THORLABS PIM05-M Piezo Inertia Actuator Mirror Mounts User Guide

Contents

THORLABS PIM05-M Piezo Inertia Actuator Mirror Mounts

Product Information

Specifications

- **Product Name:** Piezo Inertia Actuator Mirror Mounts
- **Model Numbers:** PIM05(/M), PIM1(/M)
- **Revision:** C, May 2024
- **Manufacturer:** Thorlabs

Product Usage Instructions

Safety

Safety Information

For the continuing safety of the operators of this equipment,and the protection of the equipment itself, the operator should take note of the Warnings, Cautions, and Notes throughout this handbook and on the product itself. Safety symbols used include Warning (Risk of Electrical Shock), Warning (Risk of injury to users), Caution (Risk of damage to the product), and Note (Clarification of an instruction or additional information).

General Warnings
If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. Ensure indoor use only and avoid use in explosive atmospheres.

General Cautions
Damage to the threads of the drive screw can cause inconsistency in stepping behavior. Ensure the travel of the mount is not obstructed to prevent premature wear failure of the drive screw coating.

Overview

Introduction
These Kinematic Mirror Mounts feature two piezo inertia motor adjusters and have been designed to provide long-term alignment stability in optical systems. They offer angular resolution of ~0.5 µrad per cycle via piezoelectric adjustment. When driven by the KIM001 or KIM101 Inertial Piezo Controllers, the PIM series allows continuous long term stepping.

Manual adjustment of the drive screws is achieved via the knob on each axis. A 2 mm (5/64”) hex key can also be used in the hole in each knob Fig. 4.1.
The optic is held in place by a nylon-tipped setscrew. We strongly recommend using a torque driver for securing the optic to prevent optical surface distortion and to improve thermal stability – see Section 3.3. for more details.
Post mounting is provided by two sets of three 8-32 (M4) tapped holes located at right angles with respect to each other for right- or left-handed mounting.
The internal piezo inertia motor adjusters operate by using inertia and friction to move a slider. The motor’s linear stepping is based on micro-rotation of the finely threaded drive screw circumference. In each single step, a clockwise or counterclockwise rotation is created with a voltage pulse to a piezo stack within the mechanism. This in turn creates a reciprocating linear displacement of the screw tip. Using different rise and fall voltage rates depending on the load, a typical linear step size of 20 nm (angular 0.5 µrad) can be achieved.

These actuators maintain their position with no power applied.

Safety

Safety Information
For the continuing safety of the operators of this equipment, and the protection of the equipment itself, the

operator should take note of the Warnings, Cautions and Notes throughout this handbook and, where visible, on the product itself.

The following safety symbols may be used throughout the handbook and on the equipment itself.

 **Warning:** Risk of Electrical Shock
Given when there is a risk of injury from electrical shock.

 **Warning**
Given when there is a risk of injury to users.

 **Caution**
Given when there is a risk of damage to the product.

Note
Clarification of an instruction or additional information.

General Warnings

Warning
If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. In particular, excessive moisture may impair operation.
The equipment is for indoor use only.
The equipment is not designed for use in an explosive atmosphere

General Cautions

Caution
Damage to the threads of the drive screw can cause significant inconsistency of stepping behavior.
The travel of the mount must not be obstructed.
Dust and debris can reduce the lifetime of the actuator. If left running unattended for periods of time, the application should be covered where possible.

General Notes

Note
The stick-slip nature of the mechanism uses a very short pulse width. Continuous stepping of the actuator results in an audible noise at a typical level of 60 to 70 dB.
The step size is defined as the distance moved in one step or pulse. This distance can be adjusted up to about 30% by changing the piezo drive voltage. The actual step size achieved for a given drive voltage will be dependent on application. Due to the open loop design, piezo hysteresis, component variance and application conditions, the achieved step size of the system may vary by over 20% and is not normally repeatable.

Installation

Mounting

1. **General**

   Cautions

When mounting close to other equipment, ensure that the travel of the mirror mount is not obstructed. If movement is obstructed the actuator will stall, which could cause premature wear failure of the drive screw coating.

2. Installing the Optic Mount

   The PIM series optic mount will achieve optimum performance when used with a Ø1″ RS series or PLS series post.

   To minimize the impact of vibrations and temperature changes, it is recommended that your setup have as low of a profile as possible. Using short posts will reduce the movement caused by temperature variations and vibrations.

Electrical Connections

The piezo mount must be driven by a Thorlabs KIM101 controller (or legacy TIM101).

