power.	
3B	Class 3B lasers are hazardous to the eye if exposed directly. Diffuse reflections are usually not harmful, but may be when using higher-power Class 3B lasers. Safe handling of devices in this class includes wearing protective eyewear where direct viewing of the laser beam may occur. Lasers of this class must be equipped with a key switch and a safety interlock; moreover, laser safety signs should be used, such that the laser cannot be used without the safety light turning on. Laser products with power output near the upper range of Class 3B may also cause skin burns.	
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.		

Video Insight: Setting Up a Pigtailed Butterfly Laser Diode

A laser diode packaged in a butterfly housing can be precisely controlled, in a compact package, when the laser is installed in a mount that includes thermoelectric cooler (TEC) and current drivers. The mount can make it easier, and safer, to operate the laser, but the procedure for installing the laser in the mount and configuring the settings requires some care. This video provides a step-by-step guide, which begins with an introduction to the different components and concludes with the laser operating under TEC control and with the recommended maximum current limit enabled.

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 and 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 opened. Laser diodes in their original sealed package can be returned for a full refund or credit.

Handling and Storage Precautions

Because of 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. 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 diode.

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 diode 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 diode 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
Laser diodes are susceptible to ESD damage even during operation. 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 diode or its mounting apparatus to ESD 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, and thus surge-protected outlets should always be used when working with laser diodes.

If you have any questions regarding laser diodes, please contact Thorlabs Technical Support for assistance.

FBG-Stabilized Laser Diodes, 976 nm

Item #	Info	Wavelength	Minimum Power	Typical Drive Current[a]	Package	Pin Code	Laser Mode	Monitor Photodiode[b]	Wavelength Tested
BL976-SAG300		976 nm	300 mW	470 mA	SM Butterfly, FC/APC	14-Pin Type 1[d]	Single Transverse Mode	Yes	Yes
BL976-PAG500			500 mW	830 mA	PM[c] Butterfly, FC/APC				
BL976-PAG700			700 mW	1090 mA					
BL976-PAG900			900 mW	1480 mA					

a. At Minimum Output Power
b. Laser diodes with a built-in monitor photodiode can operate at constant power.
c. The slow axis of the polarization-maintaining fiber is aligned to the connector key.
d. See the Pin Diagrams tab for the pin configuration.

Part Number	Description	Price	Availability
BL976-SAG300	**976 nm, 300 mW, Butterfly FBG-Stabilized Laser, SM Fiber, FC/APC**	**$800.65**	**7 - 10 Days**
BL976-PAG500	**976 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC**	**$1,677.35**	**Today**
BL976-PAG700	**976 nm, 700 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC**	**$1,980.27**	**Today**
BL976-PAG900	**976 nm, 900 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC**	**$2,539.78**	**Today**

FBG-Stabilized Laser Diodes, 1425 - 1456 nm

Item #	Info	Wavelength	Minimum Power	Typical Drive Current[a]	Package	Pin Code	Laser Mode	Monitor Photodiode[b]	Wavelength Tested
BL1425-PAG500		1425 nm	500 mW	1600 mA	PM Butterfly[c], FC/APC	14-Pin Type 1[d]	Single Transverse Mode	No	Yes
BL1436-PAG500		1436 nm							
BL1456-PAG500		1456 nm							

a. At Minimum Output Power
b. Laser diodes with a built-in monitor photodiode can operate at constant power.
c. The slow axis of the polarization-maintaining fiber is aligned to the connector key.
d. See the *Pin Diagrams* tab for the pin configuration.

