

User's Guide

Quantum Cascade Laser Diode Mount LDM-4872



 **ILX Lightwave**
Photonic Test and Measurement

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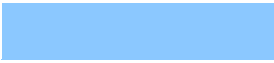
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SAFETY AND WARRANTY INFORMATION

The Safety and Warranty Information section provides details about cautionary symbols used in the manual, safety markings used on the instrument, and information about the Warranty including Customer Service contact information.

Safety Information and the Manual

Throughout this manual, you will see the words *Caution* and *Warning* indicating potentially dangerous or hazardous situations which, if not avoided, could result in death, serious or minor injury, or damage to the product. Specifically:

CAUTION

Caution indicates a potentially hazardous situation which can result in minor or moderate injury or damage to the product or equipment.

WARNING

Warning indicates a potentially dangerous situation which can result in serious injury or death.

WARNING

Visible and/or invisible laser radiation. Avoid direct exposure to the beam.

General Safety Considerations

If any of the following conditions exist, or are even suspected, do not use the instrument until safe operation can be verified by trained service personnel:

- Visible damage
- Severe transport stress
- Prolonged storage under adverse conditions
- Failure to perform intended measurements or functions

If necessary, return the instrument to ILX Lightwave, or authorized local ILX Lightwave distributor, for service or repair to ensure that safety features are maintained (see the contact information on page viii).

All instruments returned to ILX Lightwave are required to have a Return Authorization Number assigned by an official representative of ILX Lightwave Corporation. See Returning an Instrument on page vii for more information.

SAFETY SYMBOLS








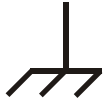


This section describes the safety symbols and classifications.

Technical specifications including electrical ratings and weight are included within the manual. See the Table of Contents to locate the specifications and other product information. The following classifications are standard across all ILX Lightwave products:

- Indoor use only
- Ordinary Protection: This product is NOT protected against the harmful ingress of moisture.
- Class I Equipment (grounded type)
- Main supply voltage fluctuations are not to exceed $\pm 10\%$ of the nominal supply voltage.
- Pollution Degree II
- Installation (overvoltage) Category II for transient overvoltages
- Maximum Relative Humidity: $< 80\%$ RH, non-condensing
- Operating temperature range of $0\text{ }^{\circ}\text{C}$ to $40\text{ }^{\circ}\text{C}$
- Storage and transportation temperature of $-40\text{ }^{\circ}\text{C}$ to $70\text{ }^{\circ}\text{C}$
- This equipment is suitable for continuous operation.

Safety Marking Symbols

This section provides a description of the safety marking symbols that appear on the instrument. These symbols provide information about potentially dangerous situations which can result in death, injury, or damage to the instrument and other components.

 <p>Caution, refer to manual</p>	 <p>Earth ground Terminal</p>	 <p>Alternating current</p>	 <p>Visible and/or invisible laser radiation</p>
 <p>Caution, risk of electric shock</p>	 <p>Protective Conductor Terminal</p>	 <p>Caution, hot surface</p>	 <p>Frame or chassis Terminal</p>
 <p>On: In position of a bistable push control. The slash (I) only denotes that mains are on.</p> <p>or (I)</p>		 <p>Off: Out position of a bistable push control. The circle (O) only denotes that mains are off.</p> <p>or (O)</p>	

WARRANTY

ILX LIGHTWAVE CORPORATION warrants this instrument to be free from defects in material and workmanship for a period of one year from date of shipment. During the warranty period, ILX will repair or replace the unit, at our option, without charge.

Limitations

This warranty does not apply to fuses, lamps, defects caused by abuse, modifications, or to use of the product for which it was not intended.

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for any particular purpose. ILX Lightwave Corporation shall not be liable for any incidental, special, or consequential damages.

If a problem occurs, please contact ILX Lightwave Corporation with the instrument's serial number, and thoroughly describe the nature of the problem.

Returning an Instrument

If an instrument is to be shipped to ILX Lightwave for repair or service, be sure to:

- 1 Obtain a Return Authorization number (RA) from ILX Customer Service.
- 2 Attach a tag to the instrument identifying the owner and indicating the required service or repair. Include the instrument serial number.
- 3 Attach the anti-static protective caps that were shipped with the instrument and place the instrument in a protective anti-static bag.
- 4 Place the instrument in the original packing container with at least 3 inches (7.5 cm) of compressible packaging material. **Shipping damage is not covered by this warranty.**
- 5 Secure the packing box with fiber reinforced strapping tape or metal bands.
- 6 Send the instrument, transportation pre-paid, to ILX Lightwave. Clearly write the return authorization number on the outside of the box and on the shipping paperwork. ILX Lightwave recommends you insure the shipment.

If the original shipping container is not available, place your instrument in a container with at least 3 inches (7.5 cm) of compressible packaging material on all sides.

