

## Z812B - September 14, 2023

Item # Z812B was discontinued on September X, 2023. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

### 1/2" (12 mm OR 13 mm) TRAVEL MOTORIZED ACTUATORS

- ▶ High-Precision Piezo Inertia Actuators
- ▶ Motorized Micrometer Head-Steppers
- ▶ Precision DC Servo Motor Actuators
- ▶ High-Load Precision Stepper Motor Actuators



### 13 mm Travel Compact Stepper Motor Actuators

#### OVERVIEW

#### Features



- Compact, Bi-Polar Stepper Motor Actuator:
- ▶ ZFS13: 89.5 mm (3.52") Long when Retracted
  - ▶ ZFS13B: 85.5 mm (3.36") Long when Retracted

- Manual Adjustment via Rear-Located Thumbscrew
- Non-Rotating Drive Tip
- Compatible with Mirror Mounts and Translation Stages using 1/4"-80 Thread (ZFS13) or Ø3/8" (9.525 mm) Mounting Barrel (ZFS13B)

▶ Also Available in 6 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 ZFS13 and ZFS13B Actuators provide smooth, precise linear motion control in a sleek, compact package measuring just 89.5 mm (3.52") or 85.5 mm (3.36"), respectively, 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 ZST actuators featured above.

Powered by a small-diameter, two-phase, bi-polar stepper motor, these actuators operate 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.

The ZFS13 actuator has a 1/4"-80 threaded barrel that can be mounted to any manual mirror mount for stage with 1/4"-80 threads, while the ZFS13B actuator has a Ø3/8" barrel for compatibility with a wide range of translation and rotation stages. Simply remove the existing manual adjuster from the mount, and screw in our ZFS Actuator.

These actuators incorporate stepper motors that provides sufficient torque for loads up to 40 N. The actuators allow very small step sizes over the entire travel range, delivering greater flexibility with low (<15 µm) backlash and fine

Item #	ZFS13	ZFS13B
<b>Mounting Barrel</b>	1/4"-80 Threaded	Ø3/8" (9.525 mm) Smooth
<b>Travel</b>	13 mm (0.51")	
<b>Backlash<sup>a</sup></b>	<15.0 µm	
<b>Bidirectional Repeatability</b>	<5.0 µm	
<b>Home Location Accuracy</b>	<5.0 µm	
<b>Maximum Load Capacity</b>	40 N (8.99 lb)	
<b>Velocity</b>	2.0 mm/s (Max)	

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 <math>5.0 \mu\text{m}</math>. The ZFS series actuators come with 0.6 m of cable terminated in a 15-pin D-Type connector (see the *Pin Diagrams* tab) that is compatible with our KST201 stepper motor controller. A 1 m (3.3 ft) extension cable (PAA614) is available separately.

The ZFS13B has a high tolerance standard  $\text{Ø}3/8$ " mounting barrel that is compatible with many translation and rotation stages including our popular MT1 Translation Stages. The ZFS13 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 our ZFS Actuator. The manual adjuster of the MT1 stage in the photo below is replaced with a ZFS13B motorized actuator.



Click to Enlarge  
MT1 Stage with Manual Adjuster Replaced by ZFS13B Actuator

<b>Acceleration</b>	10 mm/s <sup>2</sup> (Max)	
<b>Gearbox Ratio</b>	400:9 (Approx. 44:1)	
<b>Limit Switches</b>	Hall Effect Sensor	
<b>Lead Screw Pitch</b>	1.0 mm	
<b>Motor Type</b>	2-Phase Stepper	
<b>Microsteps per Revolution of the Motor<sup>b</sup></b>	24 Full Steps, 2048 Microsteps per Full Step 49 152 Microsteps per Revolution	
<b>Calculated Minimum Incremental Motion<sup>c</sup></b>	0.46 nm	
<b>Operating Temperature</b>	5 to 40 °C (41 to 104 °F)	
<b>Dimensions (W x H)</b>	35.0 mm x 19.0 mm (0.38" x 0.75")	
<b>Length when Fully Retracted</b>	89.5 mm (3.52")	85.5 mm (3.36")
<b>Cable Length</b>	0.6 m (2 ft)	
<b>Connector</b>	HDDDB15	
<b>Required Controller</b>	KST201	

