



# Linear Actuators

## Ring Actuators

### Features

- Displacement up to 3.3  $\mu\text{m}$
- Very high force in the kN range
- High stiffness for short response times (<1ms)

### Applications

- Micro- and nanopositioning
- Industrial equipment
- Active vibration control
- Valves
- Laser tuning
- Shaker

### Description

CTS tape cast multilayer piezoelectric linear actuators are ideal for a wide range of electronic designs requiring precise and fast movement. CTS multilayer piezo ring actuators are produced with a stroke up to 3.3  $\mu\text{m}$ . The piezo ring actuators are used in a wide range of applications due to the easy integration of a ring.

### Standard Product, add-on or Custom Solution

This document contains information about the CTS standard multilayer ring actuators and available add-ons. All the CTS multilayer products can be custom designed to match specific requirements – find more information on [www.ctscorp.com](http://www.ctscorp.com) or contact your local sales representative.



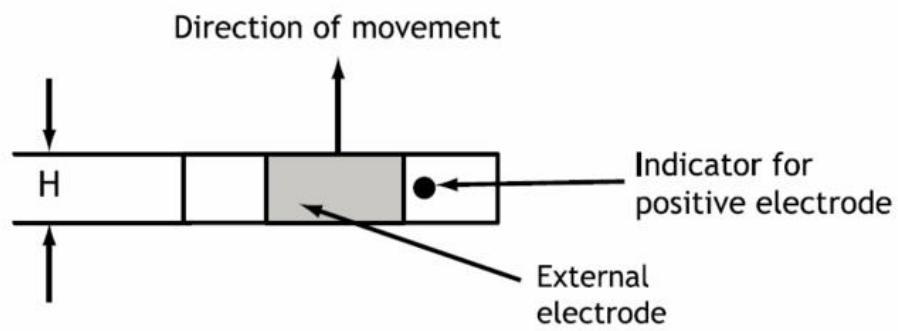
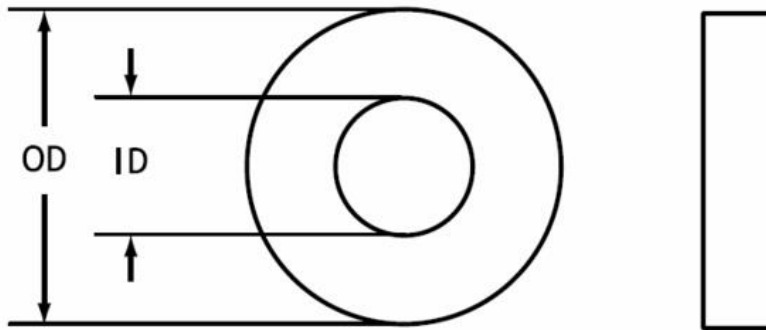


## Specifications

Product	NAC2121	NAC2122	NAC2123	NAC2124	NAC2125	Unit
Outer Diameter (OD)	6 +/- 0.20	8 +/- 0.25	12 +/- 0.40	15 +/- 0.45	20 +/- 0.60	mm
Inner Diameter (ID)	2 +/- 0.10	3 +/- 0.10	6 +/- 0.20	9 +/- 0.30	12 +/- 0.40	mm
Height (H)	2 +/- 0.05	2 +/- 0.05	2 +/- 0.05	2 +/- 0.05	2 +/- 0.05	mm
Operating Voltage, $V_{max}$	200					V
Free Stroke (+/- 15%)	3.3					$\mu\text{m}$
Blocking Force, 0 to $V_{max}$ (+/- 20%)	1060	1810	3560	4750	8450	N
Capacitance (+/- 15%)	95	200	380	510	890	nF
Large Signal Axial Stiffness (+/- 20%)	321	548	1079	1439	2561	N/ $\mu\text{m}$
Maximum Operating Temperature	200*					$^{\circ}\text{C}$
Material	NCE51F					-
Electrodes	Silver					-

\* Standard wire options A01 and A02 have a rating of 150 $^{\circ}\text{C}$

Drawing



## Add-ons

### Wire Options

When you order actuators from CTS, you can have wires fitted to save time and money. However, you should consider these parameters, when you select a wire for connection:

- Operation voltage
- Intensity of current
- Operating temperature
- Environment for example vacuum

### We recommend wires with PTFE insulation

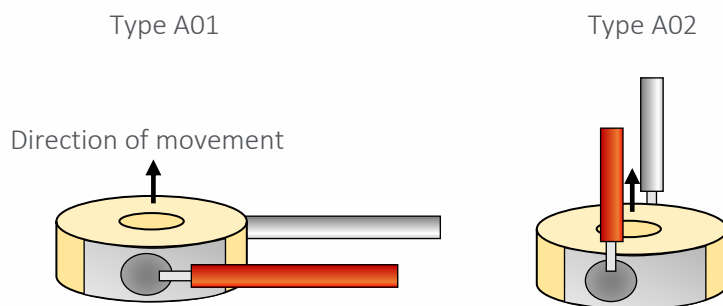
PTFE wires can stand temperatures above 200 °C, whereas PVC wires only resist temperatures up to 80 °C. We recommend PTFE for the thermal and chemical resistance of the insulation.

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

### Standard wire options for Ring Actuators

Two standard wire options are available:

	Option A01	Option A02
Type	MIL-W-16878/4, 28 AWG, 7 strands	
Length	200mm +/-10mm	
Position	Middle of the actuator	
Direction	Perpendicular to the height	Toward the top



Standard wire options A01 and A02 have a temperature rating of 150°C.