The optic mounts are shipped with a 1 m (3.3') cable, terminated in SMC connectors.
Connect each actuator to one of the MOT terminals on the rear panel of the KIM101 controller – see Fig. 3.1.
The controller can be configured for dual axis use, such that the joystick on the controller can move both axes of the mount simultaneously. If this functionality is required, use connection pairs MOT1/MOT2 or MOT3/MOT4 and see the controller handbook for further details.
To assist in ensuring that the correct controller channel is connected to the correct axis, the drive cable is marked with 'Channel 1' and 'Channel 2' identification sleeves, as shown in Fig. 3.2.

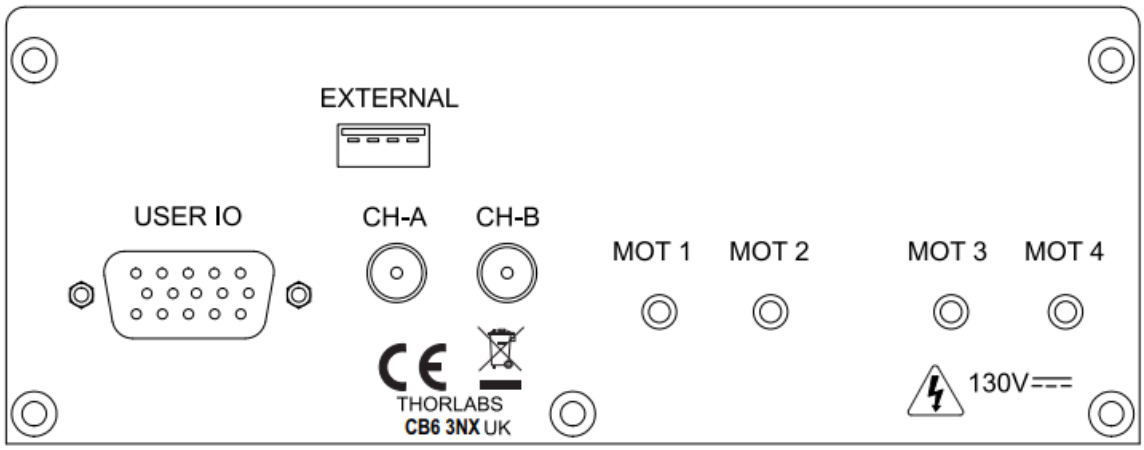

Fig. 3.1 Electrical Connections

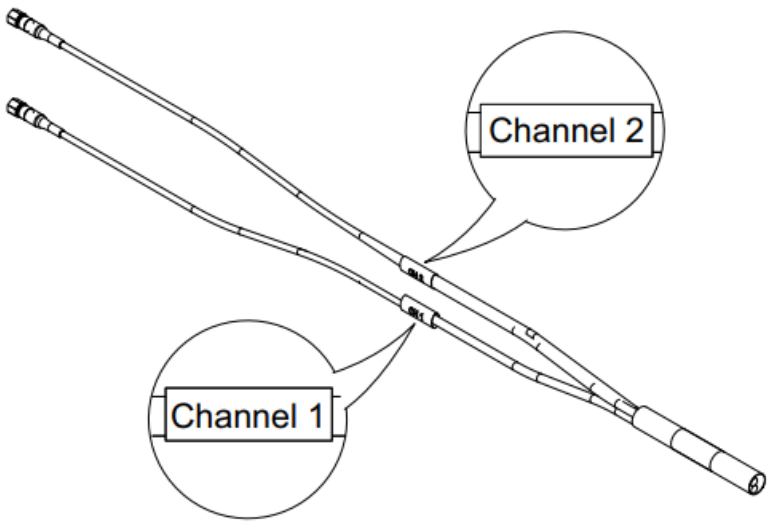

Fig. 3.2 Drive Cable Channel Identification

Caution
The piezoelectric stacks may be irreversibly damaged by abrupt changes in the applied voltage. In order to prevent such damage, ensure that the power supply is off before connecting the SMC cables.
Thorlabs offer 1.5 m extension cables (PAA101) and male adapters (T5026) to extend the drive cable length to 2.5 m, see **www.thorlabs.com**.
Due to the capacitance of the cables, do not use cables longer than 2.5 m in total.

Fitting the Optic
Since an optic is prone to movement within its mounting bore, all optics should be mounted with the mount out of the setup to ensure accurate mounting that will minimize misalignment effects.

1. Ensure that there is no grease, dirt, or dust in the optic bore or on the optic itself.
2. Remove any particulates with compressed air and/or clean with acetone or methanol. With the mount oriented at ~45° so that it stands on its corner adjuster,place the optic into the bore.
3. Lightly tap the edge of the faceplate with the plastic handle of a ball driver. This will adjust the optic's position so that it makes the correct contact with the two contact lines and the locating lip. Finally, use a ball driver or hex key to engage the optic retaining screw, preferably to the specific torque.
4. Since the mirror expands at a different rate than the mounting mechanism, it is essential to hold the optic firmly in place. A torque of 6 to 10 oz-in (0.375 to 0.675 in-lb; 0.04 to 0.07 N•m) applied to the optic mounting setscrew produces optimal results for a 6 mm thick UV fused silica mirror (use Thorlabs' TD24 Torque Wrench).

