Tunable Laser Kit

User Guide

Rev M, March 25, 2014

Table of Contents

Chapter 1 Safety

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 aprasive 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 the 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 into beam.

Chapter 2 Description

- User-Customizable Optics, Gain Chip, Tuning Actuator
- Fiber-Coupled or Free-Space Output
- Standard Center Wavelengths Available: 770, 1050, 1220, 1310, 1450, 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 770nm, 1050 nm, 1900 nm, and 1950 nm kits should be used with an optical isolator for specified performance (an optical isolator is included in the source packages for the 1220, 1310, 1450 and 1550 nm kits).

Additional Required Tools

- Laser Diode Controller
- TEC Controller

Recommended Tools

- Viewing Card (for collimation and cavity alignment with systems in the IR)
- Power Meter
- Optical Spectrum Analyser (OSA) for observing wavelength as a function of grating arm position, and for calibration updates after adjustment
- Scanning Fabry Perot (SFP) module for displaying mode structure of laser output (useful for fine adjustment to obtain single longitudinal mode operation)

Chapter 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 increased number of mode hops. The setup procedure here outlines the process of building a kit and setting up the laser cavity by aligning each component in turn, as this is useful for users who need to build from this level or reconfigure the kit to work with new parts for a different emission wavelength. However, each kit in the TLK family is shipped assembled and aligned, so normally only small tuning adjustments are necessary for optimal performance. If your system is already lasing, please skip to Step 13 for Littrow cavities or Step 15 Littman cavities for tuning instructions. An overview of tuning components to the lasers can be found in Part 4.

Step 1: The first step when building a Tunable Laser Kit from the base module is to attach a gain chip mounting top plate to the base module (TLK-BM). Two mounting plate versions are available for half-butterfly gain chips. These are an angled top plate for use with 'Single Angled Facet' (SAF) chips or an 'in-line' top plate for use with AR coated Fabry Perot (FP) chips. In addition a top plate style is also available for mounting of customer's own choice of AR-coated diode mounted in TO style Ø5.6mm or Ø9mm packages. To mount the top plate to the base module, align the plate to the vertical mounting supports on the base module. Feed the three M4 cap screws through the top plate and thread them into the mounting supports. Figure 2 shows mounting of the angled top plate but mounting of the in-line, and TO package variants uses exactly the same three M4 bolts.

Step 2: Fix the gain chip subassembly (package) into the zero insertion force (ZIF) socket. Clearance between the screw heads and the butterfly package pins is limited, so be sure to insert and tighten mounting screws very carefully. The two screws nearest to the open end of the half butterfly (where the chip is visible) should be inserted first and need careful attention. Fixing is best done by first inserting both screws through the holes in the mounting tabs on the package and then lowering the package down on to the mount while alternately tightening the screw on each side in small steps. Failure to do this properly by overtightening one bolt well ahead of the other may result in damage to the ceramic shelf on the package as the untightened bolt is forced up against this shelf. It is also recommended to use a ball-ended hex key driver to mount the package as this will avoid damage to the package leads above these first two screws. Drive the first two screws to the point where the package can still be moved side to side with the package leads sliding freely in the contact channels on the ZIF connector, then add the remaining two screws. Just before tightening of all four screws, slide the package over the limits of movement and try to center the half butterfly as closely as possible in the middle of this range; this will ease the alignment steps in the remaining sequence. With the screws tightened, check that the leads are correctly positioned in the ZIF connectors and then close the connector gates.

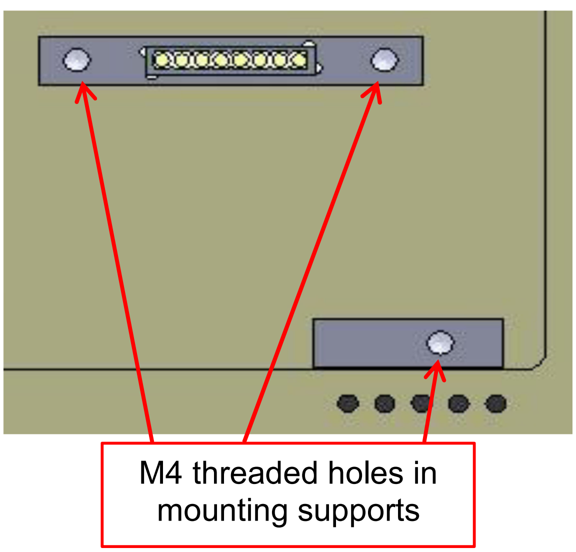


Figure 1 TLK Base

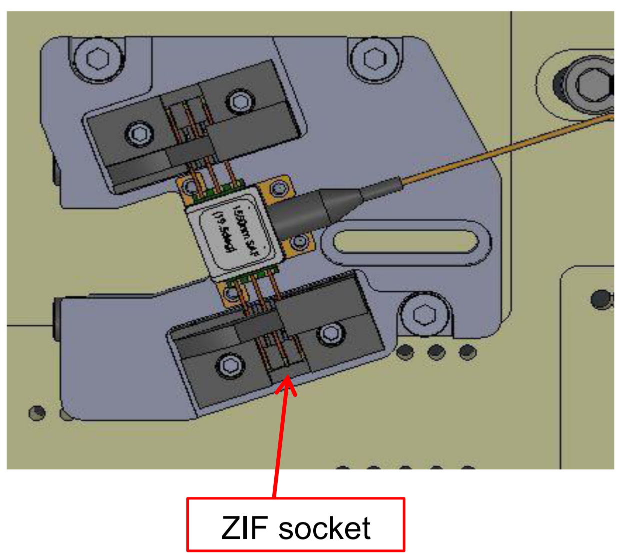


Figure 2 ZIF Socket

Step 3: Attach the focus adjuster (TLK-FM1) under the gain chip platform. Two sets of M3 screws, spring washers, and washers mount the focus adjuster to the tunable laser top plate. The screws should not be tightened completely as the position of the focus adjuster must be aligned in later steps. To avoid damage to the gain chip, slide the focus adjuster forward (to the left in Figure 4) so that the screws attaching it to the gain chip platform move to the left in the slot leading towards the half butterfly package. This will provide space to attach the lens mount in the following step without touching/damaging the gain chip.

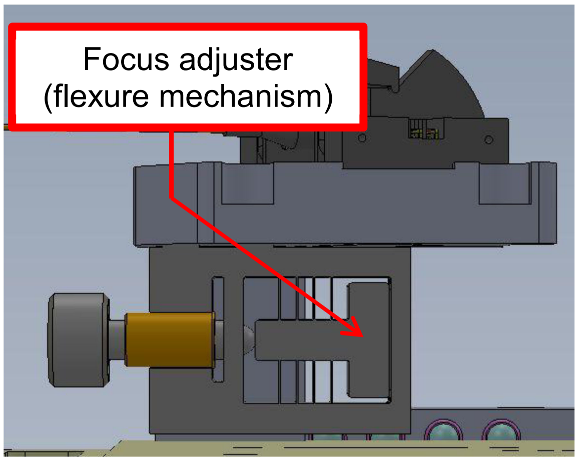


Figure 2 Focus Adjuster

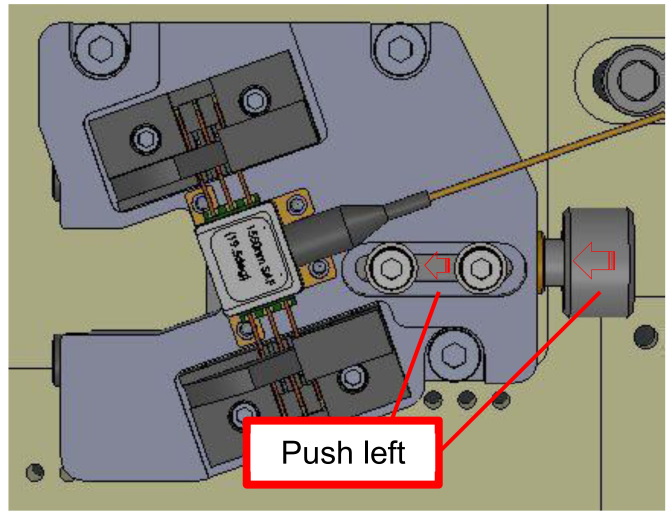


Figure 3 Initial Focus Adjuster Alignment

Step 4: Attach the lens mount to the front of the focus adjuster flexure mechanism. The fixing (screw, spring washer, flat washer) should be snug, but still allow for adjustment of the mount. The position of the lens mount attached to the flexure mechanism will be adjusted to collimate the light emitted from the gain chip. When initially bolting the lens mount to the focus adjuster, 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 this attachment operation make sure the screws fastening the focus adjuster to the top plate are <u>tight enough to avoid sudden shifts in the flexure mount</u> position.

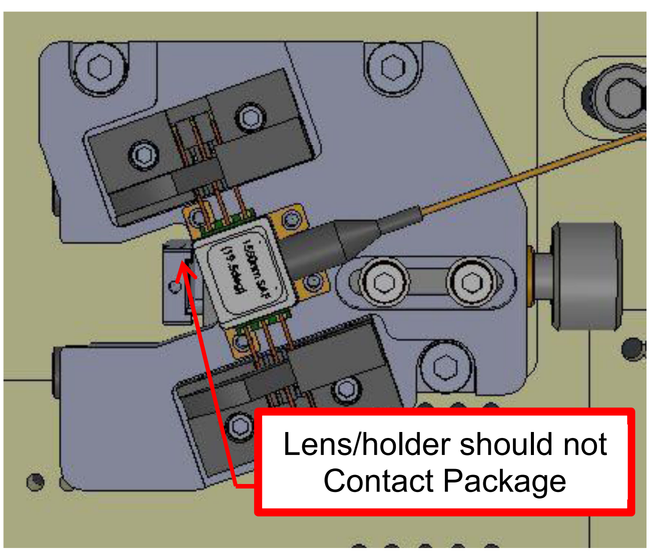


Figure 4 Lens Holder and Gain Chip

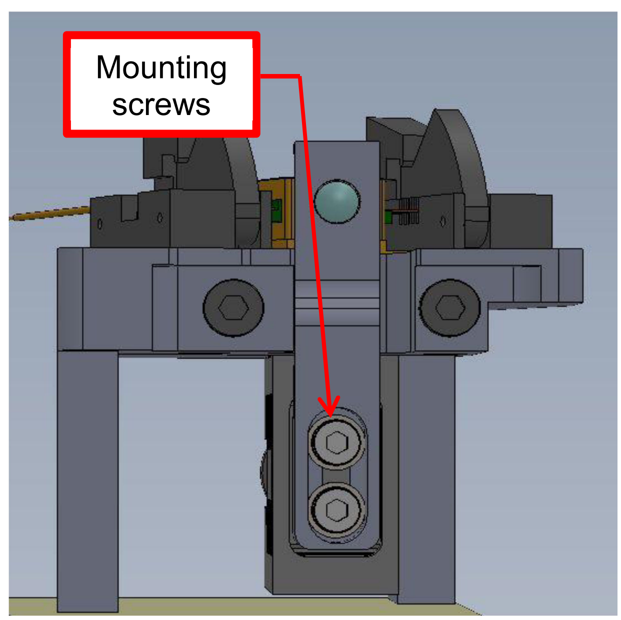


Figure 5 Lens Holder Mounting Screws

Step 5: 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. We recommend operating the gain chip at 25°C. 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 6: 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 as amplified spontaneous emission (ASE).

Step 7: 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. The aim here is to accurately align the collimated beam in a direction parallel to the axis of the slot machined into the top plate – in line with the beam that emerges from the facet of the gain chip inside the package. For this alignment to be done, the beam needs to be fairly well collimated, otherwise it will not be visible at any reasonable distance away from source. In preparation for the alignment, turn the knob on the flexure mount until the focus adjustment is in the middle of the adjustment range (which is very small) and feels reasonably tight.

It should be noted that the flexure mount is designed to be quite stiff, and also the adjustment range is small. The stiffness gives good stability for the final setting but the feel of the knob may not be as smooth as anticipated. The objective here is to put the adjuster at a reasonably stiff point, generally at least half way through its adjustment range; subsequent adjustments when we are fine tuning the lasing action will require 'tweaks' rather than movement than could be considered as smooth rotation. It is possible that when Step 10 is completed the flexure mount adjustment is found to be outside the desired range (ie., not stiff enough for stability). In this case the alignment steps, from Step 7, may need to be repeated.

Step 8: Next, obtain some rough alignment by manipulating the lens holder fastened to the flexure mount and also moving the flexure mount back and forth to get reasonable collimation over a distance of a meter of so from the source. With reasonable collimation, and the scope for making any remaining fine focus adjustment via the flexure mount knob. When reasonable collimation is achieved, the flexure mount should be firmly tightened against the underside of the top plate.

Step 9: The lens holder must now be adjusted for very accurate beam pointing. Accuracy is usually achieved by having the kit mounted to an optical table and then adjusting the lens holder to direct the beam over a line of holes in the table while travelling at a uniform height over a distance of a meter or so. With the lens holder snug yet moveable against the flexure mount, adjustment can be done in two ways as shown in Figure 7: You can either start with the beam pointing high and gently tap or rock the lens holder to bring down the beam to a uniform height, or start with the beam pointing low and then gently rock the lens holder back and forth while applying finger pressure below the holder in order to gradually bring the beam up to a level height. Coma is the main aberration that needs to be eliminated and if you see that this is present, then it may be that the package is not well centered from Step 2 or the flexure mount is slightly twisted and not aligned to the slot in the top plate.

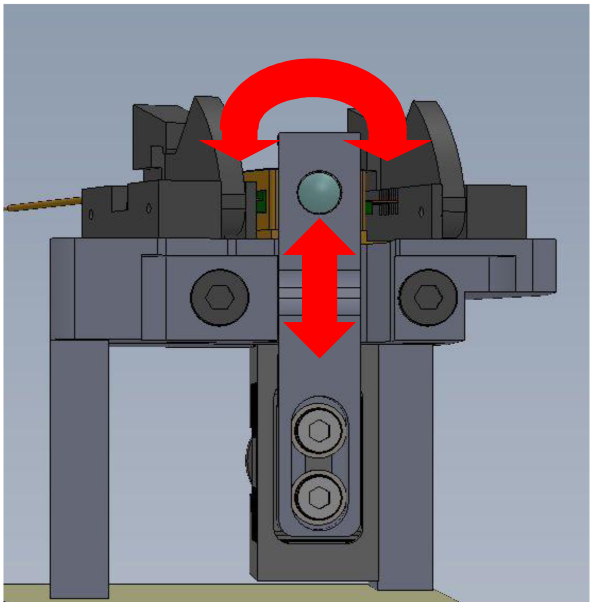


Figure 6 Lens Holder Adjustment

Step 10: Turn the Adjuster Knob of the Focus Adjuster to adjust the fine focus of the lens. By viewing the beam on an IR viewing card, beam profiler or infra-red camera, 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 essentially constant at each point.

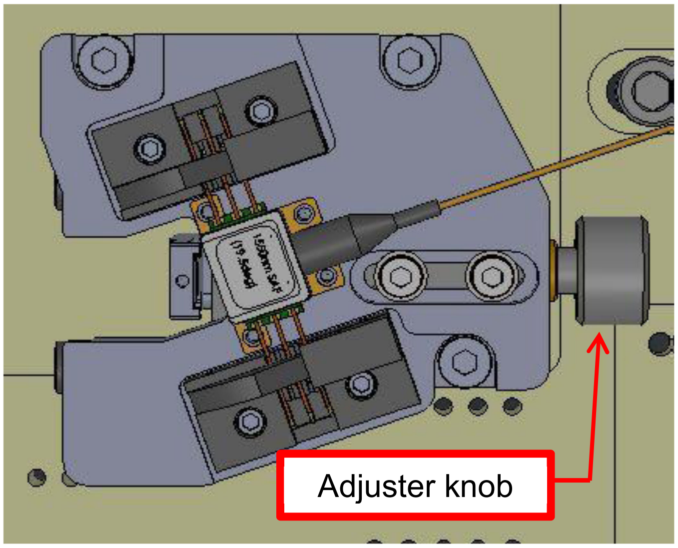


Figure 7 Collimation Adjustment

3.1. Littrow Cavity Configuration

Step 11: Attach the grating pivot bracket to the base plate using three M3 cap screws. A good starting point for the position of the grating pivot bracket is with the main body of the bracket in line with the edges of the pusher bar (bar with five fixture springs) as shown in Figures 9 and 10. 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 three mounting screws (screw, spring washer, flat washer) should be tightened enough to keep the base of the pivot bracket in contact with the base plate, yet still allow for the bracket to translate.

Now attach the mode hop adjuster. Slide the adjuster tip over the micrometer barrel and with the micrometer bolted into its clamping bracket and the two M4 bolts fastening this assembly to the base of the kit very loosely threaded into the base, 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 via the two M4 bolts. Please note that the adjuster is designed to push the pivot bracket and the pivot point for the grating arm along the machined edge as the user adjusts the pivot point to the optimum position for widest mode-hop free performance. Note that the tip of the adjuster is a sliding fit over the micrometer barrel is so is not designed to pull; if the adjustment of the pivot point is taken through the optimum position, it must be returned back through this point by applying some finger pressure to the pivot bracket to ease this back to the right hand side as the adjusting micrometer is gently backed off.

