

TUNABLE LASERS: OVERVIEW



Benchtop Systems • TXP Modules • OEM Modules

Thorlabs' tunable lasers are all based on external cavity tunable laser technology with tuning ranges up to 150nm. Since they are able to continuously tune or step between ITU grid wavelengths, Thorlabs' tunable lasers are ideal for both test and measurement as well as for research and development. Using our proprietary technology, all models exhibit mode-hop free tuning with wavelength resolution of 0.1pm and absolute wavelength accuracy within $\pm 10\text{pm}$. The highly stable output and quick tuning speed of our continuous tuning models allow the units to tune over their entire range in less than a second. The low source spontaneous emission (SSE) makes them an ideal source for testing fiber-optic components, spectroscopy, or basic research applications. Our tunable lasers cover wavelengths ranging from 770nm to 1650nm and are available with fiber output or with free-space collimated beams. The various models offer different features from benchtop units to OEM modules for integrating into larger applications.

ECL Technology

Thorlabs' models are based on external cavity lasers (ECL), which are capable of delivering very high output powers in combination with a wide tuning range.

In addition, ECL technology has the advantage of continuous, mode-hop free, tuning. ECL lasers are comprised of a laser diode with high gain and a separate grating that is mounted on a pivoting arm to form the cavity (see figure 1). To tune the laser's wavelength, the angle of the grating is changed by turning the arm with an actuator. The positioning and alignment of the grating assembly and the actuator design are critical to optimal scanning performance.

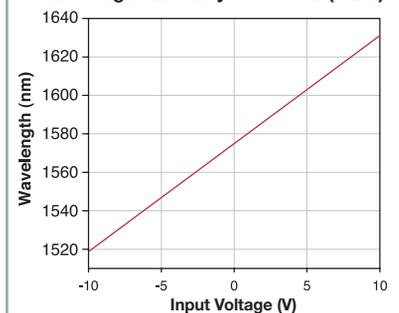
Scanning Capabilities

The patented inductive motor design of our continuously tunable models enables a smooth and quick sweep over the full wavelength range in both directions with perfect repeatability. Optional step mode operation and true continuous linear tuning without any ripple result from this unique design.

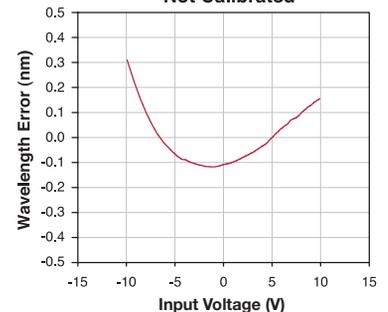
These lasers provide an excellent sweep performance while being robust and reliable at the same time.

The waveforms below show the excellent linearity of the ECL across the entire tuning range.

Wavelength Linearity of PICO D (OEM)



Not Calibrated



Calibrated

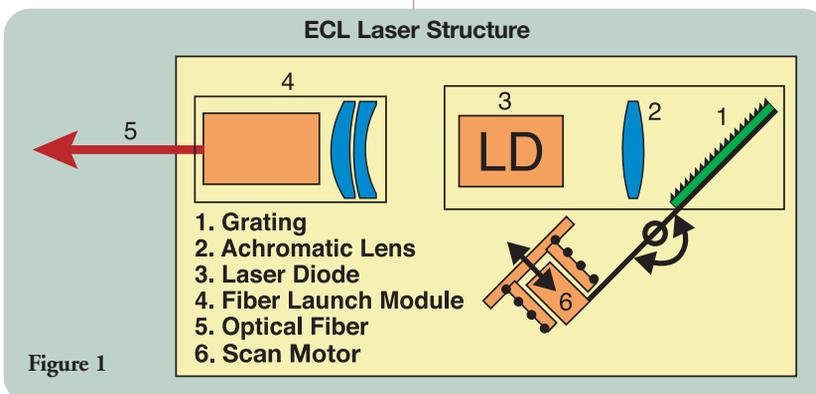
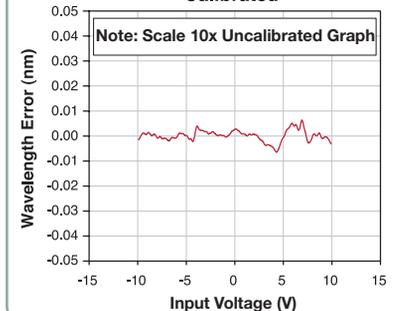


Figure 1

Applications

Heterodyne Interferometry

Optical Heterodyne Interferometry is an important measurement technique that benefit from Thorlabs' continuously tunable lasers.

Laser requirements for this high-precision measurement include smooth continuous tuning, high accuracy measurement, control of the wavelength, low noise, and narrow linewidth.

