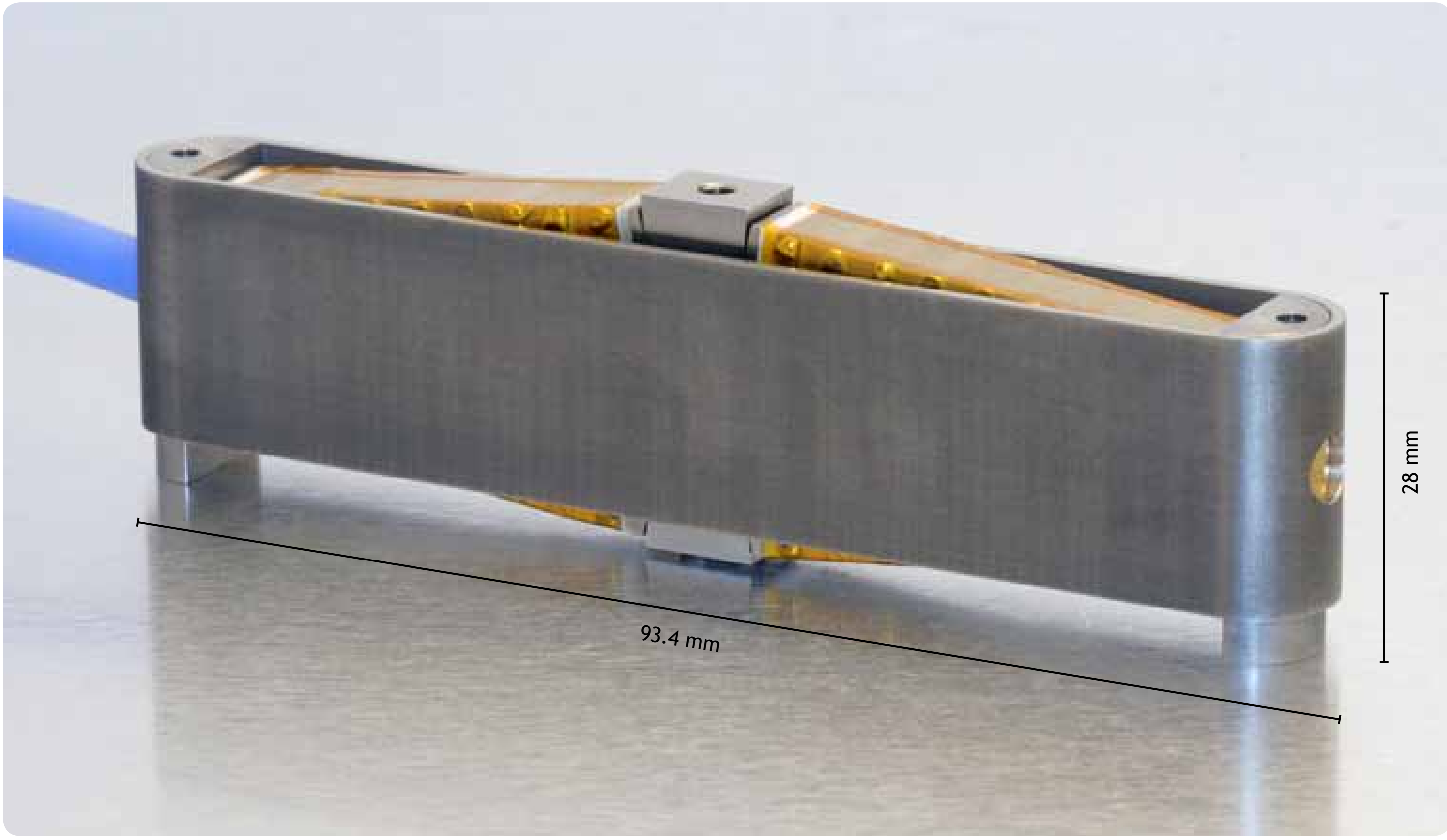
DIAMOND PIEZO ACTUATOR

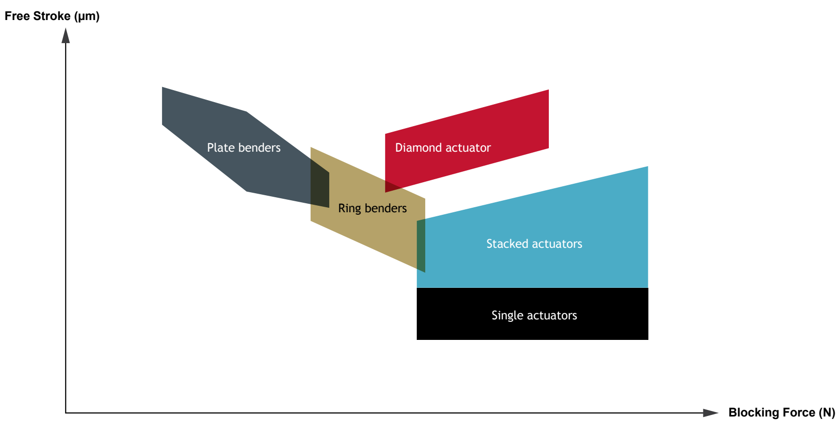
Noliac Group's amplified diamond piezo actuator is more compact and has much higher resonance frequency than its competitors.

Advantages of the amplified diamond piezo actuators:

- High resonance frequency and thus large operating bandwidth