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

## 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:

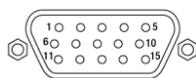
$$\text{Number of Microsteps} \times \text{Gearbox Ratio} = 49,152 \times 44.445 = 2184560.64$$

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



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
ZFS13	Customer Inspired! 13 mm Travel, Compact Stepper Motorized Actuator, 1/4"-80 Thread	\$1,286.91	Today
ZFS13B	Customer Inspired! 13 mm Travel, Compact Stepper Motorized Actuator, 3/8" Barrel	\$1,286.91	Today

## 13 mm Travel Stepper Motor Actuators

### OVERVIEW

#### Features



- ▶ Non-Rotating Drive Tip
- ▶ Bi-Polar Stepper Motor Actuator: 123.0 mm (4.84") Long
- ▶ Two Mounting Options: Ø3/8" (9.525 mm) Smooth Barrel or 1/4"-80 Threaded Barrel
- ▶ Compatible with Mirror Mounts and Translation Stages using 1/4"-80 Thread or 3/8" Mounting Block
- ▶ Also Available in 6 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 Actuators provide smooth, precise linear motion control in a package measuring 123.0 mm (4.84") in length. Powered by a small-diameter, two-phase, bi-polar stepper motor, these actuators operate 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.

These actuators incorporate a stepper motor that provides sufficient torque for loads up to 40 N. They allow 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 3072 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).

The ZST213 actuator has a 1/4"-80 threaded barrel that can be mounted to any manual mirror mount for stage with 1/4"-80 threads, while the ZT213B actuator has a Ø3/8" (9.525 mm) barrel for compatibility with a wide range of translation and rotation stages, including our popular MT1 Translation Stages. Simply remove the existing manual adjuster from the mount, and screw in our ZST Actuator.

Hall effect limit switches prevent the unit from being overdriven and provide homing capability with an accuracy of <5.0 µm. The ZST series actuators come 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.

Item #	ZST213	ZST213B
<b>Mounting Barrel</b>	1/4"-80 Threaded	Ø3/8" (9.525 mm) Smooth
<b>Travel</b>	13 mm (0.51")	
<b>Backlash<sup>a</sup></b>	<15 µm	
<b>Bidirectional Repeatability</b>	<5.0 µm	
<b>Home Location Accuracy</b>	<5.0 µm	
<b>Maximum Load Capacity</b>	40 N (8.99 lb)	
<b>Velocity</b>	2.0 mm/s (Max)	
<b>Acceleration</b>	10 mm/s <sup>2</sup> (Max)	
<b>Gearbox Ratio</b>	29 791 : 729 (Approx. 41:1)	
<b>Limit Switches</b>	Hall Effect Sensor	
<b>Lead Screw Pitch</b>	1.0 mm	
<b>Motor Type</b>	2-Phase Stepper	
<b>Microsteps per Revolution of the Motor<sup>b</sup></b>	24 Full Steps, 2048 Microsteps per Full Step 49 152 Microsteps per Revolution	
<b>Calculated Minimum Incremental Motion</b>	0.5 nm	
<b>Operating Temperature</b>	5 to 40 °C (41 to 104 °F)	
<b>Cable Length</b>	0.6 m (2 ft)	
<b>Connector</b>	HDDB15	

<b>Required Controller</b>	KST201
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- 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  
An RB13 3-Axis Stage shown with the manual adjusters replaced by three ZST213B 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:

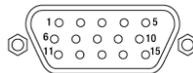
$$\text{Number of Microsteps} \times \text{Gearbox Ratio} = 49,152 \times 40.866 = 2,008,645.63$$

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
ZST213	13 mm Travel, Stepper Motorized Actuator, 1/4"-80 Threaded	\$1,107.56	Today
ZST213B	13 mm Travel, Stepper Motorized Actuator, 3/8" Barrel	\$1,107.56	Today

## 12 mm Travel DC Servo Motor Actuators

### OVERVIEW

#### Features



- ▶ 6 VDC Servo Actuator
- ▶ Submicron Resolution
- ▶ Maximum Velocity: 2.3 mm/s
- ▶ Drop In Replacement for Most 12 mm or 1/2" Manual Actuators
- ▶ Compatible with 1/4"-80 Thread or Ø3/8" (9.525 mm) Barrel-Fitted Stages and Mounts
- ▶ Limit Switches for Zero Datum and Actuator Protection
- ▶ Also Available in 6 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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These Motorized Actuators are engineered for use with optical positioning devices. They offer high resolution in a lightweight package, which makes them ideally suited for demanding optical laboratory automation applications. The Z812 delivers 12 mm of travel and has been designed as a replacement for the former-generation Z712 motor.

