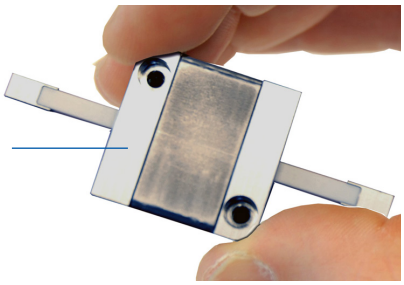
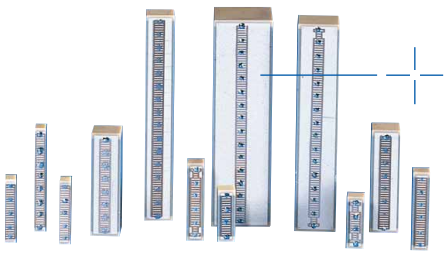
Piezo Nanopositioning Actuators

High Force, Fast Response, High Stability

HIGH FORCE

PRECISE





LONG LIFE

Click on the Images to Jump to Datasheet

Nanopositioning Actuators Overview

P-601 PiezoMove™ long travel lever-amplified piezo Z flextensional actuator

P-603 low-cost flextensional linear actuators provide travel ranges to 0.5mm

P-602 high-stiffness flexure guided piezo actuators provide travel ranges to 1 mm

PICA™ stack high-load piezo stack actuators

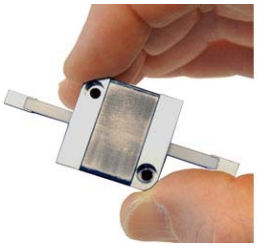
PICMA® long-life ceramic encapsulated multilayer piezo stack actuators

P-841 preloaded piezo linear translators with closed-loop option

P-845 preloaded high-force piezo linear translators with closed-loop option

PICA™-Thru high-force tubular piezo stack actuators

PiezoMike linear actuator combines long travel and nanometer resolution



N-310 miniature PiezoWalk® linear actuator provides to 125mm travel and picometer resolution

N-381 closed-loop PiezoWalk® motor-driven piezo stepper actuator

P-842 – P-845 Preloaded Piezo Actuators

For High Loads and Force Generation, Optional with Integrated Position Sensors

P-844 piezo actuators
(battery for size comparison)

- **Outstanding Lifetime Due to PICMA® Piezo Ceramic Stacks**
- **Travel Range to 90 µm**
- **Pushing Forces to 3000 N**
- **Pulling Forces to 700 N**
- **Sub-Millisecond Response, Sub-Nanometer Resolution**
- **Vacuum Version, Optional Water-Resistant Case**

The P-842 / P-843 and P-844 / P-845 series piezo translators are high-resolution linear actuators for static and dynamic applications. They provide sub-millisecond response and sub-nanometer resolution.

Design

These translators are equipped with PICMA® multilayer piezo ceramic stacks protected by a non-magnetic stainless steel case with internal spring preload. The preload makes them ideal for dynamic applications (such as precision machining, active damping etc.) and for tensile loads as well.

High Accuracy in Closed-Loop Operation

P-842 and P-844 are designed for open-loop positioning or use with external feedback. Versions P-843 and P-845 are equipped with integrated high-resolution SGS-position sensors for high precision in closed-loop operation (for further notes see the nanopositioning tutorial, see p. 2-199).

Ceramic Insulated Piezo Actuators Provide Long Lifetime

Highest possible reliability is assured by the use of award-winning PICMA® multilayer piezo actuators. PICMA® actua-

Application Examples

- Static and dynamic precision positioning
- Disc-drive-testing
- Optics
- Metrology / interferometry
- Smart structures / adaptronics
- Precision mechanics / machining
- Active vibration control
- Switches
- Laser tuning

Technical Data and Product Order Numbers

Model	Open-loop travel for 0 to 100 V [µm] ±20 %	Closed-loop travel [µm]*	Integrated feedback sensor**	Closed-loop / Open-loop resolution [nm]***	Static large-signal stiffness [N/µm] ±20 %	Push/pull force capacity [N]	Electrical capacitance [µF] ±20 %
P-842.10 (V)	15	–	–	- / 0.15	57	800 / 300	1.5
P-842.20 (V)	30	–	–	- / 0.3	27	800 / 300	3.0
P-842.30 (V)	45	–	–	- / 0.45	19	800 / 300	4.5
P-842.40 (V)	60	–	–	- / 0.6	15	800 / 300	6.0
P-842.60 (V)	90	–	–	- / 0.9	10	800 / 300	9.0
P-843.10 (V)	15	15	SGS	0.3 / 0.15	57	800 / 300	1.5
P-843.20 (V)	30	30	SGS	0.6 / 0.3	27	800 / 300	3.0
P-843.30 (V)	45	45	SGS	0.9 / 0.45	19	800 / 300	4.5
P-843.40 (V)	60	60	SGS	1.2 / 0.6	15	800 / 300	6.0
P-843.60 (V)	90	90	SGS	1.8 / 0.9	10	800 / 300	9.0
P-844.10 (V)	15	–	–	- / 0.15	225	3000 / 700	6.0
P-844.20 (V)	30	–	–	- / 0.3	107	3000 / 700	12.0
P-844.30 (V)	45	–	–	- / 0.45	75	3000 / 700	18.0
P-844.40 (V)	60	–	–	- / 0.6	57	3000 / 700	24.0
P-844.60 (V)	90	–	–	- / 0.9	38	3000 / 700	36.0
P-845.10 (V)	15	15	SGS	0.3 / 0.15	225	3000 / 700	6.0
P-845.20 (V)	30	30	SGS	0.6 / 0.3	107	3000 / 700	12.0
P-845.30 (V)	45	45	SGS	0.9 / 0.45	75	3000 / 700	18.0
P-845.40 (V)	60	60	SGS	1.2 / 0.6	57	3000 / 700	24.0
P-845.60 (V)	90	90	SGS	1.8 / 0.9	38	3000 / 700	36.0

tors are the only actuators on the market with ceramic-only insulation, which makes them resistant to ambient humidity and leakage-current failures. They are thus far superior to conventional actuators in reliability and lifetime.

Optimum UHV Compatibility - Minimum Outgassing

The lack of polymer insulation and the high Curie temperature make for optimal ultra-high-vacuum compatibility (no outgassing / high bakeout temperatures, up to 150 °C).

Mounting

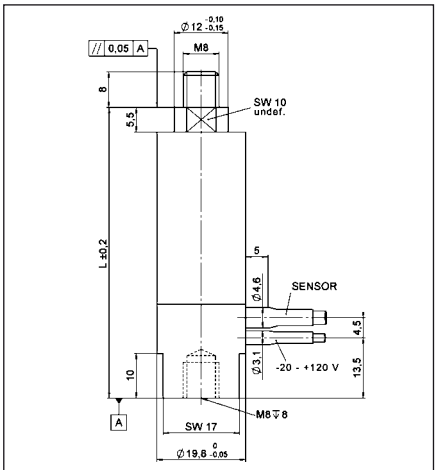
Mounting is at the foot, with push/pull forces of less than 100 N, the actuator can be held by clamping the case. Read details in Mounting and Handling Guidelines (p. 1-67).

Accessories

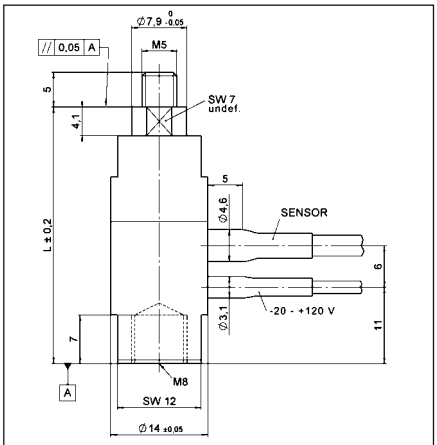
The flexible tips P-176.50 / P-176.60 can be applied for protection of the ceramics from shearing forces (only for versions without ball tip).
P-176.50
Flexible tip for P-842 / P-843 (see p. 1-103 *ff*)
P-176.60
Flexible tip for P-844 / P-845 (see p. 1-103 *ff*)
For extensions, adapter cables and connectors, see "Accessories" in the Piezo Actuators & Components section (p. 2-168 *ff*).

Piezo Drivers, Controllers & Amplifiers

High-resolution amplifiers and servo-control electronics, both digital and analog, are described in the "Piezo Drivers / Servo Controllers" section.



P-844, P-845 dimensions in mm. Length L: see table. Max. torque at top piece: 1 Nm



P-842, P-843 dimensions in mm. Length L: see table. Max. torque at top piece: 0.35 Nm

Dynamic operating current coefficient [µA / (Hz • µm)]	Resonant frequency (unloaded) [kHz] ±20 %	Mass without cable [g] ±5 %	Length L [mm]
12.5	18	31	37
12.5	14	42	55
12.5	10	53	73
12.5	8.5	64	91
12.5	6	86	127
12.5	18	31	37
12.5	14	42	55
12.5	10	53	73
12.5	8.5	64	91
12.5	6	86	127
50	16	84	47
50	12	108	65
50	9	132	83
500	7.5	156	0101
50	5.5	204	137
50	16	84	47
50	12	108	65
50	9	132	83
50	7.5	156	101
50	5.5	204	137

Voltage Connection:
LEMO FFA.00.250. Coaxial Cable, RG 178, 1 m.

