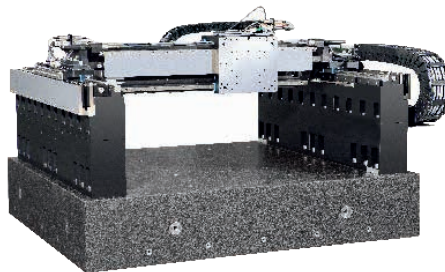




**HIGH PRECISION  
LINEAR & ROTARY  
POSITIONING SYSTEMS FOR**

**INDUSTRIAL AUTOMATION  
AND MOTION CONTROL**



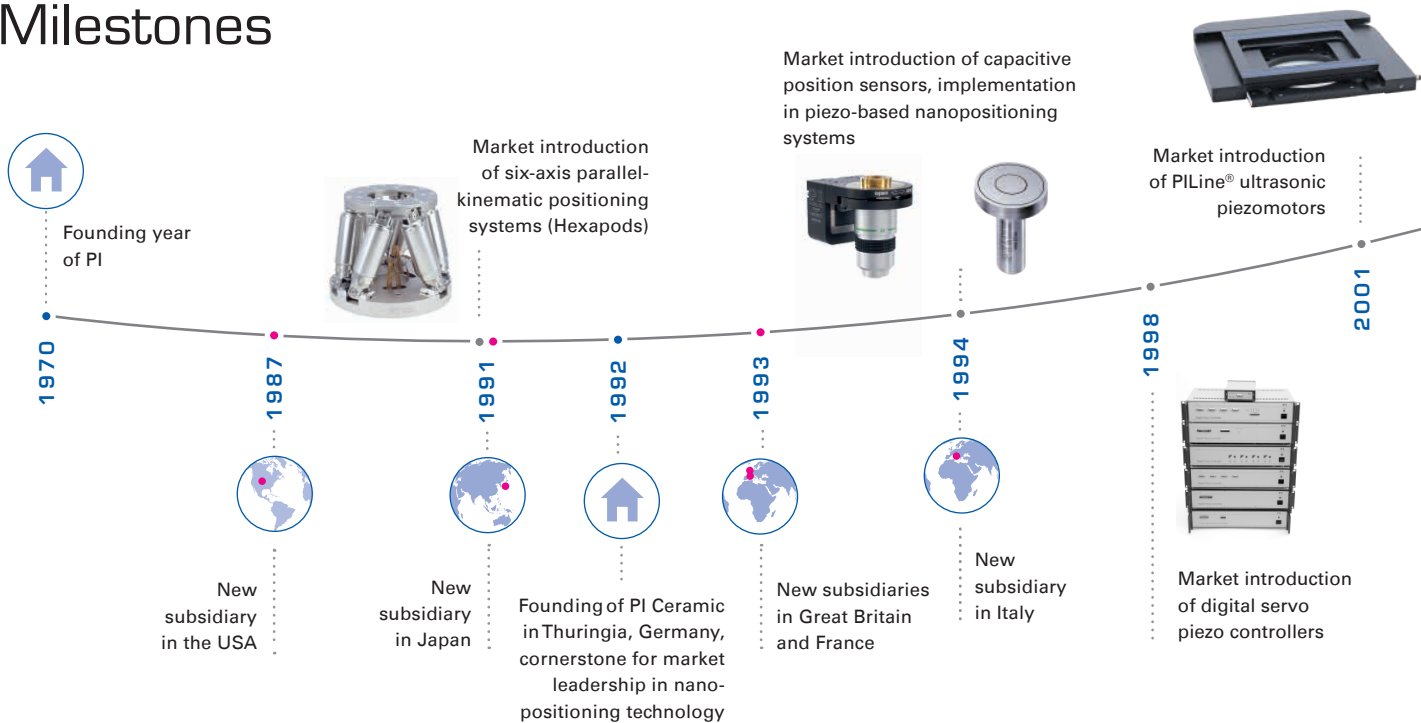
# The PI Group – A Strong Partner for Industry and Research



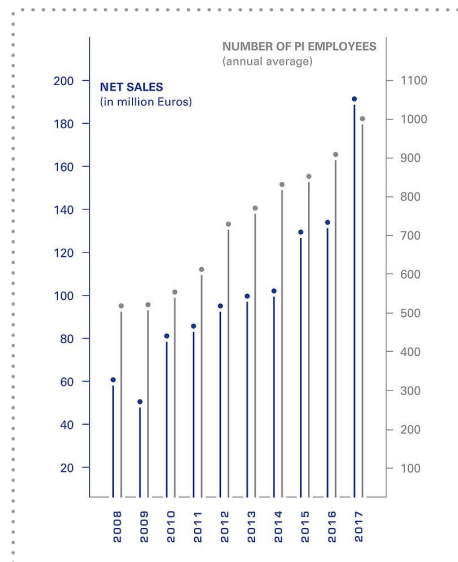
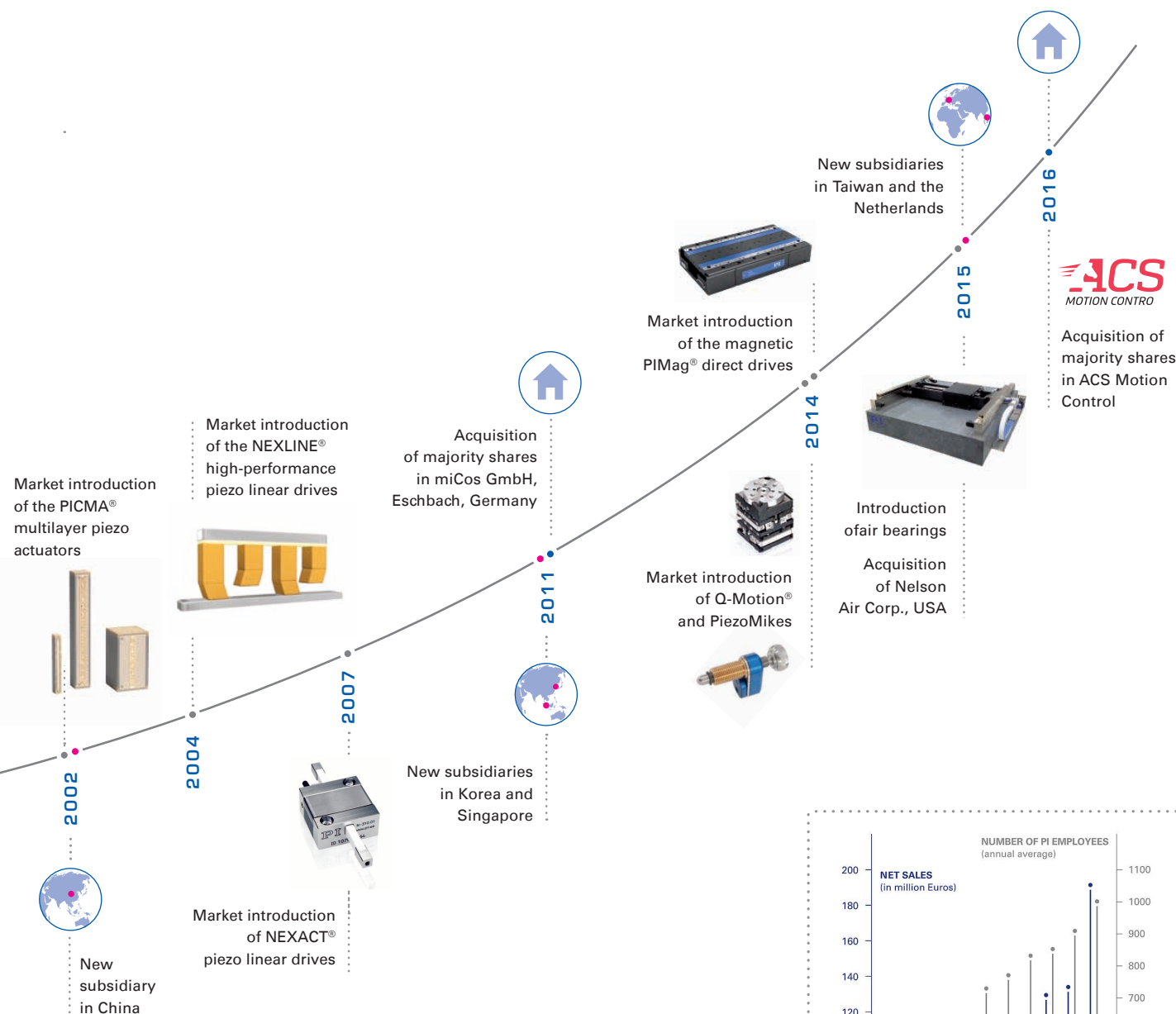
The PI headquarters in Karlsruhe, Germany, manifests the continuous growth. In front, the 2017 Technology Center

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.

## Milestones



## Milestones



# Motorized Standard Products Overview

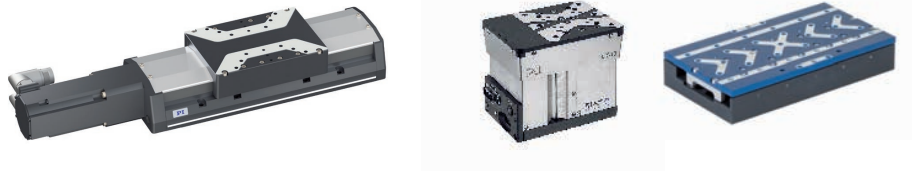
## XY Stages

- Screw or direct drive
- Mechanical or air bearing
- Incremental or absolute encoders
- Optional aperture



## Linear Stages

- Travel range up to several 100 mm
- Screw or direct drive
- Mechanical or air bearing
- Incremental or absolute encoders
- Vacuum or clean room compatible



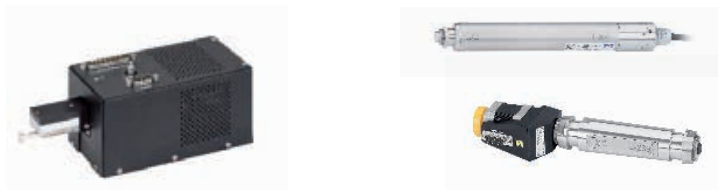
## Rotary Stages

- 360° or goniometer stages
- Worm or direct drive
- Mechanical or air bearing
- Incremental or absolute encoders
- Vacuum or clean room compatible



## Linear Actuators

- Optional force control
- Screw or voice coil drive
- Compact



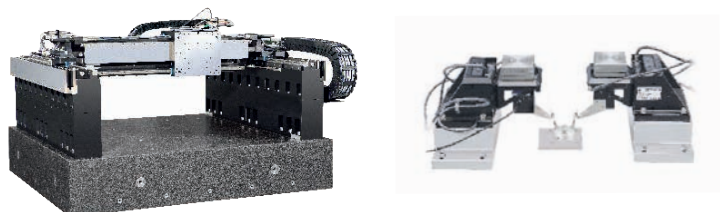
## Hexapods and Parallel Manipulators

- BLDC, Voice Coil and Piezo Motors
- Loads from 500g to 2000kg
- For Positioning and Motion Simulation



## Integrated System Solutions

- Gantries with industrial motion controllers
- Fast multi-channel photonics alignment systems



# Motorized Standard Products Overview

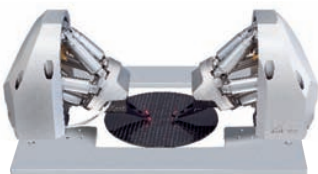
## Controllers

- Hexapod Controllers
- EtherCat Controllers
- Modular Controllers
- Desktop Controllers



# PI Products Covered in Other Catalogs & Online

## Photonics Alignment Systems



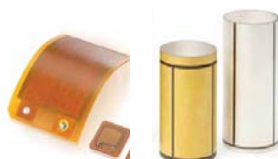
## Piezo Flexure Guided Nanopositioning Systems and Flexure Actuators



## Piezo Stacks, Piezo Ceramics



## Piezo Benders, Tubes, Materials



## Fast Steering Mirror Platforms



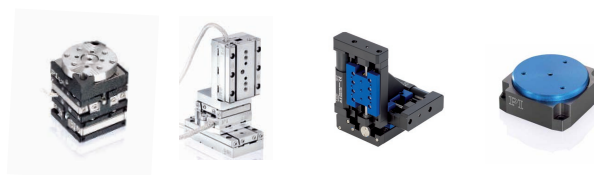
## Piezo Controllers



## Capacitive Displacement Sensors



## Miniature Positioning Stages

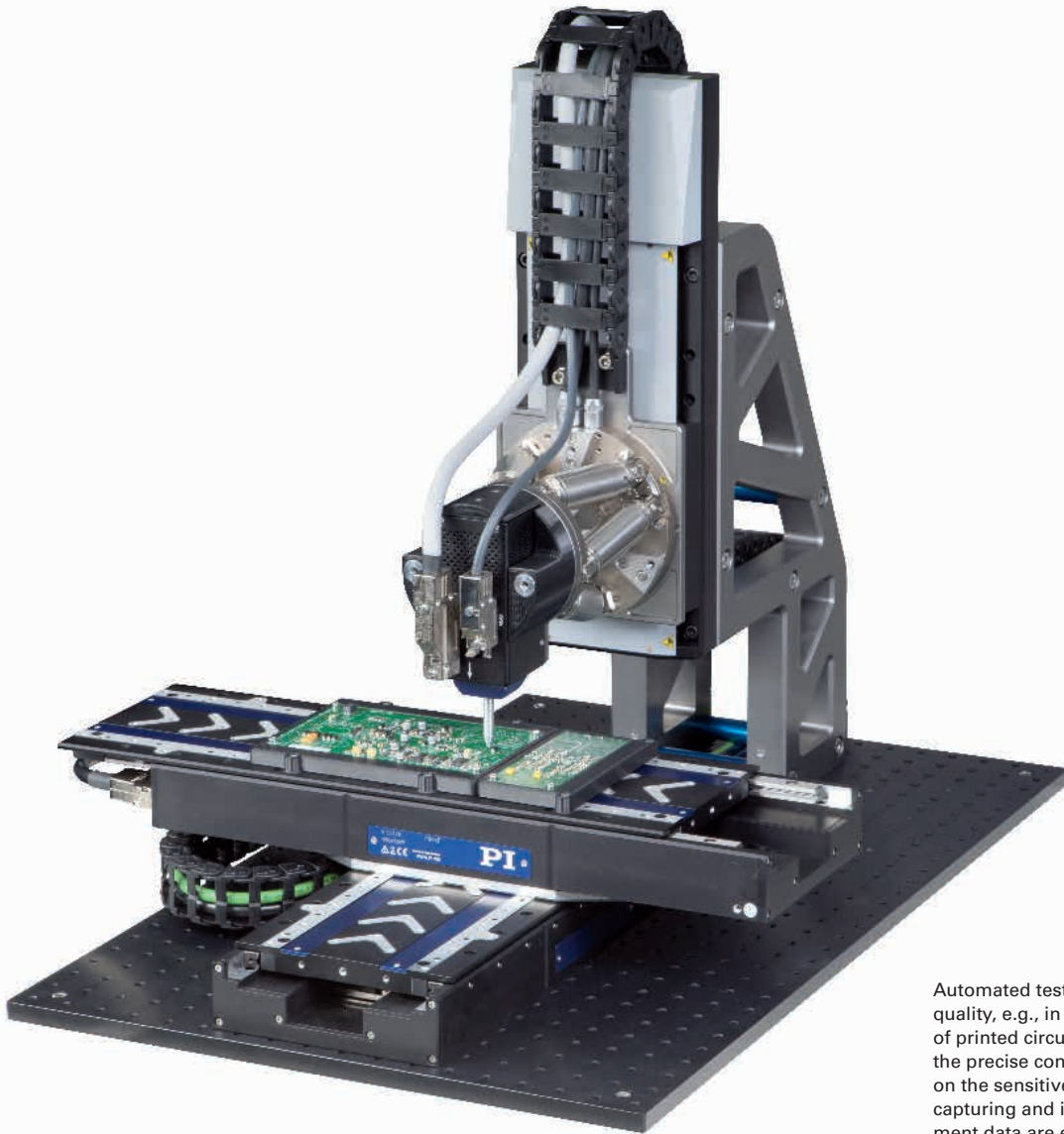


Fastest Information:  
Online Product Finder



# Markets and Applications

## INDUSTRIAL MANUFACTURING



Automated testing procedures ensure quality, e.g., in the production process of printed circuit boards (PCBs). Thereby, the precise control of the forces acting on the sensitive boards as well as the fast capturing and interpretation of measurement data are extremely important

The field of industrial manufacturing and assembly offers the widest range of applications for the PI micropositioning stages. In many applications the precision requirements keep growing for industrial application.

For example, digital printing becomes more and more common. The accuracy of the separate dots needs to be better than  $20\ \mu\text{m}$  to be recognized as equidistant by the human eye. This requires motion technology providing an accuracy typically 10 times higher meaning  $2\ \mu\text{m}$ , as well as motion with constant speed, good straightness and flatness.

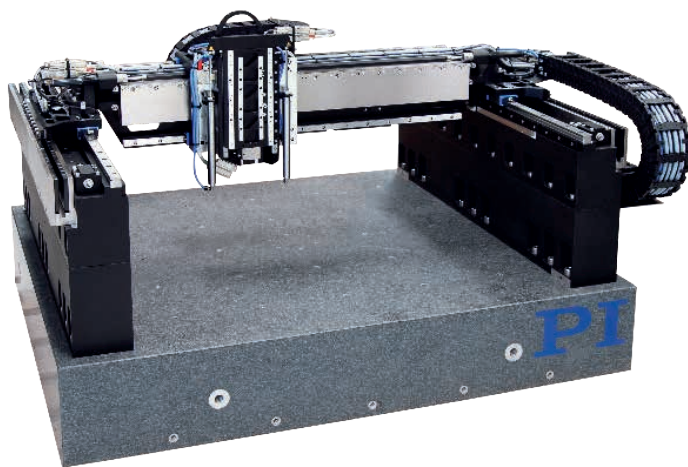
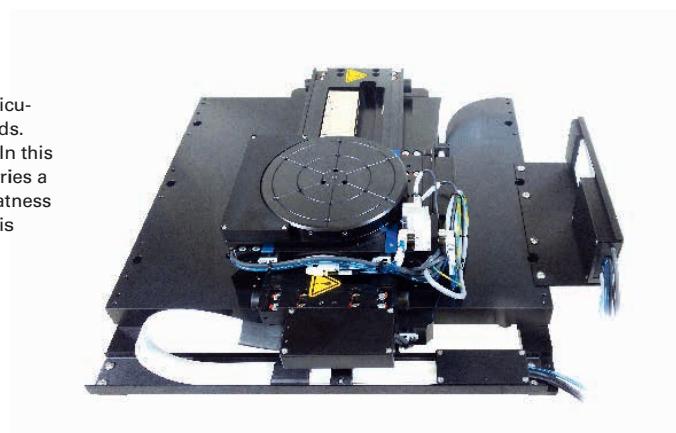
Another example is force-controlled testing of a touch screen, a keyboard or electronic car keys, as well as the control of force with which small parts are being assembled. Here, PI offers advanced solutions for those markets using its proprietary voice coil and force sensor technologies.

# Markets and Applications

## SEMICONDUCTOR PRODUCTION AND INSPECTION

The automation of process steps in production and inspection is steadily on the increase. At the same time, the requirements to accuracy required in motion and positioning are growing. Today, in many industrial areas accuracy levels are needed as they were needed just a few years ago in research institutions. PI with its linear stages, rotation stages, and lifting stages, as well as more complex multi-axis kinematics, offers excellent solutions for industrial applications in many growing markets and even for very general automation tasks with challenging specifications.

The requirements to the straightness and flatness, and the precision are particularly high in the production and inspection of semiconductors or circuit boards. High dynamics of the motion axis are required for an optimized throughput. In this case, a standard A-311 stage with a 200 mm x 200 mm travel range in XY carries a customized rotation stage. All stages have air bearings to warrant the best flatness and direct drives for precision and high dynamics positioning. In addition, it is possible to hold a stable position



The semiconductor industry often requires very specific solutions, e.g., for wire or ball bonders. PI's Gantry systems are an ideal basis for customized adaptations. The strokes and the stacking height can be varied almost arbitrarily, the configuration of the motors provides extremely high accelerations of up to 5 g and this ensures the highest productivity in the application. Control features of ACS motion controllers such as „Input Shaping“ help to build a stable system which actively suppresses possible vibrations

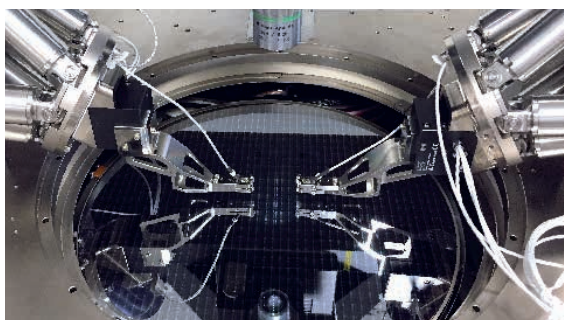


Wafer inspection system with integrated linear motor axes for fast precision XY scanning. Stepper motor axis for fine vertical position of the inspection equipment

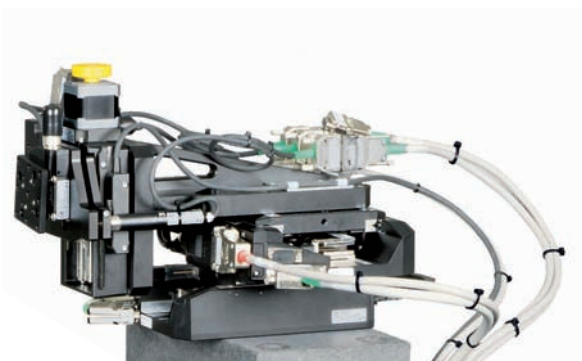
# Markets and Applications

## PHOTONICS PACKAGING AND OPTICAL ALIGNMENT

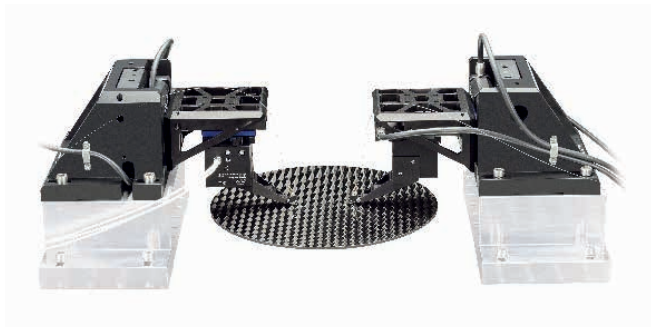
During production and inspection of components with optical data transmission, it is important to align fibers or fiber arrays for optimum connection with the highest possible accuracy. Position tolerances way under 50 nm are usual and multi-channel inputs and outputs require simultaneous alignment in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



In this multi-axis system for wafer inspection and photonics alignment, high speed linear motor stages are used for the long xy stroke, while mechanical stages with stepper motors and screw drives are used for the other degrees of freedom that do not require too high dynamics



In photonics, automated alignment is the key to high throughput and outstanding quality. The basis of this optical alignment system is a very stiff XYZ set-up consisting of three motorized linear stages and a P-616 NanoCube<sup>®</sup> piezo nanopositioner. The low overall height simplifies integration in limited installation space. The motorized drives make longer travel ranges possible and at the same time, the NanoCube<sup>®</sup> nanopositioner ensures fast scanning motion and dynamic compensation of drift effects. Flexure guides and all-ceramic insulated PICMA<sup>®</sup> actuators guarantee a long lifetime. Because all drives are equipped with position sensors, it is possible for example, to reliably prevent collisions with expensive silicon wafers



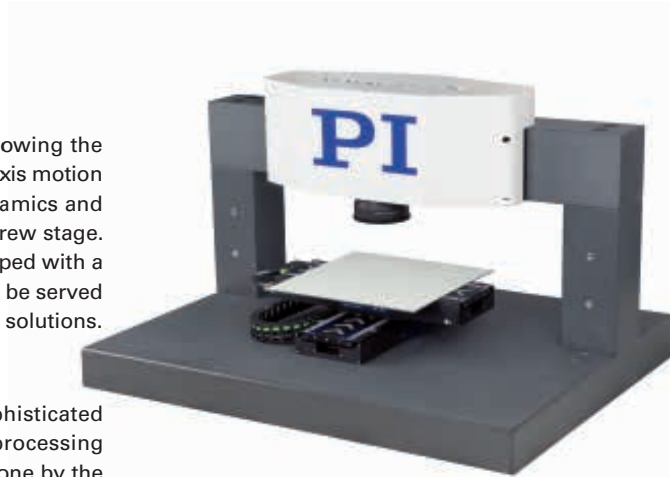
# Markets and Applications

## LASER MATERIAL PROCESSING

Laser cutting for example, often requires lowest tracking errors while following the arbitrary path of the customer's workpiece. This means very dynamic multi-axis motion that is ideally realized by using linear motor solutions which combine dynamics and accuracy. An additional vertical motion is typically realized using a ball screw stage. For improved dynamics in the Z-direction, a linear motor axis can be equipped with a mechanical, magnetic or pneumatic weight balance. These applications can be served with standard linear stages with a debris protection or with fully customized solutions.

### Building Highly Productive Laser Systems

ACS Motion Control, as part of the PI group, allows to supply highly sophisticated Motion Controller and Universal Drive Modules for the control of laser processing applications. Control of the laser power and the triggering of the laser is done by the LCMV2 Laser Control Module. A dedicated software to create a custom specific Human Machine Interface (HMI) is available as well. Additionally integrating a 3<sup>rd</sup> party galvo scanner allows to decouple the high and the low frequencies of motion: The high frequencies will be covered by the galvo scanner and the low frequency motions will be executed by PI linear stages. The resulting possibilities for the overlapping motion of the scanner and stages are practically unlimited and allow to create best-productivity systems with high-precision motion without any stitching errors.



PI's dynamic positioning systems combined with ACS motion controllers become fast, productive systems which, with the help of lasers, can label, mark, rip, cut, or drill

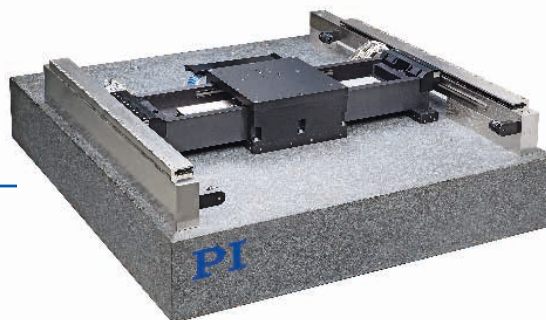
EtherCAT



SPiiPlusEC



UDMnt

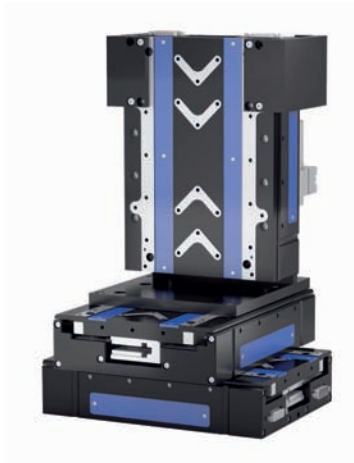


Controlled by  
ACS

ACS Motion Control and PI motion systems are perfectly matched to each other. A solution from a single-source supplier does not just offer the customer sophisticated positioning technology and high-performance control solutions, but also faster start-up and high flexibility when implementing new requirements

# Markets and Applications

## AUTOMATED OPTICAL INSPECTION (AOI)



3-axis combination of linear motor stages. The vertical axis uses weight compensation and it can, therefore, move with high dynamics while, at the same time, offering the best positioning accuracy



Typical 2-axis setup with clear aperture for the scanning of larger surfaces

The field of optical inspection widens as the requirements in quality assurance are growing higher and higher. There are different ways of inspecting devices like PCB, electronic components, and medical samples.

The easiest way is to move from **point to point**, stop, and take a picture. This requires fast step-and-settle times and a high stability when on target position. To cover large surfaces will take a long time.

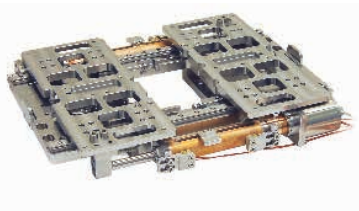
To increase productivity, it is very common to do a **meander scan**. While one axis generates a motion with constant speed, the perpendicular axis moves one step to the next line. Pictures are taken during the constant speed motion which leads to high requirements in straightness and flatness of those stages.

In many cases an additional Z-stage is used for autofocusing during the scan. Those Z-stages typically carry the objective and have to execute a high-bandwidth, very fast short-stroke motion. Depending on the requirements in stroke, PI offers different solution for the vertical systems.

# Markets and Applications

## BASIC RESEARCH, SCIENTIFIC INSTRUMENTATION

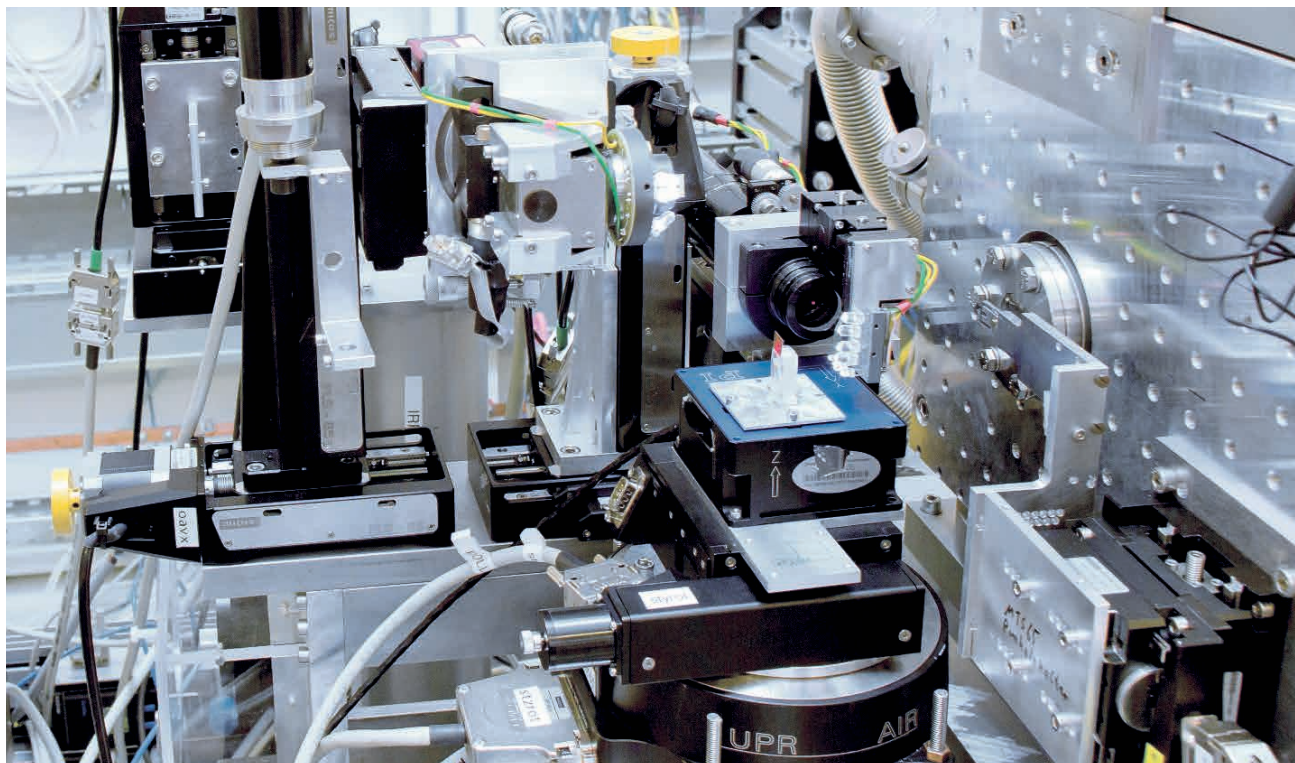
Why scientists rely on PI: Creativity for Research and Development. Many scientific publications cite PI systems because they are an important prerequisite for successful research and development projects. Customized designs for university research are everyday business for PI, also for environmental conditions such as UHV to  $10^{-10}$  hPa, radiation, or strong temperature changes down to the cryogenic range. The spectrum reaches from completely new designs to small modifications of standard products for a better adaptation to the application. Important fields of research are, for example, beamline instrumentation, micro systems and nanotechnology.



Compact linear translation stage that features two separate moving plates on one guiding

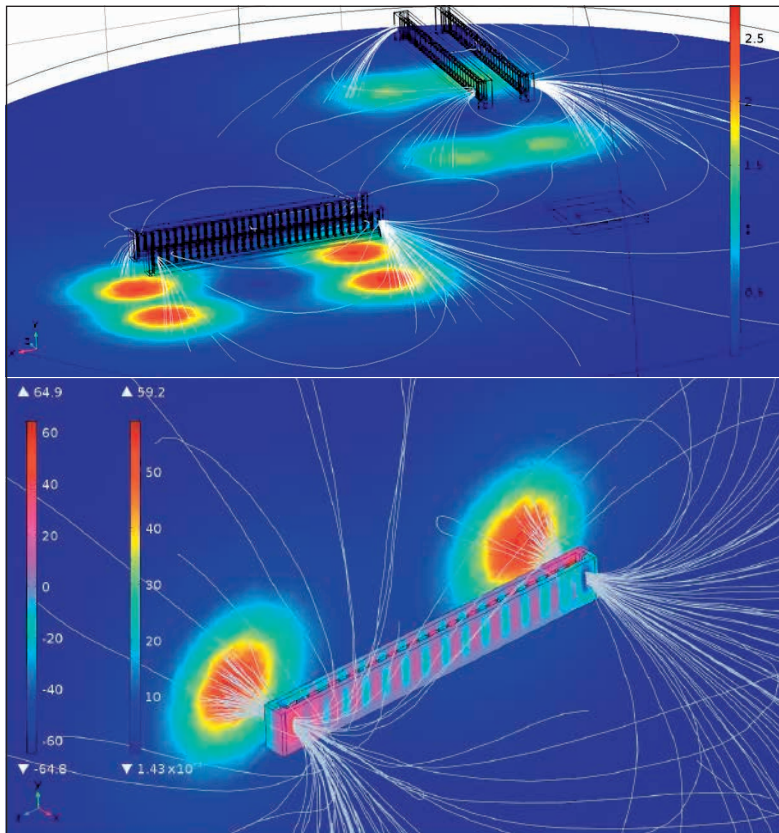


Hybrid drive, consisting of electric motor and piezo actuator, for optimum positioning accuracy and minimum path deviation



The sample positioning setup inside the holography endstation uses a variety of PI's motorized translation and rotary stages, as well as piezo stages for ultra-fine positioning (Image: M. Osterhoff, Institute for X-Ray Physics, Georg-August-University Göttingen)

# Engineering Design Expertise and Customization



## Core Technologies

- In-house manufacturing of piezo components and piezo actuators
- Magnetic direct drives: linear motors and voice coils
- 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

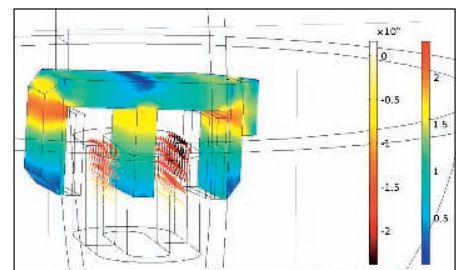
The development and customized design of electromagnetic direct drives that are used for high-resolution motion and positioning tasks require a scientific approach to the technology. The images show the analysis of magnetic fields down to a magnitude of  $5 \mu\text{T}$  that were used to select the optimum position of the drive components within an application

## 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.



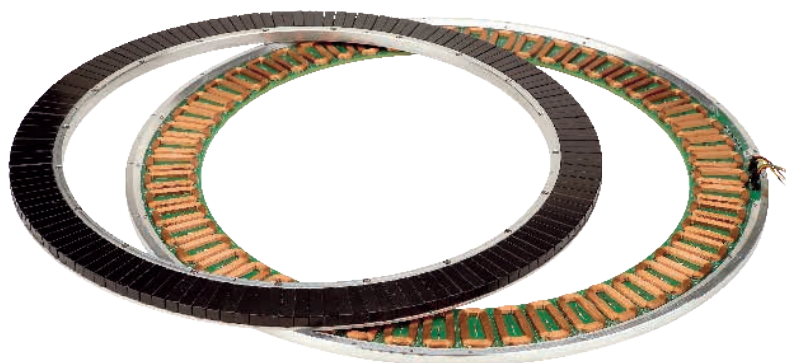
Calculation of the magnetic flux density and currents for a novel voice coil drive allowing multiple degrees of freedom

# Technological Depth for Optimized Products

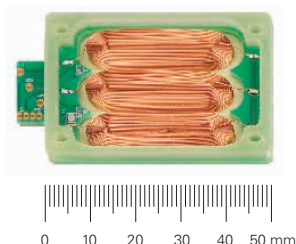
## From Standard to Custom Products

### In-House Technological Expertise

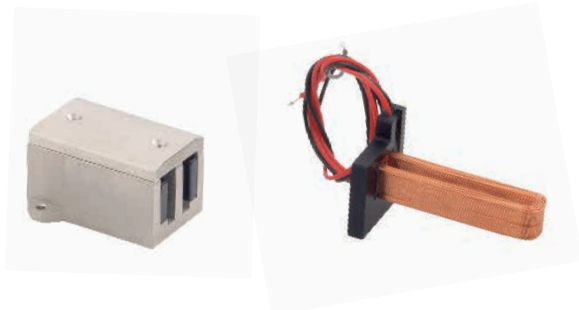
All decisive technologies required for the drive or motor, the measuring system, the motion controller, and the guiding system, are available in-house. To serve industrial applications, in-house development and the production capabilities of PIMag<sup>®</sup> magnetic drive and Plglide air bearing technologies are essential. PI also has production capabilities for high-end mechanical parts such as the milling of components with lowest tolerances.



Commercially available torque motors offer very high torque but only limited apertures. This customized PIMag<sup>®</sup> torque motor has a particularly large aperture and it positions with high dynamics and stability while needing minimal installation space. It can be integrated as a rotation stage on top of a PI hexapod



PIMag<sup>®</sup> linear motors with or without iron core are the result of in-house development. In this way, specific properties of the stages and axes can be influenced directly. PI is in a position to develop customized linear motor and voice coil solutions not only for standard products but also for customized OEM solutions, where special features are needed. In most cases, the form factor of such a motor will be customized and adapted to the customers' needs



PIMag<sup>®</sup> voice coil drives can be designed with a particularly compact size and they can be directly integrated into the customers' application. The PIMag<sup>®</sup> technology and dedicated simulation tools allow to optimize the force-to-size ratio for a required form factor



The highly precise PIONE linear encoder, one of PI's own measurement systems, permits a signal period to 0.5  $\mu\text{m}$ . In the controller, sine/cosine signals are evaluated which allow for a very high position measurement accuracy of down to a fraction of a nanometer

# Technological Depth for Optimized Products

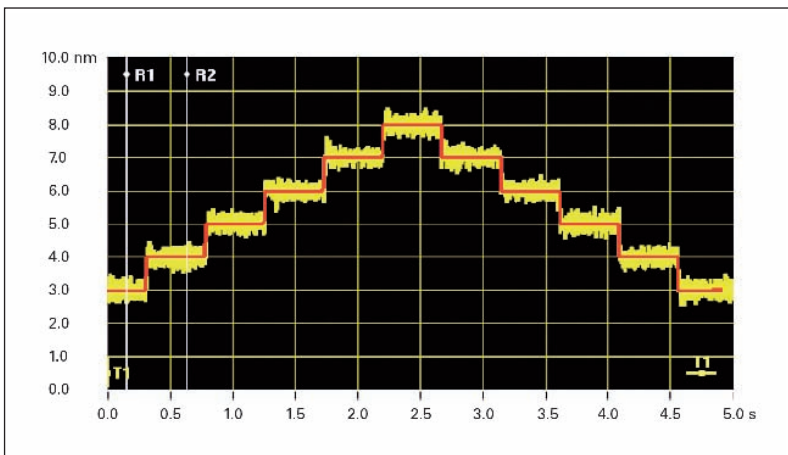
## Systems From a Single Source

The controller technology of ACS Motion Control ensures that even complex industrial applications can be managed by one single source. This means that PI can offer ideal solutions from one single source to meet the demands of the most diverse industries, which all need reliable, durable technology with increasing levels of precision.



Modular multi-axis controllers from ACS for automation control are based on an internal EtherCAT network. This modular technology allows to control stages needing a bus voltage from 24 VDC up to 560 VDC and a peak current of 5 A up to 90 A. The ACS control technologies are designed especially for direct drives such as voice coils and linear motors in the best possible way enabling fast settling times, high speed stability and low jitter

OEM controllers from PI meet customers' requirements in every aspect. They are available for any drive technology and can be adapted to include special functions such as force control



Positioning stages with PIMag® linear motor and with PIONe measuring system allow minimum incremental motion and the highest precision such as for example, the V-551.xD linear stage. The diagram shows steps from 1 nm and the idle noise of  $\pm 0.4 \text{ nm}$ . In the linear motor axes, this precision can be combined with long travel ranges, high velocities, and accelerations

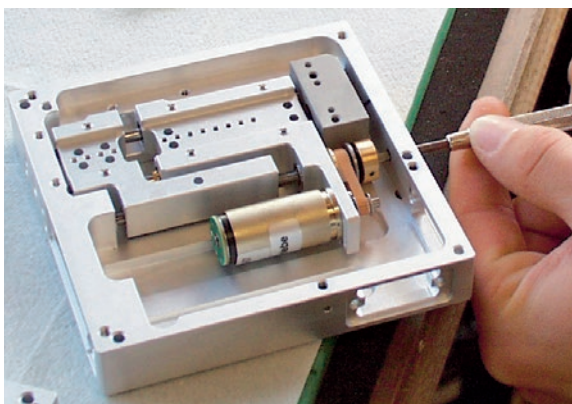


Compact motion control solutions permit the control of individual axes with different drive technologies such as stepper, DC or linear motors and piezo-based drives. The modular design allows a subsequent adaptation of the network while using one common control interface

# Technological Depth and Customization

## Customization on all levels of integration

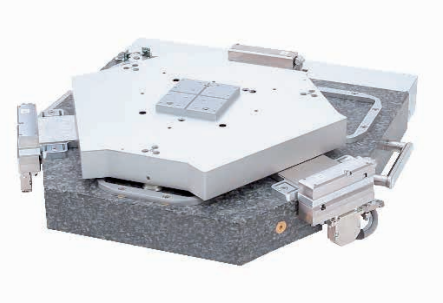
PI's proprietary technological know-how and vertically integrated production are the basis for the successful development of customized motion systems from scratch. All technologies can be adapted specifically to an application. Examples range from a PIMag® voice coil drive for integration into an OEM system, to complex multi-axis positioning setups, to fully integrated, turn-key system solutions.



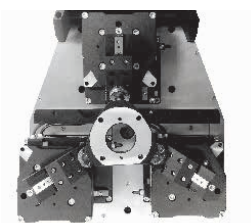
Individual assembly of a stage



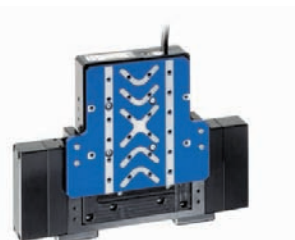
PI produces core components in-house for its precision positioning systems. This applies to sensors, electronics, and motors as well as certain milled parts with particularly low tolerances



PI's own development of guiding technologies allows the design of individual solutions. Linear guiding technologies such as flexures for small displacements, air bearings for extreme requirements on travel accuracy, or magnetic levitation for the highest demands in up to six degrees of freedom are developed in-house. Leveraging of long-standing piezo technology at PI Ceramic, PI is able to manufacture ceramic bearings in its own facilities. For many requirements, mechanical bearings in different precision grades from highly qualified suppliers are used



Customized parallel-kinematics stage with six degrees of freedom. The PIMag® linear motors ensure high dynamics and precision as required in optical alignment or fiber alignment. The solution is based on 3 XY stages which are driven by linear motors that allow high dynamics for the precision alignment. The SpaceFAB parallel kinematic allows a very flat design with long strokes in x and y. In comparison to a PI Hexapod, the footprint of the SpaceFAB is relatively large, and the hexapod is better suited for longer vertical strokes

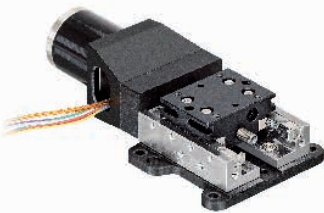


The dynamics and precision of voice coil or linear motor stages is required in vertical direction as well. For an improved position stability PI offers various solutions for a counter balance system which can be based on springs, magnetic solutions and pneumatic cylinders. The picture shows a modified V-528 standard product with PIMag® direct drive and gravity compensation for vertical applications. The compensation is done by a constant force spring and is adjusted precisely to the customers payload

# Technological Depth and Customization



56 motors, 16 motion controllers, and 20 tons weight make the system for Microscopy and Quality Assurance (MiQA). The unique system integrates hexapods, rotation stages, goniometers, and a custom sample stage and will be used in a beamline for X-ray microscopy and the qualification of X-ray optics. Virtually all available PI technologies are combined here in a highly specialized solution providing the best possible accuracy for this application, resulting in 80 nm at the tool center point over multiple stacked axes

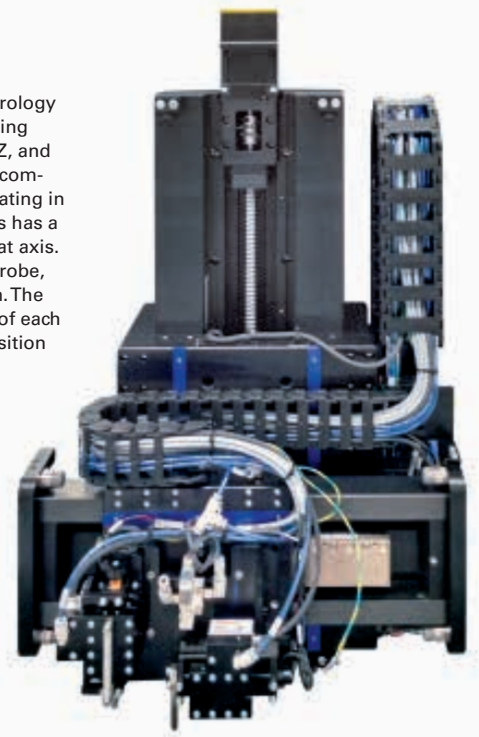


Focuses an objective in space:  
Linear stage for the "Mars 2020"  
NASA mission

Coordinate measuring machines (CMM) and metrology tools use a variety of design architectures, including moving gantries, static gantries, cantilevered XYZ, and many others. The most common type of CMM is composed of three orthogonal axes (X, Y, and Z) operating in a three-dimensional coordinate system. Each axis has a position encoder that indicates the position of that axis. The machine will read the input from the touch probe, as directed by the operator or computer program. The machine then utilizes the X, Y, and Z coordinates of each of these discrete points to determine size and position of the part being measured



Complete autofocus system  
with PIMag® voice coil drive. Not  
only the voice coil stage is supplied  
by PI but also the alignment tools and an  
alignment routine to warrant highest precision  
assembly of the payload





# Vacuum & Clean Room Manufacturing

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.

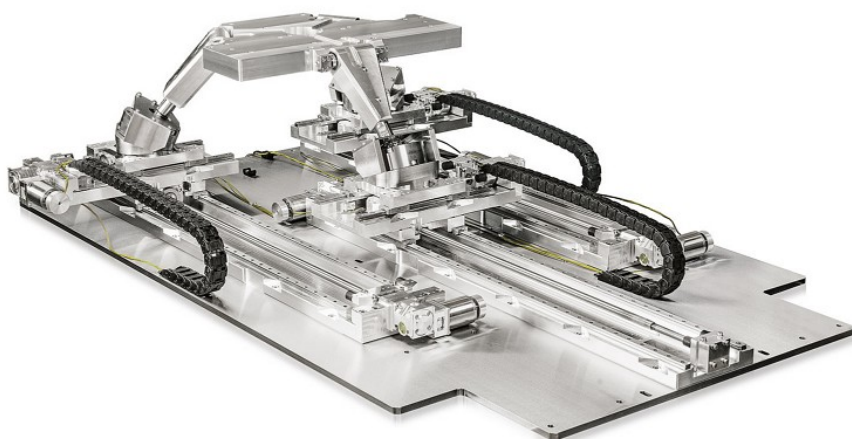
Selection of the optimum drive technology for the respective application and the mechanical design must be matched exactly to the required load capacity and velocity as well as the intended operating and planned duty cycles.

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.

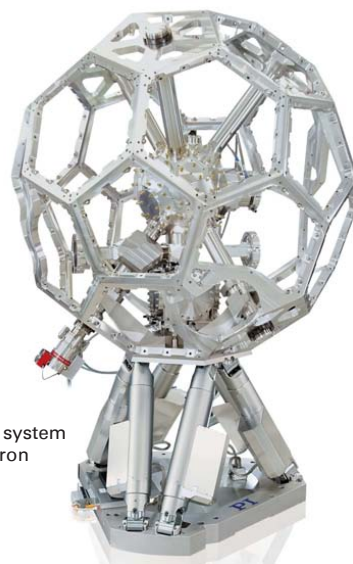
Vacuum chambers are available in several sizes with vacuum levels down to  $10^{-10}$  hPa, where start-up and measurement of outgassing, but also interferometric measuring of position accuracy under real operating conditions is possible.



At PI, several vacuum chambers are available in various sizes



This example of a customized parallel-kinematic design for 6 axes of motion (SpaceFAB) is used in a beamline application. The high load capacity of up to 250 kg and the asymmetric layout with a long travel range in one direction, allows for positioning a sample in the synchrotron beam, and removing it. The stage is intended for use in radiation environment



Double hexapod PKM system designed for synchrotron X-ray spectroscopy



Minaturized piezo-motor driven 6-Axis and XYZ positioning solutions for vacuum applications

# Production Capabilities

- 13,000 m<sup>2</sup> of overall production space
- 5,000 m<sup>2</sup> 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



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.

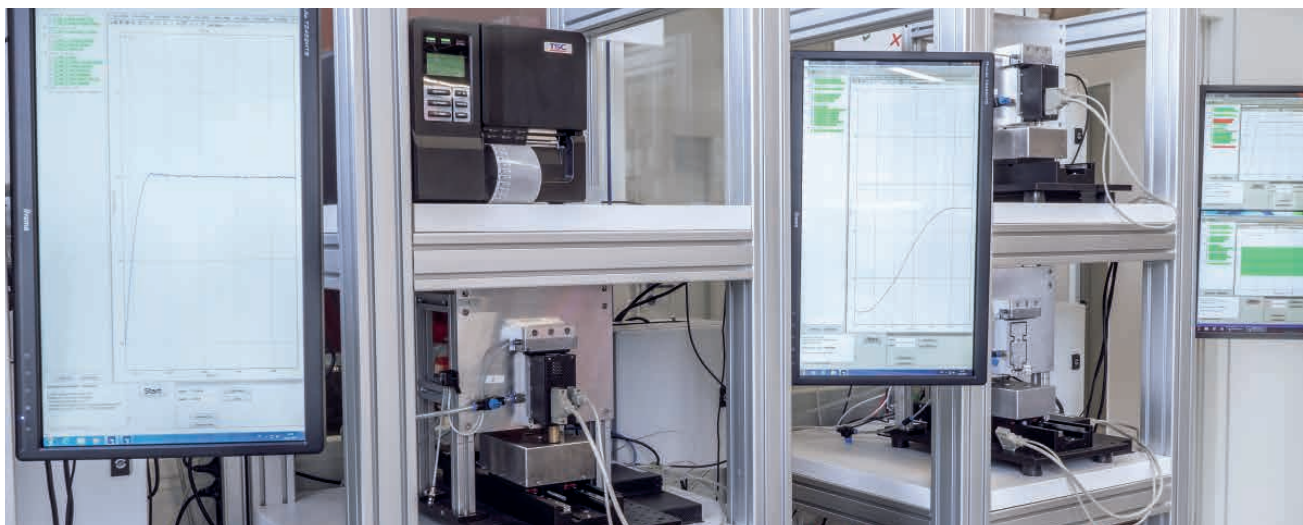
## **Vertical Production Range and Production Capacity**

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.

# OEMs Benefit From Maximum Flexibility

## From 1-off to 100000

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.



Standardized performance control with full documentation of individual measurement charts

### 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

# Expert Consulting and Global Service



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

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.

## 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.

## 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
- Support – Ongoing remote and on-site support to maximize system uptime and provide maintenance for the whole life of any system
- Training Program – User training on software and programming, through to optimization of system performance
- Maintenance Systems Health Check – Preventative maintenance

## 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.

## 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.



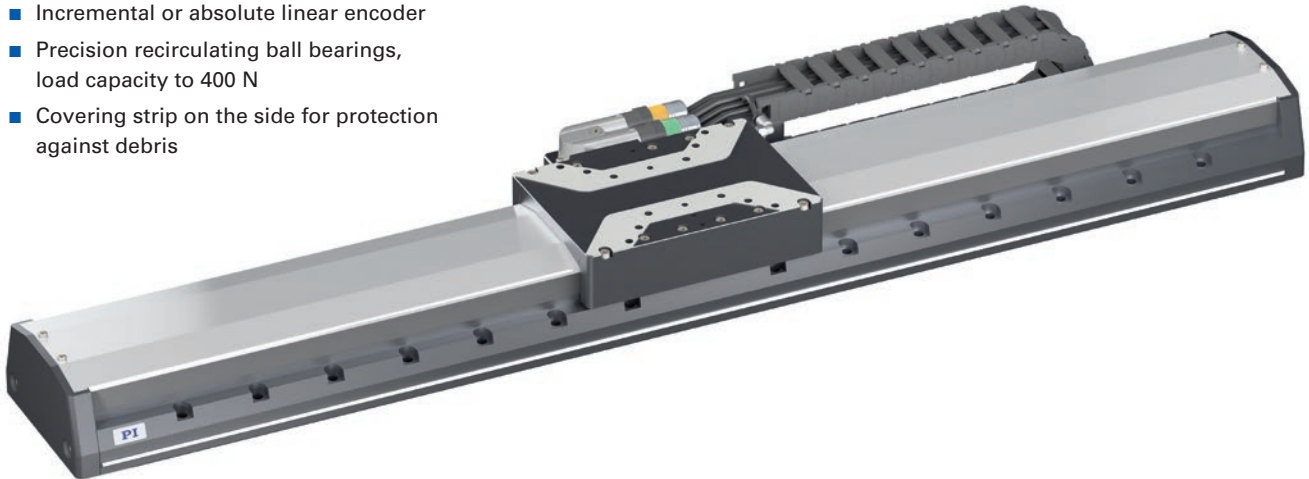
# High Speed Linear Motor Stages for Heavy Duty Applications and Precision Industrial Automation



# V-412 Linear Motor Stage for Industrial Automation

## High Performance and Cost Efficiency, Linear Motor

- Width 116 mm
- Travel range to 610 mm
- Nominal force 33 N
- Incremental or absolute linear encoder
- Precision recirculating ball bearings, load capacity to 400 N
- Covering strip on the side for protection against debris



### Reference-class linear stage

PI has extended its product portfolio for industrial solutions with a new family of precision linear motor stages. Various versions are available with high-performance linear motors, heavy-duty recirculating ball bearings, and precision linear encoders. The protective side seal and the purge air connection prevent contamination by debris entering the stage.

### PIMag® magnetic direct drive

3-phase magnetic direct drives do not use mechanical components in the drive-train, they transmit the drive force to the motion platform directly and without friction. The ironless linear motors reach high velocities and accelerations. Ironless motors are particularly suitable for positioning tasks with the highest demands on precision because there is no undesirable interaction with the permanent magnets. This is in comparison to iron core linear motors which exhibit 'cogging'. This allows smooth running even at low velocities and no vibration at high velocities.

### Class leading design

When compared to current market offerings, the new V-412 series of stages provides users with a higher specification recirculating ball bearing that offers higher load carrying capacity and dynamic performance. The encoder options offer a high resolution resulting in improved motion tracking errors and refined move and settle performance. For full flexibility the user can select either incremental or absolute types. Absolute types remove the requirement to home the stage during startup and provide additional benefits including reduced collision risks during operation.

### Applications

- Automated Optical Inspection (AOI)
- Digital Printing
- Electronics Manufacturing
- Flatpanel Inspection
- Automation
- Laser Cutting
- Scanning

	V-412.03	V-412.05	V-412.09	V-412.13	Unit	Tolerance
<b>Motion</b>						
Travel range	52	102	204	305	mm	
Pitch / yaw	±9	±14	±19	±29	µrad	max.
Straightness / flatness	±1.5	±2.5	±4	±6	µm	max.
Velocity, unloaded	2000	2000	2000	2000	mm/s	max.
Positioning accuracy (uncalibrated)	±3	±4	±8	±10	µm	typ.

	V-412.17	V-412.21	V-412.25	Unit	Tolerance
<b>Motion</b>					
Active axes	X	X	X		
Travel range	407	508	610	mm	
Pitch / yaw	±39	±48	±58	µrad	max.
Straightness / flatness	±8	±9	±10	µm	max.
Velocity, unloaded	2000	2000	2000	mm/s	max.
Positioning accuracy (uncalibrated)	±12	±14	±15	µm	typ.

	V-412.xxx211Ex	V-412.xxx025Ex	Unit	Tolerance
<b>Encoder options</b>				
Integrated sensor	Incremental linear encoder	Absolute-measuring linear encoder		
Sensor signal	Sin/cos, 1 V peak-peak, 20 µm signal period	EnDat 2.2		
Design resolution	0.0003	0.001	µm	
Minimum incremental motion	5	10	nm	typ.
Bidirectional repeatability	±0.5	±0.5	µm	typ.
Limit switches	Hall effect, 5 V NPN	–		

	V-412.xxxxxx	V-412.xxxxxxB	Unit	Tolerance
<b>Mechanical properties</b>				
Guide type	Recirculating ball bearing	Recirculating ball bearing		
Load capacity in Z	400	400	N	max.
Permissible lateral force	200	200	N	max.
Permissible torque in $\theta_x$	20	20	N·m	max.
Permissible torque in $\theta_y$	15	15	N·m	max.
Permissible torque in $\theta_z$	20	20	N·m	max.

	V-412.xx6	Unit	Tolerance
<b>Drive properties</b>			
Drive type	Ironless 3-phase linear motor		
Intermediate circuit voltage, effective	300	V DC	max.
Peak force	151	N	typ.
Nominal force	33	N	typ.
Peak current, effective (RMS)	10.6	A	typ.
Nominal current, effective (RMS)	2.3	A	typ.
Force constant, effective	14.1	N/A	typ.
Motor constant	4	N/ $\sqrt{W}$	typ.
Electrical time constant	0.19	ms	
Resistance phase-phase	8.69	$\Omega$	typ.
Inductance phase-phase	1.4	mH	typ.
Back EMF phase-phase	8.1	V·s/m	max.
Pole pitch N-N	30.5	mm	

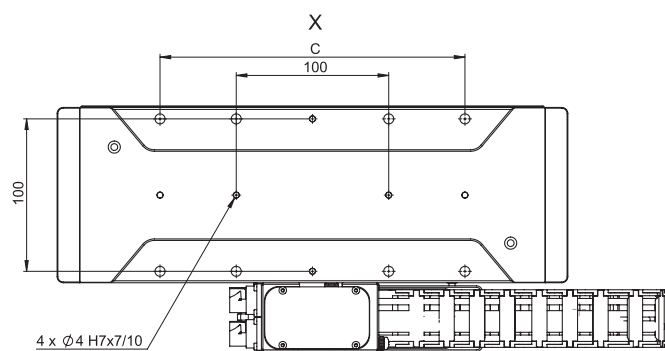
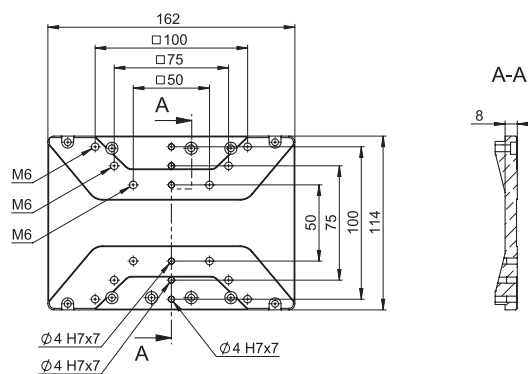
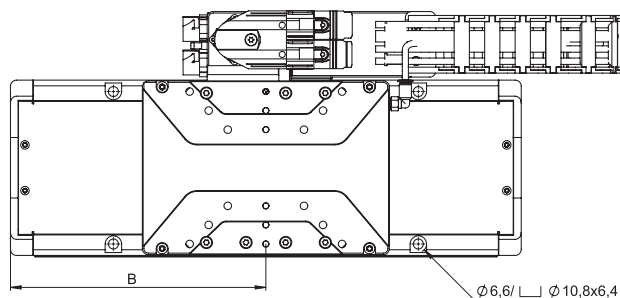
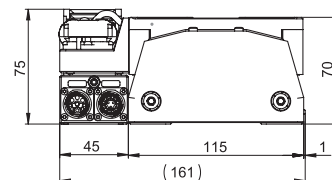
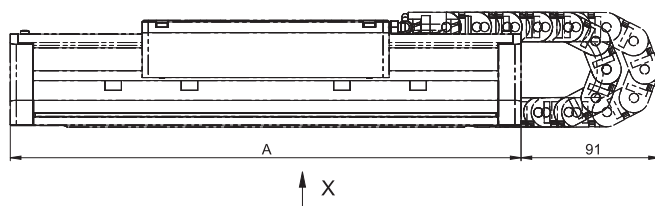
	V-412	Unit	Tolerance
<b>Miscellaneous</b>			
Material	Aluminum, black anodized stainless steel		
Overall mass	V-412.03 (52 mm travel range): 5.0 V-412.05 (102 mm travel range): 5.6 V-412.09 (204 mm travel range): 6.7 V-412.13 (305 mm travel range): 7.9 V-412.17 (407 mm travel range): 9.0 V-412.21 (508 mm travel range): 10.2 V-412.25 (610 mm travel range): 11.3	kg	±5 %
Moved mass	1.7	kg	±5 %
MTBF	20000	h	
Connection	M17 (motor) M17 (linear encoder) Fitting for purge air hose with outside diameter 4 mm		
Recommended controllers	C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller		

Connecting cables are not in the scope of delivery and must be ordered separately.  
Ask about custom designs!





