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THORLABS

ASM003 - June 11, 2018

Item # ASM003 was discontinued on June 11, 2018. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

KINEMATIC MIRROR MOUNTS WITH PIEZOELECTRIC ADJUSTERS

- 2- or 3-Adjuster Mounts with Fine Piezo and Coarse Manual Control
- Supports Ø7.0 mm, Ø1/2", Ø1", or Ø2" Mirrors
- Compatible with Any Thorlabs Piezo Controller

POLARIS-K2S2P
For Ø2" Mirrors

KC1-PZ
For Ø1" Mirrors

PZ630B
Ø1" Mirror Mount and
Three-Channel Controller Package

ASM003
For Ø7.0 mm Mirrors

OVERVIEW

Features

- Two-Axis or Three-Axis Mirror Mounts with Manual and Piezo Adjusters in Series
- For Ø7.0 mm, Ø1/2", Ø1", or Ø2" Mirrors
- SMC, BNC, or SMB Connectors for Piezo Control Voltage
- Standard Ø7.0 mm Mirror Mount is Ideal for Laser Cavities
- Standard Ø1" Mirror Mounts is 30 mm Cage Compatible and Available with Bundled Controller
- Polaris® Kinematic Mirror Mounts with Piezoelectric Adjusters are Designed for Exceptional Thermal and Long-Term Stability
- Can be Controlled with Any Thorlabs Piezo Controller

Suggested Piezo Controllers[a]
MDT693B Three-Axis Benchtop Controller
MDT694B Single-Axis Benchtop Controller
KPZ101 Single-Axis K-Cube Controller

- The mounts on this page will work with our closed-loop controllers as well, however they do not have a feedback mechanism.

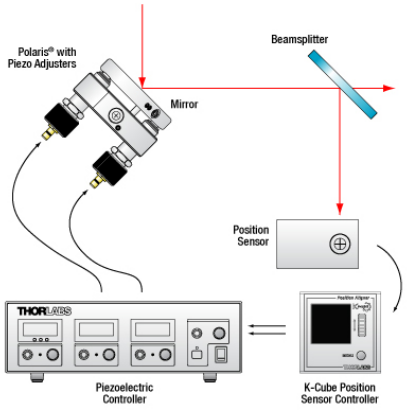
The two-axis and three-axis mirror mounts sold on this page contain manual and piezo adjusters in series, enabling coarse and fine adjustment of the tip, tilt, and translation of a mounted mirror.

Standard Three-Axis Kinematic Mirror Mounts with Piezo Adjusters
We manufacture a Ø7.0 mm mirror mount whose compact size is ideal for use in laser cavities, as well as a Ø1" (Ø25 mm) mirror mount with through holes for integration into a 30 mm cage assembly. The bore in the Ø1" mount is available with an optional internal SM1 (1.035"-40) thread, which allows a mirror to be mounted with SM1RR Retaining Rings as opposed to a setscrew. We also offer the Ø1" mirror mounts in bundles with the MDT693B Three-Channel Piezo Controller, which provides electronic control for all three axes.

Polaris Kinematic Mirror Mounts with Piezoelectric Adjusters
The Polaris Kinematic Mirror Mounts with Piezoelectric Adjusters are the ultimate solution for applications requiring stringent, actively monitored, long-term alignment stability. Two-axis mirror mounts that accept Ø1/2", Ø1", or Ø2" mirrors are available. Additionally, three-axis mirror mounts that accept Ø1" mirrors are also offered. These Polaris mounts use either a monolithic flexure arm or a flexure spring and setscrew combination to hold the optic. These designs

provide high holding force and pointing stability with minimal optic distortion. Machined from heat-treated stainless steel, Polaris mounts utilize precision-matched adjusters with ball contacts and sapphire seats to provide smooth kinematic adjustment. For more details, see the Polaris Kinematic Mirror Mounts with Piezoelectric Adjusters page.