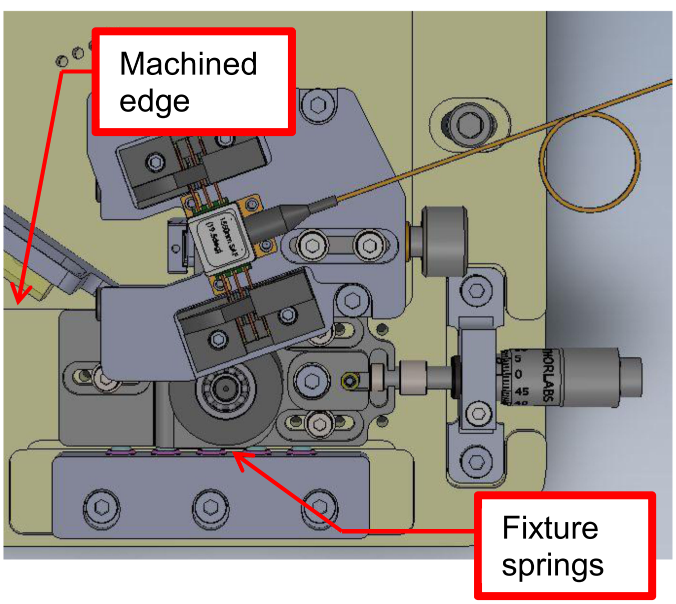


Figure 8 Grating Pivot Pracket Guide

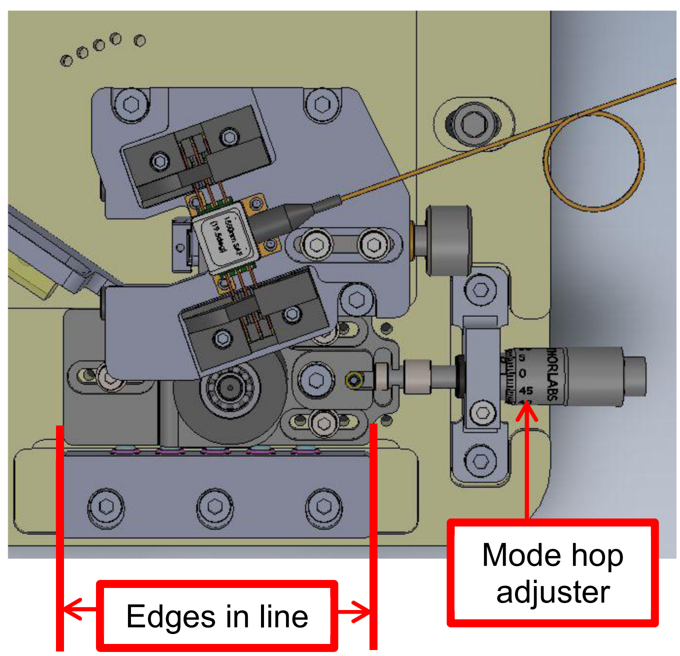


Figure 9 Grating Pivot Bracket Alignment

Step 12: Attach the tuning adjuster for the control of the angle of incidence for light on to the grating. The standard configuration is a DC Servo Motor, but options are available for a micrometer or piezo actuator. A spring pulls the grating arm into contact with the actuator. The proper angle of the grating is such that the 1st order diffraction from the grating is directed back into the gain chip. You can set up this geometry by rotating the grating and locating its strongest diffraction with the included IR viewing card.

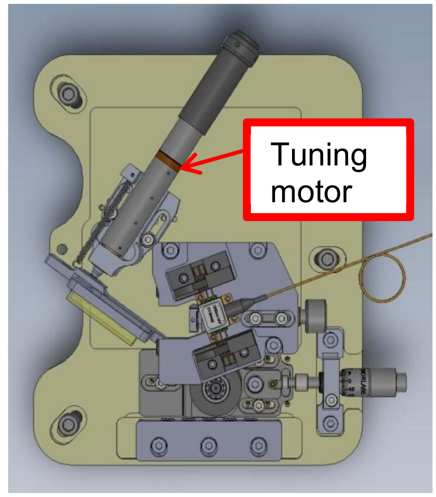


Figure 10 Tuning Motor

Step 13: In the body of the pivot bracket, there is a flexure (hinge) that adjusts the tilt of the grating (Figure 12). As you adjust the fine setscrew, the coupling efficiency for the diffracted light back into the gain chip will vary. Back off the motor and with a finger on the end of the grating arm, swing the arm back and forth while observing the output from the fiber (on a sensor card or equivalent) – also while adjusting the fine setscrew. At some point a large increase in output intensity should indicate lasing action. If this is not observed then it may simply mean that we are adjusting in the wrong direction and the flexure hinge needs to be closed slightly rather than opened. In this case, slacken off the fine set screw and swing the grating arm again while this time adjusting the M4 'tensioning' bolt. When very close to the optimal flexure angle, an alternating sequence of optimizing the laser intensity by adjusting the fine set screw and then tensioning the M4 bolt should lead to a strong output, coupled with a setting for good overall stability. In this alternating sequence adjustment of the fine setscrew should always be able to counteract the effect of the last adjustment of the tensioning bolt; the adjustment should stop just short of the point where this sequence starts to falter, as this is a sign that the tensioning is too much, and that slight distortion of the pivot bracket itself is beginning to occur.

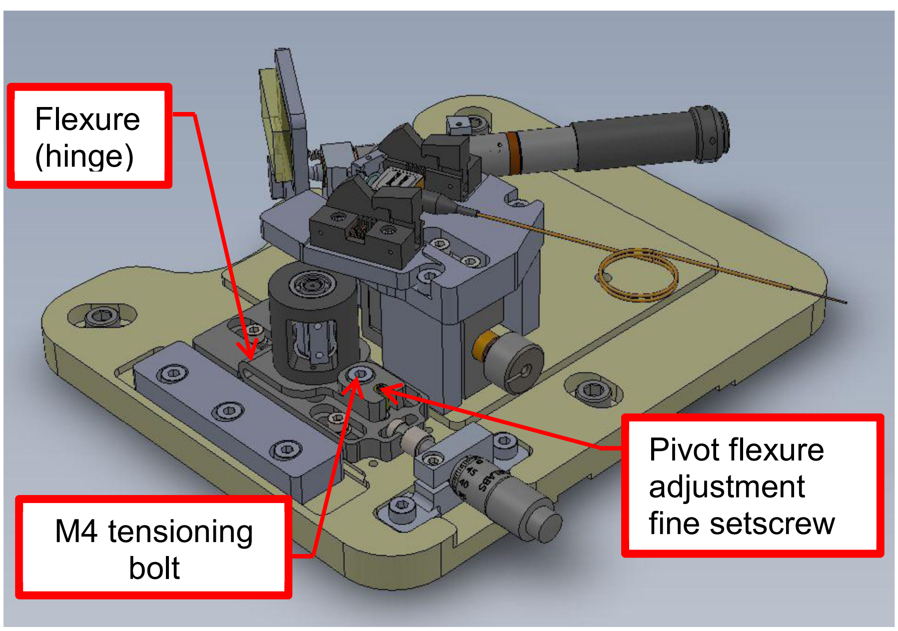


Figure 11 Grating Pivot Adjustment

Step 14: When the laser is sweeping, the position of the pivot bracket can be driven to the left by turning the micrometer on the mode hop adjuster. Using an external monitoring method such as a display from a scanning Fabry Perot (SFP) interferometer, or a display of the required driving current for the laser installed in a feedback loop for a constant optical output power, the pivot point position can be finely adjusted to minimize the number of mode hops over any given sweep range. Again, the adjuster tip is a sliding fit over the barrel of the micrometer and so the adjuster is designed to push the pivot bracket only, not pull. so if the adjustment of the pivot point is taken through the optimum position, it must be returned back through this point by applying some finger pressure to the pivot bracket to ease this back to the right hand side as the adjusting micrometer is gently backed off. When you have optimized the position to minimize the number of mode hops, tighten the three mounting screws for the pivot bracket and retract the adjuster slightly so that there is no contact pressure on the ball in the pivot bracket. This reduces the risk of accidentally adjusting the pivot after optimization.

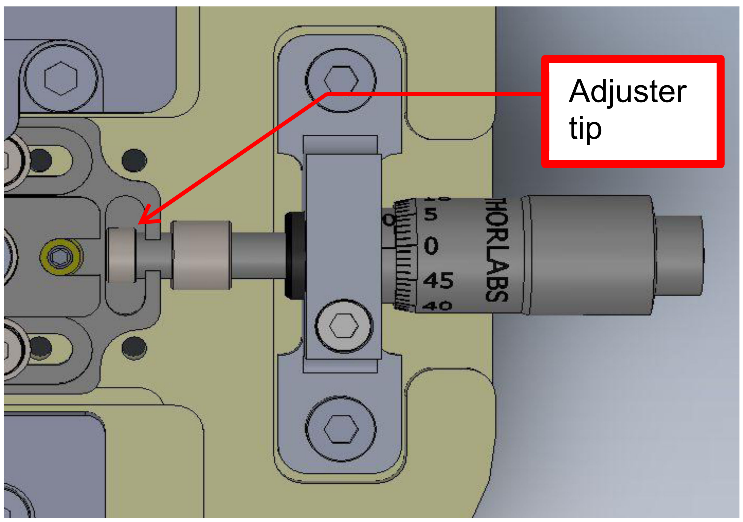


Figure 12 Mode Hop Adjuster Tip

Step 15: To further maximize power, it may be necessary to 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 should be very quick. As the grating angle provides wavelength selectability, it should remain stationary when tuning for maximum power at a set wavelength.

It should always be noted that the performance of external cavity lasers is extremely sensitive to small changes in the geometry of the cavity and so the best results will be obtained when care is taken to adjust the pivot bracket and lens holder flexure mount with an appropriate level of tension. Practice, patience and experienced gained are invaluable in this respect.

3.2. Littman Cavity Configuration

Step 11: Attach the grating platform to the gain chip platform using two M4 low profile bolts. A short stem hex key, or ball-ended hex driver is recommended for access to the more difficult screw. The grating platform will accept the diffraction grating which is clamped in position by tightening the recessed M3 bolt. When fixing the platform, the grating should also be initially in position so that the small amount of play for the two low profile M4 bolts can be used to adjust the leveling of the grating platform and so keep the reflected orders from the grating at the same height, and in plane with the main collimated beam incident from the gain chip.

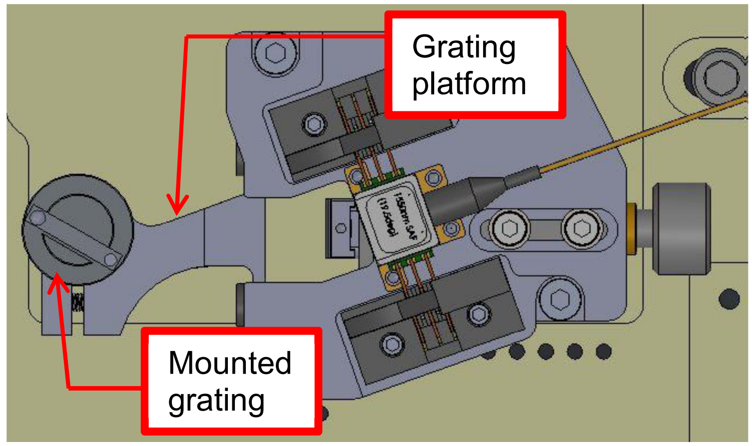


Figure 13 Grating Platform on Littman Kit

With the plane of the reflected orders from the grating set up correctly, the mounted grating should be temporarily removed from the platform to allow insertion of the mirror arm. Remove the grating by loosening the M3 clamping bolt on the grating platform and lifting the mounted grating, being sure to not touch the grating surface.

The mirror arm is bolted to the pivot bracket and can be installed by carefully guiding the pivot bracket into its channel between the fixture springs and the machined edge, while swinging the mirror arm appropriately so that the mirror clears the end of the grating platform. In the correct approximate starting position, the edges of the pivot bracket will be in line with the edges of the block carrying the five fixture springs as shown in Figure 16. In this position the three M3 bolts, each with spring washer and standard washer can be added to fix the pivot bracket in place – snug but still able to be moved along the channel when it is time for further adjustments.

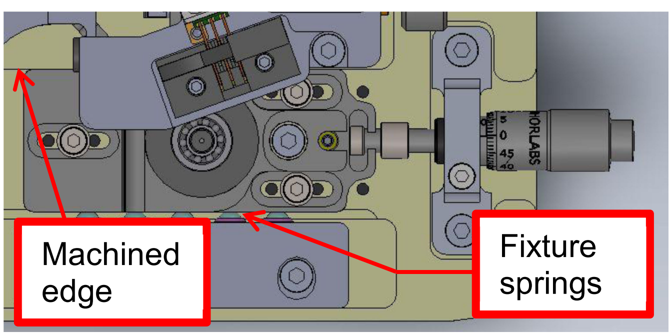


Figure 14 Mirror Pivot Bracket Guide

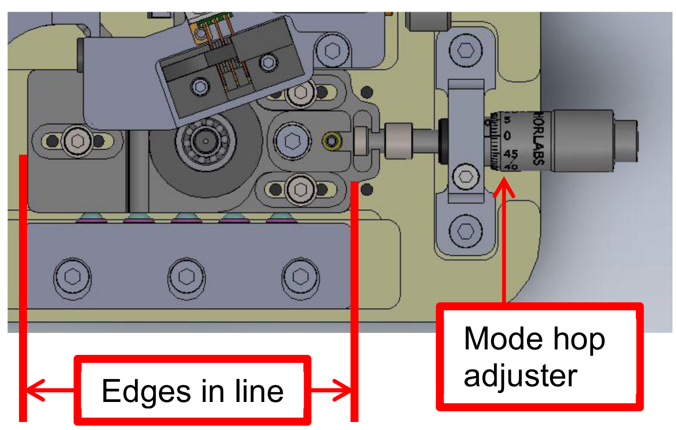


Figure 15 Mirror Pivot Bracket Alignment

Step 13: 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 spring has been attached, insert the mounted grating in to the grating platform. The mount should be fastened with a tension that still allows it to be rotated when the shaft of a hex key or small screwdriver is inserted, as a lever, into the hole in the grating mount (in the part of the mount now projecting below the grating platform).

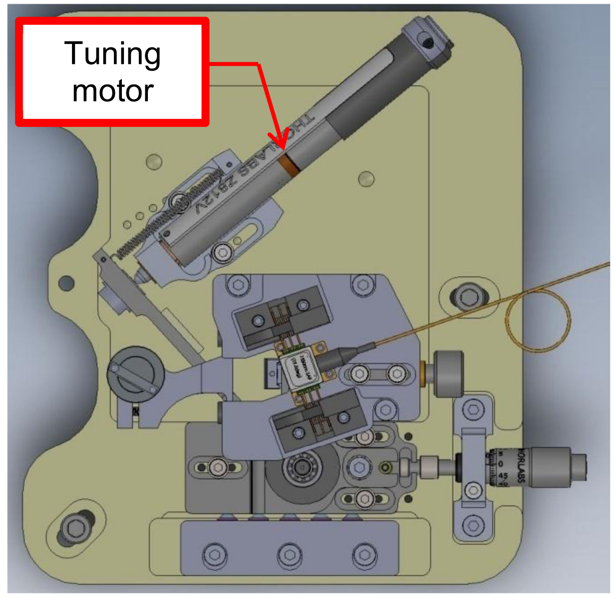


Figure 16 Tuning Motor

Step 14: Setting the correct angle of the grating for light incident from the source is now important. The grating should be angled such that the plane of the actual grating passes directly through the pivot point of the mirror; see the Imaginary Alignment Line in Figure 18. This will set up the grating and mirror geometry so that 1st order diffracted light in the appropriate wavelength range is directed back in to the gain chip. Another method to set up this geometry, when the kit is mounted on an optical table, is to direct the zero order diffraction from the grating along a well defined path across the table using the hole pattern in the table top (see Figures 19 and 20).

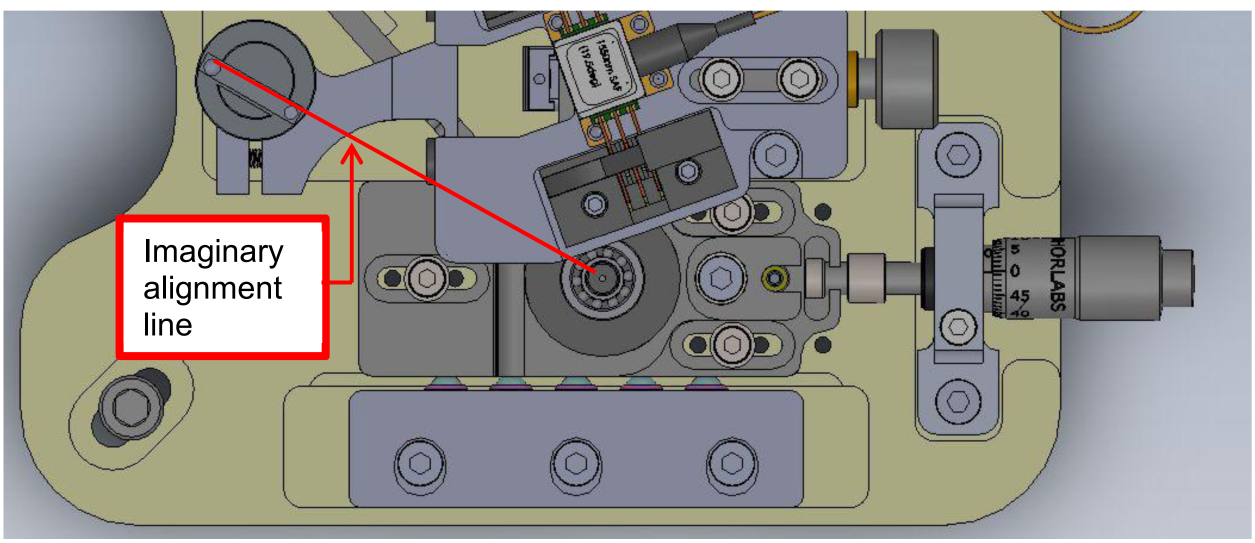


Figure 17 Littman Grating Angular Alignmet

Imperial Breadboards

A trick to align the grating properly is to mount the Tunable Laser Kit on to a breadboard and view the zero order diffraction from the grating. When the front plane of the grating is in line with the pivot point, the zero order diffraction will point to a hole on an imperial breadboard. Please see Figure 19 for the location of the intersecting point. A viewing card can be placed at this hole location to align the grating.