V-412, dimensions in mm

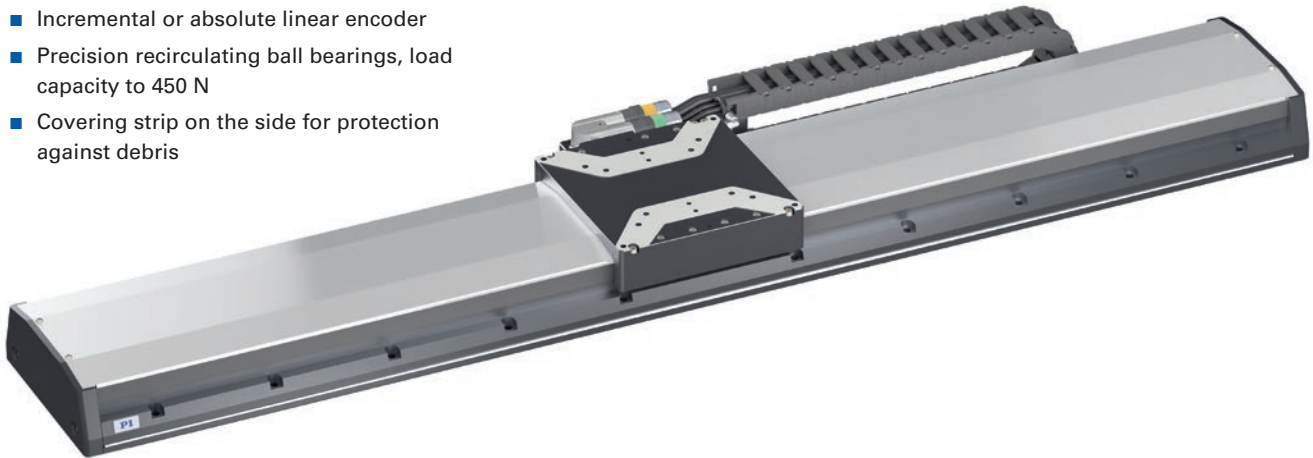


	TRAVEL	A	B	C
V-412.03xxxx	52 (2")	285	142,5	100
V-412.05xxxx	102 (4")	335	167,5	100, 200
V-412.09xxxx	204 (8")	440	220	100, 200, 300
V-412.13xxxx	305 (12")	540	270	100, 200, 300, 400
V-412.17xxxx	407 (16")	640	320	100, 200, 300, 400, 500
V-412.21xxxx	508 (20")	740	370	100, 200, 300, 400, 500, 600
V-412.25xxxx	610 (24")	845	422,5	100, 200, 300, 400, 500, 600, 700

# V-417 Linear Motor Stage for Industrial Automation

## High Performance and Cost Efficiency, Linear Motor

- Width 166 mm
- Travel range to 813 mm
- Nominal force 87 N
- Incremental or absolute linear encoder
- Precision recirculating ball bearings, load capacity to 450 N
- Covering strip on the side for protection against debris



### Reference-class linear stage

PI has extended its product portfolio for industrial solutions with a new family of precision linear motor stages. Various versions are available with high-performance linear motors, heavy-duty recirculating ball bearings, and precision linear encoders. The protective side seal and the purge air connection prevent contamination by debris entering the stage.

### PIMag® magnetic direct drive

3-phase magnetic direct drives do not use mechanical components in the drivetrain, they transmit the drive force to the motion platform directly and without friction. The ironless linear motors reach high velocities and accelerations. Ironless motors are particularly suitable for positioning tasks with the highest demands on precision because there is no undesirable interaction with the permanent magnets. This is in comparison to iron core linear motors which exhibit 'cogging'. This allows smooth running even at low velocities and no vibration at high velocities.

### Class leading design

When compared to current market offerings, the new V-417 series of stages provides users with a higher specification recirculating ball bearing that offers higher load carrying capacity and dynamic performance. The encoder options offer a high resolution resulting in improved motion tracking errors and refined move and settle performance. For full flexibility the user can select either incremental or absolute types. Absolute types remove the requirement to home the stage during startup and provide additional benefits including reduced collision risks during operation.

### Applications

- Automated Optical Inspection (AOI)
- Digital Printing
- Electronics Manufacturing
- Flatpanel Inspection
- Automation
- Laser Cutting
- Scanning

	V-417.05	V-417.09	V-417.13	V-417.17	Unit	Tolerance
<b>Motion</b>						
Travel range	102	204	305	407	mm	
Pitch / yaw	±14	±19	±29	±39	µrad	max.
Straightness / flatness	±2.5	±4	±6	±8	µm	max.
Velocity, unloaded	2000	2000	2000	2000	mm/s	max.
Positioning accuracy (uncalibrated)	±4	±8	±10	±12	µm	typ.

	V-417.21	V-417.25	V-417.33	Unit	Tolerance
<b>Motion</b>					
Active axes	X	X	X		
Travel range	508	610	813	mm	
Pitch / yaw	±40	±45	±50	µrad	max.
Straightness / flatness	±9	±10	±12	µm	max.
Velocity, unloaded	2000	2000	2000	mm/s	max.
Positioning accuracy (uncalibrated)	±14	±15	±17	µm	typ.

	V-417.xxx211Ex	V-417.xxx025Ex	Unit	Tolerance
<b>Encoder options</b>				
Integrated sensor	Incremental linear encoder	Absolute-measuring linear encoder		
Sensor signal	Sin/cos, 1 V peak-peak, 20 µm signal period	EnDat 2.2		
Design resolution	0.0003	0.001	µm	
Minimum incremental motion	5	10	nm	typ.
Bidirectional repeatability	±0.5	±0.5	µm	typ.
Limit switches	Hall effect, 5 V NPN	–		

	V-417.xxxxxx	V-417.xxxxxxB	Unit	Tolerance
<b>Mechanical properties</b>				
Guide type	Recirculating ball bearing	Recirculating ball bearing		
Load capacity in Z	450	450	N	max.
Permissible lateral force	250	250	N	max.
Permissible torque in $\theta_x$	40	40	N·m	max.
Permissible torque in $\theta_y$	30	30	N·m	max.
Permissible torque in $\theta_z$	40	40	N·m	max.

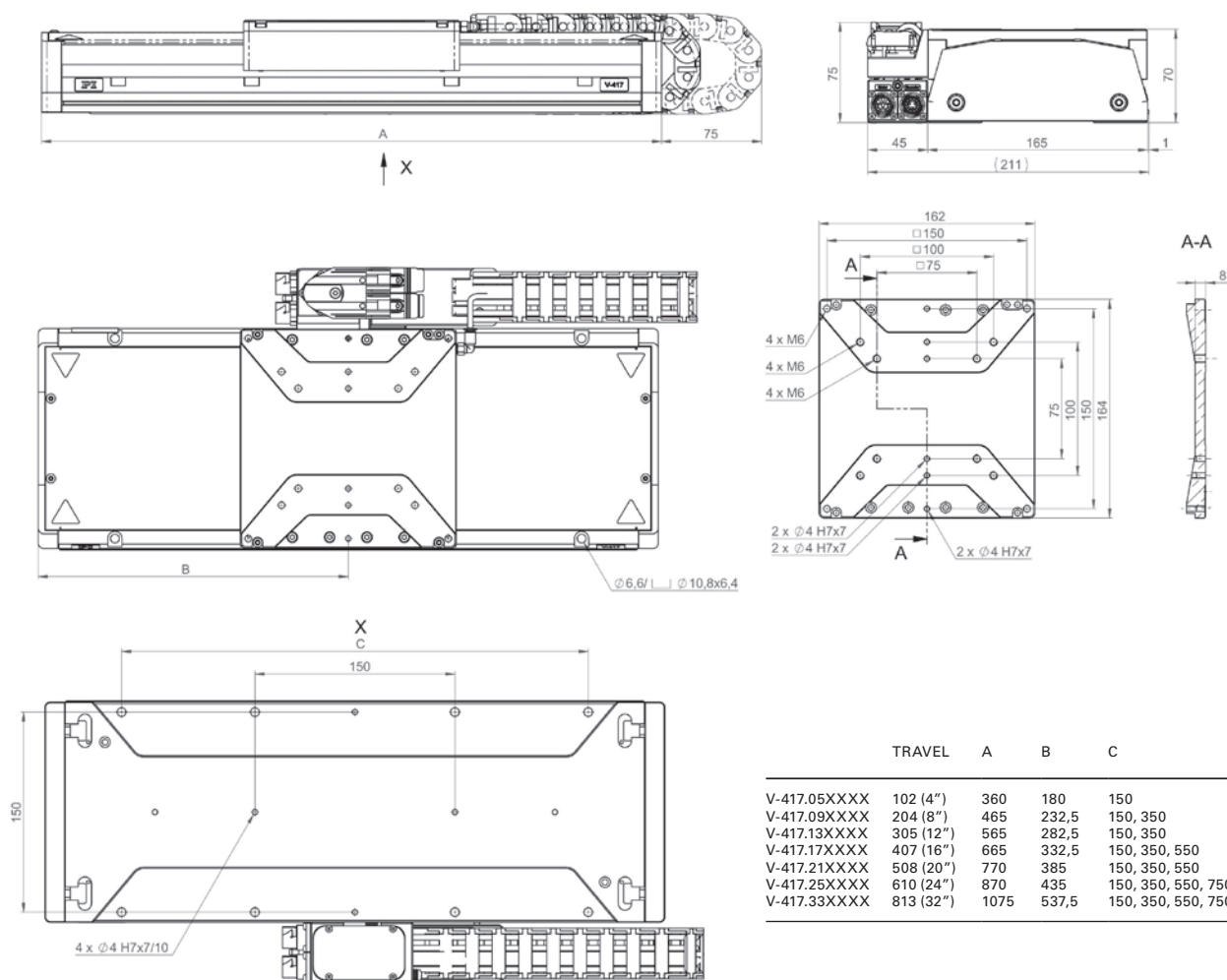
	V-417.xx6	Unit	Tolerance
<b>Drive properties</b>			
Drive type	Ironless 3-phase linear motor		
Intermediate circuit voltage, effective	300	V DC	max.
Peak force	300	N	typ.
Nominal force	87	N	typ.
Peak current, effective (RMS)	15	A	typ.
Nominal current, effective (RMS)	4.4	A	typ.
Force constant, effective	19.9	N/A	typ.
Motor constant	8.4	N/ $\sqrt{W}$	typ.
Electrical time constant	0.35	ms	
Resistance phase-phase	3.6	$\Omega$	typ.
Inductance phase-phase	1.2	mH	typ.
Back EMF phase-phase	16	V·s/m	max.
Pole pitch N-N	30	mm	

	V-417	Unit	Tolerance
<b>Miscellaneous</b>			
Material	Aluminum, black anodized stainless steel		
Overall mass	V-417.05 (102 mm travel range): 9.3 V-417.09 (204 mm travel range): 11.2 V-417.13 (305 mm travel range): 13.0 V-417.17 (407 mm travel range): 14.8 V-417.21 (508 mm travel range): 16.6 V-417.25 (610 mm travel range): 18.4 V-417.33 (610 mm travel range): 21.1	kg	$\pm 5\%$
Moved mass	2.8	kg	$\pm 5\%$
MTBF	20000	h	
Connection	M17 (motor) M17 (linear encoder) Fitting for purge air hose with outside diameter 4 mm		
Recommended controllers	C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller		

Connecting cables are not in the scope of delivery and must be ordered separately.  
Ask about custom designs!



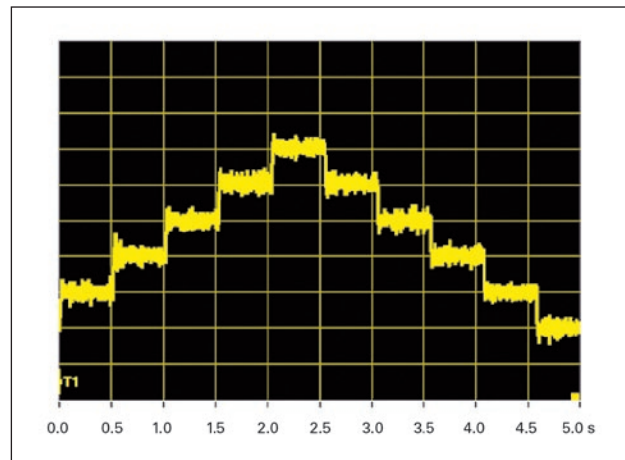
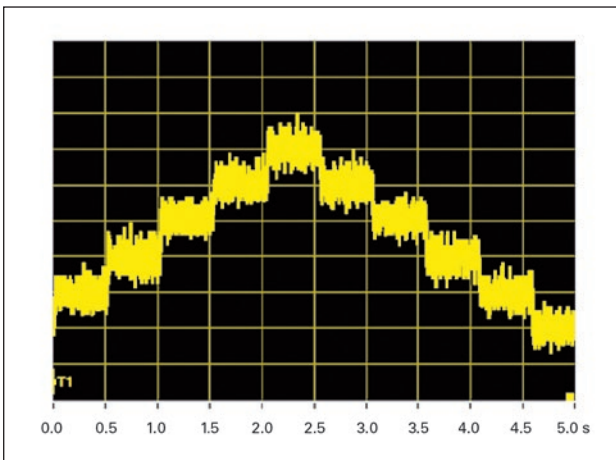
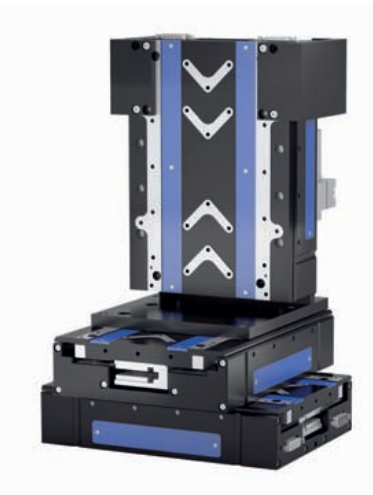
V-417, dimensions in mm



	TRAVEL	A	B	C
V-417.05XXXX	102 (4")	360	180	150
V-417.09XXXX	204 (8")	465	232,5	150, 350
V-417.13XXXX	305 (12")	565	282,5	150, 350
V-417.17XXXX	407 (16")	665	332,5	150, 350, 550
V-417.21XXXX	508 (20")	770	385	150, 350, 550
V-417.25XXXX	610 (24")	870	435	150, 350, 550, 750
V-417.33XXXX	813 (32")	1075	537,5	150, 350, 550, 750, 950



## Compact High Speed Linear Motor Stages for High Precision, Long Life Applications



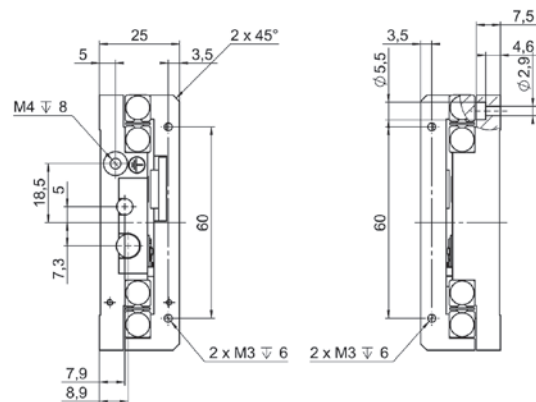
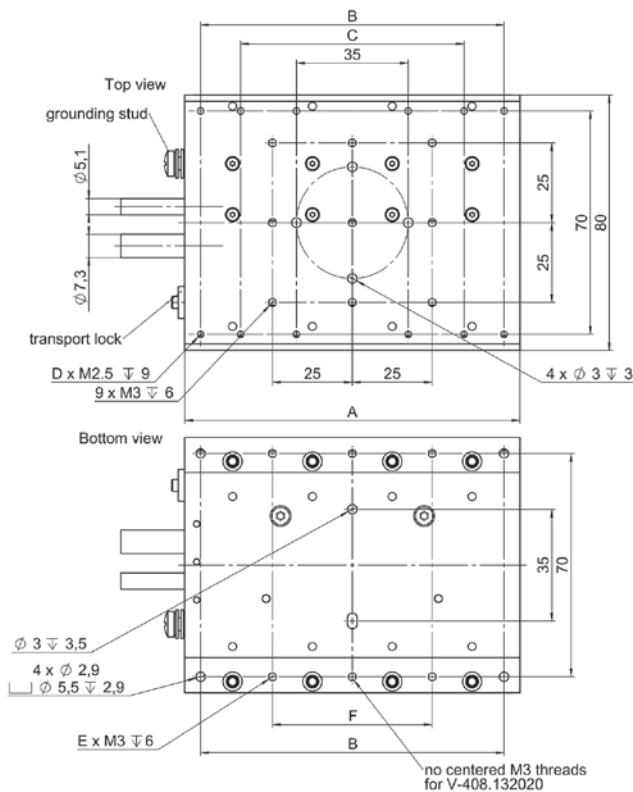
# V-408 Compact High Speed Linear Motor Stage

Inexpensive, with Linear Motor



- Iron core 3-phase linear motor
- Crossed roller bearings for high load capacity, anti-creep
- Minimum incremental motion 20 nm
- Bidirectional repeatability  $\pm 0.1 \mu\text{m}$
- Compact design
- Low price

V-408, dimensions in mm



	V-408.132020	V-408.232020
travel range	25	50
A	80	105
B	70	95
C	n/a	70
D	8	12
E	4	6
F	25	50

## Applications

- Automation
- Laser Cutting
- Laser Marking
- Photonics
- Scanning
- Scientific Instrumentation



	V-408	Unit	Tolerance
<b>Motion and positioning</b>			
Travel range	V-408.132020: 25 V-408.232020: 50	mm	
Integrated Sensor	Incremental linear encoder		
Sensor signal period	80	µm	
Sensor resolution	10 <sup>(1)</sup>	nm	typ.
Min. incremental motion	20	nm	typ.
Bidirectional repeatability	±0.1	µm	typ.
Pitch /Yaw	±150	µrad	typ.
Straightness / flatness	±4	µm	typ.
Velocity	V-408.132020: 1.2 V-408.232020: 1.5	m/s	max.
<b>Mechanical properties</b>			
Load capacity in Z	80	N	max.
Permissible lateral force	80	N	max.
Permissible torque in $\theta_x$	2.3	N·m	max.
Permissible torque in $\theta_y, \theta_z$	1.3	N·m	max.
Moved mass	V-408.132020: 0.23 V-408.232020: 0.3	kg	
Mass without cable	V-408.132020: 0.5 V-408.232020: 0.65	kg	
Overall mass	V-408.132020: 0.79 V-408.232020: 0.94	kg	
Guide type	Crossed roller guide with anti-creep system		
<b>Drive properties</b>			
Drive type	PIMag <sup>®</sup> Linear motor, iron core, 3-phase		
Intermediate circuit voltage	48	V DC	max.
Peak force	14	N	typ.
Nominal force	5	N	typ.
Peak current, effective	3.2	A	typ.
Nominal current, effective	1.1	A	typ.
Force constant, effective	4.60	N/A	typ.
Resistance phase-phase	1.23	Ω	typ.
Inductance phase-phase	0.97	mH	typ.
Back EMF phase-phase	2.81	V·s/m	max.
Pole pitch N-N	18	mm	
<b>Miscellaneous</b>			
Operating temperature range	10 to 50	°C	
Humidity	20 – 90 % rel., not condensing		
Material	Aluminum, black anodized		
Motor connector	HD Sub-D 26 (m)		
Sensor connection	Sub-D 15 (f)		
Cable length	2	m	
Recommended controllers	C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller		

(1) interpolated

Ask about custom designs!

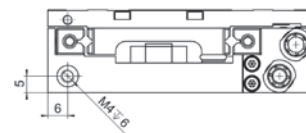
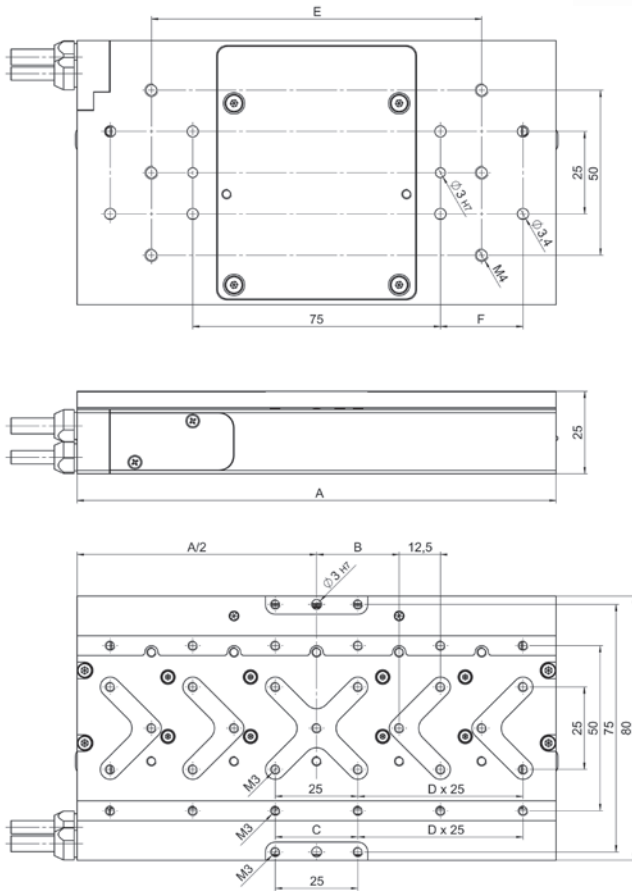
# V-508 PIMag<sup>®</sup> Precision Linear Motor Stage

## Versatile options for adapting to requirements

- Travel ranges 80, 170, and 250 mm
- Ironless or iron core linear motor
- Incremental or absolute linear encoder, various resolutions
- Compact cross section: 80 mm x 25 mm
- Crossed roller bearings for high load capacity, anti-creep



V-508, dimensions in mm



Travel	80 V-508.3xxxxx	170 V-508.6xxxxx	250 V-508.9xxxxx
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A	145	235	315
B	25	25	12.5
C	25	25	-
D	2	4	5
E	100	100 / 200	100 / 200
F	25	37,5	50

### Applications

- Digital Printing
- Electronics Manufacturing
- Laser Marking
- Medical Industry
- Metrology / Testing
- Scanning

	V-508.2	V-508.6	V-508.9	Unit	Tolerance
<b>Motion and positioning</b>					
Active axes	X	X	X		
Travel range	80	170	250	mm	
Pitch / yaw	±100	±200	±300	µrad	max.
Straightness / flatness	±4	±10	±20	µm	max.
Velocity, unloaded	1	1	1	m/s	max.
Acceleration, unloaded	5	5	5	m/s <sup>2</sup>	max.
<b>Mechanical properties</b>					
Load capacity in Z	100	100	100	N	max.
Moved mass	0.35	0.55	0.8	kg	
Overall mass	1.1	1.6	2.1	kg	
Guide type	Crossed roller guide with anti-creep system	Crossed roller guide with anti-creep system	Crossed roller guide with anti-creep system		

	V-508.x3	V-508.x5	V-508.xB	Unit	Tolerance
<b>Encoder options</b>					
Integrated sensor	Incremental linear encoder	PIOne incremental linear encoder	Absolute encoder		
Sensor signal	Sin/cos, 1 V peak-peak, 80 µm signal period	Sin/cos, 1 V peak-peak, 2 µm signal period	BiSS-C		
Sensor resolution	10 <sup>(1)</sup>	0.2 <sup>(1)</sup>	78	nm	typ.
Minimum incremental motion	20	0.5	160	nm	typ.
Bidirectional repeatability	±0.1	±0.05	±0.15		typ.

	V-508.xx1	V-508.xx2	Unit	Tolerance
<b>Drive properties</b>				
Drive type	Linear motor, ironless, 3-phase	Linear motor, iron core, 3-phase		
Intermediate circuit voltage, effective	48	48	V DC	
Peak force	12	14	N	typ.
Nominal force	3	4	N	typ.
Peak current, effective	3.2	3.2	A	typ.
Nominal current, effective	0.7	1.1	A	typ.
Force constant, effective	4.28	4.81	N/A	typ.
Resistance phase-phase	2.96	1.23	Ω	typ.
Inductance phase-phase	0.63	0.97	mH	typ.
Back EMF phase-phase	5.36	3.02	V·s/m	max.
Pole pitch N-N	20	18	mm	

	V-508
<b>Miscellaneous</b>	
Operating temperature range	10 °C to 50 °C
Humidity	20 – 90 % rel., not condensing
Material	Aluminum, black anodized
Motor connector	HD Sub-D 26 (m)
Sensor connection	Sub-D 15 (f)
Cable length	2 m
Recommended controllers	C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller

(1) interpolated  
Ask about custom designs!

# V-551 PIMag® Precision Linear Motor Stage

## High Velocity and Precision due to Magnetic Direct Drive

- Travel ranges to 230 mm
- Velocity up to 0.5 m/s
- Absolute encoder with 1 nm resolution
- Highest precision with PIONe linear encoder:  
Minimum incremental motion 0.5 nm
- High guiding accuracy
- Compact design with 160 mm width
- Crossed roller guide, anti-creep



### Reference-class linear stage

Thanks to the smooth-running precision linear guides with crossed roller bearings, the linear stage is particularly suitable for scanning applications with constant velocity. The anti-creep system reliably prevents cage creep. The guides have high load capacity and high precision under all operating conditions.

### Direct position measurement

Position measuring takes place directly at the motion platform with the highest accuracy so that nonlinearity, mechanical play or elastic deformation have no influence on position measuring. The high-resolution PIONe encoder was developed by PI and, with corresponding processing of the measured values, allows a position resolution of much less than one nanometer. The optical and noncontact PIONe encoders are based on an interferometric measuring principle. Due to the short signal period and the high quality of the signals, the linearity error of PIONe encoders is less than 1 %. PIONe encoders support direction sensing when evaluating a reference signal. Absolute encoders supply explicit position information that enables immediate determination of the position. This means that referencing is not required during switch-on, which increases efficiency and safety during operation.

### PIMag® magnetic direct drive

3-phase magnetic direct drives do not use mechanical components in the drivetrain, they transmit the drive force to the motion platform directly and without friction. The drives reach high velocities and accelerations. Ironless motors are particularly suitable for positioning tasks with the highest demands on precision because there is no undesirable interaction with the permanent magnets. This allows smooth running even at the lowest velocities and at the same time, there is no vibration at high velocities. Nonlinearity in control behavior is avoided and any position can be controlled easily. The drive force can be set freely.

### Applications

- Biotechnology
- Electronics Manufacturing
- Medical Industry
- Metrology / Testing
- Photonics
- Scanning
- Semiconductor

	V-551.2x	V-551.4x	V-551.7x	Unit	Tolerance
<b>Motion and positioning</b>					
Active axes	X	X	X		
Travel range	60	130	230	mm	
Pitch	±50	±100	±100	µrad	typ.
Yaw	±50	±50	±50	µrad	typ.
Straightness	±1	±1	±2	µm	typ.
Flatness	±2	±2	±2	µm	typ.
Velocity	0.5	0.5	0.5	m/s	max.
<b>Mechanical properties</b>					
Load capacity in Z	150	150	150	N	max.
Load capacity in Y	50	50	50	N	max.
Moved mass	2.2	2.7	4.9	kg	
Overall mass	4.2	5.5	9.7	kg	
Linear guide	Crossed roller bearing with anti-creep system	Crossed roller bearing with anti-creep system	Crossed roller bearing with anti-creep system		

	V-551	Unit	Tolerance
<b>Drive properties</b>			
Drive type	PIMag® linear motor, ironless, 3-phase		
Intermediate circuit voltage	110 *	V DC	max.
Peak force	180	N	typ.
Nominal force	27	N	typ.
Peak current, effective	10	A	typ.
Nominal current, effective	1.5	A	typ.
Force constant, effective	18	N/A	typ.
Resistance per phase	3.15	Ω	typ.
Inductance per phase	0.9	mH	typ.
Back EMF phase-phase	16	V·s/m	max.

	V-551.xB	V-551.xD
<b>Encoder options</b>		
Integrated Sensor	Absolute encoder	PIOne incremental linear encoder
Sensor signal	BiSS-C	Sin/cos, 1 V peak-peak, 2 µm signal period
Sensor resolution	1 nm	0.2 nm**
Min. incremental motion	2 nm	0.5 nm
Unidirectional repeatability	0.02 µm	0.02 µm
Bidirectional repeatability	±0.05 µm	±0.05 µm
Travel range limit	Limits are set via software; additional mechanical stop buffers.	Hall effect limit switches
Reference point switch	–	Encoder index
Reference point switch repeatability	–	<1 µm

	V-551
<b>Miscellaneous</b>	
Operating temperature range	10 °C to 50 °C
Humidity	20 – 90 % rel., not condensing
Material	Aluminum, black anodized
Motor connector	HD Sub-D 26 (m)
Sensor connection	Sub-D 15 (f)
Recommended controllers	C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller

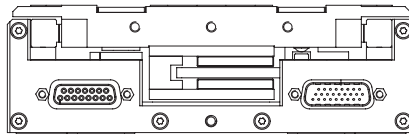
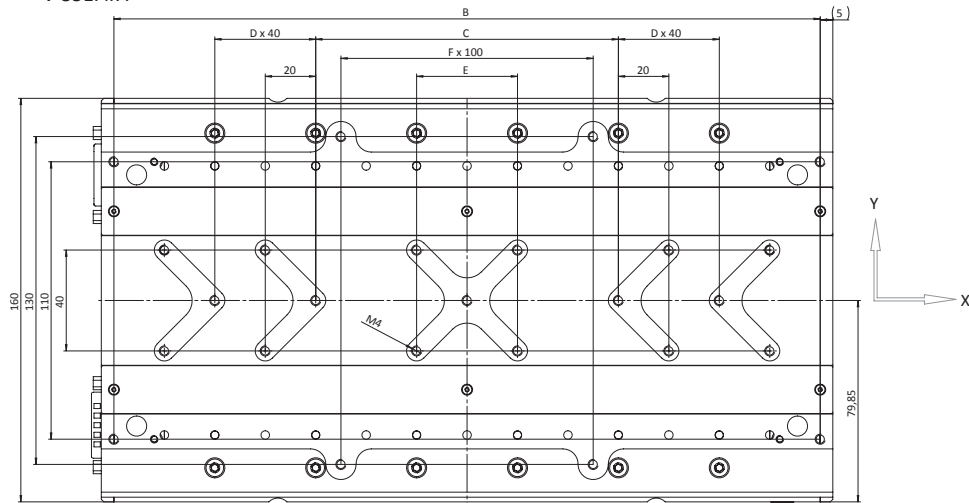
\* 24 V DC with C-891.120200

Ask about custom designs.

\*\* interpolated

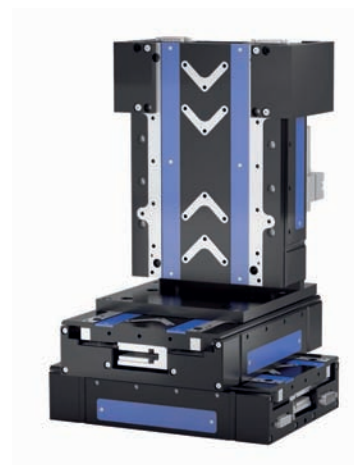
V-551, dimensions in mm

V-551.4x :

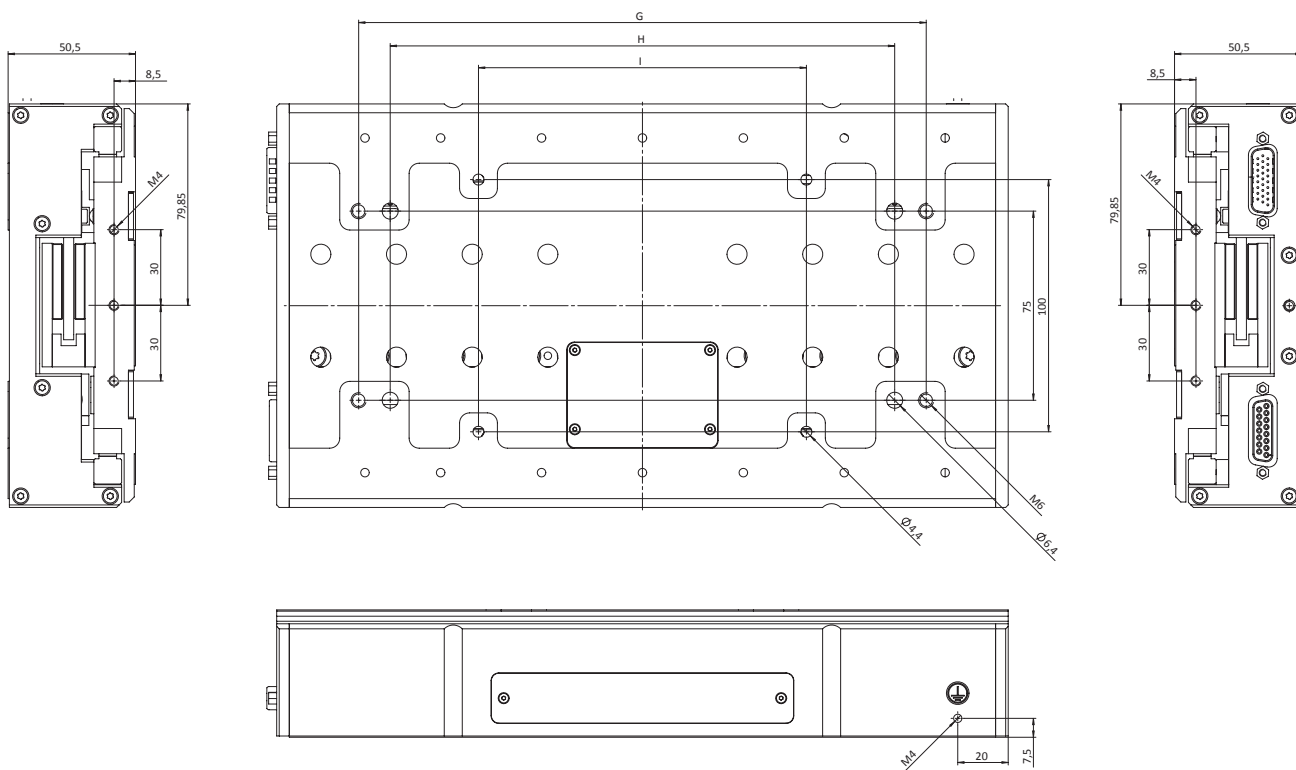


V-551.2x    V-551.4x    V-551.7x

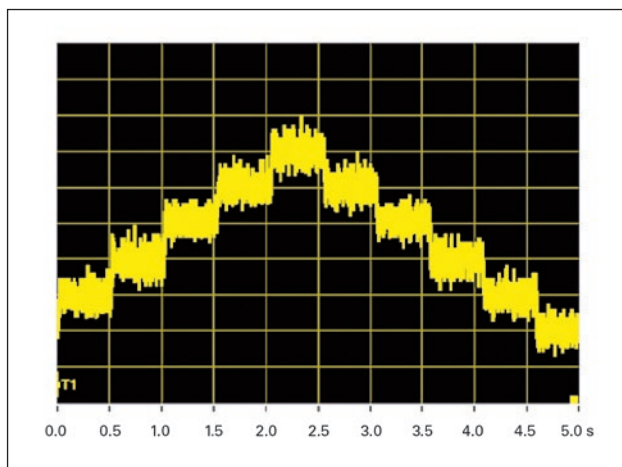
Stroke	60	130	230
A	220	290	450
B	210	280	440
C	60	120	120
D	1	1	3
E	-	40	40
F	1	1	3



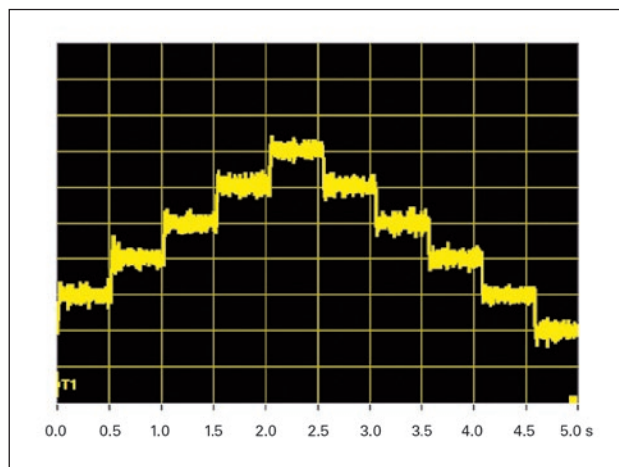
3-axis combination of linear motor stages. The vertical axis uses weight compensation and it can, therefore, move with high dynamics while, at the same time, offering the best positioning accuracy



	V-551.2x	V-551.4x	V-551.7x
G	125	225	225
H	175	200	250
I	130	130	190



A V-551.4D with PIOne linear encoder performs a sequence of 0.5-nm steps.

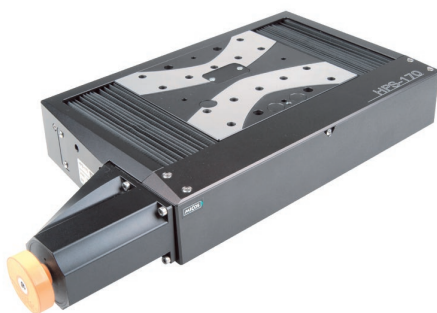


A V-551.4D with PIOne linear encoder performs a sequence of 1-nm steps.





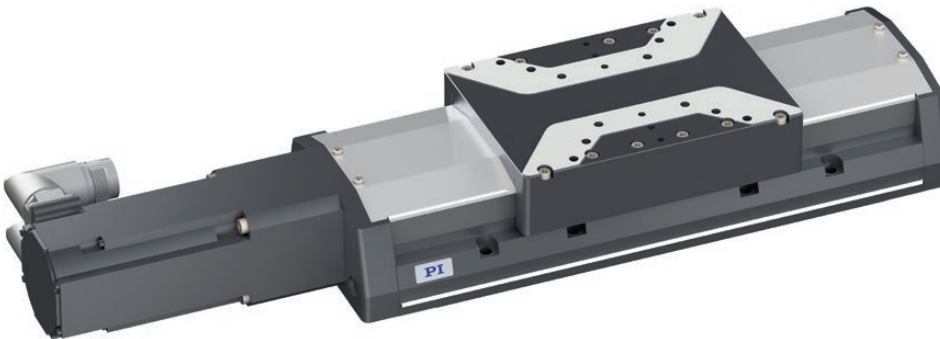
# High Load Screw Drive Stages for Heavy Duty Applications and Precision Industrial Automation



# L-412 High-Load Industrial Automation Stage

## High Performance and Cost Efficiency, Drive Screw

- Width 116 mm
- Travel range to 610 mm
- Precision ball screw
- Incremental or absolute rotary encoder options
- Additional linear encoder options
- Precision recirculating ball bearings, load capacity to 400 N
- Covering strip on the side for protection against debris



### Reference-class linear stage

PI has extended its product portfolio for industrial solutions with a new family of precision linear ball-screw stages. Various versions are available with high-performance synchronous servo motors, heavy-duty recirculating ball bearings, and precision rotary and linear encoders. An optional holding brake allows use as a vertical axis. The stage's internal ball screw can be relubricated externally thus removing the need to disassemble the stage. This provides a higher reliability and longer lifetime when compared to stages requiring additional effort in relubrication. It is also possible to integrate such lubrication into a customer's central lubrication system. The protective side seal and the purge air connection prevent contamination by debris entering the stage.

### Synchronous servo motor

These motors have high positioning accuracy and overload capacity over a large rotation speed range. High torque and low inertia ensure high dynamic operation of the stage. The motor provides an adaptable cable exit, allowing the user to be flexible with their cable positioning strategies in their machine. The long lifetime, high performance and robustness of these servo motors produce excellent results in applications in precision industrial automation.

### Options

- Holding brake (L-412.xxxxxxB)
- Various rotary and linear encoders, absolute and incremental
- Versions with linear encoder with optional drag chain and connection box (L-412.xxxxxxE1) or without drag chain (L-412.xxxxxxE0)
- Foldback kits to reduce overall length available on request
- Certification and calibration available on request

### Class leading design

When compared to current market offerings, the new L-412 series of stages provides users with a higher specification recirculating ball bearing that offers higher load carrying capacity and dynamic performance. The standard motor offers a high resolution resulting in improved motion tracking errors and refined move and settle performance.

### Applications

- Automated Optical Inspection (AOI)
- Electronics Manufacturing
- Automation
- Laser Cutting

	L-412.03	L-412.05	L-412.09	L-412.13	Unit	Tolerance
<b>Motion</b>						
Travel range	52	102	204	305	mm	
Pitch / yaw	±9	±14	±19	±29	µrad	max.
Straightness / flatness	±1.5	±2.5	±4	±6	µm	max.
Velocity, unloaded	300	300	300	300	mm/s	max.
Positioning accuracy (uncalibrated)	±5	±6	±8	±10	µm	max.

	L-412.17	L-412.21	L-412.25	Unit	Tolerance
<b>Motion</b>					
Active axes	X	X	X		
Travel range	407	508	610	mm	
Pitch / yaw	±39	±48	±58	µrad	max.
Straightness / flatness	±8	±9	±10	µm	max.
Velocity, unloaded	300	300	300	mm/s	max.
Positioning accuracy (uncalibrated)	±12	±14	±16	µm	max.

	L-412.xxx232 basic option	L-412.xxx244	L-412.xxx054	Unit	Tolerance
<b>Encoder options</b>					
Integrated sensor	Incremental rotary encoder	Absolute rotary encoder, single turn	Absolute rotary encoder, multiturn		
Sensor signal	A/B quadrature, RS-422	EnDat 2.1	EnDat 2.1		
Sensor resolution	20000	8192	8192	Cts./rev.	
Design resolution	0.25	0.6	0.6	µm	
Minimum incremental motion	1	2	2	µm	
Bidirectional repeatability	±1	±3	±3	µm	max.
Limit switches	Hall effect, 5 V NPN	Hall effect, 5 V NPN	–		
Sensor connection	M23	M23	M23		

	L-412.xxx212Ex	L-412.xxx211Ex	L-412.xxx025Ex	Unit	Tolerance
<b>Encoder options</b>					
Integrated sensor	Incremental linear encoder Additional rotary encoder, see basic option	Incremental linear encoder Additional rotary encoder, see basic option	Absolute-measuring linear encoder Additional rotary encoder, see basic option		
Sensor signal	A/B quadrature, RS-422	Sin/cos, 1 V peak-peak, 20 µm signal period	EnDat 2.2		
Design resolution	0.05	–	0.001	µm	
Minimum incremental motion	300	50	50	nm	typ.
Bidirectional repeatability	±0.5	±0.5	±0.5	µm	max.
Limit switches	Hall effect, 5 V NPN	Hall effect, 5 V NPN	–		
Sensor connection	Sub-D 15 (m)	M17	M17		

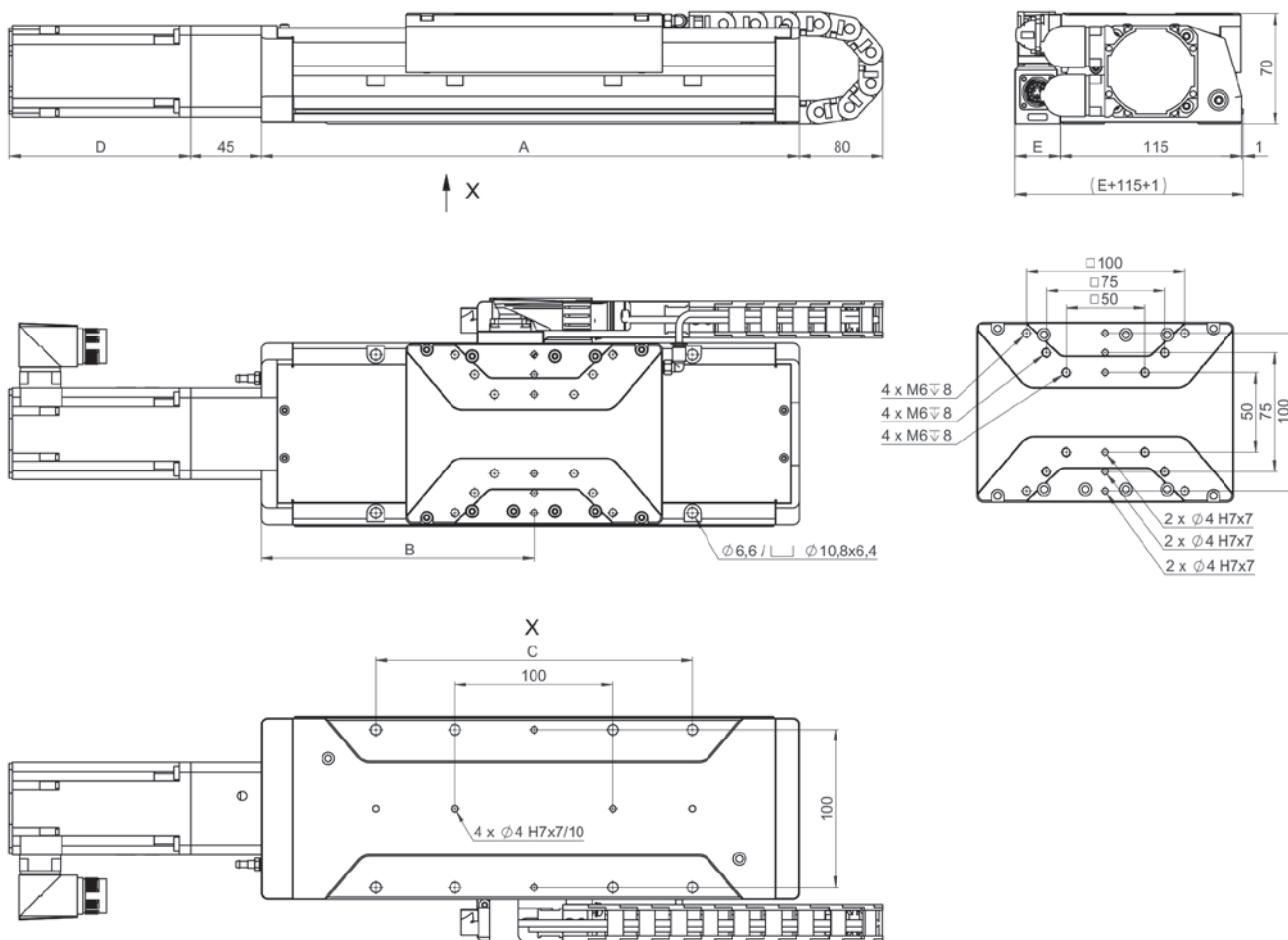
	L-412.xxxxxx	L-412.xxxxxxB	Unit	Tolerance
<b>Mechanical properties</b>				
Guide type	Recirculating ball bearing	Recirculating ball bearing		
Drive screw type	Ball screw	Ball screw		
Holding brake	–	Electromagnetic safety brake		
Drive screw pitch	5	5	mm	
Push/pull force, power on	700	700	N	max.
Holding force, power off	–	500	N	typ.
Load capacity in Z	400	400	N	max.
Permissible lateral force	200	200	N	max.
Permissible torque in $\theta_x$	20	20	N·m	max.
Permissible torque in $\theta_y$	15	15	N·m	max.
Permissible torque in $\theta_z$	20	20	N·m	max.

	L-412.xx9	Unit	Tolerance
<b>Drive properties</b>			
Drive type	Synchronous servo motor		
Intermediate circuit voltage, effective	320	V DC	max.
Peak torque	2.76	N·m	typ.
Nominal torque	0.7	N·m	typ.
Peak current, effective (RMS)	10.9	A	typ.
Nominal current, effective (RMS)	2.2	A	typ.
Torque constant, effective	0.32	N·m/A	typ.
Resistance phase-phase	5.22	$\Omega$	typ.
Inductance phase-phase	9.7	mH	typ.
Back EMF phase-phase	20.4	V/kRPM	max.
Number of pole pairs	3		

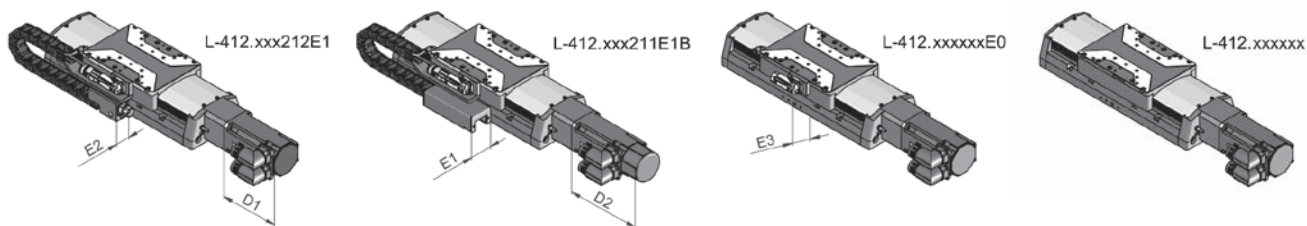
	L-412	Unit	Tolerance
<b>Miscellaneous</b>			
Material	Aluminum, black anodized stainless steel		
Overall mass	L-412.03 (52 mm travel range): 6.4 L-412.05 (102 mm travel range): 6.9 L-412.09 (204 mm travel range): 7.9 L-412.13 (305 mm travel range): 8.9 L-412.17 (407 mm travel range): 9.8 L-412.21 (508 mm travel range): 10.8 L-412.25 (610 mm travel range): 11.8	kg	$\pm 5\%$
Moved mass	1.4	kg	$\pm 5\%$
MTBF	20000	h	
Connection	M23 (motor) M23 (rotary encoder) optional connection for linear encoder Fitting for purge air hose with outside diameter 4 mm Funnel-type grease nipple for spindle lubrication		
Limit switch connection	M8 8-pin		
Recommended controllers	ACS modular controller		

Connecting cables are not in the scope of delivery and must be ordered separately.  
Ask about custom designs!

L-412, dimensions in mm



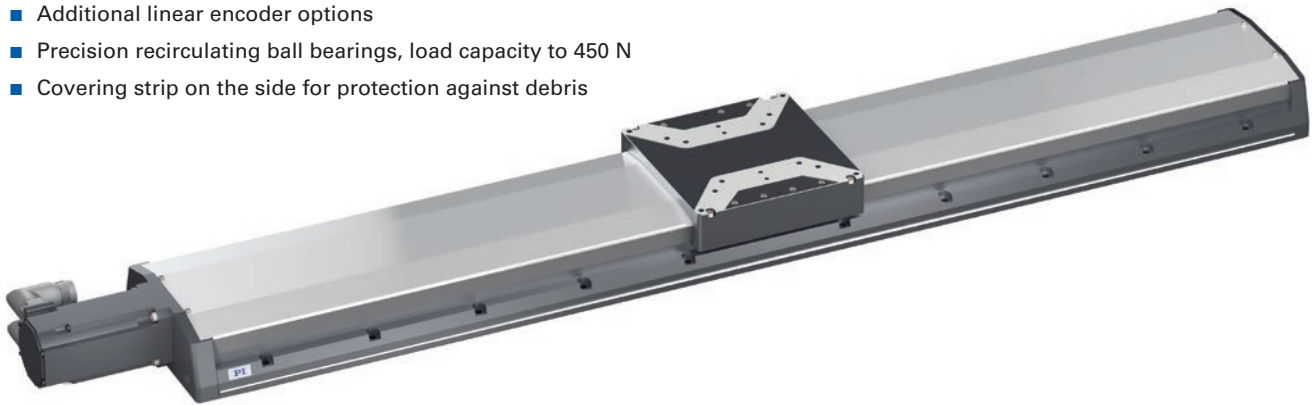
TRAVEL	A	B	C	D			E		
				D1 L-412.xxxxxxxx	D2 L-412.xxxxxxxxB	E1 L-412.xxxxxxE0	E2 L-412.xxx211E1	E3 L-412.xxx212E1	
L-417.03xxxx	52 (4")	290	147,5	100	114,5	148,5	44	28,5	28
L-417.05xxxx	102 (4")	340	172,5	100, 200	114,5	148,5	44	28,5	28
L-417.09xxxx	204 (8")	445	225	100, 200, 300	114,5	148,5	44	28,5	28
L-417.13xxxx	305 (12")	545	275	100, 200, 300, 400	114,5	148,5	44	28,5	28
L-417.17xxxx	407 (16")	645	325	100, 200, 300, 400, 500	114,5	148,5	44	28,5	28
L-417.21xxxx	508 (20")	745	375	100, 200, 300, 400, 500, 600	114,5	148,5	44	28,5	28
L-417.25xxxx	610 (24")	850	427,5	100, 200, 300, 400, 500, 600, 700	114,5	148,5	44	28,5	28



# L-417 High-Load Industrial Automation Stage

## High Performance and Cost Efficiency, Drive Screw

- Width 166 mm
- Travel range to 813 mm
- Precision ball screw
- Incremental or absolute rotary encoder options
- Additional linear encoder options
- Precision recirculating ball bearings, load capacity to 450 N
- Covering strip on the side for protection against debris



### Reference-class linear stage

PI has extended its product portfolio for industrial solutions with a new family of precision linear ball-screw stages. Various versions are available with high-performance synchronous servo motors, heavy-duty recirculating ball bearings, and precision rotary and linear encoders. An optional holding brake allows use as a vertical axis. The stage's internal ball screw can be relubricated externally thus removing the need to disassemble the stage. This provides a higher reliability and longer lifetime when compared to stages requiring additional effort in relubrication. It is also possible to integrate such lubrication into a customer's central lubrication system. The protective side seal and the purge air connection prevent contamination by debris entering the stage.

### Synchronous servo motor

These motors have high positioning accuracy and overload capacity over a large rotation speed range. High torque and low inertia ensure high dynamic operation of the stage. The motor provides an adaptable cable exit, allowing the user to be flexible with their cable positioning strategies in their machine. The long lifetime, high performance and robustness of these servo motors produce excellent results in applications in precision industrial automation.

### Options

- Holding brake (L-417.xxxxxxB)
- Various rotary and linear encoders, absolute and incremental
- Versions with linear encoder with optional drag chain and connection box (L-417.xxxxxxE1) or without drag chain (L-417.xxxxxxE0)
- Foldback kits to reduce overall length available on request
- Certification and calibration available on request

### Class leading design

When compared to current market offerings, the new L-417 series of stages provides users with a higher specification recirculating ball bearing that offers higher load carrying capacity and dynamic performance. The standard motor offers a high resolution resulting in improved motion tracking errors and refined move and settle performance.

### Applications

- Automated Optical Inspection (AOI)
- Electronics Manufacturing
- Automation
- Laser Cutting

	L-417.05	L-417.09	L-417.13	L-417.17	Unit	Tolerance
<b>Motion</b>						
Travel range	102	204	305	407	mm	
Pitch / yaw	±14	±19	±29	±35	µrad	max.
Straightness / flatness	±2.5	±4	±6	±8	µm	max.
Velocity, unloaded	300	300	300	300	mm/s	max.
Positioning accuracy (uncalibrated)	±6	±8	±10	±12	µm	max.

	L-417.21	L-417.25	L-417.33	Unit	Tolerance
<b>Motion</b>					
Active axes	X	X	X		
Travel range	508	610	813	mm	
Pitch / yaw	±40	±45	±50	µrad	max.
Straightness / flatness	±9	±10	±12	µm	max.
Velocity, unloaded	300	300	250	mm/s	max.
Positioning accuracy (uncalibrated)	±14	±16	±18	µm	max.

	L-417.xxx232 basic option	L-417.xxx244	L-417.xxx054	Unit	Tolerance
<b>Encoder options</b>					
Integrated sensor	Incremental rotary encoder	Absolute rotary encoder, single turn	Absolute rotary encoder, multiturn		
Sensor signal	A/B quadrature, RS-422	EnDat 2.1	EnDat 2.1		
Sensor resolution	20000	8192	8192	Cts./rev.	
Design resolution	0.25	0.6	0.6	µm	
Minimum incremental motion	1	2	2	µm	
Bidirectional repeatability	±1	±3	±3	µm	max.
Limit switches	Hall effect, 5 V NPN	Hall effect, 5 V NPN	–		
Sensor connection	M23	M23	M23		

	L-417.xxx212Ex	L-417.xxx211Ex	L-417.xxx025Ex	Unit	Tolerance
<b>Encoder options</b>					
Integrated sensor	Incremental linear encoder Additional rotary encoder, see basic option	Incremental linear encoder Additional rotary encoder, see basic option	Absolute-measuring linear encoder Additional rotary encoder, see basic option		
Sensor signal	A/B quadrature, RS-422	Sin/cos, 1 V peak-peak, 20 µm signal period	EnDat 2.2		
Design resolution	0.05	–	0.001	µm	
Minimum incremental motion	300	50	50	nm	typ.
Bidirectional repeatability	±0.5	±0.5	±0.5	µm	max.
Limit switches	Hall effect, 5 V NPN	Hall effect, 5 V NPN	–		
Sensor connection	Sub-D 15 (m)	M17	M17		

	L-417.xxxxxx	L-417.xxxxxxB	Unit	Tolerance
<b>Mechanical properties</b>				
Guide type	Recirculating ball bearing	Recirculating ball bearing		
Drive screw type	Ball screw	Ball screw		
Holding brake	–	Electromagnetic safety brake		
Drive screw pitch	5	5	mm	
Push/pull force, power on	700	700	N	max.
Holding force, power off	–	500	N	typ.
Load capacity in Z	450	450	N	max.
Permissible lateral force	250	250	N	max.
Permissible torque in $\theta_x$	40	40	N·m	max.
Permissible torque in $\theta_y$	30	30	N·m	max.
Permissible torque in $\theta_z$	40	40	N·m	max.

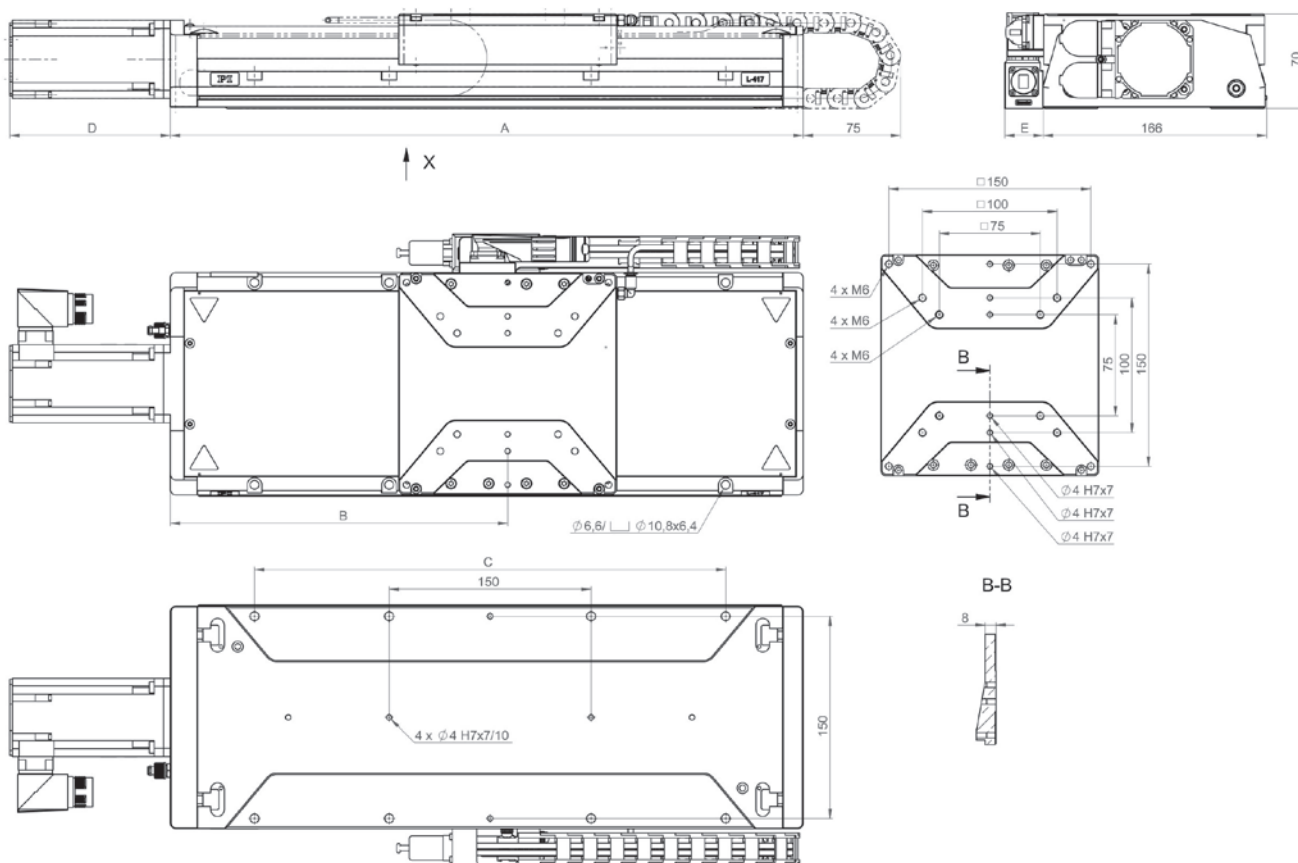
	L-417.xx9	Unit	Tolerance
<b>Drive properties</b>			
Drive type	Synchronous servo motor		
Intermediate circuit voltage, effective	320	V DC	max.
Peak torque	2.76	N·m	typ.
Nominal torque	0.7	N·m	typ.
Peak current, effective (RMS)	10.9	A	typ.
Nominal current, effective (RMS)	2.2	A	typ.
Torque constant, effective	0.32	N·m/A	typ.
Resistance phase-phase	5.22	$\Omega$	typ.
Inductance phase-phase	9.7	mH	typ.
Back EMF phase-phase	20.4	V/kRPM	max.
Number of pole pairs	3		

	L-417	Unit	Tolerance
<b>Miscellaneous</b>			
Material	Aluminum, black anodized stainless steel		
Overall mass	L-417.05 (102 mm travel range): 9.3 L-417.09 (204 mm travel range): 10.8 L-417.13 (305 mm travel range): 12.2 L-417.17 (407 mm travel range): 13.7 L-417.21 (508 mm travel range): 15.1 L-417.25 (610 mm travel range): 16.5 L-417.33 (813 mm travel range): 19.4	kg	$\pm 5\%$
Moved mass	2.4	kg	$\pm 5\%$
MTBF	20000	h	
Connection	M23 (motor) M23 (rotary encoder) optional connection for linear encoder Fitting for purge air hose with outside diameter 4 mm Funnel-type grease nipple for spindle lubrication		
Limit switch connection	M8 8-pin		
Recommended controllers	ACS modular controller		

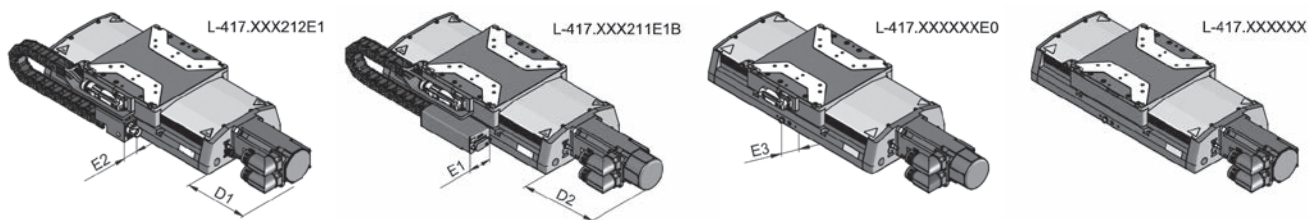
Connecting cables are not in the scope of delivery and must be ordered separately.  
Ask about custom designs!