APPLICATION



Click for Details
Piezo Controller as Part of a Closed-Loop System

Piezo Controller in a Beam Stabilization Setup

Active beam stabilization is often used to compensate for beam drift (unintended beam pointing deviations) in experimental setups. Drift can be caused by insecurely mounted optics, laser source instabilities, and thermal fluctuations within an optomechanical setup. In addition to correcting for setup errors, active stabilization is frequently used in laser cavities to maintain a high output power or used on an optical table to ensure that long measurements will take place under constant illumination conditions. Setups with long beam paths also benefit from active stabilization, since small angular deviations in a long path will lead to significant displacements downstream.

An example of a beam stabilization setup is shown in the schematic to the left. A beamsplitter inserted in the optical path sends a sample of the beam to a quadrant position sensor that monitors the displacement of the beam relative to the detector's center. (For optimal stabilization, the beamsplitter should be as close as possible to the measurement.) The quadrant detector outputs an error signal in X and Y that is proportional to the beam's position. Each error signal is fed into a channel of a piezoelectric controller that steers the beam back to the center of the quadrant sensor.

The setup illustrated here stabilizes the beam to a point in space. In order to stabilize the beam over a beam path, four independent output channels are required (i.e., at least two piezoelectric controllers), as are two mirror mounts with piezo adjusters, two position sensors, and two position sensor controllers. Suggested electronics for a beam stabilization setup are given in the table below.

Suggested Components	
Description	**Item #**
Mirror Mount with Piezo Adjusters (Choose One)	ASM003 Ø7.0 mm Mirror Mount, KC1-PZ(/M) Mirror Mount, KC1-T-PZ(/M) Mirror Mount with SM1-Threaded Bore, POLARIS-K1S3P Polaris® Mirror Mount with 3 Adjusters, or POLARIS-K05P2, POLARIS-K1S2P, POLARIS-K2S2P Polaris® Mirror Mount with 2 Adjusters
Piezoelectric Controller	MDT693B Three-Channel Benchtop Controller MDT694B Single-Channel Benchtop Controllers[a], or KPZ101 K-Cube Piezo Controllers[a]
Quadrant Position Detector	PDP90A (320 - 1100 nm), PDQ80A (400 - 1050 nm), or PDQ30C (1000 - 1700 nm)
K-Cube Position Sensor Controller	KPA101

- a. One controller is required per independently controlled axis.

CONTROLLER SPECS

Item #	MDT693B
Output Specifications	
Number of Channels	3
Connectors	BNC (One BNC-to-SMC Adapter per Channel Included)

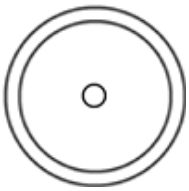
Output Voltage	0 - 75 V, 0 - 100 V, or 0 - 150 V (Selected by Switch on Rear)
Output Voltage Resolution When Using Knobs	1.1 mV (for 75 V Output Voltage Setting) 1.5 mV (for 100 V Output Voltage Setting) 2.2 mV (for 150 V Output Voltage Setting)
Output Current (Max)	60 mA
Output Noise[a]	1.5 mV (RMS) ~9.9 mV (Peak-to-Peak)
Output Impedance (Max)	150 Ω, 1.0 nF
Load Impedance[b] (Min)	2.5 kΩ
Bandwidth (-3 dB)	9 kHz (No Load, Small Signal) 8.5 kHz (No Load, 150 V_{pp})[c] 200 Hz (1.4 µF Piezo, 150 V_{pp})[c]
Bandwidth Stability (-3 dB)	<0.01% Over 5 Hours
External Control through BNC	
Input Voltage	0 - 10 V
Input Impedance	10 kΩ
Input Gain	7.5 V/V ± 5% (for 75 V Output Voltage Setting) 10 V/V ± 5% (for 100 V Output Voltage Setting) 15 V/V ± 5% (for 150 V Output Voltage Setting)
Output Voltage Resolution When Using BNC	Limited by Noise of External Voltage Source
Scan Trim Gain Adjustment	80% to 120% of Sum of Master Scan External Voltage and Offset from Rotary Adjustment Knob
External Control through Command Line	
Physical Interface	Female Type B USB 2.0 Connector
Digital-to-Analog Resolution	16-Bit, 2.75 mV
Analog-to-Digital Resolution	16-Bit, 3.0 mV
Physical Specifications	
Display Type	7-Segment LED with Four Digits
Display Resolution	0.1 V
Enclosure Size	12.18" × 4.15" × 8.55" (309.4 mm × 105.5 mm × 217.1 mm)
Weight	3.02 kg (6.65 lbs)
Operating Temperature	10 to 40 °C
Power Specifications	
Input Voltage	100 - 240 VAC
Input Frequency	50 - 60 Hz
Input Power (Max)	60 VA
Fuse Type	IEC60127-2/3 (250 VA, Slow Blow, Type "T")
Fuse Dimensions	5 mm x 20 mm
Fuse Rating	600 mA