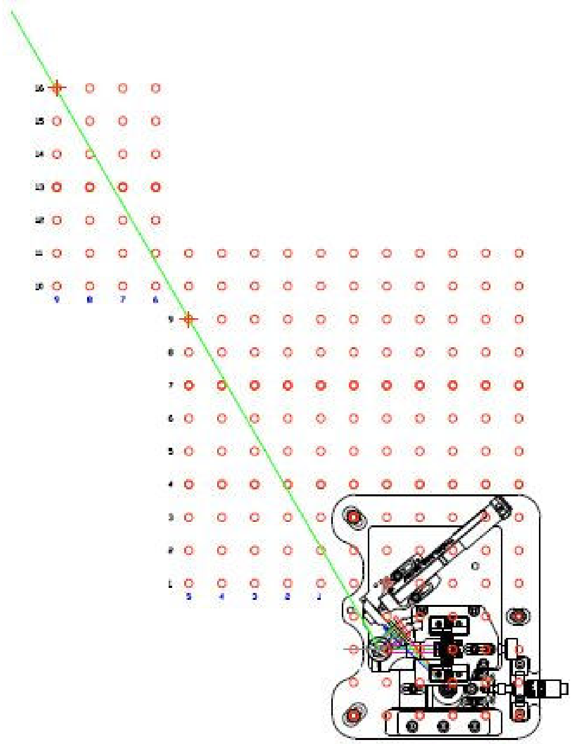


Figure 18 Imperial Breadboard Used to Align Littman Grating

Metric Breadboards

A trick to align the grating properly is to mount the Tunable Laser Kit on to a breadboard and view the zero order diffraction from the grating. When the front plane of the grating is in line with the pivot point, the zero order diffraction will point directly between two holes. Please see Figure 20 for the location of the intersecting point. A viewing card can be placed between the two holes to align the grating.

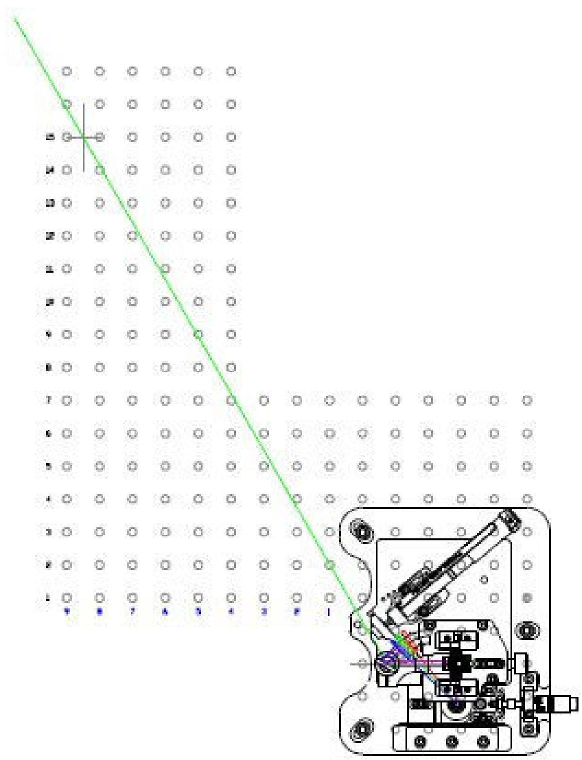


Figure 19 Metric Breadboard Used to Align Littman Grating

Step 14: In the body of the pivot bracket, there is a flexure (hinge) that adjusts the tilt of the mirror (Figure 21). As you adjust the fine setscrew, the coupling efficiency for the diffracted light returning from the mirror back into the gain chip will vary. Back off the motor and with a finger on the end of the grating arm, swing the arm back and forth while observing the output from the fiber* (on a sensor card or equivalent) – also while adjusting the fine setscrew. At some point a large increase in output intensity should indicate lasing action. If this is not observed then it may simply mean that we are adjusting in the wrong direction and the flexure hinge needs to be closed slightly rather than opened. In this case, slacken off the fine set screw and swing the grating arm again while this time adjusting the M4 'tensioning' bolt. When very close to the optimal flexure angle, an alternating sequence of optimizing the laser intensity by adjusting the fine set screw and then tensioning the M4 bolt should lead to a strong output, coupled with a setting for good overall stability. In this alternating sequence adjustment of the fine setscrew should always be able to counteract the effect of the last adjustment of the tensioning bolt; the adjustment should stop just short of the point where this sequence starts to falter, as this is a sign that the tensioning is too much, and that slight distortion of the pivot bracket itself is beginning to occur.

** In the case of the TLK-L780M kit, a fiber is not available so the output that should be observed is the free space beam propagating along the direction of the zero order diffracted beam*

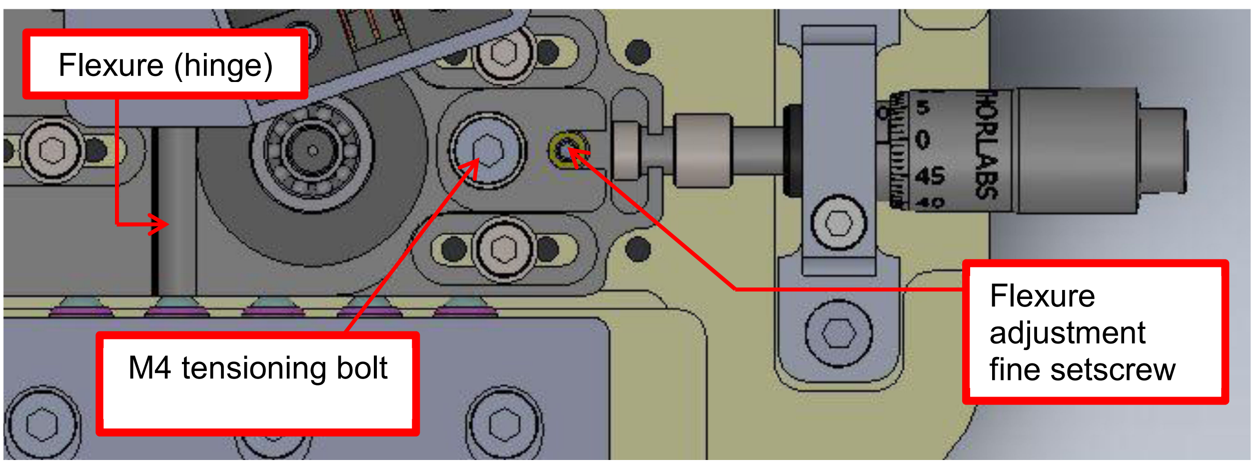


Figure 20 Flexure Adjustment

Step 15: When the laser is sweeping, the position of the pivot bracket can be driven to the left by turning the micrometer on the mode hop adjuster. Using an external monitoring method such as a display from a scanning Fabry Perot (SFP) interferometer, or a display of the required driving current for the laser installed in a feedback loop for a constant optical output power, the pivot point position can be finely adjusted to minimize the number of mode hops over any given sweep range. Again, the adjuster tip is a sliding fit over the barrel of the micrometer and so the adjuster is designed to push the pivot bracket only, not pull. so if the adjustment of the pivot point is taken through the optimum position, it must be returned back through this point by applying some finger pressure to the pivot bracket to ease this back to the right hand side as the adjusting micrometer is gently backed off. When you have optimized the position to minimize the number of mode hops, tighten the three mounting screws for the pivot bracket and retract the adjuster slightly so that there is no contact pressure on the ball in the pivot bracket. This reduces the risk of accidentally adjusting the pivot after optimization.

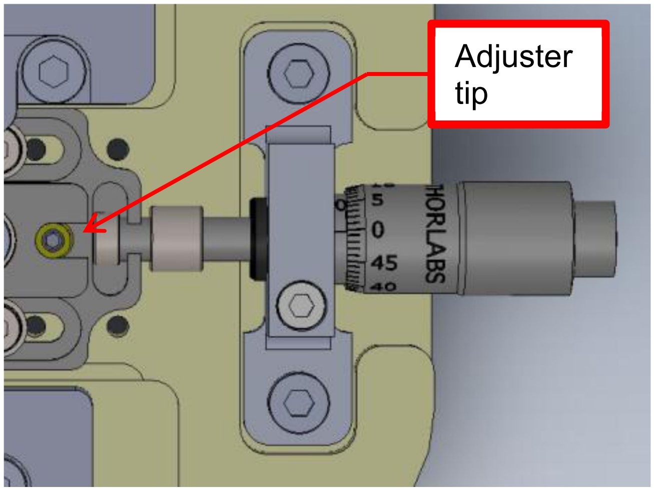


Figure 21 Mode Hop Adjuster Tip

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

It should always be noted that the performance of external cavity lasers is extremely sensitive to small changes in the geometry of the cavity and so the best results will be obtained when care is taken to adjust the pivot bracket and lens holder flexure mount with an appropriate level of tension. Practice, patience and experienced gained are invaluable in this respect.

3.3. Performance optimization for laser kits

Thorlabs' TLK series Tunable Laser kits can be purchased as a fully assembled kit or the customer can purchase any of the various parts and accessories to incorporate into his or her own design. When the kit is supplied fully assembled, it is characterized for basic performance and is shipped in this state. Test data is supplied with each assembled device, and although the laser kit is normally found to be lasing on arrival at the customer's site it is expected that the kit will require some retuning to obtain the performance that is shown in the supplied test data. Re-optimization may also be needed over time when being operated in a standard lab environment (usually weeks).

The following information describes a set up that has been found useful for setting up the tunable laser kit and characterizing the performance. In this set up, shown in Figure 23, the TLK laser kit output fiber is ideally connected to diagnostic equipment using two fiber optic splitters. The splitters should ideally have single mode operation over the wavelength range expected from the kit but the exact splitting ratio may be different to that shown in the illustration and should be chosen to suit the equipment being used; in particular it is the user's responsibility not to exceed optical power levels that could damage the diagnostic equipment.

- The optical spectrum analyzer (OSA) is used to measure lasing wavelength as the motor of the TLK kit is moved to tune across the lasing spectrum. After 'homing' the motor, calibration of wavelength vs motor position can be made using the OSA.

- Laser light is also examined using a scanning Fabry Perot etalon (SFP), where the detected transmission is shown on an oscilloscope. This display should be used in conjunction with a power meter to set up the strongest single mode lasing condition. The SFP device will usually have much better resolution and allows a more 'real-time' spectral diagnosis than the OSA, where scanning and display updating can take several seconds. To smooth out mode hops in the spectral region of interest, the motor position (tuning) should be driven slowly back and forth while translating the mode hop adjuster and adjusting the cavity alignment so that the modes sweeping across the oscilloscope display from the SFP do so in a continuously smooth fashion.

- For accurate measurement of the output power, the output fiber from the kit should be connected directly in to a calibrated detector head / power meter.

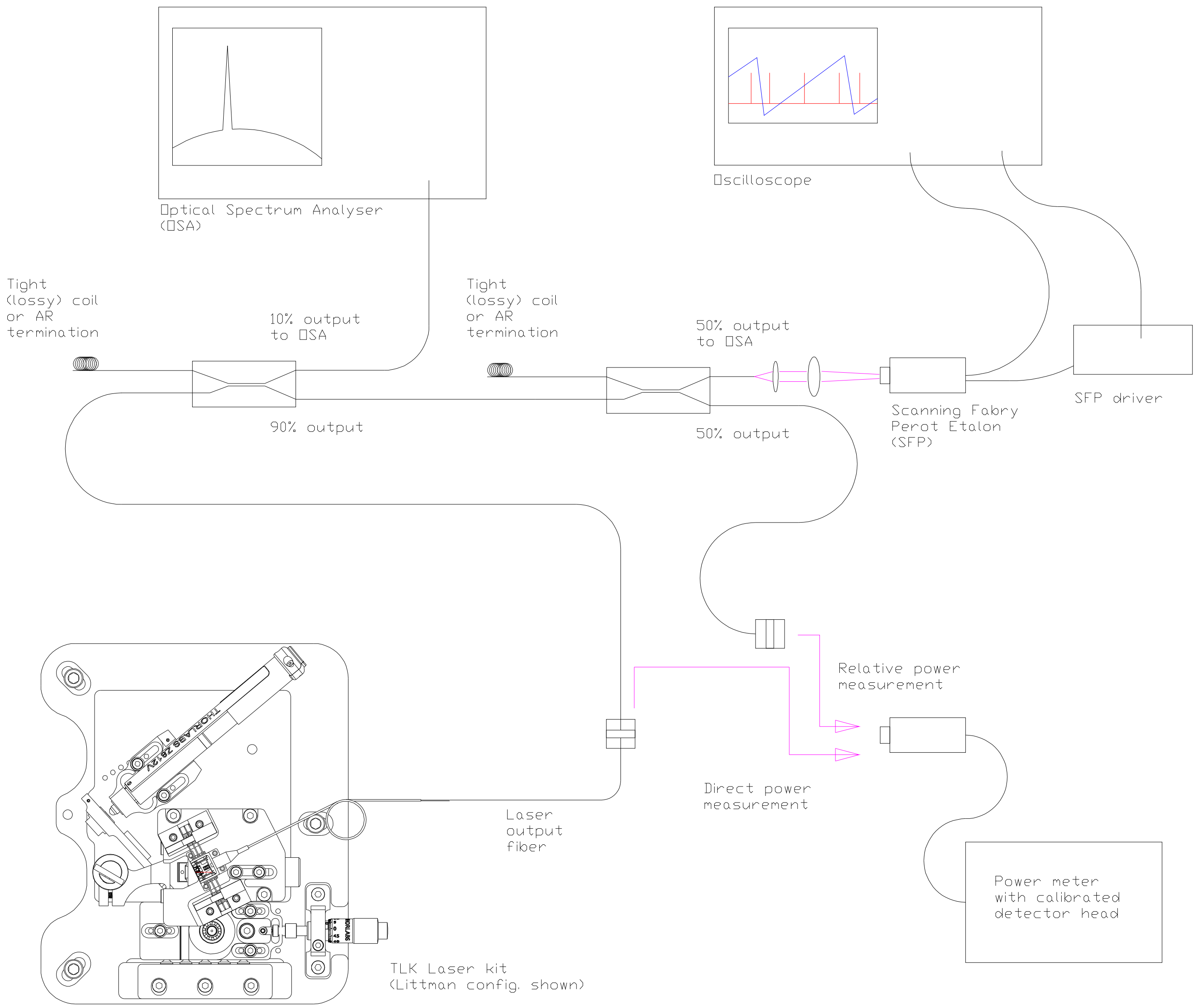


Figure 22 Suggested setup for laser kit optimization

Before making any fine adjustments for re-optimization it makes sense to move the motor to a position in the middle of the wavelength range over which the kit will be required to operate - that way the adjustments that you make will apply directly to these wavelengths of interest.

The only two adjustments that will affect lasing in the littman configuration are changes in the collimation for the beam in the external cavity, and the tilt of the reflecting mirror surface since both of these determine the level for coupling of light back into the chip. For the littrow configuration we need to consider changes in the collimation, and the tilt of the grating arm. It's unlikely that any of these conditions will have changed much during shipment of an assembled kit, or over a few weeks in the laboratory so the adjustments that need to be made should be very small. Tilt is always done via the small setscrew and for stability the set screw adjustment is 'resisted' by the M4 tensioning bolt (see these bolts identified in Step 13 and 14 of this user manual). However we have to be careful not to over-adjust the set screw OR adjust it when too much tension exists from the opposing M4 screw since this could lead to damage of the seating beneath the setscrew. When aligning a kit from scratch the M4 bolt would be made completely loose before adjusting the setscrew but for a kit 'as-shipped', lasing should already be evident and the adjustments are going to be so small (probably less than 20deg rotation in the set screw) and in this case the M4 tensioning bolt can be left alone. For initial adjustment hold a phosphor card up against the output fiber (1) and observe this as the setscrew is slowly turned to adjust the mirror tilt (use small rotational movements CW or ACW and for good control this is best done with a long stemmed hex key). You will see the brightness of the spot on the card increase and decrease as you pass though the condition where feedback is able to cause lasing. See note (1) at the foot of this section for remarks concerning the TLK-1950R, and TLK-L1900M kits.

From this highly visual indicator you can then move to a more quantitative measurement by plugging the fiber output into a calibrated power meter while simultaneously looking at the output mode using a scanning fabry perot device to look specifically for single mode operation (you can't rely on power alone to tell you that you have good single mode operation since a multimode output condition can often give high optical output power). To accurately measure the output wavelength, use either the optical spectrum analyzer or a wavemeter. Refer to the schematic diagram for recommended set-up that incorporates the recommended diagnostic equipment.

If you are not happy with the output power level you may also need to optimize beam collimation, and here are some further tips:

The collimation adjustment is the hardest adjustment to master and this is where the technique has to be learned via practice. Optimization of the collimation requires adjustment of the lens to chip distance to within +/- a few microns and when adjusted it has to be quite stable, so a fairly stiff flexure mount design is used for this adjustment. The adjustment is by tiny 'tweaks' of the adjuster knob. It is much easier to make these fine movements as a counter clockwise tweak from a position where the knob is just too tightly adjusted (the term 'tweak' rather than rotation is used because the movement should be almost imperceptible when close to the peak output). To quantify the movement, the screw pitch on this adjuster is 100 threads per inch, so a 1um change in the lens to chip distance requires only a 1.4deg tweak of the knob. When making these small tweaks, the whole mechanical assembly will flex very slightly so it's therefore necessary to let go of the knob between tweaks to observe the result. We emphasize the importance of technique in making this collimation adjustment because this is where most inexperienced users have problems – the knob looks like it should be 'rotated' – but the rotations are so very small that they have to be considered as tiny tweaks. The adjustment of the collimation has a small effect on the exact alignment of the returning external cavity beam so while making collimation adjustments, slight adjustments to the mirror/grating tilt alignment via the setscrew should also be explored.