- Push and pull with same level of performance
- Non-magnetic
- Design flexibility
- High vacuum option
- Temperature stable
- Compact
- Light



noliac



DIAMOND PIEZO ACTUATOR

Applications

Aerospace

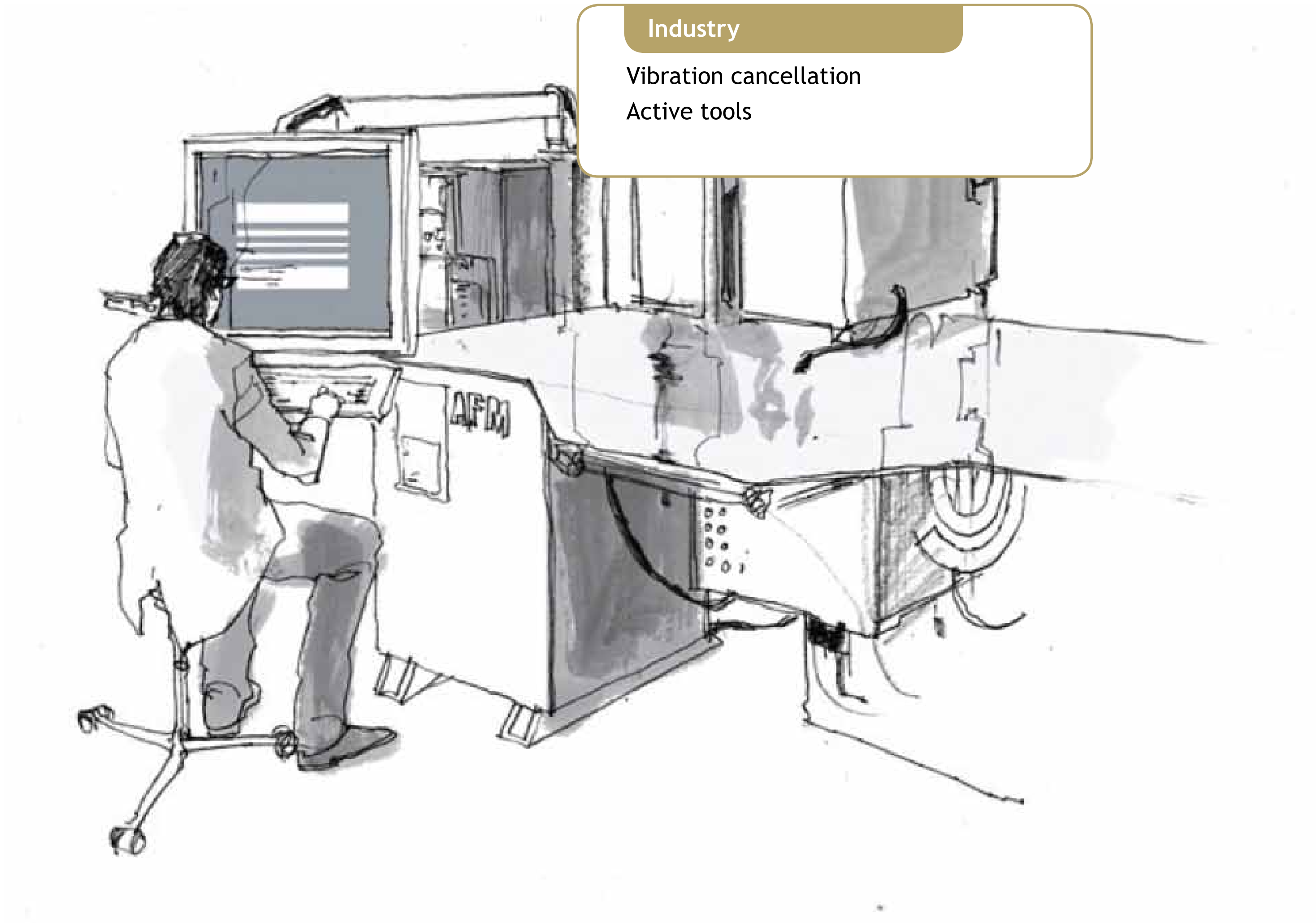
Positioning control
Direct drive valves
Space optics
Active vibration control
Airplane piezo actuated flaps

