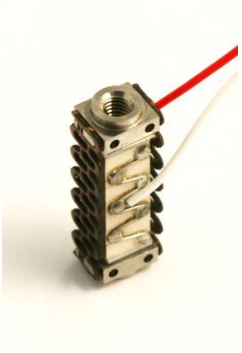
Linear Actuators

Preloaded Actuators

Features

- Displacement up to 111.6 µm
- Low operating voltages (down to 60V)
- Very high force in the kN range
- Can tolerate pull force up to 500N
- High stiffness for short response times (<1ms)
- Height up to 79.6 mm
- Available in two cross-sections, 5*5 and 7*7mm



Applications

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

Description

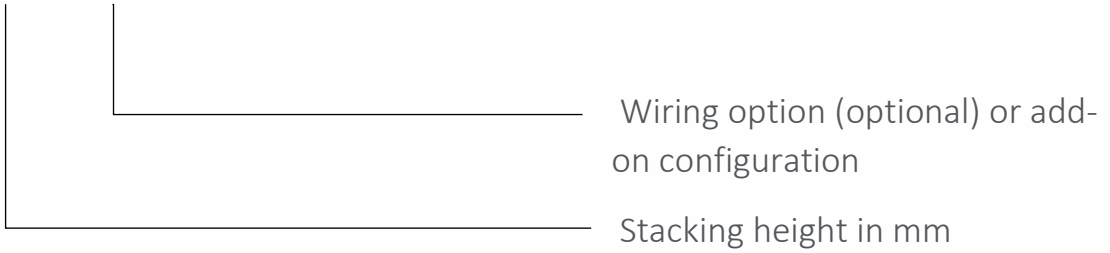
CTS tape cast multilayer piezoelectric linear actuators are ideal for a wide range of electronic designs requiring precise and fast movement. The CTS preloaded actuator is a high performance, compact solution for faster accelerations/decelerations and shorter response time. The design is easy to integrate and modular, so we can offer an exceptionally wide range of products to closely match specific requirements.

Standard Product, add-ons or Custom Solution

This document contains information about the CTS standard multilayer preloaded 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 or contact your local sales representative.

