PiezoDrive

PiezoDrive 200V Stack Actuators

The PiezoDrive SB stack actuators are high performance multilayer stack actuators with thermoplastic encapsulation for improved reliability and protection against dust and humidity. PiezoDrive actuators are designed for applications that require long range, high force, nanometre resolution, high speed, and exceptional reliability. The SB actuators are perfectly matched to the PiezoDrive PDX200b, PDQ200, PDL200, and PDm200 voltage and charge drivers.

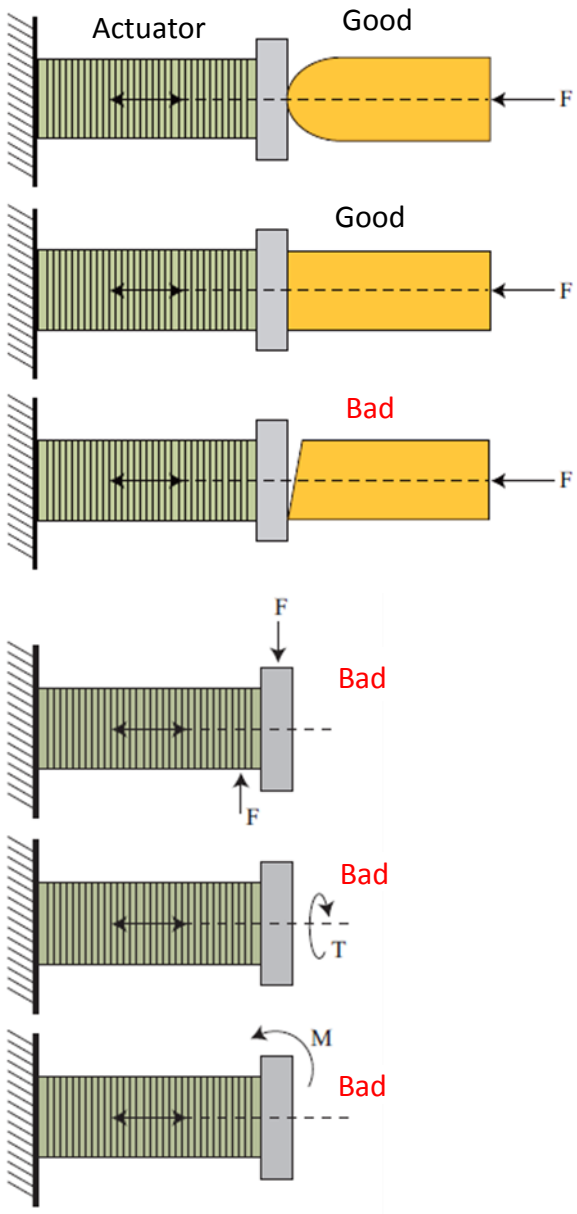
Applications include: Nanopositioning, Microscopy, Precision Machining, Vibration Control, Hydraulic Pumps, Valves, and Optics.

Order Code	SB050510	SB050520	SB050540	SB070720	SB070740
Range (±10%)	14 um	28 um	56 um	28 um	56 um
Length	10 mm	20 mm	40 mm	20 mm	40 mm
Dimensions	5 x 5 mm	5 x 5 mm	5 x 5 mm	7 x 7 mm	7 x 7 mm
Cap (±30%)	450 nF	0.9 uF	2.1 uF	2.2 uF	4.5 uF
Mass	2.3 g	4.3 g	8.1 g	7.5 g	15 g
Blocking Force	700 N	700 N	700 N	1400 N	1400 N
Stiffness	120 N/um	60 N/um	28 N/um	102 N/um	51 N/um
Power Bandwidth with PiezoDrive Amplifier					
PDX200b	2.7 kHz	1.3 kHz	568 Hz	530 Hz	265 Hz
PDL200	555 Hz	277 Hz	119 Hz	110 Hz	55 Hz
PDm200	216 Hz	108 Hz	46 Hz	42 Hz	21 Hz

Mounting Considerations

Stack actuators should not be exposed to significant tensile loads, unequally distributed loads, off-axis loads, bending moments, or torque.

