

**NEW!**

# Products

---

LASER 2015

# Contents

---

<b>Q-Motion Miniature Stages</b>	<b>Page 4</b>
High Resolution, Affordable Price	
<b>N-472</b>	<b>Page 6</b>
<b>PiezoMike Linear Actuator</b>	
With Position Sensor for Closed-Loop Operation	
<b>N-412</b>	<b>Page 8</b>
<b>Linear Actuator with PIShift Piezomotor</b>	
Cost-Effective and Easy to Integrate	
<b>N-422</b>	<b>Page 10</b>
<b>Linear Actuator with PIShift Piezomotor</b>	
Cost-Effective and Easy to Integrate	
	<b>Page 12</b>
<b>PILine® Ultrasonic Piezomotors</b>	
Small, High-Speed and Cost-Efficient	
<b>V-551</b>	<b>Page 14</b>
<b>PIMag® Precision Linear Stage</b>	
High Velocity Due to Magnetic Direct Drive, Nanometer Resolution	
<b>C-891</b>	<b>Page 16</b>
<b>PIMag® Motion Controller</b>	
For Linear Motors with Average Power Consumption	
<b>V-273</b>	<b>Page 18</b>
<b>PIMag® Voice Coil Linear Actuator</b>	
Cost-Effective with High Dynamics	
<b>V-275</b>	<b>Page 20</b>
<b>PIMag® Voice Coil Linear Actuator</b>	
High Dynamics, with Optional Force Control	
<b>V-277</b>	<b>Page 22</b>
<b>PIMag® High-Load Linear Actuator</b>	
Voice Coil Drive for High Velocity	
<b>C-413</b>	<b>Page 24</b>
<b>PIMag® Motion Controller</b>	
Control of Force, Position and Velocity	

---

<b>L-509</b> <b>Precision Linear Stage</b> High Velocity, High Precision	<b>Page 26</b>
<b>L-511</b> <b>High-Precision Linear Positioning Stage</b> High Travel Accuracy	<b>Page 28</b>
<b>H-811.S11</b> <b>6-Axis Motion Hexapod</b> Fast and Compact for High Dynamics Applications	<b>Page 30</b>
<b>H-845</b> <b>High-Load Hexapod</b> Positioning 1 Ton with Micrometer Precision	<b>Page 32</b>
<b>H-860KMAG</b> <b>High-Dynamics Hexapod</b> Magnetic Direct Drive for High Velocity	<b>Page 34</b>
<b>H-850KMLD</b> <b>High-Load Hexapod</b> High-Precision and Repeatable Positioning	<b>Page 36</b>
<b>C-887</b> <b>Controller for Hexapod Positioning Systems</b> 6-D Vector Motion Control, Comprehensive Functionality	<b>Page 38</b>
<b>P-080</b> <b>PICMA® Stack Multilayer Ring Actuator</b> With Inner Hole	<b>Page 40</b>
<b>P-88x.x5</b> <b>Encapsulated PICMA® Stack Piezo Actuators</b> For Tough Industrial Environments	<b>Page 42</b>
<b>S-331</b> <b>Fast Tip/Tilt Platform</b> Short Settling Time and High Dynamic Linearity	<b>Page 44</b>
<b>E-727</b> <b>Digital Multi-Channel Piezo Controller</b> For Nanopositioning Systems with Capacitive or Strain Sensors	<b>Page 46</b>

© Physik Instrumente (PI) GmbH & Co. KG

Although the information in this document has been compiled with the greatest care, errors cannot be ruled out completely. Therefore, we cannot guarantee for the information being complete, correct and up to date. Illustrations may differ from the original and are not binding. PI reserves the right to supplement or change the information provided without prior notice.

# Q-Motion Miniature Stages

HIGH RESOLUTION, AFFORDABLE PRICE



- Linear stages, rotary stages and parallel kinematic robots with six degrees of freedom
- Direct position measurement with incremental encoder with up to 1 nm resolution (optional)
- Piezomotor driving principle: Self-locking when at rest, therefore no holding current, no power consumption, no heat generation and no servo jitter

## Applications

Applications can be found in industry and research. The small form factor and the vacuum compatibility make Q-Motion stages ideal positioning tasks in Beamline Instrumentation or electron microscopy. Again

the small form factor, combined with the self-locking, Q-Motion stages can be integrated in mobile devices for metrology or medical applications.

## Q-Motion Linear Stages



**Q-521**

**Q-Motion Miniature Linear Positioning Stage**

Very Small Linear Positioning Stage with Position Control, High Resolution and Attractive Price



**Q-522**

**Q-Motion Miniature Linear Stage**

Piezomotors for Small Dimensions, High Resolution and a Favorable Price



**Q-545**

**Q-Motion Precision Linear Stage**

High Forces and Small Size Through Piezomotors

## Q-Motion Rotary Stages



**Q-614**

**Q-Motion Miniature Rotation Stage**

Minimum Dimensions: 14 mm Turntable Diameter



**Q-622**

**Q-Motion Miniature Rotation Stage**

Minimum Dimensions: 22 mm Turntable Diameter



**Q-632**

**Q-Motion Rotation Stage**

Compact Through Piezomotor: 30 mm Turntable Diameter

## Q-Motion Parallel Kinematic



**Q-821**

**Q-Motion Miniature SpaceFab Robot**

Piezo-Motorized Inertia Drive, only 80 mm Side Length



**Q-845**

**Q-Motion SpaceFAB Micro Robot**

Piezo-Motorized Inertia Drive, 1 nm Sensor Resolution



**E-873**

**Q-Motion Servo Controller**

1 Axis, for Positioners with Piezo Inertia Drives

# PiezoMike Linear Actuator

WITH POSITION SENSOR FOR CLOSED-LOOP OPERATION



## N-472

- High stability and holding force >100 N
- Self-locking at rest even when closed-loop control is switched off
- Travel range 7.5 mm and 13 mm
- Compact design with integrated incremental encoder
- Encoder resolution up to <1 nm, 50 nm minimum incremental motion
- Feed force 22 N
- Lifetime >1,000,000,000 steps
- Versions with cable exit offset by 180°
- Nonmagnetic and vacuum-compatible operating principle

### PIShift piezomotors

Compact, low-cost inertia drive principle (stick-slip). When at rest, the drive is self-locking, requires no current and generates no heat. It holds the position with maximum force

### Integrated position sensor

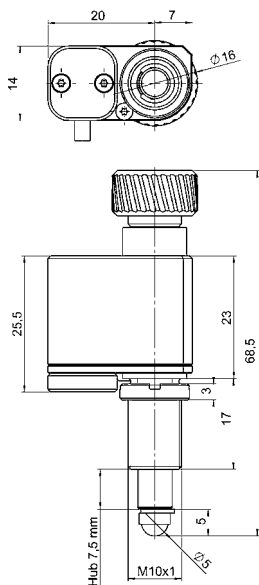
An incremental encoder measures the motion performed relative to a freely definable reference position. In combination with the E-871 motion controller, the encoder resolution is up to <1 nm

### Alignment of mechanical and optomechanical components

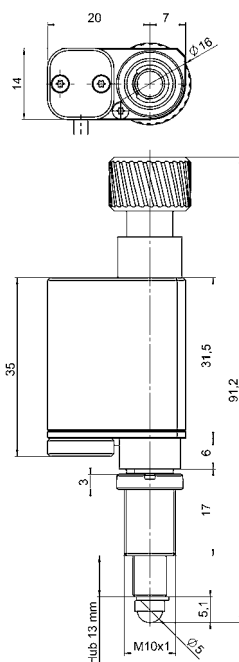
Stable alignment of optical paths. Long-term positioning stability: High stability in target position, reliable start-up even after longer downtimes. High holding force and resolution by combining piezo actuators with mechanical thread translation. Vacuum-compatible versions to  $10^{-6}$  hPa available

Preliminary Data	N-472.110; N-472.110Y / N-472.120; N-472.120Y	N-472.11V; N-472.11VY / N-472.12V; N-472.12VY	N-472.210; N-472.210Y / N-472.220; N-472.220Y	N-472.21V; N-472.21VY / N-472.22V; N-472.22VY	Unit
Active axis	X	X	X	X	
Mechanical interface	M10x1 mounting thread (N-472.110; N-472.110Y) 9.5 mm shank (N-472.120; N-472.120Y)	M10x1 mounting thread or 9.5 mm shank, vacuum-compatible to 10 <sup>-6</sup> hPa	M10x1 mounting thread (N-472.210; N-472.210Y) 9.5 mm shank (N-472.220; N-472.220Y)	M10x1 mounting thread or 9.5 mm shank, vacuum-compatible to 10 <sup>-6</sup> hPa	
<b>Motion and positioning</b>					
Travel range	7.5	7.5	13	13	mm
Integrated sensor	Incremental, optical	Incremental, optical	Incremental, optical	Incremental, optical	
Sensor signal	Analog, 1	Analog, 1	Analog, 1	Analog, 1	V <sub>pp</sub>
Resolution	0.03	0.03	0.03	0.03	nm
Unidirectional repeatability**	200	200	200	200	nm
Minimum incremental motion**	50	50	50	50	nm
Maximum velocity, open-loop	3.6	3.6	3.6	3.6	mm/min.
Recommended maximum velocity in continuous operation	2	2	2	2	mm/min.
<b>Mechanical properties</b>					
Holding force, de-energized	>100	>100	>100	>100	N
Feed force (active)	22	22	22	22	N
<b>Drive properties</b>					
Drive type	PIShift piezo inertia drive	PIShift piezo inertia drive	PIShift piezo inertia drive	PIShift piezo inertia drive	
Motor voltage	80	80	80	80	V <sub>pp</sub>
<b>Miscellaneous</b>					
Operating temperature range	10 to 40	10 to 40	10 to 40	10 to 40	°C
Material	Screw: Stainless steel Case: Aluminum	Screw: Stainless steel Case: Aluminum	Screw: Stainless steel Case: Aluminum	Screw: Stainless steel Case: Aluminum	
Cable length	2	2	2	2	m
Connector	Actuator: Sub-D 15 (m)	Actuator: Sub-D 15 (m)	Actuator: Sub-D 15 (m)	Actuator: Sub-D 15 (m)	
Recommended controller / driver	E-871	E-871	E-871	E-871	

\* with E-871 motion controller  
\*\* 20 N preload against the direction of motion  
Ask about custom designs!



N-472.110, dimensions in mm,  
Cable exit for N-472.XXXY versions offset by 180°



N-472.210, dimensions in mm,  
Cable exit for N-472.XXXY versions offset by 180°

# Linear Actuator with PIShift Piezomotor

COST-EFFECTIVE AND EASY TO INTEGRATE



## N-412

- Easy frontal mounting
- Silent: Operating frequency to >20 kHz
- Velocity over 5 mm/s
- Sub-micron resolution
- Holding force to 10 N
- Low operating voltage to 48 V<sub>pp</sub>
- Self-locking, no heat generation at rest

### Piezomotor-based direct drive

OEM actuator without position sensor. Continuous motion with step frequencies in the ultrasound range. Frontal mounting with M10x1 thread or 9.5 mm shank

### PIShift piezo inertia drive

Self-locking when at rest, no heat generation. Noiseless drive with operating frequencies beyond 20 kHz. Resolution in step mode approx. 300 nm, open-loop

### Fields of application

Industry and research. Alignment of optical elements, micromanipulation, biotechnology, cell manipulation, medical technology

### Recommended controllers / amplifiers

E-870 PIShift drive electronics



N-412 PIShift linear actuators with a kinematic mirror mount for the adjustment of optics

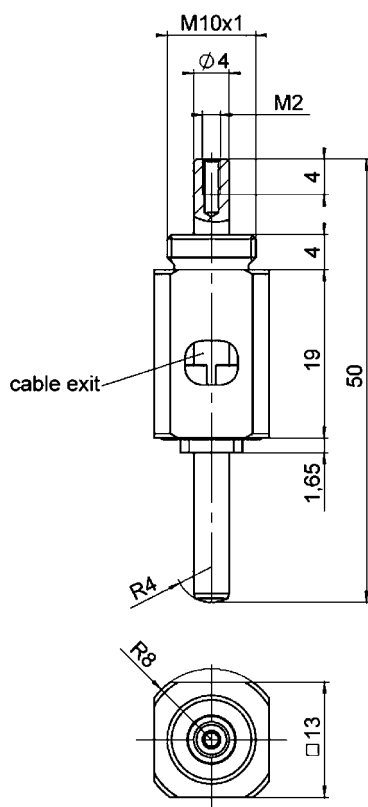


Preliminary Data	N-412.50	N-412.51	Unit	Tolerance
Active axes	X	X		
Mechanical interface	PIShift linear actuator, 9.5 mm shank	PIShift linear actuator, M10x1 thread		
<b>Motion and positioning</b>				
Travel range	13	13	mm	
Step size (in step mode)	300	300	nm	typ.
Step frequency *	20	20	kHz	max.
Max. velocity *	5	5	mm/s	min.
<b>Mechanical properties</b>				
Stiffness in motion direction	>4	>4	N/μm	±20 %
Push / pull force (active)	7	7	N	max.
Max. holding force (passive)	10	10	N	min.
<b>Drive properties</b>				
Drive type	PIShift piezo inertia drive	PIShift piezo inertia drive		
Operating voltage	48	48	V <sub>pp</sub>	max.
<b>Miscellaneous</b>				
Operating temperature range	0 to 50	0 to 50	°C	
Material**	Stainless steel	Stainless steel		
Dimensions	58 mm length, 15 mm diameter	58 mm length, 15 mm diameter		
Mass	25	25	g	±5 %
Cable length	1.5	1.5	m	±10 mm
Connector	DIN 4-pin	DIN 4-pin		
Recommended controller / driver	E-870 PIShift drive electronics	E-870 PIShift drive electronics		

Ask about custom designs!

