Tunable Laser Kit

Operating Manual

Table of Contents

Part 1. Safety

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly.

WARNING

This unit must not be operated in explosive environments

WARNING

Set TEC and max LD current parameters before operating a Tunable Laser Kit. Failure to do so may result in damage or failure of the gain element.

WARNING

Optical gratings can be easily damaged by moisture, fingerprints, aerosols, or the slightest contact with any abrasive material. Gratings should only be handled when necessary and always held by the sides. Latex gloves should be worn to prevent oil from fingers from reaching the grating surface. No attempt to clean a grating other than blowing off dust with clean, dry air or nitrogen. Scratches or other minor cosmetic imperfections on the surface of a grating do not usually affect performance and are not considered defects.

WARNING

Avoid Exposure – ASE and laser radiation emitted from apertures. Never look directly in to beam.

Part 2. Description

- User-Customizable Optics, Gain Chip, Tuning Actuator
- Fiber-Coupled or Free-Space Output
- Standard Center Wavelengths Available: 770, 1050, 1310, 1550, 1900, or 1950 nm
- Compatible with Thorlabs Half-Butterfly Gain Chips

Thorlabs' line of Tunable Laser Kits is designed for superior cavity construction flexibility and high-stability performance. Available for either Littrow or Littman configurations, these external cavity laser (ECL) kits are complete systems that only require drive electronics to operate (LD and TEC controllers). They are ideal for education, component testing, and research due to their modularity. Components are offered to convert the laser between Littrow and Littman configurations. Various gain chips, cavity optics, and tuning actuators are offered to provide customizable ECL solutions. Additionally, customer-furnished ECL components can be easily integrated, which minimizes construction time and cost compared to other tunable laser alternatives.

The 770 nm kit is a free-space design, while the others are fiber coupled. Please note that the free-space beam of the TLK-L780M does not propagate along the hole matrix on a table unless it is used with the TLK-E enclosure and two TLK-SM-1 steering mirrors.

NOTE: The 1050 nm, 1900 nm, and 1950 nm kits should be used with an optical isolator for specified performance.

Additional Required Tools

- Laser Diode Controller
- TEC Controller

Recommended Tools

- Viewing Card (for collimation and cavity alignment with systems in the IR)
- Power Meter

Part 3. Setup

Extended Cavity Lasers (ECLs) are highly-sensitive devices and proper setup is essential to produce a lasing system. Even after the system is lasing, slight misalignment of the optics in the cavity leads to decreased power and the possibility of mode hop. The setup procedure here outlines the process of building the laser cavity and aligning each component. Each kit is shipped assembled and aligned, so only small tuning adjustments are necessary for optimal performance. If your system is already lasing, please skip to step 12 for Littrow cavities or 14 Littman cavities for tuning instructions. An overview of tuning components to the lasers can be found in Part 4.

Step 1:
Insert the SAF gain chip subassembly into the zero insertion force (ZIF) socket. To improve repeatability, try to center the half butterfly package in the mount. Now, thread the 4 mounting screws to attach the half butterfly to the mount. Clearance between the screw heads and the butterfly package pins is limited, so be sure to insert and tighten mounting screws before latching the ZIF to avoid damage to the package leads when tightening the mounting screws.

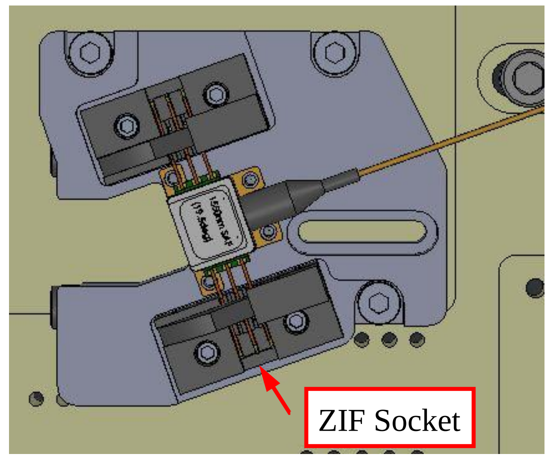


Figure 1: ZIF Socket

Step 2:
Attach the Focus Adjuster (TLK-FM1) under the gain chip platform. Two sets of screws, spring washers, and washers mount the Focus Adjuster to the tunable laser base. The screws should not be tightened completely as the position of the Focus Adjuster must be aligned in later steps. To avoid damage to your gain chip, slide the Focus Adjuster forward so that the screws attaching it to the gain chip platform are close to the gain chip. This will provide space to attach the lens mount in the following step without touching the gain chip.

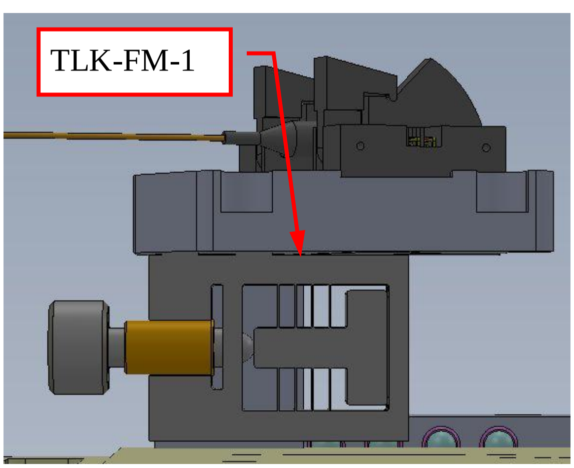


Figure 2: Focus Adjuster

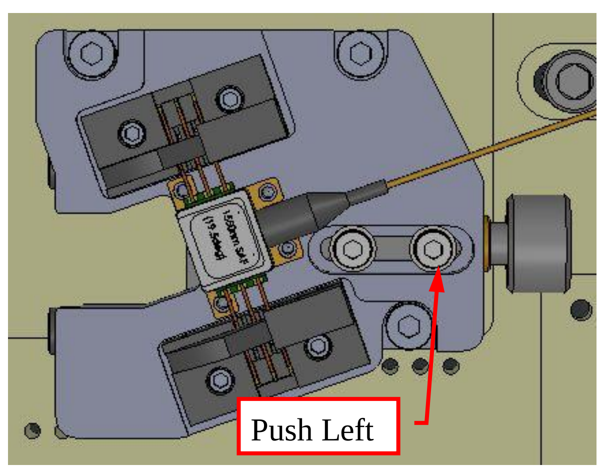


Figure 3: Initial Focus Adjuster Alignment

Step 3:
Attach the lens mount to the front of the Focus Adjuster. The two screws should be snug, but still allow for adjustment of the mount. The position of the flexure mechanism and lens mount will be adjusted to collimate the gain chip's emitted light. When initially bolting the lens mount to the Focus Adjusters, great care should be taken to avoid touching the chip facet just inside the butterfly package housing with the lens mount or lens itself. During operation make sure the screws fastening the Focus Adjuster are snug enough to avoid sudden shifts in the flexure mount position.

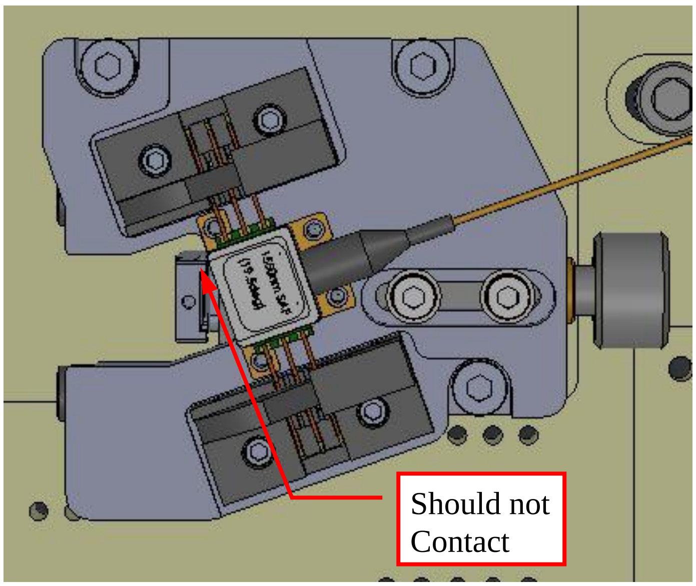


Figure 4: Lens Holder and Gain Chip

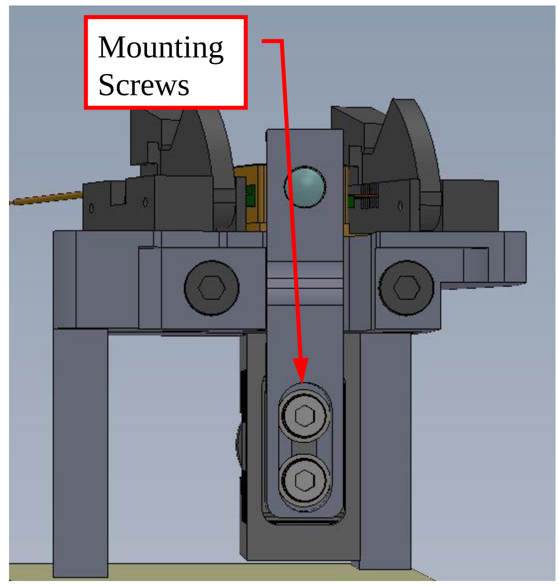


Figure 5: Lens Holder Mounting Screws

Step 4:
Connect the TEC Controller and LD Controller to the Tunable Laser Kit. When operating the tunable laser, always turn on the TEC controller first and let the temperature stabilize to prevent the chip from overheating. Additionally, it is always advised to program a current limit on the LD Controller to prevent accidental overdrive of the chip. The Tunable Laser Kits are compatible with all Thorlabs LD and TEC controllers. The LD controller's polarity should be set to cathode ground.

Step 5:
Never operate a laser at eye level as laser radiation can permanently damage your vision. Thorlabs always suggests consulting a laser lab safety expert before operating a laser. Typical safety precautions include laser goggles, remote interlock, laser barriers, and beam traps. Once appropriate precautions are observed and the TEC controller temperature has stabilized, press "enable" on the LD controller and gradually increase the drive current. Although not lasing, the gain chip will begin to emit light (see ASE spectrum of chip).

Step 6:
Now you will collimate the light emitted from the gain chip. Chips with wavelengths in the IR require an appropriate IR viewing card to view the beam. Coarsely align the height of the lens holder so that the optical axis of the lens is slightly higher than that of the gain chip. The screws securing the lens mount to the flexure mechanism should be snug, while still allowing you to adjust the lens mount's position

without excessive force. You can check this by viewing the beam a meter from the collimating lens. The beam should be sloped upwards with a slope of a few cm/m.

Step 7:
Turn the Focus Adjuster actuator knob so that the actuator tip is no longer pressing on the flexure. You then need to move the Focus Adjuster to collimate the emitted light. Since the flexure mechanism provides fine focus adjustment, you want your beam to be collimated or slightly diverging. Once this is achieved, tighten the screws that mount the flexure mechanism to the base of the tunable laser.

Step 8:
The lens holder must now be positioned so that the collimated beam is properly aligned. Coma is the main aberration that needs to be eliminated. Your beam will be asymmetrical when coma is present. As the aspheric lens moves from left to right, or up and down, the degree of coma will change. To adjust for this, use small rotations of the lens holder as well as sliding the holder vertically. When the optical axis of the lens is properly aligned to that of the cavity, coma will not be present and your beam will be symmetrical (left to right). Additionally, the emitted beam of light will be aligned to the hole matrix on a breadboard. You now need to tighten the lens holder to the Focus Adjuster.

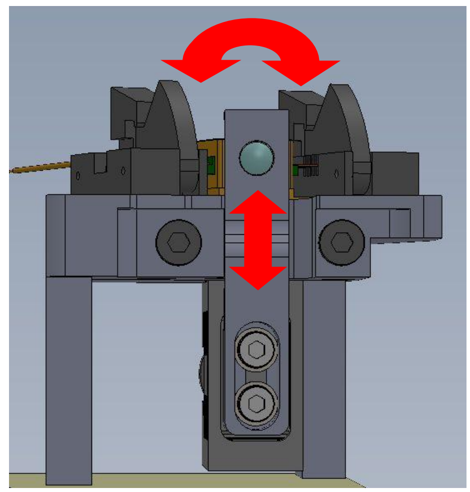


Figure 6: Lens Holder Adjustment

Step 9:
Turn the Adjuster Knob of the Focus Adjuster to adjust the fine focus of the lens. By viewing the beam on the included viewing card, you can check the beam diameter at multiple distances from the lens. If you check this diameter at three distances (i.e., 0.1 m, 0.5 m, and 1 m), you can ensure that it is collimated. The beam diameter should remain constant at each point.

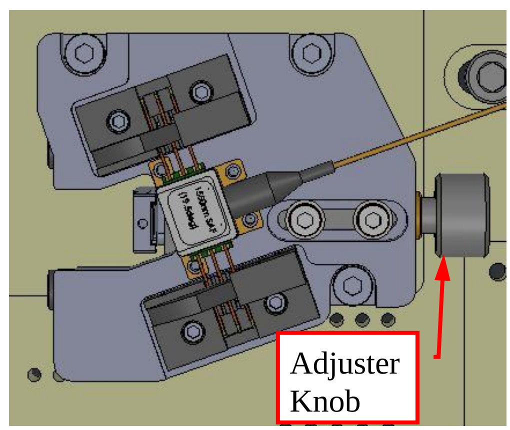


Figure 7: Collimation Adjustment

Littrow Cavity Configuration

Step 10:
Attach the grating pivot bracket to the base plate using three cap screws. The optimal location of this pivot bracket is listed in the table on the following page for each gain chip. To attach the pivot bracket, slide it into position between the machined edge provided on the base plate and the series of fixture springs such that the pressure from the fixture springs keeps the other side of the bracket in contact with the machined edge. The 3 mounting screws should be tightened enough to keep the base of the pivot bracket in contact with the base plate, yet still allow for the pivot to translate. Now, attach the mode hop

adjuster. Lower the tip of the micrometer in to the machined recess of the pivot bracket and ensure that it is correctly positioned with a little clearance for the steel ball. Now tighten the clamping bracket for the mode hop adjuster to the base plate. Please note that the adjuster is designed to push on the pivot, not pull! The pivot bracket translation will not be as good when the adjuster is used to pull on the bracket.

