

Microscope Stage

LOW PROFILE, LOW DRIFT DESIGN, LONG TRAVEL RANGE

M-545

- Stable platform for P-545 Plnano® piezo nanopositioning systems
- Low profile for easy integration: 30 mm
- Travel range 25 x 25 mm
- Micrometer screws, motor upgrade available
- For inverted microscopes made by Nikon, Zeiss, Leica, and Olympus



Standard-class, manual XY microscope stage

Coarse adjustment for P-545 piezo nanopositioning systems. Stiff design enables optimal scanning and settling behavior

Micrometer screw or optional stepper motor drive

The stage can be supplemented with motorized actuators, controller and joystick (see accessories)

Field of application

For inverted microscopes made by Nikon (TI), Zeiss (Axio Observer), Leica (DMI), and Olympus (IX2). Versions for other microscopes are available on request

	M-545.2M	Units	Tolerance
Active axes	X, Y		
Motion and positioning			
Travel range	25 x 25	mm	
Min. incremental motion	1	µm	typ.
Min. incremental motion with M-229 stepper linear actuators	1	µm	typ.
Velocity with M-229 stepper linear actuators	1.5	mm/s	max.
Mechanical properties			
Max. load	50	N	
Preloading	10	N	
Miscellaneous			
Material	Aluminum, stainless steel		
Mass	4	kg	±5%

Accessories

M-545.USG M-229 Stepper-Mike Upgrade for M-545 Stages: Includes Stepper-Mikes

M-545.SHP Adapter Plate for Microscope Sample Holder for M-545 XY Microscope Stage

M-545.USC Stepper-Mike Upgrade for M-545 Stages: Includes M-229 Stepper-Mikes, Controller and Joystick (not suitable for M-545.2MZ)

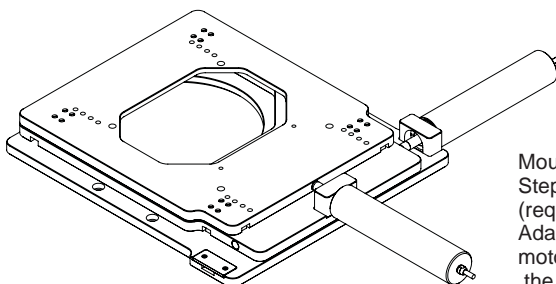
Compatible nanopositioning stages

P-517 • P-527 Multiaxis Piezo Scanner
P-518 • P-528 • P-558 Piezo Tip/Tilt Stage
P-541.2 • P-542.2 Piezo XY Stage
P-561 • P-562 • P-563 PIMars Nanopositioning Stage
P-545 Plnano® Series

Compatible nanopositioning stages (with adapter plate)

P-733.2 • P-733.3 XY(Z) Piezo Nanopositioning Stage
P-736 Plnano® Z Microscopy Scanner

Additional accessories and custom designs on request.



Mounting Kit for M-229 Stepper Motor Actuators (requires controllers)
Adapter kit for mounting motorized actuators to the M-545 Stage.



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

OEM XY Microscope Stage Family with Ultrasonic Motors

Extreme Stability, Low Profile, Fast Response, Direct Position Measurement



Ultrasonic motor XY microscope stage with inserted optional Piezo-Z scanning stage. Stages come with controller, joystick & software

- Integrated Closed-Loop Linear Piezomotor Drives Provide Smooth Motion and High Speed to 150 mm/sec
- Significantly Higher Stability than Conventional Lead-screw-Driven Stages: Self-Locking at Rest, no Servo Dither
- Travel Ranges to 225x85mm
- Integrated Linear Encoders, Sensor Resolution to 0.1 μm
- Compact Design, Low Profile, Mounts Directly to Microscope
- Compatible with Piezo-Z and Piezo XYZ Scanning Stages

Compact Design

All PI microscope stages are designed for excellent stability. The PLine® piezomotor stages excel in precision positioning and automation applications. Their form factors are optimized for a low profile height; the mounting pattern is compatible with a variety of flexure actuated PI piezo nanopositioning / scanning stages.

10X Higher Stability

The PLine® stages are based on a completely different drive principle than conventional motorized translation stages. The compact integrated piezo-electric linear motors and linear encoders make both the lead screw duct and the bulky flanged, stepper motors employed in traditional stages obsolete. An ultrasonic ceramic piezo linear motor directly drives the moving platform. At rest the motor directly clamps the stage, without holding current, allowing the exceptional long term stability

Compatibility to PI Nanopositioning and Scanning Stages

A number of standard PI piezo flexure stages can be mounted directly on the motorized stage. Depending on the application, these highly specialized, ultra-precise nanopositioning systems provide fast XYZ scanning (for fluorescence microscopy) or Z-motion (3D imaging, Z-stacks).

