PI


RELIABILITY
LEVER-AMPLIFIED
PIEZO ACTUATOR
REPEATABILITY
SCANNER
PRECISION
TIP/TILT
PLATFORMS
POSITIONING WITH
PIEZO SYSTEMS
DUTY CYCLE
STEP RESPONSE
MOTION CONTROL
ACCURACY
CAPACITIVE SENSOR
SUBNANOMETER
PARALLEL
KINEMATICS
HIGH DYNAMICS
STIFFNESS

# Positioning with Piezo Systems

**Product Finder Online – What is the easiest way for you to find the best positioning solution?**

The printed catalog is a major showcase for PI and, as well as presenting the entire product range, it also acts as a reference for all of our motion solutions. However, to take advantage of the latest products and developments, we recommend using the product finder on the PI website www.pi.ws.

How to use the product finder:

Select the product type specified by the axes of motion required. Selection of more criteria expands or shortens the list of results. Select more than one filter at a time, for example, to find positioning stages designed for higher load capacity, too.

## INTRODUCTION

# PRODUCTS



More information, step-files and downloads are available from our website www.pi.ws.

# Markets and Applications

**Microscopy: Position Lens or Specimen**

Optical methods have been relying on PI positioning systems for years, e.g. for aligning optical systems or samples. Piezo actuators and motors are best for replacing conventional motor/spindle driven systems because they are more compact, more precise and faster. Other non-optical microscopic processes, such as SEM (scanning electron microscope) and AFM (atomic force microscope), use PI systems due to their high accuracy and dynamics.

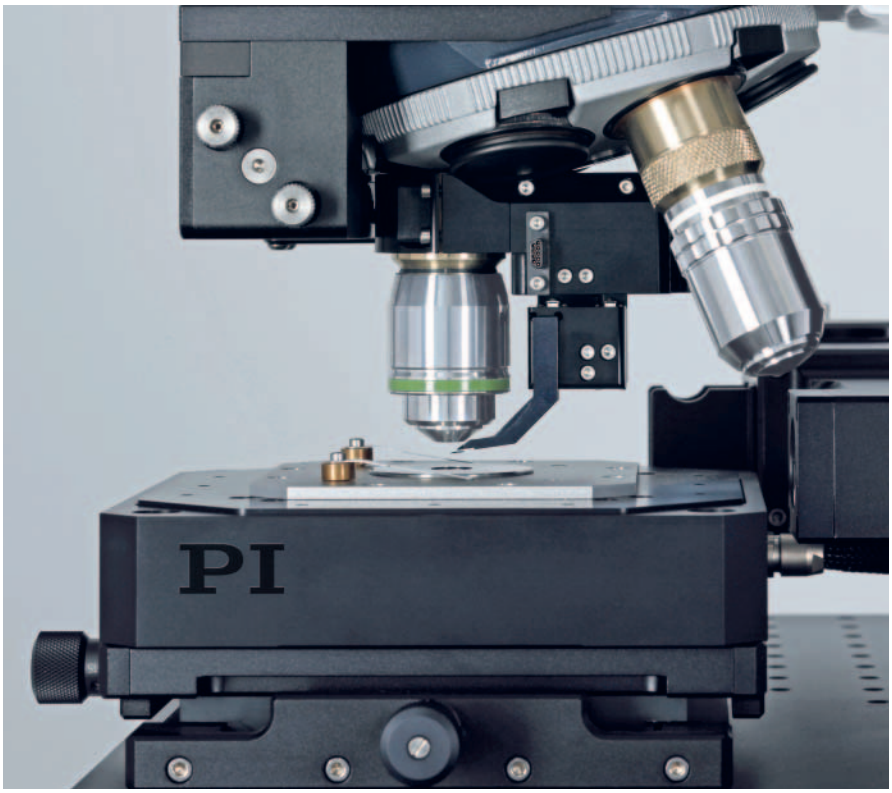



Image: WITec GmbH

**Mechanical Engineering**

Vibrations of a piezo actuator reduce the processing times for high-precision micro-sized holes

- Processing, e.g. out-of-round turning with piezo actuators
- Precise positioning, even of high loads in six degrees of freedom
- Setup of testing systems

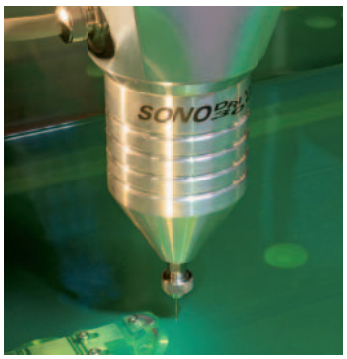
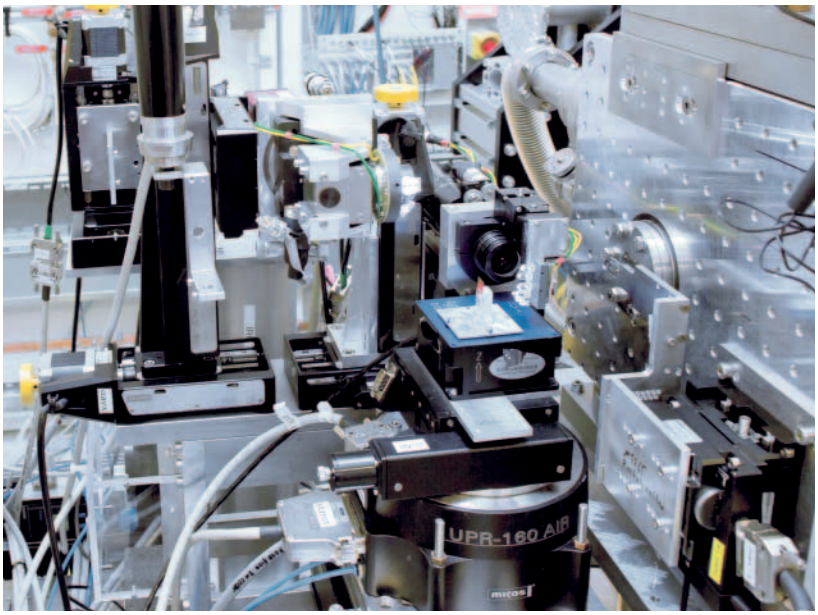


Image: ICT-IMM

**Industrial Manufacturing and Quality Assurance, Optical Metrology**

Optical inspection systems in the semiconductor industry utilize the performance features of PI systems, for example, for controlling surface structures on wafers after major manufacturing steps or for final quality inspection of flat-screen monitors with white light interferometry. PI piezo motor and piezo actuator systems are used for active alignment or autofocusing tasks in high-speed semiconductor production, where they perform precise adjustment of wafers, imaging optics, and the masks.

Image: Polytec GmbH



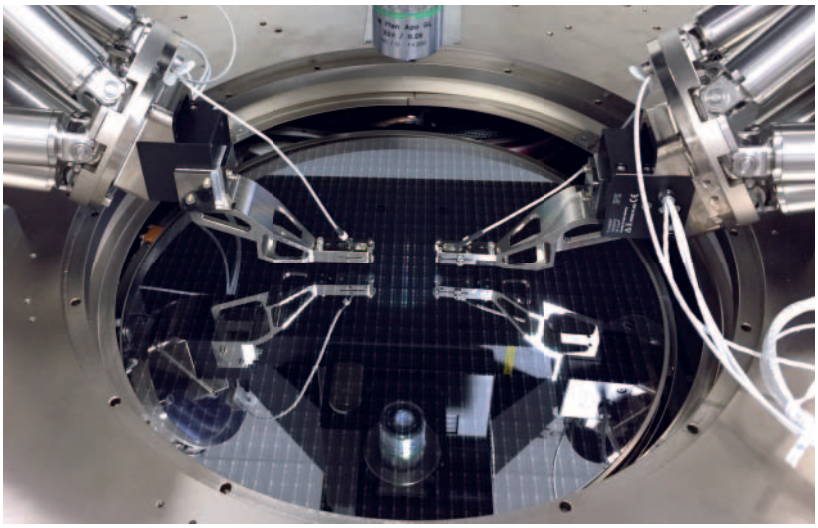

The sample positioning setup inside the holography endstation
(Image: M. Osterhoff, Institute for X-Ray Physics, Georg-August-University Göttingen)

**Scientific Instrumentation**

From small-scale laboratory automation to experimental endstations of beamlines in synchrotrons and other particle accelerators, a large variety of applications in the scientific environment benefits from piezo based, sub-nanometer precision scanning and positioning. The conditions of use vary, and include ultrahigh vacuum, non-magnetic or cryogenic.

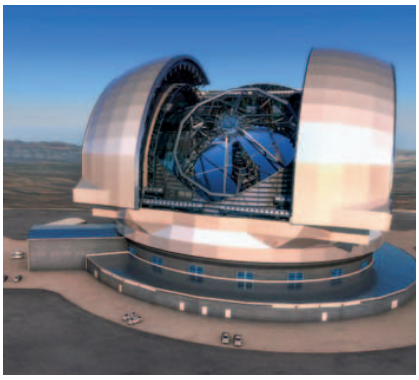
**Photonics Packaging, Silicon Photonics**

During production and inspection of components with optical data transmission, it is important to align fibers or fiber arrays for optimum coupling with the highest possible accuracy. Position tolerances way under 50 nm are common and multi-channel inputs and outputs require simultaneous alignment in several axes.



18-Axis double alignment system provides fast NxM alignment of SiP devices in wafer probers. Cascade Microtech's pioneering CM300xi photonics-enabled engineering wafer probe station integrates PI's Fast Multichannel Photonics Alignment systems for high throughput, wafer-safe, nano-precision optical probing of on-wafer Silicon Photonics devices. (Image: Cascade Microtech, a FormFactor company)

**Astronomy**

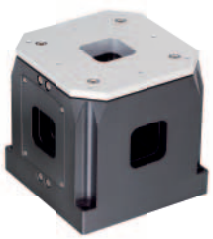


Piezo-based solutions are key to precision in the World's largest telescope, the ELT of the European Southern Observatory (ESO). This artist's impression shows the European Extremely Large Telescope (E-ELT) in its enclosure. The E-ELT will be a 39-metre aperture optical and infrared telescope sited on Cerro Armazones in the Chilean Atacama Desert. ). PI provides the nanometer-precise actuation of the main mirror segments, as well as other piezo-based, highly customized motion solutions for precision-critical points of operation within the telescope.
(Image: ESO/L. Calçada)

# Custom Examples Picture Wall

Hybrid actuator that consists of a classical PICMA® multilayer piezo actuator and a PIRest piezo actuator. While the PIRest part corrects the offset position continuously in a range of up to 10 µm, an additional dynamic motion is performed via the PICMA® actuator. This can be helpful for dynamic compensation of vibration in a range of several 10 Hz, for readjusting a focal plane during a measuring or scanning process, or for controlling a laser beam in measuring technology or material processing

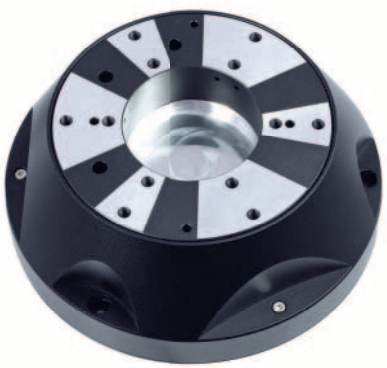
Parallel-kinematic piezo hexapod for fast scanning in 6 degrees of freedom that features 200 µm of linear travel and up to 20 mrad tip / tilt motion. With a load capacity of 50 g the hexapod is perfectly adapted for use in beamline experiments, complex optical positioning or alignment tasks



This 6D NanoCube offers motion in six degrees of freedom and a large clear aperture of 25 mm × 25 mm and 200 µm of motion in all linear axes. The 500 g-load capacity eases the integration into complex optical positioning or laser alignment setups, for example in experimental setups at beamlines. Capacitive feedback sensors allow for optimal repeatability

PiezoWalk® piezo-based drives combine excellent long-term stability and repeatability with a small form factor. This positioner is used for precise readjustment of monochromator crystals in an X-ray spectrometer

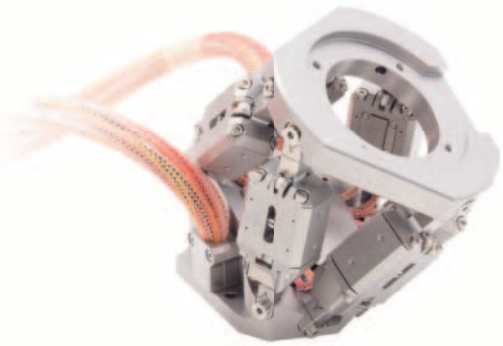
Piezo hexapod for fine adjustment and active, dynamic error correction. The space-saving, parallel-kinematic design allows a low overall height, and motion in six degrees of freedom. Resonant frequencies up to 1 kHz ensure fast position control. An optional integration of PIRest technology additionally provides for permanent, static positioning over long time periods



Power PIFOC Nosepiece Nanopositioner for high-resolution microscopy achieves high dynamics and nanometer resolution for heavy objectives

Six-axis, piezo-based positioning system for positioning a specimen in a UHV environment

The UHV-compatible miniature piezo hexapod provides high-precision positioning even in strong magnetic fields

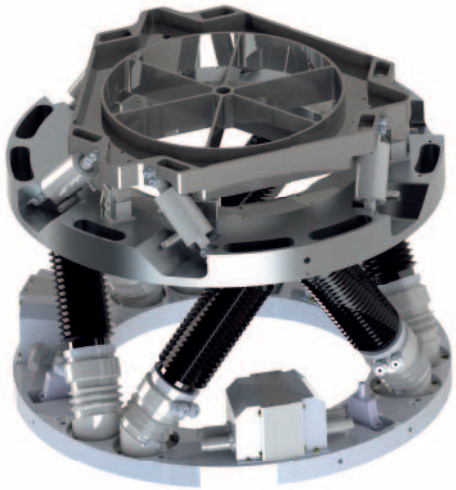


Compact piezo actuator for generating oscillations even of heavy loads which is used to accelerate high-precision EDM machining processes

This NEXLINE® Z / tip / tilt platform for the semiconductor industry is used for wafer alignment where it provides drift-free position stability during scanning and wafer processing

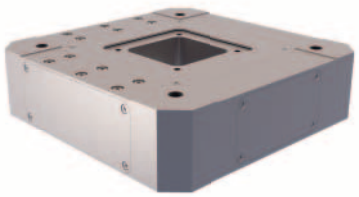
# Custom Examples Picture Wall

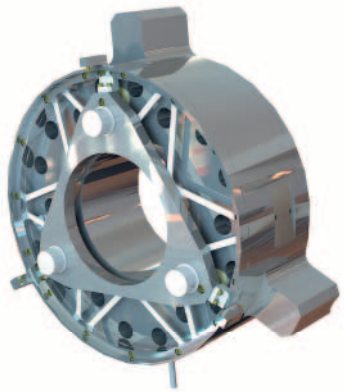
System solutions for microscopy: PIFOC and 6-axis microrobot with NEXACT® piezo walking drives and their dedicated motion controller



This double piezo hexapod combines in one system the coarse and fine travel for alignment of the M2 mirror of a large telescope

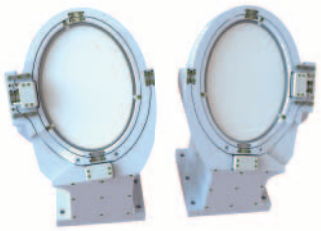
Non-magnetic stages made from titanium or other non-magnetic materials and driven by NEXLINE® piezo walking motors are intended for use in cryogenic environment to 77°K. This requirement not only arises from research laboratories, but also from telescopes exposed to large changes in environmental temperatures





This fast tip / tilt platform corrects the image jitter at an M5 telescope mirror. A high bandwidth and extremely high resolution is essential to achieve a high image quality

The differentiating feature of this NEXLINE® Z / tip / tilt positioner is the high long-term stability, which is required to align M3 and M6 mirrors in a telescope, for example



Gimbal mount mirrors are often used in astronomy to provide a tip / tilt axis in plane with the mirror surface for optimum adjustment in 2 angles

# The PI Group – A Strong Partner for Industry and Research


The PI headquarters in Karlsruhe, Germany, manifests the continuous growth. In front, the 2017 Technology Center

Over the last four decades, PI (Physik Instrumente) has developed into the leading manufacturer of nanopositioning technology. The key element and motivation of the entrepreneurial behavior have always remained the same: Finding the best possible solution for the customer.

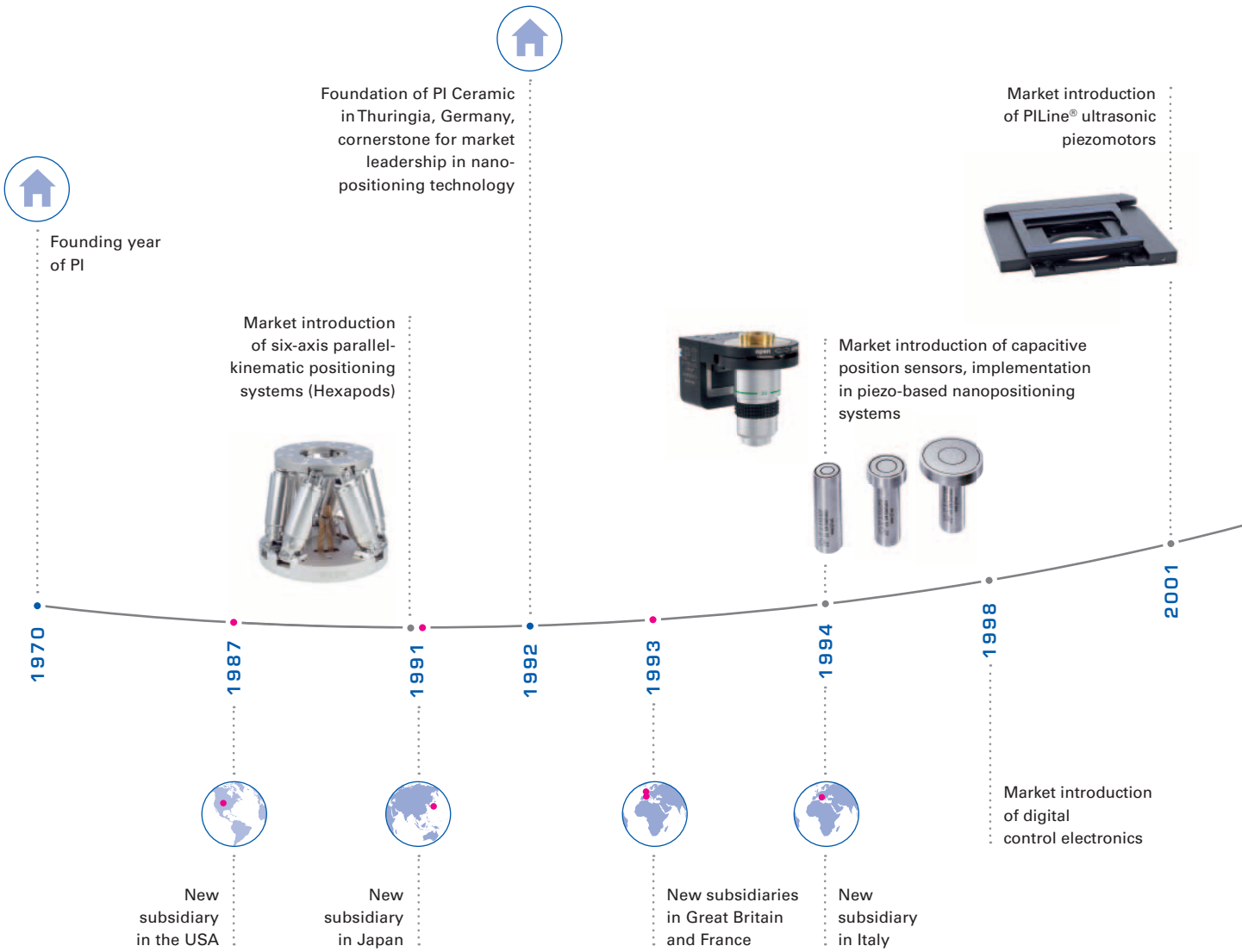
PI is well known for the quality of its products and has been one of the leading players in the global market for precision positioning technology for many years. One of the most important building blocks for this is the team spirit within the international PI family, which is based on mutual understanding and support that goes beyond international borders and functional restrictions.

PI is a privately owned company with healthy growth, more than 1000 employees worldwide and a flexible, vertically integrated organization, which enables PI to fulfill almost any request in the field of innovative precision positioning technology. The foremost priority for PI is to be a reliable and highly qualified partner for the customer.

# The PI Group Milestones

## A Success Story

Well known for the high quality of its products, PI (Physik Instrumente) has been one of the leading players in the global market for precision positioning technology for many years. PI has been developing and manufacturing standard and OEM products with piezo or motor drives for more than 40 years. In addition to four locations in Germany, the PI Group is represented internationally by fifteen sales and service subsidiaries. All of our customers worldwide can rely on this.



2002

Market introduction of the PICMA® multilayer piezo actuators

New subsidiary in China

2004

Market introduction of the NEXLINE® high-performance piezo linear drives

2007

Market introduction of NEXACT® piezo linear drives

2011

Acquisition of majority shares in miCos GmbH, Eschbach, Germany

New subsidiaries in Korea and Singapore

2014

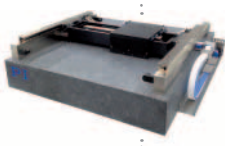
Market introduction of the magnetic PIMag® direct drives

Market introduction of Q-Motion® and PiezoMikes

2015

Introduction ofair bearings

Acquisition of Nelson Air Corp., USA



New subsidiaries in Taiwan and the Netherlands

2016

Acquisition of majority shares in ACS Motion Control

ACS MOTION CONTROL

# Expert Consulting

Time for qualified technical consultation is crucial for the success of high-tech projects

The PI Group can respond precisely to what customers want: Specific requirements can often only be satisfied by customized solutions – solutions that can be found by unconventional and creative thinking. Together with the customers, PI plans and realizes individual solutions for the most varied applications and integration levels. And that means that PI's customers can always be sure that they will get the best solution every time.

Customers directly benefit from:

**Highly Qualified Consultancy Through Trained Specialists**

Individual advice often is key to solve a complex problem. PI sales engineers are ready to come on site with all the time necessary for a solid understanding of the topic. Or they will gladly meet at the PI head office. All PI sales engineers have a background in natural sciences or engineering, and have up to 20 years of experience in optical, micro- or nanopositioning technology.

**International Support**

PI subsidiaries and distributors in many countries across the world guarantee global support – a decisive advantage, especially for globally operating customers. PI has its own sales and service offices in all important markets. Moreover, the company maintains testing devices for nanometrology on three continents. PI Shanghai and PI USA have additional development and manufacturing resources that allow rapid local reaction to custom-engineered specifications.

# Engineering Design Expertise and Customization

**Unique Technological Breadth**

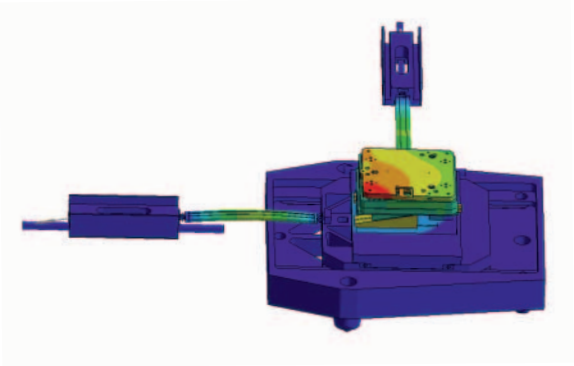
The technological diversity of the PI Group is unrivalled all over the world. PI develops, manufactures, and qualifies all its core technologies itself. PI is therefore not dependent on components available on the market. That puts PI in a position to offer its customers the most advanced products for motion and positioning tasks – without technological restriction.

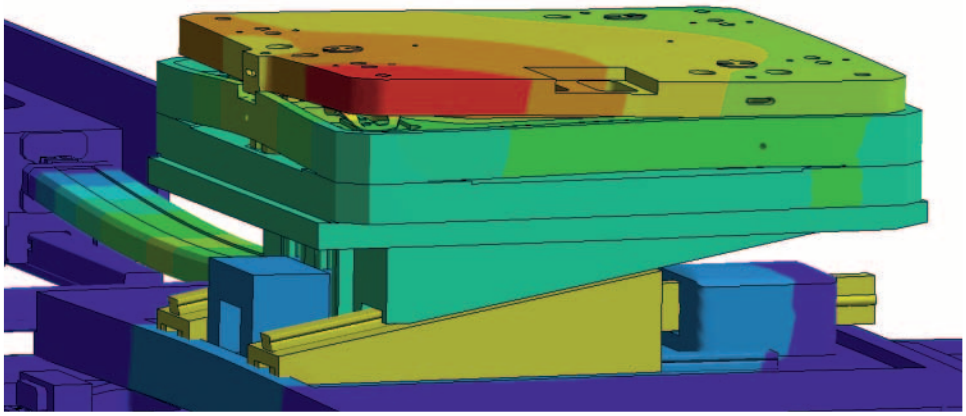
**Customized Solutions**

With this background, PI develops positioning solutions with innovative drive technologies for high-tech applications worldwide. PI covers the whole motion range from finger-tip sized nanopositioners to large-scale stages with long travel ranges, through their plethora of different drive and guiding systems.

**Core Technologies**

- In-house manufacturing of piezo components and piezo actuators
- Magnetic direct drives: linear motors and voice coil
- Air bearings, magnetic and flexure guides
- Comprehensive range of piezo motor technologies
- Nanometrology sensors
- Parallel-kinematic systems for positioning in six axes (Hexapods)
- Motion control technology
- Software





Maximum performance of precision systems is achieved through extensive design and analysis expertise, using equipment built in-house with proprietary techniques. See here the modal analysis of a complex multi-axis system that includes linear guide elements as well as mixed piezo drive technologies like PICMA® multilayer actuators and PiezoWalk® walking drives, and PIMag® magnetic drives

# Production Capabilities


PI's flexibility in serial production allows for fast adaptation of both processes and quantities

A modern production management and an integrated management system allow PI to guarantee the high quality of its products, processes, and services. The continual improvement of organization and processes is an integral part of the corporate culture. KAIZEN workshops and an active innovation management are important elements for achieving this.

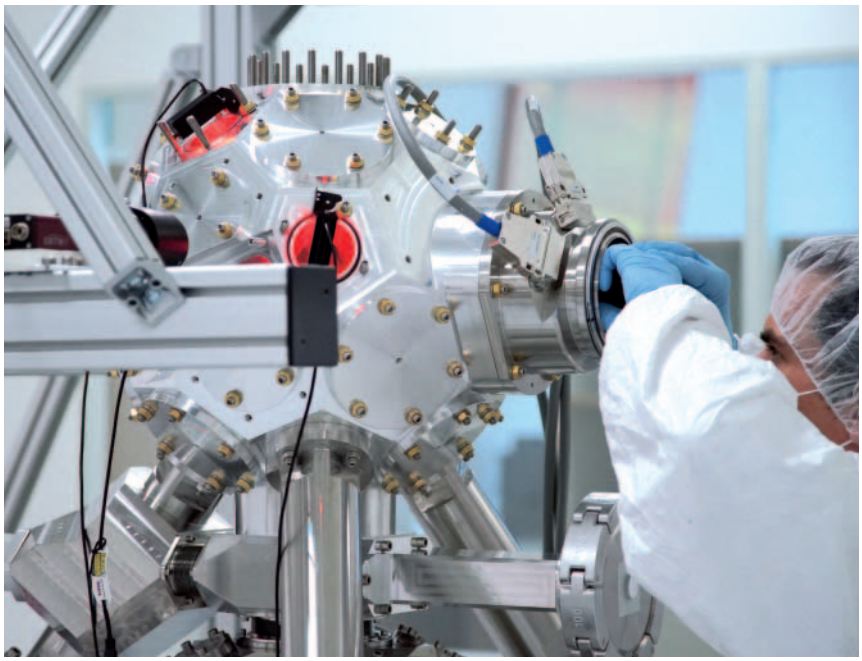
The production processes for the standard range are made flexible by the fractal production structure and it is therefore possible to manufacture even large series with full process control. Active, system-based requirements management makes it possible to dispense with comprehensive storage facilities.

**Vertical Production Range and Production Capacity**

The product spectrum ranging from the two-ton hexapod to the 10-gram nanopositioner requires PI to have the equipment and technologies at its disposal that allow the systems to be manufactured, assembled, and qualified.

- 13,000 m² of overall production space
- 5,000 m² for cleanrooms
- Air-conditioned and vibration-proof measuring conditions
- Vacuum chambers for startup and residual gas analysis
- Measuring technology with traceable, calibrated measuring equipment
- Monitoring of piezo actuator technology from material composition to final inspection
- In-house manufacturing of positioning sensors
- Production hall with measuring technology for heavy loads
- Fractal production organization

# Vacuum Know-How



PI offers high-precision solutions for positioning in vacuum conditions to $10^{-10}$ hPa. Positioning solutions in a vacuum follow clearly defined constraints. This applies to the limited installation space, as well as prevention of contamination and excessive heat input.

Selection of the optimum drive technology for the respective application and the mechanical design must be matched exactly to the required load capacity and velocity as well as the intended operating and planned duty cycles.

The handling regulations for vacuum positioning systems are just as important as the design principles. Cleanrooms are available for assembling larger parts. Suitable packaging and the corresponding instructions for the recipient are part of shipping.

Vacuum chambers are available in several sizes with vacuum levels down to $10^{-10}$ hPa, where start-up and measurement of outgassing, but also interferometric measuring of position accuracy under real operating conditions is possible.

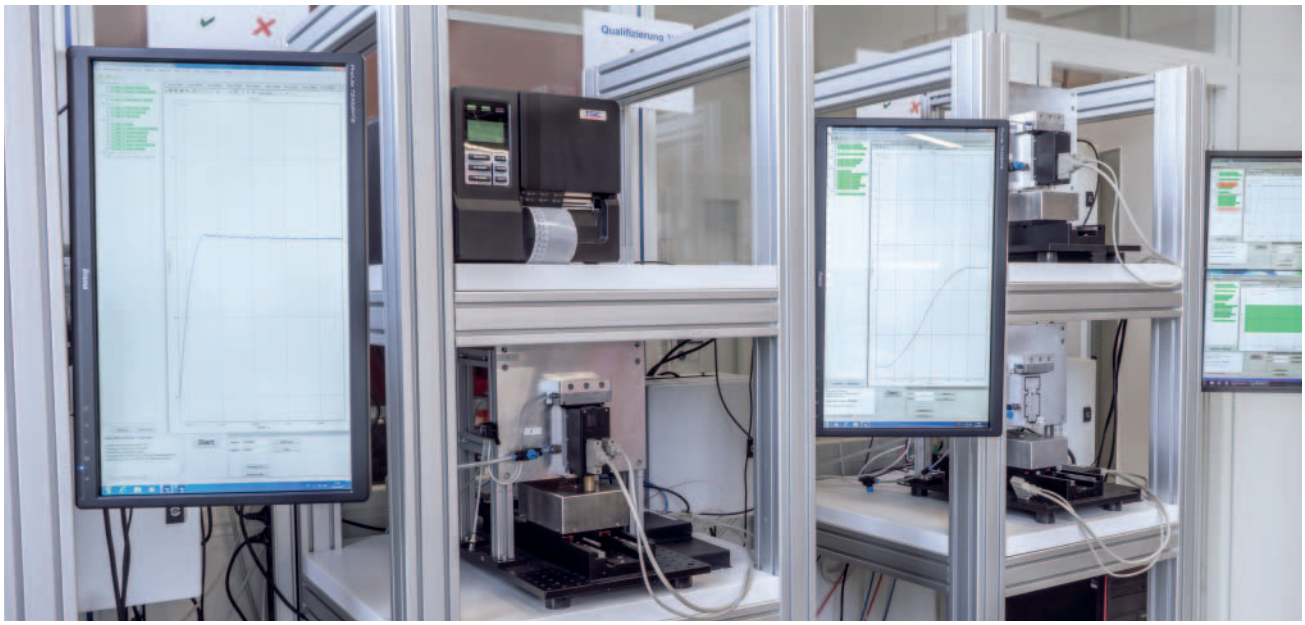
At PI, several vacuum chambers are available in various different sizes

# From 1-off to Series:
# OEM Users Benefit From Maximum Flexibility

PI serves both the research and industrial markets. The complete control over the design and manufacturing process provides our customers with significant competitive advantages. Optimized processes allow PI to deliver customized products in quantities up to several 100,000 units per year at low cost and right on time. The range of OEM products offered by the PI Group varies widely, ranging from "bare" actuators and sensors to highly integrated parallel-kinematic positioning systems. Evaluation of pre-production run samples, test procedures, production processes and quality management are all included in the development process.

**Services**

- Global account management: Close proximity to the customer thanks to international presence
- Risk assessment from design to delivery
- Depending on the task: From the drive to the turnkey system
- Copy exactly policy
- Preparation of internal and external certification
- Production of series of several 10,000 units in the shortest time
- Sustainable spare parts service
- Manufacturing and testing capacities from functional samples to mass production



Standardized performance control with full documentation of individual measurement charts

# Global Service and After-Sales

On-site training is key to optimize and maximize the potential of new PI systems

**Start-Up, User Training and Life Long Support**

PI is dedicated to supporting its customers right from the initial consultation through to when a customer has purchased a PI system. Beyond that, PI's services division is committed to ensuring that every aspect of owning a PI system is catered for.

**Global Coverage**

Supported by 4 Global Service Hubs in Asia, China, Europe and USA, with field product specialists working from these hubs, PI is able to support all technologies and customer applications via this global services team.

**PI's Standard On-Site Services**

- Set up and Commissioning – On-site support to un-box, set-up and commission the PI system
- Training Program – User training on software and programming, through to optimization of system performance
- Maintenance Systems Health Check – Preventative maintenance to prolong the life of the motion device
- Support – Ongoing remote and on-site support to maximize system uptime and provide maintenance for the whole life of any system

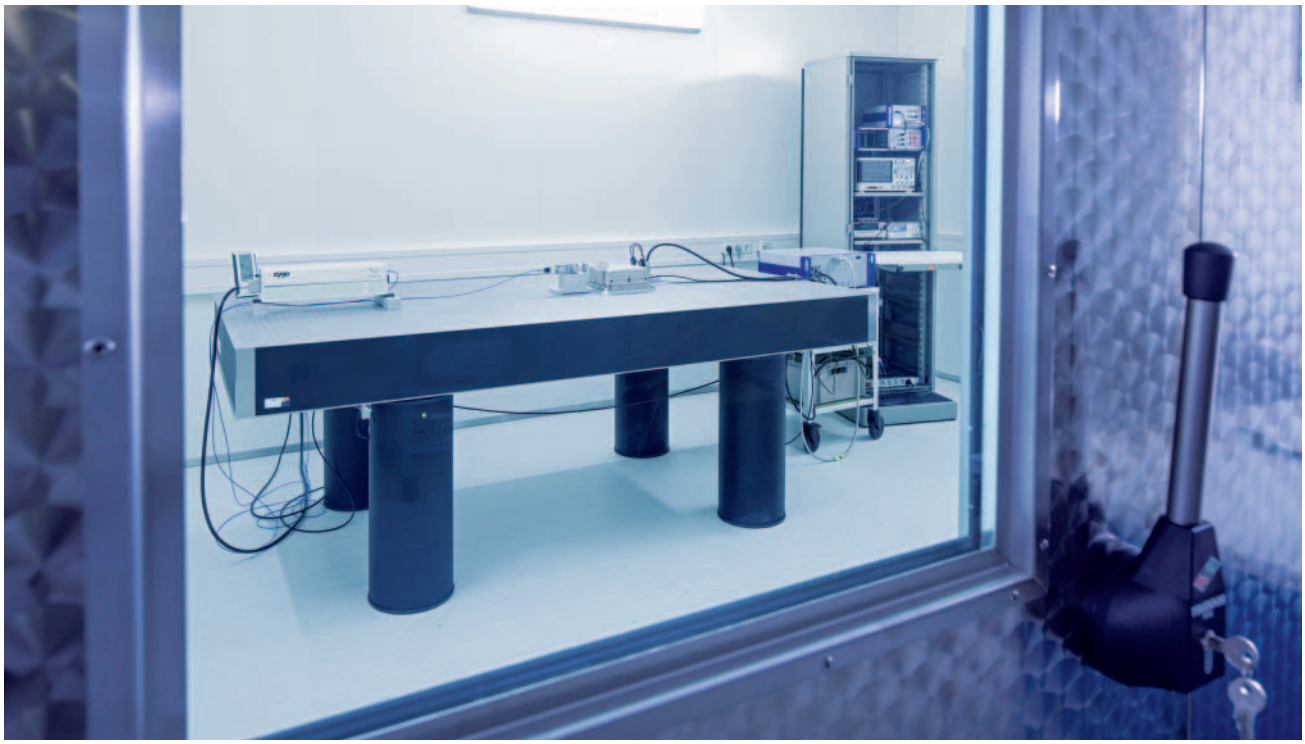
**Contracted Services**

Customers subscribing to Contractual Support Services will receive commitment from PI to achieving agreed Service Levels. These include responding to the customer's first contact and providing remote technical support, through to response times for a PI expert to be on site, either to repair or replace a defective unit.

**Extended Warranty**

Most customer applications require PI's systems to be operational beyond the standard warranty period. Extending the warranty for additional year(s), is simply extending the customers peace of mind and PI's commitment that the product will not fail due to poor workmanship or faulty materials. Should a customer's system then fail due to these conditions, PI will cover the costs to repair or replace it.

# What to Expect from PI Piezo Systems



View of a nanometrology laboratory with six-fold insulation. Qualifying is done here fully automatically under controlled ambient conditions

**Fully Equipped System with Comprehensive Scope of Delivery**

PI attaches great importance to usability, conformity to specifications and ease of initial startup of their piezo systems. To achieve this, each piezo system only leaves the factory when it is ready for immediate use and together with a main specification protocol. The scope of delivery includes the following essential components:

- Typically, the hardware consists of the piezo stage, all suitable cabling, and the piezo controller. In case a separate power supply is required, it is also part of the package. Communication cables are included for each available interface.
- The detailed user documentation clearly explains the functions and handling instructions.
- Digital piezo controllers come with an extensive software package. For easy startup and system configuration, the PIMikroMove® utility program is included in the scope of delivery. Connection to the customer's software is possible via LabVIEW drivers and shared libraries / DLLs. An outstanding feature is that system programming is identical for all PI controllers – combined control of a variety of different controllers is therefore possible without any problems. All parameters can be set and checked via software.

### Individually Calibrated Systems

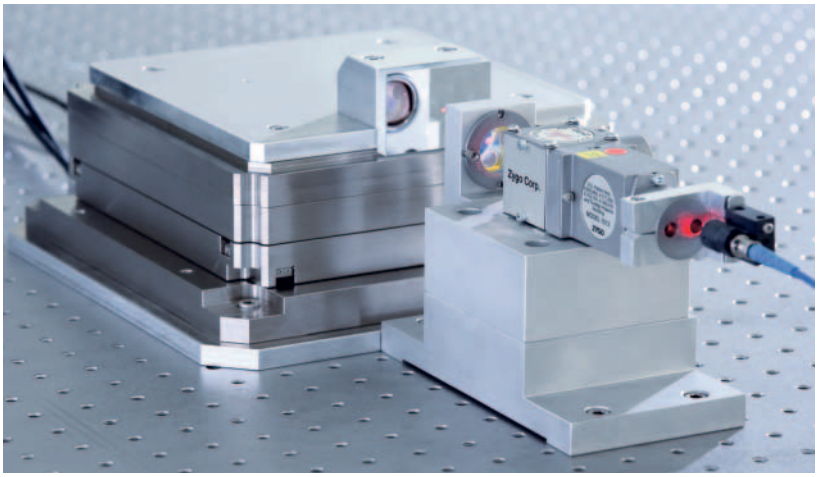
Each piezo system undergoes full testing and control before shipping. The piezo stage and controller are calibrated together as standard. Therefore, optimal interaction and performance of electronics and mechanics is guaranteed. All calibration data can be determined according to the particular application and applied payload. Additional tuning at the customer's site is therefore not necessary. These comprehensive services are already included in the scope of delivery.

### Controller Compatibility With ID Chip

Many of PI's piezo systems use an ID chip integrated in the stage that contains the active parameter set. These stages can be combined with any PI digital piezo controller. The reliability and uptime of production processes can thereby be optimized, because recalibration of the stage is not necessary e.g., when the controller needs a software update. This service is always part of the scope of delivery.

### Matching of Piezo Systems

With piezo stages that do not contain an ID chip or with analog piezo controllers, the stage and electronics are matched to a fixed pair. Tuning of all operation parameters is done at the factory under full monitoring of specifications. Optimization for customer-specific loads and application-related features can be done on request.



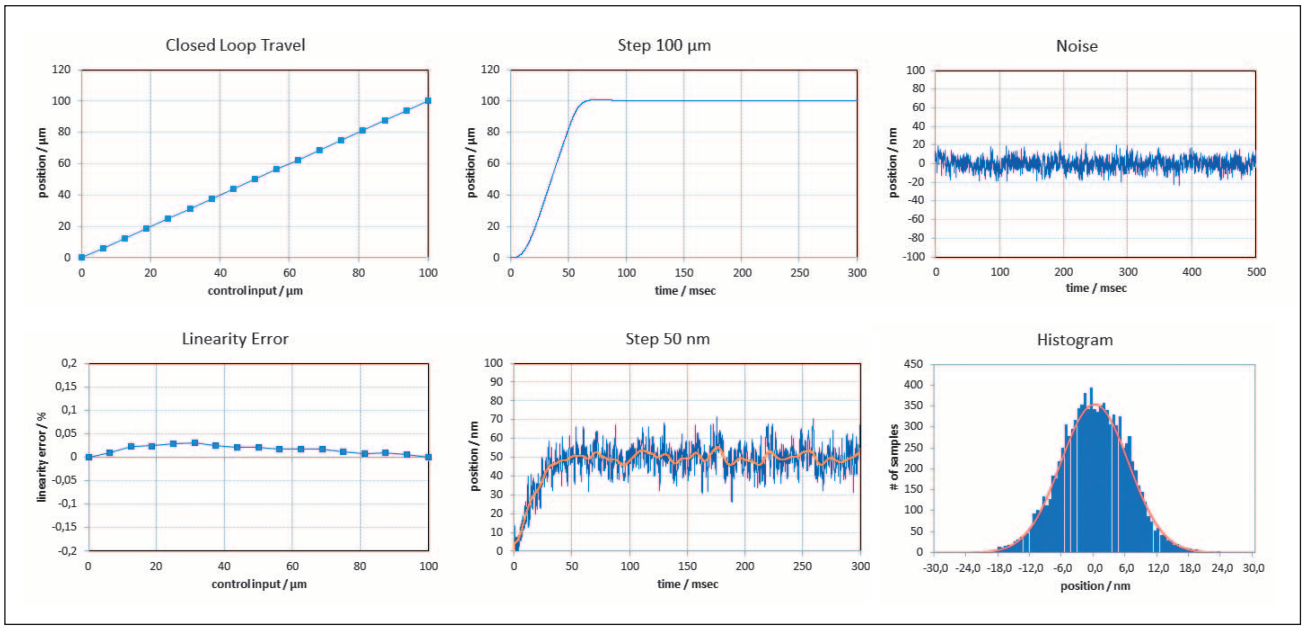
Retraceable metrology equipment is the key to calibration with sub-nanometer accuracy

**Measurement Reports and Logs for Piezo Systems**

For PI, each individual measurement and qualification is an instrument for quality assurance. This makes sure that only those positioning systems leave the premises that are within the guaranteed specifications. All measurements are made with external, verifiable measuring equipment such as high-resolution interferometers, CMMs or other suitable tactile or optical metrology equipment.

The qualification data is verifiable for each individual product. The measurement data is compiled in a database and used for process control. Retraceability at product level is particularly interesting for large production runs.

The measurement log is provided with piezo systems. It is therefore possible for the customer to verify the performance of the system with the data measured before it was dispatched and also see which system components are paired or which data set is used within the ID chip.




A typical measurement log for a closed-loop nanopositioning system contains data and diagrams on the positioning accuracy, linearity error, settling behavior, and noise. Therefore, the customer can always be sure that he receives a product exactly compliant to the requested specifications.

**Reliability and Service for OEM Customers**

OEM customers benefit from PI's special service.
Individual arrangements in various areas can be agreed, such as:

- „Copy exactly" agreements
- Spare part availability beyond normal warranty time
- Safety stock for flexible deliveries and back up scenarios
- Integration of customer supply
- Customized packaging, e.g., of preconfigured systems
- Individual labeling of stages or cables

**Cables: Stage (LEMO) to Electronics (Sub-D)**

| | |
|---|---|
| **P-895.1LDC** | Adapter cable LEMO to Sub-D 7W2 (m) for piezo actuator nanopositioning systems with capacitive sensors, 1 channel, 0.3 m. Fits motion controllers with Sub-D 7W2 (f) connector |
| **P-895.3LDC** | Adapter cable LEMO to Sub-D 25W3 (m) for piezo actuator nanopositioning systems with capacitive sensors, 3 channels, 0.3 m. Fits motion controllers with Sub-D 25W3 (f) connector |
| **P-895.4LDS** | Adapter cable LEMO to Sub-D 37 (m) for piezo actuators and piezo actuator nanopositioning systems with strain gauge sensors, 4 channels, 0,3 m. Fits motion controllers with Sub-D 37 (f) connector |

**Cables: Stage (Sub-D) to Electronics (LEMO)**

| | |
|---|---|
| **P-895.1DLC** | Adapter cable Sub-D 7W2 (f) to LEMO for piezo actuator nanopositioning systems with capacitive sensors, 1 channel, 0.3 m. Fits controllers with LEMO connectors (1 × Voltage, 2 × Sensor) |
| **P-895.3DLC** | Adapter cable Sub-D 25W3 (f) to LEMO for piezo actuator nanopositioning systems with capacitive sensors, 3 channels, 0.3 m. Fits motion controllers with LEMO connectors (up to 3 × voltage, 6 × sensor) |
| | |

**Cables: Stage (Sub-D) to Electronics (Sub-D)**

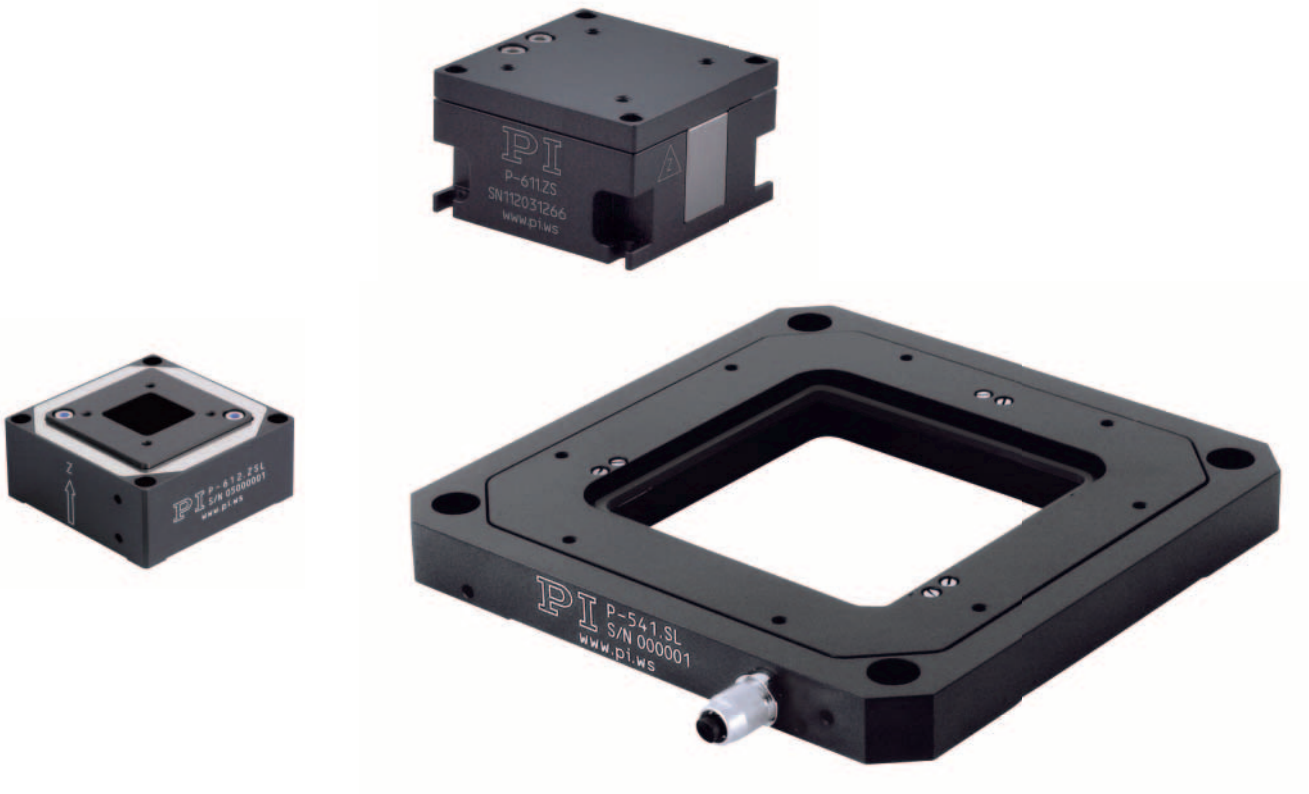
| | |
|---|---|
| **P-895.2D1DDC** | Adapter cable Sub-D 25W3 (f) and Sub-D 7W2 (f) to Sub-D 25W3 (m) for piezo actuator nanopositioning systems with capacitive sensors, 3 channels, 0.3 m. Suitable for controllers with Sub-D 25W3 socket |
| **P-895.2DDC** | Adapter cable 2 × Sub-D 7W2 (f) to Sub-D 25W3 (m) for piezo actuator nanopositioning systems with capacitive sensors, 2 channels, 0.3 m. Suitable for controllers with Sub-D 25W3 socket |
| **P-895.3DDC** | Adapter cable 3 × Sub-D 7W2 (f) to Sub-D 25W3 (m) for piezo actuator nanopositioning systems with capacitive sensors, 3 channels, 0.3 m. Suitable for controllers with Sub-D 25W3 socket |

**More Accessories**

All PI piezo systems are delivered with a complete and appropriate cable set. The cable length is noted in the data sheet. Additionally, cables can be ordered separately, see lists below.

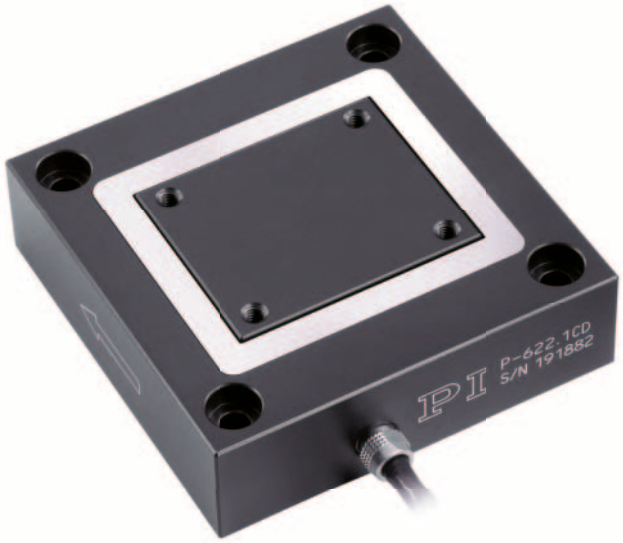
On request, it is possible to adapt the length of cable sets and material or provide other featwures. For special environments such as clean rooms or vacuum, PI provides a range of accessories, e.g., feedthroughs and dedicated cables. For optimal system performance, it is recommended to obtain all accessories from PI.

# Nanopositioning Piezo Stages



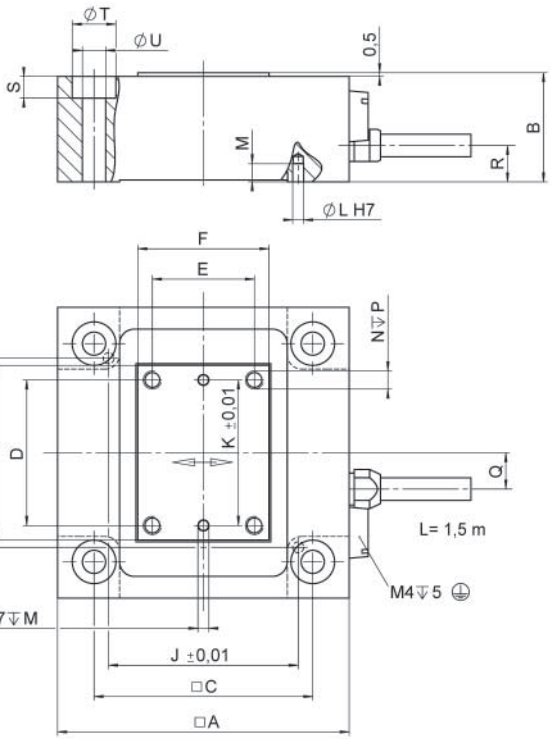
# P-620.1 / P-629.1
# PIHera Piezo Linear Stage System

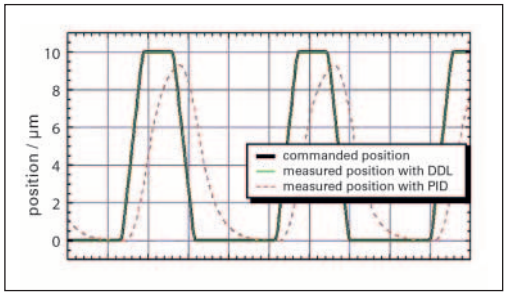
## Variable Travel Ranges and Axis Configuration




- Travel ranges 50 to 1800 µm
- Resolution to 0.1 nm
- Linearity error 0.02 %
- Direct metrology with capacitive sensors
- X, XY, Z, XYZ versions

P-62x.1CD / .1CL / .10L / .1UD, dimensions in mm.




Rapid scanning motion of a P-621.1CD (commanded rise time 5 ms) with the E-710 controller and Digital Dynamic Linearization (DDL) option. DDL virtually eliminates the tracking error (<20 nm) during the scan. The improvement over a classical PID controller is up to 3 orders of magnitude, and increases with the scanning frequency.

| | A | B | C | D | E | F | G | H | J | K | Ø L | M | N | P | Q | R | S | Ø T | Ø U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P-620.1CD / 10L | 30 | 12 | 24 | 15 | 30 | 15 | 18 | 19 | 24 | 15 | 1,01 | 1,5 | M2 | 4 | 4,5 | 6 | 2 | 4,4 | 2,2 |
| P-621.1CD / 10L | 40 | 15 | 30 | 20 | 40 | 18 | 24 | 26 | 26 | 20 | 1,51 | 2,5 | M2,5 | 5 | 5 | 5 | 3 | 6 | 3,2 |
| P-622.1CD / 10L | 50 | 15 | 40 | 24 | 50 | 25 | 30 | 35 | 35 | 24 | 1,51 | 2,5 | M2,5 | 5 | 5,5 | 5 | 3 | 6 | 3,2 |
| P-625.1CD / 10L | 60 | 15 | 50 | 40 | 60 | 32 | 44,5 | 46 | 46 | 40 | 1,51 | 2,5 | M2,5 | 5 | 5,5 | 5 | 15 | 6 | 3,2 |
| P-628.1CD / 10L | 80 | 17 | 70 | 58 | 80 | 45 | 63 | 66 | 66 | 58 | 1,51 | 2,5 | M2,5 | 5 | 5,5 | 5 | 3 | 6 | 3,2 |
| P-629.1CD / 10L | 100 | 22,5 | 90 | 60 | 100 | 60 | 84 | 82 | 82 | 60 | 2,01 | 3,5 | M2,5 | 5 | 10 | 7,5 | 4 | 8 | 4,2 |

**Applications**

- Interferometry
- Microscopy
- Nanopositioning
- Biotechnology
- Testing
- Semiconductor technology
- Photonics
- Fiber positioning


>> Capacitive Feedback Sensors
>> Direct Metrology
>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

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| | P-620.1CD / P-620.1CL | P-621.1CD / P-621.1CL | P-622.1CD / P-622.1CL | P-625.1CD / P-625.1CL | P-628.1CD / P-628.1CL | P-629.1CD / P-629.1CL | Unit | Tolerance |
|---|---|---|---|---|---|---|---|---|
| Active axes | X | X | X | X | X | X | | |
| **Motion and positioning** | | | | | | | | |
| Integrated sensor | Capacitive | Capacitive | Capacitive | Capacitive | Capacitive | Capacitive | | |
| Open-loop travel range, –20 to 120 V | 60 | 120 | 300 | 600 | 950 | 1800 | µm | +20 % / –0 % |
| Closed-loop travel range | 50 | 100 | 250 | 500 | 800 | 1500 | µm | |
| Closed-loop / open-loop resolution | 0.2 / 0.1 | 0.4 / 0.2 | 0.7 / 0.4 | 1.4 / 0.5 | 1.8 / 0.5 | 3 / 2 | nm | typ. |
| Linearity error, closed-loop | 0.02 | 0.02 | 0.02 | 0.03 | 0.03* | 0.03** | % | typ. |
| Repeatability | ±1 | ±1 | ±1 | ±5 | ±10 | ±14 | nm | typ. |
| Pitch / yaw | ±3 | ±3 | ±3 | ±6 | ±6 | ±30 / ±10 | µrad | typ. |
| **Mechanical properties** | | | | | | | | |
| Stiffness in motion direction | 0.42 | 0.35 | 0.2 | 0.1 | 0.12 | 0.13 | N/µm | ±20 % |
| Resonant frequency, no load | 1100 | 800 | 400 | 215 | 125 | 125 | Hz | ±20 % |
| Resonant frequency, under load, 20 g | 550 | 520 | 340 | 180 | 115 | 120 | Hz | ±20 % |
| Resonant frequency, under load, 120 g | 260 | 240 | 185 | 110 | 90 | 110 | Hz | ±20 % |
| Compressive / tensile stress capacity in motion direction | 10 | 10 | 10 | 10 | 10 | 10 | N | max. |
| Load capacity | 10 | 10 | 10 | 10 | 10 | 10 | N | max. |
| Lateral force | 10 | 10 | 10 | 10 | 10 | 8 | N | max. |
| **Drive properties** | | | | | | | | |
| Piezo ceramic | PICMA® P-883 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-887 | PICMA® P-888 | | |
| Electrical capacitance | 0.35 | 1.5 | 3.1 | 6.2 | 19 | 52 | µF | ±20 % |
| **Miscellaneous** | | | | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | | |
| Dimensions | 30 mm × 30 mm × 12 mm | 40 mm × 40 mm × 15 mm | 50 mm × 50 mm × 15 mm | 60 mm × 60 mm × 15 mm | 80 mm × 80 mm × 17 mm | 100 mm × 100 mm × 22.5 mm | | |
| Mass | 0.11 | 0.16 | 0.2 | 0.24 | 0.38 | 0.72 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | m | ±10 mm |
| Sensor / voltage connection | CD versions: Sub-D 7W2 CL versions: LEMO | CD versions: Sub-D 7W2 CL versions: LEMO | CD versions: Sub-D 7W2 CL versions: LEMO | CD versions: Sub-D 7W2 CL versions: LEMO | CD versions: Sub-D 7W2 CL versions: LEMO | CD versions: Sub-D 7W2 CL versions: LEMO | | |
| Recommended electronics | E-503, E-505, E-610, E-621, E-625, E-665, E-709, E-754 | E-503, E-505, E-610, E-621, E-625, E-665, E-709, E-754 | E-503, E-505, E-610, E-621, E-625, E-665, E-709, E-754 | E-503, E-505, E-610, E-621, E-625, E-665, E-709, E-754 | E-503, E-505, E-610, E-621, E-625, E-665, E-709, E-754 | E-503, E-505, E-610, E-621, E-625, E-665, E-709, E-754 | | |

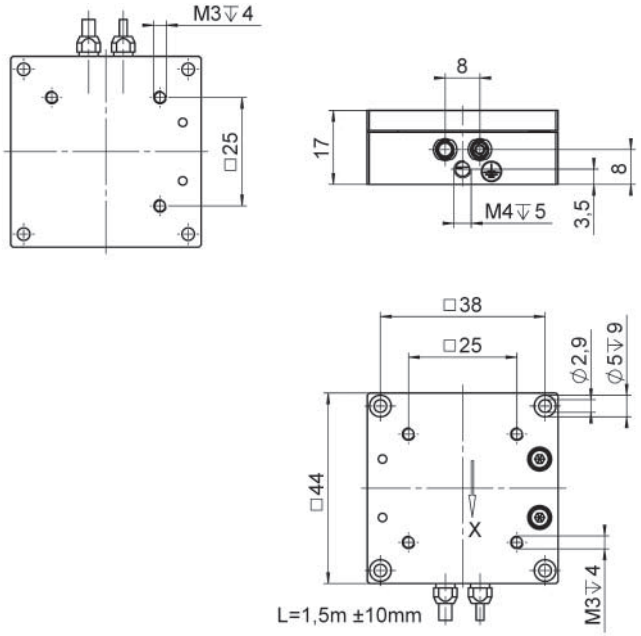
Versions without sensor are available under the P-62x.10L ordering number; operating temperature range -20 to 150 °C. Sensor / voltage connection LEMO.
Vacuum versions to $10^{-9}$ hPa are available as P-62x.1UD.
The resolution of PI piezo nanopositioners is not limited by friction or stiction. Value given as noise with E-710 digital controller.
* With digital controller. With analog controllers 0.05 %
** With digital controller. With analog controllers 0.08 %
All specifications based on room temperature (22 °C ±3 °C).

# P-611.1 Linear Piezo Positioning System

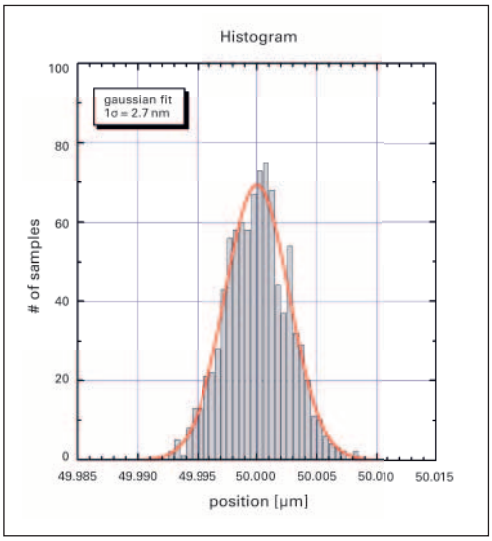
## Cost-Effective, Compact Linear Positioning System


- Compact design: Footprint 44 mm × 44 mm
- Travel range 120 µm
- Resolution to 0.2 nm
- Cost-effective mechanics / electronics system configurations
- Outstanding lifetime due to PICMA® piezo actuators
- Z stage, XY, XZ and XYZ versions available

P-611.2S, dimensions in mm.




P-611.1S repeatability equals 2.7 nm




**Applications**

- Microscopy
- Nanopositioning
- Biotechnology
- Testing
- Semiconductor technology
- Photonics
- Fiber positioning


>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators

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| | P-611.1S | P-611.10 | Unit | Tolerance |
|---|---|---|---|---|
| Active axes | X | X | | |
| **Motion and positioning** | | | | |
| Integrated sensor | SGS | – | | |
| Open-loop travel, –20 to +120 V | 120 | 120 | µm | +20 % / –0 % |
| Closed-loop travel | 100 | – | µm | |
| Open-loop resolution | 0.2 | 0.2 | nm | typ. |
| Closed-loop resolution | 2 | – | nm | typ. |
| Linearity error, closed-loop | 0.1 | – | % | typ. |
| Repeatability | <10 | – | nm | typ. |
| Pitch | ±5 | ±5 | µrad | typ. |
| Yaw | ±20 | ±20 | µrad | typ. |
| Flatness | 10 | 10 | nm | typ. |
| **Mechanical properties** | | | | |
| Stiffness in motion direction | 0.2 | 0.2 | N/µm | ±20 % |
| Unloaded resonant frequency | 400 | 400 | Hz | ±20 % |
| Resonant frequency at 30 g | 300 | 300 | Hz | ±20 % |
| Resonant frequency at 100 g | 195 | 195 | Hz | ±20 % |
| Push / pull force capacity in motion direction | 15 / 10 | 15 / 10 | N | max. |
| Load capacity | 15 | 15 | N | max. |
| **Drive properties** | | | | |
| Ceramic type | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 1.5 | 1.5 | µF | ±20 % |
| **Miscellaneous** | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum, steel | Aluminum, steel | | |
| Dimensions | 44 mm × 44 mm × 17 mm | 44 mm × 44 mm × 17 mm | | |
| Mass | 0.135 | 0.135 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | m | ±10 mm |
| Voltage connection | LEMO | LEMO | | |
| Sensor connection | LEMO | – | | |
| Recommended electronics | E-503, E-505, E-610, E-621, E-625, E-665, E-836 | E-503, E-505, E-610, E-621, E-625, E-665, E-836 | | |

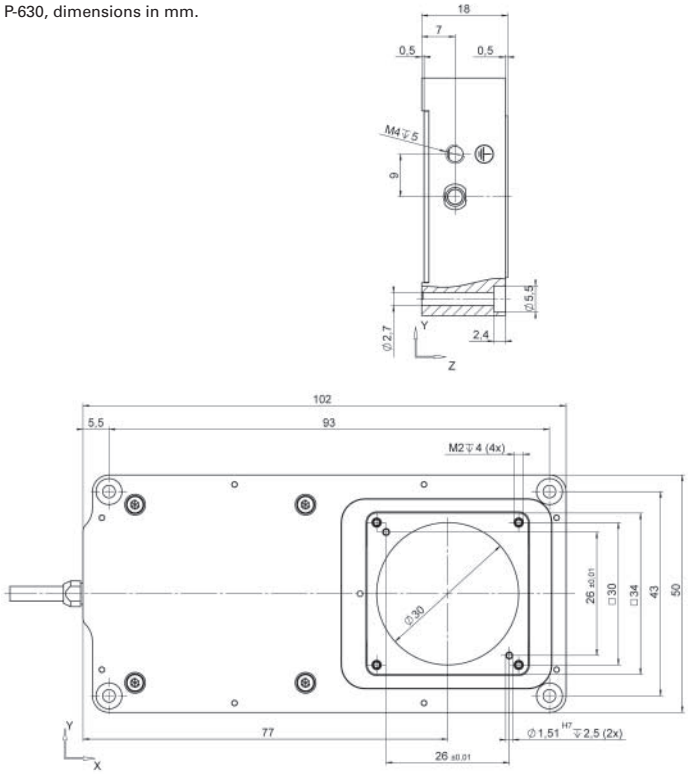
The resolution of PI piezo nanopositioners is not limited by friction or stiction. Noise equivalent motion with E-503 amplifier.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

# P-630 High-Dynamics Nanopositioning System

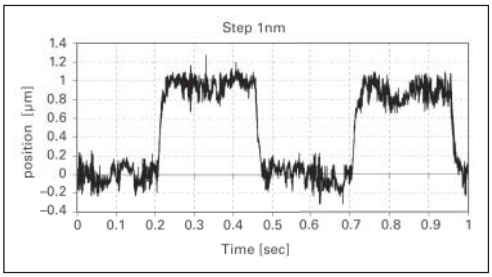
## 1 Axis with Large Clear Aperture

- Resonant frequency to 3.25 kHz
- Travel ranges to 80 µm
- Small footprint and low-profile height
- Clear aperture with 30 mm diameter

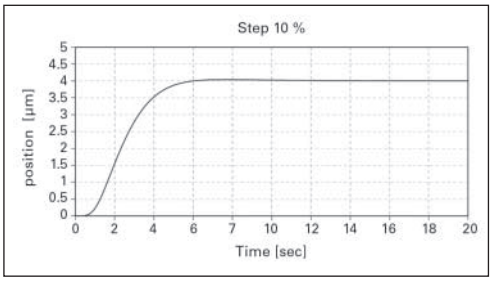
P-630, dimensions in mm.




The smallest resolvable step size of P-630.XCD with E-753.1CD digital controller is below one nm. Measured externally with a laser interferometer.




The settling time for P-630.XCD is less than 6 ms with 1 % accuracy and a 4 µm step.




**Applications**

- Optical alignment
- Microscopy
- Biotechnology
- Photonics
- Fiber positioning


>> Capacitive Feedback Sensors
>> Direct Metrology
>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

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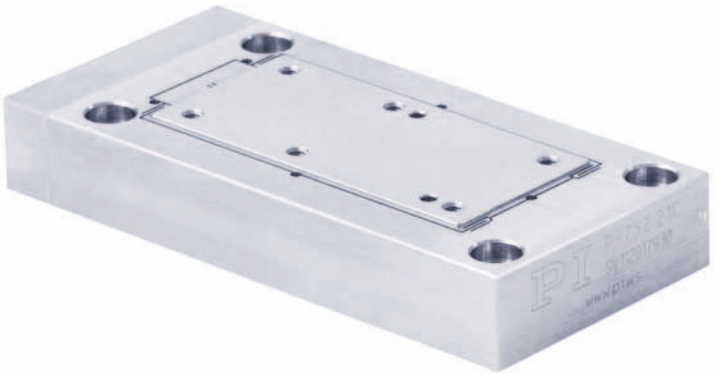
| | P-630.XCD | P-631.XCD | Unit |
|---|---|---|---|
| Active axes | X | X | |
| **Motion and positioning** | | | |
| Integrated sensor | Capacitive | Capacitive | |
| Open-loop travel, –20 to 120 V | 45 | 90 | µm |
| Closed-loop travel | 40 | 80 | µm |
| Open-loop resolution | 0.1 | 0.1 | nm |
| Closed-loop resolution | 0.2 | 0.2 | nm |
| Closed-loop nonlinearity | 0.02 | 0.02 | % |
| Repeatability over the entire travel range | ±2 | ±3 | nm |
| Pitch / yaw | ±5 | ±5 | µrad |
| Straightness / flatness | 50 | 50 | nm |
| **Mechanical properties** | | | |
| Stiffness in motion direction | 5.5 | 5 | N / µm |
| Unloaded resonant frequency | 3250 | 2850 | Hz |
| Resonant frequency at 60 g | 1600 | 1200 | Hz |
| Push / pull force capacity in motion direction | 10 | 10 | N |
| Load capacity | 10 | 10 | N |
| **Drive properties** | | | |
| Piezo ceramic | PICMA® P-887 | PICMA® P-885; P-887 | |
| Electrical capacitance | 6.4 | 12.6 | µF |
| **Miscellaneous** | | | |
| Operating temperature range | 0 to 40 | 0 to 40 | °C |
| Material | Aluminum | Aluminum | |
| Dimensions | 102 mm × 50 mm × 18 mm | 102 mm × 50 mm × 18 mm | |
| Mass | 300 | 320 | g |
| Cable length | 1.5 | 1.5 | m |
| Sensor / voltage connection | Sub-D 7W2 (m) | Sub-D 7W2 (m) | |
| Recommended electronics | E-709, E-709.CHG, E-754 | E-709, E-709.CHG, E-754 | |

All specifications based on room temperature (22 °C ±3 °C).

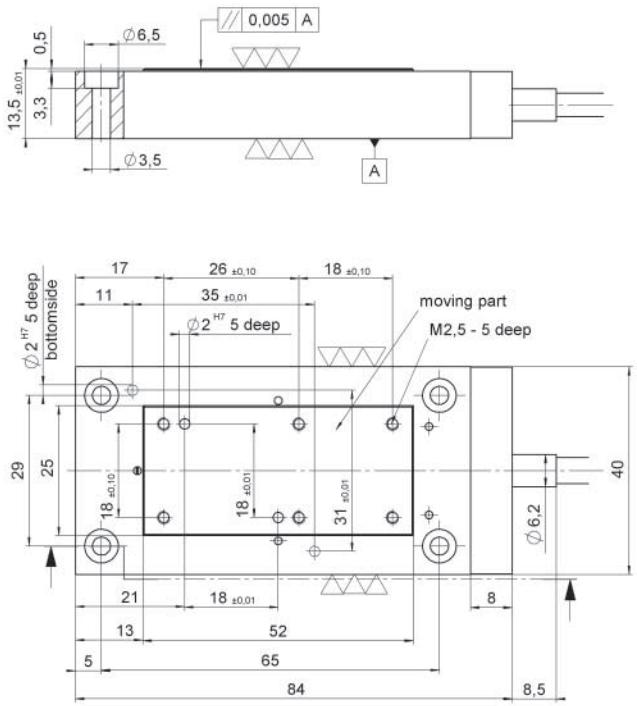
# P-752 High Precision Nanopositioning Stage

## High-Dynamics, Very Stable Piezo Scanner with Extreme Guiding Accuracy

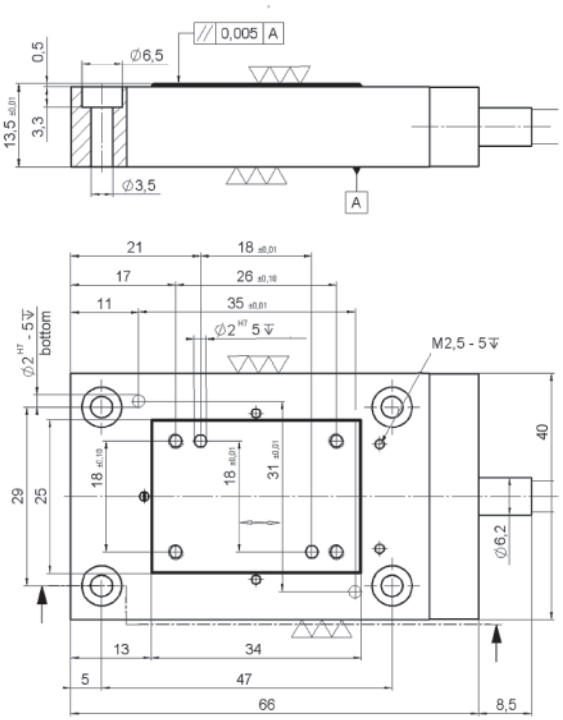


- Resolution 0.1 nm
- Rapid response
- Travel range to 35 µm
- Highest linearity due to capacitive sensors
- Frictionless flexure guides for very high travel accuracy
- Outstanding lifetime due to PICMA® piezo actuators

P-752.2xx, dimensions in mm.




P-752.1xx, dimensions in mm.




**Applications**

- Scanning microscopy
- Metrology
- Testing and quality processes
- Photonics
- Fiber positioning


>> Capacitive Feedback Sensors
>> Direct Metrology
>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators

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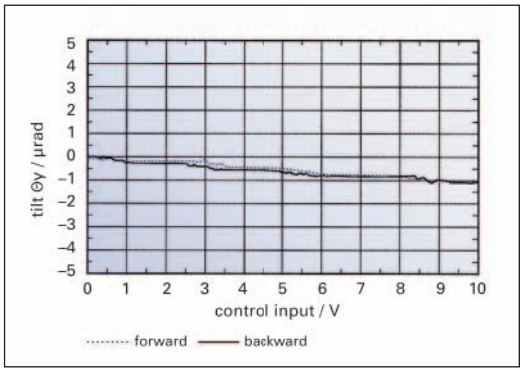
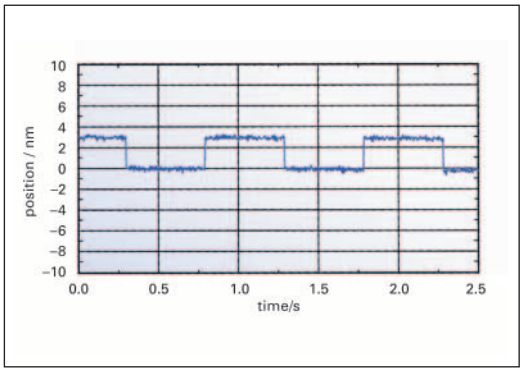
| | P-752.11C | P-752.1CD | P-752.21C | P-752.2CD | Units | Tolerance |
|---|---|---|---|---|---|---|
| Active axes | X | X | X | X | | |
| **Motion and positioning** | | | | | | |
| Integrated sensor | Capacitive | Capacitive | Capacitive | Capacitive | | |
| Open-loop travel, –20 to +120 V | 20 | 20 | 35 | 35 | µm | +20 % / –0 % |
| Closed-loop travel | 15 | 15 | 30 | 30 | µm | |
| Closed-loop / open-loop resolution | 0.1 | 0.1 | 0.2 | 0.2 | nm | typ. |
| Closed-loop linearity error | 0.03 | 0.03 | 0.03 | 0.03 | % | typ. |
| Repeatability | ±1 | ±1 | ±2 | ±2 | nm | typ., full travel |
| Pitch / yaw | ±1 | ±1 | ±1 | ±1 | µrad | typ. |
| **Mechanical properties** | | | | | | |
| Stiffness in motion direction | 30 | 30 | 20 | 20 | N/µm | ±20 % |
| Unloaded resonant frequency | 3200 | 3200 | 2100 | 2100 | Hz | ±20 % |
| Resonant frequency at 300 g | 980 | 980 | 600 | 600 | Hz | ±20 % |
| Push / pull force capacity in motion direction | 100 / 10 | 100 / 10 | 100 / 10 | 100 / 10 | N | max. |
| Load capacity | 30 | 30 | 30 | 30 | N | max. |
| **Drive properties** | | | | | | |
| Ceramic type | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 2.1 | 2.1 | 3.7 | 3.7 | µF | ±20 % |
| **Miscellaneous** | | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Steel | Steel | Steel | Steel | | |
| Dimensions | 66 mm × 40 mm × 13.5 mm | 66 mm × 40 mm × 13.5 mm | 84 mm × 40 mm × 13.5 mm | 84 mm × 40 mm × 13.5 mm | | |
| Mass | 0.25 | 0.25 | 0.35 | 0.35 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | 1.5 | 1.5 | m | ±10 mm |
| Sensor / voltage connection | LEMO | Sub-D 7W2 (m) | LEMO | Sub-D 7W2 (m) | | |
| Recommended electronics | E-505, E-610, E-625, E-665, E-754 | E-505, E-610, E-625, E-665, E-754 | E-505, E-610, E-625, E-665, E-754 | E-505, E-610, E-625, E-665, E-754 | | |

The resolution of PI piezo nanopositioners is not limited by friction or stiction. Value given is noise equivalent motion with E-503 amplifier.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!




Typical 0.5 µrad bidirectional trajectory repeatability (P-752.11C stage) means processes may be performed bidirectionally for twice the productivity.



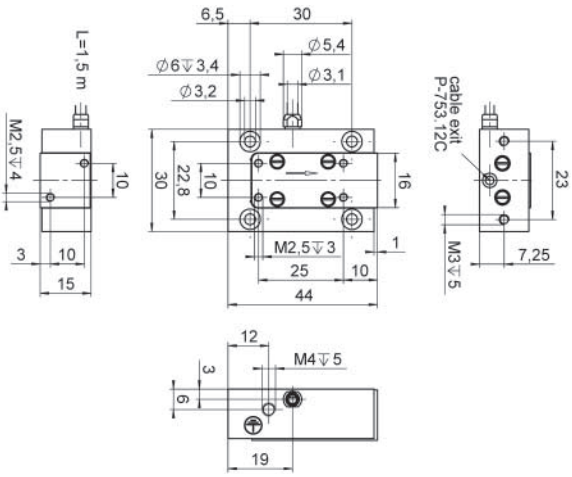

Response of a P-752.11C to a square wave control signal with 3 nm amplitude shows true sub-nm positional stability, incremental motion and bidirectional repeatability (measured with E-501 & E-503.00 & E-509.C1 controller, bandwidth set to 240 Hz).