Optics

Spectrometry
X ray diffraction
Optical switch
Resolution enhancement

Industry

Vibration cancellation
Active tools



DIAMOND PIEZO ACTUATOR

Technology

Noliac's amplified diamond actuator is based upon low voltage piezo actuator stacks for systems requiring lighter actuators with temperature stability and high resonance frequency.

The unique diamond construction makes the actuator more compact than many commercially available amplification systems. In addition, the lower mass and optimized stiffness imply higher mechanical resonance compared to other solutions, allowing operation at higher frequency.

PRINCIPLE

The amplified diamond actuator is based on four piezoelectric stacks, connected in pairs. Each stack is hinged at its ends and maintained in place with a small angle. The arrangement is shown in Figure A. The whole assembly is preloaded through the use of a tension member maintaining the fixed members in place. This ensures that the piezoelectric stacks operate in optimal conditions.

The actuator is operated as follows. When the applied voltage is increased on one pair of stacks, it is decreased on the other pair. This contributes to a movement of the output member in one direction. It should be noted that in the case of a free displacement, the tension in the piezoelectric stacks as well as in the tension members (therefore the preload) remains almost constant. This means that strain energy is transferred directly from the stacks to the output instead of being stored in the amplification mechanism. As a result, this amplification method is very efficient. In addition, the structure is not submitted to high bending mass and thus not subject to fatigue.

TEMPERATURE STABILITY

Upon temperature change, differential thermal expansion between the ceramic and the other materials in the assembly will lead to a change in force repartition. This will result in a change in the internal preload. However unlike most of the existing amplification schemes available on the market, this will not result in a movement of the output.

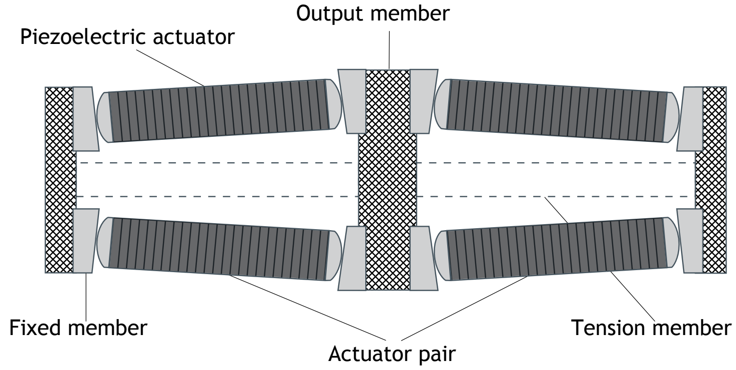


Figure A: The principle of the diamond actuator.