\* Depending on the drive electronics

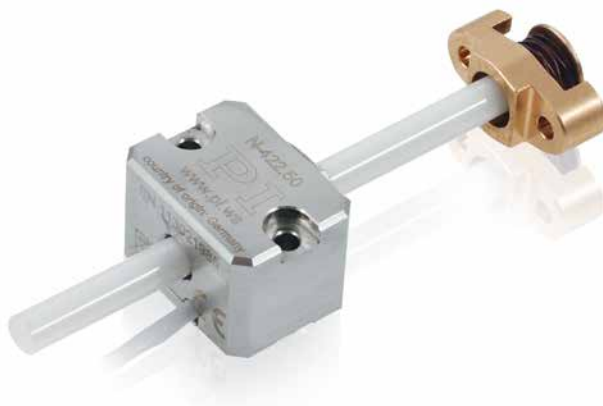
\*\* Ceramic rod



N-412.50, dimensions in mm. Version for mounting on the front via the M10 threaded flange

# Linear Actuator with PIShift Piezomotor

COST-EFFECTIVE AND EASY TO INTEGRATE



## N-422

- Simple integration:  
Two mounting versions
- Quiet: Drive frequency  
>20 kHz
- Velocity over 5 mm/s
- Sub-micron resolution
- Holding force to 10 N

### Piezomotor-based direct drive

OEM actuator without position sensor. Continuous motion with step frequencies in the ultrasound range. Easy integration, the housing can either be bolted to a level surface or mounted via a threaded flange

### PIShift inertia drive

Self-locking, no heat generation at rest. Noiseless drive with operating frequencies beyond 20 kHz. Resolution in step mode approx. 300 nm, open-loop

### Fields of application

Industry and research. Alignment of optical elements, micromanipulation, biotechnology, cell manipulation, medical technology

### Recommended controller / amplifier

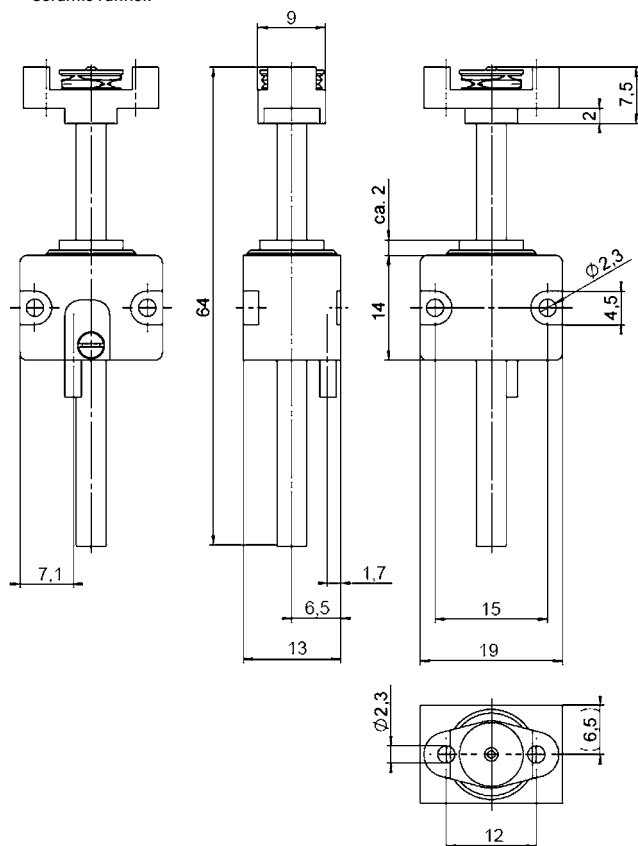
E-870 PIShift drive electronics

Preliminary data	N-422.50	Unit	Tolerance
Active axes	X		
<b>Motion and Positioning</b>			
Travel	35	mm	
Step size (in step mode)	300	nm	typ.
Step frequency*	20	kHz	max.
Max. velocity*	5	mm/s	min.
<b>Mechanical Properties</b>			
Stiffness in motion direction	>4	N/ $\mu$ m	$\pm 20$ %
Push / pull force (active)	7	N	max.
Max. holding force (passive)	10	N	min.
<b>Drive Properties</b>			
Drive type	PIShift inertia drive		
Operating voltage	48	V <sub>pp</sub>	max.
Power consumption	15 W (actuator) 30 W (drive input)	W	nominal
<b>Miscellaneous</b>			
Operating temperature range	0 to 50	$^{\circ}$ C	
Material**	Stainless steel		
Dimensions	21.5 mm $\times$ 18 mm $\times$ 13 mm + rod		
Mass	25	g	$\pm 5$ %
Cable length	1.5	m	$\pm 10$ mm
Connector	DIN 4-pin		
Recommended controller / driver	E-870 PIShift drive electronics		

Ask about custom designs!

\* Depending on drive electronics.

\*\* Ceramic runner.



N-422.50, dimensions in mm. Version for mounting on an even surface vertical to the direction of motion

# PILine® Ultrasonic Piezomotors

SMALL, HIGH-SPEED AND COST-EFFICIENT



- Silent operation through control frequencies in the ultrasonic range
- Cost-efficient drive principle: One actuator, one control phase
- Easy mechanical integration, compact design
- Self-locking at rest: No holding currents, no heating at stop, no energy consumption and no control jitter
- Holding force up to 15 N
- Velocity to 500 mm/s
- Resolution to 1 nm

## Applications

PILine® ultrasonic piezomotors are small, high-speed and cost-efficient. Ideally suitable for applications of low operating cycles, they can also be integrated as drive into mobile measuring and medical devices. Due

to their self-locking, the target position does not have to be held via additional brakes or electrical currents as in the case of magnetic drives.

## PILine® Linear Positioning Stages

---



**U-521**  
**Compact Linear Stage**  
 Fast PLine® Direct Drive, Incremental Encoder

---

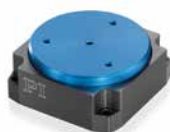
## PILine® Rotation Stages

---



**U-622**  
**Miniature Rotation Stage**  
 20 mm Side Length, Integrated Encoder

---



**U-624**  
**Fast Miniature Rotation Stage**  
 With Ultrasonic Piezomotor

---



**U-628**  
**Fast Rotation Stage with Small Footprint**  
 With Ultrasonic Piezomotor

---



**U-651**  
**Rotation Stage with Low-Profile Design**  
 Fast PLine® Direct Drive

---

## Motion Control

---



**C-877**  
**PILine® Motion Controller**  
 For Ultrasonic Piezomotors, Cost-Efficient and Compact

---



**C-867U**  
**PILine® Motion Controller**  
 For Ultrasonic Piezomotors, 1 and 2 Axes

---

# PIMag<sup>®</sup> Precision Linear Stage

HIGH VELOCITY DUE TO MAGNETIC DIRECT DRIVE, NANOMETER RESOLUTION



## V-551

- Travel ranges to 230 mm
- Velocity up to 0.5 m/s
- Incremental encoder with <2 nm resolution, absolute-measuring
- 200 N peak force
- Compact design with 160 mm width

### Reference class linear stage

High travel accuracy due to precision linear guiding rails with crossed rollers. No cage creep due to forced guidance (anti creep). Smooth-running precision linear guiding, especially suitable for scanning applications with constant velocity. No moving cables. Travel range can be adjusted mechanically due to adjustable hard stops

### PIMag<sup>®</sup> magnetic direct drive

Ironless magnetic direct drive for high velocity and acceleration. High position resolution by sine-commuted control with PI motion controller. Modularly configurable push/pull force

### Absolute-measuring encoder

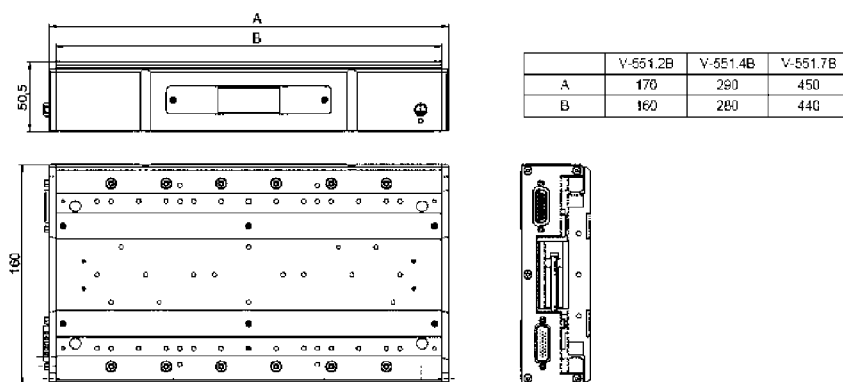
Position measurement with integrated incremental encoder. Absolute position measurement, no referencing during switch-on required, therefore increased efficiency and additional safety during operation. BiSS interface, analog signal transmission (sin/cos, 1 V<sub>pp</sub>). Up to <2 nm position resolution when operating with PI motion controller

### Fields of application

Industry and research. Metrology, photonics, medical and precision scanning in semiconductor or flat panel display manufacturing

	V-551.2B	V-551.4B	V-551.7B	Unit
<b>Motion and positioning</b>				
Travel	50	130	230	mm
Integrated sensor	Incremental encoder, absolute-measuring, BiSS	Incremental encoder, absolute-measuring, BiSS	Incremental encoder, absolute-measuring, BiSS	
Sensor resolution*	<2	<2	<2	nm
Min. incremental motion	0.01	0.01	0.01	µm
Unidirectional repeatability	0.02	0.02	0.02	µm
Bidirectional repeatability	±0.05	±0.05	±0.05	µm
Pitch / yaw	±50	±50	±25	µrad
Straightness / flatness per 100 mm	±1	±1	±1	µm
Velocity	0.5	0.5	0.5	m/s
<b>Mechanical Properties</b>				
Max. load, horizontal	15	15	15	kg
Max. load, lateral	12	12	12	kg
Moved mass	2.2	2.7	4.9	kg
Overall mass	4.2	5.5	9.7	kg
Linear guiding	Crossed roller guide, anti creep	Crossed roller guide, anti creep	Crossed roller guide, anti creep	
<b>Drive Properties</b>				
Motor Type	Ironless PIMag® linear motor	Ironless PIMag® linear motor	Ironless PIMag® linear motor	
Intermediate circuit voltage	300	300	300	VDC
Peak force	200	200	200	B
Nominal force	58	58	58	N
Peak current, effective	10	10	10	A
Nominal current, effective	2.9	2.9	2.9	A
Force constant, effective	19.9	19.9	19.9	N/A
Resistance per phase	2.8	2.8	2.8	
Inductivity per phase	0.9	0.9	0.9	mH
Back EMF phase-phase	16	16	16	Vs/m
Reference point and limit switches	Hall effect	Hall effect	Hall effect	
<b>Miscellaneous</b>				
Operating temperature range	10 to 50	10 to 50	10 to 50	°C
Humidity	20 – 90% rel., not condensing	20 – 90% rel., not condensing	20 – 90% rel., not condensing	
Material	Al (black anodized)	Al (black anodized)	Al (black anodized)	
Recommended controller	C-891	C-891	C-891	

\* With C-891 controller. Optional down to 0.03 nm with incremental encoder. Ask about custom designs!



V-551, dimensions in mm

# PIMag® Motion Controller

FOR LINEAR MOTORS WITH AVERAGE POWER CONSUMPTION



## C-891

- Maximum average current consumption 3 A
- 20 kHz control bandwidth
- USB interface for sending commands and for configuration
- Digital inputs and outputs
- Optional analog input

### Digital motion controller for PIMag® linear motors

1 motor channel, 1 sensor channel. For three-phase linear motors, maximum current consumption 3A (rms) per phase. Sine-commuted operation, field-oriented current control. Automatic detection of the motor phase. PID controller for position and velocity. 20 kHz servo update rate

### Encoder inputs

Differential signal transmission for digital (A/B) or analog (sin/cos) encoder signals. BiSS interface support for absolute encoders. TTL signal inputs for limit and reference point switches

### Extensive functionality

Data recorder: Recording of operating data such as motor

current, velocity, position or position error. Wave generator: Saves and outputs periodical motion profiles. ID chip support: Identifies the connected stages and simplifies configuration and exchangeability. Supports direction-sensing reference point switches. Extensive software support, for example for LabVIEW, dynamic libraries for Windows and Linux

### Interfaces

USB 2.0, RS-232 commanding. Digital inputs and outputs for automation. Analog input for direct control of the motor current



Preliminary Data	C-891	Unit
Function	PIMag® motion controller for 3-phase linear motors, sine-commuted, field-oriented current control	
Motor channels	1	
Sensor channels	1	
<b>Motion and control</b>		
Servo characteristics	PID controller for position and velocity, parameter change on-the-fly	
Servo cycle time	50	µs
Profile generator	Trapezoidal velocity profile, setting of maximum velocity and acceleration	
Encoder input	Sensor input for incremental sensors, analog (sin / cos) or digital signals (A / B differential, TTL) and absolute sensors (32-bit BiSS interface)	
Reference point switch	2 x TTL, direction-sensing	
<b>Electrical properties</b>		
Max. output voltage	48	V
Max. output current	3	A (rms)
<b>Interfaces and operation</b>		
Communication interfaces	USB, RS-232	
Motor connector	HD Sub-D 26-pin (w)	
Sensor connection	Sub-D 15-pin (m)	
I/O port	4 x digital input 4 x digital output Via HD Sub-D 15-pin (w) Optional analog input, -10 to 10 V	
Command set	PI General Command Set (GCS)	
User software	PIMikroMove	
Software drivers	LabVIEW driver, dynamic libraries for Windows and Linux	
Supported functions	Point-to-point motion, data recorder with 16,000 values and 8 recorder channels, movement, automatic motor phase detection, ID chip detection	
<b>Miscellaneous</b>		
Operating voltage	External power supply 24 or 48 V, included in scope of delivery	
Max. current consumption	4.5	A
Operating temperature range	5 to 50	°C
Max. mass	1.0	kg
Dimensions	190 x 88 x 107	mm

Ask about custom designs!

