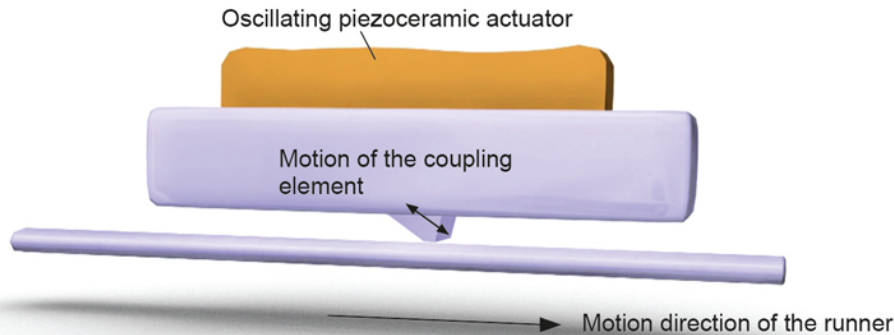


## Ultrasonic Motor Positioners

COMPACT DRIVES, FAST AND SELF-LOCKING

# PILine<sup>®</sup> Ultrasonic Piezomotors

COMPACT DRIVES, FAST AND SELF-LOCKING



- Integration levels from economical OEM motors to multi-axis positioning systems
- Excellent dynamic properties, fast step & settle
- Basically unlimited travel ranges
- Easy mechanical integration
- Self-locking at rest
- Holding force up to 15 N
- Velocity up to 500 mm/s
- Resolution to 0.05  $\mu\text{m}$  (50 nm)

## Direct-driven PILine<sup>®</sup> linear motors

These linear drives dispense with the mechanical complexity of classical rotary motor/gear/leadscrew combinations. These components can be very susceptible to wear, especially in miniaturized systems.

The simplicity of the ultrasonic linear motor promotes its precision, reliability and cost efficiency. An integral part of the ultrasonic piezomotor is a piezo ceramic that is preloaded against a moving runner with a coupling

element. The piezo element is electrically excited to produce high-frequency oscillations that cause the runner to move.

## Piezomotors are self-locking

The preload of the piezoceramic actuator against the runner ensures that the drive self-locks at rest and when powered down. As a result, it does not consume any power, it does not heat up and keeps the position stable mechanically. Applications with a short duty cycle, that are battery-operated or heat-sensitive benefit from these characteristics.

## Lifetime and reliability

The motion of the piezoceramic actuator is based on crystalline effects and is not subject to any wear. The coupling to the runner, on the other hand, is subject to friction effects. Depending on the operating mode, running distances over 2000 km or a MTBF of 20000 hours are achieved.

## Dynamics in use

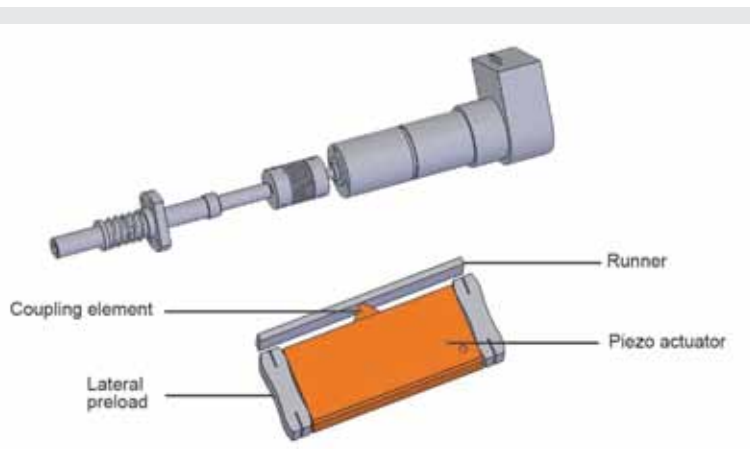
The stiff design, direct coupling and fast response of the piezo ceramics to electric inputs allows for very fast start / stop behavior and velocities to hundreds of mm/sec.

## Patented technology

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

US Pat. No. 6,765,335B2

European Patent No. 1267425B1



Motor-leadscrew combinations (above) transform the rotational motion of the motor into linear motion. Due to play in the mechanical components responsiveness is limited. Linear motors such as PILine<sup>®</sup> generate linear motion directly and provide much faster response and better stability

**Piezomotors for all applications –  
e. g. in vacuum environments and strong  
magnetic fields**

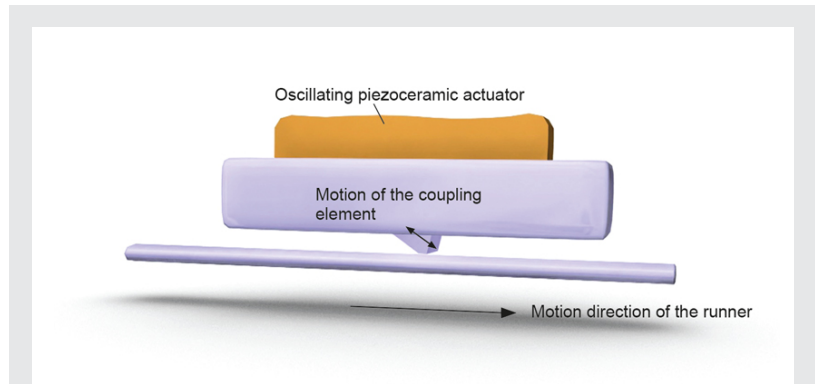
Piezomotors from PI are intrinsically vacuum-compatible and suitable for operation in strong magnetic fields. Special versions are offered for this purpose. Nanometer resolution or forces up to several 100 N can be achieved with PiezoWalk® linear motors.



The benefit of the low profile PLine® drives becomes apparent with positioning systems such as the M-660 rotation stage (left, 14 mm high) or the M-687 microscopy XY stage (right, 25 mm high): a consistently flat design without lead screw ducts or flanged motors



Implementation of rotary motion:  
PLine® motors act on a ring-shaped runner



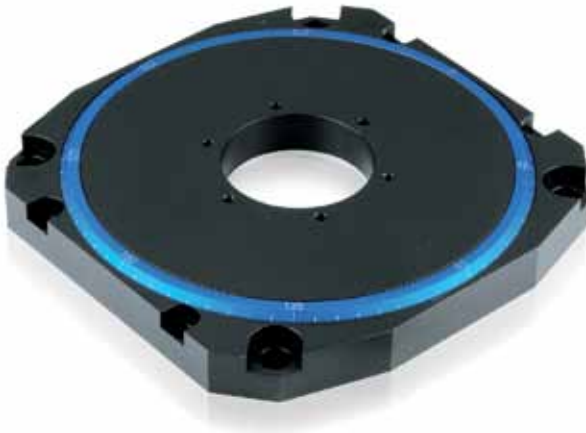
The piezoceramic actuator is excited with a high frequency electric signal (100 to 200 kHz). The deformation of the actuator leads to a periodic diagonal motion of the coupling element to the runner. The created feed is roughly 10 nm per cycle; the high frequencies lead to the high velocities