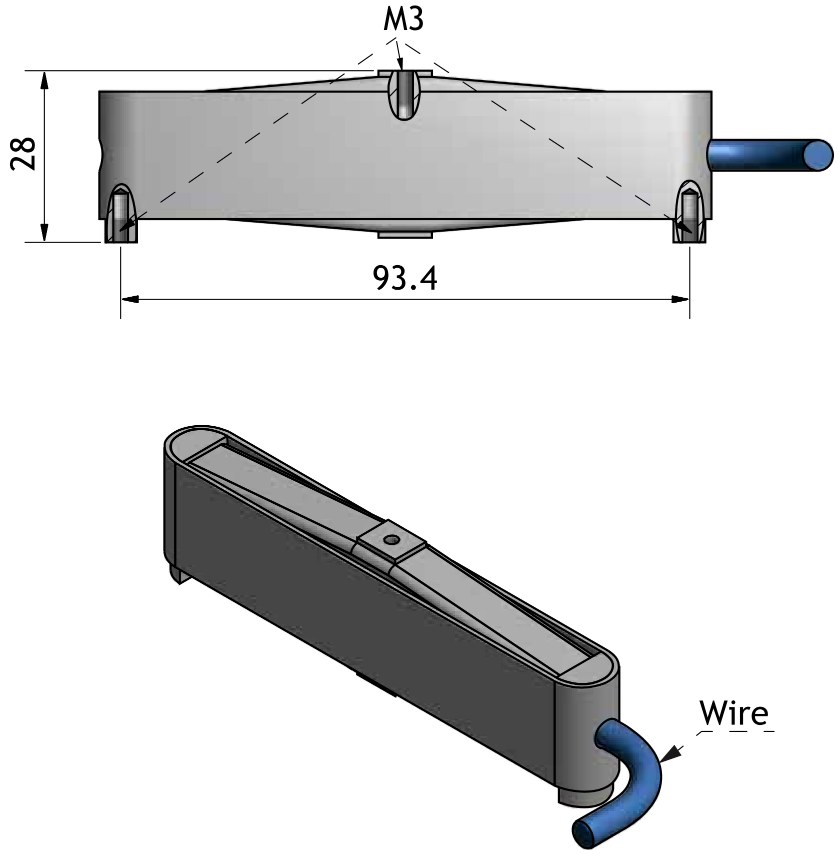


Figure B: NAC 2643, dimensions in mm.

DIAMOND PIEZO ACTUATOR

Performance

The diamod piezo actuator opens up for a whole new range of force-displacement performance.

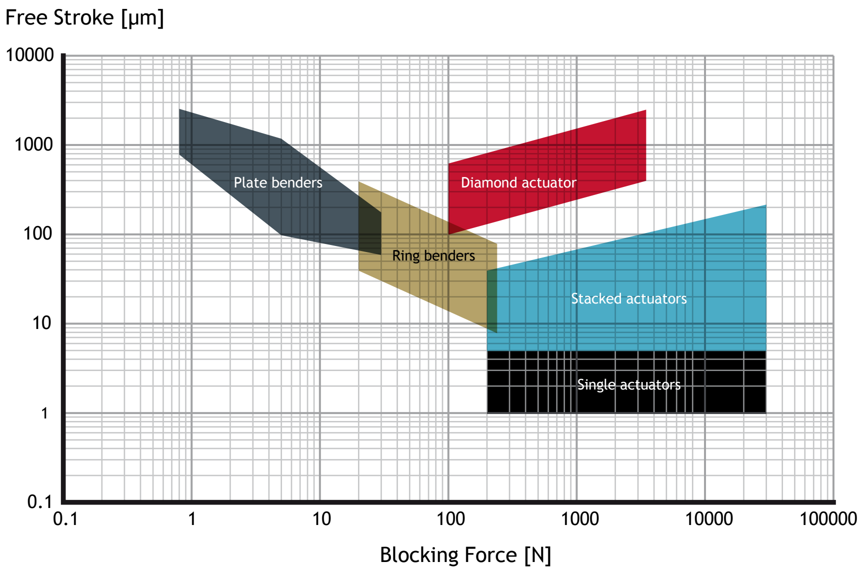


Figure C: Noliac's diamond actuator compared with other Noliac actuators.