Sensor Connector:
LEMO FFA.0S.304. Coaxial Cable, 1 m.

Temperature range: -40 to 80 °C; Case / end pieces: non-magnetic steel.

*Closed-loop models can attain linearity up to 0.15 % and are shipped with performance reports.
**Resolution of piezo actuators is not limited by stiction or friction. Noise equivalent motion with E-503 amplifier (see p. 2-146).
***Dynamic small-signal stiffness is ~ 30 % higher.
Recommended amplifiers / controllers
Single-channel: E-610 servo-controller / amplifier (p. 2-110), E-625 servo-controller, bench-top(p. 2-114), E-621 controller module (p. 2-160)
Single channel: modular piezo controller system E-500 (p. 2-142) with amplifier module E-505 (high-power) (p. 2-147) and E-509 controller (p. 2-152) (optional)
Multi-channel: modular piezo controller system E-500 (p. 2-142) with amplifier module E-503 (three channels) (p. 2-146) or E-505 (1 per axis, high-power, see p. 2-147) and E-509 controller (p. 2-152) (optional)

P-840 · P-841 Preloaded Piezo Actuators

Optional with Integrated Position Sensor

P-840, P-841 piezo translators (DIP switch for size comparison)

Ordering Information

Preloaded Piezo Actuator, 1000/50 N

- **0** No Sensor
- **1** SGS Sensor

P-84 □ . □ □ **(V)**

- **1** 15 µm Travel Range
- **2** 30 µm Travel Range
- **3** 45 µm Travel Range
- **4** 60 µm Travel Range
- **6** 90 µm Travel Range

- **0** without Ball Tip
- **B** with Ball Tip

V: Vacuum Compatible to 10^{-6} hPa

- **Outstanding Lifetime Due to PICMA® Piezo Ceramic Stacks**
- **Travel Range to 90 µm**
- **Compact Case**
- **Pushing Forces to 1000 N**
- **Pulling Forces to 50 N**
- **Sub-Millisecond Response, Sub-Nanometer Resolution**
- **Versions: with Ball Tip, Vacuum Versions**

The P-840 and P-841 series translators are high-resolution linear actuators for static and dynamic applications. They provide sub-millisecond response and sub-nanometer resolution.

Application Examples

- Static and dynamic Precision positioning
- Disc-drive-testing
- Adaptronics
- Smart structures
- Active vibration control
- Switches
- Laser tuning
- Patch-Clamp
- Nanotechnology

Design

These translators are equipped with highly reliable multilayer piezo ceramic stacks protected by a non-magnetic stainless steel case with internal spring preload. The preload makes them ideal for dynamic applications and for tensile loads as well.

Ceramic Insulated Piezo Actuators Provide Long Lifetime

The highest possible reliability is assured by employing the award-winning PICMA® multilayer piezo actuators. PICMA® actuators are the only actuators on the market with a ceramic-only insulation, which makes them resistant to ambient humidity and leakage-current failures. They are thus far superior to conventional actuators in reliability and lifetime.

Optimum UHV Compatibility – Minimum Outgassing

The lack of polymer insulation and the high Curie temperature make for optimal ultra-high-vacuum compatibility (no outgassing / high bakeout temperatures, up to 150 °C).

Mounting

Mounting is at the foot, with push/pull forces of less than 5 N, the actuator can be held by clamping the case. The versions with ball tip decouple torque and off-center forces from the piezoceramic.
To provide magnetic coupling, the P-176.20 magnetic adapter can be screwed into the top piece (only for versions without ball tip).

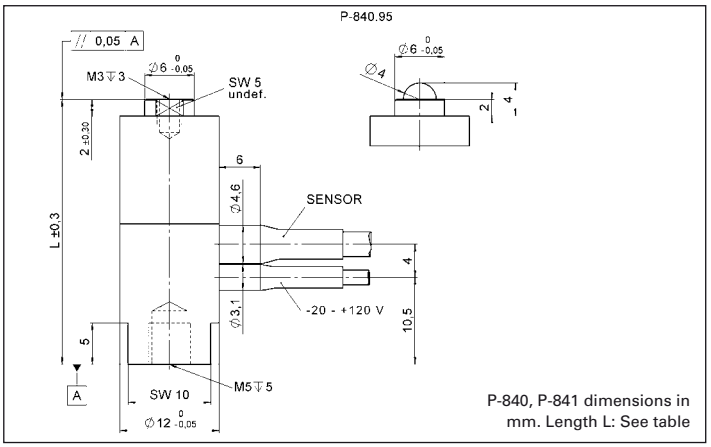
Read details in Mounting and Handling Guidelines (p. 1-67).

High Accuracy in Closed-Loop Operation

The standard model P-840 is designed for open-loop positioning. Version P-841 with integrated high-resolution strain gauge position sensors provides high precision for closed-loop operation (further details see p. 2-199).

Piezo Drivers, Controllers & Amplifiers

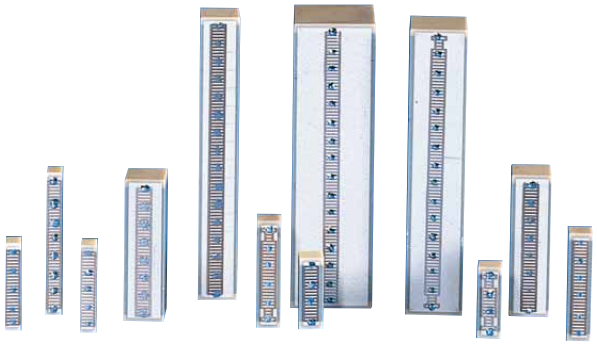
High-resolution amplifiers and servo-control electronics, both digital and analog, are described in the "Piezo Drivers / Servo Controllers" (see p. 2-99) section.



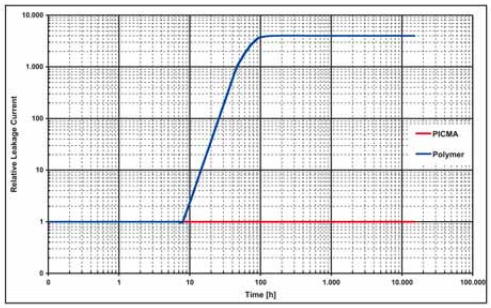
P-840, P-841 dimensions in mm. Length L: See table

P-882 · P-888 PICMA® Multilayer Piezo Stack Actuators

Ceramic-Insulated High-Power Actuators



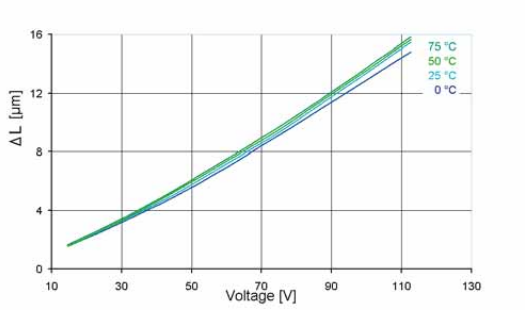
PICMA® piezo actuators are available with cross-sections of 2 x 3, 3 x 3, 5 x 5, 7 x 7 and 10 x 10 mm ²



PICMA® piezo actuators (bottom curve) compared with conventional multilayer actuators with polymer insulation (top curve). PICMA® actuators are not affected by the high-humidity test conditions. Conventional piezo actuators exhibit increased leakage current after only a few hours. Leakage current is an indicator quality and expected lifetime.

Test conditions: U = 100 VDC, T = 25 °C, Relative Humidity = 70 %

- **Superior Lifetime Even Under Extreme Conditions**
- **Very Large Operating Temperature Range**
- **High Humidity Resistance**
- **Excellent Temperature Stability**
- **High Stiffness**
- **Peak Current up to 20 A**
- **UHV Compatible to 10^{-9} hPa**
- **Sub-Millisecond Response / Sub-Nanometer Resolution**
- **Ideal for Dynamic Operation**



The displacement of PICMA® actuators exhibits very low temperature dependence. This, in combination with their low heat generation, makes PICMA® actuators optimal for dynamic operation