PLine® integration levels (left to right): OEM motor, U-264 RodDrive low-profile actuator (unguided) and M-272 losed-loop, guided linear actuator

# Rotation Stage with Direct Drive

LOW PROFILE, FAST



## M-660

- Low profile: Only 14 mm height
- Direct position measurement with up to 4  $\mu$ rad resolution
- Max. velocity 720  $^{\circ}$ /s
- Compact combinations with translation stages are possible
- Vacuum versions to  $10^{-6}$  hPa

### Precision-class rotation stage

With fast direct drive; unlimited slewing range. A vacuum-compatible version down to  $10^{-6}$  hPa is available

### PILine<sup>®</sup> piezo ultrasonic drive

Self-locking, no heat generation at rest. Excellent start/stop dynamics. Non-contact reference point switch

### Direct measuring principle

Non-contact measuring, optical linear encoder. Variants with different resolutions. High repeatability

### Valid patents

US Patent No. 6,765,335B2

European Patent No. 1267425B1

### Application fields

Research and industry. For micromanipulation, automation, optical metrology

### Related products

M-060 • M-061 • M-062 Precision Rotation Stage

M-116 Micro Rotation Stage

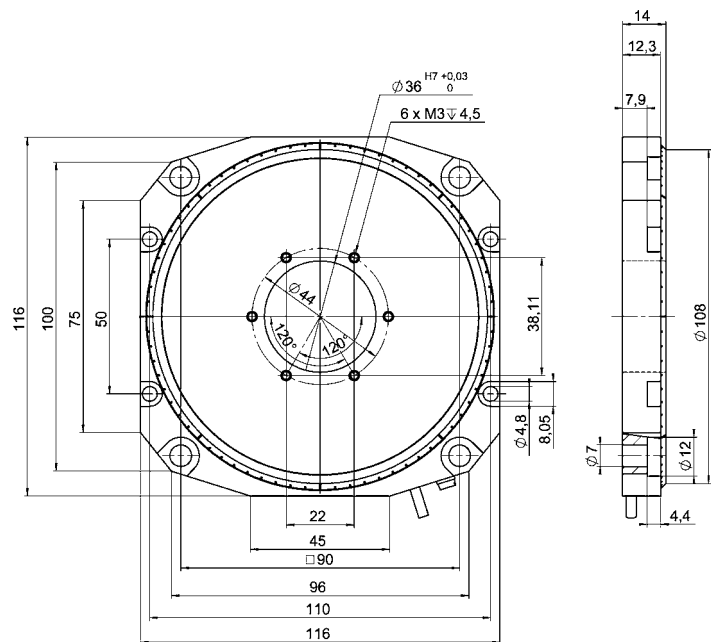
C-867 PILine<sup>®</sup> Motion Controller

	M-660.45	M-660.55	Unit	Tolerance
Active axes	$\theta_2$	$\theta_2$		
<b>Motion and positioning</b>				
Rotation range	No limit	No limit	°	
Integrated sensor	Incremental encoder	Incremental encoder		
Design resolution	4 (0.00023)	34 (0.00195)	$\mu\text{rad}$ (°)	typ.
Min. incremental motion	12	34	$\mu\text{rad}$	typ.
Bidirectional repeatability	$\pm 24$	$\pm 68$	$\mu\text{rad}$	
Velocity	720	720	° / s	max.
<b>Mechanical properties</b>				
Load capacity/axial force	20	20	N	max.
Holding force	0.3	0.3	Nm	max.
Torque cw/ccw ( $\theta_2$ )	0.3	0.3	Nm	max.
<b>Drive properties</b>				
Motor type	U-164 PILine® ultrasonic piezomotor	U-164 PILine® ultrasonic piezomotor		
Reference point switch	Optical	Optical		
<b>Miscellaneous</b>				
Operating temperature range	-20 bis 50	-20 bis 50	°C	
Material	Al (black anodized)	Al (black anodized)		
Mass	470	470	g	$\pm 5\%$
Cable length	1.3	1.3	m	$\pm 10\text{ mm}$
Connector	MDR, 14-pin	MDR, 14-pin		
Recommended controller/driver	C-867 PILine® Motion Controller	C-867 PILine® Motion Controller		

Vacuum versions to  $10^{-6}$  hPa are available under the following order number: M-660.x5V.  
Ask about custom designs!



C-867 motion controller



M-660.55, dimensions in mm

# XY Stage with Piezoceramic Linear Motors

HIGH STABILITY AND SPEED, LOW-PROFILE, DIRECT POSITION MEASUREMENT



## M-686

- Higher stability with self-clamping linear motors
- Max. velocity 100 mm/s
- Very low profile of only 32 mm, no protruding parts
- Travel range 25 × 25 mm
- 100 nm, optical linear encoders provide excellent repeatability and accuracy

### Precision-class XY stage

With fast direct drive. Clear aperture 78 × 78 mm, 65 × 65 mm at full displacement

### PILine® piezo ultrasonic drive

Self-locking, no heat generation at rest. Excellent start/stop dynamics. Flat supporting surface, no lead screw ducts or flange-mounted motors. Crossed roller guide for higher running accuracy and load capacity. Non-contact limit and reference point switches

### Direct measuring principle

Non-contact, direct-measuring, optical linear encoder per axis. High repeatability

### Valid patents

US Patent No. 6,765,335B2

European Patent No. 1267425B1

### Application fields

Research and industry. For microscopy, biotechnology, laboratory automation. Special versions for standard light microscopes available on request



Customized M-686 stage with a bigger footprint makes it possible to sink the piezo Z scanner. The system height together with the P-541 piezo scanner is reduced to only 33 mm.