L-417, dimensions in mm



TRAVEL	A			B			C			D			E		
	D1	D2	E1	E2	E3	D1	D2	E1	E2	E3	D1	D2	E1	E2	E3
L-417.05xxxx	102 (4")	356	198	150		119,5	153,5	44	28,5	28					
L-417.09xxxx	204 (8")	470	250,5	150, 350		119,5	153,5	44	28,5	28					
L-417.13xxxx	305 (12")	570	300,5	150, 350		119,5	153,5	44	28,5	28					
L-417.17xxxx	407 (16")	670	350,5	150, 350, 550		119,5	153,5	44	28,5	28					
L-417.21xxxx	508 (20")	775	403	150, 350, 550		119,5	153,5	44	28,5	28					
L-417.25xxxx	610 (24")	875	453	150, 350, 550, 750		119,5	153,5	44	28,5	28					
L-417.33xxxx	813 (32")	1080	555,5	150, 350, 550, 750, 950		119,5	153,5	44	28,5	28					



# LS-180 High-Load Ball Screw Stage

Robust Design for Industrial Use



## Reference-class linear stage Recirculating ball bearings

Recirculating ball bearings for high travel accuracy and load capacity. Precision ball screw with 5 mm pitch. Stress-relieved aluminum base for highest stability. Noncontact inductive limit switches.

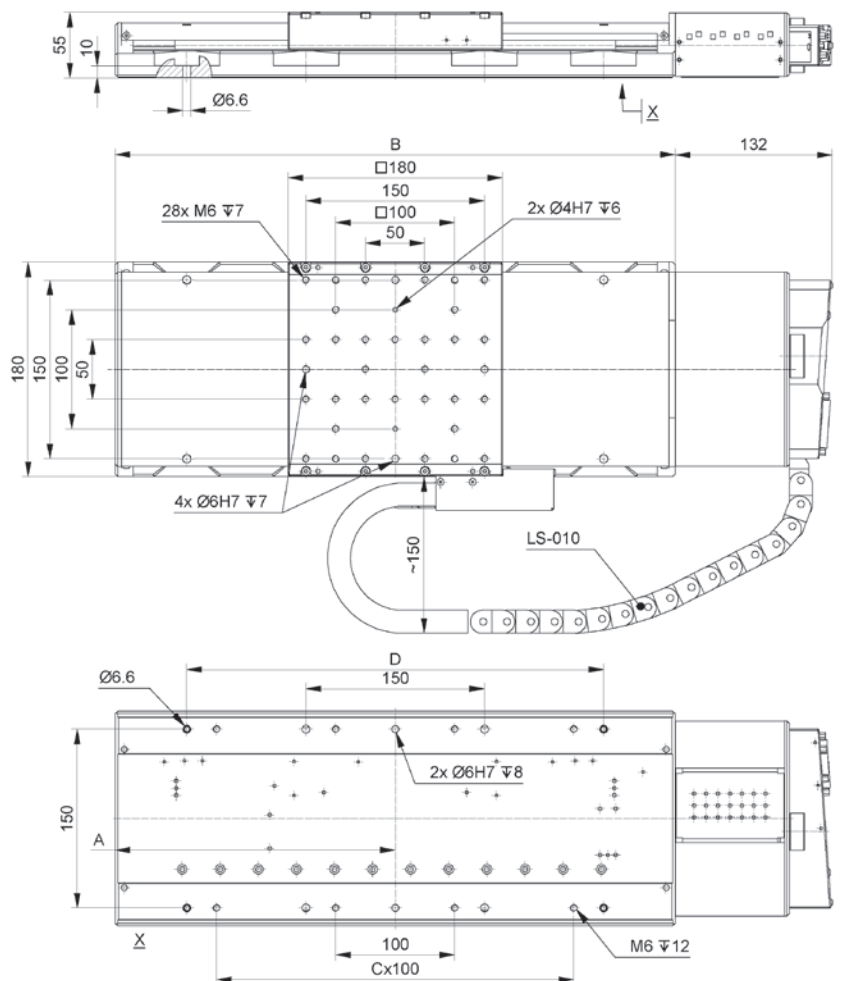
## Highly accurate position measuring with incremental linear encoder

Noncontact optical linear encoders 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.

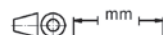
- Travel ranges from 155 mm to 508 mm (6" to 20")
- Max. velocity to 150 mm/s
- Load capacity to 1000 N
- Optional linear encoder for direct position measurement

### Drive types

- Closed-loop DC servo motor with rotary encoder on the motor shaft
- 2-phase stepper motor for high torque even at low velocities and high resolution



Travel range/mm	A	B	C	D
155	235	470	3	350
205	260	520	3	350
305	310	620	5	450
508	410	820	5	650



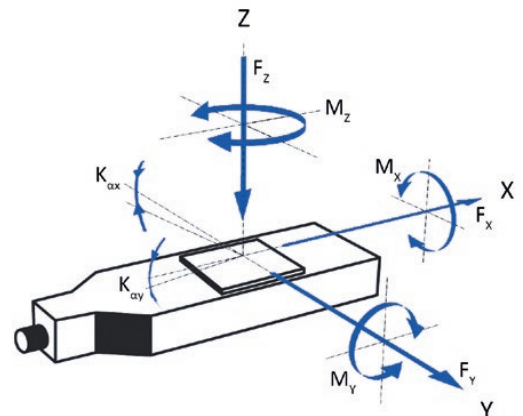
LS-180, dimensions in mm, LS-010: Cable for linear encoder

	624091x0	624091x1	624092x0	624092x1-0001	Unit	Tolerance
	Linear stage with DC motor and rotary encoder	Linear stage with DC motor, linear and rotary encoder	Linear stage with stepper motor	Linear stage with stepper motor and linear encoder		
<b>Motion and positioning</b>						
Travel range	155 / 205 / 305 / 508	155 / 205 / 305 / 508	155 / 205 / 305 / 508	155 / 205 / 305 / 508	mm	
Integrated sensor	Rotary encoder	Linear and rotary encoder	–	Linear encoder		
Sensor signal rotary encoder	A/B quadrature, RS-422	A/B quadrature, RS-422	–	–		
Sensor signal linear encoder	–	A/B quadrature, RS-422	–	Sin/cos, 1 V peak-peak, 20 µm signal period		
Design resolution	0.25	0.05	25	0.005	µm	
Sensor resolution rotary encoder	20000	20000	–	–	Counts/rev.	
Sensor resolution linear encoder	–	0.05	–	–	µm	
Minimum incremental motion	0.5	0.1	0.5	0.1	µm	typ.
Unidirectional repeatability	0.5	0.1	0.5	0.1	µm	typ.
Bidirectional repeatability	±2.5	±0.1	±2.5	±0.1	µm	typ.
Pitch	±40 / ±50 / ±60 / ±80	±40 / ±50 / ±60 / ±80	±40 / ±50 / ±60 / ±80	±40 / ±50 / ±60 / ±80	µrad	typ.
Yaw	±50	±50	±50	±50	µrad	typ.
Straightness	±2 / ±3 / ±4 / ±6	±2 / ±3 / ±4 / ±6	±2 / ±3 / ±4 / ±6	±2 / ±3 / ±4 / ±6	µm	typ.
Flatness	±2 / ±3 / ±4 / ±6	±2 / ±3 / ±4 / ±6	±2 / ±3 / ±4 / ±6	±2 / ±3 / ±4 / ±6	µm	typ.
Max. velocity	150	150	75	75	mm/s	
<b>Mechanical properties</b>						
Guide type	Recirculating ball bearing	Recirculating ball bearing	Recirculating ball bearing	Recirculating ball bearing		
Drive screw type	Ball screw	Ball screw	Ball screw	Ball screw		
Drive screw pitch	5	5	5	5	mm	
Load capacity	1000	1000	1000	1000	N	max.
Push/pull force	800	800	800	800	N	max.
Holding force, power off	20	20	50	50	N	max.
Permissible lateral force	500	500	500	500	N	max.
Permissible torque $M_x$ in $\theta_x$	250	250	250	250	N·m	max.
Permissible torque $M_y$ in $\theta_y$	132	132	132	132	N·m	max.
Permissible torque $M_z$ in $\theta_z$	125	125	125	125	N·m	max.

	624091x0	624091x1	624092x0	624092x1-0001	Unit	Tolerance
<b>Drive properties</b>						
Motor type	DC motor	DC motor	2-phase stepper motor	2-phase stepper motor		
Operating voltage, nominal	24	24	48	48	V	nom.
Operating voltage, max.	48	48	48	48	V	max.
Peak current, effective	3.8	3.8	2	2	A	typ.
Electrical time constant	6	6			ms	
Resistance phase-phase	0.62	0.62	2.4	2.4	$\Omega$	typ.
Inductance phase-phase	0.13	0.13	2.87	2.87	mH	typ.
Back EMF phase-phase	0.00349	0.00349			V/kRPM	max.
Step resolution			200	200	Full steps/rev.	
Limit switches	Inductive	Inductive	Inductive	Inductive		
<b>Miscellaneous</b>						
Operating temperature range	5 to 40	5 to 40	5 to 40	0 to 55	$^{\circ}\text{C}$	
Material	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel		
Mass	7.8 / 8.4 / 9.4 / 10.6	8.5 / 9.1 / 10.3 / 11.5	8.3 / 8.9 / 9.9 / 11.0	9.0 / 9.6 / 10.8 / 12	kg	$\pm 5\%$
Moved mass	2.2	2.2	2.2	2.2	kg	$\pm 5\%$
Connection	Sub-D 25 (m)	Motor: Sub-D 25 (m) Sensor: Sub-D 9 (m)	Sub-D 25 (m)	Motor: Sub-D 25 (m) Sensor: Sub-D 9 (m)		
Recommended controllers	C-863 (single axis) with C-863.AD11 line driver C-884 (to 6 axes) with C-863.AD11 line driver C-885 with C-863.20C885 (to 40 axes) and C-863.AD11 line driver ACS modular controller	C-863 (single axis) with C-863.AD11 line driver C-884 (to 6 axes) with C-863.AD11 line driver C-885 with C-863.20C885 (to 40 axes) and C-863.AD11 line driver ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller		

Ask about custom designs!

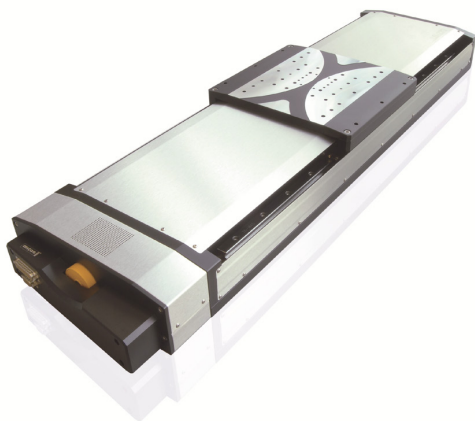
Connecting cables for motor and sensor are not in the scope of delivery and must be ordered separately.



Direction of the axes and torques for linear stages

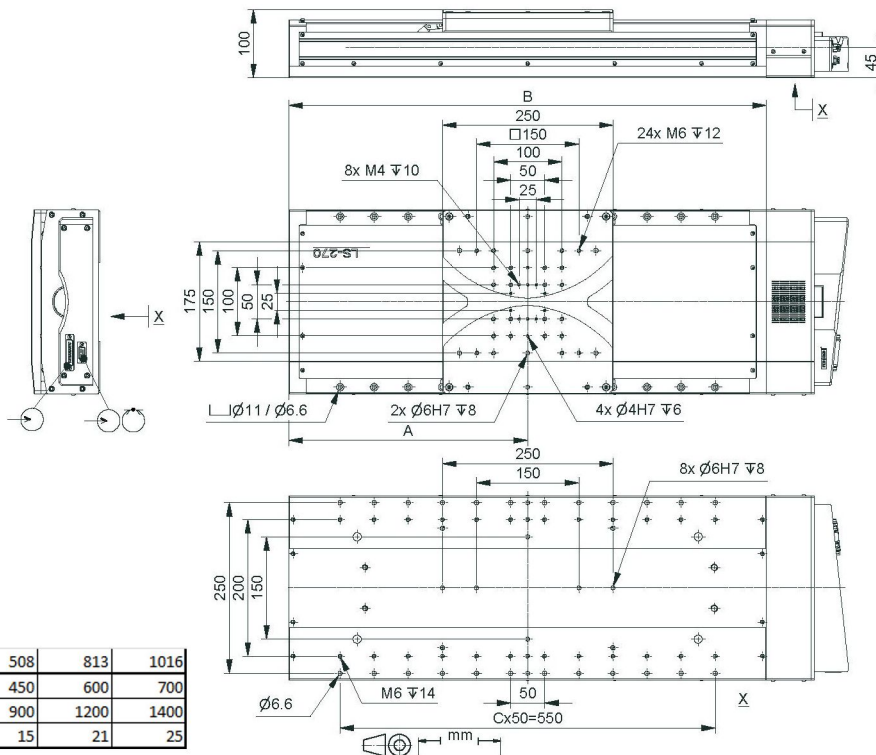
# LS-270 High-Load Ball Screw Stage

Wide Base for better Stability



## LS-270

- Travel ranges from 305 to 1016 mm
- Max. velocity to 150 mm/s
- Load capacity to 1500 N
- Versions with linear measuring system



Stellweg / mm	305	508	813	1016
A / mm	350	450	600	700
B / mm	700	900	1200	1400
C / mm	11	15	21	25

## Reference-class linear stage

High travel accuracy and load capacity due to crossed roller guides with long lifetime. Precision ball screw with 5 mm pitch. Stress-relieved aluminum base for highest stability. Noncontact inductive limit switches.

## Drive types

- Closed-loop DC servo motor with rotary encoder on the motor shaft
- 2-phase stepper motor for high torque even at low velocities and high resolution

## Versions with direct position measurement

Integrated linear encoder, mounted between the guides. Direct position measurement of the motion platform eliminates the influence of mechanical play and hysteresis in the drivetrain on the positioning precision.

## Minimum incremental motion

In conjunction with the SMC Hydra controller, versions with stepper motor and integrated linear encoder achieve repeatable minimum incremental motion in the range of the sensor resolution. The same configuration achieves constant low velocities of a few sensor increments per second.

## Application fields

Precision positioning in industry and research, high duty cycles.

	623991x04	623992x04	62399xx14	Unit	Tolerance
	Linear stage with DC motor and rotary encoder	Linear stage with stepper motor	Also with linear encoder (direct position measurement)		
Motion axis	X	X			
<b>Motion and positioning</b>					
Travel range*	305 (12") / 508 (20") / 815 (32") / 1016 (40")	305 (12") / 508 (20") / 815 (32") / 1016 (40")		mm (inch)	
Integrated sensor	Rotary encoder	–	Linear encoder		
Design resolution	0.25	12.5 (full step)	0.05**	μm	
Minimum incremental motion	0.5	0.4	0.05	μm	typ.
Unidirectional repeatability	0.5	0.4	0.15	μm	typ.
Backlash	5	5	–	μm	typ.
Bidirectional repeatability	±2.5	±2.5	±0.15	μm	typ.
Crosstalk, angular error xry (pitch)	±40 / ±80 / ±100 / ±120	±40 / ±80 / ±100 / ±120		μrad	typ.
Crosstalk, angular error xrz (yaw)	±20 / ±30 / ±40 / ±50	±20 / ±30 / ±40 / ±50		μrad	typ.
Straightness / flatness	±3 / ±4 / ±7 / ±10	±3 / ±4 / ±7 / ±10		μm	typ.
Max. velocity	150	50		mm/s	
<b>Mechanical properties</b>					
Drive screw pitch ball screw	5	5		mm	
Load capacity	1500	1500		N	max.
Push/pull force	200	260		N	max.
Permissible lateral force	1200	1200		N	max.
Holding force	20	30		N	max.
Stiffness $k_{ax}$ in X	1.6	1.6		μrad/Nm	max.
Stiffness $k_{ay}$ in Y	3.2	3.2		μrad/Nm	max.
Permissible torque $M_x$ in X	600	600		Nm	max.
Permissible torque $M_y$ in Y	250	250		Nm	max.
Permissible torque $M_z$ in Z	250	250		Nm	max.
<b>Drive properties</b>					
Motor type	DC motor	2-phase stepper motor***			
Operating voltage	24			V	
Limit switches	Inductive	Inductive			
<b>Miscellaneous</b>					
Operating temperature range	-20 to 65	-20 to 65	0 to 55	°C	
Material	Aluminum, black anodized	Aluminum, black anodized			
Mass	29 / 35 / 43 / 50	29 / 35 / 43 / 50	also 0.9	kg	±5 %
Connector	Sub-D 25	Sub-D 25	Motor: Sub-D 25 Sensor: Sub-D 9		

\* Travel range of the variants: See ordering information

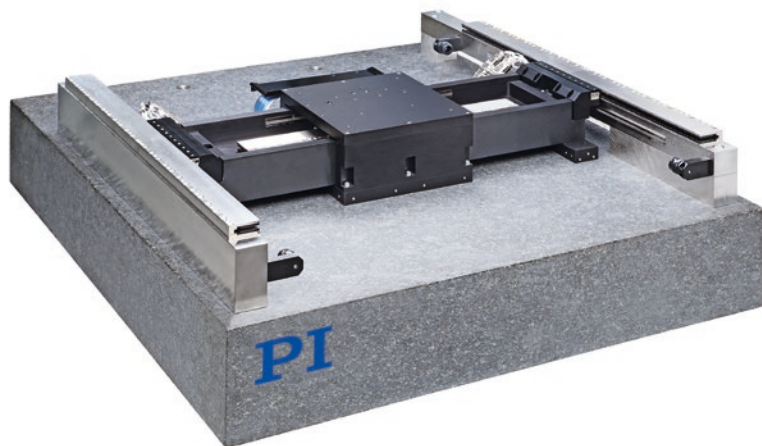
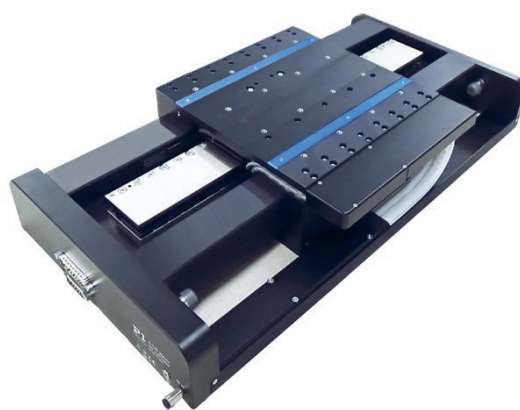
\*\* Stepper motor with linear encoder, sin/cos analog signals with 1 V peak-peak, operation with SMC Hydra controller with maximum interpolation

\*\*\* 400 full steps/rev., max. 2 A phase current

Connecting cables for motor and sensor are not in the scope of delivery and must be ordered separately.

## Ultra-High Precision Air Bearing Stages

Zero Friction / Particle Generation, High Speed & Geometric Performance



# A-141 Pliglide MB Miniature Linear Stage with Air Bearings

High Performance, Cleanroom Compatible, Customizable

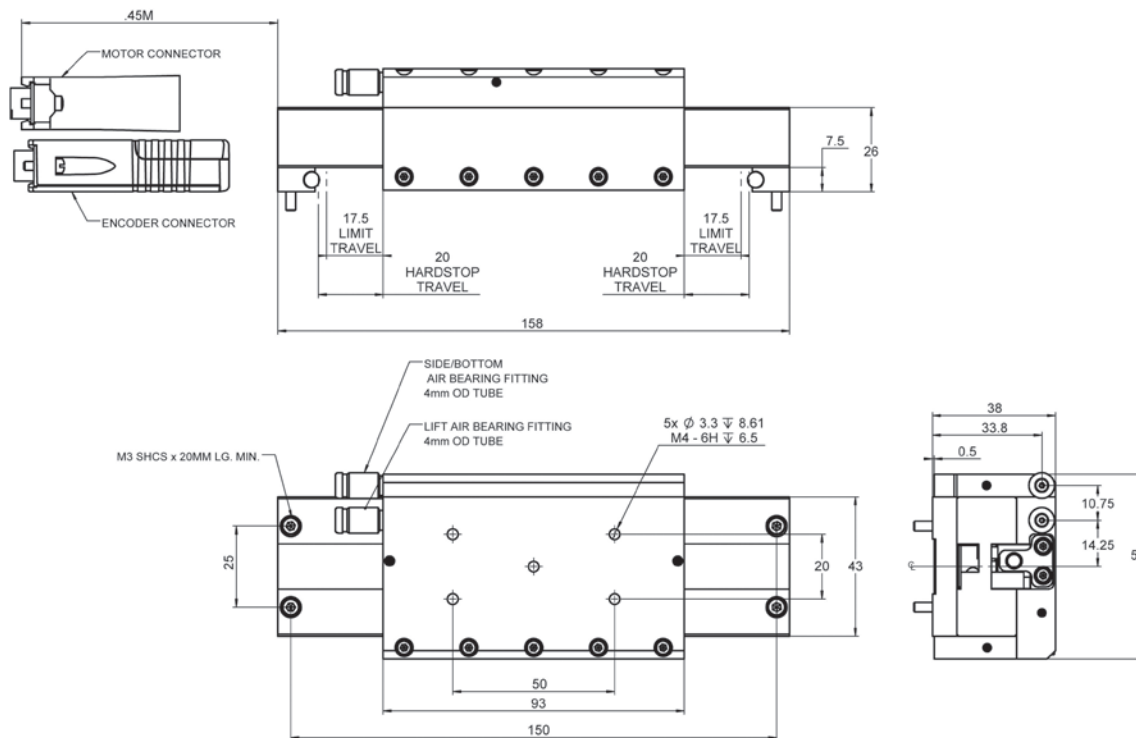


- Size of the motion platform 57 mm x 93 mm
- Low profile 38 mm
- Travel ranges to 35 mm
- Load capacity to 3 kg
- Velocity to 0.25 m/sec
- Acceleration to 3.5 m/s<sup>2</sup>

## Accessories and options

- Pliglide filter and air preparation kits
- Single and multi-axis motion controller
- XY setups and individual configurations
- Counterbalance options for vertical (Z) orientations
- Base plates made of granite and systems for reducing vibration

A-141.035A1, dimensions in mm



## Applications

- Precision Micro Assembly
- Scanning
- Photonics
- Optical Alignment



	A-141	Unit	Tolerance
<b>Motion</b>			
Active axes	X		
Travel range	35	mm	
Pitch / yaw <sup>(1)</sup> over the entire travel range	10	µrad	max.
Straightness / flatness <sup>(1)</sup> over the entire travel range	0.5	µm	max.
Velocity <sup>(2)</sup> , unloaded	0.25	m/s	max.
Acceleration <sup>(2)</sup> , unloaded	3.5	m/s <sup>2</sup>	max.
<b>Mechanical properties</b>			
Load capacity in z <sup>(3)</sup>	3	kg	max.
Moved mass	0.3	kg	
Overall mass	0.6	kg	
Guide type	Air bearing		
<b>Drive properties</b>			
Drive type	Linear motor, ironless, 3-phase		
Intermediate circuit voltage, effective	48, nominal 80, max.	V DC	
Peak force	2.3	N	typ.
Nominal force	0.58	N	typ.
Force constant, effective	2.1	N/A	typ.
Resistance phase-phase	22.4	Ω	typ.
Inductivity phase-phase	1.0	mH	typ.
Back EMF phase-phase	0.7	V-s/m	max.
Cabling	Internal, no moving cable		
<b>Positioning</b>			
Integrated sensor	Incremental linear encoder with travel range limits and home index		
Sensor signal	Sin/cos, 1 V peak-peak, 20 µm signal period		
Sensor resolution	1.2 nm <sup>(4)</sup>		
Bidirectional repeatability	±0.1 µm <sup>(4)</sup>		
Accuracy, uncompensated <sup>(5)</sup>	±2.0 µm		
Accuracy, with error compensation <sup>(5)</sup>	±0.25 µm		
<b>Miscellaneous</b>			
Operating pressure <sup>(6)</sup>	65±5 psi (450±35 kPa)		
Air consumption	<1.0 SCFM (28 SLPM)		
Air quality	Clean (unfiltered to 1.0 µm or better) – ISO 8573-1 class 1 Oil free – ISO 8573-1 class 1 Dry (-15 °C dew point) – ISO 8573-1 class 3		
Materials	Hardcoat aluminum, stainless steel fasteners		

(1) Dependent on the flatness of the surface, on which the stage is mounted.

(2) Can be limited by the payload, controller or drive.

(3) Assumes payload CG is centered no more than 50 mm above the motion platform. The stage is designed for horizontal operation only.

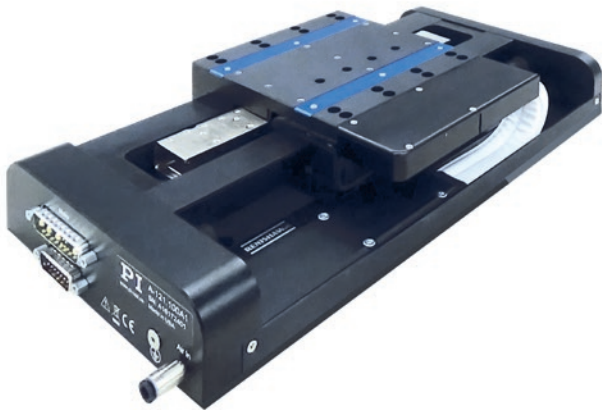
(4) Assumes 16384x interpolation. Contact PI for the use of other factors.

(5) Improved accuracy can be obtained with controller-based error compensation. The stage must be ordered with a controller from PI to reach these values. Accuracy values assume short-term duration and do not consider the long-term effects of thermal drift on the stage.

(6) To protect the stage against damage, it is recommended to connect an air pressure sensor to the E-Stop input of the controller.

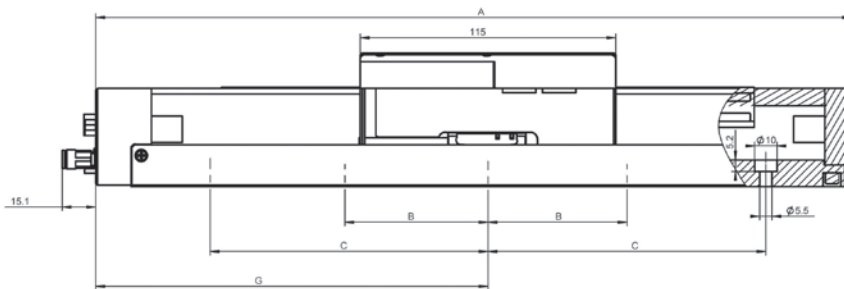
# A-121 Pliglide AT1 Linear Stage with Air Bearings

## High Performance Small Footprint Nanopositioning Stage

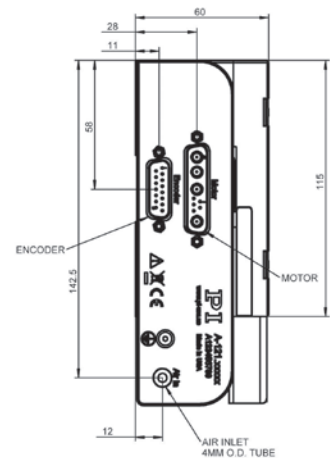
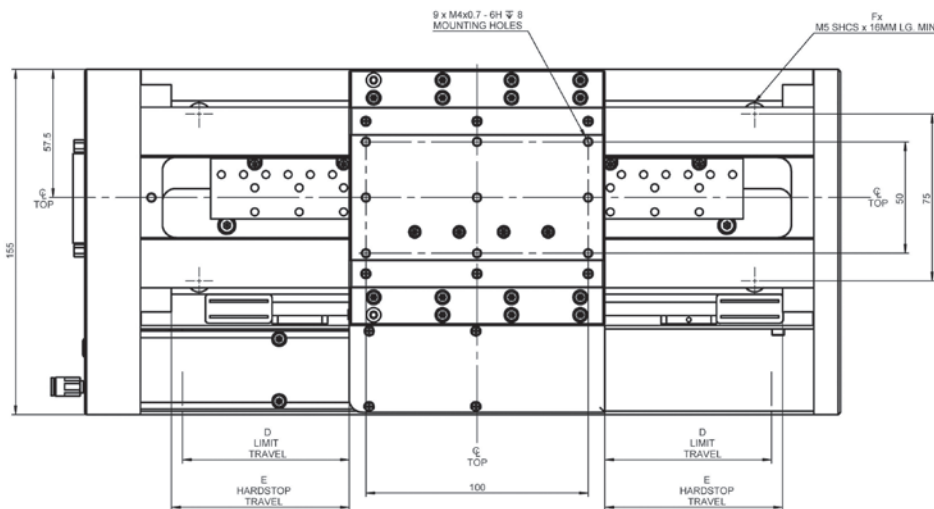


- Ideal for scanning applications or high-precision positioning
- Cleanroom compatible
- Size of the motion platform 115 mm x 115 mm
- Travel ranges to 350 mm
- Low profile from 60 mm
- Resolution to 1 nm
- Best flatness / straightness
- Counterbalance options for vertical assembly

A-121, dimensions in mm



MODEL	A	B	C	D	E	F	G
A-121.050	240		75	25	30	4	126.5
A-121.100	290		100	50	55	4	151.5
A-121.150	340		125	75	80	6	176.5
A-121.200	390		150	100	105	6	201.5
A-121.250	440		150	125	130	6	226.5
A-121.350	540	100	200	175	180	10	276.5



### Applications

- Sample Inspection
- Scanning
- Metrology / Testing
- Photonics
- Flatpanel Inspection

	A-121.050	A-121.100	A-121.150	A-121.200	A-121.250	A-121.350	Unit	Tolerance
<b>Motion</b>								
Active axes	X	X	X	X	X	X		
Travel range	50	100	150	200	250	350	mm	
Pitch / yaw <sup>(1)</sup>	12	12	15	20	25	35	μrad	max.
Straightness / flatness <sup>(1)</sup>	±0.5	±0.5	±0.5	±0.75	±0.75	±1.25	μm	max.
Straightness / flatness per 25 mm travel range <sup>(1)</sup>	0.1	0.1	0.1	0.1	0.1	0.1	μm	max.
Velocity, unloaded <sup>(2)</sup>	1	1	1	1	1	1	m/s	max.
Acceleration, unloaded <sup>(2)</sup>	20	20	20	20	20	20	m/s <sup>2</sup>	max.
<b>Mechanical properties</b>								
Load capacity in z <sup>(3)</sup>	100	100	100	100	100	100	N	max.
Load capacity in y <sup>(3)</sup>	40	40	40	40	40	40	N	max.
Moved mass	1.2	1.2	1.2	1.2	1.2	1.2	kg	
Overall mass	3.5	4.2	4.5	5.2	5.7	6.8	kg	
Guide type	Air bearing	Air bearing	Air bearing	Air bearing	Air bearing	Air bearing		

	A-121	Unit	Tolerance
<b>Drive properties</b>			
Drive type	Linear motor, ironless, 3-phase		
Intermediate circuit voltage, effective	48, nominal 80, max.	V DC	
Peak force	33.2	N	typ.
Nominal force	11.1	N	typ.
Force constant, effective	6.67	N/A	typ.
Resistance phase-phase	6.3	Ω	typ.
Inductivity phase-phase	1.0	mH	typ.
Back EMF phase-phase	7.7	V·s/m	max.
Cabling	External, moving cable		

	A-121.xxxA	A-121.xxxB	A-121.xxxC
<b>Positioning</b>			
Integrated Sensor	Incremental linear encoder	Absolute encoder	Incremental linear encoder
Sensor signal	Sin/cos, 1 V peak-peak, 20 μm signal period	BiSS-C	A/B quadrature, TTL
Sensor resolution	1.2 nm <sup>(4)</sup>	1 nm	50 nm
Bidirectional repeatability	A-121.050: ±0.25 μm <sup>(4)</sup> A-121.100: ±0.25 μm <sup>(4)</sup> A-121.150: ±0.25 μm <sup>(4)</sup> A-121.200: ±0.25 μm <sup>(4)</sup> A-121.250: ±0.25 μm <sup>(4)</sup> A-121.350: ±0.50 μm <sup>(4)</sup>	A-121.050: ±0.25 μm A-121.100: ±0.25 μm A-121.150: ±0.25 μm A-121.200: ±0.25 μm A-121.250: ±0.25 μm A-121.350: ±0.50 μm	A-121.050: ±0.25 μm A-121.100: ±0.25 μm A-121.150: ±0.25 μm A-121.200: ±0.25 μm A-121.250: ±0.25 μm A-121.350: ±0.50 μm
Accuracy, uncompensated <sup>(5)</sup>	A-121.050: ±1.0 μm A-121.100: ±1.0 μm A-121.150: ±1.5 μm A-121.200: ±2.0 μm A-121.250: ±2.0 μm A-121.350: ±3.0 μm	A-121.050: ±1.5 μm A-121.100: ±1.5 μm A-121.150: ±1.5 μm A-121.200: ±1.5 μm A-121.250: ±1.5 μm A-121.350: ±1.5 μm	A-121.050: ±1.0 μm A-121.100: ±1.0 μm A-121.150: ±1.5 μm A-121.200: ±2.0 μm A-121.250: ±2.0 μm A-121.350: ±3.0 μm
Accuracy, with error compensation <sup>(5)</sup>	A-121.050: ±0.50 μm A-121.100: ±0.50 μm A-121.150: ±0.50 μm A-121.200: ±0.50 μm A-121.250: ±0.50 μm A-121.350: ±1.0 μm	A-121.050: ±0.5 μm A-121.100: ±0.5 μm A-121.150: ±0.5 μm A-121.200: ±0.5 μm A-121.250: ±0.5 μm A-121.350: ±0.5 μm	A-121.050: ±0.50 μm A-121.100: ±0.50 μm A-121.150: ±0.50 μm A-121.200: ±0.50 μm A-121.250: ±0.50 μm A-121.350: ±1.0 μm

	A-121
<b>Miscellaneous</b>	
Operating pressure <sup>(6)</sup>	65 to 75 psi (450 to 520 kPa)
Air consumption	<1.0 SCFM (28 SLPM)
Air quality	Clean (filtered to 1.0 μm or better) – ISO 8573-1 Class 1 Oil free – ISO 8573-1 Class 1 Dry (–15 °C dew point) – ISO 8573-1 Class 3
Materials	Hardcoat aluminum, stainless steel fasteners

(1) Dependent on the flatness of the surface, on which the stage is mounted.

(2) Can be limited by the payload, controller or drive.

(3) Assumes payload CG is centered no more than 50 mm above the motion platform.

(4) Assumes 16384x interpolation. Contact PI for the use of other factors.

(5) Improved accuracy can be obtained with controller-based error compensation.

The stage must be ordered with a controller from PI to reach these values. Accuracy values assume short-term duration and do not consider the long-term effects of thermal drift on the stage.

(6) To protect the stage against damage, it is recommended to connect an air pressure sensor to the Motion-Stop input of the controller.

# A-123 PIglide AT3 Linear Stage with Air Bearings

## High Performance Nanopositioning Stage



- Ideal for scanning applications or high-precision positioning
- Cleanroom compatible
- Size of the motion platform 210 mm x 210 mm
- Travel ranges 50 mm to 750 mm
- Resolution to 1 nm

### Product Overview

The stages in the PIglide are equipped with a servo drive linear motor with preloaded air bearings and integrated linear encoder. The combination of these noncontact components results in a frictionless motion platform that offers the highest performance, quality, and lifetime. A high-force linear motor can drive the stage to top speed within a few milliseconds, and the high-capacity bearings can support payloads up to 60 kg. The laterally opposed, actively preloaded air bearing design in this model allows mounting in any orientation.

### Application fields

PIglide positioning systems are ideally suited for many high-precision applications such as metrology, photonics, and precision scanning in semiconductor or flat panel display manufacturing. Thanks to the friction-free motion, no particles are formed, which makes PIglide stages ideal for cleanroom applications.

### Accessories and options

- Encoder
- PIglide filter and air preparation kits
- Single and multi-axis motion controller
- XY setups and individual configurations
- Cable track variations
- Options with counterweight for vertical (Z) orientation
- Customizations available
- Base plates made of granite and systems for reducing vibration

### Applications

- Sample Inspection
- Scanning
- Metrology / Testing
- Photonics
- Flatpanel Inspection

	A-123.050	A-123.100	A-123.150	A-123.200	A-123.350	A-123.500	A-123.750	Unit	Tolerance
<b>Motion</b>									
Active axes	X	X	X	X	X	X	X		
Travel range	50	100	150	200	350	500	750	mm	
Pitch / yaw <sup>(1)</sup>	5	10	15	15	20	25	35	µrad	max.
Straightness / flatness <sup>(1)</sup>	±0.5	±0.5	±0.5	±1	±1.5	±1.5	±2.5	µm	max.
Straightness / flatness per 25 mm travel range <sup>(1)</sup>	0.1	0.1	0.1	0.1	0.1	0.1	0.1	µm	max.
Velocity, unloaded <sup>(2)</sup>	1	1	1	1	1	1	1	m/s	max.
Acceleration, unloaded <sup>(2)</sup>	30	30	30	30	30	30	30	m/s <sup>2</sup>	max.
<b>Mechanical properties</b>									
Load capacity in z <sup>(3)</sup>	590	590	590	590	590	590	590	N	max.
Load capacity in y <sup>(3)</sup>	295	295	295	295	295	295	295	N	max.
Moved mass	5	5	5	5	5	5	5	kg	
Overall mass	14	15.5	16.5	18	21.5	25	32	kg	
Guide type	Air bearing	Air bearing	Air bearing	Air bearing	Air bearing	Air bearing	Air bearing		

	A-123	Unit	Tolerance
<b>Drive properties</b>			
Drive type	Linear motor, ironless, 3-phase		
Intermediate circuit voltage, effective	48, nominal 80, max.	V DC	
Peak force	298	N	typ.
Nominal force	87.5	N	typ.
Force constant, effective	19.9	N/A	typ.
Resistance phase-phase	3.6	Ω	typ.
Inductivity phase-phase	1.2	mH	typ.
Back EMF phase-phase	16	V·s/m	max.
Cabling	External, moving cable		

	A 123.xxxA	A 123.xxxB	A 123.xxxC
<b>Positioning</b>			
Integrated Sensor	Incremental linear encoder	Absolute encoder	Incremental linear encoder
Sensor signal	Sin/cos, 1 V peak-peak, 20 µm signal period	BiSS-C	A/B quadrature, TTL
Sensor resolution	1.2 nm <sup>(4)</sup>	1 nm	50 nm
Bidirectional repeatability	A-123.050: ±0.25 µm <sup>(4)</sup> A-123.100: ±0.25 µm <sup>(4)</sup> A-123.150: ±0.25 µm <sup>(4)</sup> A-123.200: ±0.25 µm <sup>(4)</sup> A-123.350: ±0.5 µm <sup>(4)</sup> A-123.500: ±0.5 µm <sup>(4)</sup> A-123.750: ±0.75 µm <sup>(4)</sup>	A-123.050: ±0.25 µm A-123.100: ±0.25 µm A-123.150: ±0.25 µm A-123.200: ±0.25 µm A-123.350: ±0.5 µm A-123.500: ±0.5 µm A-123.750: ±0.75 µm	A-123.050: ±0.25 µm A-123.100: ±0.25 µm A-123.150: ±0.25 µm A-123.200: ±0.25 µm A-123.350: ±0.5 µm A-123.500: ±0.5 µm A-123.750: ±0.75 µm
Accuracy, uncompensated <sup>(5)</sup>	A-123.050: ±1 µm A-123.100: ±1 µm A-123.150: ±1.5 µm A-123.200: ±2 µm A-123.350: ±3 µm A-123.500: ±3.5 µm A-123.750: ±5 µm	A-123.050: ±1.5 µm A-123.100: ±1.5 µm A-123.150: ±1.5 µm A-123.200: ±1.5 µm A-123.350: ±1.5 µm A-123.500: ±1.5 µm A-123.750: ±1.5 µm	A-123.050: ±1 µm A-123.100: ±1 µm A-123.150: ±1.5 µm A-123.200: ±2 µm A-123.350: ±3 µm A-123.500: ±3.5 µm A-123.750: ±5 µm
Accuracy, with error compensation <sup>(5)</sup>	A-123.050: ±0.5 µm A-123.100: ±0.5 µm A-123.150: ±0.5 µm A-123.200: ±0.5 µm A-123.350: ±1 µm A-123.500: ±1 µm A-123.750: ±1.5 µm	A-123.050: ±1.5 µm A-123.100: ±1.5 µm A-123.150: ±1.5 µm A-123.200: ±1.5 µm A-123.350: ±1.5 µm A-123.500: ±1.5 µm A-123.750: ±1.5 µm	A-123.050: ±0.5 µm A-123.100: ±0.5 µm A-123.150: ±0.5 µm A-123.200: ±0.5 µm A-123.350: ±1 µm A-123.500: ±1 µm A-123.750: ±1.5 µm

### A-123

<b>Miscellaneous</b>	
Operating pressure <sup>(6)</sup>	75 to 85 psi (515 to 585 kPa)
Air consumption	<1.0 SCFM (28 SLPM)
Air quality	Clean (filtered to 1.0 µm or better) – ISO 8573-1 Class 1 Oil free – ISO 8573-1 Class 1 Dry (–15 °C dew point) – ISO 8573-1 Class 3
Materials	Hardcoat aluminum, stainless steel fasteners

(1) Dependent on the flatness of the surface, on which the stage is mounted.

(2) Can be limited by the payload, controller or drive.

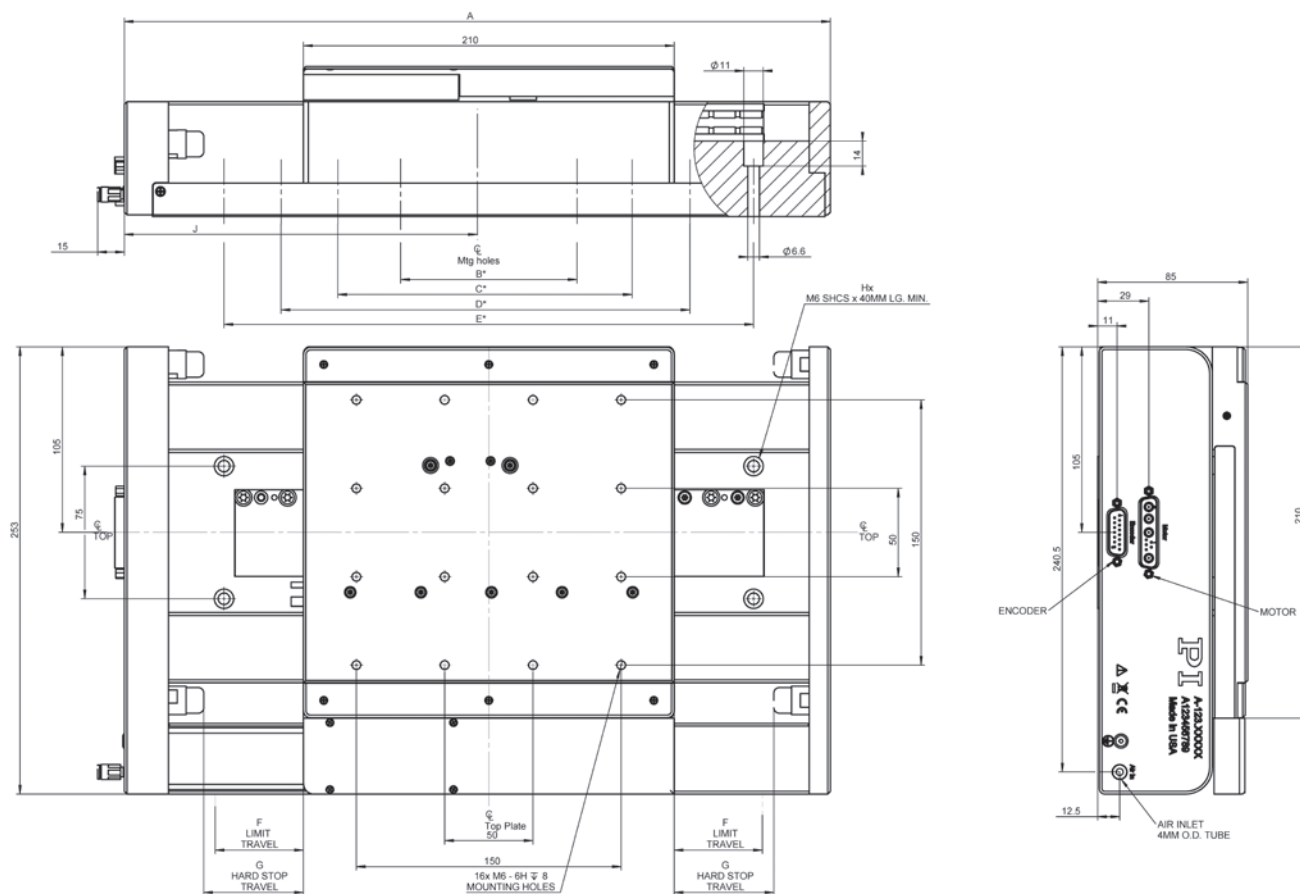
(3) Assumes payload CG is centered no more than 50 mm above the motion platform.

(4) Assumes 16384x interpolation. Contact PI for the use of other factors.

(5) Improved accuracy can be obtained with controller-based error compensation. The stage must be ordered with a controller from PI to reach these values. Accuracy values assume short-term duration and do not consider the long-term effects of thermal drift on the stage.

(6) To protect the stage against damage, it is recommended to connect an air pressure sensor to the Motion-Stop input of the controller.

A-123, dimensions in mm



MODEL	A	B*	C*	D*	E*	F	G	Hx	J	Moving Mass	Total Mass
A-123.050	350				250	25	31.5	4	181.5	5 kg	14 kg
A-123.100	400	100			300	50	56.5	8	206.5	5 kg	15.5 kg
A-123.150	450	100			350	75	81.5	8	231.5	5 kg	16.5 kg
A-123.200	500	100			400	100	106.5	8	256.5	5 kg	18 kg
A-123.350	650	100	325		550	175	181.5	12	331.5	5 kg	21.5 kg
A-123.500	800	100	300	500	700	250	256.5	16	406.5	5 kg	25 kg
A-123.750	1050	100	400	700	1000	375	381.5	16	531.5	5 kg	32 kg

\*The mounting holes are symmetric around the center line located at "J"

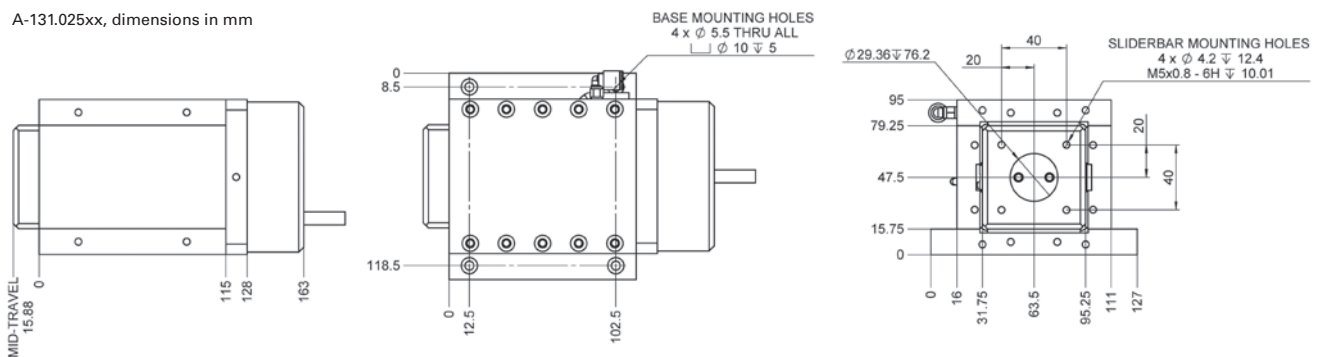
# A-131 PIGlide VC Voice Coil Linear Stage with Air Bearings

## High-Performance Miniature Nanopositioning System

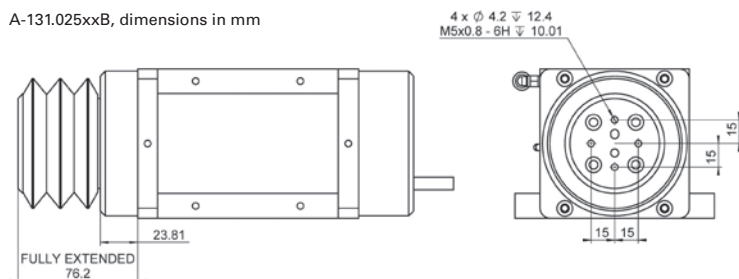


- Ideal for scanning applications or high-precision positioning
- Cleanroom compatible
- Travel ranges to 25 mm
- Load capacity to 100 N
- Acceleration to 80 m/s<sup>2</sup>
- Best flatness / straightness

A-131.025xx, dimensions in mm



A-131.025xxB, dimensions in mm



### Applications

- Medical Industry
- Scanning
- Machine Tool / Fast Tool



	A-131	Unit	Tolerance
<b>Motion</b>			
Active axes	X		
Travel range	25	mm	
Pitch <sup>(1)</sup>	10	μrad	max.
Yaw <sup>(1)</sup>	10	μrad	max.
Straightness / flatness <sup>(1)</sup>	±0.125	μm	max.
Velocity, unloaded <sup>(2)</sup>	1	m/s	max.
Acceleration, unloaded <sup>(2)</sup>	80	m/s <sup>2</sup>	max.
<b>Mechanical properties</b>			
Load capacity in z <sup>(3)</sup>	100	N	max.
Moved mass	0.85	kg	
Overall mass	3.6	kg	
Guide type	Air bearing		
<b>Drive properties</b>			
Drive type	Brushless voice coil drive, ironless, 1 phase		
Intermediate circuit voltage, effective	48, nominal 80, max.	V DC	
Peak force	70.4	N	typ.
Nominal force	22.3	N	typ.
Force constant, effective	6.9	N/A	typ.
Resistance	2.7	Ω	typ.
Inductivity (at 1000 Hz)	1.4	mH	typ.
Back EMF	6.9	V·s/m	
Nominal power	28	W	max.
Cabling	Internal, no moving cable		

	A-131.025A1x	A-131.025D1x	A-131.025F1x
<b>Positioning</b>			
Integrated sensor	Incremental linear encoder	Incremental linear encoder	Incremental linear encoder
Sensor signal	Sin/cos, 1 V peak-peak, 20 μm signal period	A/B quadrature, TTL	A/B quadrature, TTL
Sensor resolution	1.2 nm <sup>(4)</sup>	100 nm <sup>(5)</sup>	500 nm <sup>(5)</sup>
Bidirectional repeatability	±0.1 μm <sup>(4)</sup>	±0.1 μm	±0.1 μm
Accuracy <sup>(6)</sup>	0.2 μm	0.2 μm	0.2 μm
Reference point switch	Home index	Home index	Home index
Reference point switch repeatability	±1 encoder step	±1 encoder step	±1 encoder step

	A-131
<b>Miscellaneous</b>	
Operating pressure <sup>(7)</sup>	75 to 85 psi (520 to 585 kPa)
Air consumption	<1.0 SCFM (28 SLPM)
Air quality	Clean (filtered to 1.0 μm or better) – ISO 8573-1 Class 1 Oil free – ISO 857-1 Class 1 Dry (–15 °C dew point) – ISO 8573-1 Class 3
Materials	Hardcoat aluminum, stainless steel fasteners

(1) Dependent on the flatness of the surface, on which the stage is mounted.

(2) Can be limited by the payload, controller or drive.

(3) Assumes that the center of gravity is centered no more than 50 mm from the motion platform.

(4) Assumes 16384x interpolation. Contact PI for the use of other factors.

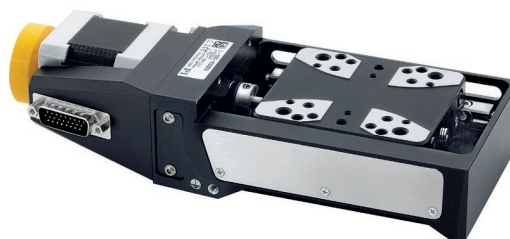
(5) Alternative resolutions on request. Higher resolutions can limit the velocity.

(6) Improved accuracy can be obtained with controller-based error compensation. The stage must be ordered with a controller from PI to reach these values.

(7) To protect the stage against damage, it is recommended to connect an air pressure sensor to the Motion-Stop input of the controller.



# Compact Screw-Driven Linear Stages



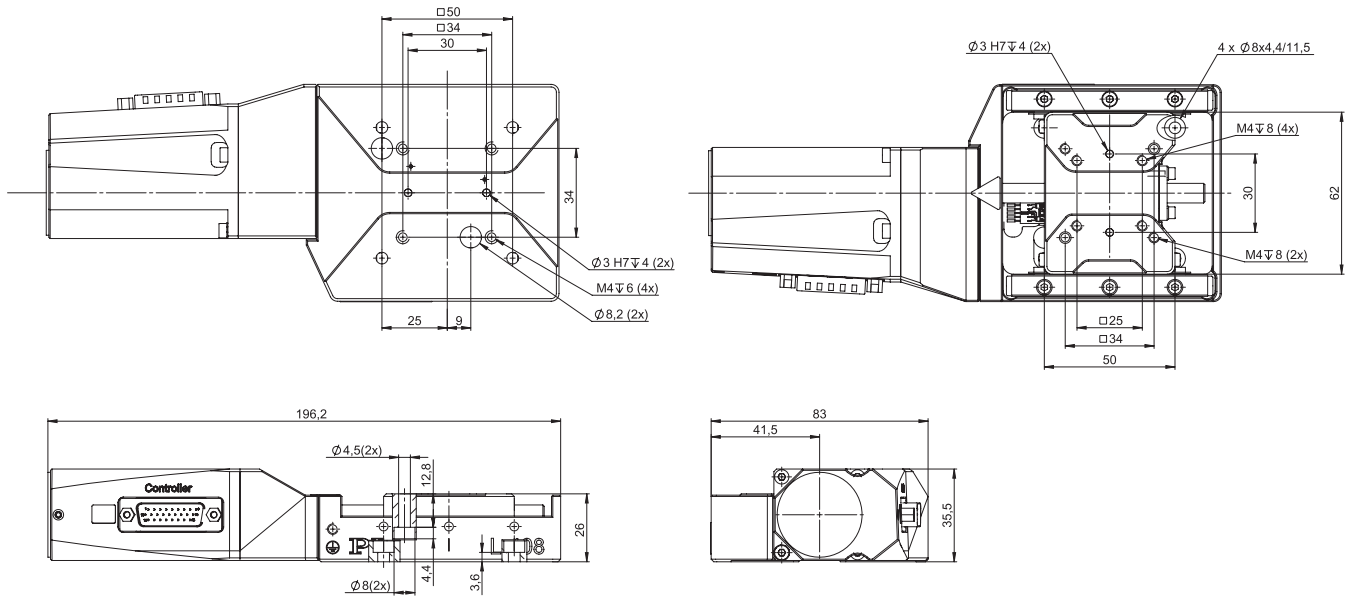
# L-408 Compact Linear Stage

For Loads up to 200 N



- Travel range 25 mm
- Stepper motor, DC or DC gear motor
- Precision sliding-thread spindle
- Crossed roller guides for high load capacity and precision, anti-creep
- Integrated optical limit switches
- Optical reference point switch with direction sensing

L-408.503232 and L-408.504232, dimensions in mm



## Applications

- Automation
- Precision Micro Assembly
- Scientific Instrumentation

	L-408.504232	L-408.503232	L-408.501200	Unit	Tolerance
<b>Motion and positioning</b>					
Travel range	25	25	25	mm	max.
Integrated sensor	Rotary encoder	Rotary encoder	–		
Sensor resolution	2048	4096	–	Cts./rev.	
Design resolution	0.008	0.122	2.5	µm	
Minimum incremental motion	0.1	0.5	0.1	µm	typ.
Unidirectional repeatability	0.5	0.5	0.5	µm	typ.
Bidirectional repeatability	±5	±5	±5	µm	typ.
Pitch / yaw	±100	±100	±100	µrad	typ.
Straightness / flatness	±2	±2	±2	µm	typ.
Max. velocity	1.1	10	10	mm/s	max.
Reference and limit switches	Hall effect	Hall effect	Hall effect		
Reference point switch repeatability	1	1	1	µm	typ.
<b>Mechanical properties</b>					
Guide type	Crossed roller guide with anti-creep system	Crossed roller guide with anti-creep system	Crossed roller guide with anti-creep system		
Drive screw	Leadscrew	Leadscrew	Leadscrew		
Drive screw pitch	0.5	0.5	0.5	mm	
Gear ratio	2401:81	–	–		
Push/pull force	50	50	40	N	max.
Holding force	50	50	40	N	max.
Load capacity	200	200	200	N	max.
Permissible lateral force	100	100	100	N	max.
Permissible torque in $\theta_x$	15	15	15	N·m	max.
Permissible torque in $\theta_y, \theta_z$	10	10	10	N·m	max.
<b>Drive properties</b>					
Motor type	DC gear motor	DC motor	2-phase stepper motor		
Operating voltage, nominal	24	24	24	V	nom.
Operating voltage, max.	48	48	48	V	max.
Step resolution	–	–	200	Full steps/rev.	
<b>Miscellaneous</b>					
Operating temperature range	5 to 40	5 to 40	5 to 40	°C	
Material	Aluminum black anodized, steel	Aluminum black anodized, steel	Aluminum black anodized, steel		
Mass	0.87	0.87	0.98	kg	±5 %
Moved mass	0.155	0.155	0.155	kg	±5 %
Connector	HD Sub-D 26	HD Sub-D 26	HD Sub-D 26		
Recommended controllers	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller		

All cables required for operation with the ordered controller are included in the scope of delivery. The cable length is 3 m. Cable for connecting to other controllers can be ordered as accessory. Ask about custom designs!

# L-509 Precision Linear Stage

Compact Design, for Loads to 10 kg

- Travel ranges from 26 to 102 mm (1" to 4")
- Repeatability to 0.1  $\mu\text{m}$
- Optional with Direct-Measuring Linear Encoder
- ActiveDrive DC, DC, BLDC, and DC gear motors
- Stepper motors
- Direction-sensing reference point switch



## Applications

- Autofocus
- Biotechnology
- Automation
- Laser Cutting
- Optical Alignment
- Scientific Instrumentation

Stages with stepper motor and ActiveDrive DC motor	L-509.xxADxx	L-509.xxSD00 / L-509.xASD00	Unit	Tolerance
<b>Motion</b>				
Active axes	X	X		
Travel range	L-509.1xADxx: 26 L-509.2xADxx: 52 L-509.4xADxx: 102	L-509.1xSDxx: 26 L-509.2xSDxx: 52 L-509.4xSDxx: 102	mm	
Pitch / yaw	L-509.1xADxx: ±60 L-509.2xADxx: ±90 L-509.4xADxx: ±120	L-509.1xSDxx: ±60 L-509.2xSDxx: ±90 L-509.4xSDxx: ±120	µrad	typ.
Straightness / flatness	L-509.1xADxx: 2 L-509.2xADxx: 4 L-509.4xADxx: 8	L-509.1xSDxx: 2 L-509.2xSDxx: 4 L-509.4xSDxx: 8	µm	typ.
Velocity	50	20	mm/s	max.

	L-509.xxADxx	L-509.xxSD00	L-509.xASD00	Unit	Tolerance
<b>Positioning</b>					
Integrated sensor	L-509.xxAD10: Incremental rotary encoder L-509.xxAD00: Incremental linear encoder	–	Incremental linear encoder		
Sensor signal	A/B quadrature, TTL	–	Sin/cos, 1 V peak-peak, 20 µm signal period		
Design resolution	L-509.xxAD10: 0.061 L-509.xxAD00: 0.05	5.0	0.005	µm	
Sensor resolution rotary encoder	L-509.xxAD10: 16384	–	–	Cts./rev.	
Sensor resolution linear encoder	L-509.xxAD00: 0.05	–	0.005	µm	
Resolution stepper motor	–	200	200	Full steps/rev.	
Minimum incremental motion	L-509.xxAD10: 0.8 L-509.xxAD00: 0.2	0.1	0.02	µm	typ.
Unidirectional repeatability	L-509.xxAD10: 0.2 L-509.xxAD00: 0.1	0.3	0.1	µm	typ.
Bidirectional repeatability	L-509.xxAD10: ±0.5 L-509.14AD00: ±0.3 L-509.24AD00: ±0.2 L-509.44AD00: ±0.2	±1	±0.2	µm	typ.
Reference and limit switches	Optical	Optical	Optical		

	L-509.xxADxx / L-509.xxSD00 / L-509.xASD00	Unit	Tolerance
<b>Mechanical properties</b>			
Drive screw type	Crossed roller guide with anti-creep system		
Drive screw pitch	1	mm	
Guide type	Recirculating ball bearings		
Holding force, power off	L-509.xxADxx: 20 L-509.xxSD00 / L-509.xASD00: 60	N	typ.
Push/pull force $F_{x,r}$ , power on	60	N	max.
Permissible lateral force	50	N	max.
Load capacity	100	N	max.
Permissible torque $M_x$ in $\theta_x$	30	N·m	max.
Permissible torque $M_y$ in $\theta_y$	25	N·m	max.
Permissible torque $M_z$ in $\theta_z$	20	N·m	max.

Stages with stepper motor and ActiveDrive DC motor	L-509.xxADxx	L-509.xxSD00 / L-509.xASD00	Unit	Tolerance
<b>Drive properties</b>				
Motor type	ActiveDrive DC motor (PWM)	Stepper motor, 2-phase		
Operating voltage, nominal	24	24	V	nom.
Operating voltage, max.	24	48	V	max.

