



Linear Actuators

High Temperature Stacks

Features

- Displacement up to 45.6 μm
- Very high force
- High stiffness for short response times ($<1\text{ms}$)
- Height up to 50 mm

Applications

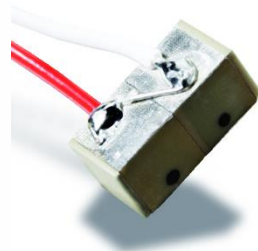
- Micro- and nanopositioning
- Industrial equipment
- Active vibration control
- Valves
- Laser tuning
- Shaker

Description

CTS tape cast multilayer piezoelectric linear actuators are ideal for a wide range of electronic designs requiring precise and fast movement. CTS high temperature plate stack actuators are designed to perform at high temperature and high frequency. The maximum operating temperature is 200 °C, and combined with a high frequency operation, they are a perfect match for applications where high temperature and high frequency is a challenge.

Standard Product, add-ons or Custom Solution

This document contains information about the CTS standard multilayer high temperature stacks 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.





Product designation

NAC6024-H20- A01

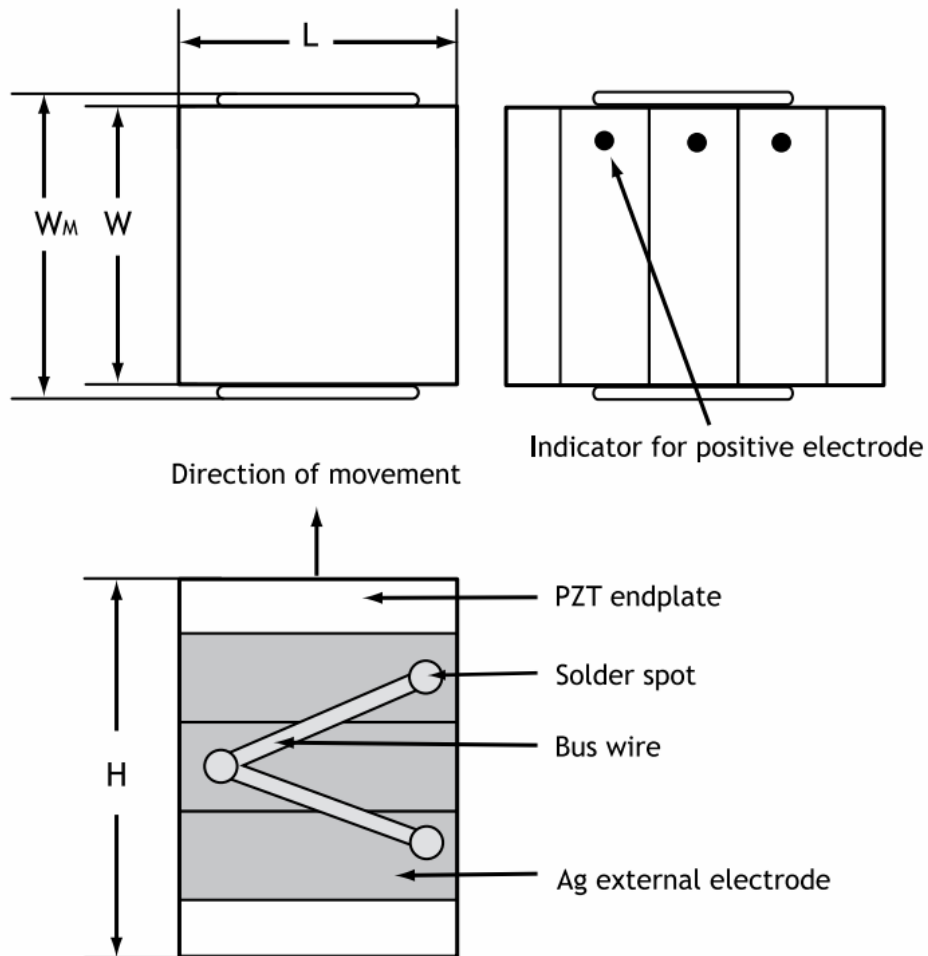


Specifications

Product series	NAC6024-HXX	NAC6025-HXX	Unit
Length (L)	3 +0.30/-0.10	5 +0.30/-0.10	mm
Width (W)	3 +0.30/-0.10	5 +0.30/-0.10	mm
Max width (W _M)	4.8 Max	6.8 Max	mm
Height (H)	4 to 30*	4 to 50*	mm
Operating voltage, V _{max}	200		V
Blocking force, 0 to V _{max}	290 +/-20%	800 +/-20%	N
Max. operating temp.	200		°C
PZT material	NCE46 or NCE41F		-
External electrodes	Screen-printed silver, soldered tinned copper bus-wire		-

* See the different height options and corresponding free displacement and capacitance data in the tables below.