- a. Tested without an external load connected (1 nF output impedance only). Adding a capacitive load, such as a piezo, will decrease the noise because the capacitance will create a low-pass filter with the output resistance.
- b. The smallest allowable terminating resistance. Applying lower impedances will cause the short-circuit protection to limit the output voltage. Continued use in this mode will cause circuit degradation and eventual circuit failure.
- c. Assume a ramp function is used. The bandwidth depends upon the load and requires a calculation for a more representative number. See Chapter 6 of the manual for details.

PIN DIAGRAMS

ASM003 Kinematic Mirror Mount

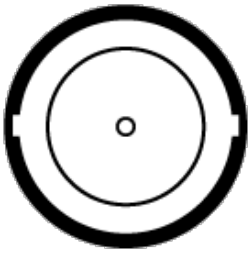
SMC Male



Input Voltage: 0 - 75 V

KC1(-T)-PZ Kinematic Mirror Mount

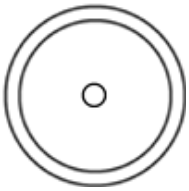
BNC Male



Input Voltage: 0 - 150 V

Polaris Kinematic Mirror Mount

SMB Male

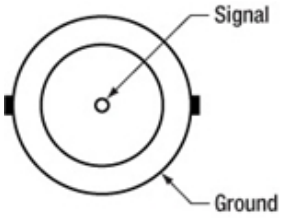


Input Voltage: 0 - 150 V

MDT693B Three-Channel Piezo Controller

Piezo Output

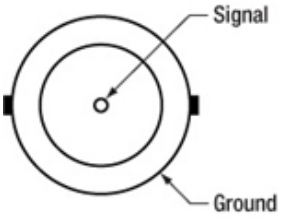
BNC Female



Output Voltage: 0 - 150 V
Output Impedance (Max): 150 Ω, 1.0 nF

External Voltage Control

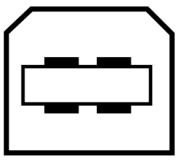
BNC Female



Input Voltage: 0 - 10 V
Input Impedance: 10 kΩ

External Computer Control

Type B USB Female



PIEZO BANDWIDTH

Piezo Driver Bandwidth Tutorial

Knowing the rate at which a piezo is capable of changing lengths is essential in many high-speed applications. The bandwidth of a piezo controller and stack can be estimated if the following is known:

1. The maximum amount of current the controllers can produce. This is 0.5 A for our BPC Series Piezo Controllers, which is the driver used in the examples below.
2. The load capacitance of the piezo. The higher the capacitance, the slower the system.
3. The desired signal amplitude (V), which determines the length that the piezo extends.
4. The absolute maximum bandwidth of the driver, which is independent of the load being driven.

