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Z806V - November 2, 2023

Item # Z806V was discontinued on November 2, 2023. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

10 mm (0.39") TRAVEL OR LESS MOTORIZED ACTUATORS

- ► High-Resolution Piezo Inertia, Stepper, and DC Servo
- ► Compatible with a Wide Range of Stages
- ► Velocities up to 5 mm/s

Z906
6 mm Travel, DC Actuator

PIAK10VF
10 mm Travel
Piezo Inertia Actuator,
Vacuum Compatible

DRV208
8 mm Travel,
Stepper Motor Actuator

ZFS06
6 mm Travel, Compact
Stepper Motor Actuator

6 mm Travel Compact Stepper Motor Actuator

OVERVIEW

Features

- Compact Package: 86.5 mm (3.40") Long, Fully Retracted
- Manual Adjustment via Rear-Located Thumbscrew
- Non-Rotating Drive Tip
- Compatible with Mirror Mounts and Translation Stages with 1/4"-80 Threads
- Also Available in 13 mm and 25 mm Travel Versions

Required Controller: KST201

- 49,152 Microsteps per Revolution
- 15 V Output at 12 W
- Trapezoidal and 'S-Curve' Velocity Profiles

Click to Enlarge

Our ZFS06 Motorized Actuator provides smooth, precise linear motion control in a sleek, compact package measuring just 86.5 mm (3.40") in length when fully retracted. This compact profile reduces the distance between the end of the actuator and optomechanical components, keeping the center of mass closer to the contact point than the ZST206 actuator featured above. This actuator has a 1/4"-80 threaded barrel that can be mounted to any manual mirror mount or positioning stage equipped with 1/4"-80 threads.

Powered by a small-diameter, two-phase, bi-polar stepper motor, this actuator operates at speeds of up to 2.0 mm/s. The non-rotating drive tip reduces wear and friction and improves smoothness of motion by removing rotational contact at the tip. If power is not supplied to the actuator, manual adjustment is achievable using the rear-located thumbscrew. The actuator motor can be damaged if this thumbscrew is rotated while power is being supplied to the motor.

Our ZFS06 actuator incorporates a stepper motor that provides sufficient torque for loads up to 40 N (8.99 lbs). The actuator allows for very small step sizes over the entire travel range, delivering greater flexibility with low (<15 µm) backlash and fine resolution. The design incorporates a 400:9 gear reduction head which, when combined with the 49,152 microsteps per revolution offered by the KST201 stepper motor driver, gives a theoretical travel per microstep of 0.46 nm (see the *Calculations* tab for details).

Hall effect limit switches prevent the unit from being overdriven and provide homing capability with an accuracy of <5.0 µm. The ZFS series actuators come with 0.6 m (2 ft) of cable terminated in a 15-pin D-Type connector (see the *Pin Diagrams* tab) that is compatible with our KST201 stepper motor controller.

Item #	ZFS06
Travel	6 mm (0.24")
Backlash[a]	<15 µm
Bidirectional Repeatability	<5.0 µm

A 1 m (3.3 ft) extension cable (PAA614) is available separately.

The ZFS06 has been designed specifically to replace the manual adjusters in stages and mirror mounts that have 1/4"-80 threaded fittings, particularly in applications where space is tight. Simply remove the existing manual adjuster from the mount and screw in the ZFS06 actuator. Two ZFS06 motorized actuators replace the thumbscrews of the KM100 in the image below.

Home Location Accuracy	<5.0 µm
Maximum Load Capacity	40 N (8.99 lbs)
Velocity	2.0 mm/s (Max)
Acceleration	10 mm/s^2 (Max)
Gearbox Ratio	400:9 (Approx. 44:1)
Limit Switches	Hall Effect
Lead Screw Pitch	1.0 mm
Motor Type	2-Phase Stepper
Microsteps per Revolution of the Motor[b]	24 Full Steps, 2048 µsteps per Full Step 49,152 µsteps per Revolution
Calculated Minimum Incremental Motion[c]	0.46 nm
Operating Temperature	5 to 40 °C (41 to 104 °F)
Dimensions (L x W x H)	86.5 mm x 35.0 mm x 19.0 mm (3.40" x 1.38" x 0.75")
Cable Length	0.6 m (2 ft)
Connector	HDDB15
Required Controller	KST201

a. The user can correct for backlash errors by adjusting software settings.
b. Measured using Thorlabs' previous generation TST101 T-Cube™ Stepper Motor Controller.
c. See the *Calculations* tab for more information.

Click to Enlarge
A KM100 mirror mount with the screw adjusters replaced by two ZFS06 actuators.

CALCULATIONS

How to calculate the linear displacement per microstep

The ZFS series of motors has 24 full steps per revolution, and when driven by the KST201 drivers, there are 2048 microsteps per full step, giving 49,152 microsteps per revolution of the motor. The output shaft of the motor goes into a 400:9 gear head. This requires the motor to rotate 44.445 times to rotate the 1.0 mm pitch lead screw one revolution. The end result is the lead screw advances by 1.0 mm.