Littrow Cavity Optimal Pivot Position
D
38.2 mm

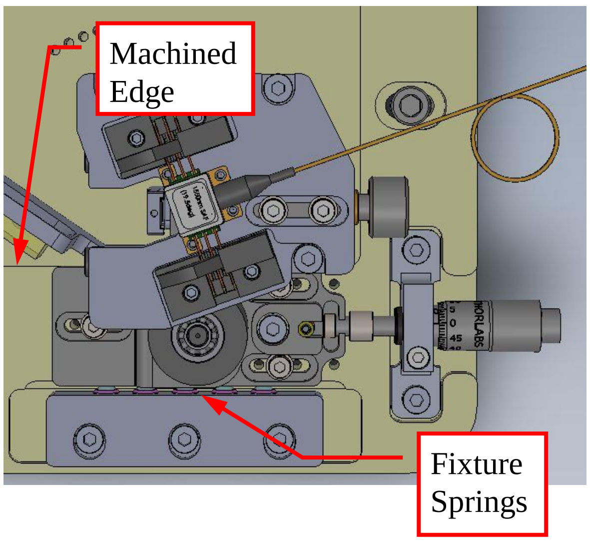


Figure 8: Grating Pivot Bracket Guide

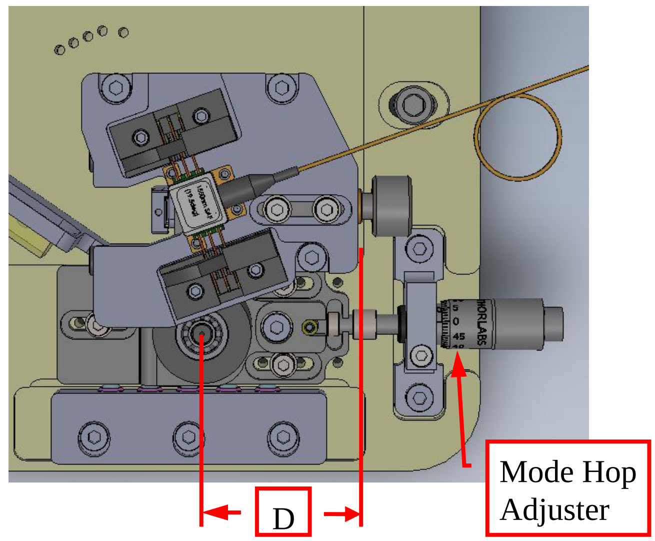


Figure 9: Grating Pivot Bracket Alignment

Step 11:
Attach the tuning adjuster for the grating angle. The standard configuration is a DC Servo Motor, but options are available for a stepper motor or piezo actuator. A spring pulls the grating holder into contact with the actuator. The proper angle of the grating is such that the 1^{st} order diffraction from the grating is directed back into the gain chip. You can accomplish this by rotating the grating and locating its strongest diffraction with the included IR viewing card.

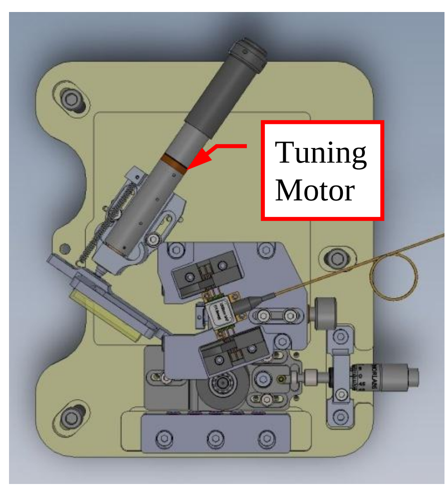


Figure 10: Tuning Motor

Step 12:
In the body of the pivot bracket, there is a flexure that adjusts the tilt of the grating. As you adjust the flexure, the coupling efficiency of the diffraction back into the gain chip will vary. Adjust this setscrew until maximum intensity/power is attained. Note that the M4 cap screw should remain slightly loosened when adjusting the setscrew. Once very close to the optimal flexure angle, tighten the M4 cap screw, being careful not to over tighten it and damage the setscrew or the sapphire disk that the setscrew contacts. The cap screw provides additional stability of the flexure angle.

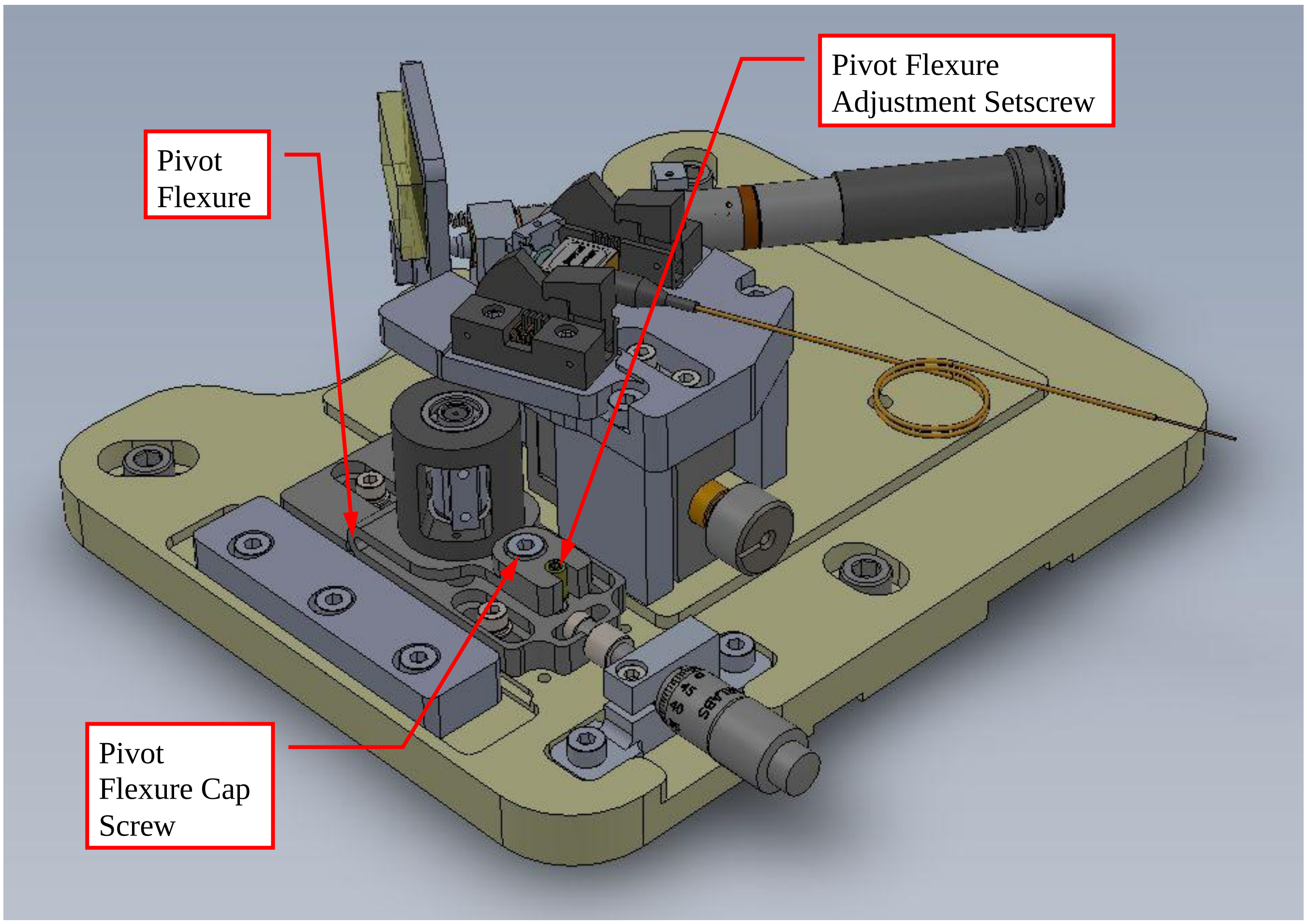


Figure 11: Grating Pivot Adjustment

Step 13:
Adjust the mode hop adjuster to eliminate fluctuations in the laser's frequency, which can be seen by intensity/power variation. Again, this adjuster is designed to push on the pivot, not pull. The adjuster will still work when pulling, but the translation will not be as good. When you have eliminated mode hops, tighten the 3 mounting screws and retract the adjuster slightly off of the pivot bracket so that it is not in contact. This reduces the risk of accidentally adjusting the pivot after optimization.

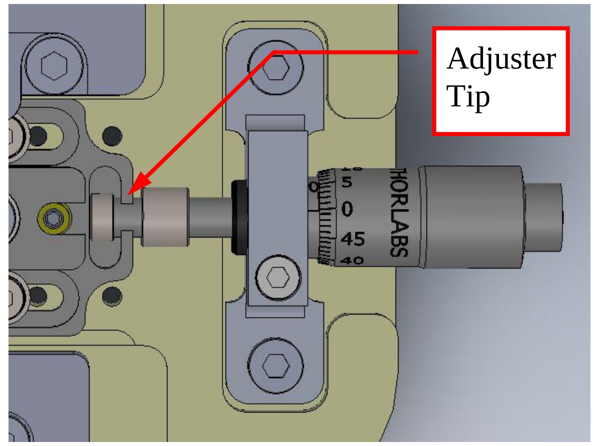


Figure 12: Mode Hop Adjuster Tip

Step 14:
To further maximize power, adjust the lens holder flexure actuator and grating pivot arm flexure a second time to optimize the system. By monitoring the lasing power of the system, this process will be very quick. As the grating angle provides wavelength selectability, it should remain stationary when tuning for maximum power at a set wavelength.

Littman Cavity Configuration

Step 10:
Attach the grating platform to the gain chip platform. At this time, the mounted grating should be disconnected from the platform. This can be done by loosening the clamping screw on the grating platform and lifting the mounted grating, being sure to not touch the grating surface.

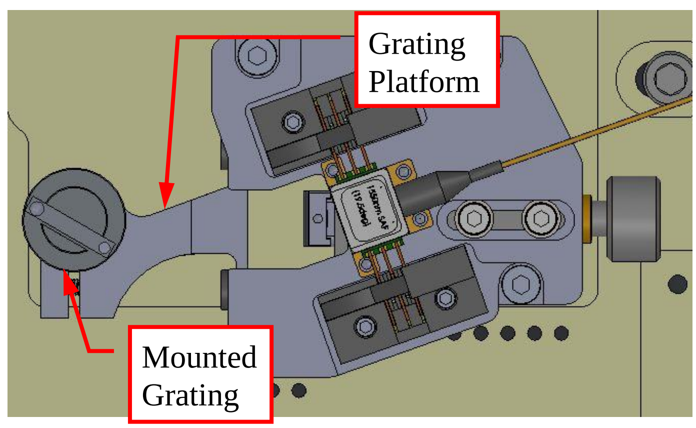


Figure 13: Grating Platform on Littman Kit

Step 11:
Attach the mirror pivot bracket to the base plate using three cap screws. The optimal location of this pivot is listed in the table below for each gain chip. The 3 mounting screws should be tightened, yet still allow for the pivot to translate. To attach the pivot bracket, slide it into position between the machined edge provided on the base plate and the series of fixture springs such that the pressure from the fixture springs keeps the other side of the bracket in contact with the machined edge. The mounting screws should be tightened enough to keep the base of the pivot bracket in contact with the base plate, yet still allow for the pivot to translate. Now, attach the mode hop adjuster. Lower the tip of the micrometer in to the machined recess of the pivot bracket and ensure that it is correctly positioned with a little clearance for the steel ball. Now tighten the clamping bracket for the mode hop adjuster to the base plate. Please note that the adjuster is only designed to push on the pivot, not pull!

Littman Cavity Optimal Pivot Position
D
38.2 mm

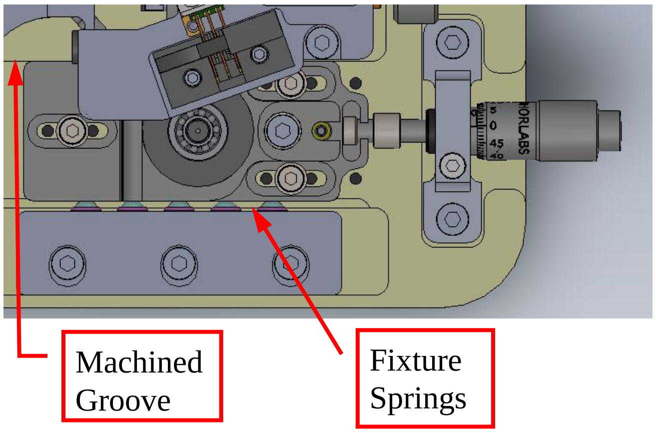


Figure 14: Mirror Pivot Bracket Guide

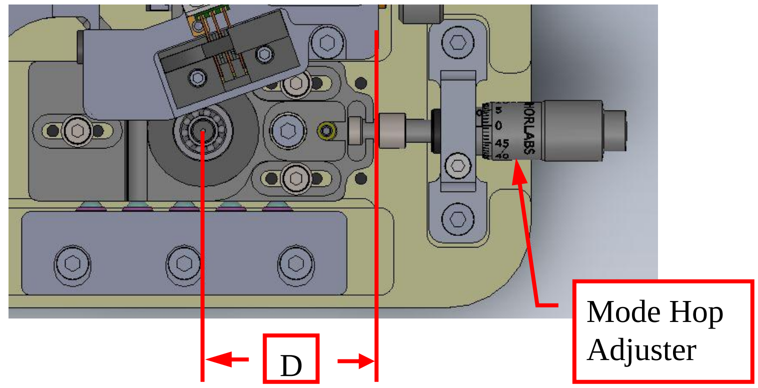


Figure 15: Mirror Pivot Bracket Alignment

Step 12:
Attach the adjuster for the mirror angle. A DC servo motor is included with standard kits, but options are available for a stepper motor or a piezo actuator. A spring pulls the mirror holder into contact with the actuator. After this has been attached, insert the mounted grating in to the grating platform.

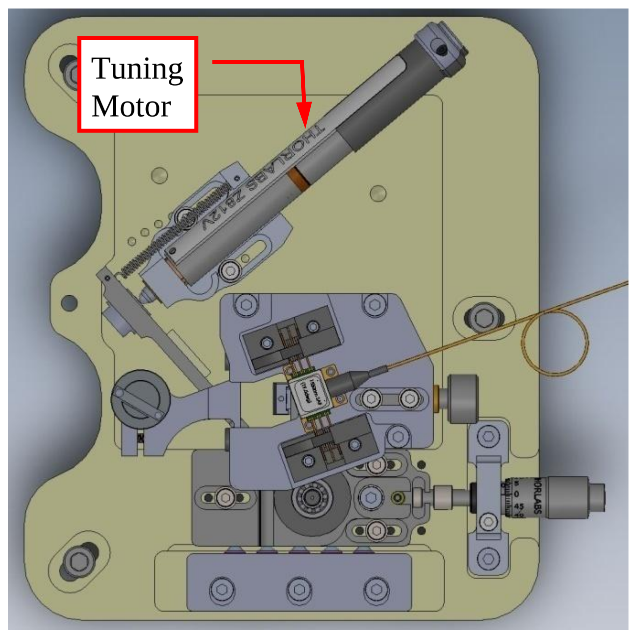


Figure 16: Tuning Motor

Step 13:
The proper angle of the grating is now important. The grating should be angled such that the front of it is in line with the pivot point of the mirror; see the Imaginary Alignment Line in Figure 17. This will couple the 1st order diffraction back in to the gain chip. A simpler way to do this alignment is described below.