Technical Data / Product Order Numbers

Order number*	Dimensions A x B x L [mm]	Nominal displacement [µm @ 100 V]	Max. displacement [µm @ 120 V]	Blocking force [N @ 120 V]	Stiffness [N/µm]	Electrical capacitance [µF] ±20 %	Resonant frequency [kHz] ±20 %
P-882.10	2 x 3 x 9	6.5 ±20 %	8 ±20 %	190	24	0.15	135
P-882.30	2 x 3 x 13.5	11 ±20 %	13 ±20 %	210	16	0.22	90
P-882.50	2 x 3 x 18	15 ±10 %	18 ±10 %	210	12	0.31	70
P-883.10	3 x 3 x 9	6.5 ±20 %	8 ±20 %	290	36	0.21	135
P-883.30	3 x 3 x 13.5	11 ±20 %	13 ±20 %	310	24	0.35	90
P-883.50	3 x 3 x 18	15 ±10 %	18 ±10 %	310	18	0.48	70
P-885.10	5 x 5 x 9	6.5 ±20 %	8 ±20 %	800	100	0.6	135
P-885.30	5 x 5 x 13.5	11 ±20 %	13 ±20 %	870	67	1.1	90
P-885.50	5 x 5 x 18	15 ±10 %	18 ±10 %	900	50	1.5	70
P-885.90	5 x 5 x 36	32 ±10 %	38 ±10 %	950	25	3.1	40
P-887.30	7 x 7 x 13.5	11 ±20 %	13 ±20 %	1700	130	2.2	90
P-887.50	7 x 7 x 18	15 ±10 %	18 ±10 %	1750	100	3.1	70
P-887.90	7 x 7 x 36	32 ±10 %	38 ±10 %	1850	50	6.4	40
P-888.30	10 x 10 x 13.5	11 ±20 %	13 ±20 %	3500	267	4.3	90
P-888.50	10 x 10 x 18	15 ±10 %	18 ±10 %	3600	200	6.0	70
P-888.90	10 x 10 x 36	32 ±10 %	38 ±10 %	3800	100	13.0	40

Standard piezo ceramic type: 252
*For optional PTFE insulated wires, pigtail length 100 mm, change order number extension to .x1 (e. g. P-882.11).
Recommended preload for dynamic operation: 15 MPa
Maximum preload for constant force: 30 MPa
Resonant frequency at 1 V_{pp}, unloaded, free at both sides. The value is halved for unilateral clamping
Capacitance at 1 V_{pp}, 1 kHz

Operating voltage: -20 to +120 V
Operating temperature range: -40 to +150 °C
Standard Mechanical Interfaces: Ceramics
Standard Electrical Interfaces: Solderable pads
Available Options: strain gauge sensors, special mechanical interfaces, etc.
Other specifications on request.

P-010.xxH – P-025.xxH PICA™ Thru Ring Actuator

High-Load Piezo Stack Actuators with Aperture

PICA™ Thru piezo stack actuators with clear aperture

- **Clear Aperture for Transmitted-Light Applications for Mechanical Preloading**
- **Extreme Reliability >10⁹ Cycles**
- **Large Cross Sections to 56 mm Diameter**
- **Variety of Shapes**
- **Sub-Millisecond Response, Sub-Nanometer Resolution**
- **Vacuum-Compatible Versions**

PICA™ Thru actuators are hollow piezo stack actuators, offered in a large variety of standard shapes and sizes with additional custom designs to meet all customer requirements. They combine the advantage of a clear aperture with the strength and force generation of stack actuators. These tubular devices are high-resolution linear actuators for static and dynamic applications. The clear aperture facilitates transmitted-light applications. Furthermore the electrical consumption is reduced due to the decreased electrical capacitance.

Flexibility / Short Leadtimes

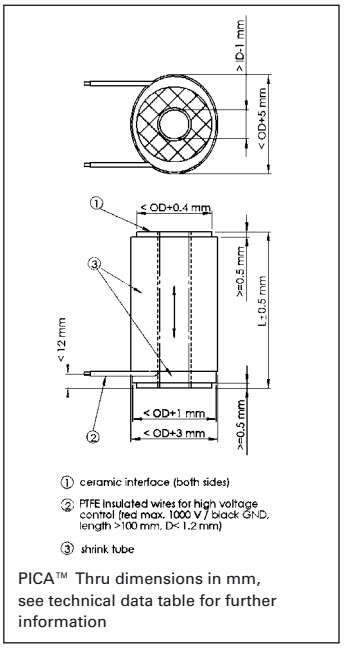
All manufacturing processes at PI Ceramic are set up for flexibility. Should our standard actuators not fit your application, let us provide you with a custom design. Our engineers will work with you to find the optimum solution at a very attractive price, even for small quantities. Some of our custom capabilities are listed below:

- Custom Materials
- Custom Voltage Ranges
- Custom Geometries (Circular, Rectangular, Triangular, Layer Thickness ...)
- Custom Load / Force Ranges
- Custom Flat or Spherical Endplates (Alumina, Glass, Sapphire, ...)
- Extra-Tight Length Tolerances
- Integrated Piezoelectric Sensor Discs
- Special High / Low Temperature Versions
- Vacuum Compatible Versions

Because all piezoelectric materials used in PICA™ actuators are manufactured at PI Ceramic, leadtimes are short and quality is outstanding. All standard and custom actuators are delivered with performance test sheets.

Piezo Drivers, Controllers & High-Voltage Amplifiers

High-resolution amplifiers and servo-control electronics, both digital and analog, are described in the "Piezo Drivers / Servo Controllers" section.



PICA™ Thru dimensions in mm, see technical data table for further information

Technical Data / Product Order Numbers

Order numbers	Displacement [µm] -10/+20 %	Diameter OD [mm]	Diameter ID [mm]	Length L [mm] ±0.5	Blocking force [N]	Stiffness [N/µm]	Capacitance [nF] ±20 %	Resonant frequency [kHz]
P-010.00H	5	10	5	7	1200	230	15	144
P-010.05H	10	10	5	12	1300	130	29	84
P-010.10H	15	10	5	15	1700	110	40	67
P-010.15H	20	10	5	21	1500	76	59	48
P-010.20H	30	10	5	27	1800	59	82	39
P-010.30H	40	10	5	40	1600	40	120	28
P-010.40H	60	10	5	54	1800	29	180	21
P-016.00H	5	16	8	7	2900	580	42	144
P-016.05H	10	16	8	12	3400	340	83	84
P-016.10H	15	16	8	15	4100	270	120	67
P-016.15H	20	16	8	21	3800	190	170	48
P-016.20H	30	16	8	27	4500	150	230	39
P-016.30H	40	16	8	40	4000	100	340	28
P-016.40H	60	16	8	52	4700	78	490	21
P-025.10H	15	25	16	16	7400	490	220	63
P-025.20H	30	25	16	27	8700	290	430	39
P-025.40H	60	25	16	51	9000	150	920	22
P-025.50H	80	25	16	66	9600	120	1200	17

Piezo ceramic type PIC 151
Recommended preload for dynamic operation: 15 MPa
Maximum preload for constant force: 30 MPa
Resonant frequency at 1 V_{pp}, unloaded, free at both sides. The value is halved for unilateral clamping
Capacitance at 1 V_{pp}, 1 kHz
Blocking force at 1000 V
Operating voltage range: 0 to 1000 V
Operating temperature range: -20 to +85 °C
Standard mechanical interface (top & bottom): ceramic, 0.5–2 mm thick (depends on model)
Standard electrical interface: two PTFE-insulated wires, pigtail length 100 mm
Available options: integrated force piezo sensor or strain gauge sensors, non-magnetic, vacuum compatible, etc.
Ask about custom designs and further specifications.

P-007 – P-056 PICA™ High Force Stack Actuator

Piezo actuator for highly dynamic applications

Variety of standard and custom PICA™ Stack piezo actuators

- **High Load Capacity to 100 kN**
- **High Force Generation to 80 kN**
- **Cross Sections to 56 mm Diameter**
- **A selection of Variety of Shapes**
- **Extreme Reliability >10⁹ Cycles**
- **Sub-Millisecond Response,**
- **Vacuum-Compatible Versions**

Flexibility / Short Leadtimes

All manufacturing processes at PI Ceramic are set up for flexibility. Should our standard actuators not fit your appli cation, let us provide you with a custom design.

Ultra-High Reliability, High Displacement, Low Power Requirements

PICA™ piezo actuators are specifically designed for high-duty-cycle applications.

Endurance tests on PICA™ actuators prove consistent performance, even after billions (1,000,000,000) of cycles.