Part Number	Description	Price	Availability
BL1425-PAG500	**1425 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC**	**$2,034.83**	**Today**
BL1436-PAG500	**1436 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC**	**$2,034.83**	**Today**
BL1456-PAG500	**1456 nm, 500 mW, Butterfly FBG-Stabilized Laser, PM Fiber, FC/APC**	**$2,034.83**	**Today**

BL976-SAG300 - 976 nm, 300 mW, Butterfly FBG-Stabilized Laser, SM Fiber, FC/APC

Specs | Fiber Specs | Drawings | Spectrum | LIV

Optical Electrical Characteristics (T_{CHIP} = 25 °C, T_{CASE} = -5 to 75 °C)				
Characteristic	Min	Typ.	Max	Unit
Peak Wavelength[a]	975	976	977	nm
Spectral Bandwidth @ -3 dB	-	-	1	nm
Output CW Operating Power	300	-	-	mW
Kink-Free Power	-	330	-	mW
Threshold Current	-	45	60	mA
Forward Current (@ Operating Power)	-	470	515	mA
Slope Efficiency	0.65	0.76	-	W/A
Forward Voltage	-	1.8	2.0	V
Power Stability[b]	-	<1	2	%
Temp Coefficient of FBG	-	0.01	0.02	nm/°C
Monitor PD Responsivity[c]	0.5	-	10	µA/mW

a. Vacuum Wavelength, @T_{CASE} = T_{FBG} = 25 °C
b. Peak-to-Peak Operating Power, 10 Hz to 50 kHz, Over 60 Seconds
c. The monitor diode indicates the power out of the rear facet and is intended to be used as an approximate indicator of power out of the chip.

Absolute Maximum Ratings[a]		
Characteristic	Value	Unit
LD Reverse Voltage	2.0	V
Absolute Max Current	600	mA
Absolute Max Power	350	mW
PD Reverse Voltage	15	V
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.

TEC Operation				
Characteristic	Min	Typ.	Max	Unit
TEC Current	-	-	1.4	A
TEC Voltage	-	-	2.1	V
Thermistor Resistance	9.5	10	10.5	kOhms

General Specifications	
Characteristic	Value
Monitor Photodiode	Yes
Package	SM-Pigtailed Butterfly
Pin Code	14-Pin Type 1[a]
Laser Mode	Single Transverse Mode
Wavelength Tested	Yes

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

BL976-SAG300 - 976 nm, 300 mW, Butterfly FBG-Stabilized Laser, SM Fiber, FC/APC

Specs | **Fiber Specs** | Drawings | Spectrum | LIV

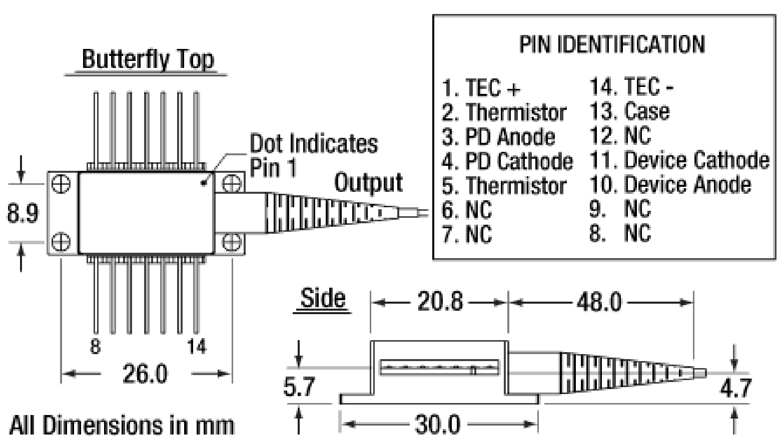
Fiber Specifications	
Characteristic	
Fiber Type	HI1060 or Equivalent SM Fiber
Mode Field Diameter[a] @ 980 nm	5.9 ± 0.3 µm
Numerical Aperture	0.14
Fiber Coating Diameter (Typical)	250 µm
FBG Coat Diameter (Max)	400 µm
FP Gain Chip to FBG Distance[b] (Typical)	2.0 m
Connector	FC/APC (2.0 mm Narrow Key)
Jacket	Ø900 µm
Bend Radius (Min)	25 mm

a. Mode Field Diameter (MFD) is specified as a nominal value.
b. To the center of the FBG, approximate location marked on outside of tubing

Auto CAD PDF | Auto CAD DXF | Solidworks | eDrawing | Step | Spec Sheet | Catalog Page