Linear displacement of the lead screw per microstep:

$$\text{Number of Microsteps} \times \text{Gearbox Ratio} = 49{,}152 \times 44.445 = 2184560.64$$

The linear displacement of the lead screw per microstep is

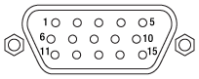
$$1.0 \text{ mm} / 2184560.64 = 0.46 \times 10^{-6} \text{ mm} = 0.46 \text{ nm}$$

PIN DIAGRAM

Pin Diagram

Connector Pin Out

Pin	Description	Pin	Description
1	Limit Ground	8	Reserved for Future Use



High-Density D-Type Male 15 Pin Connector

2	CCW Limit Switch	9	Reserved for Future Use
3	CW Limit Switch	10	Vcc (+5 VDC)
4	Motor Phase B -	11	Reserved for Future Use
5	Motor Phase B +	12	Reserved for Future Use
6	Motor Phase A -	13	Reserved for Future Use
7	Motor Phase A +	14	Reserved for Future Use
-	-	15	Ground


Click to Enlarge
High-Density D-Type Male 15 Pin Connector

Part Number	Description	Price	Availability
ZFS06	Customer Inspired! 6 mm Travel, Compact Stepper Motorized Actuator, 1/4"-80 Threaded	$1,286.91	Today

6 mm Travel Stepper Motor Actuator

OVERVIEW

Features

- Non-Rotating Drive Tip
- Bi-Polar Stepper Motor Actuator: 111.0 mm (4.37") Long
- 1/4"-80 Threaded Barrel Mounting
- Compatible with Mirror Mounts and Translation Stages with 1/4"-80 Threads
- Also Available in 13 mm and 25 mm Travel Versions

Required Controller: KST201

- 49,152 Microsteps per Revolution
- 15 V Output at 12 W
- Trapezoidal and 'S-Curve' Velocity Profiles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Our ZST series actuators provide smooth, precise linear motion control in a package measuring 111.0 mm (4.37") in length. Powered by a small-diameter, two-phase, bi-polar stepper motor, this actuator operates at speeds of up to 2.0 mm/s. The non-rotating drive tip reduces wear and friction and improves smoothness of motion by removing rotational contact at the tip. This actuator has a 1/4"-80 threaded barrel that can be mounted to any manual mirror mount or positioning stage equipped with 1/4"-80 threads.

Our ZST200 line of actuators all incorporate a stepper motor that provides sufficient torque for loads up to 40 N (8.99 lbs). The actuator allows for very small step sizes over the entire travel range, delivering greater flexibility with low (<15 µm) backlash and fine resolution. The design incorporates a 41:1 gear reduction head which, when combined with the 49,152 microsteps per revolution offered by the KST201 stepper motor driver, gives a theoretical travel per microstep of 0.5 nm (see the *Calculations* tab for details).

Hall effect limit switches prevent the unit from being overdriven and provide homing capability with an accuracy of <5.0 µm. This actuator comes with 0.6 m (2 ft) of cable terminated in a 15-pin D-Type connector that is compatible with our KST201 stepper motor controller. A 1 m (3.3 ft) extension cable (PAA614) is available separately.

The ZST206 has been designed specifically to replace the manual adjusters in stages and mirror mounts that have 1/4"-80 threaded fittings. Simply remove the existing manual adjuster from the mount and screw in the ZST206 actuator.

Item #	ZST206
Travel	6 mm (0.24")
Backlash[a]	<15 µm
Bidirectional Repeatability	<5.0 µm
Home Location Accuracy	<5.0 µm
Maximum Load Capacity	40 N (8.99 lbs)
Velocity	2.0 mm/s (Max)
Acceleration	10 mm/s^2 (Max)
Gearbox Ratio	29791:729 (Approx. 41:1)
Limit Switches	Hall Effect
Lead Screw Pitch	1.0 mm
Motor Type	2-Phase Stepper
Microsteps per Revolution of the Motor[b]	24 Full Steps, 2048 µsteps per Full Step 49,152 µsteps per Revolution
Calculated Minimum Incremental Motion	0.5 nm
Operating Temperature	5 to 40 °C (41 to 104 °F)

Dimensions (L x W)	111.0 mm x 19.0 mm (4.37" x 0.75")
Cable Length	0.6 m (2 ft)
Connector	HDDB15
Required Controller	KST201

a. The user can correct for backlash errors by adjusting software settings
b. Measured using Thorlabs' previous generation TST101 T-Cube™ Stepper Motor Controller.

Click to Enlarge
A KM100 mirror mount with the screw adjusters replaced by two ZST206 actuators.

CALCULATIONS

How to calculate the linear displacement per microstep

Each member of the ZST200 series of motors has 24 full steps per revolution, and when driven by the KST201 drivers, there are 2048 microsteps per full step. Hence, there are 49,152 microsteps per revolution of the motor. The output shaft of the motor goes into a 40.866:1 gear head. This requires the motor to rotate 40.866 times to rotate the 1.0 mm pitch lead screw one revolution. The end result is the lead screw advances by 1.0 mm. To calculate the linear displacement of the actuator per microstep, use the following:

Linear displacement of the lead screw per microstep:

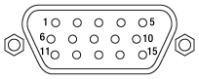
Number of Microsteps x Gearbox Ratio = 49,152 x 40.866 = 2,008,645.63

The linear displacement of the lead screw per microstep is

$1.0 \text{ mm} / 2{,}008{,}645.63 = 0.49 \times 10^{-6} \text{ mm} = 0.5 \text{ nm}$

PIN DIAGRAM

Pin Diagram



High-Density D-Type Male 15 Pin Connector

Connector Pin Out

Pin	Description	Pin	Description
1	Limit Ground	8	Reserved for Future Use
2	CCW Limit Switch	9	Reserved for Future Use
3	CW Limit Switch	10	Vcc (+5 VDC)
4	Motor Phase B -	11	Reserved for Future Use
5	Motor Phase B +	12	Reserved for Future Use
6	Motor Phase A -	13	Reserved for Future Use
7	Motor Phase A +	14	Reserved for Future Use
-	-	15	Ground