(1) Note that for the free space TLK-L780M laser kit, no fiber is currently provided and so adjustments of this laser should be made by coupling the output beam (zero order from the grating) either first into a fiber and then observing the light output on a phosphor card, or by simply collecting the free space beam on a detector in order to optimize the power level. For the TLK-1950R, and TLK-L1900M kits a power meter or an appropriately sensitive beam profiler is also usually required since phosphor cards are not readily available at these longer wavelengths.

3.4. Littrow Configuration

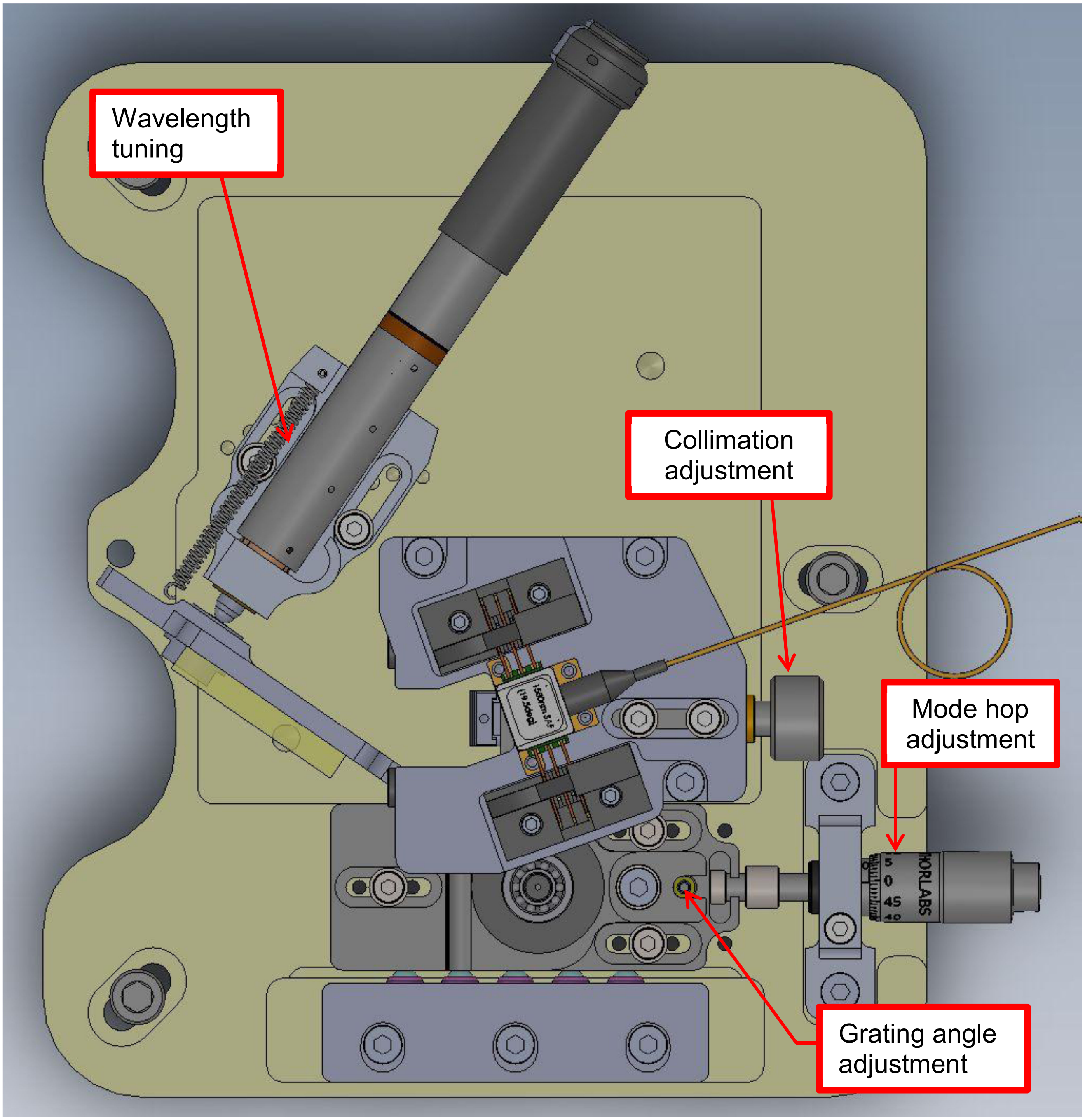


Figure 23 Littrow Configuration Tuning Adjustment

3.5. Littman Configuration

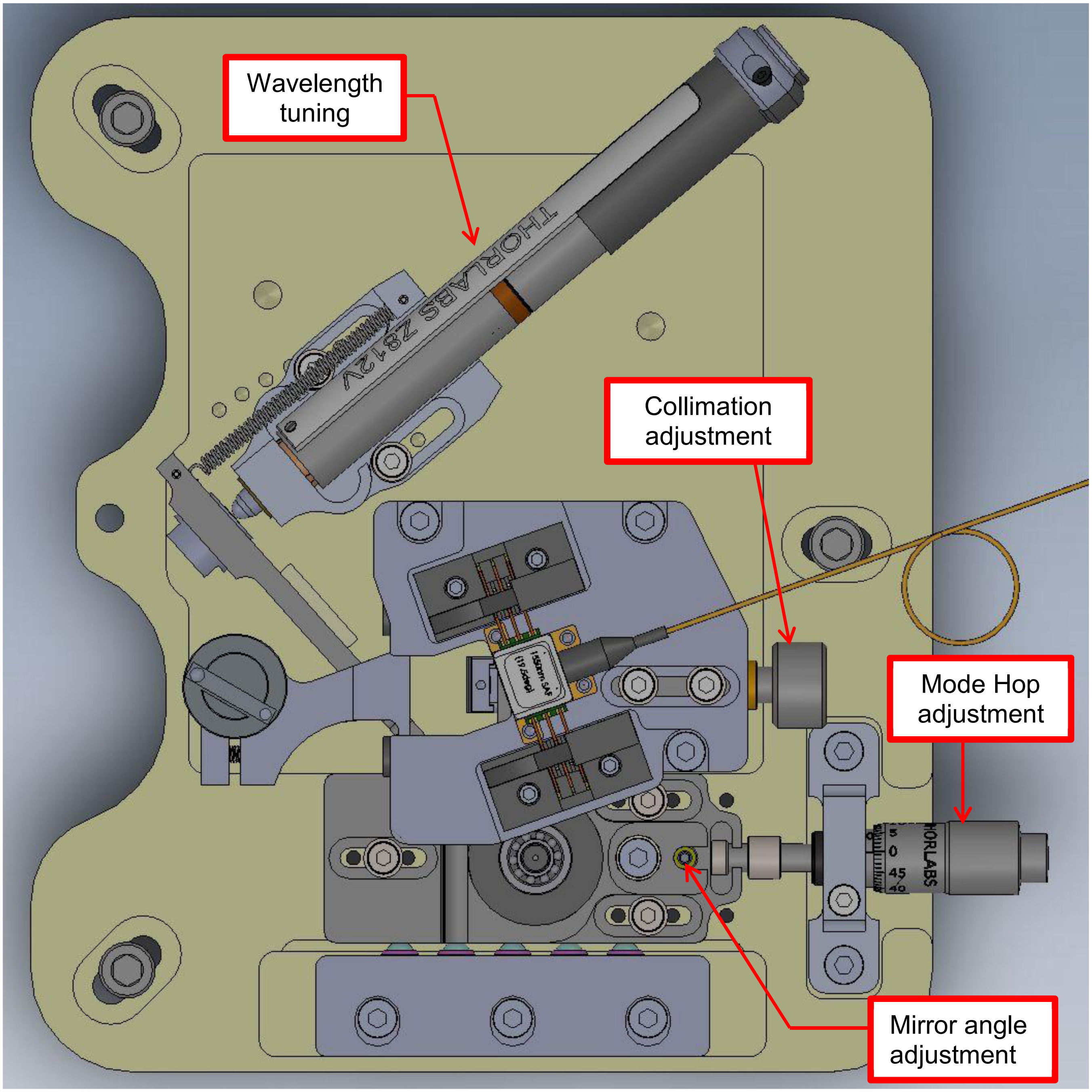


Figure 24 Littman Configuration Tuning Adjustment

Chapter 4 Operation

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

4.1. Laser Diode and TEC Controllers

Connect a TEC controller to the breakout box and set the desired temperature (See 11.10 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. We recommend setting the temperature to 25 °C.

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.

4.2. 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.

4.3. 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.

Chapter 5 Replacement Components

5.1. Littrow Configuration

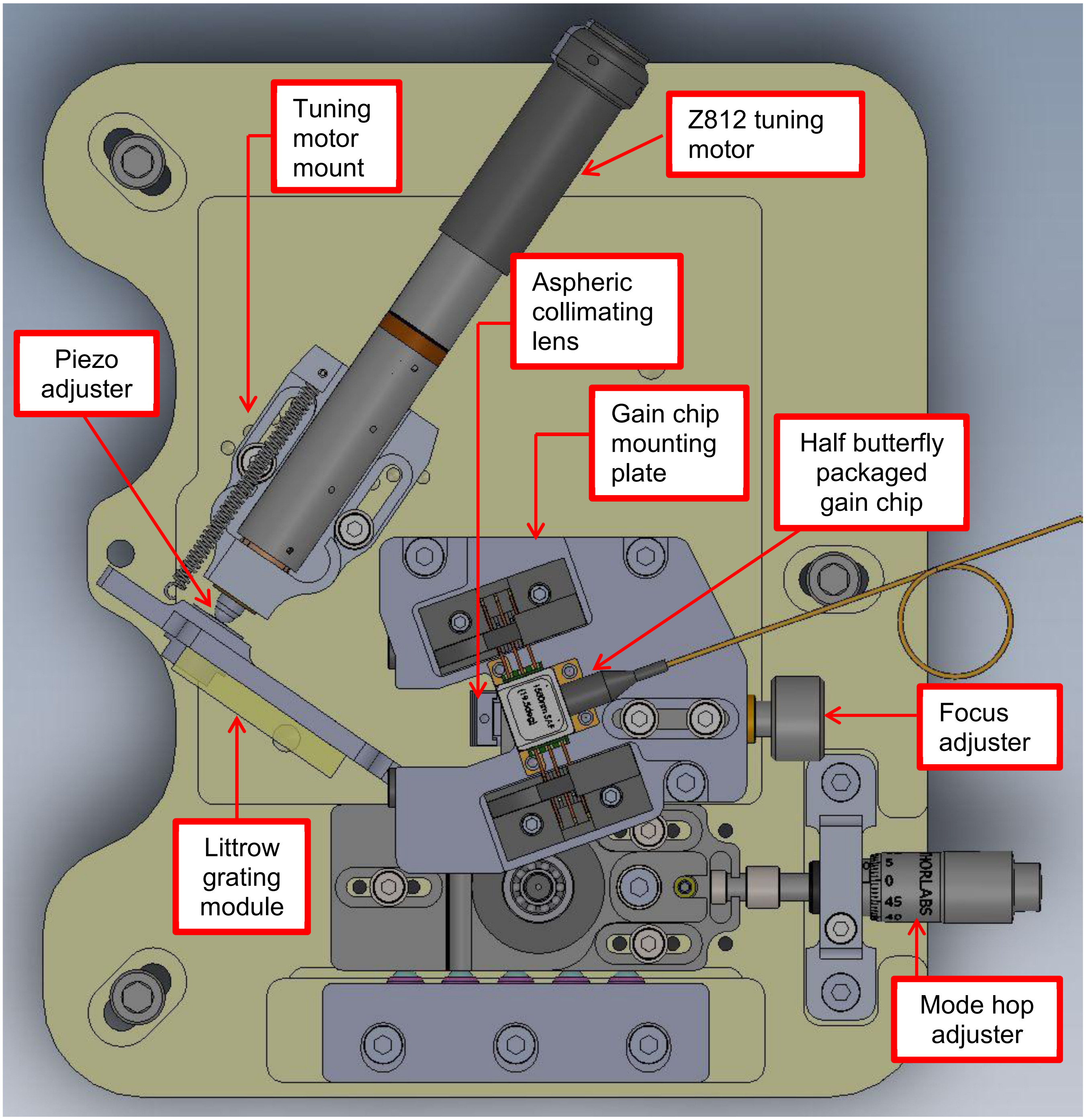


Figure 25 Replacement Components and Accessories for Littrow Configuration

5.2. Littman Configuration

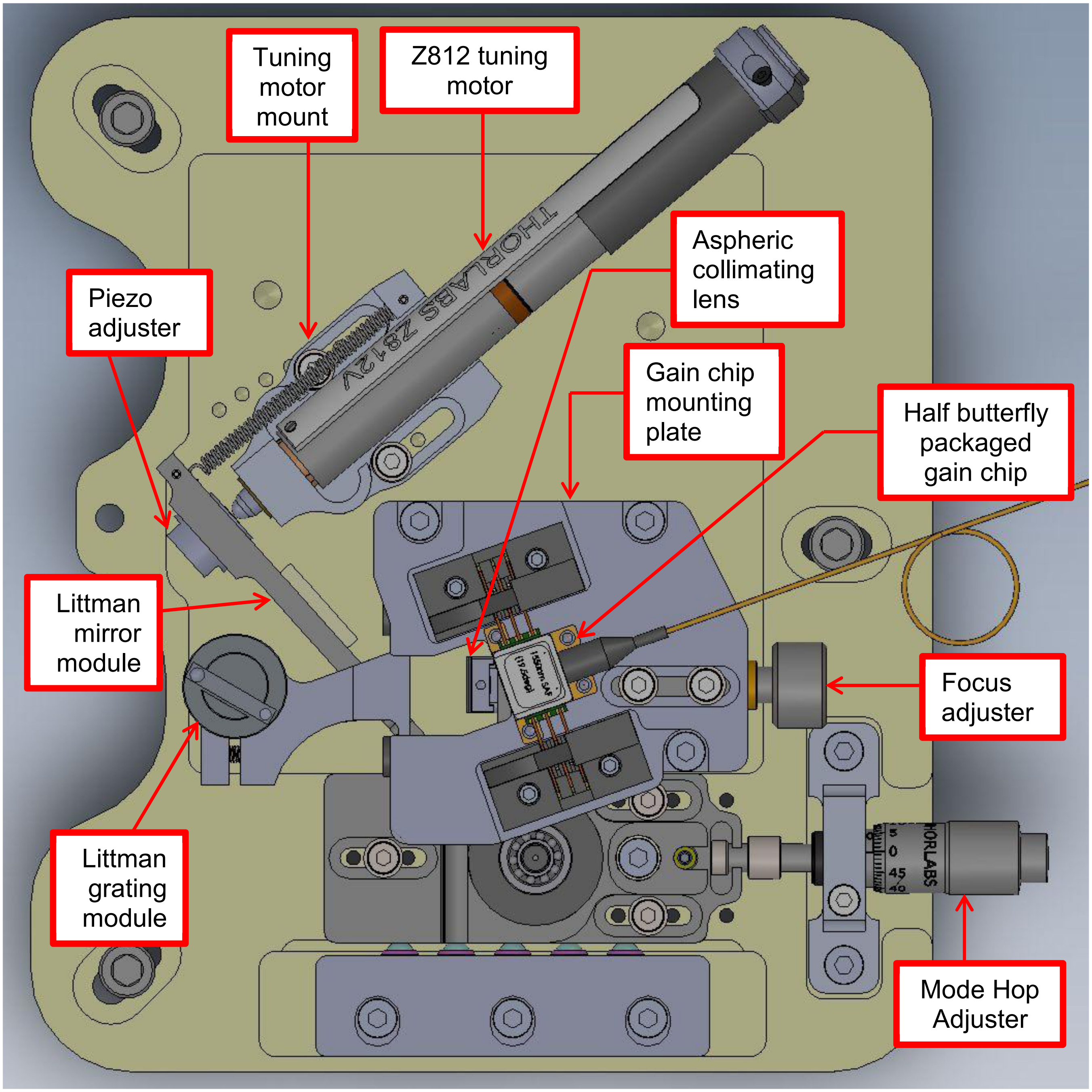


Figure 26 Replacement Components and Accessories for Littman Configuration

Chapter 6 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).