Repairs are made and the instrument returned transportation pre-paid. Repairs are warranted for the remainder of the original warranty or for 90 days, whichever is greater.

Claims for Shipping Damage

When you receive the instrument, inspect it immediately for any damage or shortages on the packing list. If the instrument is damaged, file a claim with the carrier. The factory will supply you with a quotation for estimated costs of repair. You must negotiate and settle with the carrier for the amount of damage.

Comments, Suggestions, and Problems

To ensure that you get the most out of your ILX Lightwave product, we ask that you direct any product operation or service related questions or comments to ILX Lightwave Customer Support. You may contact us in whatever way is most convenient:

Phone (800) 459-9459 or (406) 586-1244

Fax (406) 586-9405

On the web at: ilx.custhelp.com

Or mail to:

ILX Lightwave Corporation
P. O. Box 6310
Bozeman, Montana, U.S.A 59771
www.ilxlightwave.com

When you contact us, please have the following information:

Model Number: _____

Serial Number: _____

End-user Name: _____

Company: _____

Phone: _____

Fax: _____

Description of what is connected to the ILX Lightwave instrument:

Description of the problem:

If ILX Lightwave determines that a return to the factory is necessary, you will be issued a Return Authorization (RA) number. Please mark this number on the outside of the shipping box.

You or your shipping service are responsible for any shipping damage when returning the instrument to ILX Lightwave; ILX recommends you insure the shipment. If the original shipping container is not available, place your instrument in a container with at least 3 inches (7.5 cm) of compressible packaging material on all sides.

INTRODUCTION AND SPECIFICATIONS



This manual describes the LDM-4872 Quantum Cascade Laser Mount and explains its operation. You should read the entire manual to familiarize yourself with the operation of your mount before installing a laser. This chapter provides an overview of the LDM-4872 Quantum Cascade Laser Mount and contains general information and specifications.

Product Overview

The ILX Lightwave LDM-4872 is a water-cooled, thermoelectric temperature-controlled mount for quantum cascade lasers. The mount is designed for temperatures as low as -30°C and is sealed to allow for either vacuum operation or nitrogen gas purge. The mount can be configured with either a Zinc Selenide window or XYZ stage with built-in collimating lens. Figure 1.1 displays the LDM-4872 mount configured with a 487213 XYZ stage. All water, vacuum, and electrical connections are located on the rear of the mount. The mount comes with an integral mounting stand which is compatible with both English and metric optical tables. The mount is compatible with ILX Lightwave laser diode drivers and temperature controllers.



Figure 1.1 LDM-4872 Quantum Cascade Laser Mount

Available Options and Accessories

Options and accessories available for the LDM-4872 include the following:

DESCRIPTION	MODEL NUMBER
QCL Mount, Water-Cooled Base	LDM-4872
Mid-IR Window	LDM-487212
XYZ Stage	LDM-487213
6.5mm Diameter, 4.0 mm FL Mid-IR Lens, 80% Transmission	LDM-4030
6.5mm Diameter, 4.0mm FL Mid-IR Lens, AR Coasting 2-3 μm , 95% Transmission	LDM-4031
6.5mm Diameter, 4.0mm FL Mid-IR Lens, AR Coating, 3-5 μm , 95% Transmission	LDM-4032
6.5mm Diameter, 4.0mm, FL Mid-IR Lens, AR Coating 7-14 μm , 95% Transmissions	LDM-4033
C-Block (C-Mount) Mounting Block	LDM-487201
Alpes Mounting Block	LDM-487202

Specifications

Laser Packages	C-Block, COC, and customer proprietary packages
Connectors	
CW Laser Diode Current	DB9, female
Case Temperature Control	Hybrid D-sub, male, 7W2
Vacuum / Nitrogen Purge	2 x 1/8" NPT female, supplied with compression fittings for 1/4" OD tubing installed
Cooling Water Inlet and Outlet	1/4" barbed fittings
Temperature Control	
Sensor Type	Solid State Thermoelectric
Maximum TEC Current	10A
Maximum Thermal Load	10W
Temperature Range ¹	-30°C to 30°C
Contact Thermal Resistance ²	$\leq 0.10 \text{ } ^\circ\text{C}\cdot\text{in}^2\cdot\text{W}^{-1}$
Accuracy	$\pm 0.5^\circ\text{C}$
Stability ³	$< 0.005^\circ\text{C}$
General	
Size (L x W x H)	4.5" x 4.0" x 6.5" (11.4 cm x 10.1 cm x 16.5 cm)
Beam Height	4.0" (101.6 mm)
Weight ⁴	3.8 lb. (1.7 kg)
Regulatory Compliance	RoHS, CE
Water Pressure Drop	10 PSI at 3.5 LPM
LDM-487213 XYZ Stage	
XY Stage	Differential adjustment screw, locking
Travel	3.0 mm
Sensitivity	318 μm / rev coarse, 25 μm / rev fine
Z Stage	
Travel	5.0 mm
Sensitivity	397 μm / rev
LDM-403x Lens	
Lens	Aspheric
Center Thickness	2.5 mm
Working Distance	3.05 mm
Outer Diameter	6.5 mm