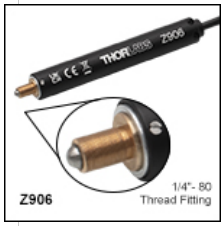
Click to Enlarge
High-Density D-Type Male 15 Pin Connector

Part Number	Description	Price	Availability
ZST206	6 mm Travel, Stepper Motorized Actuator, 1/4"-80 Thread	$1,084.27	Today

6 mm Travel DC Servo Motor Actuator

OVERVIEW

Features



- 6 VDC Servo Actuator
- Sub-Micron Resolution
- Maximum Operating Speed: 2.6 mm/s
- Drop-In Replacement for Most 6 mm Manual Actuators
- Compatible with 1/4"-80 Thread-Fitting Stages and Mounts
- Limit Switches for Zero Datum and Actuator Protection
- Also Available in 12 mm and 25 mm Travel Versions

Required Controller: KDC101

- 34,555 Microsteps per Revolution
- 15 V Output at 2.5 W
- Trapezoidal Velocity Profile

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Thorlabs' Z906 motorized actuators are engineered for use with optical positioning devices such as mirror mounts and stages. They offer high resolution in a lightweight package, which makes these actuators ideally suited for demanding optical laboratory automation applications.

Electromechanical limit switches provide overdrive protection and accurate home positioning. The incorporated motor is capable of speeds up to 2.6 mm/s, but a maximum operating speed of 2.3 mm/s is recommended to maintain the specified control. The precision of the encoder (512 counts per motor revolution) results in a minimum resolution of about 29 nm. See *Calculations* tab for details.

The Z906 has been designed specifically to replace the manual adjusters in stages and mirror mounts that have 1/4"-80 threaded fittings. Simply remove the existing manual adjuster from the mount, and screw in the actuator. The image below shows a KM100 mirror mount with one of the screw adjusters replaced by a Z906 actuator. The units are shipped with one 485 mm cable. A 2.5 m (8 ft) extension cable (Item # PAA632) is available separately.

The KDC101 DC Servo Controller is the required driver for the Z9 series actuators. The latest version of the Kinesis software can be downloaded here. Firmware version 2.2.8 or higher, included in the Kinesis software version 1.14.40 or higher download, is required for using the KDC101 with the Z9 actuators. Prior versions of firmware will operate the Z9 actuators but will call the actuators Z8.

For applications with longer travel requirements, see our 12 mm travel Z912 and 25 mm travel Z825 actuators. We also offer the Z806V vacuum-compatible version, which is rated for use down to 10^{-6} torr and is shipped with a 1.6' flat ribbon cable, IDC connector, and converter cable for use with the KDC101 controller. See below for more details.

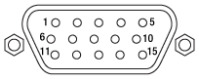
Item #	Z906
Travel Range	6 mm (0.24")
Encoder Resolution[a]	34,555 counts/mm (Linear Displacement)
Maximum Pushing Force	45 N
Homing Repeatability	±5 µm
Uncompensated Backlash	6 µm
Uncompensated Bidirectional Repeatability	±3 µm
Residual Backlash After Compensation[b]	0.1 µm
Compensated Bidirectional Repeatability	±0.3 µm
Travel Accuracy[c]	6 µm
Minimum Repeatable Incremental Movement	0.2 µm
Maximum Speed[d]	2.6 mm/s
Maximum Acceleration	4 mm/s^2
Maximum Phase to Phase Resistance	33.0 Ω
Maximum Phase to Phase Inductance	0.6 mH
Tested Lifetime[e]	>100,000 Cycles
Operating Temperature Range	41° to 104° F (5° to 40° C)
Weight	0.13 kg
Motor Type[f]	DC Servo
Cable Length	485.0 mm (19.09")
Required Controller	KDC101

a. See *Calculations* tab for details.
b. For an inward move, the system moves inwards 300 µm beyond the target location to compensate for known backlash.
c. Default backlash compensation is present against a constant force.
d. At 2.6 mm/s, velocity ripple and distortion of the acceleration/deceleration profile may occur. For improved control, the maximum speed should be limited to 2.3 mm/s.
e. Tested with a load of 9 N on the lead screw.
f. Variable voltage under pulse width modulation (PWM) from a 15 V supply.

Click to Enlarge
[APPLIST]
[APPLIST]
A KM100 mirror mount with one screw adjuster replaced with Z906 actuator.

PIN DIAGRAM

Pin Diagram



High-Density D-Type Male 15 Pin Connector

Connector Pin Out

Pin	Description	Pin	Description
1	Ground (Limit and Vcc)	9	Resistive Identification
2	Forward Limit	10	+5 VDC
3	Reverse Limit	11	Encoder Channel A
4	Reserved for Future Use	12	Reserved for Future Use
5	Motor (-)	13	Encoder Channel B
6	Reserved for Future Use	14	Pin 2 Ident EEPROM
7	Motor (+)	15	Pin 1 Ident EEPROM
8	Reserved for Future Use		

Click to Enlarge
High-Density D-Type Male 15 Pin Connector

CALCULATIONS

How to Calculate the Linear Displacement per Encoder Count

For the Z906, there are 512 encoder counts per revolution of the motor. The output shaft of the motor goes into a 67.49:1 planetary gear head. This requires the motor to rotate 67.49 times to rotate the 1.0 mm pitch lead screw one revolution. The end result is the lead screw advances by 1.0 mm.