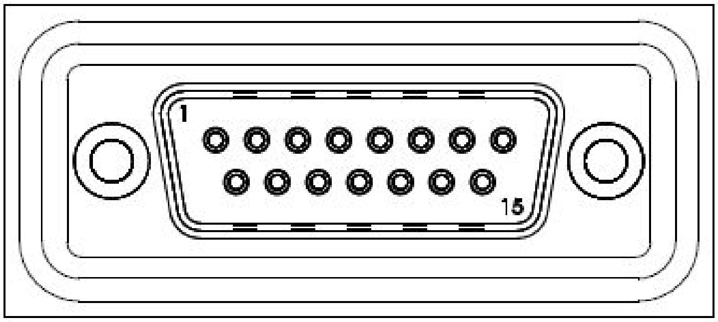


Figure 27 Male DB15 Connector Front View

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	-	-

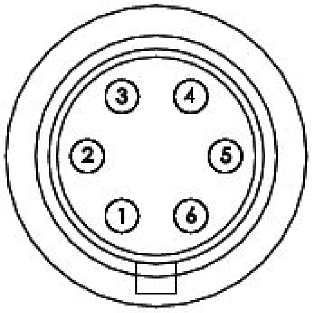
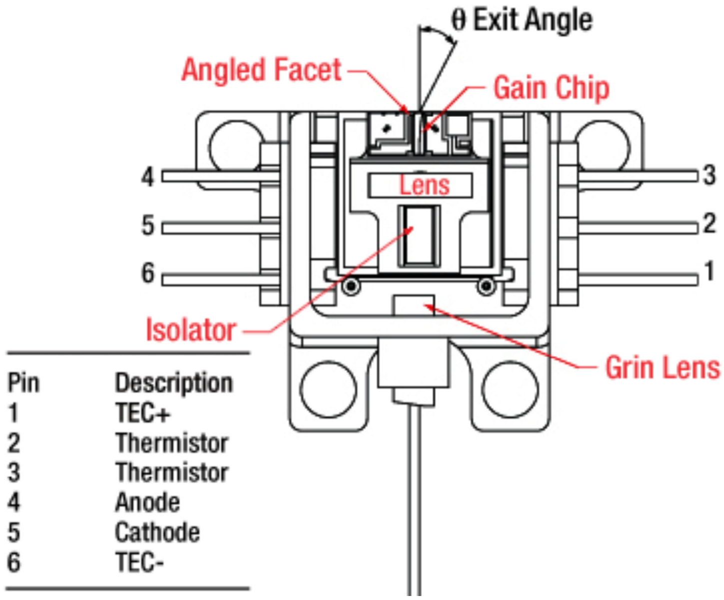


Figure 28 Hirose HRA10A-7R-6S Front View, for TC200 Heater

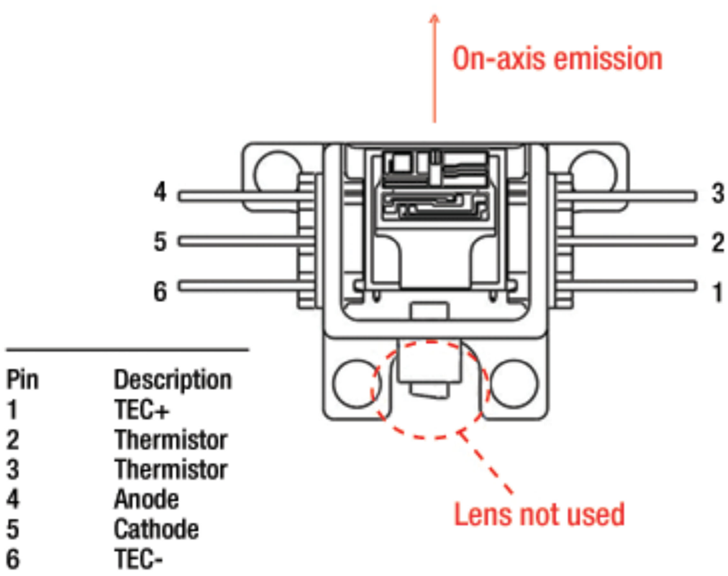
Male DB15 Front View			
Pin	**Use**	**Pin**	**Use**
1	Heater (+)	4	Sensor (+)
2	Heater (GND)	5	Sensor (GND)
3	NC	6	NC

Chapter 7 Half Butterfly Package Pin Outs



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

Figure 29 Pigtailed Half Butterfly Gain Chip



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

Figure 30 Free-Space Half Butterfly Gain Chip

Chapter 8 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.

Chapter 9 Specifications (Operate at 25°C)

9.1. TLK-L780M

	Min	Typ	Max
Center Wavelength	760 nm	770 nm	780 nm
Tuning Range (10 dB)	15 nm	30 nm	-
Peak Power	15 mW	50 mW	-
Wavelength Tuning Resolution	2 pm	-	-
Tuning Speed (using Z812)	-	-	17 nm/s
Linewidth	-	100 kHz	130 kHz
Side Mode Supression Ratio	30 dB	45 dB	-
Polarization Extinction Ratio	-	17 dB	-
Power Stability (30 s)*	1%	-	-
Power Stability (24 hr)*	10%	-	-
Wavelength Stability (30 s)*	-	-	4 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.

9.2. TLK-L1050M

	Min	Typ	Max
Center Wavelength	1040 nm	1050 nm	1060 nm
Tuning Range (10 dB)	45 nm	60 nm	-
Peak Power	5 mW	8 mW	-
Wavelength Tuning Resolution	2 pm	-	-
Tuning Speed (using Z812)	-	-	23 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)*	-	-	4 pm
Wavelength Stability (24 hr)*	-	-	50 pm
Operating Current	-	120 mA	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.

9.3. TLK-L1220R

	Min	Typ	Max
Center Wavelength	1200 nm	1220 nm	1240 nm
Tuning Range (10 dB)	80 nm	90 nm	-
Peak Power	30 mW	40 mW	-
Wavelength Tuning Resolution	2.5 pm	-	-
Tuning Speed (using Z812)	-	-	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)*	-	-	4 pm
Wavelength Stability (24 hr)*	-	-	50 pm
Operating Current	-	200 mA	450 mA
Chip Forward Voltage	-	-	2 V
TEC Forward Current	-	-	2.1 A
TEC Forward Voltage	-	-	3.6 V
Fiber Output	1.0 m, HI1060, FC/APC		

*Measurements taken with laser operating in open loop.

9.4. TLK-L1300M

	Min	Typ	Max
Center Wavelength	1290 nm	1310 nm	1320 nm
Tuning Range (10 dB)	80 nm	100 nm	-
Peak Power	20 mW	45 mW	-
Wavelength Tuning Resolution	2.5 pm	-	-
Tuning Speed (using Z812)	-	-	29 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)*	-	-	4 pm
Wavelength Stability (24 hr)*	-	-	50 pm
Operating Current	-	400 mA	700 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.

9.5. TLK-L1300R

	Min	Typ	Max
Center Wavelength	1290 nm	1310 nm	1320 nm
Tuning Range (10 dB)	80 nm	100 nm	-
Peak Power	30 mW	50 mW	-
Wavelength Tuning Resolution	2 pm	-	-
Tuning Speed (using Z812)	-	-	20 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)*	-	-	4 pm
Wavelength Stability (24 hr)*	-	-	50 pm
Operating Current	-	400 mA	700 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.

9.6. TLK-L1450R

	Min	Typ	Max
Center Wavelength	1430 nm	1450 nm	1470 nm
Tuning Range (10 dB)	70 nm	120 nm	-
Peak Power	20 mW	40 mW	-
Wavelength Tuning Resolution	-	-	3 pm
Tuning Speed (using Z812)	-	-	33 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)*	-	-	4 pm
Wavelength Stability (24 hr)*	-	-	50 pm
Operating Current	-	400 mA	-
Chip Forward Voltage	-	-	2.0 V
TEC Forward Current	-	-	2.1 A
TEC Forward Voltage	-	-	3.6 V
Fiber Output	1.5 m, SMF-28e, FC/APC		

9.7. TLK-L1550M

	Min	Typ	Max
Center Wavelength	1530 nm	1550 nm	1570 nm
Tuning Range (10 dB)	70 nm	120 nm	-
Peak Power	15 mW	35 mW	-
Wavelength Tuning Resolution	3 pm	-	-
Tuning Speed (using Z812)	-	-	35 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)*	-	-	4 pm
Wavelength Stability (24 hr)*	-	-	50 pm
Operating Current	-	400 mA	600 mA
Chip Forward Voltage	-	-	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.

9.8. TLK-L1550R

	Min	Typ	Max
Center Wavelength	1530 nm	1550 nm	1570 nm
Tuning Range (10 dB)	70 nm	120 nm	-
Peak Power	20 mW	40 mW	-
Wavelength Tuning Resolution	3 pm	-	-
Tuning Speed (using Z812)	-	-	33 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)*	-	-	4 pm
Wavelength Stability (24 hr)*	-	-	50 pm
Operating Current	-	400 mA	600 mA
Chip Forward Voltage	-	-	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.

9.9. TLK-L1900M

	Min	Typ	Max
Center Wavelength	1870 nm	1900 nm	1930 nm
Tuning Range (10 dB)	90 nm	120 nm	-
Peak Power	4 mW	7 mW	-
Wavelength Tuning Resolution	4 pm	-	-
Tuning Speed (using Z812)	-	-	45 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)*	-	-	10 pm
Wavelength Stability (24 hr)*	-	-	100 pm
Operating Current	-	500 mA	700 mA
Chip Forward Voltage	-	-	2.0 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.

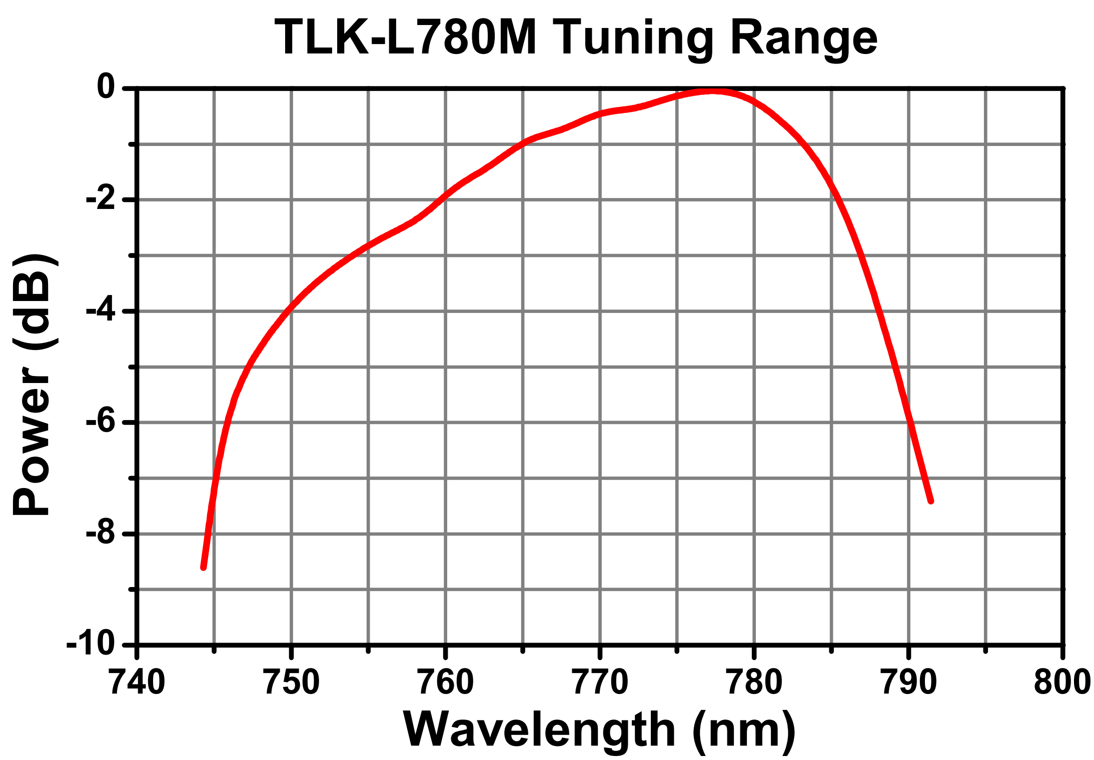
9.10. TLK-L1950R

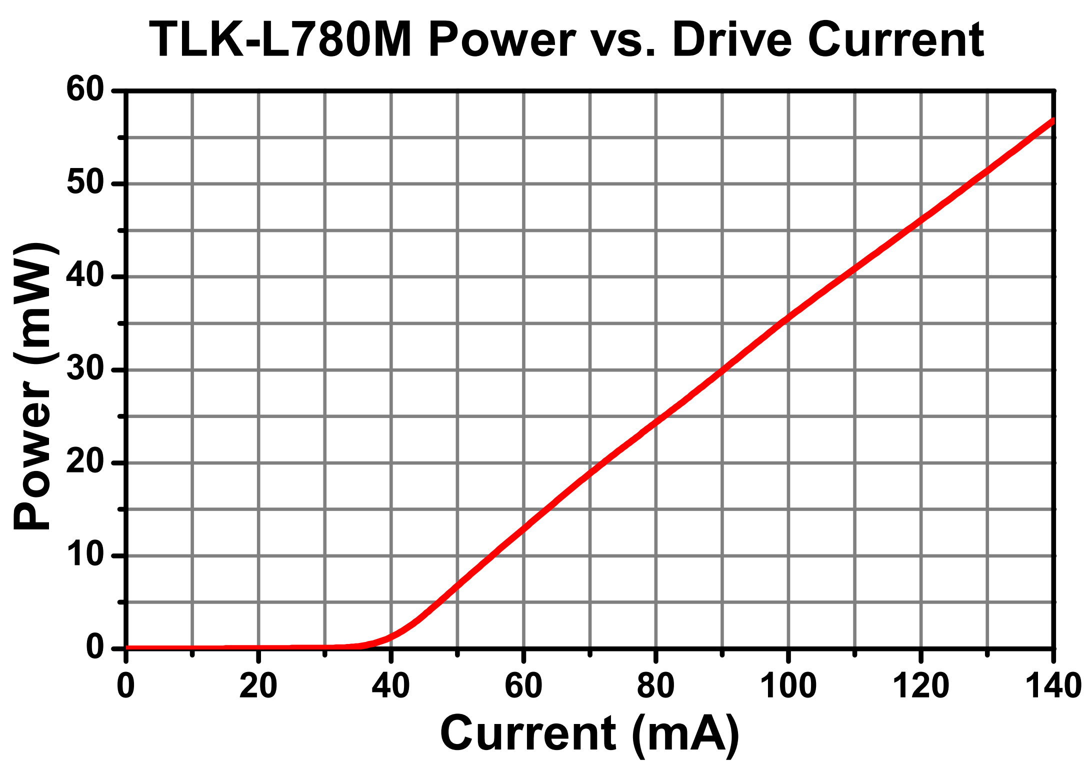
	Min	Typ	Max
Center Wavelength	1920 nm	1950 nm	1970 nm
Tuning Range (10 dB)	90 nm	120 nm	-
Peak Power	4 mW	7 mW	-
Wavelength Tuning Resolution	3 pm	-	-
Tuning Speed (using Z812)	-	-	32 nm/s
Linewidth	-	100 kHz	130 kHz
Side Mode Supression Ratio	30 dB	45 dB	-
Polarization Extinction Ratio	-	N/A	-
Power Stability (30 s)*	1%	-	-
Power Stability (24 hr)*	10%	-	-
Wavelength Stability (30 s)*	-	-	10 pm
Wavelength Stability (24 hr)*	-	-	100 pm
Operating Current	-	500 mA	700 mA
Chip Forward Voltage	-	-	2.0 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.