### The following stages fit directly

P-561 • P-562 • P-563 PIMars Nanopositioning Stage

P-541.2 • P-542.2 Piezo XY Stage

P-541.Z Vertical Nanopositioning Stage

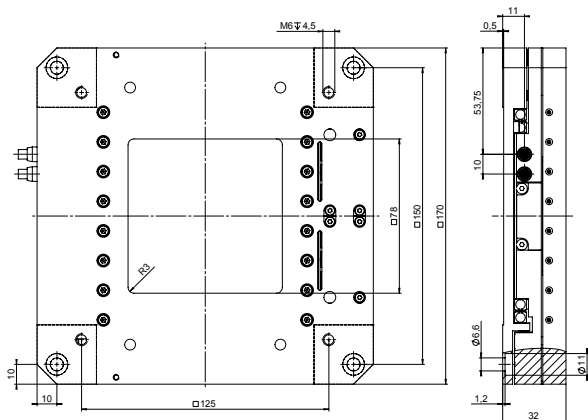
### Related products

M-683 Dynamic Micropositioning Stage

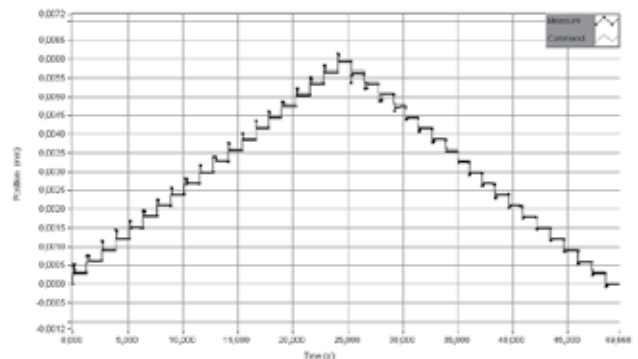
M-545 Microscopy Stage

	M-686.D64	Unit	Tolerance
Active axes	XY		
<b>Motion and positioning</b>			
Travel range	25 x 25	mm	
Integrated sensor	Linear encoder		
Sensor resolution	0,1	µm	
Design resolution	0,1	µm	typ.
Min. incremental motion	0,3	µm	typ.
Bidirectional repeatability	±0,3	µm	
Pitch / yaw	±50	µrad	typ.
Velocity	100	mm/s	max.
<b>Mechanical properties</b>			
Load capacity*	50	N	max.
Push / pull force	7	N	max.
Holding force	6	N	max.
<b>Mechanical properties</b>			
Motor type	PILine® U-164 (Dual Motor)		
Reference point switch	Optical		
Limit switches	Hall-effect		
<b>Miscellaneous</b>			
Operating temperature range	-20 to 50	°C	
Material	Al (black anodized)		
Dimensions	170 x 170 x 32	mm	
Mass	1,8	kg	±5 %
Cable length	1,5	m	±10 mm
Connector	2x MDR, 14-pin		
Recommended controller/driver	C-867 PILine® Motion Controller		

Ask about custom designs!  
 \* 10 N for maximum velocity.



M-686.D64, dimensions in mm. At an extreme displacement, the aperture still is 65 x 65 mm



Series of 0.3 µm steps performed by M-686 shows excellent equidistance and repeatability; measured with laser interferometer



M-686 open-frame long-travel stage combined with P-541.2DD high-speed piezo scanner (0.1 nanometer resolution). The system height of the combination with the P-541 XY (or Z) piezo scanner is only 48 mm



The two-channel C-867.260 controller serves to control XY scanning stages, as in this case a customized M-686 stage for microscopy

# Dynamic Micropositioning Stage

LOW PROFILE, LINEAR ENCODER



## M-683

- Piezoceramic linear drive with excellent dynamics
- Max. velocity 350 mm/s
- Low profile: only 21 mm
- Travel range 50 mm
- Encoder resolution 0.1  $\mu\text{m}$

### Precision-class micropositioning stage

Integrated piezoceramic direct drive. A vacuum-compatible version down to  $10^{-6}$  hPa is available

### PILine® piezo ultrasonic drive

Self-locking, no heat generation at rest. Excellent start/stop dynamics. Crossed roller guides. Non-contact limit and reference point switches

### Direct-metrology linear encoder

Excellent linearity and repeatability

### Application fields

Research and industry. For biotechnology, micromanipulation, test equipment

### Related products

M-605 High-Accuracy Translation Stage

N-661 Miniature Linear Stage with NEXACT® Drive

### Valid patents

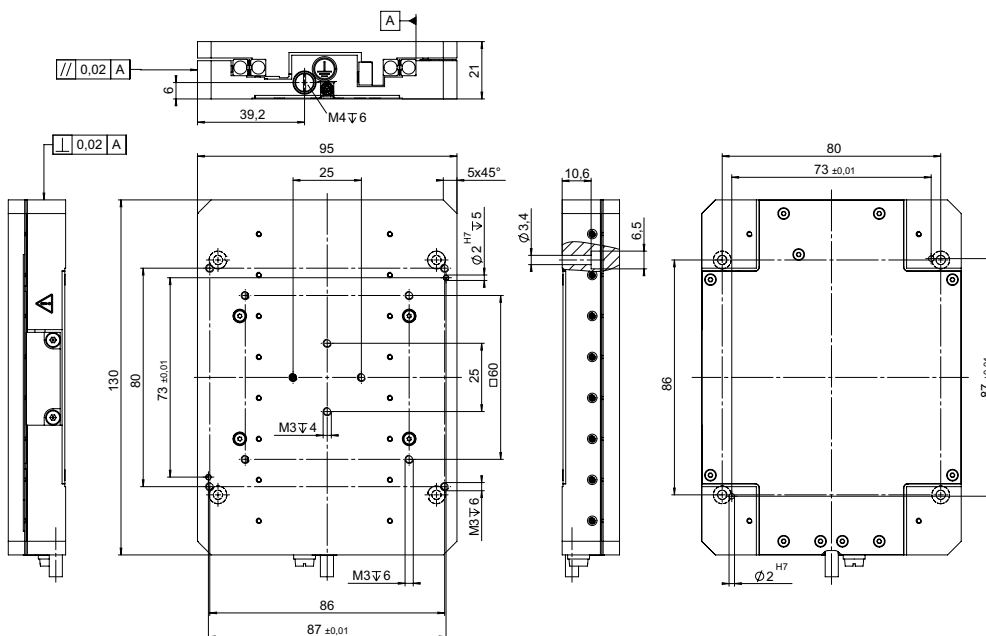
US Patent Nr. 6,765,335B2

European Patent Nr. 1267425B1



	M-683.2U4	Unit	Tolerance
Active axes	X		
<b>Motion and positioning</b>			
Travel range	50	mm	
Integrated sensor	Linear encoder		
Sensor resolution	0.1	μm	
Min. incremental motion	0.3	μm	typ.
Bidirectional repeatability	±1	μm	typ.
Unidirectional repeatability	0.2	μm	typ.
Pitch	±150	μrad	typ.
Yaw	±50	μrad	typ.
Velocity	350	mm/s	max.
Reference point switch repeatability	±1	μm	typ.
<b>Mechanical properties</b>			
Guiding	Crossed-roller bearings		
Load capacity	50	N	max.
Push / pull force	6	N	max.
Holding force	6	N	max.
<b>Drive properties</b>			
Motor type	PILine® U-164 (dual motor)		
Reference point switch	Optical		
Limit switches	Hall-effect		
<b>Miscellaneous</b>			
Operating temperature range	0 to +50	°C	
Material	Al (black anodized)		
Dimensions	130 × 95 × 21	mm	
Mass	0.65	kg	±5 %
Cable length	1.5	m	±10 mm
Connector	MDR, 14-pin		
Recommended controller	C-867 PILine® controller incl. driver		

M-683.2V4: Delivery includes 1 m cable (vacuum), feedthrough and 1.5 m cable (air). Specifications for vacuum versions can differ. Ask about custom designs!