# PIMag<sup>®</sup> Voice Coil Linear Actuator

COST-EFFECTIVE WITH HIGH DYNAMICS



## V-273

- Travel ranges to 20 mm
- Velocity to 250 mm/s
- Integrated linear encoder, 0.1  $\mu\text{m}$  resolution
- Optional force sensor with 1 mN resolution
- Optional: Weight force compensation
- Maximum force 6.4 N
- Resolution 0.002  $\mu\text{m}$  (open-loop)
- Long Lifetime; >10 million cycles
- C-413: Motion controller for simultaneous position and force control

### OEM linear actuator

PIMag<sup>®</sup> Voice coil magnetic drive, high velocity and high dynamics. Low wear and high lifetime. Integrated linear encoder for reliable position control and repeatable accuracy. Position sensor resolution: 0.01  $\mu\text{m}$ . Optional force sensor for applying defined forces. Force sensor resolution: 1 mN. Easy integration by coupling the guided load to the moving runner

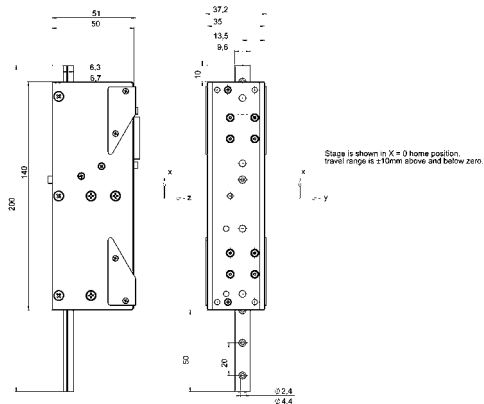
### Fields of application

OEM drives in automation. For fast handling tasks and precision positioning in the micrometer range, micro-manipulation

	V-273.430 / V-273.431	Unit	Tolerance
Active axes	Z		
<b>Motion and positioning</b>			
Travel	20	mm	
Integrated sensor	Optical linear encoder		
Sensor resolution	10*	nm	max.
Min. incremental motion	100	nm	typ.
Linearity error, closed-loop	1	%	typ.
Repeatability	±0.5	nm	typ.
Velocity	200	mm/s	max.
Force sensor resolution (optional)	1	mN	max.
Smallest force step (optional)	5	mN	typ.
<b>Mechanical properties</b>			
Bearing / guiding	Linear guiding		
Straightness of travel	±20	µm	±5 %
Smallest force step (optional)	56 (186 with force sensor)	g	typ.
<b>Drive properties</b>			
Motor type	PIMag® voice coil drive, moving coil		
Coil resistance	16	Ω	typ., at 20 °C
Coil inductance	6	mH	typ., at 20 °C
Time constant	0.375	ms	
Mutual inductance	8	Vs/m	
Force constant	8	N/A	typ.
Motor constant	2	N/W <sup>1/2</sup>	
Current constant	0.125	A/N	typ.
Average continuous current	400**	mA	max.
Peak current (max. 3 s)	800	mA	
Average push / pull force	3	N	nominal
Power dissipation with 100 % duty cycle	2.25	W	
Maximum push / pull force	6	N	max.
Power dissipation with 10 % duty cycle	10	W	
<b>Miscellaneous</b>			
Operating temperature range	10 to 60	°C	
Material	Aluminum		
Mass	560 (690 with force sensor)	g	±5 %
Cable length	1	m	
Motor / sensor connection	Sub-D 15 (m) with force sensor: 2 × Sub-D 15 (m)		
Lifetime	>10 <sup>7</sup>	cycles	min.
Recommended controller	C-413		

\* With C-413 controller.

\*\* Allowable average value for continuous operation, not to be exceeded.



V-273, dimensions in mm



Optional force sensor on V-273

# PIMag® Voice Coil Linear Actuator

HIGH DYNAMICS, WITH OPTIONAL FORCE CONTROL



## V-275

- Push force up to 10 N
- Velocity to 600 mm/s
- Integrated linear encoder, 0.01  $\mu\text{m}$  resolution
- Optional force sensor with 1 mN resolution
- Optional: Weight force compensation

### OEM Linear Actuator

PIMag® voice coil linear drive, high velocity and high dynamics. Low wear and high lifetime. Integrated linear encoder for reliable position control and repeatable accuracy. Position sensor resolution: 0.01  $\mu\text{m}$ . Optional force sensor for applying defined forces. Force sensor resolution: 1 mN. Easy integration by coupling the guided load to the moving runner

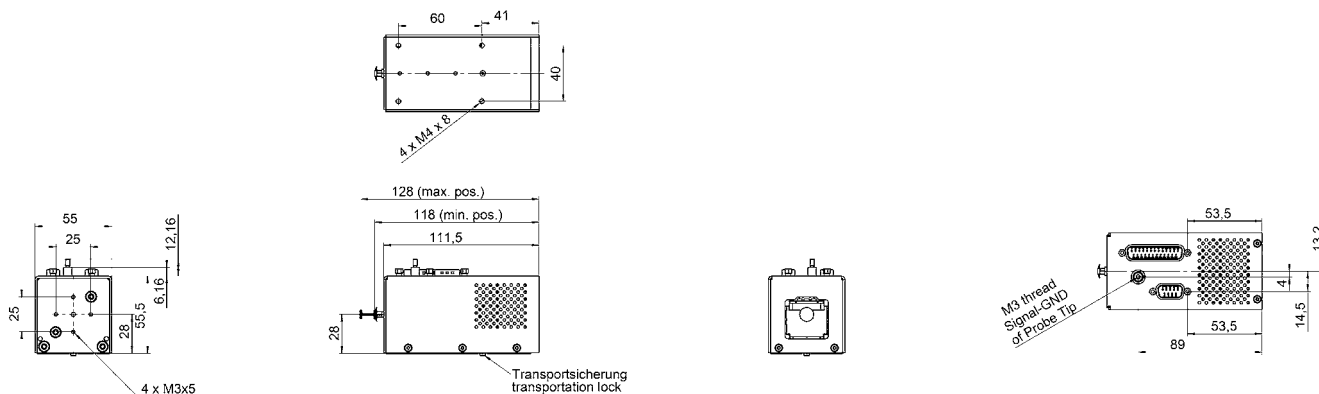
### Fields of application

OEM drives in automation. For fast handling tasks and precision positioning in the micrometer range, micromanipulation. Testing of force-sensitive switches and surfaces

	V-275	Unit	Tolerance
Active axes	Z		
<b>Motion and positioning</b>			
Travel	20	mm	
Integrated sensor	Optical linear encoder		
Sensor resolution	10*	nm	max.
Min. incremental motion	100	nm	typ.
Linearity error, closed-loop	1	%	typ.
Repeatability	±0.5	µm	typ.
Velocity	600	mm/s	max.
Force sensor resolution (optional)	1	mN	max.
Smallest force step (optional)	5	mN	typ.
<b>Mechanical properties</b>			
Bearing / guiding	Linear recirculating ball bearings		
Straightness of travel	±5	µm	±5 %
Moved mass without load	150	g	typ.
<b>Drive properties</b>			
Motor type	PIMag® voice coil drive, moving coil		
Coil resistance	5.7	Ω	typ., at 20 °C
Coil inductance	3.75	mH	typ., at 1 kHz, at 20 °C
Time constant	0.65	ms	
Mutual inductance	10	Vs/m	
Force constant	10	N/A	typ.
Motor constant	13.5	N/W <sup>1/2</sup>	
Current constant	0.1	A/N	typ.
Average continuous current	1100**	mA	max.
Peak current (max. 3 s)	1500	mA	
Average push / pull force	7	N	nominal
Power dissipation with 100 % duty cycle	6.5	W	
Maximum push / pull force	10	N	max.
<b>Miscellaneous</b>			
Operating temperature range	10 to 60	°C	
Material	Aluminum		
Mass	800	g	±5 %
Cable length	3	m	
Motor / sensor connection	Sub-D 26 (m), with force sensor Sub-D 9 (m)		
Lifetime	>10 <sup>7</sup>	cycles	min.
Recommended controller	C-413		

\* With C-413 controller.

\*\* Allowable average value for continuous operation, not to be exceeded.



V-275, dimensions in mm

# PIMag® High-Load Linear Actuator

VOICE COIL DRIVE FOR HIGH VELOCITY



## V-277

- Force up to 20 N
- Velocity up to 750 mm/s
- Integrated linear encoder, 0.01  $\mu\text{m}$  resolution
- Optional force sensor with 1 mN resolution
- Optional: Weight force compensation

### OEM Linear Actuator

PIMag® voice coil linear drive, high velocity and high dynamics. Low wear and high lifetime. Integrated linear encoder for reliable position control and repeatable accuracy. Position sensor resolution: 0.01  $\mu\text{m}$ . Optional force sensor for applying defined forces. Force sensor resolution: 1 mN. Easy integration by coupling the guided load to the moving runner

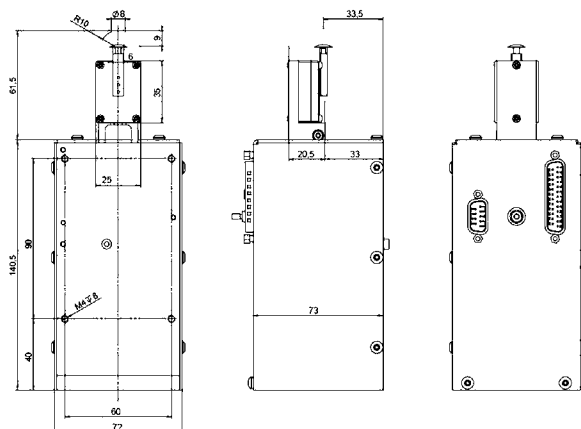
### Fields of application

OEM drives in automation. For fast handling tasks and precision positioning in the micrometer range, micromanipulation. Testing of force-sensitive switches and surfaces

	V-277	Unit	Tolerance
Active axes	Z		
<b>Motion and positioning</b>			
Travel	15	mm	
Integrated sensor	Optical linear encoder		
Sensor resolution	10*	nm	max.
Min. incremental motion	100	nm	typ.
Linearity error, closed-loop	1	%	typ.
Repeatability	±0.5	µm	typ.
Velocity	750	mm/s	max.
Force sensor resolution (optional)	1	mN	max.
Force resolution, closed-loop	5	mN	typ.
<b>Mechanical properties</b>			
Bearing / guiding	Linear recirculating ball bearings		
Straightness of travel	±5	µm	±5 %
Moved mass without load	190	g	typ.
<b>Drive properties</b>			
Motor type	PIMag® voice coil drive, moving coil		
Coil resistance	6.3	Ω	typ., at 20 °C
Coil inductance	2.70	mH	typ., at 1 kHz, at 20 °C
Time constant	0.43	ms	typ.
Mutual inductance	14	Vs/m	
Force constant	13.5	N/A	typ.
Motor constant	5.6	N/W <sup>1/2</sup>	
Current constant	0.072	A/N	typ.
Average continuous current	800**	mA	max.
Peak current (max. 3 s)	1500	mA	
Average push / pull force	10	N	nominal
Power dissipation with 100 % duty cycle	4	W	
Maximum push / pull force	20	N	max.
<b>Miscellaneous</b>			
Operating temperature range	10 to 60	°C	
Material	Aluminum		
Mass	1850	g	±5 %
Cable length	3	m	
Motor / sensor connection	Sub-D 26 (m), with force sensor Sub-D 9 (m)		
Lifetime	>10 <sup>7</sup>	cycles	min.
Recommended controller	C-413		

\* With C-413 controller.

\*\* Allowable average value for continuous operation, not to be exceeded.