### Wire gauge (AWG)

The wire gauge (AWG) and insulation type should be determined according to the voltage, current and operating environment. Should the standard –A01 or –A02 configuration not suit your application, we offer 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*	0.58	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 ( $\sim 10^{-9}$  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 vapour 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.

## 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 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

When submitted to a force or to temperature changes, be aware that piezoelectric components will generate charge (i.e. voltage when in open circuit), so they must be properly discharged before use. Always discharge through a resistor rather than shorting the wires, as it would create high dynamic forces that can damage the component. It is recommended to keep larger components short-circuited during shipment and storage to avoid charge build-up.

## 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, plate actuators can be fully submerged in solvent.

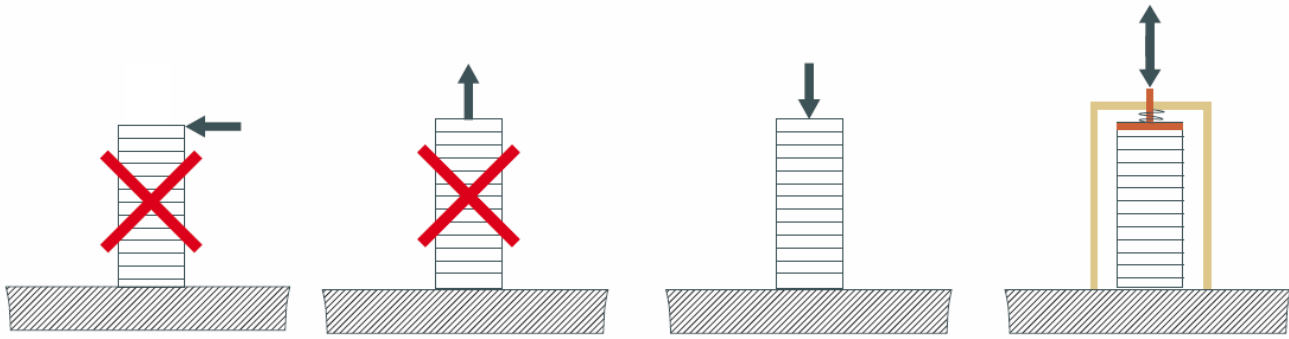
## Mounting

Ring actuators offer flat and parallel surfaces for mounting. The actuators may be mounted either by mechanical clamping or using adhesive.

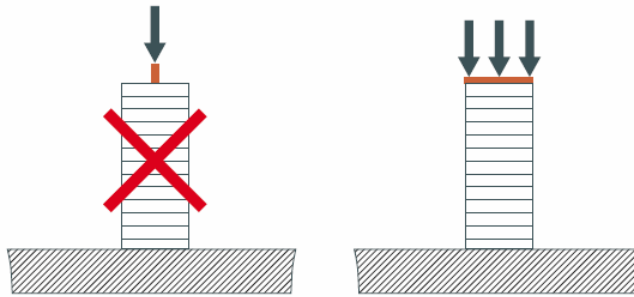
### General recommendations

Piezoelectric ceramics can tolerate high compressive stress, but only limited tensile stress. CTS actuators can be safely operated without preload in quasi-static conditions, however preload is required to achieve the specified stiffness and dynamic performance. We recommend 5 MPa preload for quasi-static applications, 10 MPa for dynamic applications and up to 40 MPa in specific high loading conditions.

We recommend to avoid tensile stress, which could result from direct pulling, inertial forces or bending forces. If pull or bending forces cannot be avoided, the actuator must be properly pre-stressed to ensure tensile stress is eliminated. Refer to our online tutorial for additional information on the estimation of actuator loads.

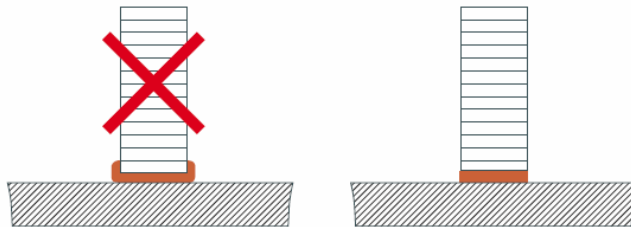


The mechanical load must be applied on the full surface of the actuator in order to avoid stress concentrations.



### Mounting using adhesive

Epoxy adhesives are well suited for mounting piezoceramics. For linear actuators, we recommend using a semi-soft (Shore D hardness 50-70), non-conductive, unfilled epoxy. When bonding, it is important to ensure a very thin glue line between the actuator and the substrate. It is recommended to apply a pressure, e.g. 2-5 MPa, during the curing process. To avoid significant loss of performance, the mounting should avoid adhesive on the sides of the actuator.





## Connecting and Driving

Linear actuators are easily connected using the optional wires. Alternatively, soldering, conductive epoxy, conductive film or mechanical contacting can be used. Refer to our website for soldering guidelines.

Ensure that the components are properly discharged and that there is no voltage on the output when connecting to a driver. Voltage differences will generate current peaks that can damage the actuator or the driver.

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.

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.

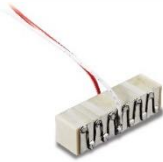


## Linear Actuators Product Families

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Plate and Ring Actuators



Stacked Actuators:

- Plate Stacks
- Plate stacks, compact
- Ring Stacks
- High Temperature Stacks
- Damage Tolerant Stacks



Preloaded Actuators

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Learn more about the different linear actuators product families on [www.ctscorp.com](http://www.ctscorp.com).