Numerical Aperture ⁵	0.56
Effective Focal Length	4.0 mm
Material	Molded chalcogenide glass
Optional AR Coatings	LDM-4030: Uncoated LDM-4031: 1.75-3 μm LDM-4032: 2-6 μm LDM-4033: 7-14 μm
LDM-487212 Window Assembly	
Minimum Distance to Front Facet	5.8 mm
Dimensions	12.7 mm diameter; 3 mm thickness
Material	Zinc Selenide, IR coated
LDM-487201 C-Mount Mounting Block	
Laser Package	C-mount
Laser Dimensions	Package width: 6.35 +/- 1 mm Flying lead height: 7.75 +/- 1 mm Package depth: 2.18 mm to 3.16 mm
LDM-487202 Alpes Mounting Block	
Laser Package	Alpes NS and ST
Laser Dimensions	Package width: 19 mm Package height: 2.5 mm Package depth: 7 mm

1. Minimum temperature at 10W, 10°C cooling water, 2 LPM flow rate.
2. $CTR = (\text{Laser case temperature} - \text{mount temperature}) / \text{laser waste heat}$.
3. Stability measured at -25°C with a 5W load under 100 mTorr vacuum using LDT-5980 temperature controller.
4. Weight with XYZ stage.
5. Based on calculation of index of refraction in air.

Our goal is to make the best laser diode instrumentation available anywhere. To achieve this, we need your ideas and comments on ways we can improve our products. We invite you to contact us at any time with your suggestions.



This chapter describes the operation of the LDM-4872 Quantum Cascade Laser Mount including electrical connections, vacuum/purge connections, water connection, laser installation, and XYZ stage operation.

LDM-4872 Connections

The rear panel of the mount has connections for a temperature control cable, current source cable, vacuum/purge connections, and cooling water. For pin-outs of the control cables, see the following section. The vacuum and purge connections accept 1/8" NPT male fittings. Use three full wraps of Teflon tape on all threaded connections. The water fittings accept 1/4" ID flexible tubing. Hose clamps are recommended. The cold plate is symmetrical, thus flow direction through the mount does not matter. For more detail on vacuum, purge, and water connections see the following sections. Figure 2.1 illustrates the rear panel connections.