Commercial limit switches have been added to provide overdrive protection and accurate home positioning. The motor in the Z8 provides a motion velocity of 2.3 mm/s. The precision of the encoder (512 counts/rev) results in a minimum resolution of about 29 nm.

The Z812 has been designed specifically to replace the manual adjusters in stages and mirror mounts that have 1/4"-80 screw-in fittings, while the Z812B is for use with 3/8" barrel clamps (e.g., the 1/2" manual micrometer in the MT Series Translation Stages). Simply remove the existing manual adjuster from the mount, and screw in our Z8 actuator. The photo below shows a KS2 mirror mount with one of the thumbscrew actuators replaced by a Z812 motor actuator.

In addition to the Z812 and Z812B motorized actuators, we also offer the Z812V and Z812BV vacuum-compatible versions (sold below), which are rated for use down to  $10^{-6}$  Torr and are shipped with a 1.6' flat ribbon cable, IDC connector, and converter cable for use with our KDC101 controller. For applications with different travel requirements, please see our 6 mm Z806 and 25 mm Z825 actuators.

The KDC101 DC Servo Controller is the required driver for the Z8 series actuators. Please note that older 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 #	Z812	Z812B
<b>Mounting Barrel</b>	1/4"-80 Threaded	Ø3/8" (9.525 mm) Smooth
<b>Travel Range</b>	12.0 mm (0.47")	
<b>Backlash</b>	<8 $\mu$ m	
<b>Bidirectional Repeatability</b>	<1.5 $\mu$ m	
<b>Home Location Accuracy</b>	<2 $\mu$ m	
<b>Homing Repeatability</b>	$\pm$ 1.0 $\mu$ m	
<b>Vertical Load Capacity</b>	4.5 kg (Max)	
<b>Horizontal Load Capacity</b>	9 kg (Max)	
<b>Vertical Load Capacity<sup>a</sup></b>	<4.0 kg	
<b>Horizontal Load Capacity<sup>a</sup></b>	<7.5 kg	
<b>Velocity<sup>b</sup></b>	2.6 mm/s (Max)	
<b>Acceleration</b>	4 mm/s <sup>2</sup> (Max)	
<b>Absolute On-Axis Accuracy</b>	95 $\mu$ m	
<b>Maximum Percentage Accuracy</b>	0.82%	
<b>Motor Type<sup>c</sup></b>	6 VDC Servo	
<b>Motor Coil Temperature</b>	85 °C (Max)	
<b>Phase to Phase Resistance</b>	33.0 $\Omega$ (Max)	
<b>Phase to Phase Inductance</b>	0.6 mH (Max)	
<b>Limit Switch Lifetime</b>	<100,000 Cycles	
<b>Minimum Achievable Incremental Movement</b>	0.05 $\mu$ m	
<b>Minimum Repeatabile Incremental Movement</b>	0.2 $\mu$ m	
<b>Operating Temperature Range</b>	41° to 104° F (5° to 40° C)	
<b>Weight</b>	0.134 kg	

a. Recommended

b. At 2.6 mm/s, velocity ripple and distortion of the acceleration/deceleration profile may occur. For improved control, the maximum velocity should be limited to 2.3 mm/s.

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



The units are shipped with a non-detachable 0.5 m (1.6 ft) cable. A 2.5 m (8 ft) extension cable (PAA632) is available separately.

