Bending Actuators

Plate Benders

Features

- Free displacement up to +/- 1490 µm
- Blocking force up to 10.4 N
- High stiffness for short response times (<1ms)

Applications

- Optical communication
- Valves
- Industrial equipment
- Haptic feedback

Description

CTS tape cast multilayer piezoelectric bending actuators are ideal for a wide range of applications requiring precise and fast movement in upwards and downwards directions. CTS Plate Benders feature very high displacement in a compact design for applications requiring only low force. The plates are produced with a stroke up to +/- 1490 µm.

Standard Product, add-on or Custom Solution

This document contains information about the CTS standard multilayer plate benders and available add-ons. All the CTS multilayer products can be custom designed to match specific requirements – find more information on www.ctscorp.com or contact your local sales representative.

Specifications

Specification are given for room temperature in cantilever configuration, nominal clamping length (see drawing).

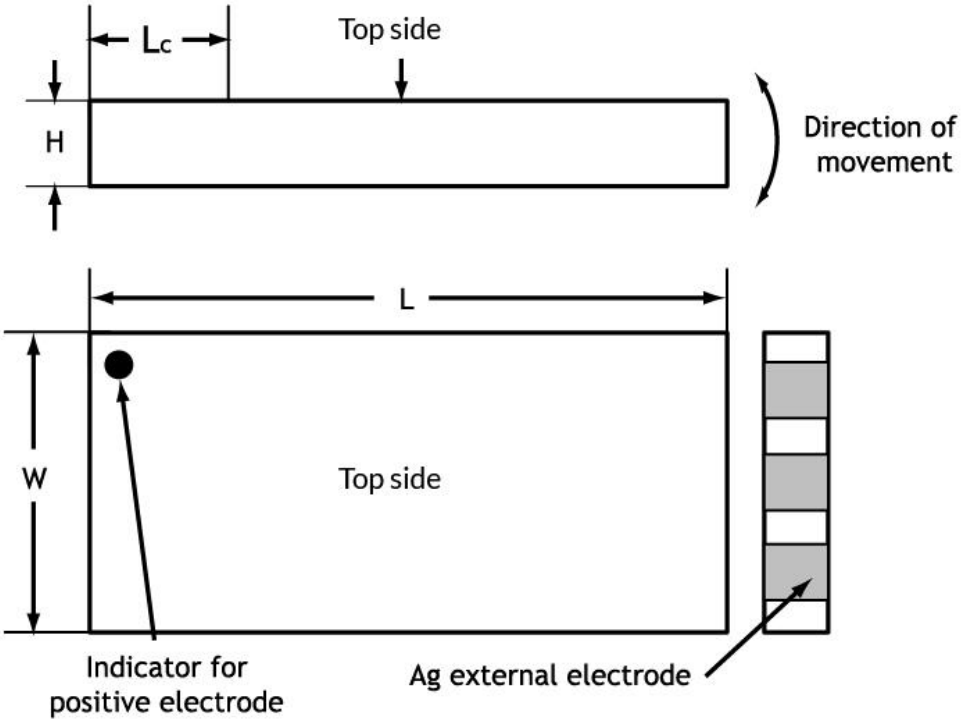
Product	NAC2221	NAC2222	NAC2223	Unit
Length (L)		21.0 +/- 0.45		mm
Width (W)		7.8 +/- 0.15		mm
Height (H)	0.7 +/- 0.10	1.3 +/- 0.10	1.8 +/- 0.10	mm
Operating Voltage, V_{max}		200		V
Free Stroke (+/- 15%)	+/- 210	+/- 140	+/- 95	µm
Blocking Force, 0 to V_{max} (+/- 20%)	1.5	5.5	10.4	N
Capacitance C_0 (+/- 15%)	2x105	2x220	2x330	nF
Large Signal Stiffness, typical	7.1	39.3	109	N/ mm
Unloaded Resonance Frequency, typical	920	1600	2300	Hz
Maximum Operating Temperature		150		°C
Material		NCE51F		-
External electrodes		Silver		-