	L-509.xxADxx	L-509.xxSD00	L-509.xASD00	Unit	Tolerance
<b>Miscellaneous</b>					
Operating temperature range	5 to 40	5 to 40	5 to 40	°C	
Material	Aluminum, steel	Aluminum, steel	Aluminum, steel		
Mass	L-509.10AD10: 1.4 L-509.20AD10: 1.5 L-509.40AD10: 1.7 L-509.14AD00: 1.4 L-509.24AD00: 1.6 L-509.44AD00: 1.8	L-509.10SD00: 1.4 L-509.20SD00: 1.5 L-509.40SD00: 1.7	L-509.1ASD00: 1.5 L-509.2ASD00: 1.6 L-509.4ASD00: 1.8	kg	±5 %
Moved mass, unloaded	L-509.x0AD10: 0.22 L-509.14AD00: 0.24 L-509.24AD00: 0.24 L-509.44AD00: 0.25	0.22	L-509.1ASD00: 0.24 L-509.2ASD00: 0.24 L-509.4ASD00: 0.25	kg	±5 %
Connection	1 × Sub-D 15 (m) (motor/sensor)	1 × HD Sub-D 26 (m) (motor)	1 × HD Sub-D 26 (m) (motor) 1 × Sub-D 9 (m) (sensor)		
Recommended controllers / drivers	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller		

Stages with DC motor and BLDC motor	L-509.xxDG10	L-509.xx3111 / L-509.xx3132	L-509.xx5132	Unit	Tolerance
<b>Motion</b>					
Active axes	X	X	X		
Travel range	L-509.10DG10: 26 L-509.20DG10: 52 L-509.40DG10: 102	L-509.023xxx: 26 L-509.033xxx: 52 L-509.053xxx: 102	L-509.025132: 26 L-509.035132: 52 L-509.055132: 102	mm	
Pitch / yaw	L-509.10DG10: ±60 L-509.20DG10: ±90 L-509.40DG10: ±120	L-509.023xxx: ±60 L-509.033xxx: ±90 L-509.053xxx: ±120	L-509.025132: ±60 L-509.035132: ±90 L-509.055132: ±120	μrad	typ.
Straightness / flatness	L-509.10DG10: 2 L-509.20DG10: 4 L-509.40DG10: 8	L-509.023xxx: 2 L-509.033xxx: 4 L-509.053xxx: 8	L-509.025132: 2 L-509.035132: 4 L-509.055132: 8	μm	typ.
Velocity	3	50	50	mm/s	max.



	L-509.xxDG10	L-509.xx3111	L-509.xxx132	Unit	Tolerance
<b>Positioning</b>					
Integrated sensor	Incremental rotary encoder	Incremental linear encoder	Incremental rotary encoder		
Sensor signal	A/B quadrature, TTL	Sin/cos, 1 V peak-peak, 20 µm signal period	A/B quadrature, TTL		
Design resolution	0.008	0.005	0.05	µm	
Sensor resolution rotary encoder	4096	–	20000	Cts./rev.	
Sensor resolution linear encoder	–		–	µm	
Minimum incremental motion	0.1	0.1	0.5	µm	typ.
Unidirectional repeatability	0.1	0.1	0.2	µm	typ.
Bidirectional repeatability	±2	±0.2	±0.5	µm	typ.
Reference and limit switches	Optical	Optical	Optical		

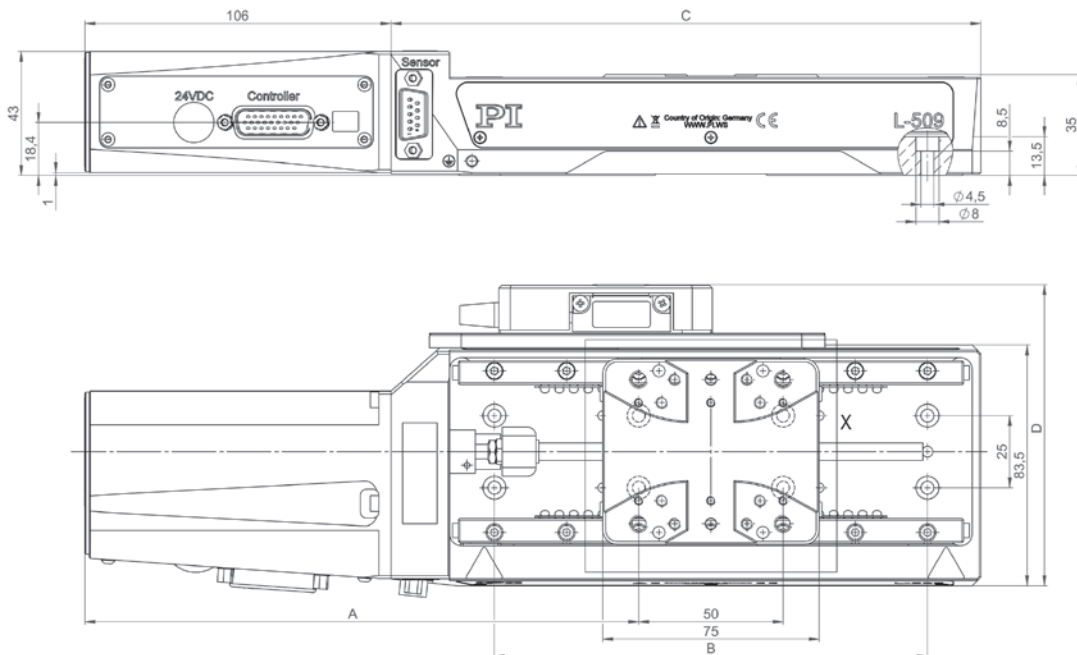
	L-509.xxDG10	L-509.xx3xxx L-509.xx5xxx	Unit	Tolerance
<b>Mechanical properties</b>				
Drive screw type	Crossed roller guide with anti-creep system	Crossed roller guide with anti-creep system		
Drive screw pitch	1	1	mm	
Gear ratio	2401:81	–		
Guide type	Recirculating ball bearings	Recirculating ball bearings		
Holding force, power off	L-509.10DG10: 40 L-509.20DG10: 60 L-509.40DG10: 60	20	N	typ.
Push/pull force $F_x$ , power on	60	60	N	max.
Permissible lateral force	50	50	N	max.
Load capacity	100	100	N	max.
Permissible torque $M_x$ in $\theta_x$	30	30	N·m	max.
Permissible torque $M_y$ in $\theta_y$	25	25	N·m	max.
Permissible torque $M_z$ in $\theta_z$	20	20	N·m	max.

	L-509.xxDG10	L-509.xx3xxx	L-509.xx5xxx	Unit	Tolerance
<b>Drive properties</b>					
Motor type	DC motor (with gearhead)	DC motor	Brushless DC motor, 3-phase		
Operating voltage, nominal	24	24	24	V	nom.
Operating voltage, max.	48	48	48	V	max.

Stages with DC motor and BLDC motor	L-509.xxDG10	L-509.xx3xxx	L-509.xx5132	Unit	Tolerance
<b>Miscellaneous</b>					
Operating temperature range	5 to 40	5 to 40	5 to 40	°C	
Material	Aluminum, steel	Aluminum, steel	Aluminum, steel		
Mass	L-509.10DG10: 1.4 L-509.20DG10: 1.6 L-509.40DG10: 1.9	L-509.023xxx: 1.2 L-509.033xxx: 1.3 L-509.053xxx: 1.5	L-509.025132: 1.4 L-509.035132: 1.5 L-509.055132: 1.7	kg	±5 %
Moved mass, unloaded	0.22	L-509.023111: 0.24 L-509.033111: 0.24 L-509.053111: 0.25	0.22	kg	±5 %
Connection	1 × HD Sub-D 26 (m) (motor/sensor)	1 × HD Sub-D 26 (m) (motor) L-509.xx3111 additional: 1 × Sub-D 9 (m) (sensor)	1 × HD Sub-D 26 (m) (motor/sensor)		
Recommended controllers / drivers	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller		

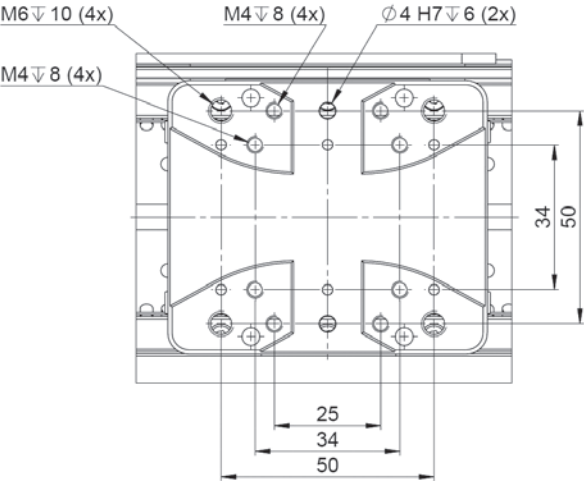
All cables required for operation with the ordered controller are included in the scope of delivery. The cable length is 3 m. Cable for connecting to other controllers can be ordered as accessory. Ask about custom designs!

L-509 versions with DC and BLDC motor, dimensions in mm

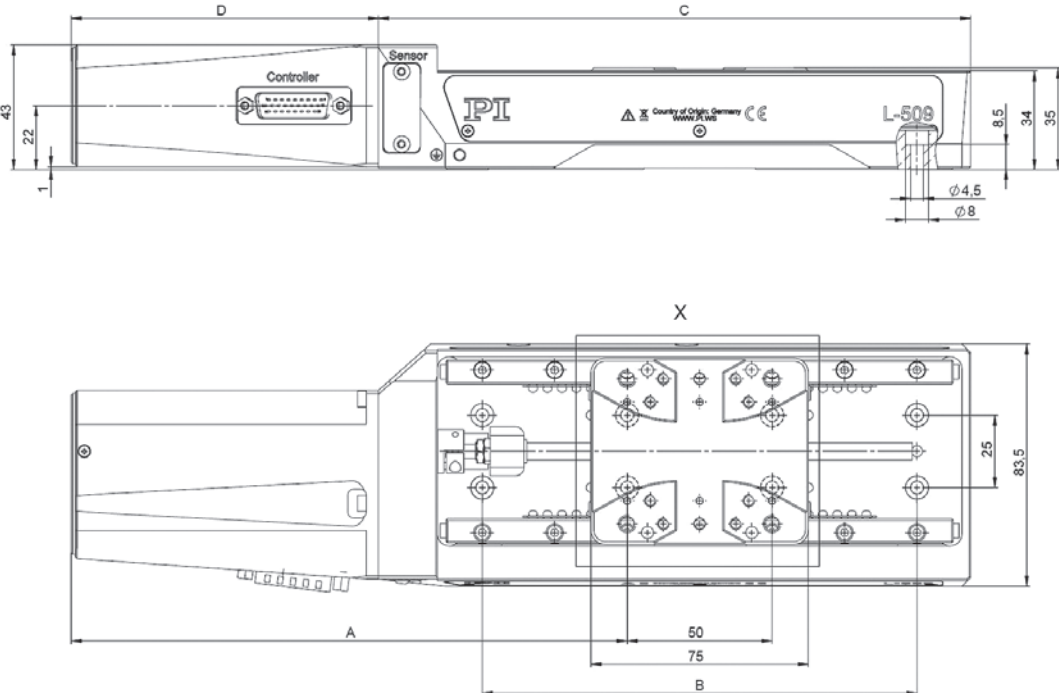


	A	B	C	D
L-509.023111	157.3	100	135.3	104.4
L-509.023132	157.3	100	135.3	-
L-509.025132	157.3	100	135.3	-
L-509.033111	166.8	100	154.3	104.4
L-509.033132	166.8	100	154.3	-
L-509.035132	166.8	100	154.3	-
L-509.053111	191.8	150	204.3	104.4
L-509.053132	191.8	150	204.3	-
L-509.055132	191.8	150	204.3	-

Detail drawing of the L-509 motion platform

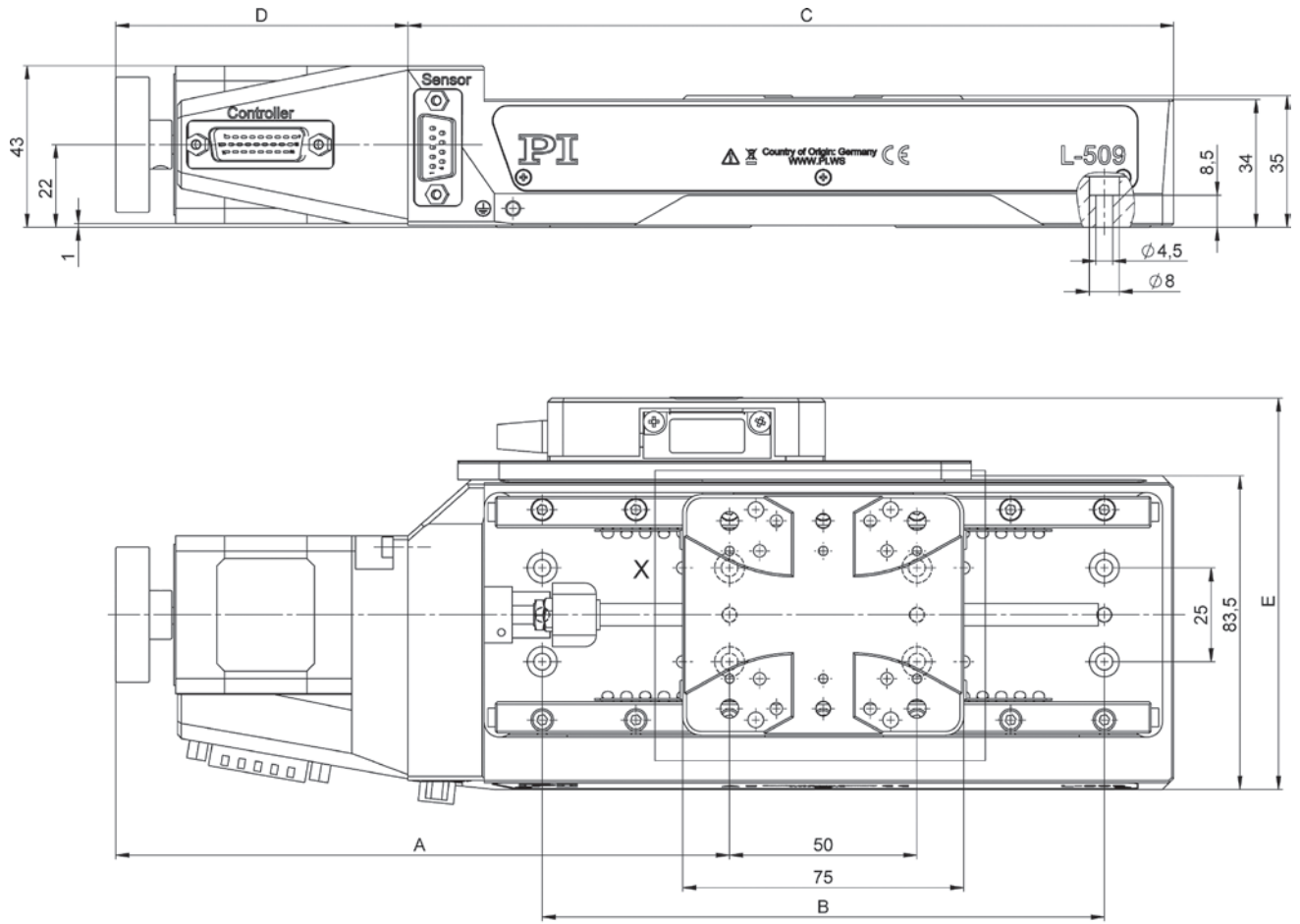


L-509 versions with DC gear motor, dimensions in mm



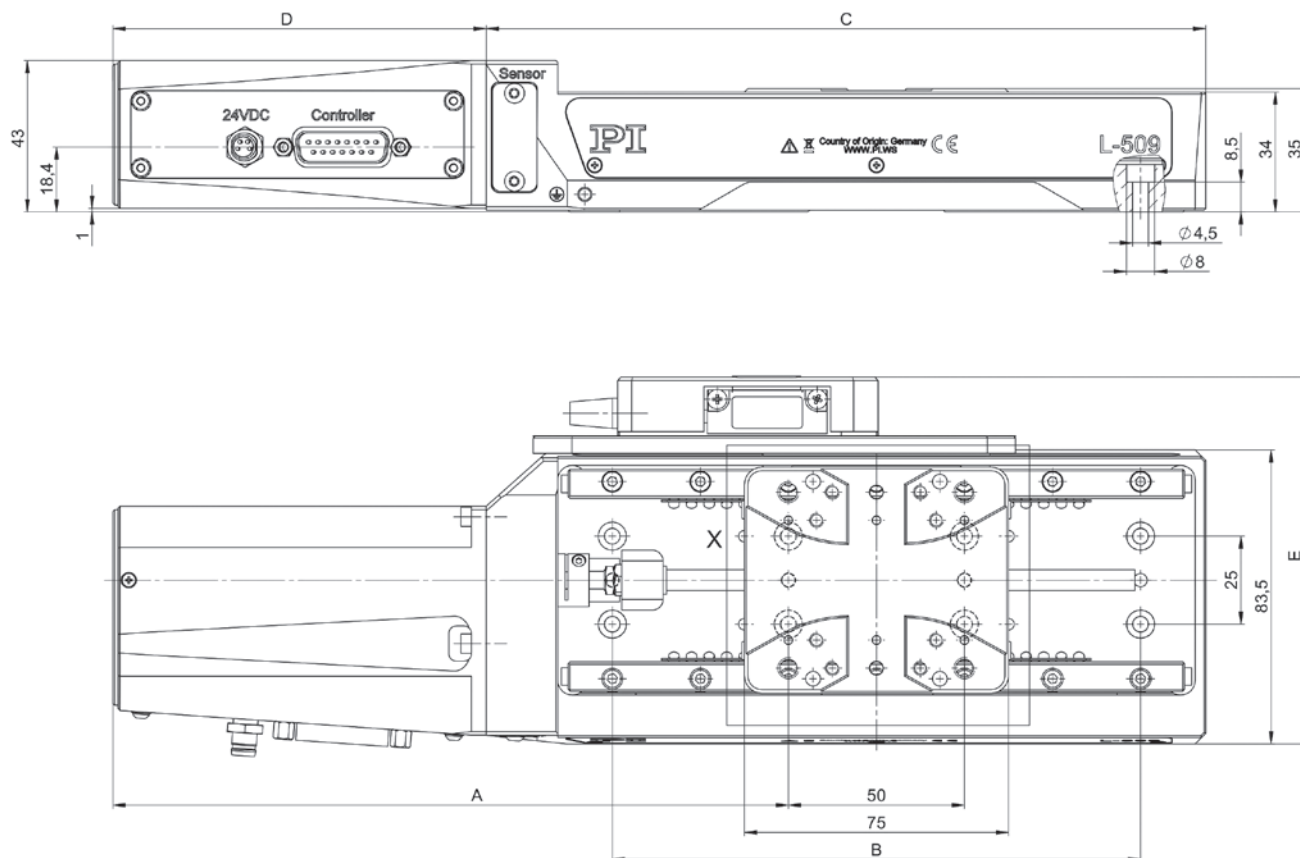
	A	B	C	D
L-509.10DG10	157.3	100	135.3	106
L-509.20DG10	166.8	100	154.3	106
L-509.40DG10	191.8	150	204.3	106

L-509 versions with stepper motor, dimensions in mm



	A	B	C	D	E
L-509.10SD00	129.3	100	135.3	78	-
L-509.1ASD00	129.3	100	135.3	78	104.2
L-509.20SD00	138.8	100	154.3	78	-
L-509.2ASD00	138.8	100	154.3	78	104.2
L-509.40SD00	163.8	150	204.3	78	-
L-509.4ASD00	163.8	150	204.3	78	104.2

L-509 versions with ActiveDrive DC motor, dimensions in mm



	A	B	C	D	E
L-509.10AD10	157.3	100	135.3	106	-
L-509.14AD00	157.3	100	135.3	106	104.2
L-509.20AD10	166.8	100	154.3	106	-
L-509.24AD00	166.8	100	154.3	106	104.2
L-509.40AD10	191.8	150	204.3	106	-
L-509.44AD00	191.8	150	204.3	106	104.2

# L-511 High-Precision Linear Stage

## High Travel Accuracy

- Travel ranges to 155 mm (6")
- Repeatability to 0.1  $\mu\text{m}$
- ActiveDrive DC, DC, BLDC, and DC gear motors
- Stepper motors
- Optional linear encoder for direct position measurement
- Direction-sensing reference point switch



### Reference-class linear stage

Recirculating ball bearings for high travel accuracy and load capacity. Precision ball screw with 2 mm pitch. Stress-relieved aluminum base for highest stability. Noncontact limit switches. Noncontact optical reference point switch with direction sensing in the middle of the travel range.

### Highly accurate position measuring with incremental linear encoder

Noncontact optical linear encoders 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.

### Minimum incremental motion and slow motion

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

### Drive types

- .xxAD variant: ActiveDrive DC motor for high velocity: Control via pulse-width-modulated (PWM) signals, the operating voltage is attained via an amplifier integrated in the motor housing.
- .xxDG variant: DC servo motor with gearhead for high torques and resolution at low motor power
- .xxSD variant: 2-phase stepper motor for low velocity and high resolution
- .xx3xxx variant: DC motor
- .xx5xxx variant: Brushless DC motor

### Position measurement

- Integrated rotary encoder on the motor shaft (xxAD10, xxDG10, xxx32).
- Incremental linear encoder (xxAD00, xASD00, xxx11).

### Applications

- Autofocus
- Biotechnology
- Automation
- Laser Cutting
- Optical Alignment
- Scientific Instrumentation

Stages with stepper motor and ActiveDrive DC motor	L-511.xxADxx	L-511.xxSD00 / L-511.xASD00	Unit	Tolerance
<b>Motion</b>				
Active axes	X	X		
Travel range	L-511.2xADxx: 52 L-511.4xADxx: 102 L-511.6xADxx: 155	L-511.2xSD00: 52 L-511.4xSD00: 102 L-511.6xSD00: 155	mm	
Pitch / yaw	L-511.2xADxx: ±40 L-511.4xADxx: ±60 L-511.6xADxx: ±70	L-511.2xSD00: ±40 L-511.4xSD00: ±60 L-511.6xSD00: ±70	µrad	typ.
Straightness / flatness	L-511.2xADxx: ±1.5 L-511.4xADxx: ±2.5 L-511.6xADxx: ±3.0	L-511.2xSD00: ±1.5 L-511.4xSD00: ±2.5 L-511.6xSD00: ±3.0	µm	typ.
Velocity	90	45	mm/s	max.

	L-511.xxADxx	L-511.xxSD00	L-511.xASD00	Unit	Tolerance
<b>Positioning</b>					
Integrated sensor	L-511.xxAD10: Incremental rotary encoder L-511.xxAD00: Incremental linear encoder	–	Incremental linear encoder		
Sensor signal	A/B quadrature, TTL	–	Sin/cos, 1 V peak-peak, 20 µm signal period		
Design resolution	L-511.xxAD10: 0.122 L-511.xxAD00: 0.05	10.0	0.005	µm	
Sensor resolution rotary encoder	L-511.xxAD10: 16384	–	–	Cts./rev.	
Sensor resolution linear encoder	L-511.xxAD00: 0.05	–	0.005	µm	
Resolution stepper motor	–	200	200	Full steps/rev.	
Minimum incremental motion	L-511.xxAD10: 0.488 L-511.xxAD00: 0.1	0.2	0.02	µm	typ.
Unidirectional repeatability	L-511.xxAD10: 0.488 L-511.xxAD00: 0.1	0.2	0.1	µm	typ.
Bidirectional repeatability	L-511.xxAD10: ±1.250 L-511.xxAD00: ±0.2	±2	±0.2	µm	typ.
Reference and limit switches	Optical	Optical	Optical		

	L-511.xxADxx / L-511.xxSD00 / L-511.xASD00	Unit	Tolerance
<b>Mechanical properties</b>			
Drive screw type	Ball screw		
Drive screw pitch	2	mm	
Guide type	Recirculating ball bearings		
Holding force, power off	L-511.xxADxx: 20 L-511.xxSD00 / L-511.xASD00: 60	N	typ.
Push/pull force $F_{xr}$ power on	100	N	max.
Permissible lateral force	250	N	max.
Load capacity	500	N	max.
Permissible torque $M_x$ in $\theta_x$	60	N·m	max.
Permissible torque $M_y$ in $\theta_y$	30	N·m	max.
Permissible torque $M_z$ in $\theta_z$	30	N·m	max.

Stages with stepper motor and ActiveDrive DC motor	L-511.xxADxx	L-511.xxSD00 / L-511.xASD00	Unit	Tolerance
<b>Drive properties</b>				
Motor type	ActiveDrive DC motor (PWM)	Stepper motor, 2-phase		
Operating voltage, nominal	24	24	V	nom.
Operating voltage, max.	24	48	V	max.

	L-511.xxADxx	L-511.xxSD00	L-511.xASD00	Unit	Tolerance
<b>Miscellaneous</b>					
Operating temperature range	5 to 40	5 to 40	5 to 40	°C	
Material	Aluminum, stainless steel	Aluminum, stainless steel	Aluminum, stainless steel		
Mass	L-511.2xADxx: .25 L-511.40AD10: 2.8 L-511.60AD10: 3.3 L-511.44AD00: 2.7 L-511.64AD00: 3.5	L-511.20SDxx: 2.4 L-511.40SDxx: 2.6 L-511.60SDxx: 3.1	L-511.2ASDxx: 2.4 L-511.4ASDxx: 2.6 L-511.6ASDxx: 3.1	kg	±5 %
Moved mass, unloaded	L-511.2xADxx: 0.6 L-511.4xADxx: 0.6 L-511.6xADxx: 0.65	L-511.20SDxx: 0.6 L-511.40SDxx: 0.6 L-511.60SDxx: 0.65	L-511.2ASDxx: 0.6 L-511.4ASDxx: 0.6 L-511.6ASDxx: 0.65	kg	±5 %
Connection	1 × Sub-D 15 (m) (motor/sensor)	1 × HD Sub-D 26 (m) (motor)	1 × HD Sub-D 26 (m) (motor) 1 × Sub-D 9 (m) (sensor)		
Recommended controllers / drivers	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller		

Stages with DC motor and BLDC motor	L-511.xxDG10	L-511.xx3111 / L-511.xx3132 L-511.xx5111 / L-511.xx5132	Unit	Tolerance
<b>Motion</b>				
Active axes	X	X		
Travel range	L-511.20DG10: 52 L-511.40DG10: 102 L-511.60DG10: 155	L-511.03xxxx: 52 L-511.05xxxx: 102 L-511.07xxxx: 155	mm	
Pitch / yaw	L-511.20DG10: ±40 L-511.40DG10: ±60 L-511.60DG10: ±70	L-511.03xxxx: ±40 L-511.05xxxx: ±60 L-511.07xxxx: ±70	µrad	typ.
Straightness / flatness	L-511.20DG10: ±1.5 L-511.40DG10: ±2.5 L-511.60DG10: ±3.0	L-511.03xxxx: ±1.5 L-511.05xxxx: ±2.5 L-511.07xxxx: ±3.0	µm	typ.
Velocity	6	90	mm/s	max.

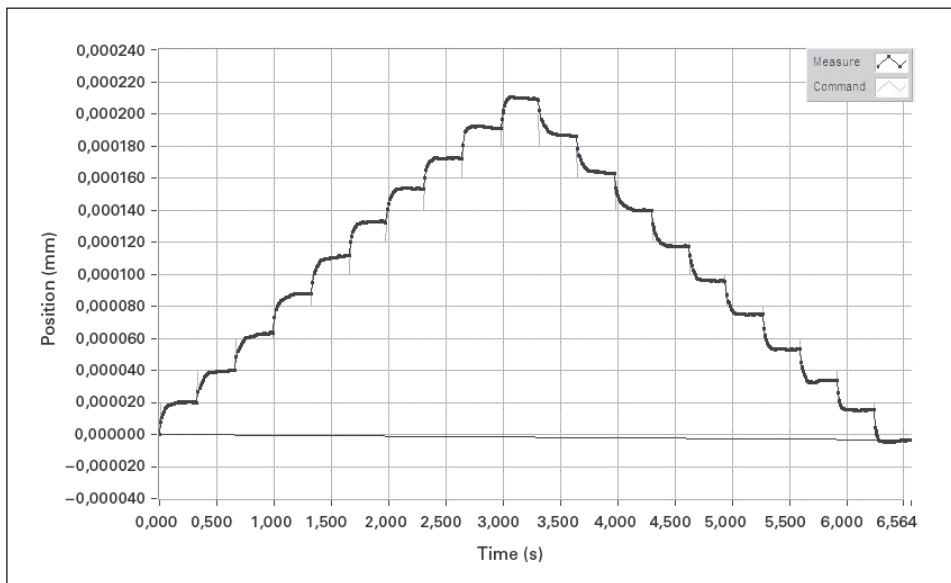


	L-511.xxDG10	L-511.xx3111 / L-511.xx5111	L-511.xx3132 / L-511.xx5132	Unit	Tolerance
<b>Positioning</b>					
Integrated sensor	Incremental rotary encoder	L-511.xx3111: Incremental linear encoder L-511.xx5111: Incremental rotary encoder, incremental rotary encoder	Incremental rotary encoder		
Sensor signal	A/B quadrature, TTL	Linear encoder: Sin/cos, 1 V peak-peak, 20 $\mu$ m signal period Rotary encoder: A/B quadrature, TTL	A/B quadrature, TTL		
Design resolution	0.017	L-511.xx3111: 0.005 L-511.xx5111: 0.05	0.1	$\mu$ m	
Sensor resolution rotary encoder	4096	20000	20000	Cts./rev.	
Sensor resolution linear encoder	–	L-511.xx3111: 0.005 L-511.xx5111: 0.05	0.1	$\mu$ m	
Minimum incremental motion	0.1	0.1	0.2	$\mu$ m	typ.
Unidirectional repeatability	0.2	0.1	0.2	$\mu$ m	typ.
Bidirectional repeatability	$\pm 2$	$\pm 0.1$	$\pm 1.25$	$\mu$ m	typ.
Reference and limit switches	Optical	Optical	Optical		

	L-511.xxDG10	L-511.xx3xxx / L-511.xx5xxx	Unit	Tolerance
<b>Mechanical properties</b>				
Drive screw type	Ball screw	Ball screw		
Drive screw pitch	2	2	mm	
Gear ratio	2401:81	–		
Guide type	Recirculating ball bearings	Recirculating ball bearings		
Holding force, power off	100	20	N	typ.
Push/pull force $F_x$ , power on	100	100	N	max.
Permissible lateral force	250	250	N	max.
Load capacity	500	500	N	max.
Permissible torque $M_x$ in $\theta_x$	60	60	N·m	max.
Permissible torque $M_y$ in $\theta_y$	30	30	N·m	max.
Permissible torque $M_z$ in $\theta_z$	30	30	N·m	max.

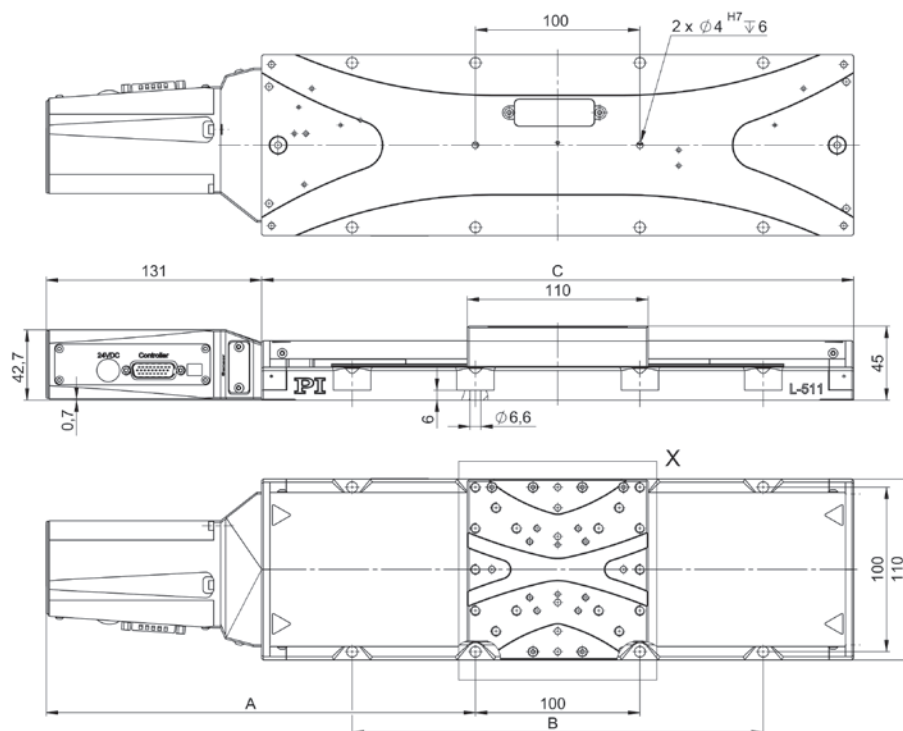
Stages with DC motor and BLDC motor	L-511.xxDG10	L-511.xx3xxx	L-511.xx5xxx	Unit	Tolerance
<b>Drive properties</b>					
Motor type	DC motor (with gearhead)	DC motor	Brushless DC motor, 3-phase		
Operating voltage, nominal	24	24	24	V	nom.
Operating voltage, max.	48	48	48	V	max.
<b>Miscellaneous</b>					
Operating temperature range	5 to 40	5 to 40	5 to 40	°C	
Mass	L-511.20DG10: 2.5 L-511.40DG10: 2.7 L-511.60DG10: 2.9	L-511.033xxx: 2.5 L-511.053xxx: 2.6 L-511.073xxx: 3.1	L-511.035xxx: 2.4 L-511.055xxx: 2.7 L-511.075xxx: 3.0	kg	±5 %
Moved mass, unloaded	L-511.20DG10: 0.6 L-511.40DG10: 0.6 L-511.60DG10: 0.65	L-511.033xxx: 0.6 L-511.053xxx: 0.6 L-511.073xxx: 0.65	L-511.035xxx: 0.6 L-511.055xxx: 0.6 L-511.075xxx: 0.65	kg	±5 %
Connection	1 × HD Sub-D 26 (m) (motor/sensor)	L-511.xx3111: 1 × HD Sub-D 26 (m) (motor), 1 × Sub-D 9 (m) (sensor) L-511.xx3132: 1 × HD Sub-D 26 (m) (motor/sensor)	L-511.xx5111: 1 × HD Sub-D 26 (m) (motor/sensor), 1 × Sub-D 9 (m) (sensor) L-511.xx5132: 1 × HD Sub-D 26 (m) (motor/sensor)		
Recommended controllers / drivers	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	L-511.xx5111: C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller L-511.xx5132 additional: SMC Hydra (double axis)		

All cables required for operation with the ordered controller are included in the scope of delivery. The cable length is 3 m. Cable for connecting to other controllers can be ordered as accessory. Ask about custom designs!



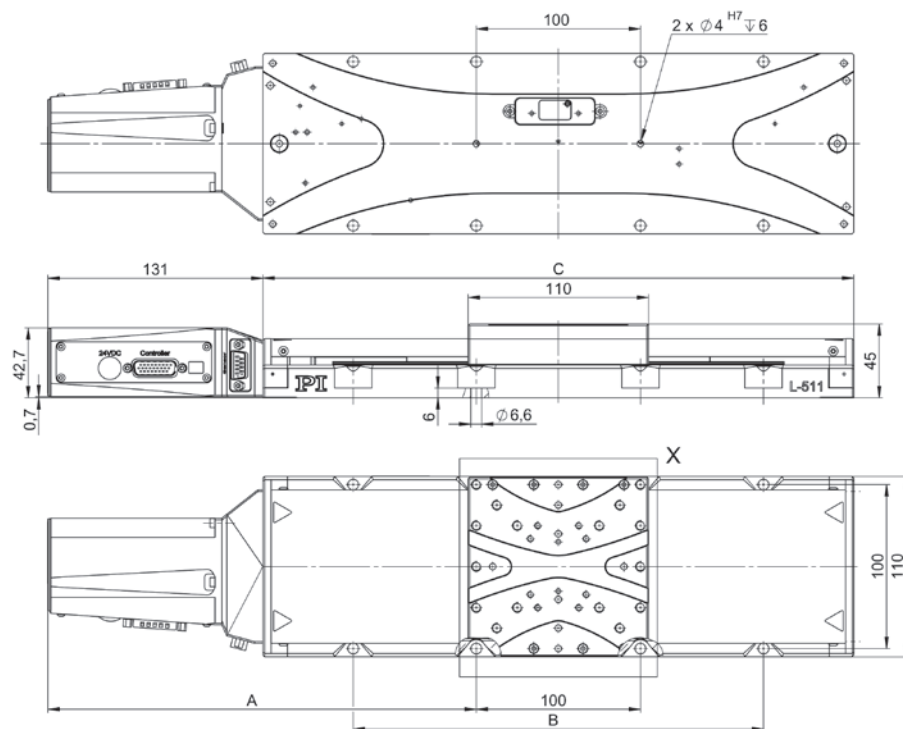
The L-511 reliably performs repeatable 20-nm steps with the linear encoder and SMC Hydra motion controller

L-511 versions with DC and BLDC motor, and rotary encoder, dimensions in mm



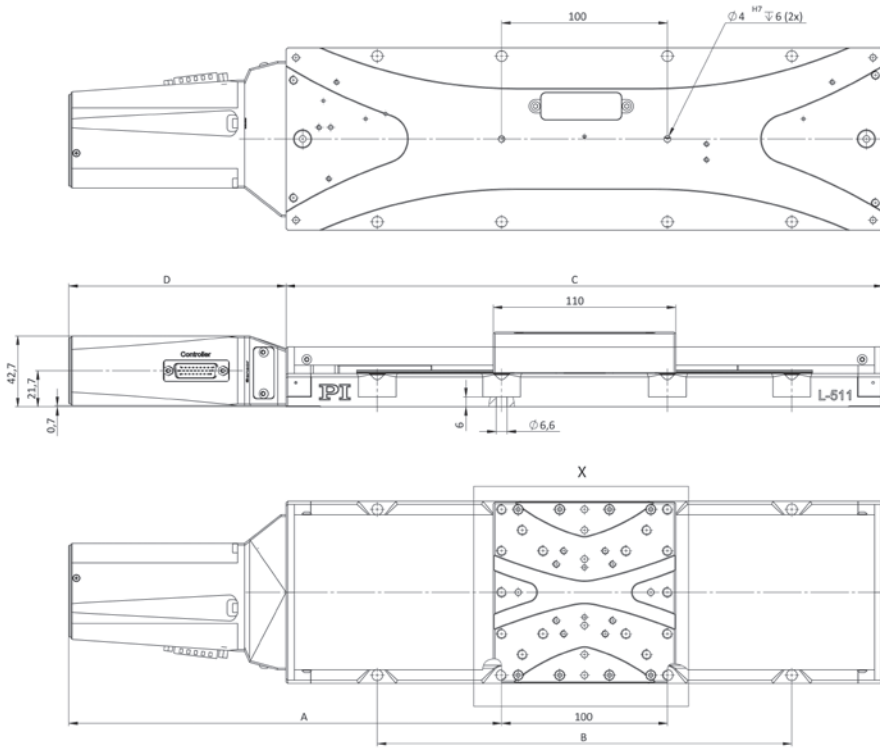
	A	B	C
L-511.033132	186	-	210
L-511.035132	186	-	210
L-511.053132	211	-	260
L-511.055132	211	-	260
L-511.073132	261	250	360
L-511.075132	261	250	360

L-511 versions with DC and BLDC motor, and linear encoder, dimensions in mm



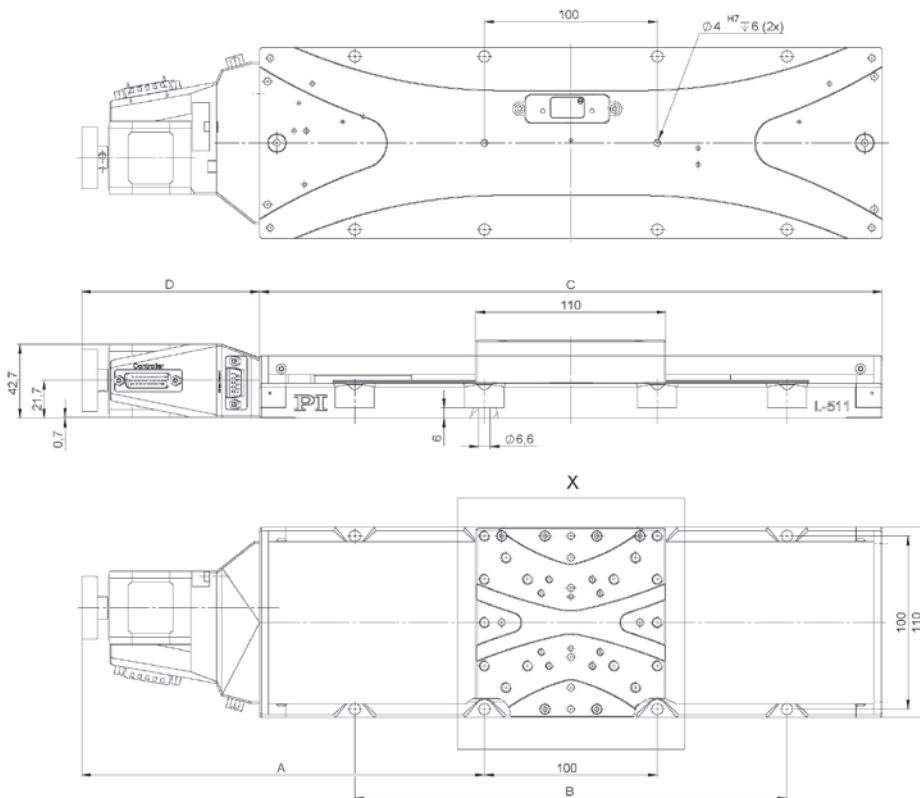
	A	B	C
L-511.033111	186	-	210
L-511.053111	211	-	260
L-511.073111	261	250	360
L-511.035111	186	-	210
L-511.055111	211	-	260
L-511.075111	261	250	360

L-511 versions with DC gear motor, dimensions in mm



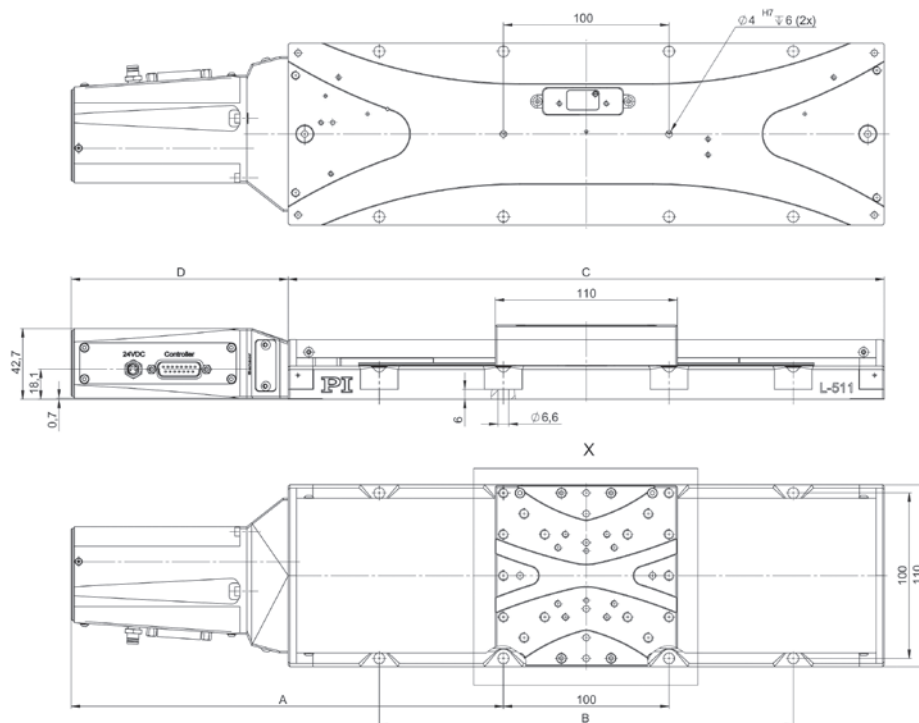
	A	B	C	D
L-511.20DG10	186	-	210	131
L-511.40DG10	211	-	260	131
L-511.60DG10	261	250	360	131

L-511 versions with stepper motor, dimensions in mm

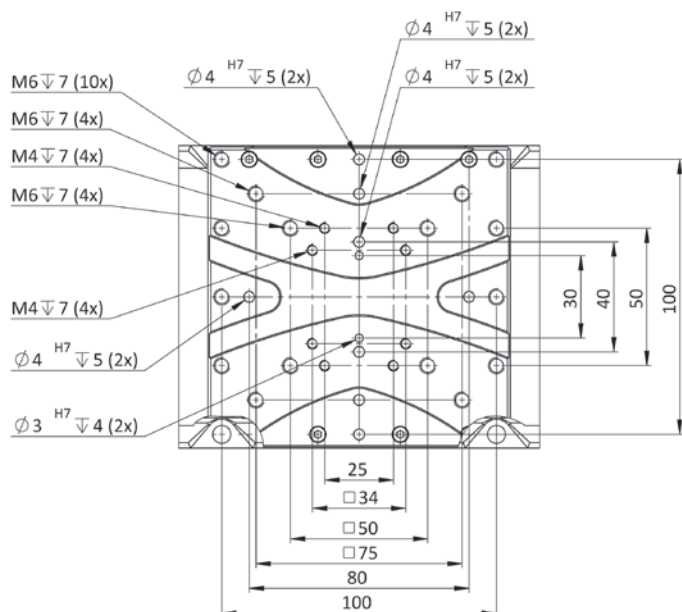


	A	B	C	D
L-511.20SD00	158	-	210	103
L-511.2ASD00	158	-	210	103
L-511.40SD00	183	-	260	103
L-511.4ASD00	183	-	260	103
L-511.60SD00	233	250	360	103
L-511.6ASD00	233	250	360	103

L-511 versions with ActiveDrive DC motor, dimensions in mm



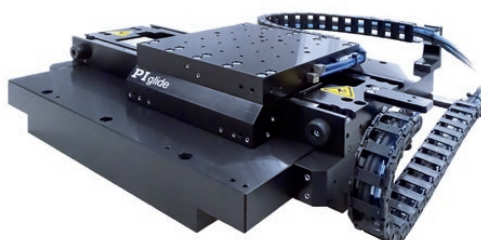
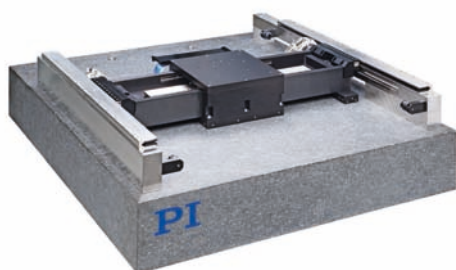
Detail drawing of the L-511 motion platform, dimensions in mm





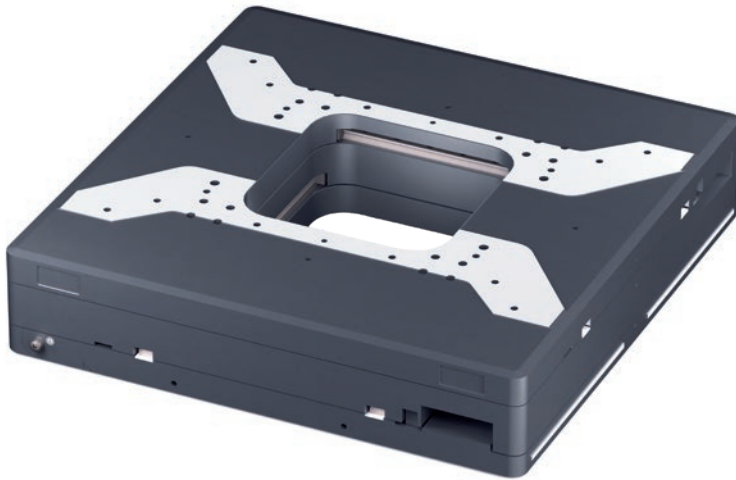
## Precision XY Stages

with Ball Screws/Servo & Stepper Motors,  
Linear Motors, Air Bearings & Linear Motors

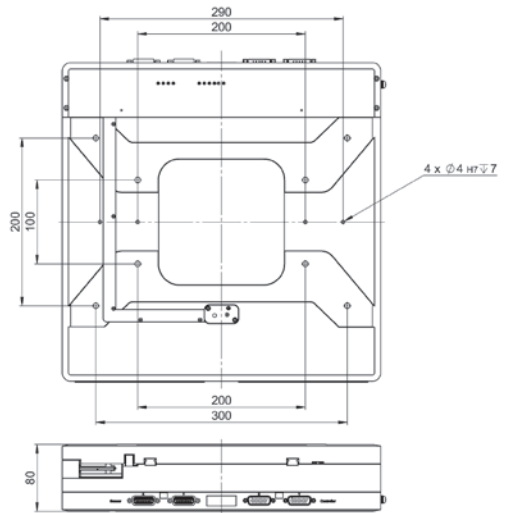


# V-738 4" Linear Motor High-Precision XY Stage

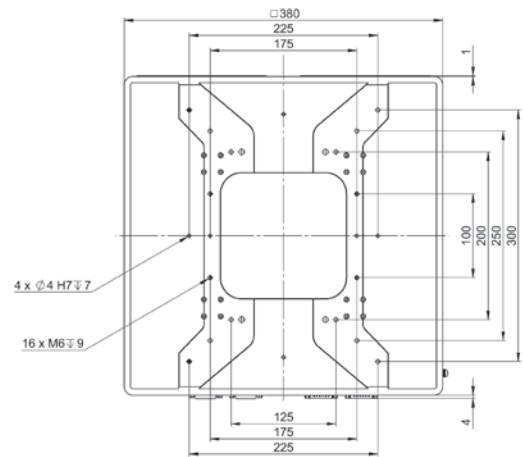
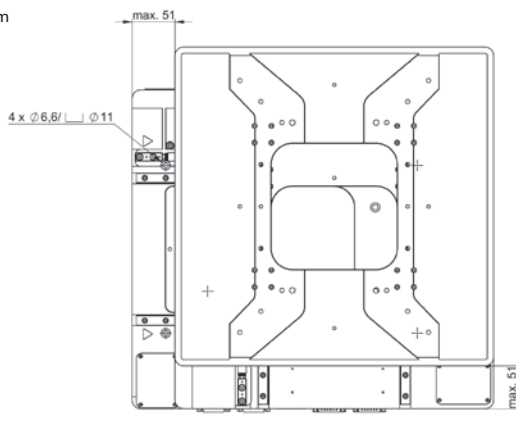
Clear Aperture, High Travel Accuracy and Stability, Magnetic Direct Drive



- Travel range 102 mm x 102 mm (4")
- Large aperture, 150 mm x 150 mm
- Unidirectional repeatability to 0.1 μm
- Velocity to 500 mm/s
- Ironless 3-phase linear motor
- Incremental linear encoder with 1 nm resolution



V-738, dimensions in mm



## Applications

- Automated Optical Inspection (AOI)
- Biotechnology
- Laser Cutting
- Laser Marking
- Medical Industry
- Metrology / Testing
- Scanning



	V-738.056111	Unit	Tolerance
<b>Motion and positioning</b>			
Travel range	102 × 102	mm	
Integrated sensor	Incremental linear encoder		
Design resolution	0.001	µm	
Sensor signal	Sin/cos, 1 V peak-peak, 20 µm signal period		
Minimum incremental motion	0.02	µm	typ.
Unidirectional repeatability	0.1	µm	typ.
Bidirectional repeatability	±0.25	µm	typ.
Angular error xry (pitch)	±40	µrad	typ.
Angular error xrz (yaw)	±20	µrad	typ.
Angular error yrx (pitch)	±40	µrad	typ.
Angular error yrz (yaw)	±20	µrad	typ.
Straightness / flatness	±2	µm	typ.
Orthogonality	±96.963	µrad	typ.
Velocity	500	mm/s	max.
Acceleration in X,Y, without load	10	m/s <sup>2</sup>	max.
Reference and limit switches	Optical		
<b>Mechanical properties</b>			
Load capacity	100	N	max.
Permissible torque in $\theta_x, \theta_y$	130	N·m	max.
Permissible torque in $\theta_z$	90	N·m	max.
Guide	Recirculating ball bearing		
<b>Drive properties</b>			
Motor type	Ironless 3-phase linear motor		
Operating voltage, nominal	48	V	nom.
Operating voltage, max.	48	V	max.
Peak force	200	N	max.
Nominal force	87	N	typ.
Peak current, effective	15	A	typ.
Nominal current, effective	4.4	A	typ.
Motor constant	71	N/√W	typ.
Electrical time constant	0.4	ms	
Resistance phase-phase	3.6	Ω	typ.
Inductance phase-phase	1.2	mH	typ.
Back EMF phase-phase	16	V·s/m	max.
Pole pitch N-N	30	mm	
<b>Miscellaneous</b>			
Operating temperature range	5 to 40	°C	
Material	Aluminum, black anodized		
Moved mass in X, unloaded	16.8	kg	±5 %
Moved mass in Y, unloaded	8	kg	±5 %
Overall mass	24	kg	±5 %
Connection	2 × HD Sub-D 26 (m) (motor) 2 × Sub-D 15 (f) (sensor)	h	
Recommended controller	SMC Hydra (double axis) C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller		

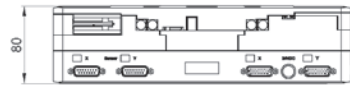
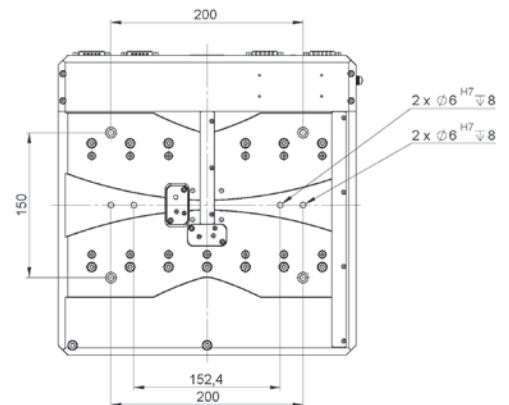
All cables required for operation with the ordered controller are included in the scope of delivery. The cable length is 3 m. Cable for connecting to other controllers can be ordered as accessory. Ask about custom designs!

# V-731 8" Linear Motor High-Precision XY Stage

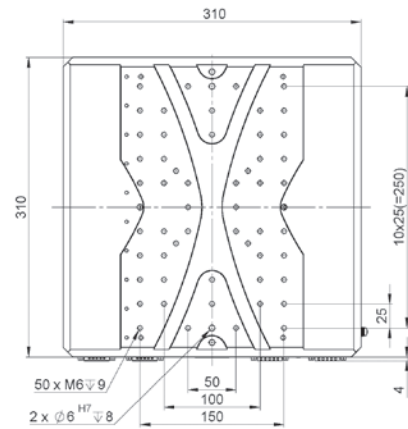
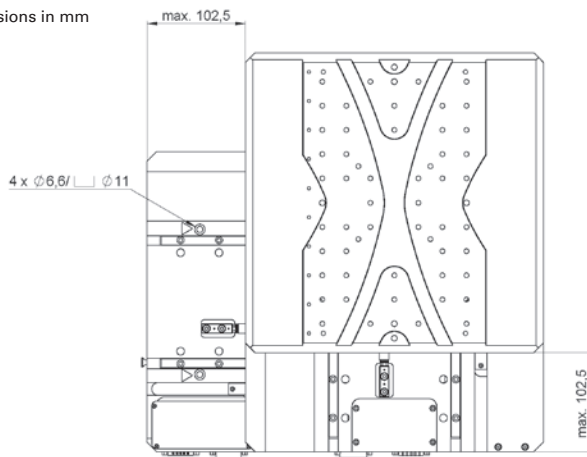
High Travel Accuracy and Stability, Magnetic Direct Drive



- Travel range 205 mm x 205 mm (8")
- Unidirectional repeatability to 0.1 μm
- Ironless 3-phase linear motor
- Velocity to 200 mm/s
- Incremental linear encoder with 1 nm resolution
- Crossed roller guides, anti-creep



V-731, dimensions in mm



## Applications

- Automated Optical Inspection (AOI)
- Biotechnology
- Laser Cutting
- Laser Marking
- Medical Industry
- Metrology / Testing
- Scanning

	V-731.096111	Unit	Tolerance
<b>Motion and positioning</b>			
Active axes	X, Y		
Travel range	205 × 205	mm	
Integrated sensor	Incremental linear encoder		
Design resolution	0.001	µm	
Sensor signal	Sin/cos, 1 V peak-peak, 20 µm signal period		
Minimum incremental motion	0.02	µm	typ.
Unidirectional repeatability	0.1	µm	typ.
Bidirectional repeatability	±0.25	µm	typ.
Angular error xry (pitch)	±50	µrad	typ.
Angular error xrz (yaw)	±30	µrad	typ.
Angular error yrx (pitch)	±40	µrad	typ.
Angular error yrz (yaw)	±30	µrad	typ.
Orthogonality	±96.963	µrad	typ.
Straightness / flatness	±2	µm	typ.
Velocity	200	mm/s	max.
Acceleration in X, without load	5	m/s <sup>2</sup>	max.
Acceleration in Y, without load	15	m/s <sup>2</sup>	max.
Reference and limit switches	Optical		
<b>Mechanical properties</b>			
Load capacity	50	N	max.
Permissible torque in $\theta_x, \theta_y$	125	N·m	max.
Permissible torque in $\theta_z$	125	N·m	max.
Guide	Crossed roller guide with anti-creep system		
<b>Drive properties</b>			
Motor type	Ironless 3-phase linear motor		
Operating voltage, nominal	48	V	nom.
Operating voltage, max.	48	V	max.
Peak force	80	N	max.
Nominal force	29	N	typ.
Peak current, effective	5	A	typ.
Nominal current, effective	1.5	A	typ.
Force constant, effective	19.9	N/A	typ.
Motor constant	4.89	N/√W	typ.
Electrical time constant	0.4	ms	
Resistance phase-phase	11	Ω	typ.
Inductance phase-phase	3.6	mH	typ.
Back EMF phase-phase	16	V·s/m	max.
Pole pitch N-N	30	mm	
<b>Miscellaneous</b>			
Operating temperature range	5 to 40	°C	
Material	Aluminum, black anodized		
Moved mass in X	15.4	kg	±5 %
Moved mass in Y	5.6	kg	±5 %
Overall mass	19.4	kg	±5 %
MTBF	20000	h	
Connection	2 × HD Sub-D 26 (m) (motor) 2 × Sub-D 15 (f) (sensor)		
Recommended controller	SMC Hydra (double axis) C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller		

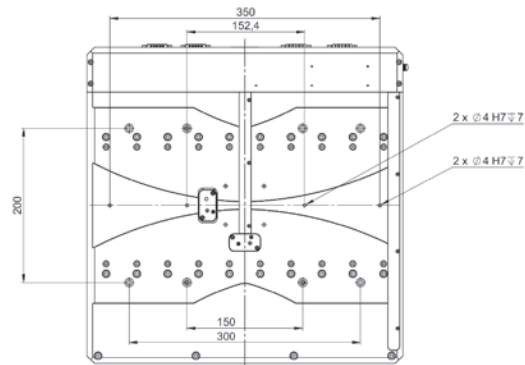
All cables required for operation with the ordered controller are included in the scope of delivery.  
The cable length is 3 m. Cable for connecting to other controllers can be ordered as accessory.  
Ask about custom designs!