M-683.2U4, dimensions in mm

# Compact Linear Positioning Stage

FAST LINEAR MOTOR, LINEARENCODER



## M-663

- Max. velocity 400 mm/s
- Travel range 19 mm
- 0.1  $\mu\text{m}$  linear encoder
- XY combinations without adapter plate possible

### Precision-class micropositioning stage

Integrated piezoceramic direct drive. A vacuum-compatible version down to  $10^{-6}$  hPa is available

### PI Line® piezo ultrasonic drive

Self-locking, no heat generation at rest. Excellent start/stop dynamics. Centered ball bearings. Non-contact reference point switch

### Direct measuring principle

Non-contact, optical linear encoder. High linearity and repeatability

### Valid patents

US Patent No. 6,765,335B2

European Patent No. 1267425B1

### Application fields

Research and industry. For optical metrology, laser technology, micromanipulation, biotechnology, photonics packaging



XY combination of two M-663

### Related products

M-110 • M-111 • M-112 Compact, Cost-Efficient Linear Stage

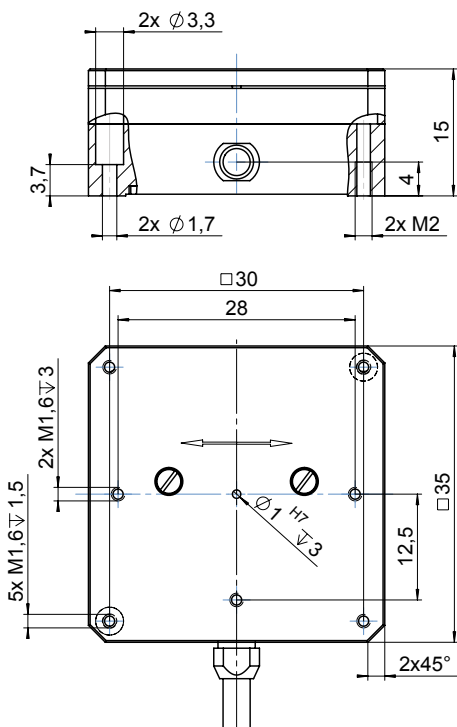
M-122 Compact, Fast Linear Stage

M-683 Fast Micropositioning Stage

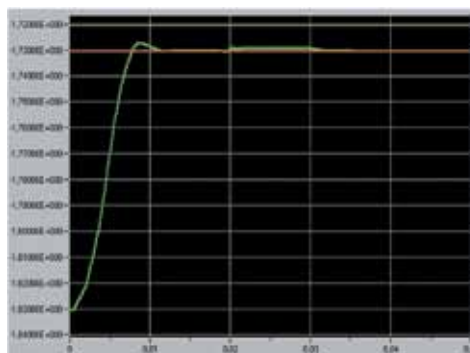
C-867 PI Line® Motion Controller

	M-663.465	Unit	Tolerance
Active axes	X		
<b>Motion and positioning</b>			
Travel range	19	mm	
Integrated sensor	Linear encoder		
Sensor resolution	0.1	μm	
Min. incremental motion	0.3	μm	typ.
Unidirectional repeatability	0.2	μm	typ.
Bidirectional repeatability	±0.3	μm	
Pitch / yaw	±300	μrad	typ.
Velocity	400	mm/s	max.
Reference point switch repeatability	1	μm	typ.
<b>Mechanical properties</b>			
Load capacity	5	N	max.
Push / pull force	2	N	max.
Holding force	2	N	max.
<b>Drive properties</b>			
Motor type	P-661 PILine® ultrasonic piezomotor		
Reference point switch	Optical		
<b>Miscellaneous</b>			
Operating temperature range	-20 to 50	°C	
Material	Al (black anodized)		
Dimensions	35 x 35 x 15	mm	
Mass	40	g	±5 %
Cable length	1.5	m	±10 mm
Connector	MDR, 14-pin		
Recommended controller/driver	C-867 PILine® Motion Controller		

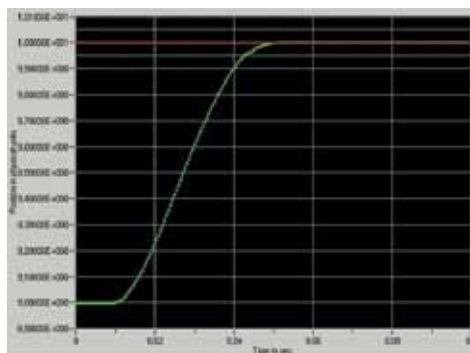
Vacuum versions to 10<sup>-6</sup> hPa are available under the following ordering number: M-663.46V.  
 A version with 90 deg. shifted cable exit for XY mounting is available as the M-663.Y65



M-663.465, dimensions in mm



Step and settle example:  
 An M-663 positioner loaded with 100 g can execute a 100 μm step and settle to within 0.1 μm in only 10 ms. Performed with a C-867 PILine® motion controller



1-mm step performed by an M-663 stage and a C-867 controller. The stage is loaded with 300 g and reaches the target position in less than 40 ms

# Linear Drive for Automation

FAST AND SELF-LOCKING WITH PILINE® PIEZOMOTOR



## M-272

- Velocity up to 150 mm/s
- Self-locking at rest
- Integrated linear encoder
- Integrated linear guiding system

### Compact standard-class linear drive

Fast, maintenance-free and easy to integrate. Integrated ball bearing guidance

### PILine® ultrasonic drive

Cost effective alternative to the conventional combination of electric motor and spindle. Ceramic direct drive, self-locking at rest, no heat generation

### Integrated linear scale encoder

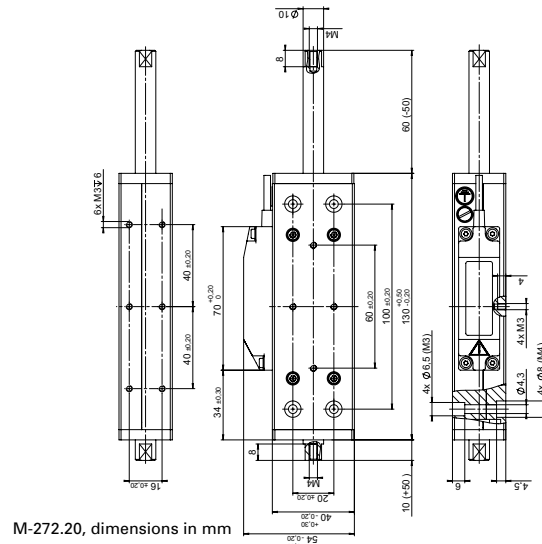
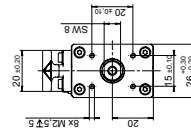
Reliable position control, repeatable accuracy. Optical reference point switch