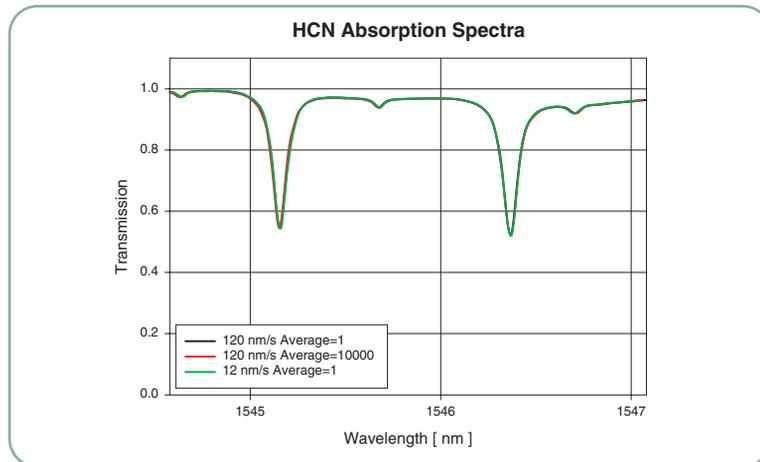
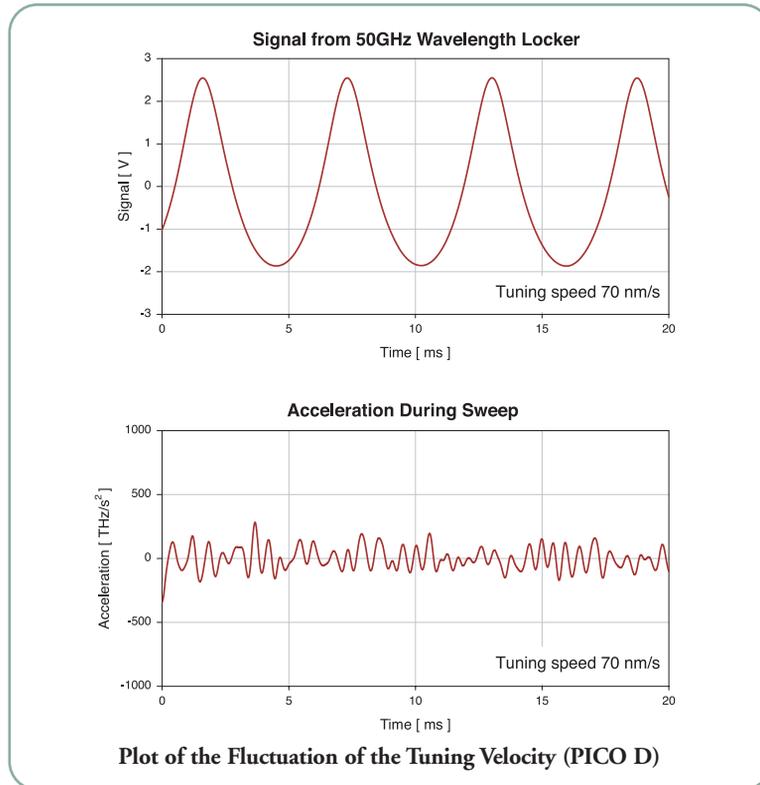
Our patented motor design enables a highly constant tuning speed. The constant sweep speed (low acceleration) makes these lasers suitable for interferometric and heterodyne measurements.

The acceleration during sweep (variation in the tuning speed) is measured using a wavelength locker (low finesse Etalon). The wavelength locker signal provides evenly spaced peaks (clock) in the frequency space (k-space). There are several methods to acquire data, which enables the calculation of the tuning speed and the acceleration. One method is to use the k-space clock to determine the tuning speed, and the time fluctuations of the k-space clock to determine the tuning speed variations (acceleration). In the figure to the right, we have used (in addition to the k-space clock) the knowledge of the finesse of the Etalon to improve the time resolution of the measurement. When using the knowledge of the finesse, the time resolution of the tuning speeds and the measurement of the acceleration is limited to the sampling frequency rather than the k-space clock.

Spectral Monitoring

The ECL tunable lasers provide an outstanding building block in spectral measuring and monitoring. The waveform shows an HCN (Hydrogen Cyanide) scan using Thorlabs' ECL technology. See pages 851-857 for our gas cell products.

The impressive scan-to-scan repeatability allows the user to average spectral features without smearing (see figure to the right).