# P-753 LISA Linear Actuator & Stage

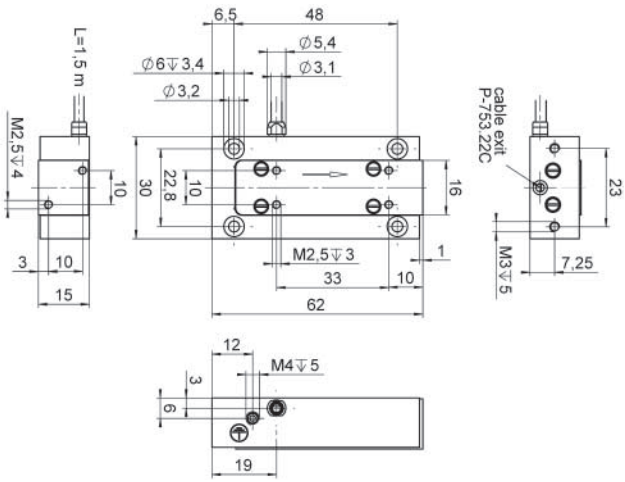
## High-Dynamics, Very Stable Piezo Nanopositioner


- Versatile design: Flexure stage or actuator
- Travel range to 38 µm
- Resolution 0.05 nm
- Non-magnetic versions available
- Direct-drive design for fastest response
- Highest linearity due to capacitive sensors

P-753.1, dimensions in mm.
Max. torque at M2.5 threads: 0.3 Nm.




P-753.2, dimensions in mm.
Max. torque at M2.5 threads: 0.3 Nm.




**Applications**

- Scanning microscopy
- Metrology
- Testing and quality processes
- Photonics
- Fiber positioning


>> Capacitive Feedback Sensors
>> Direct Metrology
>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

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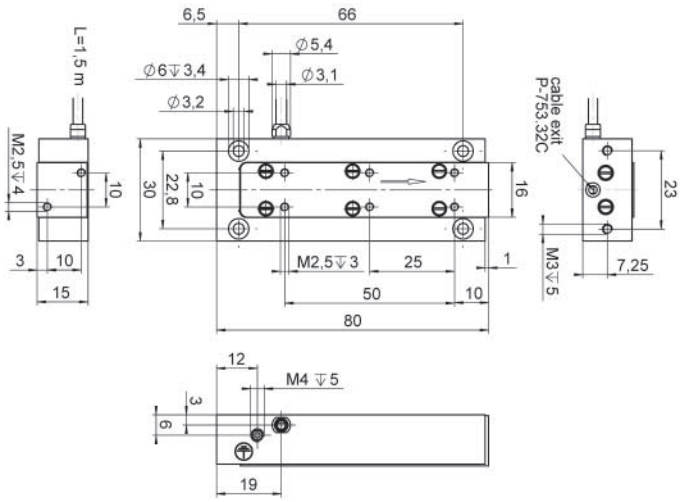
| | P-753.1CD | P-753.2CD | P-753.3CD | Unit | Tolerance |
|---|---|---|---|---|---|
| Active axes | X | X | X | | |
| **Motion and positioning** | | | | | |
| Integrated sensor | Capacitive | Capacitive | Capacitive | | |
| Closed-loop travel | 12 | 25 | 38 | µm | |
| Closed-loop / open-loop resolution | 0.05 | 0.1 | 0.2 | nm | typ., full travel |
| Linearity error, closed-loop | 0.03 | 0.03 | 0.03 | % | typ. |
| Repeatability | ±1 | ±2 | ±3 | nm | typ. |
| Pitch / yaw | ±5 | ±7 | ±10 | µrad | typ. |
| **Mechanical properties** | | | | | |
| Stiffness in motion direction | 45 | 24 | 16 | N/µm | ±20 % |
| Unloaded resonant frequency | 5.6 | 3.7 | 2.9 | kHz | ±20 % |
| Resonant frequency at 200 g | 2.5 | 1.7 | 1.4 | kHz | ±20 % |
| Push / pull force capacity in motion direction | 100 / 20 | 100 / 20 | 100 / 20 | N | max. |
| Load capacity (vertical / horizontal mounting) | 10 / 2 | 10 / 2 | 10 / 2 | kg | max. |
| **Drive properties** | | | | | |
| Ceramic type | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 1.5 | 3.1 | 4.6 | µF | ±20 % |
| **Miscellaneous** | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Steel | Steel | Steel | | |
| Dimensions | 44 mm × 30 mm × 15 mm | 62 mm × 30 mm × 15 mm | 80 mm × 30 mm × 15 mm | | |
| Mass | 0.16 | 0.215 | 0.26 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | 1.5 | m | ±10 mm |
| Sensor / voltage connection | Sub-D 7W2 (m) | Sub-D 7W2 (m) | Sub-D 7W2 (m) | | |
| Recommended electronics | E-625 | E-625 | E-625 | | |

The resolution of PI piezo nanopositioning systems is not limited by friction or stiction.
Value given is noise-equivalent motion with the E-503 piezo amplifier module.
Versions with LEMO connector available as P-753.x1C.
Vacuum versions to $10^{-9}$ hPa are available under the following ordering number: P-753.xUD.
No-magnetic versions available as P-753.xND.
All specifications based on room temperature (22 °C ±3 °C).

P-753.3, dimensions in mm.
Max. torque at M2.5 threads: 0.3 Nm.

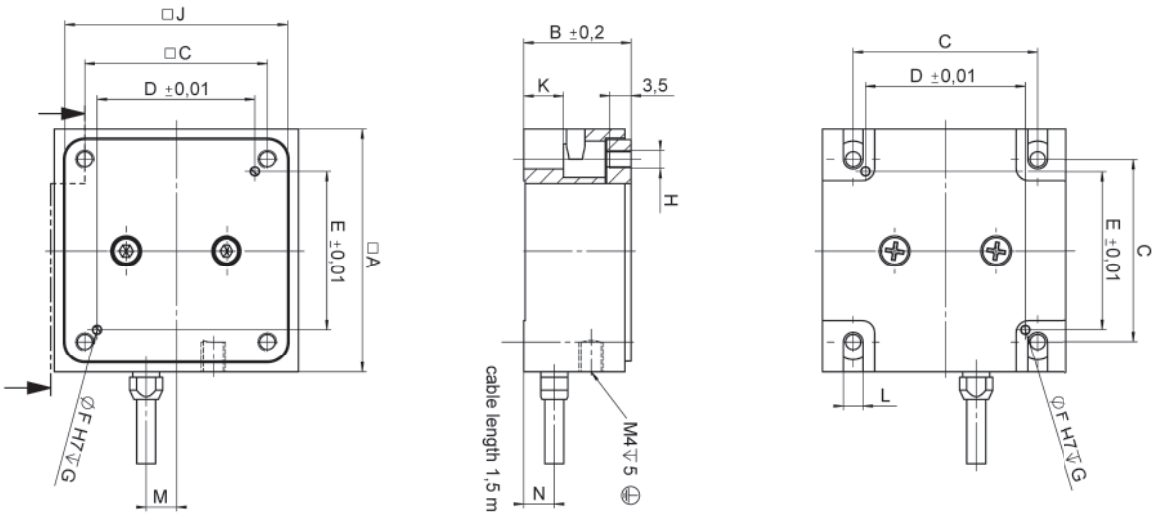


# P-620.Z / P-622.Z PIHera Precision Z-Stage

## Variable Travel Ranges and Axis Configuration


- Travel ranges 50 µm to 250 µm (400 µm open-loop)
- Resolution to 0.1 nm
- Positioning accuracy 0.02 %
- Direct metrology with capacitive sensors
- X, XY, Z, XYZ versions

P-62x.ZCD / .ZCL / .Z0L, dimensions in mm.




| | A | B | C | D | E | Ø F | G | H | J | K | L | M | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P-620.ZCD / Z0L | 30 | 12 | 24 | 19 | 24 | 1,01 | 2 | M2 | 28 | 5 | 2,2 | 4,5 | 6 |
| P-621.ZCD / Z0L | 40 | 17,5 | 30 | 26 | 26 | 1,51 | 2,5 | M3 | 36,5 | 6,5 | 3,2 | 5 | 5 |
| P-622.ZCD / Z0L | 50 | 17,5 | 40 | 35 | 35 | 1,51 | 2,5 | M3 | 46,5 | 6,5 | 3,2 | 5 | 5 |

**Applications**

- Interferometry
- Microscopy
- Nanopositioning
- Biotechnology
- Testing and quality processes
- Semiconductor technology


>> Capacitive Feedback Sensors
>> Direct Metrology
>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

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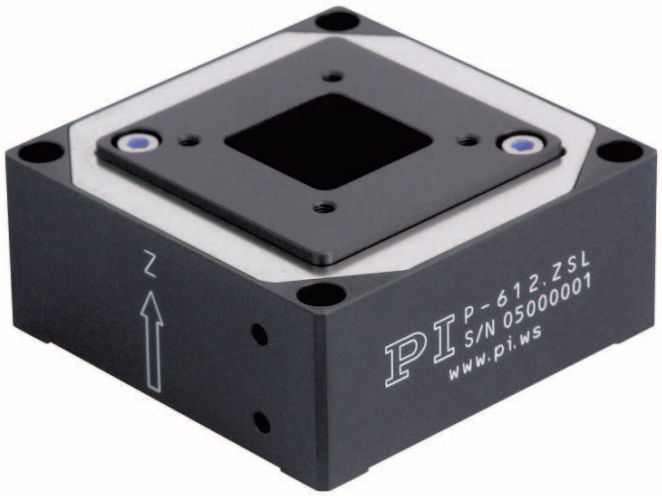
| | P-620.ZCD / P-620.ZCL | P-621.ZCD / P-621.ZCL | P-622.ZCD / P-622.ZCL | Unit | Tolerance |
|---|---|---|---|---|---|
| Active axes | Z | Z | Z | | |
| **Motion and positioning** | | | | | |
| Integrated sensor | Capacitive | Capacitive | Capacitive | | |
| Open-loop travel range, –20 to 120 V | 65 | 140 | 400 | µm | +20 % / –0 % |
| Closed-loop travel range | 50 | 100 | 250 | µm | |
| Open-loop resolution | 0.1 | 0.2 | 0.5 | nm | typ. |
| Closed-loop resolution | 0.2 | 0.3 | 1 | nm | typ. |
| Linearity error | 0.02 | 0.02 | 0.02 | % | typ. |
| Repeatability | ±1 | ±1 | ±1 | nm | typ. |
| Tilt $\theta_X$, $\theta_Y$ | <20 | <20 | <80 | µrad | typ. |
| **Mechanical properties** | | | | | |
| Stiffness | 0.5 | 0.6 | 0.24 | N/µm | ±20 % |
| Resonant frequency, no load | 1000 | 790 | 360 | Hz | ±20 % |
| Resonant frequency, under load, 30 g | 690 | 500 | 270 | Hz | ±20 % |
| Compressive / tensile stress capacity | 10 / 5 | 10 / 8 | 10 / 8 | N | max. |
| Load capacity | 10 | 10 | 10 | N | max. |
| Lateral force | 10 | 10 | 10 | N | max. |
| **Drive properties** | | | | | |
| Ceramic type | PICMA® P-883 | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 0.7 | 3 | 6.2 | µF | ±20 % |
| **Miscellaneous** | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | Aluminum | | |
| Dimensions | 30 mm × 30 mm × 15 mm | 40 mm × 40 mm × 17.5 mm | 50 mm × 50 mm × 17.5 mm | | |
| Mass | 0.12 | 0.17 | 0.24 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | 1.5 | m | ±10 mm |
| Sensor / voltage connection | CD versions: Sub D 7W2 (m) CL versions: LEMO | CD versions: Sub D 7W2 (m) CL versions: LEMO | CD versions: Sub D 7W2 (m) CL versions: LEMO | | |
| Recommended electronics | E-503, E-505, E 610, E-621, E 625, E-665, E-709, E-754 | E-503, E-505, E 610, E-621, E 625, E-665, E-709, E-754 | E-503, E-505, E 610, E-621, E 625, E-665, E-709, E-754 | | |

Versions without sensor are available as P-62x.Z0L; operating temperature range –20 to 150 °C. Voltage connection LEMO.
All specifications based on room temperature (22 °C ±3 °C).

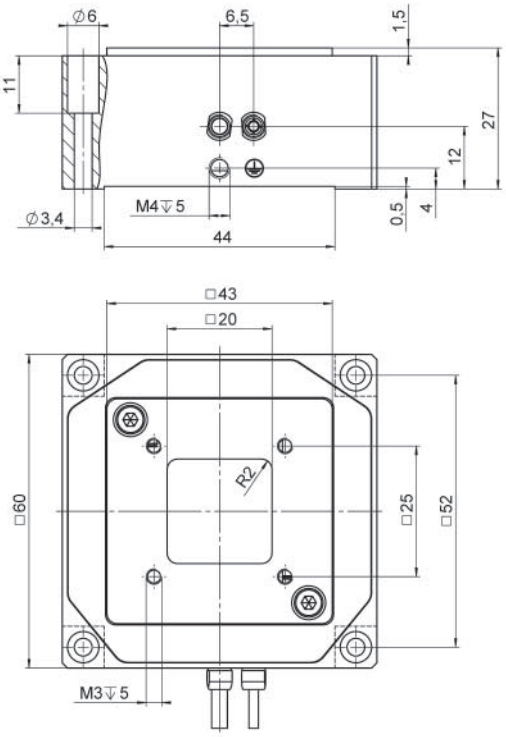
# P-612.Z Piezo Z Stage

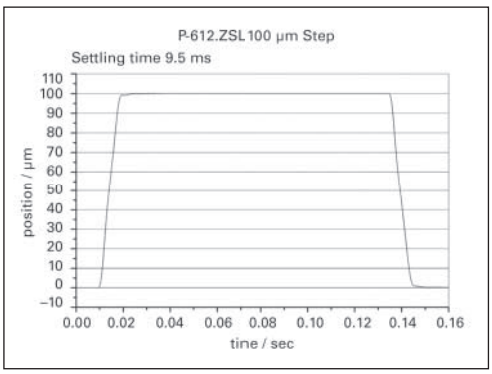
## Compact Nanopositioning Stage with Aperture




- Travel range 100 µm
- Resolution to 0.2 nm
- Linearity error 0.2 %
- Compact: Footprint 60 mm × 60 mm
- Very cost-effective controller / piezomechanics systems
- Zero-play, high-precision flexure guide system
- Outstanding lifetime due to PICMA® piezo actuators

P-612.Z, dimensions in mm.




Settling takes less than 10 ms over the entire travel range in closed-loop operation.

**Applications**

- Interferometry
- Microscopy
- Nanopositioning
- Biotechnology
- Testing and quality processes
- Semiconductor technology


>> **Flexure Guiding Systems**
>> **PICMA® Multilayer Piezo Actuators**

**Technology Glossary** ..... **page 240**

| | P-612.ZSL | P-612.Z0L | Unit | Tolerance |
|---|---|---|---|---|
| Active axes | Z | Z | | |
| **Motion and positioning** | | | | |
| Integrated sensor | SGS | – | | |
| Open-loop travel, –20 to +120 V | 110 | 110 | µm | +20 % / –0 % |
| Closed-loop travel range | 100 | – | µm | |
| Open-loop resolution | 0.2 | 0.2 | nm | typ. |
| Closed-loop resolution | 1.5 | – | nm | typ. |
| Linearity error, closed-loop | 0.2 | – | % | typ. |
| Repeatability | ±4 | – | nm | typ. |
| Runout $\theta_X$, $\theta_Y$ | ±10 | ±10 | µrad | typ. |
| Crosstalk in X, Y | ±20 | ±20 | µm | typ. |
| **Mechanical properties** | | | | |
| Stiffness in motion direction | 0.63 | 0.63 | N/µm | ±20 % |
| Resonant frequency, no load | 490 | 490 | Hz | ±20 % |
| Resonant frequency under load | 420 (30 g) | 420 (30 g) | Hz | ±20 % |
| Load capacity | 15 / 10 | 15 / 10 | N | max. |
| **Drive properties** | | | | |
| Ceramic type | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 3 | 3 | µF | ±20 % |
| **Miscellaneous** | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | | |
| Mass | 0.28 | 0.275 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | m | ±10 mm |
| Sensor / voltage connection | LEMO | LEMO (no sensor) | | |
| Recommended electronics | E-610, E-621, E-625, E-665 | E-610, E-621, E-625, E-665 | | |

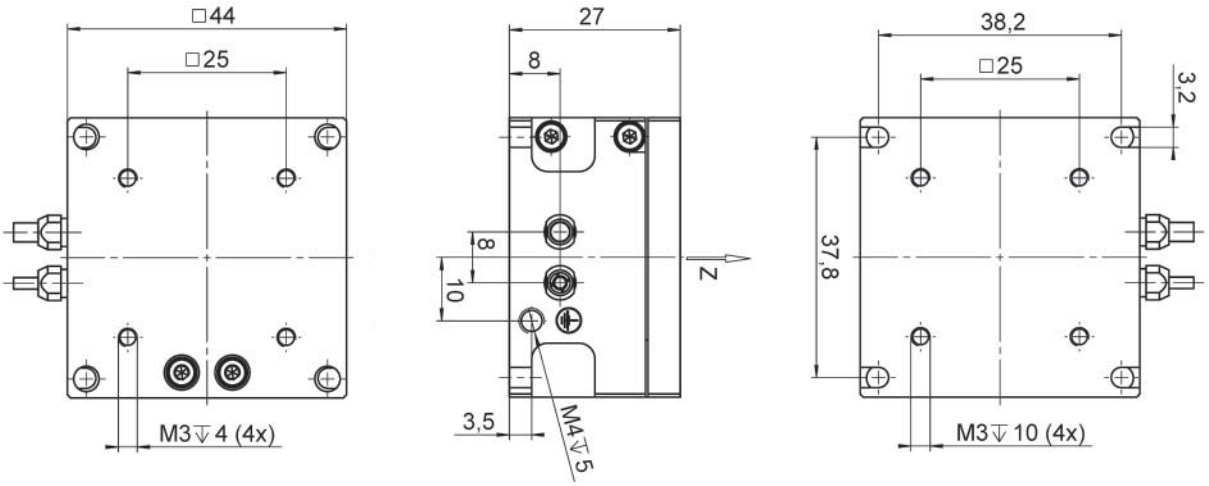
The resolution of PI piezo nanopositioners is not limited by friction or stiction. Value given is noise equivalent motion with E-503 amplifier.
All specifications based on room temperature (22 °C ±3 °C).

# P-611.Z Piezo Z Stage

## Compact Nanopositioner


- Compact: Footprint only 44 mm × 44 mm
- Travel range 100 µm
- Resolution to 0.2 nm
- Cost-effective mechanics / electronics system configurations
- Zero-play, high-precision flexure guide system
- Outstanding lifetime due to PICMA® piezo actuators
- X, XY, XZ and XYZ versions

P-611.ZS, dimensions in mm.




**Applications**

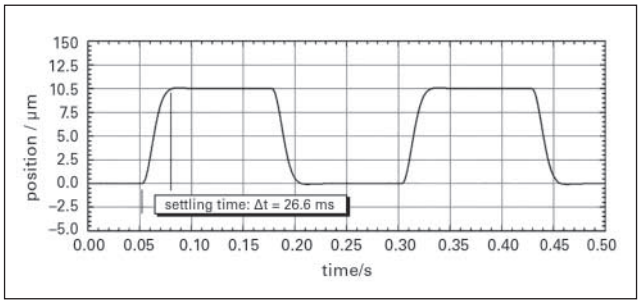
- Micromachining
- Photonics
- Fiber positioning
- Testing and quality processes
- Photonics
- Fiber positioning


>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators

Technology Glossary ..... page 240

| | P-611.ZS | P-611.Z0 | Unit | Tolerance |
|---|---|---|---|---|
| Active axes | Z | Z | | |
| **Motion and positioning** | | | | |
| Integrated sensor | SGS | – | | |
| Open-loop travel, –20 to +120 V | 120 | 120 | µm | +20 % / –0 % |
| Closed-loop travel | 100 | – | µm | |
| Open-loop resolution | 0.2 | 0.2 | nm | typ. |
| Closed-loop resolution | 2 | – | nm | typ. |
| Linearity error | 0.1 | – | % | typ. |
| Repeatability | <10 | – | nm | typ. |
| Runout $\theta_Z$ (Z motion) | ±5 | ±5 | µrad | typ. |
| Runout $\theta_X$ (Z motion) | ±20 | ±20 | µrad | typ. |
| Runout $\theta_Y$ (Z motion) | ±5 | ±5 | µrad | typ. |
| **Mechanical properties** | | | | |
| Stiffness | 0.45 | 0.45 | N/µm | ±20 % |
| Unloaded resonant frequency | 460 | 460 | Hz | ±20 % |
| Resonant frequency at 30 g | 375 | 375 | Hz | ±20 % |
| Resonant frequency at 100 g | 265 | 265 | Hz | ±20 % |
| Push / pull force capacity | 15 / 10 | 15 / 10 | N | max. |
| **Drive properties** | | | | |
| Ceramic type | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 1.5 | 1.5 | µF | ±20 % |
| **Miscellaneous** | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum, steel | Aluminum, steel | | |
| Dimensions | 44 mm × 44 mm × 27 mm | 44 mm × 44 mm × 27 mm | | |
| Mass | 176 | 176 | g | ±5 % |
| Cable length | 1.5 | 1.5 | m | ±10 mm |
| Sensor connection | LEMO | LEMO | | |
| Voltage connection | LEMO | LEMO | | |
| Recommended electronics | E-610, E-625, E-665, E-836 | E-610, E-625, E-665, E-836 | | |

All specifications based on room temperature (22 °C ±3 °C).



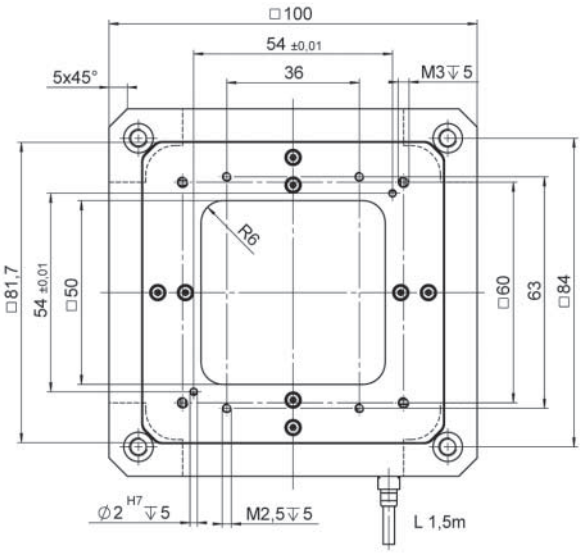

The settling time of a P-611.Z with a load of 30 g is 26 ms for a 10 µm step.
Measured with interferometer.

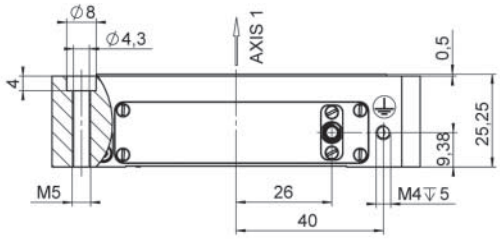
# P-733.Z High-Dynamics Z-Nanopositioner / Scanner

## Direct Position Metrology and Clear Aperture


- Travel range 100 µm
- Direct metrology with capacitive sensors
- Resolution to 0.3 nm, closed-loop
- Clear aperture 50 mm × 50 mm
- Versions with additional degrees of freedom available
- XY and XYZ versions also available
- Vacuum-compatible versions available

P-733.Z, dimensions in mm.




**Applications**

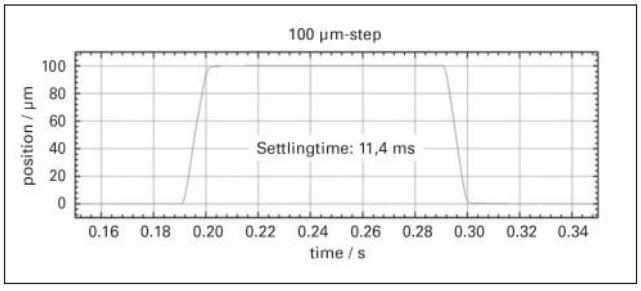
- Scanning microscopy
- Confocal microscopy
- Mask / wafer positioning
- Surface measurement technique
- Nano-imprinting
- Micromanipulation
- Image processing / stablilization
- Nanopositioning with high flatness & straightness

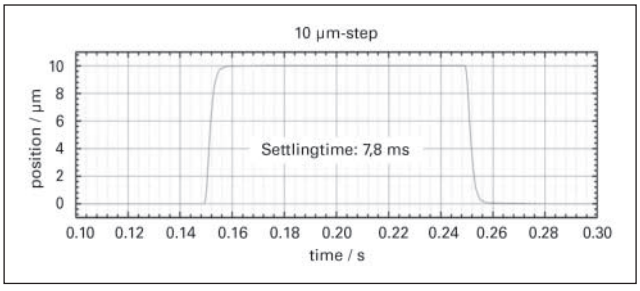

>> Capacitive Feedback Sensors
>> Direct Metrology
>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

Technology Glossary ..... page 240

| | P-733.ZCD / P-733.ZCL | Unit | Tolerance | |
|---|---|---|---|---|
| Active axes | Z | | | |
| **Motion and positioning** | | | | |
| Integrated sensor | Capacitive | | | |
| Open-loop travel, –20 to 120 V | 115 | µm | +20 % / –0 % | |
| Closed-loop travel | 100 | µm | | |
| Open-loop resolution | 0.2 | nm | typ. | |
| Closed-loop resolution | 0.3 | nm | typ. | |
| Linearity error | 0.03 | % | typ. | |
| Repeatability | <2 | nm | typ. | |
| Rotation around Z | <10 | µrad | typ. | |
| Rotation around X | <5 | µrad | typ. | |
| Rotation around Y | <5 | µrad | typ. | |
| **Mechanical properties** | | | | |
| Stiffness | 2.5 | N/µm | ±20 % | |
| Resonant frequency, no load | 700 | Hz | ±20 % | |
| Resonant frequency, under load, at 120 g | 530 | Hz | ±20 % | |
| Resonant frequency, under load, at 200 g | 415 | Hz | ±20 % | |
| Push / pull force capacity | 50 / 20 | N | max. | |
| **Drive properties** | | | | |
| Piezo ceramic | PICMA® P-885 | | | |
| Electrical capacitance | 6 | µF | ±20 % | |
| **Miscellaneous** | | | | |
| Operating temperature range | 20 to 80 | °C | | |
| Material | Aluminum | | | |
| Dimensions | 100 mm × 100 mm × 25 mm | | | |
| Mass | 580 | g | ±5 % | |
| Cable length | 1.5 | m | ±10 mm | |
| Sensor / voltage connection | Sub-D 7W2 (m) (CD version); LEMO (CL version) | | | |
| Recommended electronics | E-503, E-505, E-610, E-621, E-625, E-754 | | | |

All specifications based on room temperature (22 °C ±3 °C).



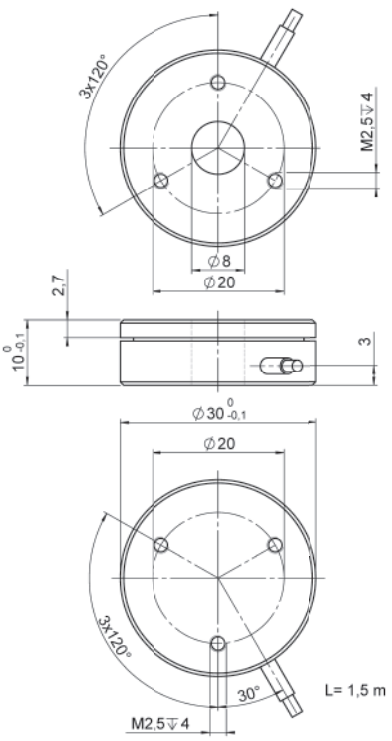

Step response of the P-733.ZCD. Settling time is in the 10 ms range.

# S-303 Piezo Phase Shifter

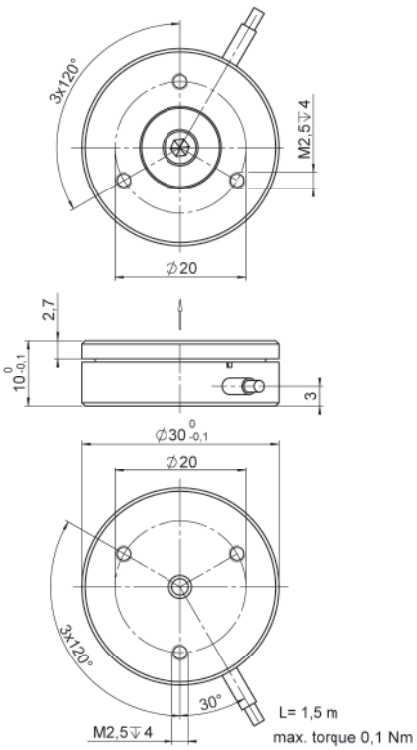
## High-Speed Piezo Phase Shifters with Direct Metrology Option

- Resonant frequency 25 kHz for sub-millisecond dynamics
- Capacitive sensor option for highest linearity and stability
- 3 µm travel range
- Compact size: Ø 30 mm × 10 mm
- Open-loop versions with aperture
- Invar option for highest thermal stability

S-303.0Lx, dimensions in mm.




S-303.CDx, dimensions in mm.




**Applications**

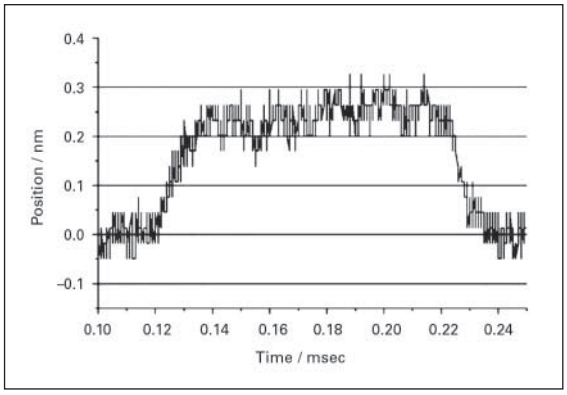
- (Fizeau) Interferometry
- Optical nanomanipulation and testing
- Scanning microscopy


>> Capacitive Feedback Sensors
>> Direct Metrology
>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators

Technology Glossary ..... page 240

| | S-303.CDx | S-303.0Lx | Unit | Tolerance |
|---|---|---|---|---|
| Active axis | Z | Z | | |
| Open-loop travel, at –20 to 120 V | 3 | 3 | µm | ±20 % |
| Closed-loop travel | 2 | – | µm | |
| Integrated feedback sensor | Capacitive | – | | |
| Resolution, closed-loop / open-loop* | 0.03 / 0.03 | 0.03 / – | nm | |
| Linearity error, closed-loop** | 1.0 | – | % | typ. |
| Repeatability | 0.7 | – | nm | typ. |
| Stiffness | >400 | >400 | N/µm | |
| Push / pull force capacity | 0.5 | 0.5 | N | max. |
| Electrical capacitance | 0.9 | 0.9 | µF | ±20 % |
| Resonant frequency, no load | 25 | 25 | kHz | ±20 % |
| Operating temperature range | –20 to 80 | –20 to 80 | °C | |
| Voltage connection | Sub-D 7W2 (m) | LEMO | | |
| Sensor connection | Sub-D 7W2 (m) | – | | |
| Mass | 100 | 30 | g | ±5 % |
| Casing material | Al (Invar optional) | Al (Invar optional) | | |
| Recommended electronics | E-503, E-505, E-610, E-621, E-625, E-663, E-665, E-754 | E-503, E-505, E-610, E-621, E-625, E-663, E-665, E-754 | | |

* The resolution of PI piezo nanopositioners is not limited by friction or stiction. Value given is noise equivalent motion with E-503 amplifier or E-710 controller.
** With digital controller, analog controllers will provide a linearity of typ. 1 nm.
All specifications based on room temperature (22 °C ±3 °C).

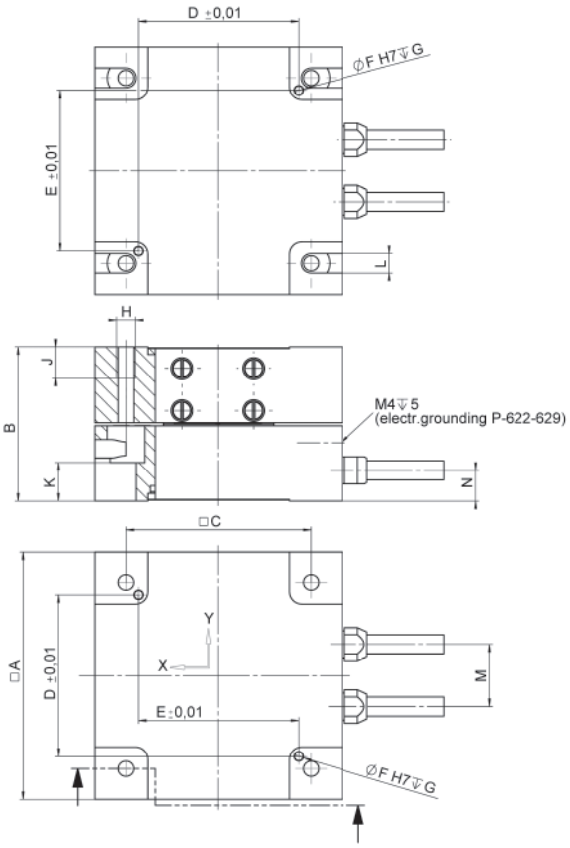



A 250 picometer step (0.25 nm) of the S-303 platform, controlled by an E-503 amplifier module and an E-509.C1A servocontroller module. Measured with special ultrahigh resolution capacitive gauge, ±0.02 nm resolution.

# P-620.2 / P-629.2 PIHera XY Piezo Stage

## High-precision XY Nanopositioning System with Variable Travel Ranges

P-62x.2CD / .2CL / .20L, dimensions in mm.





- Travel ranges 50 to 1800 µm
- Resolution to 0.1 nm
- Positioning accuracy 0.02 %
- Direct metrology with capacitive sensors
- X, XY, Z, XYZ versions

| | A | B | C | D | E | Ø F | G | H | J | K | L | M | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P-620.2CD / 20L | 30 | 21,5 | 24 | 24 | 19 | 1,01 | 1,5 | M2 | 3,5 | 5,1 | 2,2 | 9 | 6 |
| P-621.2CD / 20L | 40 | 25 | 30 | 26 | 26 | 1,51 | 2,5 | M3 | 5 | 6,25 | 3,2 | 10 | 5 |
| P-622.2CD / 20L | 50 | 25 | 40 | 35 | 35 | 1,51 | 2,5 | M3 | 5 | 6,25 | 3,2 | 11 | 5 |
| P-625.2CD / 20L | 60 | 25 | 50 | 46 | 46 | 1,51 | 2,5 | M3 | 6 | 6,25 | 3,2 | 11 | 5 |
| P-628.2CD / 20L | 80 | 30 | 70 | 66 | 66 | 1,51 | 2,5 | M3 | 6 | 6,75 | 3,2 | 11 | 5 |
| P-629.2CD / 20L | 100 | 40 | 90 | 82 | 82 | 2,01 | 3,5 | M4 | 7 | 6,75 | 4,3 | 16 | 7,5 |

**Applications**

- Interferometry
- Microscopy
- Nanopositioning
- Biotechnology
- Testing and quality processes
- Photonics
- Fiber positioning
- Semiconductor technology


>> Capacitive Feedback Sensors
>> Direct Metrology
>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

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| | P-620.2CD / P-620.2CL | P-621.2CD / P-621.2CL | P-622.2CD / P-622.2CL | P-625.2CD / P-625.2CL | P-628.2CD / P-628.2CL | P-629.2CD / P-629.2CL | Unit | Tolerance |
|---|---|---|---|---|---|---|---|---|
| Active axes | X, Y | X, Y | X, Y | X, Y | X, Y | X, Y | | |
| **Motion and positioning** | | | | | | | | |
| Integrated sensor | Capacitive | Capacitive | Capacitive | Capacitive | Capacitive | Capacitive | | |
| Travel range in X, Y at –20 to 120 V, open loop | 60 | 120 | 300 | 600 | 950 | 1800 | µm | +20 % / –0 % |
| Travel range in X, Y, closed loop | 50 | 100 | 250 | 500 | 800 | 1500 | µm | |
| Resolution in X, Y, open loop | 0.1 | 0.2 | 0.4 | 0.5 | 0.5 | 2 | nm | typ. |
| Resolution in X, Y, closed loop | 0.2 | 0.4 | 0.7 | 1.4 | 3.5 | 3.5 | nm | typ. |
| Linearity error in X, Y | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 (1) | 0.03 (2) | % | typ. |
| Repeatability X, Y | ±2 | ±2 | ±2 | ±5 | ±10 | ±14 | nm | typ. |
| Pitch / yaw | ±3 | ±3 | ±3 | ±3 / ±5 | ±20 / ±5 | ±30 / ±5 | µrad | typ. |
| **Mechanical properties** | | | | | | | | |
| Stiffness X, Y | 0.22 | 0.25 | 0.2 | 0.1 | 0.05 | 0.1 | N/µm | ±20 % |
| Resonant frequency in X, no load | 575 | 420 | 225 | 135 | 75 | 60 | Hz | ±20 % |
| Resonant frequency in Y, no load | 800 | 535 | 300 | 195 | 105 | 100 | Hz | ±20 % |
| Resonant frequency in X, under load, 50 g | 270 | 285 | 180 | 120 | 60 | 55 | Hz | ±20 % |
| Resonant frequency in Y, under load, 50 g | 395 | 365 | 215 | 150 | 85 | 85 | Hz | ±20 % |
| Resonant frequency in X, under load 100 g | 285 | 220 | 160 | 105 | 55 | 50 | Hz | ±20 % |
| Resonant frequency in Y, under load, 100 g | 300 | 285 | 175 | 125 | 75 | 80 | Hz | ±20 % |
| Compressive / tensile stress capacity in motion direction | 10 / 5 | 10 / 8 | 10 / 8 | 10 / 8 | 10 / 8 | 10 / 8 | N | max. |
| Load capacity | 10 | 10 | 10 | 10 | 10 | 10 | N | max. |
| Lateral force | 10 | 10 | 10 | 10 | 10 | 10 | N | max. |
| **Drive properties** | | | | | | | | |
| Piezo ceramic | PICMA® P-883 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-887 | PICMA® P-888 | | |
| Electrical capacitance in X, Y | 0.35 | 1.5 | 3.1 | 6.2 | 19 | 52 | µF | ±20 % |
| **Miscellaneous** | | | | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | | |
| Dimensions | 30 mm × 30 mm × 21.5 mm | 40 mm × 40 mm × 25 mm | 50 mm × 50 mm × 25 mm | 60 mm × 60 mm × 25 mm | 80 mm × 80 mm × 25 mm | 100 mm × 100 mm × 40 mm | | |
| Mass | 0.195 | 0.295 | 0.348 | 0.43 | 0.7 | 1.37 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | m | ±10 mm |
| Sensor / voltage connection | CD versions: Sub-D 7W2 (m) CL versions: LEMO | CD versions: Sub-D 7W2 (m) CL versions: LEMO | CD versions: Sub-D 7W2 (m) CL versions: LEMO | CD versions: Sub-D 7W2 (m) CL versions: LEMO | CD versions: Sub-D 7W2 (m) CL versions: LEMO | CD versions: Sub-D 7W2 (m) CL versions: LEMO | | |
| Recommended electronics | E-503, E-505, E-663, E-712, E-727 | E-503, E-505, E-663, E-712, E-727 | E-503, E-505, E-663, E-712, E-727 | E-503, E-505, E-663, E-712, E-727 | E-503, E-505, E-663, E-712, E-727 | E-503, E-505, E-663, E-712, E-727 | | |

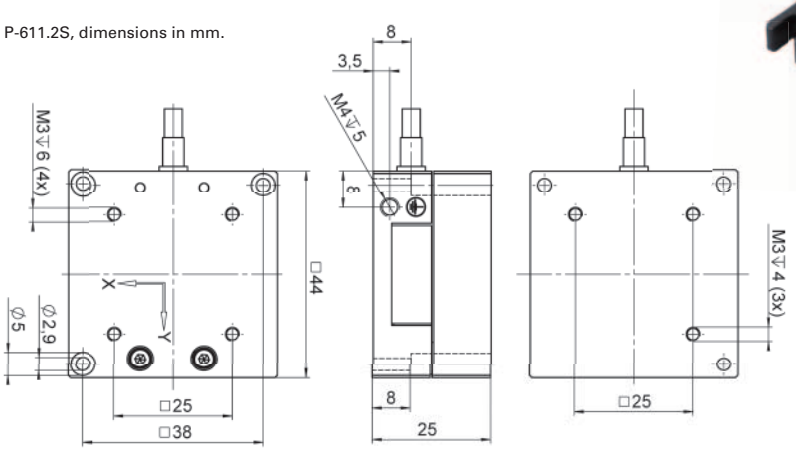
(1) With digital controller. With analog controllers 0.05 %.
(2) With digital controller. With analog controllers 0.08 %.
Lower axis: X; upper axis: Y.
Versions without sensor are available under the P-62x.20L order numbers; operating temperature range –20 to 150 °C. Voltage connection LEMO.
Vacuum versions to $10^{-9}$ hPa are available under the P-62x.2UD order numbers.
The resolution of PI piezo nanopositioners is not limited by friction. Value given as noise with E-710 digital controller.
All specifications based on room temperature (22 °C ±3 °C).

# P-611.XZ / P-611.2 XZ & XY Nanopositioner

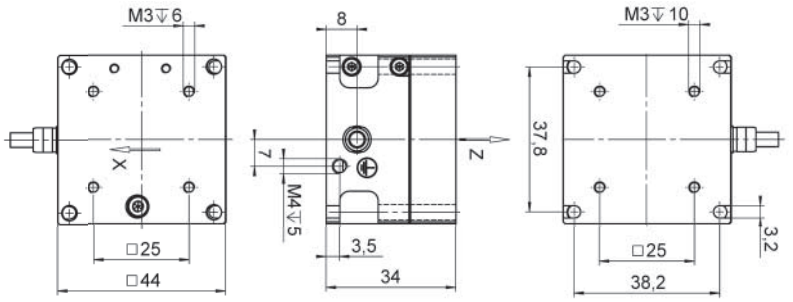
## Compact 2-Axis Piezo System for Nanopositioning Tasks

- Compact: Footprint 44 mm × 44 mm
- Travel range to 120 µm × 120 µm
- Resolution to 0.2 nm
- Cost-effective mechanics / electronics system configurations
- Zero-play, high-precision flexure guide system
- Outstanding lifetime due to PICMA® piezo actuators
- X, Z and XYZ version available


P-611.2S, dimensions in mm.




P-611.XZS, dimensions in mm.




**Applications**

- Interferometry
- Microscopy
- Nanopositioning
- Biotechnology
- Testing and quality processes
- Photonics
- Fiber positioning
- Semiconductor technology


>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators

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| | P-611.2S | P-611.20 | P-611.XZS | P-611.XZ0 | Unit | Tolerance |
|---|---|---|---|---|---|---|
| Active axes | X, Y | X, Y | X, Z | X, Z | | |
| **Motion and positioning** | | | | | | |
| Integrated sensor | SGS | – | SGS | – | | |
| Open-loop travel, –20 to 120 V | 120 | 120 | 120 | 120 | µm | +20 % / –0 % |
| Closed-loop travel | 100 | – | 100 | – | µm | |
| Open-loop resolution | 0.2 | 0.2 | 0.2 | 0.2 | nm | typ. |
| Closed-loop resolution | 2 | – | 2 | – | nm | typ. |
| Linearity error | 0.1 | – | 0.1 | – | % | typ. |
| Repeatability | <10 | – | <10 | – | nm | typ. |
| Pitch in X, Y | ±5 | ±5 | ±5 | ±5 | µrad | typ. |
| Runout $\theta_X$ (motion in Z) | – | – | ±10 | ±10 | µrad | typ. |
| Yaw in X | ±20 | ±20 | ±20 | ±20 | µrad | typ. |
| Yaw in Y | ±10 | ±10 | – | – | µrad | typ. |
| Runout $\theta_Y$ (motion in Z) | – | – | ±10 | ±10 | µrad | typ. |
| **Mechanical properties** | | | | | | |
| Stiffness | 0.2 | 0.2 | 0.2<br>Z: 0.35 | 0.2<br>Z: 0.35 | N/µm | ±20 % |
| Resonant frequency, no load | X: 345; Y: 270 | X: 345; Y: 270 | X: 365; Z: 340 | X: 365; Z: 340 | Hz | ±20 % |
| Resonant frequency, under load, at 30 g | X: 270; Y: 225 | X: 270; Y: 225 | X: 280; Z: 295 | X: 280; Z: 295 | Hz | ±20 % |
| Resonant frequency, under load, at 100 g | X: 180; Y: 165 | X: 180; Y: 165 | X: 185; Z: 230 | X: 185;<br>Z: 230 | Hz | ±20 % |
| Push / pull force capacity in motion direction | 15 / 10 | 15 / 10 | 15 / 10 | 15 / 10 | N | max. |
| Load capacity | 15 | 15 | 15 | 15 | N | max. |
| **Drive properties** | | | | | | |
| Ceramic type | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 1.5 | 1.5 | 1.5 | 1.5 | µF | ±20 % |
| **Miscellaneous** | | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum, steel | Aluminum, steel | Aluminum, steel | Aluminum, steel | | |
| Dimensions | 44 mm × 44 mm × 25 mm | 44 mm × 44 mm × 25 mm | 44 mm × 44 mm × 34 mm | 44 mm × 44 mm × 34 mm | | |
| Mass | 0.235 | 0.235 | 0.27 | 0.27 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | 1.5 | 1.5 | m | ±10 mm |
| Sensor connection | LEMO | – | LEMO | – | | |
| Voltage connection | LEMO | LEMO | LEMO | LEMO | | |
| Recommended electronics | E-503, E-505, E-663, E-664, E-727 | E-503, E-505, E-663, E-664, E-727 | E-503, E-505, E-663, E-664, E-727 | E-503, E-505, E-663, E-664, E-727 | | |

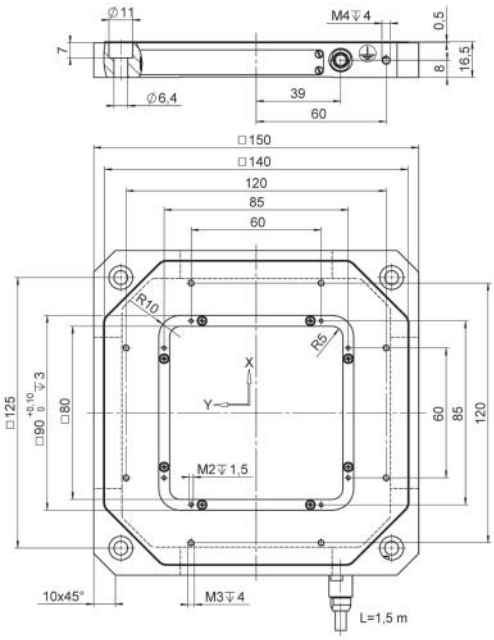
The resolution of PI piezo nanopositioners is not limited by friction or stiction.
Value is given noise equivalent motion with E-503 amplifier.
All specifications based on room temperature (22 °C ±3 °C).

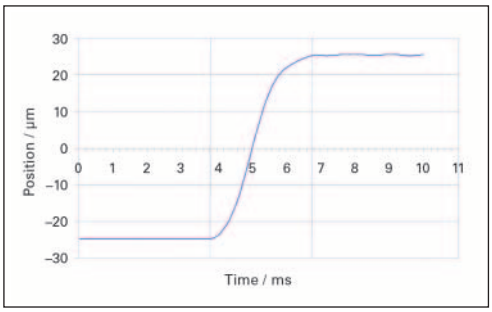
# P-541.2 / P-542.2 XY Piezo Stage

## Low-Profile XY Nanopositioning System with Large Aperture


- Low profile for easy integration: 16.5 mm
- Clear aperture 80 mm × 80 mm
- Travel range to 200 µm × 200 µm
- Parallel kinematics for faster response times and higher multi-axis accuracy
- High-dynamics direct-drive version
- Choice of sensors: Strain gauge (lower cost) or capacitive sensors (higher performance)
- Outstanding lifetime due to PICMA® piezo actuators
- Combination with long-travel microscopy stages for longer stroke

P-541.2 / P-542.2, dimensions in mm.




The settling time of a P-541.2DD stage is only 3 ms for a 50 µm step.

**Applications**

- Scanning microscopy
- Highthroughput microscopy
- Super-resolution microscopy
- Mask / wafer positioning
- Interferometry
- Metrology
- Biotechnology
- Micromanipulation


>> Capacitive Feedback Sensors
>> Direct Metrology
>> Flexure Guiding Systems
>> Parallel-Kinematic Piezo Stages
>> PICMA® Multilayer Piezo Actuators

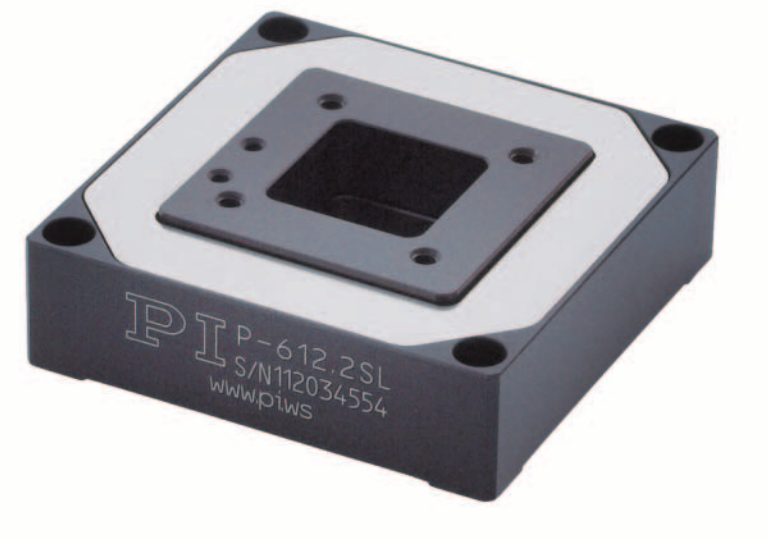
Technology Glossary ..... page 240

| | P-541.2CD / P-541.2CL | P-542.2CD / P-542.2CL | P-541.2DD | P-541.2SL | P-542.2SL | P-541.20L / P-542.20L | Unit | Tolerance |
|---|---|---|---|---|---|---|---|---|
| Active axes | X, Y | X, Y | X, Y | X, Y | X, Y | X, Y | | |
| **Motion and positioning** | | | | | | | | |
| Integrated sensor | Capacitive | Capacitive | Capacitive | SGS | SGS | – | | |
| Open-loop travel, –20 to +120 V | 150 µm × 150 µm | 250 µm × 250 µm | 60 µm × 60 µm | 150 µm × 150 µm | 250 µm × 250 µm | see P-541.2CD / P-542.2CD | | +20 % / –0 % |
| Closed-loop travel | 100 µm × 100 µm | 200 µm × 200 µm | 45 µm × 45 µm | 100 µm × 100 µm | 200 µm × 200 µm | – | | |
| Closed-loop / open-loop resolution | 0.2 / 0.3 | 0.4 / 0.7 | 0.1 / 0.3 | 0.2 / 2.5 | 0.4 / 4 | open-loop 0.2 / 0.4 | nm | typ. |
| Linearity error | 0.03 | 0.03 | 0.03* | 0.2 | 0.2 | – | % | typ. |
| Repeatability | <5 | <5 | <5 | <10 | <10 | – | nm | typ. |
| Pitch | <5 | <5 | <3 | <5 | <5 | <5 | µrad | typ. |
| Yaw | <10 | <10 | <3 | <10 | <10 | <10 | µrad | typ. |
| **Mechanical properties** | | | | | | | | |
| Stiffness in motion direction | 0.47 | 0.4 | 10 | 0.47 | 0.4 | 0.47 / 0.4 | N/µm | ±20 % |
| Resonant frequency, no load | 255 | 230 | 1550 | 255 | 230 | 255 / 230 | Hz | ±20 % |
| Resonant frequency, under load, at 100 g | 200 | 190 | – | 200 | 190 | 200 / 190 | Hz | ±20 % |
| Resonant frequency, under load, at 200 g | 180 | – | 1230 | 180 | – | 180 / – | Hz | ±20 % |
| Resonant frequency, under load, at 300 g | 150 | 145 | – | 150 | 145 | 150 / 145 | Hz | ±20 % |
| Push / pull force capacity in motion direction | 100 / 30 | 100 / 30 | 100 / 30 | 100 / 30 | 100 / 30 | 100 / 30 | N | max. |
| Load capacity | 20 | 20 | 20 | 20 | 20 | 20 | N | max. |
| **Drive properties** | | | | | | | | |
| Piezo ceramic | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance per axis | 4.2 | 7.5 | 9 | 4.2 | 7.5 | 4.2 / 7.5 | µF | ±20 % |
| **Miscellaneous** | | | | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | | |
| Mass | 0.75 | 0.75 | 0.75 | 0.73 | 0.73 | 0.7 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | m | ±10 mm |
| Sensor / voltage connection | CD versions: Sub-D 25W3 (m) CL versions: LEMO | CD versions: Sub-D 25W3 (m) CL versions: LEMO | Sub-D 25W3 (m) | LEMO | LEMO | LEMO (no sensor) | | |
| Recommended electronics | E-503, E-505, E-621, E-712, E-727 | E-503, E-505, E-621, E-712, E-727 | E-503, E-505, E-621, E-712, E-727 | E-503, E-505, E-621, E-712, E-727 | E-503, E-505, E-621, E-712, E-727 | E-503, E-505, E-621, E-712, E-727 | | |

* With digital controller. Non-linearity of direct drive stages measured with analog controllers is up to 0.1 % typ.
All specifications based on room temperature (22 °C ±3 °C).

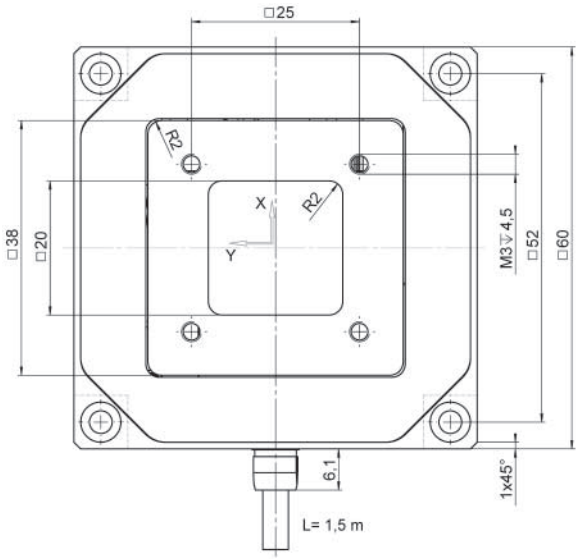
# P-612.2 XY Piezo Nanopositioning System

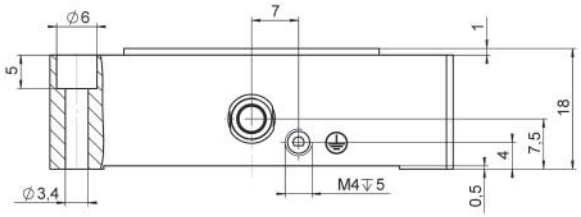
## Compact, Clear Aperture




- Compact: Footprint 60 mm × 60 mm
- 100 µm × 100 µm closed-loop travel range (130 µm × 130 µm, open-loop)
- For cost-sensitive applications
- Clear aperture 20 mm × 20 mm
- Parallel kinematics for faster response times and higher multi-axis accuracy
- Outstanding lifetime due to PICMA® piezo actuators
- Available as compact version

P-612.2, dimensions in mm.




**Applications**

- Scanning microscopy
- High-throughput microscopy
- Super-resolution microscopy
- Mask / wafer positioning
- Interferometry
- Metrology
- Biotechnology
- Micromanipulation


>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators

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| | P-612.2SL | P-612.20L | Unit | Tolerance |
|---|---|---|---|---|
| Active axes | X, Y | X, Y | | |
| **Motion and positioning** | | | | |
| Integrated sensor | SGS | – | | |
| Open-loop travel, –20 to +120 V | 130 | 130 | µm | +20 % / –0 % |
| Closed-loop travel range | 100 | – | µm | |
| Open-loop resolution | 0.8 | 0.8 | nm | typ. |
| Closed-loop resolution | 5 | – | nm | typ. |
| Linearity error | 0.4 | – | % | typ. |
| Repeatability | <10 | – | nm | typ. |
| Pitch | ±10 | ±10 | µrad | typ. |
| Yaw in X /Y | ±10 / ±50 | ±10 / ±50 | µrad | typ. |
| **Mechanical properties** | | | | |
| Stiffness | 0.15 | 0.15 | N/µm | ±20 % |
| Resonant frequency, no load | 400 | 400 | Hz | ±20 % |
| Resonant frequency at 100 g | 200 | 200 | Hz | ±20 % |
| Compressive / tensile stress capacity in motion direction | 15 / 5 | 15 / 5 | N | max. |
| Load capacity | 15 | 15 | N | max. |
| **Drive properties** | | | | |
| Ceramic type | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 1.5 | 1.5 | µF | ±20 % |
| **Miscellaneous** | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum, steel | Aluminum, steel | | |
| Mass | 105 | 105 | g | ±5 % |
| Cable length | 1.5 | 1.5 | m | ±10 mm |
| Sensor / voltage connection | LEMO | LEMO (no sensor) | | |
| Recommended electronics | E-503, E-505, E-621 | E-503, E-505, E-621 | | |

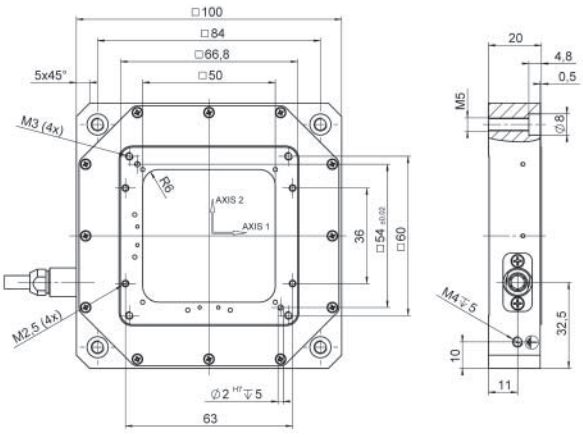
Resolution of PI piezo nanopositioning systems is not limited by friction or stiction. Value given is noise equivalent motion with E-503 amplifier.
All specifications based on room temperature (22 °C ±3 °C).

# P-733.2 XY Piezo Nanopositioner

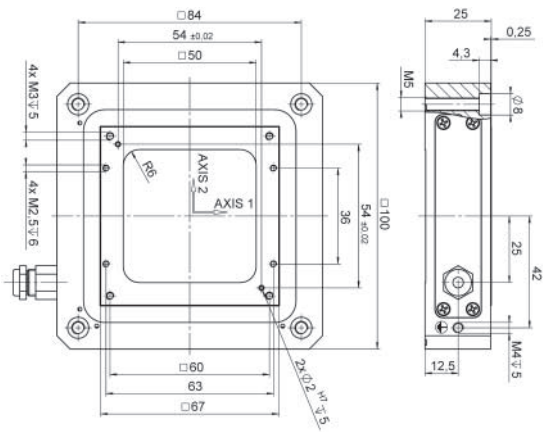
## High-Precision XY Scanner with Aperture


- Travel ranges to 100 µm × 100 µm in X and Y
- Resolution to 0.1 nm due to capacitive sensors
- High-speed versions with direct drive
- Vacuum-compatible and non-magnetic versions available
- Parallel kinematics for higher accuracy and dynamics
- Parallel metrology for active compensation of guiding errors
- Zero-play, high-precision flexure guide system
- Clear aperture 50 mm × 50 mm for transmitted-light applications

P-733.2DD, dimensions in mm.




P-733.2CD/.2CL, dimensions in mm.




**Applications**

- Scanning microscopy
- Confocal microscopy
- Mask / wafer positioning
- Surface measurement technique
- Nano-imprinting
- Micromanipulation
- Image processing / stablilization
- Nanopositioning with high flatness & straightness

>> **Capacitive Feedback Sensors**
>> **Direct Metrology**
>> **Flexure Guiding Systems**
>> **Parallel-Kinematic Piezo Stages**
>> **PICMA® Multilayer Piezo Actuators**
>> **Vacuum-Compatible Version**

**Technology Glossary** ..... **page 240**

| | P-733.2CD / P-733.2CL | P-733.2DD | Unit | Tolerance |
|---|---|---|---|---|
| Active axes | X, Y | X, Y | | |
| **Motion and positioning** | | | | |
| Integrated sensor | Capacitive | Capacitive | | |
| Open-loop travel range, –20 to 120 V | 115 µm × 115 µm | 33 µm × 33 µm | | +20 % / –0 % |
| Closed-loop travel range | 100 µm × 100 µm | 30 µm × 30 µm | | |
| Open-loop resolution | 0.2 | 0.1 | nm | typ. |
| Closed-loop resolution | 0.3 | 0.1 | nm | typ. |
| Linearity error (X, Y) | 0.03 | 0.03* | % | typ. |
| Repeatability (X, Y) | <2 | <2 | nm | typ. |
| Pitch (X,Y) | <±3 | <±5 | µrad | typ. |
| Yaw (X, Y) | <±10 | <±10 | µrad | typ. |
| **Mechanical properties** | | | | |
| Stiffness | 1.5 | 20 | N/µm | ±20 % |
| Resonant frequency, no load | 500 | 2230 | Hz | ±20 % |
| Resonant frequency, under load, 120 g | 370 | – | Hz | ±20 % |
| Resonant frequency, under load, 200 g | 340 | 1550 | Hz | ±20 % |
| Compressive / tensile stress capacity in motion direction | 50 / 20 | 50 / 20 | N | max. |
| **Drive properties** | | | | |
| Piezo ceramic | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 6 | 6.2 | µF | ±20 % |
| **Miscellaneous** | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | | |
| Mass | 0.58 | 0.58 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | m | ±10 mm |
| Sensor / voltage connection | Sub-D 25W3 (m) (CD version); LEMO (CL version) | Sub-D 25W3 (m) | | |
| Recommended electronics | E-503, E-505, E-610, E-621, E-625, E-712 | E-503, E-505, E-610, E-621, E-625, E-712 | | |

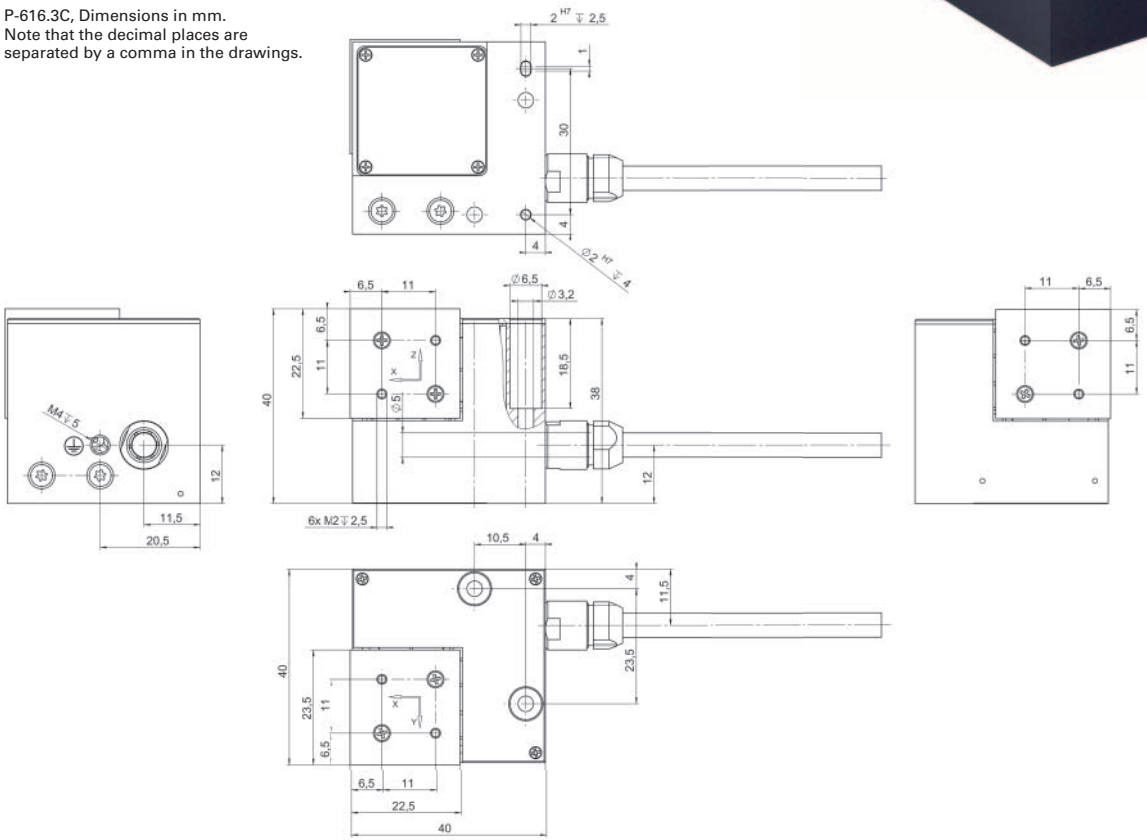
* With digital controller. Nonlinearity of direct drive stages measured with analog controllers is up to 0.1 % typ.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

# P-616 NanoCube® Nanopositioner

## Compact Parallel-Kinematic Piezo System for Nanopositioning and Fiber Alignment

- Parallel-kinematic design for the highest stiffness in all spatial directions
- Highly dynamic motion due to high resonant frequencies even with loads up to 100 g
- Innovative product design for flexible use due to single mounting platform
- Only nanopositioner available on the market with ID chip functionality
- Smallest and lightest NanoCube® with 100 µm travel range on the market

P-616.3C, Dimensions in mm.
Note that the decimal places are separated by a comma in the drawings.




**Applications**

- Fiber positioning and alignment
- Photonics / integrated optics
- Scanning microscopy
- Micromanipulation
- Sample positioning
- Scanning and screening


>> Capacitive Feedback Sensors
>> Flexure Guiding Systems
>> Parallel-Kinematic Piezo Stages
>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

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| | P-616.3C | Unit | Tolerance |
|---|---|---|---|
| **Motion and positioning** | | | |
| Active axes | X, Y, Z | | |
| Travel range at -20 to 120 V, open loop | 110 / axis | µm | +20 % / –0 % |
| Closed-loop travel range | 100 / axis | µm | +20 % / –0 % |
| Resolution, 1 σ, open loop* | 0.3 | nm | typ. |
| Resolution, 1 σ, closed loop* | 0.4 | nm | typ. |
| Linearity error, for the entire travel range, with digital controller (E-727.3CD) | 0.03 | % | typ. |
| Bidirectional repeatability, 1 σ, 10 % travel range | <10 | nm | typ. |
| Bidirectional repeatability, 1 σ, 100 % travel range | <15 | nm | typ. |
| **Sensor** | | | |
| Sensor type | Capacitive sensors | | |
| **Mechanical properties** | | | |
| Stiffness | 0.5 | N/µm | ±10 % |
| Resonant frequency X /Y / Z, no load | 700 | Hz | ±10 % |
| Resonant frequency with 38 g load X /Y / Z | 380 | Hz | ±20 % |
| Resonant frequency with 100 g load X /Y / Z | 250 | Hz | ±20 % |
| Compressive/tensile stress capacity | 15 | N | max. |
| Maximum permissible torque | 0.4 | Nm | max. |
| Recommended maximum load | 300 | g | max. |
| **Drive properties** | | | |
| Ceramic type | PICMA® P-885.50 | | |
| Electrical capacitance | 1.5 / axis | µF | ±20 % |
| **Miscellaneous** | | | |
| Operating temperature range | –20 to 80 | °C | |
| Material | Aluminum, steel | | |
| Dimensions | 40 × 40 × 40 | mm | |
| Moved mass without load | 0.021 | kg | |
| Mass without cable | 0.125 | kg | |
| Mass with cable | 0.4 | kg | |
| Cable length | 1.5 | m | ±10 mm |
| Connection | Sub-D 25W3 (m) | | |
| Recommended electronics | E-503, E-663, E-712, E-727 | | |

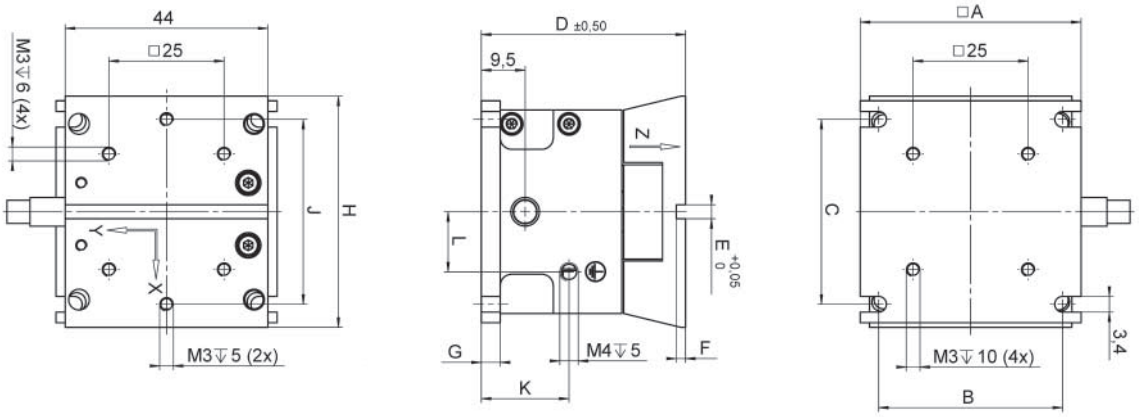
* The resolution of PI piezo nanopositioning systems is not limited by friction. Specification as position noise with E-727 controller.
All specifications based on room temperature (22 °C ±3 °C).

# P-611.3 NanoCube® XYZ Piezo Stage

## Compact Multi-Axis Piezo System for Nanopositioning and Fiber Alignment


- Travel range to 120 µm × 120 µm × 120 µm
- Ultra-compact: 44 mm × 44 mm × 44 mm
- Resolution to 0.2 nm
- Rapid response
- Zero-play, high-precision flexure guide system
- Outstanding lifetime due to PICMA® piezo actuators
- For fast scanning
- Version with integrated fiber adapter interface
- Especially cost-effective systems

P-611.3, dimensions in mm




| | A | B | C | D | E | F | G | H | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|
| P-611.3O | 44 | 38.2 | 37.8 | 43.2 | – | – | 3.5 | 44 | – | 3.5 | 10 |
| P-611.3S | 44 | 38.2 | 37.8 | 43.2 | – | – | 3.5 | 44 | – | 3.5 | 10 |
| P-611.3OF | 44 | 38.2 | 37.8 | 44.2 | 3 | 2 | 3.5 | 50 | 40 | 3.5 | 10 |
| P-611.3SF | 48 | 40 | 40 | 44.2 | 3 | 2 | 4.1 | 50 | 40 | 19 | 13 |

**Applications**

- Photonics / integrated optics
- Micromanipulation
- Biotechnology
- Semiconductor testing
- Fiber positioning


>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators

Technology Glossary ..... page 240

| | P-611.3S<br>P-611.3SF | P-611.3O<br>P-611.3OF | Unit | Tolerance |
|---|---|---|---|---|
| Active axes | X, Y, Z | X, Y, Z | | |
| **Motion and positioning** | | | | |
| Integrated sensor | SGS | | | |
| Open-loop travel, –20 to 120 V | 120 / axis | 120 / axis | µm | +20 % / –0 % |
| Closed-loop travel | 100 / axis | – | µm | |
| Open-loop resolution | 0.2 | 0.2 | nm | typ. |
| Closed-loop resolution | 1 | – | nm | typ. |
| Linearity error | 0.1 | – | % | typ. |
| Repeatability | <10 | – | nm | typ. |
| Pitch in X, Y | ±5 | ±5 | µrad | typ. |
| Runout $\theta_X$ (motion in Z) | ±10 | ±10 | µrad | typ. |
| Yaw in X | ±20 | ±20 | µrad | typ. |
| Yaw in Y | ±10 | ±10 | µrad | typ. |
| Runout $\theta_Y$ (motion in Z) | ±10 | ±10 | µrad | typ. |
| **Mechanical properties** | | | | |
| Stiffness | 0.3 | 0.3 | N/µm | ±20 % |
| Unloaded resonant frequency X / Y / Z | 350 / 220 / 250 | 350 / 220 / 250 | Hz | ±20 % |
| Resonant frequency at 30 g in X / Y / Z | 270 / 185 / 230 | 270 / 185 / 230 | Hz | ±20 % |
| Resonant frequency at 100 g in X / Y / Z | 180 / 135 / 200 | 180 / 135 / 200 | Hz | ±20 % |
| Push / pull force capacity in motion direction | 15 / 10 | 15 / 10 | N | max. |
| Load capacity | 15 | 15 | N | max. |
| **Drive properties** | | | | |
| Ceramic type | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 1.5 | 1.5 | µF | ±20 % |
| **Miscellaneous** | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum, steel | Aluminum, steel | | |
| Dimensions | S version:<br>48 mm × 44 mm × 43.2 mm<br>SF version:<br>44 mm × 50 mm × 44.2 mm | O version:<br>44 mm × 44 mm × 43.2 mm<br>OF version:<br>44 mm × 50 mm × 44.2 mm | | |
| Mass | 0.32 | 0.32 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | m | ±10 mm |
| Sensor connection | Sub-D 25 (m) | – | | |
| Voltage connection | Sub-D 25 (m) | Sub-D 25 (m) | | |
| Recommended electronics | E-503, E-505, E-663, E 664, E-727 | E-503, E-505, E-663, E 664, E-727 | | |

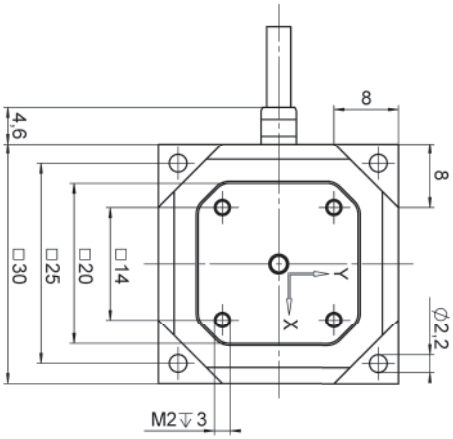
The resolution of PI piezo nanopositioners is not limited by friction or stiction. Value is given noise equivalent motion with E-503 amplifier.
Adapter cable with LEMO connectors for sensor and operating voltage available.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

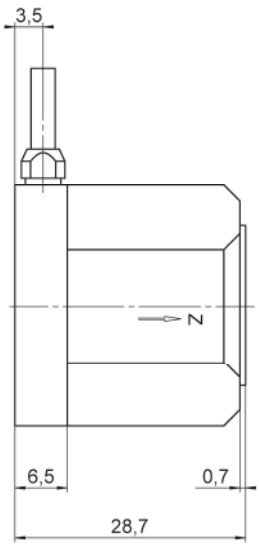
# P-313 PicoCube XY(Z) Piezo Scanner

## Picometer Precision, High Bandwidth, for Scanning Probe Microscopy


- Highly linear scanner for AFM / SPM
- Up to 20 picometers resolution, hysteresis <1 nm
- Highest bandwidth due to open-loop drive concept
- Highest-resolution manipulation tool for biotechnology / nanotechnology
- Resonant frequency 4.0 kHz (X, Y), 11 kHz (Z)
- Travel range 1 µm × 1 µm × 0.6 µm

P-313, dimensions in mm.




**Applications**

- Scanning probe microscopy
- Atomic force microscopy
- Scanning and screening


>> Flexure Guiding Systems
>> Parallel-Kinematic Piezo Stages

Technology Glossary ..... page 240

| | P-313 PicoCube XY(Z) piezo scanner | Unit | |
|---|---|---|---|
| **Motion and positioning** | | | |
| Active axes | X, Y, Z | | |
| Travel range X,Y (±250 V) | 1 | µm | |
| Travel range Z (±250 V) | 0.6 | µm | |
| Resolution in X, Y | 0.02 | nm | |
| Resolution in Z | 0.14 | nm | |
| **Mechanical properties** | | | |
| Resonant frequency in X, Y | 4 | kHz | |
| Resonant frequency in Z | 11 | kHz | |
| Compressive / tensile stress capacity in motion direction | ±10 | N | |
| Load capacity | ±10 | N | |
| **Miscellaneous** | | | |
| Operating temperature range | 5 to 40 | °C | |
| Mass | 80 | g | |
| Cable length | 1.5 | m | |
| Voltage connection | Sub-D 24W7 (m) | | |
| Recommended electronics | E-536 | | |

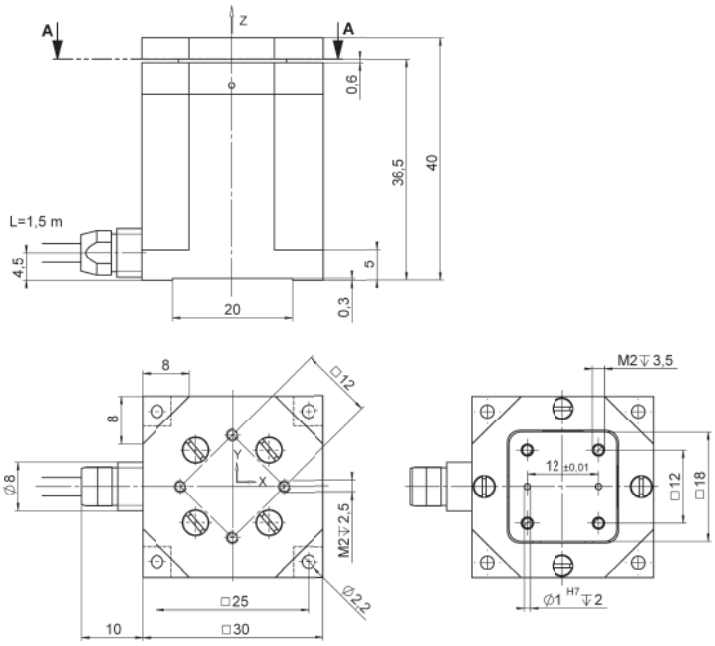
All specifications based on room temperature (22 °C ±3 °C).