# V-741 12" Linear Motor High-Precision XY Stage

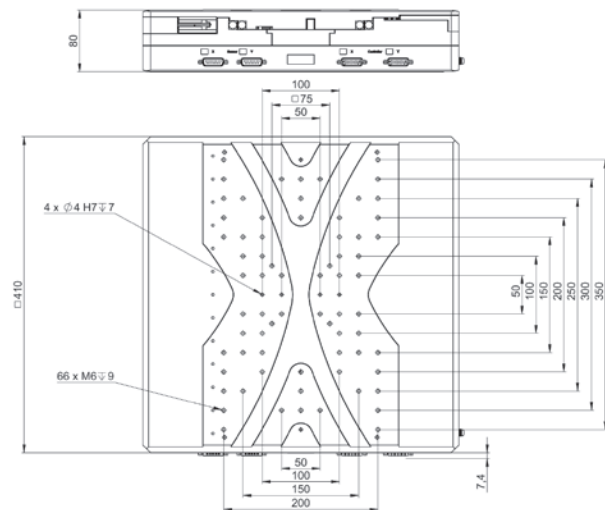
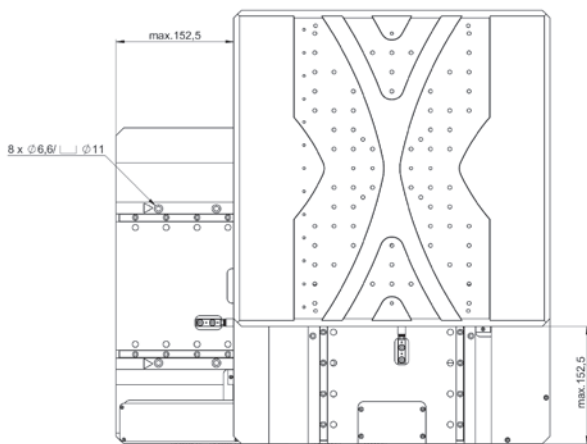
High Travel Accuracy and Stability, 305 mm x 305 mm Travel Range, Magnetic Direct Drive



- Travel range 305 mm x 305 mm (12")
- Unidirectional repeatability to 0.1 μm
- Ironless 3-phase linear motor
- Velocity to 200 mm/s
- Incremental linear encoder with 1 nm resolution
- Crossed roller guides, anti-creep



V-741, dimensions in mm



## Applications

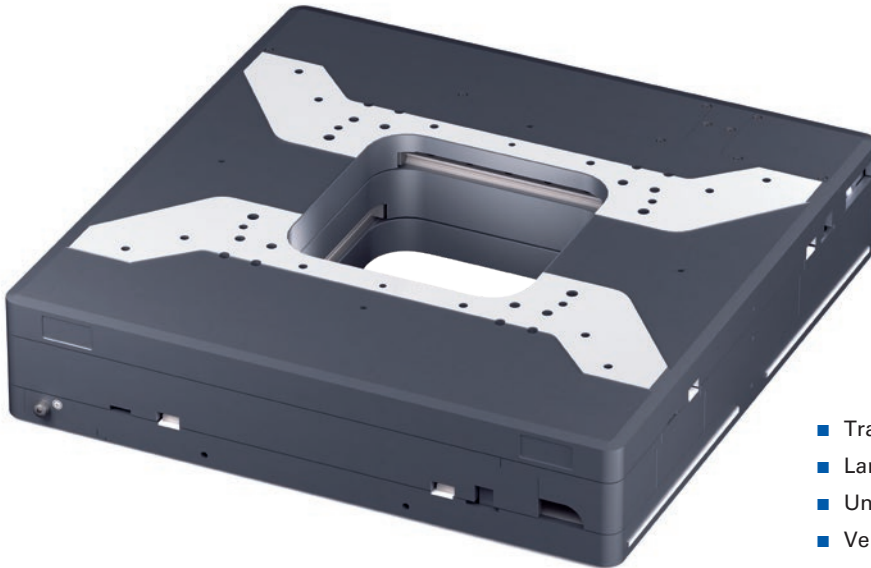
- Automated Optical Inspection (AOI)
- Biotechnology
- Laser Cutting
- Laser Marking
- Medical Industry
- Metrology / Testing
- Scanning

	V-741.136111	Unit	Tolerance
<b>Motion and positioning</b>			
Active axes	X, Y		
Travel range	305 × 305	mm	
Integrated sensor	Incremental linear encoder		
Design resolution	0.001	µm	
Sensor signal	Sin/cos, 1 V peak-peak, 20 µm signal period		
Minimum incremental motion	0.02	µm	typ.
Unidirectional repeatability	0.1	µm	typ.
Bidirectional repeatability	±0.25	µm	typ.
Angular error xry (pitch)	±70	µrad	typ.
Angular error xrz (yaw)	±50	µrad	typ.
Angular error yrx (pitch)	±60	µrad	typ.
Angular error yrz (yaw)	±50	µrad	typ.
Orthogonality	±96.963	µrad	typ.
Straightness / flatness	±3	µm	typ.
Velocity	200	mm/s	max.
Acceleration in X, without load	3	m/s <sup>2</sup>	max.
Acceleration in Y, without load	9	m/s <sup>2</sup>	max.
Reference and limit switches	Optical		
<b>Mechanical properties</b>			
Load capacity	50	N	max.
Permissible torque in $\theta_x, \theta_y$	125	N·m	max.
Permissible torque in $\theta_z$	125	N·m	max.
Guide	Crossed roller guide with anti-creep system		
<b>Drive properties</b>			
Motor type	Ironless 3-phase linear motor		
Operating voltage, nominal	48	V	nom.
Operating voltage, max.	48	V	max.
Peak force	80	N	max.
Nominal force	29	N	typ.
Peak current, effective	5	A	typ.
Nominal current, effective	1.5	A	typ.
Force constant, effective	19.9	N/A	typ.
Motor constant	4.89	N/√W	typ.
Electrical time constant	0.4	ms	
Resistance phase-phase	11	Ω	typ.
Inductance phase-phase	3.6	mH	typ.
Back EMF phase-phase	16	V·s/m	max.
Pole pitch N-N	30	mm	
<b>Miscellaneous</b>			
Operating temperature range	5 to 40	°C	
Material	Aluminum, black anodized		
Moved mass in X	25.5	kg	±5 %
Moved mass in Y	9.2	kg	±5 %
Overall mass	33	kg	±5 %
MTBF	20000	h	
Connection	2 × HD Sub-D 26 (m) (motor) 2 × Sub-D 15 (f) (sensor)		
Recommended controller	SMC Hydra (double axis) C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller		

All cables required for operation with the ordered controller are included in the scope of delivery.  
The cable length is 3 m. Cable for connecting to other controllers can be ordered as accessory.  
Ask about custom designs!

# L-738 4" Ball Screw-Driven Precision XY Stage

Clear Aperture, High Travel Accuracy, and Stability



- Travel range 102 mm × 102 mm (4")
- Large aperture, 150 mm × 150 mm
- Unidirectional repeatability to 0.05 μm
- Velocity to 90 mm/s
- 2-phase stepper motors, DC motors
- Incremental linear encoder with 1 nm resolution

## Highly accurate position measuring with incremental linear encoder

Noncontact optical linear encoders 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. Optical reference points and limit switches.

## Recirculating ball bearings

When carefully assembled, recirculating ball bearings are distinguished by a beneficial combination of high load capacity, lifetime, maintenance-free operation, and guiding accuracy. The moving part of the stages is supported by four preloaded linear ball bearing units which run on two guide rails. Each bearing unit is made up of two independent rows of circulating ball bearings.

## Drive types

- 2-phase stepper motor for high torque even at low velocities and higher resolution
- DC motor for high velocity constancy, low vibration, and high velocities

## Applications

- Biotechnology
- Laser Cutting
- Laser Marking
- Medical Industry
- Metrology / Testing

Stages with DC motor	L-738.053111 / L-738.053112 / L-738.053132	Unit	Tolerance
<b>Motion</b>			
Active axes	X, Y		
Travel range	102 × 102	mm	
Angular error xry (pitch)	±40	μrad	typ.
Angular error xrz (yaw)	±20	μrad	typ.
Angular error yrx (pitch)	±40	μrad	typ.
Angular error yrz (yaw)	±20	μrad	typ.
Straightness / flatness	±2	μm	typ.
Orthogonality	±96.963	μrad	typ.
Velocity	L-738.053111 / L-738.053112: 50 L-738.053132: 90	mm/s	max.

Stages with DC motor	L-738.053111	L-738.053112	L-738.053132	Unit	Tolerance
<b>Positioning</b>					
Integrated sensor	Incremental linear encoder	Incremental linear encoder	Incremental rotary encoder		
Sensor signal	Sin/cos, 1 V peak-peak, 20 μm signal period	A/B quadrature, TTL	A/B quadrature, TTL		
Design resolution	0.001	0.01	0.1	μm	
Sensor resolution rotary encoder	–	–	20000	Cts./rev.	
Minimum incremental motion	0.1	0.1	0.4	μm	typ.
Unidirectional repeatability	0.1	0.1	0.4	μm	typ.
Bidirectional repeatability	±0.5	±0.5	±2	μm	typ.
Reference point switch repeatability	<1	<1	<1	μm	typ.
Reference and limit switches	Optical	Optical	Optical		

Stages with DC motor	L-738.053xxx	Unit	Tolerance
<b>Mechanical properties</b>			
Drive screw type	Ball screw		
Drive screw pitch	2	mm	
Guide type	Recirculating ball bearing		
Holding force, power off	20	N	typ.
Push/pull force $F_x$ , $F_y$ power on	100	N	max.
Load capacity	200	N	max.
Permissible torque $M_x$ in $\theta_x$	130	N·m	max.
Permissible torque $M_y$ in $\theta_y$	130	N·m	max.
Permissible torque $M_z$ in $\theta_z$	90	N·m	max.
<b>Drive properties</b>			
Motor type	DC motor		
Operating voltage, nominal	24	V	nom.
Operating voltage, max.	48	V	max.

Stages with DC motor	L-738.053111	L-738.053112 / L-738.053132	Unit	Tolerance
<b>Miscellaneous</b>				
Operating temperature range	5 to 40	5 to 40	°C	
Material	Aluminum, black anodized	Aluminum, black anodized		
Mass	24	24	kg	±5 %
Moved mass in X, unloaded	14.6	14.6	kg	±5 %
Moved mass in Y, unloaded	5.8	5.8	kg	±5 %
Connection	2 × HD Sub-D 26 (m) (motor) 2 × Sub-D 15 (f) (sensor)	2 × HD Sub-D 26 (m) (motor/sensor)		
Recommended controllers / drivers	SMC Hydra (double axis) C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller		

Stages with stepper motor	L-738.051100 / L-738.051111 / L-738.051112	Unit	Tolerance
<b>Motion</b>			
Active axes	X, Y		
Travel range	102 × 102	mm	
Angular error xry (pitch)	±40	μrad	typ.
Angular error xrz (yaw)	±20	μrad	typ.
Angular error yrx (pitch)	±40	μrad	typ.
Angular error yrz (yaw)	±20	μrad	typ.
Straightness / flatness	±2	μm	typ.
Orthogonality	±96.963	μrad	typ.
Velocity	35	mm/s	max.

Stages with stepper motor	L-738.051100	L-738.051111	L-738.051112	Unit	Tolerance
<b>Positioning</b>					
Integrated sensor	–	Incremental linear encoder	Incremental linear encoder		
Sensor signal	–	Sin/cos, 1 V peak-peak, 20 μm signal period	A/B quadrature, TTL		
Design resolution	10.0	0.001	0.01	μm	
Minimum incremental motion	0.2	0.05	0.05	μm	typ.
Unidirectional repeatability	0.2	0.05	0.05	μm	typ.
Bidirectional repeatability	±2	±0.5	±0.5	μm	typ.
Reference point switch repeatability	<1	<1	<1	μm	typ.
Reference and limit switches	Optical	Optical	Optical		

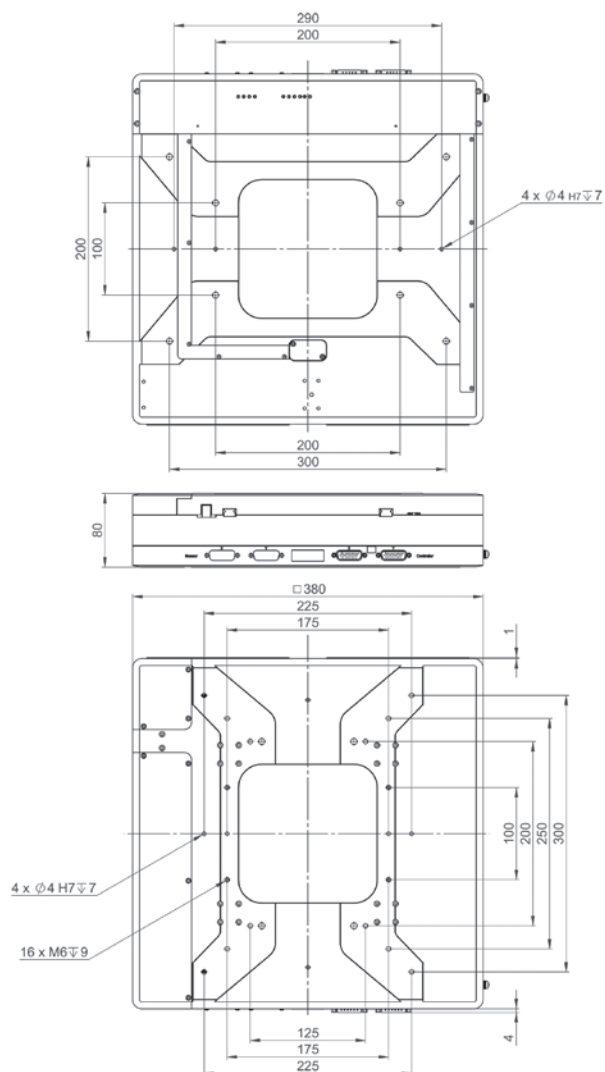
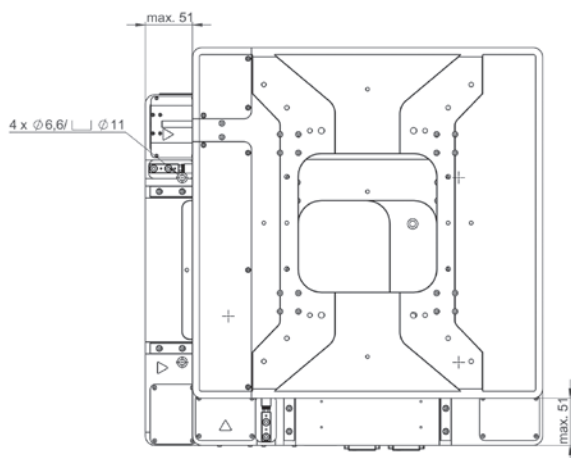
Stages with stepper motor	L-738.051xxx	Unit	Tolerance
<b>Mechanical properties</b>			
Drive screw type	Ball screw		
Drive screw pitch	2	mm	
Guide type	Recirculating ball bearing		
Holding force, power off	60	N	typ.
Push/pull force $F_x$ , $F_y$ power on	100	N	max.
Load capacity	200	N	max.
Permissible torque $M_x$ in $\theta_x$	130	N·m	max.
Permissible torque $M_y$ in $\theta_y$	130	N·m	max.
Permissible torque $M_z$ in $\theta_z$	90	N·m	max.
<b>Drive properties</b>			
Motor type	Stepper motor, 2-phase		
Operating voltage, nominal	24	V	nom.
Operating voltage, max.	48	V	max.
Step resolution	200	Full steps/ rev.	



Stages with stepper motor	L-738.051100	L-738.051111	L-738.051112	Unit	Tolerance
<b>Miscellaneous</b>					
Operating temperature range	5 to 40	5 to 40	5 to 40	°C	
Material	Aluminum, black anodized	Aluminum, black anodized	Aluminum, black anodized		
Mass	22	22	22	kg	±5 %
Moved mass in X, unloaded	13.8	13.8	13.8	kg	±5 %
Moved mass in Y, unloaded	5.8	5.8	5.8	kg	±5 %
Connection	2 × HD Sub-D 26 (m) (motor)	2 × HD Sub-D 26 (m) (motor) 2 × Sub-D 15 (f) (sensor)	2 × HD Sub-D 26 (m) (motor/sensor)		
Recommended controllers / drivers	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller	SMC Hydra (double axis) ACS modular controller	C-663.12 (single axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller		

All cables required for operation with the ordered controller are included in the scope of delivery. The cable length is 3 m. Cable for connecting to other controllers can be ordered as accessory. Ask about custom designs!

L-738, dimensions in mm



# L-731 8" Ball Screw-Driven Precision XY Stage

## High Travel Accuracy and Stability



- Travel range 205 mm × 205 mm (8")
- Unidirectional repeatability to 0.05  $\mu\text{m}$
- Velocity to 90 mm/s
- 2-phase stepper motor or DC motors
- Incremental encoder with 1 nm resolution
- Rotary encoder with 20000 impulses/revolution
- Crossed roller guide, anti-creep

### Highly accurate position measuring with incremental linear encoder

Noncontact optical linear encoders 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. Optical limit and reference point switches.

### Crossed roller guide

With crossed roller guides, the point contact of the balls in ball guides is replaced by line contact of the hardened rollers. Consequently, they are considerably stiffer and need less preload, which reduces friction and allows smoother running. Crossed roller guides are also distinguished by high guiding accuracy and load capacity. Force-guided rolling element cages prevent cage creep.

### Drive types

- 2-phase stepper motor for high torque even at low velocities and higher resolution
- DC motor for high velocity constancy, low vibration, and high velocities

Other travel ranges on request.



### Applications

- Biotechnology
- Laser Cutting
- Laser Marking
- Medical Industry
- Metrology / Testing

Stages with DC motor	L-731.093111 / L-731.093112 / L-731.093132	Unit	Tolerance
<b>Motion</b>			
Active axes	X, Y		
Travel range	205 × 205	mm	
Angular error xry (pitch)	±50	μrad	typ.
Angular error xrz (yaw)	±30	μrad	typ.
Angular error yrx (pitch)	±40	μrad	typ.
Angular error yrz (yaw)	±30	μrad	typ.
Straightness / flatness	±2	μm	typ.
Orthogonality	±96.963	μrad	typ.
Velocity	L-731.093111 / L-731.093112: 50 L-731.093132: 90	mm/s	max.

Stages with DC motor	L-731.093111	L-731.093112	L-731.093132	Unit	Tolerance
<b>Positioning</b>					
Integrated sensor	Incremental linear encoder	Incremental linear encoder	Incremental rotary encoder		
Sensor signal	Sin/cos, 1 V peak-peak, 20 μm signal period	A/B quadrature, TTL	A/B quadrature, TTL		
Design resolution	0.001	0.01	0.1	μm	
Sensor resolution rotary encoder	–	–	20000	Cts./rev.	
Minimum incremental motion	0.1	0.5	0.8	μm	typ.
Unidirectional repeatability	0.1	0.5	0.8	μm	typ.
Bidirectional repeatability	±0.5	±0.5	±2.5	μm	typ.
Reference point switch repeatability	<1	<1	<1	μm	typ.
Reference and limit switches	Optical	Optical	Optical		

Stages with DC motor	L-731.093xxx	Unit	Tolerance
<b>Mechanical properties</b>			
Drive screw type	Ball screw		
Drive screw pitch	2	mm	
Guide type	Crossed roller guide with anti-creep system		
Load capacity	200	N	max.
Permissible torque $M_x$ in $\theta_x$	125	N·m	max.
Permissible torque $M_y$ in $\theta_y$	125	N·m	max.
Permissible torque $M_z$ in $\theta_z$	125	N·m	max.
<b>Drive properties</b>			
Motor type	DC motor		
Operating voltage, nominal	24	V	nom.
Operating voltage, max.	48	V	max.

Stages with DC motor	L-731.093111	L-731.093112 / L-731.093132	Unit	Tolerance
<b>Miscellaneous</b>				
Operating temperature range	5 to 40	5 to 40	°C	
Material	Aluminum, black anodized	Aluminum, black anodized		
Mass	16	16	kg	±5 %
Moved mass in X, unloaded	12	12	kg	±5 %
Moved mass in Y, unloaded	3.5	3.5	kg	±5 %
Connection	2 × HD Sub-D 26 (m) (motor) 2 × Sub-D 15 (f) (sensor)	2 × HD Sub-D 26 (m) (motor/sensor)		
Recommended controllers / drivers	SMC Hydra (double axis) C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller		

Stages with stepper motor	L-731.40SD / L-731.44SD / L-731.4ASD	Unit	Tolerance
<b>Motion</b>			
Active axes	X, Y		
Travel range	205 × 205	mm	
Angular error xry (pitch)	±50	μrad	typ.
Angular error xrz (yaw)	±30	μrad	typ.
Angular error yrx (pitch)	±40	μrad	typ.
Angular error yrz (yaw)	±30	μrad	typ.
Straightness / flatness	±2	μm	typ.
Orthogonality	±96.963	μrad	typ.
Velocity	45	mm/s	max.

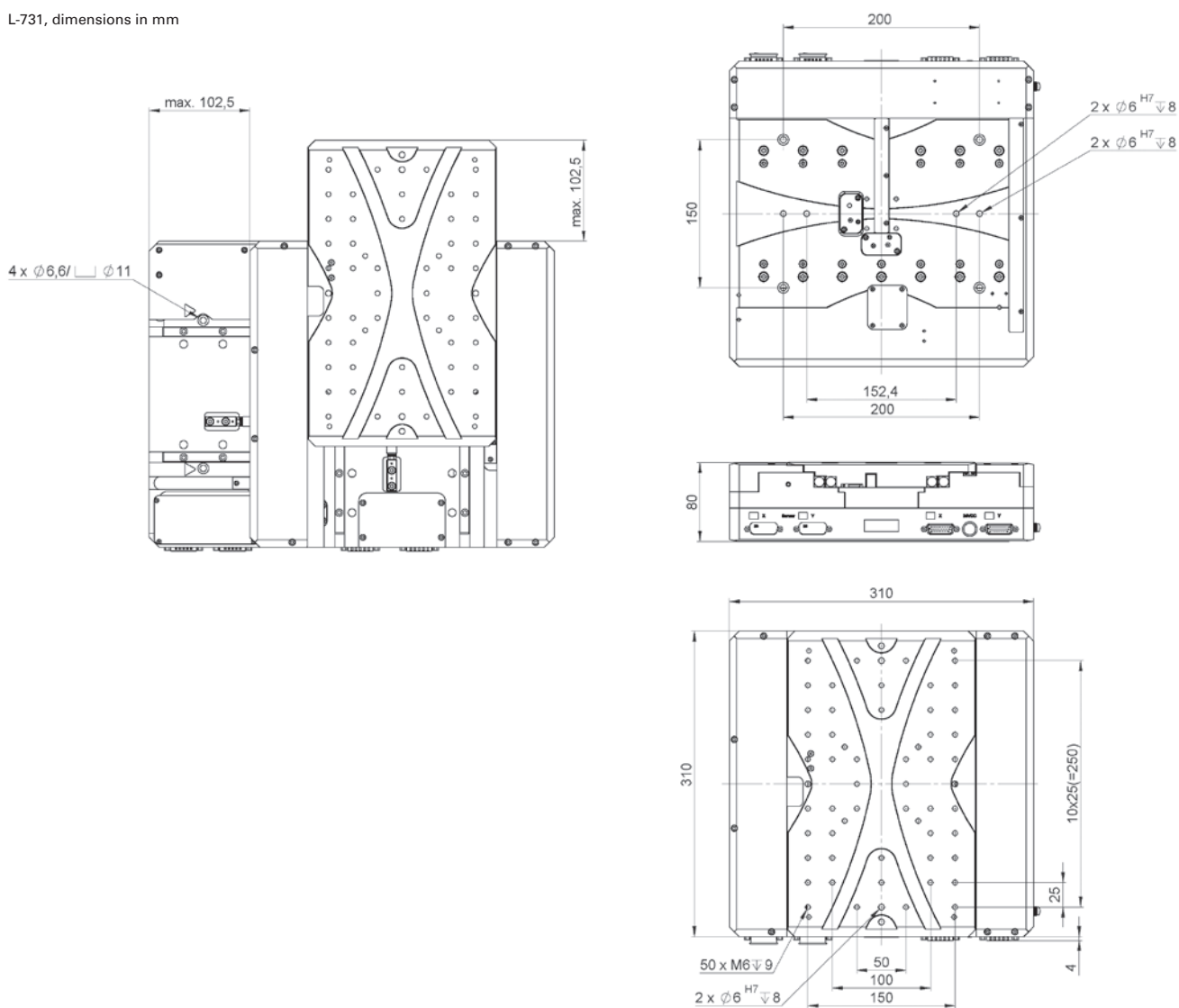
Stages with stepper motor	L-731.40SD	L-731.44SD	L-731.4ASD	Unit	Tolerance
<b>Positioning</b>					
Integrated sensor	–	Incremental linear encoder	Incremental linear encoder		
Sensor signal	–	A/B quadrature, TTL	Sin/cos, 1 V peak-peak, 20 μm signal period		
Design resolution	10.0	0.01	0.001	μm	
Minimum incremental motion	1	0.05	0.05	μm	typ.
Unidirectional repeatability	1	0.05	0.05	μm	typ.
Bidirectional repeatability	±2.5	±0.5	±0.5	μm	typ.
Reference and limit switches	Optical	Optical	Optical		

Stages with stepper motor	L-731.4xSD	Unit	Tolerance
<b>Mechanical properties</b>			
Drive screw type	Ball screw		
Drive screw pitch	2	mm	
Guide type	Crossed roller guide with anti-creep system		
Load capacity	200	N	max.
Permissible torque $M_x$ in $\theta_x$	125	N·m	max.
Permissible torque $M_y$ in $\theta_y$	125	N·m	max.
Permissible torque $M_z$ in $\theta_z$	125	N·m	max.
<b>Drive properties</b>			
Motor type	Stepper motor, 2-phase		
Operating voltage, nominal	24	V	nom.
Operating voltage, max.	48	V	max.
Stepper motor	200	Full steps/ rev.	

Stages with stepper motor	L-731.40SD / L-731.44SD	L-731.4ASD	Unit	Tolerance
<b>Miscellaneous</b>				
Operating temperature range	5 to 40	5 to 40	°C	
Material	Aluminum, black anodized	Aluminum, black anodized		
Mass	15.5	15.5	kg	±5 %
Moved mass in X, unloaded	12	12	kg	±5 %
Moved mass in Y, unloaded	3.5	3.5	kg	±5 %
Connection	L-731.40SD: 2 × HD Sub-D 26 (m) (motor) L-731.44SD: 2 × HD Sub-D 26 (m) (motor/sensor)	2 × HD Sub-D 26 (m) (motor) 2 × Sub-D 15 (f) (sensor)		
Recommended controllers / drivers	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller	SMC Hydra (double axis) ACS modular controller		

All cables required for operation with the ordered controller are included in the scope of delivery. The cable length is 3 m. Cable for connecting to other controllers can be ordered as accessory. Ask about custom designs!

L-731, dimensions in mm



# L-741 12" Ball Screw-Driven Precision XY Stage

High Travel Accuracy and Stability, 305 x 305 mm Travel Range



- Travel range 305 mm x 305 mm (12")
- Unidirectional repeatability to 0.05 µm
- Velocity to 90 mm/s
- 2-phase stepper motors or DC motors
- Incremental linear encoder with 1 nm resolution
- Rotary encoder with 20000 impulses/revolution
- Crossed roller guide, anti-creep

## Highly accurate position measuring with incremental linear encoder

Noncontact optical linear encoders 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. Optical limit and reference point switches.

## Crossed roller guide

With crossed roller guides, the point contact of the balls in ball guides is replaced by line contact of the hardened rollers. Consequently, they are considerably stiffer and need less preload, which reduces friction and allows smoother running. Crossed roller guides are also distinguished by high guiding accuracy and load capacity. Force-guided rolling element cages prevent cage creep.

## Drive types

- 2-phase stepper motor for high torque even at low velocities and higher resolution
- DC motor for high velocity constancy, low vibration, and high velocities

Other travel ranges on request.



## Applications

- Biotechnology
- Laser Cutting
- Laser Marking
- Medical Industry
- Metrology / Testing

Stages with DC motor	L-741.133111 / L-741.133112 / L-741.133132	Unit	Tolerance
<b>Motion</b>			
Active axes	X, Y		
Travel range	305 × 305	mm	
Angular error xry (pitch)	±60	μrad	typ.
Angular error xrz (yaw)	±40	μrad	typ.
Angular error yrx (pitch)	±60	μrad	typ.
Angular error yrz (yaw)	±40	μrad	typ.
Straightness / flatness	±4	μm	typ.
Orthogonality	±96.963	μrad	typ.
Velocity	L-741.133111 / L-741.133112: 50 L-741.133132: 90	mm/s	max.

Stages with DC motor	L-741.133111	L-741.133112	L-741.133132	Unit	Tolerance
<b>Positioning</b>					
Integrated sensor	Incremental linear encoder	Incremental linear encoder	Incremental rotary encoder		
Sensor signal	Sin/cos, 1 V peak-peak, 20 μm signal period	A/B quadrature, TTL	A/B quadrature, TTL		
Design resolution	0.001	0.01	0.1	μm	
Sensor resolution rotary encoder	–	–	20000	Cts./rev.	
Minimum incremental motion	0.1	0.5	0.8	μm	typ.
Unidirectional repeatability	0.1	0.5	0.8	μm	typ.
Bidirectional repeatability	±0.5	±0.5	±2.5	μm	typ.
Reference point switch repeatability	<1	<1	<1	μm	typ.
Reference and limit switches	Optical	Optical	Optical		

Stages with DC motor	L-741.133xxx	Unit	Tolerance
<b>Mechanical properties</b>			
Drive screw type	Ball screw		
Drive screw pitch	2	mm	
Guide type	Crossed roller guide with anti-creep system		
Load capacity	200	N	max.
Permissible torque $M_x$ in $\theta_x$	125	N·m	max.
Permissible torque $M_y$ in $\theta_y$	125	N·m	max.
Permissible torque $M_z$ in $\theta_z$	125	N·m	max.
<b>Drive properties</b>			
Motor type	DC motor		
Operating voltage, nominal	24	V	nom.
Operating voltage, max.	48	V	max.

Stages with DC motor	L-741.133111	L-741.133112 / L-741.133132	Unit	Tolerance
<b>Miscellaneous</b>				
Operating temperature range	5 to 40	5 to 40	°C	
Material	Aluminum, black anodized	Aluminum, black anodized		
Mass	28	28	kg	±5 %
Moved mass in X, unloaded	20.2	20.2	kg	±5 %
Moved mass in Y, unloaded	6.1	6.1	kg	±5 %
Connection	2 × HD Sub-D 26 (m) (motor) 2 × Sub-D 15 (f) (sensor)	2 × HD Sub-D 26 (m) (motor/sensor)		
Recommended controllers / drivers	SMC Hydra (double axis) C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller		

Stages with stepper motor	L-741.131100 / L-741.131111 / L-741.131112	Unit	Tolerance
<b>Motion</b>			
Active axes	X,Y		
Travel range	305 × 305	mm	
Angular error xry (pitch)	±60	μrad	typ.
Angular error xrz (yaw)	±40	μrad	typ.
Angular error yrx (pitch)	±60	μrad	typ.
Angular error yrz (yaw)	±40	μrad	typ.
Straightness / flatness	±4	μm	typ.
Orthogonality	±96.963	μrad	typ.
Velocity	45	mm/s	max.

Stages with stepper motor	L-741.131100	L-741.131111	L-741.131112	Unit	Tolerance
<b>Positioning</b>					
Integrated sensor	–	Incremental linear encoder	Incremental linear encoder		
Sensor signal	–	Sin/cos, 1 V peak-peak, 20 μm signal period	A/B quadrature, TTL		
Design resolution	10.0	0.001	0.01	μm	
Sensor resolution rotary encoder	–	–	–	Cts./rev.	
Sensor resolution linear encoder	–	0.001	0.01	μm	
Minimum incremental motion	1	0.05	0.05	μm	typ.
Unidirectional repeatability	1	0.05	0.05	μm	typ.
Bidirectional repeatability	±2.5	±0.5	±0.5	μm	typ.
Reference point switch repeatability	<1	<1	<1	μm	typ.
Reference and limit switches	Optical	Optical	Optical		

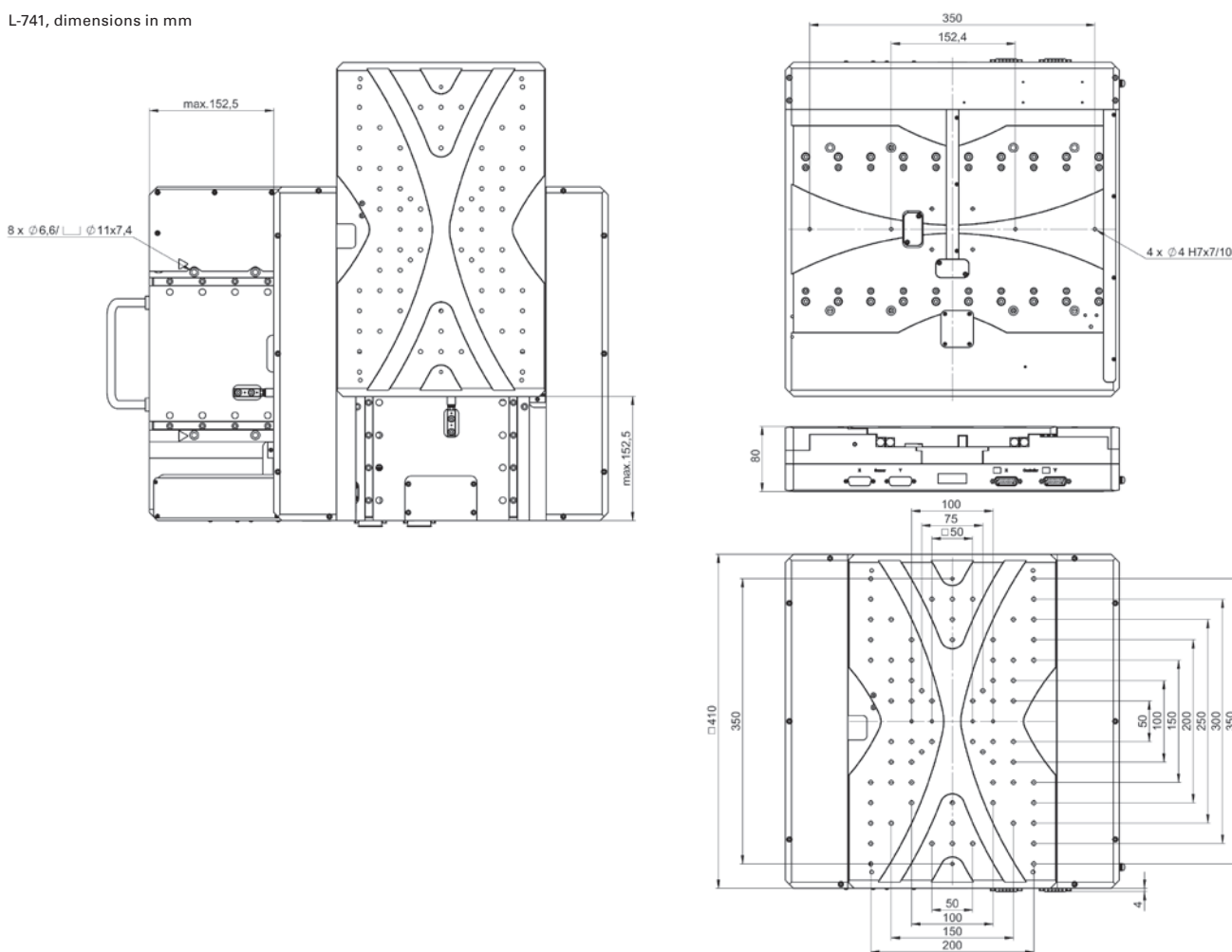
Stages with stepper motor	L-741.131xxx	Unit	Tolerance
<b>Mechanical properties</b>			
Drive screw type	Ball screw		
Drive screw pitch	2	mm	
Guide type	Crossed roller guide with anti-creep system		
Load capacity	200	N	max.
Permissible torque $M_x$ in $\theta_x$	125	N·m	max.
Permissible torque $M_y$ in $\theta_y$	125	N·m	max.
Permissible torque $M_z$ in $\theta_z$	125	N·m	max.
<b>Drive properties</b>			
Motor type	Stepper motor, 2-phase		
Operating voltage, nominal	24	V	nom.
Operating voltage, max.	48	V	max.
Step resolution	200	Full steps/rev.	



Stages with stepper motor	L-741.131100 / L-741.131112	L-741.131111	Unit	Tolerance
<b>Miscellaneous</b>				
Operating temperature range	5 to 40	5 to 40	°C	
Material	Aluminum, black anodized	Aluminum, black anodized		
Mass	27.5	27.5	kg	±5 %
Moved mass in X, unloaded	19.9	19.9	kg	±5 %
Moved mass in Y, unloaded	6.1	6.1	kg	±5 %
Connection	L-741.131100. 2 × HD Sub-D 26 (m) (motor) L-741.131112. 2 × HD Sub-D 26 (m) (motor/sensor)	2 × HD Sub-D 26 (m) (motor) 2 × Sub-D 15 (f) (sensor)		
Recommended controllers / drivers	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller	SMC Hydra (double axis) ACS modular controller		

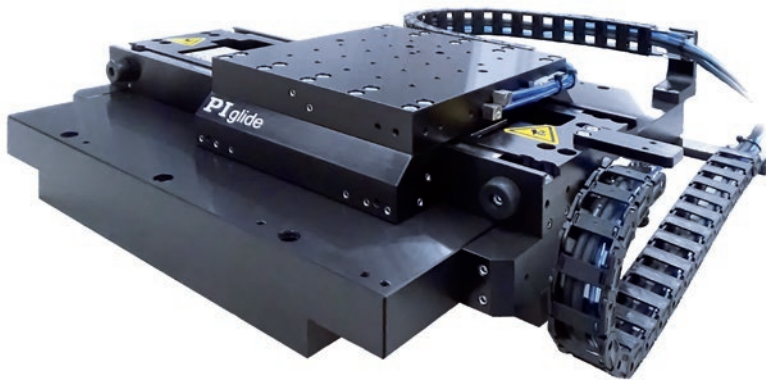
All cables required for operation with the ordered controller are included in the scope of delivery. The cable length is 3 m. Cable for connecting to other controllers can be ordered as accessory. Ask about custom designs!

L-741, dimensions in mm



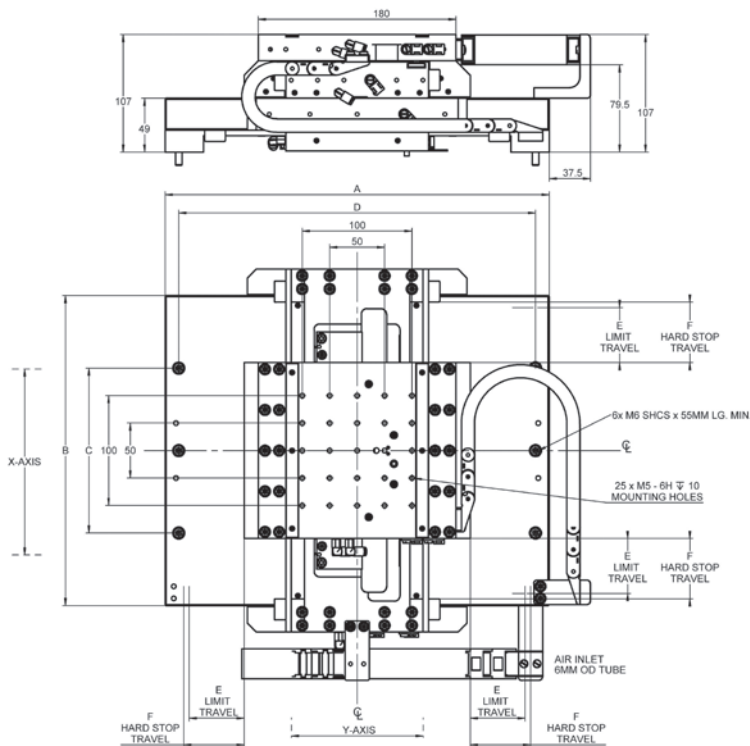
# A-311 PIglide IS Planar Scanner with Air Bearing

## High-Performance, Compact XY Nanopositioning System

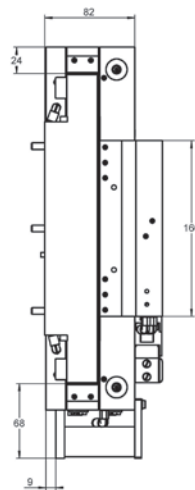


- Ideal for scanning applications or high-precision positioning
- Cleanroom compatible
- Travel ranges to 200 mm x 200 mm
- Load capacity to 147 N
- Low profile
- Resolution to 1 nm
- Optional granite base plates

A-311.xxx, dimensions in mm



	A	B	C	D	E	F
A-311.Dxx	300	232	100	275	25	30
A-311.Axx	350	282	150	325	50	55
A-311.Bxx	400	332	200	375	75	80
A-311.Cxx	450	382	250	425	100	105



### Applications

- Electronics Manufacturing
- Laser Marking
- Scanning
- Scientific Instrumentation
- Semiconductor

	A-311.Dxx	A-311.Axx	A-311.Bxx	A-311.Cxx	Unit	Tolerance
<b>Motion</b>						
Travel range	50 × 50	100 × 100	150 × 150	200 × 200	mm	
Pitch <sup>(1)</sup>	20	30	40	50	µrad	max.
Yaw <sup>(1)</sup>	5	10	15	20	µrad	max.
Straightness <sup>(1)</sup>	±0.25	±0.25	±0.5	±0.5	µm	max.
Straightness per 10 mm travel range <sup>(1)</sup>	±10	±10	±10	±10	nm	max.
Flatness <sup>(1)</sup>	±0.5	±0.5	±1	±1	µm	max.
Flatness per 10 mm travel range <sup>(1)</sup>	±10	±10	±10	±10	nm	max.
XY orthogonality	25	25	25	25	µrad	max.
Velocity, unloaded <sup>(2)</sup>	2	2	2	2	m/s	max.
Acceleration of the upper axis, unloaded <sup>(2)</sup>	27.5	27.5	27.5	27.5	m/s <sup>2</sup>	max.
Acceleration of the lower axis, unloaded <sup>(2)</sup>	15	13	11	10	m/s <sup>2</sup>	max.
<b>Mechanical properties</b>						
Load capacity in z <sup>(3)</sup>	147	147	147	147	N	max.
Moved mass, upper axis	3	3	3	3	kg	
Moved mass, lower axis	5.5	6.5	7.5	8.5	kg	
Overall mass	14.5	18.5	22.5	27.5	kg	

	A-311.xAx	A-311.xBx	A-311.xCx
<b>Positioning</b>			
Integrated sensor	Incremental linear encoder	Absolute encoder	Incremental linear encoder
Sensor signal	Sin/cos, 1 V peak-peak, 20 µm signal period	BiSS-C	A/B quadrature, TTL
Sensor resolution	1.2 nm <sup>(4)</sup>	1 nm	50 nm
Bidirectional repeatability	±0.05 µm <sup>(4)</sup>	±0.05 µm	±0.05 µm
Accuracy, uncompensated <sup>(5)</sup>	A-311.Dxx: ±1 µm A-311.Axx: ±1.5 µm A-311.Bxx: ±2 µm A-311.Cxx: ±2.5 µm	A-311.Axx: ±1.5 µm A-311.Axx: ±1.5 µm A-311.Axx: ±1.5 µm A-311.Axx: ±1.5 µm	A-311.Dxx: ±1 µm A-311.Axx: ±1.5 µm A-311.Bxx: ±2 µm A-311.Cxx: ±2.5 µm
Accuracy, with error compensation <sup>(5)</sup>	±0.5 µm	±0.5 µm	±0.5 µm

	A-311	Unit	Tolerance
<b>Drive properties</b>			
Drive type	Linear motor, ironless, 3-phase		
Intermediate circuit voltage, effective	48, nominal 80, max.	V DC	
Peak force	85	N	typ.
Nominal force	39	N	typ.
Force constant, effective	12.3	N/A	typ.
Resistance phase-phase	3.6	Ω	
Inductivity phase-phase	1.24	mH	
Back EMF phase-phase	10.1	V-s/m	max.
Cabling	External, movable drag chain		
<b>Miscellaneous</b>			
Operating pressure <sup>(6)</sup>	60 to 70 psi (415 to 485 kPa)		
Air consumption	<2 SCFM (56 SLPM)		
Air quality	see A-322 datasheet, next page		
Materials	Hardcoat aluminum, stainless steel fasteners		

(1) Dependent on the flatness of the surface, on which the stage is mounted.

(2) Can be limited by the payload, controller or drive.

(3) Assumes payload CG is centered no more than 50 mm above the motion platform. The stage is designed for horizontal operation only.

(4) Assumes 16384x interpolation. Contact PI for the use of other factors.

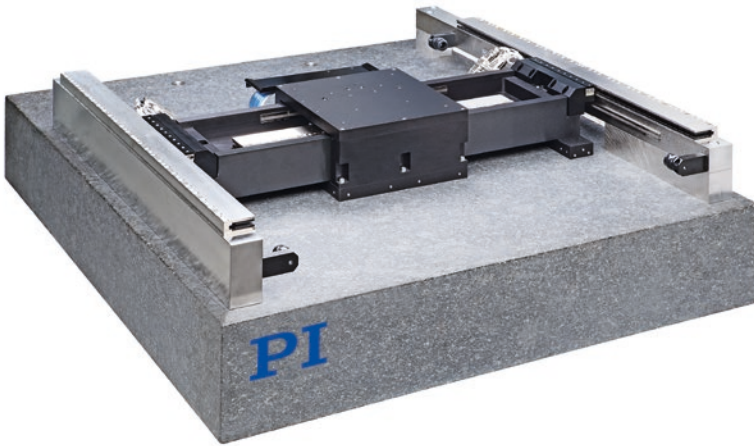
(5) Improved accuracy can be obtained with controller-based error compensation. The stage must be ordered with a controller from PI to reach these values. Accuracy values assume short-term duration and do not consider the long-term effects of thermal drift on the stage.

(6) To protect the stage against damage, it is recommended to connect an air pressure sensor to the Motion-Stop input of the controller.

All specifications apply per axis, if not otherwise described.

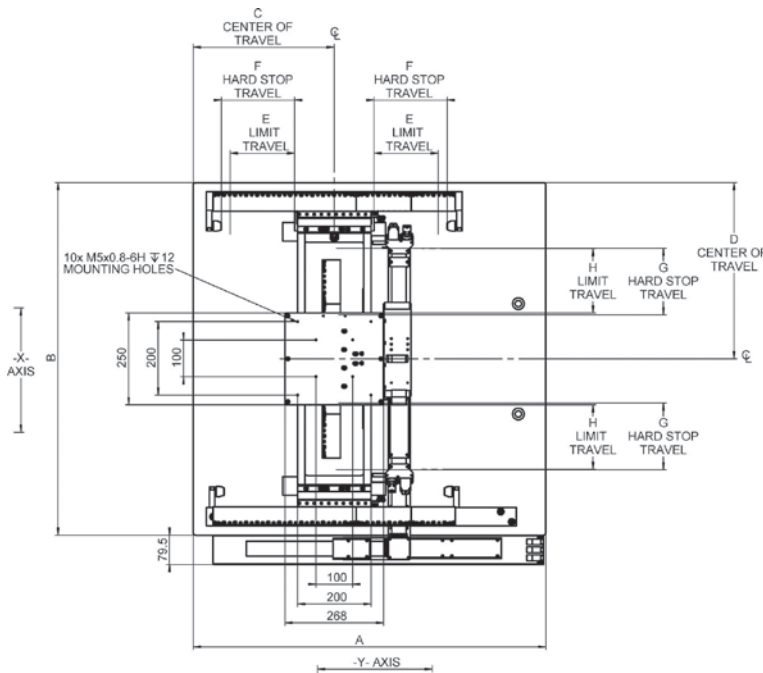
# A-322 Pliglide HS Planar Scanner with Air Bearing

## XY Positioning System with 1 nm Resolution

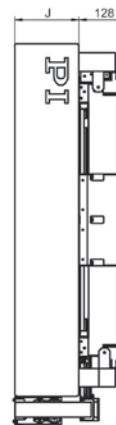


- Ideal for scanning applications or high-precision positioning
- Cleanroom compatible
- Travel ranges to 500 mm × 1000 mm
- Load capacity to 245 N
- Resolution to 1 nm
- Velocity up to 2 m/s

A-322.xxx, dimensions in mm



	A	B	C	D	E	F	G	H	J
A-322.Axx	960	960	348	480	175	200	182	175	175
A-322.Bxx	1110	960	459	480	250	275	182	175	175
A-322.Cxx	1110	1110	459	555	250	275	257	250	250
A-322.Dxx	1610	1110	709	555	500	525	257	250	250



### Applications

- Electronics Manufacturing
- Laser Cutting
- Scanning
- Scientific Instrumentation
- Semiconductor

	A-322.Axx	A-322.Bxx	A-322.Cxx	A-322.Dxx	Unit	Tolerance
<b>Motion and positioning</b>						
Active axes	X, Y	X, Y	X, Y	X, Y		
Travel range (bridge axis × gantry axis)	350 × 350	350 × 500	500 × 500	500 × 1000	mm	
Integrated sensors	Absolute Encoders	Absolute Encoders	Absolute Encoders	Absolute Encoders		
Sensor resolution	1	1	1	1	nm	
Bidirectional repeatability	±0.08	±0.08	±0.08	±0.08	µm	max.
Accuracy*	±0.5	±0.5	±0.5	±0.5	µm	max.
Pitch	15	20	30	40	µrad	max.
Yaw*	5	5	7	7	µrad	max.
Straightness*	±0.5	±0.5	±1	±1	µm	max.
Straightness per 10 mm travel range*	±10	±10	±10	±10	nm	max.
Flatness	±0.5	±1	±1.5	±2.5	µm	max.
Flatness per 10 mm travel range	±10	±10	±10	±10	nm	max.
XY orthogonality	25	25	25	25	µrad	max.
Velocity**	2	2	2	2	m/s	max.
Acceleration, bridge axis**	20	20	20	20	m/s <sup>2</sup>	max.
Acceleration, gantry axis**	15	15	12	12	m/s <sup>2</sup>	max.
<b>Mechanical properties</b>						
Load capacity in Z***	245	245	245	245	N	max.
Moved mass, bridge axis	14	14	14	14	kg	
Moved mass, gantry axis	40	40	43	43	kg	
Overall mass	610	700	1075	1525	kg	
Guide type	Air bearings	Air bearings	Air bearings	Air bearings		

<b>A-322</b>							
<b>Drive properties</b>							
Drive type	Linear motor, ironless, 3-phase, 1 × to bridge axis, 2 × to gantry axis						
Intermediate circuit voltage, effective	48, nominal 80, max.				VDC		
Peak force #	298				N	typ.	
Nominal force #	87				N	typ.	
Force constant, effective #	19.9				N/A	typ.	
Resistance phase-phase #	3.6				Ω		
Inductivity phase-phase #	1.2				mH		
Back EMF phase-phase #	16				V-s/m	max.	
Cabling	moved ribbon cable, cleanroom compatible						
<b>Motion and positioning</b>							
Operating pressure ##	80 psi (552 kPa)						
Air consumption with external vacuum supply	<2 SCFM (56 SLPM)						
Air consumption with internal vacuum supply	<3.2 SCFM (100 SLPM)						
Vacuum	10.8 psi (74.7 kPa), <0.5 SCFM (14 SLPM)						
Air quality	Clean (filtered to 1.0 µm or better) – ISO 8573-1 Class 1 Oil free – ISO 8573-1 Class 1 Dry (–15 °C dew point) – ISO 8573-1 Class 3						
Materials	Hardcoat aluminum and nickel-plated steel with stainless steel mounting material, granite base						

\* Improved accuracy can be obtained with controller-based error compensation. Stage must be ordered with controller. Accuracy values assume short-term time duration and do not consider the long-term effects of thermal drift on the stage.

\*\* Unloaded. Can be limited by the insulating system payload, controller or drive.

\*\*\* Assumes payload CG is centered no more than 50 mm above the stage table.

# Specifications for the drive apply per motor. Two motors are located at the gantry axis.

## To protect the stage against damage, it is recommended to connect an air pressure sensor to the Motion-Stop input of the controller.

All specifications apply per axis, if not otherwise described.



# Vertical Translation Stages



# L-310 Precision Z Stage

## Compact Multi-Axis Combinations with Linear and Rotation Stages



- Travel range 26 mm (1")
- High-resolution encoder
- ActiveDrive DC, DC, BLDC, and stepper motors
- Zero-play ball screw
- MTBF 10000 h
- Self-locking to 10 kg

### Precision-class Z stage

High guiding accuracy and stiffness due to ball screws and crossed roller guides. Stress-relieved aluminum base for highest stability. Vacuum versions available on request. Noncontact limit and reference point switches (Hall effect). Reference point switch with direction sensing in the middle of the travel range.

### Highly accurate position measuring with incremental linear encoder

Noncontact optical linear encoders 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.

### Minimum incremental motion and slow motion

In conjunction with the SMC Hydra controller, versions with stepper motor and integrated linear encoder (L-310.xASD) achieve repeatable minimum incremental motion in the range of the sensor resolution. The same configuration attains constant low velocities of a few sensor increments per second.

### Drive types

- .xxSD variant: 2-phase stepper motor for high torque even at low velocities and high resolution.
- .xxAD variant: ActiveDrive DC motor for high velocity: Control via pulse-width-modulated (PWM) signals, the operating voltage is attained via an amplifier integrated in the motor housing.
- .023xxx variant: DC servo motor
- .025xxx variant: Brushless DC motor (BLDC) for high rotational velocity. Smooth running and low wear, therefore higher lifetime.

### Position measurement

- Versions with DC motor: Rotary encoder
- Optional: Integrated linear encoder, installed centrally.

### Applications

- General Automation
- Photonics
- Scientific Instrumentation
- Semiconductor



	L-310	Unit	Tolerance
<b>Motion</b>			
Active axis	Z		
Travel range	26	mm	
Pitch / yaw	±150	µrad	typ.
Straightness / flatness	±3	µm	typ.
Velocity	L-310.2xAD: 20 L-310.2xSD: 15 L-310.02xxxx: 50	mm/s	max.

	L-310.2ASD L-310.023211	L-310.24AD L-310.xxx212	L-310.20AD L-310.xxx232	L-310.20SD	Unit	Tolerance
<b>Positioning</b>						
Design resolution	0.005	0.05	L-310.20AD: 0.061 L-310.023232: 0.061 L-310.025232: 0.05	5	µm	
Integrated sensor	Incremental linear encoder	Incremental linear encoder L-310.025212 additional rotary encoder	Rotary encoder	–		
Sensor signal	Sin/cos, 1 V peak-peak, 20 µm signal period	A/B quadrature, TTL	A/B quadrature, TTL	–		
Sensor resolution rotary encoder	–	L-310.025212: 20000	L-310.20AD: 16384 L-310.023232: 16384 L-310.025232: 20000	–	Cts./rev.	
Sensor resolution linear encoder		0.05		–	µm	
Minimum incremental motion	L-310.2ASD: 0.05 L-310.023211: 0.2	L-310.24AD: 0.3 L-310.xxx212: 0.2	0.3	0.3	µm	typ.
Unidirectional repeatability	L-310.2ASD: 0.1 L-310.023211: 0.2	L-310.24AD: 0.3 L-310.xxx212: 0.2	0.3	0.3	µm	typ.
Bidirectional repeatability	±0.2	±0.2	±2	±2	µm	typ.
Limit switches	Hall effect	Hall effect	Hall effect	Hall effect		
Reference point switch repeatability	2	2	2	2	µm	typ.

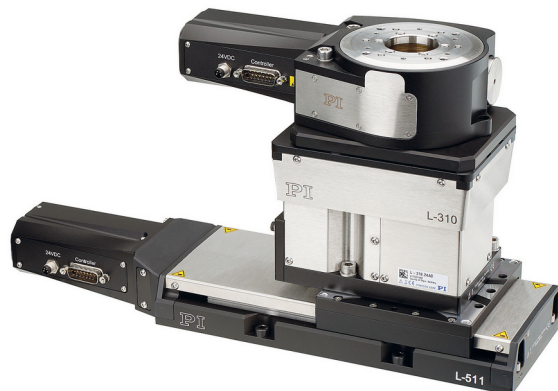
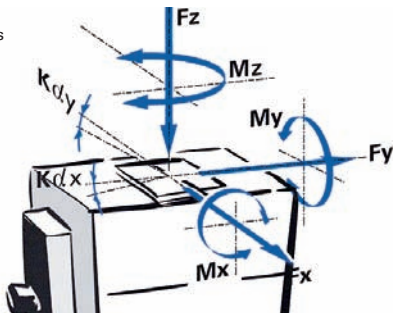
	L-310	Unit	Tolerance
<b>Mechanical properties</b>			
Drive screw	Ball screw		
Drive screw pitch	1	mm	
Guide	Crossed roller guide with anti-creep system		
Holding force, power off	L-310.2xAD: 30 / L-310.2xSD: 50 / L-310.02xxxx: 30	N	max.
Permissible lateral force, F <sub>x</sub>	100	N	max.
Permissible lateral force, F <sub>y</sub>	50	N	max.
Permissible torque in θ <sub>x</sub> (M <sub>x</sub> )	40	N·m	max.
Permissible torque in θ <sub>y</sub> (M <sub>y</sub> )	80	N·m	max.
Permissible torque in θ <sub>z</sub> (M <sub>z</sub> )	80	N·m	max.

	L-310.xxSD	L-310.xxAD	L-310.xx3xxx	L-310.xx5xxx	Unit	Tolerance
<b>Drive properties</b>						
Motor type	2-phase stepper motor	DC motor with PWM control	DC motor	BLDC motor		
Operating voltage, nominal	24	24	24	24	V	nom.
Operating voltage, max.	48	48	48	48	V	max.
Step resolution	200	–	–	–	Full steps/rev.	

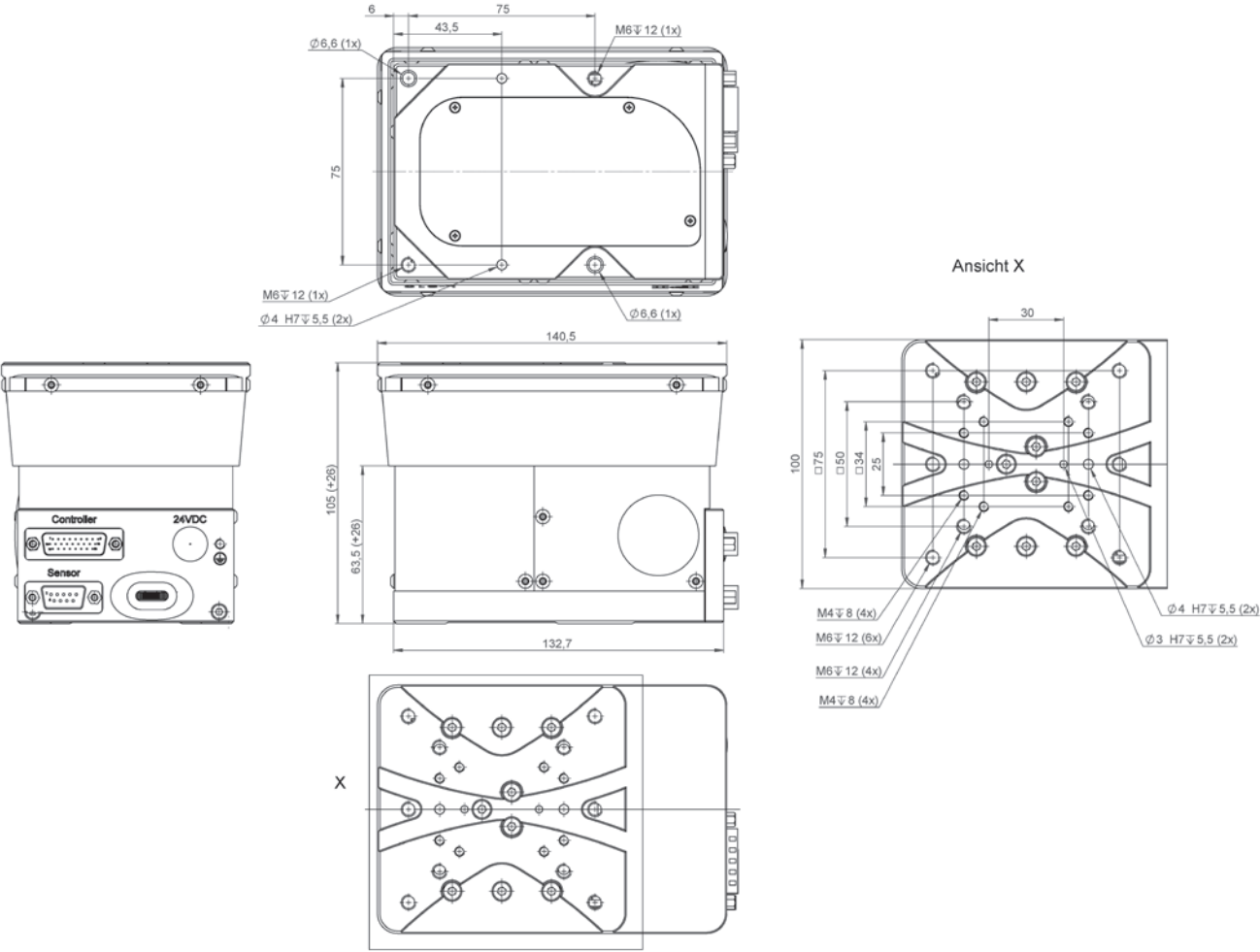
	L-310.20SD	L-310.2ASD	L-310.023xxx L-310.2xAD	L-310.025xxx	Unit	Tolerance
<b>Miscellaneous</b>						
Operating temperature range	5 to 40	5 to 40	5 to 40	5 to 40	°C	
Material	Al (black anodized)	Al (black anodized)	Al (black anodized)	Al (black anodized)		
MTBF	–	–	–	10000	h	
Mass	2.7	2.8	2.7	2.7	kg	±5 %
Moved mass, unloaded	0.9	0.9	0.9	0.9	kg	±5 %
Connection	HD Sub-D 26 (m)	HD Sub-D 26 (m) (motor) Sub-D 9 (m) (sensor)	L-310.2xAD: Sub-D 15 (m) L-310.023232: HD Sub-D 26 (m) L-310.023211: HD Sub-D 26 (m) (motor), Sub-D 9 (m) (sensor)	HD Sub-D 26 (m)		
Recommended controllers / drivers	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller		

All cables required for operation with the ordered controller are included in the scope of delivery. The cable length is 3 m. Cable for connecting to other controllers can be ordered as accessory. Ask about custom designs!

Direction of the axes and torques for Z stages



L-310, dimensions in mm



# UPL-120 Precision Z Stage

## Excellent Accuracy for High Loads



- Travel range 13 mm (1/2")
- Unidirectional repeatability to 0.05 µm
- Load capacity to 20 kg
- Integrated optical limit switches
- Available with direct-measuring encoder
- Crossed roller guide, anti-creep

### Reference-class Z stage

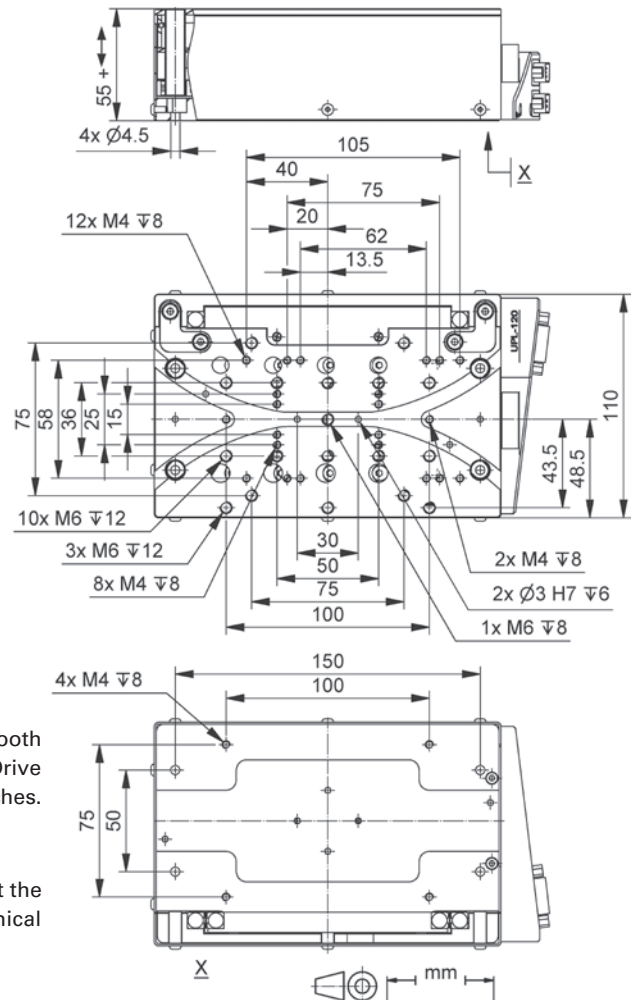
Extremely accurate and reliable positioning. Crossed roller guides for smooth feed at high loads. Stress-relieved aluminum base for highest stability. Drive variants with DC motor and 2-phase stepper motor. Noncontact limit switches.