WAVELENGTH (nm)	TUNING RANGE (nm)	POWER (mW)	FIBER OUTPUT	MODEL
780	15	>5	—	INTUN
980	25	20	—	INTUN
1320	>110	>5* to >20	Yes	INTUN, PICO D ECL5000
1560	>130	>5* to >20	Yes	INTUN, PICO D ELC5000, μ ECL

* For the fiber coupled versions

LASER SELECTION TABLE	PICO D	ELC5000DT	INTUN-T	INTUN-B	ELC1525
Mode-Hop Free Tuning	***	***	***	***	***
Fiber Output	***	***	**	**	***
Swept Wavelength Applications	***	***	***	*	*
Step and Measurement	*	*	*	***	***
Digital Interface		***		***	***
ITU References					***

Legend *** Best **Selected Models Only *Standard

Tunable Lasers

Femtosecond Laser

WDM Laser Sources

Benchtop Laser Sources

HeNe Lasers

ASE Sources

Terahertz

Electro-Optic Modulators

PICO D Series Continuously Tunable OEM Lasers (1260-1630nm)



Thorlabs' PICO D family of OEM tunable ECLs allows for integration into larger or custom environments. The PICO D family is specially designed for swept wavelength applications and interferometric measurements. The laser has an outstanding tuning smoothness, which is a necessity in applications such as interferometric optical component testing and high-resolution fiber sensing.

The PICO D features analog tuning and continuous mode-hop free tuning across more than 100nm in the O-, S-, C-, and L-bands (1260-1630nm). The standard product offers a typical output power of >5dBm across the tuning range. The PICO D offers low SSE, providing a Signal to Total Source Spontaneous Emission Ratio (STSSER) of >65dB. This makes the PICO D an ideal source for testing optical components.

Thorlabs also offers an evaluation board for the PICO D module. The unit helps evaluate the performance of the module and demonstrates how the PICO D can be easily integrated into other platforms such as test and measurement instruments for optical telecom and optical sensing applications. The PICO series is ideal for fiber-sensor-based temperature and pressure monitoring in petrochemical facilities, refineries, oil wells, power plants, and bridges.

LASER RADIATION
DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS!
CLASS 1M LASER PRODUCT
1454-1650nm <50mw
IEC 60825-1 EDITION 1.2 2001-08

Optical Specifications

Parameter	Typical
Tuning Range*	
PICO D 1300 (O-Band)	1260-1370nm
PICO D 1500 (S- and C-Bands)	1460-1570nm
PICO D (C- and L-Bands)	1519-1630nm
Mode Hops	0
Continuous Tuning Speed	0-130nm/s
Tuning Speed	
1nm	30ms
10nm	100ms
100nm Step	800ms
Wavelength Resolution	0.6pm
Wavelength Repeatability	1pm
Absolute Wavelength Accuracy	±10pm
Wavelength Stability pm (1hr)	±2pm
(24hr)	±10pm
Optical Peak Power	>6dBm
Optical Power Over Entire Tuning Range	>5dBm
Power Resolution	0.1µW
Spectral Linewidth	150kHz Max**
Coherence Control	Optional
Side Mode Suppression Ratio (SMSR)	45dB
Signal to Source Spontaneous Emission (SSE)	70dBm/nm
Signal to Total Source Spontaneous Emission Ratio (STSSER)	65dB
Optical Isolation	60dB
RIN	-140 (dB/Hz)

* Standard product, other wavelengths available upon request.

** Measurement time <1ms.

Features

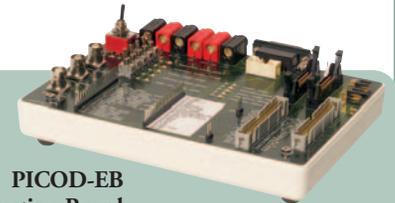
- Tuning Without Mode-Hop
- Models Covering O, S, C, and L Bands Available
- Peak Power >6dBm (Typ.)
- Low SSE >70dB/nm

Electrical and Interface Specifications

- **Operating Temperature Range:** 15-40°C
- **Optical Connector:** FC/APC
- **DC Power:** +5V and ±15V
- **Wavelength Set Voltage:** ±10V
- **Output Power Set Voltage:** -1V to +10V
- **Digital Control and Status:** 0-5V
- **Electrical Connectors:**
 - 6-pin Power Rear Panel
 - 40-pin Electrical Rear Panel
- **Physical Size:** 49 x 93 x 27.3mm (W x H x L)

The evaluation board lets you control the PICO D using peak isolation BNC connectors for easy integration in the lab. Also, the evaluation board indicates the laser status with built-in LEDs. It works with any PICO D and INTUN-T laser.