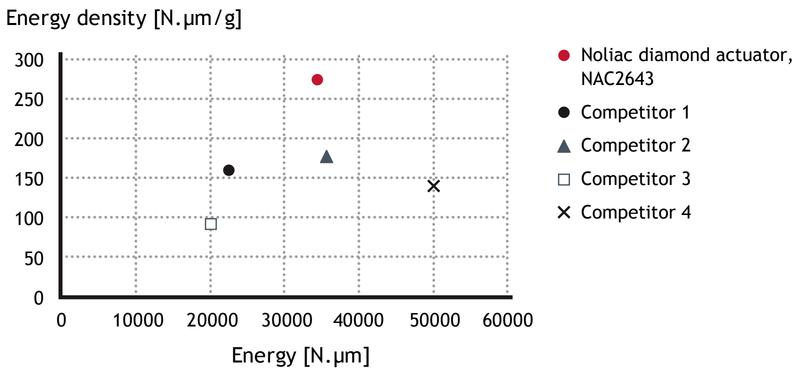


Figure D: Energy density of Noliac's diamond actuator, NAC2643, compared with competitive amplified actuators from other suppliers.

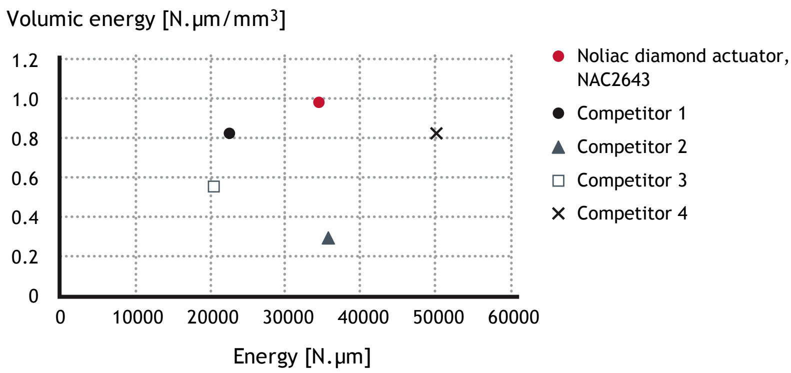


Figure E: Volumic energy Noliac's diamond actuator, NAC2643, compared with competitive amplified actuators from other suppliers.

Note: "Energy" represents the maximum mechanical work transferred from the actuator to a spring load. It is equal to ⅛ × Free stroke × Blocking force.

Compared to competitive amplified actuators, the diamond actuator is at least 15% smaller and 35% lighter for comparable performance. Further, the Noliac diamond actuator has higher resonance frequency.

DIAMOND PIEZO ACTUATOR

Mounting

The actuator provides 2 mechanical interfaces:
Fixed interface: 2 × M3
Moving interface: 1 × M3

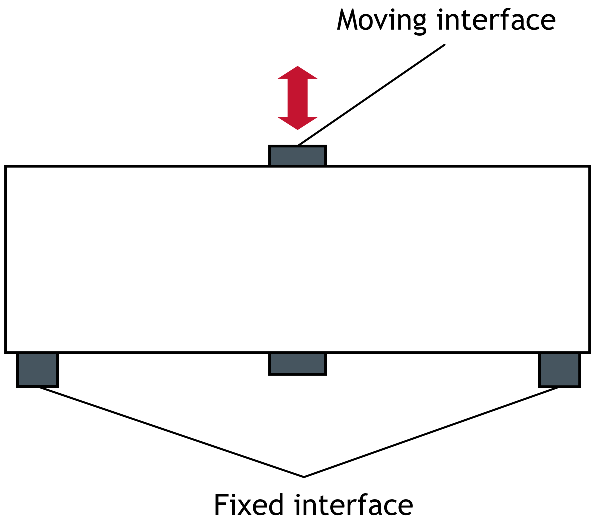


Figure F: Mechanical interfaces.