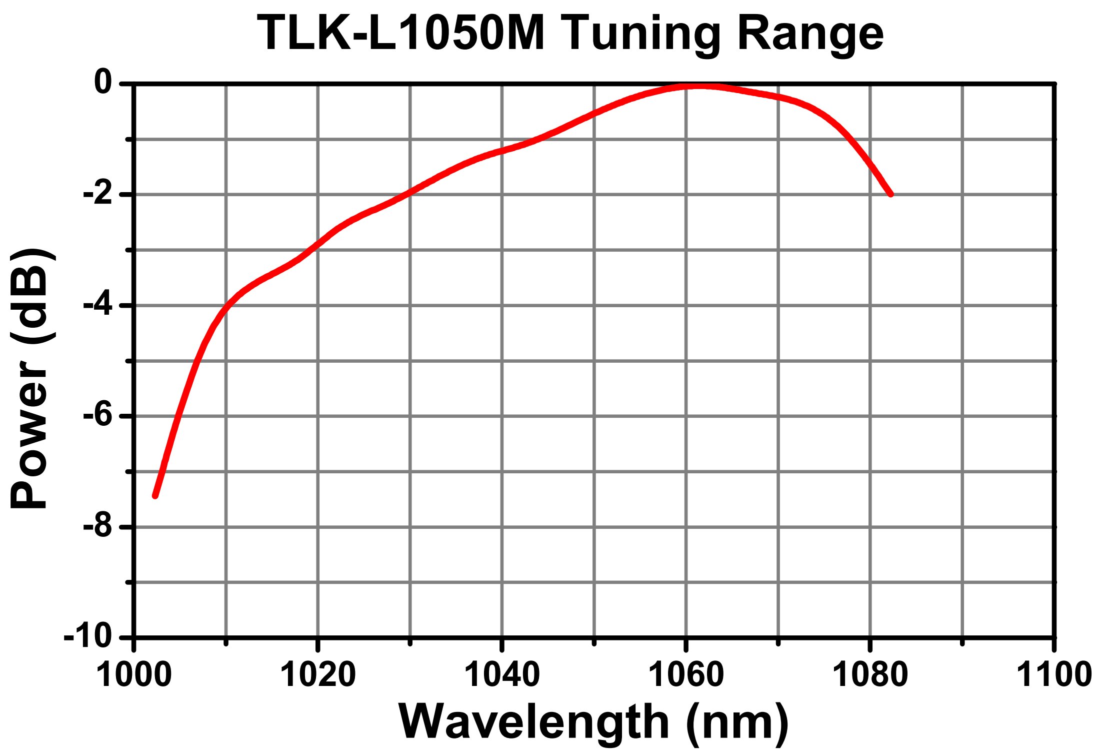
Chapter 10 Graphs

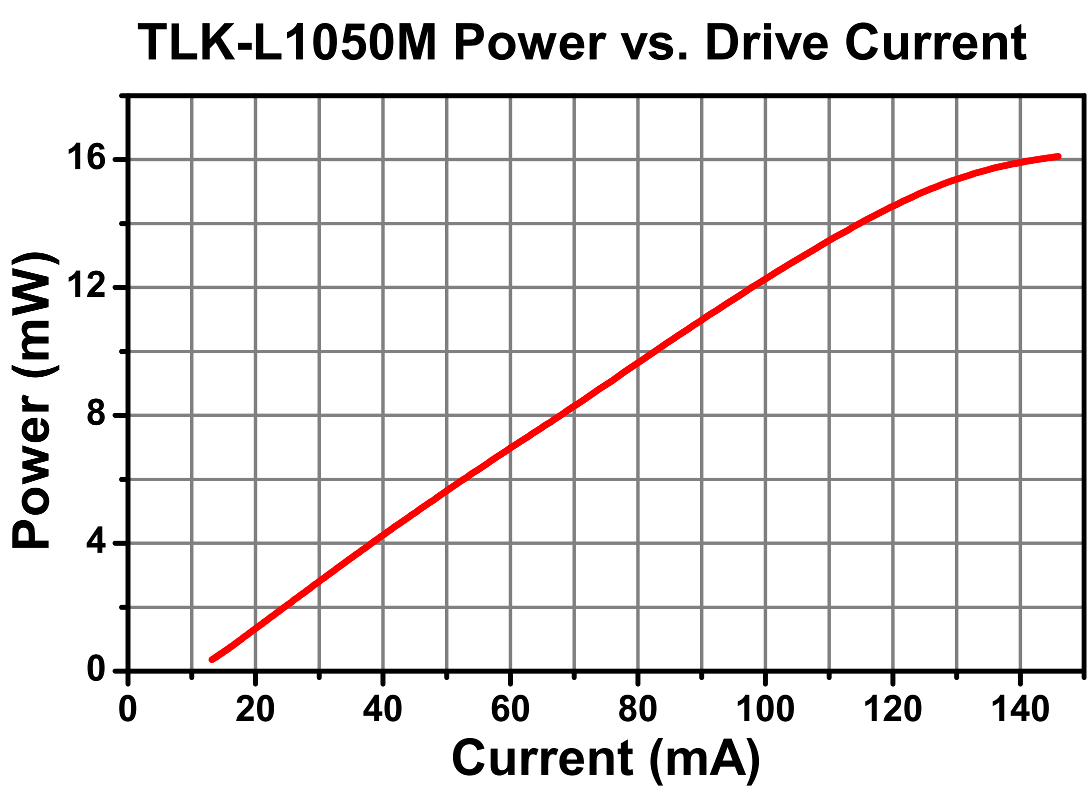
10.1. TLK-L780M



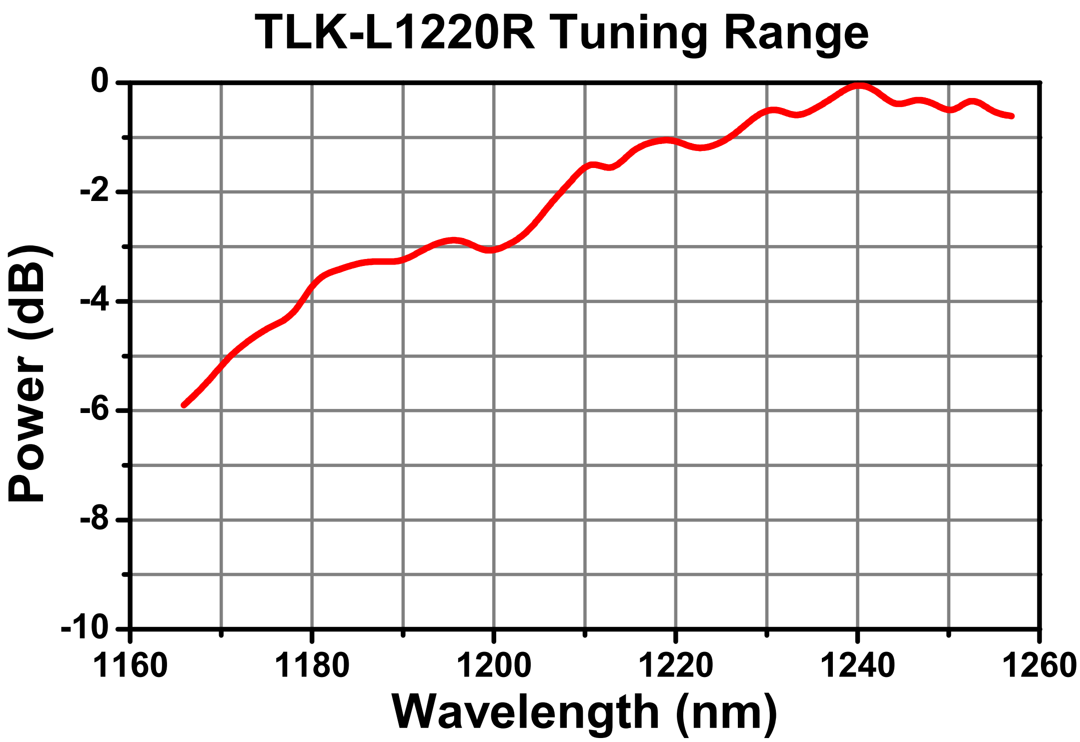


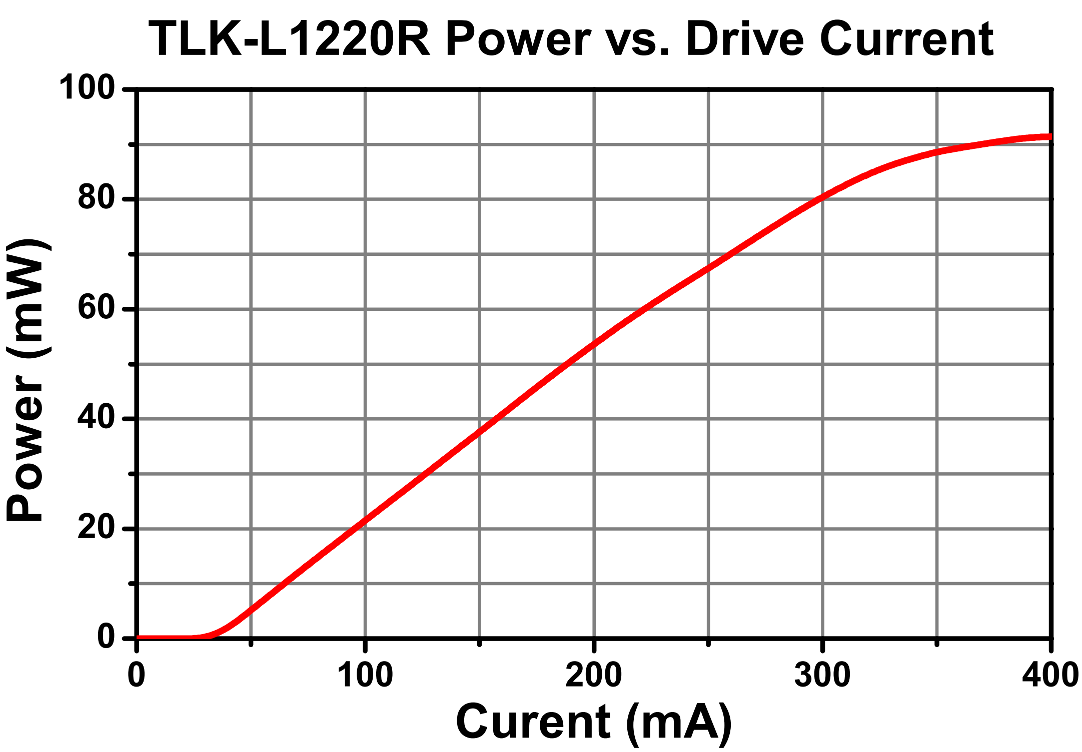
10.2. TLK-L1050M



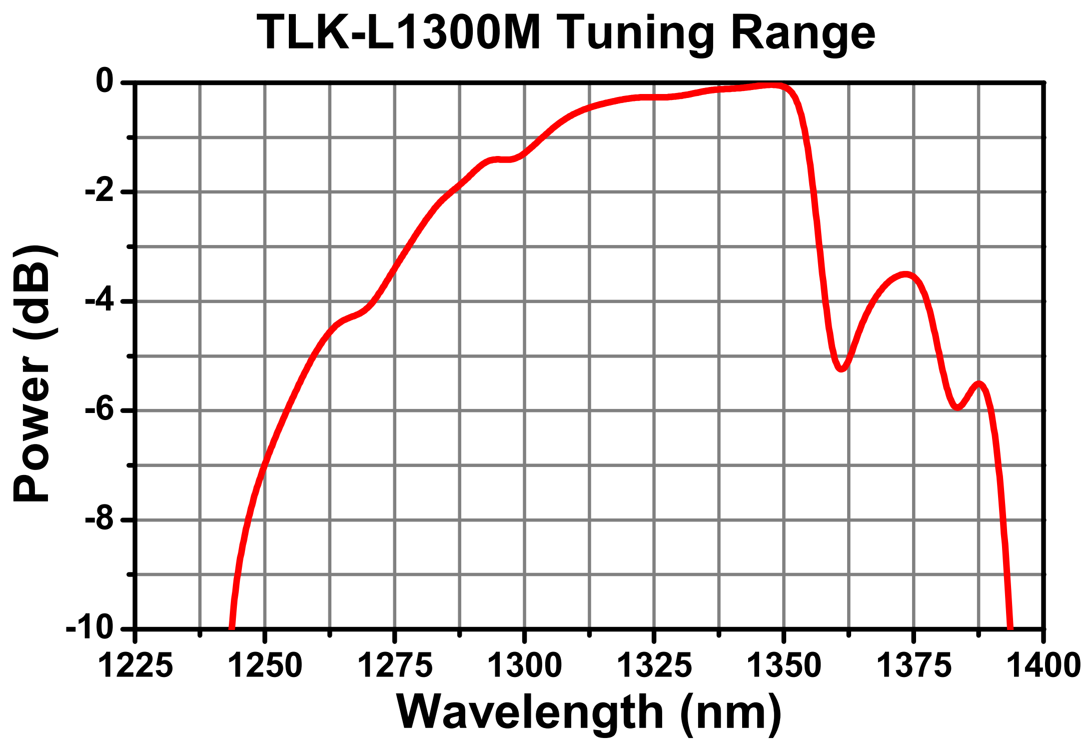


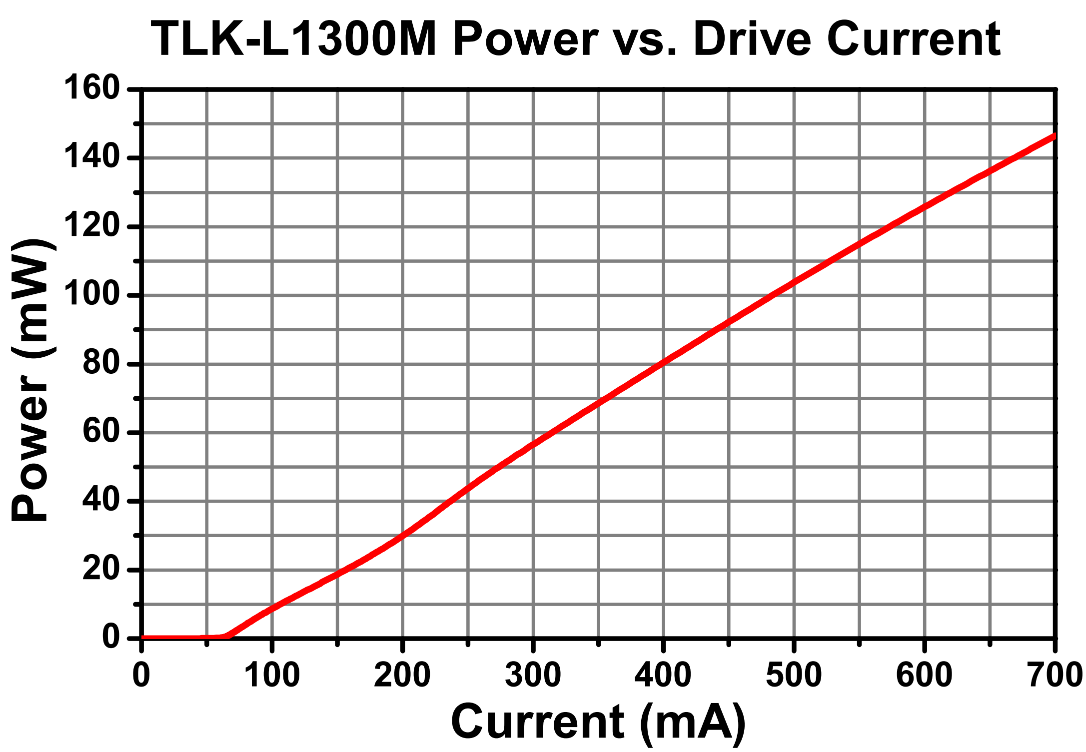
10.3. TLK-L1220R



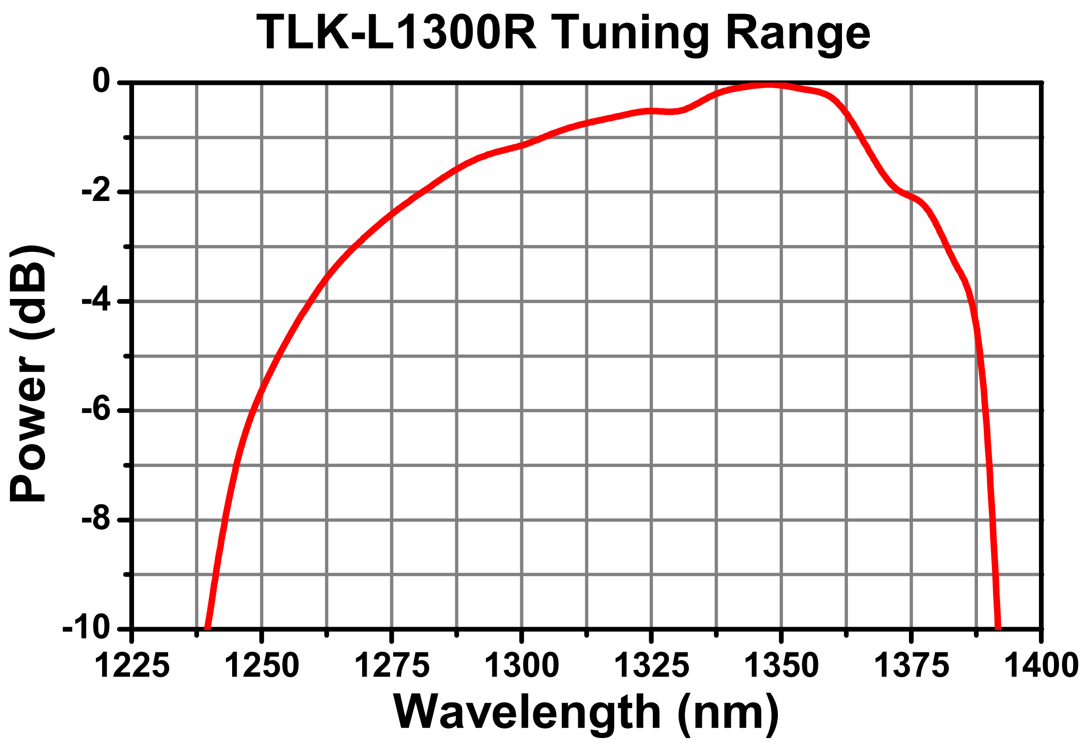


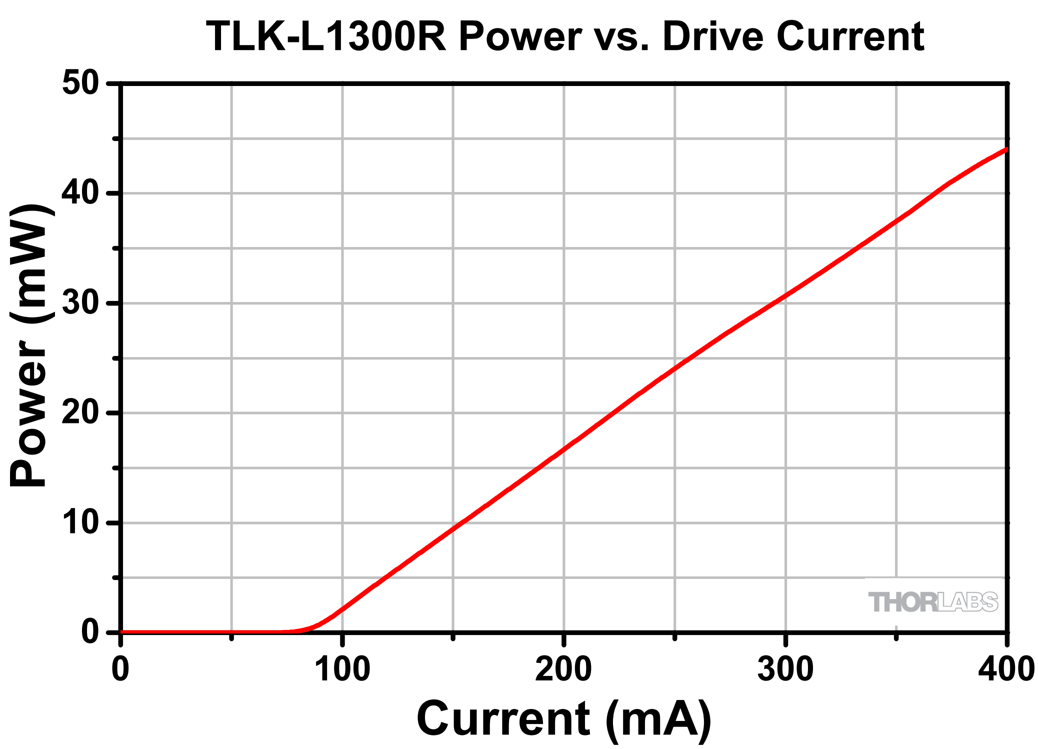
10.4. TLK-L1300M



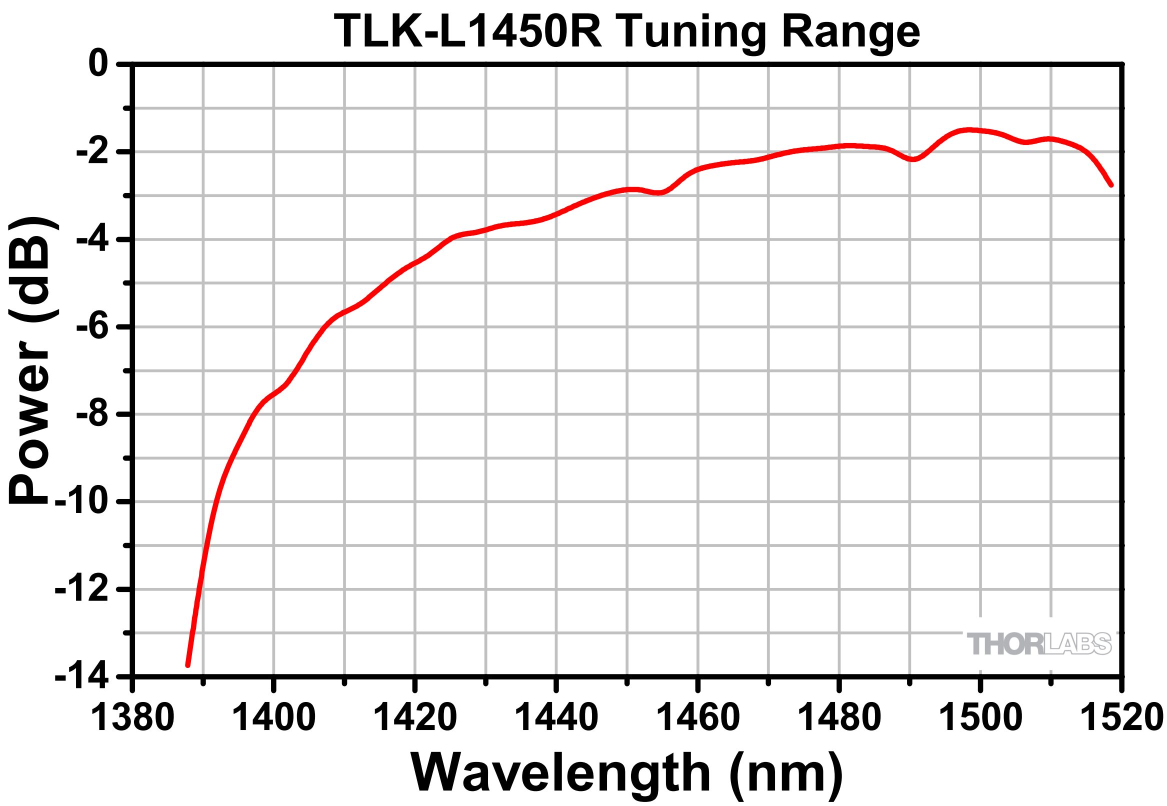


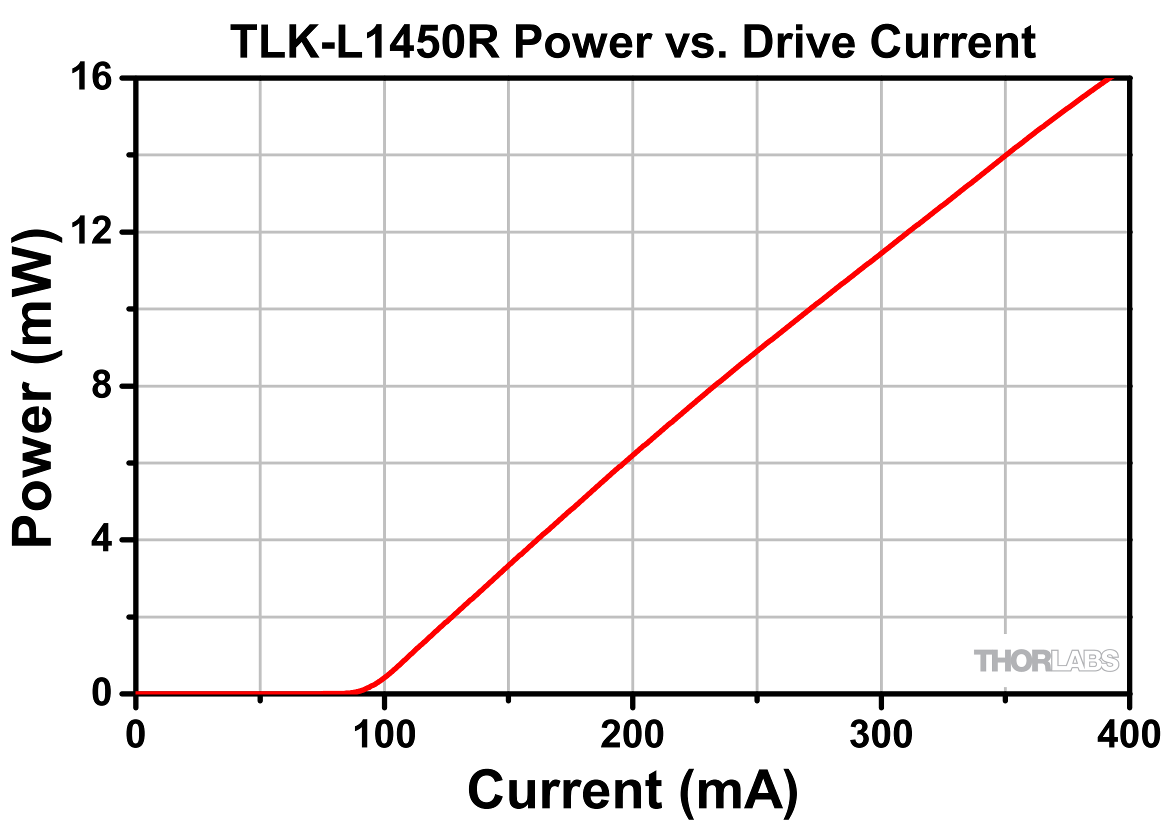
10.5. TLKL1300R



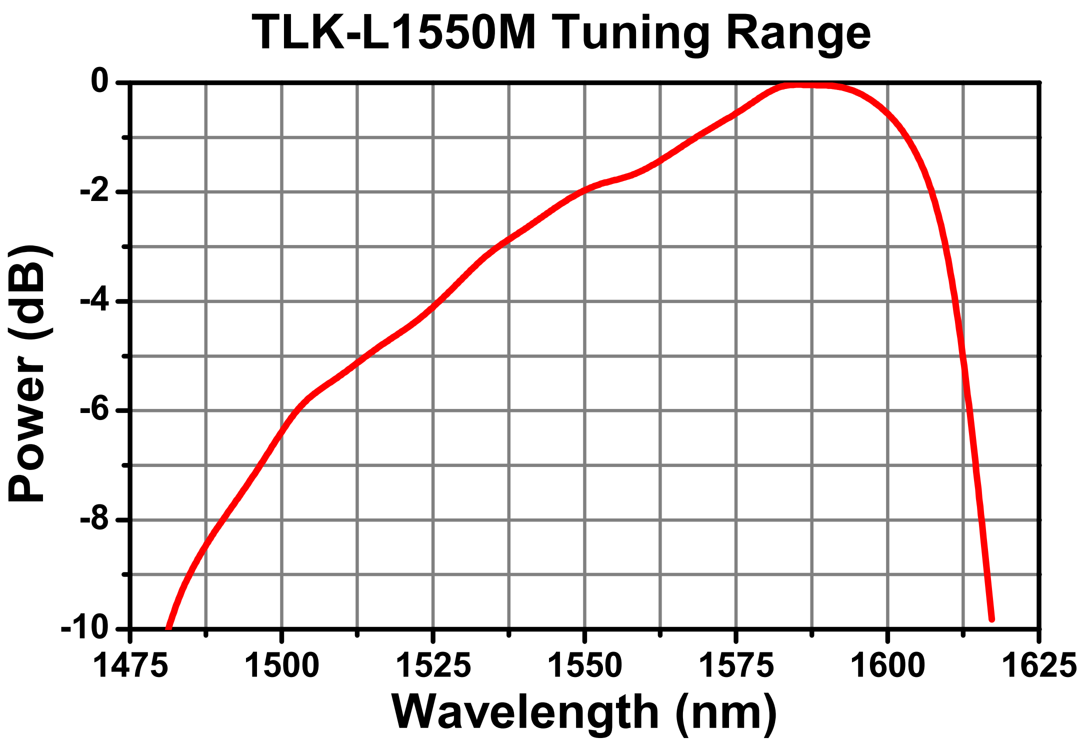


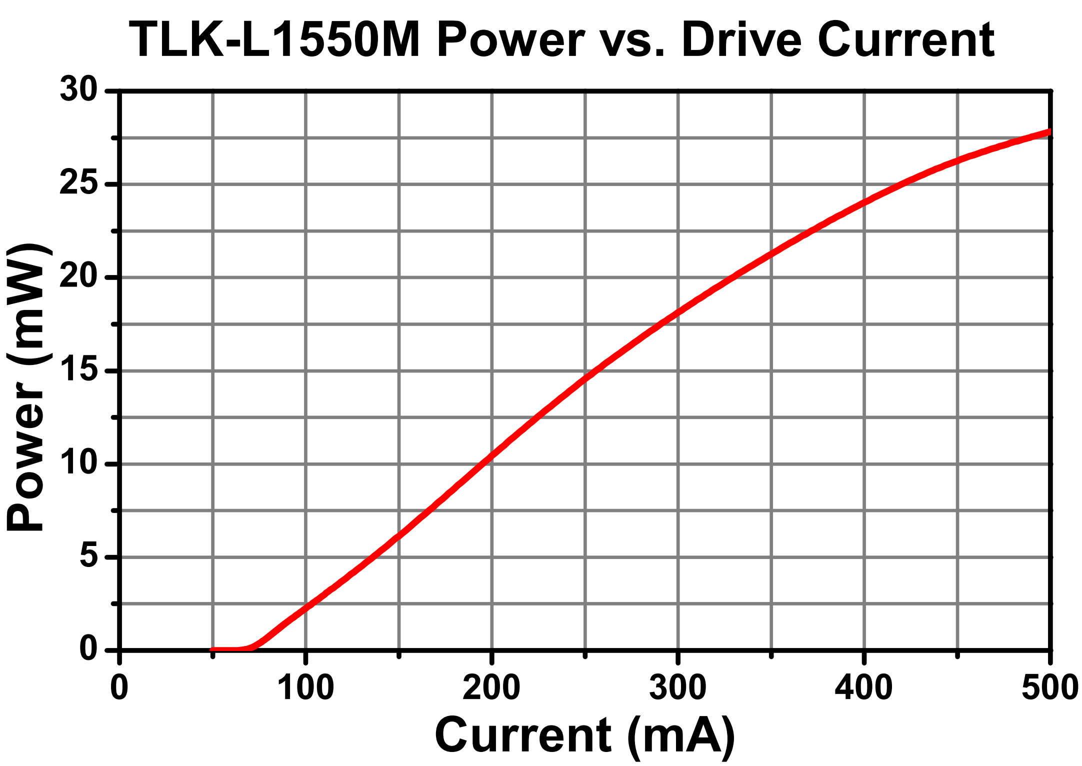
10.6. TLK-L1450R



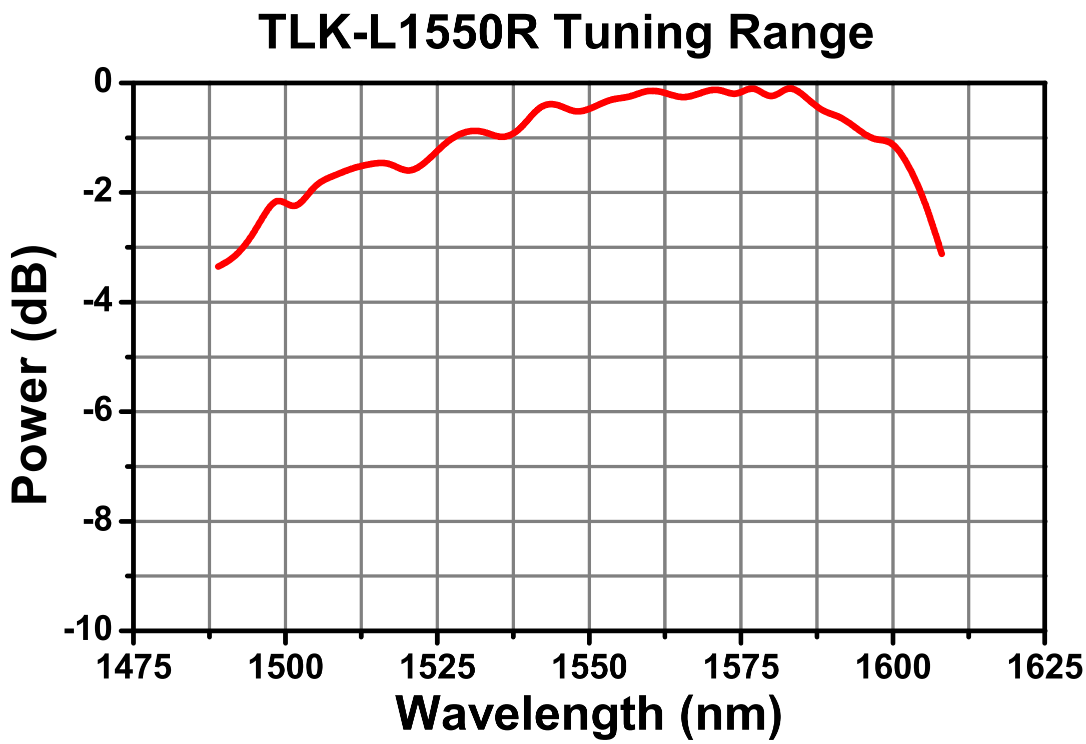


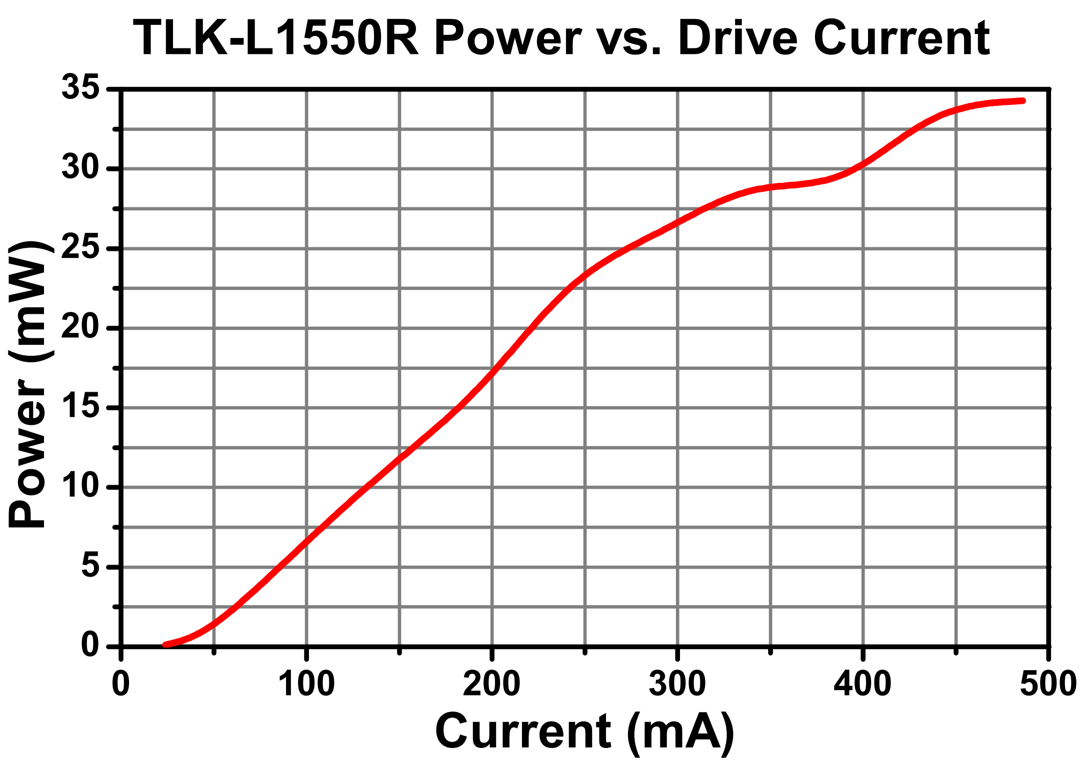
10.7. TLK-L1550M



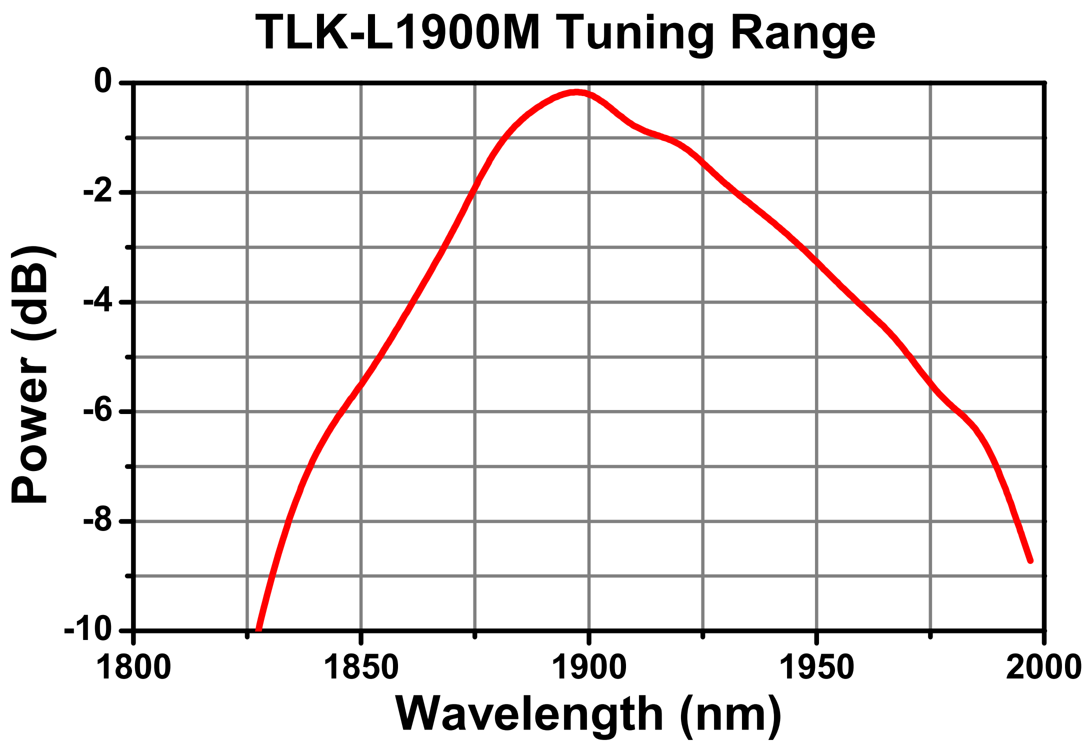


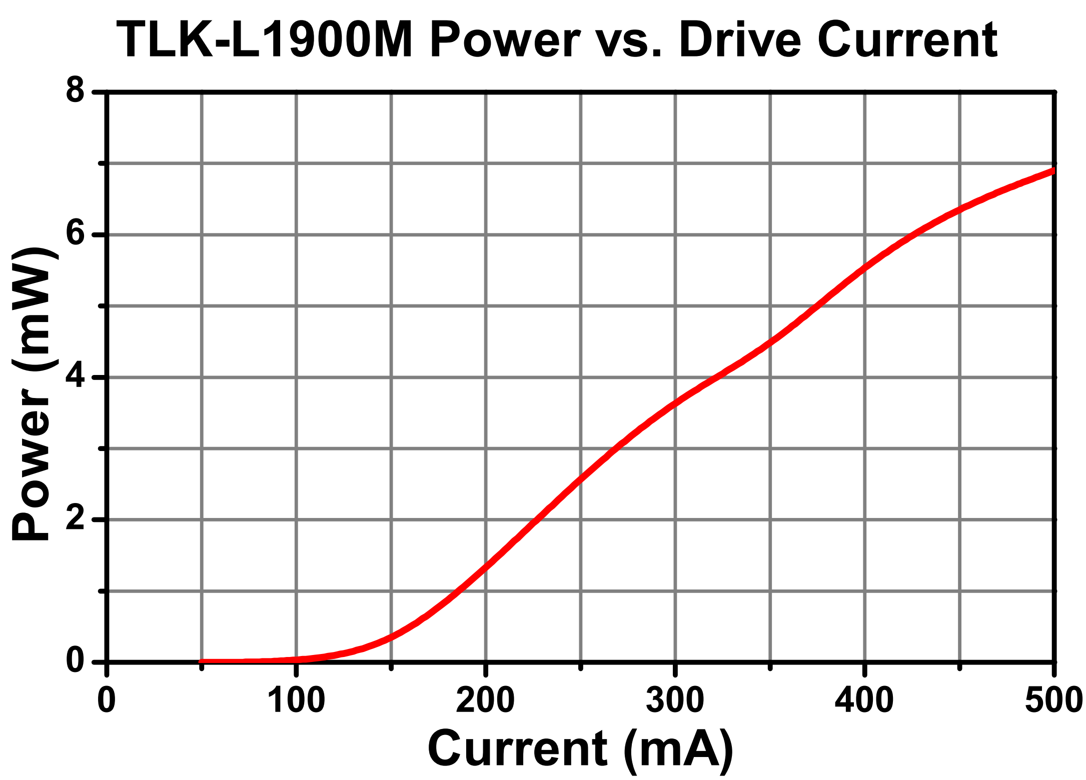
10.8. TLK-L1550R



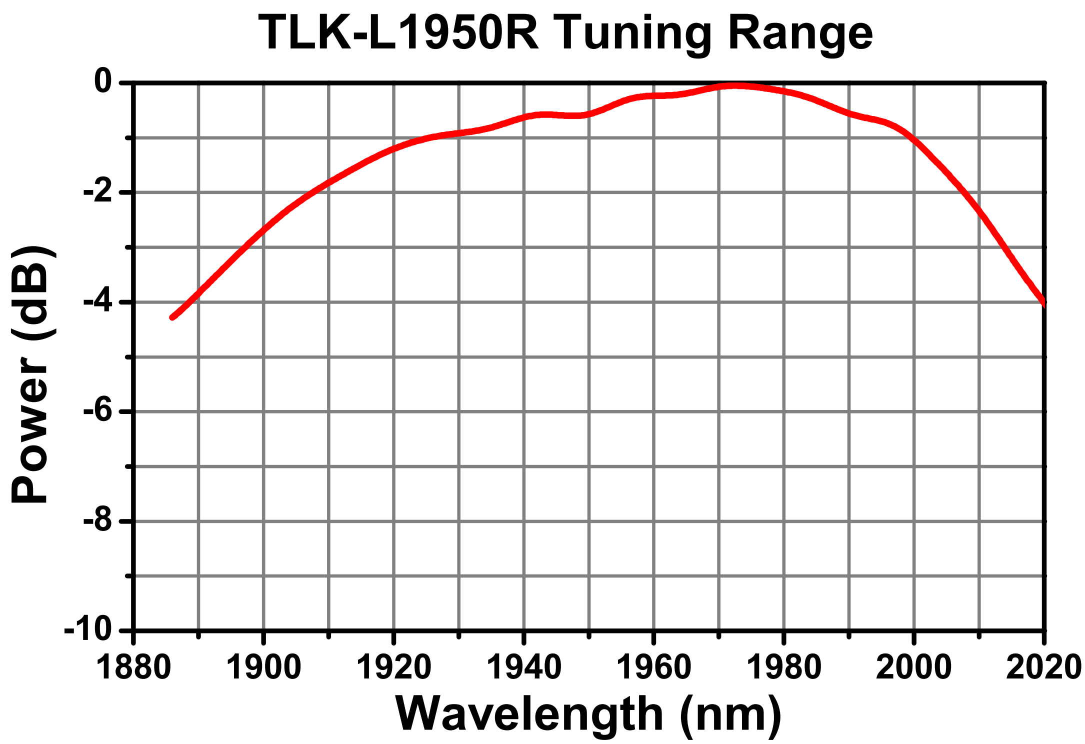


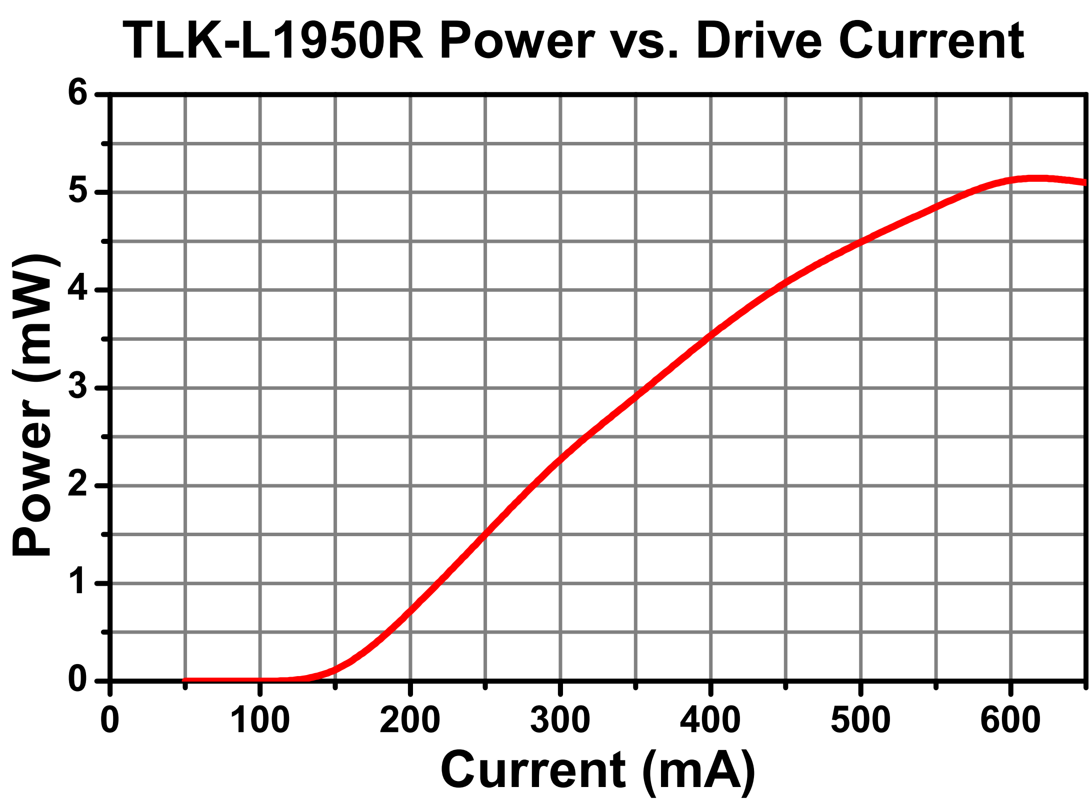
10.9. TLK-L1900M





10.10. TLK-L1950R



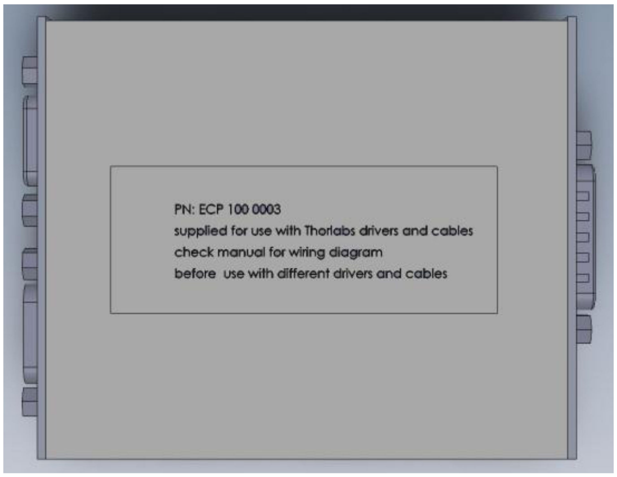