Product Designation

NAC2003-H20P-A01



Specifications

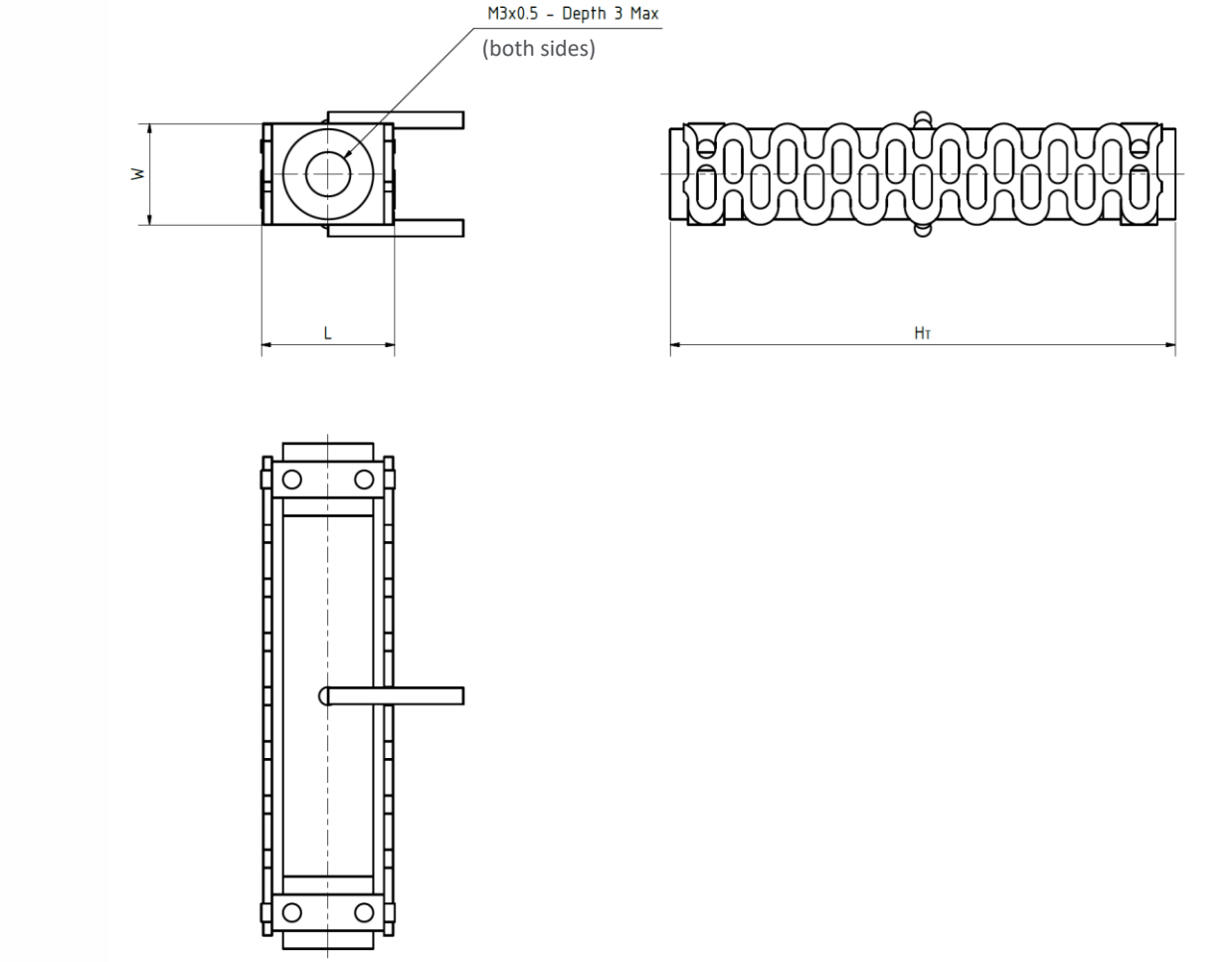
Product series	NAC2003-HXXP	NAC2013-HXXP	NAC2014-HXXP	NAC2021-HXXP	Unit
Length (L), Max	7.6		10.0		mm
Max width (W), excluding wire	6.8		8.8		mm
Total height (H_T)	22.2 to 58.4*	22.2 to 58.4*	25.6 to 79.6*	25.6 to 79.6*	mm
Operating voltage, V_{max}	60	150	150	200	V
Maximum Pull Force	250		500		N
Blocking force, 0 to V_{max}	1050 +/-20%		2050 +/-20%		N
Max. operating temp.	150		150		°C
PZT material	NCE51	NCE51F	NCE51F	NCE51F	-
Preload Mechanism Material	Alumina, Stainless steel, Copper-Beryllium				-

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

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.

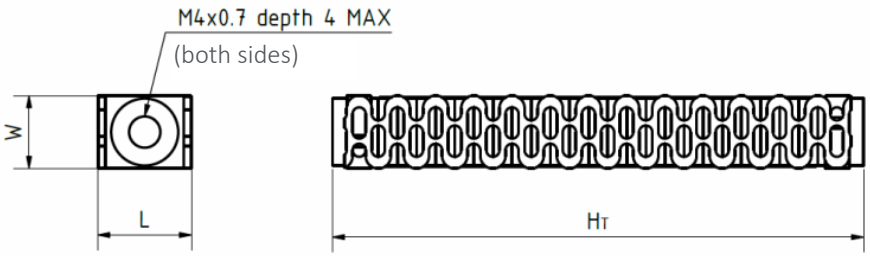
Drawings

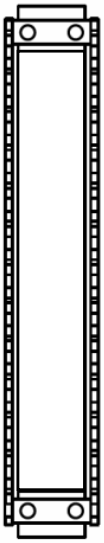
For NAC2003-HXXP and NAC2013-HXXP series:



Note: stack shown with –A01 wire option

For NAC2014-HXXP and NAC2021-HXXP series:





Stacking Options

For NAC2003-HXXP and NAC2013-HXXP series:

Product series	NAC2003-HxxP			NAC2013-HxxP		
Total height H_T	Product Reference	Free Stroke	Capacitance	Product Reference	Free Stroke	Capacitance
+/-0,2 mm or 1%*		+/-15%	+/-15%		+/-15%	+/-15%
mm		µm	nF		µm	nF
22.2	NAC2003-H16P	20.4	7550	NAC2013-H16P	22.3	1320
23.7	NAC2003-H18P	23.2	8600	NAC2013-H18P	25.5	1510
26.7	NAC2003-H20P	26.2	9700	NAC2013-H20P	28.7	1700
28.2	NAC2003-H22P	29.0	10800	NAC2013-H22P	31.8	1890
29.7	NAC2003-H24P	31.9	11900	NAC2013-H24P	35	2080
32.7	NAC2003-H26P	34.8	12900	NAC2013-H26P	38.2	2270
34.2	NAC2003-H28P	37.7	14000	NAC2013-H28P	41.3	2460
35.7	NAC2003-H30P	41.0	15100	NAC2013-H30P	45	2650
40.3	NAC2003-H32P	43.8	16200	NAC2013-H32P	48	2840
42.3	NAC2003-H34P	47.0	17200	NAC2013-H34P	51.6	3020
44.3	NAC2003-H36P	50.1	18300	NAC2013-H36P	55.1	3210
44.8	NAC2003-H38P	52.1	19400	NAC2013-H38P	57.2	3400
46.3	NAC2003-H40P	55.0	20500	NAC2013-H40P	60.3	3590
47.8	NAC2003-H42P	57.9	21500	NAC2013-H42P	63.4	3780
50.9	NAC2003-H44P	60.8	22600	NAC2013-H44P	66.6	3970
52.4	NAC2003-H46P	63.7	23700	NAC2013-H46P	69.8	4160
53.9	NAC2003-H48P	66.5	24800	NAC2013-H48P	72.9	4350
56.9	NAC2003-H50P	69.4	25900	NAC2013-H50P	76.1	4540
58.4	NAC2003-H52P	72.3	26900	NAC2013-H52P	79.3	4730

* whichever is largest

For NAC2014-HXXP and NAC2021-HXXP series:

Product series	NAC2014-HxxP			NAC2021-HxxP		
Total height H_T	Product Reference	Free Stroke	Capacitance	Product Reference	Free Stroke	Capacitance
+/-0,2 mm or 1%*		+/-15%	+/-15%		+/-15%	+/-15%
mm		µm	nF		µm	nF
25.6	NAC2014-H18P	25.6	2830	NAC2021-H18P	25.6	1640
27.6	NAC2014-H20P	28.8	3180	NAC2021-H20P	28.8	1840
29.6	NAC2014-H22P	32.0	3530	NAC2021-H22P	32.0	2050
31.6	NAC2014-H24P	35.2	3890	NAC2021-H24P	35.2	2250
33.6	NAC2014-H26P	38.4	4240	NAC2021-H26P	38.4	2460
35.6	NAC2014-H28P	41.6	4590	NAC2021-H28P	41.6	2660
37.6	NAC2014-H30P	44.8	4950	NAC2021-H30P	44.8	2860
39.6	NAC2014-H32P	47.9	5300	NAC2021-H32P	47.9	3070
41.6	NAC2014-H34P	51.1	5650	NAC2021-H34P	51.1	3270
43.6	NAC2014-H36P	54.3	6010	NAC2021-H36P	54.3	3480
45.6	NAC2014-H38P	57.5	6360	NAC2021-H38P	57.5	3680
47.6	NAC2014-H40P	60.7	6720	NAC2021-H40P	60.7	3890
49.6	NAC2014-H42P	63.9	7070	NAC2021-H42P	63.9	4090
51.6	NAC2014-H44P	67.0	7420	NAC2021-H44P	67.0	4300
53.6	NAC2014-H46P	70.2	7780	NAC2021-H46P	70.2	4500
55.6	NAC2014-H48P	73.4	8130	NAC2021-H48P	73.4	4710
57.6	NAC2014-H50P	76.6	8480	NAC2021-H50P	76.6	4910
59.6	NAC2014-H52P	79.8	8840	NAC2021-H52P	79.8	5120
61.6	NAC2014-H54P	83.0	9190	NAC2021-H54P	83.0	5320
63.6	NAC2014-H56P	86.1	9540	NAC2021-H56P	86.1	5520
65.6	NAC2014-H58P	89.3	9900	NAC2021-H58P	89.3	5730
67.6	NAC2014-H60P	92.5	10250	NAC2021-H60P	92.5	5930
69.6	NAC2014-H62P	95.7	10600	NAC2021-H62P	95.7	6140
71.6	NAC2014-H64P	98.9	10960	NAC2021-H64P	98.9	6340
73.6	NAC2014-H66P	102.1	11310	NAC2021-H66P	102.1	6550
75.6	NAC2014-H68P	105.2	11660	NAC2021-H68P	105.2	6750
77.6	NAC2014-H70P	108.4	12020	NAC2021-H70P	108.4	6960
79.6	NAC2014-H72P	111.6	12370	NAC2021-H72P	111.6	7160

* 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

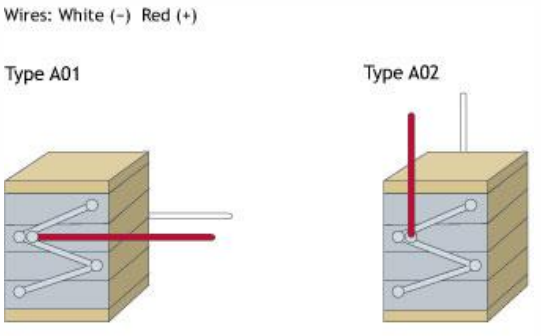
PTFE wires can stand temperatures above 200 °C, whereas PVC wires only resist temperatures up to 80 °C. We recommend PTFE for the thermal and chemical resistance of the insulation.

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

Standard wire options for Preloaded Stacks

Two standard wire options are available:

	Option A01	Option A02
Wire 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



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)	1000*	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.

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 bending is limited
- 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.

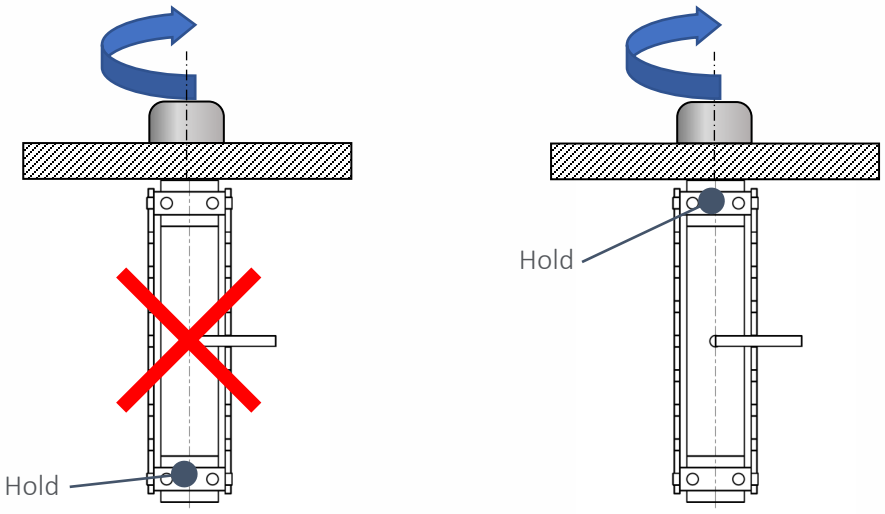
Cleaning

For the cleaning of ceramic components, we recommend isopropyl-alcohol (propanol) or ethanol. The components have to be thoroughly dried before use. If needed, preloaded stacks can be fully submerged in solvent, however we recommend to limit the exposure to a few seconds.