## CALCULATIONS

### How to Calculate the Linear Displacement per Encoder Count

For the Z812 and Z812B, 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

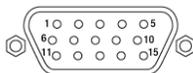
$$512 \times 67.49 = 34,555 \text{ encoder counts per revolution of the lead screw,}$$

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

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

## PIN DIAGRAMS

### Pin Diagram



High-Density D-Type Male 15 Pin Connector

### 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

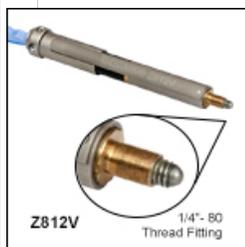


Click to Enlarge  
High-Density D-Type Male 15 Pin Connector

Part Number	Description	Price	Availability
Z812	12 mm Motorized Actuator, 1/4"-80 Thread (0.5 m Cable)	\$717.41	Lead Time
Z812B	12 mm Motorized Actuator, 3/8" Barrel Fitting (0.5 m cable)	\$717.41	Today

## OVERVIEW

### Features



- ▶ 6 VDC Servo Actuator
- ▶ Submicron Resolution
- ▶ Maximum Velocity: 2.3 mm/s
- ▶ Drop In Replacement for Most 12 mm Manual Actuators
- ▶ Compatible with 1/4"-80 Thread (Z812V) and Ø3/8" (9.525 mm) Barrel-Fitted (Z812BV) Stages and Mounts
- ▶ Limit Switches for Zero Datum and Actuator Protection
- ▶ Rated Down To 10<sup>-6</sup> Torr.
- ▶ Also Available in 6 mm and 25 mm Travel Versions

The Z812V and Z812BV offer all the features and specifications of the standard Z812 actuators described above with the added benefit of being vacuum compatible down to 10<sup>-6</sup> Torr. These motors feature vacuum rated servo motors, phosphorus bronze internal coupling mechanism and mounting bush, and high vacuum grease.

These actuators are shipped with a 1.6' (0.5 m) vacuum-compatible flat ribbon cable with IDC connector. The 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 different travel requirements, please see our 6 mm and 25 mm 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](#).

### Required Controller KDC101

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



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Item #	Z812V	Z812BV
Mounting Barrel	1/4"-80 Threaded	Ø3/8" (9.525 mm) Smooth
Travel Range	12.0 mm (0.47")	
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 <sup>a</sup>	<4.0 kg	
Horizontal Load Capacity <sup>a</sup>	<7.5 kg	
Velocity <sup>b</sup>	2.6 mm/s (Max)	
Acceleration	4 mm/s <sup>2</sup> (Max)	
Absolute On-Axis Accuracy	95 µm	
Percentage Accuracy	0.75% (Max)	
Motor Type <sup>c</sup>	6 VDC Servo	
Motor Coil Temperature	85 °C (Max)	
Limit Switch Lifetime	>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 <sup>-6</sup> Torr	
Weight	0.134 kg	

a. Recommended

b. 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.

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

## CALCULATIONS

### How to Calculate the Linear Displacement per Encoder Count

For the Z812V and Z812BV, 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

$$512 \times 67.49 = 34,555 \text{ encoder counts per revolution of the lead screw,}$$

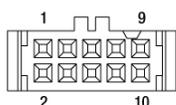
whereas the linear displacement of the lead screw per encoder count is given by

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

## PIN DIAGRAM

The vacuum-compatible cable integrated with the Z812V and Z812BV 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 Z812V and Z812BV 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)



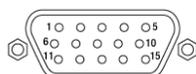
[Click to Enlarge](#)  
10 Pin Female IDC Socket Connector  
(Amphenol T812 Series, 2.54 mm Pitch)

### Female IDC 10-Pin Connector Pin Out

Pin	Description	Pin	Description
1	Motor (+ve) (6 V) <sup>a</sup>	6	Motor (-ve) (6 V) <sup>a</sup>
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



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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
Z812V	Vacuum-Compatible 12 mm Motorized Actuator, 1/4"-80 Thread	\$996.92	Today
Z812BV	Vacuum-Compatible 12 mm Motorized Actuator, 3/8" Barrel Fitting	\$996.92	Lead Time

## 13 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
- ▶ Ø3/8" Mounting Barrel for Compatibility with Translation Stages
- ▶ Ideal for Set-and-Hold Applications that Require High-Resolution Relative Positioning
- ▶ Also Available in 10 mm, 25 mm, and 50 mm Travel Versions

## Required Controller: KIM001 or KIM101

- 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



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Thorlabs' PIA13 Piezoelectric Inertia Actuator provides high-resolution linear motion control with a long piezo-controlled translation range in a compact package. It can support loads up to 2.5 kg and preloads up to 25 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<sup>®</sup> 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.