10.11. Thermistor Temperature Coefficients

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	22687	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	12	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

Chapter 11 Breakout Box

11.1. 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	NC
2	PD Cathode**	5	Tied to Pin 1*	8	LD Anode
3	LD Cathode	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 Thorlab's Half Butterfly gain elements. 2-pin connector on ribbon cable (Itme # CAB 000 0011) is for external photodiode connection only.

DB9 Male Connector

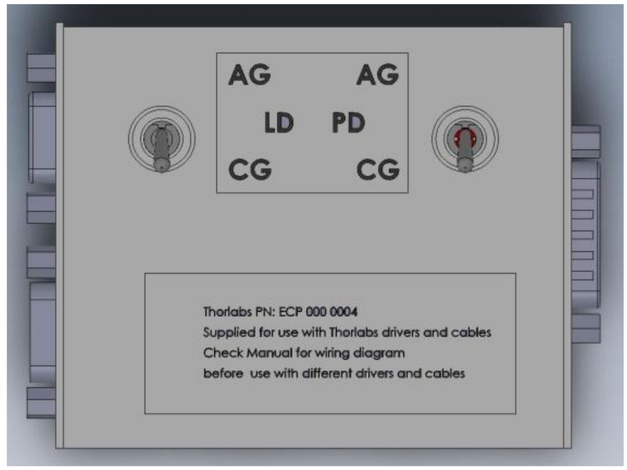
Pin	Description	Pin	Description	Pin	Description
1	NC	4	TEC +	7	NC
2	Thermistor +	5	TEC -	8	NC
3	Thermistor -	6	NC	9	NC

DB15 Male Connector

Pin	Description	Pin	Description	Pin	Description
1	TEC +	6	TEC -	11	NC
2	Thermistor +	7	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

11.2. 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

11.3. Internal Cable Connections with Molex Connectors