To drive the output capacitor, current is needed to charge it and to discharge it. The change in charge, *dV/dt*, is called the slew rate. The larger the capacitance, the more current needed:

$$slew\,rate = \frac{dV}{dt} = \frac{I_{max}}{C}$$

For example, if a 100 µm stack with a capacitance of 20 µF is being driven by a BPC Series piezo controller with a maximum current of 0.5 A, the slew rate is given by

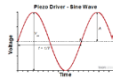
$$slew\,rate = \frac{0.5\,A}{20\,\mu F} = 25\,V/ms$$

Hence, for an instantaneous voltage change from 0 V to 75 V, it would take 3 ms for the output voltage to reach 75 V.

Note: For these calculations, it is assumed that the absolute maximum bandwidth of the driver is much higher than the bandwidths calculated, and thus, driver bandwidth is not a limiting factor. Also please note that these calculations only apply for open-loop systems. In closed-loop mode, the slow response of the feedback loop puts another limit on the bandwidth.

Sinusoidal Signal

The bandwidth of the system usually refers to the system's response to a sinusoidal signal of a given amplitude. For a piezo element driven by a sinusoidal signal of peak amplitude *A*, peak-to-peak voltage V_{pp}, and frequency *f*, we have:


Click to Enlarge

$$V(t) = Asin(2\pi ft) + A$$

A diagram of voltage as a function of time is shown to the right. The maximum slew rate, or voltage change, is reached at *t = 2nπ, (n=0, 1, 2,...)* at point *a* in the diagram to the right:

$$\left.\frac{dV}{dt}\right|_{t\,=\,2n\pi} = 2\pi A f_{max}$$

From the first equation, above:

$$\frac{dV}{dt} = \frac{I_{max}}{C}$$

Thus,

$$f_{max} = \frac{I_{max}}{2\pi AC} = \frac{I_{max}}{\pi V_{pp} C}$$

For the example above, the maximum full-range (75 V) bandwidth would be

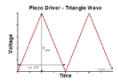
$$f_{max} = \frac{I_{max}}{\pi V_{pp} C} = \frac{0.5\,A}{\pi(20\,\mu F)(75\,V)} \approx 106\,Hz$$

.

For a smaller piezo stack with 10 times lower capacitance, the results would be 10 times better, or about 1060 Hz. Or, if the peak-to-peak signal is reduced to 7.5 V (10% max amplitude) with the 100 µm stack, again, the result would be 10 times better at about 1060 Hz.

Triangle Wave Signal

For a piezo actuator driven by a triangle wave of max voltage V_{peak} and minimum voltage of 0, the slew rate is equal to the slope: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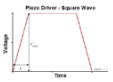
$$\frac{I_{max}}{C} = \frac{2V_{peak}}{T}$$

.

Or, since *f = 1/T*:

$$f_{max} = \frac{I_{max}}{2V_{peak}C} = \frac{0.5\,A}{2(20\,\mu F)(75\,V)} \approx 167\,Hz$$

Square Wave Signal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For a piezo actuator driven by a square wave of maximum voltage V_{peak} and minimum voltage 0, the slew rate limits the minimum rise and fall times. In this case, the slew rate is equal to the slope while the signal is rising or falling. If t_r is the minimum rise time, then

$$\frac{I_{max}}{C} = \frac{V_{peak}}{t_r}$$

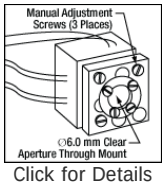
or

$$t_r = \frac{CV_{peak}}{I_{max}}.$$

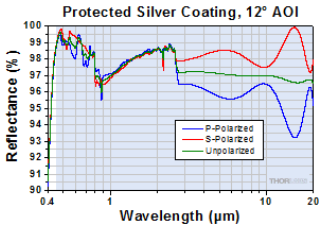
For additional information about piezo theory and operation, see the Piezoelectric Tutorials page.

