Shear Actuators

Shear Plate Actuators

Features

- Displacement of 1.5 µm
- Symmetrical operating voltage
- Very high stiffness for short response times (<1ms)
- Low capacitance

Applications

- Micro- and nanopositioning
- Optical systems
- Atomic Force Microscopy

Description

CTS piezoelectric shear actuators are ideal for a wide range of electronic designs requiring precise and fast movement. CTS shear plate actuators feature very high displacement at low operating voltages. The standard plates are produced with a thickness of 0.5mm, providing a maximum stroke of 1.5 µm.

Standard Product, Add-ons or Custom Solution

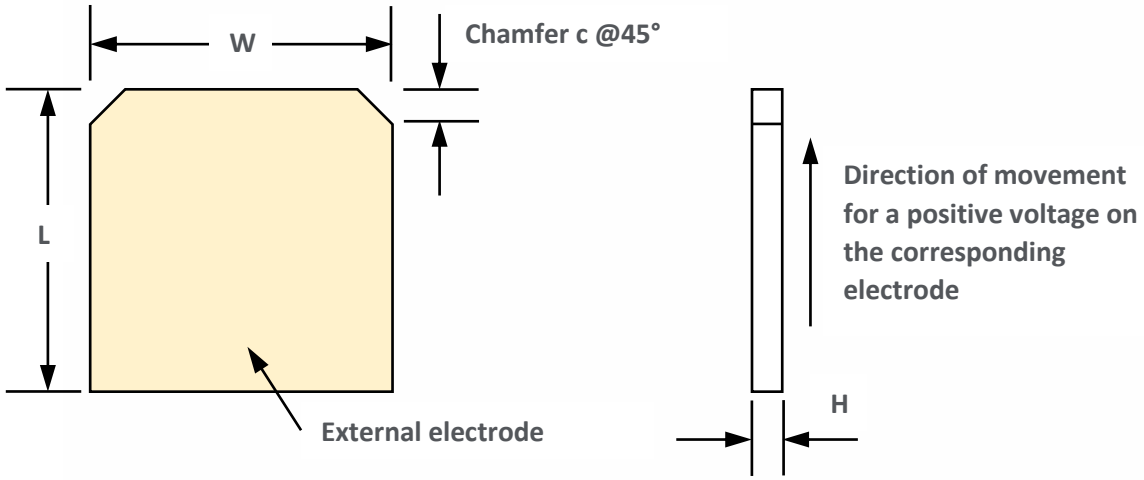
This document contains information about the CTS standard shear plate actuators and available add-ons. All the CTS standard products can be custom designed to match specific requirements – find more information on www.ctscorp.com or contact your local sales representative.

Specifications

Product	CSAP01	CSAP02	CSAP03	CSAP04	Unit
Length (L)	2 +/- 0.10	5 +/- 0.10	10 +/- 0.20	15 +/- 0.30	mm
Width (W)	2 +/- 0.10	5 +/- 0.10	10 +/- 0.20	15 +/- 0.30	mm
Chamfer size (c)	0.2	0.5	1	1.5	mm
Height (H)	0.5 +/- 0.05				mm
Operating Voltage, V_{max}	320				V
Free Stroke, $-V_{max}$ to $+V_{max}$*	1.5 +/- 15%				µm
Estimated small signal shear stiffness** (Typ.)	180	1’100	4’500	10’000	N/µm
Capacitance @1V_{RMS}, 1kHz (+/15%)	0.13	0.83	3.32	7.47	nF
Maximum Operating Temperature	200***				°C
PZT material	NCE51				-
External electrodes	Plated Gold on Nickel				-

* At room temperature. Operating voltage must be reduced at elevated temperature
** Shear stiffness is very high and it is likely that other components in the system will introduce more compliance
*** Standard wire option A01 has a rating of 150°C
This product contains materials that present health hazards by inhalation or ingestion. Do not attempt to disassemble, grind or melt the product and dispose of according to local regulations.