[Click for Details](#)  
The control cable can be adjusted up to 110° for space-constrained applications.

This actuator has a Ø3/8" (Ø9.525 mm) barrel that can be mounted in a manual stage that has a Ø3/8" mounting clamp. For compatibility with 1/4"-80 threaded mirror mounts see our 10 mm travel piezo inertia actuator. 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 PIA13 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. The KIM001 and KIM101 controllers offer one and four output channels, respectively.

For more information, please see the full web presentation.

Item #	PIA13
<b>Travel</b>	13 mm (0.51")
<b>Typical Step Size<sup>a</sup></b>	20 nm
<b>Maximum Step Size<sup>b</sup></b>	<30 nm
<b>Step Size Adjustability<sup>c</sup></b>	≤30%
<b>Maximum Step Frequency<sup>d</sup></b>	2000 Hz
<b>Backlash</b>	None
<b>Maximum Active Preload<sup>e</sup></b>	25 N
<b>Recommended Maximum Axial Load Capacity<sup>f</sup></b>	2.5 kg (5.51 lbs)
<b>Speed (Continuous Stepping)</b>	2 mm/minute (Typical) <3.5 mm/minute (Maximum)
<b>Drive Screw</b>	1/4"-80 Thread, Hard PVD Coated
<b>Motor Type</b>	Piezoelectric Inertia
<b>Mounting Feature (Auxiliary)</b>	Ø3/8" (Ø9.525 mm) Barrel (3/8"-40 Thread with Lock Nut)
<b>Operating Temperature</b>	10 to 40 °C (50 to 104 °F)
<b>Dimensions</b>	2.34" x 1.24" x 0.67" (59.5 mm x 31.5 mm x 17.0 mm)
<b>Cable Length</b>	1.0 m (3.28')
<b>Connector</b>	SMC, Female
<b>Required Controller<sup>g</sup></b>	KIM001 or KIM101 <sup>h</sup>

- 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. A higher maximum load is possible but it may decrease the typical step size.
- g. Controllers Sold Separately
- h. These actuators can also be controlled using the legacy TIM101 T-Cube™ controller.



Click to Enlarge  
PIA13 Inertia Actuator Being Used to Drive an MT1  
13 mm  
Translation Stage (Stage Sold Separately)

Part Number	Description	Price	Availability
PIA13	Piezo Inertia Actuator, 13 mm Travel, Ø3/8" Mounting Barrel	\$592.80	Today

## 13 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<sup>-6</sup> Torr
- ▶ 125 V Maximum Operating Voltage
- ▶ Ø3/8" Mounting Barrel for Compatibility with Translation Stages
- ▶ Ideal for Set-and-Hold Applications that Require High-Resolution Relative Positioning
- ▶ Vacuum-Compatible PIAK10VF Actuator for KS1TV Mirror Mount Also Available

#### Required Controller: KIM001 or KIM101



- 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 to Enlarge

Thorlabs' PIA13VF Vacuum-Compatible Piezoelectric Inertia Actuator is rated down to 10<sup>-6</sup> Torr operation and provides high-resolution linear motion control with a long piezo-controlled translation range in a compact, vacuum-compatible package. It can support loads up to 2.5 kg and preloads up to 25 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<sup>®</sup> 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 Ø3/8" (Ø9.525 mm) barrel that can be mounted in a manual stage that has a Ø3/8" mounting clamp. 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.

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 below, 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 this piezo inertia "slip-stick" motor actuator, please see the complete presentation here.

#### Required Controller

A KIM001 or KIM101 controller is required to operate our PIA13VF 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. The KIM001 and KIM101 controllers offer one and four output channels, respectively.