### Application fields

Automation, handling, micromanipulation, metrology

### Related Products

N-310 NEXACT® OEM Miniature Linear Motor / Actuator  
 M-664 Precision Stage with Linear Drive  
 M-228 • M-229 Linear Actuator Series with Stepper Motor  
 C-867 Controller for PILine®  
 C-867.OE Controller Board for PILine®



M-272.20, dimensions in mm

	M-272.20	Tolerance
Active axes	X	
<b>Motion and positioning</b>		
Travel range	50 mm	
Integrated sensor	Linear encoder	
Sensor resolution	0.6 $\mu\text{m}$	
Min. incremental motion	1.8 $\mu\text{m}$	typ.
Unidirectional repeatability	2 $\mu\text{m}$	typ.
Bidirectional repeatability	3 $\mu\text{m}$	typ.
Velocity	150 mm/s	max.
<b>Mechanical properties</b>		
Guiding	Ball bearings	
Push/pull force	8 N	max.
Holding force	8 N	max.
Lateral force	10 N	max.
<b>Drive properties</b>		
Motor type	U-164 PILine® ultrasonic piezo drive	
Current consumption	800 mA*	
Reference point switch	Optical	
<b>Miscellaneous</b>		
Operating temperature range	-20 to +50 °C	
Material	Aluminum	
Mass	0.47 kg	$\pm 5\%$
Cable length	1.5 m	$\pm 10 \text{ mm}$
Connector	MDR, 14-pin	

Recommended controller/driver: C-867.OE

Power for the motor is supplied by the drive electronics, which requires 24 V DC.

\* For drive electronics



Cost-effective combination: M-272 Closed-loop Linear Pusher and C-867.OE Controller Card

# PILine® Motion Controller

FOR ULTRASONIC PIEZOMOTORS, 1 AND 2 AXES



## C-867

- For PILine® ultrasonic piezo linear motors
- 50-MHz encoder inputs for high velocity and position resolution
- USB, RS-232 and analog interfaces (e.g. for a joystick)

### **Servocontroller and power amplifier**

One and two channels, bench top, proprietary PID control for ultrasonic motors, network-compatible with up to 16 units per interface

### **For PILine® ultrasonic linear motors**

Power amplifier for PILine® drives and stages with up to two piezomotors per channel. Automated frequency tracking for improved servo performance

### **Incremental encoders**

Differential signal transmission (A/B). Evaluation of TTL signals for limit and reference point switches

### **Digital communication**

USB, RS-232 and analog interfaces (e. g. for a joystick). Data recorder. Powerful macro programming language, e. g. for standalone operation. Extensive software support, e. g. LabVIEW, shared libraries for Windows and Linux

	C-867.160	C-867.260
Function	Controller for single-axis positioning or scanning stages	Controller for XY positioning or scanning stages
Drive type	PILine® motors, single and dual drives with P-661, P-664, U-161 and U-164	
Channels	1	2
<b>Motion and control</b>		
Servo characteristics	Programmable PID filter, parameter changes on the fly	
Trajectory profile modes	Trapezoid	
Encoder input	A/B (quadrature) differential, 50 MHz	
Stall detection	Servo off, triggered by programmable position error	
Limit switches	2 TTL (programmable) per channel	
Reference point switch	1 TTL per channel (active high/low, programmable)	
<b>Electrical properties</b>		
Max. output power per channel	15 W	
Max. output voltage per channel	200 V <sub>pp</sub>	
<b>Interface and operation</b>		
Communication interfaces	USB, RS-232	
Motor connector	MDR14	2 × MDR14
Controller network	Up to 16 units on single interface	
I/O ports	4 analog/digital in 4 digital out (Mini-DIN, 9-pin) Digital: TTL Analog: 0 to 5 V	
Command set	PI General Command Set (GCS)	
User software	PIMikroMove	
Software drivers	GCS-DLL, LabVIEW driver	
Supported functionality	Start-up macro, macro, data recorder for recording parameters as motor input voltage, velocity, position or position error	
Manual control	Pushbutton box, joystick (for two axes), Y cable for 2-D motion	Pushbutton box, joystick (for two axes)
<b>Miscellaneous</b>		
Operating voltage	24 VDC from external power supply (included)	
Max. operating current	300 mA plus motor current (max. 2 A)	600 mA plus motor current (max. 4 A)
Operating temperature range	5 to 40°C	
Mass	1 kg	2.4 kg
Dimensions	206 × 130 × 66 mm (incl. mounting rails)	320 × 150 × 80.5 mm (incl. mounting rails)

Ask about custom designs!



The two-channel C-867.260 controller serves to control XY scanning stages, as in this case a customized M-686 stage for microscopy

# OEM Piezomotors

## TECHNICAL DATA

### Different integration levels offer flexibility

PILine® allow the design of positioning systems with higher dynamics and smaller dimensions. PI offers various integration levels of PILine® drives for easier integration into customer designs:

- Complete positioning stages with integrated PILine® motors are available in custom designs for OEMs,
- Linear actuators move the load via a guided rod. Position feedback is available as an option,

- RodDrives are unguided and open-loop linear drives that replace motor-leadscrew combinations. They can easily be coupled to a guided positioning platform,

- The integration of OEM motors requires more experience and technical knowledge because the optimal preload between runner and actuator has to be set-up by the customer.

### Drive electronics

To produce the ultrasonic oscillations in the piezo actuator, special drive electronics are required that are also provided by PI. These range from OEM boards to integrated servo controllers for closed-loop systems.



OEM motor



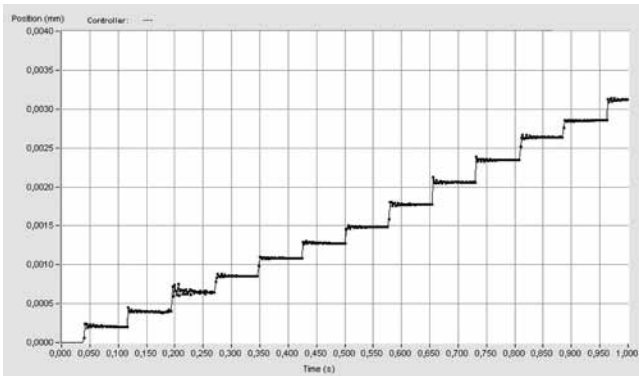
Drive electronics create the ultrasonic oscillations in the piezo-ceramic actuator of the PILine® drive. PI offers universal drives for all actuator sizes – as well as specialized, compact boards