V-277, dimensions in mm

# PIMag<sup>®</sup> Motion Controller

CONTROL OF FORCE, POSITION AND VELOCITY



## C-413

- 2 motor channels
- USB interface for sending commands and for configuration
- Real-time SPI interface for sending commands
- Digital in- and outputs
- Optional analog inputs and outputs
- Auto zero function for holding current
- ID chip support
- Extensive software support

### Digital motion controller for PIMag<sup>®</sup> Voice Coil drives

2 motor channels, 4 sensor channels. PID controller for force, position and velocity. Servo update rate selectable between 5 to 10 kHz

### Force control

With the force control, PIMag<sup>®</sup> actuators and stages can be operated at a defined holding and feed force. Force and position sensors are read and the sensor values are processed simultaneously. Thus it is possible to add a secondary position or velocity control loop to the force control. PI offers PIMag<sup>®</sup> actuators with additional force sensor. The models C-413.20A / .2GA provide analog input sockets for external force sensors

### Extensive functionality

Data recorder: Recording of operating data such as motor

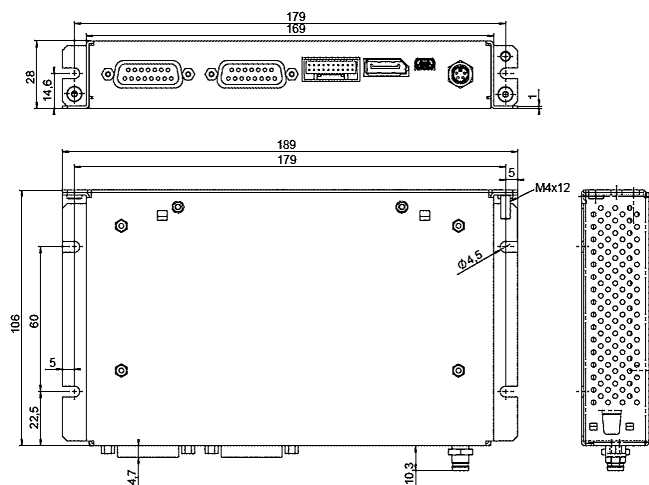
current, velocity, position or position error. Wave generator: Saves and outputs periodical motion profiles. Auto zero function defines holding current level at which the drive in open-loop operation outputs a force of 0 N , e.g. for compensating gravity. ID chip support: Identifies the connected stages and simplifies configuration and exchange of stages. Supports direction-sensing reference point switches. Extensive software support, e.g. for LabVIEW, dynamic libraries for Windows and Linux

### Interfaces

USB 2.0, SPI for sending commands. Digital inputs and outputs for automation. Optional analog inputs and outputs, e.g. for sensors, for sending commands or for position feedback



Preliminary data	C-413.20 / C-413.20A C-413.2G / C-413.2GA	Unit
Function	PIMag® motion controller for voice coil drives, 2 channels C-413.20 / .20A: OEM board C-413.2G / .2GA: Device with case	
Motor channels	2	
Sensor channels	4	
<b>Motion and control</b>		
Servo characteristics	PID controller for force, position and velocity; parameter change on-the-fly	
Servo cycle time	100 µs to 200 µs, selectable in 4 steps	
Profile generator	Trapezoidal velocity profile, setting of maximum velocity and acceleration	
Encoder input	SPI sensor interface	
Reference point switches	4 × TTL, direction- sensing	
<b>Electrical properties</b>		
Max. output voltage	24	V
Max. output current	±1.5	A, closed-loop
<b>Interface and operation</b>		
Communication interfaces	USB 2.0, real time SPI	
Motor connector	Sub-D 15-pin (f)	
Drive Properties	2 x analog inputs, -10 to 10 V, 16 bit, 1 kHz (only C-413.20A and C-413.2GA) 2 x analog outputs, -10 to 10 V, 17 bit, 1 kHz (only C-413.20A and C-413.2GA) 6 x digital outputs (open collector, voltage range 5 V to 24 V, 33 k internal pull-up to 5 V) 4 x digital input (5 V TTL level, to 24 V max. input voltage, 10 k input resistance)	
Command set	PI General Command Set (GCS)	
User software	PIMikroMove	
Software drivers	LabVIEW driver, dynamic libraries for Windows and Linux	
Supported functionality	Point-to-point motion; data recorder; wave generator; auto zero; ID chip detection	
<b>Miscellaneous</b>		
Operating voltage	External power supply 24 V, included in scope of delivery	
Max. operating current	2	A
Operating temperature range	5 to 50	°C
Max. mass	0.3	kg
Dimensions	188 × 28 × 105 (C-413.2G / .2GA) 160 × 18 × 100 (C-413.20 / .20A)	mm



C-413 with case, dimensions in mm

# Precision Linear Stage

HIGH VELOCITY, HIGH PRECISION



## L-509

- Travel ranges from 26 to 102 mm (1" to 4")
- Repeatability to 0.05  $\mu\text{m}$
- Integrated optical limit switch
- Optional direct metrology linear encoder
- Efficient ActiveDrive DC servo motor, stepper motor or DC gear motor
- Direction-sensing reference point switch

### Reference-class linear stage

High travel accuracy and load capacity due to crossed roller guides. Precision ball screw with 1 mm pitch. Compact design. Stress-relieved aluminum base for highest stability. Optical limit switches. Travel ranges L-509.2 versions: 26 mm (1"), L-509.4: 52 mm (2"), L-509.6: 102 mm (4")

### Drive types

.xxAD variant: ActiveDrive DC motor for high velocity: Control via pulse-width-modulated (PWM) signals, the operating voltage is attained via an amplifier integrated in the motor case.

.xxDG variant: DC servo motor with gearhead for high torques and resolution at low motor power

.xxSD variant: 2-phase stepper motor for low velocity and high resolution

Noncontact limit switches. Noncontact, direction-sensing reference point switch in the middle of the travel range

### Position measurement

- Integrated rotary encoder on motor shaft (variants with DC motor, ActiveDrive or gearhead).
- Laterally mounted linear encoder. Direct position measurement of moved platform without impact on positioning precision due to mechanical play or hysteresis in the drive

### Min. incremental motion and slow motion

In conjunction with the SMC Hydra controller, versions with stepper motor and integrated linear encoder (L-509.xASD00) achieve repeatable minimum incremental motion in the range of the sensor resolution. With this configuration, constant, low velocities of a few sensor steps per second can be attained

### Fields of application

Precision positioning for science and industry, high duty cycles.

Preliminary Data	L-509.x4AD20	L-509.x0AD10	L-509.xADG20	L-509.x0DG10	L-509.xASD00	L-509.x0SD00	Unit
	Linear stage with ActiveDrive DC motor and linear encoder (direct position measurement)	Linear stage with ActiveDrive DC motor and rotation encoder	Linear stage with DC gear motor and linear encoder (direct position measurement)	Linear stage with DC gear motor and rotary encoder	Linear stage with stepper motor and linear encoder (direct position measurement)	Linear stage with stepper motor	
<b>Motion and Positioning</b>							
Travel	26 / 52 / 102	26 / 52 / 102	26 / 52 / 102	26 / 52 / 102	26 / 52 / 102	26 / 52 / 102	mm
Integrated sensor	Rotary encoder and linear encoder*	Rotary encoder	Rotary encoder and linear encoder*	Rotary encoder	Linear encoder	–	
Sensor resolution rotary encoder	5000*	5000	2048*	2048	–	–	cts./rev.
Sensor resolution linear encoder	50#	–	16##	–	16##	–	nm
Minimum incremental motion	0.1	0.2	0.02	0.1	0.02	0.6	µm
Unidirectional repeatability	0.1	0.2	0.1	0.2	0.1	0.6	µm
Backlash	0.2	1	0.2	1	0.1	1	µm
Crosstalk, angular error xry (pitch)	±120	±120	±120	±120	±120	±120	µrad per 100 mm travel
Crosstalk, angular error xry (yaw)	±100	±100	±100	±100	±100	±100	µrad per 100 mm travel
Max. velocity	50	50	10	10	20	20**	mm/s
Min. velocity	–	–	–	–	0.05	–	mm/s
<b>Mechanical Properties</b>							
Thread/spindle pitch	1	1	1	1	1	1	mm
Gear ratio	–	–	2401:81	2401:81	–	–	
Max. load	100	100	100	100	100	100	N
Max. push / pull force	60	60	60	60	60	60	N
Max. lateral force	50	50	50	50	50	50	N
<b>Drive Properties</b>							
Motor type	DC motor with PWM control	DC motor with PWM control	DC gear motor	DC gear motor	2-phase stepper motor	2-phase stepper motor	
Operating voltage	24 (PWM)	24 (PWM)	0 to ±12	0 to ±12	24	24	V
Motor power	60	60	8.5	8.5	10	10	W
Reference point and limit switches	Optical	Optical	Optical	Optical	Optical	Optical	
<b>Miscellaneous</b>							
Operating temperature range	-20 to 65	-20 to 65	-20 to 65	-20 to 65	-20 to 65	-20 to 65	°C
Material	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	
Mass	2.3 / 2.6 / 3.0	2.3 / 2.6 / 3.0	2.3 / 2.6 / 3.0	2.3 / 2.6 / 3.0	2.6 / 2.8 / 3.1	2.6 / 2.8 / 3.1	kg
Connector	HD Sub-D 26-pin (motor and rotary encoder*), Sub-D 9-pin (linear encoder), adapter HD Sub-D 26-pin / Sub-D 9-pin to Sub-D 15-pin, 3 m cable	HD Sub-D 26-pin (motor and rotary encoder) to Sub-D 15-pin, 3 m cable	HD Sub-D 26-pin (motor), Sub-D 9-pin (linear encoder), 3 m cable set	HD Sub-D 26-pin (motor and rotary encoder) to Sub-D 15-pin, 3 m cable	HD Sub-D 26-pin (motor), Sub-D 9-pin (linear encoder), 3 m cable set	HD Sub-D 26-pin (motor) to Sub-D 15-pin, 3 m cable	
Recommended controller / driver	C-863 (single-axis), C-884 (up to 4 axes)	C-863 (single-axis), C-884 (up to 4 axes)	SMC Hydra (single-axis)	C-863 (single-axis), C-884 (up to 4 axes)	SMC Hydra (single-axis)	C-663 (single-axis)	

Ask about custom designs!

All cables required for operation with the recommended controller are included in the scope of delivery.

\* When operated with the C-863 or C-884 motion controller or with the SMC Hydra controller, only the linear encoder is read out. Both encoders are available so that velocity-controlled operation of the stage is also possible with suitable controllers. / \*\* With SMC Hydra controller

# RS-422 signals (AB quadrature signals, inverted) / ## Sin/cos analog signals with 1 Vpp, operation with SMC Hydra controller with maximum interpolation

# High-Precision Linear Positioning Stage

HIGH TRAVEL ACCURACY



## L-511

- Travel range to 155 mm (6")
- Optional direct metrology linear encoder
- Efficient ActiveDrive DC servo motor, stepper motor or DC gear motor
- Direction-sensing reference point switch

### Reference-class linear stage

Recirculating ball bearings for high travel accuracy and load capacity. Precision ball screw with 2 mm pitch. Stress-relieved aluminum base for highest stability. Travel ranges L-511.2 variants: 52 mm (2"), L-511.4: 102 mm (4"), L-511.6: 155 mm (6")

### Drive types

.xxAD variant: ActiveDrive DC motor for high velocity: Control via pulse-width-modulated (PWM) signals, the operating voltage is attained via an amplifier integrated in the motor case.  
.xxDG variant: DC servo motor with gearhead for high torques and resolution at low motor power  
.xxSD variant: 2-phase stepper motor for low velocity and high resolution  
Noncontact limit switches. Noncontact, direction-sensing reference point switch in the middle of the travel range

### Position measurement

- Integrated rotary encoder on motor shaft (variants with DC motor, ActiveDrive or gearhead).
- Integrated linear encoder, centrally installed. Direct position measurement of moved platform without impact on positioning precision due to mechanical play or hysteresis in the drive

### Min. incremental motion and slow motion

In conjunction with the SMC Hydra controller, versions with stepper motor and integrated linear encoder (L-511.xASD00) achieve repeatable minimum incremental motion in the range of the sensor resolution. With this configuration, constant, low velocities of a few sensor steps per second can be attained

### Fields of application

Precision positioning for science and industry, high duty cycles

Preliminary Data	L-511.x4AD20	L-511.x0AD10	L-511.xADG20	L-511.x0DG10	L-511.xASD00	L-511.x0SD00	Unit
	Linear stage with ActiveDrive DC motor and linear encoder (direct position measurement)	Linear stage with ActiveDrive DC motor and rotation encoder	Linear stage with DC gear motor and linear encoder (direct position measurement)	Linear stage with DC gear motor and rotary encoder	Linear stage with stepper motor and linear encoder (direct position measurement)	Linear stage with stepper motor	
<b>Motion and Positioning</b>							
Travel	52 / 102 / 155	52 / 102 / 155	52 / 102 / 155	52 / 102 / 155	52 / 102 / 155	52 / 102 / 155	mm
Integrated sensor	Rotary encoder and linear encoder*	Rotary encoder	Rotary encoder and linear encoder*	Rotary encoder	Linear encoder	–	
Sensor resolution rotary encoder	5000*	5000	2048*	2048	–	–	cts./rev.
Sensor resolution linear encoder	50#	–	16##	–	16##	–	nm
Minimum incremental motion	0.2	0.5	0.02	0.1	0.02	0.6	µm
Unidirectional repeatability	0.1	0.2	0.1	0.2	0.1	0.6	µm
Backlash	0.2	0.5	0.2	0.5	0.2	1	µm
Crosstalk, angular error xry (pitch)	±60	±60	±60	±60	±60	±60	µrad per 100 mm travel
Crosstalk, angular error xry (yaw)	±40	±40	±40	±40	±40	±40	µrad per 100 mm travel
Max. velocity	50	50	7###	7###	50	50**	mm/s
Min. velocity	–	–	–	–	0.05	–	mm/s
<b>Mechanical Properties</b>							
Thread/spindle pitch	2	2	2	2	2	2	mm
Gear ratio	–	–	2401:81	2401:81	–	–	
Max. load	100	100	100	100	100	100	N
Max. push / pull force	80	80	80	80	80	80	N
Max. lateral force	50	50	50	50	50	50	N
<b>Drive Properties</b>							
Motor Type	DC motor with PWM control	DC motor with PWM control	DC gear motor	DC gear motor	2-phase stepper motor	2-phase stepper motor	
Operating voltage	24 (PWM)	24 (PWM)	0 to ±12	0 to ±12	24	24	V
Motor power	60	60	8.5	8.5	10	10	W
Reference point and limit switches	Optical	Optical	Optical	Optical	Optical	Optical	
<b>Miscellaneous</b>							
Operating temperature range	-20 to 65	-20 to 65	-20 to 65	-20 to 65	-20 to 65	-20 to 65	°C
Material	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	
Mass	2.3 / 2.6 / 3.0	2.3 / 2.6 / 3.0	2.3 / 2.6 / 3.0	2.3 / 2.6 / 3.0	2.6 / 2.8 / 3.1	2.6 / 2.8 / 3.1	kg
Connector	HD Sub-D 26-pin (motor and rotary encoder*), Sub-D 9-pin (linear encoder), adapter HD Sub-D 26-pin / Sub-D 9-pin to Sub-D 15-pin, 3 m cable	HD Sub-D 26-pin (motor and rotary encoder) to Sub-D 15-pin, 3 m cable	HD Sub-D 26-pin (motor), Sub-D 9-pin (linear encoder), 3 m cable set	HD Sub-D 26-pin (motor and rotary encoder) to Sub-D 15-pin, 3 m cable	HD Sub-D 26-pin (motor), Sub-D 9-pin (linear encoder), 3 m cable set	HD Sub-D 26-pin (motor) to Sub-D 15-pin, 3 m cable	
Recommended controller/driver	C-863 (single-axis), C-884 (up to 4 axes)	C-863 (single-axis), C-884 (up to 4 axes)	SMC Hydra (single-axis)	C-863 (single-axis), C-884 (up to 4 axes)	SMC Hydra (single-axis)	C-663 (single-axis)	

Ask about custom designs!