Item # <sup>a</sup>	PIA13VF
<b>Travel</b>	13 mm (0.51")
<b>Typical Step Size<sup>b,c</sup></b>	20 nm
<b>Maximum Step Size</b>	30 nm
<b>Step Size Adjustability<sup>c</sup></b>	≤30%
<b>Maximum Step Frequency</b>	2000 Hz
<b>Backlash</b>	None
<b>Maximum Active Preload<sup>d</sup></b>	25 N
<b>Recommended Maximum Axial Load Capacity<sup>e</sup></b>	2.5 kg (5.51 lbs)
<b>Speed (Continuous Stepping)</b>	2 mm/minute (Typical) <3.5 mm/minute (Maximum)
<b>Drive Screw</b>	1/4"-80 Thread, Hard PVD Coated
<b>Motor Type</b>	Piezoelectric Inertia
<b>Mounting Feature<sup>f</sup> (Auxiliary)</b>	Ø3/8" (Ø9.525 mm) Barrel (3/8"-40 Thread with Lock Nut)
<b>Vacuum Rating</b>	10 <sup>-6</sup> Torr
<b>Operating Temperature</b>	5 to 130 °C (41 to 266 °F)
<b>Dimensions</b>	2.34" x 1.24" x 0.67" (59.5 mm x 31.5 mm x 17.0 mm)
<b>Cable Length</b>	0.75 m (2.48 ft) Flying Lead for Vacuum, 1.0 m (3.3 ft) Cored Cable for Wiring Outside Chamber
<b>Connector</b>	SMC Female
<b>Required Controller<sup>g</sup></b>	KIM001 or KIM101 <sup>h</sup>

- 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. To order vacuum-compatible versions of our translation stages, please contact Technical Support.
- g. Controllers Sold Separately
- h. These actuators can also be controlled using the legacy TIM101 T-Cube™ controller.

For more information, please see the full web presentation.



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

Part Number	Description	Price	Availability
PIA13VF	Customer Inspired! Vacuum-Compatible Piezo Inertia Actuator, 13 mm Travel, Ø3/8" Mounting Barrel	\$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<sup>-9</sup> 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, and Z8 series actuators described above. It is supplied in a syringe for easy application and is recommended both for general use and for vacuum applications down to 10<sup>-9</sup> Torr. It has an optimal working range of 10 to 30 °C (50 to 86 °F).

**Note:** It is recommended that the lead screws of the Z8, ZFS, and ZST motors are lubricated every 50,000 cycles or 6 months, whichever comes first.

Part Number	Description	Price	Availability
GKZ8	Grease Kit for Z8, 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 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 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



	BSC Benchtop Controller and MST602 Rack Controller	KST201 K-Cube Controller	KDC101 K-Cube Controller <sup>a</sup>
	PAA612 (1 m) or PAA613 (3 m)	PAA614 (1 m) <sup>b</sup>	-
<b>DRV Stepper Motor Actuators</b>			
	-	PAA614 (1 m)	-
<b>ZST and ZFS Stepper Motor Actuators</b>			
	-	-	PAA632 (2.5 m)
<b>Z8 DC Servo Motor Actuators</b>			

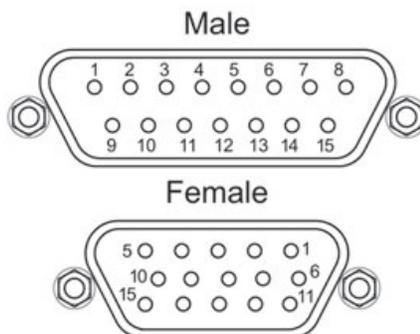
a. Green shading indicates hardware for DC servo motors.

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**

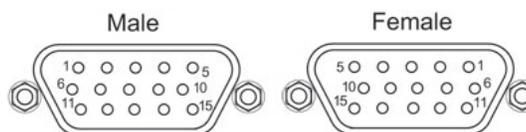
DA15 Male D-Type to DE15 Female D-Type



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

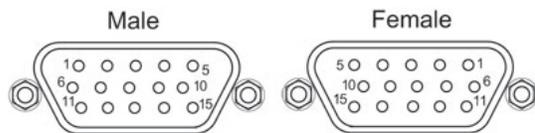


DE15 Male Pin	DE15 Female Pin	Description
1	1	Ground

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 Motors, DE15 Male to DE15 Female, 2.5 m	\$64.64	Today