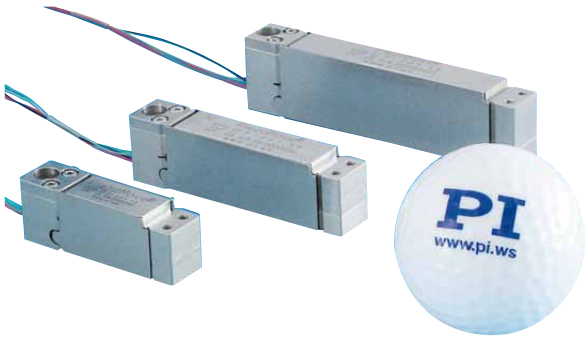
Technical Data / Product Order Numbers

Order number	Displacement [µm] -10/+20%	Diameter D [mm]	Length L [mm] ±0.5	Blocking force [N]	Stiffness [N/µm]	Capacitance [nF] ±20%	Resonant frequency [kHz]
P-007.00	5	7	8	650	130	11	126
P-007.10	15	7	17	850	59	33	59
P-007.20	30	7	29	1000	35	64	36
P-007.40	60	7	54	1150	19	130	20
P-010.00	5	10	8	1400	270	21	126
P-010.10	15	10	17	1800	120	64	59
P-010.20	30	10	30	2100	71	130	35
P-010.40	60	10	56	2200	38	260	20
P-010.80	120	10	107	2400	20	510	10
P-016.10	15	16	17	4600	320	180	59
P-016.20	30	16	29	5500	190	340	36
P-016.40	60	16	54	6000	100	680	20
P-016.80	120	16	101	6500	54	1300	11
P-016.90	180	16	150	6500	36	2000	7
P-025.10	15	25	18	11000	740	400	56
P-025.20	30	25	30	13000	440	820	35
P-025.40	60	25	53	15000	250	1700	21
P-025.80	120	25	101	16000	130	3400	11
P-025.90	180	25	149	16000	89	5100	7
P-025.150	250	25	204	16000	65	7100	5
P-025.200	300	25	244	16000	54	8500	5
P-035.10	15	35	20	20000	1300	700	51
P-035.20	30	35	32	24000	810	1600	33
P-035.40	60	35	57	28000	460	3300	19
P-035.80	120	35	104	30000	250	6700	11
P-035.90	180	35	153	31000	170	10000	7
P-045.20	30	45	33	39000	1300	2800	32
P-045.40	60	45	58	44000	740	5700	19
P-045.80	120	45	105	49000	410	11000	10
P-045.90	180	45	154	50000	280	17000	7
P-050.20	30	50	33	48000	1600	3400	32
P-050.40	60	50	58	55000	910	7000	19
P-050.80	120	50	105	60000	500	14000	10
P-050.90	180	50	154	61000	340	22000	7
P-056.20	30	56	33	60000	2000	4300	32
P-056.40	60	56	58	66000	1100	8900	19
P-056.80	120	56	105	76000	630	18000	10
P-056.90	180	56	154	78000	430	27000	7

Standard piezo ceramic type: PIC 151
Recommended preload for dynamic operation: 15 MPa
Maximum preload for constant force: 30 MPa
Resonant frequency at 1 V_{pp}, unloaded, free at both sides. The value is halved for unilateral clamping
Capacitance at 1 V_{pp}, 1 kHz
blocking force at 1000 V
Operating voltage: 0 to 1000 V
Operating temperature range: -20 to +85 °C
Standard mechanical interfaces: steel plates, 0.5 to 2 mm thick (depends on model)
Standard electrical interfaces: two PTFE-insulated wires, pigtail length 100 mm
Available options: integrated piezo force sensor or strain gauge sensors, non magnetic, vacuum compatible, etc.
Other specifications on request.

P-601 PiezoMove™ Z-Actuator

Flexure-Guided OEM Piezo Actuator with Long Stroke to 400 µm



PiezoMove™ Lever-amplified piezo actuators of the P-601 series

- **Flexure Guidance for Frictionless, Ultra-Straight Motion**
- **Travel Ranges to 400 µm**
- **Resolution to 0.2 nm**
- **High Dynamics and Stiffness**
- **Custom Designs with Longer Travel or Faster Response and Non-Magnetic Versions Feasible**
- **Outstanding Lifetime Due to PICMA® Piezo Actuators**
- **Choice of Closed-Loop and Open-Loop Models**
- **Ideal OEM Actuator for Precision Motion Control in Optics, Medical, Biotech and Microfluidics Applications**

The flexure-guided, lever-amplified PiezoMove™ P-601 actuators provide large vertical travel ranges up to 400 µm, fast response and high positioning accuracy in a very small package. With settling times of only a few milliseconds and a resolution in the sub-nanometer range they are well suited for both static and dynamic applications.

P-601 PiezoMove™ lever-amplified actuators cover the range between direct-driven preloaded piezo translators, such as the P-840 series (see p. 1-74) and single-axis nanopositioning stages, like the P-611 series (see p. 2-20). Compared to direct-driven piezo translators, lever-amplified actuators offer larger travel ranges and much higher lateral stiffness and guiding precision. Compared to single-axis nanopositioning stages, they offer significantly smaller sizes. PiezoMove™ lever-amplified actuators feature a resolution to 0.2 nm and a repeatability to 8 nm.

Application Example

- Nanopositioning
- Imaging
- High-speed switching
- Patch clamp
- Micro-dispensing
- Semiconductor testing
- Adaptronics / Automation
- Photonics / integrated optics
- Biotechnology

OEM Actuator with Integrated Guidance

With their highly precise, frictionless flexure guidance, a very high stiffness and excellent straightness of motion are achieved. Together with their small dimensions and the cost-effective design, the P-601 lever amplified actuators are especially suited for OEM applications. Versions with strain-gauge sensors (SGS) are equipped with a full bridge circuit that is insensitive to thermal drift. Versions without sensors are also available for open-loop applications such as in high-speed switches and pumps. In addition to the standard steel models, special invar and non-magnetic versions are available on request.

Ceramic Insulated Piezo Actuators Provide Long Lifetime

Highest possible reliability is assured by the use of award-winning PICMA® multilayer piezo actuators. PICMA® actuators are the only actuators on the market with ceramic-only insulation, which makes them resistant to ambient humidity and leakage-current failures. They are thus far superior to conventional actuators in reliability and lifetime.

Ordering Information

P-601.1S
PiezoMove™ OEM Flexure-Guided, Lever-Amplified Actuator, 100 µm, SGS-Sensor

P-601.3S
PiezoMove™ OEM Flexure-Guided, Lever-Amplified Actuator, 250 µm, SGS-Sensor

P-601.4S
PiezoMove™ OEM Flexure-Guided, Lever-Amplified Actuator, 400 µm, SGS-Sensor

P-601.1SL
PiezoMove™ OEM Flexure-Guided, Lever-Amplified Actuator, 100 µm, SGS-Sensor, LEMO Connector

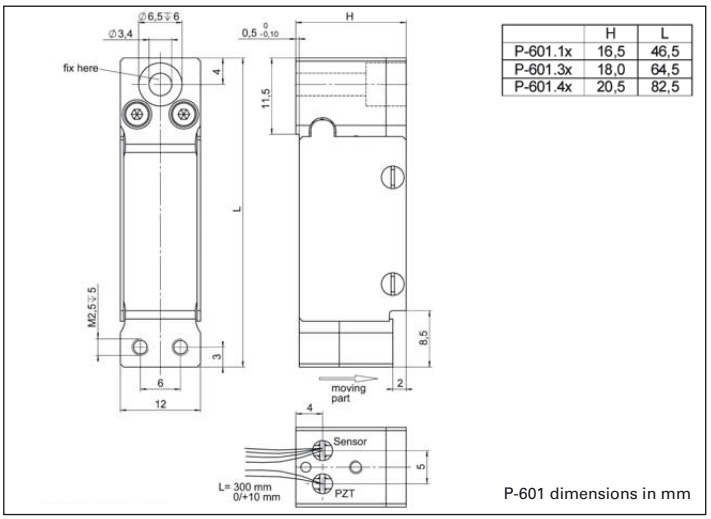
P-601.3SL
PiezoMove™ OEM Flexure-Guided, Lever-Amplified Actuator, 250 µm, SGS-Sensor, LEMO Connector

P-601.4SL
PiezoMove™ OEM Flexure-Guided, Lever-Amplified Actuator, 400 µm, SGS-Sensor, LEMO Connector

P-601.10
PiezoMove™ OEM Flexure-Guided, Lever-Amplified Actuator, 100 µm, Open-Loop

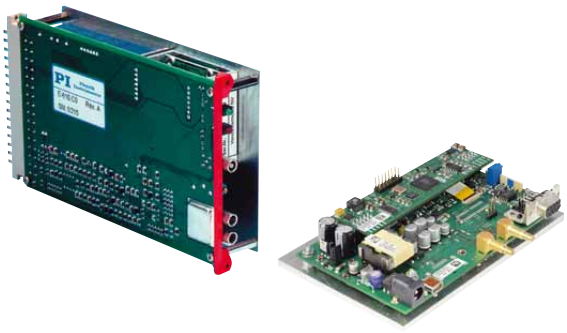
P-601.30
PiezoMove™ OEM Flexure-Guided, Lever-Amplified Actuator, 250 µm, Open-Loop

P-601.40
PiezoMove™ OEM Flexure-Guided, Lever-Amplified Actuator, 400 µm, Open-Loop

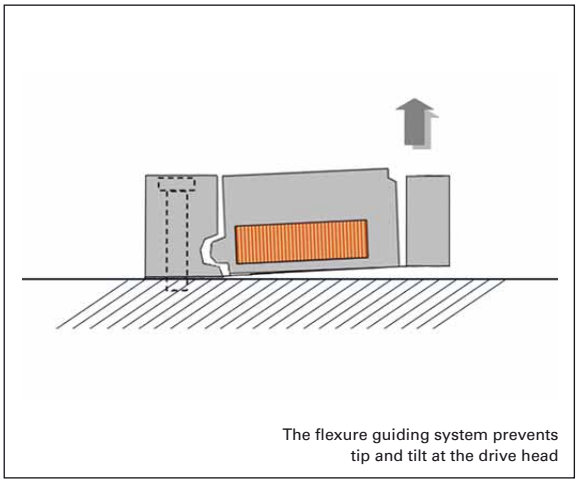


	H	L
P-601.1x	16,5	46,5
P-601.3x	18,0	64,5
P-601.4x	20,5	82,5

P-601 dimensions in mm



The E-610 analog controller OEM module left or the E-609 digital OEM controller are available for closed-loop versions with position sensor