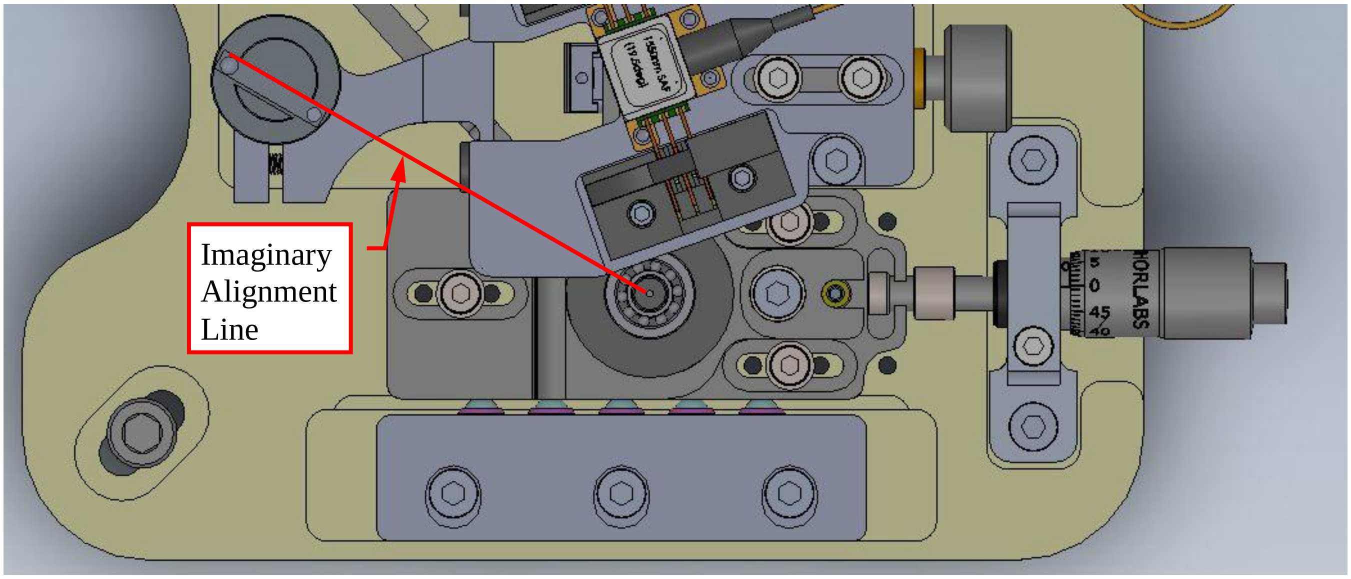


Figure 17: Littman Grating Angular Alignment

Imperial Breadboards
A trick to align the grating properly is to mount the Tunable Laser Kit on to a breadboard and view the 0th order diffraction from the grating. When the front plane of the grating is in line with the pivot point, the 0th order diffraction will point to a hole on an imperial breadboard. Please see Figure 18 for the location of the intersecting point. A viewing card can be placed at this hole location to align the grating.

Metric Breadboards
A trick to align the grating properly is to mount the Tunable Laser Kit on to a breadboard and view the 0th order diffraction from the grating. When the front plane of the grating is in line with the pivot point, the 0th order diffraction will point directly between two holes. Please see Figure 19 for the location of the intersecting point. A viewing card can be placed between the two holes to align the grating.

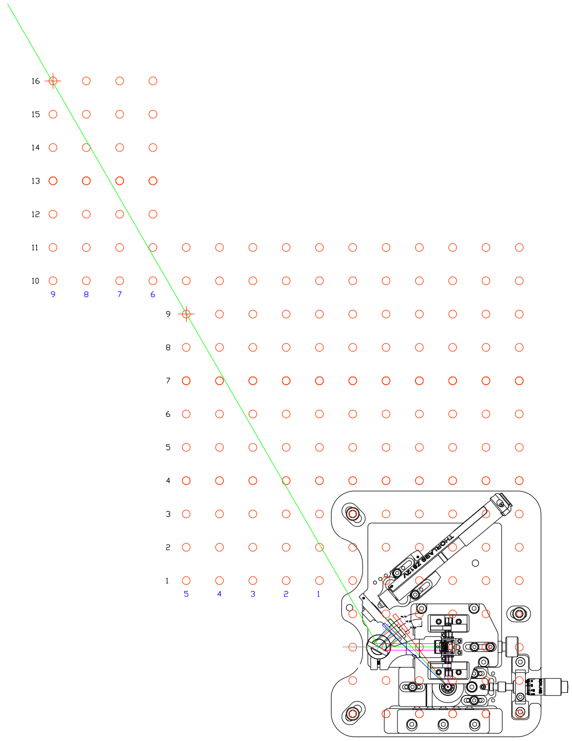


Figure 18: Imperial Breadboard Used to Align Littman Grating

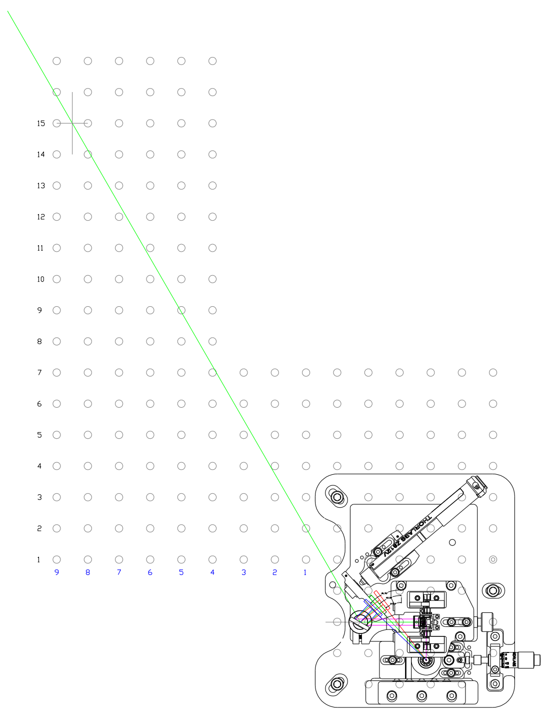


Figure 19: Metric Breadboard Used to Align Littman Grating

Step 14:
Adjust the angle of the mirror pivot bracket. This will ensure that the mirror and grating are vertically parallel to each other. The cap screw should be slightly loosened and the setscrew should be adjusted until maximum intensity is achieved. Once this is accomplished, tighten the cap screw without excessive force.

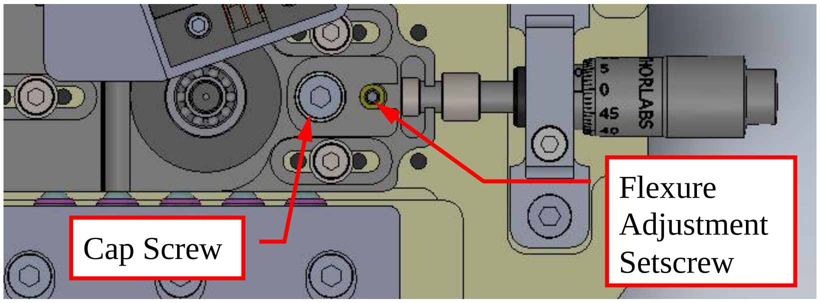


Figure 20: Flexure Adjustment

Step 15:
Adjust the mode hop adjuster to eliminate fluctuations in the laser's frequency, which can be seen by intensity/power variation. Again, this adjuster is only designed to push on the pivot, not pull. When you have eliminated mode hops, tighten the 3 mounting screws and retract the adjuster slightly off of the pivot bracket so that it is not in contact. This reduces the risk of accidentally adjusting the pivot after optimization.

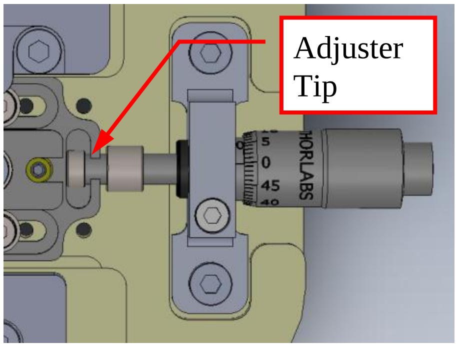


Figure 21: Mode Hop Adjuster Tip

Step 16:
To further maximize power, adjust the lens holder flexure actuator and mirror pivot arm flexure a second time to optimize the system. By monitoring the lasing power of the system, this process will be very quick. As the mirror angle provides wavelength selectability, it should remain stationary when tuning for maximum power at a set wavelength.

Part 4. Tuning

Thorlabs' TLK Series Tunable Laser Kits are designed to allow customers to make fine tuning adjustments to the laser cavity to maximize the laser's performance. Other tunable lasers on the market require that the laser be returned to the manufacturer for this tuning, thus creating downtime, which is not acceptable in many applications. If you find that your TLK is no longer lasing, please follow the Setup instructions in Part 3 of this manual.