The linear displacement of the actuator per encoder count is given by

512 x 67.49 = 34,555 encoder counts per revolution of the lead screw,

whereas the linear displacement of the lead screw per encoder count is given by

1.0 mm / 34,555 counts = 2.9 x 10^{-5} mm (29 nm).

Part Number	Description	Price	Availability
Z906	**NEW! 6 mm Motorized DC Actuator, 1/4"-80 Thread Fitting, 485 mm Cable**	**$840.00**	**Today**

6 mm Travel Vacuum-Compatible DC Servo Motor Actuator

OVERVIEW

Features

- 6 VDC Servo Actuator
- Sub-Micron Resolution
- Maximum Velocity: 2.3 mm/s
- Drop In Replacement for Most 6 mm Manual Actuators
- Compatible with 1/4"-80 Thread-Fitting Stages and Mounts
- Limit Switches for Zero Datum and Actuator Protection
- Rated Down To 10^{-6} Torr
- Also Available in 12 mm and 25 mm Travel Versions

The Z806V actuator offers features and specifications similar to the Z906 actuator described above with the added benefit of being vacuum compatible down to 10^{-6} Torr. It incorporates vacuum-rated servo motors, a phosphorus bronze internal coupling mechanism and mounting bush, and high-vacuum grease.

The Z806V actuator is shipped with a 1.6' (0.5 m) vacuum compatible flat ribbon cable with IDC connector. This cable has a 0.05" (1.27 mm) pitch, 28 AWG stranded conductors and Fluorinated Ethylene Propylene (FEP) insulation. A converter cable for use with the KDC101 controller is also supplied, but it is not vacuum compatible and should only be used outside the chamber.

For applications with longer travel requirements, see our 12 mm travel Z812V and 25 mm travel Z825BV actuators. For vacuum compatible versions of our stages and mirror mounts, please contact Tech Support.

The KDC101 DC Servo Controller is the required driver for the Z8 series actuators. Please note that previous generation TDC001 units will require a firmware upgrade to V1.0.10 or later, before they can be used with the Z8 series motors. An upgrade is included with the latest APT Server software, which can be downloaded here.

Item #	Z806V
Motor Type[a]	6 VDC Servo
Travel	6.0 mm (0.24")
Backlash	<8 µm
Bidirectional Repeatability	<1.5 µm
Home Location Accuracy	<2 µm
Homing Repeatability	±1.0 µm
Vertical Load Capacity	4.5 kg (Max)
Horizontal Load Capacity	9 kg (Max)
Vertical Load Capacity[b]	<4.0 kg
Horizontal Load Capacity[b]	<7.5 kg
Velocity[c]	2.6 mm/s (Max)
Acceleration	4 mm/s^2 (Max)
Absolute On-Axis Accuracy	42 µm
Percentage Accuracy	0.82% (Max)
Motor Coil Temperature	85 °C (Max)
Limit Switch Life Time	>100,000 Cycles
Minimum Achievable Incremental Movement	0.05 µm
Minimum Repeatable Incremental Movement	0.2 µm
Operating Temperature Range	41 to 104 °F (5 to 40 °C)
Vacuum Rating	10^{-6} Torr
Weight	0.134 kg
Required Controller	KDC101

a. The nominal motor drive voltage is 6 V. Voltages up to 12 V can be used with pulse width modulation (PWM) controlled outputs.
b. Recommended
c. At 2.6 mm/s velocity ripple and distortion of the acceleration/deceleration profile may occur. For improved control, the max velocity should be limited to 2.3 mm/s.

Required Controller: KDC101

- 34,555 Microsteps per Revolution
- 15 V Output at 2.5 W
- Trapezoidal Velocity Profile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CALCULATIONS

How to Calculate the Linear Displacement per Encoder Count

For the Z806V, there are 512 encoder counts per revolution of the motor. The output shaft of the motor goes into a 67.49:1 planetary gear head. This requires the motor to rotate 67.49 times to rotate the 1.0 mm pitch lead screw one revolution. The end result is the lead screw advances by 1.0 mm.

The linear displacement of the actuator per encoder count is given by

512 x 67.49 = 34,555 encoder counts per revolution of the lead screw,

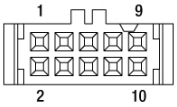
whereas the linear displacement of the lead screw per encoder count is given by

1.0 mm / 34,555 counts = 2.9 x 10^{-5} mm (29 nm).

PIN DIAGRAM

The vacuum-compatible cable integrated with the Z806V is terminated in a Female IDC 10-Pin socket connector. A short converter cable, which adapts this female IDC socket connector to a D-Type male HD15 pin connector, is included with the Z806V to facilitate connecting the actuator to the recommended KDC101 controller. This converter cable, whose terminating connectors are shown at right, is not vacuum compatible. Information describing the pin assignments for both the female IDC socket and Male D-Type HD connector (when it is connected to the female IDC socket connector) follows.

Pin Diagram



10 Pin Female IDC Socket Connector
(Amphenol T812 Series, 2.54 mm Pitch)

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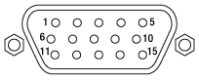
10 Pin Female IDC Socket Connector
(Amphenol T812 Series, 2.54 mm Pitch)

Female IDC 10-Pin Connector Pin Out

Pin	Description	Pin	Description
1	Motor (+ve) (6 V)[a]	6	Motor (-ve) (6 V)[a]
2	Vcc (+5 V)	7	Limit Ground
3	Encoder Channel A	8	Reverse Limit
4	Encoder Channel B	9	Forward Limit
5	Ground	10	Reserved for Future Use

a. The nominal motor drive voltage is 6 V. Voltages up to 12 V can be used with pulse width modulation (PWM) controlled outputs.