BL976-SAG300 - 976 nm, 300 mW, Butterfly FBG-Stabilized Laser, SM Fiber, FC/APC

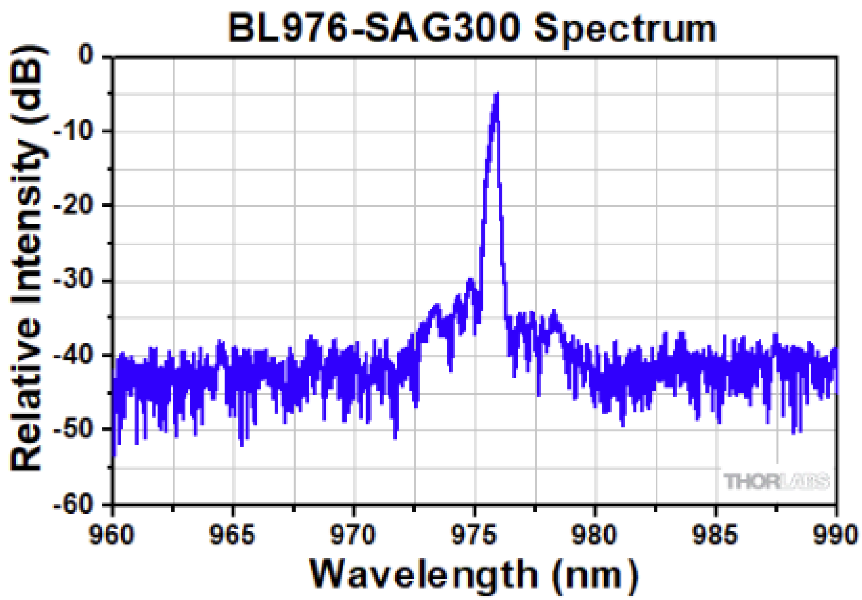
Specs | Fiber Specs | **Drawings** | Spectrum | LIV



BL976-SAG300 - 976 nm, 300 mW, Butterfly FBG Laser, SM Fiber, FC/APC

BL976-SAG300 - 976 nm, 300 mW, Butterfly FBG-Stabilized Laser, SM Fiber, FC/APC

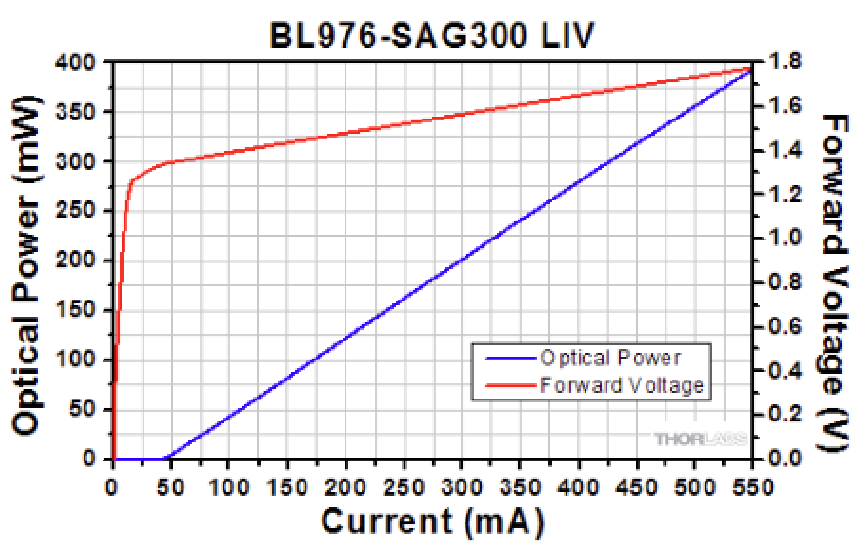
Specs | Fiber Specs | Drawings | **Spectrum** | LIV



The typical optical spectrum is shown above. The data was obtained with the OSA201C Optical Spectrum Analyzer. The laser diode was driven at P_{OP} (300 mW) and held at 25 °C. Performance will vary between individual lasers, serial-number-specific documentation is provided with each FBG-stabilized laser diode.

BL976-SAG300 - 976 nm, 300 mW, Butterfly FBG-Stabilized Laser, SM Fiber, FC/APC

Specs | Fiber Specs | Drawings | 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.