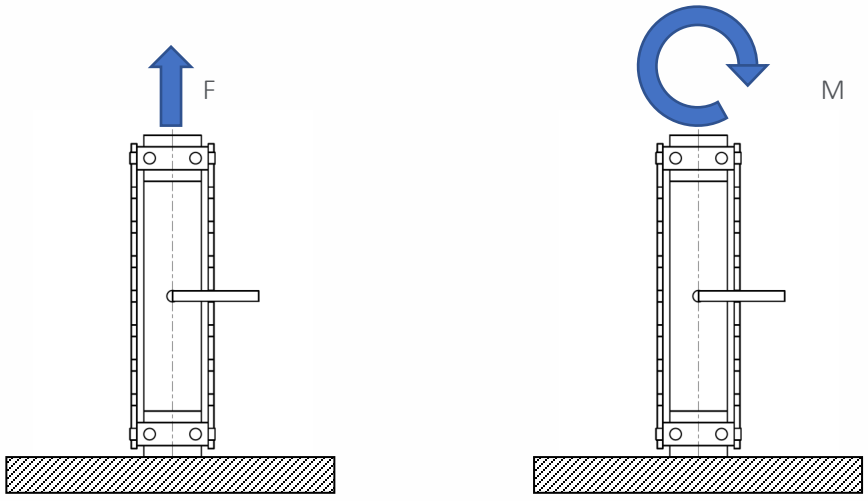
Mounting

Preloaded stacks offer machined interfaces for mounting. The actuators are designed to be mounted using the appropriate threaded element or machine screw. Ensure that the treaded element is not too long. Too long threaded elements will damage the assembly.

Ensure that the tightening torque is reacted at the adjacent metallic interface and not transmitted through the body of the actuator, as this could cause misalignment.



Piezoelectric ceramics can tolerate high compressive stress, but only limited tensile stress. CTS preloaded stacks offset that limitation by adding a compressive force on the ceramic. As a result, preloaded stacks can sustain external tensile loads, which could result from direct pulling, inertial forces or bending forces. However, it is important to ensure that the preload is maintained at any point of the ceramic and uring the while operation time.



Product series	NAC2003-HXXP	NAC2013-HXXP	NAC2014-HXXP	NAC2021-HXXP	Unit
Maximum Pull Force[1] F	250		500		N
Maximum Bending Torque[2] M	208		583		N.mm

[1] Pull force includes static force induced by the load and inertial force due to the motion of the attached mass as well as the piezo element's own inertia. Refer to our online tutorial for additional information on the estimation of inertial loads. The stated value assumes no other load on the actuator and must be reduced in case of combined loading.

[2] Bending torque includes torque induced by the load as well as bending moment due to lateral force. Bending moment must be calculated at the base of the actuator where it is highest (bending force multiplied by distance between the base of the actuator and the point of application of the force). The stated value assumes no other load on the actuator and must be reduced in case of combined loading.

Connecting and Driving

Preloaded stacks 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.

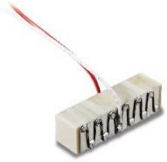
Ensure that the stacks are properly discharged and that there is no voltage on the output when connecting to a driver. Voltage differences will generate current peaks that can damage the actuator or the driver.

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.

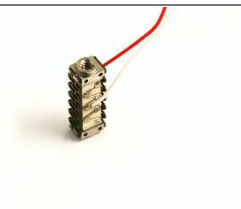
Linear Actuators Product Families


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.