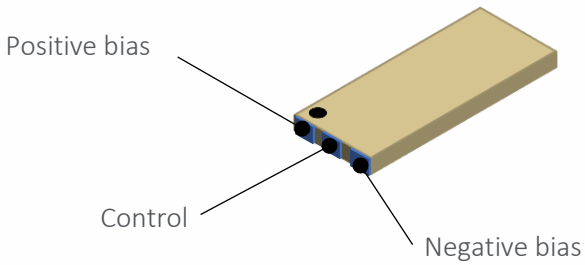
Product	NAC2224	NAC2225	NAC2226	Unit
Length (L)		32.0 +/- 0.65		mm
Width (W)		7.8 +/- 0.15		mm
Height (H)	0.7 +/- 0.10	1.3 +/- 0.10	1.8 +/- 0.10	mm
Operating Voltage, V_{max}		200		V
Free Stroke (+/- 15%)	+/- 530	+/- 365	+/- 250	µm
Blocking Force, 0 to V_{max} (+/- 20%)	0.92	3.4	6.2	N
Capacitance C_0 (+/- 15%)	2x170	2x350	2x520	nF
Large Signal Stiffness, typical	1.7	9.3	24.8	N/mm
Unloaded Resonance Frequency, typical	340	620	890	Hz

Maximum Operating Temperature	150	°C
Material	NCE51F	-
External electrodes	Silver	-

Product	NAC2227	NAC2228	NAC2229	Unit
Length (L)		50.0 +/- 1.00		mm
Width (W)		7.8 +/- 0.15		mm
Height (H)	0.7 +/- 0.10	1.3 +/- 0.10	1.8 +/- 0.10	mm
Operating Voltage, V_{max}		200		V
Free Stroke (+/- 15%)	+/- 1490	+/- 1000	+/- 700	µm
Blocking Force, 0 to V_{max} (+/- 20%)	0.58	2.1	4.0	N
Capacitance C_0 (+/- 15%)	2x280	2x560	2x860	nF
Large Signal Axial Stiffness, typical	0.4	2.1	5.7	N/mm
Unloaded Resonance Frequency, typical	130	230	330	Hz
Maximum Operating Temperature		150		°C
Material		NCE51F		-
External electrodes		Silver		-

Drawing





L_C inactive clamping length = 3.5mm

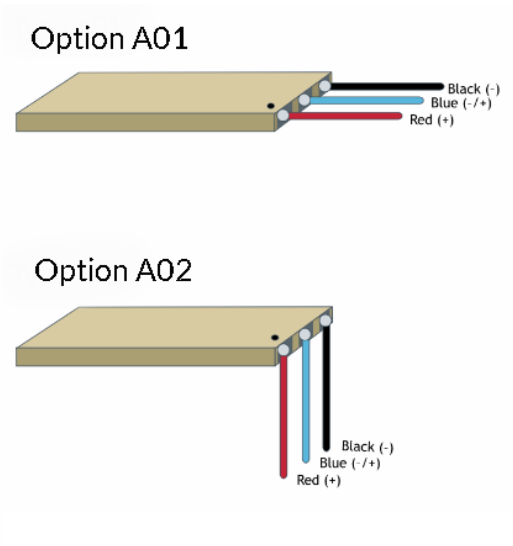
Add-ons

Wire Options

Two standard wire options are available:

		Option A01	Option A02
Wire type	NAC2221, NAC2224, NAC2227	32 AWG MIL-W-16878/6, 7 strands	
	NAC2222, NAC2223, NAC2225, NAC2226, NAC2228, NAC2229	28 AWG MIL-W-16878/4, 7 strands	
Length		200mm +/-10mm	
Position		Middle of the actuator	
Direction		Perpendicular to the height	Toward the top

We solder a red wire to the positive electrode, black to the negative and blue to the control terminal.



As part of our custom program, we can also supply specific wire types and configurations.