4.1. Littrow Configuration

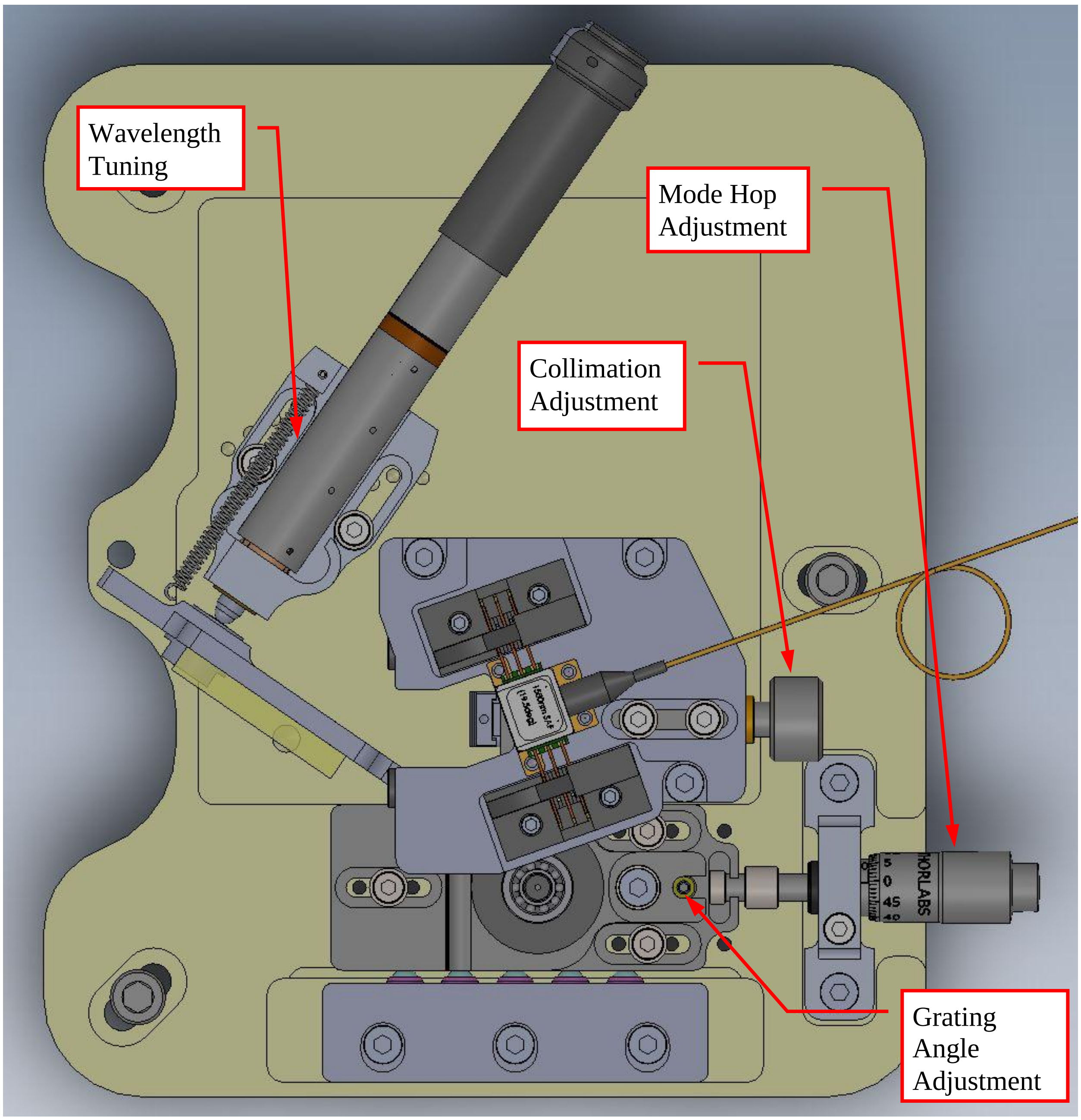


Figure 22: Littrow Configuration Tuning Adjustment

4.2. Littman Configuration

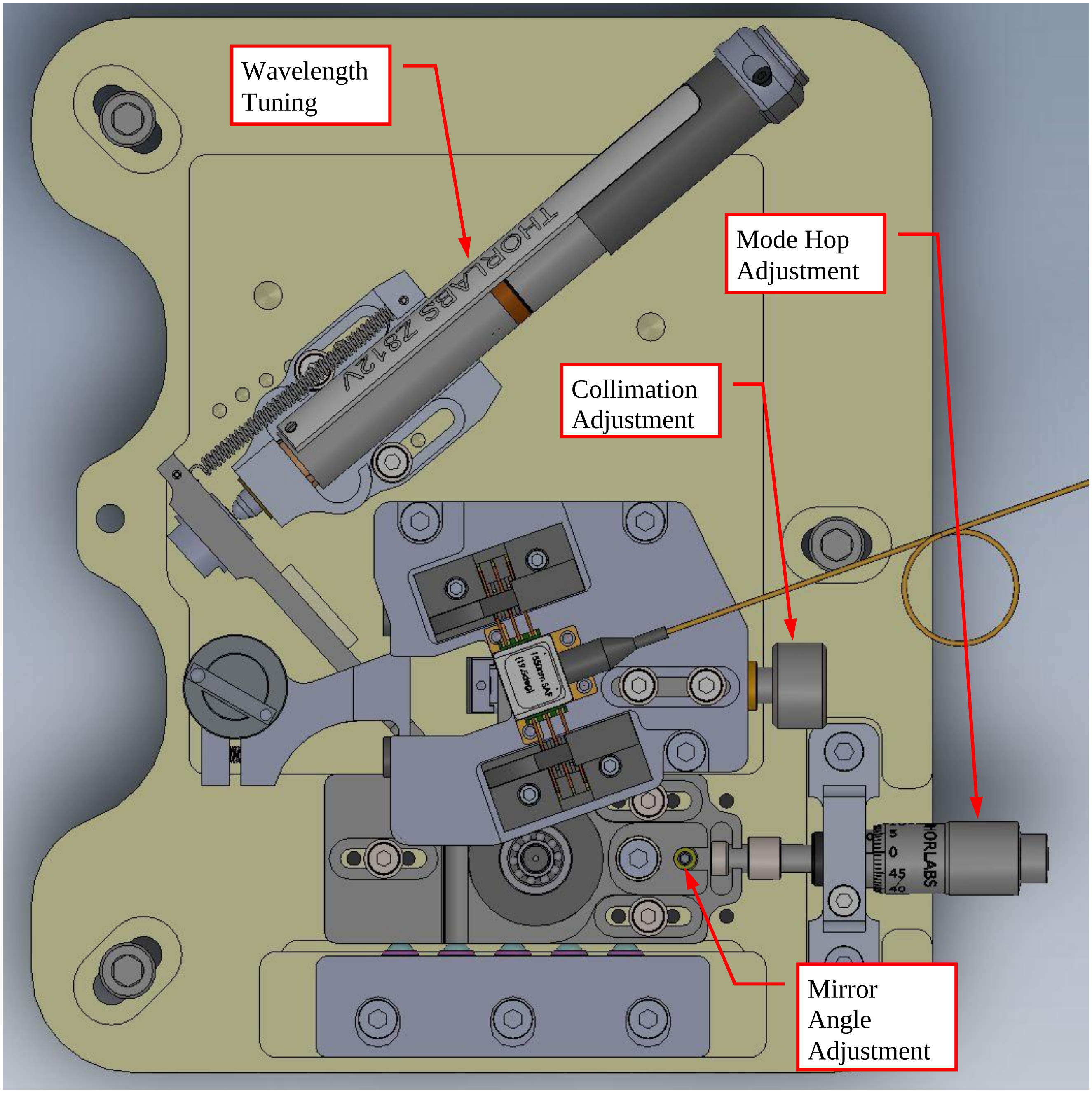


Figure 23: Littman Configuration Tuning Adjustment

Part 5. Basic Operation

Once the ECL lasing is optimized, the only thing left to do is to tune the supported wavelength of the cavity.

5.1. Laser Diode and TEC Controllers

Connect a TEC controller to the breakout box and set the desired temperature (See 11.9 for thermistor temperature coefficients). Now enable the TEC controller so that the temperature of the gain chip stabilizes before turning on the laser driver current.

Now it is time to setup the laser current controller. First connect the controller to the breakout box and set the controller to cathode ground. Now, set the maximum drive current based on the maximum operating current specified for the laser in Part 10. The laser driver current may now be turned on and the laser can be operated.

5.2. Fixed Wavelength

Operating at a single wavelength is very simple to do. After lasing is supported by the cavity, connect a spectrometer to the fiber output of the gain element. If the device is not fiber coupled, use a wavemeter or monochromator to monitor the cavity wavelength. Now as you change the angle of the grating (Littrow) or mirror (Littman), the wavelength feedback into the gain element will cause the wavelength of the laser to change. Once the desired wavelength is achieved, fine tune the pivot flexure and aspheric lens focus to maximize power. The angle of the grating (Littrow) or mirror (Littman) should not be altered.

5.3. Continuously Tunable

First, tune the laser as outlined in Part 4. If there is a desired tuning range of the ECL, ensure that the laser is capable of supporting this range at your drive current by viewing the tuning range graph in Part 11 of this manual. Remember that this curve is an example of one device and the tuning range will vary with each gain chip.

Now we need to determine the angle that the grating (Littrow) or mirror (Littman) must be to support the minimum and maximum wavelengths of your desired range. The TDC001 DC servo controller should be connected to a computer via USB to help in this process. Now adjust the DC servo motor until the minimum wavelength is reached. Record this position, which the TDC001’s software displays. Now adjust the DC servo motor until the maximum wavelength is reached. Record this position. You will now set the DC servo motor to continuously tune between these two positions.

Part 6. Replacement Components

6.1. Littrow Configuration

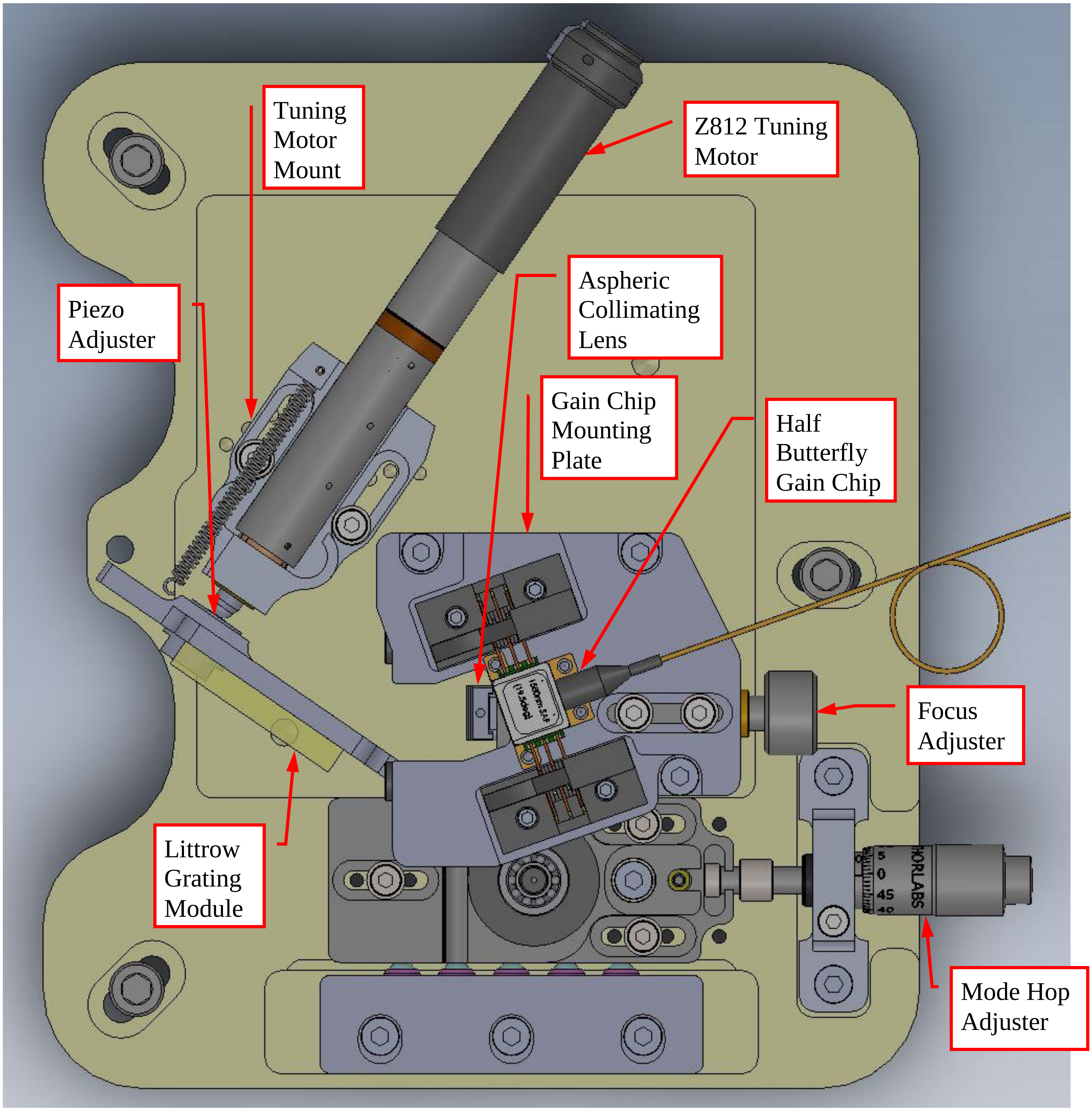


Figure 24: Replacement Components and Accessories for Littrow Configuration

6.2. Littman Configuration

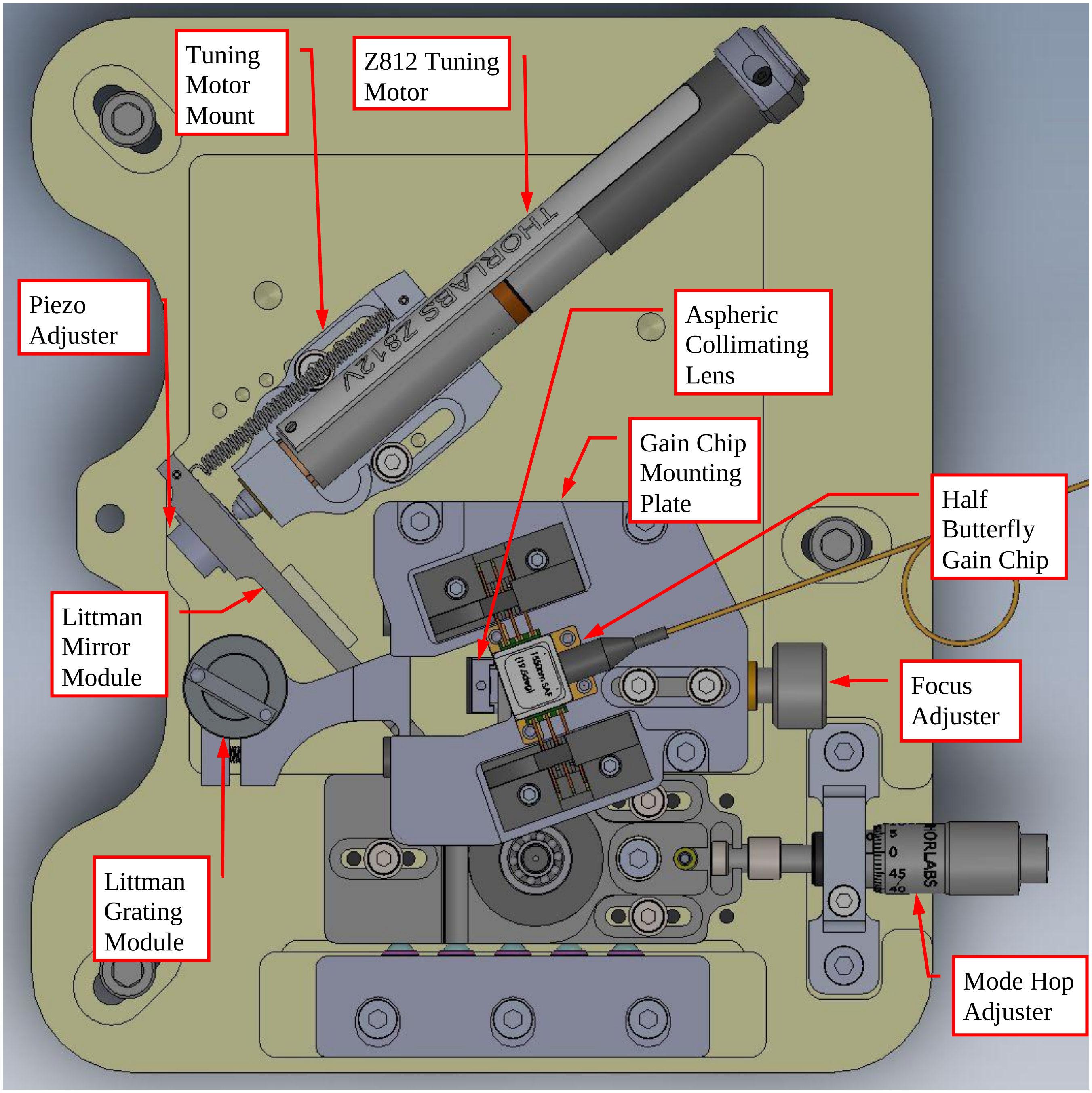


Figure 25: Replacement Components and Accessories for Littman Configuration

Part 7. Enclosure Back Panel Overview (TLK-E)

The TLK-E enclosure is an optional Tunable Laser Kit component. There are feedthroughs on the enclosure for connecting LD and TEC controllers (DB15, below), a heater controller (HR10A-7R-6S, below for TC200 heater), a piezo controller (BNC), fiber output (FC/PC), purge inlet (MJQC-B4MP), and purge output (MNV-1K).

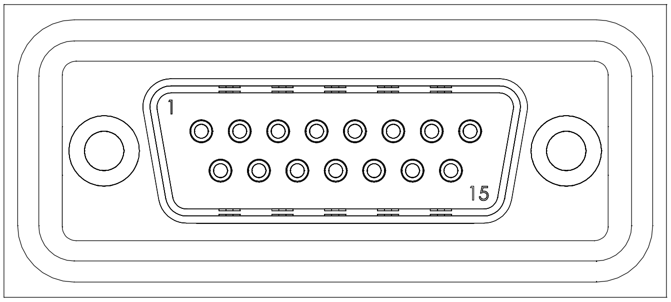


Figure 26: Male DB15 Connector Front View

Male DB15 Front View			
Pin	**Use**	**Pin**	**Use**
1	TEC (+)	9	NC
2	Thermistor (+)	10	NC
3	Thermistor (-)	11	NC
4	Laser Diode Anode	12	NC
5	Laser Diode Cathode	13	NC
6	TEC (-)	14	NC
7	Photodiode Cathode	15	NC
8	Photodiode Anode		

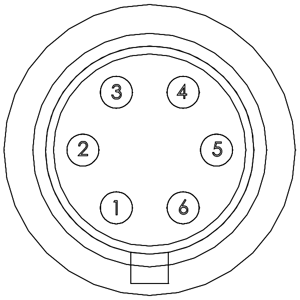
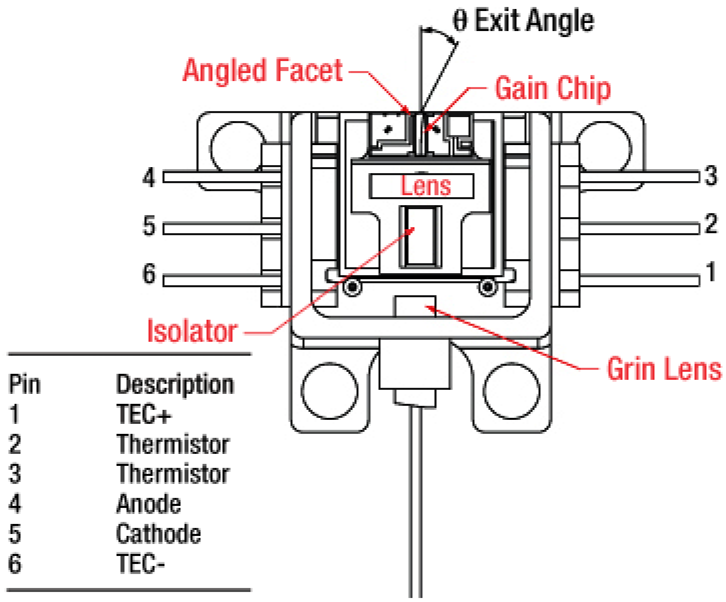


