

PAS015 - March 30, 2023

Item # PAS015 was discontinued on March 30, 2023. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

PIEZO ACTUATORS WITH REPLACEABLE TIPS

- Three Travel Ranges Available: 20, 40, and 100 μm
- Open or Closed Loop Piezo Designs
- $\varnothing 1/2"$ Barrel Diameter

Application Idea
LNR50M 50 mm Linear Stage with
PAZ009 Closed-Loop Actuator Installed



PAS009
Open Loop Actuator,
40 μm Travel



PAZ009
Closed-Loop Actuator,
40 μm Travel



Modular Contact Tips
PAA005 **PAA013**

[Hide Overview](#)

OVERVIEW

Features

- Modular Piezoelectric Actuators for Fine Positioning
- Available as Open or Closed-Loop with Feedback
- $\varnothing 1/2"$ Barrel for Compatibility with LNR50 Series TravelMax Stages

These piezo actuators offer a wide selection of travel ranges in a convenient mounting package. Available with or without feedback, both types offer the flexibility of interchangeable tips. Each actuator has a $\varnothing 1/2"$ barrel for compatibility with our manual or motorized LNR50 Series TravelMax Stages. To install the piezo actuator for supplemental fine positioning of LNR50 series stages, simply remove the static pin that acts as the stop for the stage's primary actuator and replace it with the piezo actuator.

Common Specifications

Common Specifications	
Mounting Barrel	$\varnothing 1/2"$ ($\varnothing 12.7$ mm)
Preload	30 N
Piezo Blocking Force	1000 N at 60 V 1150 N at 75 V
Operating Temp	-20 to 80 °C
Piezo Input Voltage	0 to 75 V

[Hide Piezo Bandwidth](#)

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:

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

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

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

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:

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

A diagram of voltage as a function of time is shown to the right. The maximum slew rate, or voltage change, is reached at $t = 2n\pi$, ($n=0, 1, 2, \dots$) 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,

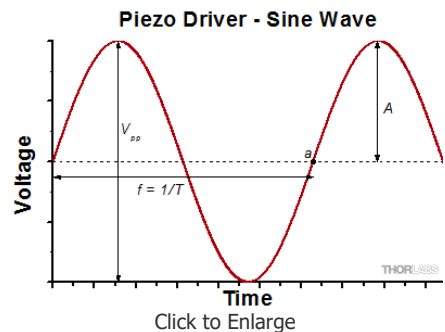
$$f_{max} = \frac{I_{max}}{2\pi AC} = \frac{I_{max}}{\pi V_{pp}C}$$

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

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

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:

$$\frac{I_{max}}{C} = \frac{2V_{peak}}{T}$$

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

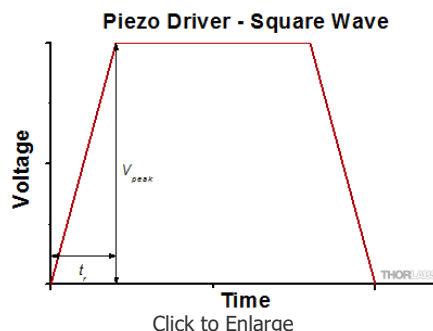
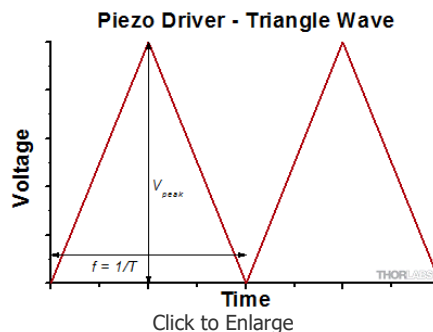
For a piezo actuator driven by a square wave of maximum voltage V_{peak} and minimum voltage 0, the slew rate limits the minimum rise and fall times. In this case, the slew rate is equal to the slope while the signal is rising or falling. If t_r is the minimum rise time, then

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

or

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

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



[Hide Pin Diagrams](#)

PIN DIAGRAMS

Displacement Sensor 7 Pin LEMO Male PAZ Series ONLY



Pin	Designation
1	+15 V
2	Oscillator +
3	0 V
4	Signal Out -
5	Signal Out +
6	-15 V
7	Travel

Piezo Drive Input SMC Male



Maximum Input Voltage: 75 V

[Hide Modular Piezoelectric Drives for LNR50 Series Stages and OEM Applications](#)

Modular Piezoelectric Drives for LNR50 Series Stages and OEM Applications

▶ Removable Tip

Open-Loop Actuator Specifications



- ▶ Permanent Preload
- ▶ Compatible with our LNR50 Series TravelMax Stages

The PAS Series of Piezoelectric Actuators offer three travel ranges in a convenient mounting package: 20, 40, and 100 μm . The mounting barrel

allows the actuator to be mounted in any standard $\text{\O}1/2"$ ($\text{\O}12.7\text{ mm}$) mounting hole. These actuators can be driven by any of our Piezo Controllers.