Pin Diagram



High-Density D-Type Male 15 Pin Connector

Male HDDB15 Connector Pin Out

Pin	Description	Pin	Description
1	Ground (Limit and Vcc)	8	Reserved For Future Use
2	Forward Limit	9	Ident Resistor
3	Reverse Limit	10	Vcc (+5 VDC)
4	Reserved For Future Use	11	Encoder Channel A
5	Motor (-)	12	Reserved for Future Use
6	Reserved for Future Use	13	Encoder Channel B
7	Motor (+)	14, 15	Reserved For Future Use

Click to Enlarge
Connectors terminating the converter cable. The image on the left shows the high-density D-Type male 15-pin connector, and the image on the right shows the 10-pin male IDC socket connector.

Part Number	Description	Price	Availability
Z806V	Vacuum-Compatible 6 mm Motorized DC Actuator, 1/4"-80 Thread Fitting	$996.92	Lead Time

8 mm Travel Stepper Motor Actuator

OVERVIEW

Features

- 8 mm Total Travel
- High Maximum Force of 180 N
- Non-Rotating Drive Tip

Compatible Controller: BSC201

- 409,600 Microsteps per Revolution

- 500 mm (19.7") D-Type Connection Cable Attached
- 3 m Extension Cable Included
- MCA1 and MCA2 Adapters Convert to Ø3/8" or Ø10 mm Mounting Barrel

- 48 V Output at 25 W
- Trapezoidal and 'S-Curve' Velocity Profile

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The DRV208 Modular Stepper Motor Actuator is designed to be used with our 3-axis and 6-axis NanoMax™ flexure stages. The M22 x 0.75 threaded flange interfaces directly with the NanoMax stage, making it easy to select an actuator for each axis based on the user's requirements. Using the MCA1 or MCA2 quick-connect adapters, this actuator can also be fitted to a stage with standard Ø3/8" or Ø10 mm mounting clamps, respectively. Additionally, the DRV208 drive is compatible with the DRV120 piezo drive, which adds 20 µm of electronically controlled piezo-actuated travel.

This actuator features an 8 mm travel range and is capable of speeds up to 5 mm/s. The powerful stepper motor driver has a maximum force of 180 N.

The knurled knob on the rear shaft of the motor can function as a manual adjuster when the actuator is powered down. Note that in an open-loop system, manually adjusting the actuator position will desynchronize the actuator from the position display in the control software. This can be corrected by homing the actuator back to its original zero position, which should be done immediately upon powering up the actuator. The knob also serves as an inertial damper which absorbs vibrations from the stepper motor.

A 500 mm (19.7") cable with a 15-pin D-type connector is attached to the unit to connect the stepper motor to a controller. The unit also comes with a 3 m (9.8 ft) extension cable (item # PAA613). If a shorter cable is needed, the 1 m (3.3 ft) PAA612 cable is available separately.

Item #	DRV208
Travel	8 mm (0.3")
Unidirectional Repeatability	3.6 µm
Bidirectional Repeatability	5.0 µm
Absolute Accuracy	17.1 µm
Maximum Force	180 N
Maximum Velocity	5 mm/s
Maximum Acceleration	5 mm/s^2
Full Step Angle	1.8°
Feedback	None
Limit Switches	Hall Effect
Lead Screw Pitch	0.5 mm
Homing Repeatability	13.5 µm
Motor Type	2-Phase Stepper
Microsteps per Revolution of Leadscrew	409,600
Compatible Controllers	BSC201 MST602

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The DRV208 can be installed on a 3-axis NanoMax stage.

CALCULATIONS

How to Calculate the Linear Displacement per Microstep

The stepper motor used in the DRV208 actuator has 200 full steps per revolution of the motor. Each full step is broken down into 2048 microsteps. There are 409,600 microsteps per revolution of the motor when using the BSC201 controller. The end result is the leadscrew advancing by 0.5 mm. To calculate the linear displacement of the actuator microstep, use the following:

409,600 microsteps per revolution of the lead screw

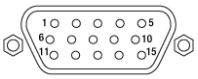
The linear displacement of the lead screw per microstep is:

$$0.5 \text{ mm} / 409{,}600 = 1.2 \times 10^{-6} \text{ mm}$$

To calculate the linear displacment for a full step, substitute 409,600 with 200.

PIN DIAGRAM

Pin Diagram



High-Density D-Type Male 15 Pin Connector

Connector Pin Out

Pin	Description	Pin	Description
1	Limit Switch 0 V	9	For Future Use
2	Limit Switch 0 V	10	+5 V
3	CW Limit Switch	11	-
4	Motor Phase B -ve	12	-

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5	Motor Phase B +ve	13	+5 V
6	Motor Phase A -ve	14	-
7	Motor Phase A +ve	15	Ground
8	-	-	-

High-Density D-Type Male 15 Pin Connector

Part Number	Description	Price	Availability
DRV208	8 mm Travel, Modular NanoMax Stepper Motor Actuator	$601.35	Today
MCA1	Modular Quick-Connect Adapter, Ø9.525 mm (Ø3/8") Mounting	$21.93	Today
MCA2	Modular Quick-Connect Adapter, Ø10 mm Mounting	$21.93	Today

10 mm Travel Piezo Inertia Actuator

OVERVIEW

Features

- Compact Design: 31.5 mm x 17.0 mm (W x H)
- 20 nm Typical Step Size
- Manual Adjustment via Knob on Adjuster Screw
- 125 V Maximum Operating Voltage
- 1/4"-80 Mounting Thread for Compatibility with Mirror Mounts
- Also Available in 13 mm, 25 mm, and 50 mm Travel Versions for Translation Stages
- Ideal for Set-and-Hold Applications that Require High-Resolution Relative Positioning

Required Controller: KIM001 or KIM101

Click to Enlarge

- KIM001: Single-Channel Output
- KIM101: Four Output Channels, Capable of Multi-Channel Operation
- Standalone Control via Top Panel or PC Control via USB
- Voltage Output from 85 V to 125 V

Click for Details
The control cable can be adjusted up to 110° for space-constrained applications.