All cables required for operation with the recommended controller are included in the scope of delivery.

\* When operated with the C-863 or C-884 motion controller or with the SMC Hydra controller, only the linear encoder is read out. Both encoders are available so that velocity-controlled operation of the stage is also possible with suitable controllers. / \*\* With SMC Hydra controller

# RS-422 signals (AB quadrature signals, inverted) / ## Sin/cos analog signals with 1 Vpp, operation with SMC Hydra controller with maximum interpolation / ### Continuous velocity 3 mm/s

# 6-Axis Motion Hexapod

FAST AND COMPACT FOR HIGH DYNAMICS APPLICATIONS



## H-811.S11

- Travel ranges to 34 mm / 42°
- Velocity to 25 mm/s
- Dynamics to 25 Hz over 0.1° travel range
- Integrated wave generator
- Developed for test stations for image stabilization
- CIPA certified

### Reference-class 6-axis positioning system

Parallel-kinematic design for six degrees of freedom making it significantly more compact and stiff than serial-kinematic systems, higher dynamic range, no moved cables: Higher reliability, reduced friction. Vacuum-compatible version to  $10^{-6}$  hPa available

### Direct drive with brushless DC motors (BLDC) and long-life ball screws

High precision, velocity and lifetime

### H-811.S11 incl. 6D controller for Hexapods, plus two additional servo axes

- Digital I/O interfaces for trigger signal emission
- Precise running of predefined motion profiles with high path accuracy

### Powerful digital controller, open software architecture

User-defined, stable pivot point, software-selectable. Positions commanded in Cartesian coordinates. Macro programming. Open source LabVIEW driver set. Work space simulation software. Virtual Hexapod machine software. Optional: Collision avoidance software (external obstacles)

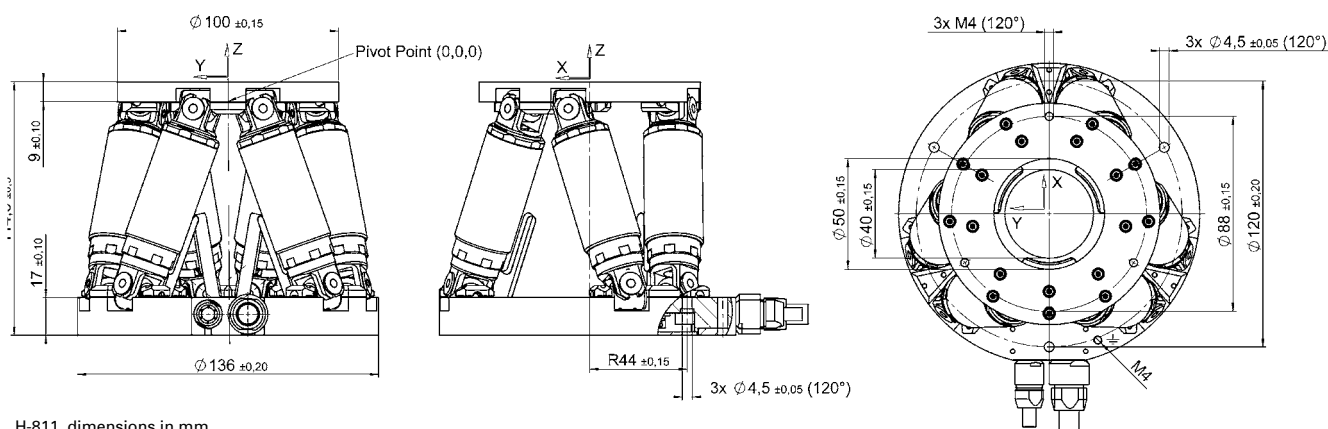
### Fields of application

Research and industry, test systems, e.g. for image stabilization in cameras and mobile devices

Preliminary data	H-811.S11	Unit	Tolerance
Active axes	X, Y, Z, $\theta_x$ , $\theta_y$ , $\theta_z$		
<b>Motion and positioning</b>			
Travel range* X, Y, Z	$\pm 17$ , $\pm 16$ , $\pm 6.5$	mm	
Travel range* $\theta_x$ , $\theta_y$ , $\theta_z$	$\pm 10$ , $\pm 10$ , $\pm 21$	°	
Single-actuator design resolution	80	nm	
Min. incremental motion X, Y	2	$\mu\text{m}$	typ.
Min. incremental motion Z	1	$\mu\text{m}$	typ.
Min. incremental motion $\theta_x$ , $\theta_y$ , $\theta_z$	12	$\mu\text{rad}$	typ.
Repeatability X, Y	$\pm 0.5$	$\mu\text{m}$	typ.
Repeatability Z	$\pm 0.2$	$\mu\text{m}$	typ.
Repeatability $\theta_x$ , $\theta_y$	$\pm 8$	$\mu\text{rad}$	typ.
Repeatability $\theta_z$	$\pm 15$	$\mu\text{rad}$	typ.
Velocity X, Y, Z	25	mm/s	max.
Velocity $\theta_x$ , $\theta_y$ , $\theta_z$	325	mrads	max.
Velocity X, Y, Z	10	mm/s	typ.
Velocity $\theta_x$ , $\theta_y$ , $\theta_z$	250	mrads	typ.
<b>Mechanical properties</b>			
Stiffness X, Y	0.2	N/ $\mu\text{m}$	
Stiffness Z	3.6	N/ $\mu\text{m}$	
Load (base plate horizontal / any orientation)	1.5 / 0.3	kg	max.
Holding force, de-energized (base plate horizontal / any orientation)	15 / 2.5	N	max.
Motor type	Brushless DC Motor		
<b>Miscellaneous</b>			
Operating temperature range	0 to 50	°C	
Material	Stainless steel, aluminum		
Mass	2.2	kg	$\pm 5\%$
Cable length	2	m	$\pm 10\text{ mm}$

Technical data specified at  $20 \pm 3$  °C.

\* The travel ranges of the individual coordinates (X, Y, Z,  $\theta_x$ ,  $\theta_y$ ,  $\theta_z$ ) are interdependent. The data for each axis in this table shows its maximum travel, where all other axes are at their zero positions. If the other linear or rotational coordinates are not zero, the available travel may be less.



H-811, dimensions in mm

# High-Load Hexapod

POSITIONING 1 TON WITH MICROMETER PRECISION



## H-845

- Load capacity to 1000 kg
- Velocity to 50 mm/s
- Repeatability to  $\pm 0.5 \mu\text{m}$
- Travel ranges to 340 mm / 60°
- Scalable design: Dimensions, travel ranges and loads
- Actuator resolution to 40 nm
- Drive: brushless motors with brake
- Sophisticated controller using vector algorithms, virtual pivot point
- Extensive software support

### Reference-class 6-axis positioning system

Parallel-kinematic design for six degrees of freedom making it significantly more compact and stiff than serial-kinematic systems, higher dynamic range, no moved cables: Higher reliability, reduced friction. Large clear aperture. Brushless DC motors with brakes

### Rapid implementation of customer requests

The high-load Hexapod has a modular structure and uses a set of different modules for drive unit and joint. The platforms can be adapted to the customer's application. This allows for rapid implementation of special customer requirements

### Powerful digital controller, open software architecture

6D vector motion controller for Hexapods, incl. two additional servo axes. Arbitrary, stable pivot point, software-selectable. Positions commanded in Cartesian coordinates. Macro command language. Open-source LabVIEW driver and libraries. Determination of the workspace. Virtual machine for Hexapod emulation. Optional: Software for avoiding collisions in restricted workspace

### Fields of application

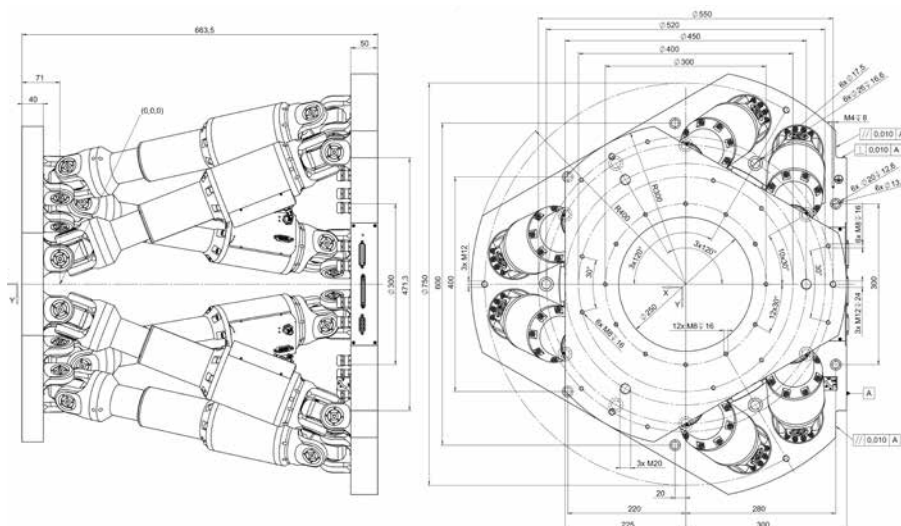
Research and industry. For astronomy, aviation and aerospace



Preliminary Data	H-845.D11	H-845.D21	H-845.D31	H-845.D41	H-845.D51	H-845.D61	Unit	Tolerance
Active axes	X, Y, Z, $\theta_x$ , $\theta_y, \theta_z$	X, Y, Z, $\theta_x$ , $\theta_y, \theta_z$	X, Y, Z, $\theta_x$ , $\theta_y, \theta_z$	X, Y, Z, $\theta_x$ , $\theta_y, \theta_z$	X, Y, Z, $\theta_x$ , $\theta_y, \theta_z$	X, Y, Z, $\theta_x$ , $\theta_y, \theta_z$		
<b>Motion and positioning</b>								
Travel range* X, Y	±110	±170	±110	±170	±110	±170	mm	
Travel range* Z	±50	±105	±50	±105	±50	±105	mm	
Travel range* $\theta_x, \theta_y$	±15	±20	±15	±20	±15	±20	°	
Travel range* $\theta_z$	±30	±30	±30	±30	±30	±30	°	
Single- actuator design resolution	0.04	0.04	0.08	0.08	0.1	0.1	µm	
Min. incremental motion X, Y	1	1	2	2	2.5	2.5	µm	typ.
Min. incremental motion Z	0.5	0.5	1	1	1	1	µm	typ.
Min. incremental motion $\theta_x, \theta_y, \theta_z$	15	15	30	30	30	30	µrad	typ.
Backlash X, Y	5	5	10	10	10	10	µm	typ.
Backlash Z	1	1	2	2	2	2	µm	typ.
Backlash $\theta_x, \theta_y$	15	15	30	30	30	30	µrad	typ.
Backlash $\theta_z$	30	30	60	60	60	60	µrad	typ.
Repeatability X, Y	±2	±2	±4	±4	±5	±5	µm	typ.
Repeatability Z	±0.5	±0.5	±1	±1	±2	±2	µm	typ.
Repeatability $\theta_x, \theta_y, \theta_z$	±10	±10	±20	±20	±25	±25	µrad	typ.
Max. velocity X, Y, Z	20	20	40	40	50	50	mm/s	
Max. velocity $\theta_x, \theta_y, \theta_z$	50	50	100	100	120	120	mrad/s	
Typ. Velocity X, Y, Z	10	10	20	20	25	25	mm/s	
Typ. Velocity $\theta_x, \theta_y, \theta_z$	20	20	40	40	50	50	mrad/s	
<b>Mechanical properties</b>								
Load (base plate horizontal / any orientation)	1000 / 300	1000 / 300	500 / 150	500 / 150	400 / 120	400 / 120	kg	max.
Motor type	Brushless DC motor	Brushless DC motor	Brushless DC motor	Brushless DC motor	Brushless DC motor	Brushless DC motor		
<b>Miscellaneous</b>								
Operating temperature range	-10 to 50	-10 to 50	-10 to 50	-10 to 50	-10 to 50	-10 to 50	°C	
Material	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum		
Mass	120	150	120	150	120	150	kg	±5 %
Cable length	9	9	9	9	9	9	m	±10 mm
<b>Controller</b>								
Included in delivery	C-887	C-887	C-887	C-887	C-887	C-887		

Technical data specified at 20 ±3°C. Ask about custom designs!