UHV preparation

Ultra high vacuum (UHV) is the vacuum regime characterized by pressures lower than about 10^{-7} pascal or 100 nanopascals (~10^{-9} torr). Extreme cleanliness and low outgassing are essential parameters in sustaining the vacuum level in such systems. Elevated temperature compatibility is often needed since water vapor and other trace gasses are removed from the system during a "bake-out".

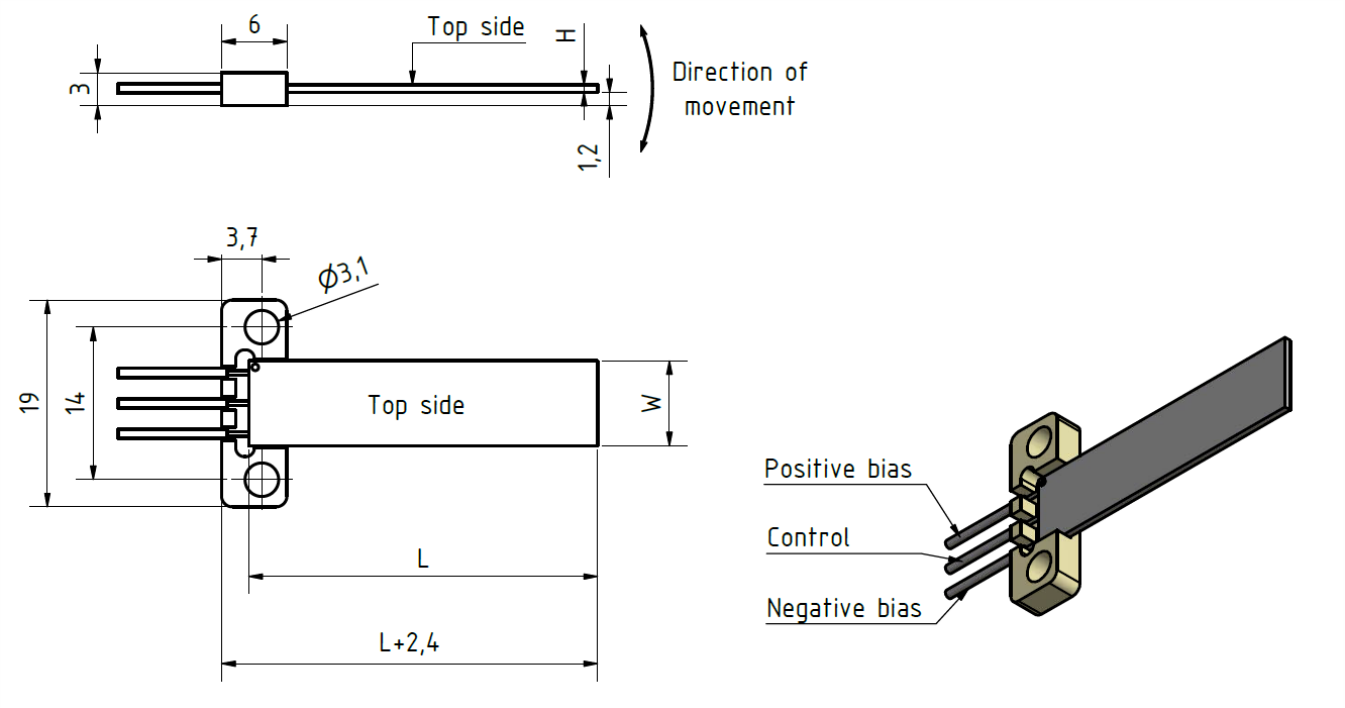
CTS piezoceramic components are designed to support system development and integration of piezo technology in UHV applications. Among many technical capabilities, CTS is competent in producing piezoelectric actuators meeting the demands on temperature compatibility and out gassing levels set by UHV operation.

For low outgassing, Kapton-insulated wires are recommended. In addition, with the UHV preparation the products will undergo a specific cleaning process and be packaged in sealed pouches.

Bender holder

To facilitate integration into experimental setups, CTS offers to fit a holder on standard plate benders. The holder is non-magnetic, compact and easy to mount and dismount. In addition, the bender holder provides strain relief for the wires.