Thorlabs' PIAK10 Piezoelectric Inertia Actuator provides high-resolution linear motion control with a long piezo translation range in a compact package. It can support loads up to 2.5 kg (5.51 lbs) and preloads up to 30 N with typical movements of 20 nm and no backlash. The step size can be adjusted up to 30% to a maximum of approximately 30 nm using the KIM101 Controller and Kinesis® software. However, due to the open-loop design, piezo hysteresis, and application conditions such as the direction of travel, the achieved step size of the system can vary by up to 20% and is not normally repeatable. An external feedback system will need to be used to overcome this variance.

This actuator has a 1/4"-80 threaded barrel that can be mounted to manual mirror mount or positioning stages equipped with 1/4"-80 threads. The actuator is self-locking when at rest and when there is no power supplied to the piezo, making the actuator ideal for set-and-hold applications that require nanometer resolution and long-term alignment stability. Manual adjustments can be made using the knob on the adjuster screw, as long as the piezo is not actively translating the screw; the knob is also compatible with 5/64" (2.0 mm) hex keys.

Powered by a 10 mm long discrete piezo stack, the actuator can operate at speeds of up to 3.5 mm/minute. The design of the piezo motor will rotate the tip of the lead screw during translation. For information on the design of our piezo inertia "slip-stick" motor actuators, please see the complete presentation here.

Required Controller
A KIM001 or KIM101 Controller is required to operate our PIAK10 Piezo Inertia Actuator; the actuator cannot be operated using a standard piezo controller. These drivers have internal sawtooth voltage signal generators capable of sending sub-millisecond pulses (steps) with controllable amplitudes from 85 V to 125 V.

For more information, please see the full web presentation.

Item #	PIAK10
Travel	10 mm (0.39")
Typical Step Size[a]	20 nm
Maximum Step Size[b]	<30 nm
Step Size Adjustability[c]	≤30%
Maximum Step Frequency[d]	2000 Hz
Backlash	None
Maximum Active Preload[e]	30 N
Typical Angular Resolution[f]	Ø1" Mirror Mounts: 0.5 µrad Ø2" Mirror Mounts: 0.3 µrad
Recommended Maximum Axial Load Capacity[g]	2.5 kg (5.51 lbs)
Speed (Continuous Stepping)	2 mm/minute (Typical) <3.5 mm/minute (Maximum)
Drive Screw	1/4"-80 Thread, Hard PVD Coated
Motor Type	Piezoelectric Inertia
Mounting Feature (Auxiliary)	1/4"-80 Thread with Lock Nut (Ø3/8" [Ø9.525 mm] Barrel)
Operating Temperature	10 to 40 °C (50 to 104 °F)
Dimensions	72.9 mm x 31.5 mm x 17.0 mm (2.87" x 1.24" x 0.67")

Cable Length	1.0 m (3.28 ft)
Connector	SMC, Female
Required Controller[h]	KIM001 or KIM101

a. This value can vary by up to 20% and is not normally repeatable due to component variance, change of direction, and application conditions.
b. This can be adjusted up to 30% in both directions using the controller and Kinesis Software.
c. This can be Adjusted using the controller and Kinesis Software.
d. Using the KIM101 Inertia Piezo Controller
e. The axial force applied to the drive tip to achieve the specified step size. A minimum of 5 N is recommended to enhance stepping behavior.
f. The typical angular resolution when a PIAK10 Actuator is fitted to a Ø1" or Ø2" mirror mount with a maximum active preload of 30 N.
g. A higher maximum load is possible but it may decrease the typical step size.
h. Controllers are sold separately. These actuators can also be controlled using the legacy TIM101 T-Cube™ controller.

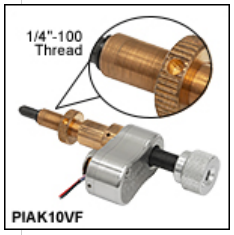
Click to Enlarge
Two PIAK10 Inertia Actuators Being Used in Place of the
1/4"-80 Adjustment Screws in our KM100 Mirror Mount
(Mount Sold Separately)

Part Number	Description	Price	Availability
PIAK10	**Piezo Inertia Actuator, 10 mm Travel, 1/4"-80 Mounting Thread**	**$592.80**	**Today**

10 mm Travel Vacuum-Compatible Piezo Inertia Actuator

OVERVIEW

Features



- Compact Design: 31.5 mm x 17.0 mm (W x H)
- 20 nm Typical Step Size
- Manual Adjustment via Knob on Adjuster Screw
- Rated Down to 10^{-6} Torr
- 125 V Maximum Operating Voltage
- 1/4"-100 Mounting Thread for Compatibility with KS1TV Ø1" Mirror Mount
- Ideal for Set-and-Hold Applications that Require High-Resolution Relative Positioning
- Vacuum-Compatible PIA13VF Actuator for Translation Stages Also Available

Required Controller: KIM001 or KIM101

Click to Enlarge

- KIM001: Single-Channel Output
- KIM101: Four Output Channels, Capable of Multi-Channel Operation
- Standalone Control via Top Panel or PC Control via USB
- Voltage Output from 85 V to 125 V

Click for Details
The flying lead can be adjusted up to 110° for space-constrained applications.