### Highly accurate position measuring with incremental linear encoder

Noncontact optical linear encoders 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.

### Crossed roller guide

With crossed roller guides, the point contact of the balls in ball guides is replaced by line contact of the hardened rollers. Consequently, they are considerably stiffer and need less preload, which reduces friction and allows smoother running. Crossed roller guides are also distinguished by high guiding accuracy and load capacity. Force-guided rolling element cages prevent cage creep.



UPL-120, dimensions in mm

### Applications

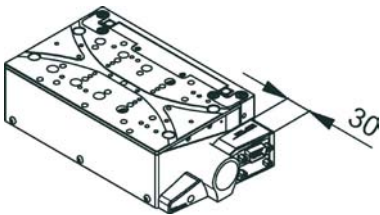
- General Automation
- Scientific Instrumentation
- Photonics
- Semiconductor

	6635911030	6635921030	6635911130	6635921130-0001	Unit	Tolerance
	Z stage with DC motor and rotary encoder	Z stage with stepper motor	Z stage with DC motor, linear and rotary encoder	Z stage with stepper motor and linear encoder		
Active axes	Z	Z	Z	Z		
<b>Motion and positioning</b>						
Travel range	13	13	13	13	mm	
Integrated sensor	Rotary encoder	–	Linear encoder Rotary encoder	Linear encoder		
Sensor signal rotary encoder	A/B quadrature, RS-422	–	A/B quadrature, RS-422	–		
Sensor signal linear encoder	–	–	A/B quadrature, RS-422	Sin/cos, 1 V peak-peak, 20 µm signal period		
Design resolution	0.013	1.34	0.05	0.005	µm	
Sensor resolution rotary encoder	20000	–	20000	–	Cts./rev.	
Sensor resolution linear encoder	–	–	0.05	–	µm	
Minimum incremental motion	0.1	0.1	0.1	0.05	µm	typ.
Unidirectional repeatability	0.1	0.1	0.1	0.05	µm	typ.
Bidirectional repeatability	±2	±2	±0.1	±0.05	µm	typ.
Pitch	±100	±100	±100	±100	µrad	typ.
Yaw	±100	±100	±100	±100	µrad	typ.
Straightness	±3.0	±3.0	±3.0	±3.0	µm	typ.
Flatness	±3.0	±3.0	±3.0	±3.0	µm	typ.
Velocity	6	3	6	3	mm/s	max.
Reference point switch repeatability	<1	<1	<1	<1	µm	typ.
<b>Mechanical properties</b>						
Guide type	Crossed roller guide with anti-creep system	Crossed roller guide with anti-creep system	Crossed roller guide with anti-creep system	Crossed roller guide with anti-creep system		
Drive screw type	Ball screw	Ball screw	Ball screw	Ball screw		
Drive screw pitch	1	1	1	1	mm	
Gear ratio	2911:780	2911:780	2911:780	2911:780		
Push/pull force, power on	200	200	200	200	N	max.
Holding force, power off	40	80	40	80	N	typ.
Load capacity	200	200	200	200	N	max.
Permissible lateral force $F_y$ in Y	150	150	150	150	N	max.
Permissible torque $M_x$ in $\theta_x$	130	130	130	130	N·m	max.
Permissible torque $M_y$ in $\theta_y$	38	38	38	38	N·m	max.
Permissible torque $M_z$ in $\theta_z$	150	150	150	150	N·m	max.

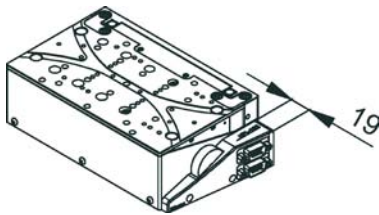
	6635911030	6635921030	6635911130	6635921130-0001	Unit	Tolerance
<b>Drive properties</b>						
Motor type	DC motor	2-phase stepper motor	DC motor	2-phase stepper motor		
Step resolution	–	200	–	200	Full steps/rev.	
Operating voltage, nominal	24	24	24	24	V	nom.
Operating voltage, max.	48	48	48	48	V	max.
Limit switches	Optical	Optical	Optical	Optical		
<b>Miscellaneous</b>						
Operating temperature range	5 to 40	5 to 40	5 to 40	5 to 40	°C	
Mass	2.4	2.3	2.4	2.4	kg	±5 %
Moved mass	1.3	1.3	1.3	1.3	kg	±5 %
Material	Aluminum, black anodized	Aluminum, black anodized	Aluminum, black anodized	Aluminum, black anodized		
Connection	HD Sub-D 15 (m)	HD Sub-D 15 (m)	Motor: HD Sub-D 15 (m) Sensor: Sub-D 9 (m)	Motor: HD Sub-D 15 (m) Sensor: Sub-D 9 (m)		
Recommended controllers / drivers	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller		

Connecting cables for motor and sensor are not in the scope of delivery and must be ordered separately.  
Ask about custom designs!

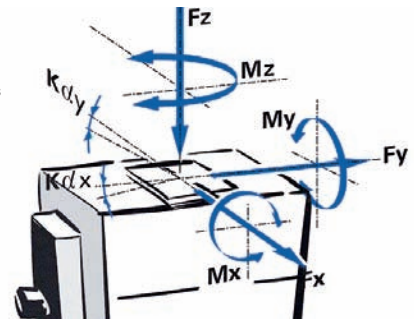
UPL-120, DC motor, dimensions in mm



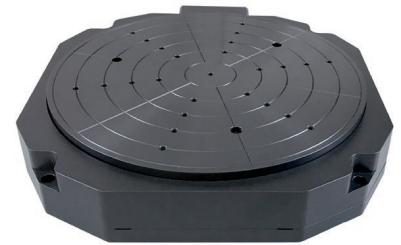
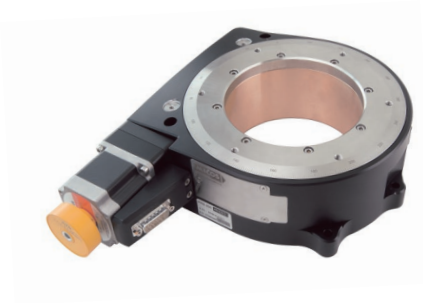
UPL-120, stepper motor, dimensions in mm



Direction of the axes and torques for Z stages



## Rotation Stages: Worm Gear, Direct-Drive Mechanical and Air Bearings Goniometers



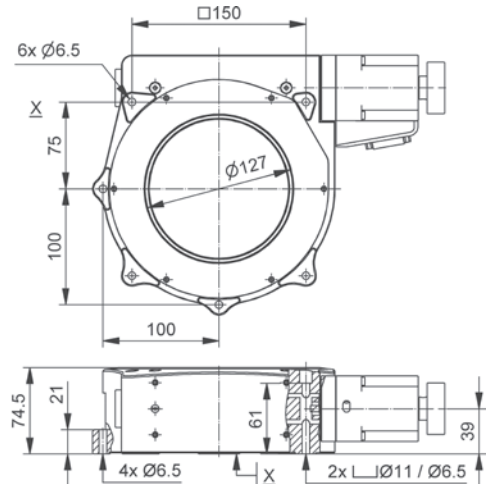
# PRS-200 Precision Rotation Stage

Large Aperture, High Travel Accuracy

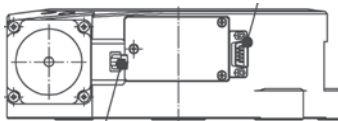


- Unlimited travel range
- Repeatability to 0.5  $\mu$ rad
- Load capacity to 50 kg
- Option: Direct position measurement with angle measuring system

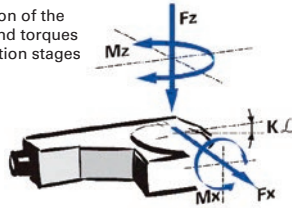
PRS-200 precision rotation stage, dimensions in mm



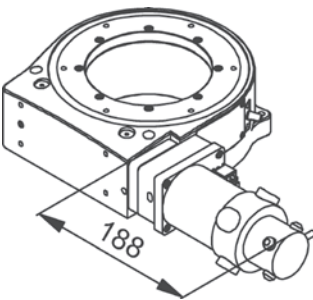
PRS-200 precision rotation stage, connection for angle measuring system



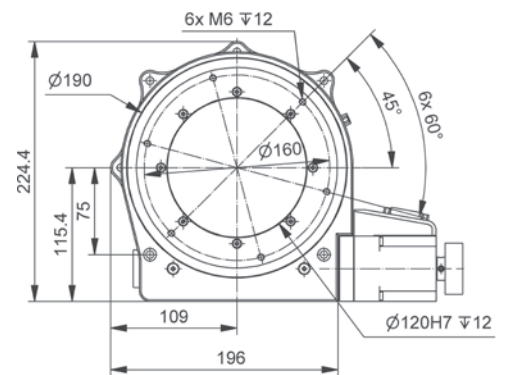
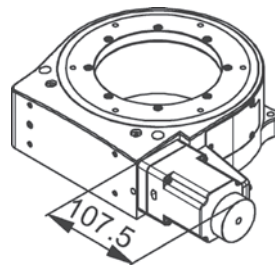
Direction of the axes and torques for rotation stages



PRS-200 precision rotation stage, DC motor, dimensions in mm



PRS-200 precision rotation stage, stepper motor, dimensions in mm



## Applications

- Medical Industry
- Metrology / Testing
- Photonics
- Precision Micro Assembly
- Sample Inspection



	6449911011	6449921011	6449921111	Unit	Tolerance
	With DC motor	With stepper motor	With stepper motor and angle measuring system		
Active axes	$\theta_z$	$\theta_z$	$\theta_z$		
<b>Motion and positioning</b>					
Rotation range	>360	>360	>360	°	
Integrated sensor	Rotary encoder		Incremental angle measuring system		
Sensor signal	A/B quadrature, RS-422	–	Sin/cos, 1 V peak-peak		
Sensor resolution rotary encoder	20000	–	–	Cts./rev.	
Sensor resolution angle measuring system	–	–	23600	Lines/revolution	
Design resolution	1.75	175.00	0.017	$\mu$ rad	
Minimum incremental motion	8.72	8.72	0.50	$\mu$ rad	typ.
Unidirectional repeatability	17.44	17.44	0.5	$\mu$ rad	typ.
Bidirectional repeatability	$\pm 175$	$\pm 175$	$\pm 5$	$\mu$ rad	typ.
Wobble	$\pm 17.5$	$\pm 17.5$	$\pm 17.5$	$\mu$ rad	typ.
Flatness	$\pm 1$	$\pm 1$	$\pm 1$	$\mu$ m	typ.
Eccentricity	$\pm 2.5$	$\pm 2.5$	$\pm 2.5$	$\mu$ m	typ.
Angular velocity	75	35	35	°/s	max.
<b>Mechanical properties</b>					
Bearing	Crossed roller bearings	Crossed roller bearings	Crossed roller bearings		
Torque, power on	4	4	4	N·m	max.
Worm gear ratio	180:1	180:1	180:1		
Load capacity / axial force	500	500	500	N	max.
Permissible lateral force	200	200	200	N	max.
Permissible torque in $\theta_x, \theta_y$	60	60	60	N·m	max.
Permissible torque in $\theta_z$	4	4	4	N·m	max.
<b>Drive properties</b>					
Motor type	DC motor	2-phase stepper motor	2-phase stepper motor		
Operating voltage, nominal	24	48	48	V	nom.
Operating voltage, max.	48	48	48	V	max.
Limit switches	2 × Hall effect	2 × Hall effect	2 × Hall effect		
<b>Miscellaneous</b>					
Operating temperature range	5 to 40	5 to 40	5 to 40	°C	
Material	Aluminum, black anodized, stainless steel, red bronze	Aluminum, black anodized, stainless steel, red bronze	Aluminum, black anodized, stainless steel, red bronze		
Mass	8	8	8.7	kg	$\pm 5$ %
Moved mass, unloaded	4.3	4.3	4.7	kg	$\pm 5$ %
Connection	Sub-D 7W2 (m) (motor) M23 12-pin (m) (sensor)	Sub-D 15 (m)	Sub-D 15 (m) (motor) HD Sub-D 26 (m) (sensor)		
Recommended controllers / drivers	C-863 (single axis) with C-863.AD12 line driver C-884 (to 6 axes) with C-863.AD12 line driver C-885 with C-863.20C885 (to 40 axes) and C-863.AD12 line driver ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller		

Connecting cables for motor and sensor are not in the scope of delivery and must be ordered separately. Ask about custom designs!



	680591111	Unit	Tolerance
<b>Motion and positioning</b>			
Active axes	$\theta_z$		
Travel range	>360	°	
Integrated sensor	Incremental angle measuring system		
Sensor signal	Sin/cos, 1 V peak-peak		
Sensor resolution	15744	Lines/revolution	
Minimum incremental motion	1.4	$\mu\text{rad}$	typ.
Unidirectional repeatability	1.4	$\mu\text{rad}$	typ.
Bidirectional repeatability	$\pm 1.75$	$\mu\text{rad}$	typ.
Flatness	$\pm 2.5$	$\mu\text{m}$	typ.
Eccentricity	$\pm 3.5$	$\mu\text{m}$	typ.
Wobble	$\pm 25$	$\mu\text{rad}$	typ.
Angular velocity	360	°/s	max.
Reference point switch	Encoder index		
<b>Mechanical properties</b>			
Bearing	Crossed roller bearings		
Torque, power on	0.25	N·m	
Load capacity / axial force	20	N	max.
Permissible lateral force	15	N	max.
Permissible torque in $\theta_x, \theta_y$	5	N·m	max.
<b>Drive properties</b>			
Drive type	Ironless 3-phase torque motor		
Intermediate circuit voltage	48	V DC	max.
Nominal current, effective	1.2	A	typ.
Peak current, effective	3.8	A	typ.
Torque constant, effective	0.13	N·m/A	typ.
Motor constant	0.04	N·m/ $\sqrt{\text{W}}$	typ.
Electrical time constant	0.1	ms	
Resistance phase-phase	6.6	$\Omega$	typ.
Inductance phase-phase	0.7	mH	typ.
Back EMF phase-phase	0.67	V/kRPM	max.
Number of pole pairs	14		
<b>Miscellaneous</b>			
Operating temperature range	5 to 40	°C	
MTBF	20000	h	
Material	Aluminum, black anodized		
Mass	1.2	kg	$\pm 5\%$
Moved mass	0.4	kg	$\pm 5\%$
Connection	Sub-D 17W2 (motor) HD Sub-D 26 (m) (sensor)		
Recommended controller	SMC Hydra (double axis) C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller		

Connecting cables for motor and sensor are not in the scope of delivery and must be ordered separately.  
Ask about custom designs!

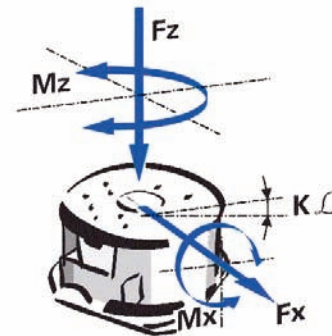
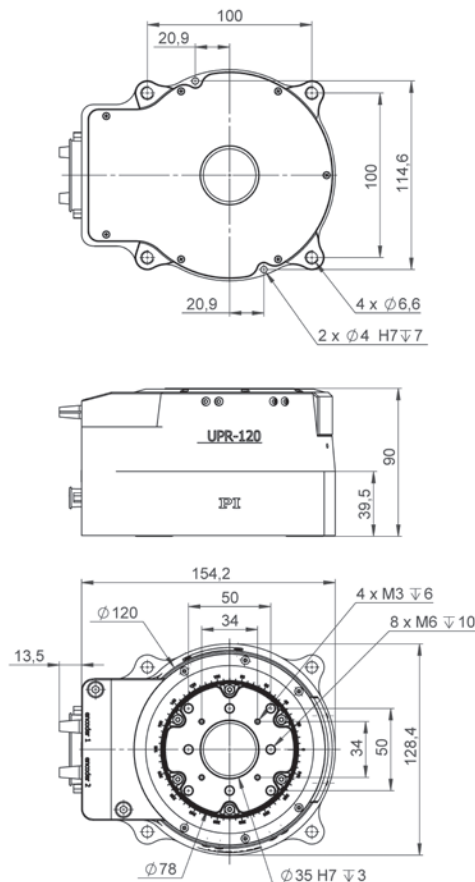
# UPR-120 Ultraprecision Rotation Stage

## Excellent Stability and Travel Accuracy

- Unlimited travel range
- Velocity to 360 °/s
- Incremental angle measuring system with 0.017  $\mu$ rad resolution
- Clear aperture with 35 mm diameter
- Cleanroom compatible
- Direct drive



UPR-120, dimensions in mm



Directions of the axes and torques for rotation stages

### Applications

- Biotechnology
- Automation
- Medical Industry
- Metrology / Testing
- Precision Micro Assembly
- Sample Inspection
- Scientific Instrumentation
- Semiconductor

	6808911130	Unit	Tolerance
<b>Motion and positioning</b>			
Active axes	$\theta_2$		
Travel range	>360	°	
Integrated sensor	Incremental angle-measuring system		
Sensor signal	Sin/cos, 1 V peak-peak		
Sensor resolution	15744	Lines/revolution	
Minimum incremental motion	1.4	$\mu\text{rad}$	typ.
Unidirectional repeatability	1.4	$\mu\text{rad}$	typ.
Bidirectional repeatability	$\pm 1.4$	$\mu\text{rad}$	typ.
Flatness	$\pm 1$	$\mu\text{m}$	typ.
Eccentricity	$\pm 3$	$\mu\text{m}$	typ.
Wobble	$\pm 25$	$\mu\text{rad}$	typ.
Angular velocity	360	°/s	max.
Reference point switch	Encoder index		
Limit switches	Optical		
<b>Mechanical properties</b>			
Bearing	Crossed roller bearings		
Torque, power on	0.5	N·m	
Load capacity / axial force	200	N	max.
Permissible lateral force	100	N	max.
<b>Drive properties</b>			
Drive type	Iron-core 2-phase torque motor		
Intermediate circuit voltage	48	V DC	max.
Nominal current, effective	7.7	A	typ.
Torque constant, effective	0.26	N·m/A	typ.
Resistance phase-phase	2.2	$\Omega$	typ.
Inductance phase-phase	1.17	mH	typ.
Back EMF phase-phase	0.18	V·s/rad	max.
<b>Miscellaneous</b>			
Operating temperature range	5 to 40	°C	
Material	Aluminum, black anodized		
MTBF	20000	h	
Mass	6	kg	$\pm 5\%$
Moved mass	0.8	kg	$\pm 5\%$
Connection	Sub-D 9W4 (m) (motor) Sub-D 15 (m) (sensor)		
Recommended controller	SMC Hydra (double axis) C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller		

Connecting cables for motor and sensor are not in the scope of delivery and must be ordered separately.  
Ask about custom designs!

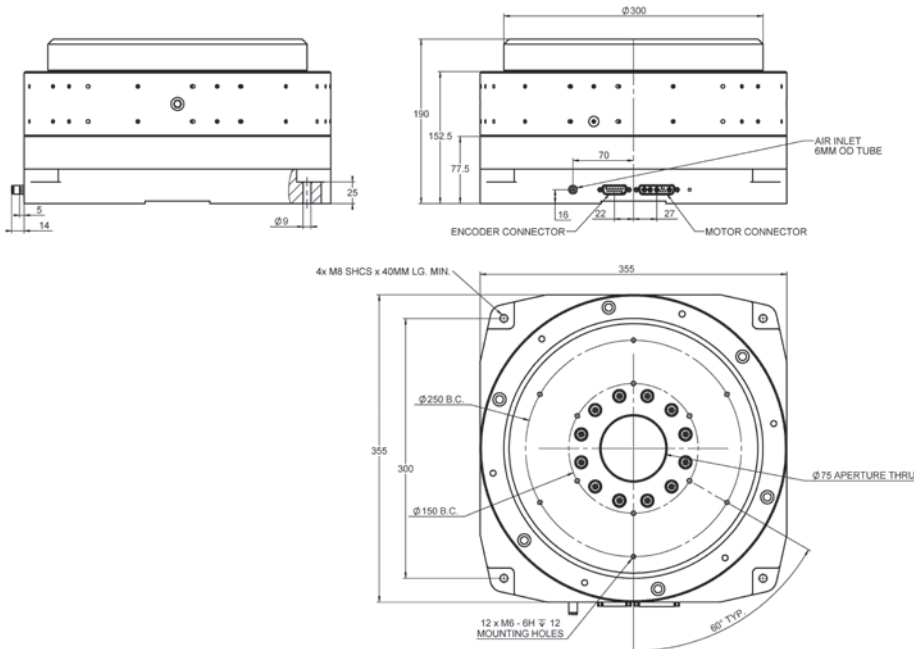
# A-62x Pliglide RM Rotation Stage with Air Bearings

Friction-Free, Ideal for Indexing, Positioning, Scanning, Measuring Technology

- Cleanroom compatible
- Motion platform diameter from 50 mm to 300 mm
- Load capacity to 4170 N
- Eccentricity and flatness <200 nm
- Can be mounted vertically or horizontally



A-627.075xx, dimensions in mm



## Applications

- Metrology / Testing
- Optical Alignment
- Sample Inspection
- Scanning
- Scientific Instrumentation

	A-621.025	A-623.025	A-623.050	A-624.050	A-627.075	Unit	Tolerance
<b>Motion</b>							
Travel range	unlimited, >360°	unlimited, >360°	unlimited, >360°	unlimited, >360°	unlimited, >360°		
Motion platform diameter	50	100	100	150	300	mm	
Journal length	25	25	50	50	75	mm	
Eccentricity <sup>(1)</sup>	300	175	175	100	75	nm	max.
Flatness	100	75	75	50	40	nm	max.
Wobble	5	3	3	2	1	μrad	max.
<b>Mechanical properties</b>							
Load capacity, axial	134	536	536	1206	4244	N	max.
Load capacity, radial	57	115	229	344	1203	N	max.
Load torque M <sub>x,y</sub>	0.57	1.7	4.52	22.6	141.3	N·m	max.
Axial stiffness	26	96	96	210	788	N/μm	
Radial stiffness	8	18	35	64	204	N/μm	
Moment of inertia	125	1485	1530	8790	210850	kg·mm <sup>2</sup>	
Moved mass	0.4	1.2	1.4	3.2	21.5	kg	
Overall mass	1.2	3.1	4.5	8.6	50	kg	
Guide type	Air bearing	Air bearing	Air bearing	Air bearing	Air bearing		
<b>Drive properties</b>							
Drive type	Torque motor, 3-phase, brushless, ironless, slotless	Torque motor, 3-phase, brushless, ironless, slotless	Torque motor, 3-phase, brushless, ironless, slotless	Torque motor, 3-phase, brushless, ironless, slotless	Torque motor, 3-phase, brushless, ironless, slotless		
Intermediate circuit voltage, effective	48, nominal 80, max.	48, nominal 80, max.	48, nominal 80, max.	48, nominal 80, max.	48, nominal 80, max.	V DC	
Peak torque	0.21	2.1	2.1	4.71	8.46	N·m	typ.
Nominal torque	0.07	0.7	0.7	1.57	2.82	N·m	typ.
Force constant, effective	0.03	0.26	0.26	0.59	0.61	N·m/A	typ.
Resistance phase-phase	2.7	4.2	4.2	6.7	4.5	Ω	
Inductance phase-phase	0.1	0.4	0.4	0.9	0.6	mH	
Back EMF phase-phase	4.1	31.8	31.8	71	74	V/kRPM	max.

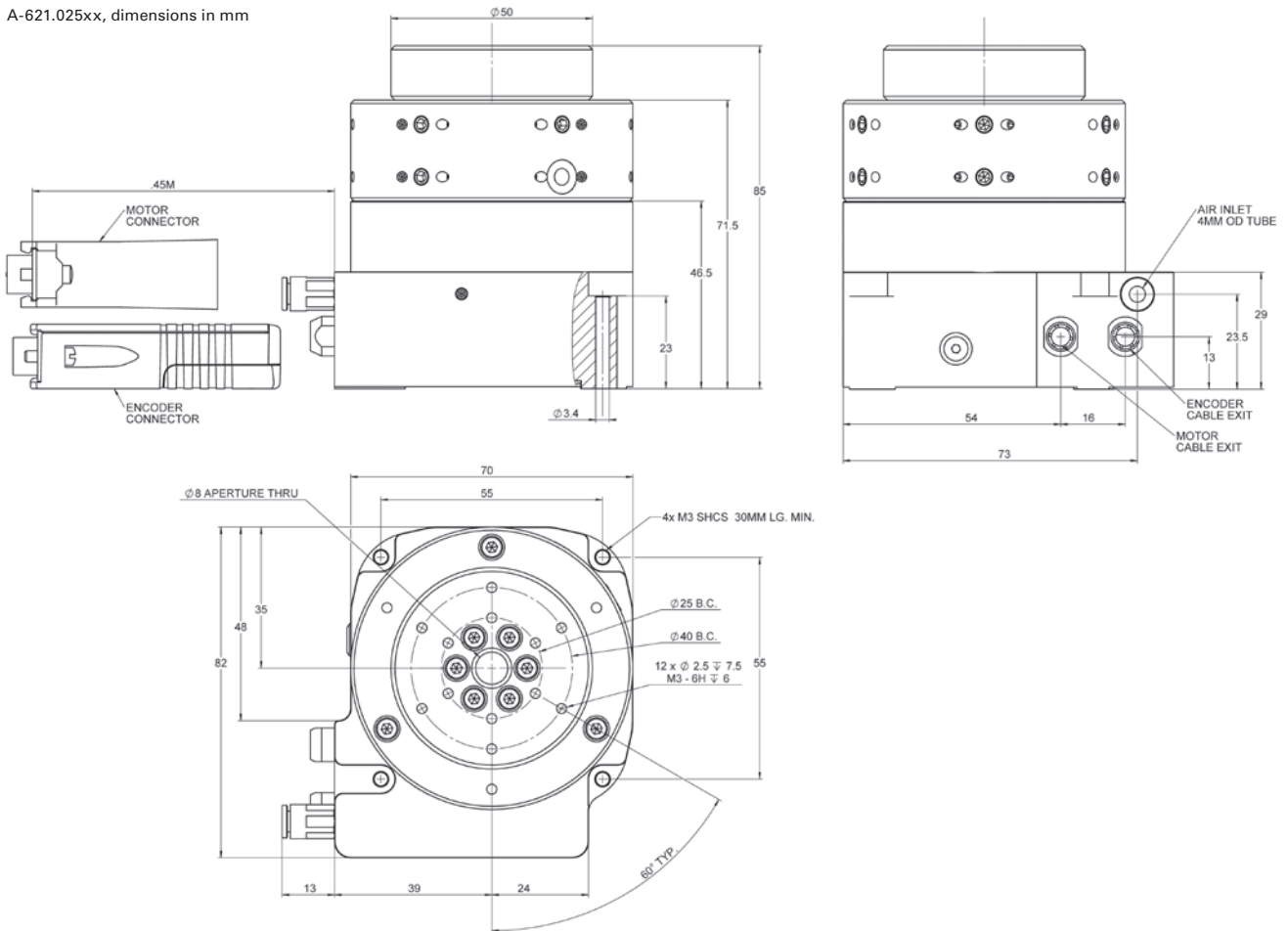
	A-62x.xxxAx	A-62x.xxxBx	A-62x.xxxCx
<b>Positioning</b>			
Integrated sensor	Incremental angle measuring system	Absolute-measuring angle measuring system	Incremental angle measuring system
Sensor signal	Sin/cos, 1 V peak-peak	BiSS-C	A/B quadrature, TTL
Lines/revolution	A-621: 8192 A-623: 15744 A-624: 23600 A-627: 47200	–	A-621: 8192 A-623: 15744 A-624: 23600 A-627: 47200
Velocity <sup>(2)</sup>	A-621: 2500 RPM max. A-623: 1200 RPM max. A-624: 600 RPM max. A-627: 500 RPM max.	A-621: 2500 RPM max. A-623: 1200 RPM max. A-624: 600 RPM max. A-627: 500 RPM max.	A-621: 550 RPM max. <sup>(3)</sup> A-623: 300 RPM max. <sup>(3)</sup> A-624: 175 RPM max. <sup>(3)</sup> A-627: 75 RPM max. <sup>(3)</sup>
Sensor resolution	A-621: 0.047 μrad <sup>(4)</sup> A-623: 0.024 μrad <sup>(4)</sup> A-624: 0.016 μrad <sup>(4)</sup> A-627: 0.008 μrad <sup>(4)</sup>	A-621: 0.0015 μrad A-623: 0.0015 μrad A-624: 0.0015 μrad A-627: 0.0015 μrad	A-621: 1.94 μrad <sup>(5)</sup> A-623: 1.02 μrad <sup>(5)</sup> A-624: 0.68 μrad <sup>(5)</sup> A-627: 0.33 μrad <sup>(5)</sup>
Bidirectional repeatability	±4 μrad	±4 μrad	±4 μrad
Accuracy, with error compensation <sup>(6)</sup>	±8 μrad	±8 μrad	±8 μrad
Reference point switch	1 / revolution, differential pulse over one sensor signal period, 1 V peak-peak	–	1 / revolution, one count over one step of the encoder, synchronized to output signal

**A-62x**

<b>Miscellaneous</b>	
Operating pressure <sup>(7)</sup>	75 to 85 psi (515 to 585 kPa)
Air consumption	<2 SCFM (56 SLPM)
Air quality	Clean (filtered to 1.0 µm or better) – ISO 8573-1 Class 1 Oil free – ISO 8573-1 Class 1 Dry (-15 °C dew point) – ISO 8573-1 Class 3
<b>Materials<sup>(8)</sup></b>	
	Hardcoat aluminum, stainless steel fasteners

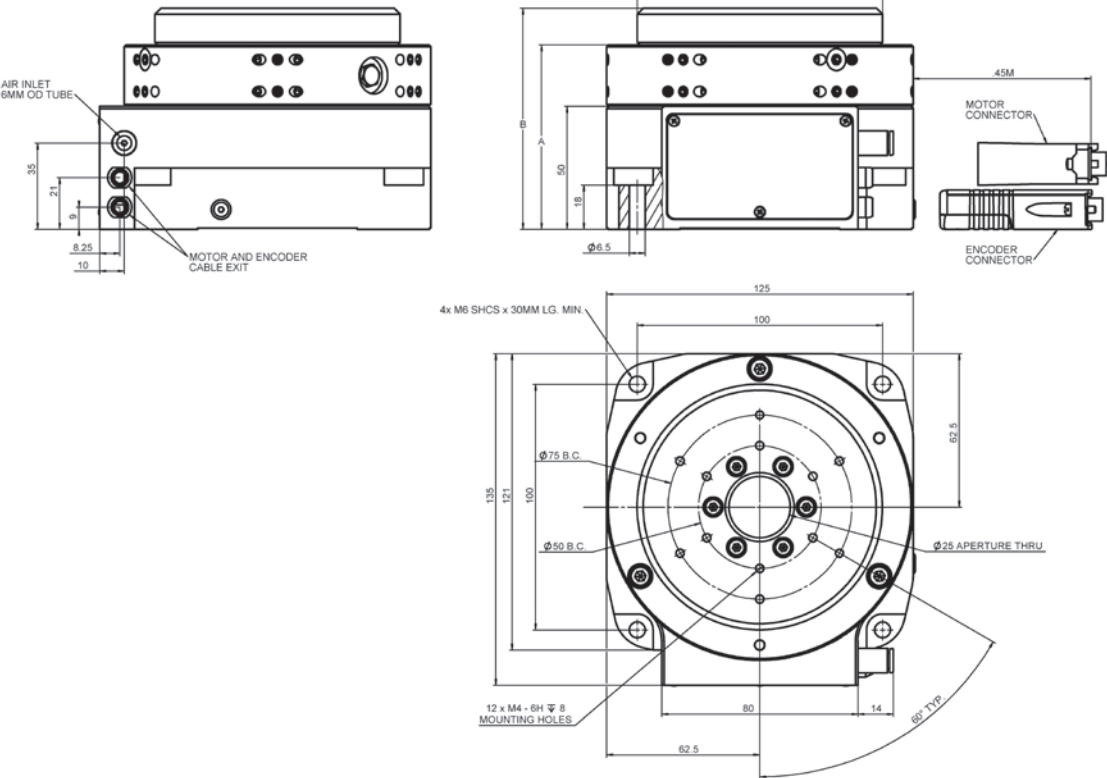
- (1) Dependent on the quality of the underlying surface, the payload, orientation, and forces that act on the stage from the outside. Please contact PI for application-specific parameters. The specified values are static (no rotary motion during measuring) and without load.
- (2) Can be limited by imbalance of the payload or the controller and the drive.
- (3) Assumes a sampling rate of 50 MHz.
- (4) Assumes 16384x interpolation. Contact PI for the use of other factors.
- (5) Uses 400x interpolation. Alternative digital encoder resolutions on request. Please contact PI for a quote.
- (6) The specified values are based on error compensation controlled by the controller. The stage must be ordered with a controller from PI to reach these values. Accuracy values assume short-term duration and do not consider the long-term effects of thermal drift on the stage.
- (7) To protect the stage against damage, it is recommended to connect an air pressure sensor to the Motion-Stop input of the controller.
- (8) Customer-specific materials such as rust-free steel on request. Please contact PI for a quote.

A-621.025xx, dimensions in mm

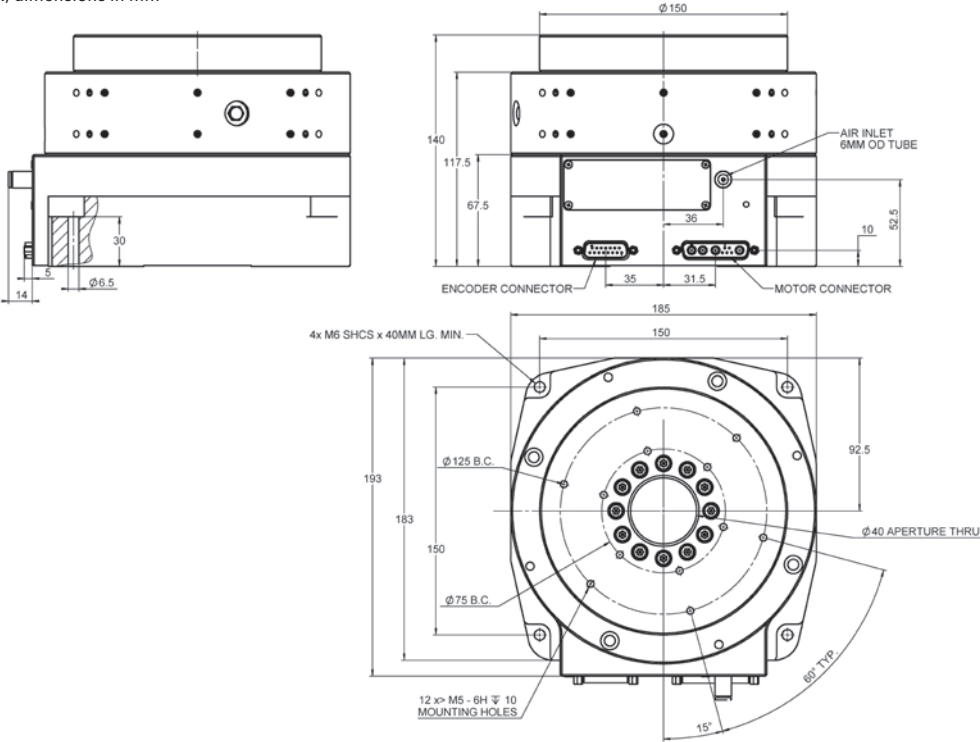




A-623.xxxxx, dimensions in mm  
 A-623.025xx: A=75 mm; B=90 mm  
 A-623.050xx: A=100 mm; B=115 mm



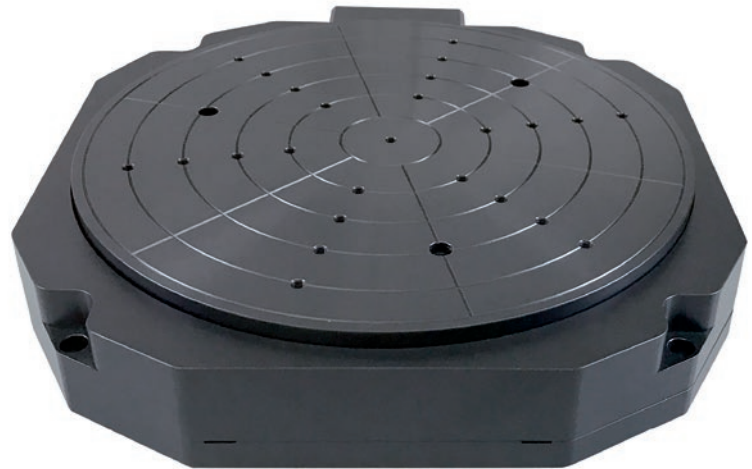
A-624.050xx, dimensions in mm



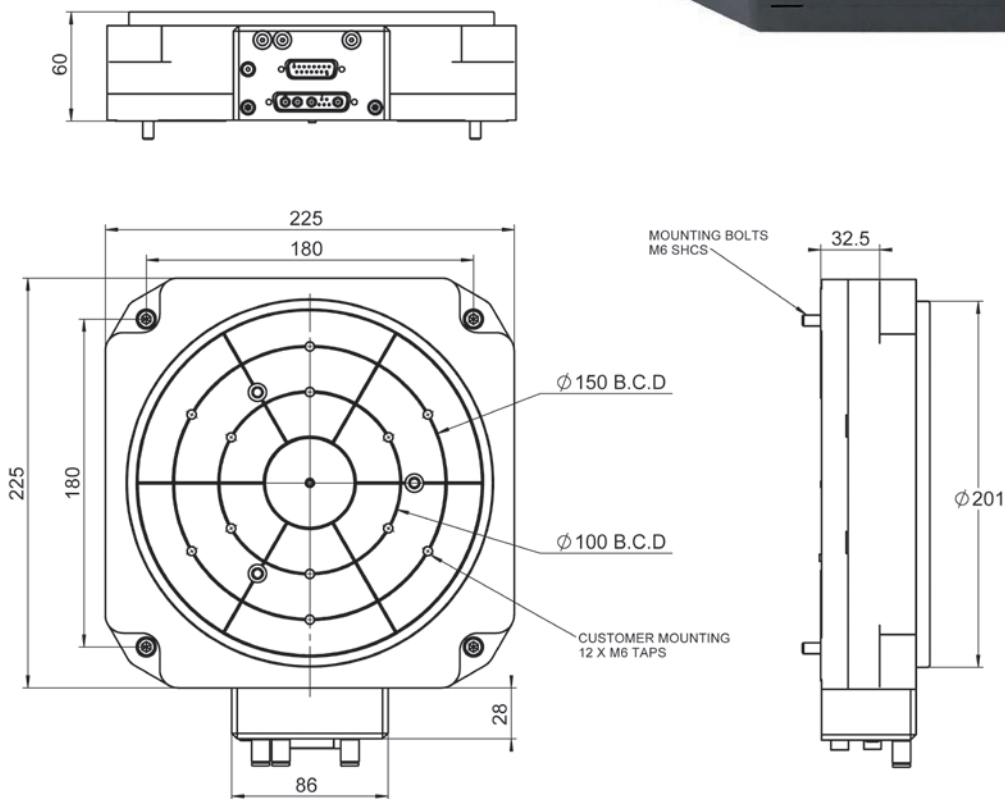
# A-63x Pliglide RL Low-Profile Rotation Stage with Air Bearing

## Friction-Free, Motorized

- 200 mm or 300 mm motion platform diameter
- Low profile, 60 mm
- Eccentricity and flatness <100 nm
- Option for self-locking at rest by magnetic preload
- Direct Drive



A-635.x100 , dimensions in mm



Drawing for A-637.x100  
available on [www.pi.ws](http://www.pi.ws)

### Applications

- Metrology / Testing
- Optical Alignment
- Sample Inspection
- Scanning
- Scientific Instrumentation
- Semiconductor

	A-635	A-637	Unit	Tolerance
<b>Motion</b>				
Travel range	unlimited, >360°	unlimited, >360°		
Motion platform diameter	200	300	mm	
Eccentricity <sup>(1)</sup>	100	100	nm	max.
Flatness <sup>(1)</sup>	50	50	nm	max.
Wobble <sup>(1)</sup>	2	1	μrad	max.
<b>Mechanical properties</b>				
Load capacity, axial <sup>(2)</sup>	200	500	N	max.
Load capacity, radial <sup>(2)</sup>	50	200	N	max.
Load torque, M <sub>X,Y</sub> <sup>(2)</sup>	5	10	N·m	max.
Moment of inertia	25820	72000	kg·mm <sup>2</sup>	
Moved mass	4.2	6.4	kg	
Overall mass	7.5	14	kg	
Guide type	Air bearing, magnetic preload	Air bearing, magnetic preload		

	A-63x	Unit	Tolerance
<b>Drive properties</b>			
Drive type	Torque motor, 3-phase, brushless, ironless, slotless		
Intermediate circuit voltage, effective	48, nominal 80, max.	V DC	
Peak torque	9	N·m	typ.
Nominal torque	3	N·m	typ.
Torque constant, effective	0.66	N·m/A	typ.
Resistance phase-phase	4.5	Ω	
Inductance phase-phase	0.6	mH	
Back EMF phase-phase	80	V/kRPM	max.

	A-63x.A100	A-63x.B100
<b>Positioning</b>		
Integrated sensor	Incremental angle-measuring system	Absolute angle-measuring system
Sensor signal	Sin/cos, 1 V peak-peak	BiSS-C
Lines/revolution	A-635: 31488 A-637: 47200	–
Velocity <sup>(3)</sup>	A-635: 500 rpm max. A-637: 500 rpm max.	A-635: 500 rpm max. A-637: 500 rpm max.
Sensor resolution	A-635: 0.05 μrad <sup>(4)</sup> A-637: 0.03 μrad <sup>(4)</sup>	A-635: 0.0015 μrad A-637: 0.0015 μrad
Bidirectional repeatability	±2 μrad	±2 μrad
Accuracy, with error compensation <sup>(5)</sup>	±6 μrad	±6 μrad
Reference point switch	1 / revolution, differential pulse over one sensor signal period, 1 V peak-peak	–

	A-63x
<b>Miscellaneous</b>	
Operating pressure <sup>(6)</sup>	75 to 85 psi (515 to 585 kPa)
Air consumption	<2 SCFM (56 SLPM)
Air quality	Clean (filtered to 1.0 μm or better) – ISO 8573-1 Class 1 Oil free – ISO 8573-1 Class 1 Dry (–15 °C dew point) – ISO 8573-1 Class 3
Materials	Hardcoat aluminum, stainless steel fasteners

(1) Dependent on the quality of the underlying surface, the payload, orientation, and forces that act on the stage from the outside.

Please contact PI for application-specific parameters. The specified values are static (no rotary motion during measuring) and without load.

(2) The loads listed assume a supply pressure of 550 kPa (80 psi). Please contact PI if other pressures are required.

(3) May be limited by the payload, payload imbalance, controller or drive.

(4) Assumes 4096x interpolation. Contact PI for the use of other factors.

(5) The specified values are based on error compensation controlled by the controller. The stage must be ordered with an A-8xx series controller from PI to reach these values. Accuracy values assume short-term duration and do not consider the long-term effects of thermal drift on the stage.

(6) To protect the stage against damage, it is recommended to connect an air pressure sensor to the Motion-Stop input of the controller.

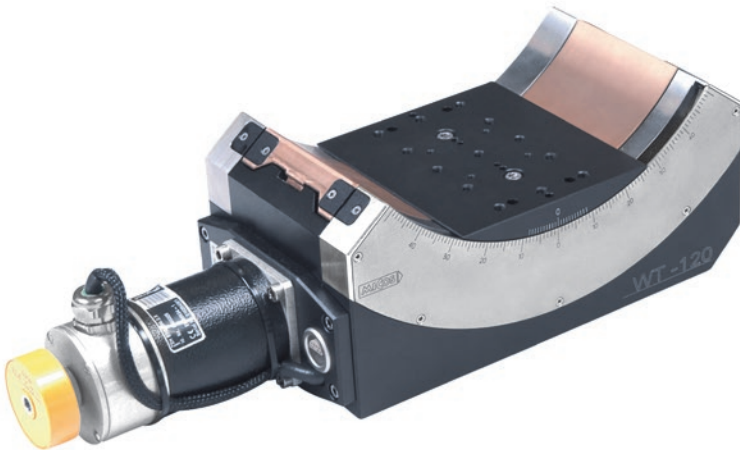


	65509100	65509200	65509201	Unit	Tolerance
	With DC motor	With stepper motor	With stepper motor and angle measuring system		
Active axes	$\theta_x$	$\theta_x$	$\theta_x$		
<b>Motion and positioning</b>					
Rotation range	90	90	90	°	
Integrated sensor	Rotary encoder	–	Incremental angle measuring system		
Sensor signal rotary encoder	AB quadrature, RS-422	–	–		
Sensor signal angle measuring system	–	–	Sin/cos, 1 V peak-peak		
Sensor resolution rotary encoder	20000	–	–		
Sensor signal periods angle measuring system	–	–	269.3	$\mu$ rad	
Design resolution	1.047	105	2.69	$\mu$ rad	
Minimum incremental motion	52.4	4.8	2.7	$\mu$ rad	typ.
Unidirectional repeatability	87	9.6	17.5	$\mu$ rad	typ.
Bidirectional repeatability	$\pm 350$	$\pm 175$	$\pm 17.5$	$\mu$ rad	typ.
Wobble	$\pm 125$	$\pm 125$	$\pm 125$	$\mu$ rad	typ.
Angular velocity	15	10	10	°/s	max.
Limit switches	2 x mechanical	2 x mechanical	2 x mechanical		
<b>Mechanical properties</b>					
Guide type	Ball bearings	Ball bearings	Ball bearings		
Drive screw type	Worm gear	Worm gear	Worm gear		
Drive screw pitch				mm	
Worm gear ratio	300:1	300:1	300:1		
Torque, power on	2.5	2.5	2.5	N-m	max.
Holding torque, power off	2.5	2.5	2.5	N-m	max.
Load capacity	80	80	80	N	max.
Permissible lateral force	50	50	50	N	max.
Permissible torque in $\theta_y, \theta_z$	12	12	12	N-m	max.
<b>Drive properties</b>					
Motor type	DC motor	2-phase stepper motor	2-phase stepper motor		
Step resolution	–	200	200	Full steps/rev.	
<b>Miscellaneous</b>					
Operating temperature range	5 to 40	5 to 40	5 to 40	°C	
Material	Aluminum, black anodized, stainless steel, red bronze	Aluminum, black anodized, stainless steel, red bronze	Aluminum, black anodized, stainless steel, red bronze		
Mass	2.8	2.8	3	kg	$\pm 5$ %
Connection	Sub-D 15 (m)	HD Sub-D 15 (m)	HD Sub-D 15 (m) (motor) Sub-D 9 (m) (sensor)		
Recommended controllers / drivers	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller		

Connecting cables for motor and sensor are not in the scope of delivery and must be ordered separately.  
Ask about custom designs!

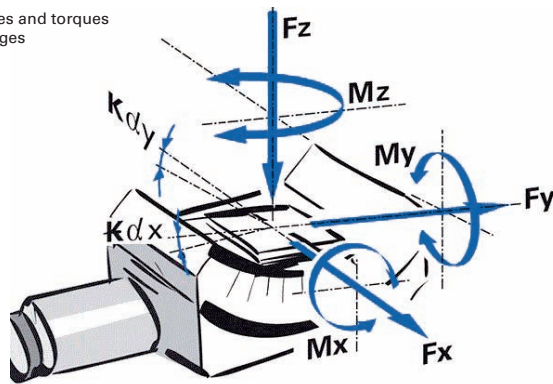
# WT-120 Motorized Precision Goniometer

Long Travel Range, High Loads

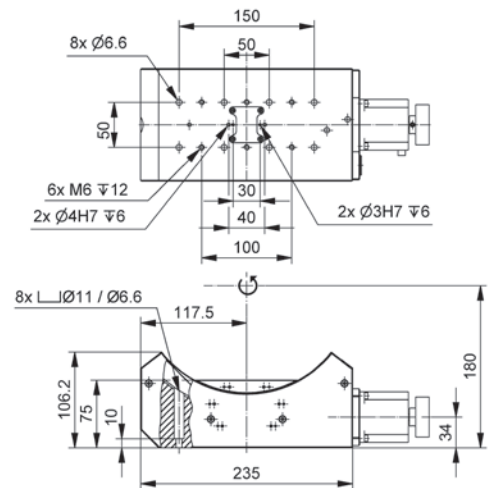


- Rotation range 90°
- Repeatability to 17.5 μrad
- Load capacity to 20 kg
- Option: Direct position measurement with angle measuring system
- Combination with WT-90 with common pivot point

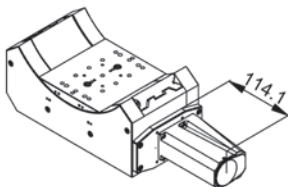
Direction of the axes and torques for goniometer stages



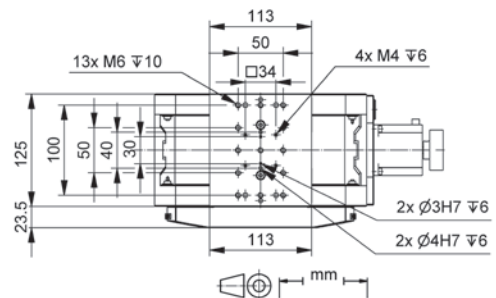
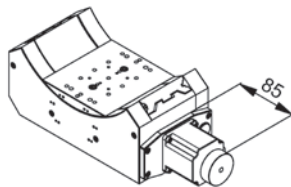
WT-120 goniometer stage, dimensions in mm



WT-120 goniometer stage, DC motor, dimensions in mm



WT-120 goniometer stage, stepper motor, dimensions in mm



## Applications

- Sample Inspection
- Precision Micro Assembly
- Metrology / Testing
- Photonics
- Optical Alignment
- Scientific Instrumentation

	65609110	65609200	65609211	Unit	Tolerance
	With DC motor	With stepper motor	With stepper motor and angle measuring system		
Active axes	$\theta_x$	$\theta_x$	$\theta_x$		
<b>Motion and positioning</b>					
Rotation range	90	90	90	°	
Integrated sensor	Rotary encoder	–	Incremental angle measuring system		
Sensor signal rotary encoder	AB quadrature, RS-422	–	–		
Sensor signal angle measuring system		–	Sin/cos, 1 V peak-peak		
Sensor resolution rotary encoder	20000	–	–		
Sensor signal periods angle measuring system	–	–	150	$\mu$ rad	
Design resolution	1.745	174.5	1.5	$\mu$ rad	
Minimum incremental motion	69.8	69.8	17.5	$\mu$ rad	typ.
Unidirectional repeatability	87	87	17.5	$\mu$ rad	typ.
Bidirectional repeatability	$\pm 350$	$\pm 350$	$\pm 17.5$	$\mu$ rad	typ.
Wobble	$\pm 125$	$\pm 125$	$\pm 125$	$\mu$ rad	typ.
Angular velocity	30	25	25	°/s	max.
Limit switches	2 x mechanical	2 x mechanical	2 x mechanical		
<b>Mechanical properties</b>					
Guide type	Ball bearings	Ball bearings	Ball bearings		
Drive screw type	Worm gear	Worm gear	Worm gear		
Drive screw pitch				mm	
Worm gear ratio	180:1	180:1	180:1		
Torque, power on	8	8	8	N·m	max.
Load capacity	200	200	200	N	max.
Permissible lateral force	90	90	90	N	max.
Permissible torque in $\theta_y, \theta_z$	25	25	25	N·m	max.
<b>Drive properties</b>					
Motor type	DC motor	2-phase stepper motor	2-phase stepper motor		
Step resolution	–	200	200	Full steps/rev.	
<b>Miscellaneous</b>					
Operating temperature range	5 to 40	5 to 40	5 to 40	°C	
Material	Aluminum, black anodized, stainless steel, red bronze	Aluminum, black anodized, stainless steel, red bronze	Aluminum, black anodized, stainless steel, red bronze		
Mass	11.5	11.5	11.5	kg	$\pm 5\%$
Connection	Sub-D 15 (m)	LEMO ERA.3S.316 16-pin	LEMO ERA.3S.316 16-pin (motor) Sub-D 9 (m) (sensor)		
Recommended controllers / drivers	C-863 (single axis) with C-863.AD12 line driver C-884 (to 6 axes) with C-863.AD12 line driver C-885 with C-863.20C885 (to 40 axes) and C-863.AD12 line driver ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller		

Connecting cables for motor and sensor are not in the scope of delivery and must be ordered separately.  
Ask about custom designs!





# Precision 6-Axis Hexapods

For Loads from 2 kg to 2500kg



- Six-axis positioning system with high precision
- System with powerful controller with vector algorithms, virtual pivot point
- Comprehensive software package
- Optional EtherCat interface

# H-855 Modular 6-Axis Hexapod

Modular System for the Highest Adaptability in the 500-kg Class



- Modular design, fast and flexible adaptation to requirements
- Horizontal holding force up to 5000 N
- Travel ranges to  $\pm 75$  mm, rotation ranges to  $\pm 20^\circ$
- Velocities up to 23 mm/s and 200 mrad/s
- Actuator resolution to 5 nm

## Modularity

- The H-855 hexapod allows a larger application range to be covered in the 500-kg class. All essential components such as the drive units, position sensors, strut lengths, base and plates as well as joints are modularly designed. The hexapod can be quickly configured to the requirements. Already tested components and efficient production processes simplify realization of customer-specific requirements. Be inspired by 4 of more than 1000 possible configurations.
- Parallel-kinematic design for six degrees of freedom making it significantly more compact and stiff than serial-kinematic systems, higher dynamic range, no moved cables: Higher reliability, reduced friction.

## Brushless DC motor (BLDC)

- Brushless DC motors are particularly suitable for high rotational speeds. They can be controlled very accurately and ensure high precision. Because they dispense with sliding contacts, they run smoothly, are wear-free and therefore achieve a long lifetime.

## Absolute encoder

- Absolute encoders supply explicit position information that enables immediate determination of the position. This means that referencing is not required during switch-on, which increases efficiency and safety during operation.

## Fields of application

- Research and industry. Industrial automation, precision assembly, astronomy, aerospace.

The detailed description including all data is on our homepage at [www.pi.ws](http://www.pi.ws)

	H-855	H-855	H-855	H-855	Unit	Tolerance
	The golden mean	The fastest	The flattest	With maximum travel range		
Active axes	X, Y, Z, $\theta_x$ , $\theta_y$ , $\theta_z$	X, Y, Z, $\theta_x$ , $\theta_y$ , $\theta_z$	X, Y, Z, $\theta_x$ , $\theta_y$ , $\theta_z$	X, Y, Z, $\theta_x$ , $\theta_y$ , $\theta_z$		
Motion and positioning						
Travel range in X, Y*	±10	±10	±22.5	±75	mm	
Travel range in Z*	±50	±50	±12.5	±37.5	mm	
Travel range in $\theta_x$ , $\theta_y$ *	±15	±15	±6.5	±10	°	
Travel range in $\theta_z$ *	±35	±35	±10	±20	°	
Actuator design resolution	5	41	5	16	nm	
Max. velocity in X, Y, Z	2.8	25	2.8	9	mm/s	
Max. velocity in $\theta_x$ , $\theta_y$ , $\theta_z$	25	270	25	70	mrad/s	
Typ. velocity on X, Y, Z	1.5	20	1.5	5	mm/s	
Typ. velocity on $\theta_x$ , $\theta_y$ , $\theta_z$	14	55	14	39	mrad/s	
Mechanical properties						
Height (motion platform in reference position)	380	380	280	450	mm	
Baseplate diameter	450	450	450	570	mm	
Top plate diameter	300	300	300	360	mm	
Load capacity (base plate horizontal / any orientation)	500 / 200	260 / 120	500 / 200	300 / 200	kg	max.
Holding force, de-energized (base plate horizontal / any orientation)	5000 / 2000	2600 / 1200	5000 / 2000	3000 / 2000	N	max.
Motor type	BLDC gear motor	BLDC gear motor	BLDC gear motor	BLDC gear motor		

\* The travel ranges of the individual coordinates (X, Y, Z,  $\theta_x$ ,  $\theta_y$ ,  $\theta_z$ ) are interdependent. The data for each axis in this table shows its maximum travel range, where all other axes and the pivot point are at the reference position.

Technical data specified at 20±3 °C. Ask about custom designs! Specifications for vacuum versions can differ.

# High-Load Hexapod

POSITIONING 1 TON WITH MICROMETER PRECISION



## H-845

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

### Reference-class 6-axis positioning system

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

### Rapid implementation of customer requests

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

### Powerful digital controller, open software architecture

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

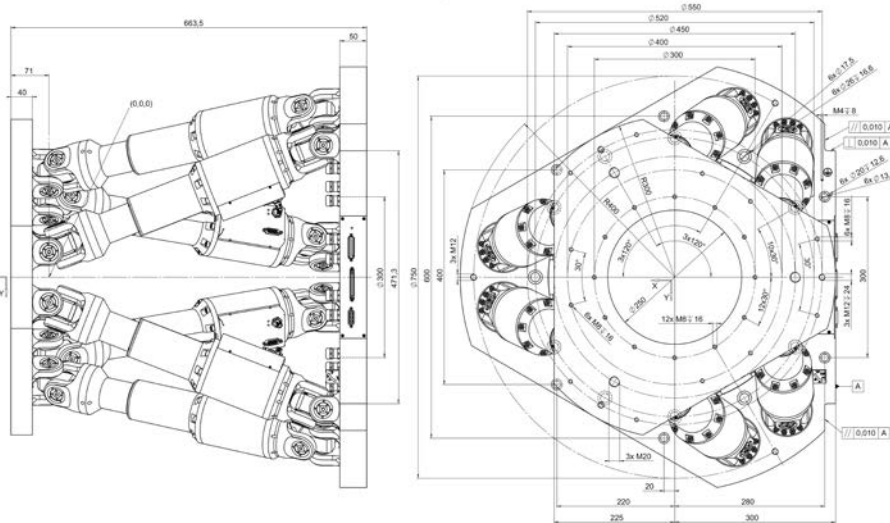
### Fields of application

Research and industry. For astronomy, aviation and aerospace

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

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

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



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

# 6-Axis Hexapod

FOR LOADS OF UP TO 250 KG



## Reference-class 6-axis positioning system

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

## Drive variants

H-850.Hxx with DC gear motors for heavy loads  
H-850.Gxx with powerful DC motors for higher velocity.  
Heavy-duty, ultra-high-resolution bearings for 24/7 applications

## Powerful digital controller, open software architecture

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

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## H-850

- Load capacity to 250 kg
- Repeatability to  $\pm 0.2 \mu\text{m}$
- Travel ranges to 100 mm /  $60^\circ$
- Actuator resolution to 5 nm
- MTBF 20,000 h
- Works in any orientation
- Linear and rotary multi-axis scans
- Vacuum-compatible versions available
- Sophisticated controller using vector algorithms, virtual pivot point
- Comprehensive software package

Hexapods are by default configured and delivered as a system including a controller

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

## Fields of application

Research and industry, standard and vacuum environments. For astronomy, optics positioning, aviation and aerospace



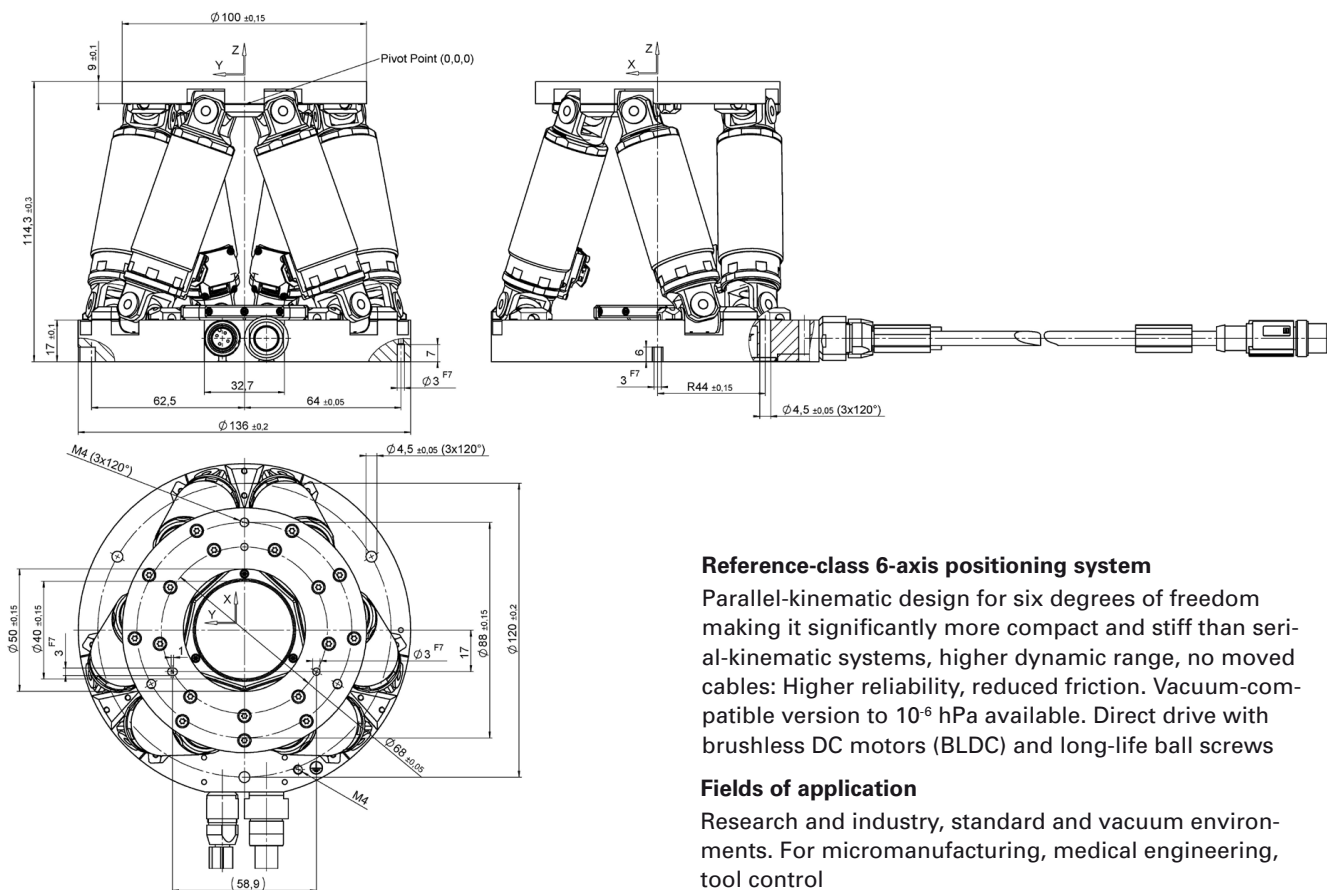
# 6-Axis Miniature Hexapod

FAST, COMPACT AND HIGHLY PRECISE



## H-811.I2

- Travel ranges to  $\pm 17$  mm /  $\pm 21^\circ$
- Load capacity to 5 kg
- Repeatability to  $\pm 0.06 \mu\text{m}$
- Velocity to 20 mm/s
- Superior lifetime
- Vacuum-compatible versions available



### Reference-class 6-axis positioning system

Parallel-kinematic design for six degrees of freedom making it significantly more compact and stiff than serial-kinematic systems, higher dynamic range, no moved cables: Higher reliability, reduced friction. Vacuum-compatible version to  $10^{-6}$  hPa available. Direct drive with brushless DC motors (BLDC) and long-life ball screws

### Fields of application

Research and industry, standard and vacuum environments. For micromanufacturing, medical engineering, tool control



## Specifications

Preliminary data	H-811.I2	Unit	Tolerance
Active axes	X, Y, Z, $\theta_x$ , $\theta_y$ , $\theta_z$		
<b>Motion and positioning</b>			
Travel range* in X, Y, Z	$\pm 17$ , $\pm 16$	mm	
Travel range* in Z	$\pm 6.5$	mm	
travel range* in $\theta_x$ , $\theta_y$	$\pm 10$ , $\pm 10$	°	
travel range* in $\theta_z$	$\pm 21$	°	
Actuator design resolution	5	nm	
Min. incremental motion X, Y	0.2	$\mu\text{m}$	typ.
Min. incremental motion Z	0.08	$\mu\text{m}$	typ.
Min. incremental motion $\theta_x$ , $\theta_y$ , $\theta_z$	2.5	$\mu\text{rad}$	typ.
Backlash X, Y	0.2	$\mu\text{m}$	typ.
Backlash Z	0.06	$\mu\text{m}$	typ.
Backlash $\theta_x$ , $\theta_y$	4	$\mu\text{rad}$	typ.
Backlash $\theta_z$	4	$\mu\text{rad}$	typ.
Repeatability X, Y	$\pm 0.15$	$\mu\text{m}$	typ.
Repeatability Z	$\pm 0.06$	$\mu\text{m}$	typ.
Repeatability $\theta_x$ , $\theta_y$	$\pm 2$	$\mu\text{rad}$	typ.
Repeatability $\theta_z$	$\pm 3$	$\mu\text{rad}$	typ.
Max. velocity X, Y, Z	20	mm/s	
Max. velocity $\theta_x$ , $\theta_y$ , $\theta_z$	500	mrad/s	
Typ. Velocity X, Y, Z	10	mm/s	
Typ. Velocity $\theta_x$ , $\theta_y$ , $\theta_z$	240	mrad/s	
<b>Mechanical properties</b>			
Stiffness X / Y	0.7	N/ $\mu\text{m}$	
Stiffness Z	8	N/ $\mu\text{m}$	
Load capacity (base plate horizontal / any orientation)	5 / 2.5	kg	max.
Holding force, de-energized (base plate horizontal / any orientation)	15 / 2.5	N	max.
Motor type	BLDC motor		
<b>Miscellaneous</b>			
Operating temperature range	0 to 50	°C	
Material	Stainless steel, aluminum		
Mass	2.2	kg	$\pm 5\%$
Cable length	0.5 + 3	m	$\pm 10$ mm

# C-887.52x Hexapod Motion Controller

## Compact Bench-Top Device for Controlling 6-Axis Systems



- Sophisticated controller using vector algorithms
- Commanding in Cartesian coordinates
- Changes of the reference system with a simple command
- Analog interfaces and Motion Stop

### Digital controller for 6-axis parallel kinematics

- High-performance digital controller for hexapods with DC motors. Additional control for two further single axes with integrated ActiveDrive.