Inverted and Upright Microscopes

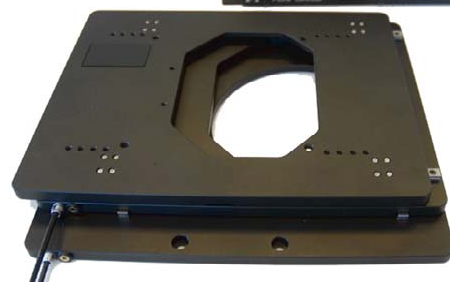
PLine® stages can be designed for inverted or upright microscopes. Talk to us about your application!

Advantages of PI Ultrasonic Motors over Classical Drives

- Self-Locking at rest, no servo dither, no heat
- Smaller Form Factor
- No vibration, smooth motion
- Higher acceleration, speed
- No rotating shafts, gears, ...
- Non-magnetic, vacuum compatible drive principle



Customized long travel PLine® microscope stages



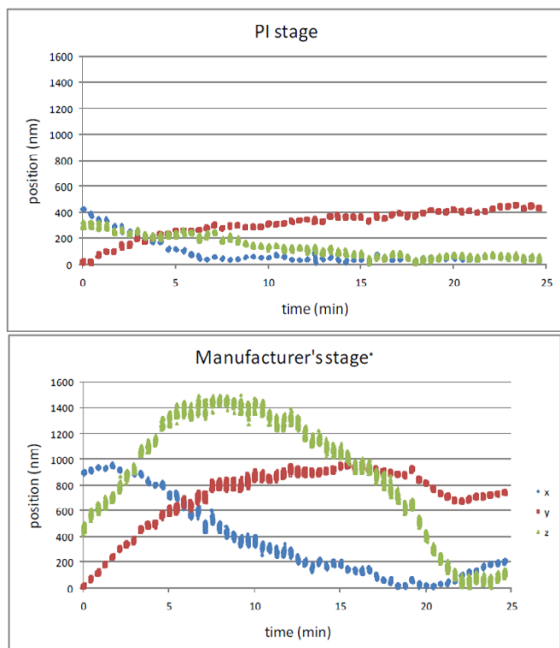
PILine® Microscope Stage Family, General Specs

Description	XY Microscope stage with controller, software and joystick
Travel range	100x75 to 225x85mm
Controller	C-867.262
Joystick	Included (USB)
Compatible piezo-Z / XYZ stages	P-736K003, P-737, PI Mars, PInano™
Max Speed	Up to. 150mm/sec
Resolution	0.1µm
Repeatability	0.4µm
Max load	5 kg
Mass	4kg

*PILine® Microscope Stages have several advantages over classical stepper and electromagnetic motor stages: Stability: Self clamping, low heat generation at low speed, no heat at rest. Convenience: Lower noise than stepper motors. Precision and stiffness: direct drive and direct metrology encoders. Large dynamic range: Fast response and crisp settling, smooth and high velocity constancy even at low velocities of 20µm/sec.



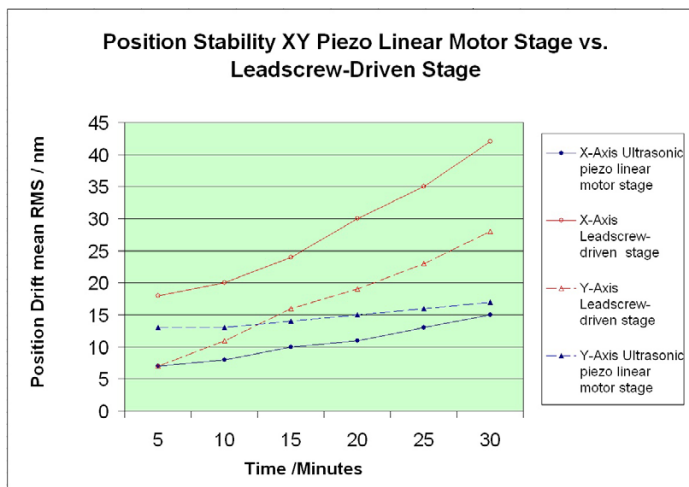
Custom Piezo-Z flexure stage, 200µm Travel, sub-nanometer resolution, millisecond response.



Stability comparison if a PI M-545 manual microscope stage (top) with a manufacturer's stage (bottom). Green: Z; Red:Y, Blue: X



M-545 manual microscope stage



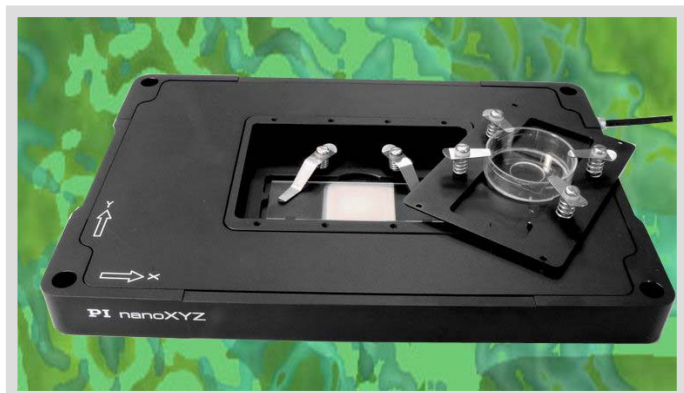
Position stability of PI M-686 piezomotor stage vs leadscrew driven stage. Excerpt from: Design Considerations for Micro- and Nanopositioning, Leveraging the Latest for Biophysical Applications, Current Pharmaceutical Biotechnology, 2009, 10, 515-521 by S.C. Jordan, and P.C. Anthony. <http://www.bentham.org/cpb/sample/cpb10-5/0008G%5B1%5D.pdf>