Warning: avoid additional stress on the actuator such as:

- Pushing/pulling and bending between the two points of the fixed interface
- Transverse and bending on the moving interface

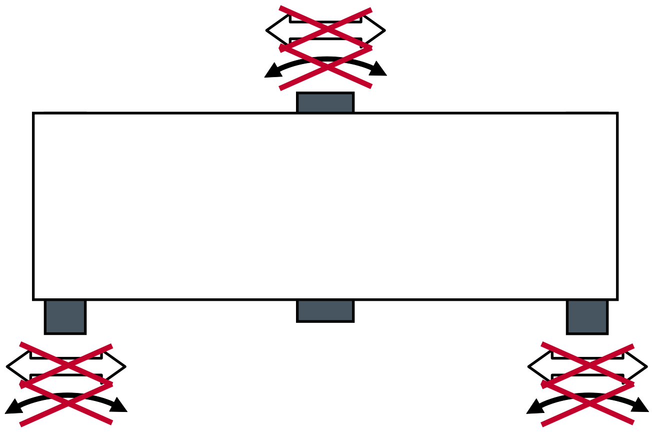


Figure G: Avoid additional stress.

A 3D model is available (STP file).

DIAMOND PIEZO ACTUATOR

Connecting and driving

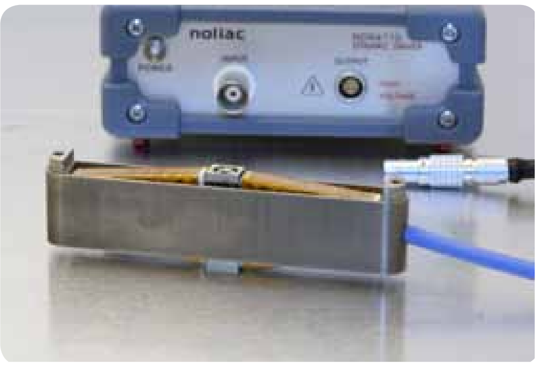
CONNECTOR

As a standard, the actuator is fitted with a connector LEMO FGG.0B.304.CLAD52Z.
It mates for example with:

- EGG.0B.304.CLL (panel mount)
- PHG.0B.304.CLLD52 (cable mount)

DRIVING

The amplified actuator can be driven using a standard driver NDR6110 -100+100 (+/-100V version). Due to the high capacitance of the stacks, this is only recommended for static operation (<1Hz).



PIN-OUT

Signal name	Description	Connector pin
Control	“Middle” voltage, 0 to 200V	1
–	Not connected	2
Positive bias	+200Vdc	3
Negative bias	0Vdc	4

Table A: Pin-out for the NAC2643.

ELECTRICAL CONFIGURATION

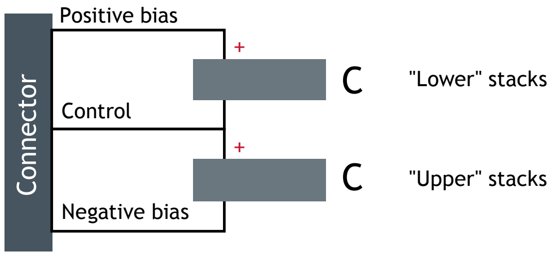


Figure H: Electrical interface.

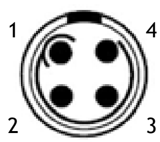


Figure I: Actuator (male) connector seen from the back.

DIAMOND PIEZO ACTUATOR

Connecting and driving

Driver 1 should be adjusted to 200Vdc.
It should be able to provide both positive and negative current (2 quadrants operation).