For application information, email us at scandinavia@thorlabs.com



PICOD-EB Evaluation Board

ITEM#	\$	£	€	RMB	DESCRIPTION
PICOD-SM	\$ 19,800.00	£ 12,474.00	€ 18,414.00	¥ 189,090.00	Continuously Tunable Laser, 1519-1630nm SM Fiber
PICOD-PM	\$ 20,400.00	£ 12,852.00	€ 18,972.00	¥ 194,820.00	Continuously Tunable Laser, 1519-1630nm PM Fiber
PICOD-1300-SM	\$ 20,600.00	£ 12,978.00	€ 19,158.00	¥ 196,730.00	Continuously Tunable Laser, 1260-1370nm SM Fiber
PICOD-1300-PM	\$ 21,200.00	£ 13,356.00	€ 19,716.00	¥ 202,460.00	Continuously Tunable Laser, 1260-1370nm PM Fiber
PICOD-1500-SM	\$ 20,600.00	£ 12,978.00	€ 19,158.00	¥ 196,730.00	Continuously Tunable Laser, 1460-1570nm SM Fiber
PICOD-1500-PM	\$ 21,200.00	£ 13,356.00	€ 19,716.00	¥ 202,460.00	Continuously Tunable Laser, 1460-1570nm PM Fiber
PICOD-EB	\$ 208.80	£ 131.50	€ 194.20	¥ 1,994.00	Continuously Tunable Laser, Evaluation Board



Using the PICO D Tunable Laser for Polarization Measurement



PMD5000 SERIES
Complete PMD/PDL Analysis System
(Laptop Included)

The PMD5000 measurement system consists of three parts: the tunable laser source ECL5000D, the fast deterministic polarization controller, and either our fast or our high dynamic range polarimeter. This system provides extensive measurement and analysis of Polarization Mode Dispersion on components, optical fibers, and installed optical systems that are either active or passive, or broadband or narrow band. The PMD5000 is also capable of determining Polarization Dependent Loss (PDL) and Polarization Dependent Gain (PDG).

The system uses the Jones Matrix Eigenanalysis (JME) method to ensure accuracy when making measurements on a large variety of optical elements. Key components of the JME are the tunable laser detector, ministic polarization controller, and the DPC5500. (Refer to page 979 for more information).

Clean and Fast

The core of the ECL5000D is the PICO D tunable laser. The PICO D, with low noise and fast linear tuning characteristics, is a natural choice for integration into optical parameter measurement instruments such as the PMD5000 System.

High demands on fiber optic equipment require reliable testing, and the source must not impose limits on the subject being measured.

Range and Power

The tunable laser provides continuous, mode-hop free tuning. It is available in several models spanning the 1260-1630nm range and each model has more than 110nm of tuning range. With a Signal on Total Source Spontaneous Emission Ratio (STSSER) specification of >65dB, the PICO D provides plenty of margin when measuring PMD and PDL, for example.

Accurate and Adaptable

The tunable laser provides outstanding performance with a wavelength resolution and repeatability of 1pm each and a one-hour wavelength stability of ± 2 pm. This is important for demanding applications such as polarization measurement (JME) where the PMD5000 System measures the optical transfer function.

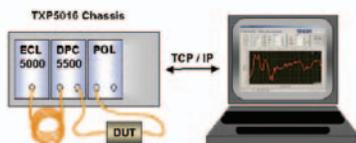
PMD and PDL analysis of fibers and broadband components can be performed with this model. This includes the PMD measurement of passive components (couplers, isolators, and narrow bandwidth components such as optical filters, Bragg gratings, and OADM), and active components (EDFAs and PDFAs).

The OEM Solution

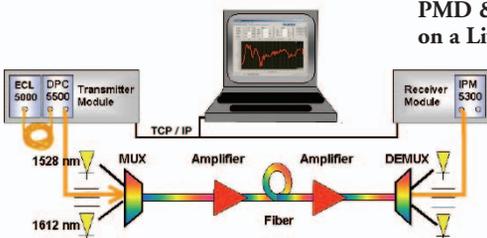
Cost effectiveness and quality of light are equally important. When selecting a Tunable Laser Source (TLS), one must consider the following:

- **Wavelength Range:** The Wider the Range, the Lower the Risk For Needing More Than One Source
- **Tuning Speed:** The Faster the Sweep, the More Units That Can Be Tested Over Time
- **Power:** High Output Means the Ability to Test High-Power Components and the Possibility of Light Sharing Among Multiple Devices Simultaneously
- **Price:** The TLS Must Have a Modular Design to be Easily Integrated Into the Test Equipment, Which Would Avoid the Need for Separate Benchtop Tunable Lasers

Standard Single Chassis System



PMD & PDL Measurements of Broadband and Narrow Bandwidth Devices



PMD & PDL Monitoring on a Live Fiber With Traffic