# P-363 PicoCube XY(Z) Piezo Scanner

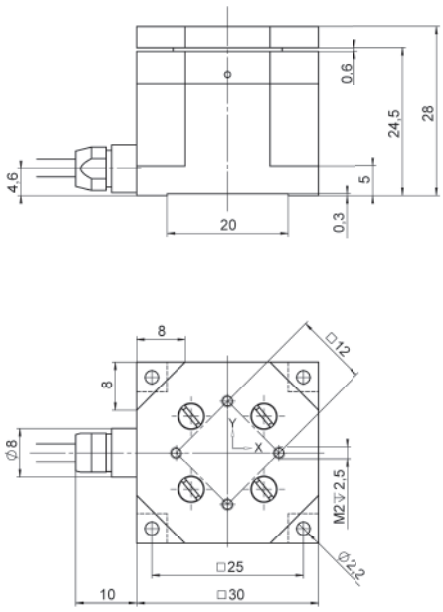
## High-Dynamics Nanoscanner for Scanning Probe Microscopy

- Ultra-high-performance closed-loop scanner for AFM / SPM
- Compact manipulation tool for bio- / nanotechnology
- Resonant frequency 9.8 kHz
- Capacitive sensors for highest accuracy
- Parallel-motion metrology for automated compensation of guiding errors
- Resolution 50 picometer
- Travel range 5 µm × 5 µm × 5 µm
- Vacuum-compatible versions

P-363.3Cx, dimensions in mm. Removable top plate.




P-363.2Cx, dimensions in mm. Removable top plate.




**Applications**

- Scanning probe microscopy
- Atomic force microscopy
- Scanning and screening

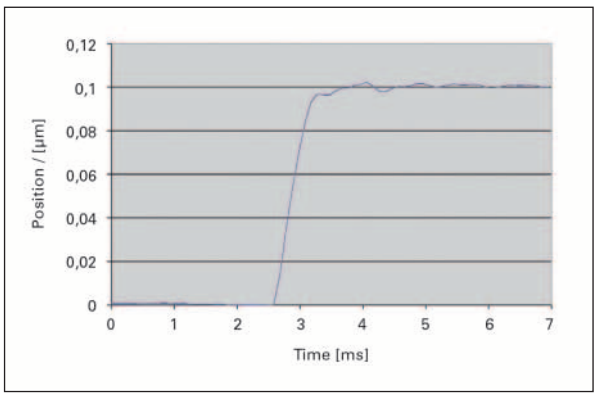
>> Capacitive Feedback Sensors
>> Flexure Guiding Systems
>> Parallel Metrology
>> Vacuum-Compatible Version

Technology Glossary ..... page 240

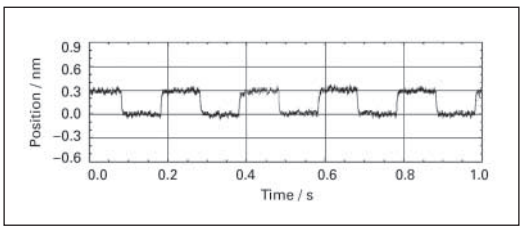
| | P-363.3CD | P-363.2CD | Unit |
|---|---|---|---|
| Active axes | X, Y, Z | X, Y | |
| **Motion and positioning** | | | |
| Integrated sensor | Capacitive | Capacitive | |
| Open-loop travel in X, Y, –250 to +250 V | ±3 | ±3 | µm |
| Open-loop travel in Z, –250 to +250 V | ±2.7 | – | µm |
| Closed-loop travel in X, Y | ±2.5 | ±2.5 | µm |
| Closed-loop travel in Z | ±2.5 | – | µm |
| Open-loop resolution* | 0.03 | 0.03 | nm |
| Closed-loop resolution | 0.1 | 0.1 | nm |
| Linearity error | 0.05 | 0.05 | % |
| Repeatability** | 1 | 1 | nm |
| Pitch / yaw in X, Y | 0.5 | 0.5 | µrad |
| Runout X, Y (Z motion) | 0.2 | – | µrad |
| Straightness in X, Y | 3 | 3 | nm |
| Flatness in X, Y | <10 | <10 | nm |
| Crosstalk in X, Y (motion in Z) | 5 | – | nm |
| **Mechanical properties** | | | |
| Unloaded resonant frequency in X, Y | 3.1 | 4.2 | kHz |
| Unloaded resonant frequency in Z | 9.8 | – | kHz |
| Loaded resonant frequency in X, Y | 1.5 (20 g) | 2.1 (20 g) | kHz |
| Load capacity | 10 | 10 | N |
| Ceramic type | PICA, PICA Shear | PICA Shear | |
| **Miscellaneous** | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | °C |
| Material | Titanium | Titanium | |
| Dimensions | 30 mm × 30 mm × 40 mm | 30 mm × 30 mm × 28 mm | |
| Mass | 225 | 190 | g |
| Cable length | 1.5 | 1.5 | m |
| Sensor / voltage connection | Sub-D 24W7 (m) | Sub-D 24W7 (m) | |
| Recommended electronics | E-536 | E-536 | |
| | | | |

* With E-536.3xH controller.
The resolution of PI piezo nanopositioners is not limited by friction or stiction. Value given is noise equivalent motion with E-536.

** For 10 % travel in Z; 50 nm for 100 % travel in Z.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!



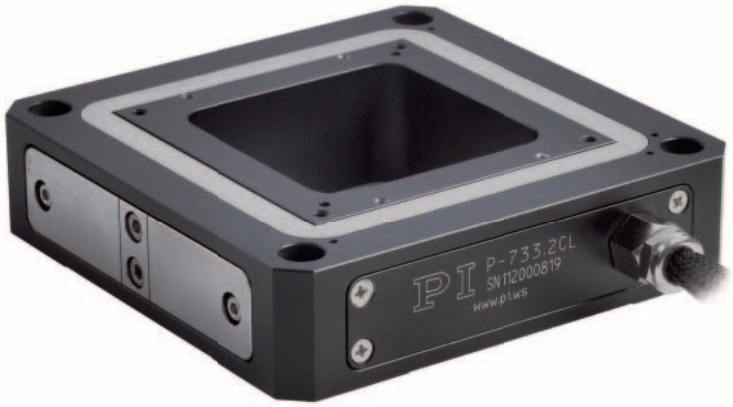

The P-363 settles to within 1 nm in 1 ms (100 nm step, X and Y motion; faster response in Z).




300 picometer steps (0.3 nm) performed with the P-363, measured with an external high-resolution, capacitive measurement system.

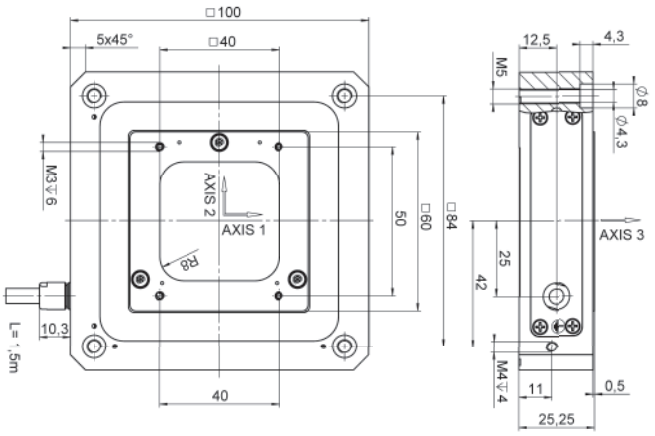
# P-733.3 XYZ Piezo Nanopositioner

## High-Precision XYZ Scanner with Aperture

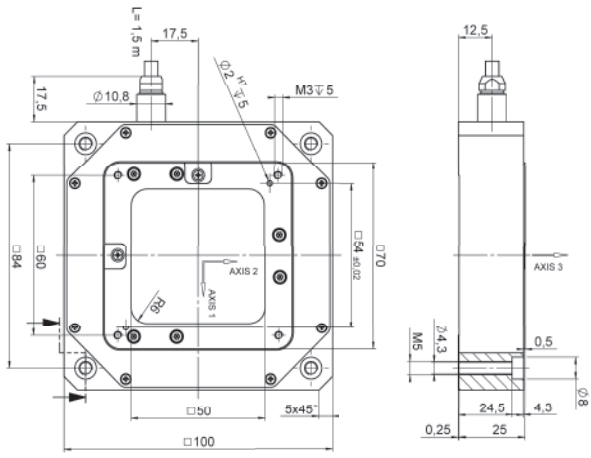



- Travel ranges to 100 µm × 100 µm in X,Y and to 10 µm in Z
- Resolution to 0.1 nm due to capacitive sensors
- High-speed versions with direct drive
- Ultra-high-vacuum compatible and non-magnetic versions
- Parallel kinematics for higher accuracy and dynamics
- Parallel metrology for active compensation of guiding errors
- Zero-play, high-precision flexure guide system
- Clear aperture 50 mm × 50 mm for transmitted-light applications

P-733.3CD/.3CL, dimensions in mm.




P-733.3DD, dimensions in mm.




**Applications**

- Scanning microscopy
- Confocal microscopy
- Mask / wafer positioning
- Surface measurement technique
- Nano-imprinting
- Micromanipulation
- Image processing / stablilization
- Nanopositioning with high flatness & straightness


>> Capacitive Feedback Sensors
>> Flexure Guiding Systems
>> Parallel Metrology
>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

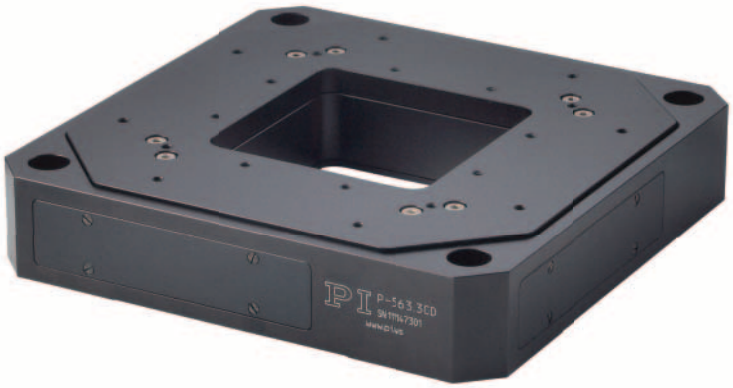
Technology Glossary ..... page 240

| | P-733.3CD<br>P-733.3CL | P-733.3DD | Unit | Tolerance |
|---|---|---|---|---|
| Active axes | X, Y, Z | X, Y, Z | | |
| **Motion and positioning** | | | | |
| Integrated sensor | Capacitive | Capacitive | | |
| Open-loop travel range, –20 to 120 V | 115 µm × 115 µm × 12 µm | 33 µm × 33 µm × 14 µm | | +20 % / –0 % |
| Closed-loop travel range | 100 µm × 100 µm × 10 µm | 30 µm × 30 µm × 10 µm | | |
| Open-loop resolution | 0.2 (0.1 in Z) | 0.1 | nm | typ. |
| Closed-loop resolution | 0.3 (0.2 in Z) | 0.1 | nm | typ. |
| Linearity error (X, Y) | 0.03 | 0.03* | % | typ. |
| Linearity error (Z) | 0.03 | 0.03* | % | typ. |
| Repeatability (X, Y) | <2 | <2 | nm | typ. |
| Repeatability (Z) | <1 | <1 | nm | typ. |
| Pitch (X, Y) | <±3 | <±5 | µrad | typ. |
| Yaw (X, Y) | <±10 | <±10 | µrad | typ. |
| Runout $\theta_Z$ (motion in Z) | <±5 | <±5 | µrad | typ. |
| **Mechanical properties** | | | | |
| Stiffness | 1.4 (9 in Z) | 4 (10 in Z) | N/µm | ±20 % |
| Resonant frequency, no load | 460 (1400 in Z) | 1200 (1100 in Z) | Hz | ±20 % |
| Resonant frequency, under load, 120 g | 340 (1060 in Z) | – | Hz | ±20 % |
| Resonant frequency, under load, 200 g | 295 (650 in Z) | 530 (635 in Z) | Hz | ±20 % |
| Compressive/tensile stress capacity in motion direction | 50 / 20 | 50 / 20 | N | max. |
| **Drive properties** | | | | |
| Piezo ceramic | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 6 (2.4 in Z) | 6.2 (3.3 in Z) | µF | ±20 % |
| **Miscellaneous** | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | | |
| Mass | 0.675 | 0.675 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | m | ±10 mm |
| Sensor / voltage connection | Sub-D 25W3 (m) (CD version); | | | |
| LEMO (CL version) | Sub-D 25W3 (m) | | | |
| Recommended electronics | E-503, E-505, E-610, E-621, E-625, E-712 | E-503, E-505, E-610, E-621, E-625, E-712 | | |

* With digital controller. Nonlinearity of direct drive stages measured with analog controllers is up to 0.1 % typ.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

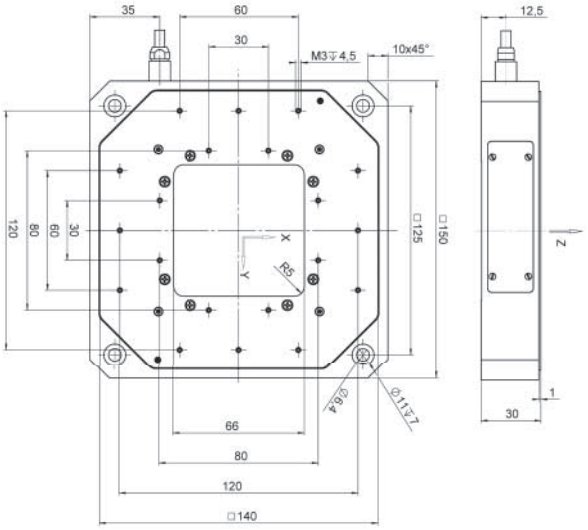
# P-561 / P-562 / P-563
# PIMars Nanopositioning Stage

**High-Precision Nanopositioning System for up to 3 Axes**

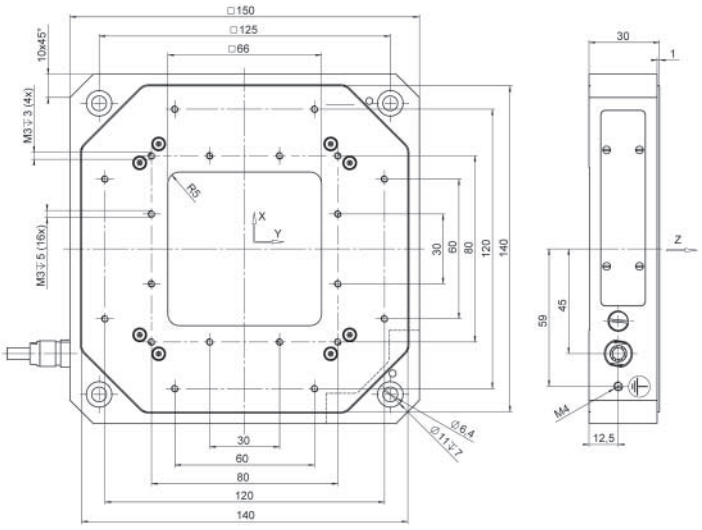


- Parallel kinematics / metrology for enhanced responsiveness and multi-axis precision
- Travel ranges to 300 × 300 × 300 µm
- Highest linearity due to capacitive sensors
- Zero-play, high-precision flexure guide system
- Excellent scanning flatness
- High-dynamics XYZ version available
- Clear aperture 66 mm × 66 mm
- Outstanding lifetime due to PICMA® piezo actuators
- UHV versions to $10^{-9}$ hPa

P-561.3DD, dimensions in mm.




P-56x.3CD and P-56x.3CL, dimensions in mm




**Applications**

- Scanning microscopy
- Mask/wafer positioning
- Interferometry
- Metrology
- Biotechnology
- Scanning and screening


>> Capacitive Feedback Sensors
>> Flexure Guiding Systems
>> Parallel Metrology
>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

Technology Glossary ..... page 240

| | P-561.3CD<br>P-561.3CL | P-562.3CD<br>P-562.3CL | P-563.3CD<br>P-563.3CL | P-561.3DD | Unit | Tolerance |
|---|---|---|---|---|---|---|
| PIMars XYZ piezo-nanopositioning system, closed-loop travel | 100 × 100 × 100 | 200 × 200 × 200 | 300 × 300 × 300 | 45 × 45 × 15, direct drive | µm | |
| **Motion and positioning** | | | | | | |
| Integrated sensor | Capacitive | Capacitive | Capacitive | Capacitive | | |
| Open-loop travel, –20 to 120 V | 150 × 150 × 150 | 300 × 300 × 300 | 340 × 340 × 340 | 58 × 58 × 18 | µm | +20 % / –0 % |
| Open-loop resolution | 0.2 | 0.4 | 0.5 | 0.1 | nm | typ. |
| Closed-loop resolution | 0.8 | 1 | 2 | 0.2 | nm | typ. |
| Linearity error | 0.03 | 0.03 | 0.03 | 0.01* | % | typ. |
| Repeatability in X / Y / Z | 2 / 2 / 2 | 2 / 2 / 4 | 2 / 2 / 4 | 2 / 2 / 2 | nm | typ. |
| Pitch in X, Y | ±1 | ±2 | ±2 | ±3 | µrad | typ. |
| Crosstalk $\theta_X$, $\theta_Y$ (motion in Z) | ±15 | ±20 | ±25 | ±3 | µrad | typ. |
| Yaw in X, Y | ±6 | ±10 | ±10 | ±3 | µrad | typ. |
| Flatness in X, Y | ±15 | ±20 | ±25 | ±10 | nm | typ. |
| Crosstalk in X, Y (motion in Z) | ±30 | ±50 | ±50 | ±20 | nm | typ. |
| **Mechanical properties** | | | | | | |
| Unloaded resonant frequency in X / Y / Z | 190 / 190 / 380 | 160 / 160 / 315 | 140 / 140 / 250 | 920 / 920 / 1050 | Hz | ±20 % |
| Resonant frequency at 100 g in X / Y / Z | – | 145 / 145 / 275 | 120 / 120 / 215 | 860 / 860 / 950 | Hz | ±20 % |
| Resonant frequency at 330 g in X / Y / Z | 140 / 140 / 300 | 130 / 130 / 195 | 110 / 110 / 170 | 500 / 500 / 470 | Hz | ±20 % |
| Load capacity** | 5 | 5 | 5 | 5 | kg | max. |
| **Drive properties** | | | | | | |
| Piezo ceramic | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 in Z, P-888 in XY | | |
| Electrical capacitance in X / Y / Z | 5.2 / 5.2 / 10.4 | 7.4 / 7.4 / 14.8 | 7.4 / 7.4 / 14.8 | 38 / 38 / 6 | µF | ±20 % |
| **Miscellaneous** | | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | Aluminum | Aluminum | | |
| Mass | 1.45 | 1.45 | 1.45 | 1.55 | kg | ±5 % |
| Sensor / voltage connection | CD version: Sub-D 25W3 (m), 1.5 m cable CL version: LEMO | CD version: Sub-D 25W3 (m), 1.5 m cable CL version: LEMO | CD version: Sub-D 25W3 (m), 1.5 m cable CL version: LEMO | CD version: Sub-D 25W3 (m), 1.5 m cable CL version: LEMO | | |
| Recommended electronics | E-503, E-505, E 621, E-712, E 727 | E-503, E-505, E 621, E-712, E 727 | E-503, E-505, E 621, E-712, E 727 | E-503, E-505, E 621, E-712, E 727 | | |

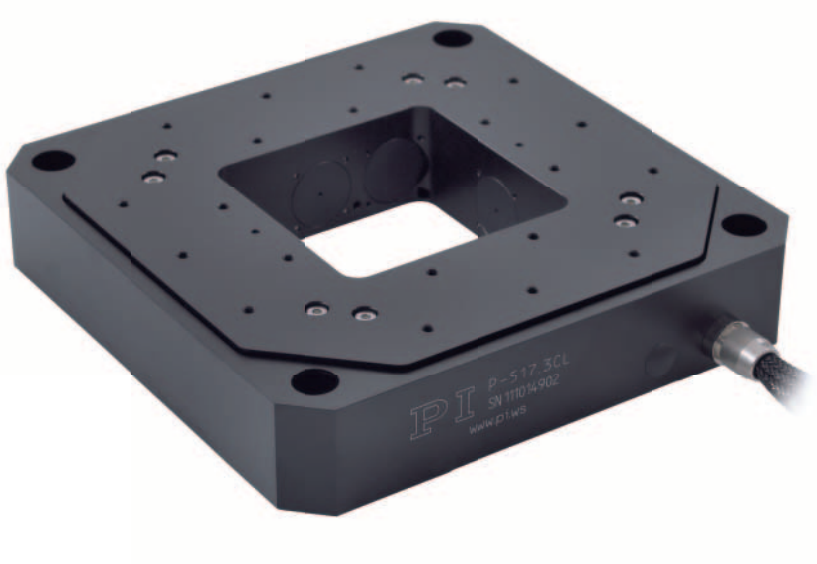
* With digital controller. Nonlinearity of direct drive stages measured with analog controllers is up to 0.1 % typ.

** When mounted horizontally (standing on a surface, not suspended).

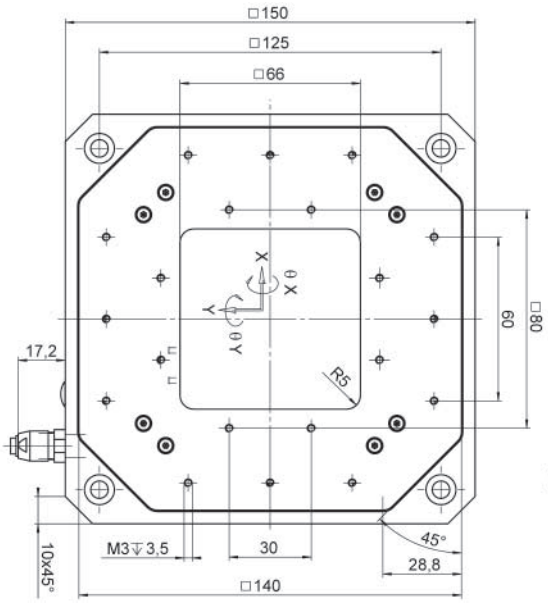
The resolution of PI piezo nanopositioning systems is not limited by friction or stiction.
Value given is noise equivalent motion with E-725 / E-712 controller.
All specifications based on room temperature (22 °C ±3 °C).
Super-invar and titanium versions available.
Ask about custom designs!

# P-517 / P-527 Multi-Axis Piezo Scanner

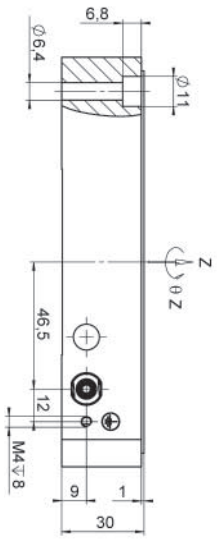
## High-Dynamics Nanopositioner / Scanner with Direct Position Measuring



- 2- and 3-axis versions (XY and XY$\theta_Z$)
- Travel ranges to 200 µm
- Subnanometer resolution




P-517, P-527, dimensions in mm.




**Applications**

- Metrology
- Interferometry
- Photonics / integrated optics
- Lithography
- Nanopositioning
- Scanning microscopy
- Sample alignment;
- Micromachining


>> Capacitive Feedback Sensors
>> Flexure Guiding Systems
>> Parallel Metrology
>> PICMA® Multilayer Piezo Actuators

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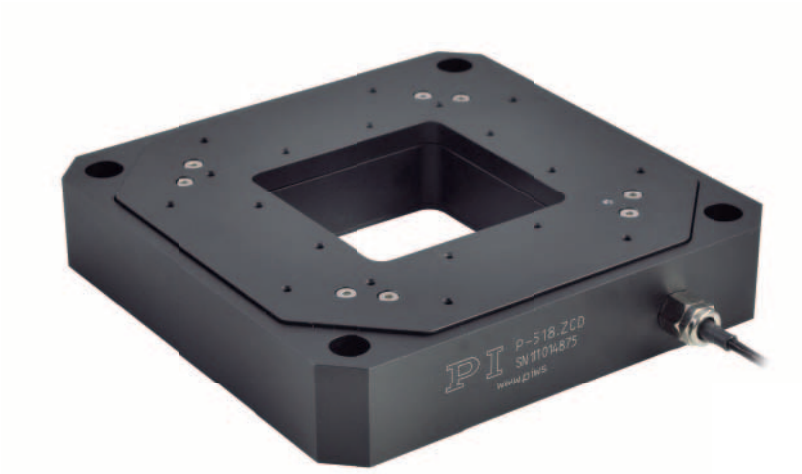
| | P-517.2CL / P-517.2CD | P-527.2CL / P-527.2CD | P-517.3CL / P-517.3CD | P-527.3CL / P-527.3CD | P-517.RCD | P-527.RCD | Unit | Tolerance |
|---|---|---|---|---|---|---|---|---|
| Active axes | X, Y | X, Y | X, Y, Z | X, Y, Z | X, Y, $\theta_Z$ | X, Y, $\theta_Z$ | | |
| **Motion and positioning** | | | | | | | | |
| Integrated sensor | Capacitive | Capacitive | Capacitive | Capacitive | Capacitive | Capacitive | | |
| Open-loop travel range, –20 to 120 V | 130 µm | 250 µm | X, Y: 130 µm<br>Z: 25 µm | X, Y: 250 µm<br>Z: 25 µm | X, Y: 130 µm<br>$\theta_Z$: ±1.3 mrad | X, Y: 250 µm<br>$\theta_Z$: ±2.5 mrad | | +20 % / –0 % |
| Closed-loop travel range | 100 µm | 200 µm | X, Y: 100 µm<br>Z: 20 | X, Y: 200 µm<br>Z: 20 | X, Y: 100 µm<br>$\theta_Z$: ±1 mrad | X, Y: 200 µm<br>$\theta_Z$: ±2 mrad | | |
| Resolution, open loop | 0.3 nm | 0.5 nm | X, Y: 0.3 nm<br>Z: 0.1 nm | X, Y: 0.5 nm<br>Z: 0.1 nm | X, Y: 0.3 nm<br>$\theta_Z$: 0.1 µrad | X, Y: 0.5 nm<br>$\theta_Z$: 0.1 µrad | | typ. |
| Resolution, closed loop | 1 nm | 2 nm | X, Y: 1 nm<br>Z: 0.1 nm | X, Y: 2 nm<br>Z: 0.1 nm | X, Y: 1 nm<br>$\theta_Z$: 0.3 µrad | X, Y: 2 nm<br>$\theta_Z$: 0.3 µrad | | typ. |
| Linearity error | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | % | typ. |
| Repeatability | ±5 nm | ±10 nm | X, Y: ±5 nm<br>Z: ±1 nm | X, Y: ±10 nm<br>Z: ±1 nm | X, Y: ±5 nm<br>$\theta_Z$: ±0.5 µrad | X, Y:±10 nm<br>$\theta_Z$: ±1 µrad | | typ. |
| **Mechanical properties** | | | | | | | | |
| Stiffness | 2 | 1 | X, Y: 2<br>Z: 15 | X, Y: 1<br>Z: 15 | 2 | 1 | N/µm | ±20 % |
| Resonant frequency, no load | 450 | 350 | X, Y: 450<br>Z: 1100 | X, Y: 350<br>Z: 1100 | X, Y: 450<br>$\theta_Z$: 400 | X, Y: 350<br>$\theta_Z$: 300 | Hz | ±20 % |
| Resonant frequency under load in X, Y, 500 g | 250 | 190 | 250 | 190 | 250 | 190 | 250 | 190 |
| Resonant frequency under load in X, Y, 2500 g | 140 | 110 | 140 | 110 | 140 | 110 | 140 | 110 |
| Load capacity* | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **Drive properties** | | | | | | | | |
| Piezo ceramic | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 9.2 | 9.2 | X, Y: 9<br>Z: 6 | X, Y: 9<br>Z: 6 | 9 | 9 | µF | ±20 % |
| **Miscellaneous** | | | | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | | |
| Mass | 1.4 | 1.4 | 1.45 | 1.45 | 1.4 | 1.4 | kg | ±5 % |
| Sensor / voltage connection | CL version: LEMO<br>Sub-D 25W3 (m) | CL version: LEMO<br>Sub-D 25W3 (m) | CL version: LEMO<br>Sub-D 25W3 (m) | CL version: LEMO<br>Sub-D 25W3 (m) | Sub-D 25W3 (m) | Sub-D 25W3 (m) | | |
| Recommended electronics | E-503, E-505, E-621, E-712, E-727 | E-503, E-505, E-621, E-712, E-727 | E-503, E-505, E-621, E-712, E-727 | E-503, E-505, E-621, E-712, E-727 | E-503, E-505, E-621, E-712, E-727 | E-503, E-505, E-621, E-712, E-727 | | |

* When mounted horizontally (standing on a surface, not suspended).
The resolution of PI piezo nanopositioning systems is not limited by friction or stiction.
Specification is position noise with the E-503 piezo amplifier module or E-710 digital piezo controller.
All specifications based on room temperature (22 °C ±3 °C).

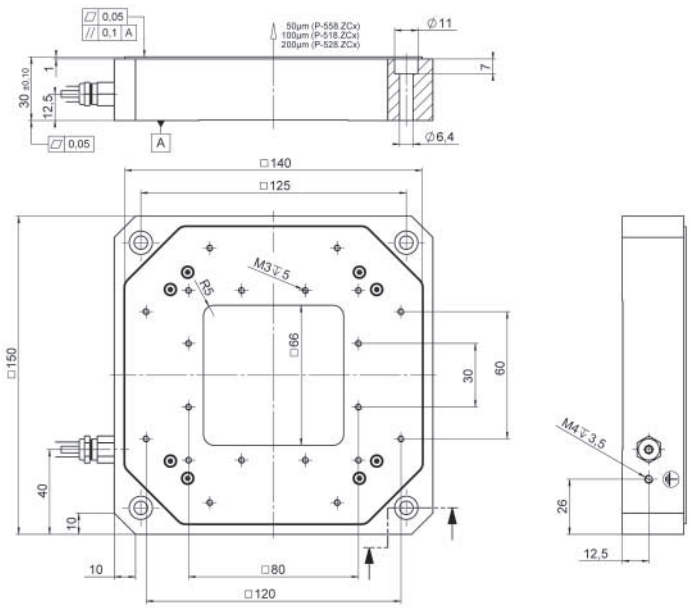
# P-518 / P-528 / P-558 Piezo Z / Tip / Tilt Stage

## High Dynamics, with Large Aperture

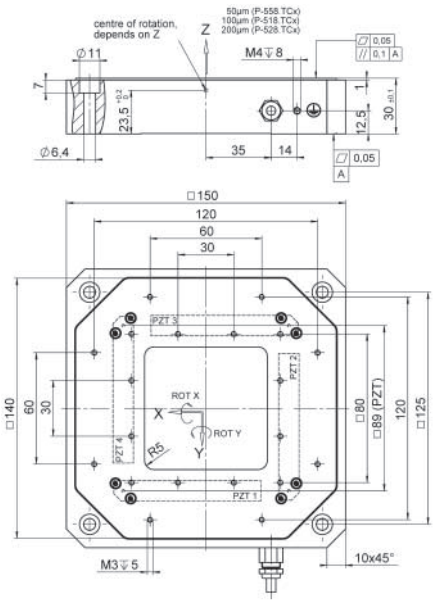



- Z and tip / tilt stages with 3 axes / Z stages with 1 axis
- Closed-loop vertical / tilt range to 200 µm / 2 mrad (open-loop to 240 µm / 2.4 mrad)
- Parallel kinematics for faster response times and higher multi-axis accuracy
- Zero-play, high-precision flexure guide system
- Outstanding lifetime due to PICMA® piezo actuators
- Clear aperture 66 mm × 66 mm
- Highest linearity due to capacitive sensors

P-518 / P-528 / P-558 Z stage, dimensions in mm.




P-518 / P-528 / P-558 Z and tip / tilt stage, dimensions in mm.




**Applications**

- Metrology
- Interferometry
- Photonics / integrated optics
- Lithography
- Nanopositioning
- Scanning microscopy
- Sample alignment;
- Micromachining


>> Capacitive Feedback Sensors
>> Flexure Guiding Systems
>> Parallel Metrology
>> PICMA® Multilayer Piezo Actuators

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| | P-558.ZCD / P-558.ZCL | P-558.TCD | P-518.ZCD / P-518.ZCL | P-518.TCD | P-528.ZCD / P-528.ZCL | P-528.TCD | Unit | Tolerance |
|---|---|---|---|---|---|---|---|---|
| Active axes | Z | Z, $\theta_X$, $\theta_Y$ | Z | Z, $\theta_X$, $\theta_Y$ | Z | Z, $\theta_X$, $\theta_Y$ | | |
| **Motion and positioning** | | | | | | | | |
| Integrated sensor | Capacitive | Capacitive | Capacitive | Capacitive | Capacitive | Capacitive | | |
| Travel range in Z at –20 to 120 V, open loop | 60 | 60 | 140 | 140 | 240 | 240 | µm | +20 % / –0 % |
| Tip / tilt angle in $\theta_X$, $\theta_Y$ at –20 to 120 V, open loop | – | ±0.3 | – | ±0.7 | – | ±1.2 | mrad | +20 % / –0 % |
| Travel range in Z, closed loop | 50 | 50 | 100 | 100 | 200 | 200 | µm | |
| Tip / tilt angle in $\theta_X$, $\theta_Y$, closed loop | – | ±0.25 | – | ±0.5 | – | ±1 | mrad | |
| Resolution in Z, open loop | 0.2 | 0.2 | 0.2 | 0.4 | 0.6 | 0.6 | nm | typ. |
| Resolution in $\theta_X$, $\theta_Y$, open loop | – | 0.02 | – | 0.04 | – | 0.06 | µrad | typ. |
| Resolution in Z, closed loop | 0.5 | 0.5 | 0.8 | 0.8 | 1 | 1 | nm | typ. |
| Resolution in $\theta_X$, $\theta_Y$, closed loop | – | 0.05 | – | 0.05 | – | 0.1 | µrad | typ. |
| Linearity error in $\theta_X$, $\theta_Y$ | – | 0.03 | – | 0.03 | – | 0.03 | % | typ. |
| Repeatability in Z | ±5 | ±5 | ±5 | ±5 | ±10 | ±10 | nm | typ. |
| Repeatability in $\theta_X$, $\theta_Y$ | – | ±0.03 | – | ±0.05 | – | ±0.1 | µrad | typ. |
| Crosstalk θZ (motion in Z) | <10 | <10 | <10 | <10 | <20 | <20 | µrad | typ. |
| Crosstalk $\theta_X$, $\theta_Y$ (motion in Z) | <50 | <50 | <50 | <50 | <100 | <100 | µrad | typ. |
| **Mechanical properties** | | | | | | | | |
| Stiffness in Z | 4 | 4 | 2.7 | 2.7 | 1.5 | 1.5 | N/µm | ±20 % |
| Resonant frequency in Z, no load | 570 | 570 | 500 | 500 | 350 | 350 | Hz | ±20 % |
| Resonant frequency in $\theta_X$, $\theta_Y$, no load | – | 610 | – | 530 | – | 390 | Hz | ±20 % |
| Resonant frequency in Z, under load, 500 g | 410 | 410 | 350 | 350 | 210 | 210 | Hz | ±20 % |
| Resonant frequency in $\theta_X$, $\theta_Y$, under load 500 g | – | 430 | – | 370 | – | 250 | Hz | ±20 % |
| Resonant frequency in Z, under load, 2500 g | 245 | 245 | 200 | 200 | 130 | 130 | Hz | ±20 % |
| Resonant frequency in $\theta_X$, $\theta_Y$ under load, 2500 g | – | 240 | – | 190 | – | 115 | Hz | ±20 % |
| Load capacity* | 5 | 5 | 5 | 5 | 5 | 5 | kg | max. |
| **Drive properties** | | | | | | | | |
| Piezo ceramic | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 6 | 6 | 8.4 | 8.4 | 14.8 | 14.8 | µF | ±20 % |
| **Miscellaneous** | | | | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | | |
| Dimensions | 150 mm × 150 mm × 30 mm | 150 mm × 150 mm × 30 mm | 150 mm × 150 mm × 30 mm | 150 mm × 150 mm × 30 mm | 150 mm × 150 mm × 30 mm | 150 mm × 150 mm × 30 mm | | |
| Mass | 1380 | 1380 | 1400 | 1400 | 1420 | 1420 | g | ±5 % |
| Cable length | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | m | ±10 mm |
| Sensor / voltage connection | CL version: LEMO CD version: Sub-D 7W2 (m) | ub-D 25W3 (m) | CL version: LEMO CD version: Sub-D 7W2 (m) | Sub-D 25W3 (m) | CL version: LEMO CD version: Sub-D 7W2 (m) | Sub-D 25W3 (m) | | |
| Recommended electronics | E-503, E-505, E-610, E-621, E-625, E-712, E-727, E-754 | E-503, E-505, E-610, E-621, E-625, E-712, E-727, E-754 | E-503, E-505, E-610, E-621, E-625, E-712, E-727, E-754 | E-503, E-505, E-610, E-621, E-625, E-712, E-727, E-754 | E-503, E-505, E-610, E-621, E-625, E-712, E-727, E-754 | E-503, E-505, E-610, E-621, E-625, E-712, E-727, E-754 | | |

* When mounted horizontally (standing on a surface, not suspended).

The resolution of PI piezo nanopositioning systems is not limited by friction or stiction.
Specification as position noise with the E-503 piezo amplifier module or E-710 digital piezo controller.

All specifications based on room temperature (22 °C ±3 °C).

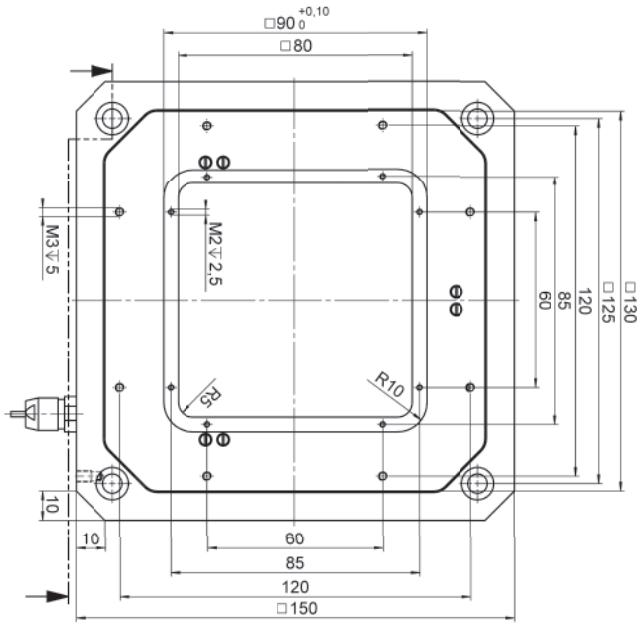
Ask about custom designs!

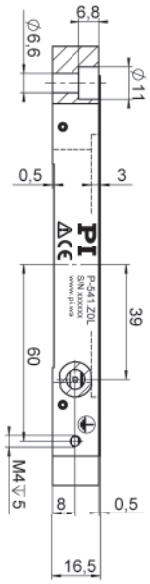
# P-541.Z Piezo Z and Z / Tip / Tilt Stages

## Low Profile, Large Aperture


- Low profile for easy integration: 16.5 mm
- Clear aperture 80 mm × 80 mm
- Vertical and Z / tip / tilt stages
- Travel range 100 µm
- 1 mrad tilt
- Parallel kinematics for faster response times and higher multi-axis accuracy
- Choice of sensors: Strain gauge (lower cost) or capacitive sensors (higher performance)
- Outstanding lifetime due to PICMA® piezo actuators
- Combination with long-travel microscopy stages

P-541.Z0L, dimensions in mm.




**Applications**

- Scanning microscopy
- Super-resolution microscopy
- Biotechnology
- Mask / wafer positioning
- Sample positioning
- Interferometry
- Metrology


>> Capacitive Feedback Sensors
>> Flexure Guiding Systems
>> Parallel-Kinematic Piezo Stages
>> PICMA® Multilayer Piezo Actuators

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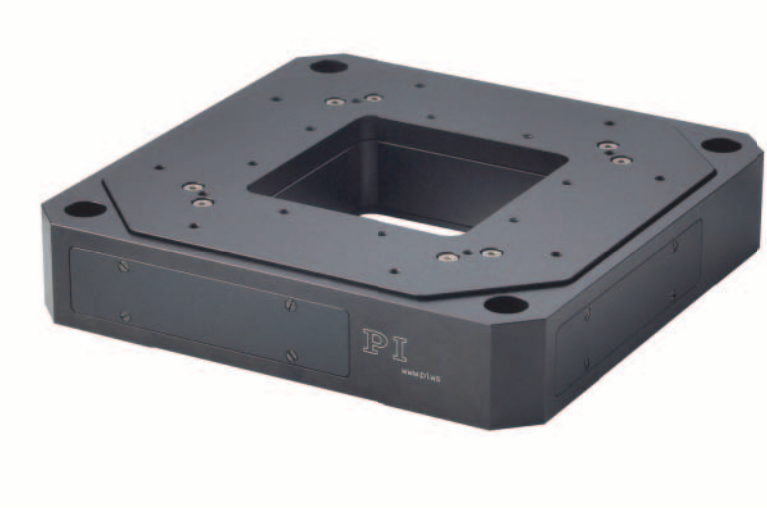
| | P-541.ZCD | P-541.TCD* | P-541.ZSL | P-541.TSL* | P-541.Z0L | P-541.T0L* | Unit | Tolerance |
|---|---|---|---|---|---|---|---|---|
| Active axes | Z | Z, $\theta_X$, $\theta_Y$ | Z | Z, $\theta_X$, $\theta_Y$ | Z | Z, $\theta_X$, $\theta_Y$ | | |
| **Motion and positioning** | | | | | | | | |
| Integrated sensor | Capacitive | Capacitive | SGS | SGS | Open-loop | Open-loop | | |
| Open-loop Z-travel, –20 to 120 V | 150 | 150 | 150 | 150 | 150 | 150 | µm | +20 % / –0 % |
| Open-loop tip / tilt angle in $\theta_X$, $\theta_Y$ at -20 to 120 V | – | ±0.6 | – | ±0.6 | – | ±0.6 | mrad | +20 % / –0 % |
| Closed-loop Z-travel | 100 | 100 | 100 | 100 | – | – | µm | |
| Closed-loop tip / tilt angle in $\theta_X$, $\theta_Y$ | – | ±0.4 | - | ±0.4 | – | – | mrad | |
| Open-loop Z-resolution | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | nm | typ. |
| Open-loop resolution in $\theta_X$, $\theta_Y$ | – | 0.02 | – | 0.02 | – | 0.02 | µrad | typ. |
| Closed-loop Z-resolution | 0.5 | 0.5 | 2.5 | 2.5 | – | – | nm | typ. |
| Closed-loop resolution in $\theta_X$, $\theta_Y$ | – | 0.08 | – | 0.25 | – | – | µrad | typ. |
| Linearity error (Z-travel), $\theta_X$, $\theta_Y$ | 0.03 | 0.03 | 0.2 | 0.2 | – | – | % | typ. |
| Repeatability Z | <2 | <2 | <10 | <10 | – | – | nm | typ. |
| Repeatability $\theta_X$, $\theta_Y$ | – | 0.01 | – | 0.05 | – | – | µrad | typ. |
| Runout $\theta_X$, $\theta_Y$ (motion in Z) | ±15 | ±15 | ±15 | ±15 | ±15 | ±15 | µrad | typ. |
| **Mechanical properties** | | | | | | | | |
| Stiffness Z | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | N/µm | ±20 % |
| Unloaded resonant frequency (Z) | 410 | 410 | 410 | 410 | 410 | 410 | Hz | ±20 % |
| Unloaded resonant frequency $\theta_X$, $\theta_Y$ | – | 330 | – | 330 | – | 330 | Hz | ±20 % |
| Resonant frequency at 200 g (Z) | 250 | 250 | 250 | 250 | 250 | 250 | Hz | ±20 % |
| Resonant frequency at 200 g, $\theta_X$, $\theta_Y$ | – | 270 | – | 270 | – | 270 | Hz | ±20 % |
| Push / pull force capacity | 50 / 20 | 50 / 20 | 50 / 20 | 50 / 20 | 50 / 20 | 50 / 20 | N | max. |
| **Drive properties** | | | | | | | | |
| Ceramic type | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | µF | ±20 % |
| **Miscellaneous** | | | | | | | | |
| Operating temperature range | 20 to 80 | 20 to 80 | 20 to 80 | 20 to 80 | 20 to 80 | 20 to 80 | °C | |
| Material | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | | |
| Mass | 750 | 750 | 730 | 730 | 700 | 700 | g | ±5 % |
| Cable length | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | m | ±10 mm |
| Sensor connection | Sub-D 7W2 (m) | Sub-D 25W3 (m) | LEMO | 3 × LEMO | – | – | | |
| Voltage connection | Sub-D 7W2 (m) | Sub-D 25W3 (m) | LEMO | 3 × LEMO | LEMO | 3 × LEMO | | |
| Recommended electronics | E 503, E 505, E 610, E 621, E 625, E 712, E 727, E 754 | E 503, E 505, E 610, E 621, E 625, E 712, E 727, E 754 | E 503, E 505, E 610, E 621, E 625, E 712, E 727, E 754 | E 503, E 505, E 610, E 621, E 625, E 712, E 727, E 754 | E 503, E 505, E 610, E 621, E 625, E 712, E 727, E 754 | E 503, E 505, E 610, E 621, E 625, E 712, E 727, E 754 | | |

* Parallel kinematics design; the maximum displacement for translation and tilt motion cannot be achieved at the same time.
Resolution of PI piezo nanopositioners is not limited by friction or stiction. Value given is noise equivalent motion with E-503 or E-710 controller.
All specifications based on room temperature (22 °C ±3 °C).

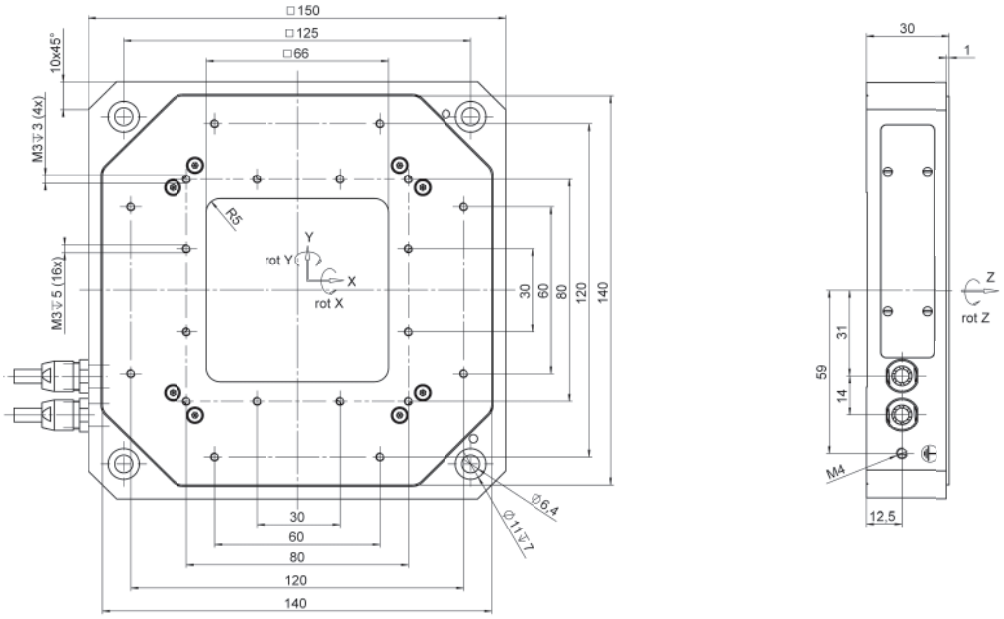
# P-562.6CD PIMars 6-Axis Piezo Stage System

## High-Precision Nanopositioning System with 6 Degrees of Freedom



- 6 motion axes: 3 × linear, 3 × rotational
- Travel ranges to 200 µm linear and to 1 mrad tilt angle
- Parallel kinematics for faster response times and higher multi-axis accuracy
- Highest linearity due to capacitive sensors
- Zero-play, high-precision flexure guide system
- Excellent scan-flatness
- Clear aperture 66 mm × 66 mm
- Outstanding lifetime due to PICMA® piezo actuators
- UHV-compatible to $10^{-9}$ hPa

P-562, dimensions in mm.




**Applications**

- Scanning microscopy
- Super-resolution microscopy
- Biotechnology
- Mask / wafer positioning
- Sample positioning
- Interferometry
- Metrology


>> Capacitive Feedback Sensors
>> Flexure Guiding Systems
>> Parallel Metrology
>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

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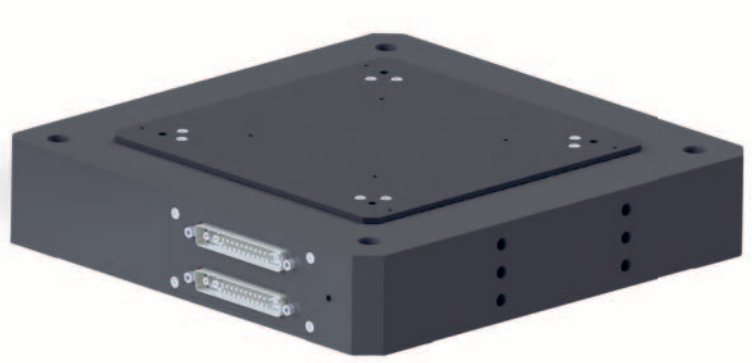
| | P-562.6CD | Unit | Tolerance |
|---|---|---|---|
| Active axes | X, Y, Z, $\theta_X$, $\theta_Y$, $\theta_Z$ | | |
| **Motion and positioning** | | | |
| Integrated sensor | Capacitive | | |
| Closed-loop travel in X, Y, Z | 200 | µm | |
| Closed-loop tilt angle in $\theta_X$, $\theta_Y$, $\theta_Z$ | ±0.5 | mrad | |
| Closed-loop resolution X, Y, Z | 1 | nm | typ. |
| Closed-loop resolution in $\theta_X$, $\theta_Y$, $\theta_Z$ | 0.1 | µrad | typ. |
| Linearity error in X, Y, Z | 0.01 | % | typ. |
| Linearity error $\theta_X$, $\theta_Y$, $\theta_Z$ | 0.1 | % | typ. |
| Repeatability in X / Y / Z | ±2 / ±2 / ±3 | nm | typ. |
| Repeatability $\theta_X$, $\theta_Y$, $\theta_Z$ | ±0.1 / ±0.1 / ±0.15 | µrad | typ. |
| Flatness | <15 | nm | typ. |
| Unloaded resonant frequency in X / Y / Z | 110 / 110 / 190 | Hz | ±20 % |
| Load capacity* | 5 | kg | max. |
| **Drive properties** | | | |
| Ceramic type | PICMA® | | |
| Electrical capacitance in X / Y / Z | 7.4 / 7.4 / 14.8 | µF | ±20 % |
| **Miscellaneous** | | | |
| Operating temperature range | –20 to 80 | °C | |
| Material | Aluminum | | |
| Mass | 1.45 | kg | ±5 % |
| Cable length | 1.5 | m | ±10 mm |
| Sensor / voltage connection | 2 × Sub-D 25W3 (m) | | |
| Recommended electronics | E-712 | | |
| | | | |

* When mounted horizontally (standing on a surface, not suspended).
The resolution of PI piezo nanopositioning systems is not limited by friction or stiction.
Specification is position noise with the E-503 piezo amplifier module or E-710 digital piezo controller.
All specifications based on room temperature (22 °C ±3 °C).
Other travel ranges on request.

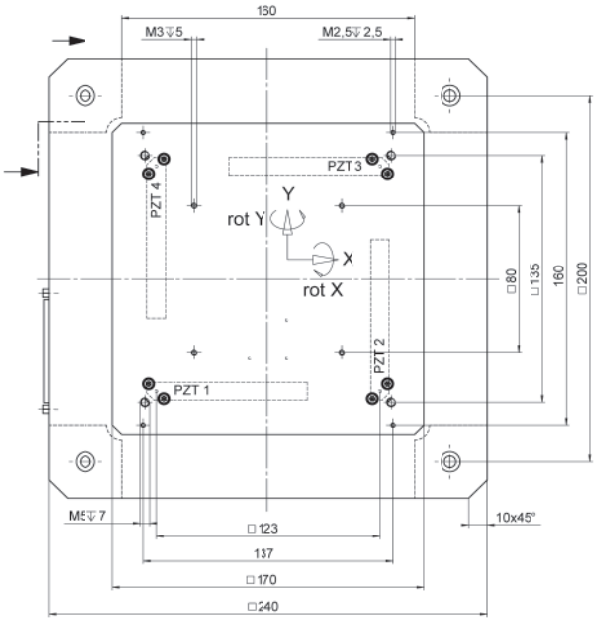
# P-587 6-Axis Precision Piezo Stage

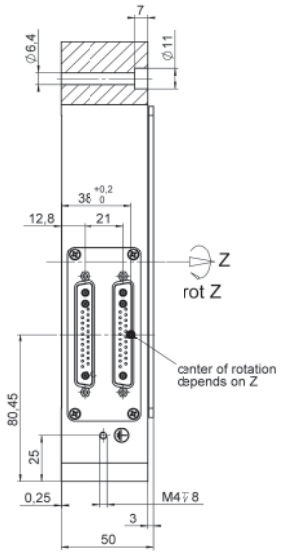
## Long Scanning Range, Direct Position Measurement



- For scanning and positioning in X, Y, Z, $\theta_X$, $\theta_Y$, $\theta_Z$
- 800 µm × 800 µm × 200 µm linear range
- Up to 1 mrad rotational angle
- Parallel kinematics for faster response times and higher multi-axis accuracy
- Direct metrology with capacitive sensors for highest linearity
- Outstanding lifetime due to PICMA® piezo actuators
- Zero-play, high-precision flexure guide system
- Active trajectory control in all 6 degrees of freedom

P-587, dimensions in mm.




**Applications**

- Interferometry
- Metrology
- Nano-imprinting
- Semiconductor testing
- Semiconductor production


>> Capacitive Feedback Sensors
>> Direct Metrology
>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

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| | P-587.6CD | Unit | Tolerance |
|---|---|---|---|
| Active axes | X, Y, Z, $\theta_X$, $\theta_Y$, $\theta_Z$ | | |
| **Motion and positioning** | | | |
| Integrated sensor | Capacitive | | |
| Closed-loop travel in X, Y | 800 | µm | |
| Closed-loop travel in Z | 200 | µm | |
| Closed-loop tilt angle in $\theta_X$, $\theta_Y$ | ±0.5 | mrad | |
| Closed-loop tilt angle in $\theta_Z$ | ±0.5 | mrad | |
| Open-loop / closed-loop resolution X, Y | 0.9 / 2.2 | nm | typ. |
| Open-loop / closed-loop resolution Z | 0.4 / 0.7 | nm | typ. |
| Open-loop / closed-loop resolution in $\theta_X$, $\theta_Y$ | 0.05 / 0.1 | µrad | typ. |
| Open-loop / closed-loop resolution in $\theta_Z$ | 0.1 / 0.3 | µrad | typ. |
| Linearity error in X, Y, Z | 0.01 | % | typ. |
| Linearity error $\theta_X$, $\theta_Y$, $\theta_Z$ | 0.1 | % | typ. |
| Repeatability X, Y | ±3 | nm | typ. |
| Repeatability in Z | ±2 | nm | typ. |
| Repeatability in $\theta_X$, $\theta_Y$ | ±0.1 | µrad | typ. |
| Repeatability in $\theta_Z$ | ±0.15 | µrad | typ. |
| Flatness | <15 | nm | typ. |
| Stiffness in X / Y / Z | 0.55 / 0.55 / 1.35 | N / µm | |
| Unloaded resonant frequency in X / Y / Z | 103 / 103 / 235 | Hz | ±20 % |
| Resonant frequency at 500 g in X / Y / Z | 88 / 88 / 175 | Hz | ±20 % |
| Resonant frequency at 2000 g in X / Y / Z | 65 / 65 / 118 | Hz | ±20 % |
| Load capacity* | 5 | kg | max. |
| **Drive properties** | | | |
| Ceramic type | PICMA® | | |
| Electrical capacitance in X / Y / Z | 81 / 81 / 18.4 | µF | ±20 % |
| **Miscellaneous** | | | |
| Operating temperature range | –20 to 80 | °C | |
| Material | Aluminum | | |
| Dimensions | 240 mm × 240 mm × 50 mm | | |
| Mass | 7.2 | kg | ±5 % |
| Cable length | 1.5 | m | ±10 mm |
| Sensor / voltage connection | 2 × Sub-D 25W3 (m) | | |
| Recommended electronics | E-712 | | |

* When mounted horizontally (standing on a surface, not suspended).
The maximum rotational angle in Z is 8 mrad, the tilt angles around X and Y rate 3 mrad.
Due to the parallel kinematics design, linear motion in X or Y is not possible simultaneously when the stage is in extreme tilt angle position.
The resolution of PI piezo nanopositioning systems is not limited by friction or stiction.
Specification is position noise with the E-503 piezo amplifier module or E-710 digital piezo controller.
All specifications based on room temperature (22 °C ±3 °C).

# Scanners for Microscopy


# Microscopy Solutions

Piezo stages are ideal for moving the objective (PIFOC, top) and / or the sample (XYZ sample scanning, middle). The small-stroke piezo stages can be supplemented by low-profile PILine® Scanning Stages for large travel ranges (bottom)

**Positioning Tasks in Microscopy**

Modern microscopic techniques have some similar basic requirements in regard to the positioning elements: compact design and very high accuracy which refers to precision positioning, high repeatability and short settling time. For example, Z-stacks of samples are realized by many individual images in as short a time as possible to avoid damage of the biological cells. Next to that, the observation of dynamic processes is an important application scenario as well – both tasks place great demands on the dynamics of the stage itself.

**Sample or Objective?**

Fast focusing in the direction of the optical axis can be done by moving the objective, for example. PIFOC systems with their easily exchangeable PI QuickLock thread inserts, and large apertures, offer up to 2000 µm of travel for the objective or turret. Z stack acquisition, autofocus / focus tracking or drift compensation are typical use cases.

Sample fine positioning can be enhanced by offering additional motion in XY for high-dynamic tracking, e.g. to examine motion of individual molecules. PInano® tracking stages offer XYZ motion in one compact package.

**Long Range PILine® XY Scanning Stages**

Automated tasks require positioning over larger ranges of approx. 130 mm × 80 mm with high speed and precision. PILine® stages are characterized by a low profile, an extremely large dynamic range (10 µm/s to 100 mm/s) and very good velocity constancy, position stability and repeatability. These stages are also very well suited for super resolution microscopy applications such as STORM, PALM, STED or SIM, which place very high demands on the stability.

See details on the PI website (www.pi.ws).

**System Packages?**

Preconfigured packages that include the appropriate controller and software are available for the major product lines. PI piezo controllers come with high resolution digital interfaces (USB, Ethernet, RS-232), high-speed analog interfaces, as well as solid software support for all major image acquisition packages.

## Compatibility of Piezo Scanners with Manual, Motorized and PILine® XY Microscope Stages

| | **P-545.xR8S**<br>**P-545.xC8S**<br>**P-545.3D8S**<br>PInano® piezo system | **P-736.ZCN2S**<br>**P-736.ZRN2S**<br>PInano® Z piezo scanner system | **PD73Z2COW**<br>**PD73Z2ROW**<br>PInano® Z piezo scanner system | **P-736.ZR1S**<br>**P-736.ZR2S**<br>PInano® Z piezo slide sanner system | **P-733.2xx**<br>**P-733.3xx**<br>Piezo nanopositioning stage | **P-541.2xx / P-541.Txx**<br>**P-541.Zxx / P-542.2xx**<br>Piezo nanopositioning stage | **P-737.xxx**<br>PIFOC specimen-focusing Z stage |
|---|---|---|---|---|---|---|---|
| **U-780.DNS**<br>PILine® XY stage system for Nikon microscopes | • | • | | | | • | • |
| **U-780.DOS**<br>PILine® XY stage system for Olympus microscopes | • | | • | | | • | • |
| **U-780.DLS**<br>PILine® XY stage system for Leica microscopes | • | | | | | • | • |
| **U-760.DNOS**<br>PILine® XY stage system for Nikon / Olympus microscopes | • | | | •* | •** | • | |
| **M-545.2MN**<br>XY stage for Nikon microscopes TI series | • | | | •* | •** | • | |
| **M-545.2MO**<br>XY stage for Olympus microscopes IX2, IX3 | • | | | •* | •** | • | |
| **M-545.2ML**<br>XY stage for Leica microscopes DMI series | • | | | •* | •** | • | |
| **M-545.2MZ**<br>XY stage for Zeiss microscopes Axio Observer | • | | | •* | •** | • | |

* With P-736.AP1 adapter plate / ** With P-733.AP1 adapter plate

## Inserts for PI Sample Stages

| | **P-545.xR8S**<br>**P-545.xC8S**<br>**P-545.3D8S** | **P-736.ZCN2S**<br>**P-736.ZRN2S** | **PD73Z2COW**<br>**PD73Z2ROW** | **P-736.ZR1S**<br>**P-736.ZR2S** | **P-541.2xx**<br>**P-541.Txx**<br>**P-541.Zxx**<br>**P-542.2xx** | **P-737.xxx** | **U-780.DNS** | **U-780.DOS** | **U-780.DLS** | **U-760.DNOS** | **M-545.2MN**<br>**M-545.2MO**<br>**M-545.2ML**<br>**M-545.2MZ** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Microscope slide holder | P-545.SH3* | P-736.SHN* | P-736.SHO* | P-545.SH3* | | P-737.AP1* | P-736.SHN*<br>P-736.SHO* | P-736.SHN*<br>P-736.SHO* | P-736.SHN*<br>P-736.SHO* | P-545.SH3* with M-545.SHP | P-545.SH3* with M-545.SHP |
| Petri dish holder | P-545.PD3 | P-736.PDN | P-736.PDO | P-545.PD3 | P-542.PD1 | P-737.AP2 | P-736.PDN<br>P-736.PDO | P-736.PDN<br>P-736.PDO | P-736.PDN<br>P-736.PDO | P-545.PD3 with M-545.SHP adapter plate | P-545.PD3 with M-545.SHP adapter plate |
| Microtiter plate holder | | P-736.WPN | P-736.WPO | | P-542.SH1* | | P-736.WPN<br>P-736.WPO | P-736.WPN<br>P-736.WPO | P-736.WPN<br>P-736.WPO | | |
| Universal holder | | P-736.UHN* | M-687.AP1* | | | | P-736.UHN*<br>M-687.AP1* | P-736.UHN*<br>M-687.AP1* | P-736.UHN*<br>M-687.AP1* | | |
| Universal holding plate | P-545.PP3 | | | P-545.PP3 | | | | | | P-545.PP3 with M-545.SHP | P-545.PP3 with M-545.SHP |

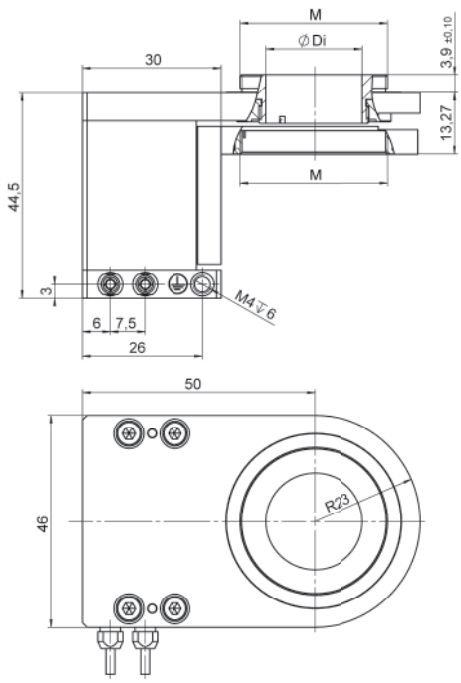
M-545.SHP adapter plate
* Also available: P-545.C18 Coverslip holder (for 18 mm × 18 mm coverslips), P-545.C22 (for 22 mm × 22 mm coverslips) and P-545.C25 (for 25 mm × 25 mm coverslips)

# ND72Z2LAQ
# PIFOC Objective Scanning System 2000 µm

**Nanometer Resolution and Fast Step-and-Settle**



N-725.2A with M32 thread insert, dimensions in mm.




| M | Di | Quicklock |
|---|---|---|
| M26 × 0,75 | 21 | P-721.02Q |
| M27 × 0,75 | 21 | P-721.03Q |
| M28 × 0,75 | 21 | P-721.04Q |
| M32 × 0,75 | 21 | P-721.05Q |
| M26 × 1/36" | 21 | P-721.06Q |
| M19 × 0,75 | 14 | P-721.0SQ |
| M25 × 0,75 | 21 | P-721.11Q |
| W0,8 × 1/36" | 14 | P-721.12Q |

- Complete system with digital controller, software and M32 QuickLock thread insert
- USB, RS-232
- Sensor resolution 0.5 nm
- Highly dynamic step-and-settle for Z stacks
- Further thread adapters as optional accessory
- Compatible with µManager, MetaMorph and MATLAB
- Adaptation of all control parameters on the fly

**Applications**

- 2-photon microscopy
- Confocal microscopy
- 3D-Imaging
- Laser technology
- Interferometry
- Biotechnology
- Micromanipulation
- Autofocus for large travel ranges


>> **Extensive Software Package**
>> **Incremental Encoder**
>> **PiezoWalk® Walking Drive**

**Technology Glossary** ..... **page 240**

| | ND72Z2LAQ | Unit | Tolerance |
|---|---|---|---|
| Active axes | Z | | |
| **Motion and positioning** | | | |
| Integrated sensor | Optical linear encoder | | |
| Closed-loop travel | 2000 | µm | |
| Min. incremental motion, closed-loop | 5 | nm | typ. |
| **Mechanical properties** | | | |
| Step-and-settle time for a 3 µm step at 200 g payload, 100 nm settling band | <20 | ms | |
| Recommended load* | 700 | g | max. |
| **Drive properties** | | | |
| Piezoceramics | NEXACT® | | |
| **Miscellaneous** | | | |
| Operating temperature range | 15 to 40 | °C | |
| Material | Aluminum | | |
| Mass | 290 | g | ±5 % |
| Cable length | 1.5 | m | ±10 mm |
| **Piezo controller** | E-861 digital servo (included in delivery) | | |
| Communication interfaces | USB, RS-232 | | |
| Connector (motor) | HD Sub-D 15-pin | | |
| Connector (sensor) | HD Sub-D 15-pin | | |
| I/O connector | 4 × digital input (TTL, programmable) | | |
| 4 × digital output (TTL, programmable) | | | |
| Command set | PI General Command Set (GCS) | | |
| User software | PIMikroMove | | |
| Software drivers | LabVIEW driver, shared libraries for Windows and Linux. Supports MATLAB, MetaMorph, µManager | | |
| Supported functionality | Wave generator, data recorder, macro programming | | |
| Controller dimensions | 160 mm × 96 mm × 33 mm | | |
| | | | |

* For dynamic operation. Higher dynamics are possible with a reduced load.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

**Accessory included in delivery**

P-721.05Q QuickLock-Thread adapter M32 × 0.75

**Further accessories**

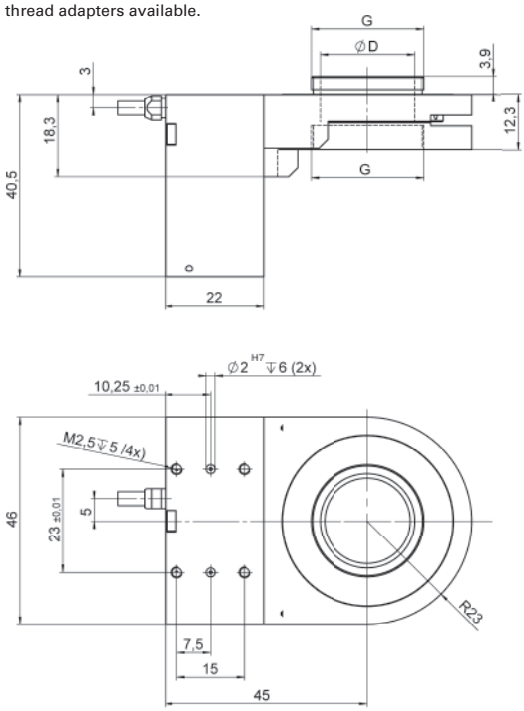
P-721.02Q QuickLock-Thread adapter M26 × 0.75
P-721.03Q QuickLock-Thread adapter M27 × 0.75
P-721.04Q QuickLock-Thread adapter M28 × 0.75
P-721.06Q QuickLock-Thread adapter M26 × 1/36"
P-721.08Q QuickLock-Thread adapter M19 × 0.75
P-721.11Q QuickLock-Thread adapter M25 × 0.75
P-721.12Q QuickLock-Thread adapter W0.8 × 1/36"

# PD72Z2x/4x
# PIFOC Objective Scanning System 400 µm

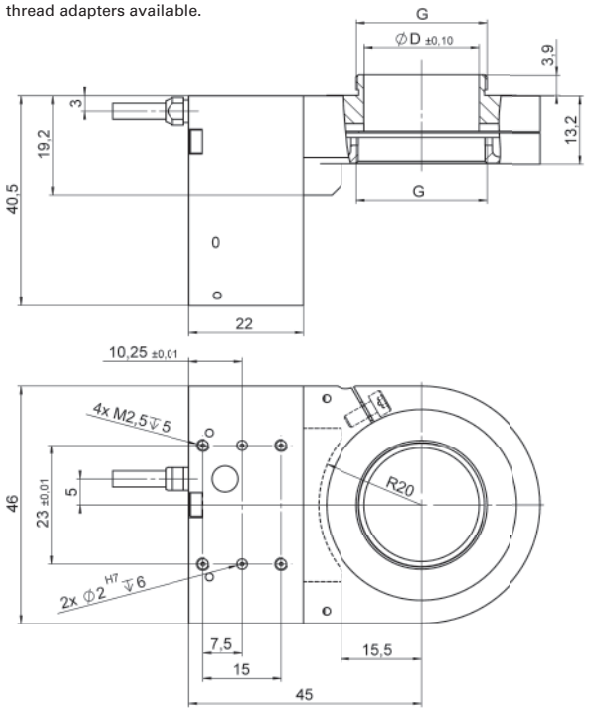
**High-dynamics Piezo Drive for Sub-Nanometer Resolution**


- Complete system with digital controller, software and QuickLock thread adapter
- USB, RS-232, analog interfaces
- Travel ranges to 400 µm
- Scans and positions objectives with sub-nanometer resolution
- Zero-play, high-precision flexure guide system
- Direct metrology with capacitive sensors
- Compatible with µManager, MetaMorph and MATLAB
- Adaptation of all control parameters on the fly

PD72ZxCAQ, dimensions in mm.
P-721.xxQ: Suitable PIFOC QuickLock thread adapters available.




PD72ZxCAA, dimensions in mm.
P-721.xxA: Suitable PIFOC QuickLock thread adapters available.




**Applications**

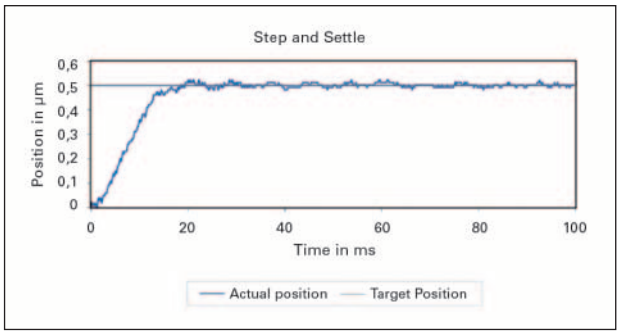
- Microscopy
- Confocal microscopy
- 3D-Imaging
- Screening
- Autofocus systems
- Surface analysis
- Wafer inspection
- Multi-photon microscopy


>> Capacitive Sensors
>> Direct Metrology
>> Extensive Software Package

Technology Glossary ..... page 240

| | PD72Z2CAA / PD72Z2CAQ | PD72Z4CAA / PD72Z4CAQ | Units | Tolerance |
|---|---|---|---|---|
| Active axes | Z | Z | | |
| **Motion and positioning** | | | | |
| Integrated sensor | Capacitive | Capacitive | | |
| Closed-loop travel | 250 | 400 | µm | |
| Closed-loop resolution | 1.5 | 2.5 | nm | typ. |
| Linearity, closed-loop | 0.06 | 0.06 | % | typ. |
| Repeatability | ±5 | ±5 | nm | typ. |
| Runout $\theta_X$ | 6 | 10 | µrad | typ. |
| Runout $\theta_Y$ | 45 | 45 | µrad | typ. |
| Crosstalk in X | 20 | 60 | nm | typ. |
| Crosstalk in Y | 40 | 60 | nm | typ. |
| Settling time (0.5 µm step with 5 % accuracy, 150 g) | 15 | 20 | ms | typ. |
| **Mechanical properties** | | | | |
| Stiffness in motion direction | 0.17 | 0.12 | N/µm | ±20 % |
| Unloaded resonant frequency | 330 | 230 | Hz | ±20 % |
| Resonant frequency at 150 g | 140 | 120 | Hz | ±20 % |
| Push / pull force capacity in motion direction | 100 / 20 | 100 / 20 | N | max. |
| **Drive properties** | | | | |
| Piezo ceramics | PICMA® P-885 | PICMA® P-885 | | |
| **Miscellaneous** | | | | |
| Operating temperature range | 10 to 50 | 10 to 50 | °C | |
| Material | Aluminum | Aluminum | | |
| Mass | 0.23 | 0.23 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | m | |
| **Piezo controller** | E-709 (included in delivery) | E-709 (included in delivery) | | |
| Communication interfaces | USB, RS-232 | | | |
| I/O Connector | HD-Sub-D 26-pin<br>1 analog input 0 to 10 V<br>1 sensor monitor 0 to 10 V<br>1 digital input (LVTTL, programmable)<br>5 digital outputs (LVTTL, 3 predefined, 2 programmable) | HD-Sub-D 26-pin<br>1 analog input 0 to 10 V<br>1 sensor monitor 0 to 10 V<br>1 digital input (LVTTL, programmable)<br>5 digital outputs (LVTTL, 3 predefined, 2 programmable) | | |
| Command set | PI General Command Set (GCS) | PI General Command Set (GCS) | | |
| User software | PIMikroMove | PIMikroMove | | |
| Software drivers | LabVIEW drivers, shared libraries for Windows and Linux | LabVIEW drivers, shared libraries for Windows and Linux | | |
| Supported functionality | Wave generator, data recorder, auto zero, trigger I/O, MATLAB, MetaMorph, µManager | Wave generator, data recorder, auto zero, trigger I/O, MATLAB, MetaMorph, µManager | | |
| Controller dimensions | 160 mm × 96 mm × 33 mm | 160 mm × 96 mm × 33 mm | | |

All specifications based on room temperature (22 °C ±3 °C).



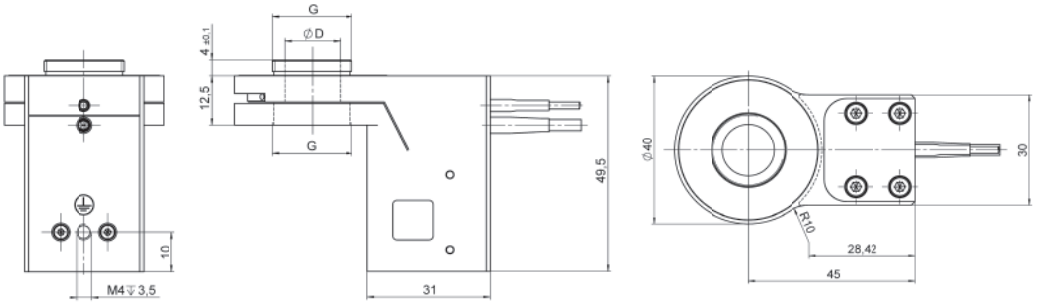

20 ms settling time with 150 g objective (PD72Z4CAQ system, measured with laser interferometer)

# PD72Z1x
# PIFOC Objective Scanning System 100 µm

## High-Dynamics Piezo Drive for Sub-Nanometer Resolution

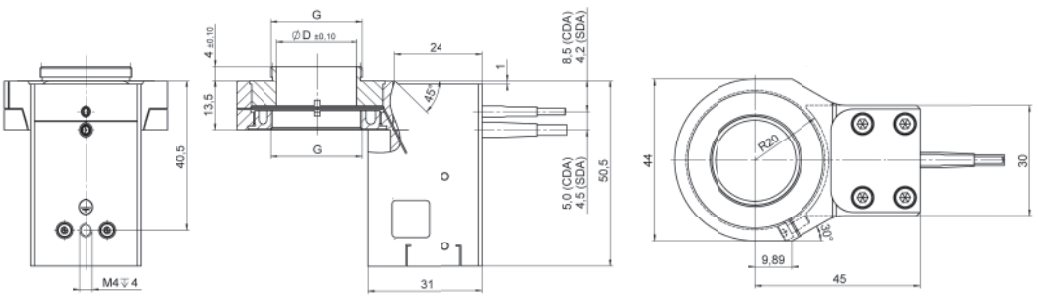

- Complete system with digital controller, software and QuickLock thread insert
- USB, RS-232, analog interfaces
- Travel range 100 µm
- Scans and positions objectives with sub-nm resolution
- Zero-play, high-precision flexure guide system
- Direct metrology with capacitive sensors
- Compatible with µManager, MetaMorph and MATLAB
- Adaptation of all control parameters on the fly

PD72Z1xAQ, dimensions in mm. P-721.xxQ: Suitable PIFOC QuickLock thread adapters.




| | G | D |
|---|---|---|
| P-721.02Q | M26×0,75 | 21 |
| P-721.03Q | M27×0,75 | 21 |
| P-721.04Q | M28×0 75 | 21 |
| P-721.05Q | M32×0,75 | 21 |
| P-721.06Q | M26×1/36" | 21 |
| P-721.0BQ | M19×0,75 | 14 |
| P-721.11Q | M25×0,75 | 21 |
| P-721.12Q | W0,8×1/36" | 14 |

PD72Z1xAA, dimensions in mm. P-721.xxA: Suitable PIFOC QuickLock thread adapters.




| | G | D |
|---|---|---|
| P-721.02A | M26×0,75 | 23 |
| P-721.03A | M27×0,75 | 24 |
| P-721.04A | M28×0,75 | 25 |
| P-721.05A | M32×0,75 | 29 |
| P-721.06A | M26×1/36" | 23 |
| P-721.11A | M25×0,75 | 22 |

**Applications**

- Microscopy
- Confocal microscopy
- 3D-Imaging
- Screening
- Autofocus systems
- Surface analysis
- Wafer inspection


>> Capacitive Sensors
>> Direct Metrology
>> Extensive Software Package

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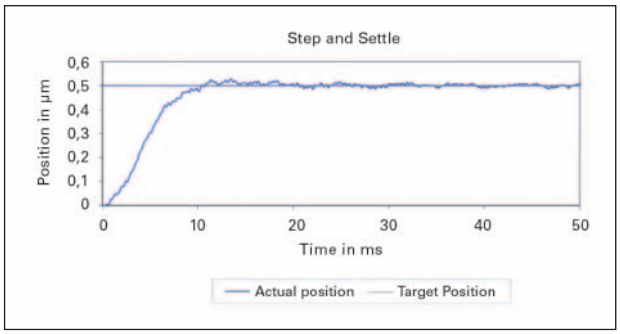
| | PD72Z1SAA / PD72Z1SAQ | PD72Z1CAA / PD72Z1CAQ | Units | Tolerance |
|---|---|---|---|---|
| Active axes | Z | Z | | |
| **Motion and positioning** | | | | |
| Integrated sensor | SGS | Capacitive | | |
| Closed-loop travel | 100 | 100 | µm | |
| Closed-loop resolution | 5 | 1 | nm | typ. |
| Linearity error, closed-loop | 0.2 | 0.06 | % | typ. |
| Repeatability | ±10 | ±5 | nm | typ. |
| Runout $\theta_X$, $\theta_Y$ | 13 | 13 | µrad | typ. |
| Crosstalk in X, Y | 100 | 100 | nm | typ. |
| Settling time (0.5 µm step with 5 % accuracy, 150 g) | 10 | 10 | ms | typ. |
| **Mechanical properties** | | | | |
| Stiffness in motion direction | 0.3 | 0.3 | N/µm | ±20 % |
| Resonant frequency, no load | 580 | 580 | Hz | ±20 % |
| Resonant frequency at 120 g | 235 | 235 | Hz | ±20 % |
| Resonant frequency at 200 g | 180 | 180 | Hz | ±20 % |
| Push / pull force capacity in motion direction | 100 / 20 | 100 / 20 | N | max. |
| **Drive properties** | | | | |
| Piezo ceramic | PICMA® P-885 | PICMA® P-885 | | |
| **Miscellaneous** | | | | |
| Operating temperature range | 10 to 50 | 10 to 50 | °C | |
| Material | Aluminum | Aluminum | | |
| Mass | 0.22 | 0.24 | kg | ±5 % |
| Cable length | 1 | 1 | m | |
| **Piezo controller** | E-709 digital servo (included in delivery) | E-709 digital servo (included in delivery) | | |
| Communication interfaces | USB, RS-232, SPI | USB, RS-232, SPI | | |
| I/O connector | HD Sub-D 26-pin<br>1 analog input 0 to 10 V<br>1 sensor monitor 0 to 10 V<br>1 digital input (LVTTL, programmable)<br>1 analog output<br>5 digital outputs (LVTTL, 3 × predefined, 2 × programmable) | HD Sub-D 26-pin<br>1 analog input 0 to 10 V<br>1 sensor monitor 0 to 10 V<br>1 digital input (LVTTL, programmable)<br>1 analog output<br>5 digital outputs (LVTTL, 3 × predefined, 2 × programmable) | | |
| Command set | PI General Command Set (GCS) | PI General Command Set (GCS) | | |
| User software | PIMikroMove | PIMikroMove | | |
| Software drivers | LabVIEW drivers, shared libraries for Windows and Linux | LabVIEW drivers, shared libraries for Windows and Linux | | |
| Supported functionality | Wave generator, data recorder, auto zero, trigger I/O, MATLAB, MetaMorph, µManager | Wave generator, data recorder, auto zero, trigger I/O, MATLAB, MetaMorph, µManager | | |
| Controller dimensions | 160 mm × 96 mm × 33 mm | 160 mm × 96 mm × 33 mm | | |

All specifications based on room temperature (22 °C ±3 °C).