Thorlabs' PIAK10VF Vacuum-Compatible Piezoelectric Inertia Actuator is rated down to 10^{-6} Torr operation and provides high-resolution linear motion control with a long piezo translation range in a compact, vacuum-compatible package. It can support loads up to 2.5 kg (5.51 lbs) and preloads up to 30 N with typical movements of 20 nm and no backlash. The step size can be adjusted up to 30% to a maximum of approximately 30 nm using a compatible controller and the Kinesis® software. However, due to the open-loop design, piezo hysteresis, and application conditions such as the direction of travel, the achieved step size of the system can vary by up to 20% and is not normally repeatable. An external feedback system will need to be used to overcome this variance.

The actuator is self-locking when at rest and when there is no power supplied to the piezo, making the actuator ideal for set-and-hold applications that require nanometer resolution and long-term alignment stability. Manual adjustments can be made using the knob on the adjuster screw, as long as the piezo is not actively translating the screw; the knob is also compatible with 5/64" (2.0 mm) hex keys.

This actuator has a 1/4"-100 threaded barrel that can be mounted to the KS1TV mirror mount or other mounts with non-matched 1/4"-100 actuators. Note that the PIAK10VF actuator is not compatible with Polaris® mounts that use 1/4"-100 adjusters. These mounts require a specific actuator ball size and tip design to ensure that the ball contact is centered on the sapphire end stone and that there is proper screw clearance during full translation. In the case of the PIAK10VF actuator, the side of the screw, rather than the ball tip, will contact the sapphire end stone and, as a result, the actuator should not be used with Polaris mounts.

Each actuator has an integrated 0.75 m flying lead, plus 1.0 m of cored cable for wiring outside the vacuum chamber. The flying leads and cored cable lengths can be cut down as needed, but the total length (inside and outside) should not exceed 2.0 m. As shown in the image above, the flying lead for each actuator can be rotated up to 110° for space-constrained applications.

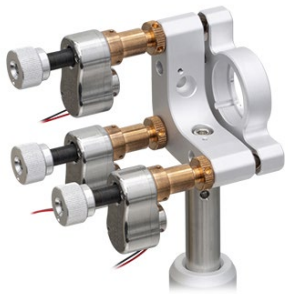
Powered by a 10 mm long discrete piezo stack, the actuator can operate at speeds of up to 3.5 mm/minute. The design of the piezo motor will rotate the tip of the lead screw during translation. For information on the design of our piezo inertia "slip-stick" motor actuators, please see the complete presentation here.

Required Controller
A KIM001 or KIM101 Controller is required to operate our PIAK10VF Piezo Inertia Actuator; the actuator cannot be operated using a standard piezo controller. These drivers have an internal sawtooth voltage signal generator capable of sending sub-millisecond pulses (steps) with controllable amplitudes from 85 V to 125 V.

For more information, please see the full web presentation.

Item #[a]	PIAK10VF
Travel	10 mm (0.39")
Typical Step Size[b,c]	20 nm
Maximum Step Size	30 nm
Step Size Adjustability[c]	≤30%
Maximum Step Frequency	2000 Hz
Backlash	None
Maximum Active Preload[d]	30 N
Typical Angular Resolution	KS1TV Ø1" Mirror Mount: 0.5 µrad
Recommended Maximum Axial Load Capacity[e]	2.5 kg (5.51 lbs)
Speed (Continuous Stepping)	2 mm/minute (Typical) <3.5 mm/minute (Maximum)
Drive Screw	1/4"-80 Thread, Hard PVD Coated
Motor Type	Piezoelectric Inertia
Mounting Feature (Auxiliary)	1/4"-100 Thread with Lock Nut[f] (Ø3/8" [Ø9.525 mm] Barrel)
Operating Temperature	5 to 130 °C (41 to 266 °F)
Dimensions	77.7 mm x 31.5 mm x 17.0 mm (3.06" x 1.24" x 0.67")
Cable Length	0.75 m (2.48 ft) Flying Lead for Vacuum, 1.0 m (3.3 ft) of Cored Cable for Wiring Outside Chamber
Connector	SMC, Female
Vacuum Rating	10^{-6} Torr
Required Controller[g]	KIM001 or KIM101

a. Specifications are measured using the KIM101 Piezo Inertia Controller.
b. This value can vary by up to 20% and is not normally repeatable due to component variance, change of direction, and application conditions.
c. This can be adjusted by changing the piezo drive voltage - refer to the controller manual for more details.
d. The axial force applied to the drive tip to achieve the specified step size. A minimum of 5 N is recommended to enhance stepping behavior.
e. A higher maximum load is possible but it may decrease the typical step size.
f. This actuator is not compatible with our Polaris mirror mounts.
g. Controllers are sold separately. These actuators can also be controlled using the legacy TIM101 T-Cube™ controller.