\* The travel ranges of the individual coordinates (X, Y, Z,  $\theta_x, \theta_y, \theta_z$ ) are interdependent. The data for each axis in this table shows its maximum travel, where all other axes are at their zero positions. If the other linear or rotational coordinates are not zero, the available travel may be less.



H-845.D11, H-845.D31, H-845.D51 Hexapod, dimensions in mm

# High-Dynamics Hexapod

MAGNETIC DIRECT DRIVE FOR HIGH VELOCITY



## H-860KMAG

- Dynamics to 25 Hz over 0.1° travel range
- Integrated wave generator
- Developed for test stations for image stabilization
- Low moved mass
- Velocity >250 mm/s
- Freely programmable, virtual pivot point

### Reference-class 6-axis positioning system

Parallel-kinematic design for six degrees of freedom making it significantly more compact and stiffer than serialkinematic systems, no moved cables. Precise running of predefined motion profiles with high path accuracy: Sine curves and freely definable trajectories. Digital I/O interfaces for trigger signal emission

### Powerful digital controller, open software architecture

User-defined, stable pivot point, software-selectable. Positions commanded in Cartesian coordinates. Macro programming. Open source LabVIEW driver set. Work space simulation software. Virtual hexapod machine software. Optional: Collision avoidance software (external obstacles)

### PIMag™ voice coil magnetic drive for high velocity and high dynamics

Noncontact magnetic drive principle, no frictional or

rolling parts for guiding and joints. Zero-backlash positioning, no mechanical noise in the drivetrain. Silent. Low wear and high lifetime. Integrated linear encoder for reliable position control and repeatable accuracy. Fast and precise direction reversal through low moved mass and lightweight design (highly stiff, milled carbon parts)

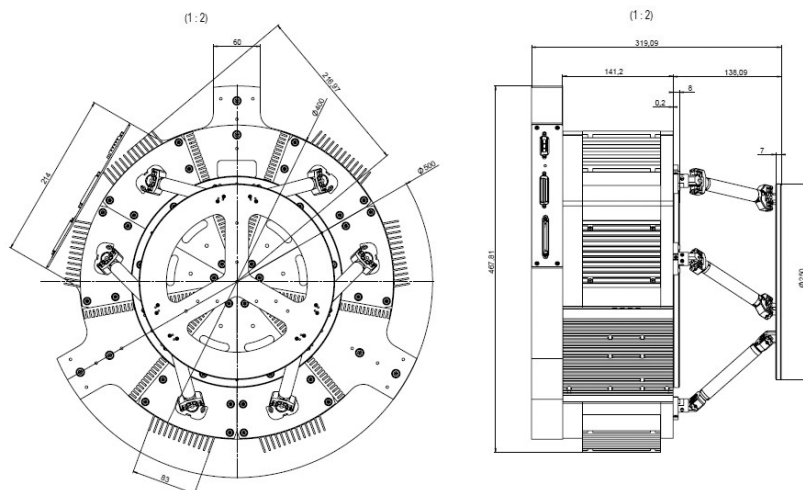
### Fields of application

Research and industry, test systems, e.g. for image stabilization in cameras and mobile devices. Equipment for camera test systems and image stabilization software, certification according to CIPA planned. Oscillation simulation, eye tracking, simulation of human and artificial motion

Preliminary Data	H-860KMAG	Unit	Tolerance
Active axes	X, Y, Z, $\theta_x$ , $\theta_y$ , $\theta_z$		
<b>Motion and positioning</b>			
Travel range X, Y, Z	$\pm 7.5$	mm	
Travel range $\theta_x$ , $\theta_y$ , $\theta_z$	$\pm 4$	°	
Integrated sensor	Linear encoder		
Velocity X, Y, Z	250	mm/s	max.
Linear acceleration	4	g	
Load capacity	1	kg	max.
Resonant frequency $F_x$ , $F_y$ , $F_z$	200	Hz	
<b>Drive properties</b>			
Actuator drive / motor type	PIMag™ voice coil		
<b>Motion and control</b>			
Servo characteristics	32-bit PID filter		
Trajectory profile modes	Sine, freely definable trajectories		
Cycle time	1		ms
Processor	CPU: ATOM Dual Core (1.8 GHz)		
<b>Electrical properties</b>			
Max. output power	10- bit outputs for PWM drivers, 30 kHz		
Max. output voltage	TTL in PWM operation for SIGN and MAGN		
Operating voltage	230	V	typ.
Power consumption	600	W	max.
<b>Interface and operation</b>			
Communication interfaces	TCP/ IP, RS-232 USB (keyboard, mouse, manual control unit)		
Command set	PI General Command Set (GCS)		
User software	PIMikroMove		
Software drivers	LabVIEW drivers, dynamic libraries for Windows and Linux		
<b>Miscellaneous</b>			
Operating temperature range	+5 to +40	°C	
Hexapod mass	30	kg	$\pm 5 \%$
Cable length	3	m	$\pm 10 \text{ mm}$
Controller mass	2,8	kg	$\pm 5 \%$

Technical data specified at  $20 \pm 3 \text{ }^\circ\text{C}$ .

\* The travel ranges of the individual coordinates (X, Y, Z,  $\theta_x$ ,  $\theta_y$ ,  $\theta_z$ ) are interdependent. The data for each axis in this table shows its maximum travel, where all other axes are at their zero positions. If the other linear or rotational coordinates are not zero, the available travel may be less.



H-860KMAG, dimensions in mm

# High-Load Hexapod

HIGH-PRECISION AND REPEATABLE POSITIONING



## H-850KMLD

- Load capacity to 500 kg
- Min. incremental motion 1  $\mu\text{m}$  (X, Y), 0.5  $\mu\text{m}$  (Z)
- Travel ranges to 100 mm / 60°
- Optionally with absolute encoders

### Reference-class 6-axis positioning system

Parallel-kinematic design for six degrees of freedom making it significantly more compact and stiff than serial-kinematic systems, higher dynamic range, no moved cables: Higher reliability, reduced friction. Large clear aperture

### Optional feature: Absolute position measurement

Optionally, the position is measured using absolute encoders. The exact position of the axes is determined after the Hexapod has been switched on. A reference move is not necessary

### Powerful digital controller, open software architecture

6D vector motion controller for Hexapods, plus two

additional servo axes. Arbitrary, stable pivot point, software-selectable. Positions commanded in Cartesian coordinates. Macro command language. Open-source LabVIEW driver and libraries. Determination of the workspace. Virtual machine for Hexapod emulation. Optional: Software for avoiding collisions in restricted workspace

### Fields of application

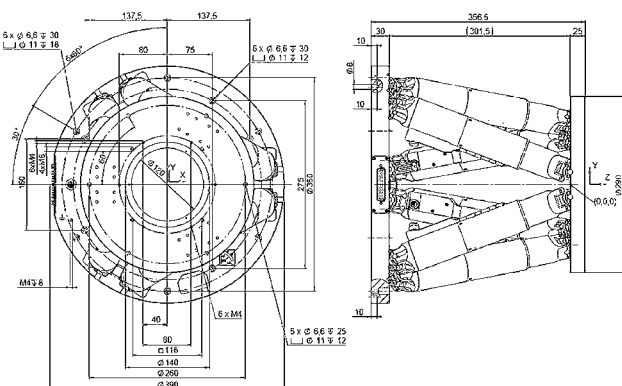
Research and industry. For astronomy, aviation and aerospace

Preliminary Data	H-850KMLD	H-850KMLA	Unit	Tolerance
Active axes	X, Y, Z, $\theta_x$ , $\theta_y$ , $\theta_z$	X, Y, Z, $\theta_x$ , $\theta_y$ , $\theta_z$		
<b>Motion and positioning</b>				
Travel range* X, Y	±50	±50	mm	
Travel range* Z	±25	±25	mm	
Travel range* $\theta_x$ , $\theta_y$	±15	±15	°	
Travel range* $\theta_z$	±30	±30	°	
Min. incremental motion X, Y	1	0.5	µm	typ.
Min. incremental motion Z	0.5	0.2	µm	typ.
Min. incremental motion $\theta_x$ , $\theta_y$ , $\theta_z$	5	2.5	µrad	typ.
Backlash X, Y	4	2.5	µm	typ.
Backlash Z	1	0.7	µm	typ.
Backlash $\theta_x$ , $\theta_y$	15	10	µrad	typ.
Backlash $\theta_z$	30	20	µrad	typ.
Repeatability X, Y	±1	±1	µm	typ.
Repeatability Z	±0.3	±0.3	µm	typ.
Repeatability $\theta_x$ , $\theta_y$	±5	±5	µrad	typ.
Repeatability $\theta_z$	±9	±9	µrad	typ.
Max. velocity X, Y, Z	0.5	0.5	mm/s	
Max. velocity $\theta_x$ , $\theta_y$ , $\theta_z$	6	6	mrad/s	
Typ. velocity X, Y, Z	0.3	0.3	mm/s	
Typ. velocity $\theta_x$ , $\theta_y$ , $\theta_z$	3	3	mrad/s	
<b>Mechanical properties</b>				
Load (base plate horizontal / any orientation)	500 / 200	500 / 200	kg	max.
Holding force, de-energized (base plate horizontal / any orientation)	4000 / 2000	4000 / 2000	N	max.
Motor type	DC gear motor	DC gear motor		
<b>Miscellaneous</b>				
Operating temperature range	-10 to 50	-10 to 50	°C	
Material	Aluminum	Aluminum		
Dimensions	Base plate Ø 370 Moving platform Ø 280 Clear aperture Ø 100 Hexapod height in center position 350	Base plate Ø 370 Moving platform Ø 280 Clear aperture Ø 100 Hexapod height in center position 350	mm	±10 mm
Mass	20	25	kg	
Cable length	3	3	m	±10 mm

Technical data specified at 20 ±3 °C.

Ask about custom designs!

\* The travel ranges of the individual coordinates (X, Y, Z,  $\theta_x$ ,  $\theta_y$ ,  $\theta_z$ ) are interdependent. The data for each axis in this table shows its maximum travel, where all other axes are at their zero positions. If the other linear or rotational coordinates are not zero, the available travel may be less.



H-850.KMLD, dimensions in mm

# Controller for Hexapod Positioning Systems

6-D VECTOR MOTION CONTROL, COMPREHENSIVE FUNCTIONALITY



## C-887

- Sophisticated controller using vector algorithms
- Freely programmable, virtual pivot point
- Data recorder
- Macro program functionality
- Stand-alone operation possible and control through TCP/IP and RS-232 interfaces
- Extensive software support
- Simulation software for working space and single strut analysis
- Optional: Collision avoidance software

### Digital controller for 6-axis-parallel kinematics

Features control for two additional single axes with servo motors. Hexapods are by default configured and delivered as a system including a controller

- C-887.52 compact bench-top controller for a lower system price. Digital I/ O interfaces, e.g. for external triggering
- C-887.11 19" controller, comprises the control for two additional single axes with servo motors. Options: Control of piezo axes, photometer cards for visible light or infrared light range

### Functions

Real-time system. Position control using Cartesian coordinates, vectorized motion. Stable, virtual pivot point can be defined freely in the working space. Data recorder for recording operating parameters such as motor control, velocity, position or position error. Macro command language. Stand-alone operation possible with autostart macro or connection of keyboard and monitor. Optional: Manual control unit

### Custom designs

Custom designs are available for use at high altitudes, e.g. for astronomical telescope applications. Evaluation of absolute-measuring sensors. Control of motor brakes. Evaluation of additional (redundant) position sensors for increased safety requirements, e.g. in medical technology

### Extensive software

PIMikroMove user software. Common command set for all PI positioning systems. Dynamic libraries for Windows and Linux. Complete set of LabVIEW VI's. Graphical user interfaces, configuration software and graphically displayed scan routines. Optional: PIVeriMove software for checking a restricted operating space

### Interfaces

TCP/ IP Ethernet can also be used for remote control and service, RS-232. Monitor, mouse and keyboard interface. On request: RS-422 for up to 1.4 km cable length