Drawing:



Storage

We recommend storing piezoelectric ceramic components in a cool and dry environment to avoid tarnishing of the silver electrodes. The ceramic material itself is not affected by humidity, as long as no voltage is applied. If components have been stored in uncontrolled environment, we recommend drying them thoroughly before use. Heat drying is well adapted, for example 24h at 110°C, if possible in low-pressure environment.

Piezoelectric components can be stored for many years without problem. Piezoelectric ceramic is subject to aging from the date of poling, meaning that performance (capacitance, stroke) will decrease slowly according to a logarithmic trend, typically 2-5% per decade (after 1 day, 10 days, 100 days, etc.).

Handling

Piezoelectric ceramic components are fragile and must be handled with care. We recommend to:

- Prevent the components from hitting each other or other hard surfaces, keep components separate
- Particularly for long, thin benders, make sure that no excessive bending stress is induced
- Use plastic tweezers and tools rather than metallic ones
- Use gloves to avoid contamination
- Do not apply excessive force on the pre-attached wires

When submitted to a force or to temperature changes, be aware that piezoelectric components will generate charge (i.e. voltage when in open circuit), and must be properly discharged before use. Always discharge through a resistor rather than shorting the contacts or the wires, as this would create high dynamic forces that can damage the componant.

Cleaning

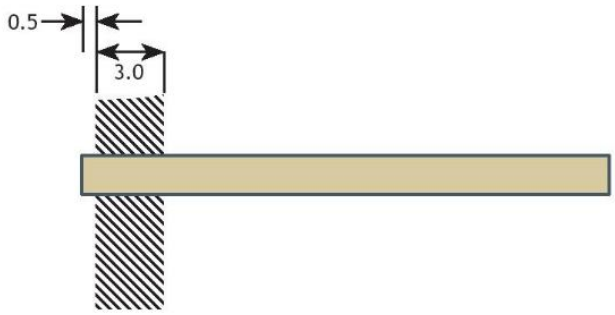
For the cleaning of ceramic components, we recommend isopropyl-alcohol (propanol) or ethanol. If needed, bending actuators can be fully submerged in solvent, however when fitted with the bender holder option we recommend to limit the exposure to a few seconds to avoid weakening of the epoxy. Ensure that the components are dried thoroughly before use.

Mounting

Bending plate actuators may be mounted either by mechanical clamping or using adhesive.

Mechanical clamping

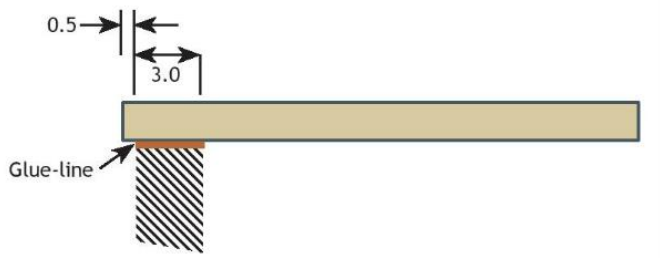
Bending plate actuators offer as-fired top and bottom surfaces and as such may present some unevenness in the surface. For this reason, mechanical clamping should be done with moderate force, approximately 5 times the specified blocking force and preferably with a compliant material as counterpart (polymer, GFRP).