Ø7.0 mm Kinematic Mirror Mount with Piezo Adjusters

- Compatible with Ø7.0 mm Mirrors up to 2.5 mm (0.10") Thick
- Ø6.0 mm Clear Aperture Through Entire Mount
- Manual and Piezo Adjusters in Series
  - Manual: ±2° (±35 mrad) Angular Range; ±0.5 mm Linear Travel
  - Piezo: ±1 arcmin (±0.3 mrad) Angular Range; ±3.5 µm Linear Travel
- Minimum Piezo Angular Adjustment: <1 arcsec (<5 µrad)
- SMC Connectors Accept Control Voltages up to 75 V
- Up to 2 kHz Operating Rate
- Mount Fabricated from Stainless Steel
- Includes Ø7.0 mm Silver Mirror and Mounting Plate for Flexure Stages



Click for Details
Schematic of ASM003 Mirror Mount



Click to Enlarge
The shaded region in the graph above denotes the range over which we recommend using our protected silver coating. Click here to download the raw data used to make this plot, as well as data at a 45° AOI.

Limited Stock

The ASM003 will be retired without replacement when stock is depleted. If you require this part for line production, please contact our OEM Team.

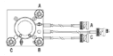
This piezo-driven mirror mount provides an angular resolution of better than 1 arcsec (<5 µrad). Each of the three adjustable axes consists of a manual and piezo adjuster in series. Ø7.0 mm optics up to 2.5 mm (0.10") thick are accommodated, and the Ø6.0 mm bore through the entire mount permits use with transmissive optics. A Ø7.0 mm protected silver mirror (Item # PF03-03-P01) is included; the reflectance of protected silver is shown to the right.

The fine-pitch manual adjusters, actuated with a flat head screwdriver (see diagram at right), provide 250 µm/rev and a full translation range of 1 mm (0.04"), for a full angular range of 4° (70 mrad). The piezoelectric elements embedded in the mount allow an additional 7 µm of translation, thereby providing an additional angular range of 2 arcmin (0.6 mrad). Each piezo adjuster is connected to a built-in 200 mm cable with a male SMC connector, and the maximum control voltage is 75 V. When driven by one of our piezoelectric drivers, the piezo elements can operate at up to 2 kHz, making this mirror mount an ideal laser cavity mirror holder when rapid scanning of a resonator cavity length is required.

The bottom of the ASM003 includes a mounting plate with an alignment key for mechanical compatibility with our family of flexure stages. The mounting plate is secured in place by two M2.5 cap screws that can be removed for custom mounting needs.

Part Number	Description	Price	Availability
ASM003	Ø7.0 mm Mirror Mount, 3 Piezo Adjusters, Protected Silver Mirror Included	$1,554.48	Lead Time

Ø1" (Ø25 mm) Kinematic Mirror Mounts with Piezo Adjusters



Click to Enlarge
Cable Diagram

- Compatible with Ø1" (Ø25 mm) Mirrors
- Available with Smooth or SM1-Threaded (1.035"-40) Central Bore
- Through Holes for Integration with a 30 mm Cage System
- Manual and Piezo Adjusters in Series
  - Manual: ±5° (±87 mrad) Angular Range; ±3 mm Linear Travel
  - Piezo: ±15 arcsec (±73 µrad) Angular Range; ±4 µm Linear Travel
- Minimum Piezo Angular Adjustment: 0.06 arcsec (0.3 µrad)
- BNC Connectors Accept Control Voltages up to 150 V
- Mount Fabricated from Black Anodized Aluminum
- Available with Bundled Controller (See Below)

These mirror mounts, based upon our KC1 mirror mounts, provide piezo-driven fine adjustments with a minimum angular resolution of 0.06 arcsec (0.3 µrad). Each of the three adjustable axes consists of a manual and piezo adjuster (Item # AE0505D08F) in series. The smooth bore version [Item # KC1-PZ(/M)] secures the mirror with an 8-32 (M4) setscrew and accepts mirrors at least 0.12" (3 mm) thick, while the SM1-threaded version [Item # KC1-T-PZ(/M)] secures the mirror with two included SM1RR Retaining Rings and accepts mirrors up to 0.20" (5 mm) thick.