Figure 27: Hirose HR10A-7R-6S Front View, for TC200 Heater

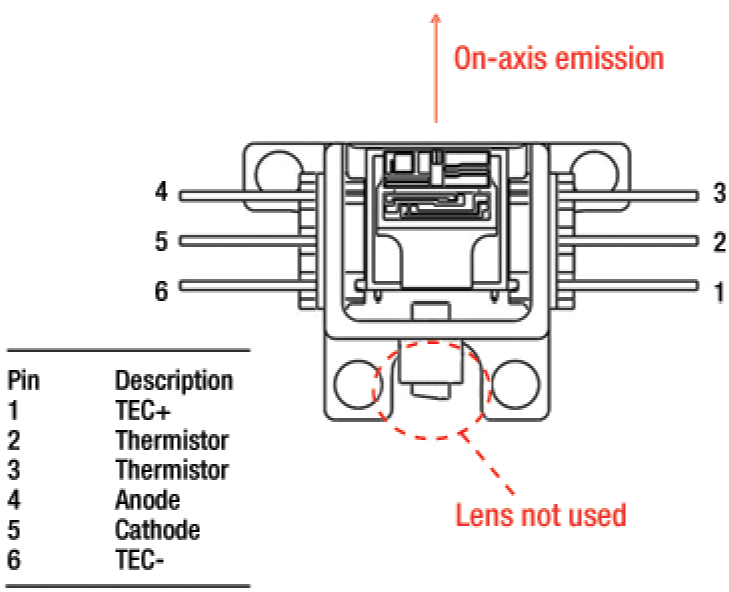
Hirose HR10A-7R-6S (73) Front View			
Pin	**Use**	**Pin**	**Use**
1	Heater (+)	4	Sensor (+)
2	Heater (GND)	5	Sensor (GND)
3	NC	6	NC

Part 8. Half Butterfly Package Pin Outs



Pin	Description
1	TEC+
2	Thermistor
3	Thermistor
4	Anode
5	Cathode
6	TEC-

Figure 28: Pigtailed Half Butterfly Gain Chip



Pin	Description
1	TEC+
2	Thermistor
3	Thermistor
4	Anode
5	Cathode
6	TEC-

Figure 29: Free-Space Half Butterfly Gain Chip

Part 9. Remote Communications

Please refer to the TDC001 manual for remote communication to the DC Servo Motor Controller.

Please refer to the manuals for your TEC and LD controllers for their remote communication.

Part 10. Specifications

10.1. TLK-L780M

	Min	Typ	Max
Center Wavelength (nm)	760 nm	770 nm	780 nm
Tuning Range (10 dB)	15 nm	30 nm	-
Peak Power	5 mW	10 mW	-
Wavelength Tuning Resolution	-	-	1 pm
Tuning Speed	-	-	40 nm/s
Linewidth	-	100 kHz	130 kHz
Side Mode Supression Ratio	30 dB	45 dB	-
Polarization Extinction Ratio	-	N/A	-
Power Stability (30 s)*	1%	-	-
Power Stability (24 hr)*	10%	-	-
Wavelength Stability (30 s)*	-	-	1 pm
Wavelength Stability (24 hr)*	-	-	50 pm
Operating Current	-	140 mA	180 mA
Chip Forward Voltage	-	-	2 V
TEC Forward Current	-	-	2.1 A
TEC Forward Voltage	-	-	3.6 V

*Measurements taken with laser operating in open loop.

10.2. TLK-L1050M

	Min	Typ	Max
Center Wavelength (nm)	1040 nm	1050 nm	1060 nm
Tuning Range (10 dB)	45 nm	60 nm	-
Peak Power	10 mW	15 mW	-
Wavelength Tuning Resolution	2 pm	-	-
Tuning Speed	-	-	30 nm/s
Linewidth	-	100 kHz	130 kHz
Side Mode Supression Ratio	45 dB	-	-
Polarization Extinction Ratio	-	N/A	-
Power Stability (30 s)*	1%	-	-
Power Stability (24 hr)*	10%	-	-
Wavelength Stability (30 s)*	-	-	1 pm
Wavelength Stability (24 hr)*	-	-	50 pm
Operating Current	-	-	150 mA
Chip Forward Voltage	-	-	2.5 V
TEC Forward Current	-	-	2.1 A
TEC Forward Voltage	-	-	3.6 V
Fiber Output	1.5 m, HI1060, FC/APC		

*Measurements taken with laser operating in open loop.

10.3. TLK-L1300M

	Min	Typ	Max
Center Wavelength (nm)	1290 nm	1310 nm	1320 nm
Tuning Range (10 dB)	100 nm	130 nm	-
Peak Power	20 mW	65 mW	-
Wavelength Tuning Resolution	1 pm	-	-
Tuning Speed	-	-	25 nm/s
Linewidth	-	100 kHz	130 kHz
Side Mode Supression Ratio	30 dB	45 dB	-
Polarization Extinction Ratio	-	N/A	-
Power Stability (30 s)*	1%	-	-
Power Stability (24 hr)*	10%	-	-
Wavelength Stability (30 s)*	-	-	1 pm
Wavelength Stability (24 hr)*	-	-	50 pm
Operating Current	-	500 mA	800 mA
Chip Forward Voltage	-	-	1.8 V
TEC Forward Current	-	-	2.1 A
TEC Forward Voltage	-	-	3.6 V
Fiber Output	1.5 m, SMF-28e, FC/APC		

*Measurements taken with laser operating in open loop.

10.4. TLK-L1300R

	Min	Typ	Max
Center Wavelength (nm)	1290 nm	1310 nm	1320 nm
Tuning Range (10 dB)	100 nm	130 nm	-
Peak Power	30 mW	70 mW	-
Wavelength Tuning Resolution	1 pm	-	-
Tuning Speed	-	-	25 nm/s
Linewidth	-	100 kHz	130 kHz
Side Mode Supression Ratio	30 dB	45 dB	-
Polarization Extinction Ratio	-	N/A	-
Power Stability (30 s)*	1%	-	-
Power Stability (24 hr)*	10%	-	-
Wavelength Stability (30 s)*	-	-	1 pm
Wavelength Stability (24 hr)*	-	-	50 pm
Operating Current	-	500 mA	800 mA
Chip Forward Voltage	-	-	1.8 V
TEC Forward Current	-	-	2.1 A
TEC Forward Voltage	-	-	3.6 V
Fiber Output	1.5 m, SMF-28e, FC/APC		

*Measurements taken with laser operating in open loop.

10.5. TLK-L1550M

	Min	Typ	Max
Center Wavelength (nm)	1530 nm	1550 nm	1570 nm
Tuning Range (10 dB)	70 nm	120 nm	-
Peak Power	8 mW	25 mW	-
Wavelength Tuning Resolution	-	-	1 pm
Tuning Speed	-	-	40 nm/s
Linewidth	-	100 kHz	130 kHz
Side Mode Supression Ratio	30 dB	45 dB	-
Polarization Extinction Ratio	-	N/A	-
Power Stability (30 s)*	1%	-	-
Power Stability (24 hr)*	10%	-	-
Wavelength Stability (30 s)*	-	-	1 pm
Wavelength Stability (24 hr)*	-	-	50 pm
Operating Current	-	300 mA	500 mA
Chip Forward Voltage	-	1.1 V	1.4 V
TEC Forward Current	-	-	2.1 A
TEC Forward Voltage	-	-	3.6 V
Fiber Output	1.5 m, SMF-28e, FC/APC		

*Measurements taken with laser operating in open loop.

10.6. TLK-L1550R

	Min	Typ	Max
Center Wavelength (nm)	1530 nm	1550 nm	1570 nm
Tuning Range (10 dB)	70 nm	120 nm	-
Peak Power	10 mW	30 mW	-
Wavelength Tuning Resolution	-	-	1 pm
Tuning Speed	-	-	40 nm/s
Linewidth	-	100 kHz	130 kHz
Side Mode Supression Ratio	30 dB	45 dB	-
Polarization Extinction Ratio	-	N/A	-
Power Stability (30 s)*	1%	-	-
Power Stability (24 hr)*	10%	-	-
Wavelength Stability (30 s)*	-	-	1 pm
Wavelength Stability (24 hr)*	-	-	50 pm
Operating Current	-	300 mA	500 mA
Chip Forward Voltage	-	1.1 V	1.4 V
TEC Forward Current	-	-	2.1 A
TEC Forward Voltage	-	-	3.6 V
Fiber Output	1.5 m, SMF-28e, FC/APC		

*Measurements taken with laser operating in open loop.

10.7. TLK-L1900M

	Min	Typ	Max
Center Wavelength (nm)	1870 nm	1900 nm	1930 nm
Tuning Range (10 dB)	130 nm	170 nm	-
Peak Power	5 mW	7 mW	-
Wavelength Tuning Resolution	4 pm	-	-
Tuning Speed	-	-	57 nm/s
Linewidth	-	100 kHz	130 kHz
Side Mode Supression Ratio	30 dB	45 dB	-
Polarization Extinction Ratio	-	N/A	-
Power Stability (30 s)*	1%	-	-
Power Stability (24 hr)*	10%	-	-
Wavelength Stability (30 s)*	-	-	2 pm
Wavelength Stability (24 hr)*	-	-	100 pm
Operating Current	-	500 mA	800 mA
Chip Forward Voltage	-	-	2 V
TEC Forward Current	-	-	2.1 A
TEC Forward Voltage	-	-	3.6 V
Fiber Output	1.5 m, SM2000, FC/APC		

*Measurements taken with laser operating in open loop.

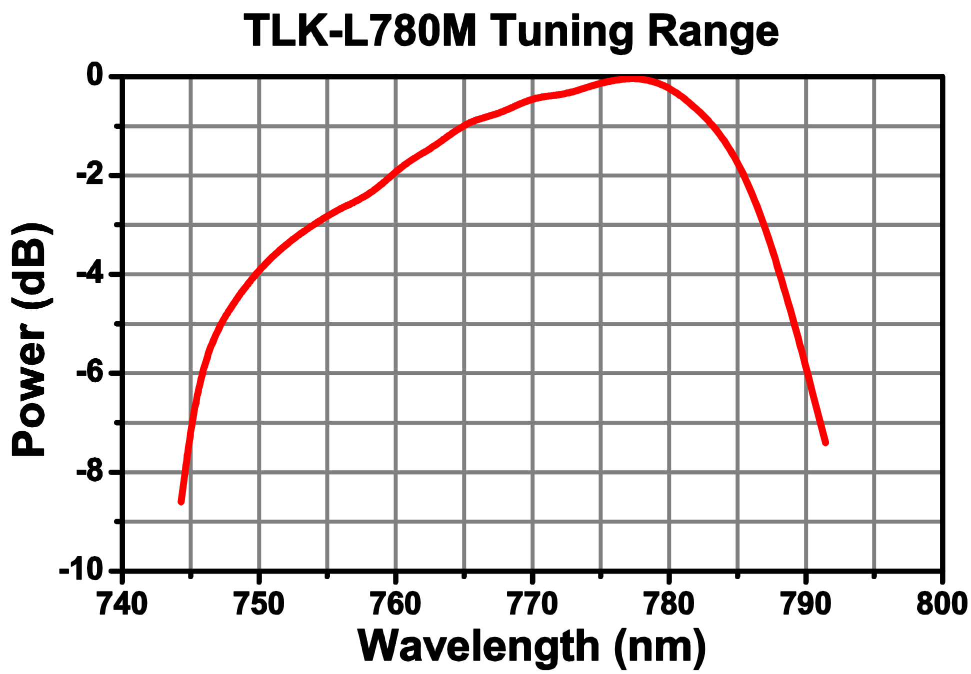
10.8. TLK-L1950R

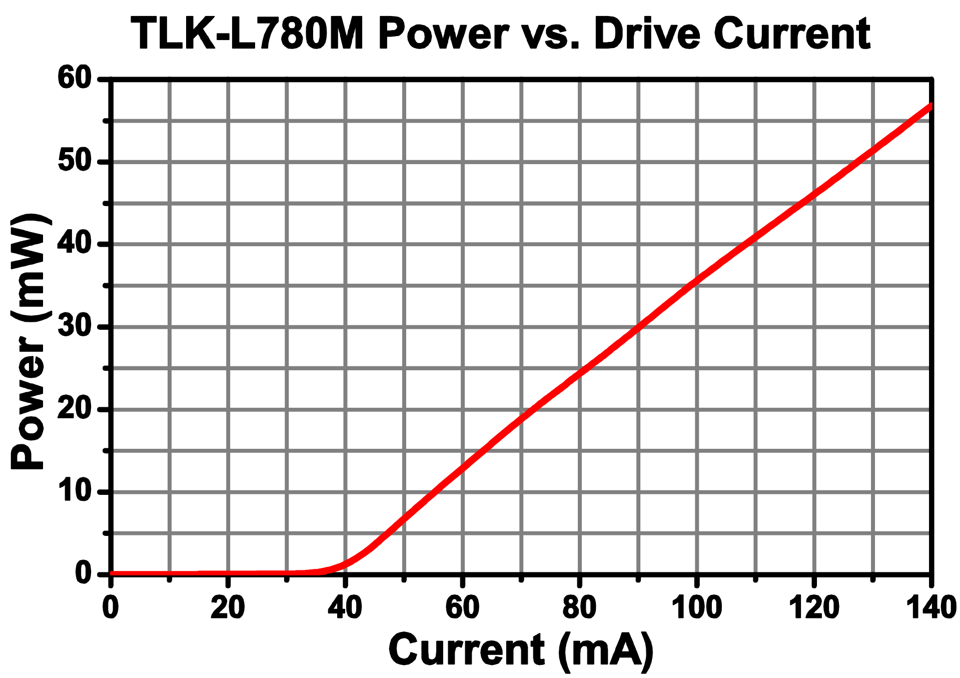
	Min	Typ	Max
Center Wavelength (nm)	1920 nm	1950 nm	1970 nm
Tuning Range (10 dB)	50 nm	80 nm	-
Peak Power	5 mW	7 mW	-
Wavelength Tuning Resolution	4 pm	-	-
Tuning Speed	-	-	57 nm/s
Linewidth	-	100 kHz	130 kHz
Side Mode Supression Ratio	30 dB	45 dB	-
Polarization Extinction Ratio	-	N/A	-
Power Stability (30 s)*	1%	-	-
Power Stability (24 hr)*	10%	-	-
Wavelength Stability (30 s)*	-	-	2 pm
Wavelength Stability (24 hr)*	-	-	100 pm
Operating Current	-	500 mA	800 mA
Chip Forward Voltage	-	-	2 V
TEC Forward Current	-	-	2.1 A
TEC Forward Voltage	-	-	3.6 V
Fiber Output	1.5 m, SM2000, FC/APC		

*Measurements taken with laser operating in open loop.