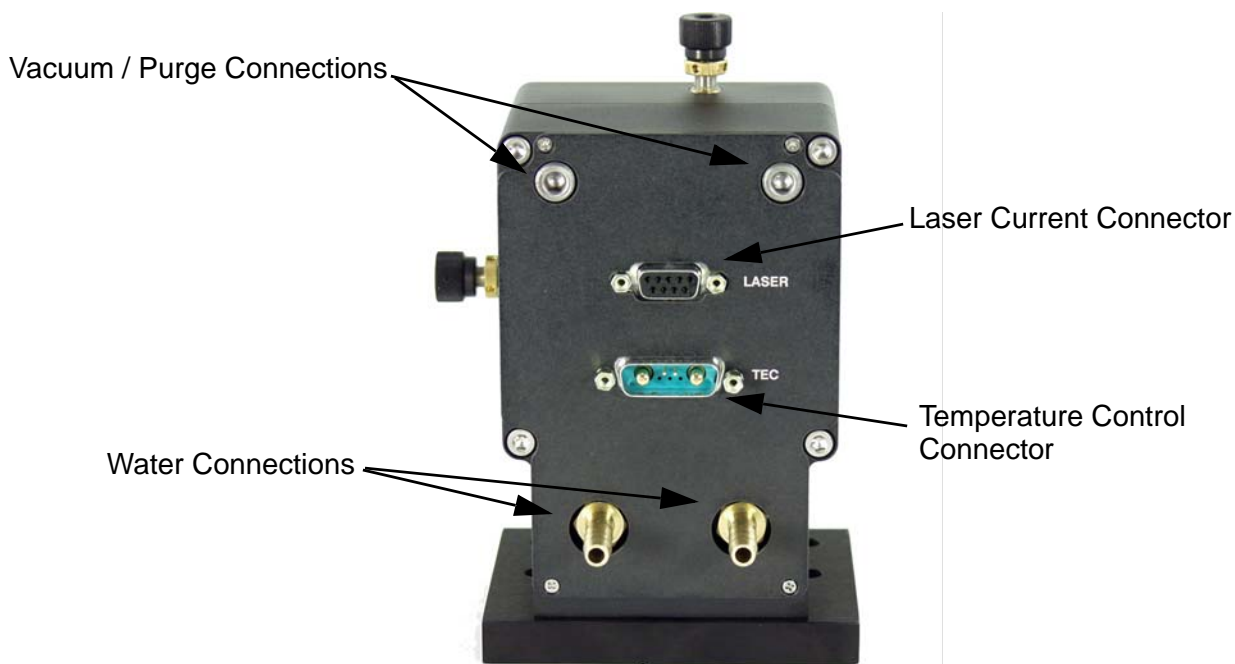


Figure 2.1 LDM-4872 Rear Panel Connections

Pin-Out

The laser current connection uses a 9 pin female D-sub connector with a standard ILX Lightwave pin-out (see Figure 2.2 below).

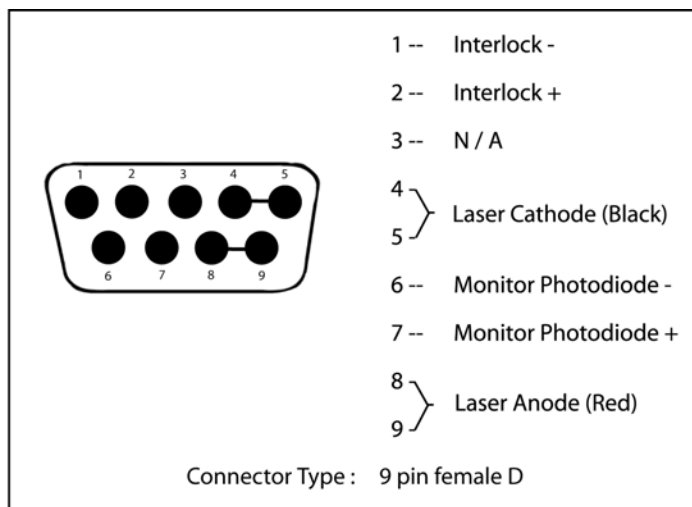


Figure 2.2 Laser Current Connector Pin Out

The temperature control connection uses a 7W2 hybrid D-sub connector with standard ILX Lightwave pin-out for high power temperature control (see Figure 2.3).

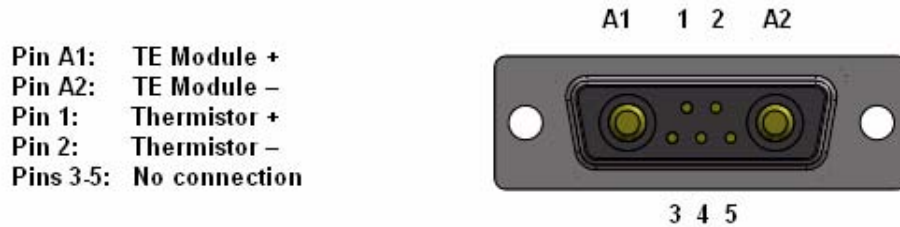


Figure 2.3 Temperature Control Connector Pin Out

Current Sources and Current Measurements

Operate the LDM-4872 using an appropriate ILX Lightwave current source and temperature controller. Operation with other current sources or temperature controllers is also possible, provided that the correct wiring is observed (refer to Figures 2.2 and 2.3). If an ILX Lightwave current source is used with the system interlock feature, the interlock connections are available at pins 1 and 2 of the current source connector (see Figure 2.2). With the ILX Lightwave interlock feature enabled, the interlock pins must be connected before current can flow from the source.

Proper shielding of the current source and temperature controller signals is necessary to ensure proper noise-free performance. This is accomplished by grounding the shield on the interconnect cables to the controller and not to the mount. The CC-596H Temperature Control Cable provides this shielding automatically by connecting the 25 pin housing into the temperature controller. The CC-305S Current Source Cable, being symmetrical, must be oriented correctly to ensure proper grounding of the shield. This is done by connecting the serial-number end of the cable to the current source. The current source will still drive the laser normally with the cable reversed, but the noise performance will be degraded. If noise becomes excessive during testing, check the orientation of your laser cable.

Do not exceed the specified maximum drive current of the laser. If you are using an ILX Lightwave current source, or any other current source which has an adjustable limit setting, be sure to set the current limit to a safe level for your laser.

If it is necessary to measure the current of your laser during operation, follow these steps:

- NEVER connect an ammeter in series with the laser circuit.
- Place a known resistance (1 ohm works well) in series with the laser diode circuit. Then, measure the voltage across the resistor. Calculate the current by using Ohm's Law,

$$I = E/R.$$

- NEVER turn the voltmeter on or off, or change the voltage measurement range, while current is flowing to the laser. These actions could result in damage to your laser diode.