PILine® Piezo Linear Drive	P-661	U-164	Unit	Tolerance
<b>Motion and positioning</b>				
Travel range*	No limit	No limit	mm	
Min. incremental motion, open-loop**	0.05	0.05	µm	typ.
Open-loop velocity	500	500	mm/s	max.
<b>Mechanical properties</b>				
Stiffness, de-energized	0.7	3	N/µm	±10 %
Holding force, de-energized	1.5	3	N	max.
Push / pull force	2	4	N	max.
Optimum preload on runner	9	18	N	±10 %
<b>Drive properties</b>				
Resonant frequency	210	155	kHz	±2 kHz
Motor voltage	42 V <sub>rms</sub> (120 V <sub>pp</sub> )	60 V <sub>rms</sub> (170 V <sub>pp</sub> )		
<b>Miscellaneous</b>				
Operating temperature range	-20 to +50	-20 to +50	°C	
Casing material	Al (black anodized)	Al (black anodized)		
Mass	10	20	g	±5 %

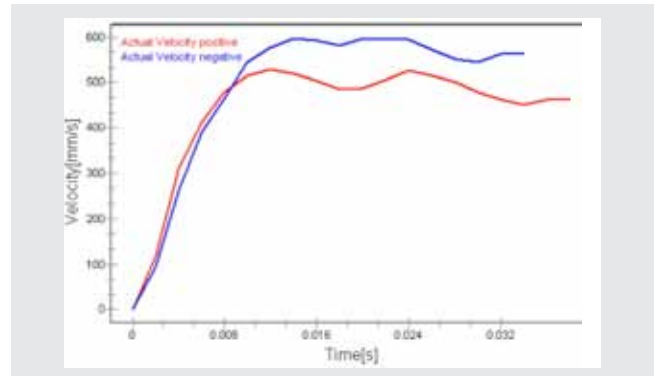
\* The travel range of piezo linear motors is practically unlimited and it only depends on the length of the runner

\*\* The minimum incremental motion is a typical value which can be reached in open-loop operation. However, it is important to follow the installation guidelines for the motors

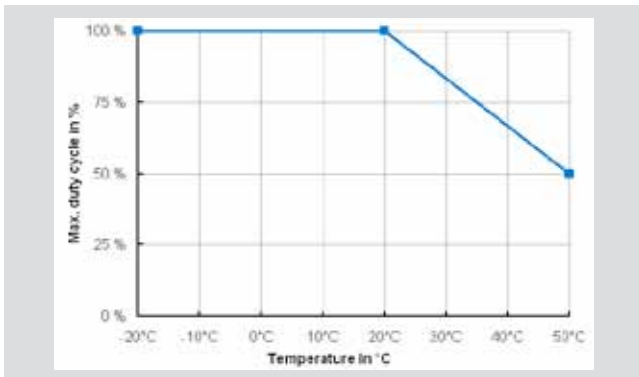




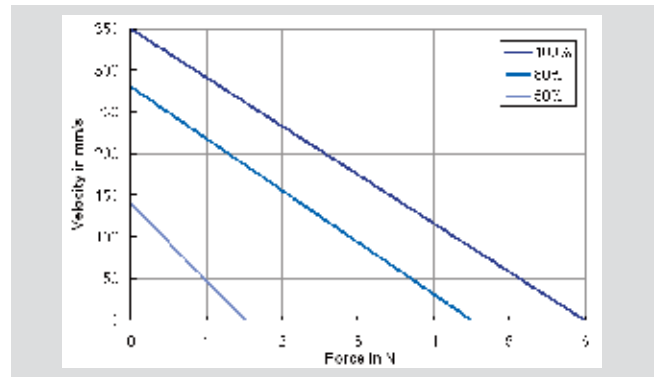
Open-loop step sequence of a PILine® based translation stage. Steps of approx. 300 nm shown. For repeatable increments closed-loop operation is recommended, because the step size depends on the force applied from outside



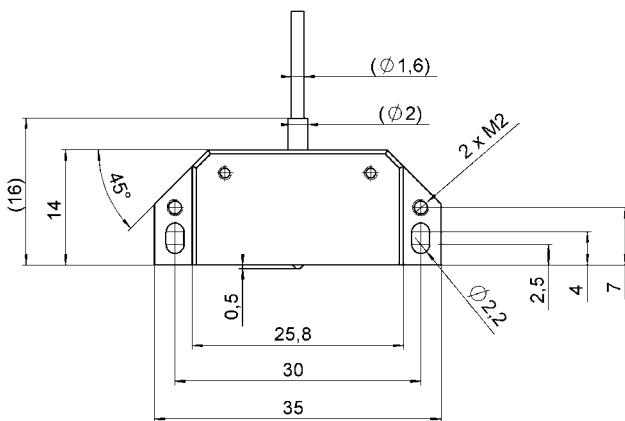
PILine® ultrasonic linear motors provide excellent dynamic properties. They provide acceleration to several g and can achieve step and settle of a few 10 ms for small distances



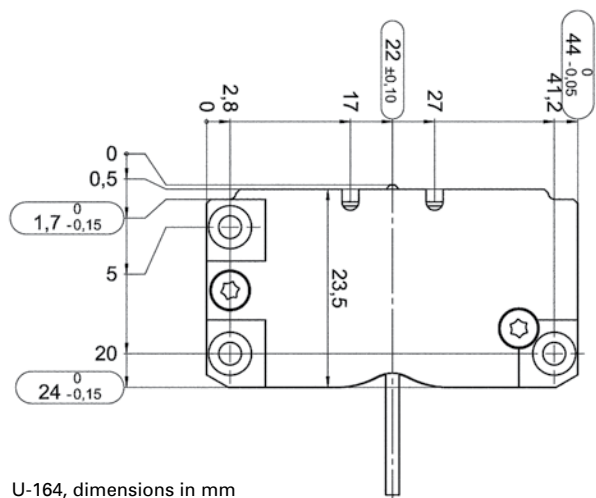
Maximum duty cycle depending on the ambient temperature with a control signal level of 100 %



Force / velocity motor characteristic of a U-164 PILine® motor. The percentages refer to the control signal level, which denotes the coupling of the electric power of the actuator



P-661, dimensions in mm



U-164, dimensions in mm

# Vertical Drive for Bio-Automation



- Actuator with PILine® piezomotor
- Compact and cost-effective design
- Stackable
- Non-magnetic and vacuum-compatible operating principle
- Self-locking at rest

	Travel range	Max. push/pull force	Max. closed-loop velocity	Resolution	Dimensions
M-664KCEP compact PILine® positioner	50 mm	5 N	100 mm/s	0.5 µm	120 × 40 × 9 mm

# Z Actuator for Bio-Automation



- Extremely slim design, matched with standard multiwell plates
- Stackable
- Integrated linear encoder for highest accuracy
- Self-locking at rest
- Non-magnetic and vacuum-compatible operating principle