The flexure guiding system prevents tip and tilt at the drive head

Technical Data

Model	P-601.1S P-601.1SL	P-601.3S P-601.3SL	P-601.4S P-601.4SL	P-601.x0 Open-loop versions	Units	Tolerance
Active axes	Z	Z	Z	Z		
Motion and positioning						
Integrated sensor	SGS	SGS	SGS	–		
Open-loop travel, -20 to +120 V	100	250	400	as P-601.xS	µm	min. (+20 %/-0 %)
Closed-loop travel	100	250	400	–	µm	calibrated
Open-loop resolution	0.2	0.3	0.4	as P-601.xS	nm	typ.
Closed-loop resolution	2	6	12	–	nm	typ.
Linearity, closed-loop	0.1	0.3	0.3	–	%	typ.
Repeatability	8	10	30	–	nm	typ.
Runout θ_X, θ_Y	20 / 10	20 / 10	20 / 10	as P-601.xS	µrad	typ.
Mechanical properties						
Stiffness in motion direction	0.8	0.38	0.28	as P-601.xS	N/µm	±20 %
Unloaded resonant frequency	750	440	350	as P-601.xS	Hz	±20 %
Resonant frequency @ 30 g	620	350	290	as P-601.xS	Hz	±20 %
Push/pull force capacity in motion direction	30/10	20/10	15/10	as P-601.xS	N	Max.
Lateral force	30	30	30	as P-601.xS	N	Max.
Drive properties						
Ceramic type	PICMA® P-885	PICMA® P-885	PICMA® P-885	as P-601.xS		
Electrical capacitance	1.5	3.1	4.6	as P-601.xS	µF	±20 %
Dynamic operating current coefficient	1.9	1.6	1.4	as P-601.xS	µA/(Hz•µm)	±20 %
Miscellaneous						
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	-20 to 80	°C	
Material	Stainless steel	Stainless steel	Stainless steel	Stainless steel		
Mass without cables	0.05	0.08	0.11	as P-601.xS	kg	±5 %
Cable length	S-version: 0.3 SL-version: 1.5	S-version: 0.3 SL-version: 1.5	S-version: 0.3 SL-version: 1.5	0.3	m	±10 mm
Sensor / voltage connection	S-version: open leads SL-version: LEMO	S-version: open leads SL-version: LEMO	S-version: open leads SL-version: LEMO	Open leads (no sensor)		

Recommended controller / amplifier
E-610 controller / amplifier (p. 2-110), E-625 bench-top controller (p. 2-114)

P-603 PiezoMove Linear Actuator

Low-cost and with Large Travel Ranges

P-603 linear actuators with 500 and 100 µm travel range (from left to right). CD for size comparison

- **Frictionless, High-Precision Flexure Guiding System**
- **Travel Ranges to 500 µm**
- **Cost-Effective Design**
- **Outstanding Lifetime Due to PICMA® Piezo Actuators**
- **Available with Integrated Position Sensor**
- **Ideal OEM Actuators for Precision Motion Control in Optics, Medical, Biotech and Microfluidics Applications**
- **Custom Designs with Larger Travel or Faster Response and Non-Magnetic Versions Feasible**

P-603 PiezoMove flexure-guided piezo actuators integrate a frictionless high-efficiency motion amplifier to combine large travel ranges up to 500 µm with high stiffness and very fast response. The flexure guides reduce tip at the drive head to a minimum saving the cost for additional guiding systems when integrating these actuators in micro-dispensing devices, pumps or servo valves. The overall precision of 10s of nanometers also makes these devices ideal for nanomanipulation applications.

Application Example

- Nanopositioning
- CCD / CMOS camera technology / Micro scanning
- Cell manipulation, biohandling
- Medical technology
- Micropumps
- Micro-dispensing
- Slit width adjustment
- Cavity Tuning
- Beam stabilization
- Photonics / integrated optics
- Switches

Options and Custom Versions

For OEM applications, PiezoMove actuators can be modified in various ways to suit the customer's requirements. The stiffness and force generation can be influenced via the lever design and the dimensions of the piezo ceramics used in the actuator. If only a small force and low guiding accuracy are required, large strokes of several 100 µm and high frequencies can be achieved with small actuators, e.g. for micropump drives. For high-accuracy applications, an integrated position feedback sensor is available. The actuators were designed to allow for considerable cost savings in large production runs.

OEM Control Electronics

PI also supplies a variety of controllers to match the actuators. These range from simple amplifier modules (see p. 2-164) and analog closed-loop OEM controllers (see p. 2-110) to high-performance digital controllers (see p. 2-100*ff*). The great choice of actuators and controllers allows customers to select the optimum combination of performance and cost for their application.

Increased Lifetime Through Humidity Resistance

The monolithic ceramic-encapsulated design provides better humidity protection than polymer-film insulation. Diffusion of water molecules into the insulation layer is greatly reduced by the use of cofired, outer ceramic encapsulation. Due to their high resonant frequency the actuators are suitable for highly dynamic applications with small loads; depending on the load an external preload for dynamic applications is recommended. The high Curie temperature of 320° gives PICMA® actuators a usable temperature range extending up to 150 °C, far beyond 80°C as is common for conventional multilayer actuators. With conventional multilayer actuators, heat generation – which is proportional to operating frequency – either limits the operating frequency or duty cycle in dynamic operation, or makes ungainly cooling provisions necessary. At the low end, operation down to a few Kelvin is possible (with reduced travel range).

Ordering Information

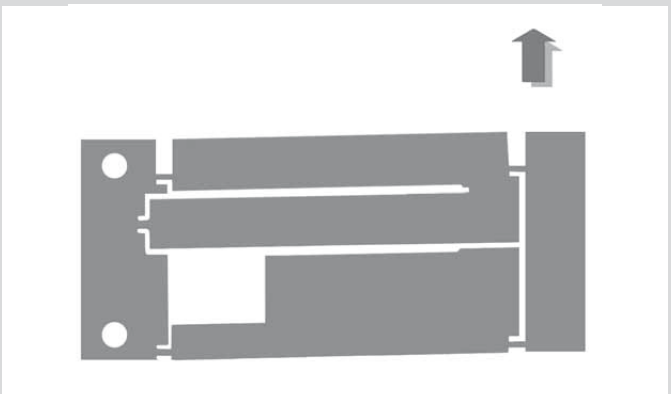
PiezoMove® OEM Linear Actuator with High Stiffness

P-603. [ ] [ ]

- **1** Travel Range 100 µm
- **3** Travel Range 300 µm
- **5** Travel Range 500 µm

- **00** Open loop
- **S0** SGS Sensor
- **SL** SGS Sensor, LEMO Connector

Ask about custom designs!

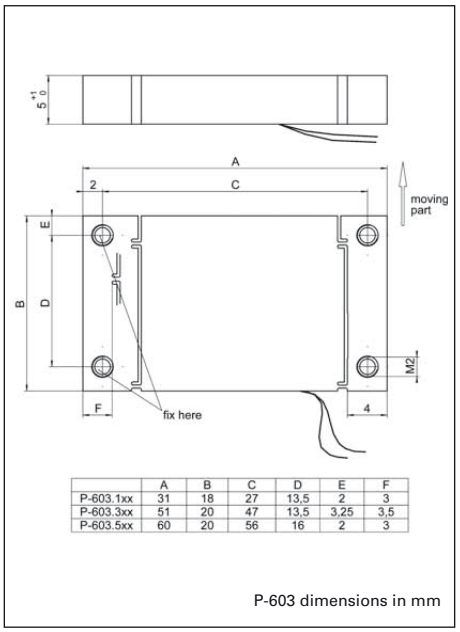


The flexure guiding system prevents tip and tilt at the drive head!

Levels of Integration: From Stack Actuator to 6-Axis Stage

	Stack actuators	Lever-amplified actuators	Positioning systems
Travel ranges	up to approx. 150 µm	up to 1 mm	up to 2 mm
Axes moved	one	one	up to three linear axes and three tip/ tilt axes
Sensors	SGS optional	SGS optional	SGS or direct measuring capacitive sensors
Linearity	up to 99.8 %	up to 99.8 %	over 99.9 %
Guidance	none	flexures for rotations <10"	flexures for rotations <2"
Space required	low	low	depends on features
Price	low	low	depends on features
Integration effort	high	low	low

Flexure guided, lever-amplified actuators form a reasonably priced and easily integrated class of products between conventional piezo stack actuators and the complex piezo nanopositioning systems



	A	B	C	D	E	F
P-603.1xx	31	18	27	13,5	2	3
P-603.3xx	51	20	47	13,5	3,25	3,5
P-603.5xx	60	20	56	16	2	3

P-603 dimensions in mm

Technical Data (preliminary)