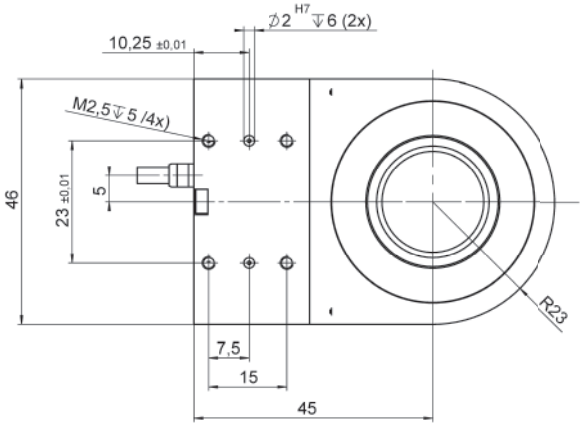

10 ms settling time with 150 g objective (PD72Z1CAQ system).

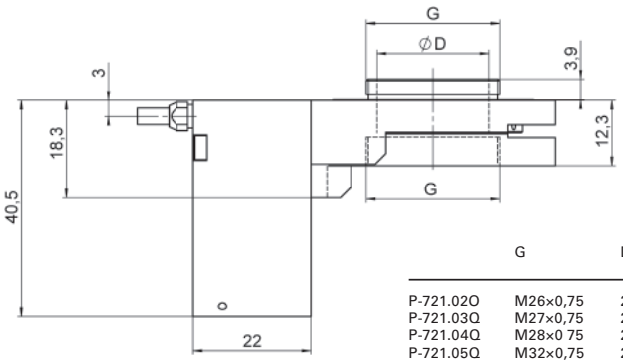
# P-725 PIFOC
# Objective Scanner with Long Travel Range

**High-precision Positioner / Scanner for Microscope Objectives**

- Travel ranges to 460 µm
- Significantly faster response and higher lifetime than motorized drives
- Fine positioning of objectives with sub-nm resolution
- Direct metrology with capacitive sensors: Highest linearity
- Zero-play, high-precision flexure guide system for better focus stability
- Compatible with MetaMorph imaging software
- Outstanding lifetime due to PICMA® piezo actuators
- QuickLock thread adapter for easy attachment
- Clear aperture up to Ø 29 mm


P-725.xCD/.xCL, dimensions in mm
(please order adapter separately).




| | G | D |
|---|---|---|
| P-721.02O | M26×0,75 | 21 |
| P-721.03Q | M27×0,75 | 21 |
| P-721.04Q | M28×0 75 | 21 |
| P-721.05Q | M32×0,75 | 21 |
| P-721.06Q | M26×1/36" | 21 |
| P-721.08Q | M19×0,75 | 14 |
| P-721.11Q | M25×0,75 | 21 |
| P-721.12Q | W0,8×1/36" | 14 |

**Applications**

- Super-resolution microscopy
- Lightsheet microscopy
- Confocal microscopy
- 3D-Imaging
- Screening
- Interferometry
- Metrology
- Autofocus systems
- Biotechnology
- Semiconductor testing


>> Capacitive Sensors
>> Direct Metrology
>> Flexure Guiding System
>> PICMA® Multilayer Piezo Actuators

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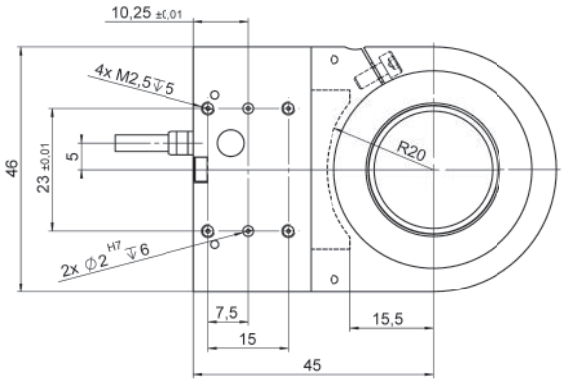
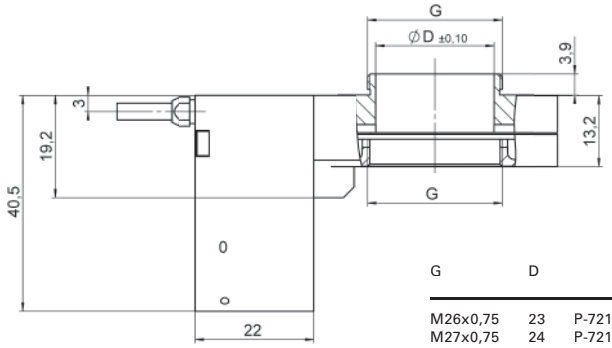
| | P-725.1CL<br>P-725.1CD<br>P-725.1CA | P-725.2CL<br>P-725.2CD<br>P-725.2CA | P-725.4CL<br>P-725.4CD<br>P-725.4CA | P-725.x0L<br>open-loop<br>version | Units | Tolerance |
|---|---|---|---|---|---|---|
| Active axes | Z | Z | Z | Z | | |
| **Motion and positioning** | | | | | | |
| Integrated sensor | Capacitive | Capacitive | Capacitive | – | | |
| Travel range at –20 to +120 V, open loop | 150 | 330 | 460 | as P-725.xCL | µm | +20 % / –0 % |
| Closed-loop travel range | 100 | 250 | 400 | – | µm | |
| Open-loop resolution | 0.3 | 0.4 | 0.5 | as P-725.xCL | nm | typ. |
| Closed-loop resolution | 0.65 | 0.75 | 1.25 | – | nm | typ. |
| Linearity, closed-loop | 0.03 | 0.03 | 0.03 | – | % | typ. |
| Repeatability | ±5 | ±5 | ±5 | – | nm | typ. |
| Tilt θX | 1 | 6 | 10 | as P-725.xCL | µrad | typ. |
| Tilt θY | 20 | 45 | 45 | as P-725.xCL | µrad | typ. |
| Crosstalk in X | 20 | 20 | 60 | as P-725.xCL | nm | typ. |
| Crosstalk in Y | 20 | 40 | 60 | as P-725.xCL | nm | typ. |
| **Mechanical properties** | | | | | | |
| Stiffness in motion direction | 0.23 | 0.17 | 0.12 | as P-725.xCL | N/µm | ±20 % |
| Resonant frequency, no load | 470 | 330 | 230 | as P-725.xCL | Hz | ±20 % |
| Resonant frequency under load, 150 g | 185 | 140 | 120 | as P-725.xCL | Hz | ±20 % |
| Compressive / tensile stress capacity in motion direction | 100 / 20 | 100 / 20 | 100 / 20 | as P-725.xCL | N | max. |
| **Drive properties** | | | | | | |
| Ceramic type | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | as P-725.xCL | | |
| Electrical capacitance | 4.2 | 6.2 | 6.2 | as P-725.xCL | µF | ±20 % |
| **Miscellaneous** | | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | Aluminum | Aluminum | | |
| Objective diameter | 39 | 39 | 39 | 39 | mm | max. |
| Mass | 0.215 | 0.23 | 0.23 | as P-725.xCL | kg | ±5 % |
| Sensor / voltage connection | CL version: LEMO<br>Other: Sub-D 7W2 (m) | CL version: LEMO<br>Other: Sub-D 7W2 (m) | CL version: LEMO<br>Other: Sub-D 7W2 (m) | LEMO<br>(no sensor) | | |
| Recommended electronics | E-505, E-610, E-621, E-625, E-665, E-709, E-754 | E-505, E-610, E-621, E-625, E-665, E-709, E-754 | E-505, E-610, E-621, E-625, E-665, E-709, E-754 | E-505, E-610, E-621, E-625, E-665, E-709, E-754 | | |

All specifications based on room temperature (22 °C ±3 °C).

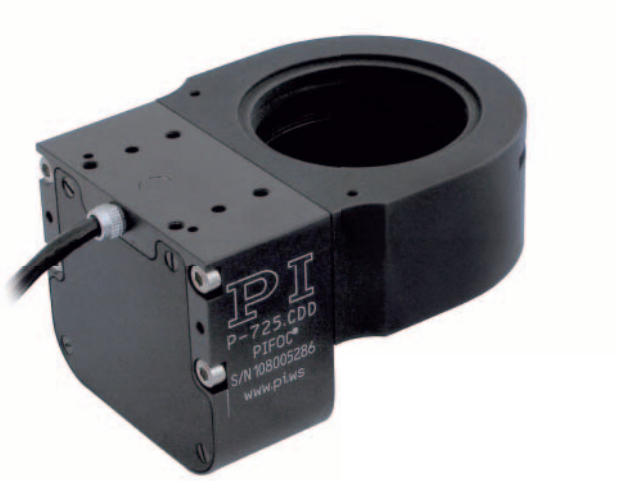



| G | D | |
|---|---|---|
| M26x0,75 | 23 | P-721.02A |
| M27x0,75 | 24 | P-721.03A |
| M28x0,75 | 25 | P-721.04A |
| M32x0,75 | 29 | P-721.0SA |
| M26x1/36" | 23 | P-721.06A |
| M25x0,75 | 22 | P-721.11A |

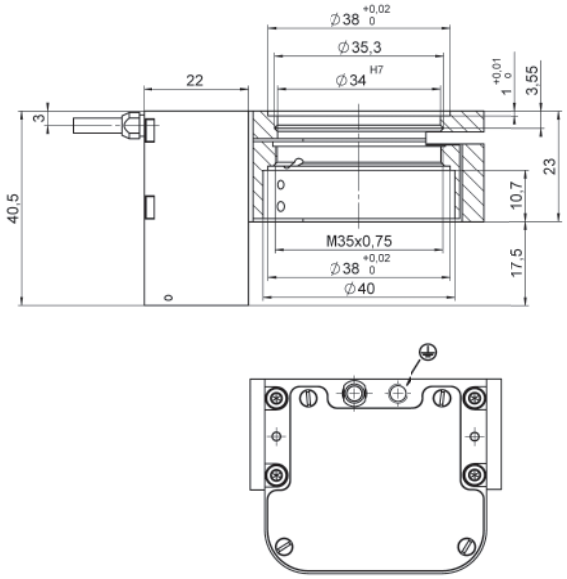
# P-725.xDD PIFOC High-Dynamics Piezo Scanner

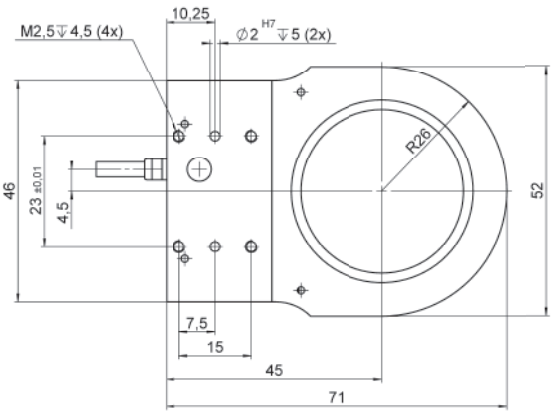
## Nanopositioning and Scanning System for Microscope Objectives




- Fastest settling time under 5 ms with microscope objective
- Travel range 18 µm
- Scans and positions objectives with sub nm resolution
- Parallel flexure guiding for minimized objective offset
- Direct metrology with capacitive sensors for highest linearity
- Cost-efficient version with SGS sensors
- Compatible with MetaMorph imaging software
- Outstanding lifetime due to PICMA® piezo actuators
- QuickLock adapter for easy attachment

P-725.xDD, dimensions in mm.




**Applications**

- Super-resolution microscopy
- Lightsheet microscopy;
- Confocal microscopy
- 3D-Imaging
- Screening
- Interferometry
- Metrology
- Autofocus systems
- Biotechnology
- Semiconductor testing


>> Capacitive Sensors
>> Direct Metrology
>> Flexure Guiding System
>> PICMA® Multilayer Piezo Actuators

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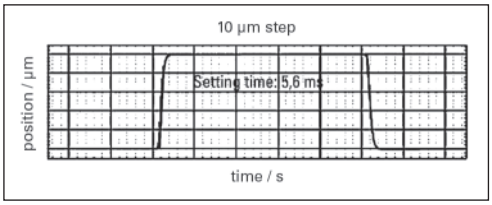
| | P-725.CDD | P-725.SDD | Units | Tolerance |
|---|---|---|---|---|
| Active axes | Z | Z | | |
| **Motion and positioning** | | | | |
| Integrated sensor | Capacitive | SGS | | |
| Open-loop travel, –20 to +120 V | 18 | 18 | µm | +20 % / –0 % |
| Closed-loop travel | 18 | 18 | µm | |
| Open-loop resolution | 0.2 | 0.2 | nm | typ. |
| Closed-loop resolution | 0.2 | 0.2 | nm | typ. |
| Closed-loop linearity error | 0.04* | 0.5 | % | typ. |
| Repeatability | ±1.5 | ±5 | nm | typ. |
| Runout θX, θY | 2 | 2 | µrad | typ. |
| Crosstalk in X, Y | 150 | 150 | nm | typ. |
| **Mechanical properties** | | | | |
| Stiffness in motion direction | 1.5 | 1.5 | N/µm | ±20 % |
| Resonant frequency, no load | 1180 | 1180 | Hz | ±20 % |
| Resonant frequency, under load, at 200 g | 450 | 450 | Hz | ±20 % |
| Push / pull force capacity in motion direction | 100 / 20 | 100 / 20 | N | max. |
| **Drive properties** | | | | |
| Ceramic type | PICMA® P-887 | PICMA® P-887 | | |
| Electrical capacitance | 3.1 | 3.1 | µF | ±20 % |
| **Miscellaneous** | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | | |
| Mass | 0.21 | 0.2 | kg | ±5 % |
| Cable length | 1.5 | 1.5 | m | ±10 mm |
| Sensor / voltage connection | Sub-D 7W2 (m) | LEMO | | |
| Recommended electronics | E-610, E-625, E-665, E-709.CHG, E-754 | E-610, E-625, E-665, E-709.CHG, E-754 | | |

* With E-753 digital controller. Non-linearity of direct drive stages measured with analog controllers is up to 0.1 % typ.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

# P-726 PIFOC High-Load Objective Scanner

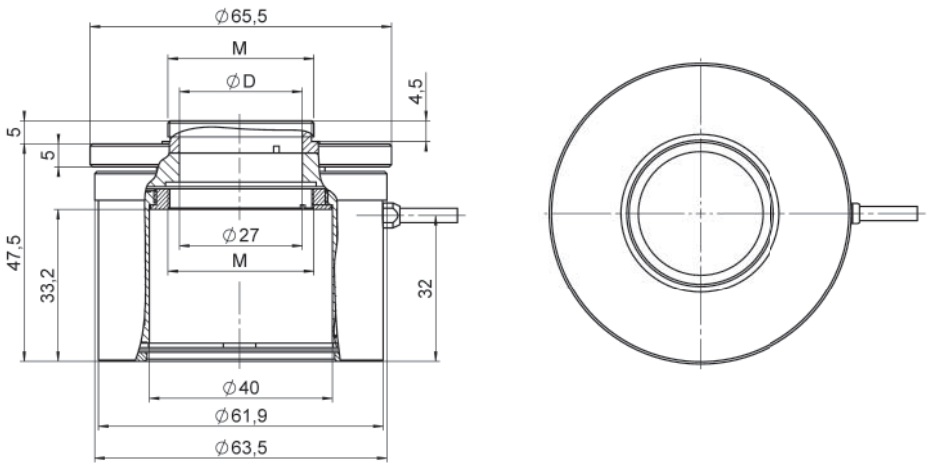
## Highly Dynamic Scanning System with Long Travel Range for Heavy Objectives


- Highly dynamic positioning and scanning for large objectives
- Resonant frequency 1120 Hz, 560 Hz with 210 g objective mass
- Typ. settling time of about 6 ms
- Travel range 100 µm
- Direct-metrology capacitive sensors for best linearity, stability and control dynamics
- Resolution 0.3 nm
- Zero-play, high-precision flexure guide system for better focus stability




Settling behavior of the P-726 under load.

P-726 with QuickLock thread adapter, dimensions in mm.




| Quicklock | M | D |
|---|---|---|
| P-726.O4 | M28×0,75 | 23 |
| P-726.O5 | M32×0,75 | 27 |
| P-726.O6 | M26×1/36" | 21 |
| P-726.11 | M25×0,75 | 21 |
| P-726.12 | W0,8×1/36" | 16 |

**Applications**

- Super-resolution microscopy
- Lightsheet microscopy
- Confocal microscopy
- 3D-Imaging
- Screening
- Interferometry
- Metrology
- Autofocus systems
- Biotechnology
- Semiconductor testing

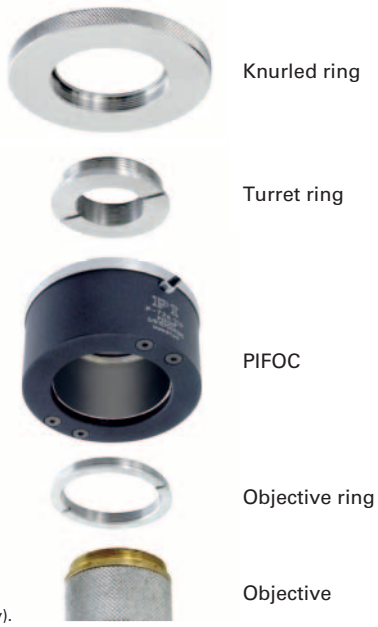

>> Capacitive Sensors
>> Direct Metrology
>> Flexure Guiding System
>> PICMA® Multilayer Piezo Actuators

Technology Glossary ..... page 240

| | P-726.1CD | Tolerance | |
|---|---|---|---|
| Active axes | Z | | |
| **Motion and positioning** | | | |
| Integrated sensor | Capacitive, direct metrology | | |
| Closed-loop travel range | 100 µm | | |
| Closed-loop resolution | 0.4 nm | typ. | |
| Open-loop resolution | 0.3 nm | typ. | |
| Linearity error, closed loop | 0.02 % | typ. | |
| Repeatability | ±3 nm | typ. | |
| Tilt θX, θY | ±5 µrad | typ. | |
| Crosstalk in X, Y | 50 nm | typ. | |
| **Mechanical properties** | | | |
| Stiffness in motion direction | 3.4 N/µm | ±20 % | |
| Resonant frequency, no load | 1120 Hz | ±20 % | |
| Resonant frequency under load | 560 Hz (210 g) | ±20 % | |
| Resonant frequency under load | 480 Hz (310 g) | ±20 % | |
| Compressive / tensile stress capacity in motion direction | 100 / 50 N | max. | |
| Load capacity | 20 N | max. | |
| **Drive properties** | | | |
| Piezo ceramic type | PICMA® P-885 | | |
| Electrical capacitance | 6 µF | ±20 % | |
| **Miscellaneous** | | | |
| Operating temperature range | –20 to 80 °C | | |
| Material | Aluminum, steel | | |
| Objective thread | M32 | max. | |
| Mass | 575 g | ±5 % | |
| Cable length | 1.5 m | ±10 mm | |
| Sensor / voltage connection | Sub-D 7W2 (m) | | |
| Recommended electronics | E-505, E-621, E-625, E-665, E-709, E-754 | | |

All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

**Microscope turret**



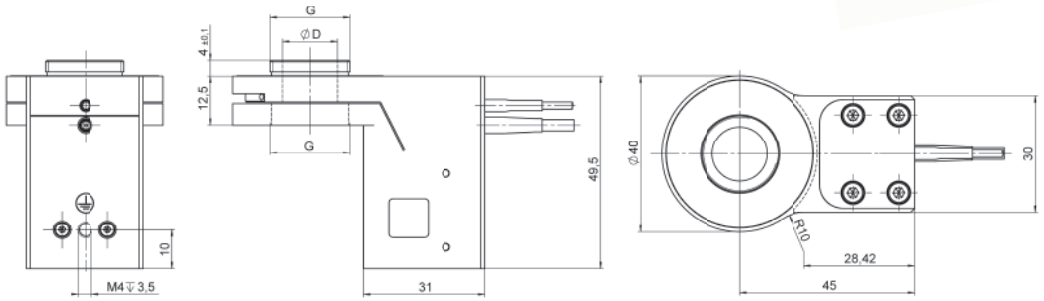

Exploded view of the P-726 QuickLock adapter with P-726 PIFOC (mounting tools included in the scope of delivery).

# P-721 PIFOC Piezo Flexure Objective Scanner

## Fast Nanopositioner and Scanner for Microscope Objectives

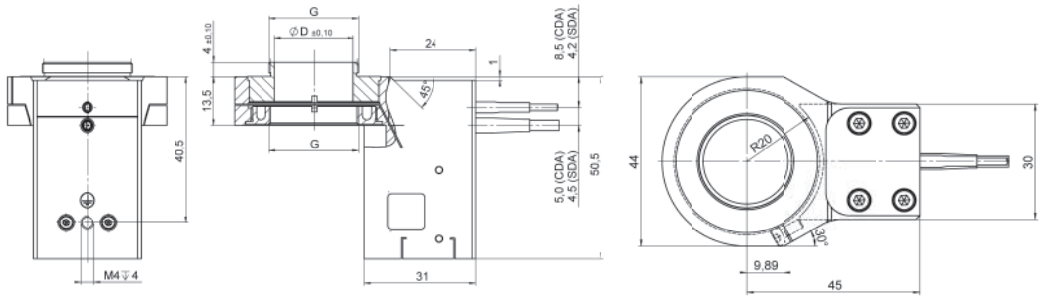
- Scans and positions objectives with sub-nm resolution
- Travel ranges to 140 µm, millisecond settling time
- Significantly faster response and higher lifetime than motorized drives
- Parallel precision flexure guiding for better focus stability
- Direct metrology with capacitive sensors for highest linearity
- Cost-efficient version with SGS sensors
- Compatible with MetaMorph imaging software
- Outstanding lifetime due to PICMA® piezo actuators
- QuickLock thread adapter for easy attachment
- Clear aperture up to Ø 29 mm

P-721.xxQ, .SL2, dimensions in mm (adapter to be ordered separately).




| | G | D |
|---|---|---|
| P-721.02Q | M26×0,75 | 21 |
| P-721.03Q | M27×0,75 | 21 |
| P-721.04Q | M28×0 75 | 21 |
| P-721.05Q | M32×0,75 | 21 |
| P-721.06Q | M26×1/36" | 21 |
| P-721.08Q | M19×0,75 | 14 |
| P-721.11Q | M25×0,75 | 21 |
| P-721.12Q | W0,8×1/36" | 14 |

P-721.CDA, .SDA, dimensions in mm (adapter to be ordered separately).




| | G | D |
|---|---|---|
| P-721.02A | M26×0,75 | 23 |
| P-721.03A | M27×0,75 | 24 |
| P-721.04A | M28×0,75 | 25 |
| P-721.05A | M32×0,75 | 29 |
| P-721.06A | M26×1/36" | 23 |
| P-721.11A | M25×0,75 | 22 |

**Applications**

- Super-resolution microscopy
- Lightsheet microscopy
- Confocal microscopy
- 3D-Imaging
- Screening
- Interferometry
- Metrology
- Autofocus systems
- Biotechnology
- Semiconductor testing


>> Capacitive Sensors
>> Direct Metrology
>> Flexure Guiding System
>> PICMA® Multilayer Piezo Actuators

Technology Glossary ..... page 240

| | P-721.CLQ | P-721.CDQ<br>P-721.CDA | P-721.SL2<br>P-721.SDA | P-721.0LQ | Units | Tolerance |
|---|---|---|---|---|---|---|
| Active axes | Z | Z | Z | Z | | |
| **Motion and positioning** | | | | | | |
| Integrated sensor | Capacitive | Capacitive | SGS | – | | |
| Open-loop travel, –20 to +120 V | 140 | 140 | 140 | 140 | µm | +20 % / -0 % |
| Closed-loop travel | 100 | 100 | 100 | – | µm | |
| Open-loop resolution | 0.5 | 0.5 | 0.5 | 0.5 | nm | typ. |
| Closed-loop resolution | 0.7 | 0.7 | 5 | – | nm | typ. |
| Closed-loop linearity error | 0.03 | 0.03 | 0.2 | – | % | typ. |
| Repeatability | ±5 | ±5 | ±10 | – | nm | typ. |
| Runout θX, θY | 13 | 13 | 13 | 13 | µrad | typ. |
| Crosstalk X, Y | 100 | 100 | 100 | 100 | nm | typ. |
| **Mechanical properties** | | | | | | |
| Stiffness in motion direction | 0.3 | 0.3 | 0.3 | 0.3 | N/µm | ±20 % |
| Unloaded resonant frequency | 580 | 580 | 580 | 550 | Hz | ±20 % |
| Resonant frequency at 120 g | 235 | 235 | 235 | 235 | Hz | ±20 % |
| Resonant frequency at 200 g | 180 | 180 | 180 | 180 | Hz | ±20 % |
| Push / pull force capacity in motion direction | 100 / 20 | 100 / 20 | 100 / 20 | 100 / 20 | N | max. |
| **Drive properties** | | | | | | |
| Ceramic type | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 3.1 | 3.1 | 3.1 | 3.1 | µF | ±20 % |
| **Miscellaneous** | | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | Aluminum | Aluminum | | |
| Mass | 0.24 | 0.24 | 0.22 | 0.22 | kg | ±5 % |
| Objective diameter | 39 | 39 | 39 | 39 | mm | max. |
| Cable length | 1 | 1 | 1 | 1 | m | ±10 mm |
| Sensor / voltage connection | LEMO | Sub-D 7W2 (m) | LEMO / Sub-D 9 (m) | LEMO (no sensor) | | |
| Recommended electronics | E-505, E-610, E-621, E-625, E-665, E-709, E-754 | E-505, E-610, E-621, E-625, E-665, E-709, E 754 | E-505, E-610, E-621, E-625, E-665, E-709, E 754 | E-505, E-610, E-621, E-625, E-665, E-709, E 754 | | |

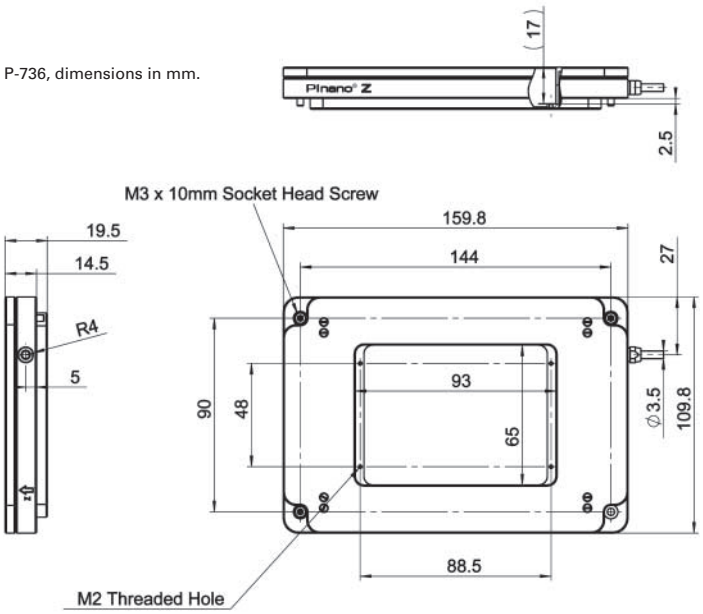
* The resolution of PI piezo nanopositioners is not limited by friction or stiction.
Value given is noise equivalent motion with E-503 amplifier.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

# P-736 Plnano® Z Microscope Scanner

**Cost-efficient, low-profile**



P-736, dimensions in mm.




- Step-and-settle to 5 ms
- Low profile of 20 mm for easy integration
- Travel range 100 µm or 200 µm
- Clear aperture 93 mm × 65 mm
- E-709 digital servo piezo controller included
- USB, RS-232, analog interfaces
- Compatible with MetaMorph imaging software

**Applications**

- Super-resolution microscopy
- Lightsheet microscopy
- Confocal microscopy
- 3D-Imaging
- Screening
- Interferometry
- Metrology
- Autofocus systems
- Biotechnology
- Semiconductor testing


>> Extensive Software Package
>> Flexure Guiding System
>> PICMA® Multilayer Piezo Actuators

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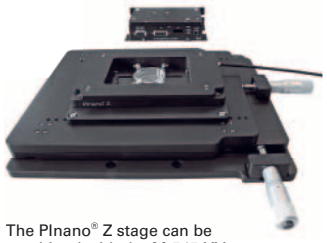
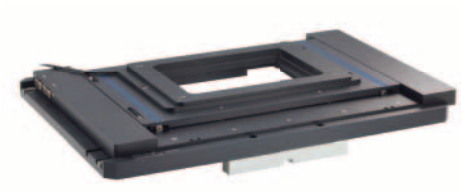
| | P-736.ZR1S | P-736.ZR2S | Unit | Tolerance |
|---|---|---|---|---|
| Active axes | Z | Z | | |
| **Motion and positioning** | | | | |
| Integrated sensor | Piezoresistive | Piezoresistive | | |
| Closed-loop travel | 100 | 200 | µm | |
| Open-loop resolution | 0.2 | 0.4 | nm | typ. |
| Closed-loop resolution | 0.4 | 0.7 | nm | typ. |
| **Mechanical properties** | | | | |
| Settling time (10 % step width) | 5 | 7 | ms | |
| Load capacity | 500 | 500 | g | max. |
| **Drive properties** | | | | |
| Piezo ceramic | PICMA® P-885 | PICMA® P-885 | | |
| **Miscellaneous** | | | | |
| Operating temperature range | 15 to 40 | 15 to 40 | °C | |
| Material | Aluminum | Aluminum | | |
| Mass | 550 | 550 | g | ±5 % |
| Cable length | 1.5 | 1.5 | m | ±10 mm |
| **Piezo controller** | E-709 digital servo (included in delivery) | E-709 digital servo (included in delivery) | | |
| Communication interfaces | USB, RS-232, SPI | USB, RS-232, SPI | | |
| I/O connector | HD Sub-D 26-pin<br>1 × analog input 0 to 10 V<br>1 × sensor monitor 0 to10 V<br>1 × digital input (LVTTL, programmable)<br>1 × analog output<br>5 × digital outputs (LVTTL, 3 × predefined, 2 × programmable) | HD Sub-D 26-pin<br>1 × analog input 0 to 10 V<br>1 × sensor monitor 0 to10 V<br>1 × digital input (LVTTL, programmable)<br>1 × analog output<br>5 × digital outputs (LVTTL, 3 × predefined, 2 × programmable) | | |
| Command set | PI General Command Set (GCS) | PI General Command Set (GCS) | | |
| User software | PIMikroMove | PIMikroMove | | |
| Software drivers | LabVIEW driver, dynamic libraries for Windows and Linux | LabVIEW driver, dynamic libraries for Windows and Linux | | |
| Supported functionality | Wave generator, data recorder, auto zero, trigger I/O, MATLAB, MetaMorph, µManager | Wave generator, data recorder, auto zero, trigger I/O, MATLAB, MetaMorph, µManager | | |
| Controller dimensions | 160 mm × 96 mm × 33 mm | 160 mm × 96 mm × 33 mm | | |

All specifications based on room temperature (22 °C ±3 °C).



The PInano® Z stage can be combined with the M-545 XY 25 × 25 mm microscope stage



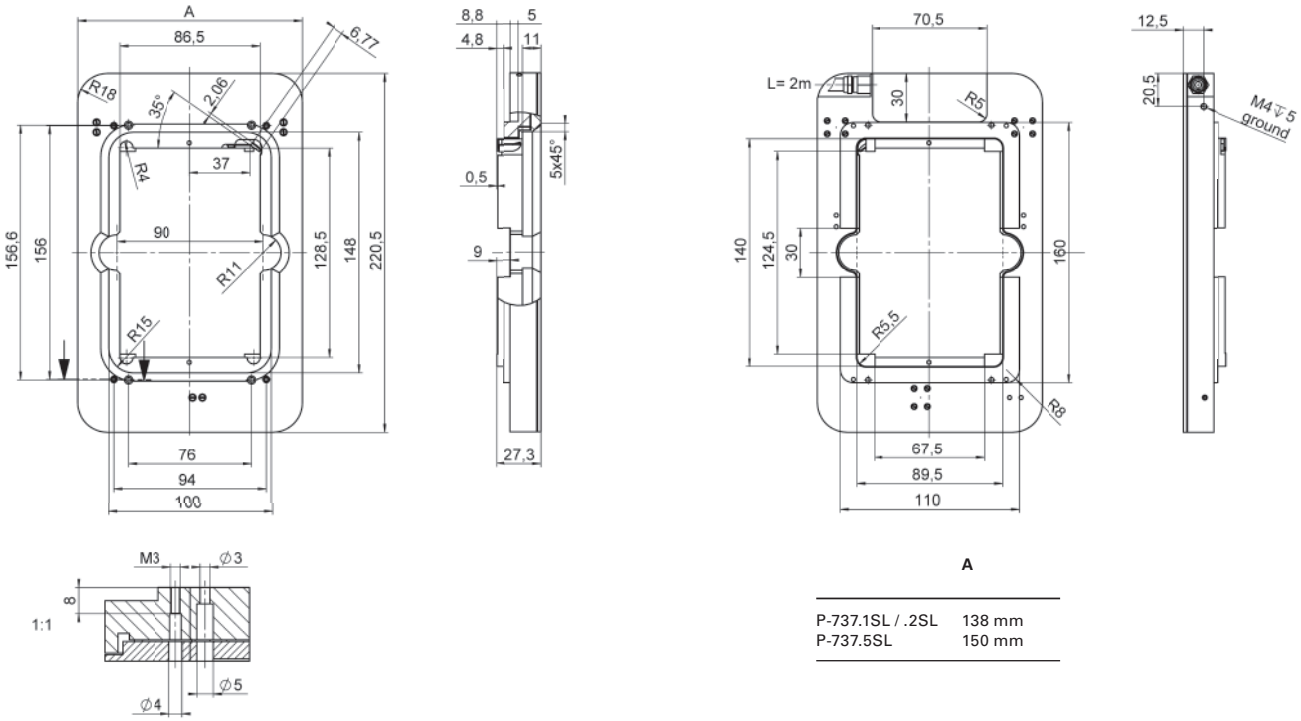
Custom versions are feasible. The example above shows a P-736 version with a particularly large aperture mounted on a XY stage driven by PILine® piezomotors.

# P-737 PIFOC Specimen-Focusing Z Stage

## Low-Profile with Large Aperture

- Travel ranges to 500 µm
- Clear aperture 128.5 mm × 86.5 mm to accommodate microtiter plates
- Low profile 20 mm
- Compatible with MetaMorph imaging software

P-737, dimensions in mm.




| A | |
|---|---|
| P-737.1SL / .2SL | 138 mm |
| P-737.5SL | 150 mm |

**Applications**

- Super-resolution microscopy
- Lightsheet microscopy
- Confocal microscopy
- 3D-Imaging
- Screening
- Interferometry
- Metrology
- Autofocus systems
- Biotechnology
- Semiconductor testing


>> Flexure Guiding System
>> PICMA® Multilayer Piezo Actuators

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| | P-737.1SL | P-737.2SL | P-737.5SL | Unit | Tolerance |
|---|---|---|---|---|---|
| Active axes | Z | Z | Z | | |
| **Motion and positioning** | | | | | |
| Integrated sensor | SGS | SGS | SGS | | |
| Open-loop travel, –20 to 120 V | 150 | 280 | 550 | µm | +20 % / –0 % |
| Closed-loop travel | 100 | 250 | 500 | µm | |
| Open-loop resolution | 0.8 | 1 | 1.6 | nm | typ. |
| Closed-loop resolution | 2.5 | 4 | 5 | nm | typ. |
| Closed-loop linearity error | 0.2 | 0.5 | 0.8 | % | typ. |
| Repeatability | 6 | 12 | 15 | nm | typ. |
| Angular runout $\theta_X$ | ±36 | ±36 | ±36 | µrad | typ. |
| Angular runout $\theta_Y$ | ±36 | ±100 | ±100 | µrad | typ. |
| **Mechanical properties** | | | | | |
| Unloaded resonant frequency | 270 | 210 | 122 | Hz | ±20 % |
| Resonant frequency at 100 g | 230 | 180 | 115 | Hz | ±20 % |
| Resonant frequency at 200 g | 210 | 155 | 100 | Hz | ±20 % |
| Push / pull force capacity in motion direction | 50 / 20 | 50 / 20 | 50 / 20 | N | max. |
| **Drive properties** | | | | | |
| Piezo ceramic | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 6.3 | 9.3 | 13.8 | µF | ±20 % |
| **Miscellaneous** | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Aluminum | Aluminum | Aluminum | | |
| Dimensions | 220.5 mm × 138 mm × 27.3 mm | 220.5 mm × 138 mm × 27.3 mm | 220.5 mm × 150 mm × 27.3 mm | | |
| Mass | 0.7 | 0.7 | 0.85 | kg | ±5 % |
| Cable length | 2 | 2 | 2 | m | ±10 mm |
| Sensor / voltage connection | LEMO | LEMO | LEMO | | |
| Recommended electronics | E-625, E-665, E-709 | E-625, E-665, E-709 | E-625, E-665, E-709 | | |
| **System properties** | | | | | |
| System configuration | E-500 system with E-503 amplifier (6 W) E-509 servo module | E-500 system with E-503 amplifier (6 W) E-509 servo module | E-665.SR controller / driver (12 W) | | |
| Closed-loop amplifier bandwidth, small signal | 60 | 30 | 15 | Hz | typ. |
| Settling time (10 % step width) | 24 | 30 | 50 | ms | typ. |

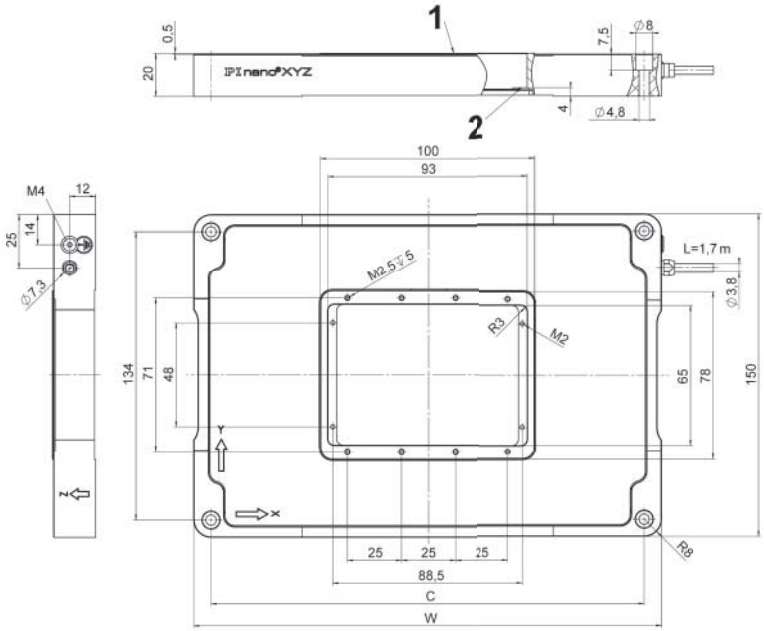
All specifications based on room temperature (22 °C ±3 °C).
Versions with directly measuring, high-resolution capacitive sensors and custom versions on request!

# P-545.3D8S PInano® Trak Piezo Tracking System

## Fast XY(Z) stage for high dynamics microscopy


- Fast response time <5 ms with subnanometer resolution: Ideal for tracking
- E-727 USB controller and software included
- Travel ranges to 70 µm × 70 µm × 50 µm
- Low profile for easy integration: 20 mm
- Recessed sample holders, freely revolving nosepiece
- Extensive optional accessories
- Cost-effective design

P-545.xx8S, dimensions in mm.




1: Upper mounting surface of the motion platform
2: Lower mounting surface of the motion platform

| Model | W | C |
|---|---|---|
| P-545.3x8S | 217 | 201 |
| P-545.2x8S | 182 | 166 |

**Applications**

- Tracking
- High-resolution microscopy
- Inverted microscopy
- Screening
- Confocal microscopy
- Biotechnology


>> Extensive Software Package
>> Flexure Guiding System
>> PICMA® Multilayer Piezo Actuators

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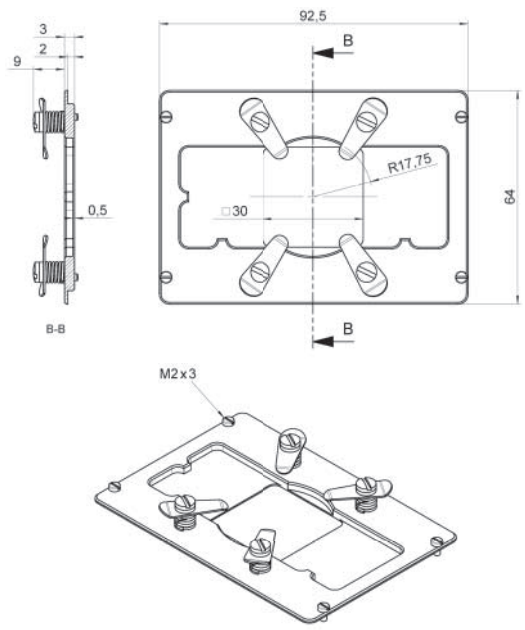
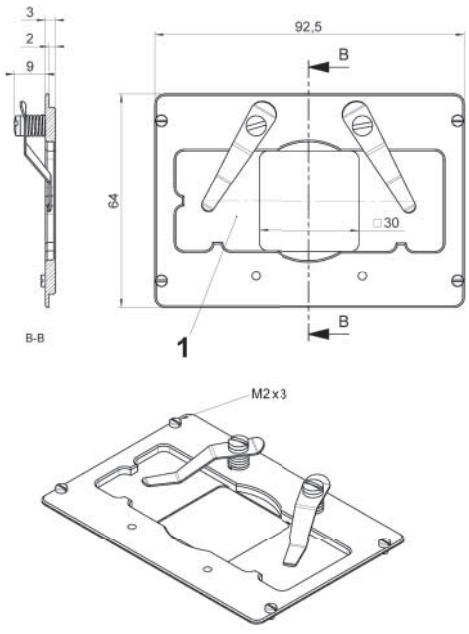
| | P-545.3D8S | Unit | Tolerance |
|---|---|---|---|
| Active axes | X, Y, Z | | |
| **Motion and positioning** | | | |
| Integrated sensor | Piezoresistive | | |
| Closed-loop travel range | 70 × 70 × 50 | µm | |
| Closed-loop resolution* | <1 | nm | typ. |
| **Mechanical properties** | | | |
| Resonant frequency, no load | 1 (X, Y), 0.8 (Z) | kHz | |
| Push/pull force capacity | 100 / 30 | N | max. |
| Recommended load** | 0.5 | kg | max. |
| **Drive properties** | | | |
| Piezo ceramic | PICMA® | | |
| Electrical capacitance | 12 (X, Y), 24 (Z) | µF | ±20 % |
| **Miscellaneous** | | | |
| Operating temperature range | 15 to 40 | °C | |
| Material | Aluminum | | |
| Mass | 1.2 | kg | ±5 % |
| Cable length | 1.7 | m | +10 cm |
| **Piezo controller** | E-727.3RDA (included in scope of delivery) | | |
| Communication interfaces | Ethernet, USB, RS-232, serial SPI high-speed interface | | |
| Analog input / Analog output | Sub-D (15-pin)<br>Input via 18-bit A/D converter<br>Output via 20-bit D/A converter | | |
| Command set | PI General Command Set (GCS) | | |
| User software | PIMikroMove | | |
| Software drivers | LabVIEW drivers, shared libraries for Windows and Linux | | |
| Supported functions | Wave generator, data recorder, drift compensation, macros | | |
| Software drivers | LabVIEW drivers, shared libraries for Windows and Linux | | |
| Supported functions | Wave generator, data recorder, drift compensation, macros | | |
| | | | |

* With flexure guides, the resolution is not limited by friction. Value given is noise equivalent motion measured with interferometer.
** For dynamic operation. Higher dynamics are possible with a reduced load.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

Accessories: P-545.PD3, Petri dish holder, dimensions in mm.




Accessories: P-545.SH3, microscope slide holder, dimensions in mm.



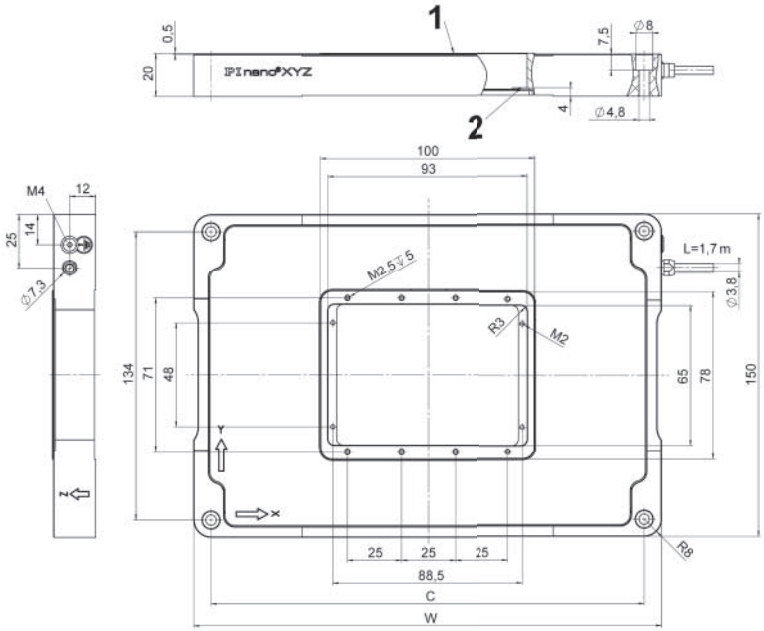

1: Recess for standard microscope slides (25 mm × 75 mm)

# P-545.xR8S Plnano® XY(Z) Piezo System

## Low-cost nanopositioning system for superresolution microscopy


- Inexpensive cost-optimized design due to piezoresistive sensors
- Travel ranges to 200 µm × 200 µm × 200 µm
- E-727 USB controller and software included
- Low profile for easy integration: 20 mm
- Clear aperture for 3 × 1″ microscope slide, recessed sample holders
- Outstanding lifetime due to PICMA® piezo actuators
- Subnanometer resolution, fast response in the ms range

P-545.xx8S, dimensions in mm




1: Upper mounting surface of the motion platform
2: Lower mounting surface of the motion platform

| Model | W | C |
|---|---|---|
| P-545.3x8S | 217 | 201 |
| P-545.2x8S | 182 | 166 |

**Applications**

- High-resolution microscopy
- Screening
- Confocal microscopy
- Biotechnology
- High reliability even with high ambient humidity


>> Extensive Software Package
>> Flexure Guiding System
>> PICMA® Multilayer Piezo Actuators

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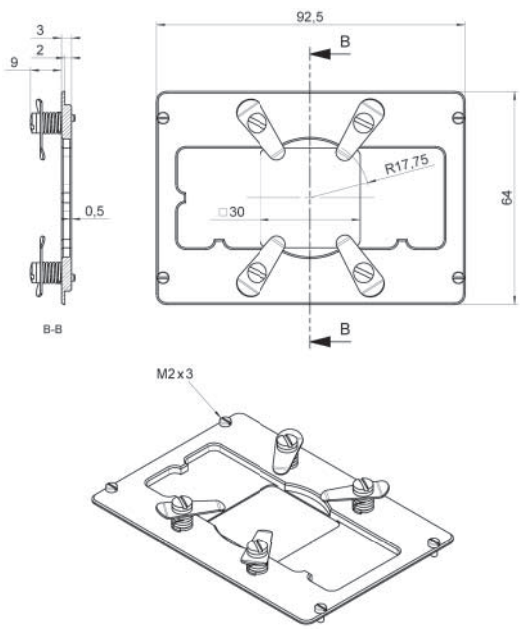
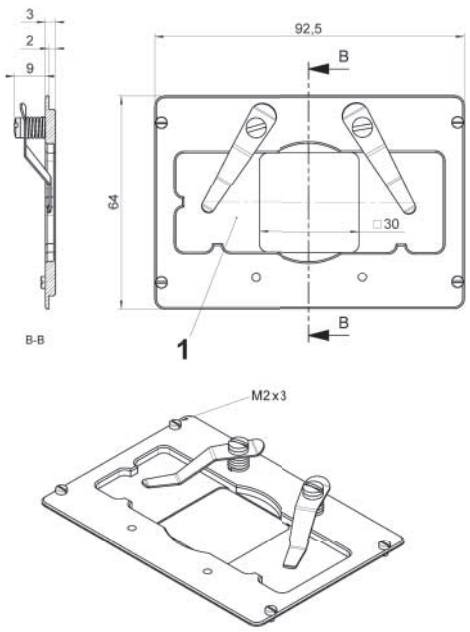
| | P-545.2R8S | P-545.3R8S | Unit | Tolerance |
|---|---|---|---|---|
| Active axes | X, Y | X, Y, Z | | |
| **Motion and positioning** | | | | |
| Integrated sensor | Piezoresistive | Piezoresistive | | |
| Closed-loop travel | 200 × 200 | 200 × 200 × 200 | µm | |
| Closed-loop resolution* | 1 | 1 | nm | typ. |
| **Mechanical properties** | | | | |
| Push / pull force capacity | 50 / 30 | 50 / 30 | N | max. |
| Recommended load** | 0.5 | 0.5 | kg | max. |
| **Drive properties** | | | | |
| Piezo ceramic | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 6 (X, Y) | 6 (X, Y), 12 (Z) | µF | ±20 % |
| **Miscellaneous** | | | | |
| Operating temperature range | 15 to 40 | 15 to 40 | °C | |
| Material | Aluminum | Aluminum | | |
| Mass | 1 | 1.2 | kg | ±5 % |
| Cable length | 1.7 | 1.7 | m | +10 cm |
| **Piezo controller** | E-727.3RDA (included in scope of delivery) | | | |
| Communication interfaces | Ethernet, USB, RS-232, serial SPI high-speed interface | | | |
| Analog input / Analog output | Sub-D (15-pin)<br>Input via 18-bit A/D converter<br>Output via 20-bit D/A converter | | | |
| Command set | PI General Command Set (GCS) | | | |
| User software | PIMikroMove | | | |
| Software drivers | LabVIEW drivers, shared libraries for Windows and Linux | | | |
| Supported functions | Wave generator, data recorder, drift compensation, macros | | | |

* With flexure guides, the resolution is not limited by friction. Value given is noise equivalent motion measured with interferometer.
** For dynamic operation. Higher dynamics are possible with a reduced load.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

Accessories: P-545.PD3, Petri dish holder, dimensions in mm




Accessories: P-545.SH3, microscope slide holder, dimensions in mm



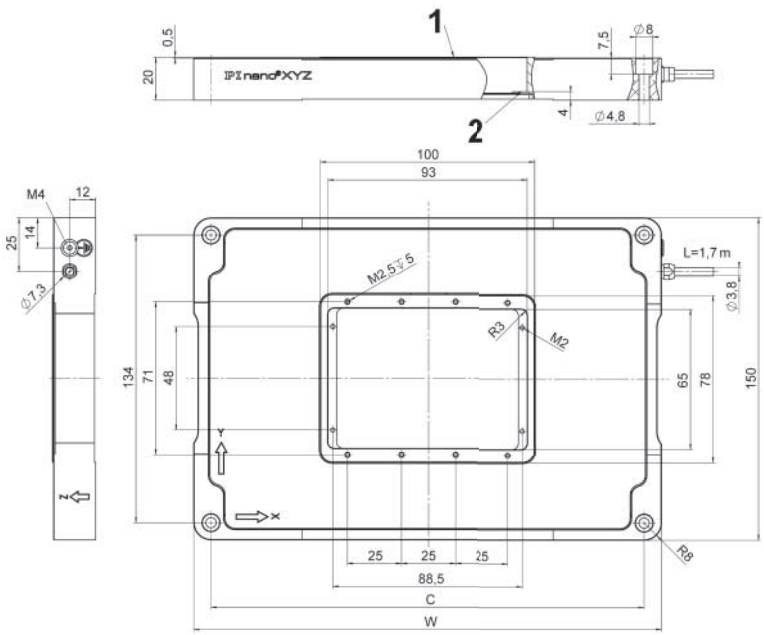

1: Recess for standard microscope slides (25 mm × 75 mm)

# P-545.xC8S Plnano® Cap XY(Z) Piezo System

## Capacitive Positioning Measurement for Superresolution Microscopy


- Highest stability and repeatability
- Travel ranges to 200 µm × 200 µm × 200 µm
- E-727 USB controller and software included
- Subnanometer resolution
- Fast response in the ms range
- Low profile for easy integration: 20 mm
- Recessed sample holders, freely revolving nosepiece

P-545.xx8S, dimensions in mm.




1: Upper mounting surface of the motion platform
2: Lower mounting surface of the motion platform

| Model | W | C |
|---|---|---|
| P-545.3x8S | 217 | 201 |
| P-545.2x8S | 182 | 166 |

**Applications**

- Superresolution microscopy
- Screening
- Confocal microscopy
- Biotechnology
- High reliability even in environments with high ambient humidity

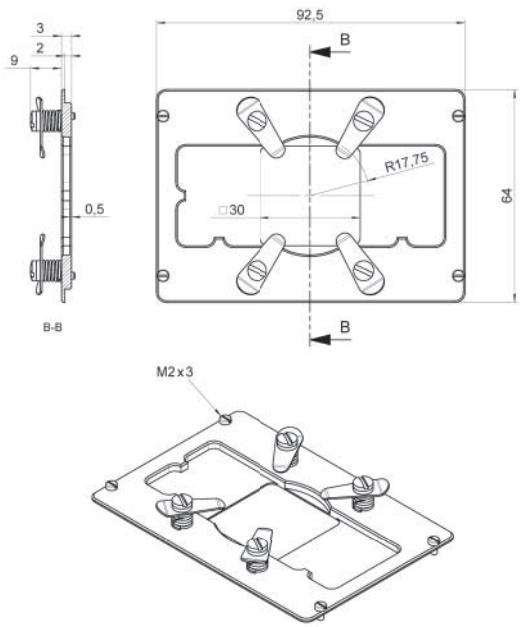

>> Capacitive Sensors
>> Direct Metrology
>> Extensive Software Package
>> Flexure Guiding System
>> PICMA® Multilayer Piezo Actuators

Technology Glossary ..... page 240

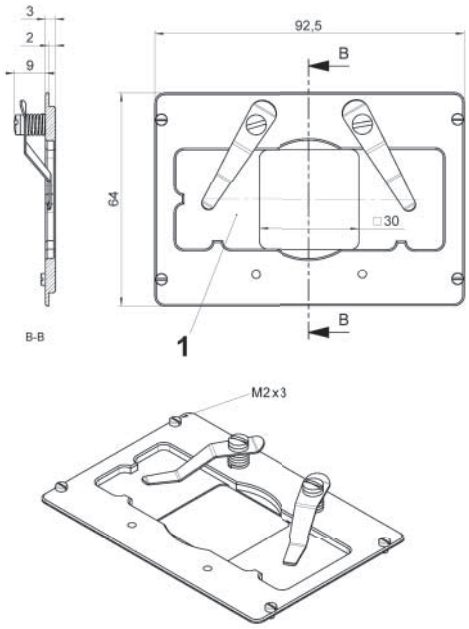
| | P-545.2C8S | P-545.3C8S | Unit | Tolerance |
|---|---|---|---|---|
| Active axes | X, Y | X, Y, Z | | |
| **Motion and positioning** | | | | |
| Integrated sensor | Capacitive | Capacitive | | |
| Closed-loop travel range | 200 × 200 | 200 × 200 × 200 | µm | |
| Closed-loop resolution* | <1 | <1 | nm | typ. |
| **Mechanical properties** | | | | |
| Compressive/tensile stress capacity | 50 / 30 | 50 / 30 | N | max. |
| Recommended load** | 0.5 | 0.5 | kg | max. |
| Drive properties | | | | |
| Piezo ceramic | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 6 (X, Y) | 6 (X, Y), 12 (Z) | µF | ±20 % |
| **Miscellaneous** | | | | |
| Operating temperature range | 15 to 40 | 15 to 40 | °C | |
| Material | Aluminum | Aluminum | | |
| Mass | 1 | 1.2 | kg | ±5 % |
| Cable length | 1.7 | 1.7 | m | +10 cm |
| **Piezo controller** | E-727.3CDA (included in scope of delivery) | | | |
| Communication interfaces | Ethernet, USB, RS-232, serial SPI high-speed interface | | | |
| Analog input / Analog output | Sub-D (15-pin)<br>Input via 18-bit A/D converter<br>Output via 20-bit D/A converter | | | |
| Command set | PI General Command Set (GCS) | | | |
| User software | PIMikroMove | | | |
| Software drivers | LabVIEW drivers, shared libraries for Windows and Linux | | | |
| Supported functions | Function generator, data recorder, drift compensation, macros | | | |

* With flexure guides, the resolution is not limited by friction. Value given is noise equivalent motion measured with interferometer.
** For dynamic operation. Higher dynamics are possible with a reduced load.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

Accessories: P-545.PD3, Petri dish holder, dimensions in mm.




Accessories: P-545.SH3, microscope slide holder, dimensions in mm.




1: Recess for standard microscope slides (25 mm × 75 mm)

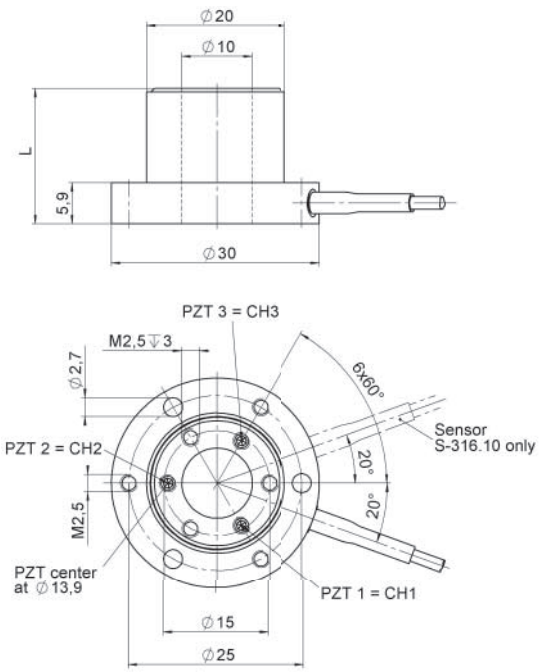
# Tilting Mirrors

# S-310 / S-316 Piezo Z / Tip / Tilt Scanner

## High-Speed System with Clear Aperture

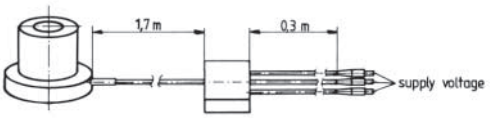
- 10 mm clear aperture
- Piezo tripod design
- Optical beam deflection to 2.4 mrad
- Piston movement up to 12 µm (phase shifter)
- Sub-ms response time
- Sub-µrad resolution
- Closed-loop versions for higher precision
- For optics, mirrors or other components
- Zero-play, high-precision flexure guide system
- Parallel kinematics for higher accuracy and dynamics

S-31x, dimensions in mm. The general tolerance according to DIN ISO 2768-f-H applies to all non-tolerated dimensions.

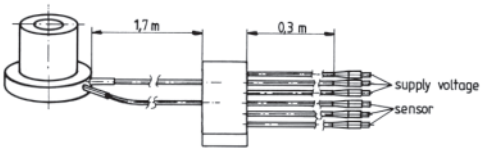



| | L [mm] |
|---|---|
| S-310.10 | 19,5 |
| S-311.10 | 19,5 |
| S-314.10 | 28,5 |
| S-315.10 | 28,5 |
| S-316.10 | 28,5 |

S-315 cable configuration




S-316 cable configuration




**Applications**

- Image processing / stabilization
- Laser scanning / beam steering
- Laser tuning
- Optical filters / switches
- Beam stabilization
- Interferometry


>> Flexure Guiding Systems
>> Parallel-Kinematic Piezo Stages
>> PICMA® Multilayer Piezo Actuators

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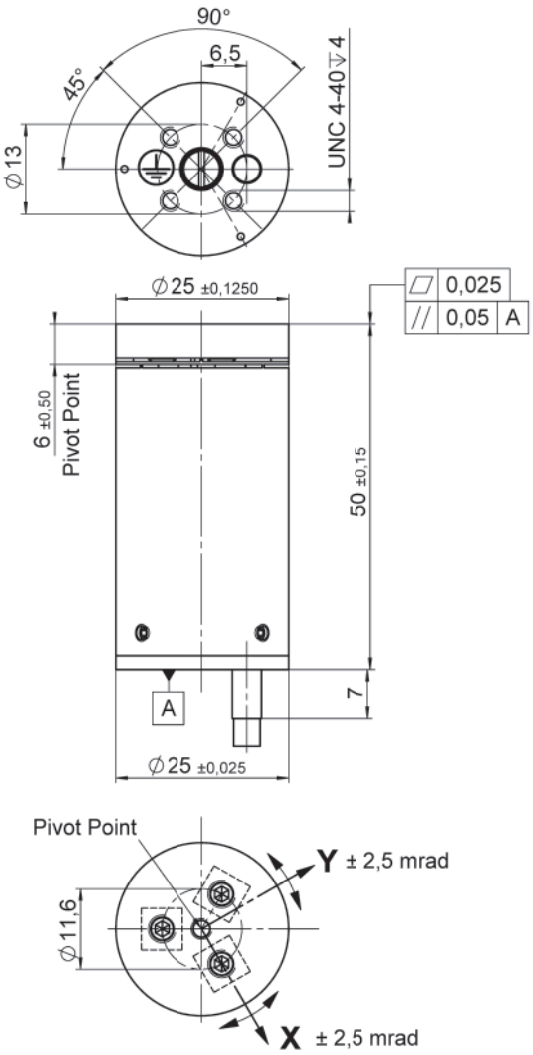
| | S-310.10 | S-314.10 | S-311.10 | S-315.10 | S-316.10<br>S-316.10H | Unit | Tolerance |
|---|---|---|---|---|---|---|---|
| Active axes | Z | Z | Z, $\theta_X$,$\theta_Y$ | Z, $\theta_X$,$\theta_Y$ | Z, $\theta_X$,$\theta_Y$ | | |
| **Motion and positioning** | | | | | | | |
| Integrated sensor | – | – | – | – | SGS | | |
| Open-loop travel in Z at 0 to 100 V | 6 / – | 12 / – | 6 / – | 12 / – | 12 / 12 | µm | +20 % / –0 % |
| Open-loop tip / tilt angle, 0 to 100 V | – | – | 600 | 1200 | 1200 | µrad | +20 % / –0 % |
| Closed-loop travel in Z | – | – | – | – | 12 | µm | |
| Closed-loop tilt angle | – | – | – | – | 1200 | µrad | |
| Open-loop resolution in Z | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | nm | typ. |
| Open-loop resolution in $\theta_X$, $\theta_Y$ | – | – | 0.02 | 0.05 | 0.05 | µrad | typ. |
| Closed-loop resolution in Z | – | – | – | – | 0.4 | nm | typ. |
| Closed-loop resolution in $\theta_X$, $\theta_Y$ | – | – | – | – | 0.1 | µrad | typ. |
| Linearity error | – | – | – | – | 0.2 | % | typ. |
| **Mechanical properties** | | | | | | | |
| Stiffness in Z | 20 | 10 | 20 | 10 | 10 | N/µm | ±20 % |
| Resonant frequency, no load, in Z | 9.5 | 5.5 | 9.5 | 5.5 | 5.5 | kHz | ±20 % |
| Resonant frequency, under load (with 15 mm × 4 mm glass mirror) | 6.5 | 4.4 | 6.5 | 4.1 | 4.1 | kHz | ±20 % |
| Resonant frequency, under load (with 20 mm × 4 mm glass mirror) | 6.1 | 4.2 | 6.1 | 3.4 | 3.4 | kHz | ±20 % |
| Distance of pivot point to platform surface | – | – | 5 | 5 | 5 | mm | ±0.5 mm |
| Platform moment of inertia | – | – | 150 | 150 | 150 | g × mm² | ±20 % |
| **Drive properties** | | | | | | | |
| Ceramic type | PICMA® P-882 | PICMA® P-882 | PICMA® P-882 | PICMA® P-882 | PICMA® P-882 | | |
| Electrical capacitance | 0.39 | 0.93 | 0.39 (0.13 per axis) | 0.93 (0.31 per axis) | 0.93 (0.31 per axis) | µF | ±20 % |
| **Miscellaneous** | | | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Steel | Steel | Steel | Steel | Steel | | |
| Mass | 0.053 | 0.055 | 0.045 | 0.055 | 0.055 | kg | ±5 % |
| Cable length | 2 | 2 | 2 | 2 | 2 | m | +100 mm / –0 mm |
| Sensor connection | – | – | – | – | S-316.10: LEMO<br>S-316.10H: Sub-D 37 (m) | | |
| Voltage connection | LEMO | LEMO | LEMO | LEMO | S-316.10: LEMO<br>S-316.10H: Sub-D 37 (m) | | |
| Recommended electronics | E-505, E-610, E-625, E-727 | E-505, E-610, E-625, E-727 | E-505, E-610, E-625, E-727 | E-505, E-610, E-625, E-727 | E-505, E-610, E-625, E-727 | | |

Resolution of PI piezo scanners is not limited by friction or stiction. Value given is noise equivalent motion with E 503 amplifier.
Mechanical tilt, optical beam deflection is twice as large. For maximum tilt range, all three piezo actuators must be biased at 50 V.
Due to the parallel-kinematics design, linear travel and tilt angle are interdependent. The values quoted here refer to pure linear / pure angular motion.
All specifications based on room temperature (22 °C ±3 °C).

# S-325 Piezo Z / Tip / Tilt Platform

## High-Speed Tripod System for Mirrors and Optics

S-325, dimensions in mm.




- Optical beam deflection to 10 mrad
- Resolution to 50 nrad
- Piston movement up to 30 µm (for path length adjustment)
- Compact tripod design
- Sub-ms response time
- Closed-loop versions for higher precision
- For optics up to Ø 25 mm (1")
- Zero-play, high-precision flexure guide system
- Parallel kinematics for higher accuracy and dynamics

**Applications**

- Image processing / stabilization
- Optical trapping
- Laser scanning / beam steering
- Laser tuning
- Optical filters / switches
- Optics
- Beam stabilization


>> Flexure Guiding Systems
>> Parallel-Kinematic Piezo Stages
>> PICMA® Multilayer Piezo Actuators

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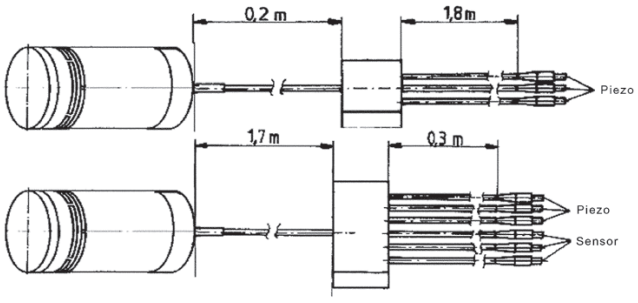
| | S-325.30L | S-325.3SL | S-325.3SD | Unit | Tolerance |
|---|---|---|---|---|---|
| Active axes | Z, $\theta_X$, $\theta_Y$ | Z, $\theta_X$, $\theta_Y$ | Z, $\theta_X$, $\theta_Y$ | | |
| **Motion and positioning** | | | | | |
| Integrated sensor | 0 | SGS | SGS | | |
| Open-loop travel in Z at 0 to 100 V | 30 | 30 | 30 | µm | +20 % / –0 % |
| Open-loop tip / tilt angle, 0 to 100 V | 5 | 5 | 5 | mrad | +20 % / –0 % |
| Closed-loop travel in Z | – | 30 | 30 | µm | |
| Closed-loop tip / tilt angle in $\theta_X$, $\theta_Y$ | – | 4 | 4 | mrad | |
| Open-loop resolution in Z | 0.5 | 0.5 | 0.5 | nm | typ. |
| Open-loop resolution in $\theta_X$, $\theta_Y$ | 0.05 | 0.05 | 0.05 | µrad | typ. |
| Closed-loop resolution in Z | – | 0.6 | 0.6 | nm | typ. |
| Closed-loop resolution in $\theta_X$, $\theta_Y$ | – | 0.1 | 0.1 | µrad | typ. |
| **Mechanical properties** | | | | | |
| Unloaded resonant frequency in Z | 2 | 2 | 2 | kHz | ±20 % |
| Resonant frequency, under load (with 25 mm × 8 mm glass mirror) | 1 | 1 | 1 | kHz | ±20 % |
| Distance of pivot point to platform surface | 6 | 6 | 6 | mm | ±0.5 mm |
| Platform moment of inertia | 515 | 515 | 515 | g × mm² | ±20 % |
| **Drive properties** | | | | | |
| Ceramic type | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | | |
| Electrical capacitance | 9.3 | 9.3 | 9.3 | µF | ±20 % |
| **Miscellaneous** | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material case | Aluminum | Aluminum | Aluminum | | |
| Mass | 0.065 | 0.065 | 0.065 | kg | ±5 % |
| Cable length | 2 | 2 | 1.5 | m | ±10 mm |
| Sensor / voltage connection | LEMO | LEMO | Sub-D 25 (m) | | |
| Recommended electronics | E-610, E-616, E-663, E-727 | E-610, E-616, E-663, E-727 | E-610, E-616, E-663, E-727 | | |

For maximum tilt range, all three piezo actuators must be biased at 50 V. Due to the parallel-kinematics design linear travel and tilt angle are interdependent. The values quoted here refer to pure linear / pure angular motion.
All specifications based on room temperature (22 °C ±3 °C).

S-325 cable configuration
(top: S-325.30L, bottom: S-325.3SL)

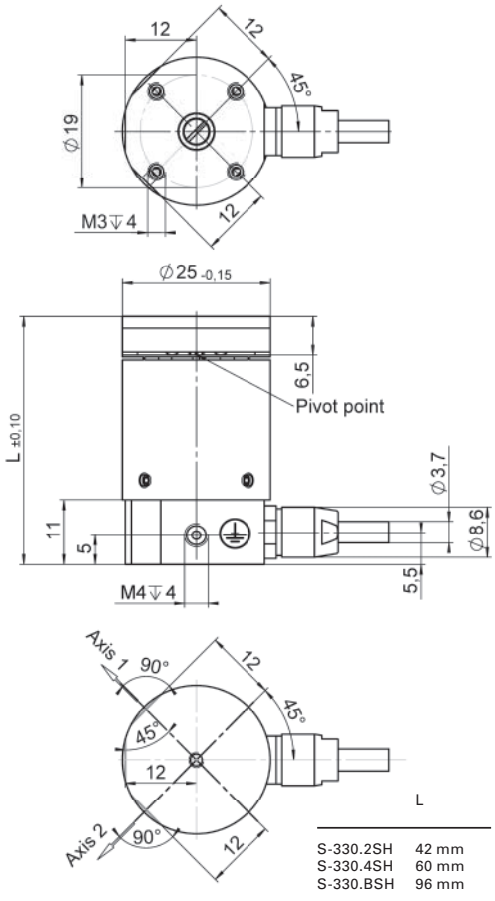


# S-330 Piezo Tip / Tilt Platform

## Highly Dynamic, with Large Deflection Angle for Mirrors and Optics

- Resolution to 20 nrad
- Excellent position stability
- Optical beam deflection to 20 mrad (>1°)
- Parallel kinematics for higher accuracy and dynamics and full bridge strain gauge sensors
- Sub-ms response time
- For mirrors to Ø 50 mm

S-330.xSH, dimensions in mm.




| | |
|---|---|
| S-330.2SH | 42 mm |
| S-330.4SH | 60 mm |
| S-330.BSH | 96 mm |

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

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

**Strain sensors for low linearity errors**

Strain gauge sensors with low temperature sensitivity. Linearity error to 0.2 %.

**PICMA high-performance drives**

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

**Applications**

- Image processing / stabilization
- Optical trapping
- Laser scanning / beam steering
- Laser tuning
- Optical filters / switches
- Optics
- Beam stabilization


>> Flexure Guiding Systems
>> Parallel-Kinematic Piezo Stages
>> PICMA® Multilayer Piezo Actuators

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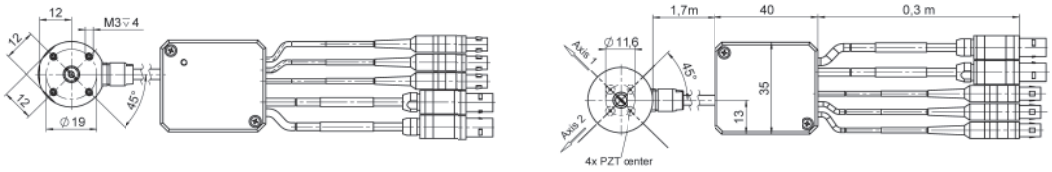
| | S-330.2SH / S-330.2SL | S-330.4SH / S-330.4SL | S-330.8SH / S-330.8SL | Unit | Tolerance |
|---|---|---|---|---|---|
| Active axes | $\theta_X$, $\theta_Y$ | $\theta_X$, $\theta_Y$ | $\theta_X$, $\theta_Y$ | | |
| **Motion and positioning** | | | | | |
| Integrated sensor* | SGS | SGS | SGS | | |
| Open-loop tip / tilt angle in $\theta_X$, $\theta_Y$ at –20 to 120 V | 3.5 | 7 | 15 | mrad | min. |
| Closed-loop tip / tilt angle in $\theta_X$, $\theta_Y$ | 2 | 5 | 10 | mrad | |
| Open-loop resolution in $\theta_X$, $\theta_Y$ | 0.02 | 0.1 | 0.2 | µrad | typ. |
| Closed-loop resolution in $\theta_X$, $\theta_Y$ | 0.05 | 0.25 | 0.5 | µrad | typ. |
| Linearity error in $\theta_X$, $\theta_Y$ | 0.05 **<br>0.2 *** | 0.1 **<br>0.2 *** | 0.1 **<br>0.2 *** | % | typ. |
| Repeatability in $\theta_X$, $\theta_Y$, 10 % tip / tilt angle | 0.06 **<br>0.15 *** | 0.08 **<br>0.5 *** | 0.15 **<br>1 *** | µrad | typ. |
| Repeatability in $\theta_X$, $\theta_Y$, 100 % tip / tilt angle | 0.6 **<br>1.5 *** | 0.8 **<br>5 *** | 1.5 **<br>10 *** | µrad | typ. |
| **Mechanical properties** | | | | | |
| Resonant frequency, no load, in $\theta_X$, $\theta_Y$ | 2.4 | 2.0 | 1.0 | kHz | ±20 % |
| Resonant frequency, under load, in $\theta_X$, $\theta_Y$ (with glass mirror, Ø 25 mm, thickness 8 mm) | 1.6 | 1.5 | 1.0 | kHz | ±20 % |
| Distance of pivot point to platform surface | 6.5 | 6.5 | 6.5 | mm | ±1 mm |
| Platform moment of inertia | 1530 | 1530 | 1530 | g × mm² | ±20 % |
| **Drive properties** | | | | | |
| Ceramic type | PICMA® | PICMA® | PICMA® | | |
| Electrical capacitance | 3 / axis | 6 / axis | 12.5 / axis | µF | ±20 % |
| **Miscellaneous** | | | | | |
| ID chip functionality | S-330.2SH | S-330.4SH | S-330.8SH | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material housing | Steel | Steel | Steel | | |
| Material platform | Invar | Invar | Invar | | |
| Mass | 0.2 | 0.38 | 0.7 | kg | ±5 % |
| Cable length | 2 | 2 | 2 | m | +100 mm / –0 mm |
| Sensor / voltage connection | Sub-D 37 (m) (S-330.2SH), LEMO (S-330.2SL) | Sub-D 37 (m) (S-330.4SH), LEMO (S-330.4SL) | Sub-D 37 (m) (S-330.8SH), LEMO (S-330.8SL) | | |
| Recommended electronics | E-503, E-505, E-663, E-727 | E-503, E-505, E-663, E-727 | E-503, E-505, E-663, E-727 | | |

* Models without sensor are available on request.
** .xSH in conjunction with digital controllers
*** .xSL in conjunction with E-5xx analog controller modules
All specifications based on room temperature (22 °C ±3 °C).