A PAA001 Flat End tip is included with each actuator. The tip of the actuator is tapped to accept any of our PAA Series Actuator Tips (sold below).

Item #	PAS005	PAS009	PAS015
Travel	20 μm	40 μm	100 μm
Length	2.24" (57 mm)	3.66" (93 mm)	7.91" (201 mm)
Resolution	20 nm	40 nm	100 nm
Capacitance	3.6 μF	7.2 μF	18 μF
Included Cable	SMC Female, 3 m		
Recommended Controllers	BPC301, MDT694B, MPZ601, KPZ101		
Compatible Stages	LNR50 Series or OEM Applications		

Part Number	Description	Price	Availability
PAS005	Piezoelectric Actuator, 20 μm Travel	\$538.06	Lead Time
PAS009	Piezoelectric Actuator, 40 μm Travel	\$831.55	Today
PAS015	Piezoelectric Actuator, 100 μm Travel	\$1,811.00	Lead Time

[Hide Modular Piezoelectric Drives with Feedback for LNR50 Series Stages and OEM Applications](#)

Modular Piezoelectric Drives with Feedback for LNR50 Series Stages and OEM Applications



- ▶ Includes Positional Feedback for Greater Positional Accuracy
- ▶ Removable Tip
- ▶ Permanent Preload
- ▶ PAZ009 is Compatible with our LNR50 Series TravelMax Stages

The PAZ Series of Piezoelectric Actuators are available in two travel ranges, 20 and 40 μm . Each has a convenient mounting barrel diameter that is compatible with any industry standard $\text{\O}1/2"$ ($\text{\O}12.7\text{ mm}$) bushing size. These actuators provide positional feedback via a 7 pin LEMO connector that can be used in conjunction with our APT series of motion controllers. These actuators can be driven by any of our Piezo Controllers. A PAA622 piezo control cable is also included with each actuator.

A PAA001 Flat End tip is included with each actuator. The tip of the actuator is tapped to accept any of our PAA Series Actuator Tips (sold below).

Specifications		
Item #	PAZ005	PAZ009
Travel	20 μm	40 μm
Length	2.24" (57 mm)	3.66" (93 mm)
Resolution ^a	5 nm	10 nm
Capacitance	3.6 μF	7.2 μF
Feedback	Strain Gauge	
Accuracy	+1%/-0%	
Repeatability	0.7 μm	
Included Cables	SMC Female to SMC Female, 3 m 9-pin D-Sub Male to 7-pin LEMO Female, 3 m	
Recommended Controllers	BPC301, MPZ601, KPZ101/KSG101	
Compatible Stages	OEM Applications	LNR50 Series or OEM Applications

• a. Dependent on control electronics.

Part Number	Description	Price	Availability
PAZ005	Piezoelectric Actuator With Feedback, 20 μm Travel	\$999.24	Today
PAZ009	Piezoelectric Actuator With Feedback, 40 μm Travel	\$1,346.30	Today

[Hide Modular Piezo Actuator Tips for PAS and PAZ Actuators](#)

Modular Piezo Actuator Tips for PAS and PAZ Actuators

- ▶ Replaceable Tips for Piezoelectric Actuators
- ▶ Flat, Ball, and Threaded Tips Available
- ▶ Stainless Steel

These actuator tips provide additional mechanical interfacing options for the PAS and PAZ series of piezoelectric actuators. These tips



are precision machined from durable stainless steel for high accuracy and long life. The PAA001 is a replacement for the flat tip included with each of the above actuators. The PAA005 features a captive ball end and the PAA007 and PAA013 provide an 8-32 or M4 threaded stud, respectively.

Part Number	Description	Price	Availability
PAA007	Piezo Actuator Tip, M4 Threading	\$28.77	Today
PAA001	Piezo Actuator Tip, Flat End	\$25.75	Today
PAA005	Piezo Actuator Tip, Ball End	\$45.14	Today
PAA013	Piezo Actuator Tip, 8-32 UNC Threading	\$32.61	Today