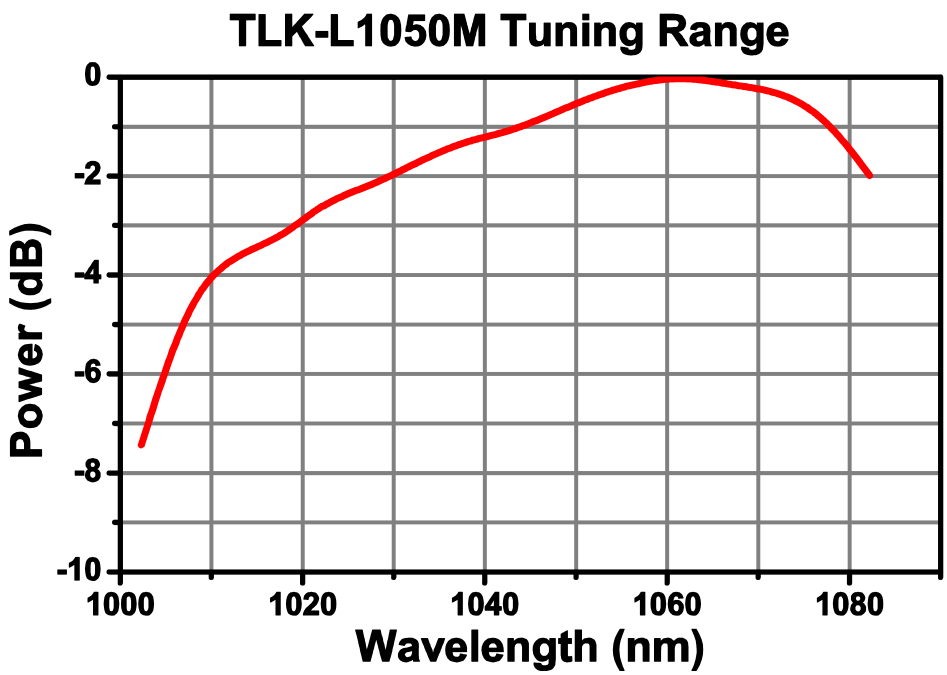
Part 11. Graphs

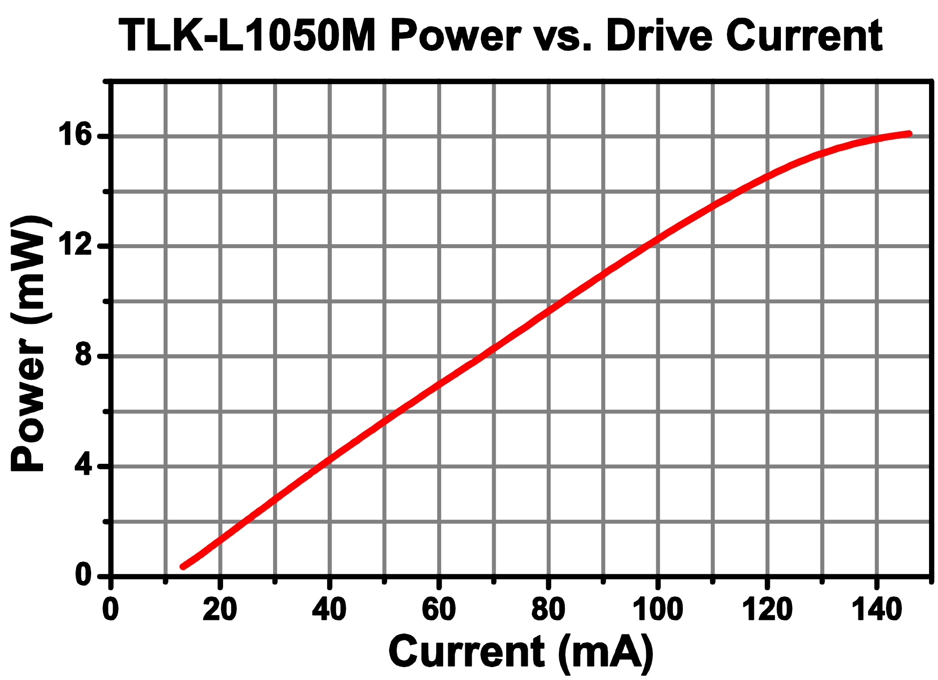
11.1. TLK-L780M



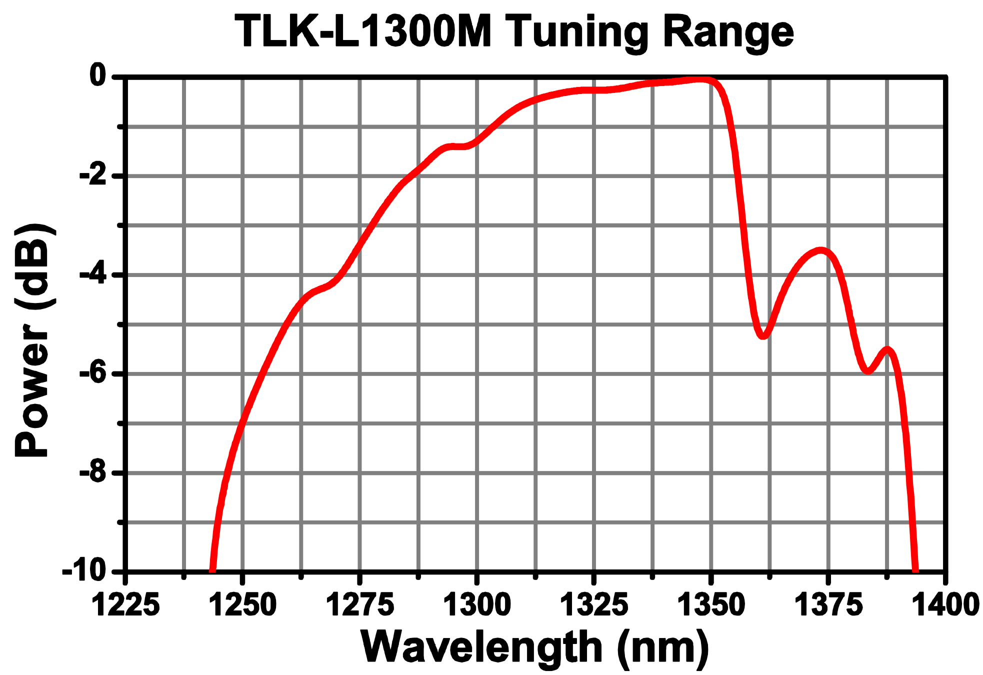


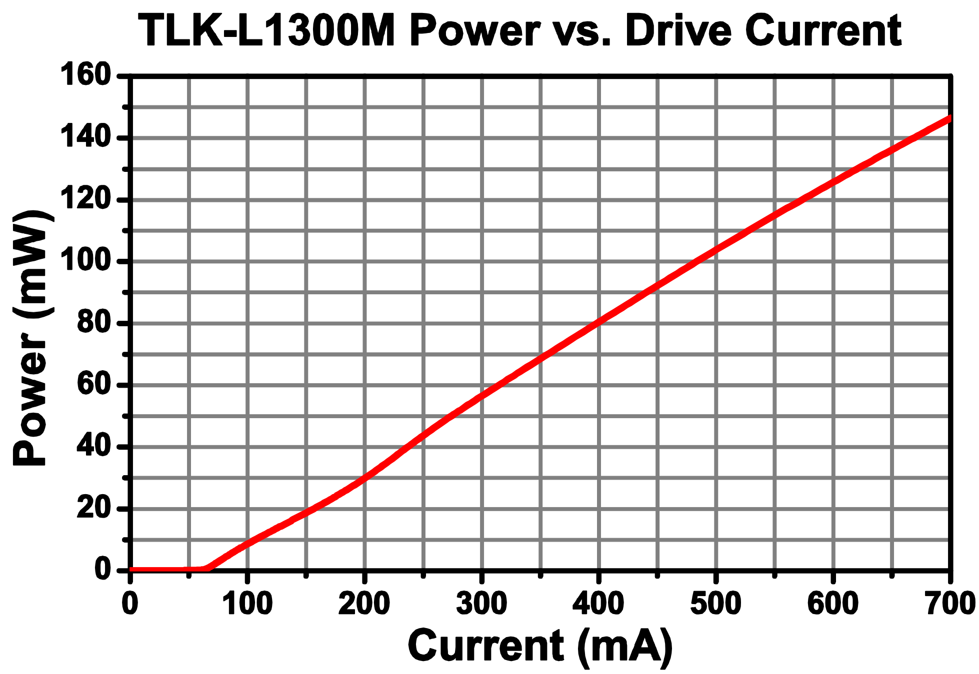
11.2. TLK-L1050M



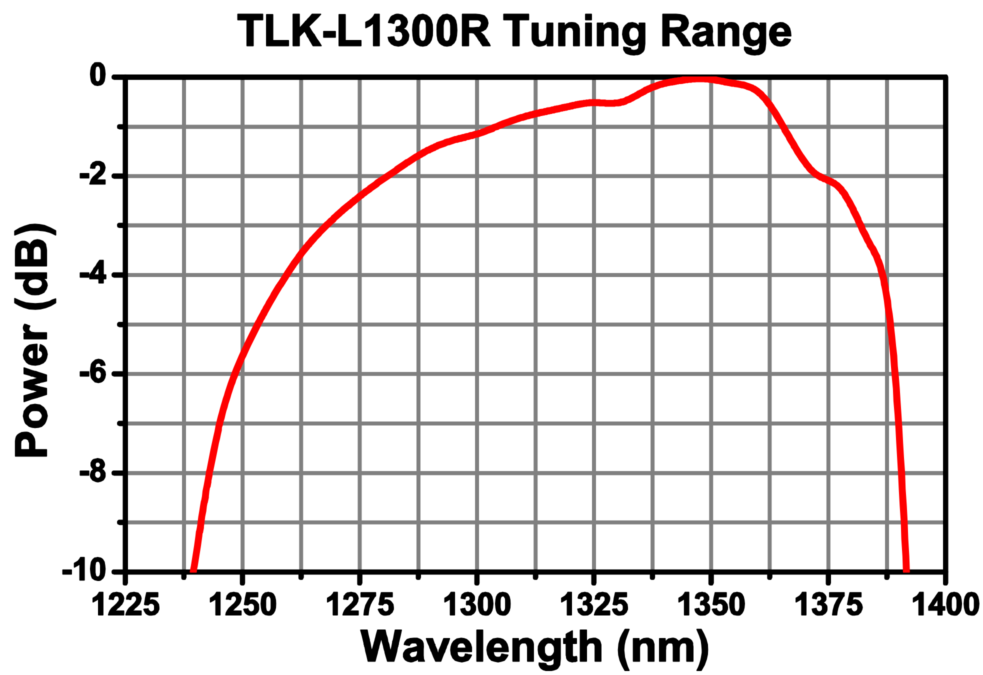


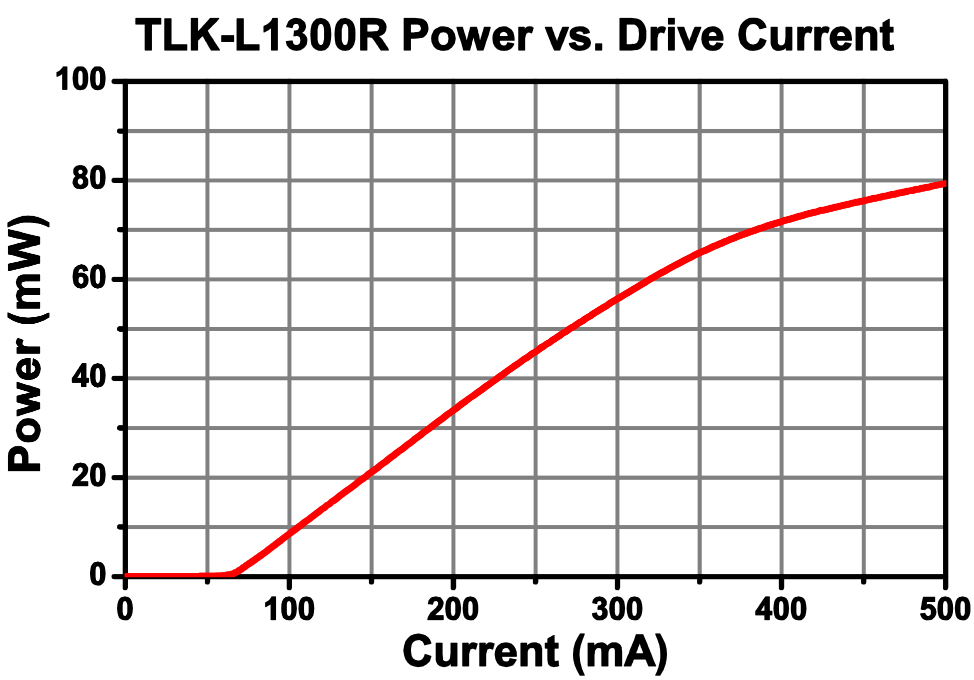
11.3. TLK-L1300M



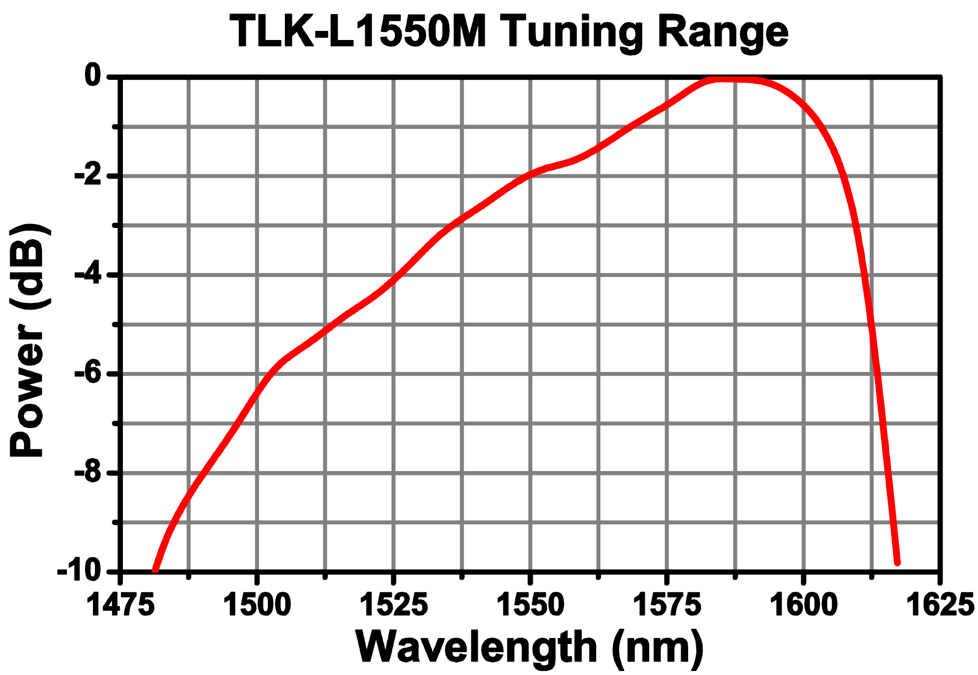


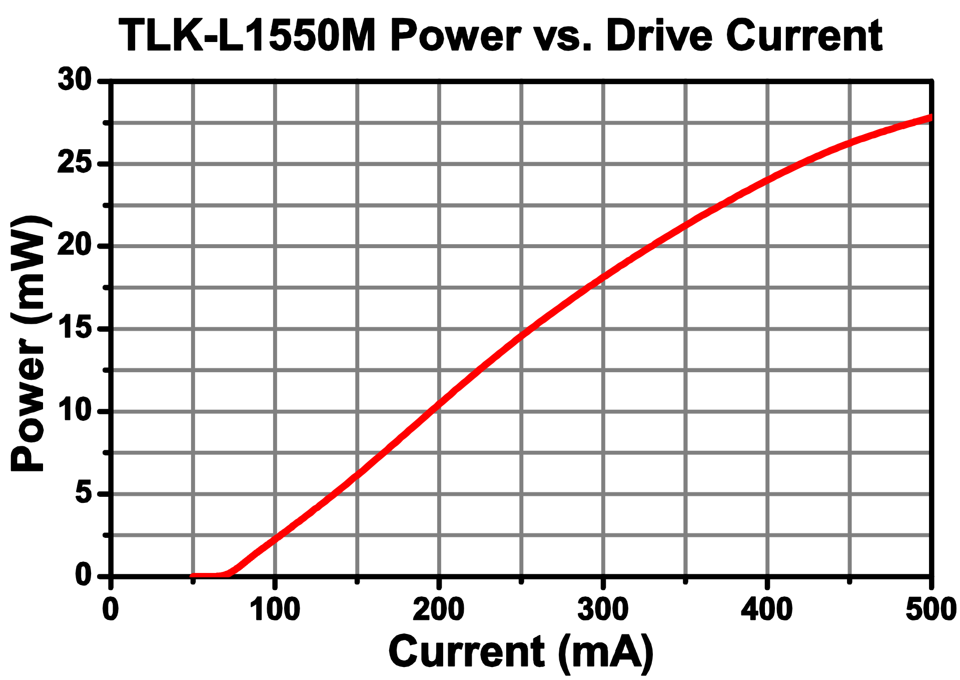
11.4. TLK-L1300R



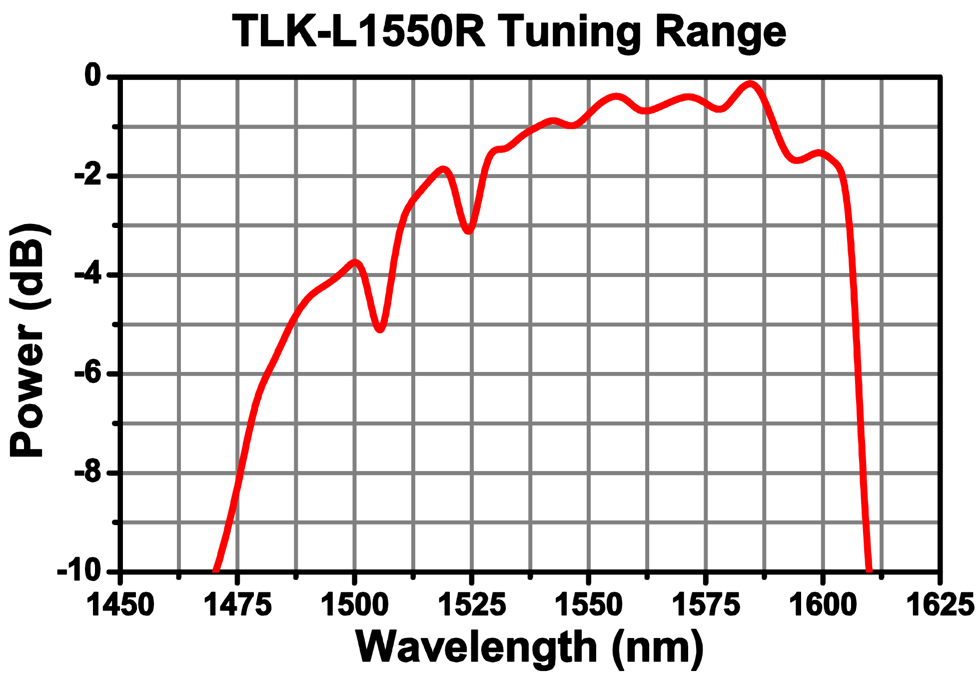


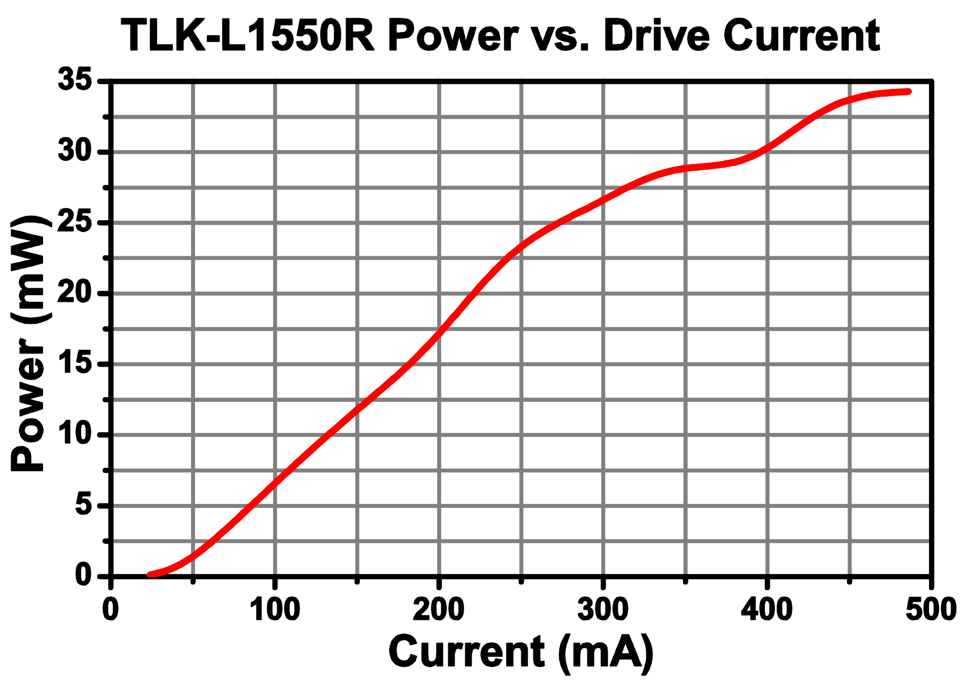
11.5. TLK-L1550M



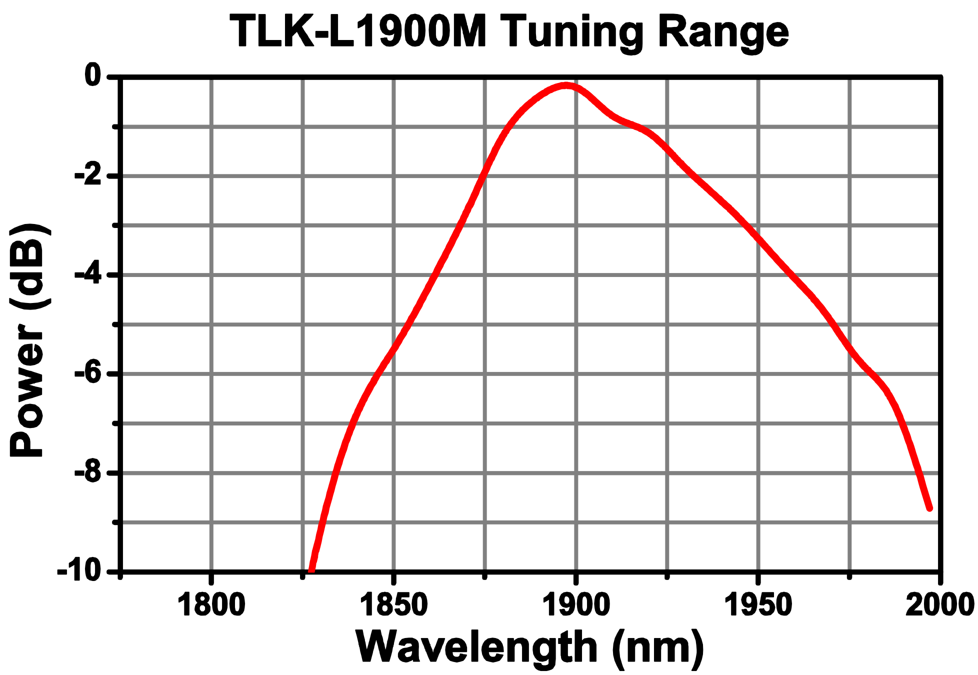


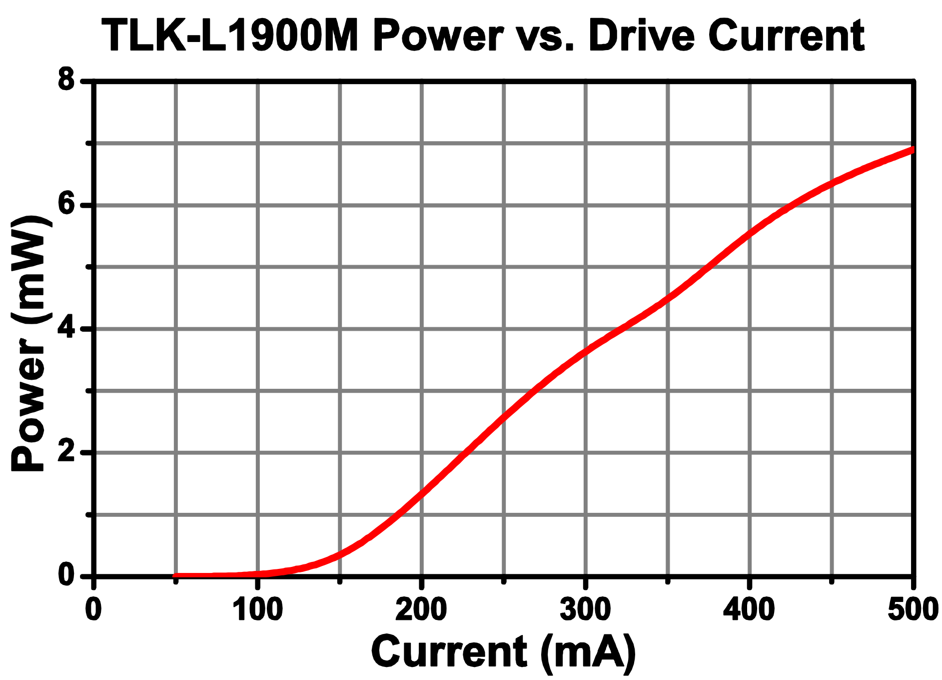
11.6. TLK-L1550R



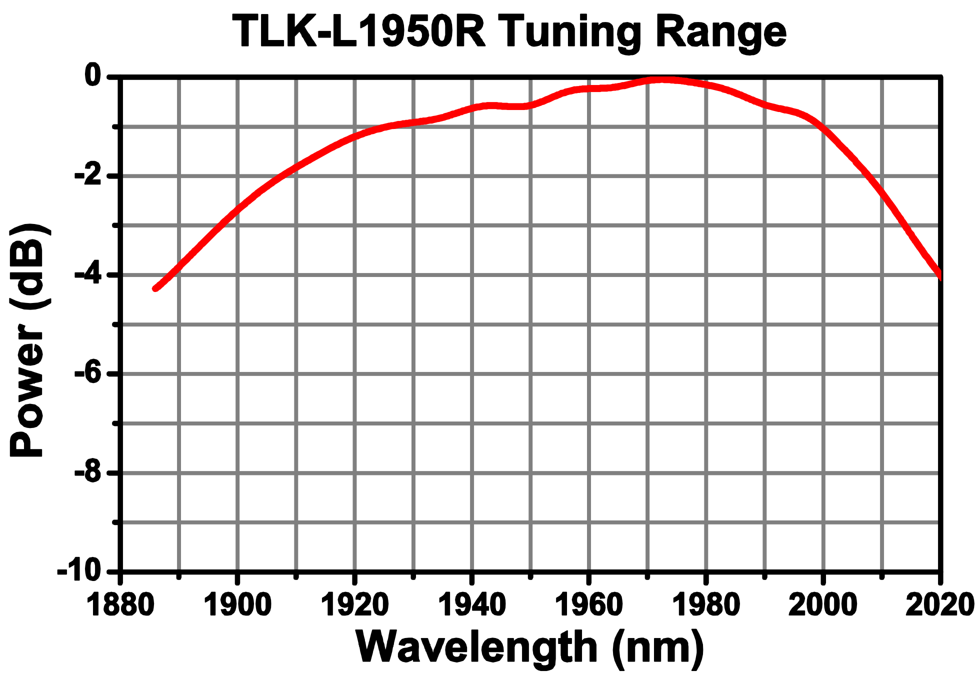


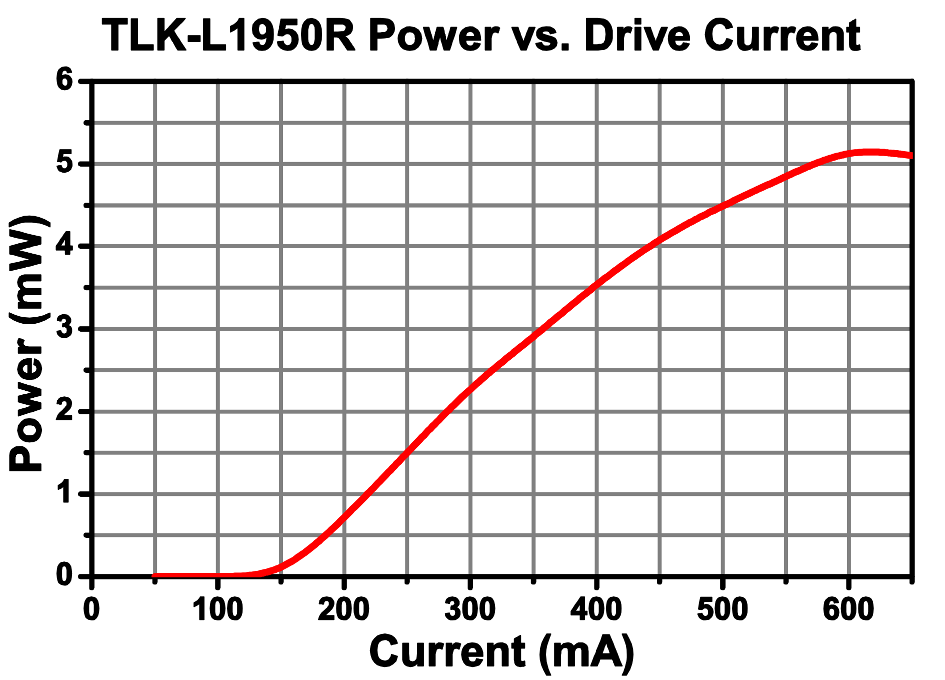
11.7. TLK-L1900M





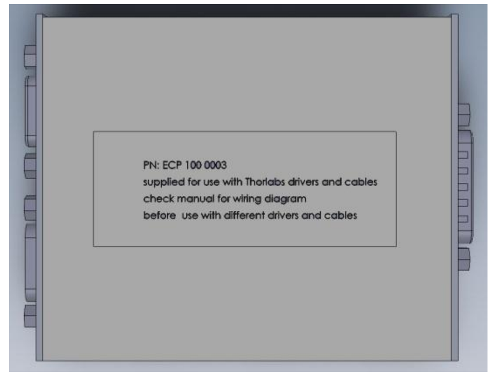
11.8. TLK-L1950R





11.9. Thermistor Temperature Coefficients

T °C	Ω	T °C	Ω	T °C	Ω	T °C	Ω
-40	336098	1	31031	42	4916	83	1141
-39	314553	2	29500	43	4724	84	1105
-38	294524	3	28054	44	4542	85	1070
-37	275897	4	26687	45	4367	86	1037
-36	258563	5	25395	46	4200	87	1005
-35	242427	6	24172	47	4040	88	974
-34	227398	7	23016	48	3887	89	945
-33	213394	8	21921	49	3741	90	916
-32	200339	9	20885	50	3601	91	888
-31	188163	10	19903	51	3467	92	862
-30	176803	11	18973	52	3339	93	836
-29	166198	12	18092	53	3216	94	811
-28	156294	13	17257	54	3098	95	787
-27	147042	14	16465	55	2985	96	764
-26	138393	15	15714	56	2877	97	741
-25	130306	16	15001	57	2773	98	720
-24	122741	17	14324	58	2674	99	699
-23	115661	18	13682	59	2579	100	678
-22	109032	19	13073	60	2487	101	659
-21	102824	20	12493	61	2399	102	640
-20	97006	21	11943	62	2315	103	622
-19	91553	22	11420	63	2234	104	604
-18	86439	23	10923	64	2157	105	587
-17	81641	24	10450	65	2082	106	571
-16	77138	25	10000	66	2011	107	555
-15	72911	26	9572	67	1942	108	539
-14	68940	27	9165	68	1876	109	524
-13	65209	28	8777	69	1813	110	510
-12	61703	29	8408	70	1752	111	496
-11	58405	30	8056	71	1693	112	482
-10	55304	31	7721	72	1637	113	469
-9	52385	32	7402	73	1582	114	457
-8	49638	33	7097	74	1530	115	444
-7	47050	34	6807	75	1480	116	432
-6	44613	35	6530	76	1432	117	421
-5	42317	36	6266	77	1385	118	410
-4	40151	37	6014	78	1341	119	399
-3	38110	38	5774	79	1298	120	388
-2	36184	39	5544	80	1256	121	378
-1	34366	40	5325	81	1216	122	368
0	32651	41	5116	82	1178	123	359



Part 12. Breakout Box

12.1. Breakout Box without Polarity Switches

Notes:

1. Breakout box Item# ECP 100 0003.
2. Use together with cable Item# CAB 000 0011 only.
3. This breakout box was originally designed for the gain element without the built-in photo detector. The 2-pin connector on the ribbon cable CAB 000 0011 is for external photo diode connection only. It is included with standard, half-butterfly tunable laser kits.