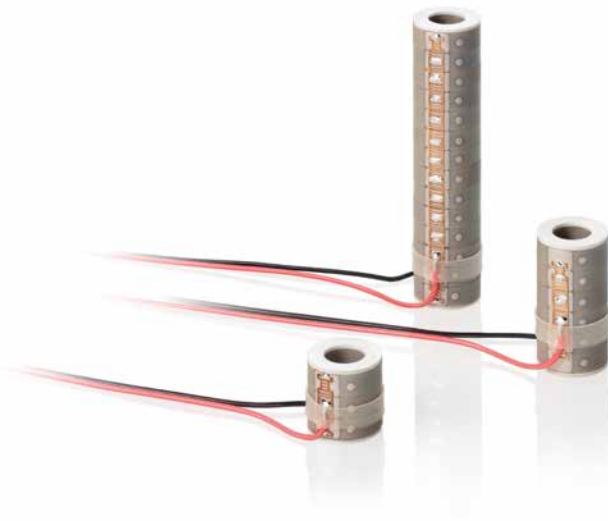
	C-887.11	C-887.52
Function	6D controller for Hexapods, incl. control of two additional single axes 19" case, rack mountable	6D controller for Hexapods, incl. control of two additional single axes Compact bench-top
Drive type	Servo motors (Hexapod and single axes) Optional: Piezo drives	Servo motors (Hexapod and single axes)
<b>Motion and control</b>		
Servo characteristics	32-bit PID filter	
Trajectory profile modes	Trapezoid, linear interpolation	Jerk-controlled generation of dynamics profile with linear interpolation
Processor	CPU: 1.8 GHz, motion control chip with 2.5 kHz servo update rate	CPU: ATOM dual-core (1.8 GHz) Motion control chip with 10 kHz servo update rate
Encoder input	AB (quadrature) differential TTL signal, 5 MHz	AB (quadrature) differential TTL signal, 50 MHz
Stall detection	Servo off, triggered by position error	
Reference point switches	TTL level	
<b>Electrical properties</b>		
Max. output power per channel	10-bit outputs for PWM drivers, 24 kHz	12-bit outputs for PWM drivers, 24 kHz
Max. output voltage per channel	TTL in PWM operation for SIGN and MAGN	
<b>Interfaces and operation</b>		
Interface / communication	TCP/ IP, RS-232 VGA (monitor), USB (keyboard, mouse, manual control unit)	TCP/ IP, RS-232 USB (manual control unit)
Hexapod connection	MDR 68-pin for data transfer M12 4-pin power input	HD Sub-D connector 78-pin (f) for data transfer M12 4-pin power input
Connectors for single axes	Sub-D connector 15- pin	Sub-D connector 15-pin
I/ O ports	Optional: Analog inputs (photometer cards)	HD Sub-D 26 (f): 4 × analog input (-10 to 10 V; 12 bit) 4 × digital input (TTL) 4 × digital output (TTL)
Command set	PI General Command Set (GCS)	
User software	PIMikroMove	
Software drivers	LabVIEW driver, dynamic libraries for Windows and Linux	
Manual operation	Optional: C-887.MC control unit for Hexapods	
<b>Miscellaneous</b>		
Operating voltage	100 to 240 VAC, 50 / 60 Hz	24 V, max. 8 A, external power supply for 100 to 240 VAC, 50 / 60 Hz, in the scope of delivery
Operating temperature range	5 to 40 °C	
Mass	11 kg	2.8 kg
Dimensions	395 mm × 483 mm × 185 mm	280 (320) mm × 150 mm × 103 mm Power supply: 170 mm × 85 mm × 42.5 mm



C-887.52

# PICMA® Stack Multilayer Ring Actuator

WITH INNER HOLE



## P-080

- Inner hole for preload or as aperture for optical applications
- Superior lifetime
- Ideal for dynamic operation
- Microsecond response
- Sub-nanometer resolution

### Multilayer Stack Actuators

Flexible travel range up to 30  $\mu\text{m}$ . Annular cross-section for easy integration.  
UHV-compatible to  $10^{-9}$  hPa, high bakeout temperature

### PICMA® Piezo Linear Actuators

Low operating voltage -20 to 100 V. Ceramic insulation.  
High reliability and long lifetime

### Available Options

Different heights, easy to mount on customer request.  
Variety of shapes. Precision-ground end plates for reduced tolerances

### Fields of Application

Research and industry. For laser tuning, micro-dispensing, life sciences



Preliminary data	P-080.311	P-080.341	P-080.391	Unit
Dimensions OD × ID × L	8 × 4.5 × 8.5	8 × 4.5 × 16	8 × 4.5 × 36	mm × mm × mm
Nominal travel range	5.5 ±20 %	11 ±20 %	25 ±10 %	μm
Blocking force	800	825	850	N
Stiffness	145	75	34	N/μm
Electrical capacitance	0.86	1.7	4.0	μF
Resonant frequency	160	85	40	kHz

All data at 0 to 100 V.

Standard connections: PTFE-insulated stranded wires, 100 mm, AWG 30 (Ø 0.61 mm).

For optional solderable contacts without stranded wires, change order number extension to 0.

Piezo ceramic type PIC252. Ceramic end plates made of Al<sub>2</sub>O<sub>3</sub>.

Recommended preload for dynamic operation: 15 MPa.

Maximum preload for constant force: 30 MPa.

Axial resonant frequency: measured at 1 V<sub>pp</sub> unloaded, unclamped.

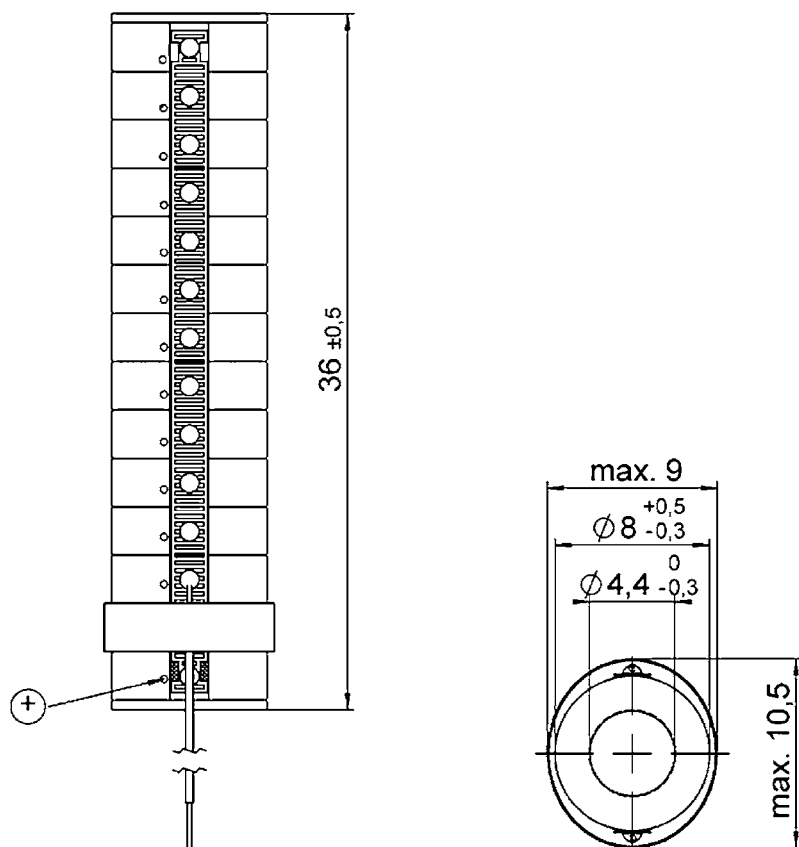
The value is halved for unilateral clamping.

Electrical capacitance: Tolerance ±20%, measured at 1 V<sub>pp</sub>, 1 kHz, RT.

Operating voltage: -20 to 100 V.

Operating temperature range: -40 to 150°C.

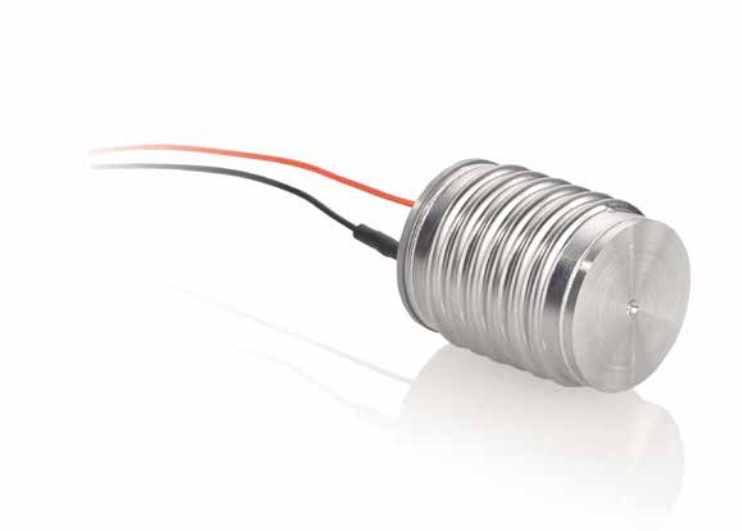
Ask about custom designs!



P-080.390, dimensions in mm

# Encapsulated PICMA<sup>®</sup> Stack Piezo Actuators

FOR TOUGH INDUSTRIAL ENVIRONMENTS



## P-88x.x5

- Splash-resistant full encapsulation
- Superior lifetime
- High stiffness
- Microsecond response
- Sub-nanometer resolution
- UHV-compatible to  $10^{-9}$  hPa

### Encapsulated PICMA<sup>®</sup> Stack multilayer piezo actuators with inert gas filling

Operating voltage -20 to 120 V. UHV-compatible to  $10^{-9}$  hPa. Version for operation in environments where exposure to splash water, high humidity or oil occurs



Encapsulated PICMA<sup>®</sup> Stack actuators can also be used when the application environment is characterized by oil, splash water or continuously high humidity. The piezo actuators are surrounded by inert gas

	Dimensions OD x L	Nominal travel range	Max. displacement	Blocking force	Stiffness	Capacitance	Resonant frequency
		μm	μm	N	N/μm	μF	kHz
P-885.55	11.2 mm x 22.5 mm	14	17	850	50	1.5	60
P-885.95	11.2 mm x 40.5 mm	30	36	900	25	3.1	35
P-888.55	18.6 mm x 22.5 mm	14	17	3400	200	6.0	60

Nominal travel range: at 0 to 100 V, tolerance ±10 %.

Maximum travel range: at 0 to 120 V, tolerance ±10 %.

Blocking force: at 0 to 120 V.

Electrical capacitance: Tolerance ±20 %, measured at  $1 V_{pp}$ , 1 kHz, RT.

Resonant frequency at  $1 V_{pp}$ , unloaded, unclamped. The value is halved for unilateral clamping, tolerance ±20 %.

Piezo ceramic type: PIC252.

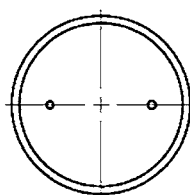
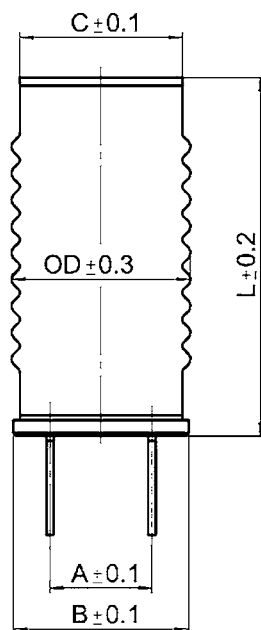
Standard connections: PTFE- insulated wire leads, 100 mm, AWG 30, Ø 0.61 mm.

Operating voltage: -20 to 120 V.

Operating temperature range: -40 to 150 °C.

Ask about custom designs!

	A [mm]	B [mm]	C [mm]
P-885.XX	6.40	11.00	10.25
P-888.XX	12.00	17.50	16.85



# Fast Tip/Tilt Platform

SHORT SETTling TIME AND HIGH DYNAMIC LINEARITY



## S-331

- Tip/tilt angle up to 5 mrad, optical deflection angle up to 10 mrad (0.57°)
- Parallel kinematic design for identically high performance characteristics for both tip/tilt axes
- High resonance frequencies for dynamic motion and fast step-and-settle
- Position sensors for high linearity
- For mirrors up to Ø 12.7 mm (0.5")

### Precision class tip/tilt platform for applications with high demand on the dynamics

Two orthogonal tip/tilt axes with common centre of rotation. Parallel kinematic design for identical performance characteristics of both axes. Flexure joints for friction-free motion and high stiffness. Direct drive.

### Strain sensors for low linear errors

Metal foil strain gauge sensors with low temperature sensitivity. Linearity error to 0.1 %.

### PICMA® High-performance drives

Piezoceramic actuators with all-ceramic insulation. Longer lifetime, insensitive to humidity and high operating temperatures.

### Fields of application

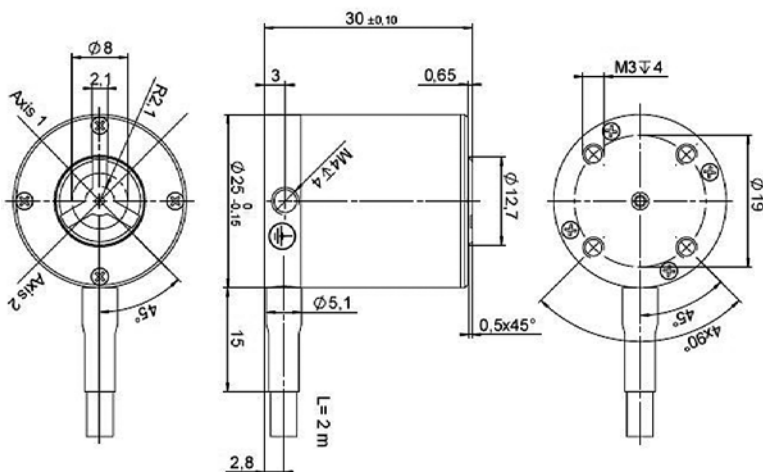
Image processing, image stabilization. Laser beam steering. Scanning microscopy. Materials processing, lithography. Optical filters, optical switches.