Most ILX Lightwave current sources measure the output current during laser operation. Therefore, if you are using an ILX Lightwave current source, it is not necessary to measure the laser current as described above.

Laser Installation

CAUTION

Laser diodes are extremely susceptible to damage caused by electrostatic discharge and surge currents. To avoid early failure or damage to the device, workers and work benches must be grounded at all times when handling or working with laser diodes.

Prior to inserting the laser, connect the current source and temperature controllers to the mount using the appropriate cables (refer to Figures 2.2 and 2.3 for laser and temperature connector pin outs). When the mount electrical connections and laser driver are correctly configured, the laser cathode and anode connections are shorted through an ILX Lightwave current source when the current drive is switched off. This prevents damage to the laser from electrostatic discharge and supports other laser safety features of all ILX Lightwave laser diode drivers.

Alpes Laser

The laser is clamped onto the temperature-controlled laser plate using an anodized aluminum clamp with two socket head mounting screws (3/32" hex wrench). The clamp is spring-biased with a moveable printed circuit board (PCB) containing two spring contact pins (anode and cathode) that make the laser current connections (see figure 2.4 and figure 2.6). The PCB can be attached to either the left or right side of the clamp, and can be rotated 180 degrees to align the anode and cathode pins with the anode and cathode pads on the device. To install a device, first remove the window or XYZ stage cover assembly to gain access to the laser mounting plate and clamp. Check that the contact pin PCB is configured correctly for the device. To move or rotate the PCB, remove the 0-80 socket head cap screw (.050" hex wrench) which holds the PCB in place. Move PCB and reinstall the screw. Alternately loosen the two clamp mounting screws until adequate clearance for the device is present. Ensure that the mounting surface of the laser plate is clean. Place the device on the laser plate, checking for proper orientation. Alternately and evenly tighten the mounting screws until the device is secured. Take care that the clamp does not contact the wire bonds of the device. With the clamp fully tightened the anode and cathode spring contact pins should be contacting their respective pads on the device (Figure 2.5 and Figure 2.7).

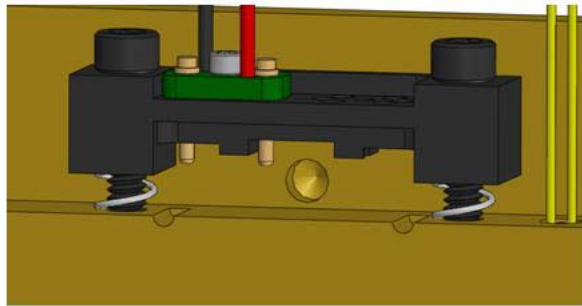


Figure 2.4 Laser Mounting Clamp with the Spring Contact Pins in the Left Position

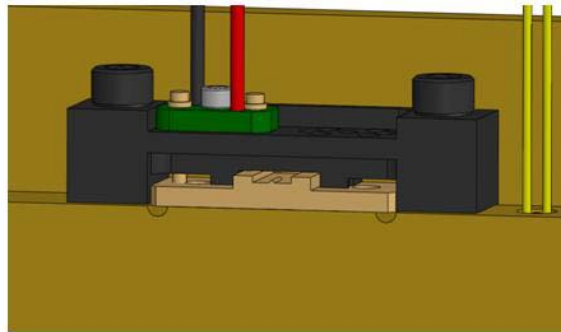


Figure 2.5 Correctly Installed Laser

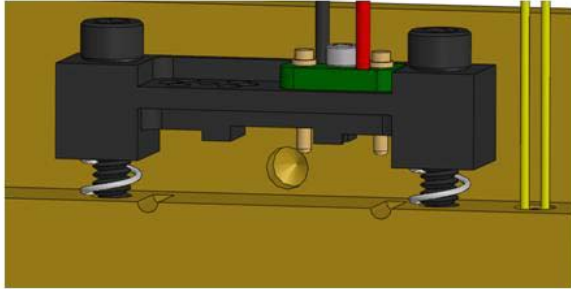


Figure 2.6 Laser Mounting Clamp with the Spring Contact Pins in the Right Position

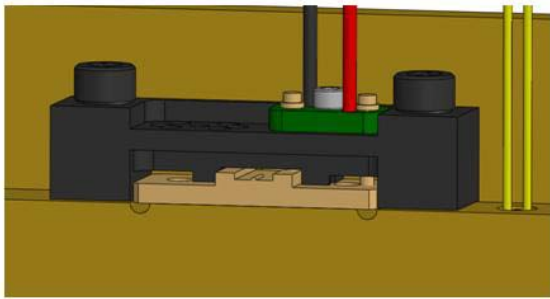


Figure 2.7 Correctly Installed Laser

C-mount Laser

The laser is secured to the temperature-controlled laser plate using a 2-56 x 3/16" button head cap screw (0.050" hex wrench). The contact block is spring-biased and contains spring contact pins which make the laser current connections (Figure 2.6). To install a device, first remove the window or XYZ stage cover assembly to gain access to the laser mounting plate. Alternately loosen the two contact block mounting screws until adequate clearance for the device is present. Ensure that the mounting surface of the laser plate is clean. Using tweezers place the device into the slot on the laser plate, checking for proper orientation. Secure with screw. Make sure that the flying lead is straight and aligned with the insulator and contact pin. Alternately and evenly tighten the mounting screws until tight. Take care that the contact block does not contact the wire bonds of the device. With the contact block fully tightened the anode and cathode spring contact pins should be contacting their respective pads on the device (Figure 2.7).