Operation

General

Caution
The PIM series optic mounts can only be driven by the Thorlabs KIM001,KIM101 or legacy TIM101 Controllers.

Warning: Risk of Electrical Shock
The piezo actuators in this product use high voltages. Voltages up to 130V may be present at the SMC connector. This is hazardous and can cause serious injury. Appropriate care should be taken when using this device. Persons using the device must understand the hazards associated with using high voltages and the steps necessary to avoid risk of electrical shock.
The piezo controller must be switched OFF before the mount is plugged in or unplugged. Failure to switch the controller off may result in damage to either the controller, the stage or both.

For a complete tutorial on driving the actuator, see the manual supplied with the KIM101 controller. Basic steps in controlling the actuator are as follows:

1. Mount the optic into the mount as detailed in Section 3.3.
2. Install the optic mount within the set up, see Section 3.1.
3. Make electrical connections as detailed in Section 3.2.
4. Turn the knobs on the mount to manually position the device being driven to the required start position, usually the center of travel in both axes.

   Note

   During operation, the actuator makes a high pitch whistling noise, and may generate some heat. This is normal behavior in the performance of the device and does not indicate a fault condition.
5. Run the software and click the 'zero' button on the GUI panel. This establishes a datum at the current position, from which subsequent positional moves can be measured.

6. The stage can now be moved using the controls on the KIM101 unit, the GUI panel, or by setting commands to move each axis – see the handbook supplied with the KIM101 controller, and the help file supplied with the software for more information.

Note
The PIM series optic mounts are open loop devices that have been designed to offer relative positioning which can be commanded via the number of steps.

Caution
If the actuator is driven into its end stops, the motor may stick and may not respond to subsequent motion demands. If this is the case, turn the adjustment knob of the mount manually to move the device away from its end stop, then the motor should move normally.

Manual Adjustment
Manual adjustment is achieved via the knob on each axis. A 2 mm (5/64”) hex key can also be used in the hole in each knob as shown below.

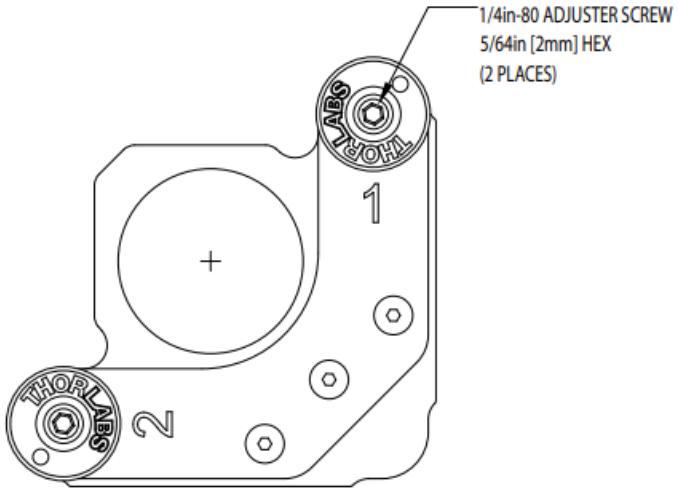

Fig. 4.1 Manual Adjustment

Maintenance
Periodically, move the drive screw from one end of travel to the other, in order to redistribute the grease. The periodicity will depend on usage. In applications involving continuous use or where a small travel range is used at high duty cycle, the grease should be redistributed often to ensure optimal performance of the actuator.

Due to the frictional-inertia nature of the mechanism, wear of the screw coating occurs during its lifetime. Periodic maintenance helps to increase the optimum stepping performance during its lifetime.

Transportation

Caution
When packing the unit for shipping, use the original packing. If this is not available, use a strong box and surround the unit with at least 20 mm of shock absorbent material.

Specifications

Parameter	PIM05(/M)	PIM1(/M)
Optic Size	Ø0.5” (12.7 mm)	Ø1” (25.4 mm)
Optic Thickness (Minimum)	3 mm	
Optic Mounting Torque	6 to 10 oz-in (0.375 to 0.675 lb-in; 0.04 to 0.07 N•m)	
Total Angular Range[a]	±2°	
Typical Step Size[b]	0.5 µrad	
Typical Angular Velocity	0.05 rad/min	
Max Step Frequency	2.0 kHz	
Max Axial Preload	12 N	
Adjusters	Manually Adjustable 1/4”-80 drive screws with Integrated Piezo electric Elements and Matched Actuator/Body Pairs (2 Screws Total)	
Piezo Resonant Frequency	125 kHz	
Piezo Control Voltage	85 to 125 V	
Piezo Connectors	Female SMC	
Mounting	Six 8-32 (M4) Mounting Holes	
Operating Temperature	10 to 40 °C (50 to 104 °F)	
Cable Length	1 m (3.3’)	
Lifetime	>1 Billion Steps	
Weight (including Cable)	297 g (10.48 oz)	

- Using any combination of Piezoelectric Adjustment and Mechanical Adjustment.
- Due to the open loop design, piezo hysteresis, variance among components, and variation in application conditions, the step size may vary by 20%.