Preliminary Data	S-331.2SL / S-331.2SD	S-331.5SL / S-331.5SD	Unit
Active axes	$\theta_x, \theta_y$	$\theta_x, \theta_y$	
<b>Motion and Positioning</b>			
Integrated sensor	SGS	SGS	
Open-loop tip/tilt angle in $\theta_x, \theta_y$ at -20 to 120 V	4.2	7	mrad
Closed-loop tilt angle in $\theta_x, \theta_y$	3	5	mrad
Open-loop resolution in $\theta_x, \theta_y$	0.05	0.1	$\mu$ rad
Closed-loop resolution in $\theta_x, \theta_y$	0.1	0.25	$\mu$ rad
Linearity error in $\theta_x, \theta_y$	0.4	0.4	%
Repeatability in $\theta_x, \theta_y$ , 10% tip/tilt angle	0.3	0.3	$\mu$ rad
Repeatability in $\theta_x, \theta_y$ , 100% tip/tilt angle	3	5	$\mu$ rad
<b>Mechanical Properties</b>			
Resonance frequency, unloaded in $\theta_x, \theta_y$	10	6	kHz
Resonant frequency unloaded in $\theta_x, \theta_y$ (with glass mirror, $\varnothing$ 12.7 mm, thickness 3 mm)	6	4	kHz
Distance of pivot point to platform surface	4	4	mm
Platform moment of inertia	30	30	$g \times mm^2$
<b>Drive Properties</b>			
Ceramic type	PICMA®	PICMA®	
Electrical capacitance	0.96/axis	1.44/axis	$\mu$ F
<b>Miscellaneous</b>			
Operating temperature range	-20 to 80	-20 to 80	°C
Material case	Steel	Steel	
Material platform	Titanium	Titanium	
Mass	0.13	0.14	kg
Cable length	1.5	1.5	m
Sensor / voltage connection	LEMO (S-331.2SL), Sub-D 25-pin (m) (S-331.2SD)	LEMO (S-331.5SL), D-Sub 25-pin (m) (S-331.5SD)	

#### Recommended controllers / amplifiers

Versions with LEMO connectors: E-500 modular piezo controller system with E-503.00S amplifier module (three channel) or 1 x E-505.00S and 2 x E-505 (highly dynamic applications) and E-509 power amplifier (optional).

Versions with Sub-D connector: E-616 controller for tip/tilt mirror systems.



S-331.2SL, dimensions in mm

# Digital Multi-Channel Piezo Controller

FOR NANOPositionING SYSTEMS WITH CAPACITIVE OR STRAIN SENSORS



## E-727

- 25 kHz control bandwidth
- Digital inputs and outputs
- Optional analog inputs and outputs
- WLAN interface for remote control
- DSP 32/64-bit floating point, 375 MHz
- Interfaces: Ethernet, USB and RS-232
- 20-bit DAC and ADC resolution
- Auto-loading of calibration data from stage ID chip for interchangeability of controller and mechanics
- 4<sup>th</sup> order polynomial linearization for mechanics & electronics

### Digital motion controller for piezo-based nanopositioning systems

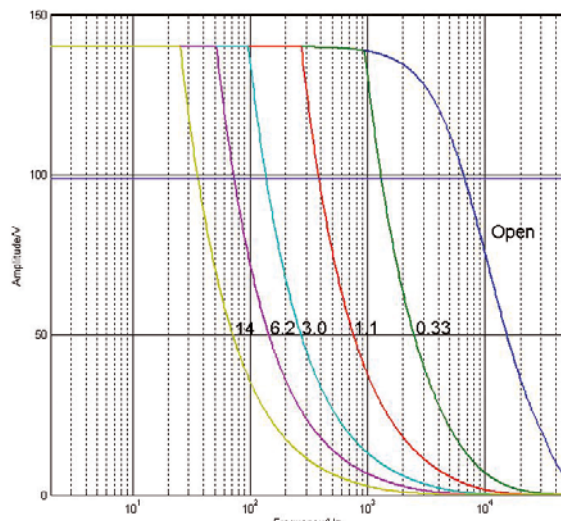
3 channels. Integrated low-noise power amplifiers for PICMA<sup>®</sup> piezo actuators. Output voltage -30 to +130 V. Supports nanopositioning systems with strain sensors or capacitive sensors. P-I controller with 2 notch filters. Linearization based on 4<sup>th</sup> order polynomials. Optional Dynamic Digital Linearization (DDL). Delivery includes wide-range power supply, USB and RS-232 cable

### Extensive functionality

Data recorder. ID chip for quick start-up and quick exchange of system components. Simultaneous, programmable drift compensation. Extensive software support, e.g. for LabVIEW, shared libraries for Windows and Linux

### Interfaces

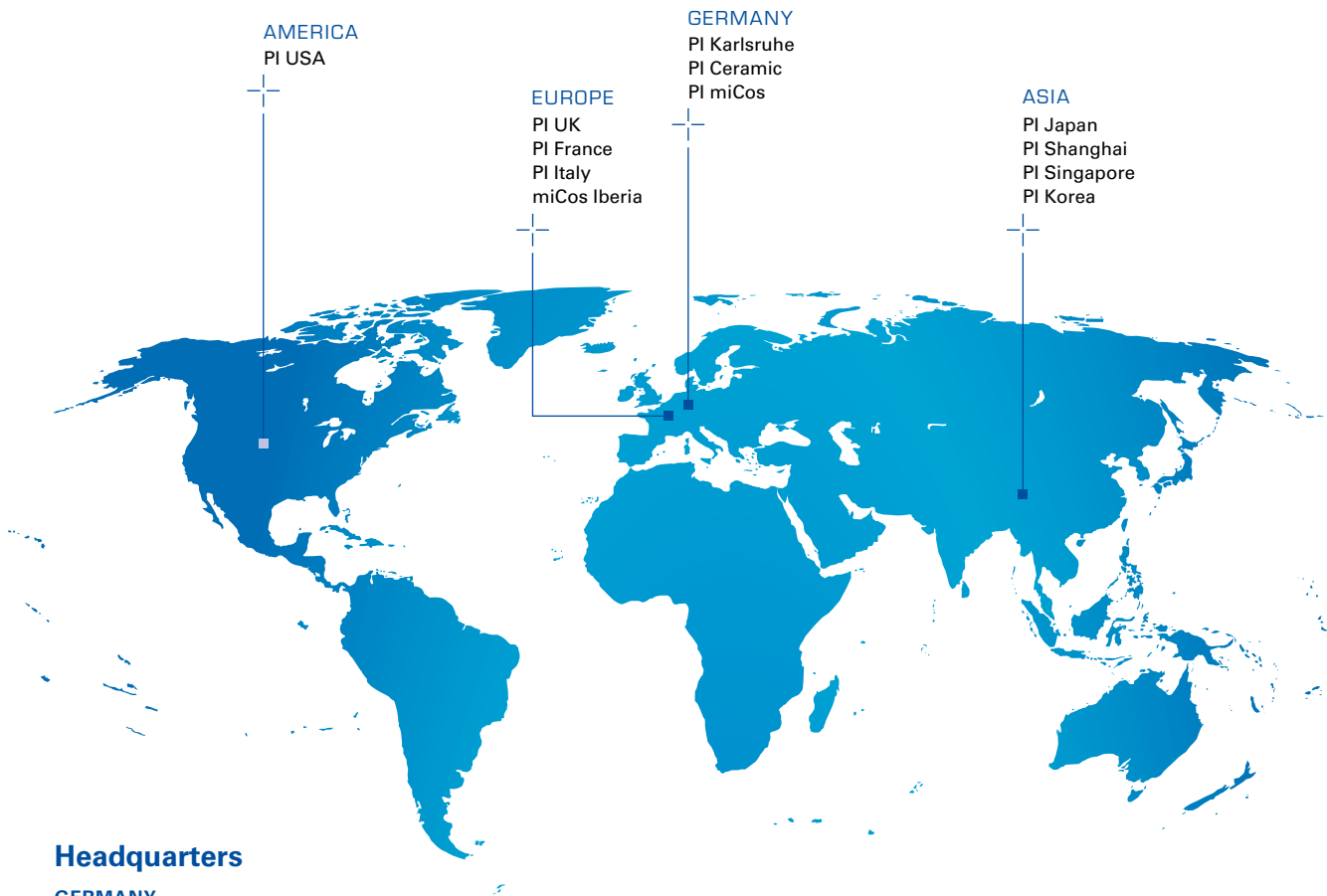
Ethernet. USB. RS-232. SPI. WLAN. 4 analog inputs and outputs each (optional) for external sensors, target values or external amplifiers. 4 digital inputs and outputs each



E-727: Operating limits with various PZT loads (open-loop), capacitance is measured in  $\mu\text{F}$

Preliminary Data	E-727.3CD E-727.3CDA	E-727.3SD E-727.3SDA	Unit	Tolerance
Function	Digital controller for multi-axis piezo nanopositioning systems with capacitive sensors. 3CDA: Optional analog interfaces	Digital controller for multi-axis piezo nanopositioning systems with strain sensors .3SDA: Optional analog interfaces		
Axes	3	3		
Processor	DSP 32/64- bit, floating point, 375 MHz	DSP 32/64- bit, floating point, 375 MHz		
Sampling rate, servocontrol	25	25	kHz	
Sampling rate, sensor	25	25	kHz	
<b>Sensor</b>				
Servo characteristics	P-I, two notch filters Optional: Advanced piezo control	P-I, two notch filters Optional: Advanced piezo control		
Sensor type	Capacitive	Strain gauge, piezoresistive sensors		
Sensor channels	3	3		
Sensor bandwidth (-3 dB)	6	6	kHz	max.
Sensor resolution	20 at 1 kSPS oversampling	20 at 1 kSPS oversampling	bit	
Ext. synchronization	Yes	-		
<b>Amplifier</b>				
Output voltage	-30 to 130	-30 to 130	V	±3 V
Amplifier channels	4	4		
Peak output power per channel, max. 30 ms	28	28	W	max.
Average output power per channel	14	14	W	max. 300 ms
Peak current per channel, max. 30 ms	200	200	mA	max.
Average output current per channel	100	100	mA	max.
Current limitation	Short-circuit-proof	Short-circuit-proof		
Resolution DAC	20	20	bit	
Amplifier bandwidth	6.5	6.5	kHz	
<b>Interface and operation</b>				
Interface / communication	Ethernet, USB, RS-232, serial SPI high-speed interface Optional Ethercat and WLAN	Ethernet, USB, RS-232, serial SPI high-speed interface Optional Ethercat and WLAN		
Piezo / sensor connection	Sub-D Special	Sub-D Special		
Analog input	Sub-D, 15-pin 4 inputs, 18-bit	Sub-D, 15-pin 4 inputs, 18-bit	±10 V	
Analog outputs	Universal output, 20-bit	Universal output, 20-bit	±10 V	
Digital input/ output	MDR14; 4 inputs, 4 outputs	MDR14; 4 inputs, 4 outputs		
Command set	PI General Command Set (GCS)	PI General Command Set (GCS)		
User software	PiezoMove	PiezoMove		
Software drivers	LabVIEW drivers, DLLs	LabVIEW drivers, DLLs		
Supported functionality	Wave generator, data recorder, drift compensation	Wave generator, data recorder, drift compensation		
Display	LEDs for Power, On Target, Error, Cmd	LEDs for Power, On Target, Error, Cmd		
Linearization	4th order polynomials, DDL (Dynamic Digital Linearization)	4th order polynomials, DDL (Dynamic Digital Linearization)		
Separate protective earth connection	Yes	Yes		
<b>Miscellaneous</b>				
Operating temperature range	5 to 35	5 to 35	°C	
Overtemp protection	Max. 71 °C, deactivation of the piezo voltage output	Max. 71 °C, deactivation of the piezo voltage output		
Mass	3	3	kg	approx.
Dimensions	263 × 89 × 302	263 × 89 × 302	mm	
Power consumption	80	80	W	max.
Operating voltage	24 VDC from external power supply (included)	24 VDC from external power supply (included)		

Ask about custom designs!



## Headquarters

### GERMANY

**Physik Instrumente (PI) GmbH & Co. KG**  
 Auf der Roemerstr. 1  
 76228 Karlsruhe  
 Phone +49 721 4846-0  
 Fax +49 721 4846-1019  
 info@pi.ws  
 www.pi.ws

**PI miCos GmbH**  
 Eschbach  
 info@pimicos.com  
 www.pi.ws

**PI Ceramic GmbH**  
 Lederhose  
 info@piceramic.com  
 www.piceramic.com



## Subsidiaries

### USA (East) & CANADA

**PI (Physik Instrumente) L.P.**  
 Auburn, MA 01501  
 info@pi-usa.us  
 www.pi-usa.us

### USA (West) & MEXICO

**PI (Physik Instrumente) L.P.**  
 Irvine, CA 92620  
 info@pi-usa.us  
 www.pi-usa.us

### UK & IRELAND

**PI (Physik Instrumente) Ltd.**  
 Cranfield, Bedford  
 uk@pi.ws  
 www.physikinstrumente.co.uk

### ITALY

**Physik Instrumente (PI) S. r. l.**  
 Bresso  
 info@pionline.it  
 www.pionline.it

### JAPAN

**PI Japan Co., Ltd.**  
 Tokyo  
 info@pi-japan.jp  
 www.pi-japan.jp

**PI Japan Co., Ltd.**  
 Osaka  
 info@pi-japan.jp  
 www.pi-japan.jp

### SOUTHEAST ASIA

**PI (Physik Instrumente) Singapore LLP**  
 Singapore  
 info-sg@pi.ws  
 www.pi-singapore.sg  
 For ID / MY / PH / SG / TH / VNM / TW

### KOREA

**PI Korea Ltd.**  
 Seoul  
 info-kr@pi.ws  
 www.pikorea.co.kr

### FRANCE

**PI France S.A.S.**  
 Montrouge  
 info.france@pi.ws  
 www.pi.ws

### SPAIN

**Micos Iberia S.L.**  
 Vilanova i la Geltrú  
 info@pimicos.es  
 www.pimicos.es

### CHINA

**Physik Instrumente (PI Shanghai) Co., Ltd.**  
 Shanghai  
 info@pi-china.cn  
 www.pi-china.cn

**Physik Instrumente (PI Shanghai) Co., Ltd.**  
 Peking  
 info@pi-china.cn  
 www.pi-china.cn