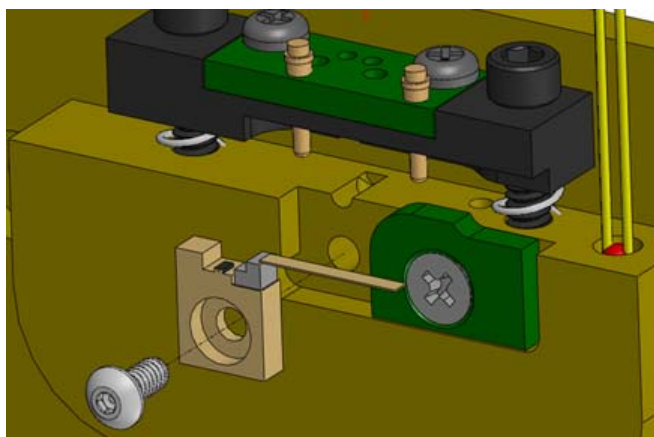


Figure 2.8 C-mount Laser Mounting

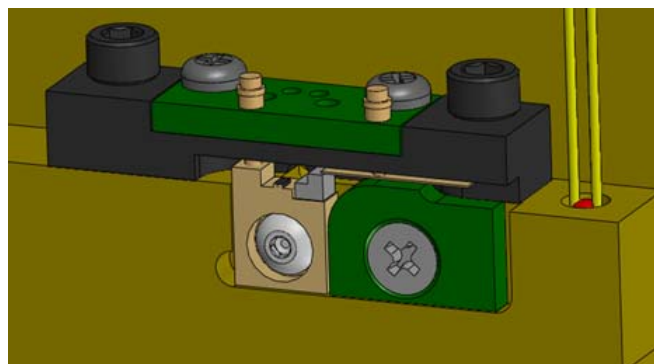


Figure 2.9 Correctly Installed C-mount Laser

Installation of Cover (XYZ or Window)

Before installing either the window assembly or the XYZ stage assembly, ensure all mating surfaces and areas subject to vacuum are clean and free of dirt or other residues. Clean surfaces with a lint-free wipe first with acetone, followed by a final cleaning with alcohol. Inspect the o-ring to ensure it is clean. Apply a thin layer of vacuum grease to the entire o-ring and carefully place it in its gland on the front face of the mount body. Place the window or XYZ stage assembly onto the mount, using the alignment pins for guidance. Secure with four 10-32 x 1.5" socket head cap screws (5/32" hex wrench) which are inserted from the rear of the mount. Alternately tighten the screws until metal to metal contact is made from the cover to the mount body. Refer to Figure 2.8 below.