S-330.xSL with cable splitter box; dimensions in mm.



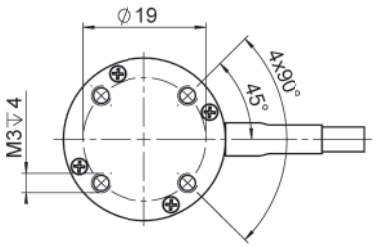

| | L |
|---|---|
| S-330.2SL | 42 mm |
| S-330.4SL | 60 mm |
| S-330.8SL | 96 mm |

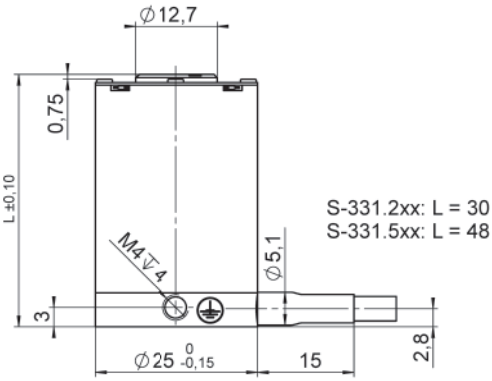
# S-331 Fast Tip / Tilt Platform

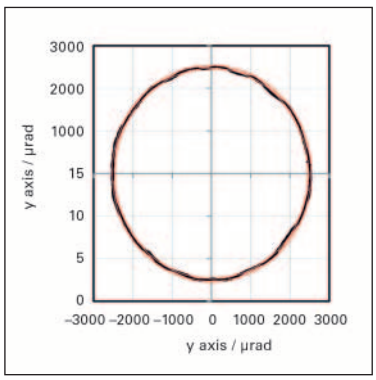
## Short Settling Time and High Dynamic Linearity

- 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 resonant frequencies for dynamic motion and fast step-and-settle
- Position sensors for high linearity
- For mirrors up to Ø 12.7 mm (0.5")

S-331, dimensions in mm.

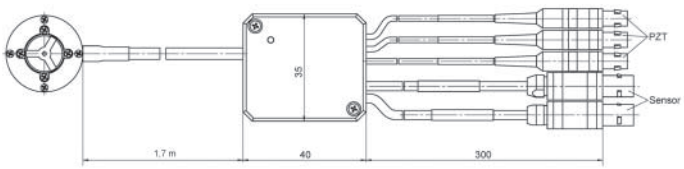


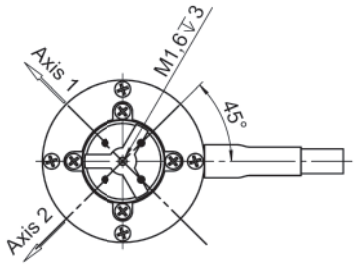




High dynamic linearity of a circular motion with 5 mrad displacement per axis (full displacement of the S 311.5SL with E-505 power amplifier and E-509 controller). The linear error on the ideal circular path at a frequency of 25 Hz is approx. 0.5 %, which corresponds to 2.5 µrad.

S-331.xSL with cable splitter box; dimensions in mm.




**Applications**

- Image processing / stabilization
- Optical trapping
- Laser scanning / beam steering
- Laser tuning
- Optical filters / switches
- Optics
- Beam stabilization


>> Flexure Guiding Systems
>> Parallel-Kinematic Piezo Stages
>> PICMA® Multilayer Piezo Actuators

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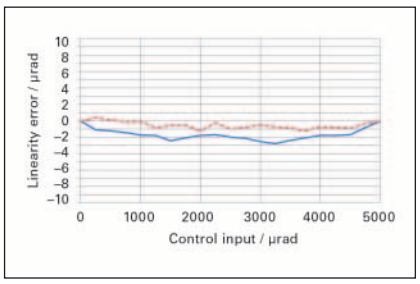
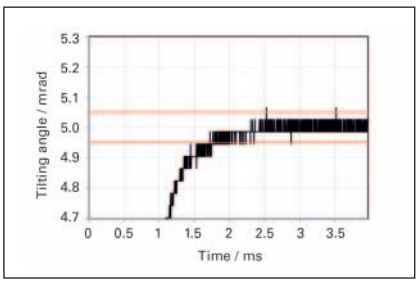
| | S-331.2SL / S-331.2SH | S-331.5SL / S-331.5SH | Unit | Tolerance |
|---|---|---|---|---|
| Active axes | $\theta_X$, $\theta_Y$ | $\theta_X$, $\theta_Y$ | | |
| **Motion and positioning** | | | | |
| Integrated sensor | SGS | SGS | | |
| Open-loop tip / tilt angle in $\theta_X$, $\theta_Y$ at –20 to 120 V | 4.2 | 7 | mrad | min. |
| Closed-loop tip / tilt angle in $\theta_X$, $\theta_Y$ | 3 | 5 | mrad | |
| Open-loop resolution in $\theta_X$, $\theta_Y$ | 0.05 | 0.1 | µrad | typ. |
| Closed-loop resolution in $\theta_X$, $\theta_Y$ | 0.1 | 0.25 | µrad | typ. |
| Linearity error in $\theta_X$, $\theta_Y$ | 0.3 *<br>0.1 ** | 0.3 *<br>0.1 ** | nm | typ. |
| Repeatability in $\theta_X$, $\theta_Y$, 10 % tip / tilt angle | 0.3 | 0.5 | µrad | typ. |
| Repeatability in $\theta_X$, $\theta_Y$, 100 % tip / tilt angle | 3 | 5 | nm | typ. |
| **Mechanical properties** | | | µrad | typ. |
| Resonant frequency, unloaded in $\theta_X$, $\theta_Y$ | 12 | 16 | µrad | typ. |
| Resonant frequency, unloaded in $\theta_X$, $\theta_Y$ (with glass mirror, Ø 12.7 mm, thickness 3 mm) | 9 | 10 | | |
| Distance of pivot point to platform surface | 4 | 4 | kHz | ±20 % |
| Platform moment of inertia | 30 | 30 | kHz | ±20 % |
| **Drive properties** | | | mm | ±1 mm |
| Ceramic type | PICMA® | PICMA® | g × mm² | ±20 % |
| Electrical capacitance | 0.96 / axis | 6.2 / axis | | |
| **Miscellaneous** | | | | |
| ID chip functionality | S-331.2SH | S-331.5SH | µF | ±20 % |
| Operating temperature range | –20 to 80 | –20 to 80 | | |
| Material housing | Steel | Steel | | |
| Material platform | Titanium | Titanium | °C | |
| Mass | 0.13 | 0.28 | | |
| Cable length | 2 | 2 | | |
| Sensor / voltage connection | 0.13 | 0.28 | kg | ±5 % |
| Recommended electronics | 2 | 2 | m | +100 mm / –0 mm |
| Sensor / voltage connection | LEMO (S-331.2SL),<br>Sub-D 37 (m) (S-331.2SH) | LEMO (S-331.5SL),<br>Sub-D 37 (m) (S-331.5SH) | | |
| Recommended electronics | E-503, E-727 | E-503, E-727 | | |

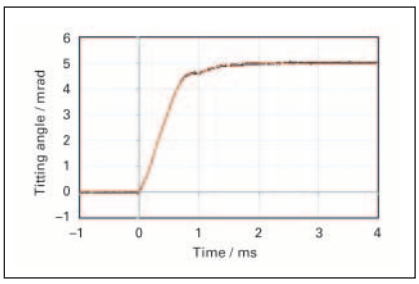
* S-331.xSL in conjunction with E-5xx analog controller modules
** S-331.xSH in conjunction with digital controllers, unidirectional
All specifications based on room temperature (22 °C ±3 °C).




Unidirectional linearity error for both axes: The blue, solid line represents axis 1, the brown, dotted line represents axis 2. The linearity error at full displacement of the S-331.5SH with an E-727.3SD digital piezo controller is less than 0.05 %.




Settling time of an unloaded S-331.5SL at full displacement with E-505 piezo amplifier and the E-509 servo controller: The settling time for a step of 5 mrad is 1.8 ms at accuracy of ±1 %.

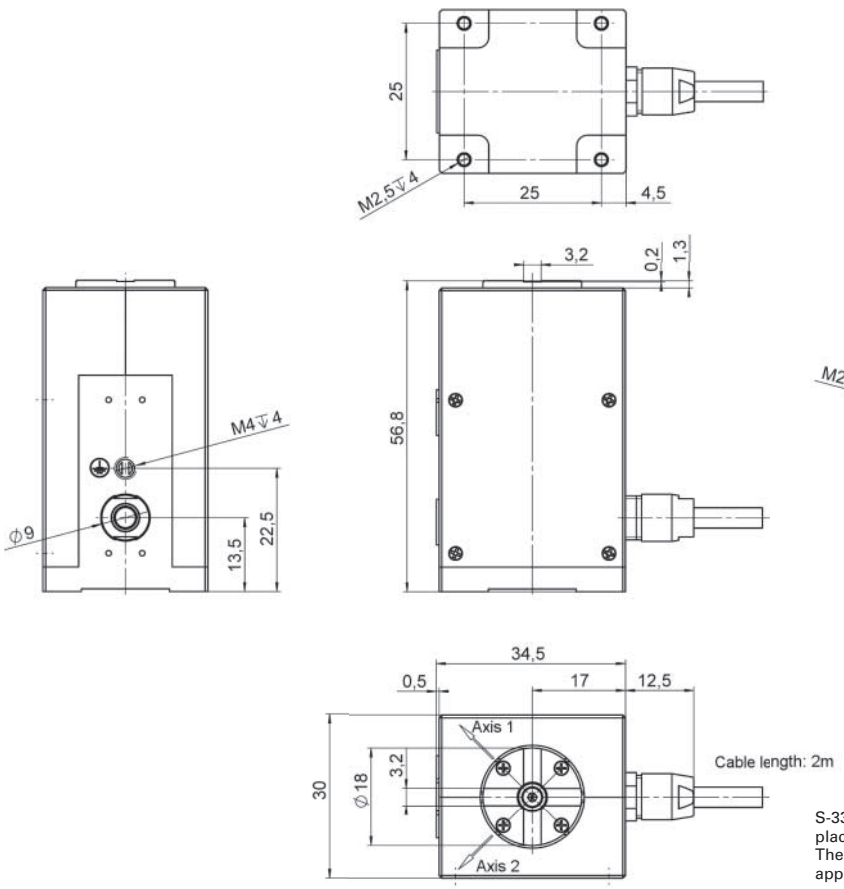



The settling time of the unloaded S-331.5SL for one 5 mrad step (full displacement) is 1.8 ms with an accuracy of ±1 %.

# S-335 Fast Tip / Tilt Platform

## Short Settling Time and High Dynamic Linearity

- Tip / tilt angle to 35 mrad, high optical deflection angle to 70 mrad (4°)
- High resonant frequencies for dynamic motion and fast step-and-settle
- Parallel-kinematic design: Two orthogonal tip / tilt axes with one common center of rotation
- Strain sensors for high linearity
- For mirrors to Ø 25.4 mm (1") (can be supplied with mirror on request)




S-335.2SH, dimensions in mm. Note that the decimal places are separated by a comma in the drawings. The general tolerance according to DIN ISO 2768-f-H applies to all non-tolerated dimensions.

**Applications**

- Image processing / stabilization
- Optical trapping
- Laser scanning / beam steering with large angles
- Laser tuning
- Optical filters / switches
- Optics
- Beam stabilization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>> Parallel-Kinematic Piezo Stages
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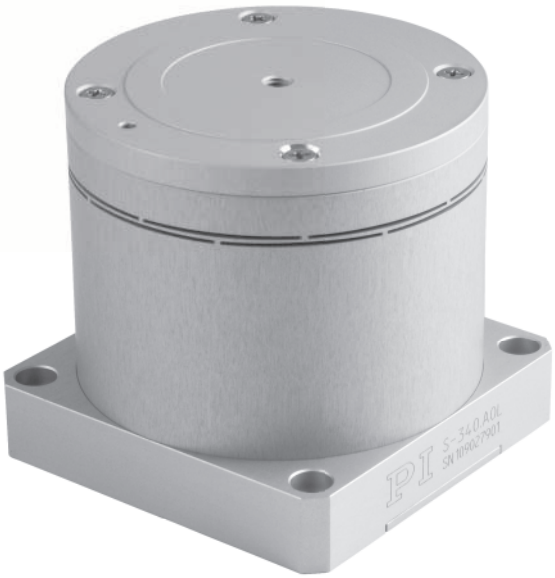
| | S-335.2SH | Unit | Tolerance | |
|---|---|---|---|---|
| Active axes | $\theta_X$, $\theta_Y$ | | | |
| **Motion and positioning** | | | | |
| Integrated sensor | SGS | | | |
| Tip / tilt angle, closed loop (static motion at 0 to 120 V) | ±17.5 | mrad | | |
| Open-loop resolution | 0.1 | µrad | typ. | |
| Closed-loop resolution | 1.0 | µrad | typ. | |
| Linearity | 0.05 (unidirectional) | % | typ. | |
| Repeatability | 1 (bidirectional) | µrad | typ. | |
| **Mechanical properties** | | | | |
| Resonant frequency, no load | 2 | kHz | ±20 % | |
| Resonant frequency, under load (with Ø 12.7 mm × 3 mm Zerodur mirror) | 1.6 | kHz | ±20 % | |
| Resonant frequency, under load (with Ø 25.4 mm × 5 mm Zerodur mirror) | 0.7 | kHz | ±20 % | |
| Gap between the center of rotation and platform surface | 3.3 | mm | ±0.25 mm | |
| **Drive properties** | | | | |
| Ceramic type | PICMA® P-885 | | | |
| Electrical capacitance per axis | 6.2 | µF | ±20 % | |
| **Miscellaneous** | | | | |
| ID chip functionality | Yes | | | |
| Operating temperature range* | –20 to 80 | °C | | |
| Material platform | Titanium | | | |
| Mass (with cable and connector) | 280 | g | ±5 % | |
| Cable length | 2 | m | +0.1 m | |
| Sensor / voltage connection | Sub-D 37 (m) | | | |
| Recommended electronics | E-727 | | | |

* The specifications apply to 21 °C ±10 °C, specifications may deviate outside of this range. If you have any questions, contact your PI representative.

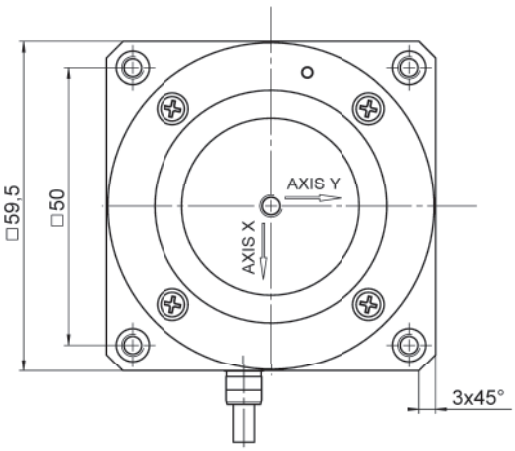
# S-340 Piezo Tip / Tilt Platform

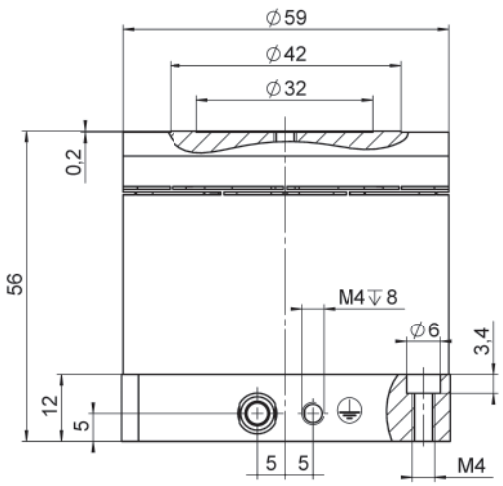
## High-Dynamics for Mirrors and Optics up to Ø 75 mm (3 inch)



- Resolution up to 20 nrad, excellent position stability
- Optical beam deflection to 4 mrad
- Parallel kinematics for higher accuracy and dynamics
- Sub-ms response time
- For mirrors up to Ø 75 mm (3 inch); Ø 100 mm (4 inch) on request
- Closed-loop versions for improved linearity
- Excellent temperature stability

S-340, dimensions in mm.
The general tolerance according to DIN ISO 2768-f-H applies to all non-tolerated dimensions.




**Applications**

- Image processing / stabilization
- Optical trapping
- Laser scanning / beam steering with large angles
- Laser tuning
- Optical filters / switches
- Optics
- Beam stabilization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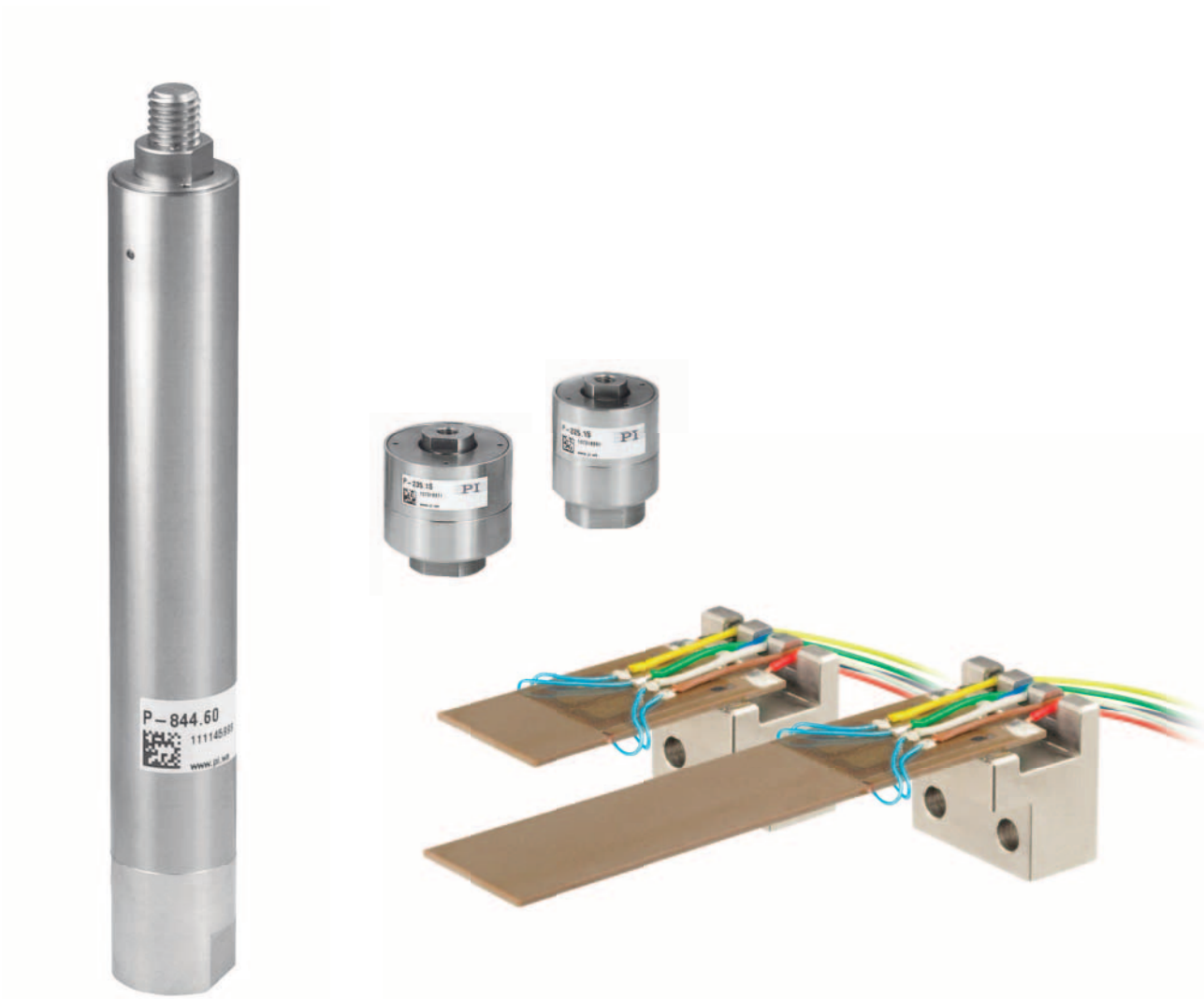
| | S-340.ASD / ASL | S-340.A0L | Unit | Tolerance |
|---|---|---|---|---|
| Active axes | $\theta_X$, $\theta_Y$ | $\theta_X$, $\theta_Y$ | | |
| **Motion and positioning** | | | | |
| Integrated sensor | SGS | - | | |
| Open-loop tip / tilt angle in $\theta_X$, $\theta_Y$, –20 to +120 V | 2 | 2 | mrad | min. |
| Closed-loop tip / tilt angle in $\theta_X$, $\theta_Y$ | 2 | - | mrad | |
| Open-loop tip / tilt angle resolution in $\theta_X$, $\theta_Y$ | 0.02 | 0.02 | µrad | typ. |
| Closed-loop tip / tilt angle resolution in $\theta_X$, $\theta_Y$ | 0.2 | - | µrad | typ. |
| Linearity error in $\theta_X$, $\theta_Y$ | 0.1 | - | % | typ. |
| Repeatability in $\theta_X$, $\theta_Y$ | 0.15 | - | µrad | typ. |
| **Mechanical properties** | | | | |
| Unloaded resonant frequency in $\theta_X$, $\theta_Y$ | 1.4 | 1.4 | kHz | ±20 % |
| Resonant frequency loaded in $\theta_X$, $\theta_Y$ (with glass mirror, diameter 50 mm, thickness 15 mm) | 0.9 | 0.9 | kHz | ±20 % |
| Resonant frequency loaded in $\theta_X$, $\theta_Y$ (with glass mirror, diameter 75 mm, thickness 22 mm) | 0.4 | 0.4 | kHz | ±20 % |
| Distance of pivot point to platform surface | 7.5 | 7.5 | mm | ±1 mm |
| Platform moment of inertia | 18000 | 18000 | g × mm² | ±20 % |
| **Drive properties** | | | | |
| Ceramic type | PICMA® | PICMA® | | |
| Electrical capacitance | 6 / axis | 6 / axis | µF | ±20 % |
| **Miscellaneous** | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | °C | |
| Material case | Aluminum | Aluminum | | |
| Material platform | Aluminum; or optionally Steel, Titanium or Invar | Aluminum; or optionally Steel, Titanium or Invar | | |
| Mass | 0.355 | 0.35 | kg | ±5 % |
| Cable length | 2 | 2 | m | +100 mm / –0 mm |
| Sensor / voltage connection | Sub-D 25 (m) / LEMO | LEMO | | |
| Recommended electronics | E-616, E-727 | E-616, E-727 | | |

All specifications based on room temperature (22 °C ±3 °C).

# Piezo Actuators with Guiding and Preload

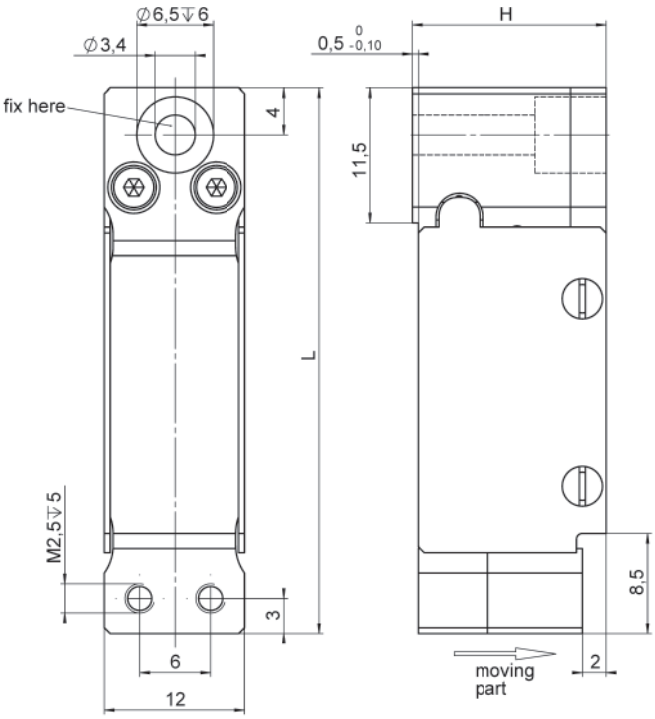


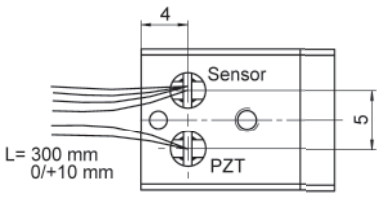
# P-601
# PiezoMove Flexure-Guided Linear Actuator

## With Optional Position Sensor


P-601, dimensions in mm.

- Flexure guides for linear motion with minimum tip and tilt
- Travel ranges to 400 µm
- Resolution to 0.2 nm
- Available with integrated position sensor
- Outstanding lifetime due to PICMA® piezo actuators
- Ideal OEM actuators for precision motion control in optics, medical, biotech and microfluidics applications
- Custom designs with larger travel or faster response and non-magnetic versions feasible




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

**Applications**

- Nanopositioning
- High-speed switching
- Patch clamp
- Micro-dispensing
- Adaptronics / Automation
- Photonics / integrated optics
- Biotechnology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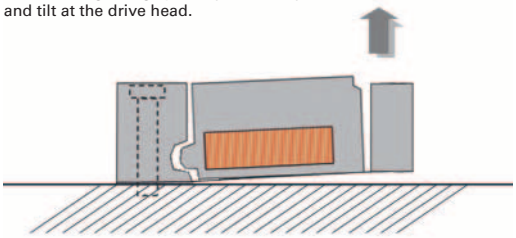
| | P-601.1S<br>P-601.1SL | P-601.3S<br>P-601.3SL | P-601.4S<br>P-601.4SL | P-601.x0<br>P-601.x0L<br>open-loop<br>versions | Unit | Tolerance |
|---|---|---|---|---|---|---|
| Active axes | Z | Z | Z | Z | | |
| **Motion and positioning** | | | | | | |
| Integrated sensor | SGS | SGS | SGS | – | | |
| Open-loop travel, –20 to 120 V | 100 | 250 | 400 | as P-601.xS | µm | +20 % / –0 % |
| Closed-loop travel | 100 | 250 | 400 | – | µm | calibrated |
| Open-loop resolution | 0.2 | 0.3 | 0.4 | as P-601.xS | nm | typ. |
| Closed-loop resolution | 2 | 6 | 12 | – | nm | typ. |
| Closed-loop nonlinearity | 0.1 | 0.3 | 0.3 | – | % | typ. |
| Repeatability | 8 | 10 | 30 | – | nm | typ. |
| **Mechanical properties** | | | | | | |
| Stiffness in motion direction | 0.8 | 0.38 | 0.28 | as P-601.xS | N/µm | ±20 % |
| Unloaded resonant frequency | 750 | 440 | 350 | as P-601.xS | Hz | ±20 % |
| Resonant frequency at 30 g | 620 | 350 | 290 | as P-601.xS | Hz | ±20 % |
| Push / pull force capacity in motion direction | 30 / 10 | 20 / 10 | 15 / 10 | as P-601.xS | N | max. |
| Lateral force | 30 | 30 | 30 | as P-601.xS | N | max. |
| **Drive properties** | | | | | | |
| Ceramic type | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | as P-601.xS | | |
| Electrical capacitance | 1.5 | 3.1 | 4.6 | as P-601.xS | µF | ±20 % |
| **Miscellaneous** | | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Material | Stainless steel | Stainless steel | Stainless steel | Stainless steel | | |
| Mass without cables | 0.05 | 0.08 | 0.11 | as P-601.xS | kg | ±5 % |
| Cable length | S versions: 0.3 m<br>SL versions: 1.5 m | S versions: 0.3 m<br>SL versions: 1.5 m | S versions: Stranded wires<br>SL versions: LEMO | x0 versions: Stranded wires<br>x0L versions: LEMO | 0.3 m | |
| Sensor / voltage connection | S versions: Stranded wires<br>SL versions: LEMO | S versions: Stranded wires<br>SL versions: LEMO | S versions: Stranded wires<br>SL versions: LEMO | x0 versions: Stranded wires<br>x0L versions: LEMO | | |
| Recommended electronics | E-610, E-625, E 831 | E-610, E-625, E 831 | E-610, E-625, E 831 | E-610, E-625, E 831 | | |

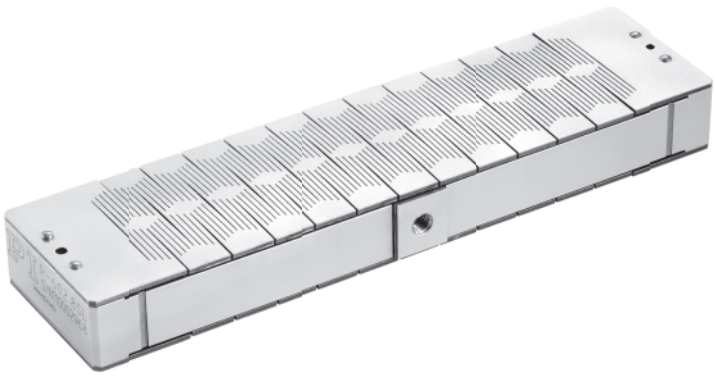
All specifications based on room temperature (22 °C ±3 °C).

Direction of motion of the P-601.
The flexure guiding system prevents tip and tilt at the drive head.



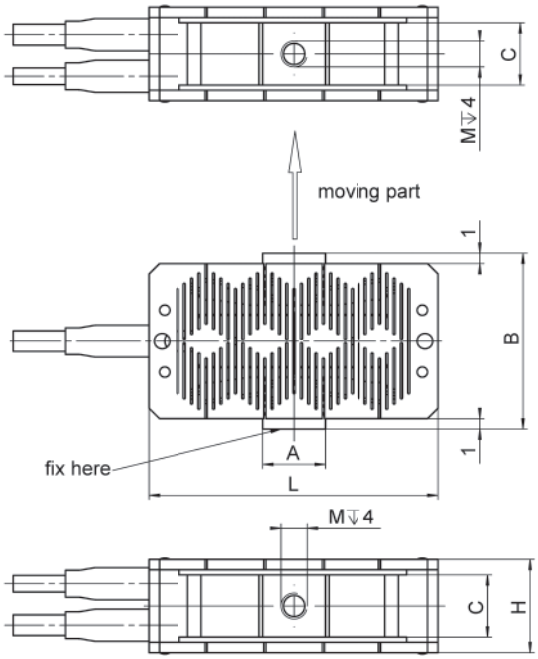
# P-602
# PiezoMove High-Stiffness Linear Piezo Actuator

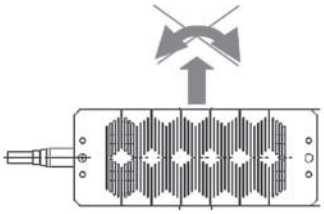
**With Flexure-Guided Motion Amplifier for Travel Ranges to 1 mm**



- Flexure guides for linear motion with minimum tip and tilt
- Travel ranges to 1 mm
- Forces to 100 N
- Stiff and backlash-free construction
- Available with integrated position sensor
- Outstanding lifetime due to PICMA® piezo actuators
- Ideal OEM actuator for force generation in adaptive systems technology, for nanoimprint processes or machine tools
- Custom designs with larger travel or faster response and non-magnetic versions feasible

P-602, dimensions in mm.



Flexure guides provide straight motion with no tip and minimum tilt.

| | L | B | H | M | A | C |
|---|---|---|---|---|---|---|
| P-602.1xx | 28 | 17 | 9 | M2,5 | 6 | 6 |
| P-602.3xx | 46 | 19 | 9 | M2,5 | 6 | 6 |
| P-602.5xx | 85 | 26 | 9 | M2,5 | 6 | 6 |
| P-602.8xx | 126 | 34 | 14 | M4 | 10 | 11 |
| P-602.1x8 | 28 | 22 | 14 | M2,5 | 6 | 11 |
| P-602.3x8 | 46 | 24 | 14 | M2,5 | 6 | 11 |
| P-602.5x8 | 85 | 31 | 14 | M2,5 | 6 | 11 |

**Applications**

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


>> **Flexure Guiding Systems**

>> **PICMA® Multilayer Piezo Actuators**

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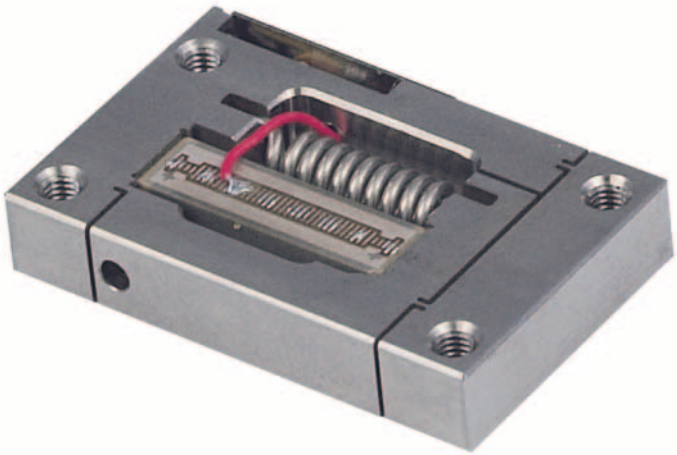
| | P-602.100 / P-602.1S0 / P-602.1SL | P-602.300 / P-602.3S0 / P-602.3SL | P-602.500 / P-602.5S0 / P-602.5SL | P-602.108 / P-602.1S8 / P-602.1L8 | P-602.308 / P-602.3S8 / P-602.3L8 | P-602.508 / P-602.5S8 / P-602.5L8 | P-602.800 / P-602.8S0 / P-602.8SL | Unit |
|---|---|---|---|---|---|---|---|---|
| Active axes | X | X | X | X | X | X | X | |
| **Motion and positioning** | | | | | | | | |
| Integrated sensor | – / SGS / SGS | – / SGS / SGS | – / SGS / SGS | – / SGS / SGS | – / SGS / SGS | – / SGS / SGS | – / SGS / SGS | |
| Open-loop travel, –20 to 120 V | 120 | 300 | 600 | 100 | 300 | 500 | 1000 | µm |
| Closed-loop travel | – / 100 / 100 | – / 300 / 300 | – / 500 / 500 | – / 100 / 100 | – / 300 / 300 | – / 500 / 500 | – / 1000 / 1000 | µm |
| Open-loop resolution | 0.2 | 0.3 | 0.4 | 0.2 | 0.3 | 0.4 | 0.5 | nm |
| Closed-loop resolution | – / 2 / 2 | – / 3 / 3 | – / 3 / 3 | – / 2 / 2 | – / 3 / 3 | – / 3 / 3 | – / 7 / 7 | nm |
| Closed-loop nonlinearity | – / 0.5 / 0.5 | – / 0.5 / 0.5 | – / 0.5 / 0.5 | – / 0.5 / 0.5 | – / 0.5 / 0.5 | – / 0.5 / 0.5 | – / 1.5 / 1.5 | % |
| Repeatability | – / 10 / 10 | – / 20 / 20 | – / 35 / 35 | – / 10 / 10 | – / 20 / 20 | – / 35 / 35 | – / 60 / 60 | nm |
| **Mechanical properties** | | | | | | | | |
| Stiffness in motion direction | 0.8 | 0.35 | 0.3 | 2.3 | 0.75 | 0.65 | 0.4 | N/µm |
| Unloaded resonant frequency | 1000 | 450 | 230 | 1000 | 450 | 230 | 150 | Hz |
| Push force capacity in motion direction | 100 | 100 | 100 | 100 | 100 | 100 | 100 | N |
| Pull force capacity in motion direction | 5 | 5 | 5 | 5 | 5 | 5 | 5 | N |
| **Drive properties** | | | | | | | | |
| Piezoceramics | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-888 | PICMA® P-888 | PICMA® P-888 | PICMA® P-888 | |
| Electrical capacitance | 1.5 | 3.1 | 6.2 | 6 | 13 | 26 | 39 | µF |
| **Miscellaneous** | | | | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C |
| Material | Stainless steel | Stainless steel | Stainless steel | Stainless steel | Stainless steel | Stainless steel | Stainless steel | |
| Dimensions | 28 mm × 17 mm × 9 mm | 46 mm × 19 mm × 9 mm | 8 mm × 26 mm × 9 mm | 28 mm × 22 mm × 14 mm | 46 mm × 24 mm × 14 mm | 85 mm × 31 mm × 14 mm | 126 mm × 34 mm × 14 mm | |
| Mass | 0.02 | 0.04 | 0.105 | 0.05 | 0.088 | 0.215 | 0.355 | kg |
| Cable length | 0.5 / 0.5 / 2 | 0.5 / 0.5 / 2 | 0.5 / 0.5 / 2 | 0.5 / 0.5 / 2 | 0.5 / 0.5 / 2 | 0.5 / 0.5 / 2 | 0.5 / 0.5 / 2 | m |
| Power / sensor connector | Stranded wires / Stranded wires / LEMO | Stranded wires / Stranded wires / LEMO | Stranded wires / Stranded wires / LEMO | Stranded wires / Stranded wires / LEMO | Stranded wires / Stranded wires / LEMO | Stranded wires / Stranded wires / LEMO | Stranded wires / Stranded wires / LEMO | |
| Recommended electronics | E-610, E-625, E-831 | E-610, E-625, E-831 | E-610, E-625, E-831 | E-610, E-625, E-831 | E-610, E-625, E-831 | E-610, E-625, E-831 | E-610, E-625, E-831 | |

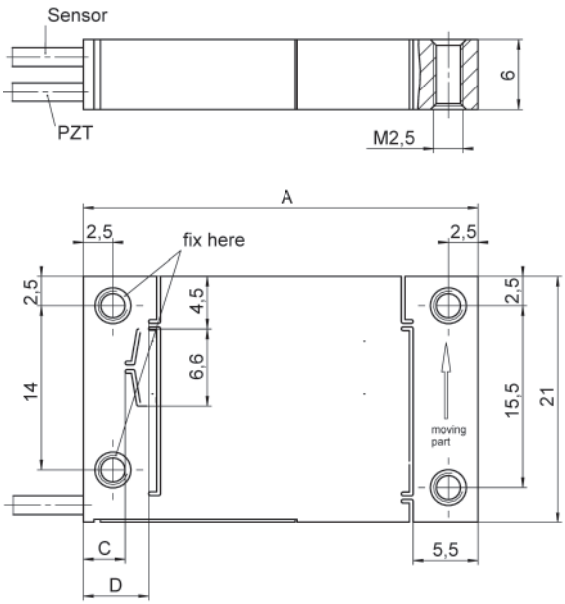
All specifications based on room temperature (22 °C ±3 °C).

# P-603
# Cost-Efficient PiezoMove Linear Flexure Actuator

**Frictionless Guidings and Travel Ranges to 0.5 mm**



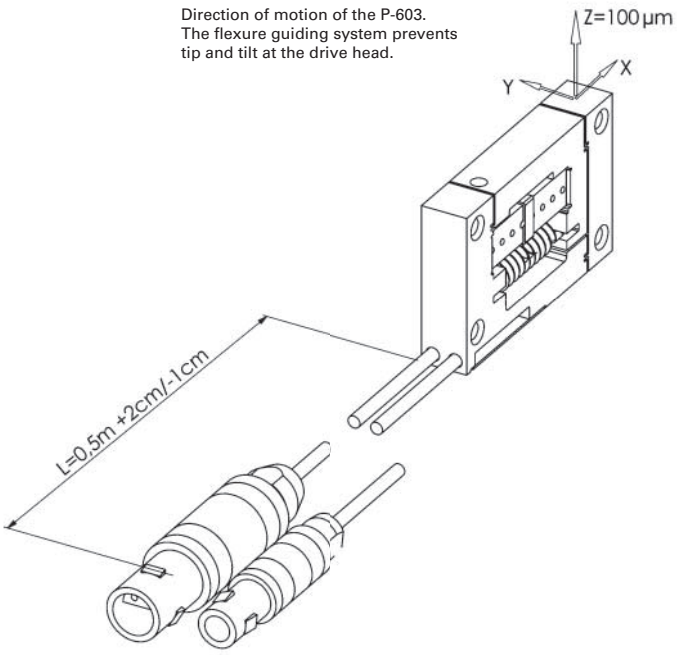
P-603, dimensions in mm.




| | A [mm] | C [mm] | D [mm] |
|---|---|---|---|
| P-603.1S1 / .1S2 / .101 | 33,5 | 3,5 | 5,5 |
| P-603.3S1 / .3S2 / .301 | 52 | 3,5 | 5,6 |
| P-603.5S1 / .5S2 /. 501 | 62 | 4,5 | 6,2 |

- Flexure guides for linear motion with minimum tip and tilt
- Travel ranges to 500 µm
- Optimized design for manufacturing in large quantities
- Available with integrated position sensor
- Outstanding lifetime due to PICMA® piezo actuators
- Ideal OEM actuators for precision motion control in optics, medical, biotech and micro-fluidics applications
- Custom designs with larger travel or faster response and non-magnetic versions feasible

Direction of motion of the P-603.
The flexure guiding system prevents tip and tilt at the drive head.




**Applications**

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


>> **Flexure Guiding Systems**
>> **PICMA® Multilayer Piezo Actuators**

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| | P-603.1S1<br>P-603.1S2 | P-603.3S1<br>P-603.3S2 | P-603.5S1<br>P-603.5S2 | P-603.x01<br>open-loop<br>versions | Unit |
|---|---|---|---|---|---|
| Active axes | Z | Z | Z | Z | |
| **Motion and positioning** | | | | | |
| Integrated sensor | SGS | SGS | SGS | – | |
| Open-loop travel, –20 to 120 V | 120 | 380 | 550 | as P-603.xS1 | µm |
| Closed-loop travel | 100 | 300 | 500 | – | µm |
| Open-loop resolution, 180 g | 2 | 3 | 5 | as P-603.xS1 | nm |
| Closed-loop resolution, 180 g | 6 | 8 | 10 | – | nm |
| Closed-loop nonlinearity | 0.2 | 0.2 | 0.2 | – | % |
| Unidir. Repeatability, 10 %, 1 Sigma | 7 | 10 | 20 | – | nm |
| **Mechanical properties** | | | | – | |
| Stiffness in motion direction | 0.3 | 0.14 | 0.06 | as P-603.xS1 | N/µm |
| Unloaded resonant frequency | 900 | 410 | 300 | as P-603.xS1 | Hz |
| Resonant frequency at 180 g | 160 | 110 | 80 | as P-603.xS1 | Hz |
| Push / pull force capacity in motion direction | 40 / 20 | 35 / 13 | 30 / 10 | as P-603.xS1 | N |
| **Drive properties** | | | | | |
| Piezoceramics | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | as P-603.xS1 | |
| Electrical capacitance | 1.5 | 3.1 | 3.7 | as P-603.xS1 | µF |
| **Miscellaneous** | | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | as P-603.xS1 | °C |
| Material | Stainless steel | Stainless steel | Stainless steel | as P-603.xS1 | |
| Dimensions | 33.5 mm × 21 mm × 6 mm | 52 mm × 21 mm × 6 mm | 62 mm × 21 mm × 6 mm | as P-603.xS1 | |
| Mass | S1-version: 0.03<br>S2-version: 0.04 | S1-version: 0.04<br>S2-version: 0.05 | S1-version: 0.05<br>S2-version: 0.06 | as P-603.xS1 | kg |
| Cable length | 0.5 | 0.5 | 0.5 | as P-603.xS1 | m |
| Sensor connection | S1 versions:<br>Wire leads<br>S2 versions: LEMO (strain gauge sensor | S1 versions:<br>Wire leads<br>S2 versions: LEMO (strain gauge sensor | S1 versions:<br>Wire leads<br>S2 versions: LEMO (strain gauge sensor) | – | |
| Voltage connection | S1 versions:<br>Wire leads<br>S2 versions: LEMO (low voltage) | S1 versions:<br>Wire leads<br>S2 versions: LEMO (low voltage) | S1 versions:<br>Wire leads<br>S2 versions: LEMO (low voltage) | as P-603.xS1 | |
| Recommended electronics | E-610, E-831 | E-610, E-831 | E-610, E-831 | E-610, E-831 | |

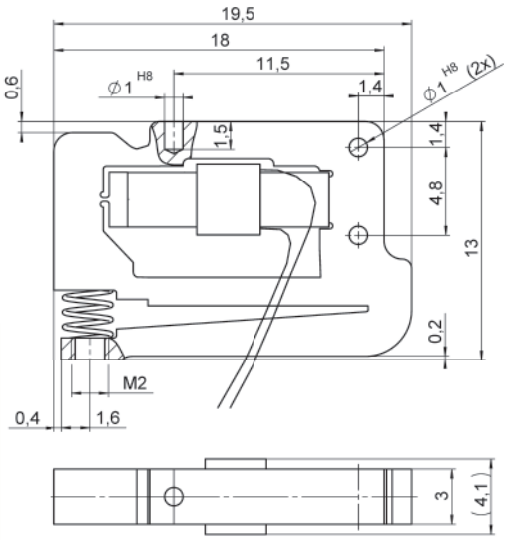
All specifications based on room temperature (22 °C ±3 °C).

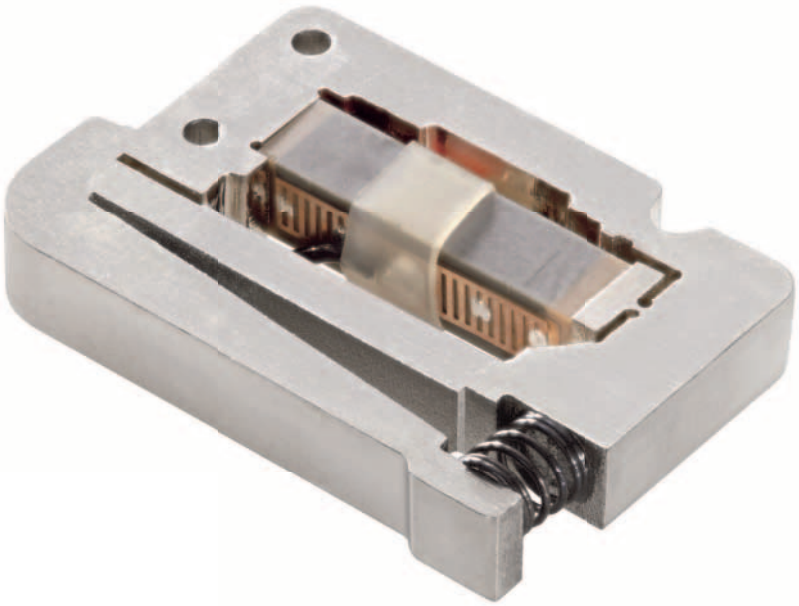
# P-604 Compact PiezoMove Linear Actuator

## Cost-Efficient, with 300 µm Travel Range

- Lightweight and compact: 4 g and <13 mm × 20 mm footprint
- Travel range 300 µm
- Optimized design for manufacturing in large quantities
- Customer-specific adaptations can be provided
- Outstanding lifetime due to PICMA® piezo actuators
- Ideal OEM actuators for precision motion control in optics, medical, biotech and microfluidics applications

P-604, dimensions in mm.



**Applications**

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


>> Flexure Guiding Systems
>> PICMA® Multilayer Piezo Actuators

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| | P-604.300 | Unit | Tolerance | |
|---|---|---|---|---|
| Active axes | Z | | | |
| **Motion and positioning** | | | | |
| Open-loop travel, –20 to 120 V | 300 | µm | +20 % / –0 % | |
| Open-loop resolution | 0.5 | nm | typ. | |
| **Mechanical properties** | | | | |
| Stiffness in motion direction | 0.01 | N/µm | ±20 % | |
| Unloaded resonant frequency | 900 | Hz | ±20 % | |
| Push / pull force capacity in motion direction | 2 / 1.5 | N | max. | |
| **Drive properties** | | | | |
| Piezoceramics | PICMA® P-883 | | | |
| Electrical capacitance | 0.27 | µF | ±20 % | |
| **Miscellaneous** | | | | |
| Operating temperature range | –20 to 80 | °C | | |
| Material | Steel | | | |
| Dimensions | 19.5 mm × 13 mm × 4.1 mm | | | |
| Mass | 4 | g | ±10 % | |
| Cable length | 0.1 | m | ±10 mm | |
| Voltage connection | Stranded wire | | | |
| Recommended electronics | E-610, E-831 | | | |

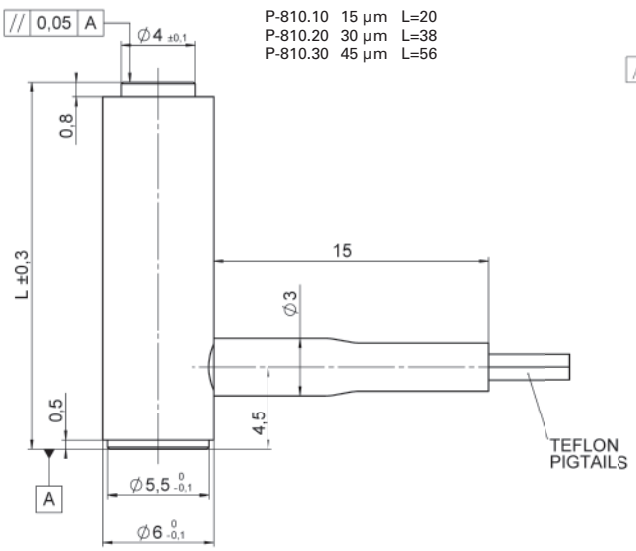
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

# P-810 / P-830 Piezo Actuators

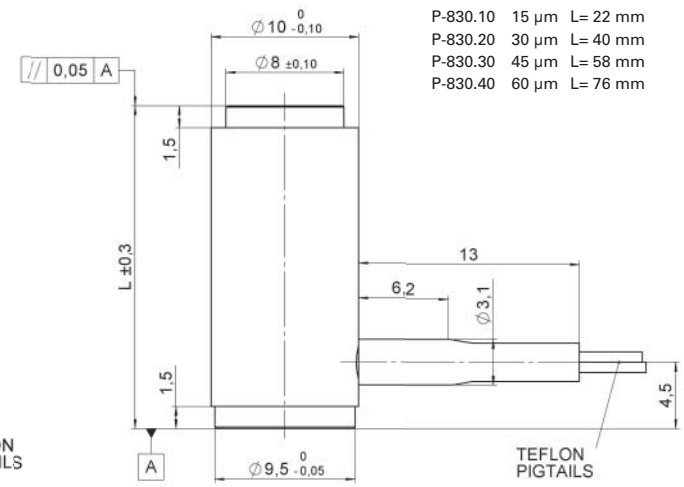
## For Light and Medium Loads

- Outstanding lifetime due to PICMA® piezo actuators
- Travel range to 60 µm
- Push forces to 1000 N
- Pull forces to 5 N
- Microsecond response
- Subnanometer resolution

P-810, dimensions in mm.
Two braids Teflon insulated, length 0.1 m.




P-830, dimensions in mm.
Two braids Teflon insulated, length 0.1 m.




**Applications**

- Static and dynamic precision positioning
- Fiber positioning
- Laser tuning
- Patch-Clamp
- Nanotechnology


>> **PICMA® Multilayer Piezo Actuators**

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| | P-810.10 | P-810.20 | P-810.30 | P-830.10 | P-830.20 | P-830.30 | P-830.40 | Unit | Tolerance |
|---|---|---|---|---|---|---|---|---|---|
| Travel range at 0 to 100 V | 15 | 30 | 45 | 15 | 30 | 45 | 60 | µm | ±20 % |
| Resolution* | 0.15 | 0.3 | 0.45 | 0.15 | 0.3 | 0.45 | 0.6 | nm | |
| Static large-signal stiffness** | 14 | 7 | 4 | 57 | 27 | 19 | 15 | N/µm | ±20 % |
| Push / pull force capacity | 50 / 1 | 50 / 1 | 50 / 1 | 1000 / 5 | 1000 / 5 | 1000 / 5 | 1000 / 5 | N | |
| Electrical capacitance | 0.3 | 0.7 | 1 | 1.5 | 3 | 4.5 | 6 | µF | ±20 % |
| Resonant frequency $f_0$ (no load) | 22 | 15 | 12 | 23 | 14 | 10 | 8.5 | kHz | ±20 % |
| Mass | 4 | 6 | 8 | 10 | 16 | 21 | 27 | g | ±5 % |
| Length L | 20 | 38 | 56 | 22 | 40 | 58 | 76 | mm | ±0.3 |
| Recommended electronics | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | | |

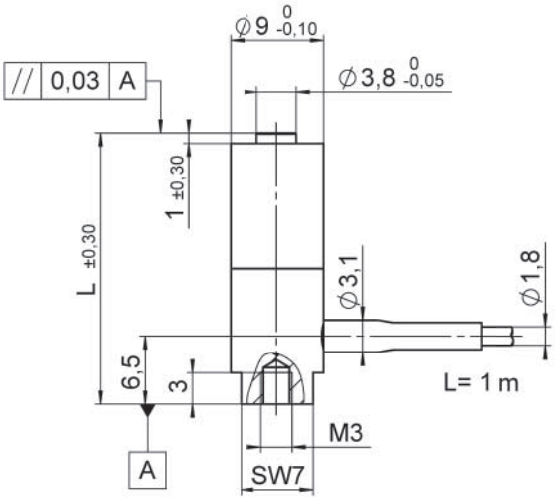
* The resolution of piezo actuators is not limited by stiction or friction. Value given is noise equivalent motion with E-503 amplifier.
** Dynamic small-signal stiffness is ~30 % higher. Operating temperature range: –20 to 80 °C.
Case: non-magnetic steel. End pieces: stainless steel. Recommended preload for dynamic operation: $10^{-20}$ MPa.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

# P-820 Preloaded Piezo Actuators

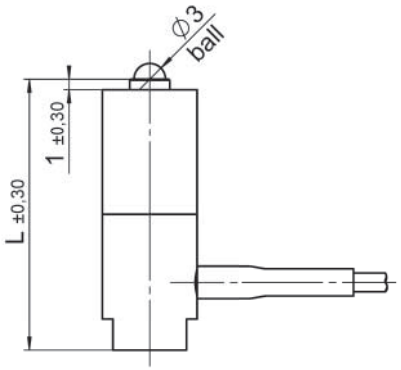
## For Light and Medium Loads

- Outstanding lifetime due to PICMA® piezo actuators
- Travel range to 45 µm
- Push forces to 50 N
- Pull forces to 10 N
- Microsecond response, subnanometer resolution
- Versions with ball tip

P-820, dimensions in mm.




Accessory P-176.30: Magnetic Adapter for P-820, can be glued on the top piece




| | L |
|---|---|
| P-820.10 / P-820.1B | 26 |
| P-820.20 / P-820.2B | 44 |
| P-820.30 / P-820.3B | 62 |

**Applications**

- Static and dynamic precision positioning
- Fiber positioning
- Laser tuning
- Nanotechnology


>> PICMA® Multilayer Piezo Actuators

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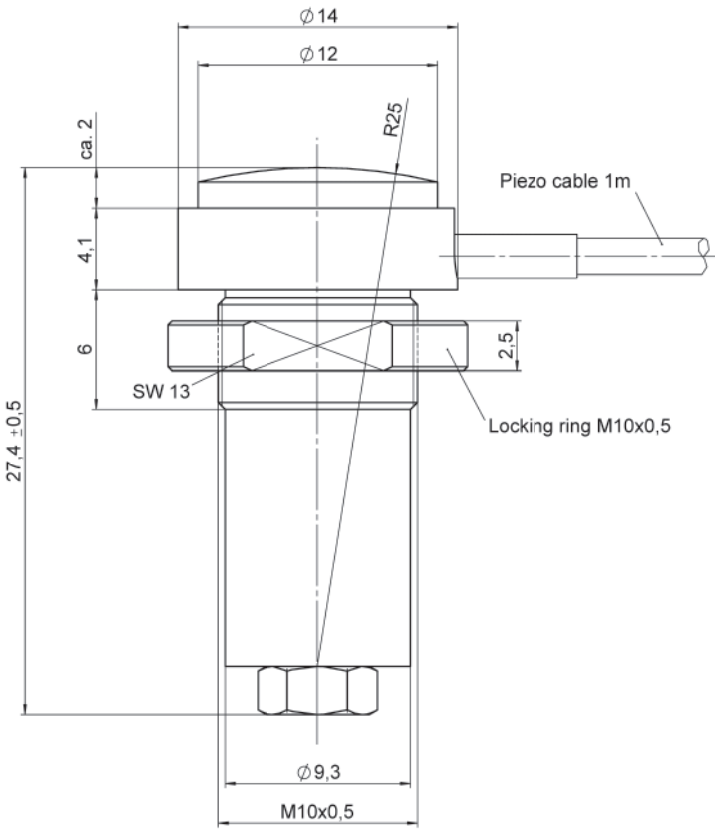
| | P-820.10<br>P-820.1B | P-820.20<br>P-820.2B | P-820.30<br>P-820.3B | Unit | Tolerance |
|---|---|---|---|---|---|
| Travel range at 0 to 100 V | 15 | 30 | 45 | µm | ±20 % |
| Resolution* | 0.15 | 0.3 | 0.45 | nm | |
| Static large-signal stiffness** | 13 | 7 | 4 | N/µm | ±20 % |
| Push / pull force capacity | 50 / 10 | 50 / 10 | 50 / 10 | N | |
| Max. torque limit (on tip) | 0.08 | 0.08 | 0.08 | Nm | |
| Electrical capacitance | 0.3 | 0.7 | 1.0 | µF | ±20 % |
| Resonant frequency $f_0$ (no load) | 22 | 15 | 12 | kHz | ±20 % |
| Operating temperature | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Mass | 8 | 11 | 14 | g | ±5 % |
| Material case | Non-magnetic steel | Non-magnetic steel | Non-magnetic steel | | |
| Material end pieces | Stainless steel | Stainless steel | Stainless steel | | |
| Length L | 26 | 44 | 62 | mm | ±0.3 |
| Recommended electronics | E-503,<br>E-505,<br>E 610,<br>E-617,<br>E-621,<br>E-625,<br>E-663,<br>E-709,<br>E-831 | E-503,<br>E-505,<br>E 610,<br>E-617,<br>E-621,<br>E-625,<br>E-663,<br>E-709,<br>E-831 | E-503,<br>E-505,<br>E 610,<br>E-617,<br>E-621,<br>E-625,<br>E-663,<br>E-709,<br>E-831 | | |

* The resolution of piezo actuators is not limited by stiction or friction. Value given is noise equivalent motion with E-503 amplifier.
** Dynamic small-signal stiffness is ~30 % higher.
Voltage connection: LEMO FFA.00.250. Coaxial cable, RG 178, 1 m.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

# P-855 Piezo Fine Adjustement Drive for Micrometer Screws

## Micrometer-Mountable Open-Loop Piezo Translator

P-855, dimensions in mm.




- Travel range 20 µm
- Mounts inside micrometer tip
- Sub-ms response time
- Subnanometer resolution

**Applications**

- Laser tuning
- Static and dynamic
- Positioning of small parts
- Fiber positioning


>> PICMA® Multilayer Piezo Actuators

Technology Glossary ..... page 240

| | P-855.20 | Unit | Tolerance | |
|---|---|---|---|---|
| Open-loop travel at –20 to 120 V | 20 | µm | ±20 % | |
| Resolution* | 0.2 | nm | | |
| Static large-signal stiffness** | 48 | N/µm | ±20 % | |
| Push / pull force capacity | 100 / 5 | N | | |
| Operating voltage range | –20 to 120 | V | | |
| Piezo ceramic type | PICMA® | | | |
| Electrical capacitance | 1.5 | µF | ±20 % | |
| Resonant frequency $f_0$ (no load) | 18 | kHz | ±20 % | |
| Operating temperature | –40 to 80 | °C | | |
| Voltage connection | LEMO | | | |
| Mass | 28 | g | ±5 % | |
| Recommended electronics | E-610, E-831, E-836 | | | |
| | | | | |

* The resolution of piezo actuators is not limited by stiction or friction. Value given is noise equivalent motion with E-505 amplifier.

** Dynamic small-signal stiffness is ~50 % higher.

All specifications based on room temperature (22 °C ±3 °C).

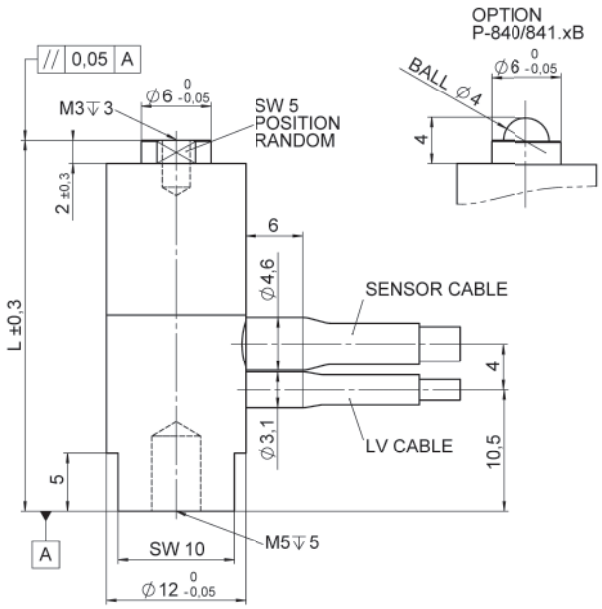
Ask about custom designs!

# P-840 / P-841 Preloaded Piezo Actuators

## Optional with Integrated Position Sensor

- Outstanding lifetime due to PICMA® piezo actuators
- Travel range to 90 µm
- Compact case
- Push forces to 1000 N
- Pull forces to 50 N
- Microsecond response
- Subnanometer resolution
- Versions with ball tip, vacuum versions

P-840 / P-841, dimensions in mm.




| | | |
|---|---|---|
| P-840.10/P-841.10 | 15 µm | L= 32 mm |
| P-840.20/P-841.20 | 30 µm | L= 50 mm |
| P-840.30/P-841.30 | 45 µm | L= 68 mm |
| P-840.40/P-841.40 | 60 µm | L= 86 mm |
| P-840.60/P-841.60 | 90 µm | L=122 mm |

Accessories P-176.20:
Magnetic Adapter for P-840 and P-841

**Applications**

- Static and dynamic precision positioning
- Fiber positioning
- Laser tuning
- Nanotechnology


>> **PICMA® Multilayer Piezo Actuators**
>> **Vacuum-Compatible Version**

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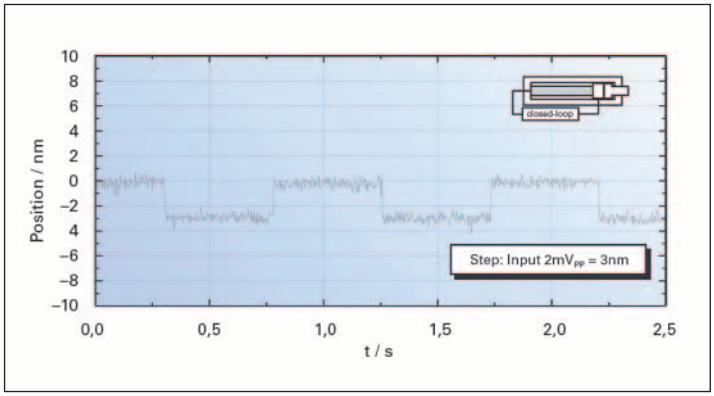
| | P-841.10 / P-840.10* | P-841.20 / P-840.20* | P-841.30 / P-840.30* | P-841.40 / P-840.40* | P-841.60 / P-840.60* | Unit | Tolerance |
|---|---|---|---|---|---|---|---|
| Open-loop travel, at 0 to 100 V | 15 | 30 | 45 | 60 | 90 | µm | ±20 % |
| Closed-loop travel | 15 / – | 30 / – | 45 / – | 60 / – | 90 / – | µm | |
| Integrated feedback sensor** | SGS / – | SGS / – | SGS / – | SGS / – | SGS / – | | |
| Resolution, closed-loop / open-loop*** | 0.3 / 0.15 | 0.6 / 0.3 | 0.9 / 0.45 | 1.2 / 0.6 | 1.8 / 0.9 | nm | |
| Static large-signal stiffness**** | 57 | 27 | 19 | 15 | 10 | N/µm | ±20 % |
| Push force capacity | 1000 | 1000 | 1000 | 1000 | 1000 | N | |
| Pull force capacity | 50 | 50 | 50 | 50 | 50 | N | |
| Torque on tip | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | Nm | max. |
| Electrical capacitance | 1.5 | 3.0 | 4.5 | 6.0 | 9.0 | µF | ±20 % |
| Resonant frequency $f_0$ (no load) | 18 | 14 | 10 | 8.5 | 6 | kHz | ±20 % |
| Operating temperature | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | –20 to 80 | °C | |
| Mass without cable | 20 | 28 | 46 | 54 | 62 | g | ±5 % |
| Material: case, end pieces | N-S, S | N-S, S | N-S, S | N-S, S | N-S, S | | |
| Length L | 32 | 50 | 68 | 86 | 122 | mm | ±0.3 |
| Recommended electronics | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | | |

* P-841.xx: Models with sensor; P-840.xx: Models without sensor.
** Closed-loop models can attain linearity up to 0.15 % and are shipped with performance reports.
*** The position resolution of piezo actuators is not limited by stiction or friction.
Value given is noise equivalent motion with E-503 amplifier.
**** Dynamic small-signal stiffness is approx. 30 % higher.
Voltage connection: LEMO FFA.00.250. Coaxial cable, RG 178, 1 m.
Sensor connection (P-841.xx only): LEMO FFA.0S.304. Cable, 1 m.
All specifications based on room temperature (22 °C ±3 °C).

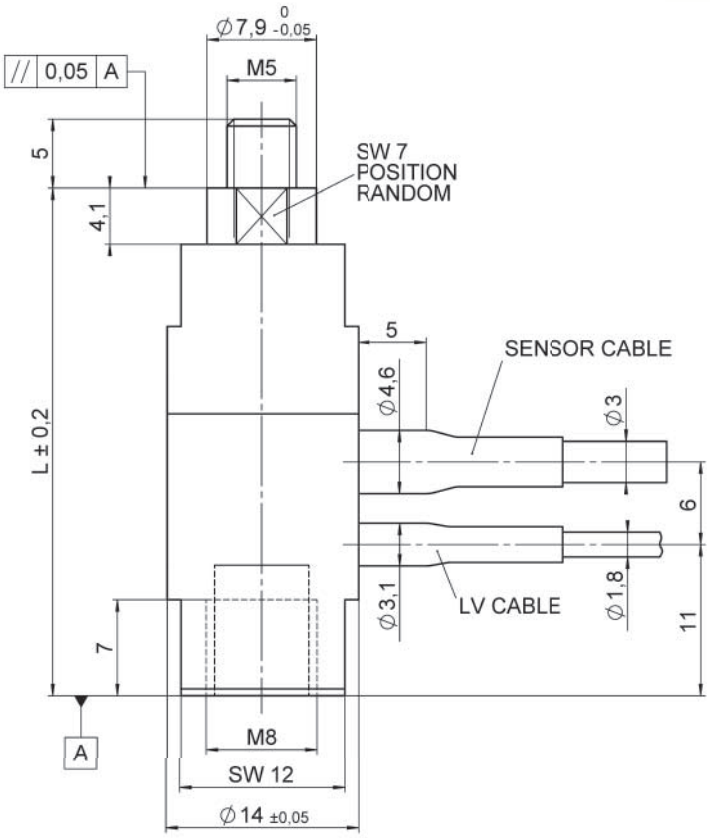



Response of a P-841.10 to a 3 nm peak-to-peak square wave control input signal, measured with servo-control bandwidth set to 240 Hz and 2 msec settling time.

# P-842 Preloaded Piezo Actuators

## For High Loads and Force Generation

P-842 / P-843, dimensions in mm. Max. torque on tip: 0.35 Nm.
Sensor only included with P-843.




- Outstanding lifetime due to PICMA® piezo actuators
- Travel range to 90 µm
- Push forces to 800 N
- Pull forces to 300 N
- Microsecond response
- Subnanometer resolution
- Vacuum versions

| Model | Travel range | L |
|---|---|---|
| P-842.10 / P-843.10 | 15 µm | 37 mm |
| P-842.20 / P-843.20 | 30 µm | 55 mm |
| P-842.30 / P-843.30 | 45 µm | 73 mm |
| P-842.40 / P-843.40 | 60 µm | 91 mm |
| P-842.60 / P-843.60 | 90 µm | 127 mm |

Actuators with position sensor available as P-843
Accessory P-176.50: Flexible Tips for P-842 / P-843

**Applications**

- Static and dynamic precision positioning
- Fiber positioning
- Laser tuning
- Nanotechnology


>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

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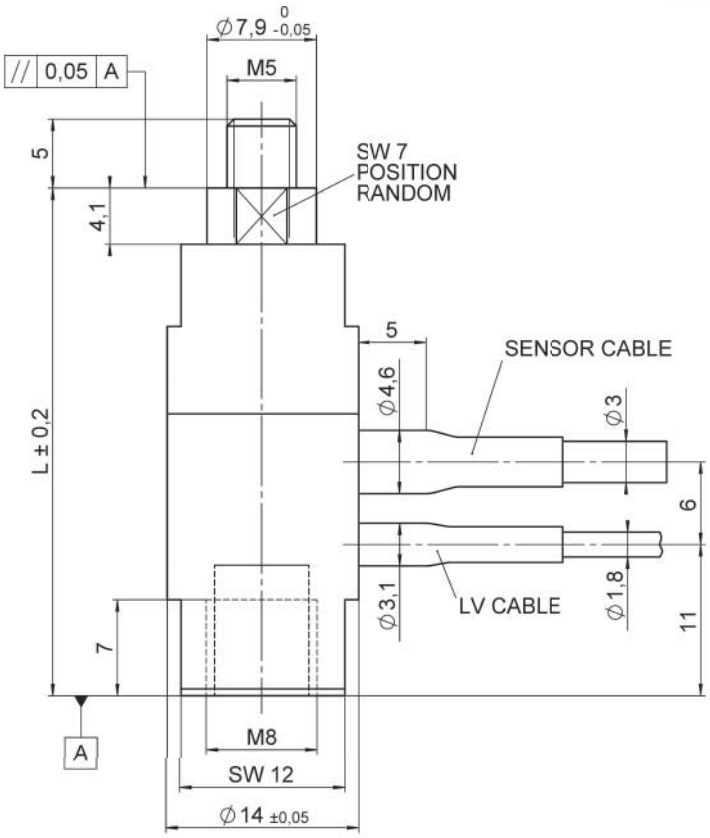
| | P-842.10 | P-842.20 | P-842.30 | P-842.40 | P-842.60 | Unit | Tolerance |
|---|---|---|---|---|---|---|---|
| Travel range at 0 to 100 V | 15 | 30 | 45 | 60 | 90 | µm | ±20 % |
| Resolution* | 0.15 | 0.3 | 0.45 | 0.6 | 0.9 | nm | |
| Static large-signal stiffness** | 57 | 27 | 19 | 15 | 10 | N/µm | ±20 % |
| Push / pull force capacity | 800 / 300 | 800 / 300 | 800 / 300 | 800 / 300 | 800 / 300 | N | |
| Electrical capacitance | 1.5 | 3 | 4.5 | 6 | 9 | µF | ±20 % |
| Resonant frequency $f_0$ (no load) | 18 | 14 | 10 | 8.5 | 6 | kHz | ±20 % |
| Mass without cable | 31 | 42 | 53 | 64 | 86 | g | ±5 % |
| Length | 37 | 55 | 73 | 91 | 127 | mm | |
| Recommended electronics | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | | |

Voltage connection: LEMO FFA.00.250. Coaxial cable RG 178, 1 m.
Temperature range: –40 to 80 °C.
Case / end pieces: Stainless steel.
Vacuum versions to $10^{-6}$ hPa are available under the following ordering number: P-842.x0V.
* The resolution of piezo actuators is not limited by stiction or friction. Value given is noise equivalent motion with E-503 amplifier.
** Dynamic small-signal stiffness is approx. 30 % higher.
All specifications based on room temperature (22 °C ±3 °C).

# P-843 Preloaded Piezo Actuators

## For High Loads and Force Generation with Integrated Position Sensors

P-842 / P-843, dimensions in mm. Max. torque on tip: 0.35 Nm.
Sensor only included with P-843.





- Outstanding lifetime due to PICMA® piezo actuators
- Travel range to 90 µm
- Push forces to 800 N
- Pull forces to 300 N
- Microsecond response
- Subnanometer resolution
- Vacuum versions

| Model | Travel range | L |
|---|---|---|
| P-842.10 / P-843.10 | 15 µm | 37 mm |
| P-842.20 / P-843.20 | 30 µm | 55 mm |
| P-842.30 / P-843.30 | 45 µm | 73 mm |
| P-842.40 / P-843.40 | 60 µm | 91 mm |
| P-842.60 / P-843.60 | 90 µm | 127 mm |

Accessory P-176.50: Flexible Tips for P-842 / P-843

**Applications**

- Static and dynamic precision positioning
- Fiber positioning
- Laser tuning
- Nanotechnology


>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

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| | P-843.10 | P-843.20 | P-843.30 | P-843.40 | P-843.60 | Unit | Tolerance |
|---|---|---|---|---|---|---|---|
| Travel range at 0 to 100 V | 15 | 30 | 45 | 60 | 90 | µm | |
| Sensor* | SGS | SGS | SGS | SGS | SGS | | |
| Resolution** | 0.3 | 0.6 | 0.9 | 1.2 | 1.8 | nm | |
| Static large-signal stiffness*** | 57 | 27 | 19 | 15 | 10 | N/µm | ±20 % |
| Push / pull force capacity | 800 / 300 | 800 / 300 | 800 / 300 | 800 / 300 | 800 / 300 | N | |
| Electrical capacitance | 1.5 | 3 | 1.5 | 6 | 9 | µF | ±20 % |
| Resonant frequency $f_0$ (no load) | 18 | 14 | 10 | 8.5 | 6 | kHz | ±20 % |
| Mass without cable | 31 | 42 | 53 | 64 | 86 | g | ±5 % |
| Length | 37 | 55 | 73 | 91 | 127 | mm | |
| Recommended electronics | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | | |

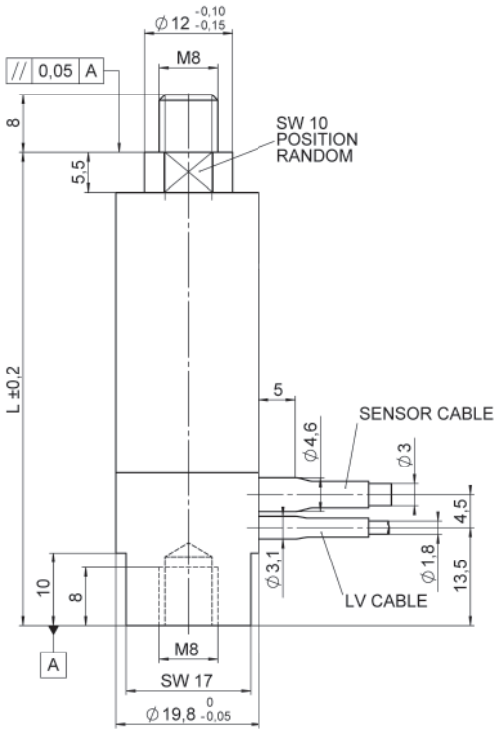
Voltage connection: LEMO FFA.00.250. Coaxial cable, RG 178, 1 m.
Sensor connector: LEMO FFA.0S.304. Cable, 1 m.
Temperature range: –40 to 80 °C.
Case / end pieces: Stainless steel.
Vacuum versions to $10^{-6}$ hPa are available under the following ordering number: P-843.x0V.
* Models with SGS can attain linearity up to 0.15 % and are shipped with performance reports.
** The resolution of piezo actuators is not limited by stiction or friction. Value given is noise equivalent motion with E-503 amplifier.
*** Dynamic small-signal stiffness is approx. 30 % higher.
All specifications based on room temperature (22 °C ±3 °C).

# P-844 Preloaded Piezo Actuators

## For High Loads and Force Generation

- Outstanding lifetime due to PICMA® piezo actuators
- Travel range to 90 µm
- Push forces to 3000 N
- Pull forces to 700 N
- Microsecond response
- Subnanometer resolution
- Vacuum versions, optional water-resistant case


P-844 / P-845, dimensions in mm.
Max. torque on tip: 1 Nm.




| Model | Travel range | L |
|---|---|---|
| P-844.10 / P-845.10 | 15 µm | 47 mm |
| P-844.20 / P-845.20 | 30 µm | 65 mm |
| P-844.30 / P-845.30 | 45 µm | 83 mm |
| P-844.40 / P-845.40 | 60 µm | 101 mm |
| P-844.60 / P-845.60 | 90 µm | 137 mm |

Actuators with position sensor available under P-845
Accessory P-176.60: Flexible Tips for P-844 / P-845

**Applications**

- Static and dynamic precision positioning
- Fiber positioning
- Laser tuning
- Nanotechnology


>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

Technology Glossary ..... page 240

| | P-844.10 | P-844.20 | P-844.30 | P-844.40 | P-844.60 | Unit | Tolerance |
|---|---|---|---|---|---|---|---|
| Travel range at 0 to 100 V | 15 | 30 | 45 | 60 | 90 | µm | ±20 % |
| Resolution* | 0.15 | 0.3 | 0.45 | 0.6 | 0.9 | nm | |
| Static large-signal stiffness** | 225 | 107 | 75 | 57 | 38 | N/µm | ±20 % |
| Push / pull force capacity | 3000 / 700 | 3000 / 700 | 3000 / 700 | 3000 / 700 | 3000 / 700 | N | |
| Electrical capacitance | 6 | 12 | 18 | 24 | 36 | µF | ±20 % |
| Resonant frequency $f_0$ (no load) | 16 | 12 | 9 | 7.5 | 5.5 | kHz | ±20 % |
| Mass without cable | 84 | 108 | 132 | 156 | 204 | g | ±5 % |
| Length L | 47 | 65 | 83 | 101 | 137 | mm | |
| Recommended electronics | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | | |

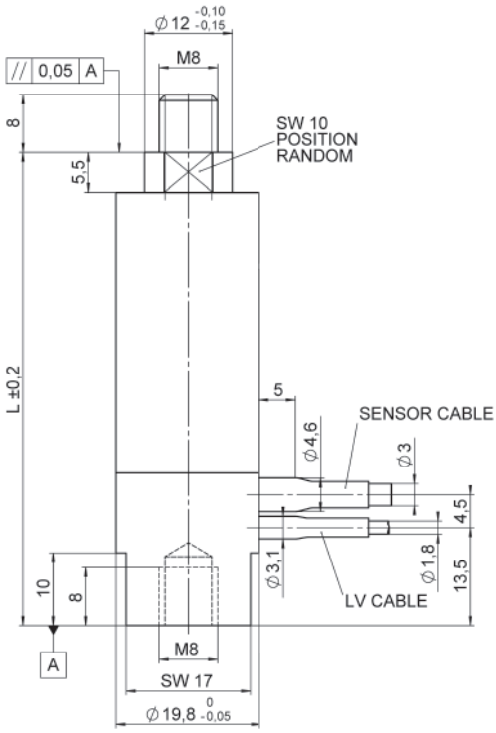
Voltage connection: LEMO FFA.00.250. Coaxial cable RG 178, 1 m.
Temperature range: –40 to 80 °C.
Case / end pieces: Stainless steel.
Vacuum versions to $10^{-6}$ hPa are available under the following ordering number: P-844.x0V.
* The resolution of piezo actuators is not limited by stiction or friction. Value given is noise equivalent motion with E-503 amplifier.
** Dynamic small-signal stiffness is approx. 30 % higher.
All specifications based on room temperature (22 °C ±3 °C).