	Travel range	Max. push/pull force	Max. closed-loop velocity	Resolution	Dimensions
M-674KCPP compact PILine® positioner	50 mm	7 N	100 mm/s	0.1 µm	120 × 40 × 9 mm

# Micro Linear Stage



- Smallest micropositioning stages with linear motor drive
- Acceleration 5 g
- Push / pull force 1 N
- Self-locking at rest
- XY combination possible
- MTBF 20,000 h
- Vacuum-compatible versions to 10<sup>-7</sup> hPa

	Travel range	Max. load	Max. velocity	Min. incremental motion	Dimensions
M-661.370	18 mm	5 N	500 mm/s	50 nm	30 × 23 × 10 mm
M-662.470	20 mm	5 N	500 mm/s	50 nm	28 × 28 × 8 mm

# RodDrive Piezomotor Direct Drive

LOW PROFILE, HIGH SPEED, EASY INTEGRATION



## U-264

- Velocity up to 250 mm/s
- Travel ranges up to 150 mm
- Linear drive for integration
- Generated force up to 15 N

### Fast OEM linear drive

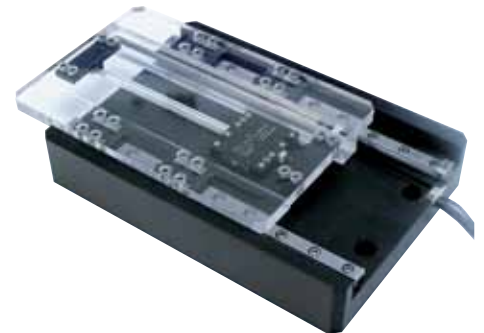
For integration into guided systems

### RodDrive direct drive with integrated and preloaded PiLine ultrasonic piezo drives

Self-locking, no heat generation at rest. Excellent start/stop dynamics. Easy integration by coupling the rod to a guided payload (e.g. a linear slide)

### Application fields

OEM drives for automation. For handling and high-precision positioning systems



RodDrive integrated in a micro stage

### Related Products

M-272 Linear Drive for Automation

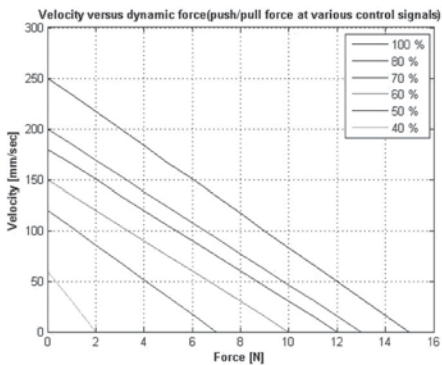
N-310 NEXACT OEM Miniature Linear Motor / Actuator

C-872 Driver for PiLine® Ultrasonic Piezomotors

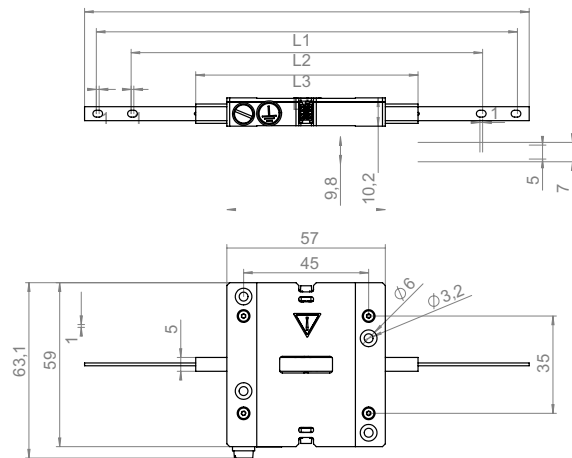
	U-264.10/20/30	U-264.11/21/31	Units	Tolerance
<b>Motion and positioning</b>				
Travel range	50 / 100 / 150	50 / 100 / 150	mm	
Open-loop step size	0.1*	2*	μm	typ.
Open-loop velocity	250	200	mm/s	max.
<b>Mechanical properties</b>				
Stiffness when powered down	1.5	1.5	N/μm	±10 %
Holding force when powered down	8	15	N	max.
Push/pull force	7 (at 50 mm/s) 2 (at 250 mm/s)	12 (at 50 mm/s) 3 (at 200 mm/s)	N	max.
<b>Drive properties</b>				
Resonant frequency	158	159	kHz	±2 kHz
Motor voltage	200 V <sub>pp</sub> 65 V <sub>rms</sub>	200 V <sub>pp</sub> 65 V <sub>rms</sub>		
Input impedance	40 to 80**	50 to 100**	Ω	
<b>Miscellaneous</b>				
Operating temperature range	0 to 40	0 to 40	°C	
Material case	Al (black anodized)	Al (black anodized)		
Mass	0.08 / 0.09 / 0.1	0.08 / 0.09 / 0.1	kg	±5 %
Connector	D-Sub 15 (m)	D-Sub 15 (m)		
Recommended controller/driver	C-872.160 driver, C-867 motion controller/driver	C-872.160 driver, C-867 motion controller/driver		
Dimensions	57 x 63 x 10.2 plus rod	57 x 63 x 10.2 plus rod	mm	

\* pulsed operation, 1 msec ON time, 50 % duty cycle

\*\* at resonant frequency



U-264.11/21/31, velocity (open-loop) vs. dynamic force (push/pull force) at various drive signal amplitudes



	U-264.10/11	U-264.20/21	U-264.30/31
L1	160.0	210.0	260.0
L2	151.5	201.5	251.5
L3	126.5	176.5	226.5
L4	80.0	130.0	180.0

U-264, dimensions in mm



PI Line RodDrive with variable travel ranges

# OEM Driver for PLine® Piezomotors

HIGHLY EFFICIENT PIEZOMOTOR AMPLIFIER



## C-872

- For all PLine® motors
- Analog control input
- Automatic frequency control
- Minimum heat generation

**All-purpose driver for all PLine® single and dual drives**  
 OEM board with analog control input. Suitable for PLine® ultrasonic piezomotors P-661, U-161, U-164 and PLine® RodDrive U-264

**PLine® ultrasonic piezomotors and drives**  
 High velocity. Self-locking, no heat generation at rest. Excellent start/stop dynamics

**Resonance tracking**  
 Automatically adjusts the driving frequency for maximum motor performance and efficiency (can be switched off)



RodDrive Piezomotor Direct Drive

**Related products**  
 U-264 RodDrive Piezomotor Direct Drive  
 M-272 Ceramic Linear Drive for Automation  
 C-867.OE Controller Board PLine®