Model	P-603.1S0 P-603.1SL	P-603.3S0 P-603.3SL	P-603.5S0 P-603.5SL	P-603.x00 open-loop versions	Units	Tolerance
Active axes	X	X	X	X		
Motion and positioning						
Integrated sensor	SGS	SGS	SGS	–		
Open-loop travel, -20 to +120 V	100	300	550	as P-603.xS0	µm	min. (+20%/-0)
Closed-loop travel	100	300	500	–	µm	calibrated
Open-loop resolution	0.2	0.3	0.4	as P-603.xS0	nm	typ.
Closed-loop resolution	2	4	7.5	–	nm	typ.
Linearity, closed-loop	0.3	0.3	0.3	–	%	typ.
Repeatability	8	10	30	–	nm	typ.
Mechanical properties						
Stiffness in motion direction	0.25	0.14	0.06	as P-603.xS0	N/µm	±20%
Unloaded resonant frequency	900	450	300	as P-603.xS0	Hz	±20%
Blocking force	20	35	25	as P-603.xS0	N	max.
Drive properties						
Ceramic type	PICMA® P-885	PICMA® P-885	PICMA® P-885	PICMA® P-885		
Electrical Capacitance	1.5	3.1	3.7	as P-603.xS0	µF	±20%
Dynamic operating current coefficient	1.9	1.3	1.6	as P-603.xS0	µA/(Hz•µm)	±20%
Miscellaneous						
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	-20 to 80	°C	
Material	Stainless steel	Stainless steel	Stainless steel	Stainless steel		
Dimensions	31x18x5	50x20x5	51x20x5	as P-603.xS0	mm	
Mass	0.02 / 0.031	0.032 / 0.043	0.038 / 0.049	as P-603.xS0	kg	±5%
Cable length	0.5	0.5	0.5	0.5	m	±10 mm
Sensor / voltage connection	S-version: open leads SL-version: LEMO connector (SGS Sensor)	S-version: open leads SL-version: LEMO connector (SGS Sensor)	S-version: open leads SL-version: LEMO connector (SGS Sensor)	Open leads		

Recommended controller / amplifier
E-610 controller / amplifier see p. 2-110, E-625 bench-top controller see p. 2-114

P-602 PiezoMove Flexure Actuator with High Stiffness

Integrated Guiding System, High Force and Large Travel Ranges

P-602 linear actuator
family featuring travel ranges
of 100, 500, and 1000 µm (from left to right)

Ordering Information

PiezoMove® OEM Linear Actuator with High Stiffness

- **1** Travel Range 100 µm
- **3** Travel Range 300 µm
- **5** Travel Range 500 µm
- **8** Travel Range 1000 µm

P-602. ☐

- **00** Open-loop
- **S0** SGS Sensor
- **SL** SGS Sensor, LEMO Connector

PiezoMove® OEM Linear Actuators with High Force

- **1** Travel Range 100 µm
- **3** Travel Range 300 µm
- **5** Travel Range 500 µm

P-602. ☐

- **08** Open-loop
- **S8** SGS Sensor
- **L8** SGS Sensor, LEMO Connector

Ask about custom designs!

- **Frictionless Flexure Guiding System for Straight Motion**
- **Integrated Motion Amplifier for Travel Ranges to 1 mm**
- **High Dynamics and Stiffness, Forces to 400 N, Backlash-Free Construction**
- **Outstanding Lifetime Due to PICMA® Piezo Actuators**
- **Available with Integrated Position Sensor**
- **Custom Designs with Larger Travel or Faster Response and Non-Magnetic Versions Feasible**
- **Ideal for OEM-Applications in Adaptronics, Biotechnology or Microfluidics**

P-602 PiezoMove flexure-guided piezo actuators integrate a frictionless high-efficiency motion amplifier to combine large travel ranges up to 1 millimeter with high stiffness and very fast response. They do not contain any components that require maintenance or are subject to wear or tear. The flexure guides eliminate tip motion permitting only for a very slight tilt at the drive head. This design feature saves the cost for additional guiding systems when integrating these actuators in applications for the active control of tools, vibrations or deformations for accuracies down to a few 10s of nanometers.

Application Examples

- Nanopositioning
- Adaptronics
- Active vibration control
- Nano-imprinting
- Active Tool control
- Laser technology
- Semiconductor technology
- Active and adaptive optics

Options and Custom Versions

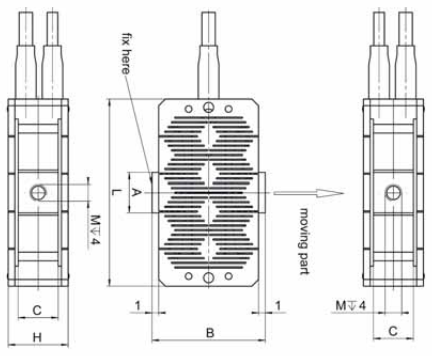
For OEM applications, PiezoMove actuators can be modified in various ways to suit the customer's requirements. The stiffness and force generation can be influenced via the lever design and the dimensions of the piezo ceramics used in the actuator. If only a small force and low guiding accuracy are required, large strokes of several 100 µm and high frequencies can be achieved with small actuators, e.g. for micropump drives. For high-accuracy applications, an integrated position feedback sensor is available. The actuators were designed to allow for considerable cost savings in large production runs.

OEM Control Electronics

PI also supplies a variety of controllers to match the actuators. These range from simple amplifier modules (see p. 2-164) and analog closed-loop OEM controllers (see p. 2-110) to high-performance digital controllers (see p. 2-100*ff*). The great choice of actuators and controllers allows customers to select the optimum combination of performance and cost for their application.

Ceramic-Insulated Piezo Actuators Provide Superior Lifetime

The highest possible reliability is assured by employing the award-winning PICMA® multilayer piezo actuators. PICMA® actuators are the only actuators on the market with a ceramic-only insulation which makes them resistant to ambient humidity and leakage-current failures. They are thus far superior to conventional actuators in reliability and lifetime.

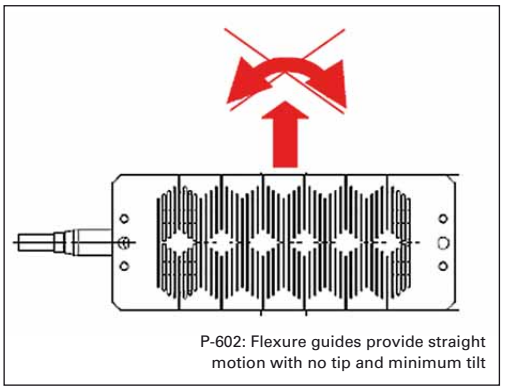


	L	B	H
P-602.1xx	28	17	9
P-602.3xx	46	19	9
P-602.5xx	85	26	9
P-602.8xx	126	34	14
P-602.1x8	28	22	14
P-602.3x8	46	24	14
P-602.5x8	85	31	14

	M	A	C
P-602.1xx	M2,5	6	6
P-602.3xx	M2,5	6	6
P-602.5xx	M2,5	6	6
P-602.8xx	M4	10	11
P-602.1x8	M2,5	6	11
P-602.3x8	M2,5	6	11
P-602.5x8	M2,5	6	11

P-602 dimensions in mm

PI offers a large variety of standard and custom lever-amplified piezo actuators for almost any application



P-602: Flexure guides provide straight motion with no tip and minimum tilt

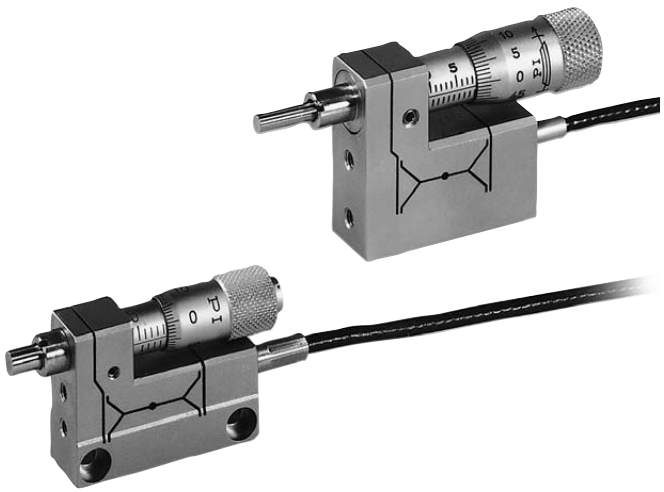
Technical Data (preliminary)