# P-845 Preloaded Piezo Actuators

## For High Loads and Force Generation with Integrated Position Sensors

- Outstanding lifetime due to PICMA® piezo actuators
- Travel range to 90 µm
- Push forces to 3000 N
- Pull forces to 700 N
- Microsecond response
- Subnanometer resolution
- Vacuum versions, optional water-resistant case


P-844 / P-845, dimensions in mm.
Max. torque on tip: 1 Nm.




| Model | Travel range | L |
|---|---|---|
| P-844.10 / P-845.10 | 15 µm | 47 mm |
| P-844.20 / P-845.20 | 30 µm | 65 mm |
| P-844.30 / P-845.30 | 45 µm | 83 mm |
| P-844.40 / P-845.40 | 60 µm | 101 mm |
| P-844.60 / P-845.60 | 90 µm | 137 mm |

Actuators without position sensor available under P-844
Accessory P-176.60: Flexible Tips for P-844 / P-845

**Applications**

- Static and dynamic precision positioning
- Fiber positioning
- Laser tuning
- Nanotechnology


>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

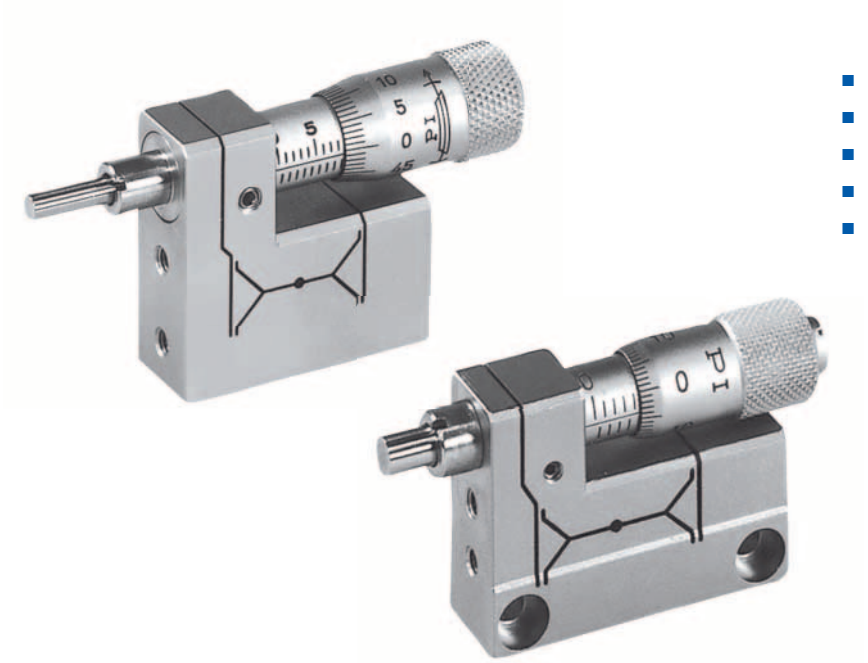
Technology Glossary ..... page 240

| | P-845.10 | P-845.20 | P-845.30 | P-845.40 | P-845.60 | Unit | Tolerance |
|---|---|---|---|---|---|---|---|
| Travel range at 0 to 100 V | 15 | 30 | 45 | 60 | 90 | µm | |
| Sensor* | SGS | SGS | SGS | SGS | SGS | | |
| Resolution** | 0.3 | 0.6 | 0.9 | 1.2 | 1.8 | nm | |
| Static large-signal stiffness *** | 225 | 107 | 75 | 57 | 38 | N/µm | ±20 % |
| Push / pull force capacity | 3000 / 700 | 3000 / 700 | 3000 / 700 | 3000 / 700 | 3000 / 700 | N | |
| Electrical capacitance | 6 | 12 | 18 | 24 | 36 | µF | ±20 % |
| Resonant frequency $f_0$ (no load) | 16 | 12 | 9 | 7.5 | 5.5 | kHz | ±20 % |
| Mass without cable | 84 | 108 | 132 | 156 | 204 | g | ±5 % |
| Length L | 47 | 65 | 83 | 101 | 137 | mm | |
| Recommended electronics | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | E-503, E-505, E-610, E-617, E-621, E-625, E-663, E-709, E-831 | | |

Voltage connection: LEMO FFA.00.250. Coaxial cable RG 178, 1 m.
Sensor connector: LEMO FFA.0S.304. Cable, 1 m.
Temperature range: –40 to 80 °C.
Case / end pieces: Stainless steel.
Vacuum versions to $10^{-6}$ hPa are available under the following ordering number: P-845.x0V.
* Models with SGS can attain linearity up to 0.15 % and are shipped with performance reports.
** The resolution of piezo actuators is not limited by stiction or friction. Value given is noise equivalent motion with E-503 amplifier.
*** Dynamic small-signal stiffness is approx. 30 % higher.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

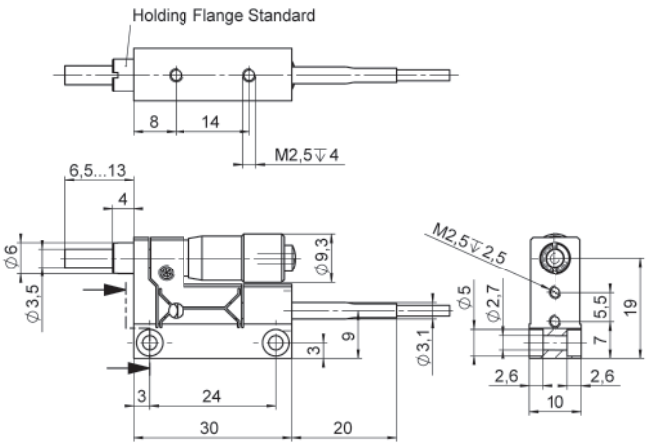
# P-853 / P-854 Piezoelectric Micrometer Drive

## Integrated Piezo Drive with Sub-Nanometer Resolution

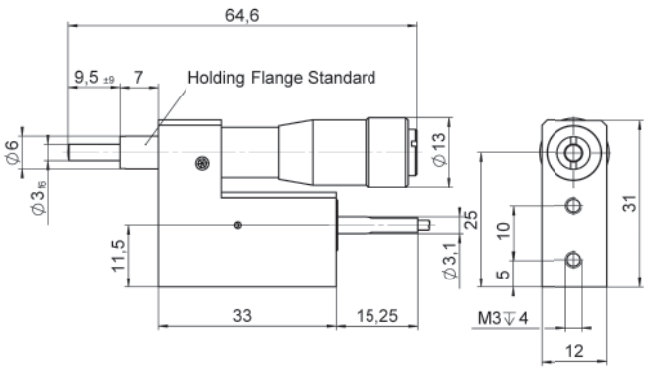


- Travel ranges to 18 mm
- Piezoelectric high-resolution travel to 25 µm
- Subnanometer resolution
- Dynamic operation to 10 Hz
- Alternative for standard micrometer drives

P-853, dimensions in mm.




P-854, dimensions in mm.




**Applications**

- Laboratory automation
- Autoadjust for optics

>> Flexure Guiding Systems

>> PICMA® Multilayer Piezo Actuators

Technology Glossary ..... page 240

| | P-853.00 | P-854.00 | Unit | Tolerance |
|---|---|---|---|---|
| Travel range (micrometer drive) | 6 | 18 | mm | |
| Piezo fine travel range, at 0 to 100 V | 25 | 25 | µm | |
| Min. incremental motion (piezo drive) | <1 | <1 | nm | |
| Micrometer sensitivity | 1 | 1 | µm | ±20 % |
| Axial push / pull force | 10 / 5 | 20 / 5 | N | |
| Micrometer drive | M-619.10 | M-626.10 | | ±20 % |
| Micrometer pitch | 0.5 | 0.5 | mm/rev. | ±20 % |
| Stiffness | 1 | 1.5 | N/µm | ±5 % |
| Electrical capacitance (piezo) | 0.45 | 1.5 | µF | |
| Electrical connection | LEMO FFA.00.250, male. Coaxial cable: RG 178, Teflon coated, 1 m | LEMO FFA.00.250, male. Coaxial cable: RG 178, Teflon coated, 1 m | | |
| Mass | 0.05 | 0.1 | kg | |
| Case material | N - S | N - S | | |
| Recommended electronics | E-610, E-836 | E-610, E-836 | | |

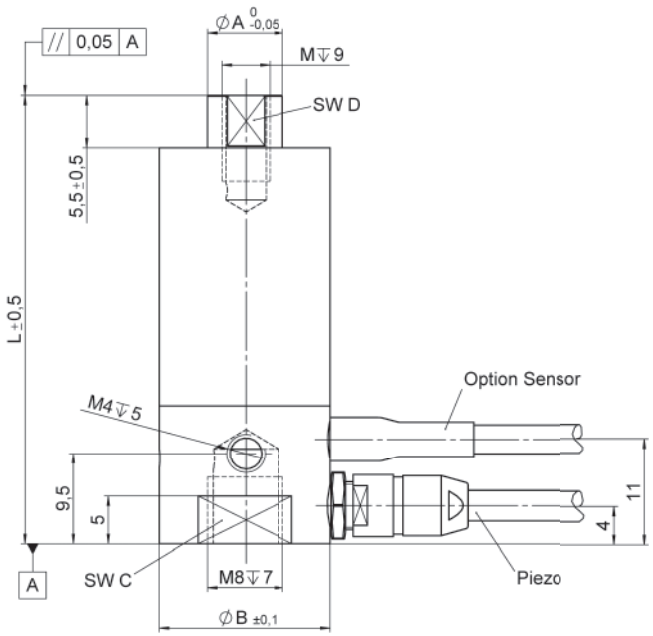
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

# P-212 PICA Power Piezo Actuator

## Preloaded Piezo Actuators (HVPZT) with Sensor Option

- Travel range to 120 µm
- Push forces to 2000 N
- Pull forces to 300 N
- Sub-ms response time
- Subnanometer resolution
- Options: Vacuum, high-temperature

P-212, dimensions in mm.




| | L | A | B | C | D | M |
|---|---|---|---|---|---|---|
| P-212.1x | 47 | 8 | 18 | 15 | 7 | 5 |
| P-212.2x | 60 | 8 | 18 | 15 | 7 | 5 |
| P-212.4x | 86 | 8 | 18 | 15 | 7 | 5 |
| P-212.8x | 139 | 8 | 18 | 15 | 7 | 5 |

**Applications**

- Active vibration damping
- Adaptive mechanics
- Precision engineering / micromechanics
- Optics
- Metrology / interferometry
- Adaptronics
- Switches Laser tuning
- Force generation / materials testing
- Nanotechnology


>> **Vacuum-Compatible Version**

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| | P-212.10 | P-212.20 | P-212.40 | P-212.80 | Unit | Tolerance |
|---|---|---|---|---|---|---|
| Operating voltage | 0 to 1000 | 0 to 1000 | 0 to 1000 | 0 to 1000 | V | |
| **Motion and positioning** | | | | | | |
| Closed-loop travel* | 15 | 30 | 60 | 120 | µm | |
| Closed-loop resolution*/** | 0.3 | 0.6 | 1.2 | 2.4 | nm | |
| Open-loop resolution** | 0.15 | 0.3 | 0.6 | 1.2 | nm | typ. |
| Linearity error* | 0.2 | 0.2 | 0.2 | 0.2 | % | typ. |
| **Mechanical properties** | | | | | | |
| Static large-signal stiffness in motion direction*** | 90 | 60 | 34 | 18 | N/µm | ±20 % |
| Unloaded resonant frequency | 17 | 12 | 7 | 4.5 | kHz | ±20 % |
| Push / pull force capacity in motion direction | 2000 / 300 | 2000 / 300 | 2000 / 300 | 2000 / 300 | N | max. |
| Shear load | 15 | 10 | 10 | 10 | N | max. |
| Torque on tip | 0.5 | 0.5 | 0.5 | 0.5 | Nm | max. |
| **Drive properties** | | | | | | |
| Electrical capacitance | 47 | 90 | 180 | 370 | nF | ±20 % |
| **Miscellaneous** | | | | | | |
| Mass with cable | 110 | 120 | 150 | 210 | g | ±5 % |
| Recommended electronics | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | | |

Piezo ceramic: PICA Power.
Temperature range: –40 to 80 °C.
The operating voltage should not exceed 750 V in continuous operation.
* Requires integrated strain gauge sensor. These versions are shipped with a performance report.
** The position resolution of piezo actuators is not limited by stiction or friction.
*** Dynamic small-signal stiffness is approx. 50 % higher.
All specifications based on room temperature (22 °C ±3 °C).

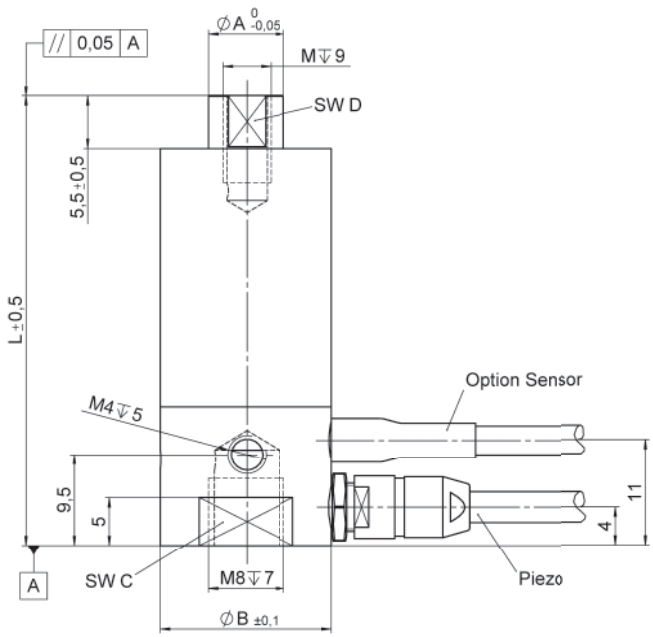
**Accessories**
P-176.B12 ball tip for P-212
P-176.F12 flat tip for P-212
P-176.10 magnetic adapter for P-212 translators

# P-216 PICA Power Piezo Actuator

## Preloaded Piezo Actuators (HVPZT) with Sensor Option

- Travel range to 180 µm
- Push forces to 4500 N
- Pull forces to 500 N
- Sub-ms response time
- Subnanometer resolution
- Options: Vacuum, high-temperature

P-216, dimensions in mm.




| | L | A | B | C | D | M |
|---|---|---|---|---|---|---|
| P-216.1x | 47 | 10 | 25 | 22 | 8 | 6 |
| P-216.2x | 60 | 10 | 25 | 22 | 8 | 6 |
| P-216.4x | 86 | 10 | 25 | 22 | 8 | 6 |
| P-216.8x | 139 | 10 | 25 | 22 | 8 | 6 |
| P-216.9x | 191 | 10 | 25 | 22 | 8 | 6 |

**Applications**

- Active vibration damping
- Adaptive mechanics
- Precision engineering / micromechanics
- Optics
- Metrology / interferometry
- Adaptronics
- Switches Laser tuning
- Force generation / materials testing
- Nanotechnology


>> Vacuum-Compatible Version

Technology Glossary ..... page 240

| | P-216.10 | P-216.20 | P-216.40 | P-216.80 | P-216.90 | Unit | Tolerance |
|---|---|---|---|---|---|---|---|
| Operating voltage | 0 to 1000 | 0 to 1000 | 0 to 1000 | 0 to 1000 | 0 to 1000 | V | |
| **Motion and positioning** | | | | | | | |
| Closed-loop travel* | 15 | 30 | 60 | 120 | 180 | µm | |
| Closed-loop resolution*/** | 0.3 | 0.6 | 1.2 | 2.4 | 3.6 | nm | typ. |
| Open-loop resolution** | 0.15 | 0.3 | 0.6 | 1.2 | 1.8 | nm | typ. |
| Linearity error* | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | % | typ. |
| **Mechanical properties** | | | | | | | |
| Static large-signal stiffness in motion direction*** | 210 | 140 | 80 | 50 | 32 | N/µm | ±20 % |
| Unloaded resonant frequency | 17 | 12 | 7 | 4.5 | 3 | kHz | ±20 % |
| Push / pull force capacity in motion direction | 4500 / 500 | 4500 / 500 | 4500 / 500 | 4500 / 500 | 4500 / 500 | N | max. |
| Shear load | 60 | 36 | 23 | 23 | 23 | N | max. |
| Torque on tip | 1 | 1 | 1 | 1 | 1 | Nm | max. |
| **Drive properties** | | | | | | | |
| Electrical capacitance | 130 | 250 | 500 | 1000 | 1500 | nF | ±20 % |
| **Miscellaneous** | | | | | | | |
| Mass with cable | 170 | 200 | 250 | 370 | 480 | g | ±5 % |
| Recommended electronics | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | | |

Piezo ceramic: PICA Power.
Temperature range: –40 to 80 °C.
The operating voltage should not exceed 750 V in continuous operation.
* Requires integrated strain gauge sensor. These versions are shipped with a performance report.
** The position resolution of piezo actuators is not limited by stiction or friction.
*** Dynamic small-signal stiffness is approx. 50 % higher.
All specifications based on room temperature (22 °C ±3 °C).

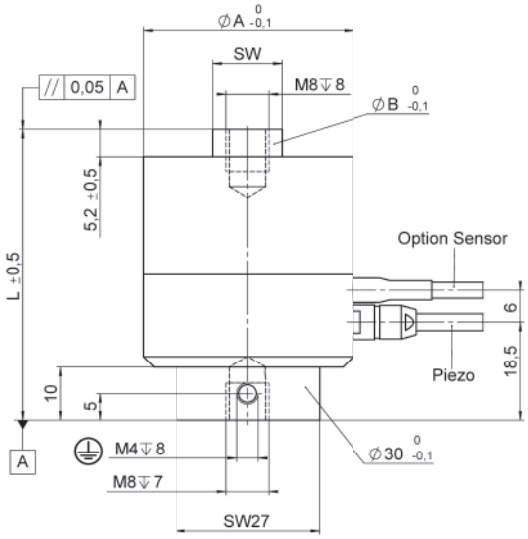
**Accessories**
P-176.B16 ball tip for P-216
P-176.F16 flat tip for P-216

# P-225 PICA Power Piezo Actuators

## Preloaded High-Load Piezo Actuators (HVPZT) with Sensor Option

- Extremely high stiffness
- Push forces to 12500 N
- Pull forces to 2000 N
- Travel range to 120 µm
- Options: Versions for vacuum, high temperatures and with water-resistant case

P-225, dimensions in mm.




| | L [mm] | Ø A [mm] | Ø B [mm] | SW |
|---|---|---|---|---|
| P-225.1x | 55 | 39,8 | 16 | 13 |
| P-225.2x | 68 | 39,8 | 16 | 13 |
| P-225.4x | 94 | 39,8 | 16 | 13 |
| P-225.8x | 147 | 39,8 | 16 | 13 |

**Applications**

- Active vibration damping
- Adaptive mechanics
- Precision engineering / micromechanics
- Optics
- Metrology / interferometry
- Adaptronics
- Switches Laser tuning
- Force generation / materials testing
- Nanotechnology

>> **Vacuum-Compatible Version**

**Technology Glossary** ..... **page 240**

| | P-225.10 | P-225.20 | P-225.40 | P-225.80 | Unit | Tolerance |
|---|---|---|---|---|---|---|
| Operating voltage | 0 to 1000 | 0 to 1000 | 0 to 1000 | 0 to 1000 | V | |
| **Motion and positioning** | | | | | | |
| Closed-loop travel* | 15 | 30 | 60 | 120 | µm | |
| Closed-loop resolution* | 0.3 | 0.6 | 1.2 | 2.4 | nm | typ. |
| Open-loop resolution** | 0.15 | 0.3 | 0.6 | 1.2 | nm | typ. |
| Linearity error | 0.2 | 0.2 | 0.2 | 0.2 | % | typ. |
| **Mechanical properties** | | | | | | |
| Static large-signal stiffness in the direction of motion*** | 480 | 330 | 200 | 110 | N/µm | ±20 % |
| Unloaded resonant frequency | 14 | 10 | 7 | 4 | kHz | ±20 % |
| Push / pull force capacity in motion direction | 12500 / 2000 | 12500 / 2000 | 12500 / 2000 | 12500 / 2000 | N | max. |
| Shear load | 255 | 152 | 84 | 73 | N | max. |
| Torque on tip | 1.5 | 1.5 | 1.5 | 1.5 | Nm | max. |
| **Drive properties** | | | | | | |
| Electrical capacitance | 320 | 630 | 1300 | 2600 | nF | ±20 % |
| **Miscellaneous** | | | | | | |
| Mass (with cable) | 410 | 470 | 610 | 900 | g | ±5 % |
| Recommended electronics | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | | |

Piezo ceramic: PICA Power
Temperature range: –40 to 80 °C
The operating voltage should not exceed 750 V in continuous operation.
* Requires integrated strain gauge sensor. These versions are shipped with a performance report.
** Measured interferometrically. The position resolution of piezo actuators is not limited by stiction or friction.
** Dynamic small-signal stiffness is approx. 50 % higher.
All specifications based on room temperature (22 °C ±3 °C).
The specifications of vacuum versions can differ. Ask about custom designs!

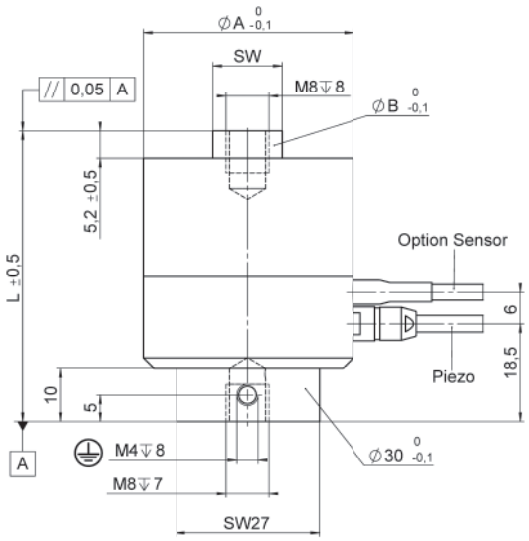
**Accessories**
P-176.B25 ball tip for P-225 and P-235
P-176.F35 flat tip for P-235

# P-235 PICA Power Piezo Actuators

## Preloaded High-Load Piezo Actuators (HVPZT) with Sensor Option

- Extremely high stiffness
- Push forces to 30000 N
- Pull forces to 3500 N
- Travel range to 180 µm
- Options: Versions for vacuum, high temperatures and with water-resistant case

P-235, dimensions in mm.




| | L [mm] | Ø A [mm] | Ø B [mm] | SW |
|---|---|---|---|---|
| P-235.1x | 55 | 49,8 | 20 | 17 |
| P-235.2x | 68 | 49,8 | 20 | 17 |
| P-235.4x | 94 | 49,8 | 20 | 17 |
| P-235.8x | 147 | 49,8 | 20 | 17 |
| P-235.9x | 199 | 49,8 | 20 | 17 |

**Applications**

- Active vibration damping
- Adaptive mechanics
- Precision engineering / micromechanics
- Optics
- Metrology / interferometry
- Adaptronics
- Switches Laser tuning
- Force generation / materials testing
- Nanotechnology

>> **Vacuum-Compatible Version**

**Technology Glossary** ..... **page 240**

| | P-235.10 | P-235.20 | P-235.40 | P-235.80 | P-235.90 | Unit | Tolerance |
|---|---|---|---|---|---|---|---|
| Operating voltage | 0 to 1000 | 0 to 1000 | 0 to 1000 | 0 to 1000 | 0 to 1000 | V | |
| **Motion and positioning** | | | | | | | |
| Closed-loop travel* | 15 | 30 | 60 | 120 | 180 | µm | |
| Closed-loop resolution* | 0.3 | 0.6 | 1.2 | 2.4 | 3.6 | nm | typ. |
| Open-loop resolution** | 0.15 | 0.3 | 0.6 | 1.2 | 1.8 | nm | typ. |
| Linearity error | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | % | typ. |
| **Mechanical properties** | | | | | | | |
| Static large-signal stiffness in the direction of motion*** | 860 | 600 | 380 | 210 | 150 | N/µm | ±20 % |
| Unloaded resonant frequency | 14 | 10 | 7 | 4 | 2.8 | kHz | ±20 % |
| Push / pull force capacity in motion direction | 30000 / 3500 | 30000 / 3500 | 30000 / 3500 | 30000 / 3500 | 30000 / 3500 | N | max. |
| Shear load | 707 | 420 | 232 | 147 | 147 | N | max. |
| Torque on tip | 2 | 2 | 2 | 2 | 2 | Nm | max. |
| **Drive properties** | | | | | | | |
| Electrical capacitance | 550 | 1100 | 2400 | 5100 | 7800 | nF | ±20 % |
| **Miscellaneous** | | | | | | | |
| Mass (with cable) | 580 | 690 | 940 | 1400 | 1900 | g | ±5 % |
| Recommended electronics | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | E-462, E-464, E-470 / E-472 / E-421, E-481, E-482, E-508 | | |

Piezo ceramic: PICA Power
Temperature range: –40 to 80 °C
The operating voltage should not exceed 750 V in continuous operation.
* Requires integrated strain gauge sensor. These versions are shipped with a performance report.
** Measured interferometrically. The position resolution of piezo actuators is not limited by stiction or friction.
*** Dynamic small-signal stiffness is approx. 50 % higher.
All specifications based on room temperature (22 °C ±3 °C).
The specifications of vacuum versions can differ. Ask about custom designs!

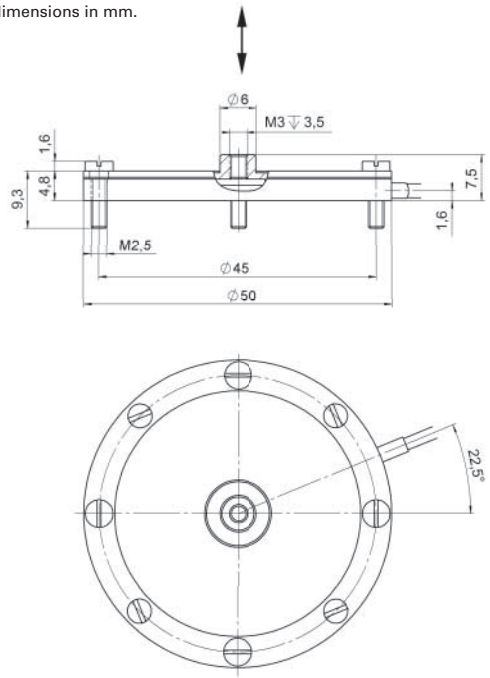
**Accessories**
P-176.B25 ball tip for P-225 and P-235
P-176.F35 flat tip for P-235

# P-286 / P-288 / P-289 Disk Translators

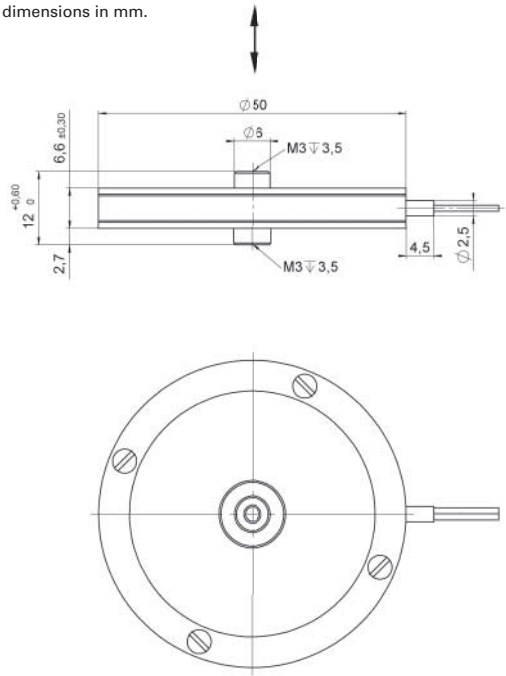
## Bimorph Piezo Actuators with High Dynamics

- Travel range to 200 µm
- Sub-nm resolution
- Sub-ms response time
- Cost-efficient
- Low profile

P-286, dimensions in mm.




P-289, dimensions in mm.




**Applications**

- Active vibration damping
- Adaptive mechanics
- Precision engineering / micromechanics
- Optics
- Metrology / interferometry
- Adaptronics
- Switches Laser tuning
- Force generation / materials testing
- Nanotechnology

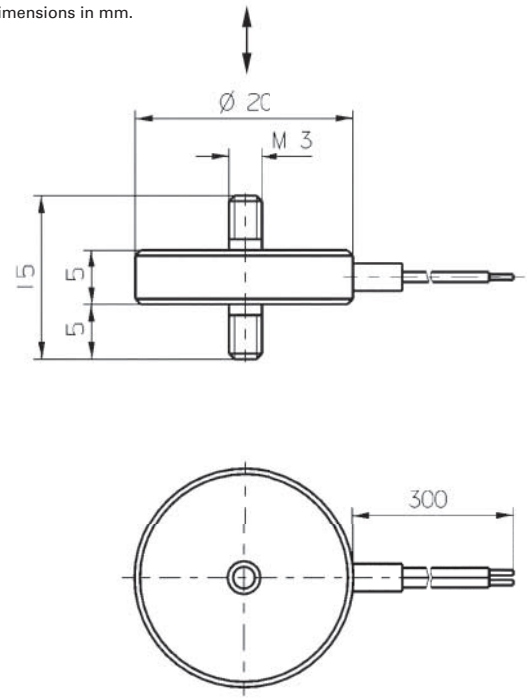
**Technology Glossary** ..... **page 240**

| | P-286.xx | P-288.00 | P-289.20 | Unit | Tolerance |
|---|---|---|---|---|---|
| Travel at 0 to -750 V (P-288), 0 to –1000 V (P-286, P-289) | 100 | 50 | 200 | µm | ±20 % |
| **Resolution*** | 1.0 | 0.5 | 2.0 | nm | |
| Static large-signal stiffness** | 0.3 | 0.2 | 0.15 | N/µm | ±20 % |
| Push / pull force capacity | 20 / 10 | 10 / 5 | 20 / 10 | N | |
| Max. torque limit (on tip) | 0.003 | 0.003 | 0.003 | Nm | |
| Max. operating voltage | –1000 | –750 | –1000 | V | |
| **Electrical capacitance** | 65 | 9 | 130 | nF | ±20 % |
| Unloaded resonant frequency $f_0$ | 2.5 | 2 | 1.1 | kHz | ±20 % |
| Operating temperature | –40 to +80 | –40 to +80 | –40 to +80 | °C | |
| Voltage connection | Stranded wires (PTFE-insulated) | Stranded wires (PTFE-insulated) | Stranded wires (PTFE-insulated) | | |
| Mass | 42 | 8 | 56 | g | ±5 % |
| Material: case, end pieces | Stainless steel | Brass | Stainless steel | | |
| | | | | | |

* Resolution of piezo actuators is not limited by friction or stiction. Noise equivalent motion with E-507 amplifier.
** Dynamic small-signal stiffness ~50 % higher.
All specifications based on room temperature (22 °C ±3 °C).

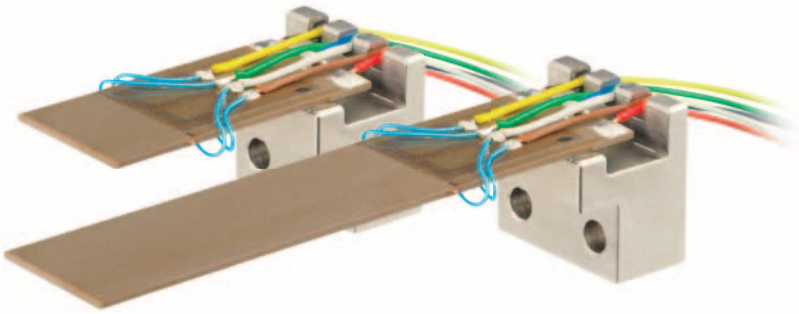


P-288, dimensions in mm.



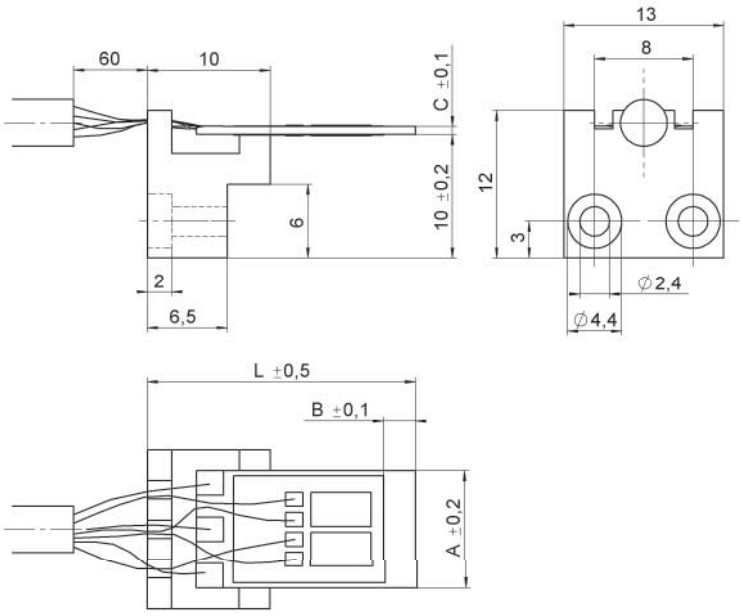
# P-871 PICMA® Multilayer Bending Actuators

## With Position Sensor



- Closed-loop operation for superior accuracy
- Nanometer resolution
- Displacement to 1.6 mm
- Ceramic encapsulation for extended lifetime
- Ideal for scanning applications
- Vacuum-compatible versions
- Low operating voltage
- Mounting hardware included
- Special OEM- and bench-top amplifiers available

P-871, dimensions in mm.




| | L | A | B | C |
|---|---|---|---|---|
| P-871.112 | 22 | 9,6 | 2,6 | 0,65 |
| P-871.122 | 29 | 9,6 | 9,6 | 0,65 |
| P-871.127 | 35 | 9,6 | 15,6 | 0,65 |
| P-871.128 | 40 | 6,25 | 17 | 0,75 |
| P-871.140 | 49 | 11 | 29, 1 | 0,60 |

**Applications**

- Wire bonders
- Pneumatic valves
- Fiber optic positioning & switches
- (Laser)-Beam steering
- Micromanipulation
- Micropositioning
- Nanotechnology

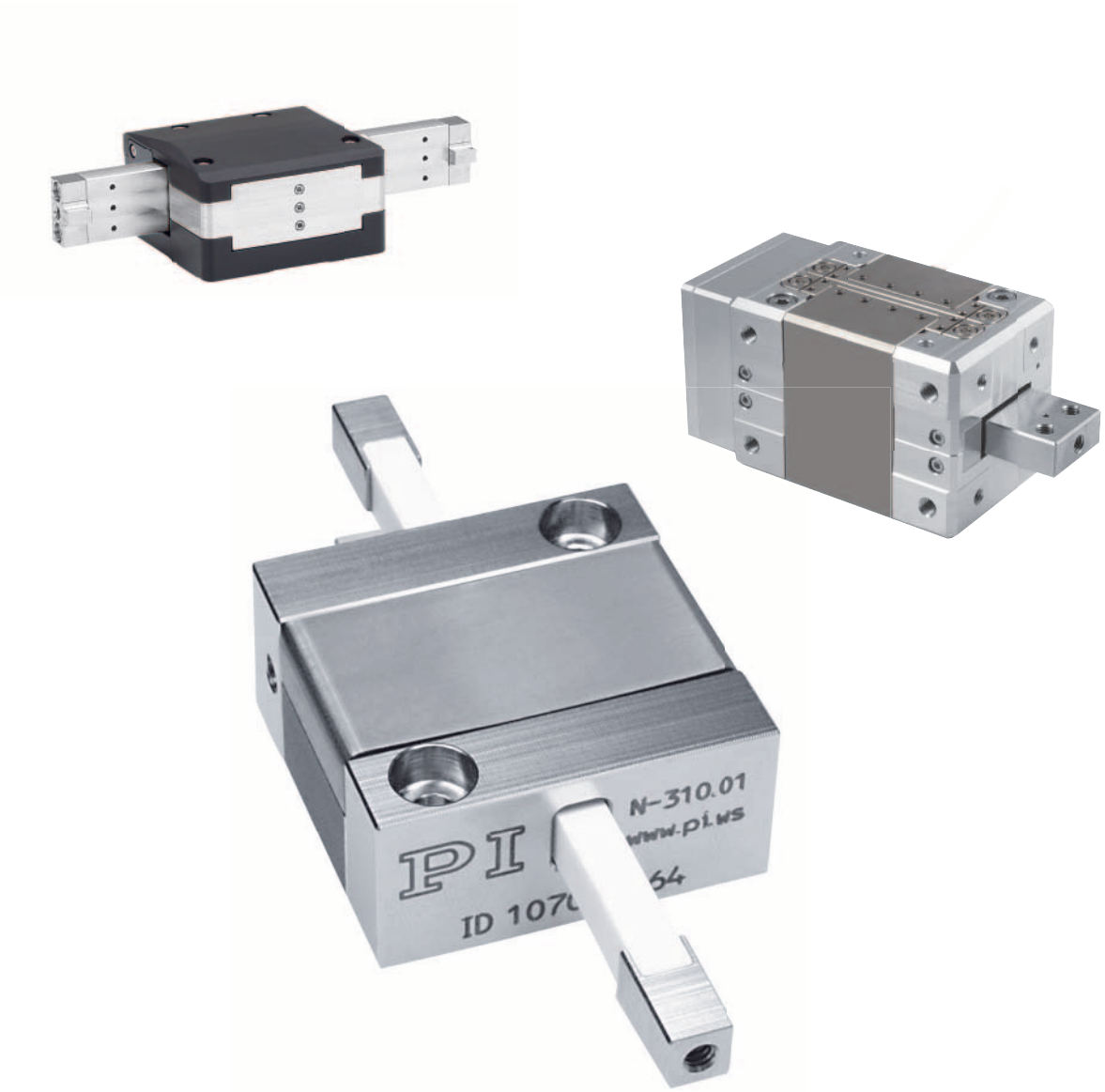

>> PICMA® Multilayer Piezo Actuators

Technology Glossary ..... page 240

| | P-871.112 | P-871.122 | P-871.127 | P-871.128 | P-871.140 | Unit | Tolerance |
|---|---|---|---|---|---|---|---|
| Operating voltage | 0 to 60 (±30) | 0 to 60 (±30) | 0 to 60 (±30) | 0 to 60 (±30) | 0 to 60 (±30) | V | |
| Closed-loop travel | ±80 | ±200 | ±360 | ±360 | ±800 | µm | |
| Integrated feedback sensor | SGS | SGS | SGS | SGS | SGS | | |
| Closed-loop linearity error | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | % | |
| Static large-signal stiffness | 0.02 | 0.01 | 0.003 | 0.002 | 0.0007 | N/µm | |
| Blocking force | ±2.0 | ±1.1 | ±1.0 | ±0.5 | ±0.5 | N | ±20 % |
| Electrical capacitance* | 2 × 1.1 | 2 × 2.4 | 2 × 3.4 | 2 × 1.2 | 2 × 4.0 | µF | ±20 % |
| Unloaded resonant frequency** | 2540 | 1010 | 560 | 340 | 195 | Hz | ±20 % |
| Resonant frequency at 6.5 g | 480 | 220 | 145 | 100 | 60 | Hz | ±20 % |
| Operating temperature range | –20 to 150 | –20 to 85 | –20 to 85 | –20 to 150 | –20 to 85 | °C | |
| Cable length | >1 | >1 | >1 | >1 | >1 | m | |
| Sensor and voltage connection | LEMO | LEMO | LEMO | LEMO | LEMO | | |
| Recommended electronics | E-651 / E-614 | E-651 / E-614 | E-651 / E-614 | E-651 / E-614 | E-651 / E-614 | | |

* Electrical capacitance: Measured at 1 $V_{pp}$, 1 kHz, RT, tolerance ±20 %.
** Resonant frequency: Measured at 1 $V_{pp}$, unloaded.
All specifications depend on actual clamping conditions and mechanical load applied.
All specifications based on room temperature (22 °C ±3 °C).
Custom designs or different specifications on request.

# PiezoWalk OEM Piezomotors and Controllers

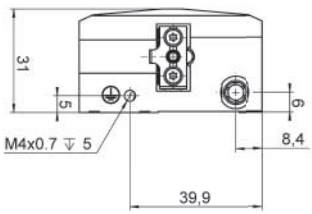


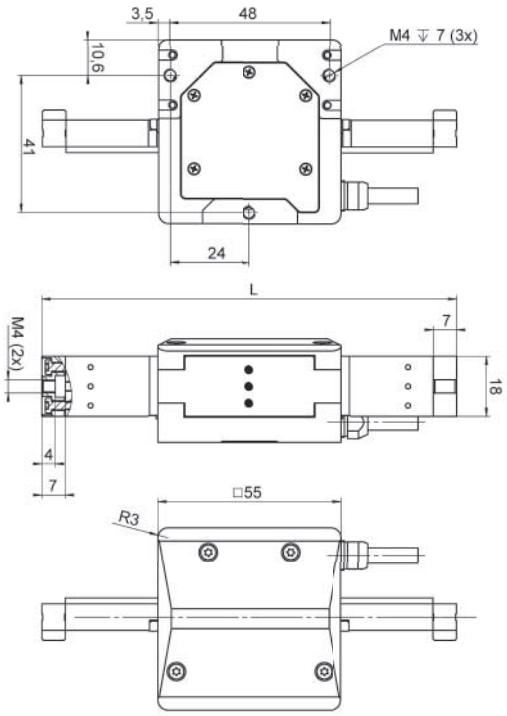
# N-331 PICMAWalk Walking Drive

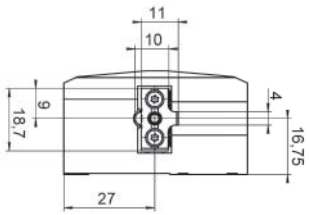
**OEM Walking Drive for Durable Applications with up to 15 mm/s Velocity and up to 50 N Push/Pull Force**

- Robust walking drive with PICMA® technology and extreme durability for industrial use
- Fastest and strongest drive of its size class
- Variable runner lengths from 25 mm to 100 mm
- Precise, nanometer precision positioning of loads up to 5 kg
- Plug-and-play, thanks to PI proprietary controller technology

N-331.x3, dimensions in mm.
Dimensions for the N-331.x0 are identical.




N-331.1x: L = 99 mm
N-331.2x: L = 124 mm
N-331.4x: L = 174 mm

Drive dimensions without runner:
55 mm × 55 mm × 31 mm.

**Applications**

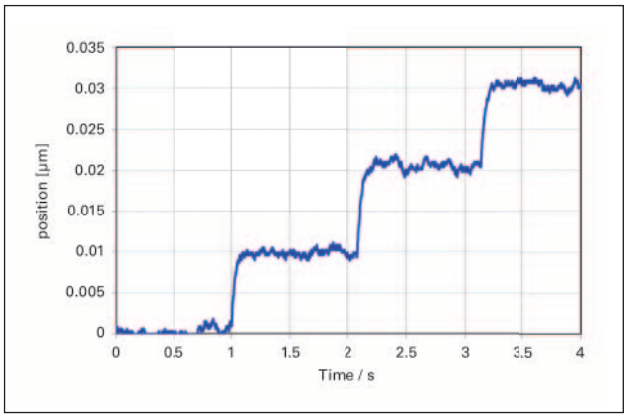
- Industrial precision motion
- Semiconductor technology
- Semiconductor testing
- Wafer inspection
- Lithography
- Nano imprint
- Nanometrology
- Motion in strong magnetic fields and vacuum


>> Incremental Encoder
>> PiezoWalk® Walking Drive
>> PICMA® Multilayer Piezo Actuators
>> Vacuum-Compatible Version

Technology Glossary ..... page 240

| | N-331.10 / N-331.13<br>N-331.20 / N-331.23<br>N-331.40 / N-331.43 | Unit | Tolerance |
|---|---|---|---|
| Active axes | X | | |
| **Motion and positioning** | | | |
| Integrated sensor | N-331.x0: Without sensor<br>N-331.x3: With incremental sensor | | |
| Travel range (step mode, open loop)* | N-331.1x: 30<br>N-331.2x: 55<br>N-331.4x: 105 | mm | ±0.5 mm |
| Travel range (step mode, closed loop) | N-331.1x: 25<br>N-331.2x: 50<br>N-331.4x: 100 | mm | |
| Step frequency** | 600 | Hz | max. |
| Velocity (step mode)** | 15 | mm/s | max. |
| Travel range (analog mode) | ±10 | µm | typ. |
| Resolution (open loop) | 0.02 | nm | typ. |
| Resolution (closed loop) | <10 (N-331.x3) | nm | typ. |
| Endurance (atmospherical operation)*** | >30 | km | |
| **Mechanical properties** | | | |
| Push / pull force (active) | 50 | N | max. |
| Holding force (passive) | 60 | N | max. |
| **Drive properties** | | | |
| Drive type | PICMAWalk | | |
| Operating voltage | –20 to 120 | V | |
| **Connectors** | | | |
| Connector | Sub-D 37 (m) | | |
| **Miscellaneous** | | | |
| Operating temperature range | 0 to 50 | °C | |
| Material | Aluminum, stainless steel | | |
| Mass with cable | N-331.1x: 580<br>N-331.2x: 610<br>N-331.4x: 660 | g | |
| Moved Mass | N-331.1x: 580<br>N-331.2x: 610<br>N-331.4x: 660 | g | ±10 g |
| Cable length | 2.0 | m | ±10 mm |
| Recommended electronics | E-712.1AN / E-712.2AN / E 712.3AN | | |
| | | | |

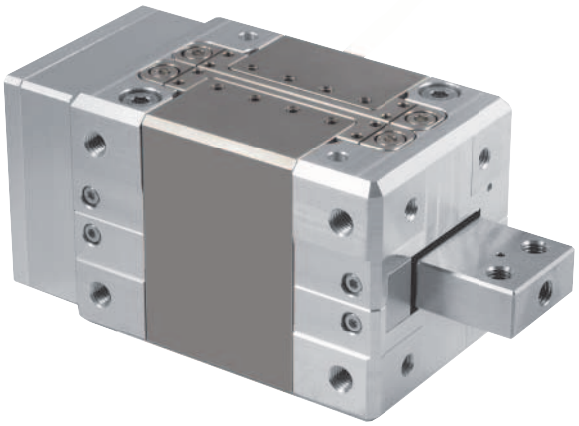
* From one mechanical hard stop of the runner to the other mechanical hard stop, only in open-loop operation.
** When operating with the E-712.xAN.
*** At an optimally decoupled load of 2 kg with max. 70 % duty cycle and external cooling of the E-712.1AN, at 20 °C and 1013 hPa. Highest endurance within the PiezoWalk® family.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!




The N-331 drive reliably performs repeatable 10-nm steps.
An interferometer was used for measuring.

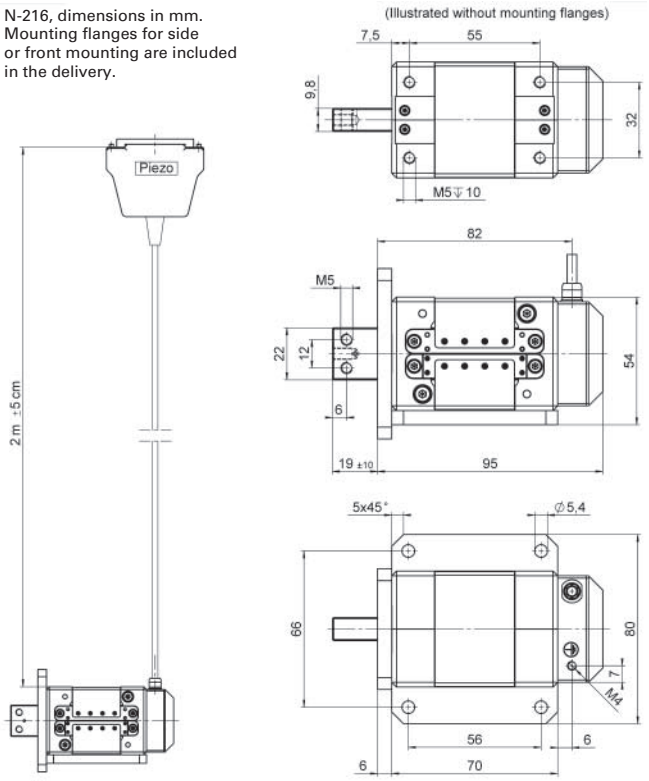
# N-216 NEXLINE® Linear Actuator

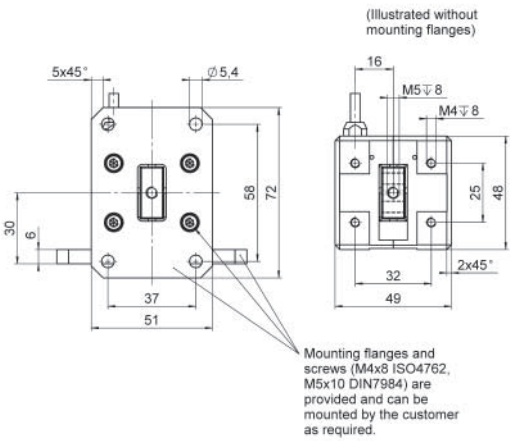
## High-Force PiezoWalk® Drive for Long-Range Nanopositioning



- Force generation up to 600 N
- Holding force up to 800 N
- Travel range 20 mm
- Integrated linear encoder with resolution 5 nm

N-216, dimensions in mm. Mounting flanges for side or front mounting are included in the delivery.




**Applications**

- Industrial precision motion
- Semiconductor technology
- Semiconductor testing
- Wafer inspection
- Lithography
- Nano imprint
- Nanometrology
- Motion in strong magnetic fields and vacuum


>> Incremental Encoder
>> PiezoWalk® Walking Drive
>> Vacuum-Compatible Version

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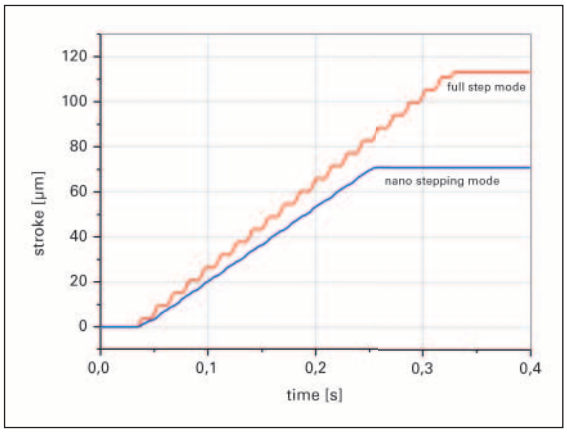
| | N-216.101 / N-216.1A1 | N-216.201 / N-216.2A1 | Tolerance |
|---|---|---|---|
| Active axes | X | X | |
| **Motion and positioning** | | | |
| Travel range | 20 mm | 20 mm | |
| Travel range in analog mode | ±3 µm | ±3 µm | |
| Integrated sensor | N-216.101: none<br>N-216.1A1: linear encoder | N-216.201: none<br>N-216.2A1: linear encoder | |
| Open-loop resolution | 0.03 nm | 0.03 nm | typ. |
| Closed-loop resolution | – / 5 nm (N-216.1A1) | – / 5 nm (N-216.2A1) | |
| Velocity (10 % duty cycle, full step mode)* | 1.0 mm/s | 1.0 mm/s | max. |
| Velocity (100 % duty cycle, full step mode)* | 0.6 mm/s | 0.6 mm/s | max. |
| Velocity (100 % duty cycle, nanostepping mode)** | 0.4 mm/s | 0.4 mm/s | max. |
| **Mechanical properties** | | | |
| Drive force (active)*** | 300 N | 600 N | max. |
| Holding force (passive) | 400 N | 800 N | min. |
| **Drive properties** | | | |
| Motor type | NEXLINE® | NEXLINE® | |
| Operating voltage | –250 V to +250 V | –250 V to +250 V | |
| **Miscellaneous** | | | |
| Operating temperature range | 0 to 55 °C | 0 to 55 °C | |
| Material | Aluminum, stainless steel | Aluminum, stainless steel | |
| Mass | 1150 g | 1250 g | |
| Cable length | 2.0 m | 2.0 m | |
| Connector | Sub-D 25 (m) | Sub-D 25 (m) | |
| Recommended electronics | E-712.1AM | E-712.1AM | |
| Connector | Sub-D 25 (m) | Sub-D 25 (m) | |
| Recommended electronics | E-712.1AM | E-712.1AM | |

* Depending on drive electronics. Data refer to operation together with E-712 controller.
** Depending on drive electronics. Data refer to operation together with E-712 controller. The maximum velocity in nanostepping mode is designed for the best possible constancy so that no velocity variations occur when executing the steps.
*** Data refer to full step mode operation.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!



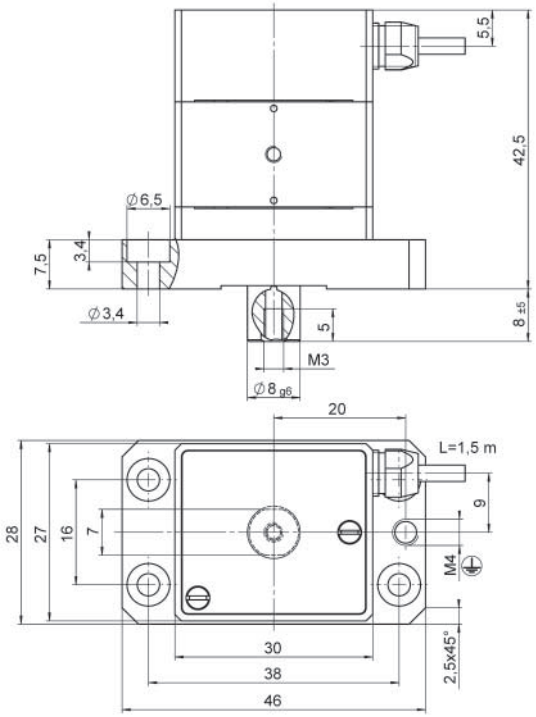

Motion mode comparison of a NEXLINE® actuator: The nanostepping mode provides a very smooth motion. Full step mode allows higher speed.

# N-111 NEXLINE® OEM Linear Actuator

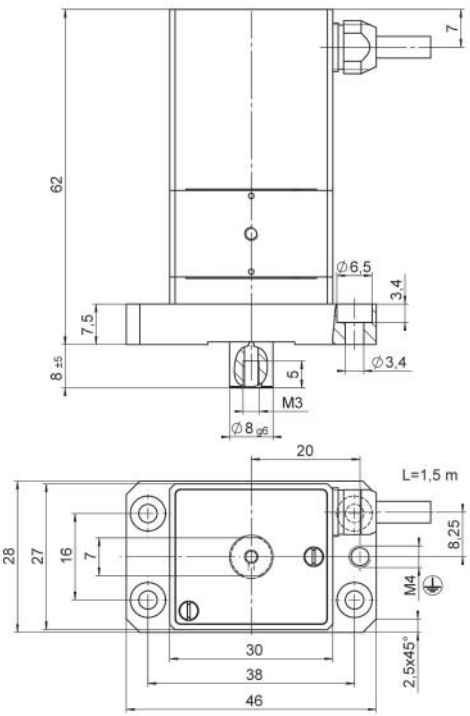
## Nanopositioning Over Long Travel, PiezoWalk® Principle


- Travel range 10 mm
- Integrated linear encoder with resolution 5 nm
- Force generation to 50 N
- Holding force to 70 N

N-111.20, dimensions in mm.




N-111.2A, dimensions in mm.




**Applications**

- Industrial precision motion
- Semiconductor technology
- Semiconductor testing
- Wafer inspection
- Lithography
- Nano imprint
- Nanometrology
- Motion in strong magnetic fields and vacuum

>> Incremental Encoder
>> PiezoWalk® Walking Drive
>> Vacuum-Compatible Version

Technology Glossary ..... page 240

| | N-111.201 | N-111.2A1 | Unit | Tolerance |
|---|---|---|---|---|
| Active axes | X | X | | |
| **Motion and positioning** | | | | |
| Travel range | 10 | 10 | mm | |
| Travel range in analog mode | ±2 | ±2 | µm | |
| Integrated sensor | – | Linear encoder | | |
| Open-loop resolution | 0.025 | 0.025 | nm | typ. |
| Closed-loop resolution | – | 5 nm | | |
| Velocity (10 % duty cycle, full step mode)* | 1.0 | 1.0 | mm/s | max. |
| Velocity (100 % duty cycle, full step mode)* | 0.6 | 0.6 | mm/s | max. |
| Velocity (100 % duty cycle, nanostepping mode)** | 0.4 | 0.4 | mm/s | max. |
| **Mechanical properties** | | | | |
| Drive force (active)*** | 50 | 50 | N | max. |
| Holding force (passive) | 70 | 70 | N | min. |
| **Drive properties** | | | | |
| Motor type | NEXLINE® | NEXLINE® | | |
| Operating voltage | ±250 | ±250 | V | |
| **Miscellaneous** | | | | |
| Operating temperature range | 0 to 55 | 0 to 55 | °C | |
| Material | Aluminum, stainless steel, titanium | Aluminum, stainless steel, titanium | | |
| Mass | 245 | 325 | g | |
| Cable length | 1.5 | 1.5 | m | ±10 mm |
| Connector | Sub-D 25 (m) | Sub-D 25 (m) | | |
| Recommended electronics | E-712.1AM | E-712.1AM | | |

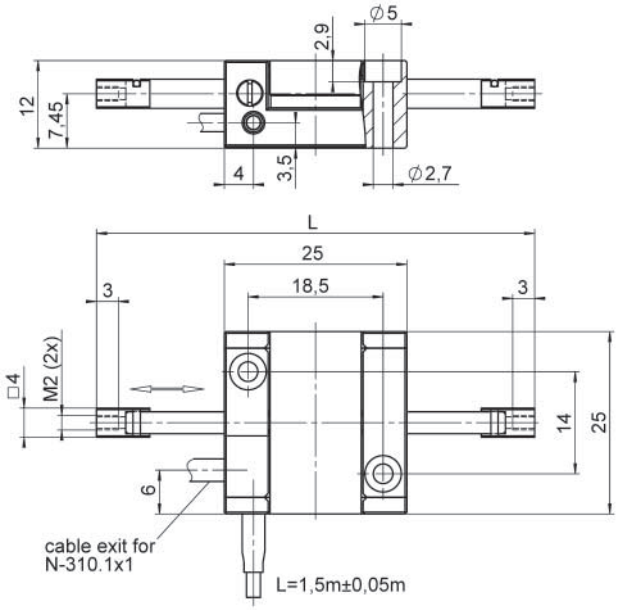
* Depending on drive electronics. Data refer to operation with E-712 controller.
** Depending on drive electronics. Data refer to operation with E-712 controller. The maximum velocity in nanostepping mode is designed for the best possible constancy so that no velocity variations occur when executing the steps.
*** Data refer to operation in full step mode.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

# N-310 NEXACT® OEM
# Miniature Linear Motor/Actuator

**Compact, High-Speed PiezoWalk® Drive**

- 20 to 125 mm travel range, flexible choice of the runner length
- Compact design, cost-effective design
- Resolution to 0.03 nm
- Force generation up to 10 N


N-310, dimensions in mm; runner length L = travel range + 40 mm.




| | L |
|---|---|
| N-310.10 / .101 | 50 |
| N-310.11 / .111 | 60 |
| N-310.12 / .121 | 70 |
| N-310.13 / .131 | 90 |
| N-310.14 / .141 | 115 |
| N-310.15 / .151 | 140 |
| N-310.16 / .161 | 165 |

**Applications**

- Industrial precision motion
- Semiconductor technology
- Semiconductor testing
- Wafer inspection
- Lithography
- Nano imprint
- Nanometrology
- Motion in strong magnetic fields and vacuum


>> Incremental Encoder
>> PiezoWalk® Walking Drive
>> Vacuum-Compatible Version

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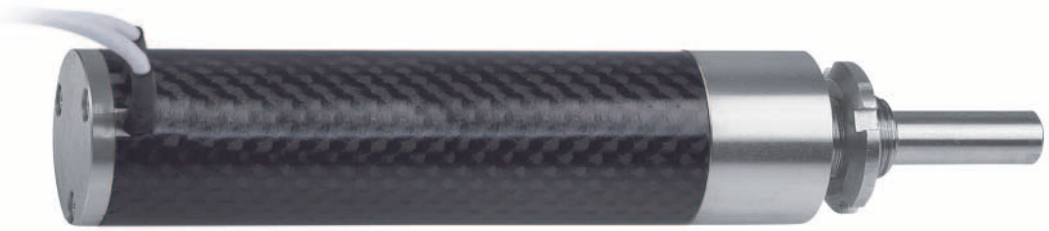
| | N-310 | Tolerance | |
|---|---|---|---|
| Active axes | X | | |
| **Motion and positioning** | | | |
| Travel range | N-310.10: 10 mm<br>N-310.11: 20 mm<br>N-310.12: 30 mm<br>N-310.13: 50 mm<br>N-310.14: 75 mm<br>N-310.15: 100 mm<br>N-310.16: 125 mm | | |
| Step size (in step mode) | 5 nm to 5 µm | | |
| Travel range in analog mode | ±5 µm | max. | |
| Open-loop resolution | 0.03 nm* | typ. | |
| Velocity | 10 mm/s** | max. | |
| **Mechanical properties** | | | |
| Push / pull force (active) | 10 N | max. | |
| **Drive properties** | | | |
| Drive type | NEXACT® linear drive | | |
| Operating voltage | –10 V to +45 V | | |
| **Miscellaneous** | | | |
| Operating temperature range | 0 to 50 °C | | |
| Casing material | Stainless steel | | |
| Mass | 50 g (20 mm travel range) | ±5 % | |
| Cable length | 1.5 m | ±10 mm | |
| Connector | HD Sub-D 15 (m) | | |
| Recommended electronics | E-712.1AM, E-861 | | |

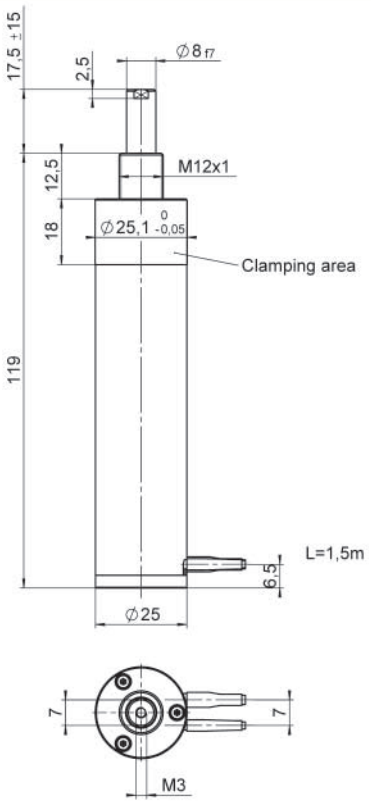
* Depending on drive electronics. 1 nm with E-861.
** Depending on drive electronics.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

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

**High-Resolution with Optional Position Sensor**



N-381, dimensions in mm.




- Travel range 30 mm
- Force generation up to 10 N
- With NEXACT® piezo stepping drive
- Optional: Integrated linear encoder with 20 nm resolution

**Applications**

- Industrial precision motion
- Semiconductor technology
- Semiconductor testing
- Wafer inspection
- Lithography
- Nano imprint
- Nanometrology
- Motion in strong magnetic fields and vacuum


>> Incremental Encoder
>> PiezoWalk® Walking Drive

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| | N-381.30 | N-381.3A |
|---|---|---|
| Active axes | X | X |
| **Motion and positioning** | | |
| Travel range | 30 mm | 30 mm |
| Integrated sensor | – | Incremental linear encoder |
| Sensor resolution | – | 20 nm* |
| Travel range in analog mode, open-loop | ±5 µm (max.) | ±5 µm (max.) |
| Open-loop resolution | 0.03 nm** | 0.03 nm** |
| Closed-loop resolution | – | 20 nm* |
| Max. velocity | 10 mm/s* | 10 mm/s* |
| **Mechanical properties** | | |
| Stiffness in motion direction | 2.4 N/µm | 2.4 N/µm |
| Max. push / pull force (active) | 10 N | 10 N |
| Max. holding force (passive) | 15 N | 15 N |
| **Drive properties** | | |
| Drive type | NEXACT® linear drive | NEXACT® linear drive |
| Operating voltage | –10 V to +45 V | –10 V to +45 V |
| **Miscellaneous** | | |
| Operating temperature range | 0 to 50 °C | 0 to 50 °C |
| Material | Stainless steel / CFRP | Stainless steel / CFRP |
| Mass | 250 g | 255 g |
| Cable length | 1.5 m | 1.5 m |
| Connector | HD Sub-D 15 (m) (motor) | HD Sub-D 15 (m) (motor)<br>HD Sub-D 15 (f) (sensor) |
| Recommended electronics | E-712.1AM, E-861 | E-712.1AM, E-861 |

* With E-861. Depending on drive electronics.
** 1 nm with E-861. Depending on drive electronics.
All specifications based on room temperature (22 °C ±3 °C).
Ask about custom designs!

# E-712.1AN / E-712.2AN / E-712.3AN PICMAWalk Digital Controller

**1 to 3 Channels, for Drives with Incremental Sensors**

- Customized control algorithms for PICMAWalk walking drives
- For one to three channels
- Plug-and-play, thanks to PI proprietary controller technology
- Flexible interfaces: TCP/IP, USB, RS-232, SPI
- Compatible with GCS (PI General Command Set)

**Digital controller for PICMAWalk walking drives**

1 to 3 channels with integrated power amplifiers and interpolator. All PiezoWalk® technology modes of motion supported. 20-bit digital-analog converter resolution. Linearization based on fourth-order polynomials.

**Extensive functionality**

Wave generator. Trigger inputs and outputs. Data recorder. Various control algorithms can be selected, including PID position control with secondary velocity control or PID velocity control. Parameter changing during operation. Extensive software support, e.g., for LabVIEW.

**Interfaces**

Ethernet, USB, RS-232, and SPI for commanding. Differential signal transmission for analog (sin/cos) encoder signals. TTL signal inputs for reference point switch.

>> Extensive Software Package

Technology Glossary ..... page 240

| | E-712.1AN · E-712.2AN · E-712.3AN |
|---|---|
| **Housing with wide-range-input power supply** | |
| Control input voltage | 100 to 240 V AC |
| Input voltage frequency | 50 to 60 Hz |
| Maximum power consumption | 225 VA |
| Fuse | 2 A TH |
| **Digital processor and interface module** | |
| Supported positioning systems | PICMAWalk |
| Interfaces for communication | TCP/IP, USB, RS-232, SPI |
| Supported axes | E-712.1AN: 1 axis<br>E-712.2AN: 2 axes<br>E-712.3AN: 3 axes |
| Processor | PC-based |
| Sampling rate, servo control | Max. 50 kHz |
| Sampling rate, sensor | Max. 50 kHz |
| External sensor synchronization | Yes |
| Digital inputs | 8 × TTL to MDR connection, 20 pin |
| Digital outputs | 8 × TTL to MDR connection, 20 pin |
| Command set | PI General Command Set (GCS) 2.0 |
| Supported functions | Function generator, trigger inputs and outputs, data recorder; various control algorithms can be selected, e.g.:<br>■ P, I, two notch filters<br>■ Advanced Piezo Control, must be ordered separately (order number E-712.U1)<br>■ PID position control with secondary velocity control, two notch filters<br>■ PID velocity control, two notch filters |
| Display | LEDs for OnTarget, Err, Power |
| Linearization | Fourth-order polynomials<br>DDL option (Dynamic Digital Linearization), must be ordered separately (order number E-710.SCN)<br>Advanced Linearization option, must be ordered separately (order number E-712.U4) |
| **Amplifier and control module** | |
| Min. output voltage | –30 V |
| Max. output voltage | 135 V |
| Amplifier channels per module | 4 |
| Peak output power per channel | 25 W* |
| Average output power per channel | 8 W |
| Peak output current per channel | 250 mA |
| Average output current per channel | 150 mA |
| Current limitation | Short-circuit proof |
| Digital-analog converter resolution | 20 bit effective |
| Temperature sensor | Max. 75 °C, deactivation of the piezo output voltage |
| Connection | Sub-D 37 (f) |
| Dimensions | 270 mm × 324 mm × 139 mm (L × W × H) |
| Mass | E-712.1AN: 4.1 kg<br>E-712.2AN: 4.62 kg<br>E-712.3AN: 5.13 kg |

* The maximum output power is limited by the power supply of the housing and the number of available channels.

# E-712.1AM Digital Motion Controller

**For NEXLINE® Piezo Stepping Drives**

- Special control algorithms for NEXLINE® nanopositioning linear-motor actuators
- Highly stable 20-bit D/A converter
- Servo frequency 50 kHz
- Flexible interfaces: Ethernet TCP/IP, RS-232, USB

**Digital Motion Controller**

The E-712.1AM is a high-performance single channel piezo controller for high-precision and powerful NEXLINE® drives with incremental encoders. It is equipped with high-performance, low-noise amplifiers and is capable of controlling NEXLINE® step algorithms. The P-I controller offers 2 configurable notch filters.

**Comprehensive Functions**

The controller is equipped with a data recorder and a wave generator. The comprehensive software package also contains LabVIEW drivers and shared libraries for Windows and Linux.

**Interfaces**

Ethernet, USB, RS-232 as well as 8 digital inputs and outputs each for triggers. The LEMO interface enables external synchronization.

>> Extensive Software Package

Technology Glossary ..... page 240

| | E 712.1AM | Unit |
|---|---|---|
| Function | Modular digital controller for NEXLINE® piezo stepping drives | |
| Axes | 1 | |
| Processor | PC-based, real-time operating system | |
| Servo frequency | 50 | kHz |
| **Sensor** | | |
| Servo characteristics | P-I, two notch filters | |
| Sensor type | Incremental, analog signals (sin/cos) | |
| Sensor resolution | 16-bit, quantized | bit |
| External synchronization | Yes | |
| **Amplifier** | | |
| Amplifier channels | 4 | |
| Output voltage | –250 to 250 | V |
| Peak output power per channel | 45 | W |
| Average output power per channel | 15 | W |
| Peak output current per channel | 180 | mA |
| Average output current per channel | 60 | mA |
| Current limitation | Short-circuit-proof | |
| Resolution DAC | 20-bit, interpolated | bit |
| Overheat protection | Output voltage switch-off at 75 °C | |
| **Interfaces and operation** | | |
| Interface / communication | Ethernet, USB, RS-232 | |
| Piezo / sensor connection | Sub-D 25-pin (f) | |
| Digital input/output | MDR20; 8 × IN, 8 × OUT; TTL | |
| Command set | PI General Command Set (GCS) | |
| User software | NanoCapture, PIMikroMove | |
| Software drivers | LabVIEW driver, shared libraries for Windows and Linux | |
| Supported functions | NEXLINE® servo algorithms, data recorder, wave generator, trigger I/O | |
| Display and indicators | LEDs for OnTarget, Error, Power | |
| Linearization | 4th order polynomials, DDL option (Dynamic Digital Linearization) | |
| **Miscellaneous** | | |
| Operating temperature range | 5 to 50 | °C |
| Mass | 5.35 | kg |
| Dimensions | 9.5" chassis, 236 mm × 132 mm × 296 mm + handles (47 mm length) | |
| Max. power consumption | 100 | W |
| Operating voltage | 90 to 240 VAC, 50 to 60 Hz | |

Ask about custom designs!

# E-861 PiezoWalk® NEXACT® Controller / Driver

**Networkable Controller for NEXACT® Linear Drives and Positioners**


- High-speed encoder input
- Macro programmable for stand-alone functionality
- Data recorder
- Nonvolatile EEPROM for macros and parameters
- USB, RS-232
- Controller module for C-885 PIMotionMaster available

>> Extensive Software Package

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| | E-861.1A1 |
|---|---|
| Function | Controller for NEXACT® drives / systems |
| Drive type | NEXACT® linear drive |
| Channels | 1 |
| **Motion and control** | |
| Servo characteristics | P-I-D servo control, parameter change on-the-fly |
| Trajectory profile modes | Trapezoidal |
| Encoder input | Analog encoder input sine-cosine,<br>interpolation selectable up to 1000;<br>Interpolation circuit for differential transmission,<br>1 $V_{pp}$ amplitude and 2.5 V offset of the encoder signal |
| Stall detection | Servo off, triggered by programmable position error |
| Input limit switch | 2 × TTL (pull-up/pull-down, programmable) |
| Input reference switch | 1 × TTL |
| **Electrical properties** | |
| Max. output power | 40 W |
| Output voltage | –10 to +45 V |
| Max. operating current | 2 A |
| **Interfaces and operation** | |
| Communication interfaces | USB 1.0, RS-232 (9-pin (m) sub-D) |
| Motor connector | HD Sub-D 15-pin (f) |
| Sensor connection | HD Sub-D 15-pin (m) |
| Controller network | Up to 16 units on single interface* |
| I/O ports | 4 analog/digital in, 4 digital out (TTL) |
| Command set | PI General Command Set (GCS) |
| User software | PIMikroMove, PITerminal |
| Software drivers | GCS DLL, LabVIEW driver |
| Supported functionality | Start-up macro; Data recorder for recording operating data such as motor voltage, velocity, position or position error; internal safety circuitry: watchdog timer |
| Manual control (optional) | Pushbutton box, joystick (for 2 axes),<br>Y-cable for 2-D motion |
| **Miscellaneous** | |
| Operating voltage | 24 V;<br>included: external power supply, 24 V; 2.0 A |
| Operating temperature range | 0 to 50 °C |
| Mass | 1.1 kg |
| Dimensions | 206 mm × 130 mm × 66 mm (incl. mounting rails) |

* 16 units with USB; 6 units with RS-232.

# E-862 NEXACT® Drive Electronics

**Low-Cost Drive Electronics for NEXACT® Piezo Stepping Drives**

- Step generator for NEXACT® piezomotors
- Integrated power amplifier
- Versatile and inexpensive
- Interface for automation, joystick for manual operation
- OEM version

>> Extensive Software Package

Technology Glossary ..... page 240

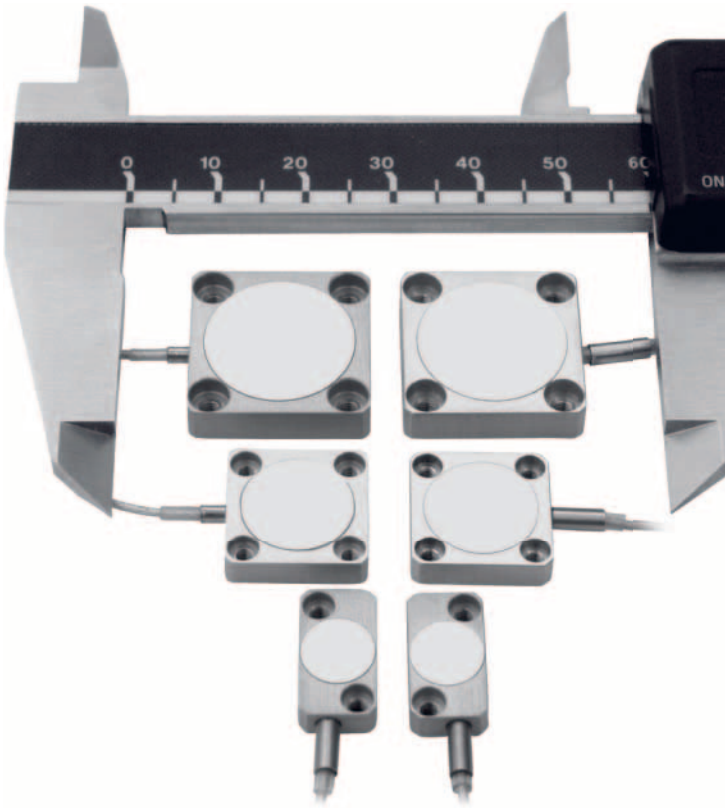
| | E-862.100 |
|---|---|
| Function | Drive electronics for NEXACT® drives / stages |
| Drive type | NEXACT® Drive |
| Channels | 1 |
| Motion resolution | 12 bit |
| Input limit switch | 2 × TTL (active high, to be activated) |
| **Electrical properties** | |
| Output power | max. 40 W |
| Output voltage | 0 to +45 V |
| Current consumption | max. 1.6 A |
| **Interface and operation** | |
| Control Mode | ±10 V analog velocity control |
| Motor connector | HD Sub-D 15-pin (f) |
| Manual control (optional) | Joystick, Y-cable for control of 2 axes with joystick |
| **Miscellaneous** | |
| Operating voltage | 24 V<br>External power supply (24 V, 2 A), not included |
| Operating temperature range | 0 to 50 °C |
| Mass | 0.64 kg |
| Dimensions | 166 mm × 100 mm × 46 mm (incl. mounting rails) |

All specifications for NEXACT® drives refer to use with E-861 controller.
Compared to the E-861 controller for NEXACT® drives/stages, the E-862 drive electronics provides only a unipolar output voltage.
Therefore, push force and velocity achievable with E-862 are derated by approx. 20 %.

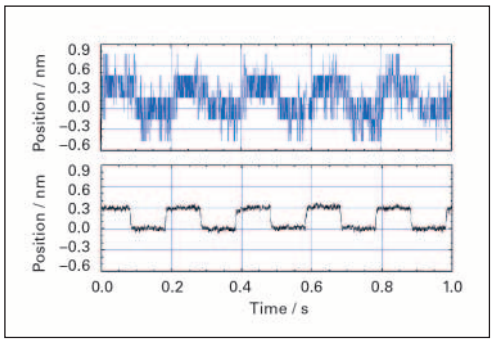
# Capacitive Feedback Sensors

# D-015 / D-050 / D-100 Capacitive Sensors

## Sub-Nanometer-Resolution Position Sensors

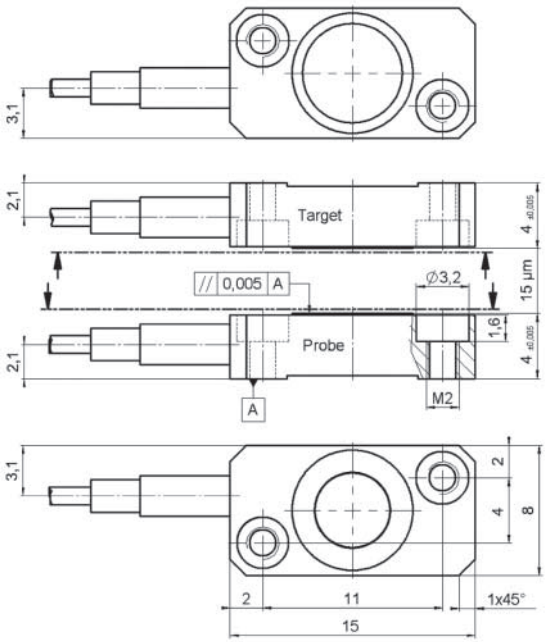


- For applications requiring highest precision
- Measurement range to 1000 µm
- Resolution to 0.01 nm
- Linearity error to 0.01 % with digital controller
- Bandwidth to 10 kHz
- Custom designs on request
- Signal conditioner / servo module available




Piezo nanopositioning system making 0.3 nm steps, measured with PI capacitive sensor (lower curve) and with a highly precise laser interferometer. The capacitive sensor provides significantly higher resolution than the interferometer.