The 1/4"-80 manual adjusters provide 7 mrad/rev and a full translation range of 6 mm (0.24"), for a full angular range of 10° (174 mrad). The piezoelectric elements embedded in the mount allow an additional 8 µm of translation, thereby providing an additional angular range of 30 arcsec (146 µrad). Each piezo adjuster is connected to a built-in 3' (91.4 cm) cable with a male BNC connector, and the maximum control voltage is 150 V. The knob assignments are shown in the diagram to the right.

Although SM1-threaded optics and lens tubes can be attached to the KC1-T-PZ, we do not recommend it because increasing the distance between the optic and the pivot points of the mount will amplify the movement of the beam. These mounts are also sold bundled with the MDT693B Three-Channel Piezo Controller, providing all the components needed for open-loop control of the mount (see below for details).

Part Number	Description	Price	Availability
KC1-PZ/M	Ø1" (Ø25 mm) Mirror Mount, 3 Piezo Adjusters, Smooth Bore, Metric	$648.72	Today
KC1-T-PZ/M	Ø1" (Ø25 mm) Mirror Mount, 3 Piezo Adjusters, SM1 Threaded, Metric	$649.74	Today
KC1-PZ	Ø1" (Ø25 mm) Mirror Mount, 3 Piezo Adjusters, Smooth Bore	$648.72	Today
KC1-T-PZ	Ø1" (Ø25 mm) Mirror Mount, 3 Piezo Adjusters, SM1 Threaded	$649.74	Today

Ø1" (Ø25 mm) Kinematic Mirror Mounts with Piezo Adjusters and Bundled Controller

- Includes One KC1-PZ(/M) or KC1-T-PZ(/M) Mirror Mount (Shown Above)
- Bundled MDT693B Controller Includes:
  - Three Output Channels with BNC Connectors and Output Voltage up to 150 V
  - Controlled Directly by Front Panel or Remotely Through BNC or Command Line
  - Ability to Drive All Channels with One Signal

Click for Details
Front Panel of Controller

These bundles provide all the components and cables needed for open-loop control of a three-axis kinematic mirror mount with piezo adjusters. They consist of our MDT693B Three-Channel Piezo Controller, a KC1-PZ(/M) or KC1-T-PZ(/M) mirror mount (see above for details on the mirror mount options), and a region-specific power cord selected at the time of the order.

The MDT693B piezo controller features three precise, low-noise, independently controllable output channels and is capable of supporting the piezo mirror mounts' maximum control voltage of 150 V. The control voltage can be modified using rotary knobs on the front panel and by providing an external signal through BNC or USB 2.0. The driver also includes a Master Scan mode that allows all three axes to be controlled by one signal. For more information, please see the full MDT693B presentation.

Part Number	Description	Price	Availability
PZ630B/M	KC1-PZ/M Smooth Bore Mirror Mount and MDT693B Piezo Controller	$2,680.56	Today
PZ631B/M	KC1-T-PZ/M SM1-Threaded Mirror Mount and MDT693B Piezo Controller	$2,680.56	Today
PZ630B	KC1-PZ Smooth Bore Mirror Mount and MDT693B Piezo Controller	$2,680.56	Today

PZ631B	KC1-T-PZ SM1-Threaded Mirror Mount and MDT693B Piezo Controller	$2,680.56	Today

Ø1/2", Ø1", and Ø2" Polaris® Kinematic Mirror Mounts with Piezoelectric Adjusters

- Compatible with Ø1/2", Ø1", or Ø2" Mirrors
- Manual and Piezo Adjusters in Series (See *Key Specifications* Table to the Right)
- SMB Connectors Accept Control Voltages up to 150 V
- Passivated Stainless Steel Surface Ideal for Vacuum and High-Power Laser Cavity Applications
- SMB-to-BNC Cables Included
- Custom Mount Configurations are Available by Contacting Tech Support