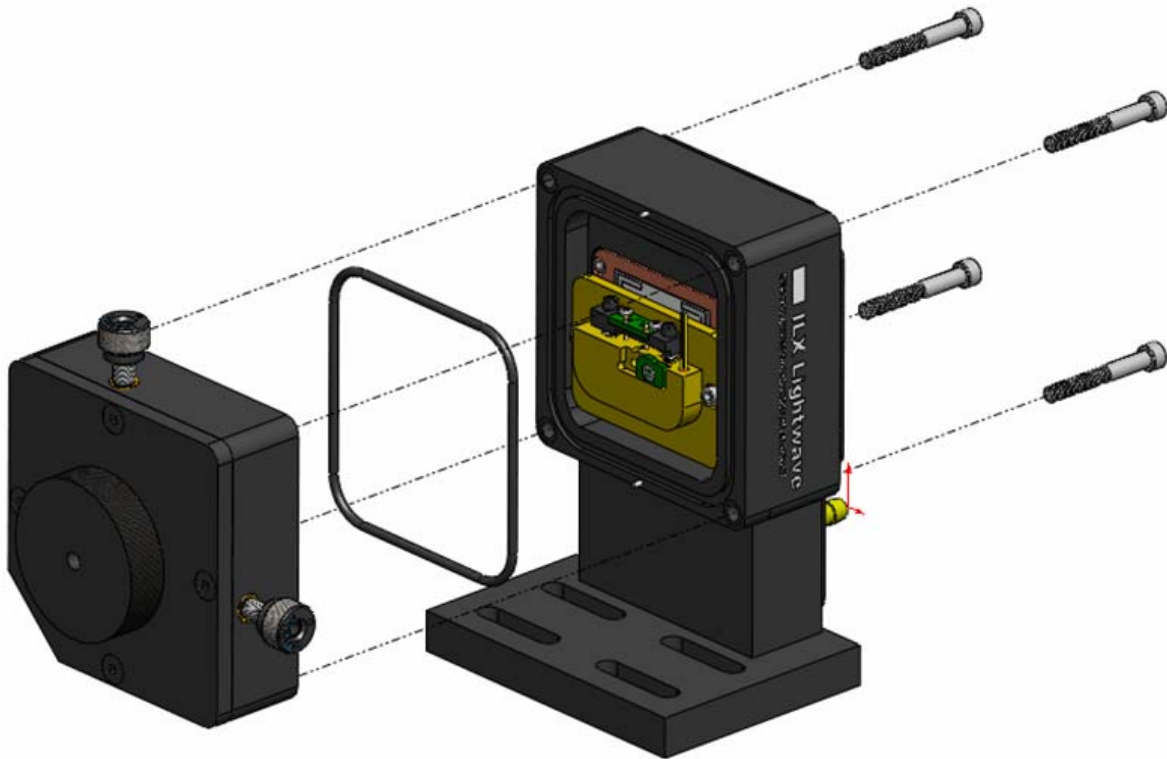


Figure 2.10 Window or XYZ Stage Installation

Water Cooling and Temperature Control

CAUTION

Cooling water must be supplied at all times when temperature control is enabled. Failure to do so may result in high temperatures that can damage the laser or internal thermoelectric module.

The LDM-4872 features a high performance thermoelectric module and liquid-cooled heatsink in order to achieve very low temperatures at device heat loads of up to 10W. Cooling water must be supplied at all times when operating the mount. A minimum flow rate of 1.5 liters per minute is recommended. It is also recommended that the cooling water temperature remain above ambient dewpoint at all times to prevent condensation. The supplied 1/8" NPT x 1/4" hose barb fittings work with soft to medium-hard tubing with an inner diameter of 1/4". Hose clamps are recommended. For best performance, keep hose lengths and bends minimized to reduce pressure drop. 100% clean, filtered water is recommended for cooling liquid. Glycol solutions of up to 50% can be used, but thermal performance will be reduced. The cold plate is symmetrical; therefore water flow direction through the mount does not matter.

The mount features an embedded calibrated thermistor for sensing laser plate temperature. The mount is supplied with calibration data including Steinhart-Hart constants. Recommended TEC current limits are 10A for cooling and 3A for heating.

Vacuum Operation

The housing is designed to be evacuated with a vacuum pump to prevent frost from forming on the laser, and to provide stable temperature control at very low temperatures. The mount comes equipped with double-sleeved compression fittings installed into the 1/8" NPT female ports. The fittings are for 1/4" OD stainless steel tubing and are compatible with Swagelok®, A-Lok®, Yor-Lok, OMEGAlok®, and similar fittings. Install the supplied compression fitting cap onto one of the fittings. ILX recommends monitoring pressure by connecting a thermocouple-style vacuum gauge to the second port. Attach a line from a vacuum pump to the second port. If continuous vacuum pumping is not desirable, install a valve along this line near the mount. Install the laser and housing cover (XYZ or window) as described previously.

CAUTION

Verify that your vacuum pump has necessary features to prevent backflow of oil or contaminants from the pump into the mount which could contaminate the laser.

Turn on the vacuum pump and allow the mount to evacuate. To prevent condensation, a pressure of less than 10 Torr should be maintained in the housing for the duration of any testing. Begin operating the mount at this point.

Nitrogen Purge

As an alternative to vacuum operation, the mount can be purged with dry nitrogen to prevent condensation and frost at low temperatures. There are two methods for nitrogen purge: a continuous flow of nitrogen into one port and out the other, or displacing the air in the housing with nitrogen and then sealing it. For better thermal performance, the second method is preferred.

Constant Flow

Connect a regulated dry nitrogen supply to one of the ports. Leave the other port open. Install the laser and housing cover (XZY or window) as described previously. Turn on the nitrogen supply to the desired flow rate. Begin operating the mount at this point.

Sealed Method

CAUTION

Do not exceed 5 PSI positive pressure with the nitrogen supply

Connect a regulated dry nitrogen supply to one of the ports. Install a valve on the other 1/8" NPT port. Install the laser and housing cover (XYZ or window) as described previously. Open the outlet valve and turn on the nitrogen, allowing the nitrogen to flow for several minutes. Close the outlet valve and adjust the inlet regulator to no more than 5 PSI. Begin operating the mount at this point.