D-015.00, dimensions in mm




**Applications**

- High precision positioning


>> Capacitive Feedback Sensors
>> Direct Metrology

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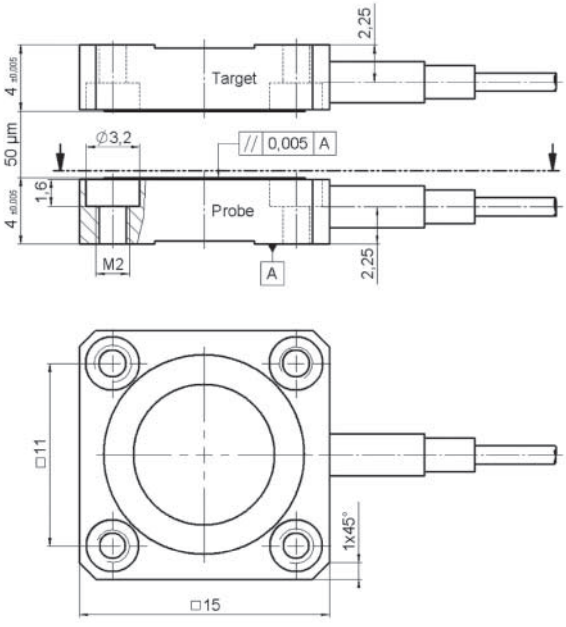
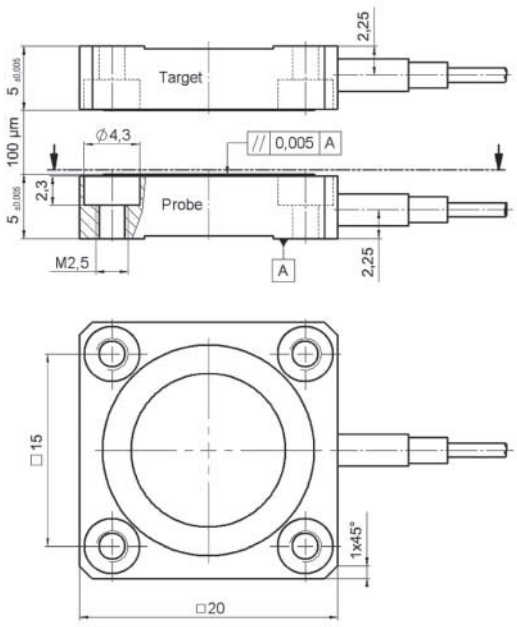
| | D-015.00 | D-050.00 | D-100.00 | Unit |
|---|---|---|---|---|
| **Sensor** | | | | |
| Sensor type | Capacitive | Capacitive | Capacitive | |
| Nominal measurement range | 15 | 50 | 100 | µm |
| Extended measurement range | 45 | 150 | 300 | µm |
| Resolution* | 0.0005 | 0.0005 | 0.0005 | % of measurement range |
| Linearity error** | 0.01 | 0.01 | 0.01 | % |
| Sensor active area | 16.6 | 56.5 | 113.1 | mm² |
| Thermal drift*** | 50 | 50 | 50 | ppm/K |
| **Miscellaneous** | | | | |
| Operating temperature range | –20 to 80 | –20 to 80 | –20 to 80 | °C |
| Material | Aluminum | Aluminum | Aluminum | |
| Recommended sensor electronics | E-509.CxA | E-509.CxA | E-509.CxA | |
| | | | | |

* 3 kHz, with E-509.C3A servo controller.
** With digital controller. Up to 0.05 % with E-509 analog controller.
*** Change of active surface size in ppm (parts per million), refers to measurement range.
Ask for custom materials.

D-050.00, dimensions in mm




D-100.00, dimensions in mm

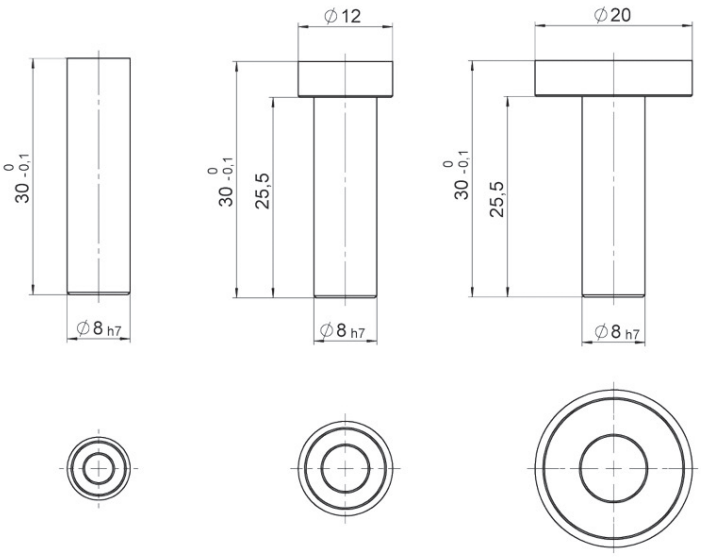


# D-510 PISeca Capacitive Sensors

## Single-Plate Sensors with Excellent Position Resolution


- Non-contact measurement for distance / motion / vibration
- Absolute position sensing
- Sub-nanometer resolution
- Selectable measurement ranges
- Easy integration
- Bench-top or rackmount signal conditioners available

D-510.021, D-510.051 and D-510.101 capacitive sensor probes, dimensions in mm. Sensor connection LEMO FFC00.650.CLA.543, triaxial




**Applications**

- Semiconductor technology
- Semiconductor testing
- Nanometrology
- Active vibration damping
- High precision machining


>> Capacitive Feedback Sensors
>> Direct Metrology

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| | D-510.021 | D-510.051 | D-510.101 | Unit | Tolerance |
|---|---|---|---|---|---|
| Sensor type | Single-electrode, capacitive | Single-electrode, capacitive | Single-electrode, capacitive | | |
| **Measurement accuracy** | | | | | |
| Nominal measurement range* | 20 | 50 | 100 | µm | |
| gap | 10 | 25 | 50 | µm | min. |
| gap | 150 | 375 | 750 | µm | max. |
| Static resolution** | <0.001 | <0.001 | <0.001 | % of measurement range | typ. |
| Dynamic resolution** | <0.002 | <0.002 | <0.002 | % of measurement range | |
| Linearity error*** | <0.2 | <0.1 | <0.1 | % | |
| **Mechanical properties** | | | | | |
| Sensor active diameter | 3.8 | 6 | 8.4 | mm | |
| Sensor active area | 11.2 | 27.9 | 56.1 | mm² | |
| Sensor diameter | 8 | 12 | 20 | mm | |
| Sensor area | 50.3 | 113.1 | 314.0 | mm² | |
| Mounting shaft diameter | 8 | 8 | 8 | mm | |
| **Miscellaneous** | | | | | |
| Operating temperature range | –20 to 100 | –20 to 100 | –20 to 100 | °C | |
| Material | stainless steel | stainless steel | stainless steel | | |
| Mass | 8 | 10 | 16 | g | ±5 % |
| Recommended signal conditioner electronics | E-852.10 | E-852.10 | E-852.10 | | |

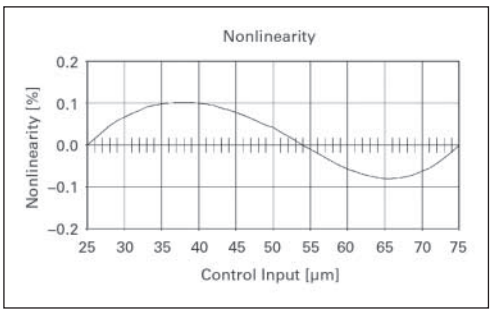
* Extended measurement ranges available for calibration with E-852.10 signal conditioner electronics
** Static: bandwidth 10 Hz, dynamic: bandwidth 10 kHz, with E-852.10 signal conditioner electronics
*** Linearity error over nominal measurement range

D-510.021 with LEMO connector for easy handling

# E-852 PISeca Signal Conditioner

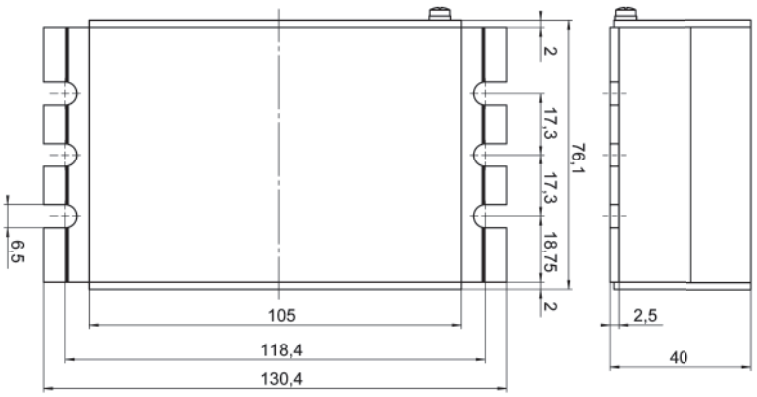
## For Capacitive Single-Plate Sensors


- Cost-effective system solution for PISeca capacitive position sensors
- ILS circuitry optimizes capacitive sensor linearity
- Selectable bandwidth from 10 Hz up to 10 kHz
- Selectable measurement range
- LED-bar measuring-range display for easy integration
- External synchronization for multi-channel applications
- Low-noise power supply included




Excellent output linearity of the E-852 signal conditioner / D-510.050 sensor combination (nominal measurement range)

E-852 signal conditioner, dimensions in mm





>> Capacitive Feedback Sensors
>> Direct Metrology

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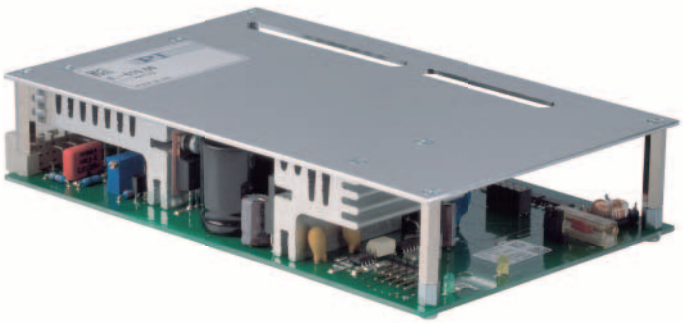
| | E-852 | E-852.10A1 | Unit |
|---|---|---|---|
| Function | Signal conditioner for PISeca | Signal conditioner for single-electrode capacitive sensors, remote operation | |
| Channels | 1 | 1 | |
| **Sensor** | | | |
| Sensor type | Single-electrode, capacitive | Single-electrode, capacitive | |
| Sensor bandwidth | 10 / 3 / 0.3<br>1.1 / 0.1 / 0.01 (optional) | 10 / 3 / 1 / 0.3 / 0.01 | kHz |
| Measurement range extension factors* | 1 & 2.5 (calibrated);<br>2 & 5 (optional) | 1 (calibrated) / 2 / 2.5 /5 (on request) | |
| Ext. synchronization | Auto master-slave | Auto master-slave | |
| Temperature stability | 0.71 ±0.25 | 0.2 | mV/K |
| **Electrical properties** | | | |
| Output voltage | –10 to 10 /<br>–5 to 5 /<br>0 to 10 (selectable) | –10 to 10 /<br>–5 to 5 /<br>0 to 10 (selectable) | V |
| Output signal | 1 kΩ / 1 nF | 1 kΩ / 1 nF | |
| Supply voltage | ±15 V (125 mA),<br>5 V (20 mA) | ±15 V (220 mA),<br>5 V (20 mA) | |
| Static resolution** | <0.001 of measurement range (RMS) | <0.001 of measurement range (RMS) | % |
| Dynamic resolution** | <0.002 of measurement range (RMS) | <0.002 of measurement range (RMS) | % |
| Noise factor*** | 0.14 | 0.14 | pp/m √Hz |
| Linearity @ nominal range | <0.1<br>(<0.2 for D-510.020) | <0.1<br>(<0.2 for D-510.020) | % |
| **Interfaces and operation** | | | |
| Sensor connection | LEMO ECP.00.650.NLL.543 socket, triaxial | LEMO ECP.00.650.NLL.543 socket, triaxial (on signal amplifier);<br>Sub-D 9-pin, 10 m cable from preamp to signal conditioner, differential signals | |
| Signal output | BNC | BNC | |
| Signal monitor | – | Test point on signal amplifier | |
| Display | LED bar | Power On | |
| Linearization | ILS | ILS | |
| **Miscellaneous** | | | |
| Operating temperature range | 5 to 40 | 5 to 40 | °C |
| Mass | Signal conditioner: 0.355<br>Power supply E-852.PS2: 0.55 | Signal conditioner: 0.355<br>Power supply E-852.PS2: 0.55<br>Signal amplifier: 0.076 | |
| Dimensions | Signal conditioner:<br>80 mm × 130 mm × 40 mm<br>Power supply E-852.PS2:<br>146 mm × 76 mm × 43 mm<br>(incl. mounting flanges) | Signal conditioner:<br>80 mm × 130 mm × 40 mm<br>Power supply E-852.PS2:<br>146 mm × 76 mm × 43 mm<br>Preamp: 55 mm × 70 mm × 20 mm<br>(incl. mounting flanges) | |
| Target ground connector | Banana jack, 4 mm | Banana jack, 4 mm, on signal amplifier | |

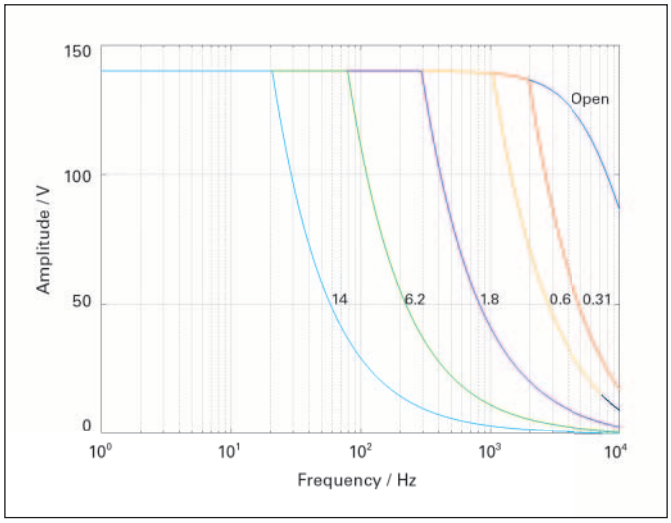
* Extension factors to multiply by the nominal measurement range of D-510 sensor probes
** Static: bandwidth 10 Hz, dynamic: bandwidth 10 kHz, cable length 1 m
*** Specifications in ppm (parts per million), refer to nominal measurement range

# Piezo Controllers and Drivers

# E-754 Digital Piezo Controller

## High-Speed, Single-Axis Controller


E-754: Operating limits (open-loop) with various capacitive loads, capacitance values in µF

- Next generation digital controller provides higher flexibility, accuracy and speed
- Autoloading of calibration data from stage ID chip for interchangeability of controller and mechanics
- Ethernet (TCP/IP), SPI, USB, RS-232
- Analog inputs and outputs
- Digital I/O lines for task triggering
- High dynamic bandwidth
- Integrated motion profile generator


>> Extensive Software Package
>> Linearization

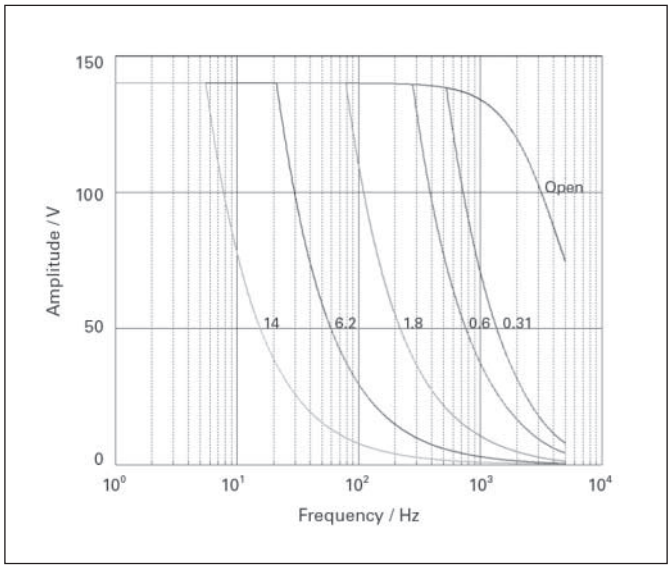
Technology Glossary ..... page 240

| | E-754.1CD |
|---|---|
| Function | Digital controller for single-axis piezo nanopositioning systems with capacitive sensors |
| Axes | 1 |
| Processor | 375 MHz, 64-bit floating point, DSP/ARM |
| Supported functions | Wave generator, trigger I/O, AutoZero, data recorder, macros |
| Sampling rate, servo control | 50 kHz |
| Sampling rate, sensor | 50 kHz |
| **Sensor** | |
| Controller type | P-I, two notch filters, optional APC |
| Sensor type | Capacitive |
| Sensor channels | 1 |
| Sensor bandwidth | 8 kHz |
| Sensor resolution | 19 bit |
| External synchronization | 100 kHz and 4.8 MHz (LVDS) |
| **Amplifier** | |
| Output voltage | –30 to 135 V |
| Amplifier channels | 1 |
| Peak output power, <2 ms | 45 W |
| Average output power | 15 W |
| Peak output current, <2 ms | 500 mA |
| Average output current | 120 mA at 20 °C |
| Current limitation | Short-circuit proof |
| Resolution DAC | 22 bit effective |
| **Interfaces and operation** | |
| Communication interfaces | Ethernet (TCP/IP), SPI, USB, RS-232 |
| Piezo / sensor connection | Sub-D 7W2 (f) |
| Analog input | LEMO, 1 channel, ±10 V, 20-bit ADC |
| Analog output | LEMO, 1 channel, ±10 V, 20-bit DAC |
| Digital input | LEMO, 2 lines, TTL |
| Digital output | LEMO, 2 lines, TTL |
| Command set | PI General Command Set (GCS) |
| User software | PIMikroMove |
| Software drivers | LabVIEW driver, dynamic libraries for Windows and Linux |
| Display and indicators | Status LEDs |
| Linearization | 4th order polynomials; optional DDL |
| Separate protective earth connection | Yes |
| **Miscellaneous** | |
| Operating temperature range | 5 to 40 °C |
| Overheat protection | Automatic deactivation of the piezo output at temperatures higher than 70 °C |
| Mass | 1.6 kg |
| Power consumption, full load | 35 W (max.) |
| Power consumption, no load | 13 W |
| Operating voltage | 24 V DC from external power supply (included in the scope of delivery) |
| Dimensions | 312 mm × 153 mm × 59 mm (incl. mounting rails) |

Ask about custom designs!

# E-709 Compact and Cost-Optimized Digital Piezo Controller

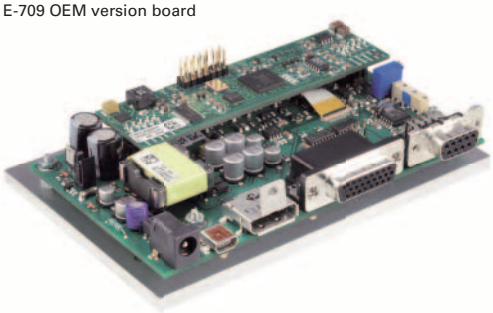
**For SGS, Piezoresistive and Capacitive Sensors**


E-709: Operating limits with various PZT loads (open-loop), capacitance is measured in µF

- Linearity error to 0.02 %
- Fast 25 Mbit/s serial interface
- Comprehensive I/O functions
- Low-cost OEM versions available
- USB, digital RS-232
- High-power version E-709.CHG

E-709 OEM version board



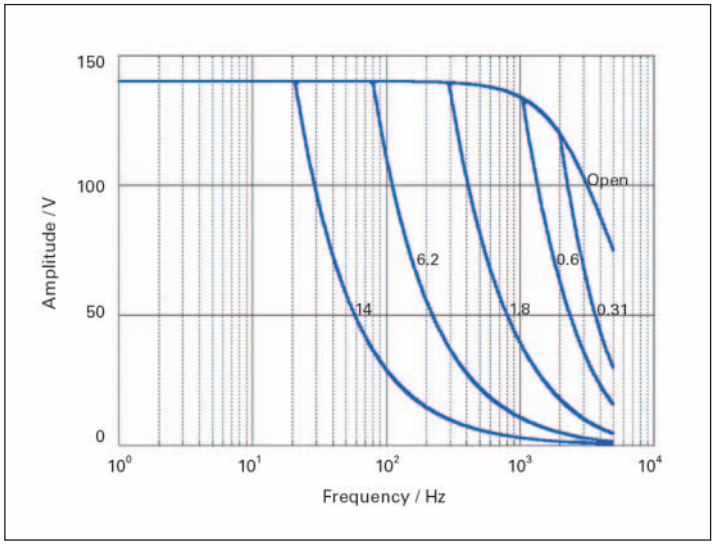
>> Extensive software package

Technology Glossary ..... page 240

| | E-709.SR / E-709.SRG | E-709.PR / E-709.PRG | E-709.CR / E-709.CRG |
|---|---|---|---|
| Sensor type | Strain Gauge Sensors | Piezoresistive sensors | Capacitive sensors |
| Function | Digital controller for single-axis piezo nanopositioning systems (.SR: OEM board) | Digital controller for single-axis piezo nanopositioning systems (.PR: OEM board) | Digital controller for single-axis piezo nanopositioning systems (.CR: OEM board) |
| Channels | 1 | 1 | 1 |
| Processor | DSP 32-bit floating point, 150 MHz | DSP 32-bit floating point, 150 MHz | DSP 32-bit floating point, 150 MHz |
| Servo characteristics | P-I, two notch filters, sensor linearization | P-I, two notch filters, sensor linearization | P-I, two notch filters, sensor linearization |
| Sampling rate, servo-control | 10 kHz | 10 kHz | 10 kHz |
| Sampling rate, sensor | 10 kHz | 10 kHz | 10 kHz |
| **Sensor** | | | |
| Linearization | 5th order polynomials | 5th order polynomials | 5th order polynomials |
| Sensor bandwidth | 5 kHz | 5 kHz | 5 kHz |
| Sensor resolution | 16 bit | 16 bit | 16 bit |
| Ext. synchronization | No | No | No |
| **Amplifier** | | | |
| Output voltage | –30 V to 130 V | –30 V to 130 V | –30 V to 130 V |
| Peak output power (<5 ms) | 10 W | 10 W | 10 W |
| Average output power (>5 ms) | 5 W | 5 W | 5 W |
| Peak current (<5 ms) | 100 mA | 100 mA | 100 mA |
| Average output current (>5 ms) | 50 mA | 50 mA | 50 mA |
| Current limitation | Short-circuit-proof | Short-circuit-proof | Short-circuit-proof |
| Resolution DAC | 17 bit | 17 bit | 17 bit |
| **Interfaces and operation** | | | |
| Communication interfaces | USB, RS-232, SPI | USB, RS-232, SPI | USB, RS-232, SPI |
| Piezo / sensor connection | Sub-D, 9-pin | Sub-D, 9-pin | Sub-D special connector |
| I/O connector | HD Sub-D 26-pin<br>1 analog input 0 to 10 V<br>1 sensor monitor 0 to 10 V<br>1 digital input (LVTTL, programmable)<br>1 analog output<br>5 digital outputs (LVTTL, 3 × predefined, 2 × programmable) | HD Sub-D 26-pin<br>1 analog input 0 to 10 V<br>1 sensor monitor 0 to 10 V<br>1 digital input (LVTTL, programmable)<br>1 analog output<br>5 digital outputs (LVTTL, 3 × predefined, 2 × programmable) | HD Sub-D 26-pin<br>1 analog input 0 to 10 V<br>1 sensor monitor 0 to 10 V<br>1 digital input (LVTTL, programmable)<br>1 analog output<br>5 digital outputs (LVTTL, 3 × predefined, 2 × programmable) |
| Command set | PI General Command Set (GCS) | PI General Command Set (GCS) | PI General Command Set (GCS) |
| User software | PIMikroMove | PIMikroMove | PIMikroMove |
| Software drivers | LabVIEW driver, dynamic libraries for Windows and Linux, MATLAB, MetaMorph, µManager, Andor iQ | LabVIEW driver, dynamic libraries for Windows and Linux, MATLAB, MetaMorph, µManager, Andor iQ | LabVIEW driver, dynamic libraries for Windows and Linux, MATLAB, MetaMorph, µManager, Andor iQ |
| Supported functions | Wave generator, data recorder, auto zero, trigger I/O | Wave generator, data recorder, auto zero, trigger I/O | Wave generator, data recorder, auto zero, trigger I/O |
| Display | Status LED, overflow LED | Status LED, overflow LED | Status LED, overflow LED |
| **Miscellaneous** | | | |
| Operating temperature range | 8 to 50°C (above 40°C, power derated) | 8 to 50°C (above 40°C, power derated) | 12 to 50°C (above 40°C, power derated) |
| Dimensions | 160 mm × 96 mm × 33 mm | 160 mm × 96 mm × 33 mm | 160 mm × 96 mm × 33 mm |
| Mass | 260 g / 470 g | 260 g / 470 g | 260 g / 470 g |
| Operating voltage | 24 VDC | 24 VDC | 24 VDC |
| Max. power consumption | 24 W | 24 W | 24 W |

# E-709.CHG Digital Single Channel Piezo Controller

**High Output Power for Dynamic Operation, Capacitive Sensors**


E-709.CHG: Operating limits (open-loop) with different PZT loads, capacity is measured in µF

- Output power up to 50 W
- Linearity error up to 0.02 %
- USB, RS-232
- SPI: Fast 25 Mbit/s serial interface
- Comprehensive I/O functions

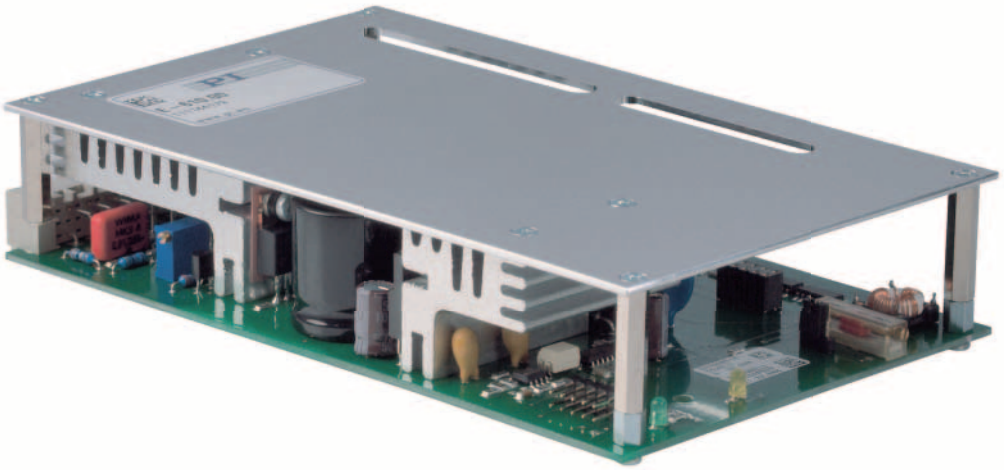

>> Extensive software package

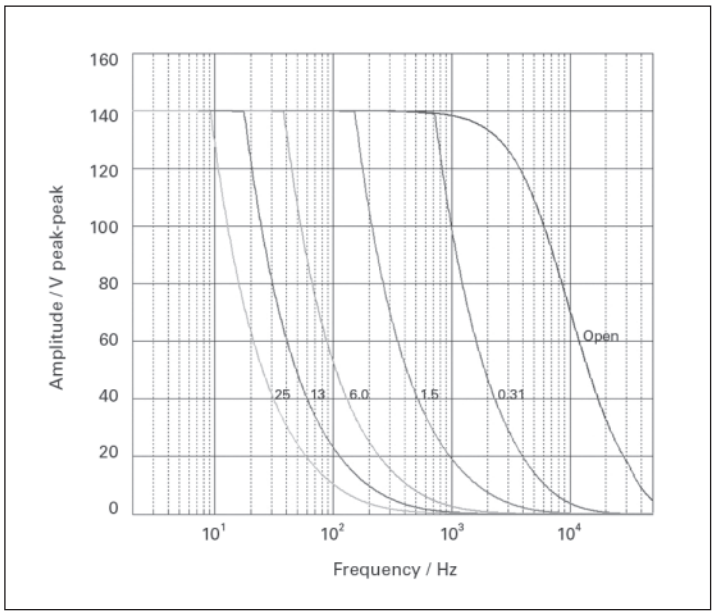
Technology Glossary ..... page 240

| | E-709.CHG |
|---|---|
| Function | Digital, highly dynamic controller for single-axis piezo nanopositioning systems |
| Channels | 1 |
| Processor | DSP 32-bit floating point, 150 MHz |
| Servo characteristics | P-I, 2 notch filter, sensor linearization |
| Sampling rate, servo-control | 10 kHz |
| Sampling rate, sensor | 10 kHz |
| **Sensor** | |
| Sensor type | Capacitive |
| Linearization | 5th order polynomials |
| Sensor bandwidth | 5 kHz |
| Sensor resolution | 16 bit |
| Ext. synchronization | Yes |
| **Amplifier** | |
| Output voltage | –30 to 130 V |
| Peak output power, <2 ms | 50 W |
| Average output power (>5 ms) | 15 W |
| Peak current, <2 ms | 500 mA |
| Average output current (>5 ms) | 160 mA |
| Current limitation | Short-circuit-proof |
| Resolution DAC | 17 bit |
| **Interface and operation** | |
| Communication interfaces | USB, RS-232, SPI |
| Piezo / sensor connection | Sub-D special connector |
| I/O connector | HD Sub-D 26-pin<br>1 analog input 0 to 10 V<br>1 sensor monitor 0 to 10 V<br>1 digital input (LVTTL, programmable)<br>1 analog output<br>5 digital outputs (LVTTL, 3 × predefined, 2 × programmable) |
| Command set | PI General Command Set (GCS) |
| User software | PIMikroMove, NanoCapture |
| Software drivers | LabVIEW driver, shared libraries for Windows and Linux.<br>Supported by MATLAB, MetaMorph, µManager, Andor iQ |
| Supported functionality | Wave generator, Datenrecorder, auto zero, trigger I/O |
| Display | Status LED, overflow LED |
| **Miscellaneous** | |
| Operating temperature range | 5 to 50 °C |
| Dimensions | 320 mm × 150 mm × 80 mm |
| Mass | 2.5 kg |
| Operating voltage | 24 VDC, in the scope of delivery: external power supply |
| Max. power consumption | 45 W |

# E-610 Piezo Amplifier / Servo Controller

**1-Channel OEM Piezo Driver Module with Optional Position Servo-Control**





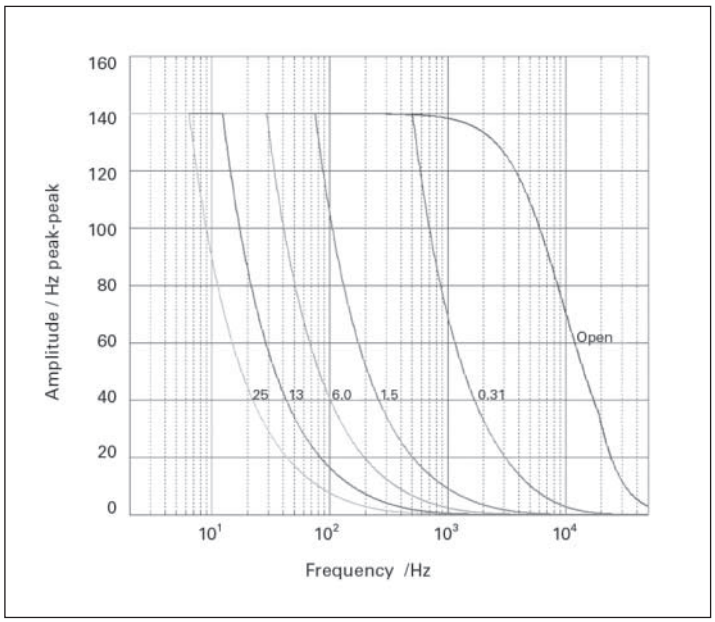

E-610: Operating limits with various PZT loads (open-loop), capacitance is measured in µF

- Inexpensive 1-channel OEM solution
- Closed-loop and open-loop versions
- Notch filter for higher bandwidth
- Position control for SGS and capacitive sensors
- Peak current 180 mA
- Capacitive and SGS feedback sensors

| | E-610.00 | E-610.C0 | E-610.S0 | Unit |
|---|---|---|---|---|
| Function | Piezo Amplifier, 1 Channel, OEM Module | Piezo Amplifier / Servo-Controller, OEM Module | Piezo Amplifier / Servo-Controller, OEM Module | |
| **Sensor** | | | | |
| Servo characteristics | – | P-I (analog), notch filter | P-I (analog), notch filter | |
| Sensor type | – | Capacitive | SGS | |
| Amplifier | | | | |
| Control input voltage | –2 to 12 | –2 to 12 | –2 to 12 | V |
| Output voltage | –30 to 130 | –30 to 130 | –30 to 130 | V |
| Peak current | 180 (<15 ms) | 180 (<50 ms) | 180 (<15 ms) | mA |
| Average current | 100 | 100 | 100 | mA |
| Current limitation | Short-circuit-proof | Short-circuit-proof | Short-circuit-proof | |
| Noise, 0 to 100 kHz | 1.6 | 0.5 | 1.6 | $mV_{rms}$ |
| Voltage gain | 10 ±0.1 | 10 ±0.1 | 10 ±0.1 | |
| Input impedance | 100 | 100 | 100 | kΩ |
| **Interface and operation** | | | | |
| Input / Output | 32-pin (m) on rear panel (DIN 41612 / D) | 32-pin (m) on rear panel (DIN 41612 / D) | 32-pin (m) on rear panel (DIN 41612 / D) | |
| Piezo connector | LEMO | LEMO | LEMO | |
| Sensor connection | – | LEMO | LEMO | |
| DC offset | External potentiometer (not included), adds 0 to 10 V to Control In | External potentiometer (not included), adds 0 to 10 V to Control In | External potentiometer (not included), adds 0 to 10 V to Control In | |
| **Miscellaneous** | | | | |
| Operating temperature range | 5 to 50 | 5 to 50 | 5 to 50 | °C |
| Dimensions | 7 HP / 3 RU | 7 HP / 3 RU | 7 HP / 3 RU | |
| Mass | 0.3 | 0.35 | 0.35 | kg |
| Operating voltage | 12 to 30 | 12 to 30 | 12 to 30 | VDC, stabilized |
| Current consumption, max. | 2 | 2 | 2 | A |

# E-625 Piezo Servo-Controller & Driver

## Compact Bench-Top Device with High-Speed Interface


E-625: Operating limits with various PZT loads (open-loop), capacitance is measured in µF

- Integrated 24-Bit USB Interface
- Network capability with up to 12 channels
- Peak current 120 mA
- Position control for SGS and capacitive sensors
- Notch filter for higher bandwidth
- Table for User-Defined Curves
- Additional Analog Interface


>> **Extensive software package**

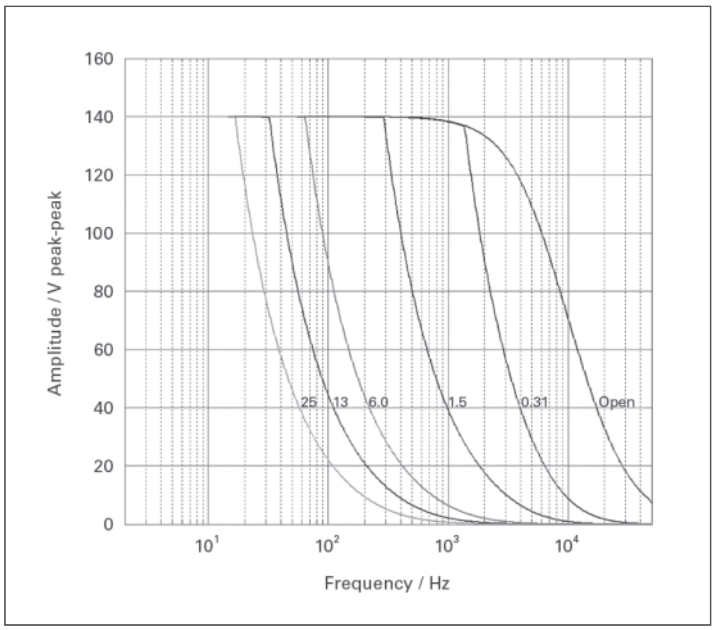
**Technology Glossary** ..... **page 240**

| | E-625.SR / E-625.CR |
|---|---|
| Function | Piezo amplifier / servo controller |
| Axes | 1 |
| **Sensor** | |
| Servo characteristics | P-I (analog), notch filter |
| Sensor type | SGS (.S) / capacitive (.C) |
| **Amplifier** | |
| Control input voltage range | –2 to +12 V |
| Min. output voltage | –30 to +130 V |
| Peak current, <50 ms | 120 mA |
| Average current | 60 mA |
| Current limitation | Short-circuit-proof |
| Noise, 0 to 100 kHz | 0.8 $mV_{rms}$ |
| Voltage gain | 10 ±0.1 |
| Input impedance | 100 kΩ |
| **Interfaces and operation** | |
| Interface / communication* | USB, RS-232 (9-pin Sub-D connector, 9.6 – 115.2 kBaud), 24-bit A/D and 20-bit D/A |
| Piezo connector | LEMO ERA.00.250.CTL (.SR) / Sub-D special (.CR) |
| Sensor connection | LEMO EPL.0S.304.HLN (.SR) / Sub-D special (.CR) |
| Control input sockets | SMB |
| Sensor monitor socket | SMB |
| Controller network | up to 12 channels |
| Command set* | PI General Command Set (GCS) |
| User software* | PIMikroMove |
| Software drivers* | LabVIEW driver, dynamic libraries for Windows (DLL) and Linux |
| Supported functionality* | Wave table, 256 data points, external trigger, up to 16 macros |
| **Miscellaneous** | |
| Operating temperature range | 5 to 50 °C |
| Overtemp protection | Deactivation at 75 °C |
| Dimensions | 205 mm × 105 mm × 60 mm |
| Mass | 1.05 kg |
| Operating voltage | 12 to 30 V DC, stabilized |
| Current consumption | 2 A |

* E-625.S0 and E-625.C0 without digital interface.

# E-665 Piezo Amplifier / Servo Controller

**Display, Analog & Digital Interface**


E-665: Operating limits with various PZT loads (open-loop), capacitance is measured in µF

- Integrated 24-Bit USB Interface
- Network capability with up to 12 channels
- Peak current 360 mA
- Notch filter for higher bandwidth
- Position control for SGS and capacitive sensors
- Table for User-Defined Curves
- RS-232 Analog Interface

>> **Extensive software package**

**Technology Glossary** ..... **page 240**

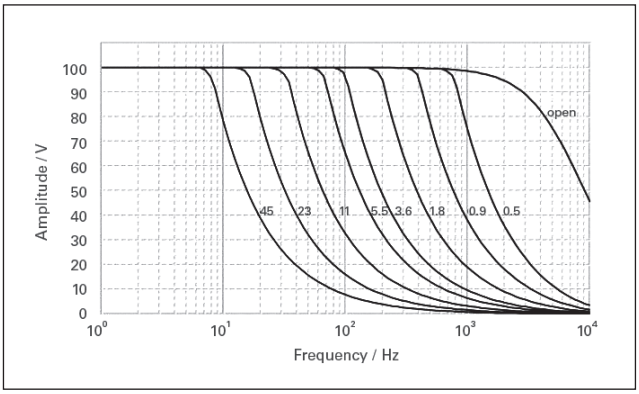
| | E-665.SR / E-665.CR |
|---|---|
| Function | Piezo amplifier & position servo-controller with digital interface |
| Axes | 1 |
| **Sensor** | |
| Servo characteristics | P-I (analog), notch filter |
| Sensor type | SGS (.SR) / capacitive (CR) |
| **Amplifier** | |
| Control input voltage range | –2 to +12 V |
| Output voltage | –30 to +130 V |
| Peak current, <20 ms | 360 mA |
| Average current | 150 mA |
| Current limitation | Short-circuit-proof |
| Noise, 0 to 100 kHz | 0.5 (.SR) / 4.0 (.CR) $mV_{rms}$ |
| Voltage gain | 10 ±0.1 |
| Input impedance | 100 kΩ |
| **Interface and operation** | |
| Communication interfaces | USB, RS-232 (9-pin Sub-D connector, 9.6 – 115.2 kBaud), 24-bit A/D and 20-bit D/A |
| Piezo connector | LEMO ERA.00.250.CTL (.SR) / Sub-D special (.CR) |
| Sensor connection | LEMO EPL.0S.304.HLN (.SR) / Sub-D special (.CR) |
| Analog input | BNC |
| Sensor monitor socket | BNC |
| Controller network | up to 12 channels, parallel |
| Supported functionality | Wave table; 256 data points, external trigger, up to 16 macros |
| Display | 2 × 4½ digit, LED |
| DC Offset | 10-turn pot., adds 0 to 10 V to Control In |
| **Miscellaneous** | |
| Operating temperature range | 5 to 40 °C |
| Overtemp protection | Deactivation at 85 °C |
| Dimensions | 236 mm × 88 mm × 273 mm + handles |
| Mass | 2.5 kg |
| Operating voltage | 115 VAC / 230 VAC, 50-60 Hz (linear power supply) |
| Max. power consumption | 60 W |

Ask about custom designs!

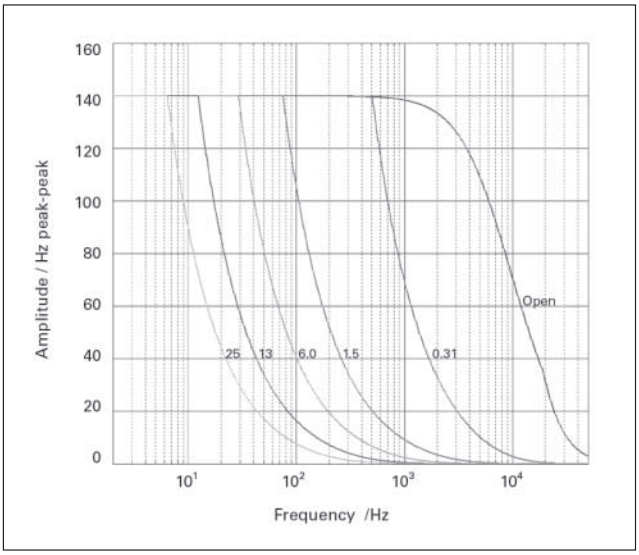
# E-621 Piezo Servo-Controller & Driver

## Modules with Fast 24-Bit Interface


- Integrated 24-Bit USB Interface, RS-232
- Network capability with up to 12 channels
- Peak current up to 120mA
- Position control for SGS and capacitive sensors
- Notch filter for higher bandwidth
- Additional Analog Interface
- Table for User-Defined Curves




E-621.SR: operating limits with various PZT loads (open-loop), capacitance is measured in µF

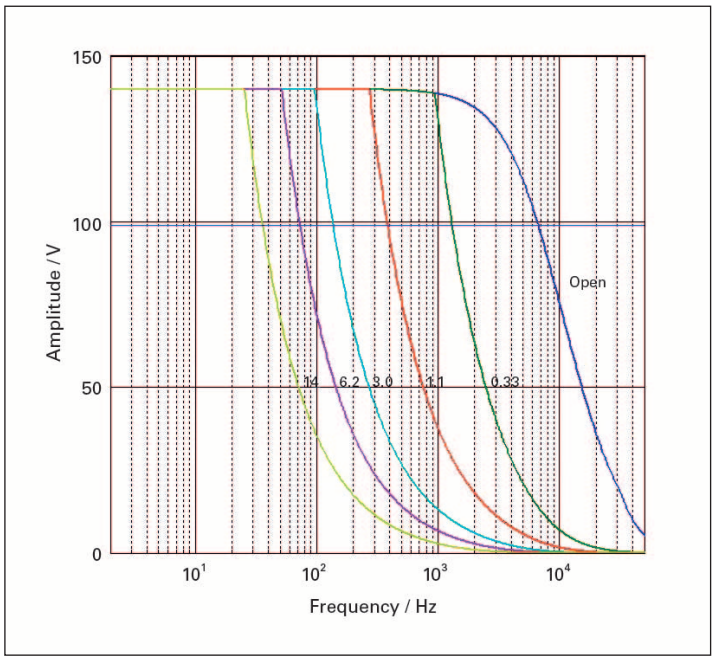



E-621: Operating limits with various PZT loads (open-loop), capacitance is measured in µF

| | E-621.SR / E-621.CR |
|---|---|
| Function | Power amplifier & piezo controller |
| **Sensor** | |
| Servo characteristics | P-I (analog), notch filter |
| Sensor type | SGS (.S) / capacitive (.C) |
| **Amplifier** | |
| Input voltage | –2 to +12 V |
| Output voltage | –30 to +130 V |
| Peak current, <50 ms | 120 mA |
| Average current | 60 mA |
| Current limitation | Short-circuit-proof |
| Noise, 0 to 100 kHz | 0.8 $mV_{rms}$ |
| Voltage gain | 10 ±0.1 |
| Input impedance | 100 kΩ |
| **Interface and operation** | |
| Interface / communication | USB, RS-232 (9-pin Sub-D connector, 9.6 – 115.2 kBaud), 24-bit A/D and 20-bit D/A |
| Piezo connector | LEMO ERA.00.250.CTL (.SR) / Sub-D special (.CR) |
| Sensor connection | LEMO EPL.0S.304.HLN (.SR) / Sub-D special (.CR) |
| Analog input | SMB |
| Sensor monitor output | SMB |
| Controller network | up to 12 channels, parallel |
| Command set | PI General Command Set (GCS) |
| User software | PIMikroMove |
| Software drivers | LabVIEW drivers, DLLs |
| Supported functionality | Wave table, 256 data points, external trigger, 16 macros |
| DC Offset | External potentiometer (not included), adds 0 to 10 V to Control In |
| **Miscellaneous** | |
| Operating temperature range | 5 °C to 50 °C (above 40 °C, power derated) |
| Overtemp protection | Deactivation at 75 °C |
| Dimensions | 7HP/3RU |
| Mass | 0.6 kg |
| Operating voltage | 12 to 30 V DC, stabilized |
| Current consumption, max. | 2 A |

# E-727 Digital Multi-Channel Piezo Controller

**For Nanopositioning Systems with Capacitive, Piezoresistive or Strain Gauge Sensors**


E-727: Operating limits (open-loop) with various capacitive loads, capacitance values in µF

- 20 kHz control bandwidth
- Interfaces: Ethernet, USB, RS-232, SPI
- Digital inputs and outputs
- Optional analog inputs and outputs
- Autoloading of calibration data from stage ID chip for interchangeability of controller and mechanics
- 4t$^{h}$ order polynomial linearization for mechanics and electronics

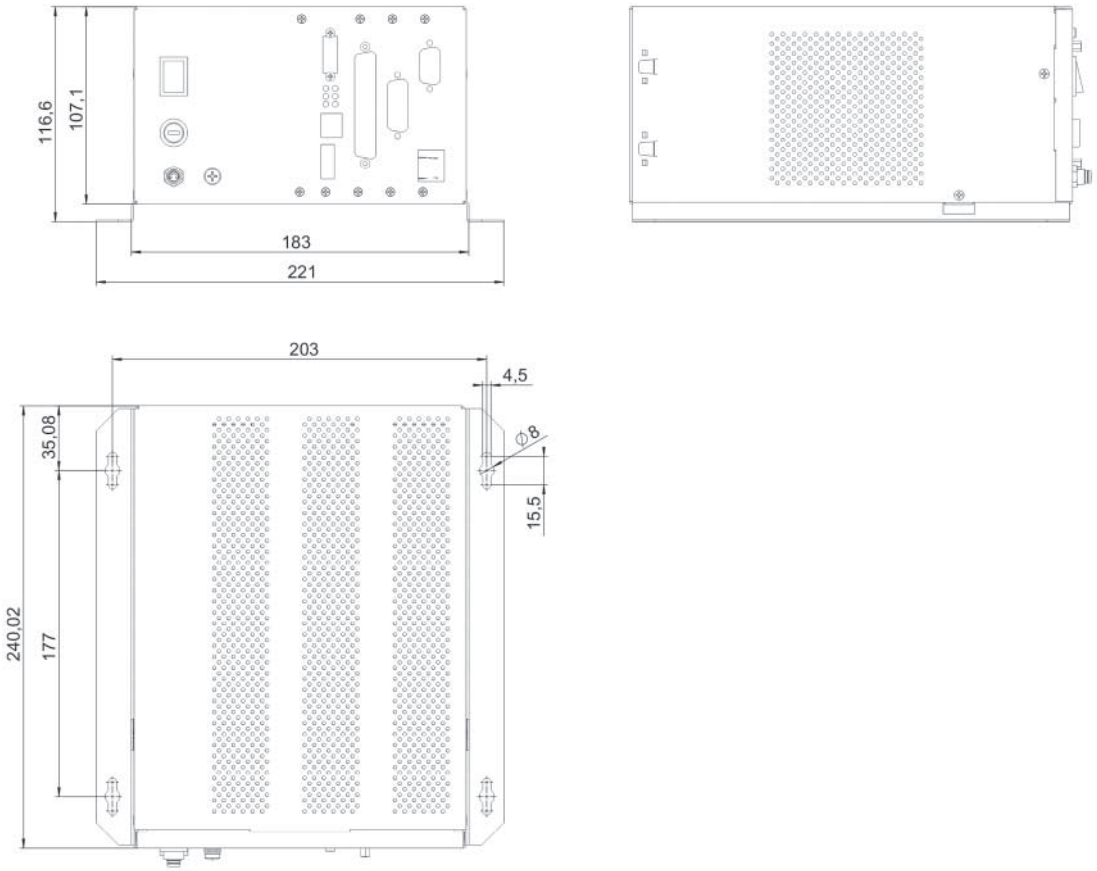

>> **Extensive Software Package**

**Technology Glossary** ..... **page 240**

| | E-727.3CD<br>E-727.3CDA | E-727.3SD<br>E-727.3SDA<br>E-727.4SD | E-727.3RD<br>E-727.3RDA<br>E-727.4RD | Unit | Tolerance |
|---|---|---|---|---|---|
| Function | Digital controller for multi-axis piezo nanopositioning systems with capacitive sensors<br>.3CDA: Additional analog interfaces | Digital controller for multi-axis piezo nanopositioning systems with strain gauge sensors<br>.3SDA: Additional analog interfaces | Digital controller for multi-axis piezo nanopositioning systems with piezoresistive sensors<br>.3RDA: Additional analog interfaces | | |
| Axes | 3 | E-727.3x: 3<br>E-727.4x: 4 | E-727.3x: 3<br>E-727.4x: 4 | | |
| Processor | DSP 32/64-bit, floating point, 375 MHz | DSP 32/64-bit, floating point, 375 MHz | DSP 32/64-bit, floating point, 375 MHz | | |
| Sampling rate, servo control | 20 | 20 | 20 | kHz | |
| Sampling rate, sensor | 100 | 100 | 100 | kHz | |
| **Sensor** | | | | | |
| Servo characteristics | P-I, two notch filters<br>Optional: Advanced piezo control | P-I, two notch filters<br>Optional: Advanced piezo control | P-I, two notch filters<br>Optional: Advanced piezo control | | |
| Sensor type | Capacitive | Strain gauge sensors | Piezoresistive | | |
| Sensor channels | 3 | 4 | 4 | | |
| Sensor bandwidth (-3 dB) | 10 | 10 | 10 | kHz | max. |
| Sensor resolution (at 1 kHz oversampling) | 20 | 20 | 20 | Bit | |
| **Amplifier** | | | | | |
| Output voltage | –30 to 130 | –30 to 130 | –30 to 130 | V | ±3 V |
| Amplifier channels | 4 | 4 | 4 | | |
| Peak output power per channel, max. 30 ms | 28 | 28 | 28 | W | max. |
| Average output power per channel | 14 | 14 | 14 | W | max. |
| Peak current per channel, max. 30 ms | 180 | 180 | 180 | mA | max. |
| Average output current per channel | 75 | 75 | 75 | mA | max. |
| Current limitation | Short-circuit proof | Short-circuit proof | Short-circuit proof | | |
| Resolution DAC | 20 | 20 | 20 | Bit | |
| Amplifier bandwidth | 6.5 | 6.5 | 6.5 | kHz | |
| **Interfaces and operation** | | | | | |
| Interface / communication | Ethernet, USB, RS-232, serial SPI high-speed interface | Ethernet, USB, RS-232, serial SPI high-speed interface | Ethernet, USB, RS-232, serial SPI high-speed interface | | |
| Piezo / sensor connection | Sub-D 25W3 (f) | Sub-D 37 (f) | Sub-D 37 (f) | | |
| Analog inputs (only .3xDA) | Sub-D 15 (f)<br>4 inputs<br>±5 V or ±10 V<br>18-bit A/D converter | Sub-D 15 (f)<br>4 inputs<br>±5 V or ±10 V<br>18-bit A/D converter | Sub-D 15 (f)<br>4 inputs<br>±5 V or ±10 V<br>18-bit A/D converter | | |
| Analog output (only .3xDA) | Sub-D 15 (f)<br>±10 V<br>20-bit D/A converter | Sub-D 15 (f)<br>±10 V<br>20-bit D/A converter | Sub-D 15 (f)<br>±10 V<br>20-bit D/A converter | | |
| Sensor monitor (only .3xDA) | Sub-D 15 (f)<br>Sensor channels 1 to 3 | Sub-D 15 (f)<br>Sensor channels 1 to 3 | Sub-D 15 (f)<br>Sensor channels 1 to 3 | | |

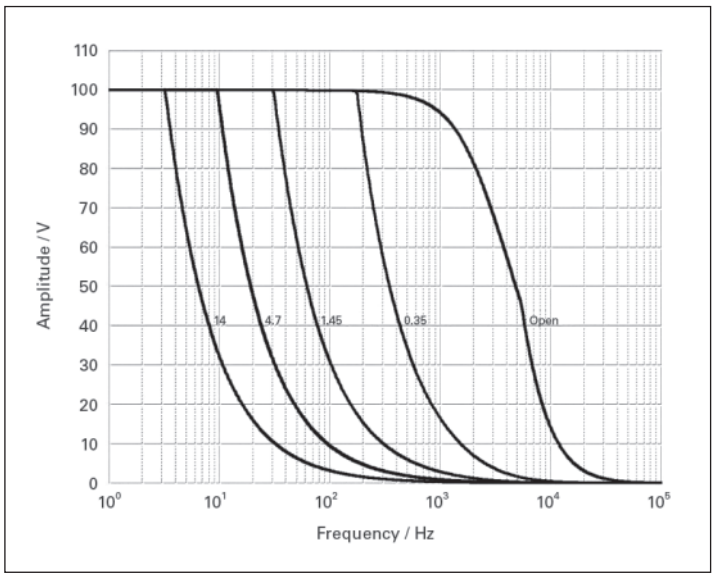
| | E-727.3CD<br>E-727.3CDA | E-727.3SD<br>E-727.3SDA<br>E-727.4SD | E-727.3RD<br>E-727.3RDA<br>E-727.4RD | Unit | Tolerance |
|---|---|---|---|---|---|
| Digital input/output | MDR14; 4 inputs, 4 outputs | MDR14; 4 inputs, 4 outputs | MDR14; 4 inputs, 4 outputs | | |
| Command set | PI General Command Set (GCS) | PI General Command Set (GCS) | PI General Command Set (GCS) | | |
| User software | PIMikroMove | PIMikroMove | PIMikroMove | | |
| Software drivers | LabVIEW driver, shared libraries for Windows, and Linux | LabVIEW driver, shared libraries for Windows, and Linux | LabVIEW driver, shared libraries for Windows, and Linux | | |
| Supported functions | Wave generator, data recorder, macros | Wave generator, data recorder, macros | Wave generator, data recorder, macros | | |
| Display and indicators | LEDs for Power, Servo, Error, Overflow | LEDs for Power, Servo, Error, Overflow | LEDs for Power, Servo, Error, Overflow | | |
| Linearization | 4th order polynomials, DDL (Dynamic Digital Linearization) | 4th order polynomials, DDL (Dynamic Digital Linearization) | 4th order polynomials, DDL (Dynamic Digital Linearization) | | |
| Separate protective earth connection | Yes | Yes | Yes | | |
| **Miscellaneous** | | | | | |
| Operating temperature range | 5 to 40 | 5 to 40 | 5 to 40 | °C | |
| Overheat protection | Max. 72 °C, deactivation of the voltage output | Max. 72 °C, deactivation of the voltage output | Max. 72 °C, deactivation of the voltage output | | |
| Mass | 2.4 to 2.6 | 2.4 to 2.6 | 2.4 to 2.6 | kg | approx. |
| Power consumption | 80 | 80 | 80 | W | max. |
| Power consumption without load | 24 | 24 | 24 | W | max. |
| Operating voltage | 24 V DC (external power supply in the scope of delivery) | 24 V DC (external power supply in the scope of delivery) | 24 V DC (external power supply in the scope of delivery) | | |
| Dimensions | 221 mm × 117 mm × 240 mm, incl. mounting rails | 221 mm × 117 mm × 240 mm, incl. mounting rails | 221 mm × 117 mm × 240 mm, incl. mounting rails | | |

E-727, dimensions in mm



# E-616 Controller for Multi-Axis Piezo Tip / Tilt Mirrors and Platforms

**Flexible Multi-Channel OEM Electronics with Coordinate Transformation**


E-616: operating limits with various PZT loads (open-loop), capacitance is measured in µF

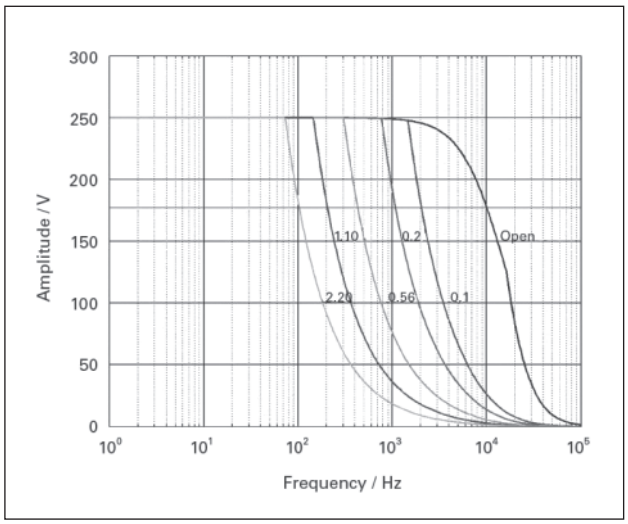
- Three integrated amplifiers provide up to 10 W peak power
- Closed-loop and open-loop versions
- Internal coordinate transformation simplifies control of parallel kinematics designs (tripod & differential drive)
- Compact and cost-effective design for OEMs or bench-top

| | E-616.S0 / S0G | E-616.SS0 / SS0G | Unit |
|---|---|---|---|
| Function | E-616.S0: Controller for parallel-kinematics piezo tip / tilt mirror systems with strain gauge sensors, tripod design<br>E-616.S0G: E-616.S0 with casing | E-616.SS0: Controller for parallel-kinematics piezo tip / tilt mirror systems with strain gauge sensors, differential design<br>E-616.SS0G: E-616.SS0 with casing | |
| Tip / tilt axes | 2 | 2 | |
| **Sensor** | | | |
| Servo characteristics | P-I (analog), notch filter | P-I (analog), notch filter | |
| Sensor type | SGS | SGS | |
| Sensor channels | 3 | 2 | |
| External synchronization | 200 | 200 | kHz TTL |
| **Amplifier** | | | |
| Control input voltage | –2 to 12 | –2 to 12 | V |
| Output voltage | –30 to 130 | –30 to 130;<br>additional fixed voltage 100 V | V |
| Amplifier channels | 3 | 3 | |
| Peak output power per channel | 10 | 10 | W |
| Average output power per channel | 5 | 5 | W |
| Peak current per channel | 100 | 100 | mA |
| Average output current per channel | 50 | 50 | mA |
| Current limitation | Short-circuit-proof | Short-circuit-proof | |
| Voltage gain | 10 | 10 | |
| Amplifier bandwidth, small signal | 3 kHz | 3 kHz | |
| Ripple, noise, 0 to 100 kHz | <20 $mV_{pp}$<br><2 $mV_{rms}$ | <20 $mV_{pp}$<br><2 $mV_{rms}$ | |
| Amplifier resolution | <1 | <1 | mV |
| **Interface and operation** | | | |
| Piezo / sensor connector | Sub-D 25-pin | Sub-D 25-pin | |
| Analog input | E-616.S0: 32-pin DIN 41612 connector<br>E-616.S0G: SMB connector | E-616.SS0: 32-pin DIN 41612 connector<br>E-616.SS0G: SMB connector | |
| Sensor monitor signal | 0 to 10 V for nominal displacement | 0 to 10 V for nominal displacement | |
| Sensor monitor output | E-616.S0: 32-pin DIN 41612 connector<br>E-616.S0G: 15-pin Sub-D connector | E-616.SS0: 32-pin DIN 41612 connector<br>E-616.SS0G: 15-pin Sub-D connector | |
| Display | Power-LED and sensor OFL display | Power-LED and sensor OFL display | |
| **Miscellaneous** | | | |
| Operating temperature range | 5 to 50 | 5 to 50 | °C |
| Overheat protection | Max. 75 °C, deactivation of the piezo voltage output | Max. 75 °C, deactivation of the piezo voltage output | |
| Dimensions | E-616.S0: 186 mm × 128.4 mm × 10 HP<br>E-616.S0G: 205 mm × 105 mm × 54.1 mm | E-616.SS0: 186 mm × 128.4 mm × 10 HP<br>E-616.SS0G: 205 mm × 105 mm × 54.1 mm | |
| Mass | E-616.S0: 950<br>E-616.S0G: 1200 | E-616.SS0: 950<br>E-616.SS0G: 1200 | g |
| Operating voltage | E-616.S0: 12 to 30<br>E-616.S0G: 23 to 26 | E-616.SS0: 12 to 30<br>E-616.SS0G: 23 to 26 | VDC |
| Power consumption | 30 | 30 | W |

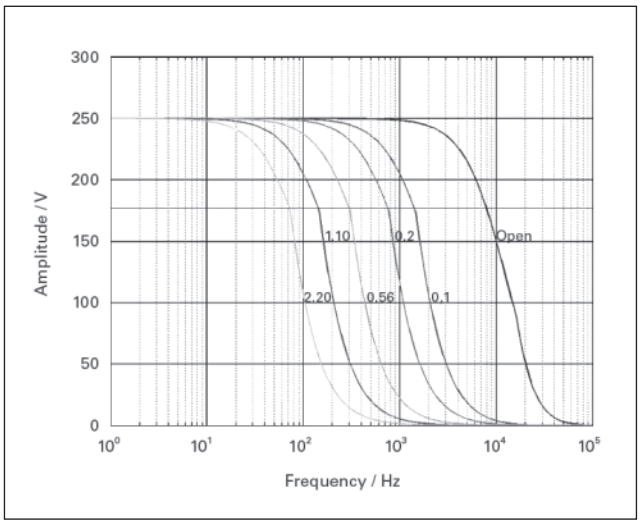
# E-536 PicoCube Piezo Controller

**High Dynamics, High Resolution, for up to 3 Axes**


- For P-363 PicoCube systems
- Peak power 3 × 100 W
- Ultra-low noise
- High dynamics and high resolution
- Output voltage ±250 V




E-536.3x: operating limits with various PZT loads, capacitance is measured in µF



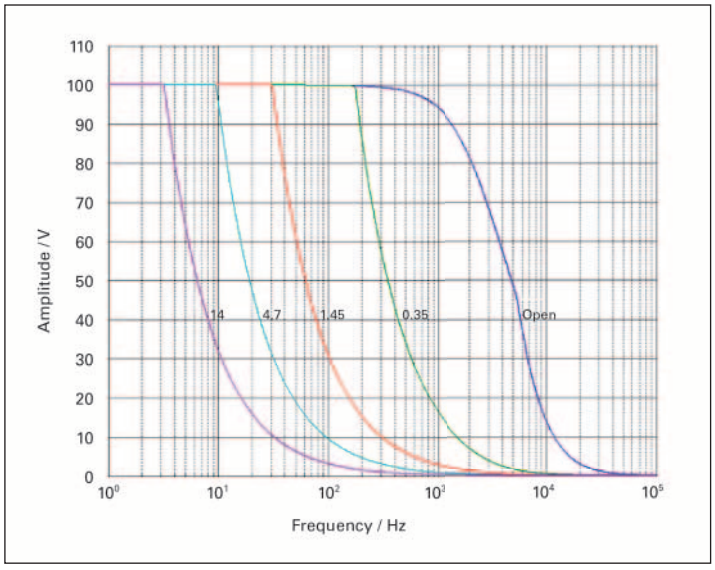

E-536.3xH: operating limits with various PZT loads, capacitance is measured in µF

| | E-536.3C / E-536.30 | E-536.3CH / E-536.30H |
|---|---|---|
| Function | Power amplifier & servo-controller for P-363 PicoCube | High-resolution power amplifier & servo-controller for P-363 PicoCube |
| **Amplifier** | | |
| Output voltage | –250 to +250 V | –250 to +250 V |
| Amplifier channels | 3 | 3 |
| Average output power per channel | 10 W, limited by temperature sensor | 6 W, limited by temperature sensor |
| Peak output power per channel, <3 ms | 100 W | 50 W |
| Average current | 30 mA | 15 mA |
| Peak output current per channel, <3 ms | 200 mA | 100 mA |
| Amplifier bandwidth, small signal | 10 kHz | 2 kHz |
| Amplifier bandwidth, large signal, @ 100 nF | 0.2 kHz | 0.125 kHz |
| Ripple, noise 0 to 100 kHz | 0.8 $mV_{rms}$ <5 $mV_{pp}$ (100 nF) | 0.5 $mV_{rms}$ <3 $mV_{pp}$ (100 nF) |
| Current limitation | Short-circuit-proof | Short-circuit-proof |
| Voltage gain | 50 | 50 |
| Input impedance | 100 kΩ | 100 kΩ |
| **Sensor*** | | |
| Servo characteristics | Analog proportional-integral (P-I) algorithm with notch filter | Analog proportional-integral (P-I) algorithm with notch filter |
| Sensor type | Capacitive sensors | Capacitive sensors |
| Sensor channels | 3 / – | 3 / – |
| Sensor bandwidth | 1.5 kHz | 1.5 kHz |
| Sensor monitor output | 0 to +10 V | 0 to +10 V |
| **Interface and operation** | | |
| Piezo connector | LEMO EGG.0B.701.CJL.1173 | LEMO EGG.0B.701.CJL.1173 |
| Sensor target and probe sockets | LEMO EPL.00.250.NTD | LEMO EPL.00.250.NTD |
| Control input sockets | SMB | SMB |
| Sensor monitor socket | LEMO FGG.0B.306.CLAD56 | LEMO FGG.0B.306.CLAD56 |
| Control input voltage | Servo off: -5 to +5 V, Servo on: 0 to +10 V | Servo off: -5 to +5 V, Servo on: 0 to +10 V |
| DC-Offset | 10-turn pot., adds 0 to +10 V to Control IN | 10-turn pot., adds 0 to +10 V to Control IN |
| **Miscellaneous** | | |
| Operating voltage | 115 VAC / 50-60 Hz or 230 VAC / 50-60 Hz | 115 VAC / 50-60 Hz or 230 VAC / 50-60 Hz |
| Mass | 8.1 kg / 7.8 kg (with E-517 module) | 8.1 kg / 7.8 kg (with E-517 module) |
| Dimensions | 450 mm × 132 mm × 296 mm + handles | 450 mm × 132 mm × 296 mm + handles |

* only E-536.3Cx with capacitive sensors
Interfaces / communication: RS-232, TCP/IP and USB (with optional E-517 computer interface and display module only)
Operating temperature range: 5 to 50 °C (over 40 °C, max. av. power derated 10 %),
high-voltage output is automatically deactivated by internal temperature sensor if temperature is too high (75 °C max.)
Ask about custom designs!

# E-712 Digital Piezo Controller

## Modular System for up to 6 Axes for Highest Precision




E-712.3CD: Operating limits with various PZT loads, capacitance values in µF

- Modular design for greatest flexibility in meeting custom requirements
- Up to 50 kHz servo update rate
- Highly stable 20-bit D/A converter
- Real-time operating system for excellent trajectory control
- Optimal linearity for highest accuracy
- Autoloading of calibration data from stage ID chip for interchangeability of controller and mechanics
- Flexible interfaces: TCP/IP, USB, RS-232
- Optional high-bandwidth analog inputs and outputs
- Extensive software package
- Integrated motion profile generator


>> **Extensive software package**
>> **Linearization**

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## Preconfigured controllers

| | E 712.3CD, E-712.3CDA | E 712.6CD, E-712.6CDA |
|---|---|---|
| Function | Modular digital controller for multi-axis piezo nanopositioning systems with capacitive sensors | Modular digital controller for multi-axis piezo nanopositioning systems with capacitive sensors |
| Axes | 3 | 6 |
| Processor | PC-based, 600 MHz, real-time operating system | PC-based, 600 MHz, real-time operating system |
| Sampling rate, servo control | 50 kHz | 20 kHz |
| Sampling rate, sensor | 50 kHz | 20 kHz |
| **Sensor** | | |
| Controller type | P-I, two notch filters | P-I, two notch filters |
| Sensor type | Capacitive | Capacitive |
| Sensor channels | 3 | 6 |
| Sensor bandwidth (-3 dB) | 10 kHz | 10 kHz |
| Sensor resolution | 18 (interpolated: 20) bits | 18 (interpolated: 20) bits |
| External synchronization | Yes | Yes |
| **Amplifier** | | |
| Output voltage | –30 to 135 V | –30 to 135 V |
| Amplifier channels | 4 | 8 |
| Peak output power / channel* | 25 W | 25 W |
| Average output power per channel | 8 W | 8 W |
| Current limitation | Short-circuit proof | Short-circuit proof |
| Resolution DAC | 20 bits | 20 bits |
| Temperature sensor | Yes | Yes |
| **Interfaces and operation** | | |
| Communication interfaces | TCP/IP, USB, RS-232, SPI | TCP/IP, USB, RS-232, SPI |
| Piezo / sensor connection | Sub-D Mix 25W3 | Sub-D Mix 25W3 |
| Analog inputs | E-712.3CD: None<br>E-712.3CDA: LEMO:<br>4 × ±10 V differential; bandwidth: max. 25 kHz; resolution: 18 bit; max. impedance: 250 Ohm | E-712.6CD: None<br>E-712.6CDA: LEMO:<br>4 × ±10 V differential; bandwidth: max. 25 kHz; resolution: 18 bit; max. impedance: 250 Ohm |
| Analog outputs | E-712.3CD: None<br>E-712.3CDA: LEMO:<br>4 × ±10 V differential; bandwidth: max. 25 kHz; resolution: 16 bit | E-712.6CD: None<br>E-712.6CDA: LEMO:<br>4 × ±10 V differential; bandwidth: max. 25 kHz; resolution: 16 bit |
| Digital inputs/outputs | MDR20: 8 ×TTL | MDR20: 8 ×TTL |
| Command set | PI General Command Set (GCS) | PI General Command Set (GCS) |
| User software | PIMikroMove | PIMikroMove |
| Software drivers | LabVIEW drivers, DLLs | LabVIEW drivers, DLLs |
| Supported functions | Wave generator, trigger I/O, macros | Wave generator, trigger I/O, macros |
| Indicators | LEDs for OnTarget, Err, Power, OverTemp | LEDs for OnTarget, Err, Power, OverTemp |
| Linearization | 4th order polynomials, DDL option (Dynamic Digital Linearization) | 4th order polynomials, DDL option (Dynamic Digital Linearization) |
| **Miscellaneous** | | |
| Operating temperature range | 5 to 40 °C | 5 to 40 °C |
| Overheat protection | Max. 75 °C, deactivation of the voltage output | Max. 75 °C, deactivation of the voltage output |
| Mass | E-712.3CD: 5.35 kg<br>E-712.3CDA: 5.53 kg | E-712.6CD: 5.78 kg<br>E-712.6CDA: 5.96 kg |
| Dimensions | 9.5" housing, 236 mm × 132 mm × 296 mm + handles (47 mm length) | 9.5" housing, 236 mm × 132 mm × 296 mm + handles (47 mm length) |
| Max. power consumption | 225 W | 225 W |
| Operating voltage | 100 to 240 VAC, 50 to 60 Hz | 100 to 240 VAC, 50 to 60 Hz |

* The maximum output power is limited by the power supply of the housing and the number of available modules.

## Available Modules

| | | |
|---|---|---|
| Housing types | **E-712.R1** | 9.5" chassis with power supply for E-712 modular digital piezo controller system, for piezo voltages to 135 V, 3 to 6 axes |
| | **E-712.R2** | 19" chassis with power supply for E-712 modular digital piezo controller system, for piezo voltages to ±250 V, 3 to 6 axes |
| | **E-712.R3** | 19" chassis with power supply for E-712 modular digital piezo controller system, for piezo voltages to 135 V, 3 to 6 axes |
| | **E-712.R4** | 9.5" chassis with power supply for E-712 modular digital piezo controller system, for piezo voltages to ±250 V, 3 to 6 axes |
| | **E-712.R5** | Universal chassis 19" 4 RU with CPCI Bus |
| Master modules | **E-712.M1** | Digital processor and interface module, TCP/IP, USB, RS-232, SPI |
| | **E-712.N1** | Digital PiezoWalk® processor and interface module, TCP/IP, USB, RS-232, SPI |
| Amplifiers | **E-711.AL4P** | High-power amplifier module for E-712 modular digital piezo controller system, 4 channels, 8 W, –30 V to +135 V |
| | **E-711.AL41** | High-power amplifier module for E-712 modular digital piezo controller system, 4 channels, 8 W, –30 V to +135 V, Sub-D 25W3 (f) |
| | **E-711.AM4** | Amplifier module for NEXLINE®, for E-712 modular digital piezo controller system, –250 V to +250 V |
| | **E-711.AM5** | Amplifier module for NEXLINE®, for E-712 modular digital piezocontroller system, –250 V to +250 V, Sub-D 25 (f) |
| | **E-711.AM6** | Amplifier module for NEXLINE®, for E-712 modular digital piezo controller system, –250 V to +250 V, without external connector |
| | **E-711.AM5A** | Amplifier module for NEXLINE®, for E-712 modular digital piezo controller system, –250 V to +250 V, incremental Sin/Cos sensor input |
| | **E-711.AM5B** | Amplifier module for NEXLINE®, for E-712 modular digital piezo controller system, –250 V to +250 V, absolute encoder |
| | **E-711.AN4** | NEXACT® amplifier module, for E-712 modular digital piezo controller system |
| | **E-711.AN40** | NEXACT® amplifier module, for E-712 modular digital piezo controller system, without external connector |
| | **E-711.C82** | DC motor driver for E-712 modular digital piezo controller system, 2 axes |
| I/O modules: Sensor modules | **E-711.SA3** | Module for incremental sensors, 3 channels, for E-712 modular digital piezo controller system |
| | **E-711.SA6** | Module for incremental sensors, 6 channels, for E-712 modular digital piezo controller system |
| | **E-711.SS3** | Module for strain gauge sensors, 3 channels, for E-712 modular digital piezo controller system |
| | **E-711.SC3H** | Module for capacitive sensors, 3 channels, for E-712 modular digital piezo controller system |
| | **E-711.SE3** | Module for PISeca capacitive 1-electrode sensors, 3 channels, for E-712 modular digital piezo controller system |
| I/O modules: Sensor signal transmission | **E-711.0CT** | Digital sensor signal transmission, 3 channels, capacitive sensors, for E-712 modular digital piezo controller system |
| | **E-711.0CT0** | Digital sensor signal transmission, 3 channels, capacitive sensors, for E-712 modular digital piezo controller system, without cable |
| | **E-711.0ET** | Digital sensor signal transmission, 3 channels, PISeca sensors, for E-712 modular digital piezo controller system, with 10 m cable |
| | **E-711.0ET0** | Digital sensor signal transmission, 3 channels, PISeca sensors, for E-712 modular digital piezo controller system, without cable |
| | **E-711.0ATS** | Sensor box for digital sensor signal transmission, 3 channels, incremental or absolute sensors with BiSS interface, for E-712 modular digital piezo controller system |
| I/O modules: Interface modules | **E-711.IA4** | Analog interface module for E-712 modular digital piezo controller system, 4 inputs and outputs |
| | **E-711.IP** | PIO interface module for E-712 modular digital piezo controller system |
| | **E-711.iS3** | SPI interface module for E-712 modular digital piezo controller system, 3 channels |
| | **E-711.iS6** | SPI interface module for E-712 modular digital piezo controller system, 6 channels |
| Accessories | **E-711.SAP** | Sensor signal distributor for E-712 modular digital piezo controller system, 3 channels, for PIOne incremental sensors |
| | **E-711.SAH** | Sensor signal distributor for E-712 modular digital piezo controller system, 3 channels, for Heidenhain incremental sensors |
| | **E-711.SAN** | Sensor signal distributor for E-712 modular digital piezo controller system, 3 channels, for Numerik Jena incremental sensors |
| | **E-711.SAX** | Cable between digital piezo controller and sensor signal distributor, HD Sub-D 26 |
| | **E-711.SAX1** | Cable between digital piezo controller and sensor signal distributor, HD Sub-D 26, 3 m |
| | **E-711.SAX2** | Cable between digital piezo controller and sensor signal distributor, HD Sub-D 26, 5 m |
| | **E-711.SAX5** | Cable between digital piezo controller and sensor signal distributor, HD Sub-D 26, 15 m |

For system configuration consultancy, contact your PI representative.