Drawing



Add-ons

Wire Options

Shear actuators are typically delivered without wires, as the preferred connection method is a mechanical contact to the gold-plated electrodes. However, CTS do have the option to apply wires.

We recommend wires with PTFE insulation

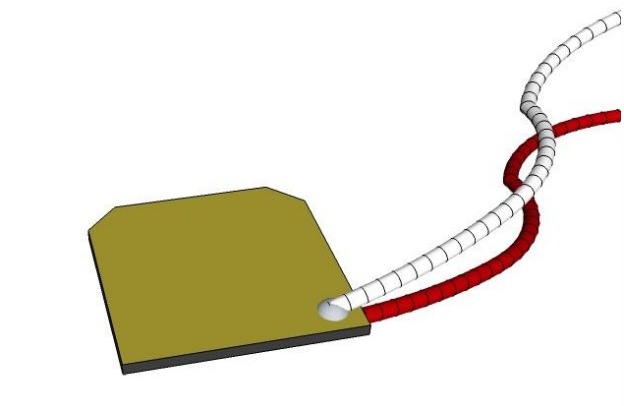
PTFE wires can stand temperatures above 200 °C, whereas PVC wires only resist temperatures up to 80 °C. We recommend PTFE for the thermal and chemical resistance of the insulation.

For vacuum and cryogenic applications, we recommend Kapton wires, which offer superior outgassing and flexibility.

Standard wire option for shear plate actuators

One standard wire option is available:

	Option A01
Wire type	MIL-W-16878/4, 30 AWG, 7 strands
Length	200mm +/-10mm
Position and orientation	See sketch



Standard wire option A01 has a temperature rating of 150°C.

Customized wire option for shear plate actuators

We stock several alternative wire types:

Wire type	Voltage rating [V]	Approx. outer diameter [mm]	Rec. max. current [A]	Min. operating temperature [°C]
32AWG, MIL-W-16878/6, 7 strands	250	0.6	0.53	-60
30AWG, MIL-W-16878/4, 7 strands	600	0.8	0.86	-60
28AWG, MIL-W-16878/4, 7 strands	600	0.9	1.4	-60
28AWG, Allectra 301-KAPM-035 (Kapton insulation, UHV)	7500*	0.6	1.0	-269
22AWG, BS3G210 Type A, 19 strands	300	1.1	8	-75

* In vacuum conditions

As part of our custom program, we can also stock specific wire.

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.

Non-magnetic design

Although piezoelectric ceramic and all accessories are non-magnetic, our shear plate actuators include a thin layer of Nickel under the gold electrodes. This can be a concern when shear plates are applied in experiments where a homogeneous magnetic field or very accurate magnetic field measurements are required. If this is the case, CTS can provide special shear plates that do not include Nickel.

Storage

We recommend storing piezoelectric ceramic components in a cool and dry environment. 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 according to a logarithmic trend, typically 2-5% per decade (after 1 day, 10 days, 100 days…).

Handling

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

- Prevent the components from hitting each other or hard surfaces, keep components separate
- Use plastic tweezers and tools rather than metallic ones
- Use gloves to avoid contamination
- Do not apply excessive force on the pre-attached wires
- Do not create stress concentrations, for example by constraining the part against an uneven surface

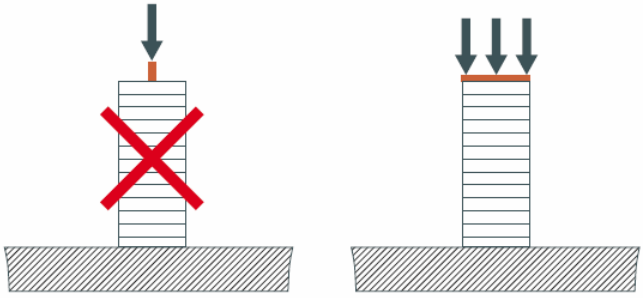
Shear elements do not generate charge (i.e. voltage when in open circuit) when submitted to temperature changes. However, it is good practice to ansure that the components are fully discharged before connecting them. Always discharge through a resistor rather than shorting the wires, as it would create high dynamic forces that can damage the component.