### Functions

- Position input via Cartesian coordinates, coordinate transformation handled by the controller. Easy change of the reference system (Work, Tool). The real-time operating system prevents jitter and therefore guarantees constantly low response times. Stable, virtual pivot point can be freely defined in space. Data recorder for operating parameters such as motor control, velocity, position or position errors. Macro command language. The controller supports motor brakes and absolute-measuring sensors with BiSS interface.

### Interfaces

- Ethernet for remote control and remote maintenance. RS-232. USB connection for external input devices (HID).
- Additional interfaces (depending on version):
  - Motion Stop: No reference move is not necessary when the drive is reactivated
  - Analog inputs

### Optional

- Control via manual control unit
- Collision checking for restricted space with PIVeriMove software

### EtherCAT®

#### Also available: C-887.53x Hexapod Motion Controller with EtherCAT® fieldbus interface

- Can be integrated seamlessly into automation systems in industry and research. Performs coordinate transformation for parallel kinematics. Cycle time 1 ms
- Customer requires a higher-level PLC control for position commanding and feedback in Cartesian coordinates (EtherCAT master with CoE protocol).

EtherCAT® is a registered trade mark and patented technology of Beckhoff Automation GmbH, Germany

The detailed description including all data is on our homepage at [www.pi.ws](http://www.pi.ws)

**C-887.52, C-887.521, C-887.522, C-887.523**

<b>Function</b>	6-axis controller for hexapods, incl. control of two additional single axes Compact benchtop Extending the functionality of C-887.52: C-887.521: Additional Analog Inputs C-887.522: Additional Motion Stop C-887.523: Additional Motion Stop and Analog Inputs
Drive type	Servo motors (hexapod and single axes)
<b>Motion and control</b>	
Servo characteristics	32-bit PID controller
Trajectory profile modes	Jerk-controlled generation of dynamics profile with linear interpolation
Processor	Intel Atom dual core (1.8 GHz)
Servo cycle time	100 µs
Encoder input	AB (quadrature) differential TTL signal, 50 MHz BiSS
Stall detection	Servo off, triggered by position error
Reference point switch	TTL
<b>Electrical properties</b>	
Hexapod control	12-bit PWM signal, TTL, 24 kHz
Hexapod power source	24 V
Maximum output current	7 A
<b>Interfaces and operation</b>	
Interface / communication	TCP/IP, RS-232 USB (HID, manual control unit)
Hexapod connection	HD Sub-D 78-pin (f) for data transfer M12 4-pin (f) for power supply
Connectors for single axes	Sub-D 15-pin (f)
I/O lines	HD Sub-D 26-pin (f): 4 × analog input (-10 to 10 V, via 12-bit A/D converter) 4 × digital input (TTL) 4 × digital output (TTL) 2 × BNC, -5 V to 5 V, via 16-bit A/D converter, 5 kHz bandwidth
Analog inputs, only C-887.521 and C-887.523	2 × BNC, -5 V to 5 V, via 16-bit A/D converter, 5 kHz bandwidth
Input for Motion Stop, only C-887.522 and C-887.523	M12 8-pin (f)
Command set	PI General Command Set (GCS)
User software	PIMikroMove
Software drivers	LabVIEW driver, dynamic libraries for Windows and Linux
Manual operation	Optional: C-887.MC manual control unit for hexapods
<b>Miscellaneous</b>	
Operating voltage	24 V external power supply for 100 to 240 VAC, 50 / 60 Hz, in the scope of delivery
Maximum current consumption	8 A
Operating temperature range	5 to 40 °C
Mass	2.8 kg
Dimensions	280 (320) mm × 150 mm × 103 mm Power supply: 170 mm × 85 mm × 42.5 mm

**Scope of Delivery**

The order is made together with suitable hexapod mechanics. Delivery comprises the Hexapod Motion Controller, a hexapod, a cable set, and a power supply as power source.



## Linear Actuators: PICMAWalk, Voice Coil, Servo & Stepper



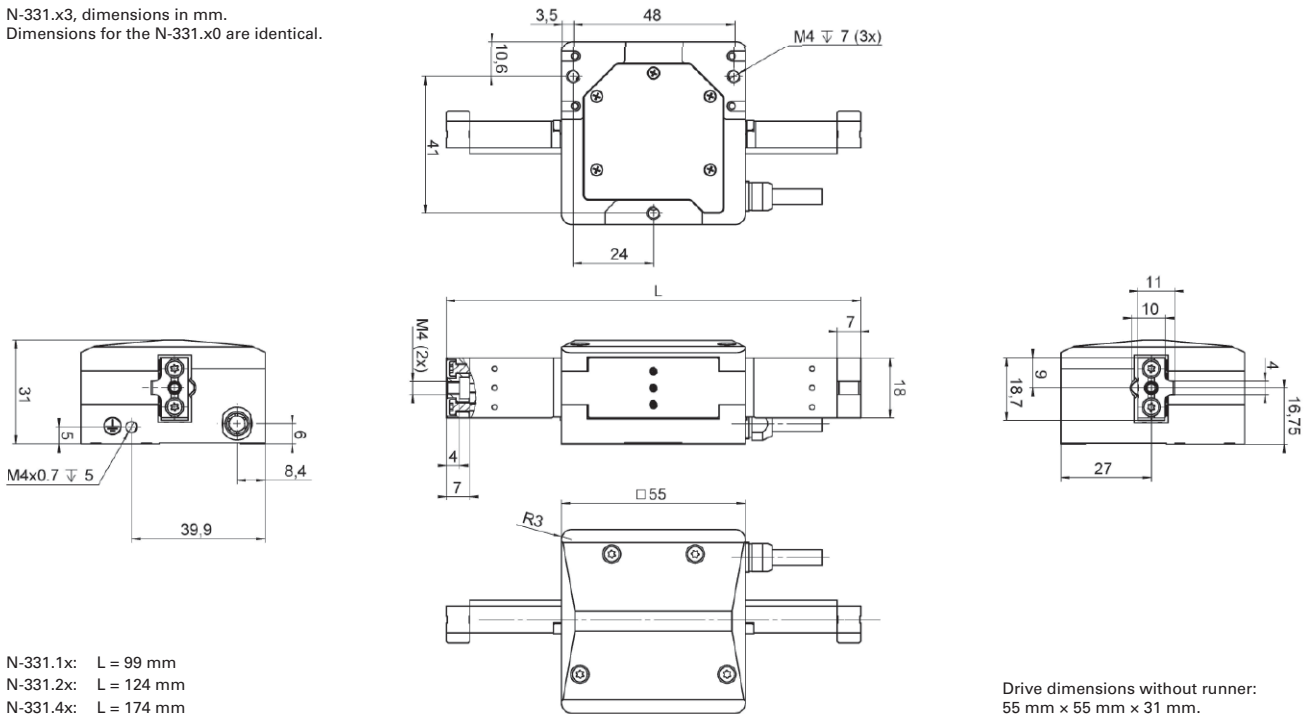
# N-331 PICMAWalk Walking Drive

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.



## Applications

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

	N-331.10 / N-331.13 N-331.20 / N-331.23 N-331.40 / N-331.43	Unit	Tolerance
Active axes	X		
<b>Motion and positioning</b>			
Integrated sensor	N-331.x0: Without sensor N-331.x3: With incremental sensor		
Travel range (step mode, open loop)*	N-331.1x: 30 N-331.2x: 55 N-331.4x: 105	mm	±0.5 mm
Travel range (step mode, closed loop)	N-331.1x: 25 N-331.2x: 50 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	
<b>Mechanical properties</b>			
Push / pull force (active)	50	N	max.
Holding force (passive)	60	N	max.
<b>Drive properties</b>			
Drive type	PICMAWalk		
Operating voltage	-20 to 120	V	
<b>Connectors</b>			
Connector	Sub-D 37 (m)		
<b>Miscellaneous</b>			
Operating temperature range	0 to 50	°C	
Material	Aluminum, stainless steel		
Mass with cable	N-331.1x: 580 N-331.2x: 610 N-331.4x: 660	g	
Moved Mass	N-331.1x: 580 N-331.2x: 610 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		

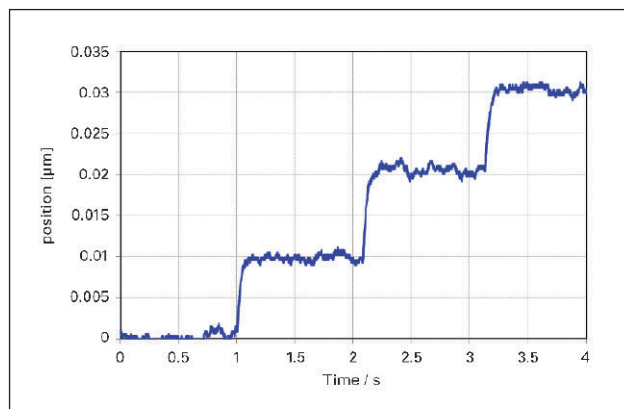
\* From one mechanical hard stop of the runner to the other mechanical hard stop, only in open-loop operation.

\*\* 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.

# V-275 PIMag<sup>®</sup> Voice Coil Linear Actuator, 10N

High Dynamics, with Optional Force Control



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

## PIMag<sup>®</sup> Voice Coil

Voice coil drives consist of 2 essential components: A permanent magnet and a coil, which is located in the air gap of the magnetic field. When current flows through the coil, it moves in the magnetic field of the permanent magnet. The direction of motion depends on the polarity. Thanks to their low weight and friction-free drive principle, voice coil drives are particularly suitable for applications, which require high dynamics and high velocities at limited travel ranges. High scan frequencies and precision positioning are also possible with these drives, because they are free of the effects of hysteresis.

## Highly accurate position measuring with incremental linear encoder

Noncontact optical linear encoders 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.

Complete autofocus system with PIMag<sup>®</sup> voice coil drive. Not only the voice coil stage is supplied by PI but also the alignment tools and an alignment routine to warrant highest precision assembly of the payload



## Applications

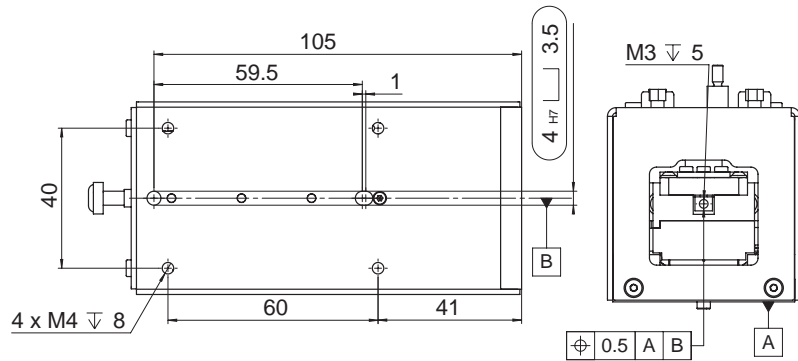
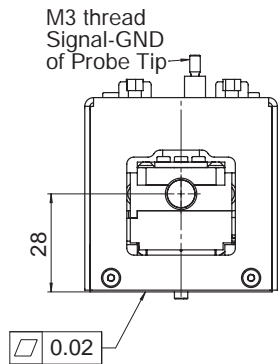
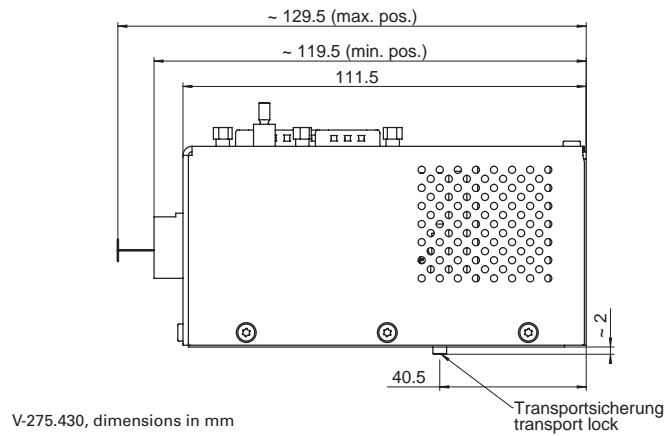
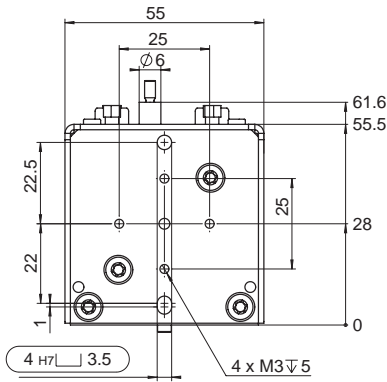
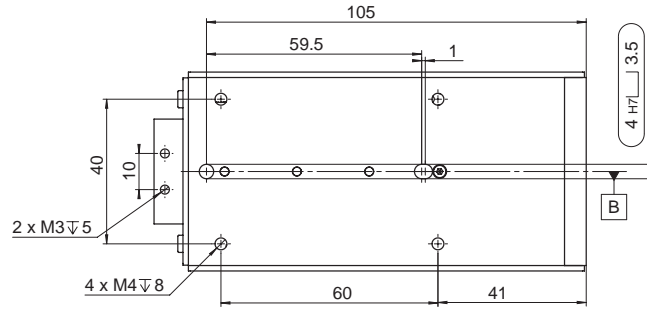
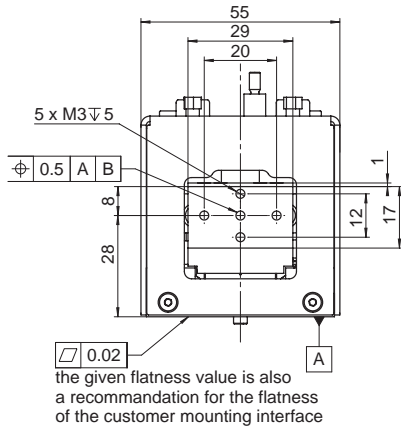
- Sample Inspection
- Precision Micro Assembly
- Electronics Manufacturing
- Metrology / Testing
- General Automation



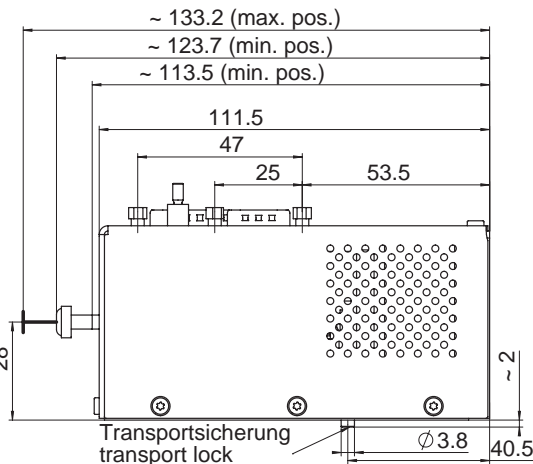
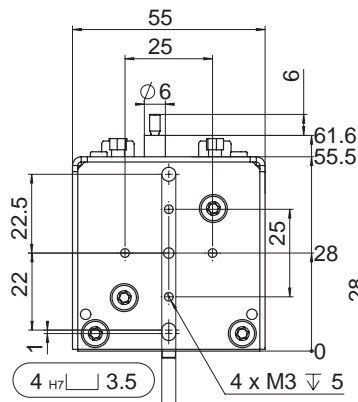
	V-275.430 V-275.431 with force sensor	Unit	Tolerance
Active axes	Z		
<b>Motion and positioning</b>			
Travel range	10	mm	
Integrated sensor	Optical linear encoder		
Sensor resolution	10 <sup>(1)</sup>	nm	max.
Minimum incremental motion	100	nm	typ.
Linearity error, closed loop	1	%	typ.
Repeatability	±0.5	µm	typ.
Velocity	600	mm/s	max.
Force sensor resolution (optional)	1	mN	max.
Smallest force step (optional)	5	mN	typ.
<b>Mechanical properties</b>			
Bearing / guide	Linear recirculating ball bearings		
Motion straightness	±5	µm	±5 %
Moved mass without load	150	g	typ.
<b>Drive properties</b>			
Motor type	PIMag <sup>®</sup> voice coil drive, moving coil		
Coil resistance	5.7	Ω	typ., at 20 °C
Coil inductance	3.75	mH	typ., at 1 kHz
Time constant	0.65	ms	
Back EMF	10	V·s/m	
Force constant	10	N/A	typ.
Motor constant	4.2	N/(√W)	
Current constant	0.1	A/N	typ.
Average continuous current	700 <sup>(2)</sup>	mA	max.
Peak current (max. 3 s)	1500	mA	
Average push/pull force	7	N	nominal
Power dissipation of the coil with 100 % duty cycle	4	W	
Maximum push/pull force	15	N	max.
<b>Miscellaneous</b>			
Operating temperature range	10 to 60	°C	
Material	Aluminum		
Mass	800	g	±5 %
Cable length	3	m	
Motor / sensor connection	Sub-D 25 (m), with force sensor Sub-D 9 (m)		
Lifetime	>10 <sup>7</sup>	cycles	min.
Recommended controller	C-413.1x		

(1) With C-413 controller.

(2) Do not exceed for continuous operation.



the given flatness value is also a recommendation for the flatness of the customer mounting interface



# V-277 PIMag<sup>®</sup> High-Load Linear Actuator, 20N

Voice Coil Drive for High Velocity



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

## PIMag<sup>®</sup> Voice Coil

Voice coil drives consist of 2 essential components: A permanent magnet and a coil, which is located in the air gap of the magnetic field. When current flows through the coil, it moves in the magnetic field of the permanent magnet. The direction of motion depends on the polarity. Thanks to their low weight and friction-free drive principle, voice coil drives are particularly suitable for applications, which require high dynamics and high velocities at limited travel ranges. High scan frequencies and precision positioning are also possible with these drives, because they are free of the effects of hysteresis.

## Highly accurate position measuring with incremental linear encoder

Noncontact optical linear encoders 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.

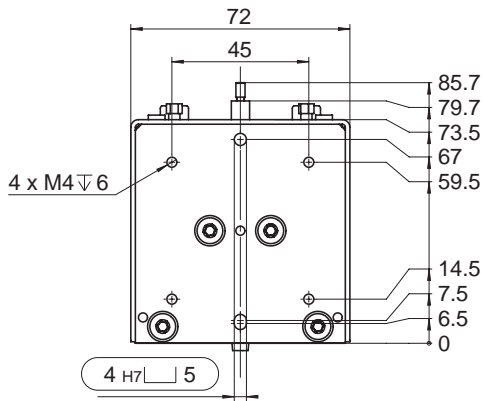
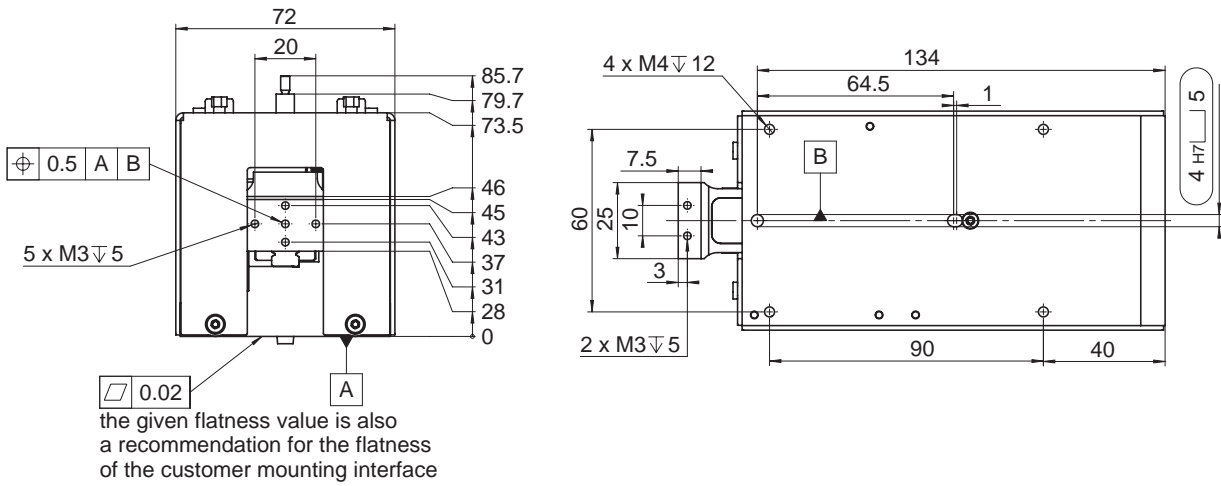
### Applications

- Sample Inspection
- Precision Micro Assembly
- Electronics Manufacturing
- Metrology / Testing
- General Automation

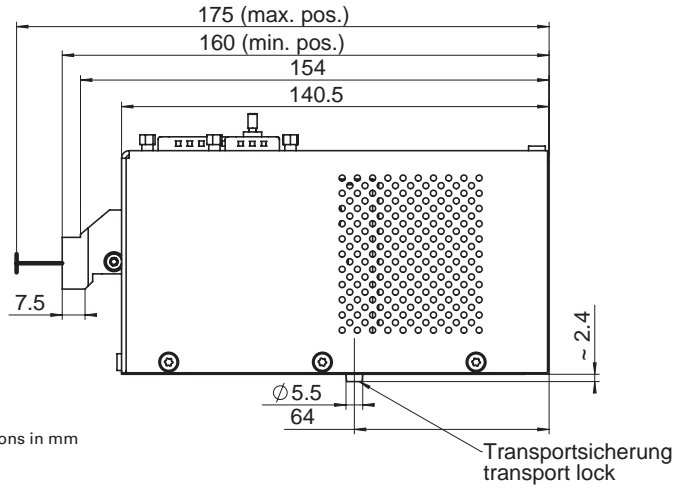
	V-277.630 V-277.631 with force sensor	Unit	Tolerance
Active axes	Z		
<b>Motion and positioning</b>			
Travel range	15	mm	
Integrated sensor	Optical linear encoder		
Sensor resolution	10 <sup>(1)</sup>	nm	max.
Minimum incremental motion	100	nm	typ.
Linearity error, closed loop	1	%	typ.
Repeatability	±0.5	µm	typ.
Velocity	750	mm/s	max.
Force sensor resolution	1	mN	max.
Force resolution, closed-loop	5	mN	typ.
<b>Mechanical properties</b>			
Bearing / guide	Linear recirculating ball bearings		
Motion straightness	±5	µm	±5 %
Moved mass without load	190	g	typ.
<b>Drive properties</b>			
Motor type	PIMag <sup>®</sup> voice coil drive, moving coil		
Coil resistance	6.3	Ω	typ., at 20 °C
Coil inductance	2.70	mH	typ., at 1 kHz, at 20 °C
Time constant	0.43	ms	typ.
Back EMF	14	V·s/m	
Force constant	13.5	N/A	typ.
Motor constant	5.6	N/(√W)	
Current constant	0.072	A/N	typ.
Average continuous current	740 <sup>(2)</sup>	mA	max.
Peak current (max. 3 s)	1500	mA	
Average push/pull force	10	N	nominal
Power dissipation of the coil with 100 % duty cycle	3.2	W	
Maximum push/pull force	20	N	max.
<b>Miscellaneous</b>			
Operating temperature range	10 to 60	°C	
Material	Aluminum		
Mass	1850	g	±5 %
Cable length	3	m	
Motor / sensor connection	Sub-D 25 (m), with force sensor Sub-D 9 (m)		
Lifetime	>10 <sup>7</sup>	cycles	min.
Recommended controller	C-413.1x		

(1) With C-413 controller.

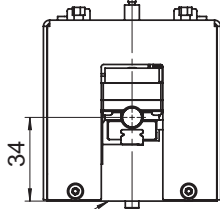
(2) Do not exceed for continuous operation.



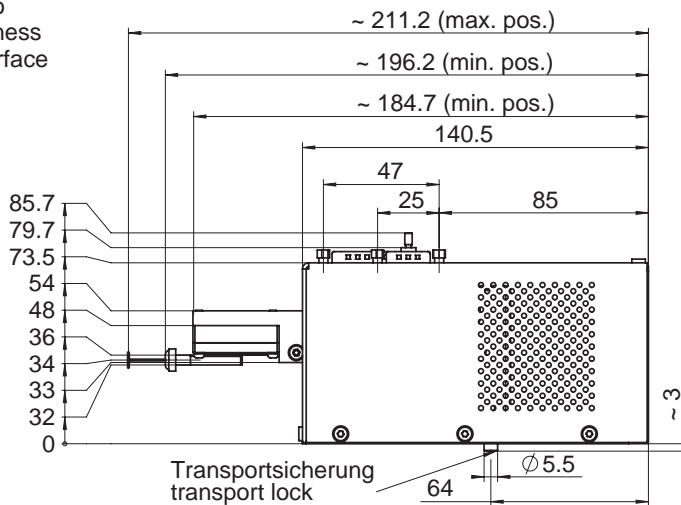
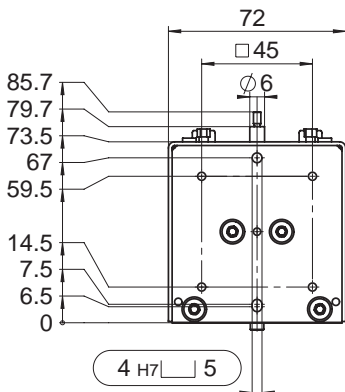
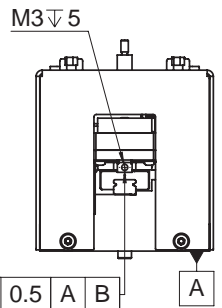
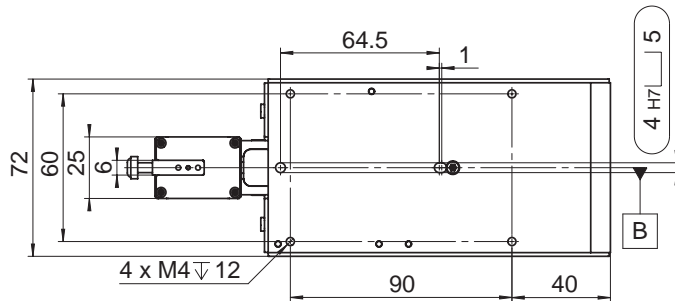
V-277.630, dimensions in mm



M3 thread  
Signal-GND  
of Probe Tip



the given flatness value is also a recommendation for the flatness of the customer mounting interface



V-277.631, dimensions in mm

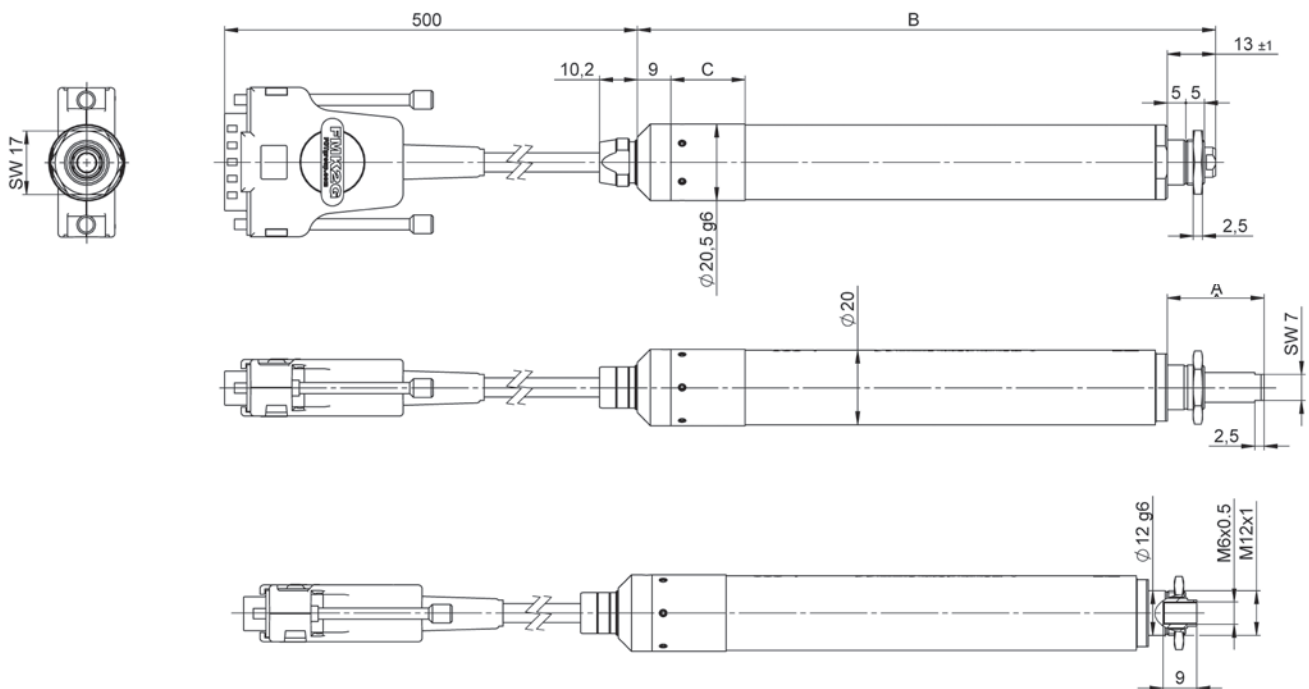
# L-220 High-Resolution Linear Actuator

## Suitable for a High Number of Cycles

- Forces up to 125 N
- Travel ranges 13 to 77 mm (½" to 3")
- DC or stepper motor
- Nonrotating tip
- Vacuum-compatible versions to 10<sup>-9</sup> hPa on request



L-220, dimensions in mm



	Travel	A	B	C
L-220.10SG	13	26	148,3	13
L-220.10DG	13	26	155,2	19,9
L-220.20SG	26	39	161,5	13
L-220.20DG	26	39	168,4	19,9
L-220.50SG	52	65	186,6	13
L-220.50DG	52	65	193,5	19,9
L-220.70SG	77	90	211,6	13
L-220.70DG	77	90	218,5	19,9

### Applications

- Electronics Manufacturing
- General Automation
- Optical Alignment
- Precision Micro Assembly
- Scientific Instrumentation
- Semiconductor

	L-220.x0DG	L-220.x0SG	Unit	Tolerance
	High precision, with DC gear motor	Stepper motor with gearhead		
Motion axes	X	X		
<b>Motion and positioning</b>				
Travel range	13 / 26 / 52 / 77	13 / 26 / 52 / 77	mm	
Integrated sensor	Rotary encoder	–		
Sensor resolution	2048	–	Cts./rev.	
Design resolution	0.022	0.55 (full step)	µm	typ.
Minimum incremental motion	0.1	0.1	µm	typ.
Unidirectional repeatability	0.5	0.5	µm	typ.
Bidirectional repeatability	±1	±1	µm	typ.
Velocity	3.5	0.8	mm/s	max.
<b>Mechanical properties</b>				
Drive screw type	Ball screw	Ball screw		
Thread pitch	1	1	mm	
Gear ratio	12493:567	387283:5103		
Motor resolution	–	384 (29184)*	Steps/rev.	
Push/pull force	125	125	N	max.
Holding force	80	125	N	typ.
Permissible lateral force	1	1	N	max.
<b>Drive properties</b>				
Motor type	DC motor with gearhead	2-phase stepper motor with gearhead		
Operating voltage, nominal	12	12	V	nom.
Operating voltage, max.	24	48	V	max.
Step resolution	–	24	Full steps/rev.	
Limit and reference point switches	Hall effect	Hall effect		
<b>Miscellaneous</b>				
Operating temperature range	5 to 40	5 to 40	°C	
Material	Stainless steel, red brass	Stainless steel, red brass		
Mass	0.21 / 0.23 / 0.26 / 0.29	0.23 / 0.25 / 0.28 / 0.32	kg	±5 %
Moved mass	0.02 / 0.02 / 0.025 / 0.030	0.02 / 0.02 / 0.025 / 0.030	kg	±5 %
Cable length	0.5	0.5	m	±10 mm
Connector	HD Sub-D 26 (m)	HD Sub-D 26 (m)		
Recommended controllers / drivers	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller		

All cables required for operation with the recommended controller are included in the scope of delivery. The cable length is 3 m. Cable for connecting to other controllers can be ordered as accessory. Ask about custom designs!

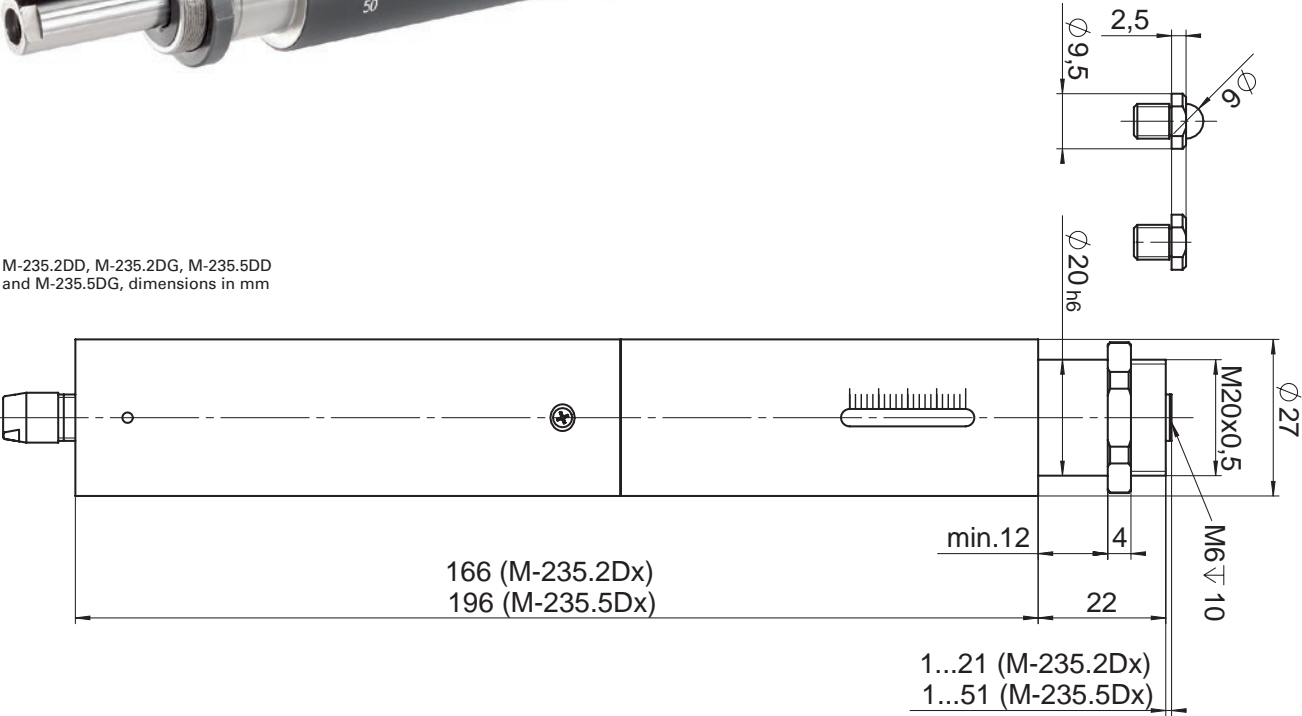
# M-235 High-Resolution Linear Actuator with DC Motor

Highly Dynamic, High Forces up to 120 N

- Travel ranges 20 and 50 mm
- Min. incremental motion to 0.1 μm
- DC motor allows high velocities
- Push/pull force capacity to 120 N
- MTBF >10000 h
- Nonrotating end piece
- Recirculating ball screw



M-235.2DD, M-235.2DG, M-235.5DD and M-235.5DG, dimensions in mm



### Applications

- General Automation
- Optical Alignment
- Scientific Instrumentation



	M-235.2DG M-235.5DG	M-235.2DD M-235.5DD	Unit	Tolerance
	High precision, with DC gear motor	High dynamics		
<b>Motion and positioning</b>				
Travel range	20 / 50	20 / 50	mm	
Integrated sensor	Rotary encoder	Rotary encoder		
Sensor resolution	2048	2048	Cts./rev.	
Design resolution	0.016	0.5	µm	typ.
Minimum incremental motion	0.1	1.5	µm	typ.
Backlash	2	2	µm	typ.
Unidirectional repeatability	±0.1	±0.5	µm	typ.
Velocity	2	30	mm/s	max.
<b>Mechanical properties</b>				
Gear ratio	29.6:1	–		
Push/pull force	120	50	N	max.
Permissible lateral force	8	8	N	max.
<b>Drive properties</b>				
Motor type	DC gear motor	DC motor		
Operating voltage	0 to ±12	0 to ±12	V	
Motor power	4	17	W	nominal
Limit and reference point switches	Hall effect	Hall effect		
<b>Miscellaneous</b>				
Operating temperature range	–20 to 65	–20 to 65	°C	
Material	Aluminum anodized, chrome steel	Aluminum anodized, chrome steel		
Mass	0.55 / 0.7	0.5 / 0.65	kg	±5 %
Cable length	0.5 m, 3 m cables incl.	0.5 m, 3 m cables incl.	m	±10 mm
Connector	15-pin sub-D, incl. encoder driver	15-pin sub-D, incl. encoder driver		
Recommended controllers / drivers	C-863 C-884	C-863 C-884		

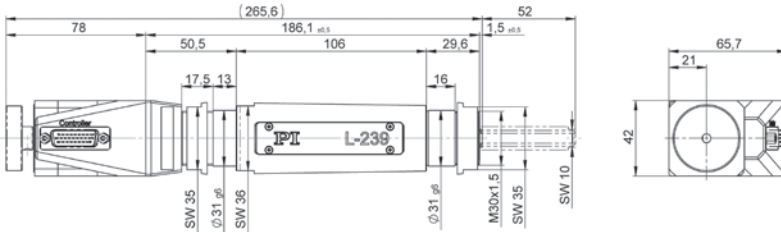
Ask about custom designs!

# L-239 High-Load Linear Actuator

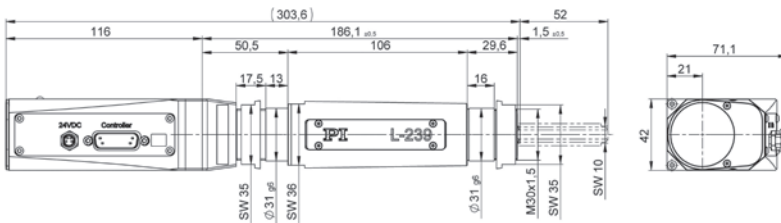
Dynamic, High-Resolution Precision Drive



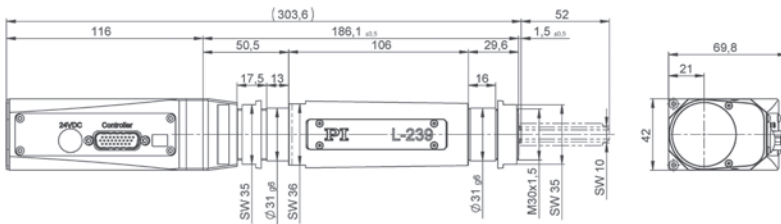
L-239.50SD with stepper motor, dimensions in mm



L-239.50AD with ActiveDrive DC motor, dimensions in mm

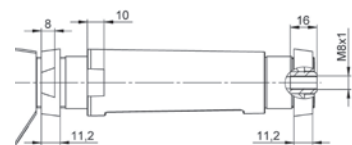


L-239.033232 with DC motor and L-239.035232 with brushless DC motor, dimensions in mm



- Robust design for industrial environments
- High feed force to 300 N
- Travel range 52 mm (2")
- Minimum incremental motion 0.1 μm
- Velocity to 50 mm/s
- Preloaded, low-friction ball screw
- Vacuum-compatible versions to 10<sup>-9</sup> hPa on request
- Stepper, DC and BLDC motors

L-239 shaft, dimensions in mm



## Applications

- Electronics Manufacturing
- General Automation
- Optical Alignment
- Precision Micro Assembly
- Scientific Instrumentation
- Semiconductor

	L-239.50AD L-239.033232 L-239.035232	L-239.50SD	Unit	Tolerance
<b>Motion</b>				
Active axis	X	X		
Travel range	52	52	mm	
Velocity	50	25	mm/s	max.
<b>Positioning</b>				
Integrated sensor	Rotary encoder	–		
Sensor resolution	20000	–	Counts./rev.	
Design resolution	0.05	5 (full step)	µm	typ.
Minimum incremental motion	0.2	0.1	µm	typ.
Unidirectional repeatability	0.2	0.1	µm	typ.
Bidirectional repeatability	±1	±1	µm	typ.
Limit and reference point switches	Hall effect	Hall effect		
<b>Mechanical properties</b>				
Guide type	Recirculating ball bearings	Recirculating ball bearings		
Drive screw type	Ball screw	Ball screw		
Drive screw pitch	1	1	mm	
Push/pull force	300	300	N	max.
Holding force, power off	40	80		
Permissible lateral force	10	10	N	max.

	L-239.50AD	L-239.50SD	L-239.033232	L-239.035232	Unit	Tolerance
<b>Drive properties</b>						
Motor type	DC motor with PWM control	2-phase stepper motor	DC motor	BLDC motor		
Operating voltage, nominal	24	24	24	24	V	nom.
Operating voltage, max.	24	48	48	48		max.
Step resolution	–	200	–	–	Full steps/rev.	
<b>Miscellaneous</b>						
Operating temperature range	5 to 40	5 to 40	5 to 40	5 to 40	°C	
Material	Aluminum, stainless steel	Aluminum, stainless steel	Aluminum, stainless steel	Aluminum, stainless steel		
Mass	1.72	1.65	1.75	1.75	kg	±5 %
Moved mass	0.155	0.155	0.155	0.155	kg	±5 %
Connector	Sub-D 15 (m)	HD Sub-D 26 (m)	HD Sub-D 26 (m)	HD Sub-D 26 (m)		
Recommended controllers / drivers	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-663.12 (single axis) SMC Hydra (double axis) C-885 with C-663.12C885 (up to 20 axes) ACS modular controller	C-863 (single axis) C-884 (up to 6 axes) C-885 with C-863.20C885 (to 40 axes) ACS modular controller	C-891 (single axis) C-885 with C-891.10C885 (up to 20 axes) ACS modular controller		

All cables required for operation with the recommended controller are included in the scope of delivery. The cable length is 3 m. Cable for connecting to other controllers can be ordered as accessory.

Ask about custom designs!

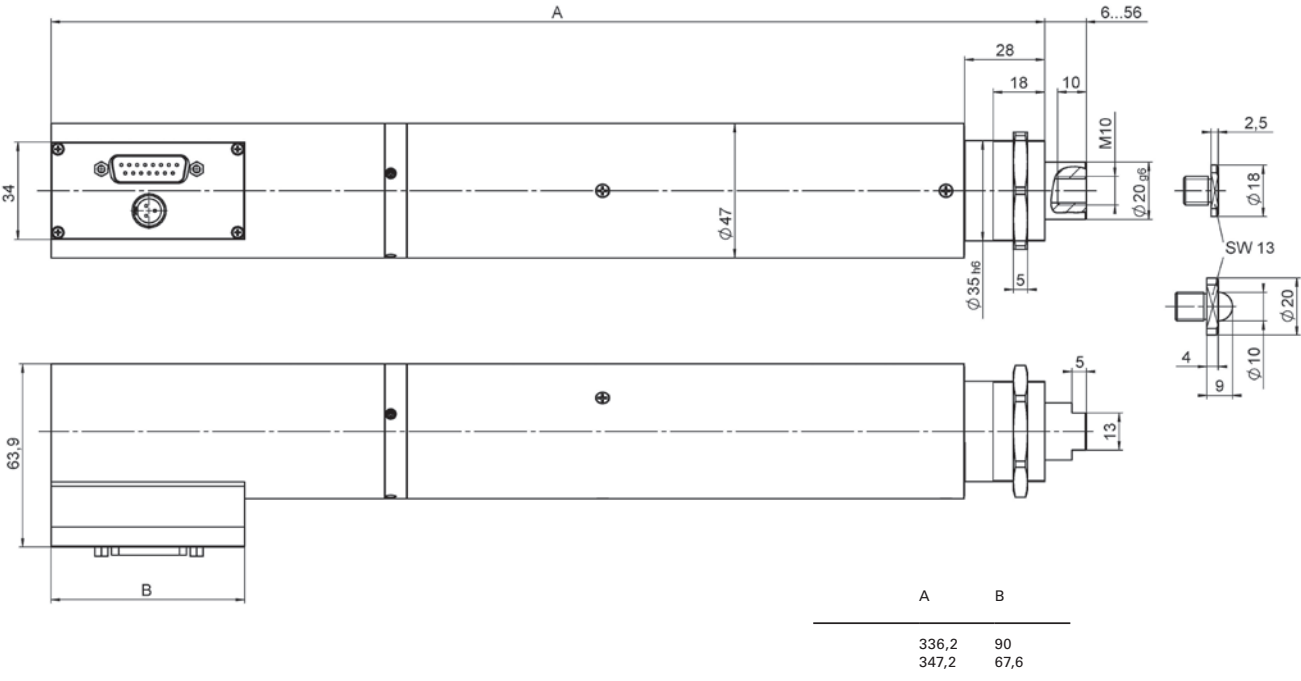
# M-238 High-Load Actuator with Linear Encoder

## Dynamic, High-Resolution Precision Drive

- Optional linear encoder for direct position measurement
- High load capacity to 400 N
- Travel range 50 mm
- Resolution to 0.1  $\mu\text{m}$
- Velocity to 30 mm/s
- Nonrotating end piece
- Recirculating ball screw



M-238, dimensions in mm

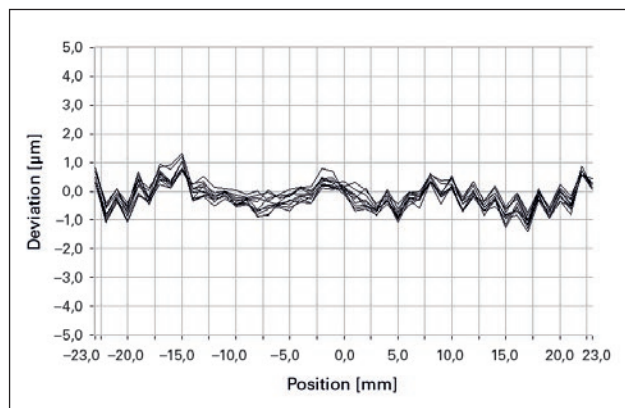


### Applications

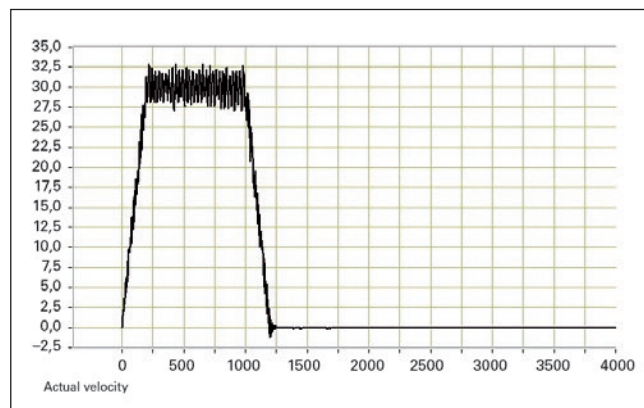
- General Automation
- Optical Alignment
- Scientific Instrumentation

	M-238.5PG	M-238.5PL	Unit	Tolerance
	Rotary encoder on motor shaft	Highest precision with linear encoder		
<b>Motion and positioning</b>				
Travel range	50	50	mm	
Integrated sensor	Rotary encoder	Linear encoder		
Sensor resolution	4000 cts/rev	0.1 $\mu\text{m}$		
Design resolution	0.13	0.1	$\mu\text{m}$	typ.
Minimum incremental motion	0.5	0.3	$\mu\text{m}$	typ.
Backlash	3	1	$\mu\text{m}$	typ.
Unidirectional repeatability	$\pm 1$	$\pm 0.3$	$\mu\text{m}$	typ.
Velocity	30	30	mm/s	max.
Reference point switch repeatability	1	1	$\mu\text{m}$	typ.
<b>Mechanical properties</b>				
Drive screw pitch	2	2	mm	
Gear ratio	3.71:1	3.71:1		
Push/pull force	400	400	N	max.
Permissible lateral force	100	100	N	max.
<b>Drive properties</b>				
Motor type	DC motor, ActiveDrive	DC motor, ActiveDrive		
Motor voltage	24 V	24 V	V	
Motor power	80	80	W	nominal
<b>Miscellaneous</b>				
Operating temperature range	-10 to 50	-10 to 50	$^{\circ}\text{C}$	
Material	Aluminum anodized, chrome steel	Aluminum anodized, chrome steel		
Mass	2.4	2.4	kg	$\pm 5\%$
Cable length	3	3	m	$\pm 10\text{ mm}$
Connector	Sub-D 15	Sub-D 15		
Recommended controllers / drivers	C-863 C-884	C-863 C-884		

Ask about custom designs!



The repeatability of the M-238.5PL with linear encoder is less than 0.3  $\mu\text{m}$ .



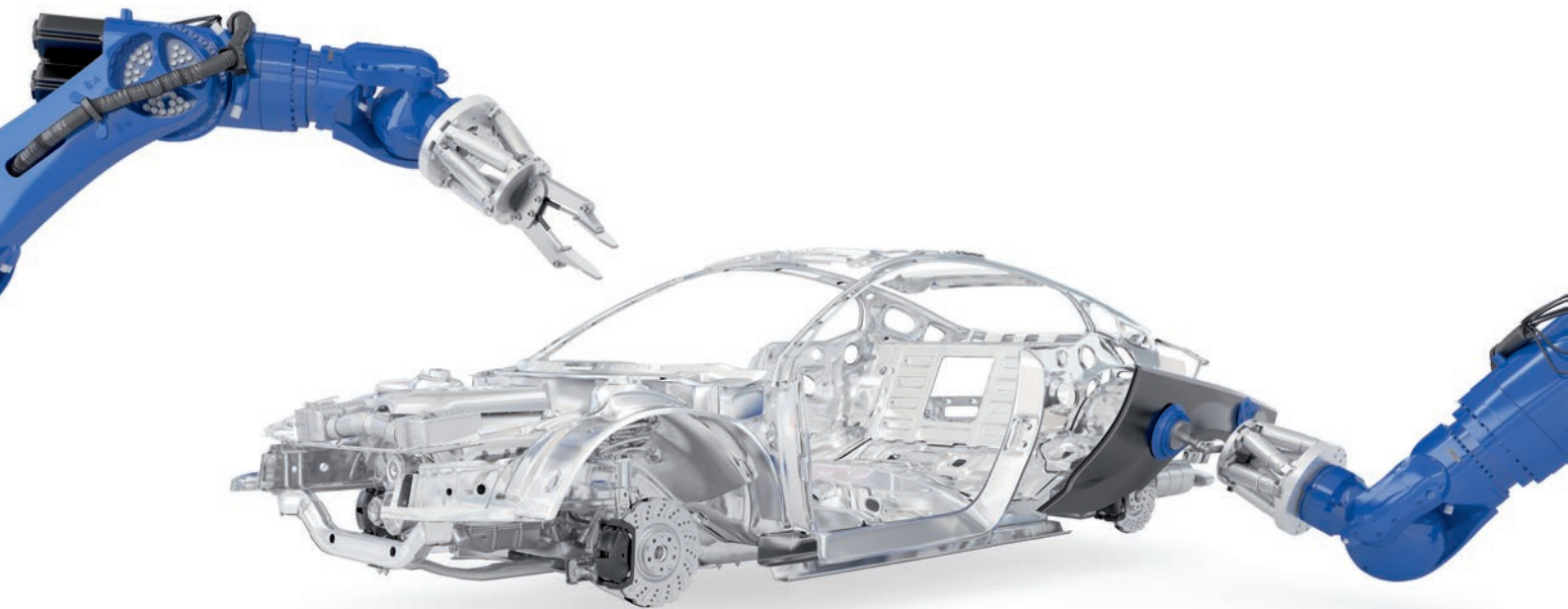
The velocity constancy of an M-238.5PL at 30 mm/s.



## Motion Control



# Solutions for Motion Centric Industrial Automation



Positioning and motion tasks in industrial automation such as those in assembly, semiconductor manufacturing, mechanical engineering, laser material processing, inspection systems or in additive manufacturing demand solutions that need to be robust and reliable. Submicrometer accuracy, exact position reproducibility, high dynamics, and throughput are just as essential. This is particularly the case with industry 4.0 where safety and simple networking options play an important role.

## SMARTER MOTION AND POSITIONING

What makes a positioner and motion solution smart? What functions and features offer to make smart motion and positioning possible? PI has identified the following list of basic requirements that make it possible to offer solutions for industrial applications that fulfill the high demands for precision and dynamics irrespective of the number of motion axes.

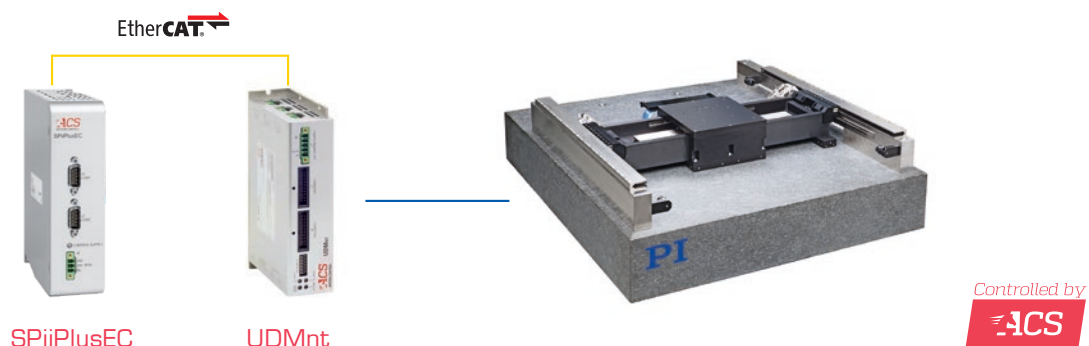
- Functional safety
- Communication via fieldbus interfaces
- Autotuning
- Synchronization of the individual axes in the system
- Multidimensional motion profiles
- 3-DOF compensation of the position error
- Yaw compensation for gantry solutions
- Suppression of system oscillation
- Robust control behavior
- Easy integration into the higher-level automation environment



## COMPLETE SOLUTIONS FOR HIGH-THROUGHPUT AND HIGH-PRECISION MULTI-AXIS APPLICATIONS

Those requirements can only be fulfilled when the mechanics, drive technology, and control electronics of the positioning system are perfectly matched to each other.

A solution from a single-source supplier does not just offer the customer sophisticated positioning technology and high-performance control solutions, but also faster start-up and high flexibility when implementing new requirements.



## HIGH-PERFORMANCE MOTION CONTROL SYSTEMS

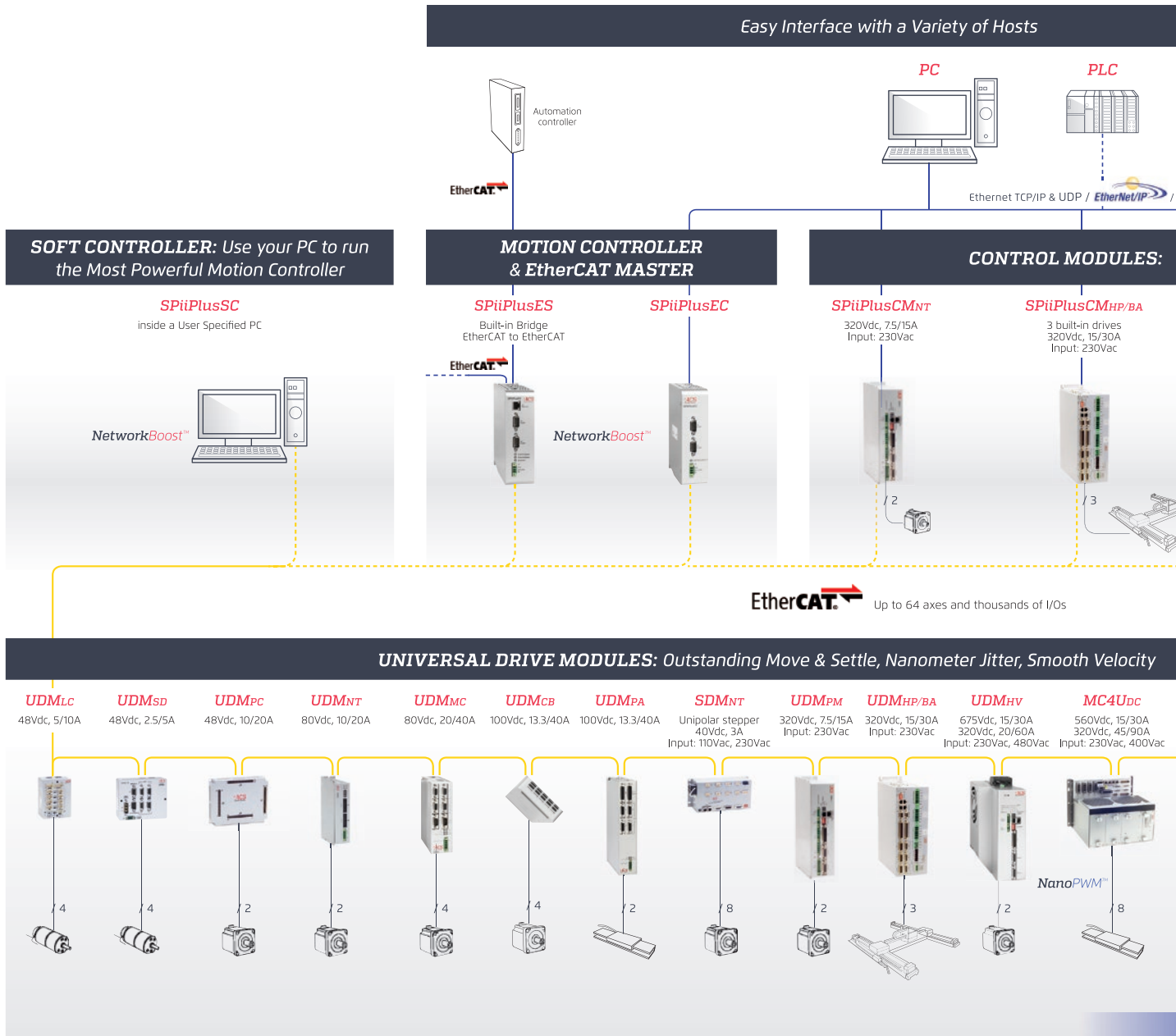
ACS Motion Control offers distributed-architecture motion control systems, completely modular, with components organized over three levels: The first level is the user interface. This is basically the host software and allows communication with the motion system.