XYZ Adjustment

The LDM-4872 uses a unique XYZ stage that allows X, Y, and Z lens adjustment while under full vacuum. The X and Y adjustment uses differential adjustment screws with both coarse (318 $\mu\text{m}/\text{rev}$) and fine adjustment (25 $\mu\text{m}/\text{rev}$). For coarse adjustment, turn the black outer knob of the screw. For fine adjustment, insert a 1/16" hex wrench into the end of the screw and adjust (while ensuring the outer coarse adjustment remains stationary). To make the Z adjustment, rotate the outer ring of the lens housing. Figure 2.9 shows the X, Y, and Z, adjustments.

Note: After sitting idle for some time, the vacuum seals in the XYZ stage can stick and cause the XY stage to remain stationary when the adjustment screws are backed off. Upon initial adjustment, first tighten the adjustment screws (turn clockwise) to break the static friction that develops at the vacuum seal.

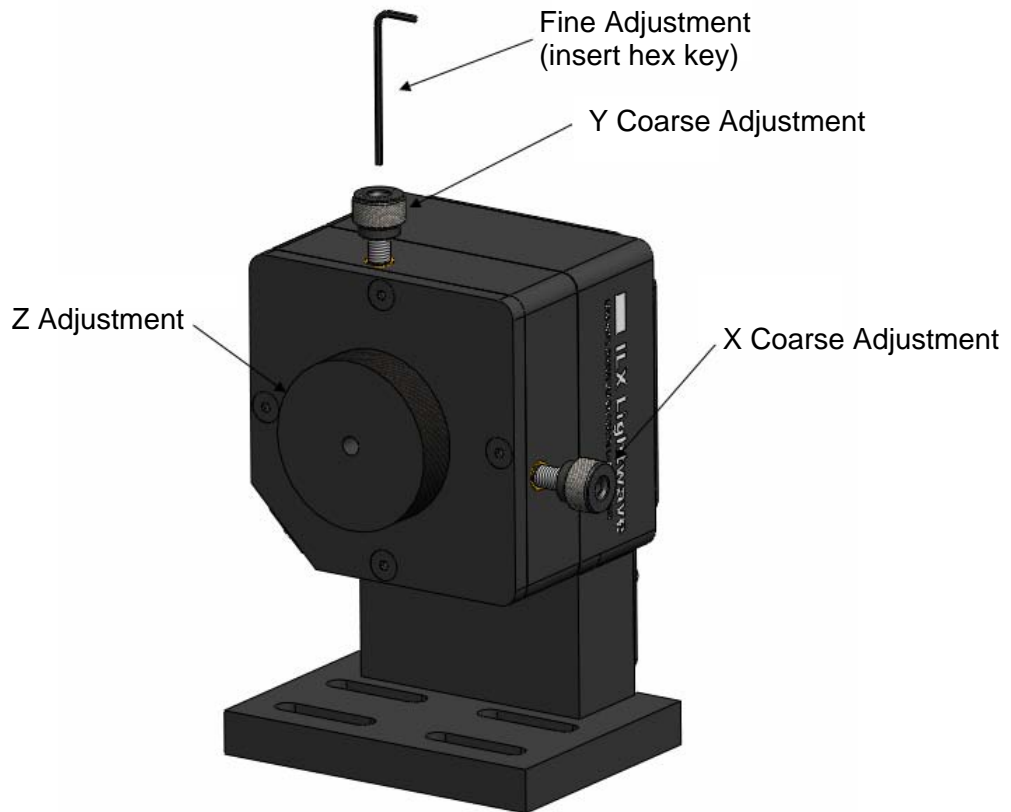


Figure 2.11 X, Y, and Z Adjustments

ZnSe Window

The ZnSe window option allows the mount to be used with external optics. See the preceding section regarding installation of the window assembly. The ZnSe window itself is fragile and susceptible to scratching. Use caution when handling.

MAINTENANCE



No maintenance procedures are required for the LDM-4872 other than an occasional cleaning, as needed, to remove any accumulated dust or dirt from the plate. Be sure to clean and re-apply vacuum grease to the o-ring each time the window assembly or XYZ stage is installed. When the mount is not in use for prolonged periods it is recommended to insert plastic anti-static covers over the temperature control connector.

SAFETY



 **CAUTION**

Lasers used with the LDM-4872 Quantum Cascade Laser Mount may emit infrared radiation which is invisible to the human eye. Extreme care must be taken to prevent the beam from being viewed either directly or through external optics or mirrors. Remove rings, jewelry, and other reflective materials when working with lasers.

Viewing of emissions may cause eye damage. Use of protective goggles is recommended when operating these lasers.

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

This product conforms to all applicable DHHS regulations 21 CFR Subchapter J, at the date of manufacture.