4. CAB 000 0011 can also be used together with TLK breakout box with polarity switches (Item# ECP 000 0004). To simplify configurations, we typically ship breakout box WITHOUT polarity switches (Item# ECP 100 0003) together with cable Item# CAB 000 0011 for the gain element without the built-in photo detector.

DB9 Female Connector

Pin	Description	Pin	Description	Pin	Description
1	Tied to Pin 5*	4	PD Anode**	7	LD Cathode
2	PD Cathode**	5	Tied to Pin 1*	8	LD Anode
3	NC	6	NC	9	NC

* Pin 1 and Pin 5 are tied together to bypass interlock on Thorlabs' LD drivers such as the ITC510
** PD is not available in Thorlabs' Half Butterfly gain elements. 2-pin connector on ribbon cable (Item# CAB 000 0011) is for external photodiode connection only.

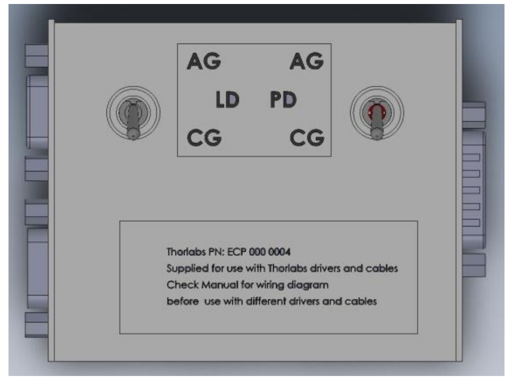
DB9 Male Connector

Pin	Description	Pin	Description	Pin	Description
1	NC	4	TEC +	7	LD Cathode
2	Thermistor +	5	TEC -	8	LD Anode
3	Thermistor -	6	NC	9	NC

DB15 Male Connector

Pin	Description	Pin	Description	Pin	Description
1	TEC +	6	TEC -	11	NC
2	Thermistor +	7	PD Cathode	12	NC
3	Thermistor -	8	PD Anode	13	NC
4	LD Anode	9	NC	14	NC
5	LD Cathode	10	NC	15	NC

12.2. Breakout Box with Polarity Switches



Notes:

1. Breakout box PN: ECP 000 0004.
2. Use together with cable Item# CAB 000 0013. (Do not use CAB 000 0013 for the Gain Element without the built-in photo detector, for example Thorlabs Half Butterfly gain elements)
3. This optional breakout box with polarity switches version can also be used together with CAB 000 0011 for the gain element without the built-in photo detector. But to simplify configurations, we typically ship breakout box without polarity switches (Item# ECP 100 0003) together with cable Item# CAB 000 0011 for the gain element without the built-in photo detector.
4. Included with custom lasers without half-butterfly gain chips.

DB9 Female Connector

Pin	Description	Pin	Description	Pin	Description
1	Tied to Pin 5*	4	PD	7	LD Cathode with AG
2	LD and PD Ground	5	Tied to Pin 1*	8	LD Anode with CG
3	LD and PD Ground	6	NC	9	NC

* Pin 1 and Pin 5 are tied together to bypass interlock on Thorlabs' LD drivers, such as the ITC510.

DB9 Male Connector

Pin	Description	Pin	Description	Pin	Description
1	NC	4	TEC +	7	NC
2	Thermistor +	5	TEC -	8	NC
3	Thermistor -	6	NC	9	NC

DB15 Male Connector

Pin	**Description**	**Pin**	**Description**	**Pin**	**Description**
1	TEC +	6	TEC -	11	NC
2	Thermistor +	7	LD and PD Ground	12	NC
3	Thermistor -	8	PD	13	NC
4	LD	9	NC	14	NC
5	LD and PD Ground	10	NC	15	NC

12.3. Internal Cable Connections with Molex Connectors