FAQ

What should I do if the actuator stalls?

Ensure that the travel of the mirror mount is not obstructed to prevent stalling of the actuator which could cause premature wear failure of the drive screw coating.

Can I use the equipment in an explosive atmosphere?

No, the equipment is not designed for use in an explosive atmosphere.

How can I prevent damage to the piezoelectric stacks during electrical connections?

Avoid abrupt changes in applied voltage and ensure the power supply is off before connecting SMC cables.

How does a piezo inertia motor work?

A piezo inertia actuator uses friction and inertia (stick/slip) to rotate a fine mechanical drive screw. The piezo is driven by a sawtooth voltage waveform. As the voltage is ramped up, the piezo will extend and turn the screw (stick). When the voltage is dropped to zero, the piezo returns to its original length. By using different rates of voltage during rising and falling, the drive screw rotates more in one direction than the other due to inertia and different frictional coefficients, resulting in a net rotation. This in turn is translated to a linear displacement of the screw which is transferred to the application via the tip of the screw.

What applications can they be used for?

Any ‘set-and forget’ application, particularly where space is tight. The primary function of the PIA series actuators is to achieve a relative position and hold it, whereby switching the controller off will result in the same drift as a 1/4-80 fine drive screw. The step size is dependent upon drive screw preload, and will differ between actuators and applications. They are not suitable where repeatable step size is required.

What is the lifetime of the typical piezo inertial motor?

The piezo stack of the actuator is rated for a service life of over a billion steps. With proper maintenance see Section 4.3. the hard coating on the drive screw should endure for this life time, however up to a 30% drop in step size may occur.

What driver can I use?

The piezo inertia actuators are designed to be driven by the Thorlabs KIM101 Inertia Piezo Driver.

Regulatory

Declarations Of Conformity

1. For Customers in Europe

   See Section 7.2.

2. For Customers In The USA

   This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.
Changes or modifications not expressly approved by the company could void the user's authority to operate the equipment.

CE Certificates

EU Declaration of Conformity

Manufacturer: Thorlabs LTD

Address: 204 Lancaster Way, Ely, CB6 3NX

We hereby declare under our sole responsibility that:

Product: **PIM Series**

Product description: **2-axis Piezo-actuated Mirror Mount**

is/are in conformity with the following directive(s):

2014/30/EU	Electromagnetic Compatibility (EMC) Directive	
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS), including 2015/863	
2006/42/EC	Machinery Directive (MD)	

and (harmonized) standards / technical specifications :

EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013
EN IEC 63000	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances	2018
EN ISO 12100	Safety of Machinery. General Principles for Design. Risk Assessment and Risk Reduction	2010

I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications and complies with all applicable Essential Requirements of the Directives.

Signed: Keith Dhese

Name: Keith Dhese *On:* 5/16/2024

Position: General Manager

CE

Appendix H 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.

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Thorlabs, Inc.
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China
Thorlabs China
chinasales@thorlabs.com

Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return “end of life” Annex I category electrical and electronic equipment sold after August 13, 2005 to Thorlabs, without incurring disposal charges. Eligible units are marked with the crossed out “wheelie bin” logo (see right), were sold to and are currently owned by a company or institute within the EC, and are not dissembled or contaminated. Contact Thorlabs for more information. Waste treatment is your own responsibility. “End of life” units must be returned to Thorlabs or handed to a company specializing in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

www.thorlabs.com

Documents / Resources

	**THORLABS PIM05-M Piezo Inertia Actuator Mirror Mounts** [pdf] User Guide PIM05-M, PIM05-M Piezo Inertia Actuator Mirror Mounts, Piezo Inertia Actuator Mirror Mounts, Inertia Actuator Mirror Mounts, Actuator Mirror Mounts, Mirror Mounts, Mounts

References

- Thorlabs, Inc. - Your Source for Fiber Optics, Laser Diodes, Optical Instrumentation and Polarization Measurement & Control
- Thorlabs, Inc. - Your Source for Fiber Optics, Laser Diodes, Optical Instrumentation and Polarization Measurement & Control
- Thorlabs - Your Source for Fiber Optics, Laser Diodes, Optical Instrumentation and Polarization Measurement & Control.
- User Manual