Key Specifications[a]			
Optic Size	**Ø1/2"**	**Ø1"**	**Ø2"**
Number of Adjusters	2	2 or 3	2
Optic Thickness (Min)	0.08" (2 mm)	0.14" (3.5 mm)	
Mechanical Angular Range	±5°	±4°	±3.4°
Piezoelectric Angular Range	>490 µrad	>500 µrad	>280 µrad
Adjusters	Manually Adjustable 100 TPI Screws with Integrated Piezoelectric Elements		
Minimum Step Size	~0.5 µrad		~0.18 µrad
Piezo Control Voltage	0 to 150 V		
Piezo Connectors	Male SMB (SMB-to-BNC Cables Included)		
Beam Deviation after Temperature Cycling[b]	<6 µrad	<1 µrad	<2 µrad
Mounting	Two #8 (M4) Counterbores		Four #8 (M4) Counterbores

- a. Please see the *Specs* tab on this page for complete specifications.
- b. While the Polaris mount was physically disconnected from its piezo controller (zero bias), the ambient temperature was increased by 15 °C, then allowed to return to room temperature. For more details, please see the *Test Data* tab on this page.

The Polaris Kinematic Mirror Mounts with Piezoelectric Adjusters are designed to provide long-term alignment stability in closed-loop systems. They offer exceptional angular resolution of ~0.5 µrad for the Ø1/2" and Ø1" mounts and ~0.18 µrad for the Ø2" mount for a 0.1 V step via piezoelectric adjustment. We recommend driving the piezo actuators using our benchtop or Kinesis K-Cube piezo controllers.

The Polaris integrated matched adjuster/body design results in greater durability and thermal performance compared to non-Polaris mirror mounts. A flexure spring and setscrew combination or monolithic flexure arm provides temperature-independent retention of the optic, unlike nylon-tipped setscrews that are sensitive to temperature fluctuations. The setscrew that adjusts the flexure spring accepts a 1/16" (1.5 mm) hex key for the Ø1/2" mirror mount, or a 0.05" (1.3 mm) hex key for the Ø1" and Ø2" mirror mounts. We strongly recommend using a torque driver for securing the optic to prevent optical surface distortion and to improve thermal stability.

The mirror mounts come with two or three adjuster lock nuts that can be tightened by holding the adjuster knob while lightly tightening the lock nut by hand or with a 11 mm thin-head (for the Ø1/2" mount) or 12 mm thin-head (for the Ø1" and Ø2" mounts), open-ended hex wrench. Lock nuts only need to be lightly tightened to a torque of approximately 4 to 8 oz-in (0.03 to 0.06 N·m). These lock nuts hold in place the manual adjustment and will not affect the fine piezoelectric adjustment of this mount. Post mounting is provided by #8 (M4) counterbores for right- or left-handed mounting. Select mounts also include Ø2 mm alignment pin holes around the mounting counterbore, allowing for precision alignments when paired with our posts for Polaris mirror mounts.

For more details, see the Polaris Kinematic Mirror Mounts with Piezoelectric Adjusters page.

Part Number	Description	Price	Availability
POLARIS-K05P2	Polaris® Piezoelectric Ø1/2" Mirror Mount, 2 Adjusters with Lock Nuts, Cables Included	$827.22	3-5 Days
POLARIS-K1S3P	Polaris® Piezoelectric Ø1" Mirror Mount, 3 Adjusters with Lock Nuts, Cables Included	$1,096.00	Today
POLARIS-K1S2P	Polaris® Piezoelectric Ø1" Mirror Mount, 2 Adjusters with Lock Nuts, Cables Included	$859.00	Today
POLARIS-K2S2P	Customer Inspired! Polaris® Piezoelectric Ø2" Mirror Mount, 2 Adjusters with Lock Nuts, Cables Included	$1,000.00	Today