Bonding with adhesive

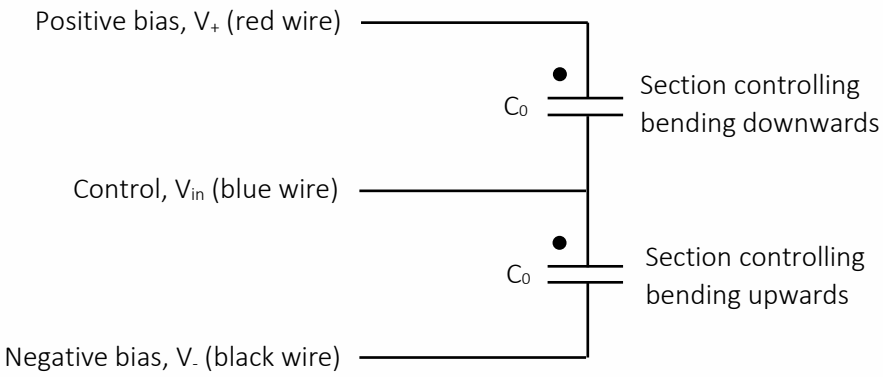
Epoxy adhesives are well suited for mounting piezoceramics. For bending actuators, we recommend using a hard (Shore D hardness 70-90), unfilled, non-conductive epoxy. When mounting with adhesive, it should be emphasized that the contact surface must be limited to cover only the inactive part of the bender in order not to reduce its stroke. Precautions include:

- Ensure that the contact surfaces are clean and adequately prepared
- Do not apply excessive clamping force during epoxy cure
- Be aware of stress build-up due to differential thermal expansion when curing at elevated temperature



Driving

Bending actuator plates contain two active sections that share one terminal. Each section can be supplied with a voltage between 0 and 200V to control the bending in a given direction. The overall bending is the combination of the influence of these two sections.

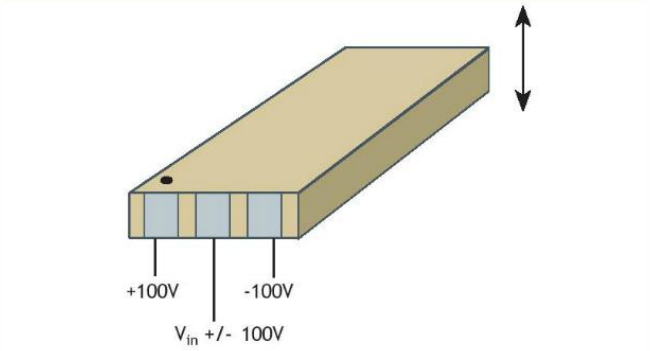


Typical driving schemes are:

Differential voltage control

In this mode, the bending can be controlled both upwards and downwards. Apply +100 V to the positive bias electrode (indicated by the black dot or red wire), -100 V to the negative bias electrode and a voltage V_{in} to the middle electrode such as -100 V< V_{in} <100 V.

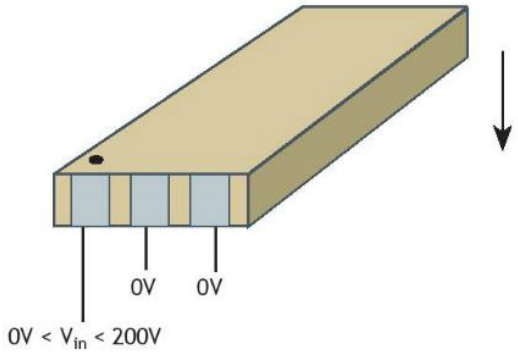
- If V_{in} = 0 V, both sections see 100 V and compensate each other; the plate remains flat.
- If 0 V< V_{in} <100 V, the plate bends up with the black dot facing up.
- If -100 V< V_{in} <0 V, the plate bends down with the black dot facing up.



Note that if a different voltage reference is used, it is also possible to apply +200 V to the positive bias electrode, 0 V to the negative bias electrode and vary V_{in} between 0 and +200 V.

Single side voltage control

In this mode, the bending can be controlled for one side only, i.e. bending down with the black dot facing up. Only one active section is used, the other section being shorted. Apply 0 V to the negative bias and control electrode connected together, and a voltage between 0 and 200V to the positive bias to control the bending.



Note that it is similarly possible to control the bending in upwards direction by applying 0 V to the negative bias and a control voltage between 0 and 200 V to the positive bias and control electrode connected together.

Bending Actuators Product Families

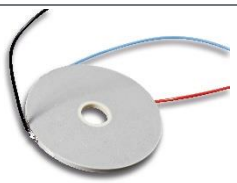


Plate and Ring Benders

Bimorphs and other geometries

Learn more about the different bending actuator product families on www.ctscorp.com.