Preliminary Data	C-872.160	Unit	Tolerance
Function	Driver for PLine® ultrasonic piezomotors / single and dual drives with P-661, U-161, U-164 and U-264		
Channels	1		
Control In	±10 V defines the velocity, polarity defines the direction of motion, 12-bit A/D converter		
<b>Electrical properties</b>			
Output power	50	W	max.
Output voltage	240 (AC voltage, amplitude and frequency depending on motor selection)	V <sub>pp</sub>	max.
Current limitation	2.5 (short-circuit-proof)	A	max.
<b>Interface and operation</b>			
DIP switches	Motor selection, frequency control activated/deactivated		
Motor connector	MDR14 and sub-D 15 (f)		
I/O ports	Sub-D 15 (m) 1x frequency control activated/deactivated Looped through: 3x signals for limit and reference point switches (TTL), 4x encoder signal (A/B, differential)		
<b>Miscellaneous</b>			
Operating voltage	24 VDC, 50 W, from external power supply (not included)		
Current consumption	2.5	A	max.
Operating temperature range	5 to 40	°C	
Mass	0.125	kg	
Dimensions	172 × 100 × 20 (incl. connector)	mm	

# PILine® Motion Controller

OEM BOARD, COST-EFFECTIVE, WITH CAN INTERFACE



## C-867.OE

- For PILINE® ultrasonic piezomotors
- 50-MHz encoder inputs for high velocity and position resolution
- CAN, RS-232 and analog interfaces (e.g. for a joystick)

### Servocontroller and power amplifier

One channel, proprietary PID control for ultrasonic motors, standard Eurocard size

### For PILINE® ultrasonic linear motors

Power amplifier for PILINE® drives and stages. Automated frequency tracking for improved servo performance

### Incremental encoders

Differential signal transmission (A/B). TTL inputs for limit and reference point switches

### Digital communication

CAN, RS-232 and analog interfaces (e.g. for a joystick). Data recorder. Powerful macro programming language, e.g. for standalone operation Extensive software support, e.g. for LabVIEW, shared libraries for Windows and Linux



Cost-effective combination: M-272 closed-loop linear pusher and C-867.OE motion controller

### Related Products

C-867 PILINE® Motion Controller

C-867.OE	
Function	Controller and drive electronics for PLine® piezomotors/systems
Drive type	PLine® motors, single and dual drives with P-661, P-664, U-161, U-164 and U-264
Channels	1
<b>Motion and control</b>	
Servo characteristics	Programmable PID filter, parameter changes on the fly
Trajectory profile modes	Trapezoid
Encoder input	A/B (quadrature) differential, 50 MHz
Stall detection	Servo off, triggered by programmable position error
Limit switches	2 TTL (programmable)
Reference point switch	1 TTL (active high/low, programmable)
<b>Electrical properties</b>	
Max. output power	15 W
Max. output voltage	200 V <sub>pp</sub>
<b>Interface and operation</b>	
Communication interfaces	RS-232, CAN, Input / output 32-pin (male) on rear panel (DIN 41612 / D)
Motor connector	MDR14
Command set	PI General Command Set (GCS)
User software	PIMikroMove
Software drivers	GCS-DLL, LabVIEW driver
Supported functionality	Start-up macro, macro, data recorder for recording parameters as motor input voltage, velocity, position or position error
<b>Miscellaneous</b>	
Operating voltage	24 VDC from external power supply (not included)
Max. operating current	150 mA plus motor current (max. 2 A)
Operating temperature range	5 to 40°C
Mass	420 g
Dimensions	175 × 100 × 38 mm (incl. connector)

# PI: Drives that Set the World in Motion

PRECISION POSITIONING FOR SCIENCE AND INDUSTRY



## Future Technology Solutions

Today PI delivers micro- and nanopositioning solutions for all important high-tech markets:

- Semiconductor technology
- Optical metrology, microscopy
- Biotechnology and medical devices
- Precision automation and handling
- Precision machining
- Data storage technology
- Photonics, telecommunications
- Nanotechnology
- Micropositioning
- Aerospace engineering
- Astronomy

**PI (Physik Instrumente) is the leading supplier of piezo-based positioning systems with accuracies in the range of a few nanometers.**

The extensive product portfolio is based on a wide range of technologies with electromotive or piezoelectric drives for up to six motion axes. Hexapods, nanometer sensors, control electronics as well as software and are supplemented by customized solutions.

All key technologies are developed in-house. This means that every phase from the design right down to the shipment can be controlled: The precision mechanics and the electronics as well as the position sensors and the piezo ceramics or actuators. The latter are produced by the subsidiary company PI Ceramic.

PI is, therefore, the only manufacturer of nanopositioning technology which employs the piezoelectric drives it produces. This ensures a high degree of flexibility for developing customized piezoceramic components.

More than 100 patents and patents applied for stand for more than 40 years of experience and pioneering work. PI products are employed wherever technology in industry and research is pushed forward – worldwide.

With four German factories and ten subsidiaries and sales offices abroad, the PI group is represented internationally.

PI stands for quality in products, processes and service. The ISO-9001 certification which focuses not only on product quality but also on customer expectations and satisfaction was achieved back in 1994.

PI is also certified according to the ISO 14001 (environmental management) and OHSAS 18001 (occupational safety) standards, which taken together form an Integrated Management System (IMS).



## Milestones

THE SUCCESS STORY



- 1970** PI founding year
- 1977** PI moved its headquarters to Waldbronn, Germany
- 1987** Foundation of a subsidiary in the USA
- 1991** Foundation of a subsidiary in Japan
- 1991** Market launch of 6-axis parallel-kinematics positioning systems (Hexapods)
- 1992** Foundation of PI Ceramic, Thuringia, Germany; crucial step towards market leadership in nan positioning
- 1993** Foundation of subsidiaries in the UK and in France
- 1994** Market launch of capacitive position sensors
- 1995** Foundation of a subsidiary in Italy
- 1998** Market launch of digital control electronics
- 2001** Market launch of PILine® ultrasonic piezomotors
- 2001** New company building in Karlsruhe, Germany
- 2002** PI Ceramic company building extended
- 2002** Foundation of a subsidiary in China
- 2002** Market launch of PICMA® multilayer piezo stack actuators
- 2004** Market launch of NEXLINE® high-performance piezo linear drives
- 2007** Market launch of NEXACT® piezo linear drives
- 2010** Acquisition of the expansion site next to the PI headquarters
- 2011** Foundation of a subsidiary in Korea
- 2011** Foundation of a subsidiary in Singapore
- 2011** Acquisition of the majority shares of miCos GmbH
- 2012** Extension of the PI headquarters company building in Karlsruhe



## PI General Catalog

# Request it now!

The 530 page hardbound catalogue from PI is the most comprehensive reference book on the fundamentals of nanopositioning, piezo systems and micro-positioning technology yet. The catalog contains 200 product families, with more than 1000 drawings, graphs, images and technical diagrams.



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