## Housing types and modules

| Housing types | E-712.R1 / E-712.R3 | E-712.R2 / E-712.R4 | E-712.R5 |
|---|---|---|---|
| Function | Chassis with power supply | Chassis with power supply | Chassis with cPCI bus |
| Piezo voltage range | –30 to 135 V | –250 to 250 V | up to –250 to 250 V |
| Channels | 3 to 6 | 3 to 6 | up to 12 |
| Dimensions | E-712.R1: 9.5″ (236 mm × 132 mm × 296 mm + handles (47 mm length))<br>E-712.R3: 19″ (450 mm × 132 mm × 296 mm + handles (47 mm length)) | E-712.R2: 19″ (450 mm × 132 mm × 296 mm + handles (47 mm length))<br>E-712.R4: 9.5″ (236 mm × 132 mm × 296 mm + handles (47 mm length)) | 19″ (450 mm × 177 mm × 375 mm + handles (47 mm length)) |
| Mass | .R1: 4.16 kg / .R3: 6.7 kg | .R2: 6.7 kg / .R4: 4.16 kg | 4.4 kg |
| Operating voltage | 100 to 240 VAC, 50 – 60 Hz | 100 to 240 VAC, 50 – 60 Hz | 100 to 240 VAC, 50 – 60 Hz |
| Line power fuses | 2 ×T1.6AH, 250 V* | 2 ×T1.6AH, 250 V* | 2 ×T3.15AH, 250 V* |
| Current consumption, max. | 225 VA | 225 VA | 450 VA |
| Max. output power | 100 W | 100 W | 200 W |

* unless stated otherwise on the type plate of the housing

| Master modules | E-712.M1 | E-712.N1 | |
|---|---|---|---|
| Function | Digital processor and interface module | Digital processor and interface module | |
| Supported drive type | Piezo nanopositioning systems (except PiezoWalk® systems) | Piezo nanopositioning systems, PiezoWalk® systems | |
| Axes | up to 16 | up to 16 | |
| Sampling rate, servo control | max. 50 kHz | max. 50 kHz | |
| Sampling rate, sensor | max. 50 kHz | max. 50 kHz | |
| Communication interfaces | TCP/IP, USB, RS-232, SPI | TCP/IP, USB, RS-232, SPI | |
| | | | |

| Amplifiers | E-711.AL4P / E-711.AL41 | E-711.AM4 / E-711.AM5 / E-711.AM6 / E-711.AM5A / E-711.AM5B | E-711.AN4 / E-711.AN40 | E-711.C82 |
|---|---|---|---|---|
| Function | Amplifier module | Amplifier module | Amplifier module | DC motor driver |
| Drive type | Piezo actuators | NEXLINE® | NEXACT® | DC motors |
| Channels | 4 | 4 | 4 | 2 |
| Average output power per channel | 8 W | 15 W | 4 W | 30 W |
| Output voltage | –30 to 135 V | –250 to 250 V | –10 to 45 V | 0 to 24 V |
| Sensor input | – | E-711.AMx: –<br>E-711.AM5A: incremental, sin/cos<br>E-711.AM5B: absolute, BiSS | – | Incremental: A/B, sin/cos<br>Absolute: BiSS |
| Connection | E-711.AL4P: via E-711.SS3 or E-711.SC3H<br>E-711.AL41: Sub-D 25W3 | E-711.AM4: Sub-D 24W7<br>E-711.AM5: Sub-D 25 (f)<br>E-711.AM6: via HD Sub-D 50 (f) of the E-712.R5 chassis<br>E-711.AM5A / .AM5B: Sub-D 25 (f) | E-711.AN4: Sub-D 15 (f)<br>E-711.AN40: via HD Sub-D 78 (f) of the E-712.R5 chassis | Sub-D 15 (f) |

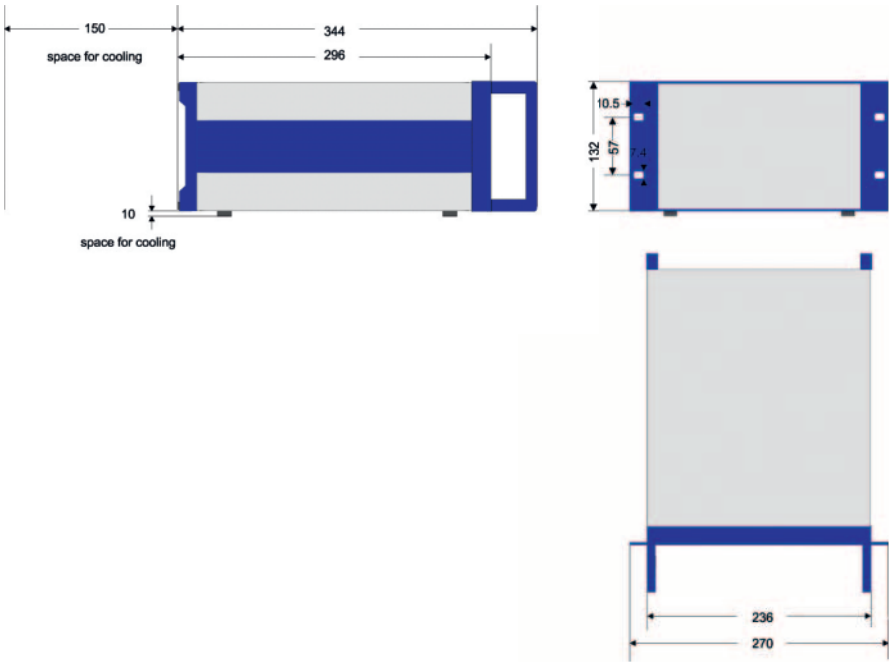
### Housing types and modules

| I/O: Sensor modules | E-711.SA3 / E-711.SA6 | E-711.SS3 | E-711.SC3H / E-711.SE3 | |
|---|---|---|---|---|
| Function | Module for incremental sensors | Module for strain gauge sensors | Module for capacitive sensors | |
| Sensor type | Incremental sensors (analog sin/cos, $V_{pp}$) | Strain gauge sensors, temperature sensors | E-711.SCH3: capacitive 2-electrode sensors<br>E-711.SE3: PISeca capacitive 1-electrode sensors | |
| Channels | 3 / 6 | 4 | 3 | |
| Sensor connection | 1 × / 2 × HD Sub-D 26 (m) | Sub-D 37 (f) | Sub-D 25W3 / 3 × Lemo triaxial socket | |
| Sensor bandwidth | 300 kHz | 10 kHz | 10 kHz / 5 kHz | |
| A/D resolution | Interpolation factor selectable | 18 bits (interpolated) | 18 bits (interpolated: 20 bits) | |

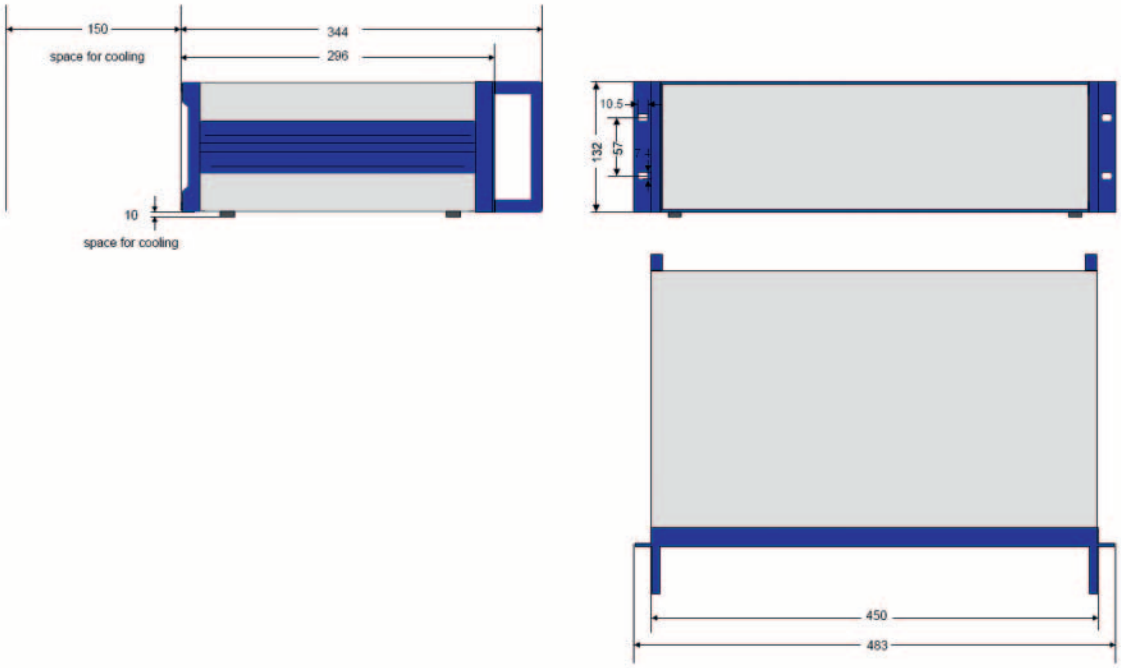
| I/O: Sensor signal transmission | E-711.0CT / E-711.0CT0 | E-711.0ET / E-711.0ET0 | E-711.0ATS |
|---|---|---|---|
| Function | Set for digital sensor signal transmission, consisting of: Interface module, sensor box with signal processing electronics; E-711.0CT additionally with connecting cables | Set for digital sensor signal transmission, consisting of: Interface module, sensor box with signal processing electronics; E-711.0ET additionally with sensor cable | Sensor box for digital sensor signal transmission |
| Sensor type | Capacitive 2-electrode sensors | PISeca capacitive 1-electrode sensors | Absolute-measuring or incremental encoders via 32-bit BiSS interface |
| Channels | 3 | 3 | 8 |
| Sensor connection | Sub-D 25W3 | 3 × Lemo triaxial socket | 8 × Sub-D 9 (f) |
| Sensor bandwidth | 10 kHz | max. 5 kHz | N/A |
| A/D resolution | 18 bits (interpolated: 20 bits) | 20 bits interpolated | N/A |

| I/O: Interface modules | E-711.IA4 | E-711.IP | E-711.iS3 / E-711.iS6 |
|---|---|---|---|
| Function | Analog interface module | Parallel input/output interface module for fast data exchange | SPI master interface module |
| Input/output | 4 × analog input<br>4 × analog output | Parallel input/output | SPI |
| Channels | 4 | 15 | 3 / 6 |
| Resolution | Input: 18 bit<br>Output: 16 bit | 32 bits | 32 bits |
| Bandwidth | Input: max. 25 kHz<br>Output: max. 12 kHz | N/A | N/A |
| Connection | 8 × LEMO EPG.00.302.NLN | HD Sub-D 62 (f) for connection to a digital interface card of the PC via the included cable (K040B0121) | Display port |

9.5" housing types E-712.R1 and .R4, dimensions in mm




19" housing types E-712.R2 and .R3, dimensions in mm



# E-500 Modular Piezo Controller

## Flexible System for Piezo Actuators and Nanopositioners

- Up to 3 axes, custom systems up to 12 axes and more
- Piezo amplifier modules for low-voltage and high-voltage, 14 to 400 W peak power
- Choice of position servo control modules for capacitive and SGS sensors, 1 to 3 channels
- Choice of PC interface / display modules
- TCP/IP, USB and RS-232 interfaces
- 19" and 9.5" chassis

**Modular motion control system for more flexibility**

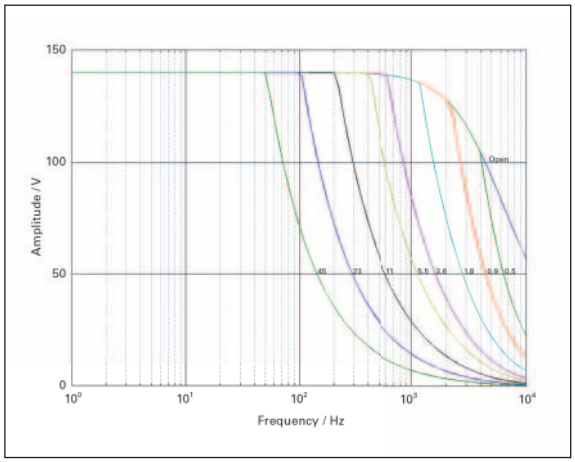
The modular E-500 system is configurable and supports piezo actuators, piezo-based tip / tilt platforms, and positioning systems with up to three motion axes. The flexibility of the E-500 system allows mixed operation with different single-channel amplifier or sensor modules. The modularity also allows suitable control for customized systems.

**Sensor modules**

PI uses capacitive or strain sensors in its positioning systems according the accuracy requirements. The E-500 supports operation of up to three axes with single- to three-channel sensor modules.

**Interface and function module for piezo-based positioning systems**

It is possible to control the modular, analog, closed-loop E-500 motion control system digitally via the three-channel E-518 interface module. Furthermore, the E-518 also includes a wide range of digital functions such as macro programming, wave generator or data recorder.




E-504: Operating limits (open-loop) with various PZT loads, capacitance values in µF


>> Energy Recovery
>> Extensive software package
>> Linearization

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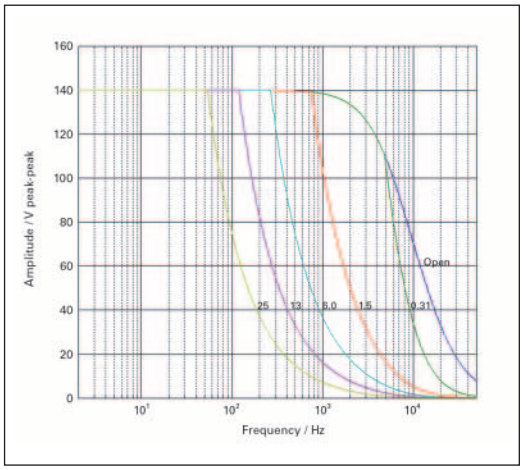
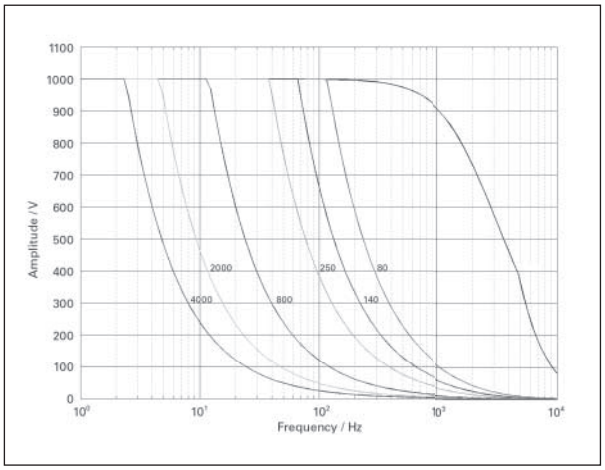
## Available Modules

| | |
|---|---|
| **E-500.00** | 19″ housing for modular piezo controller system, 1 to 3 Channels |
| **E-501.00** | 9.5″ housing for modular piezo controller system, 1 to 3 Channels |
| **E-500.ACD** | LabVIEW Driver Set for Analog Controllers |
| **E-500.HCD** | HyperBit Functionality for Enhanced System Resolution(Supports Certain D/A Boards) |
| **E-503.00** | Piezo Amplifier Module, –30 to 130 V, 3 Channels |
| **E-503.00S** | Piezo Amplifier Module, –30 to 130 V, 2 Channels. Customized version, modified for S-330, S-340, S-334 tip / tilt mirror systems, with a fixed voltage of +100 V, two variable voltages |
| **E-504.00F** | High-power-Piezo Amplifier Module, 1 Channel, 280 W Peak Power, 100 W Average Power, –30 to 130 V |
| **E-505.00** | Piezo Amplifier Module, 2 A, –30 to 130 V, 1 Channel |
| **E-505.10** | Piezo Amplifier Module for switching applications, 10 A, –30 to 130 V, 1 Channel |
| **E-505.00S** | Offset Voltage Source for tip / tilt Platforms, 100 V fixed voltage |
| **E-506.10** | High Linearity Piezo Amplifier Module, 30 W Average Output Power, –30 to 130 V, 1 Channel |
| **E-508.00** | HVPZT piezo amplifier module, 3 to 1100 V, 1 channel |
| **E-508.OE** | HVPZT piezo amplifier module, OEM, 400 mA peak current |
| **E-509.C1A** | Sensor / Piezo Servo-Control Module, capacitive sensor, 1 Channel |
| **E-509.C2A** | Sensor / Piezo Servo-Control Module, capacitive sensors, 2 Channels |
| **E-509.C3A** | Sensor / Piezo Servo-Control Module, capacitive sensors, 3 Channels |
| **E-509.S1** | Sensor / Piezo Servo-Control Module, SGS Sensor, 1 Channel |
| **E-509.S3** | Sensor / Piezo Servo-Control Module, Strain Gauge Sensors, 3 Channels |
| **E-509.E3** | PISeca Sensor / Piezo Servo-Control Module for capacitive single-electrode sensors, 3 axes |
| **E-509.E03** | PISeca Modular Evaluation electronics for single-electrode capacitive sensors, 3 axes |
| **E-515.01** | Display Module for Piezo Voltage and Displacement, 1 Channel |
| **E-515.03** | Display module for piezo voltage and displacement, 3 Channels |
| **E-518.I3** | Interface module, 3 Channels, TCP/IP, USB and RS-232 interfaces |

For system configuration consultancy, contact your PI representative.




E-505: Operating limits (open-loop) with various PZT loads, capacitance values in µF




E-508: Operating limits (open-loop) with various PZT loads, capacitance values in nF

### Housing

| | E-500.00 | E-501.00 |
|---|---|---|
| Function | 19”-chassis for piezo controller system: Amplifier modules, sensor- / servo-control modules, interface / display modules | 9.5”-chassis for piezo controller system: Amplifier modules, sensor- / servo-control modules, interface / display modules |
| Channels | 1, 2, 3 (up to 3 amplifier modules) | 1, 3 (1 amplifier module) |
| Dimensions | 450 mm × 132 mm × 296 mm + handles | 236 mm × 132 mm × 296 mm + handles |
| Operating voltage | 90 – 264 VAC, 50 – 60 Hz | 90 – 120 / 220 – 264 VAC, 50-60 Hz |
| Max. power consumption | 180 W | 80 W |

### Piezo Amplifier Modules for Static and Low-Dynamics Operation

| | E-503.00 / E-503.00S | E-505.00 | E-505.00S |
|---|---|---|---|
| Function | Power amplifier | Power amplifier | Offset voltage supply for tip / tilt systems |
| Channels | 3 / 2 | 1 | 1 |
| **Amplifier** | | | |
| Control input voltage range | –2 to +12 V | –2 to +12 V | – |
| Output voltage | –30 to 130 V (E-503.00S: one additional fixed voltage of 100 V) | –30 to +130 V | 100 V |
| Peak current per channel (<5 ms) | 140 mA | 2 A (<3 ms) | 2 A |
| Average current per channel (> 5 ms) | 40 mA | 215 mA | 300 mA |
| Current limitation | Short-circuit-proof | Short-circuit-proof | Short-circuit-proof |
| Voltage gain | 10 ±0.1 | 10 ±0.1 | – |
| Input impedance | 100 kΩ / 1 nF | 1 MΩ / 1 nF | – |
| Ripple, noise, 0 to 10 kHz | | <0.6 $mV_{rms}$ | <0.7 $mV_{rms}$ |
| Internal base load | | | |
| Amplifier resolution | | | |
| Output impedance | | | |
| **Interfaces and operation** | | | |
| Piezo connector (voltage output) | LEMO ERA.00.250.CTL | LEMO ERA.00.250.CTL | LEMO ERA.00.250.CTL |
| Analog input / control in | BNC | BNC | – |
| DC Offset | 10-turn pot., adds 0 to 10 V to Control In | 10-turn pot., adds 0 to 10 V to Control input | – |
| **Miscellaneous** | | | |
| Operating temperature range | 5 to 50 °C | 5 to 50 °C | 5 to 50 °C |
| Overtemp protection | Deactivation at 85 °C | Deactivation at 85 °C | Deactivation at 85 °C |
| Dimensions | 14HP/3RU | 14HP/3RU | 14HP/3RU |
| Mass | 0.9 kg | 0.9 kg | 0.9 kg |
| Max. power consumption | 40 W | 55 W | 55 W |

Ask about custom designs!

### Piezo Amplifier Modules for High-Dynamics Operation

| | E-504.00F | E-505.10 | E-506.10 | E-508.00 | E-508.OE |
|---|---|---|---|---|---|
| Function | Power amplifier with energy recovery* | Power amplifier for switching applications* | Linearized amplifier module, charge-controlled | Power amplifier for PICA high-voltage PZTs | Power amplifier for PICA high-voltage PZTs |
| Channels | 1 | 1 | 1 | 1 | 1 |

| | E-504.00F | E-505.10 | E-506.10 | E-508.00 | E-508.OE |
|---|---|---|---|---|---|
| **Amplifier** | | | | | |
| Control input voltage range | –2 to 12 V | –2 to +12 V | –2 to 12 V | Servo off: ±1/100 of selected output voltage range<br>Servo on: 0 to 10 V | Servo off: ±1/100 of selected output voltage range<br>Servo on: 0 to 10 V |
| Output voltage | –20 to 120 V | –30 to +130 V | –30 to 130 V | 3 to +1100 V (default)<br>Adjustable:<br>–260 to +780 V<br>–550 to +550 V<br>+260 to –780 V<br>–3 to –1100 V | 3 to +1100 V (default)<br>Optional:<br>–260 to +780 V<br>–550 to +550 V<br>+260 to –780 V<br>–3 to –1100 V |
| Peak output power | 200 W | | | 50 W (< 5 ms) | 400 W (< 5 ms) |
| Average output power | 100 W at full voltage range | | | 13 W | 13 W |
| Peak current per channel (<5 ms) | 2000 mA | 10 A (<200 µs) | 2 A (<2.5 ms) | 50 mA | 400 mA |
| Average current per channel (>5 ms) | 1000 mA | 215 mA | 215 mA | 12 mA | 12 mA |
| Current limitation | Short-circuit-proof | Short-circuit-proof | Short-circuit-proof | Short-circuit proof | Short-circuit proof |
| Amplifier bandwidth, small signal | | | | 6 kHz | 10 kHz |
| Amplifier bandwidth, large signal | | | | 50 Hz (200 nF) | 50 Hz (200 nF) |
| Voltage gain | 10 ±0.1 | 10 ±0.1 | | +100 ±1, –100 ±1 (selectable) | +100 ±1, –100 ±1 (selectable) |
| Input impedance | | 1 MΩ / 1 nF | 1 MΩ / 1 nF | 100 kΩ | 100 kΩ |
| Ripple, noise, 0 to 10 kHz | <2 $mV_{rms}$<br><10 $mV_{pp}$ | 1.0 $mV_{rms}$ | <0.6 $mV_{rms}$ | 5 $mV_{rms}$<br>50 $mV_{pp}$ (100 nF) | 20 $mV_{rms}$<br>200 $mV_{pp}$ (100 nF) |
| Internal base load | 1.5 µF | – | – | | |
| Reference capacitance (adjustable) | | | 1 to 280 µF | | |
| Suggested capacitive load | | | >0.3 µF | | |
| Amplifier resolution | <1 mV | | | | |
| Output impedance | 0.5 Ω | | | | |
| **Interfaces and operation** | | | | | |
| Piezo connector (voltage output) | LEMO ERA.00.250.CTL | LEMO ERA.00.250.CTL | LEMO 2-pin EGG.0B.302.CLL | LEMO EGG.0B.701.CJL.1173 | LEMO EGG.0B.701.CJL.1173 |
| Analog input / control in | SMB | BNC | BNC | BNC | SMB |
| DC Offset | 10-turn pot., adds 0 to 10 V to Control In | 10-turn pot., adds 0 to 10 V to Control input | 10-turn pot., adds 0 to 10 V to Control In | 10-turn pot., adds 0 to 10 V to Control In | – |
| Piezo temperature sensor (input) | – | – | PT 1000; LEMO socket; automatic deactivation of high voltage output at max. 150 °C | | |
| **Miscellaneous** | | | | | |
| Operating temperature range | 0 to 40 °C | 5 to 50 °C | 5 to 50 °C | 5 to 50 °C (above 40 °C, power derated) | 5 to 50 °C (above 40 °C, power derated) |
| Overtemp protection | | Deactivation at 85 °C | Deactivation at 85 °C | | |
| Dimensions | 14 HP / 3 RU | 14HP/3RU | 14 HP / 3 RU | 14 HP / 3 RU | 14 HP / 3 RU |
| Mass | 0.9 kg | 0.9 kg | 0.9 kg | 0.75 kg | 0.75 kg |
| Max. power consumption | | 55 W | 55 W | | |

* For piezo actuators with special high-current layout

**Signal Conditioner / Piezo Servo Modules**

| | E-509.C1A / E-509.C2A / E-509.C3A | E-509.S1 / E-509.S3 | E-509.E03 | E-509.E3 |
|---|---|---|---|---|
| Function | Sensor / position servo-control modules for piezo-driven systems | Sensor / position servo-control modules for piezo-driven systems | Sensor evaluation electronics for PISeca | Sensor / servo controller module for PISeca |
| Channels | 1 / 2 / 3 | 1 / 3 | 3 | 3 |
| Supported functions | ILS (Internal Linearized System) | ILS (Internal Linearized System) | ILS (Internal Linearized System) | ILS (Internal Linearized System) |
| **Sensor** | | | | |
| Servo characteristics | P-I (analog), notch filter | P-I (analog), notch filter | – | Analog P-I and notch filter |
| Sensor type | Capacitive | SGS | PISeca single electrode, capacitive | PISeca single electrode, capacitive |
| Sensor channels | 1 / 2 /3 | 1 / 3 | 3 | 3 |
| Sensor bandwidth | 0.3 to 3 kHz (jumper selectable); to 10 kHz on request | 0.3; 1; 3 kHz | 0.3 to 10 kHz (adjustable) | 0.3 to 10 kHz (adjustable) |
| Extension factor for measurement range* | | | 1 (default), 2 / 2.5 / 5 (optional) | 1 (default), 2 / 2.5 / 5 (optional) |
| Noise factor | 0.115 ppm/√Hz | – | 0.14 ppm/√Hz ** | 0.14 ppm/√Hz ** |
| External synchronization | | | 3 synchronized channels | 3 synchronized channels |
| Thermal drift | <0.3 mV/°C | <3 mV/°C | <1 mV/°C | <1 mV/°C |
| Linearity error | <0.05 % | <0.2 % | <0.1 % (<0.2 % for D-510.020) ** | <0.1 % ** |
| Static resolution*** | | | <0.001 % of the measurement range (RMS) | <0.001 % of the measurement range (RMS) |
| Dynamic resolution*** | | | <0.002 % of the measurement range (RMS) | <0.002 % of the measurement range (RMS) |
| Sensor monitor output | 0 – 10 V | 0 – 10 V | | |
| Sensor monitor socket | LEMO 6-pin FGG.0B.306.CLAD56 | BNC (1-ch.) / 3-pin LEMO (3-ch.) | | |
| Output voltage | | | 0 to 10 V<br>–5 to 5 V, –10 to 0 V (selectable) | 0 to 10 V<br>–5 to 5 V, –10 to 0 V (selectable) |
| **Interface and operation** | | | | |
| Sensor connection | LEMO EPL.00.250.NTD | LEMO ERA.0S.304.CLL | 3 × LEMO ECP.00.650.NLL.543 triaxial socket | 3 × LEMO ECP.00.650.NLL.543 triaxial socket |
| Signal output | | | LEMO 6-pin FGG.0B.306.CLAD56 | LEMO 6-pin FGG.0B.306.CLAD56 |
| Display | Overflow LED | Overflow LED | | |
| Target ground connector | | | 3 × banana jack, 4 mm | 3 × banana jack, 4 mm |
| **Miscellaneous** | | | | |
| Operating temperature range | 5 to 50 °C | 5 to 50 °C | 5 to 40 °C | 5 to 40 °C |
| Dimensions | 7HP/3RU | 7HP/3RU | 7HP/3RU | 7HP/3RU |
| Mass | 0.35 kg | 0.35 kg | 0.3 kg | 0.3 kg |
| Max. power consumption | 4 to 8 W | 4 to 8 W | | |

* Extension factors refer to the nominal measurement range of the respective D-510 sensor head, to be specified with the order.
** In the nominal measurement range
*** Bandwidth: Static 300 Hz, dynamic 3 kHz

## Interface / Display Modules

| | E-518.i3 | E-515.01 | E-515.03 |
|---|---|---|---|
| Function | Digital interface module for the E-500 system (E-500, E-470, E-481, E-482) | Display module for piezo voltage and positioning | Display module for piezo voltage and positioning |
| Channels | 3 | 1 | 3 |
| Processor | DSP 376 MHz | | |
| Sampling rate, sensor | 200 kHz | | |
| Servo control rate | 25 kHz | | |
| Sensor resolution | ADC: 20 bits, oversampling + filter | | |
| Voltage resolution | DAC: 20 bits, oversampling + filter, 16 bit @ 1 MHz | | |
| **Interfaces and operation** | | | |
| Interface / Communication | Ethernet (TCP/IP) USB, RS-232 | | |
| I/O ports | 3 digital inputs<br>3 digital outputs<br>3.3 V<br>MDR14 connector | | |
| Command set | PI General Command Set (GCS) | | |
| User software | PIMikroMove | | |
| Software drivers | LabVIEW driver, libraries for Windows (DLL) and Linux | | |
| Supported functions | Wave generator, data recorder, macro programming | | |
| Display linearity | | 0.1 % | 0.1 % |
| Display | | 1 × 3½ digits | 3 × 3½ digits |
| **Miscellaneous** | | | |
| Operating temperature range | 5 to 50 °C | | |
| Dimensions | 14HP / 3RU | 21HP / 3RU | 21HP / 3RU |
| Mass | 0.26 kg | 0.3 kg | 0.3 kg |

# E-651 / E-614
# Piezo Amplifier / Servo Controller

**For Closed-Loop Multilayer Bending Actuators**

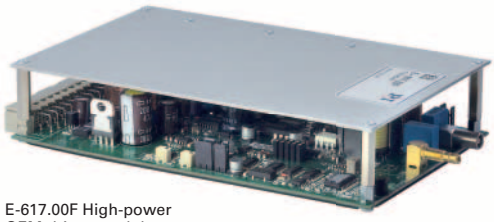

- For closed-loop multilayer piezo bending actuators
- Bench-top and OEM-board versions
- 1- and 2-channel versions

| | E-651.1S | E-651.2S | Unit |
|---|---|---|---|
| Function | Piezo amplifier & servo controller for multilayer bending actuators, bench-top | Piezo amplifier & servo controller for multilayer bending actuators, bench-top | |
| Channels | 1 | 2 | |
| **Sensor** | | | |
| Servo characteristics | P-I (analog) | P-I (analog) | |
| Sensor type | SGS | SGS | |
| Sensor bandwidth | Low-pass filter cut-off frequency: 100 Hz / 5 kHz selectable | Low-pass filter cut-off frequency: 100 Hz / 5 kHz selectable | |
| **Amplifier** | | | |
| Control input voltage | –5 to 5 | –5 to 5 | V |
| Min. output voltage | 0 to 60, plus fixed reference voltage of 60 V | 0 to 60, plus fixed reference voltage of 60 V | V |
| Peak output current per channel | 36 | 36 | mA |
| Average output current per channel | 18 | 18 | mA |
| Current limitation | Short-circuit-proof | Short-circuit-proof | |
| Voltage gain | 6 | 6 | |
| Input impedance | 100 | 100 | kΩ |
| **Interface and operation** | | | |
| Piezo / sensor connection | LEMO EPG.0B.307.HLN | LEMO EPG.0B.307.HLN | |
| Analog input / control in | BNC | BNC | |
| Sensor monitor output | 0 to 10 for nominal displacement | 0 to 10 for nominal displacement | V |
| Sensor monitor socket | BNC | BNC | |
| **Miscellaneous** | | | |
| Operating temperature range | 5 to 50 | 5 to 50 | °C |
| Overtemp protection | Deactivation at 75 °C | Deactivation at 75 °C | |
| Dimensions | 125 mm × 90 mm × 265 mm | 125 mm × 90 mm × 265 mm | |
| Mass | 1.36 | 1.45 | kg |
| Operating voltage | 14 to 16 V DC (C-890.PS power supply included) | 14 to 16 V DC (C-890.PS power supply included) | |
| Power consumption | 15 | 15 | W |

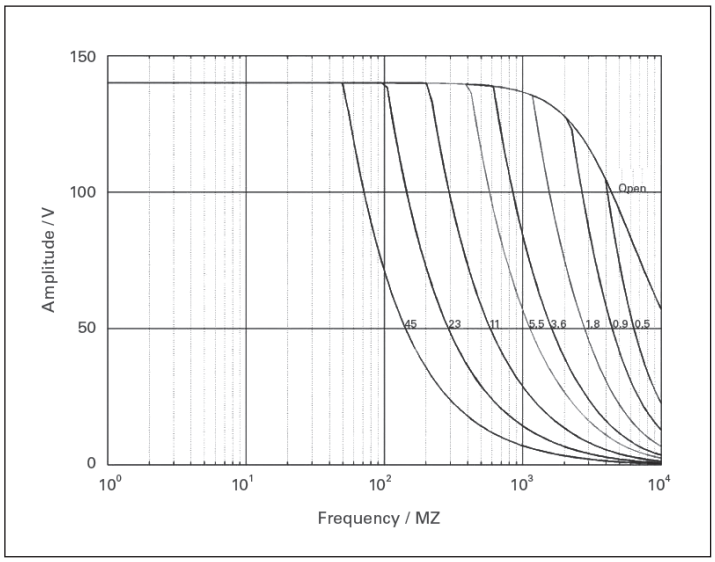
# E-617 High-Power Piezo Amplifier

## Top-Hat & OEM Modules with Energy Recovery for High-Dynamics 24/7 Operation


- Peak power to 280 W
- High currents to 2000 mA
- Low power consumption
- OEM module and top-hat-rail versions



E-617.00F High-power
OEM driver module




E-617: operating limits with various PZT loads (open-loop),
capacitance is measured in µF

>> Energy recovery operating principle

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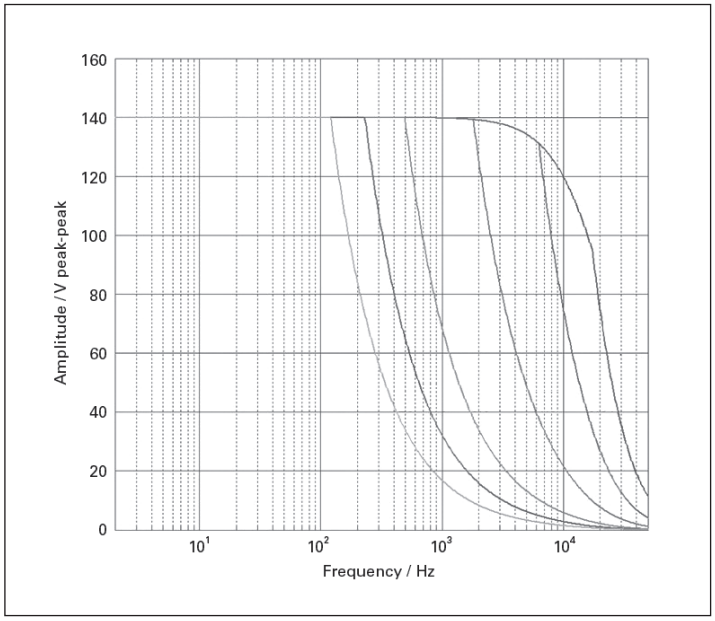
| | E-617.001 | E-617.00F | Unit |
|---|---|---|---|
| Function | High-power Piezo Amplifier with Energy Recovery, 1 Channel, –30 to 130 V, for Top-Hat-Rail Mounting | High-power Piezo Amplifier with Energy Recovery, 1 Channel, –30 to 130 V | |
| **Amplifier** | | | |
| Control input voltage | –2 to 12 | –2 to 12 | V |
| Output voltage | –30 to 130 | –30 to 130 | V |
| Peak output power, <5 ms | 280 | 280 | W |
| Average output power (>5 ms) | Equivalent to 100 W reactive power | Equivalent to 100 W reactive power | |
| Peak current, <5 ms | 2000 | 2000 | mA |
| Average output current (>5 ms) | 1000 | 1000 | mA |
| Current limitation | Short-circuit-proof | Short-circuit-proof | |
| Voltage gain | 10 ±0.1 | 10 ±0.1 | |
| Amplifier bandwidth, small signal | 3.5 | 3.5 | kHz |
| Ripple, noise, 0 to 10 kHz | <2 $mV_{rms}$<br><10 $mV_{pp}$ | <2 $mV_{rms}$<br><10 $mV_{pp}$ | |
| Capacitive base load (internal) | 1.0 | 1.0 | µF |
| Suggested capacitive load | >3 | >3 | µF |
| Output impedance | 0.5 | 0.5 | Ω |
| Amplifier resolution | <1 | <1 | mV |
| Amplifier classification | Class D (switching amp), 100 kHz | Class D (switching amp), 100 kHz | |
| Input impedance | 100 | 100 | kΩ |
| **Interface and operation** | | | |
| Piezo connector (voltage output) | Phoenix-plug connector MINI-COMBICON 3-pin MC1.5 / 3-ST-3.81 | LEMO ERA.00.250.CTL (front); DIN 41612 32-pin (rear) | |
| Analog input / control in | Phoenix-plug connector MINI-COMBICON 6-pin IMC1.5 / 6-ST-3.81 | SMB | |
| DC offset | External potentiometer (not included), adds 0 to 10 V to Control In | External potentiometer (not included), adds 0 to 10 V to Control In | |
| **Miscellaneous** | | | |
| Operating temperature range | 5 to 50 (above 40 °C, power derated) | 5 to 50 (above 40 °C, power derated) | °C |
| Dimensions | 205 mm × 105 mm × 60 mm | 7 HP / 3 RU | |
| Mass | 1 | 0.35 | kg |
| Operating voltage | 23 to 26 VDC, stabilized, on Phoenix plug MINI-COMBICON 3-pin IMC1.5 / 3-ST-3.81 | 23 to 26 VDC, stabilized, on 32-pin DIN 41612 connector | |
| Max. power consumption | <30 | <30 | W |

# E-618 High-Power Piezo Amplifier / Servo Controller

**High Currents, High Dynamics**




E-618: operating limits with various PZT loads (open-loop), capacitance is measured in µF

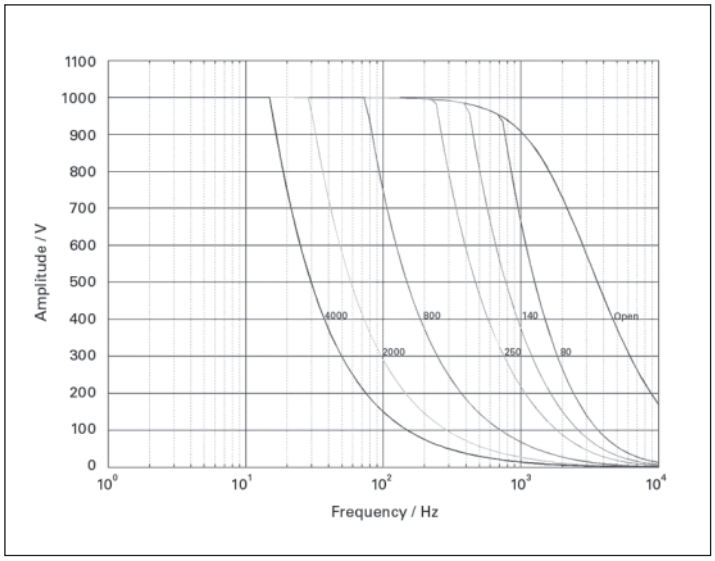
- Peak current 20 A
- Microsecond rise time
- 15 kHz bandwidth for high dynamics applications
- Ideal for fast switching or active vibration control with piezos
- Overheat protection for piezo actuators with temperature sensor
- Versions: 1 or 2 channels, OEM module, benchtop or 19'' rackmount
- Optional computer interface and display modules

| | E-618.10 |
|---|---|
| Function | Power amplifier module for PICMA® multilayer piezo actuators |
| **Amplifier** | |
| Input voltage | –2 to 12 V |
| Output voltage* | –30 to 130 V |
| Peak output power | >3200 W (<0.3 ms) |
| Average output power | 100 W (>0.3 ms) |
| Peak current | >20 A (<0.3 ms) |
| Average current | 0.8 A (>0.3 ms) |
| Current limitation | Short-circuit-proof |
| Voltage gain | 10 ±0.1 |
| Ripple, noise, 0 to 10 kHz | 20 $mV_{pp}$ / 2.4 $mV_{rms}$ (no load), <2 $mV_{rms}$ (1µF) |
| Input impedance | 100 kΩ |
| **Interface and operation** | |
| Piezo connector | LEMO EGG.1B.302.CLL, with security cover |
| Control input | BNC |
| Temperature sensor (piezo actuator) | PT 1000; LEMO socket; automatic deactivation of high voltage output at max. 150°C |
| Display | Power, temp overflow LEDs |
| DC offset | 10-turn pot., adds 0 to 10 V to Control In |
| **Miscellaneous** | |
| Operating temperature range | 5 to 50 °C (above 40 °C, power derated) |
| Dimensions | 215 mm × 123 mm × 185 mm<br>42 HP / 3 RU 19" rackmount chassis |
| Mass | 2.65 kg |
| Operating voltage | 100 to 120 or 220 to 240 VAC, selectable |
| Max. power consumption | 15 VA (no load)<br>160 VA (max. load) |

*Max. 85 °C, deactivation of the piezo voltage output (internal overtemp protection)
Ask about custom designs!

# E-470 / E-472 / E-421 PICA Piezo Controller

**Modular High-Power Amplifier / Controller**



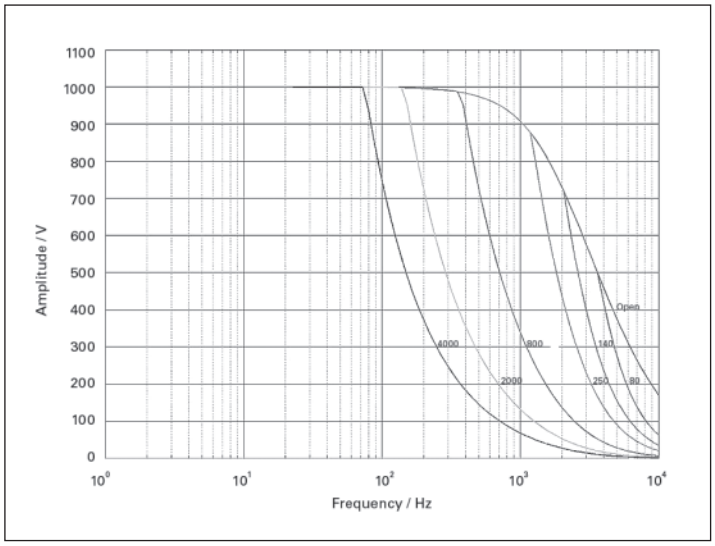

E-421, E-470, E-471, E-472: operating limits with various PZT loads, capacitance is measured in nF

- Peak power 550 W
- Output voltage range 3 to 1100 V or bipolar
- Position control (optional)
- Versions: 1 or 2 channels, OEM module, benchtop or 19″ rackmount
- Optional computer interface and display modules

| | E-470.20 / E-471.20 / E-472.20 / E-421.00 | Unit |
|---|---|---|
| Function | Power amplifier for PICA high-voltage PZTs<br>(servo-controller option for E-471) | |
| **Amplifier** | | |
| Output voltage | Default: 3 to 1100<br>Selectable: –260 to +780<br>–550 to +550<br>+260 to –780<br>–3 to –1100 | V |
| Amplifier channels | 1 (E-472: 2) | |
| Average output power | 110 | W |
| Peak output power, <5 ms | 550 | W |
| Average current | 100 | mA |
| Peak current, <5 ms | 500 | mA |
| Amplifier bandwidth, small signal | DC to 3 | kHz |
| Amplifier bandwidth, large signal | DC to 3 | kHz |
| Ripple, noise, 0 to 100 kHz | <25 $mV_{rms}$<br>100 (200 nF) | $mV_{rms}$<br>$mV_{pp}$ |
| Current limitation | Short-circuit-proof | |
| Voltage gain | 100 ±1 (default), –100 ±1 | |
| Input impedance | 100 | kΩ |
| Control input voltage | Servo off: ±1/100 of selected output voltage range<br>Servo on: 0 to 10 V | |
| **Interface and operation** | | |
| PZT voltage output | LEMO EGG.0B.701.CJL1173 | |
| Control input | BNC | |
| DC offset | 10-turn pot., adds 0 to 10 V to Control In | |
| **Miscellaneous** | | |
| Operating voltage | 100 to 120 or 220 to 240 VAC, selectable<br>(fuse change required) | |
| Operating temperature range | 5 to 50 (above 40 °C, power derated) | °C |
| Mass | E-470: 5.2<br>E-471: 7.6<br>E-472: 10.1<br>E-421: 2.5 | kg |
| Dimensions | 236 mm × 132 mm × 296 mm + handles (E-470)<br>450 mm × 132 mm × 296 mm + handles (E-471, E-472)<br>215 mm × 123 mm × 185 mm (E-421) | |
| | | |

# E-481 PICA Piezo High-Power Amplifier / Controller

## 2000 W and Energy Recovery for High Efficiency


E-481: operating limits with various PZT loads, capacitance is measured in nF

- Peak power 2000 W
- Integrated energy recovery
- Output voltage 0 to ±1100 V or bipolar
- Overheat protection for piezo actuators with temperature sensor
- Position control (optional)
- Optional computer interface and display modules

>> Energy recovery operating principle

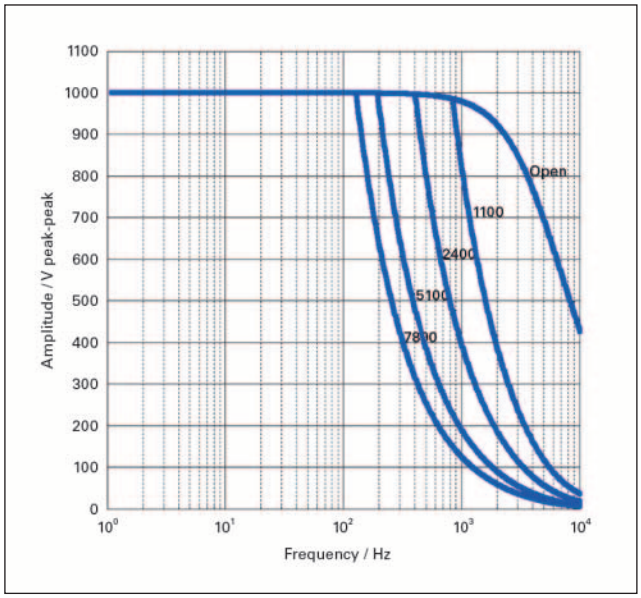
Technology Glossary ..... page 240

| | E-481.00 | Unit |
|---|---|---|
| Function | Power amplifier with energy recovery<br>for PICA high-voltage PZTs | |
| **Amplifier** | | |
| Output voltage | Default: 0 to 1100<br>Selectable: –260 to 780<br>–550 to 550<br>+260 to 780<br>0 to -1100 | V |
| Amplifier channels | 1 | |
| Average output power | equivalent to 630 VA reactive power | |
| Peak output power <5 ms | 2000 | VA |
| Average current | >600 | mA |
| Peak current, <5 ms | 2000 | mA |
| Amplifier bandwidth, small signal | 5 kHz (660 nF), 1 kHz (3.4 µF) | |
| Amplifier bandwidth, large signal | 1.4 kHz (660 nF), 350 Hz (3.4 µF) | |
| Ripple, noise, 0 to 100 kHz | 150<br>2000 (100 nF) | $mV_{rms}$<br>$mV_{pp}$ |
| Current limitation | Short-circuit-proof | |
| Voltage gain | ±100 | |
| Input impedance | 100 | kΩ |
| Control input voltage | Servo off: ±1/100 of selected output voltage range<br>Servo on: 0 to 10 V | |
| Interface and operation | | |
| PZT voltage output socket | LEMO EGG.0B.701.CJL1173 | |
| Control input socket | BNC | |
| DC offset | 10-turn potentiometer, adds 0 to 10 V to Control In | |
| Temperature sensor | LEMO socket<br>automatic deactivation of high voltage output<br>at max. 85 °C | |
| **Miscellaneous** | | |
| Operating voltage | 100 to 120 / 220 to 240 VAC, 50 60 Hz<br>(fuse change required) | |
| Operating temperature range | 5 to 50 °C (above 40 °C, power derated) | |
| Mass | 8.6 | kg |
| Dimensions | 288 mm × 450 mm × 158 mm + handles | |

Requires piezo actuators with option P-177.50, temperature sensor and protective air connection for PICA HVPZT

# E-482 PICA High-Power Piezo Driver / Servo Controller

## High Energy Efficiency through Energy Recovery


Operating limits with various PZT loads (open-loop), capacitance is measured in nF

- Peak current 6 A
- Output voltage to 1050 V
- Temperature sensor protects piezo actuator from overheating
- Position control (optional)
- Optional computer interface and display modules

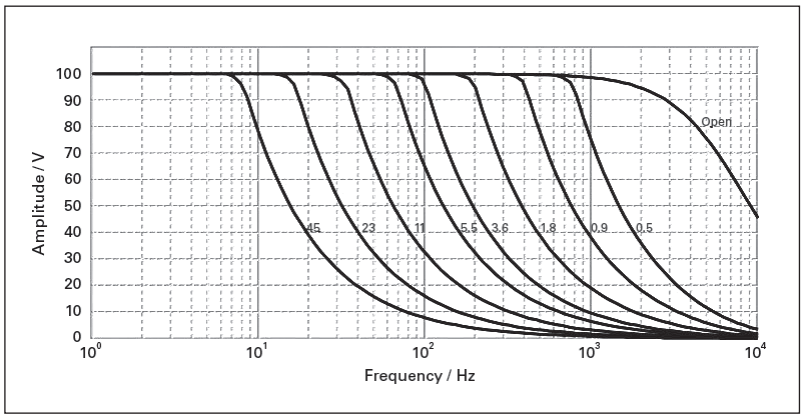
>> Energy recovery operating principle

Technology Glossary ..... page 240

| | E-482.00 | Unit |
|---|---|---|
| Function | Power amplifier with energy recovery for PICA high-voltage piezo actuators | |
| **Amplifier** | | |
| Output voltage | Default: 0 to 1050<br>Selectable:<br>–260 to +780,<br>–525 to +525 | V |
| Amplifier channels | 1 | |
| Average current (idle current) | 2 | A |
| Peak current, <5 ms | 6 | A |
| Current limitation | Short-circuit-proof | |
| Voltage gain | 100 | |
| Amplifier bandwidth, small signal | 2 kHz (1 µF) | |
| Amplifier bandwidth, large signal | 400 Hz (5 µF) | |
| Ripple, noise, 0 to 10 kHz, 1 µF | 300 | $mV_{rms}$ |
| Suggested capacitive load | 1 µF (min.), 17 µF (max.) | |
| Input impedance | 100 | kΩ |
| Control input voltage | Servo off: ±1/100 of selected output range;<br>servo on: 0 to 10 V | |
| **Interface and operation** | | |
| Piezo connector | LEMO EGG.0B.701.CJL1173 | |
| Analog input | BNC socket | |
| Temperature sensor (piezo actuator) | LEMO socket; deactivation of the piezo voltage output at 120 °C | |
| DC offset | 10-turn potentiometer, adds 0 to ±10 V to input voltage | |
| **Miscellaneous** | | |
| Operating voltage | 100 to 120 / 220 to 240 VAC, 50 to 60 Hz<br>(fuse change required) | |
| Operating temperature range | 5 to 40 | °C |
| | | |

# E-663 Three-Channel Piezo Driver

**For Open-Loop Piezo Systems and Actuators without Position Sensors**

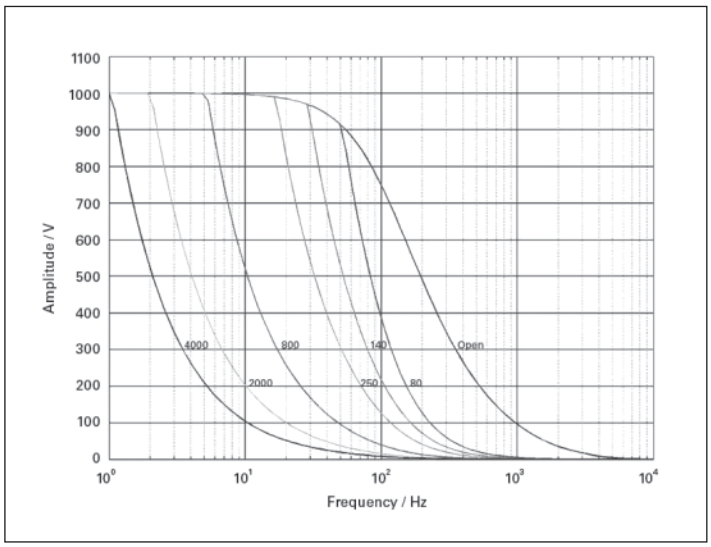

E-663: operating limits with various PZT loads (open-loop), capacitance is measured in µF

- 3 independent channels
- Peak power 3 × 14 W
- 3 LED voltage displays
- Output voltage range –20 to 120 V

| | E-663.00 | Tolerance |
|---|---|---|
| Function | Power amplifier | |
| Channels | 3 | max. |
| **Amplifier** | | |
| Input voltage | –2 to +12 V | |
| Output voltage | –20 to +120 V | min. |
| Peak output power per channel | 14 W | max. |
| Average output power per channel | 6 W | max. |
| Peak current per channel | 140 mA | <5 ms |
| Average output current per channel | 60 mA | >5 ms |
| Current limitation | Short-circuit-proof | |
| Noise, 0 to 100 kHz | <1 $mV_{rms}$<br><10$mV_{pp}$ | |
| Voltage gain | 10 ±0.1 | |
| Input impedance | 100 kΩ | |
| **Interfaces and operation** | | |
| Piezo connector | 3 × LEMO ERA.00.250.CTL | |
| Control input socket | 3 × BNC | |
| Display | 3 × 3 1/2 -digit, LED | |
| DC Offset | 3 × 10-turn pot., adds 0 to 10 V to Control In | |
| **Miscellaneous** | | |
| Operating temperature range | 5 to 50 °C | |
| Dimensions | 236 mm × 88 mm × 273 mm + handles | |
| Mass | 4.6 kg | |
| Operating voltage | 90 – 120 / 220 – 240 VAC, 50 – 60 Hz<br>(linear power supply) | |
| Power consumption | 60 W | max. |
| | | |

# E-464 PICA Piezo Driver / Amplifier

**For Piezo Systems and Actuators, for up to 3 Axes**


E-464: operating limits with various PZT loads, capacitance is measured in nanofarads

- 3 powerful channels
- Peak power 3 × 25 W
- Output voltage range 0 to 1100 V
- 3 LED voltage displays

| | E-464.00 |
|---|---|
| Function | Power amplifier for PICA high-voltage PZTs |
| **Amplifier** | |
| Output voltage | 0 to 1100 V |
| Amplifier channels | 3 |
| Average output power per channel | >3.5 W (max. 12 W if 1 channel is operated) |
| Peak output power per channel, <5 ms | 25 W |
| Average current per channel | >3.5 mA (max. 12 W if 1 channel is operated) |
| Peak output current per channel, <5 ms | 25 mA |
| Amplifier bandwidth, small signal | 1 kHz |
| Amplifier bandwidth, large signal | 3.5 Hz (660 nF); 35 Hz (70 nF) |
| Ripple, noise, 0 to 100 kHz | 5 $mV_{rms}$<br>50 (100 nF) $mV_{pp}$ |
| Current limitation | Short-circuit-proof |
| Voltage gain | 100 ±1 |
| Input impedance | 100 kΩ |
| Control input voltage | 0 to 11 V |
| **Interface and operation** | |
| PZT voltage output socket | 3 × LEMO EGG.0B.701.CJL1173 |
| Control input socket | 3 × BNC |
| DC offset | 3 × 10-turn potentiometer, adds 0 to 10 V to Control In |
| Display | 3 × 3½-digit LED display |
| **Miscellaneous** | |
| Operating voltage | 100 to 120 or 220 to 240 VAC, selectable (fuse change required) |
| Power consumption | 65 VA |
| Operating temperature range | 5 to 50 °C (above 40 °C, power derated) |
| Mass | 4.3 kg |
| Dimensions | 236 mm × 88 mm × 273 mm + handles |
| | |

# E-462 PICA Piezo Driver

**Compact, Bench-Top or OEM Module**


- Single-channel piezo driver
- Output voltage range 10 to 1000 V
- 12 V battery or external P/S operation
- For static or quasi-static operation
- Versions: Benchtop or OEM module

| | E 462.00 | E 462.OE1 | Unit | Tolerance |
|---|---|---|---|---|
| Function | Power amplifier for PICA high-voltage PZTs | Power amplifier for PICA high-voltage PZTs | | |
| **Amplifier** | | | | |
| Channels | 1 | 1 | | |
| Output voltage | 10 to 1000 | 10 to 1000 | V | |
| Average output power | 0.3 | 0.3 | W | |
| Peak output power <5 ms | 0.5 | 0.5 | W | |
| Average output current | 0.3 | 0.3 | mA | max. |
| Peak output current <5 ms | 0.5 | 0.5 | mA | |
| Current limitation | Short-circuit-proof | Short-circuit-proof | | |
| Ripple, noise, 0 to 100 kHz | 50<br>50 (100 nF) | 50<br>50 (100 nF) | $mV_{rms}$<br>$mV_{pp}$ | |
| Voltage gain | 100 | 200 | | ±1 |
| Input impedance | 10 | 10 | kΩ | |
| Frequency response | Static and quasi-static applications only | Static and quasi-static applications only | | |
| Control input voltage | 0 to 10 | 0 to 5 | V | |
| **Interface and operation** | | | | |
| PZT voltage output socket | LEMO EGG.0B.701.CJL1173 | LEMO PHG.0B.701.CJL1173 D42 | | |
| Control input socket | BNC | Header pins | | |
| DC offset | 1-turn pot., adds 0 to 10 V to Control In | – | | |
| **Miscellaneous** | | | | |
| Dimensions | 205 mm × 150 mm × 73 mm | 67 mm × 38 mm × 20 mm | | |
| Mass | 0.5 | 0.25 | kg | |
| Operating voltage | 12 VDC, stabilized | 12 VDC, stabilized | VDC | ±10 % |
| Max. operating current | 90 | 90 | mA | |
| Operating temperature range | 5 to 50 (above 40 °C, power derated) | 5 to 50 (above 40 °C, power derated) | °C | |
| Power supply | Wall-plug unit | – | | |

# Terms and Technology Glossary

## A

### Amplifier classification

PI uses the following amplifier classifications: Charge controlled, switched (class D), linear (class AB).

### Amplifier resolution

Only for digitally controlled amplifiers: Measurement of the smallest digital output value (LSB) in mV.

### Average current

Current that is available reliably over a longer period. Given as measured value. For multi-axis controllers, it is specified per channel.

## B

### Bandwidth

Max. operating frequency of a piezo driver, the measured value specifies the frequency in kHz, with which the amplitude is decreased by -3 dB. Large signal values refer to maximum output voltage. Small signal values refer to output voltage of 10 $V_{pp}$. The values are displayed in the amplifier operating diagram.

## C

### Capacitive base load (internal)

For switching amplifiers. Stabilizes the output voltage even without connected capacitive load (piezo actuator). The possible output power of a piezo controller / driver depends on internal and external capacitive loads.

### Capacitive sensors

Capacitive sensors allow contactless measuring, do not introduce much energy into the piezo drive system and have a flat design. Their direct position measurement of the piezo actuators eliminates drift effects for travel ranges of up to 1.5 mm. The overall system, which consists of the stage, sensor technology, and electronics, gains on performance and precision. Due to noncontact measuring in the 10 µm up to approx. 2 mm range, it is possible to mount the capacitive sensor in the stage at the point where the motion actually takes place. The design consists of two conductive surfaces: A high-frequency alternating current generates a homogenous electric field between the two surfaces. Customers from the semiconductor industry also appreciate the small and versatile design as well as the lack of thermal build-up in the system. See “Sensor linearization”.

### Charge-controlled piezo driver

Driver that employs a charge control principle. Here, the input signal controls the amount of electrical charge that is transferred to the piezo actuator. The result is a highly repeatable, linear displacement of the piezo actuator in high-dynamics operation, without any additional position feedback. The typical hysteresis that piezo actuators show when operated with a voltage-controlled piezo amplifier can such be reduced to 2 % only.
It is recommended to monitor the piezo temperature to protect them from over temperature damage, especially in high-dynamic applications.

### Class D piezo amplifier

See “Energy recovery operating principle”.

### Closed-loop operation

Piezo servo controllers have additional circuitry for position sensing and servo-control that compensates for nonlinearity, hysteresis, and creep. Displacement of the piezo is controlled by an analog signal. Positioning accuracy and repeatability down to the subnanometer range is possible, depending on the piezo mechanics and sensor type. High-resolution position sensors provide optimum positional stability and fast response in the nanometer range. The integrated notch filters (adjustable for each axis) improve stability and allow high bandwidth operation closer to the resonant frequency of the mechanics.
PI piezo drivers for PICMA® actuators have an output voltage range of up to –30 to +135 V to provide enough margin for the servo-controller to compensate e.g. for load changes. See “Open-loop operation”, “Capacitive sensors”, “Strain gauge sensors”.

### Control input voltage range

Also input voltage; for piezo controller / driver. Recommended range from –2 to 12 V. The usual gain value of 10 V leads to an output voltage of –20 to 120 V. Most PI controllers allow for an input voltage range of –3 to 13 V.

### Controller

The controller is an electronic system component. It supplies the current and the voltage to the drive (amplifier) and also has internal computing capacities. The controller takes care of the control and evaluation of sensor signal, trajectory calculation, trajectory control, and the communication with a host.

### Creep

An unwanted change in the displacement over time.

### Crosstalk

Deviation from the ideal motion in axes perpendicular to the direction of motion.
Angular errors are xrx = roll, xry = pitch, xrz = yaw. Linear errors are lateral runout such as xty = straightness, xtz = flatness.
See “Linearity error”.

### Current consumption

Current consumption of the system on supply end. It is specified for controller without load. Alternatively, power consumption.

### Current limitation

Short-circuit protection.

## D

### Direct metrology

Position measuring is performed with the highest accuracy directly at the motion platform so that nonlinearity, mechanical play or elastic deformation have no influence on position measuring. Precision positioning systems use different encoder types as position sensor: Incremental encoders with different accuracy levels, absolute-measuring encoders that additionally make referencing unnecessary when a machine is switched on again, and for travel ranges under 2 mm, capacitive sensors.

### Drift

See “Creep”.

### Drive type

Defines the types of drive supported by the controller / driver, such as DC motors, piezo stepping drives, piezo actuators.

### Driver

The driver is an electronic system component. It supplies the current and the voltage to the driver (amplifier).

### Dynamic digital linearization

Dynamic Digital Linearization (DDL) describes an iterative preshaping method minimizing the positioning error. DDL for example reduces the phase lag of the commanded and executed trajectory of repeated periodic motion patterns next to other piezoelectric motion effects. This is relevant for scanning applications, where a specific position must be identified and later be reapproached with high precision, or for applications where a trajectory must be followed very accurately for several processing steps.

## E

### Electrical capacitance

The piezo capacitance values indicated in the technical data tables are small signal values (measured at 1 V, 1000 Hz, 20 °C, no load). Large-signal values at room temperature are by a factor of 1.3 to 1.6 higher. The capacitance of piezoelectrics changes with amplitude, temperature, and load, up to 200 % of the unloaded, small signal capacitance at room temperature. For detailed information on power requirements, refer to the amplifier frequency response graphs provided for piezo drivers and controllers.

### Electronics

System component of a motion and positioning system. See “Controller”, “Driver”.

### Encoder input

Maximum bandwidth (-3 dB) of the input signals for the encoder input.

### Energy recovery operating principle

Switching amplifier (class D) with pulse width modulation (PWM) of the piezo output voltage. When the piezo actuator is discharged, a patented circuitry for energy recovery stores part of the returning energy in a capacitor and makes it reusable for the next charging cycle. The amplifier reduces the power consumption by up to 80 % compared to linear piezo amplifiers, runs cooler and provides better stability. Piezo drivers that use energy recovery are ideally suited for high-dynamics scanning and switching applications.

### Extensive software package

To make systems more user friendly, software plays an important role in positioning systems. Customers expect a plug-and-play solution even if several positioning systems are combined or different drive systems need to interact, and that is why PI (Physik Instrumente) provides PIMikroMove® host software. You only need to enter your parameters into the application to avoid programming altogether. Also supports a number of text-based languages, has its own LabVIEW, Python and Matlab drivers, and the software is compatible with Windows, Linux, and OSX. However, not all software tools may be available for all controller versions.

# Terms and Technology Glossary

## F

### Flatness

See “Crosstalk”.

### Flexure guiding systems

Piezo systems from PI (Physik Instrumente) use lever-amplified piezo actuators as the drive, e.g., when adjusting optical lenses. For optimum results regarding dynamics and accuracy, it is necessary to ascertain and optimize the mechanical and piezoelectric properties such as the guiding accuracy, crosstalk or temperature-related drift in the overall system. Friction-free flexure guides that allow hysteresis-free motion steer the motion and retain the stiffness. Very small, but subnanometer precision motion is transferred to the required system motion by using lever amplification.

## H

### HVPZT

Acronym for High-Voltage PZT (actuator).

### Hysteresis

Hysteresis in piezo actuators is based on crystalline polarization and molecular effects and occurs when reversing driving direction.

## I

### ID chip

An ID chip is located in the connector of many piezo stages. When the stage is calibrated at the factory with a digital controller, the calibration data is saved together with specific product information on the ID chip. When switched on, digital electronics read the data from the ID chip of the connected stage. Stages, whose ID chip contains the calibration data, can therefore be connected to any suitable digital electronics without renewed calibration.

### Incremental encoder

PI uses noncontact optical encoders to measure the actual position directly at the motion platform with the greatest accuracy so that nonlinearity, mechanical play or elastic deformation have no influence on position measuring. See “Direct metrology”.

### Input level

Permissible input level for digital interfaces.

### Integrated feedback sensor

Absolute measuring capacitive, piezo resistive (PRS) or strain gauge (SGS) and optical (absolute and relative) sensors are used to provide position information to the controller.

## L

### Lateral force, max.

Maximum lateral force perpendicular to the operating direction. For piezo systems the lateral force is limited by the piezo actuator and the flexure designs. For XY stages the push / pull force capacity of the other module (in its operating direction) limits the lateral force that can be tolerated.

### Limit switches

Function: Optical, magnetic.

### Linear amplifier / driver

Most piezo drivers use linear amplifiers (class AB) to generate the output voltage. In open-loop (voltage-controlled) piezo operation the amplifier output voltage is determined by an analog input optionally combined with a DC offset.

### Linearity error

Deviation in motion direction, of measured position from commanded position (positioning accuracy). Measured with an external, traceable device. The value is given as a percentage of the entire measuring range.
Measurement of the linearity error: The target and measured actual values of the positions are plotted against each other, a line is drawn through the first and last data point, and the maximum absolute deviation is determined. A linearity error of 0.1 % corresponds to an area of ±0.1 % around the ideal line. Example: A linearity error of 0.1 % over a measuring range of 100 µm produces a possible maximum error of 0.1 µm.

### Linearization

Digital piezo controllers offer the best positioning accuracy through linearization algorithms with higher-order polynomials. The linearity error with capacitive sensors can be reduced to less than 0.01 %. See “Dynamic digital linearization”, “Sensor linearization”.

### Load capacity

Maximum vertical load, when the stage is mounted horizontally. Limited by the flexure designs or the load capacity of the piezo actuators.

# M

### Measurement range extension factor

For capacitive sensors, used by PI.

# N

### NEXACT® Piezo walking drive

Precision piezomotor that creates the walking motion by means of piezo bending elements, in order to move a runner. The drives are very compact and achieve relatively high velocities around 10 mm/s, and forces up to 10 N. A suitable selection of the piezo elements optimizes step size, clamping force, velocity, and stiffness for the respective applications.

### NEXLINE® Piezo walking drive

High-load piezomotor that combines piezo clamping and shear actuators, in order to move a runner. The drives feature particularly high force and stiffness of several 100 N. They are capable of dynamically compensating oscillations in the range of a few micrometers with nanometer resolution. Furthermore the drives are designed for positioning and holding forces of up to 800 N, and work at velocities of about 1 mm/s.

### Noise

For capacitive sensors. In extended measurement ranges, noise is considerably higher than in the nominal measurement range.

### Nonlinearity

See “Linearity error”.

# O

### Open-loop operation

The actuator is used without a position sensor. Displacement roughly corresponds to the drive voltage. Creep, nonlinearity and hysteresis remain uncompensated. Open-loop operation is ideal for applications where fast response and very high resolution with maximum bandwidth are essential. Here, commanding and reading the target position in absolute values is either not important or carried out by external position sensors.

### Operating limits

Values measured at an ambient temperature of 20° C. A sine is used as control signal in open-loop operation. The amplifier works linearly within the operating limits, in particular without thermal limitation.

### Operating temperature range

In any case, the device can be operated safely in the maximum permissible temperature range. To avoid internal overheating however, full load is no longer available above a certain temperature (maximum operating temperature under full load). Nevertheless, recalibration or zero-point-adjustment may be required if the system is operated at different temperatures. Performance specifications are valid for room temperature range. Please refer to individual datasheets and contact PI for more details.

### Operating voltage

Allowed control input voltage range (also input frequency) for the supply of the device.

### Output voltage

The output voltage of piezo controllers show exceptional long-term stability with variations of only a few millivolt.

### Overtemperature protection

Switch-off temperature for voltage output. No automatic restart.

# P

### Patents

PI owns a large variety of patents on piezo and motor technology.

### Parallel-kinematic piezo stages

Optimal trajectory fidelity is achieved using a parallel-kinematics, parallel-metrology piezo stage with capacitive sensors. In a parallel-kinematics, multi-axis system, all actuators act directly on one moving platform. This means that all axes move the same minimized mass and can be designed with identical dynamic properties. Parallel-kinematic systems have additional advantages over serially stacked systems, including more compact construction and no cumulative errors from the individual axes. Multi-axis nanopositioning systems equipped with direct metrology are able to measure platform position in all degrees of freedom against one common reference. In such systems, undesirable motion from one actuator in the direction of another (crosstalk) is detected immediately and actively compensated by the servo loops. This active trajectory control concept can keep deviation from a trajectory to under a few nanometers, even in dynamic operation.

### Parallel metrology

Each sensor measures the position of the same moving platform in the respective degree of freedom. This keeps the off-axis runout, or crosstalk, of all actuators inside the servo-control loop and allows it to be corrected automatically.

# Terms and Technology Glossary

### Peak current

Only available for very short times, typically under a few milliseconds. It is used to estimate the possible dynamics with a certain capacitive load. Note: In this case, the piezo controller / driver does not necessarily work linearly.

### PICA / PICA Power

PICA piezo actuators are specifically designed for high duty cycle applications. PICA Power actuators are additionally optimized for high-temperature working conditions.
All materials used are specifically matched for robustness and lifetime. Endurance tests on PICA actuators prove consistent performance, even after billions (1,000,000,000 ) of cycles. The combination of high displacement and low electrical capacitance provides for excellent dynamic behavior with reduced driving power requirements.

### PICMA® Multilayer piezo actuators

PICMA® actuators take advantage of the indirect piezoelectric effect and achieve high forces with relatively low voltages. They only need a small amount of installation space. At the same time, the PICMA® actuators are very dynamic and can reach a position with a hitherto unattained precision. This is the reason why they are used as micropumps in metering technology. Due to their ceramic insulation, PICMA® actuators exhibit high reliability and climate resistance. PI (Physik Instrumente) also equips PICMA® actuators with individual connections for customer applications.

### PICMAWalk

PICMAWalk drives achieve feed forces up to 50 N and holding forces to 60 N. The maximum velocity is 15 mm/s. PICMAWalk uses the proven PICMA® multilayer piezo actuators. That means lower piezo voltages to 120 V. PICMA® piezo actuators also ensure a long lifetime and the outstanding reliability of the PICMAWalk technology.

### PiezoMove®

PiezoMove® actuators combine guided motion with long travel ranges of up to 1 mm as well as an optional sensor which provides precision up to 10 nanometers. The high-precision, frictionless flexure guides achieve very high stiffness as well as extremely low lateral displacement.
This makes them easier to handle than a simple piezo actuator, but still keeps them extremely compact. The number and size of the piezo actuators used determine stiffness and force generation. Due to these features, their small dimensions and the inexpensive design, the PiezoMove® lever actuators are particularly suitable for OEM applications.

### Piezoresistive sensors (PRS)

Strain gauge sensors that consist of a semiconductor foil. See “Strain gauge sensors”.

### PiezoWalk® walking drive

PiezoWalk® drives take advantage of the piezo walking principle and combine a subnanometer resolution with high forces, a robust design, and a scalable travel range. Industry customers use walking drives for travel ranges greater than 1 mm and to hold a stable position with nanometer precision resolution. PI (Physik Instrumente) offers walking drives with high feed forces as well as positioning and holding forces, but also relatively high velocities, and they also have a long lifetime in a vacuum. See “NEXLINE®”, “NEXACT®”, and “PICMAWalk”.

### PIRest

Piezo actuator technology for active adjustment of consistently stable gaps of several µm with subnanometer precision. The PIRest actuator is only powered during the actual positioning sequence and holds its position without power.

### Pitch

See “Crosstalk”.

### Power consumption

Maximum power consumption under full load.

### Preloaded piezo actuator

Piezoelectric stacks protected by an internal preload. The preload ensures a safe operation in any kind of application scenario and is ideal for dynamic applications and for tensile loads as well. Preloaded piezo actuators are intended for integration into a customer’s system and have no guides. If off-axis motion cannot be tolerated, an external guide is required.

### Profile generator

Functionality of motor controllers that allows motion profiles such aslinear interpolation, point-to-point, trapezoid, double bends. For several axes: Electronic gearing.

### Push / pull force capacity (in operating direction)

Specifies the maximum forces that can be applied to the system along the active axis. Limited by the piezoelectric material and the flexure design. If larger forces are applied, damage to the piezo actuator, the flexures or the sensor can occur. The force limit must also be considered in dynamic applications.

Example: the dynamic forces generated by sinusoidal operation at 500 Hz, 20 µm peak-to-peak, 1 kg moved mass, are approximately ±100 N.

### PZT

Acronym for plumbum (lead) zirconate titanate. Polycrystalline ceramic material with advanced piezoelectric properties. Often also used to refer to a piezo actuator or translator.

## R

### Reference point switch

Function: Optical, magnetic.

### Repeatability

Typical values in closed-loop operation mode (RMS, 1 σ). Repeatability is a percentage of the total distance or angle traveled. For small ranges, repeatability may be significantly better.

### Resolution

Position resolution relates to the smallest change in displacement that can still be detected by the measuring devices. The resolution in piezo-based positioning systems and piezo actuators is basically unlimited because it is not affected by static or sliding friction. Instead, the equivalent to electronic noise is specified. Values are typical results (RMS, 1 σ).

### Resonant frequency

No load: First resonant frequency in operating direction.
With load: Resonant frequency of the loaded system.
Resonant frequency does not specify the maximum operating frequency. PI recommends an operating frequency in open-loop of max. one third of the resonant frequency. Customized systems may differ from that. Please contact PI for more details.

### Rise time

Time constant of the controller / driver. Time required for increasing the voltage range from 10 % to 90 %.

### Ripple, noise, 0 to 100 kHz

Ripple of voltage in mVpp with unique frequency. Noise over the entire frequency range.

### Roll

See “Crosstalk”.

### Rotational runout

See “Crosstalk”.

## S

### Sensor bandwidth

Measured value that specifies the frequency, with which the amplitude decreased by -3 dB.

### Sensor linearization

For capacitive sensors, the signal conditioning electronics demonstrates a notably low noise level. The integrated linearization system (ILS) compensates for the influences of parallelism errors between the capacitor plates.

### Sensor resolution

The sensor can be the critical element in position resolution, for this reason the sensor resolution can be specified separately if necessary.

### Serial kinematics

Each actuator acts on its own platform. There is a clear relationship between actuators and motion axes. The advantages are the relatively simple assembly and multi-axis control. The dynamic characteristics depend on the individual axis. Guiding errors cumulate and the overall guiding accuracy is poorer if compared to “Parallel kinematics”, see there.

### Serial metrology

One sensor is assigned to each moving axis to be servo-controlled. Undesired off-axis motion, guiding error or crosstalk, go unnoticed and uncorrected. See “Parallel metrology”.

### Specifications

Performance specifications are valid for room temperature (22 ±3 °C) and closed-loop systems are calibrated at this temperature (specifications for different operating temperatures on request). Recalibration is recommended for operation at significantly higher or lower temperature. Custom designs for ultralow or ultrahigh temperatures on request.

### Stiffness

Spring constant, nonlinear for piezoelectric materials. Static large signal stiffness of the stage in operating direction at room temperature. Small signal stiffness and dynamic stiffness may differ because of effects caused by the active nature of piezoelectric material or compound effects, for example.

### Straightness

See “Crosstalk”.

# Terms and Technology Glossary

### Strain gauge sensor (SGS)

Strain gauge sensors consist of a thin metal wire packaged on a foil (SGS), or a semiconductor foil (PRS), which is attached to the piezo actuator or to the guiding system of a flexure stage. This type of position measurement is done with contact and indirectly, since the position of the moving platform is derived from a measurement on the lever, guide or piezo stack. Strain gauge sensors derive the position information from their expansion and thus change of resistivity. Full-bridge circuits with several strain gauge sensors per axis improve thermal stability and are used for signal shaping.

### Suggested capacitive load

For switching amplifiers. The possible output power of a piezo controller / driver depends on internal and external capacitive loads.

### Switching amplifier / driver

See “Energy recovery operating principle”.

## T

### Tilting mirrors

Tilting mirrors, or other fast steering mirrors or tip / tilt platforms are used for example, for active optics applications and beam deflection in laser processing and laser steering. These piezo stages provide two orthogonal tip / tilt axes with a common center of rotation. Their parallel-kinematic design creates identical performance in the tip and tilt axis, with a common fixed pivot point and no change of polarization direction. The bandwidth, resonant frequencies, and acceleration are often higher than with voice coil or galvo scanners. Tilting mirrors are wear free due to the flexure guidings used in the design.

### Trajectory control

Provisions to prevent deviation from the specified trajectory. Can be passive (e.g., flexure guidance) or active (e.g., using additional active axes and sensors).

### Translator

A linear actuator.

## U

### User software and functions

PIMikroMove®, PI General Command Set (GCS). Drivers for LabVIEW , shared libraries for Windows and Linux. Compatible with µManager, MetaMorph, MATLAB. Wave Generator. Linearization. Data recorder. Auto zero. Trigger I/O. Software configurable servo parameters. See “Extensive software package”.

## V

### Vacuum-compatible versions

In a large number of industry sectors, production in a vacuum is becoming increasingly more important. Therefore, PI (Physik Instrumente) offers various different drive technologies to its customers that can be operated in a vacuum of $10^{-7}$ or even 10–10 hPa. This includes piezo actuators that work in strong magnetic fields and in a cryogenic environment, piezo systems with travel ranges lower than 1.5 mm and subnanometer precision, piezomotors in a variety of designs with respect to force, dynamics, and travel range, as well as classical motorization with specially designed DC or stepper motors that allow greater travel ranges.

## Y

### Yaw

See “Crosstalk”.

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