Click to Enlarge
Three PIAK10VF Inertia Actuators Being Used in Place of the
1/4"-100 Adjustment Screws in our KS1TV Mirror Mount
(Mount Sold Separately)

Part Number	Description	Price	Availability
PIAK10VF	**Customer Inspired! Vacuum-Compatible Piezo Inertia Actuator, 10 mm Travel, 1/4"-100 Mounting Thread**	**$855.62**	**Today**

Re-Greasing Kit

OVERVIEW

Features

- 1.5 cc Syringe of Apiezon 100 Grease
- Convenient, Inexpensive Package that Reduces Waste
- Prolongs Lifetime of Actuator
- Ready to Dispense
- Vacuum Compatible to 10^{-9} Torr

This Apiezon grease has excellent anti-seize properties. It contains PTFE for maximum lubricity and is ideal for re-lubricating the lead screw threads of our ZST, ZFS, Z8, and Z9 series actuators. It is supplied in a syringe for easy application and is recommended both for general use and for vacuum applications down to 10^{-9} Torr. It has an optimal working range of 10 to 30 °C (50 to 86 °F).

Note: It is recommended that the lead screw and end ball of the Z8, Z9, ZFS, and ZST actuators are lubricated every 10,000 cycles or whenever a squeaking noise is heard during motion.

Part Number	Description	Price	Availability
GKZ8	Grease Kit for Z8, Z9, ZFS, and ZST Actuators	$21.05	Today

Stepper and DC Servo Drive Cables

OVERVIEW

Thorlabs' DRV, ZST, and ZFS Stepper Motor Actuators, as well as our Z8 and Z9 DC Servo Motor Actuators, come with cables for connecting to the required controllers. Thorlabs also offers separate cables that may be used as extension cables.

Stepper Motor Cables
Thorlabs offers a variety of cables to support several stepper motor actuator and controller combinations. Supported stepper motors include our ZST, ZFS, and DRV actuators; supported controllers include our BSC benchtop controllers, our KST201 K-Cube™ Controller, and our MST602 Rack Control Module. In order to see which cable is compatible with a given combination of stepper motor and controller, please see the table below. The pin assignment for each cable is given in the *Pin Diagrams* tab. Please note that these cables cannot be used with motors and controllers that do not match their pin assignment, even if the connectors are the same.

DC Motor Cables
The PAA632 is a 2.5 m cable for our Z8 and Z9 series of DC motor actuators. This cable is intended to be used with the KDC101 K-Cube DC Servo Motor Controller. The pin assignment for this cable is given in the *Pin Diagrams* tab. Although it uses a 15-pin connector, this cable is not compatible with any of our stepper motors.

Controller

Motor	 BSC Benchtop Controller and MST602 Rack Controller	 KST201 K-Cube Controller	 KDC101 K-Cube Controller[a]
 DRV Stepper Motor Actuators	PAA612 (1 m) or PAA613 (3 m)	PAA614 (1 m)[b]	-
 ZST and ZFS Stepper Motor Actuators	-	PAA614 (1 m)	-

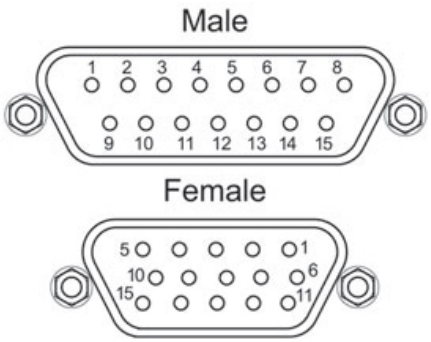
 **Z8 and Z9 DC Servo Motor Actuators**	-	-	PAA632 (2.5 m)

a. Green shading indicates hardware for DC servo motors.
b. The KST201 K-Cube Controller can be used to drive our DRV Stepper Motor Actuators (excluding the DRV208, which is incompatible) at a reduced velocity.

PIN DIAGRAMS

PAA612 and PAA613 Stepper Motor Cables

DA15 Male D-Type to DE15 Female D-Type



DA15 Male Pin	DE15 Female Pin	Description
11 and 12	1	Limit Switch Ground
10	2	Reverse Limit Switch
9	3	Forward Limit Switch
7	4	Motor Phase B -
14	5	Motor Phase B +
8	6	Motor Phase A -
15	7	Motor Phase A +
6	9	Reserved for Future Use
5	13	5 V

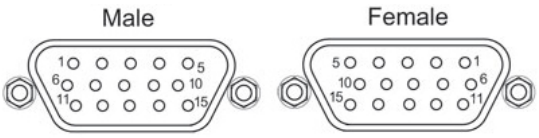
PAA632 DC Servo Motor Cable

DE15 Male D-Type to DE15 Female D-Type

DE15 Male Pin	DE15 Female Pin	Description
1	1	Ground
2	2	Forward Limit Switch
3	3	Reverse Limit Switch
5	5	Motor -
7	7	Motor +
10	10	5 V Encoder Supply
11	11	Encoder Channel A
13	13	Encoder Channel B

PAA614 Stepper Motor Cable

DE15 Male D-Type to DE15 Female D-Type



DE15 Male Pin	DE15 Female Pin	Description
1	1	Ground
2	2	CCW Limit Switch
3	3	CW Limit Switch
4	4	Motor Phase B -
5	5	Motor Phase B +
6	6	Motor Phase A -
7	7	Motor Phase A +
10	10	+5 VDC
15	15	Ground

Part Number	Description	Price	Availability
PAA612	**APT Stepper Motor Cable, DA15 Male to DE15 Female, 1 m**	**$67.85**	**Today**
PAA613	**APT Stepper Motor Cable, DA15 Male to DE15 Female, 3 m**	**$81.24**	**Today**
PAA614	**Customer Inspired! APT Stepper Motor Cable, DE15 Male to DE15 Female, 1 m**	**$65.51**	**Today**
PAA632	**APT DC Servo Motor Cable for Z8 and Z9 Motors, DE15 Male to DE15 Female, 2.5 m**	**$64.64**	**Today**