Notes: Figure 29: shows only the case with cable CAB 000 0011. Cable CAB 000 0013 does not have the 2-pin connector.

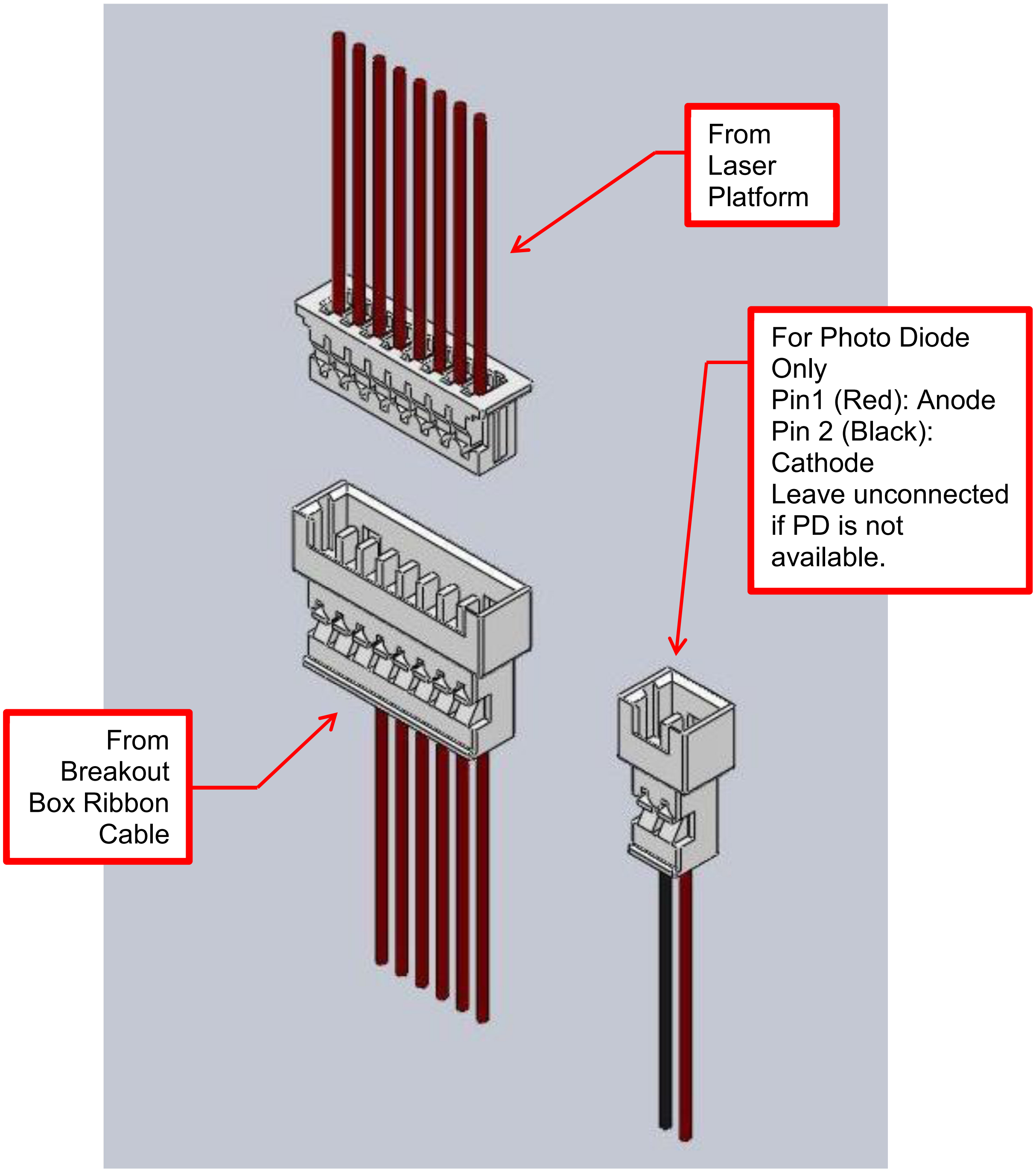


Figure 31 Internal Connections

Chapter 12 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.

12.1. 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.

12.2. 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 life products will thereby avoid negative impacts on the environment.

Chapter 13 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.

USA, Canada, and South America
Thorlabs, Inc.
sales@thorlabs.com
techsupport@thorlabs.com

Europe
Thorlabs GmbH
europe@thorlabs.com

France
Thorlabs SAS
sales.fr@thorlabs.com

Japan
Thorlabs Japan, Inc.
sales@thorlabs.jp

UK and Ireland
Thorlabs Ltd.
sales.uk@thorlabs.com
techsupport.uk@thorlabs.com

Scandinavia
Thorlabs Sweden AB
scandinavia@thorlabs.com

Brazil
Thorlabs Vendas de Fotônicos Ltda.
brasil@thorlabs.com

China
Thorlabs China
chinasales@thorlabs.com


FACE
VALUE
Ezra