Drawing



Stacking Options

NAC6024-Hxx		
Height	Free Stroke	Capacitance
+/-0,2 mm or 1%*	+/-15%	+/-15%
mm	µm	nF
4	1.8	30
6	3.6	50
8	5.4	80
10	7.2	100
12	9.0	130
14	10.8	150
16	12.6	180
18	12.4	200
20	16.2	230
22	18.1	250
24	19.9	280
26	21.7	300
28	23.5	330
30	25.3	350

* whichever is largest

NAC6025-Hxx		
Height	Free Stroke	Capacitance
+/-0,2 mm or 1%*	+/-15%	+/-15%
mm	µm	nF
4	1.9	80
6	3.8	160
8	5.7	240
10	7.6	320
12	9.5	400
14	11.4	480
16	13.3	560
18	15.2	640
20	17.1	720
22	19.0	800
24	20.9	880
26	22.8	960
28	24.7	1040
30	26.6	1120



High Temperature Stacks

32	28.5	1200
34	30.4	1280
36	32.3	1360
38	34.2	1440
40	36.1	1520
42	38.0	1600
44	39.9	1680
46	41.8	1760
48	43.7	1840
50	45.6	1920

* whichever is largest

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 wire, which offer superior outgassing and flexibility.

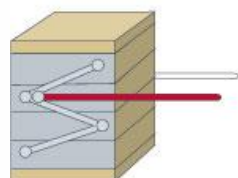
Standard wire options for High Temperature Stacks

Two standard wire options are available:

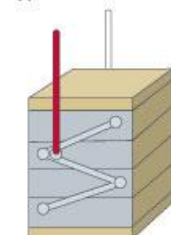
		Option A01	Option A02
Wire type	NAC6024	MIL-W-16878/6, 32 AWG, 7 strands	
	NAC6025	MIL-W-16878/4, 28 AWG, 7 strands	
Length		200mm +/-10mm	
Position		Middle of the actuator	
Direction		Perpendicular to the height	Toward the top

Wires: White (-) Red (+)

Type A01



Type A02



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	Approx. outer diameter	Rec. max. current	Min. operating temperature
	[V]	[mm]	[A]	[°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 ($\sim 10^{-9}$ 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.

Reduced tolerances

For demanding applications, piezoelectric actuators can be re-worked after stacking in order to achieve better geometrical and dimensional properties. CTS offer this customization possibility for high temperature stacks with cross sections of 5x5 mm.

Product series	Standard height tolerance	Reduced height tolerance
NAC6025	+/-0.2mm or +/-1%	+/-0.025mm

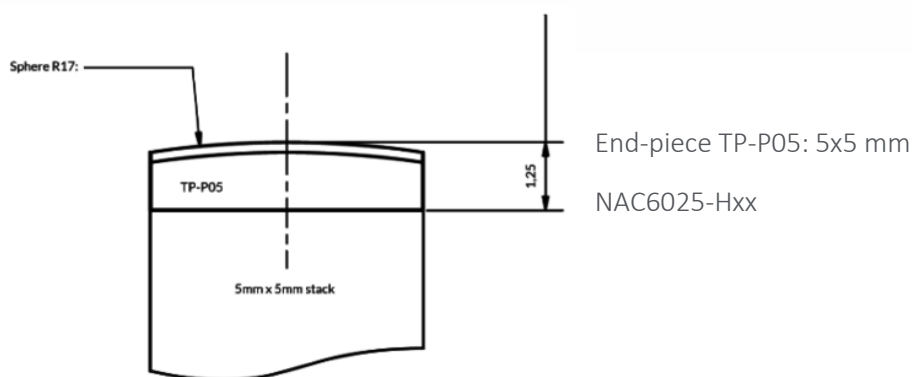
In addition, it is possible to re-work the length or specify a smaller maximum width. These possibilities are available through our custom program.