The devices on the second level are called motion controllers. The motion controller is responsible for communication with the host software and also takes care of everything related to profile generation, trajectory, macros, diagnostics, and so on. The position commands are sent to the universal drive modules on the third level via an EtherCAT real-time network. In some products, the motion controller, the drives, and the power supplies are integrated into one housing. These products are called control modules.

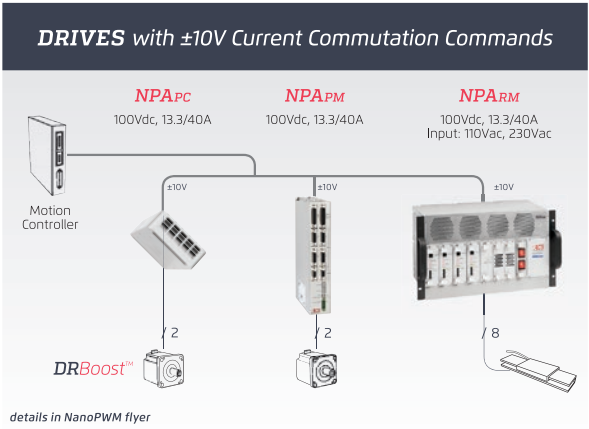
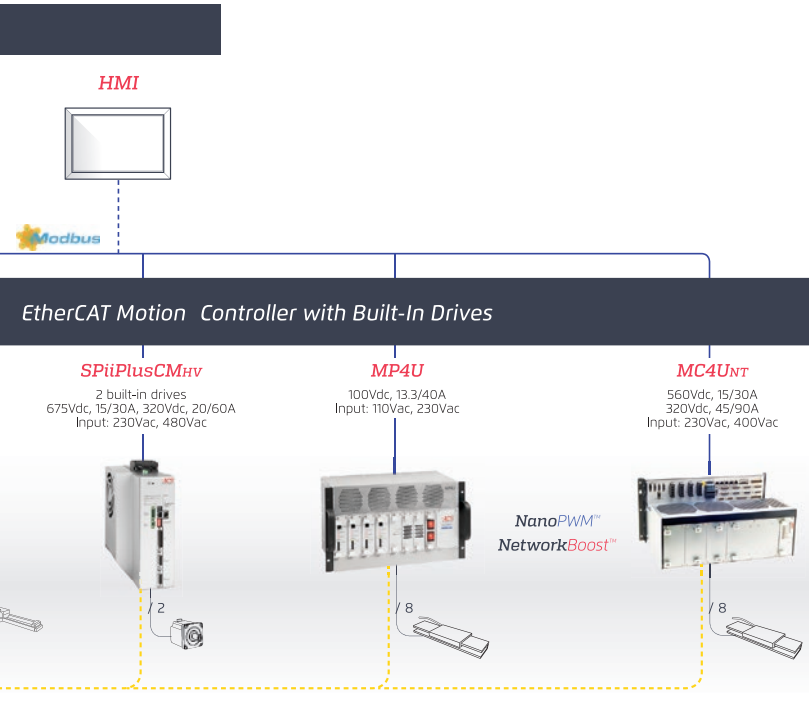
The universal drive modules on the third level include the digital servo processor (DSP). It performs the servo positioning of the axes. The drive modules power and actuate the motors, handle the feedback devices, manage the I/Os, and analyze the sensor signals for closed-loop positioning control.

# Overview of Available ACS Motion Control Modules

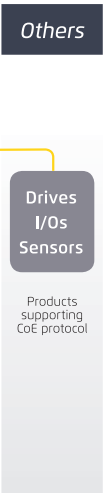
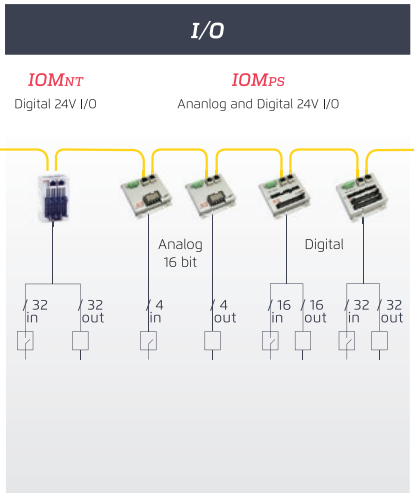
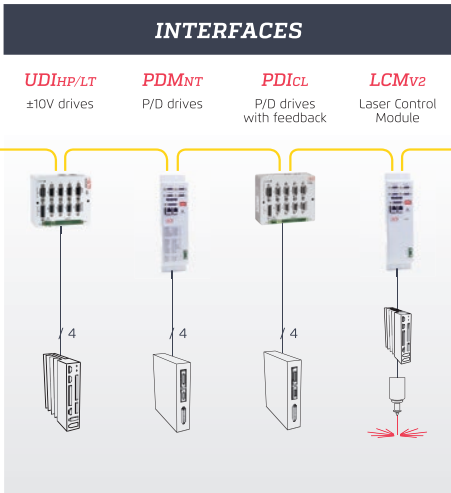
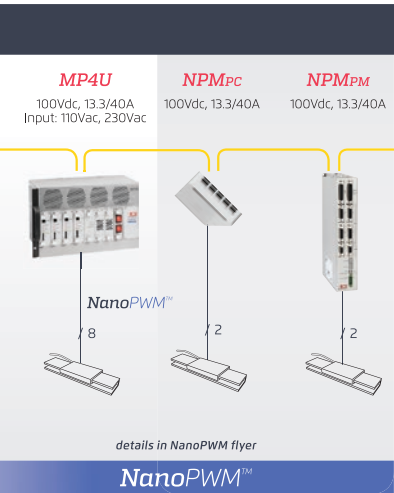
PI offers complete systems that implement the ACS motion control solutions



EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.



NanoPwm™



Motion Control

# ACS Motion Control for Motion Centric Industrial Automation

## Available Modules

### EtherCAT® Motion Controller



**SPiiPlusEC Powerful Motion Controller and EtherCAT® Network Manager**  
up to 64 axes and thousands of I/O's



**SPiiPlusES High Performance Multi-Axis Controller with Built-in EtherCAT®-to-EtherCAT® Bridge**  
up to 64 axes and thousands of I/O's



**SPiiPlusSC Software Based Powerful Motion Controller and EtherCAT® Network Manager**  
up to 64 axes and thousands of I/O's

### Control Modules



**MC4Unt Customized Multi-axis Control Using Standard Components**  
2 to 8 drives, wide power range



**SPiiPlusCMnt 32-Axis EtherCAT® Master Control Module with 2 Built-in Drives**  
1, 2 drives 85 – 265 V-AC, up to 7.5/15 A



**SPiiPlusCMhp/ba 32-Axis EtherCAT® Master Control Module with 3 Built-in Drives**  
1 to 3 drives, 85 – 265 V-AC, up to 15/30 A



**SPiiPlusCMhv 32-Axis EtherCAT® Master Control Module with 2 Built-in High-Voltage Drives**  
1, 2 axes, 230 – 480 V-AC, up to 15/30 A, or 230 V-AC, 20/60 A

### User Interface Software Applications

**SPiiPlusSPC Smart Processing Commander**  
Machine Control Interface for High-Precision Laser Processing Applications

**SPiiPlusSMC Smart Motion Commander**  
Customizable CNC HMI Platform for High-Precision Machining and Processing Applications

## Drives with $\pm 10$ V Interface



**NPAPc Single/Dual Axis NanoPWM Drive with  $\pm 10$  V Current Commutation Commands**

1,2 drives, 12–100 V, up to 13.3/40 A, PCB mount



**NPAPm Single/Dual Axis NanoPWM Drive with  $\pm 10$  V Current Commutation Commands**

1,2 drives, 12–100 V, up to 13.3/40 A



**NPAPm 2 to 8 Axis NanoPWM Drive system with  $\pm 10$  V Current Commutation Commands and Power Supply**

2 to 8 drives, up to 96 V, up to 13.3/40 A, rack mount

## Interfaces



**UDIhp/lt EtherCAT® Dual/Quad Axis Motor Drive Interface**

2 to 4 axes,  $\pm 10$  V interface to external motor drives



**PDMnt EtherCAT® Quad Axis P/D Interface Module**

4 axes, Pulse/Direction interface to external motor drives



**PDIcl EtherCAT® Dual/Quad Axis Interface Module for P/D with Feedback**

2, 4 axes, Pulse/Direction interface to external motor drives



**IOMnt EtherCAT® Digital I/O Module**

up to 32 digital inputs and outputs, 24 V-DC

# ACS Motion Control for Motion Centric Industrial Automation

## Available Modules

### Universal Drive Modules with 48 V DC



**UDMic EtherCAT® Dual/  
Quad Axis Drive Module**  
2, 4 drives, 12–48 V, up to  
5/10 A



**UDMsd EtherCAT® Dual/  
Quad Axis Drive Module**  
2, 4 drives, 12–48 V, up to  
2.5/5 A



**UDMpc EtherCAT® Single/  
Dual Axis Drive Module**  
1, 2 drives, 24–48 V, up to  
10/20 A, PCB mount

### Universal Drive Modules with 80 V DC



**UDMnt EtherCAT® Single/  
Dual Axis Drive Module**  
1, 2 drives, 12–80 V, up to  
10/20 A



**UDMmc EtherCAT® Drive Module,  
Compact, Cost Effective**  
2, 4 drives, 12–80 V, up to  
20/40 A

### Universal Drive Modules with AC



**UDMpm EtherCAT®  
Single/Dual Axis Drive  
Module**  
1, 2 drives, 85–265 V,  
up to 7.5/15 A



**UDMhp/ba EtherCAT®  
Drive Module, Compact,  
Powerful**  
1 to 3 drives, 85–265 V-AC,  
up to 15/30 A



**UDMhv EtherCAT® Single/  
Dual Axis High Voltage Drive  
Module**  
1, 2 drives, 230–480 V-AC,  
up to 15/30 A or 230 V-AC  
20/60 A

## Universal Drive Modules with NanoPWM



**NPMpc EtherCAT® Single/Dual Axis NanoPWM Drive Module**  
1, 2 drives, 12–100 V, up to 13.3/40 A, PCB mount



**NPMpm EtherCAT® Single/Dual Axis NanoPWM Drive Module**  
1, 2 drives, 12–100 V, up to 13.3/40 A

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## Other Universal Drive Modules



**UDMcb Economical EtherCAT® Single/Dual Axis Drive Module**  
1, 2 drives, up to 100 V, 13.3/40 A, PCB mount



**UDMpa EtherCAT® Single/Dual Axis Drive Module**  
1, 2 drives, up to 100 V, 13.3/40 A

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## Stepper Drive Module



**SDMnt EtherCAT® 4/8 Axis Stepper Drive Module**  
4, 8 unipolar stepper motor drives, 40 V, 3 A

# A-81x Pliglide Motion Controller for 1, 2 or 4 Axes

For Stages with Direct Drive, TCP/IP Interface



- 1, 2, & 4 motion axes
- Fully integrated closed-loop servo control, amplifier module, and power supplies
- For voice coil drives, DC motors and brushless 3-phase motors
- Quiet PWM drives
- Encoder inputs support sine/cosine and BiSS-C
- 5 A continuous current / 10 A peak output current per axis

## Overview

The A-81x motion controller series from PI offers a fully integrated electronics solution with controller, drives, and power supplies in a compact 19-inch rack unit. The A-81x controllers are designed and optimized for Pliglide air bearing stages that are equipped with direct drive linear and rotation servo motors, and high-resolution encoders.

Standard options include inputs for incremental sine/cosine and absolute encoders that use the BiSS-C data protocol. Support for sine/cosine encoders has an integrated interpolation factor of 16384x. All controllers feature integrated flash memory for stored motion programs and parameters.

The A-81x controllers can be operated in stand-alone mode running stored programs, or controlled via an external PC. A PC is required for programming and startup. All software is supplied with the controller.

If the controller is purchased together with a Pliglide air bearing stage or positioning system, PI will perform the servo tuning, startup of the controller, and error calibration, and supply a complete ready-to-use positioning system.

The A-81x motion controller features the state of the art ACS SPiiPlusEC motion controller and EtherCAT® master, and includes ServoBoost™ for up to eight axes of motion. ServoBoost™ provides better, more consistent servo performance that is insensitive to noise or changes in the system.

## Options

- Absolute encoders or incremental encoders (can be combined individually according to customer specifications for all axes of the controller)
- G-Code programming
- Input shaping
- Additional control axes for external drives via EtherCAT®
- Alternative customized packaging for OEM designs



	<b>A-811.21x00</b>	<b>A-812.21x00</b>	<b>A-814.21x00</b>
Number of axes	1	2	4
Controller type	Closed-loop servo control (PID), parameter changing during operation	Closed-loop servo control (PID), parameter changing during operation	Closed-loop servo control (PID), parameter changing during operation
Servo-frequency position control	10 kHz	10 kHz	10 kHz
Servo frequency current control	20 kHz	20 kHz	20 kHz
Trajectory profiles	Point-to-point, jog, s-curve	Point-to-point, jog, s-curve, interpolated coordinated multi-axis profiles	Point-to-point, jog, s-curve, interpolated coordinated multi-axis profiles
Cooling	Fan on the side (continuous operation, constant speed)	Fan on the side (continuous operation, constant speed)	Fan on the side (continuous operation, constant speed)
Drive type	PWM	PWM	PWM
Motor types	Voice coil Brushed DC motor Brushless 3-phase motor with sine commutation	Voice coil Brushed DC motor Brushless 3-phase motor with sine commutation	Voice coil Brushed DC motor Brushless 3-phase motor with sine commutation
Encoder options (factory default) (Can be configured individually for combinations according to customer specifications)	Incremental sine/cosine (1 V <sub>pp</sub> ) A/B quadrature (RS-422) (on request), Absolute encoder BiSS-C	Incremental sine/cosine (1 V <sub>pp</sub> ) A/B quadrature (RS-422) (on request), Absolute encoder BiSS-C	Incremental sine/cosine (1 V <sub>pp</sub> ) A/B quadrature (RS-422) (on request), Absolute encoder BiSS-C
Output current (per axis)	5 A continuous operation, 10 A peak	5 A continuous operation, 10 A peak	5 A continuous operation, 10 A peak
<b>Interfaces</b>			
Communication	Ethernet: TCP/IP, 100/1000 Mbps Ethernet/IP Modbus	Ethernet: TCP/IP, 100/1000 Mbps Ethernet/IP Modbus	Ethernet: TCP/IP, 100/1000 Mbps Ethernet/IP Modbus
User I/O (without reference and limit switch)	2 × digital input, 24 V DC, sink 2 × digital output, 24 V DC, source 1 × analog input, differential, 12 bit 1 × analog output, differential, 10 bit 1 × RS-422 high-speed output for position trigger (PEG)	2 × digital input, 24 V DC, sink 2 × digital output, 24 V DC, source 1 × analog input, differential, 12 bit 1 × analog output, differential, 10 bit 2 × RS-422 high-speed output for position trigger (PEG)	4 × digital input, 24 V DC, sink 4 × digital output, 24 V DC, source 2 × analog input, differential, 12 bit 2 × analog output, differential, 10 bit 4 × RS-422 high-speed output for position trigger (PEG)
Interlock / motion-stop	1 × 24 V DC sink	1 × 24 V DC sink	1 × 24 V DC sink
Connector interface	Rear panel connectors Sub-D for motor and signal connections IEC 60320 type C14 for power supply	Rear panel connectors Sub-D for motor and signal connections IEC 60320 type C14 for power supply	Rear panel connectors Sub-D for motor and signal connections IEC 60320 type C14 for power supply
<b>Miscellaneous</b>			
Power supply	120 – 240 V AC, single phase, 50 – 60 Hz (factory default), 600 W	120 – 240 V AC, single phase, 50 – 60 Hz (factory default), 600 W	120 – 240 V AC, single phase, 50 – 60 Hz (factory default), 600 W
Mass (approx.)	8.5 kg	8.5 kg	9.3 kg
Dimensions	19" rack unit, 483 mm × 88 mm × 487 mm (incl. handles)	19" rack unit, 483 mm × 88 mm × 487 mm (incl. handles)	19" rack unit, 483 mm × 88 mm × 487 mm (incl. handles)

# A-82x

## Pliglide Motion Controller for 4, 6 or 8 Axes

For Stages with Direct Drive and High Power Requirements, TCP/IP Interface



- 4, 6 or 8 high-performance motion axes
- Fully integrated closed-loop servo control, amplifier module, and power supplies
- For voice coil drives, DC motors and brushless 3-phase motors
- Quiet PWM drives
- Encoder inputs support sine/cosine and BiSS-C
- 10 A continuous current / 20 A peak output current per axis

### Overview

The A-82x motion controller series from PI offers a fully integrated electronics solution with controller, drives, and power supplies in a compact 4-U-high 19-inch rack unit. The A-824 supplies continuous power of 2 kW. The A-82x controllers are designed and optimized for Pliglide air bearing stages that are equipped with direct drive linear and rotation servo motors, and high-resolution encoders.

Standard options include inputs for incremental sine/cosine and absolute encoders that use the BiSS-C data protocol. Support for sine/cosine encoders has an integrated interpolation factor of 16384x. All controllers feature integrated flash memory for stored motion programs and parameters.

The A-82x controllers can be operated in stand-alone mode running stored programs, or controlled via an external PC. A PC is required for programming and startup. All software is supplied with the controller.

If the controller is purchased together with a Pliglide air bearing stage or positioning system, PI will perform the servo tuning, startup of the controller, and error calibration, and supply a complete ready-to-use positioning system.

The A-82x motion controller features the state of the art ACS SPiPlusEC motion controller and EtherCAT® master, and includes ServoBoost™ for up to eight axes of motion. ServoBoost™ provides better, more consistent servo performance that is insensitive to noise or changes in the system.

### Options

- Absolute encoders or incremental encoders (can be combined individually according to customer specifications for all axes of the controller)
- G-Code programming
- Input shaping
- Additional control axes for external drives via EtherCAT®
- Alternative customized packaging for OEM designs

	<b>A-824.21x00</b>	<b>A-826.21x00</b>	<b>A-828.21x00</b>
Number of axes	4	6	8
Controller type	Closed-loop servo control (PID), parameter changing during operation	Closed-loop servo control (PID), parameter changing during operation	Closed-loop servo control (PID), parameter changing during operation
Servo-frequency position control	10 kHz	10 kHz	10 kHz
Servo frequency current control	20 kHz	20 kHz	20 kHz
Trajectory profiles	Point-to-point, jog, s-curve, interpolated coordinated multi-axis profiles	Point-to-point, jog, s-curve, interpolated coordinated multi-axis profiles	Point-to-point, jog, s-curve, interpolated coordinated multi-axis profiles
Cooling	Fan on the side (continuous operation, constant speed)	Fan on the side (continuous operation, constant speed)	Fan on the side (continuous operation, constant speed)
Drive type	PWM	PWM	PWM
Motor types	Voice coil Brushed DC motor Brushless 3-phase motor with sine commutation	Voice coil Brushed DC motor Brushless 3-phase motor with sine commutation	Voice coil Brushed DC motor Brushless 3-phase motor with sine commutation
Encoder options (factory default) (Can be configured individually for combinations according to customer specifications)	Incremental sine/cosine (1 V <sub>pp</sub> ) A/B quadrature (RS-422) (on request), Absolute encoder BiSS-C	Incremental sine/cosine (1 V <sub>pp</sub> ) A/B quadrature (RS-422) (on request), Absolute encoder BiSS-C	Incremental sine/cosine (1 V <sub>pp</sub> ) A/B quadrature (RS-422) (on request), Absolute encoder BiSS-C
Interpolation factor sine/cosine encoder	4 x to 16384x (can be adjusted by software)	4 x to 16384x (can be adjusted by software)	4 x to 16384x (can be adjusted by software)
Output voltage	72 VDC	72 VDC	72 VDC
Output current (per axis)	10 A continuous operation, 20 A peak (<1 s)	10 A continuous operation, 20 A peak (<1 s)	10 A continuous operation, 20 A peak (<1 s)
Output power (total)	1100 W continuous operation 3900 W peak	1700 W continuous operation 3900 W peak	2000 W continuous operation 3900 W peak

	<b>A-82x</b>
<b>Interfaces</b>	
Communication	Ethernet: TCP/IP, 100/1000 Mbps Ethernet/IP Modbus
User I/O (without reference and limit switch)	4 × digital input, 24 V DC, sink 3 × digital output, 24 V DC, source 2 × analog input, differential, 12 bit 2 × analog output, differential, 10 bit 4 × RS-422 high-speed output for position trigger (PEG)
Interlock / motion-stop	1 × 24 V DC
Connector interface	Rear panel connectors Sub-D for motor and signal connections IEC 60320 type C20 for power supply

	<b>A-824.2x00</b>	<b>A-826.21x00</b>	<b>A-828.21x00</b>
<b>Miscellaneous</b>			
Power supply	200 – 240 V AC, single phase, 50 – 60 Hz	200 – 240 V AC, single phase, 50 – 60 Hz	200 – 240 V AC, single phase, 50 – 60 Hz
Mass (approx.)	13.6 kg	14.4 kg	15.2 kg
Dimensions	19" rack unit, 483 mm × 171 mm × 495 mm (incl. handles)	19" rack unit, 483 mm × 171 mm × 495 mm (incl. handles)	19" rack unit, 483 mm × 171 mm × 495 mm (incl. handles)

# C-885 PIMotionMaster

Rack with Processor and Interface Module for Modular Multi-Axis Controller System



- Easy configuration and startup
- Modular design for versatile expansion
- Efficient communication with the controller modules
- Greatly reduced wiring effort
- Saves space and costs

## Easy installation

Plug-and-play installation of the controller modules in the C-885 PIMotionMaster. The processor and interface module communicates with the PIMikroMove software and with the controller modules. It detects the available controller module type automatically. Grouping the controller modules in one housing ensures internal communication and reduces the wiring effort because of the common power supply and external communication via a single USB or Ethernet interface.

## Easy to expand

The system is easily scalable. An additional controller module can be inserted into any free slot and expands the overall system by the corresponding functions. Optional digital inputs and outputs can be installed for every controller module.

## Controller modules

- C-863.20C885 DC Motor Controller Module, 2 Axes
- C-867.10C885 PILine® Controller Module
- E-861.11C885 NEXACT® Controller Module
- E-873.10C885 Q-Motion® Controller Module for C-885 PIMotionMaster
- C-663.12C885 Mercury Step Stepper Motor Controller Module

	<b>C-885.R1</b>	<b>C-885.R2</b>	<b>C-885.R3</b>
Function	9.5" chassis for C-885 PIMotionMaster	19" chassis for C-885 PIMotionMaster	19" chassis for C-885 PIMotionMaster
Number of card slots	1 C-885.Mx module (required) 4 controller modules (max.)	1 C-885.Mx module (required) 20 controller modules (max.)	1 C-885.Mx module (required) 19 controller modules (max.)
Dimensions	269.04 mm × 133.14 mm × 349.5 mm (incl. handles)	Without modules: 482.6 mm × 132.55 mm × 265.3 mm With modules: 482.6 mm × 132.55 mm × 278.55 mm	Without modules: 482.6 mm × 132.55 mm × 265.3 mm With modules: 482.6 mm × 132.55 mm × 278.55 mm
Operating voltage	24 V DC from external power supply	24 V DC from external power supply	24 V DC from external power supply also optional: 48 V DC from external power supply
Supply voltage for controller modules	24 V DC	24 V DC	24 V DC / 48 V DC
Current consumption, max.	32 A	32 A	32 A
Mass without modules	3.2 kg	2.9 kg	5.08 kg
Operating temperature range	10 to 40 °C	10 to 40 °C	10 to 40 °C

	<b>C-885.M1</b>	<b>C-885.M2</b>
Function	Digital Processor and Interface Module for C-885 PIMotionMaster	Digital Processor and Interface Module for C-885 PIMotionMaster
Communication interfaces	Ethernet, USB	Ethernet, USB
Command set	PI General Command Set (GCS)	PI General Command Set (GCS)
User software	PIMikroMove	PIMikroMove
Software drivers	LabVIEW drivers, dynamic libraries for Windows and Linux	LabVIEW drivers, dynamic libraries for Windows and Linux
Indicators	LEDs for Power, Error	LEDs for Power, Error
Operating temperature range	10 to 40°C	10 to 40°C
Mass	132 g	270 g
Dimensions	186.42 mm × 128.4 mm (3 RU) × 19.98 mm (4 HP)	186.42 mm × 128.4 mm (3 RU) × 19.98 mm (4 HP)

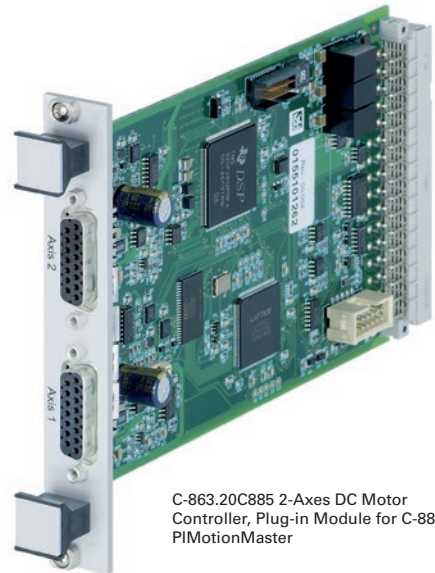
Ask about custom designs!

# C-863 Mercury Servo Controller

1 Axis, for DC Motors and Brushless DC Motors



- High-speed encoder input to 60 MHz
- Powerful macro programming language, e.g., for stand-alone operation
- Nonvolatile EEPROM for macros and parameters
- Data recorder
- Daisy chain networking
- Connection for joystick



C-863.20C885 2-Axes DC Motor Controller, Plug-in Module for C-885 PIMotionMaster

C-863.11 / C-863.12	
Function	DC motor control, servo control
Axes	1
Supported functions	Point-to-point motion. Startup macro. Data recorder for recording operating data such as motor voltage, velocity, position or position error. Internal safety circuitry: Watchdog timer. C-863.12 additional: ID chip detection
<b>Motion and control</b>	
Controller type	PID controller, parameter changing during operation
Servo cycle time	50 µs
Profile generator	Trapezoidal velocity profile
Encoder input	A/B quadrature single-ended or differential TTL signal acc. to RS-422; 60 MHz
Stall detection	Automatic motor stop when a programmable position error is exceeded
Limit switches	2 × TTL (programmable polarity)
Reference point switch	1 × TTL
Motor brake	1 × TTL, can be switched by software
<b>Interfaces and operation</b>	
Communication interfaces	USB; RS-232, Sub-D 9 (m)
Motor connection	C-863.11: Sub-D 15 (f) / C-863.12: HD Sub-D 26 (f)
Controller network	Up to 16 units** on a single interface
I/O lines	4 analog / digital inputs, 4 digital outputs (TTL), 5 VTTL
Command set	PI General Command Set (GCS)
User software	PIMikroMove
Application programming interfaces	API for C / C++ / C# / VB.NET / MATLAB / python, drivers for LabVIEW
Manual control	Joystick, Y cable for 2-D motion, pushbutton box

	C-863.11	C-863.12
<b>Electrical properties</b>		
Max. output voltage*	0 to ±15 V for direct control of DC motors	0 V to operating voltage, for direct control of DC motors
Max. output power	30 W	60 W
Average output power	45 W	48 W
Power consumption, full load	30 W	48 W
Power consumption without load	2 W	3 W
Current limitation	2 A	2.5 A
<b>Miscellaneous</b>		
Operating voltage	15 to 30 V from external power supply (15 V DC power supply in scope of delivery)	24 to 48 V DC from external power supply (48 V DC power supply in scope of delivery)
Max. current consumption	80 mA without load (when supplied with 24 V)	40 mA without load (when supplied with 48 V) 80 mA without load (when supplied with 24 V)
Operating temperature range	5 to 50 °C	5 to 50 °C (temperature protection switches off at excessively high temperatures)
Mass	0.3 kg	0.48 kg
Dimensions	130 mm × 76 mm × 40 mm (incl. mounting rails)	130 mm × 76 mm × 40 mm (incl. mounting rails)

\* The output voltage depends on the connected power supply.

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

# C-884.4DC / C-884.6DC

## Motion Controller for DC Motors, 4 or 6 Axes

For Positioners with Closed-Loop DC Motor, USB, RS-232, TCP/IP, SPI, I/O, Joystick



- PID servo control with dynamic parameter switching
- Powerful macro programming language, e.g., for stand-alone operation
- Data recorder
- Integrated interfaces: USB, RS-232, Ethernet, SPI, I/O, joystick
- Trajectory support for 1 or 2 D motion patterns

### Digital motion controller for DC servo motors

4 or 6 axes. Dual-core architecture for increased performance and flexibility by separating command processing and position control. Simple adaptation / extension possible for OEM products. Motion control of PI positioning systems with DC motors: Direct motor control, PWM control for PI positioning stages with integrated ActiveDrive amplifiers or integrated block commutation (brushless motors). Supports motor brake.

### Motion profiles

Point-to-point, trapezoidal velocity profile. User-definable trajectories (e.g., circles, sine curves) from externally fed points.

### Interfaces and communication

Interfaces: TCP/IP, USB and RS-232 for commands. A/B quadrature encoder input. TTL inputs for limit and reference point switches. I/O lines (analog/digital) for automation. USB interface for human interface devices.

### Extensive functions, software support

Powerful macro command language. Nonvolatile macro storage, e.g., for stand-alone operation with autostart macro. Data recorder. ID chip detection for fast startup. PID controller, parameter changing during operation. Extensive software support, e.g., for LabVIEW, C, C++, MATLAB, python. PIMikroMove user software.



<b>C-884.4DC / C-884.6DC</b>	
Function	Position control for closed-loop DC motors
Processor	Dual core architecture. Controller on a DSP core, with extendable command interpreter in an ARM core under Linux
Axes	C-884.4DC: 4 / C-884.6DC: 6
Supported functions	Linear vector motion. Point-to-point motion. User-definable trajectories. Startup macro. PI Python. Data recorder for recording operating data such as motor voltage, velocity, position or position error. ID chip detection.
<b>Motion and control</b>	
Controller type	PID controller, parameter changing during operation
Servo cycle time	100 $\mu$ s
Profile generator	Trapezoidal velocity profile
Encoder input	A/B quadrature (TTL differential according to RS-422), 50 MHz; BiSS interface
Stall detection	Automatic motor stop when a programmable position error is exceeded
Limit switches	2 $\times$ TTL per axis (programmable polarity)
Reference point switch	1 $\times$ TTL per axis
Motor brake	1 $\times$ TTL per axis, can be switched per software
<b>Electrical properties</b>	
Max. output voltage*	24 V
Max. output power	240 W
Current limitation	2.5 A per axis
<b>Interfaces and operation</b>	
Communication interfaces	TCP/IP: RJ45 / Ethernet; USB: Mini-USB type B; RS-232: Sub-D 9 (m); SPI: DisplayPort
Motor connector	Sub-D 15 (f)
I/O lines	4 analog inputs (-10 to 10 V), 4 digital outputs (5 V TTL) 4 digital outputs (5 V TTL)
Command set	PI General Command Set (GCS)
User software	PIMikroMove
Application programming interfaces	API for C / C++ / C# / VB.NET / MATLAB / python, drivers for LabVIEW
Manual control	USB interface for HID-compliant devices
<b>Miscellaneous</b>	
Operating voltage	External power supply 24 V / 5 A (120 W) included in the scope of delivery
Max. current consumption	C-884.4DC: 11 A / C-884.6DC: 16 A
Current consumption, no load	500 mA
Operating temperature range	5 to 50 $^{\circ}$ C
Mass	C-884.4DC: 1.77 kg / C-884.6DC: 1.97 kg
Dimensions	312 mm $\times$ 153.4 mm $\times$ 59.2 mm (incl. mounting rails)

\*The output voltage depends on the connected power supply.

# C-413 PIMag<sup>®</sup> Motion Controller

Control of Force, Position and Velocity



## Digital motion controller for PIMag<sup>®</sup> voice coil drives

C-413.1: 1 motor channel, 2 sensor channels, for the V-275 and V-277 linear actuators; C-413.2: 2 motor channels, 4 sensor channels. PID controller for force, position, velocity. Servo update rate selectable between 5 to 10 kHz.

## Force control

The force control allows operation of PIMag<sup>®</sup> drives and stages with a defined holding or feed force. The force and position sensors can be read simultaneously and the values processed. In addition to pure force control, subordinate position and velocity control is also an option. PI offers PIMag<sup>®</sup> actuators with a force sensor. The C-413.20A / .2GA models enable external force sensors to be read via analog inputs.

## Extensive functionality

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

## Interfaces

Depending on the version, commanding via TCP/IP, USB 2.0, SPI. Digital inputs and outputs for automation. Optional analog inputs and outputs, e.g., for sensors, commanding or position feedback.

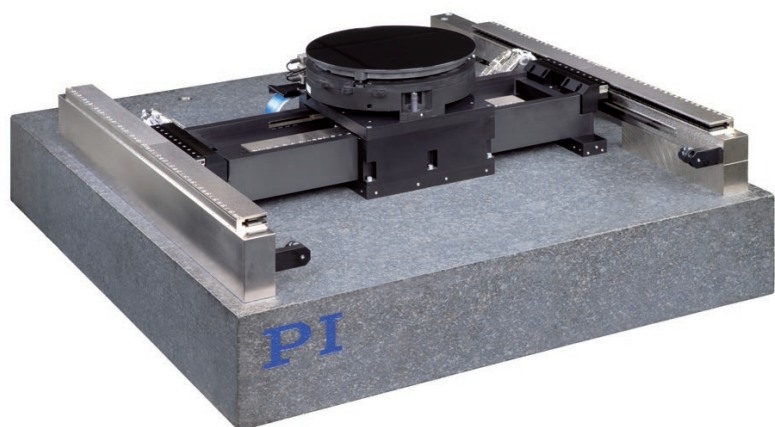
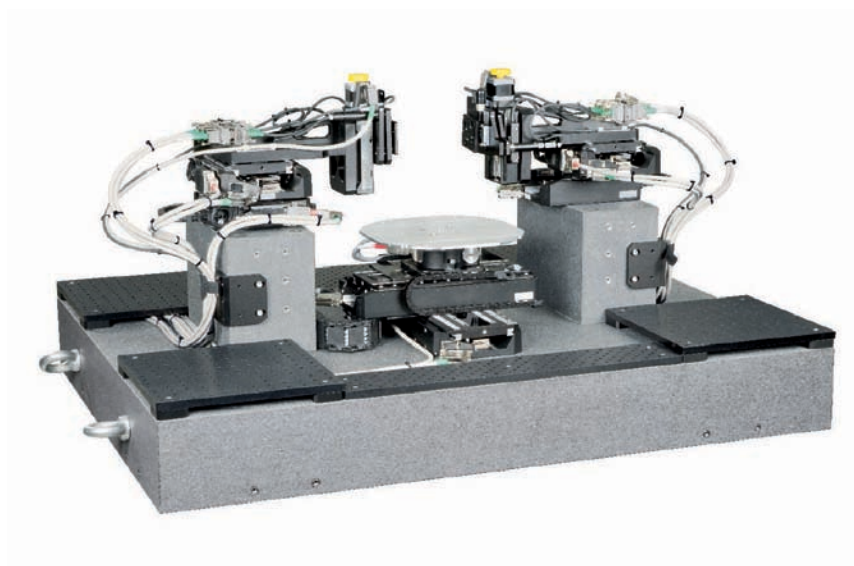
- 1 or 2 motor channels
- Up to 4 sensor channels for 2 force and 2 position sensors each
- Depending on version, TCP/IP or USB interface for configuration and sending commands
- Depending on version, real-time SPI interface for sending commands
- Digital inputs and outputs
- Optional analog inputs and outputs

	<b>C-413.1G</b>	<b>C-413.20 / C-413.20A C-413.2G / C-413.2GA</b>
Function	PIMag® motion controller for voice coil drives, 1 channel, housed device	PIMag® motion controller for voice coil drives, 2 channels C-413.20/.20A: OEM board C-413.2G/.2GA: Housed device
Motor channels	1	2
Sensor channels	2	4
<b>Motion and control</b>		
Servo characteristics	PID controller for force, position and velocity; parameter changing during operation	PID controller for force, position and velocity; parameter changing during operation
Servo cycle time	100 µs to 200 µs, selectable in 4 steps	100 µs to 200 µs, selectable in 4 steps
Profile generator	Trapezoidal velocity profile, specification of the maximum velocity and acceleration	Trapezoidal velocity profile, specification of the maximum velocity and acceleration
Encoder input	SPI sensor interface	SPI sensor interface
Reference point switches	2 × TTL, direction-sensing	4 × TTL, direction-sensing
<b>Electrical properties</b>		
Max. output voltage	24 V	24 V
Max. output current	±1.5 A (regulated)	±1.5 A (regulated)
<b>Interfaces and operation</b>		
Communication interfaces	TCP/IP	USB 2.0, real time SPI
Motor / sensor connection	Sub-D 9 (f) for motor, Sub-D 25 (f) for sensor	Sub-D 15 (f) combined for motor and sensor
I/O port	2 × analog output, –10 to 10 V, 17 bit, 1 kHz 4 × digital input, 24 V 6 × digital output, 24 V	2 × analog input, –10 to 10 V, 16 bit, 1 kHz (only .20A and .2GA) 2 × analog output, –10 to 10 V, 17 bit, 1 kHz (only .20A und .2GA) 6 × digital outputs (open collector, voltage range 5 V to 24 V, 33 kΩ internal pull-up to 5 V) 4 × digital input (5 V TTL level, to 24 V max. input voltage, 10 kΩ input resistance)
Command set	PI General Command Set (GCS)	PI General Command Set (GCS)
User software	PIMikroMove	PIMikroMove
Application programming interfaces	API for C / C++ / C# / VB.NET / MATLAB / python, drivers for LabVIEW	API for C / C++ / C# / VB.NET / MATLAB / python, drivers for LabVIEW
Supported functions	Point-to-point motion. Data recorder. Wave generator. Auto zero. ID chip detection.	Point-to-point motion. Data recorder. Wave generator. Auto zero. ID chip detection.
<b>Miscellaneous</b>		
Operating voltage	24 V DC from external power supply (included)	24 V DC from external power adapter (included in the scope of delivery for C-413.2G and .2GA)
Max. current consumption	2 A	2 A
Operating temperature range	5 to 50 °C	5 to 50 °C
Mass	0.3 kg	0.3 kg
Dimensions	210 mm × 28 mm × 105 mm	189 mm × 28 mm × 105 mm (.2G/.2GA) 160 mm × 18 mm × 100 mm (.20/.20A)

Ask about custom designs!

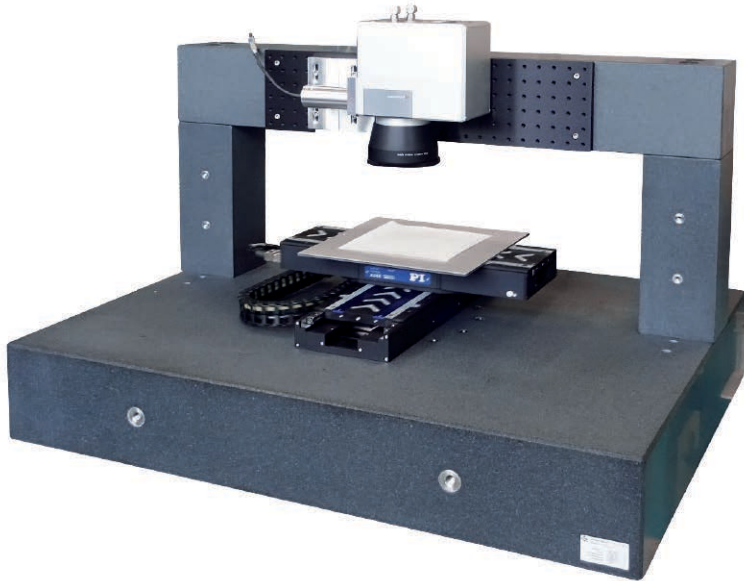


# Gantry Systems / Engineered Systems



# From Concept to Commissioning

Working Closely Together for the Best Solution



PI designs and manufactures to a wide variety of precision motion technologies, including air bearings, linear motors, piezoelectric drives, flexure guides and mag-lev systems, to name a few.

PI's **Engineered Systems Division** integrates these components into custom motion systems. Complete solutions, fitting seamlessly into existing processes that advance automation in major industrial and research installations for applications such as

- Semiconductor inspection and production
- Photonics alignment, test and packaging
- Laser micromachining
- Additive nano-manufacturing
- Surface metrology
- Biotechnology

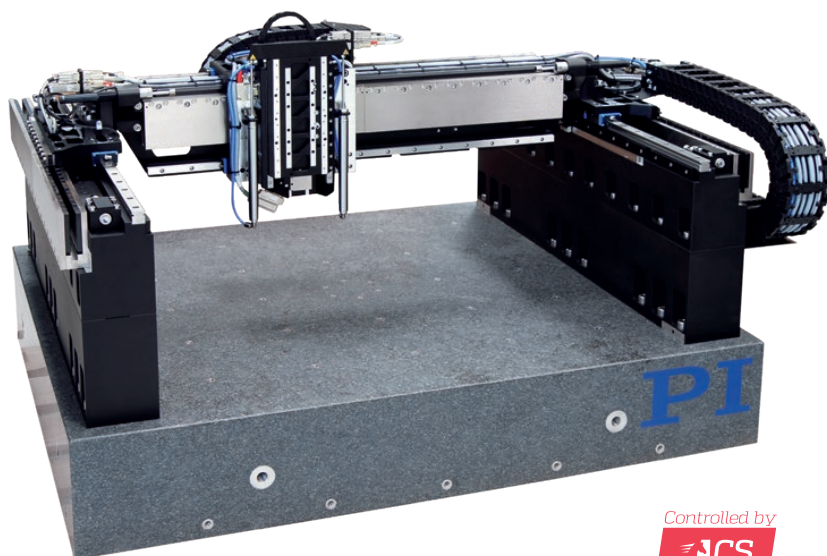
Post-delivery service is an essential part of PI's philosophy and includes commissioning and on-site installation as well as training and maintenance support.

## How PI Engineered Systems Works:

1. Definition phase: Together, we identify current issues and the goal of your new motion system
2. Concept phase: Brainstorming about the best solution in close cooperation with your and our engineering teams
3. The resulting solution is converted into a Technical and Business Proposal
4. The design and detail phase begins after your approval
5. The system is then assembled and tested, and - after your approval - delivered
6. You end up with a fully functioning system, and avoid losing time trying to integrate components from different suppliers

# Throughput, Precision and Reliability

## Solutions for Motion-Centric Industrial Automation



### Gantry Systems – High-Dynamic Precision Positioning in 3 Axes

- Linear motor or brushless drives, optionally with air bearings
- Individual travel ranges in XY up to 2 m
- Z-axis with pneumatic counterweight, DC or Stepper motor
- Piezomotor for fine adjustment
- Incremental or absolute encoders
- Controlled by ACS Motion Control

The specifications below are an example of what is feasible. Contact PI to discuss your requirements!

### XY and Gantry Systems from PI

Positioning and motion tasks in industrial automation such as those in assembly, semiconductor manufacturing, mechanical engineering, laser material processing, inspection systems or in additive manufacturing demand solutions that need to be robust and reliable.

PI offers a broad range of in-house drive and motion control technologies such as EtherCAT-based industrial controllers by ACS, where PI holds the major shares, or air bearing technology for optimized guiding accuracy. System engineering for customization and a global service and training network are added-value offers. PI is therefore the ideal partner for motion-centric industrial solutions.

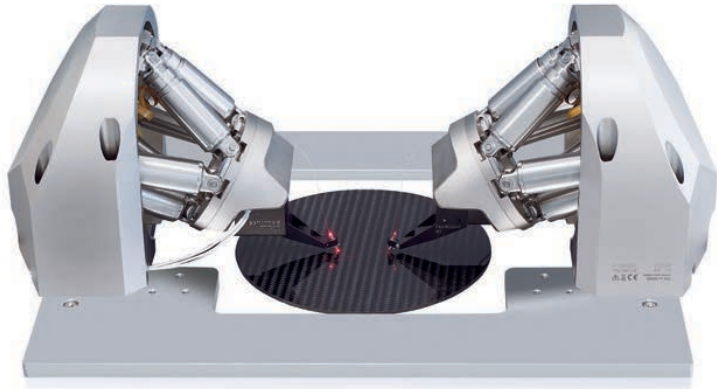
	X	Y	Z	Unit	Tolerance
Active axes	X	Y	Z		
<b>Motion and positioning</b>					
Travel range	508	508	155	mm	
Integrated sensor	Optical linear encoder, incremental	Optical linear encoder, incremental	Optical linear encoder, incremental		
Sensor resolution	0.002	0.002	0.002	µm	
Unidirectional repeatability	0.5	0.5	0.5	µm	typ.
Max. velocity*	3000	3000	2000	mm/s	typ.
Max. acceleration**	30	30	20	m/s <sup>2</sup>	typ.
<b>Mechanical properties</b>					
Bearings	Ball bearing	Ball bearing	Cross roller bearings		
Load capacity	5			kg	max.
Motor type	Ironless linear motor	Ironless linear motor	Ironless linear motor with pneumatic counterbalance		

\* Maximum speed based on stage capability. Maximum application velocity may be limited by system data rate and system resolution. Maximum speed of the z-axis is specified without pneumatic counterbalance.

\*\* No load. Maximum acceleration of the z-axis is specified without pneumatic counterbalance.

# Fast Multi-Channel Photonic Alignment System

System with 6 Degrees of Freedom for Aligning Fibers and Optical Components

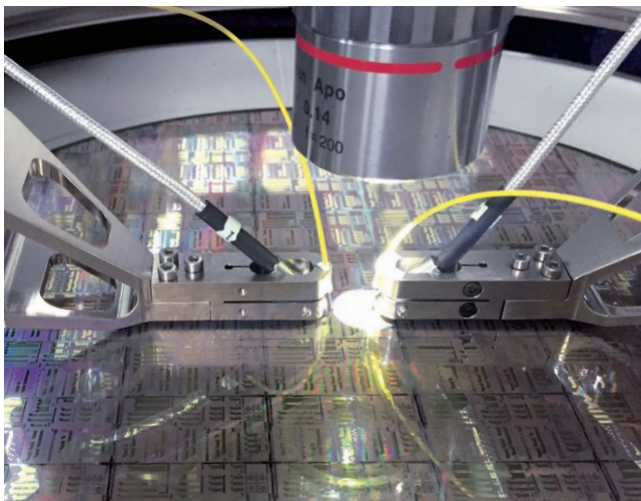


## Fast and high-precision drives

The basis of the fiber alignment system is a very stiff set-up consisting of the H-811 hexapod and P-616 NanoCube<sup>®</sup> nanopositioner. The parallel-kinematic design for motion in six degrees of freedom ensures high system stiffness. The motorized drives make longer travel ranges possible and at the same time, the NanoCube<sup>®</sup> nanopositioner ensures fast scanning motion and dynamic compensation of drift effects. Flexure guides and all-ceramic insulated PICMA<sup>®</sup> actuators guarantee a long lifetime. Because all drives are equipped with position sensors, it is possible for example, to reliably prevent collisions with expensive silicon wafers.

## High-performance scan routines

The sophisticated scan routines are integrated directly into the controller. The performance is improved considerably and integration simplified. The system can manage all tasks in the field of fiber alignment. For example, double-sided systems allow simultaneous alignment of the transmitter and receiver.



## F-712.HA1 / F-712.HA2

- Integrated scan routines for fiber optic alignment
- Ideal for applications in silicon photonics
- Extensive software package
- Direct detection of the optical signal
- Position sensors for high accuracy and operational reliability
- Automatic alignment of several fibers in <1 s

## Extensive software package

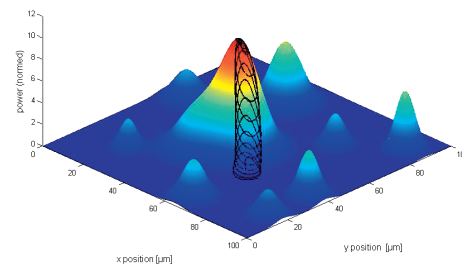
The software package supplied in the scope of delivery allows integration of the system into virtually any environment. All common operating systems such as Windows, Linux, and OS X as well as a large number of common programming languages including MATLAB and LabVIEW are supported. Thanks to sophisticated program examples and the use of software tools such as PIMikroMove, the time between starting integrating and productive operation is shortened considerably.

## High-resolution analog input

The controller receives the optical intensity signal directly via a high-resolution analog input. Complex set-ups with cameras are not necessary. Various distribution functions are available for determining the maximum intensity.

## Fields of application

Alignment of optical components, automatic wafer tests, assembling technology in silicon photonics.



Cascade Microtech's pioneering CM300 photonics-enabled engineering wafer prober integrates PI's Fast Multi-Channel Photonics Alignment systems for high throughput, wafer-safe, nano-precision optical probing of on-wafer Silicon Photonics devices. Photo courtesy Cascade Microtech div. of Formfactor, Inc.



Preliminary data	F-712.HA1 / F-712.HA2	Unit
<b>Motion and positioning</b>		
<b>Rough positioning</b>		
Active axes	X, Y, Z, $\theta_x$ , $\theta_y$ , $\theta_z$	
Travel range in X, Y, Z	$\pm 6.5$ , $\pm 16$ , $\pm 8.5^*$	mm
Travel range in $\theta_x$ , $\theta_y$ , $\theta_z$	$\pm 14.5$ , $\pm 10$ , $\pm 10^*$	°
Minimum incremental motion	0.1	$\mu\text{m}$
Max. velocity	10	mm/s
Sensor type	Rotary encoder	
Guiding	–	
Drive type	Brushless DC motor	
<b>Fine positioning</b>		
Active axes	X, Y, Z	
Closed-loop travel in X, Y, Z	100	$\mu\text{m}$
Min. incremental motion, open-loop	0.3	nm
Min. incremental motion, closed-loop	2.5	nm
Linearity error, for the entire travel range**	2	%
Repeatability (bidirectional) 10 % travel range	2	nm
Sensor type	Incremental	
Drive type	PICMA®	
<b>Alignment</b>		
Alignment time area scan 100 $\mu\text{m}$ x 100 $\mu\text{m}$ (max. deviation of peak intensity 0.02 dB)***	<0.5 / <1	s
Alignment time gradient search, randomized with $\pm 5 \mu\text{m}$ (repeatability <0.01 dB)***	<0.5 / <1	s
<b>Miscellaneous</b>		
Operating temperature range, mechanics	0 to 50	°C
Operating temperature range, controller	5 to 40	°C
Cable length	2	m

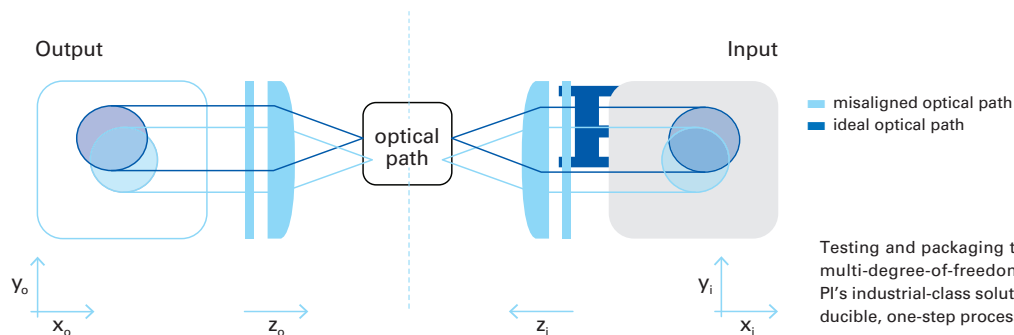
Technical data specified at  $20 \pm 3$  °C.

\* The travel ranges of the individual coordinates (X, Y, Z,  $\theta_x$ ,  $\theta_y$ ,  $\theta_z$ ) are interdependent. The data for each axis in this table shows its maximum travel range, where all other axes and the pivot point are at the reference position. See the dimensional drawings for the default coordinate system and pivot point coordinates of the hexapod. Changing the pivot point will reduce the travel range in  $\theta_x$ ,  $\theta_y$ ,  $\theta_z$ . Changing the orientation of the coordinate system (e.g., when the optical axis is to be the Z axis), will change the travel range in X, Y, and Z.

\*\* Without polynomial linearization

\*\*\* Reaching the global maximum after first light has been found

Ask about custom designs!



Testing and packaging today's photonic devices can be a multi-degree-of-freedom challenge and a moving target. PI's industrial-class solutions help you make it a fast, reproducible, one-step process.

# L-500 Adapter Bracket

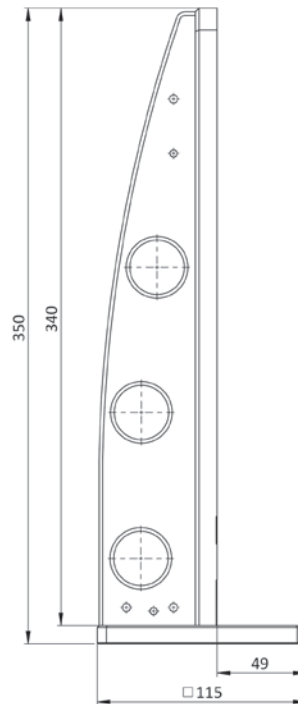
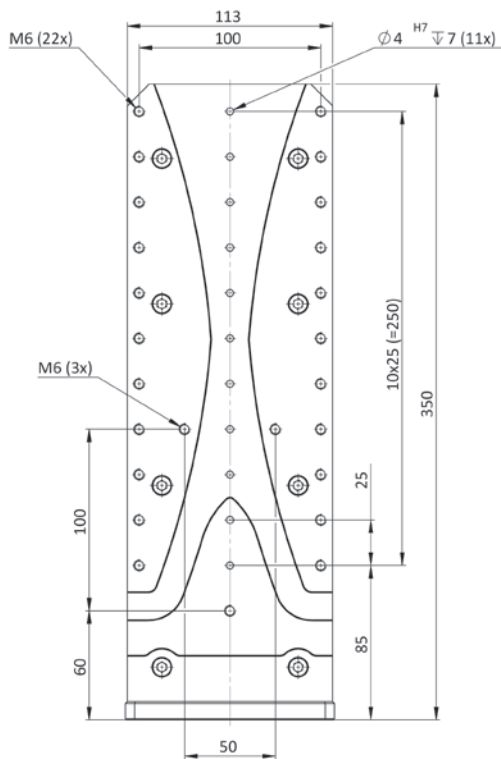
For Vertical Mounting of Linear and Rotation Stages



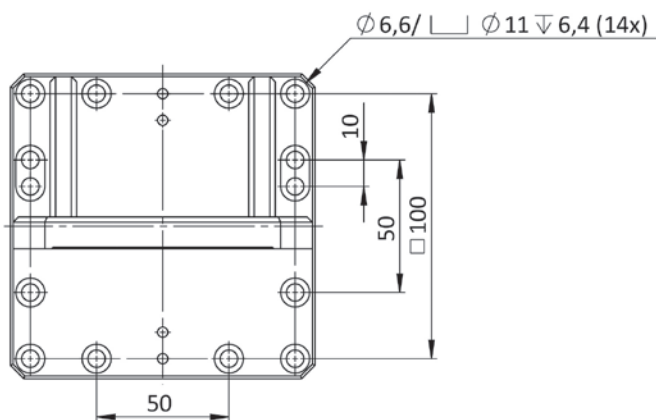
	L-500.AV1 (Angle to axis)	L-500.AV1 (Axis to angle)	L-500.AV3 (Angle to axis)	L-500.AV3 (Axis to angle)
<b>Linear stages</b>				
HPS-170	X	X*	X	-
L-406	-	-	X	X
L-408	-	-	-	X
L-412	X	X	X	-
L-417	X	-	-	-
V-412	X	X	X	-
V-417	X	-	-	-
L-509	-	-	X	X
L-511	X	X*	X	-
LS-180	X	-	X	-
UPL-120	-	-	-	X
<b>Rotation stages</b>				
DT-80	-	-	-	X
L-611	-	X	X	-
UPR-100	-	-	-	-
UPR-120	-	X	X	-
UPR-120 AIR	-	X	X	-
<b>Goniometers</b>				
WT-85	-	-	X	X
WT-90	-	-	X	-
WT-100	-	-	-	X
WT-120	-	-	X	-
<b>Z stage</b>				
L-306	-	-	X	-
L-310	-	-	X	-
<b>XY stage</b>				
L-731	X	-	X	-
V-731	X	-	X	-
L-741	X	-	X	-
V-741	X	-	X	-

\* to 155 mm stroke  
Ask about custom designs!

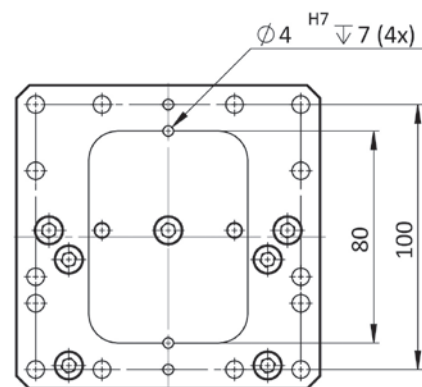
L-500.AV1, dimensions in mm



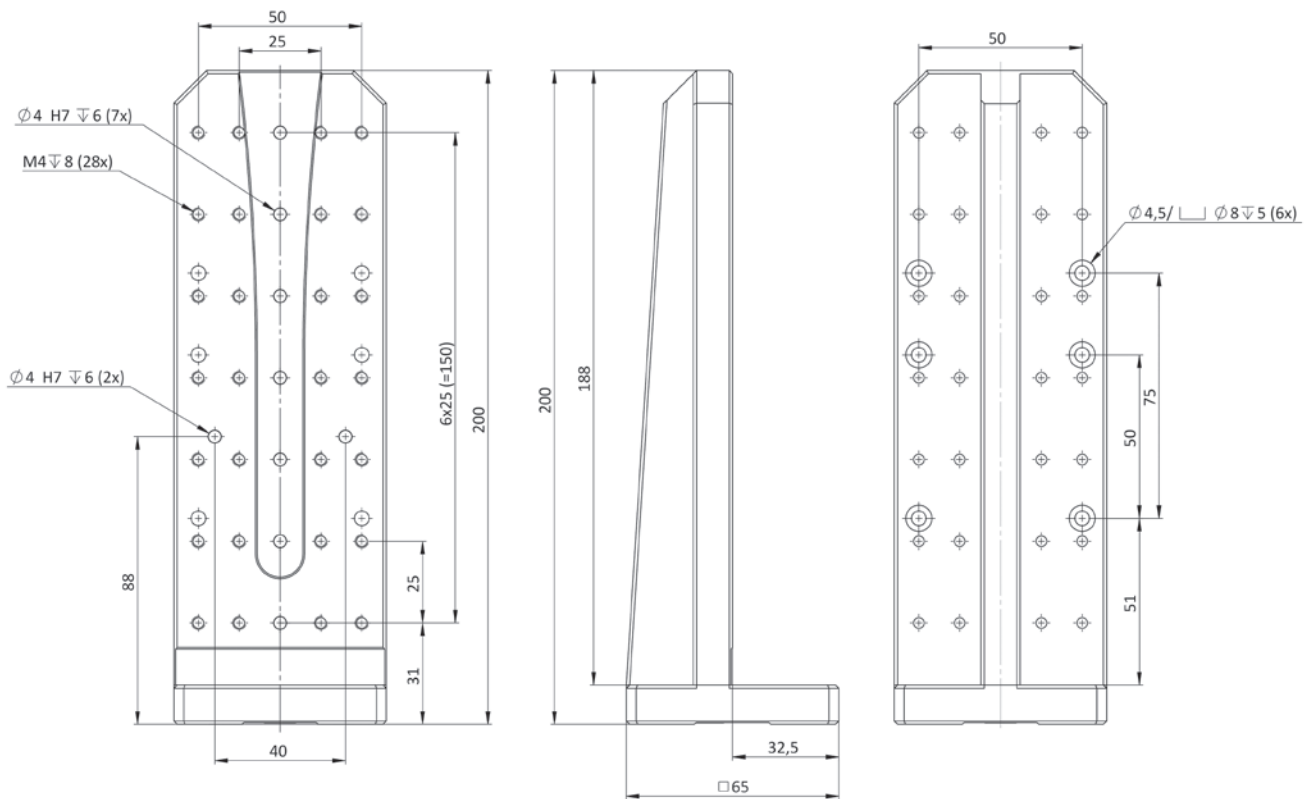
Top view of the L-500.AV1 adapter bracket, dimensions in mm



Bottom view of the L-500.AV1 adapter bracket, dimensions in mm

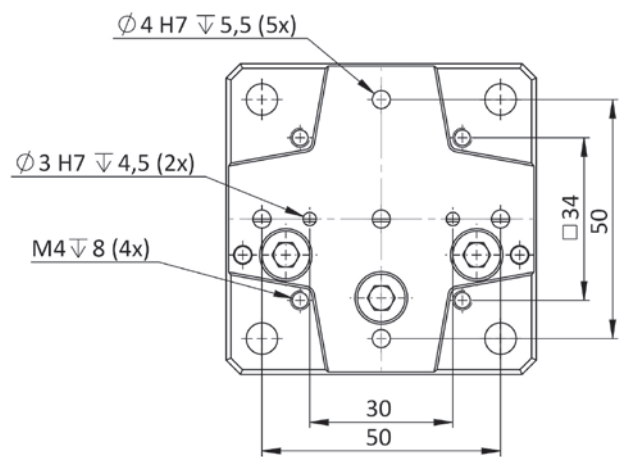
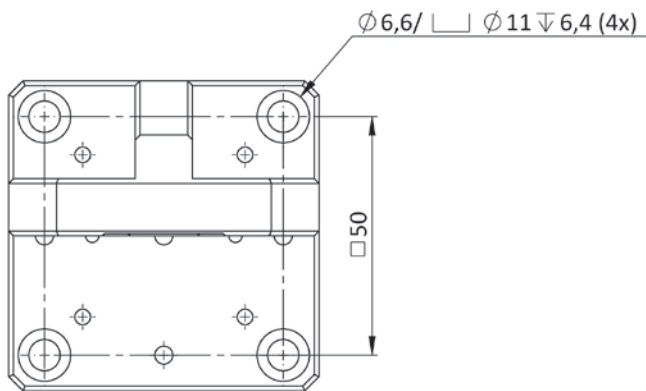


L-500.AV3, dimensions in mm



Top view of the L-500.AV3 adapter bracket, dimensions in mm

Bottom view of the L-500.AV3 adapter bracket, dimensions in mm





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