Model	P-602.100 P-602.1S0 P-602.1SL	P-602.300 P-602.3S0 P-602.3SL	P-602.500 P-602.5S0 P-602.5SL	P-602.108 P-602.1S8 P-602.1L8	P-602.308 P-602.3S8 P-602.3L8	P-602.508 P-602.5S8 P-602.5L8	P-602.800 P-602.8S0 P-602.8SL	Units	Tolerance
Active axes	X	X	X	X	X	X	X		
Motion and positioning									
Integrated sensor	- / SGS / SGS	- / SGS / SGS	- / SGS / SGS	- / SGS / SGS	- / SGS / SGS	- / SGS / SGS	- / SGS / SGS		
Open-loop travel, -20 to +120 V	120	300	600	100	300	500	1000	µm	min. (+20%/-0)
Closed-loop travel	- / 100 / 100	- / 300 / 300	- / 500 / 500	- / 100 / 100	- / 300 / 300	- / 500 / 500	- / 1000 / 1000	µm	
Open-loop resolution	0.2	0.3	0.4	0.2	0.3	0.4	0.5	nm	typ.
Closed-loop resolution	- / 2 / 2	- / 3 / 3	- / 3 / 3	- / 2 / 2	- / 3 / 3	- / 3 / 3	- / 7 / 7	nm	typ.
Linearity, closed-loop	- / 0.5 / 0.5	- / 0.5 / 0.5	- / 0.5 / 0.5	- / 0.5 / 0.5	- / 0.5 / 0.5	- / 0.5 / 0.5	- / 1.5 / 1.5	%	typ.
Repeatability	- / 10 / 10	- / 20 / 20	- / 35 / 35	- / 10 / 10	- / 20 / 20	- / 35 / 35	- / 60 / 60	nm	typ.
Mechanical properties									
Stiffness in motion direction	0.8	0.35	0.3	2.3	0.75	0.65	0.4	N/µm	± 20%
Unloaded resonant frequency	1000	450	230	1000	450	230	150	Hz	± 20%
Blocking force	80	105	150	230	225	325	400	N	max.
Drive properties									
Ceramic type	PICMA® P-885	PICMA® P-885	PICMA® P-885	PICMA® P-888	PICMA® P-888	PICMA® P-888	PICMA® P-888		
Electrical Capacitance	1.5	3.1	6.2	6	13	26	39	µF	± 20%
Dynamic operating current coefficient	1.9	1.3	1.6	7.5	5	6	4	µA/(Hz•µm)	± 20%
Miscellaneous									
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 80	°C	
Material	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel		
kg	28 x 17 x 9	46 x 19 x 9	85 x 26 x 9	28 x 22 x 14	46 x 24 x 14	85 x 31 x 14	126 x 34 x 14	mm	
Mass	0.022	0.04	0.105	0.05	0.088	0.215	0.355	kg	± 5%
Cable length	0.5 / 0.5 / 2	0.5 / 0.5 / 2	0.5 / 0.5 / 2	0.5 / 0.5 / 2	0.5 / 0.5 / 2	0.5 / 0.5 / 2	0.5 / 0.5 / 2	m	± 10 mm
Sensor / voltage connection	0- and S-version: open leads SL-version: LEMO connector	0- and S-version: open leads SL-version: LEMO connector	0- and S-version: open leads SL-version: LEMO connector	0- and S-version: open leads L-version: LEMO connector	0- and S-version: open leads L-version: LEMO connector	0- and S-version: open leads L-version: LEMO connector	0- and S-version: open leads SL-version: LEMO connector		

Recommended controller / amplifier
E-610 controller / amplifier see p. 2-110, E-625 bench-top controller see p. 2-114

P-853 · P-854

PiezoMike: Piezoelectric Micrometer Drive



P-853 (left), P-854 (right)

- **Alternative for Standard Micrometer Drives**
- **Manual Travel to 18 mm**
- **Piezoelectric High-Resolution Travel to 25 µm**
- **Sub-Nanometer Resolution**
- **Dynamic Operation to 10 Hz**

P-853/P-854 PiezoMikes are micrometer drives with integrated high-resolution piezo linear drives. They can be operated manually , like standard micrometer drives. Sensitivity of the micrometer is 1 µm. By controlling the piezo voltage, the micrometer tip is automatically moved in and out (up to 25 µm) relative to the manually set position. Resolution of the piezoelectric motion is in the sub-nanometer range. The PiezoMike can therefore be used as a remotely controlled fine positioning element.

Working Principle

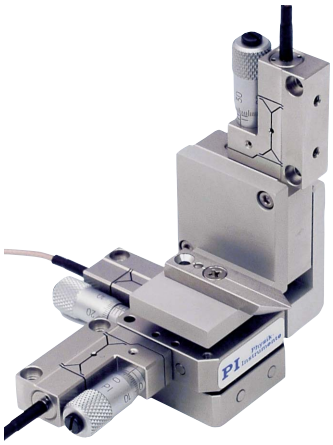
A sophisticated wire EDM (electric discharge machining) flexure motion amplifier doubles the displacement of a piezo linear actuator. It also serves as a linear guide to the micrometer drive, which is moved back and forth when the piezo drive voltage is changed. This design is compact and mechanically stable.

Ordering Information

P-853.00
PiezoMike, Piezoelectric Micrometer Drive, 6 mm, 25 µm

P-854.00
PiezoMike, Piezoelectric Micrometer Drive, 18 mm, 25 µm

Ask about custom designs!



M-313.80 XYZ miniature stage with P-853 PiezoMikes and optional fiber holder

Technical Data

Models	P-853.00	P-854.00	Units
Travel range (micrometer drive)	6	18	mm
Piezo fine travel range (@ 0 to 100 V)	25	25	µm ±20%
Min. incremental motion (piezo drive)	<1	<1	nm
Micrometer sensitivity	1	1	µm
Max. axial push/pull force	10 / 5	20 / 5	N
Micrometer drive	M-619.10	M-626.10	
Micrometer pitch	0.5	0.5	mm/rev.
Stiffness	1	1.5	N/µm
Electrical capacitance (piezo)	0.45	1.5	µF
Electrical connection	LEMO Cable: coaxial FFA.00.250, male. RG 178, Teflon coated, 1 m	LEMO Cable: coaxial, FFA.00.250, male. RG 178, Teflon coated, 1 m	
Weight	0.05	0.1	kg
Body material	N -S	N -S	
Recommended piezo driver (codes explained see page 6-11)	A, C, G	A, C, G	

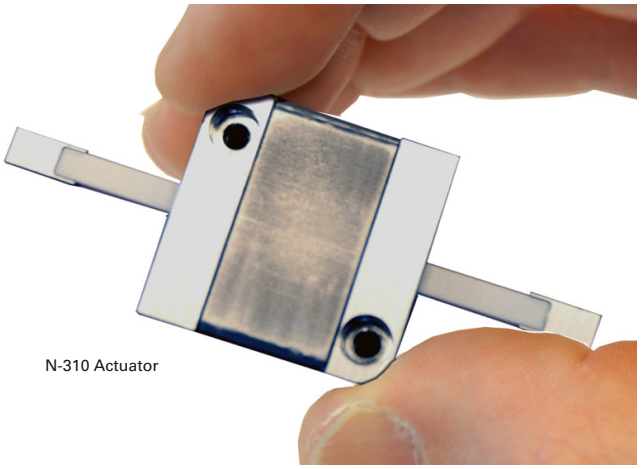
PiezoMike Applications

The PiezoMike can be mounted like a micrometer drive by clamping around the sleeve.

The P-853.00 is equipped with a 6 mm holding flange and can be directly attached to M-311 miniature translation stages (see page 7-28). The P-854 can be attached to the M-105 linear positioners (see page 7-30).

NEXACT® Piezo Linear Actuator 20 to 125 mm

Compact, High-Speed PiezoWalk® Drive



N-310 Actuator

- **20 to 125 mm Standard Travel Range**
- **Compact and Cost-Effective Design**
- **0.03 nm Resolution****
- **To 10 N Push/Pull Force**
- **Low Operating Voltage**
- **Self Locking at Rest, No Heat Generation, nm Stability**
- **Non-Magnetic and Vacuum-Compatible Working Principle**

N-310 NEXACT® PiezoWalk® linear drives feature travel ranges of up to 125 mm and push/pull force capacities to 10 N in a compact package of only 25 x 25 x 12 mm. With their high resolution, NEXACT® drives, are ideal for high-precision positioning over long travel ranges.

The N-310 can be operated in open-loop and closed-loop mode (with the addition of an external position sensor). A variety of NEXACT® controllers facilitates the integration into micro- or nanopositioning applications.

Working Principle for Application Flexibility

NEXACT® PiezoWalk® technology overcomes the limitations of conventional nanopositioning drives and combines virtually unlimited travel ranges with high stiffness in a very small package. Furthermore, NEXACT® actuators provide piezo-class resolution (far below one nanometer) and millisecond responsiveness. The special drive design reduces the operating voltage to 45 V and below.

In operation, piezoceramic bending elements act on the runner, which is connected to the moving part of the application. The length of the runner determines the travel range. Force capacity, resolution and velocity are determined by the piezo geometry and drive electronics and are scalable. To move the runner over longer distances the stepping mode is used, whereas for distances smaller than one step, the linear (analog) mode enables high-dynamics positioning with resolutions far below one nanometer.

Wear- and Maintenance-Free

In contrast to ordinary DC or stepper motor drives, the PiezoWalk® drives effect linear motion directly, without the need to transform rotation with mechanical elements such as gears, leadscrews and nuts. Therefore, mechanical limitations such as backlash and wear are eliminated and the drive is maintenance-free.

Self-Locking PiezoWalk® Piezo Stepping Drive

NEXLINE® and NEXACT® exhibit high stiffness and are self-locking even when powered down due to the clamping action of the piezo actuators in the mechanics. This entails nanometer position stability at rest, with no heat generation or servo-dither.

N-310.16
NEXACT® OEM Linear Drive, 125 mm, 10 N

Ask about custom designs!