To reduce mounting errors, a ceramic or stainless steel ball end can be used to interface the stack actuator to the load. Flexural mechanisms are also recommended.



The maximum recommended tensile load is 10% of the blocking force. In applications that require bi-directional forces or high speed motion, a preload force is recommended with a magnitude greater than the maximum tensile load. This gaurantees that the actuator is always in compression.

The maximum recommended preload is 50% of the blocking force.

Range

The range is specified for an applied voltage of -40V to +200V.

If the input voltage is unipolar (0V to +200V) the specified range is reduced by a factor of 0.75.

When a stack actuator is driving a stiff spring, the range is reduced by the factor

$$\frac{k_p}{k_p + k_L}$$

where k_p is the actuator stiffness and k_L is the load stiffness.

The travel range can also be reduced by restraining the end plates, e.g. by bonding the actuator to a stiff base. This effect is most significant in actuators that have a length less than twice the width.

Capacitance

The actuator capacitance is the small-signal capacitance measured at room temperature. Due to hysteresis, the effective capacitance increases with applied voltage. When operating at full range, the effective capacitance is approximately twice the small-signal capacitance.

The capacitance also increases with temperature. A temperature increase of approximately 50 °C will double the effective capacitance.

Thermal

Piezoelectric actuators dissipate heat when driven at full range with a high frequency. PiezoDrive actuators can be operated continuously at temperatures up to 85 °C. Continuous operation beyond this temperature may damage the actuator.

The dissipated heat is approximately 10% of the applied electrical power. For a sine-wave, the applied electrical power is:

$$P = \frac{{V_{p-p}}^2 \pi C f}{4}$$

The temperature dependence of piezoelectric properties can be found in “TP-226 Properties of Piezoelectricity Ceramics” by Morgan Electro-Ceramics.

Electrical Current Requirements

The required current is

$$I = C\frac{dV}{dt}$$

where I is the current, C is the effective capacitance, and dV/dt is the voltage rate-of-change.

For a sine-wave, the required peak current is equal to:

$$I_p = \pi C f V_{p-p}$$

where V_{p-p} is the peak-to-peak voltage.

For a triangle wave, the required peak current is

$$I_p = 2C f V_{p-p}$$

Recommended Drivers

The recommend drivers are listed in the table below.

Amplifier	Applications
PDX200b	High-speed, low noise
PDX200c or d	Ultrafast step response
PDL200	Ultra low noise
PDm200	General purpose, low cost
PDQ200b	Linear Response
PDu100	Ultra miniature (+100V)

The power bandwidth of each amplifier when connected to an actuator is listed on the previous page. Note that the power bandwidth of the PDQ200 is identical to the PDX200b.

Connecting Wires

The connecting wires are 140mm long AWG26 insulated wires. Red identifies the positive terminal.

Options / OEM Customization

- Ceramic ball ends (Order suffix – 2BE)
- Custom range and dimensions
- Custom wiring arrangement / connectors
- Preload or mechanical amplifier mechanisms

Piezoelectric Properties

The piezoelectric material is similar to PZT-5H and Navy Type VI. The material properties are listed below.

Property	Symbol	Value	Unit
Piezoelectric constants	d_{33}	600	10^{-12}m/V
	d_{31}	-270	10^{-12}m/V
	g_{33}	19.4	10^{-3}Vm/N
	g_{31}	-9.2	10^{-3}Vm/N
Electro-mechanical coupling coefficients	K_p	0.65	NA
	K_t	0.37	NA
	K_{31}	0.38	NA
Frequency constant	N_p	1980	Hz·m
	N_t	1950	Hz·m
	N_{31}	1450	Hz·m
Elastic constant	Y_{33}	5.3	10^{10} N/m^2
	Y_{11}	7.2	10^{10} N/m^2
Q Factor	Q_m	80	NA
Dielectric constant	$\frac{\epsilon_{33}^T}{\epsilon_0}$	3500	@1kHz
Dissipation factor	$\tan\delta$	2.5	% @1kHz
Curie Temp.	T_c	220	°C
Density	$\boldsymbol{\rho}$	7.8	g/cm^3

Contact and Support

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