End-pieces

Metallic end-pieces can be useful in terms of:

- Spreading a high mechanical load on the whole surface of an actuator
- Providing some de-coupling, i.e. allowing a stack to tilt
- Centering an actuator in an assembly

CTS stock end-pieces for our most popular cross-sections. The material is stainless steel (AISI 316). These products are compatible with NAC6025:

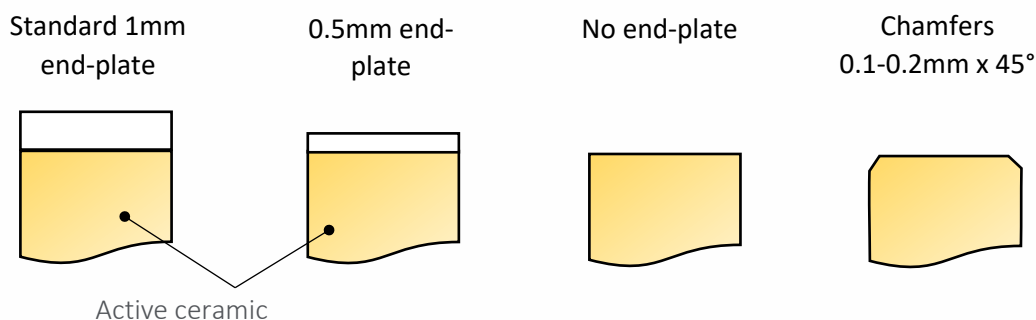


The design is compact, with spherical caps providing some de-coupling, thereby releasing the requirements on alignment. The parts are low-magnetic and compatible with our other add-ons (UHV, wires etc.). End-pieces can be attached at one or both ends of a stack. They can be supplied with a short lead-time and are more cost-effective for small series.

End-plates

As a standard, high temperature stacks are supplied with 1mm thick ceramic end-plates. All our standard end-plates are produced with our piezoceramic material NCE51. Ceramic provides ideal electrical insulation properties, low thermal expansion mismatch as well as good mechanical properties to spread the load over the surface of the active piezoceramic. We recommend a thickness of 1mm for a good spread of the load.

It is nevertheless possible to use different configurations as illustrated below:



Note that stacks without end-plates or chamfers must not be mounted against a conductive surface, to avoid the risk of short-circuits between the surface electrodes.

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
- Particularly for tall, narrow stacks, make sure that no bending 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), 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, high temperature stacks can be fully submerged in solvent, however we recommend to limit the exposure to a few seconds to avoid weakening of the epoxy.

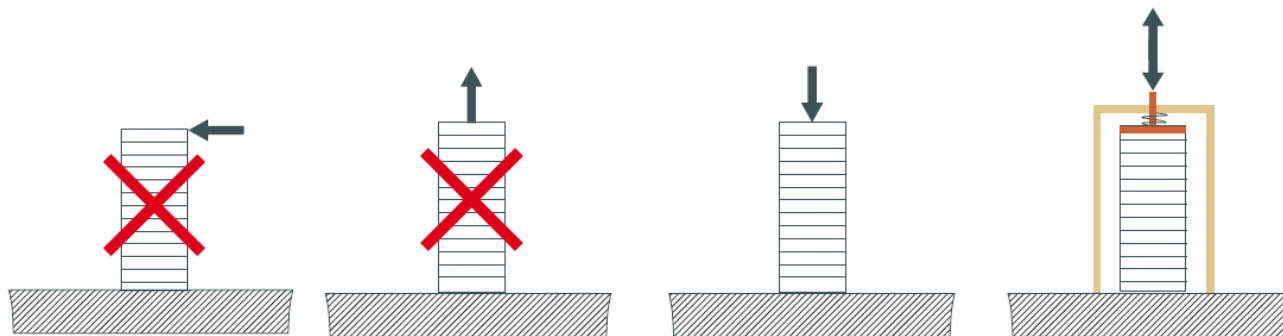
Mounting

High temperature stacks 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 stack loads.

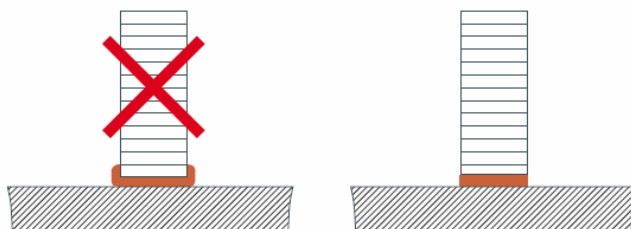


The mechanical load must be applied on the full surface of the actuator in order to avoid stress concentrations.



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 stacks 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.

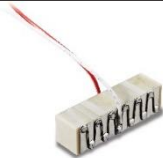
The current capability of the driver must be adapted to the driving signal. Due to the capacitive nature of the piezoelectric actuator, fast motion will often require very high currents. Please refer to our online tutorial for guidance about current calculation.

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



Plate and Ring Actuators



Stacked Actuators:

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



Preloaded Actuators

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