Cleaning

For the cleaning of ceramic components, we recommend isopropyl-alcohol (propanol) or ethanol. The components have to be thoroughly dried before use. If needed, shear plate actuators can be fully submerged in solvent.

Mounting

Shear plate actuators present electrodes on top and bottom surfaces. They may be mounted either by mechanical clamping or using adhesive. In both cases, the force must be applied on the full surface of the actuator in order to ensure a good load distribution. In particular when applying the pressure, the contact surfaces have to be sufficiently flat or compliant.



It can be necessary to insulate the contact surfaces from the rest of the structure. This can be achieved by adding inactive ceramic plates in the structure, or polyimide film insulator.

Clamping

In case of clamping, axial stress on shear plate actuators must be controlled. Too low pressure can lead to slippage whereas too high pressure can damage the ceramic. With the appropriate contact surface and in the case of low shear force, a pressure of 1 to 3 MPa can be recommended.

If clamping is used, the stiffness of the loading mechanism in the actuation direction shall be as low as possible in order not to hinder the movement of the actuator.

Bonding with adhesive

Epoxy adhesives are well suited for mounting piezoceramics. For shear actuators, we recommend using a hard (Shore D hardness 70-90), non-conductive, unfilled epoxy. If mounted with adhesive, it is important to ensure a very thin glue line between the shear plate actuators and the substrate. This is generally ensured by using low viscosity epoxy. A pressure, e.g. 2-3 MPa, should be applied during the curing process. To avoid significant loss of performance, the mounting should avoid adhesive on the sides of the actuator.

Connecting and Driving

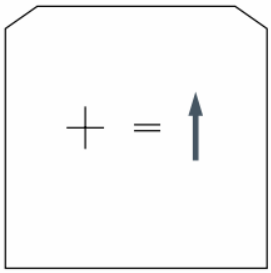
Connecting

Shear plate actuators are provided with gold plated electrodes for optimal electrical contact and to avoid oxidation of the electrodes. Mechanical connections can be arranged by e.g. copper springs contacted to the external electrodes. For demanding applications, it might be necessary to have both contacts gold plated.

Alternatively, electrical connection to the external electrodes can be achieved by soldering, bonding with electrically conductive adhesive or wire bonding. Refer to our website for soldering guidelines.

Driving

Since shear plate actuators can be used with bipolar symmetrical electrical supply, both electrodes are identical. The direction of operation is indicated by the chamfers. Sign convention: A positive voltage on one electrode leads to a relative displacement of this electrode towards the chamfered edge.

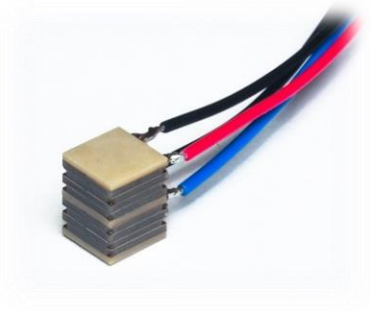


The current capability of the driver must be adapted to the driving signal. Due to the capacitive nature of the piezoelectric actuator, fast motion will often require very high currents. Please refer to our online tutorial for guidance about current calculation. In particular with shear actuators, dissipation within the actuator increases rapidly and may cause thermal drift. When operating at high frequency, it is recommended to monitor temperature and adjust the driving conditions accordingly.

We recommend to add a resistance in series with the actuator to form a RC circuit to limit the peak current, bandwidth and eventual noise that may be generated by the driver.

Shear Actuators Product Families

Shear Plate Actuators



Shear Stack Actuators:

- X
- XY
- XYZ

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