Notes: Figure 30: shows only the case with cable CAB 000 0011. Cable CAB 000 0013 does not have the 2-pin connector.

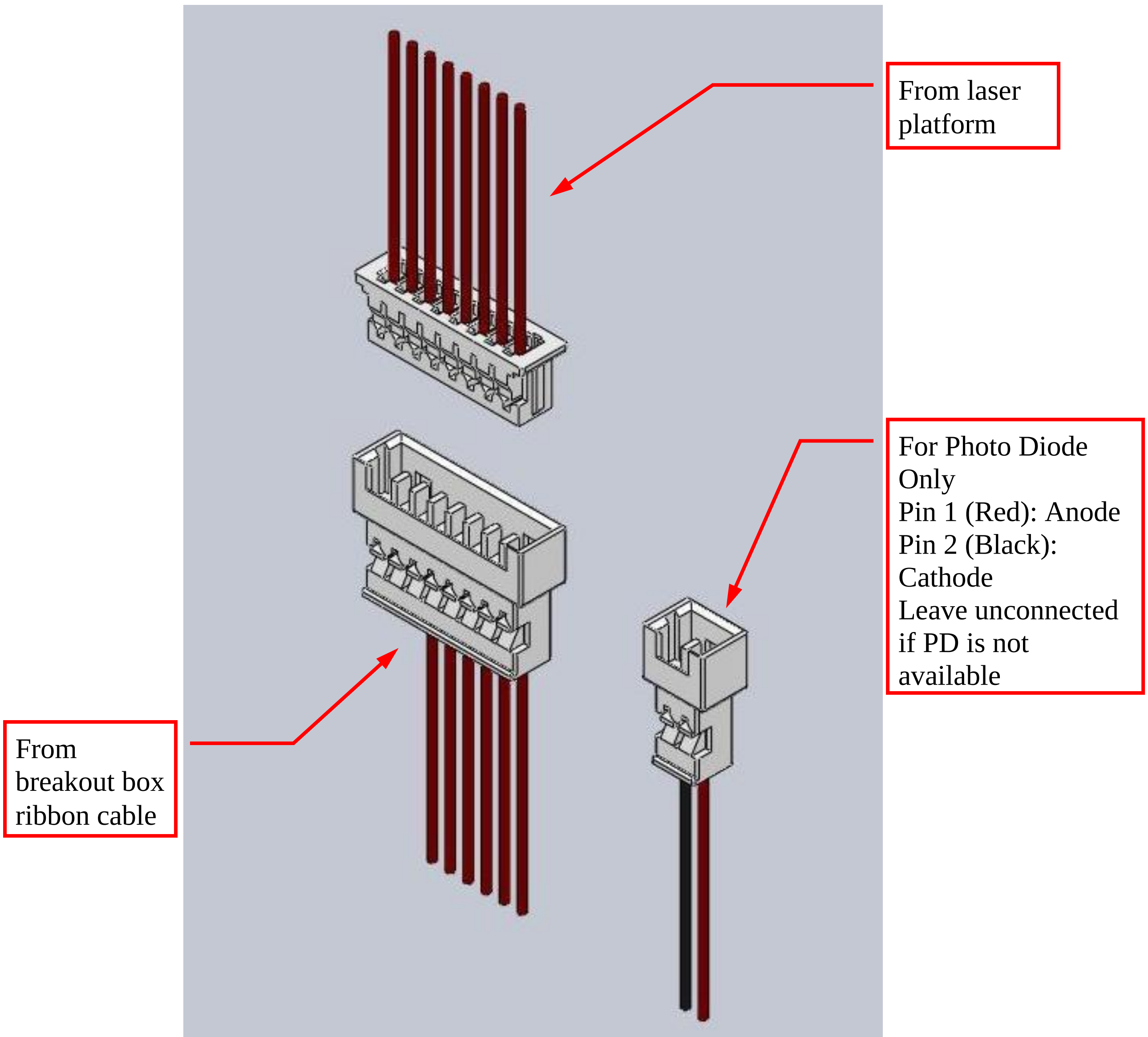


Figure 30: Internal Connections

Part 13. Regulatory

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

- This offer is valid for Thorlabs electrical and electronic equipment:
- Sold after August 13, 2005
- Marked correspondingly with the crossed out “wheelie bin” logo (see right)
- Sold to a company or institute within the EC
- Currently owned by a company or institute within the EC
- Still complete, not disassembled and not contaminated

Wheelie Bin Logo

As the WEEE directive applies to self-contained operational electrical and electronic products, this end of life take back service does not refer to other Thorlabs products, such as:

- Pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- Components
- Mechanics and optics
- Left over parts of units disassembled by the user (PCB’s, housings etc.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

13.1. Waste Treatment is Your Own Responsibility

If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

13.2. Ecological Background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of live products will thereby avoid negative impacts on the environment.

Part 14. Thorlabs Worldwide Contacts

USA, Canada, and South America
Thorlabs, Inc.
435 Route 206
Newton, NJ 07860
USA
Tel: 973-579-7227
Fax: 973-300-3600
www.thorlabs.com
email: feedback@thorlabs.com

Europe
Thorlabs GmbH
Hans-Böckler-Str. 6
85221 Dachau
Germany
Tel: +49-(0)8131-5956-0
Fax: +49-(0)8131-5956-99
www.thorlabs.de
email: Europe@thorlabs.com

UK and Ireland
Thorlabs LTD.
1 Saint Thomas Place, Ely
Cambridgeshire CB7 4EX
Great Britain
Tel: +44 (0)1353-654440
Fax: +44 (0)1353-654444
www.thorlabs.de
email: sales.uk@thorlabs.com

France
Thorlabs SAS
109, rue des Côtes
78600 Maisons-Laffitte
France
Tel: +33 (0) 970 444 844
Fax: +33 (0) 811 381 748
www.thorlabs.de
email: slaes.fr@thorlabs.com

Scandinavia
Thorlabs Sweden AB
Box 141 94
400 20 Göteborg
Sweden
Tel: +46-31-733-30-00
Fax: +46-31-703-40-45
www.thorlabs.de
email: scandinavia@thorlabs.com

Japan
Thorlabs Japan Inc.
5-17-1, Ohtsuka
Bunkyo-ku, Tokyo 112-0012
Japan
Tel: +81-3-5979-8889
Fax: +81-3-5979-7285
www.thorlabs.jp
email: sales@thorlabs.jp

China
Thorlabs China
Oasis Middlering Centre
3 Building 712 Room
915 Zhen Bei Road
Shanghai
China
Tel: +86 (0)21-32513486
Fax: +86 (0)21-32513480
www.thorlabs.com
email: chinasales@thorlabs.com

Thorlabs, Inc.
435 Route 206N
Newton, NJ 07860 USA

Phone: (973) 579-7227 ♦ Fax: (973) 300-3600
www.thorlabs.com