Driver 2 should provide a voltage between 0 and 200V. Displacement of the actuator will depend on the applied voltage: 0V = fully retracted; 200V = fully extended (see hysteresis curve below).

WARNING: Always ensure that the voltage provided by driver 2 is lower than that of driver 1. Failure to do so will lead to de-poling of the "lower" stacks, resulting in performance loss or even permanent damage.

Alternatively, the actuator can be driven using two single channel drivers:

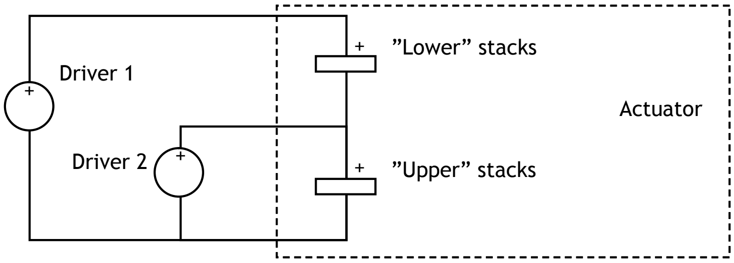


Figure J: Alternative driving configuration.

Usable drivers and frequency estimates:

Supplier	Model	Max. driving frequency (full amplitude)
Noliac	NDR6110-100+100	1 Hz
	NDR6880**	1200 Hz*

*) Actuator should not be operated at full amplitude close to the resonance frequency.
**) To be used as "driver 2". "Driver 1" should be either another driver, another channel (for drivers with multi-channel capability) or a power supply with 2 quadrants operation (power supply + resistor).

Table B: Usable drivers for the NAC2643.

Hysteresis

Due to the symmetrical configuration, the hysteresis curve is different from single piezo actuators. A typical characteristic is shown below.

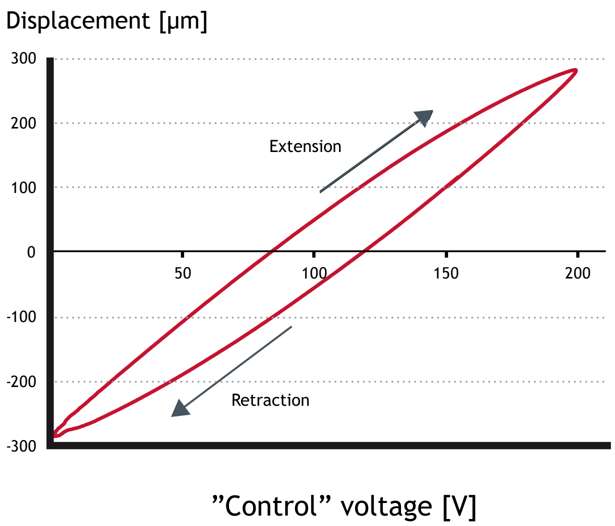


Figure K: Hysteresis.

DIAMOND PIEZO ACTUATOR

NAC2643 specifications

The first diamond actuator released as a prototype product is the NAC2643. These are the preliminary specifications.

Parameter	Unit	NAC2643	Tolerance
Piezoelectric material		NCE51F	–
Dimensions – Width (W)	mm	12.4	±0.1
Dimensions – Length (L)	mm	100.4	±0.1
Dimensions – Height (H)	mm	28	±0.3
Mass	g	180 with thick cable (125 without cable)	±10
Maximum recommended voltage, Vmax	V	200	–
Free stroke (@V_{max})	µm	550 (±275)	±15%
Stiffness (middle position, up to 250N)	N/µm	1.10	±15%
Maximum recommended force (@V_{max})	N	250 (±125)	–
Unloaded resonance frequency (blocked-free)	Hz	1100	Typical
Free capacitance (@1V_{rms}, 0.5kHz)	µF	2 x 6.7	±15%

Table C: NAC2643 specifications. Data are specified for room temperature and static operating conditions.
Specifications for dynamic operation or higher temperature operation must be determined by experiment.
Based on information provided by our suppliers, Noliac Motion designates this product as RoHS compliant.