Ordering Information

N-310.xx1: Shifted Cable Exit

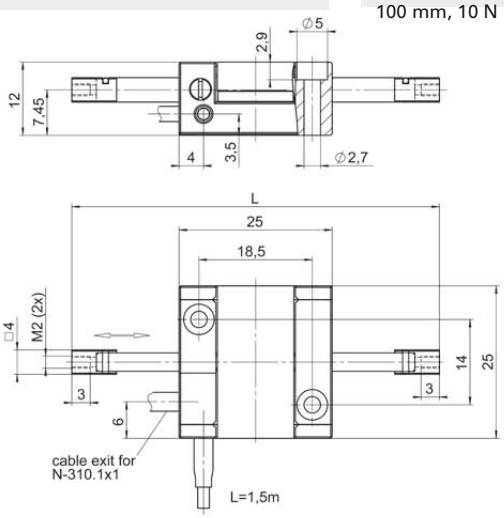
N-310.11
NEXACT® PiezoWalk® OEM Linear Drive, 20 mm, 10 N

N-310.12
NEXACT® OEM Linear Drive, 30 mm, 10 N

N-310.13
NEXACT® OEM Linear Drive, 50 mm, 10 N

N-310.14
NEXACT® OEM Linear Drive, 75 mm, 10 N

N-310.15
NEXACT® OEM Linear Drive, 100 mm, 10 N



Model	N-310
Active axes	X
Motion and positioning	
Step size (in step mode)	5 nm to 5 µm
Travel range in analog operation	7 µm, max.
Open-loop resolution	0.03 nm** typ.
Step frequency	1.5 kHz* max.
Max. speed	10 mm/s*, max.
Mechanical properties	
Push/Pull force (active)	10 N, max.
Drive properties	
Drive type	NEXACT® linear drive
Operating voltage	-10 V to +45 V
Miscellaneous	
Operating temperature range	0 to 50 °C
Body material	Stainless steel, non-magnetic
Mass	50 g (20 mm travel), ±5 %
Cable length	1.5 m ±10 mm
Connector	HD Sub-D connector 15 pin, single channel
Recommended controller/driver	E-862, E-861 (see p. 1-20)

*Depending on the control electronics.
**Depending on the drive electronics. 1 nm with E-861.

*The productsdescribedinthis document areinpartprotected by thefollowingpatents: German PatentNo.P4408618.0

N-381 NEXACT® Linear Actuator, Manipulator, Piezo Stepper

High-Resolution PiezoWalk® Linear Actuator with Optional Position Sensor

N-381 piezo stepper linear actuator for sample positioning and manipulation provides long travel, high speed and very high resolution; shown with E-861 NEXACT® Controller

- **Travel Range 30 mm**
- **Zero-Wear Piezo Stepping Drive, Ideal for Micro- and Nano-Manipulation**
- **Integrated Linear Encoder Option for Highest Accuracy with 20 nm Resolution**
- **Very High Acceleration, e.g. for Cell Penetration**
- **Two Operating Modes: Continuous Stepping Mode and Continuously Variable, High-Dynamics Analog Mode for 30 pm Resolution****
- **Up to 10 N Force Generation**
- **Self Locking at Rest, no Heat Generation**
- **Smooth Motion, no Closed-Loop Jitter**
- **Vacuum-Compatible and Non-Magnetic Versions**

The compact N-381 linear actuators are ideal drives and micro manipulators e.g. for biotechnology and nanotechnology applications. Rapid accelerations, velocities of 10 mm/s and forces up to 10 N enable high-dynamics and throughput for automation tasks. The PiezoWalk® drive principle allows long travel ranges and fast oscillations of 7 µm amplitude with frequencies up to several 100 Hz. This "analog mode" can be used to provide rapid acceleration, e.g. in cell penetration applications, or smooth motion for dynamic laser tuning or even for active damping of oscillations. Two models are available: The N-381.3A model is equipped with a high-resolution position sensor, allowing sub-micrometer repeatability in closed-loop operation. The N-381.30 open-loop version is intended for high precision applications where the absolute position is not important or is controlled by an external loop (video, laser, quadcell, etc.).

Application Examples

- Drive unit for scanning stage
- Cell manipulation, biohandling
- Micromanipulation
- Life science
- Photonics
- Laser tuning
- Motion in strong magnetic fields

Piezo Stepping Drive — the Multi-Functional Piezo Linear Motor

A great advantage characteristic of the NEXACT® piezo stepping drive is its dual-mode operating principle combining the best features of other piezo motor designs, such as high resolution, high force and high speed into one compact unit. At the target position the drive requires no current and generates no heat while providing long-term, nanometer stability. This autolocking feature also completely eliminates servo-jitter as it occurs with other closed-loop motors. Since motion is not based on dynamic friction as with piezo inertial drives (stick-slip-motors) but solely caused by the nanometer precise motion of clamped piezo actuators, there is no wear to limit the lifetime. When operated in closed-loop, excellent velocity control is achieved.

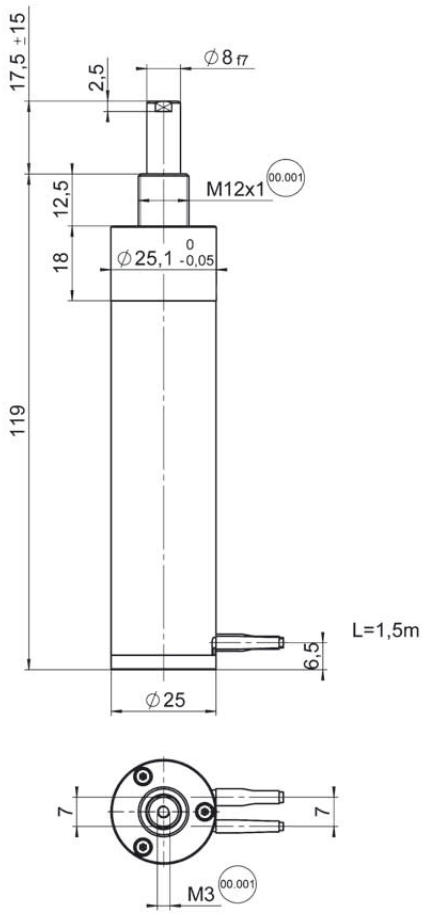
Ordering Information

N-381.3A
NEXACTUATOR® Linear Actuator, 30 mm, 20 nm Encoder Resolution

N-381.30
NEXACTUATOR® Linear Actuator, 30 mm, Open-Loop

Available on request

Ask about custom designs!



N-381 dimensions in mm

Working Principle for Application Flexibility

NEXACT® PiezoWalk® technology overcomes the limitations of conventional nanopositioning drives and combines virtually unlimited travel ranges with high stiffness in a very small package. Furthermore, NEXACT® actuators provide piezo-class resolution (far below one nanometer) and millisecond responsiveness. The special drive design reduces the operating voltage to 45 V and below.

In operation, piezoceramic bending elements act on the runner, which is connected to the moving part of the application. The length of the runner determines the travel range and can be chosen as required. To move the runner over longer distances the stepping mode is used, whereas for distances smaller than one step, the analog mode enables high-dynamics positioning with resolutions far below one nanometer.

Controllers and Drivers Optimized for the Application

NEXACT® actuators require special drive electronics to control the complex stepping sequences. The E-861 (see p.1-20) includes a complete NEXACT® servo-controller with low-noise drivers and a powerful DSP. It also comes with ample software for easy integration and highly effective computer control. For applications which do not require the highest resolution, the E-862 (see p. 3-10) lower-priced drive electronics, can be ordered.

The products described in this document are in part protected by the following patents:

German Patent No. P4408618.0

Technical Data (Preliminary)

Model	N-381.30	N-381.3A
Active axes	X	X
Motion and positioning		
Travel range	30 mm	30 mm
Step size (in step mode)	0.1 to 15 µm	–
Integrated sensor	–	Incremental linear encoder
Sensor resolution	–	20 nm*
Travel range in analog mode	7 µm	7 µm
Open-loop resolution	0.03 nm**	0.03 nm**
Closed-loop resolution	–	20 nm*
Step frequency	0 to 800 Hz	–
Max. velocity	10 mm/s*	10 mm/s*
Mechanical properties		
Stiffness in motion direction	2.4 N/µm	2.4 N/µm
Max. push / pull force (active)	10 N	10 N
Max. holding force (passive)	15 N	15 N
Lateral force	10 N	10 N
Drive properties		
Drive type	NEXACT® linear drive	NEXACT® linear drive
Operating voltage	-10 V to +45 V	-10 V to +45 V
Miscellaneous		
Operating temperature range	0 to 50 °C	0 to 50 °C
Material	Stainless steel / CFRP	Stainless steel / CFRP
Mass	250 g	255 g
Cable length	1.5 m	1.5 m
Connector	15-pin HD-Sub-D connector, one channel	15-pin HD-Sub-D connector, one channel
Recommended controller/driver	E-860 series (see p. 1-20)	E-861.1A1 (see p. 1-20)

*With E-861. Depending on drive electronics.
**Depending on the drive electronics. 1 nm with E-861.

Program Overview

- Piezo Ceramic Actuators & Motors
- Piezo Nanopositioning Systems and Scanners
- Active Optics / Tip-Tilt Platforms
- Capacitive Nanometrology Sensors
- Piezo Electronics: Amplifiers and Controllers
- Hexapod 6-Axis Positioners / Robots
- Micropositioning Stages & Actuators
- Photonics Alignment Systems, Solutions for Telecommunications
- Motor Controllers
- Ultrasonic Linear Motors

Request or download the complete PI Nanopositioning & Piezo Actuator Catalog

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