PInano™ low profile XYZ piezo flexure scanning stage

PI nano™ 1x3 XYZ & XY Piezo Stage Systems

Low-Profile, Low-Cost, Nanopositioning Systems for Super-Resolution Microscopy



PI nano™ series nanopositioning stages feature a very low profile of 20 mm (0.8"), a large aperture for 1x3" slides and deliver highly accurate motion with sub-nanometer resolution in up to 3 axes. Slide / petri dish holders optional.

- **Low Profile for Easy Integration: 20 mm (0.8")**
- **Large Aperture for 1x3" Slides. Accessories & Holders Available**
- **All Parts Black Anodized for Minimum Reflections**
- **200µm Standard Travel Range, Longer Ranges Available**
- **Longest Lifetime with Proprietary PICMA® Piezo Technology**
- **Cost Effective due to Low-Cost Piezoresistive Sensors**
- **Compatible w/ Leading Image Acquisition Software Packages**
- **Closed-Loop Control for High Repeatability and Accuracy**
- **Millisecond Step Time, ideal for Super-Resolution Microscopy**
- **Recessed Sample Holders for Maximized Utility**

Long Travel, Low Profile, Optimized for Microscopy

The new PInano™ XY and PInano™ XYZ low-profile piezo scanning stages are optimized for easy integration into high-resolution microscopes. They feature a very low profile of 0.8" (20 mm), a large aperture, and long travel ranges of up to

200x200x200 µm with sub-nanometer closed-loop resolution—ideal for leading-edge microscopy and imaging applications.

Longest lifetime is guaranteed by the integrated ceramic-encapsulated PICMA® piezo actuators. Due to the significantly higher humidity resistance, the patented PICMA® design provides up to 10 times longer life than conventional piezo actuators.

Cost Effective Design, High Performance

PInano™ series piezo positioning stages are designed to provide high performance at minimum cost. For highly-stable, closed loop operation, piezoresistive sensors are applied directly to the moving structure and precisely meas-

ure the displacement of the stage platform. The very high sensitivity of these sensors provides optimum position stability and responsiveness as well as sub-nanometer resolution. A proprietary servo controller significantly improves the motion linearity compared to conventional piezoresistive sensor controllers.

Working Principle / Reliability

Flexures optimized with Finite Element Analysis (FEA) are employed to guide the PInano™ series stages. FEA techniques give the design the highest possible stiffness in, and perpendicular to, the direction of motion, and to minimize linear and angular runout. Flexures allow extremely high-precision motion, no matter how minute, as they are completely free of play and friction. The award-winning PICMA® piezo drives are more robust than conventional piezo

Ordering Information

P-545.2R7

PI nano™ XY Nanopositioning System, 1x3" Aperture, Slide Holder 200x200 µm, Piezoresistive Sensors, 24 Bit /USB controller.

P-545.3R7

PI nano™ XYZ Nanopositioning System, 1x3" Aperture, Slide Holder 200x200x200 µm, Piezoresistive Sensors, 24 Bit /USB controller.

P-545.2R2

PI nano™ XY Nanopositioning System, 60x60 mm Aperture, 200x200 µm, Piezoresistive Sensors, 24 Bit /USB controller.

P-545.3R2

PI nano™ XYZ Nanopositioning System, 60x60 mm Aperture, 200x200x200 µm, Piezoresistive Sensors, 24 Bit /USB controller.

actuators, featuring superior lifetime and performance in both dynamic and static applications. Because guidance, actuators and sensors are all maintenance-free, these nanopositioning systems achieve outstanding levels of reliability.

Application Examples

- Super-resolution microscopy
- 3D Imaging
- Laser technology
- Mask / wafer positioning
- Interferometry
- Metrology
- Biotechnology
- Micromanipulation



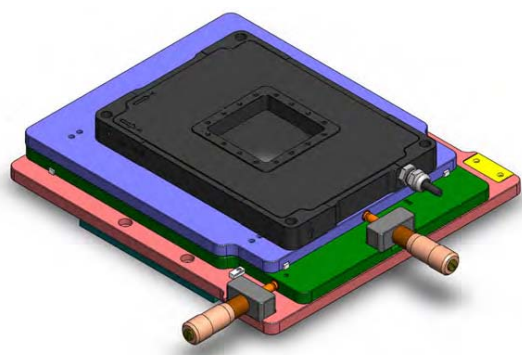
Background: The piezo controller is included and comes with a 24-bit resolution USB port as well as ethernet, RS-232 and an analog interface.

Foreground: The optional M-545 manual XY stage provides a stable platform for the the PInano™ piezo stage. R2 piezo stage versions (60x60 mm aperture) shown.

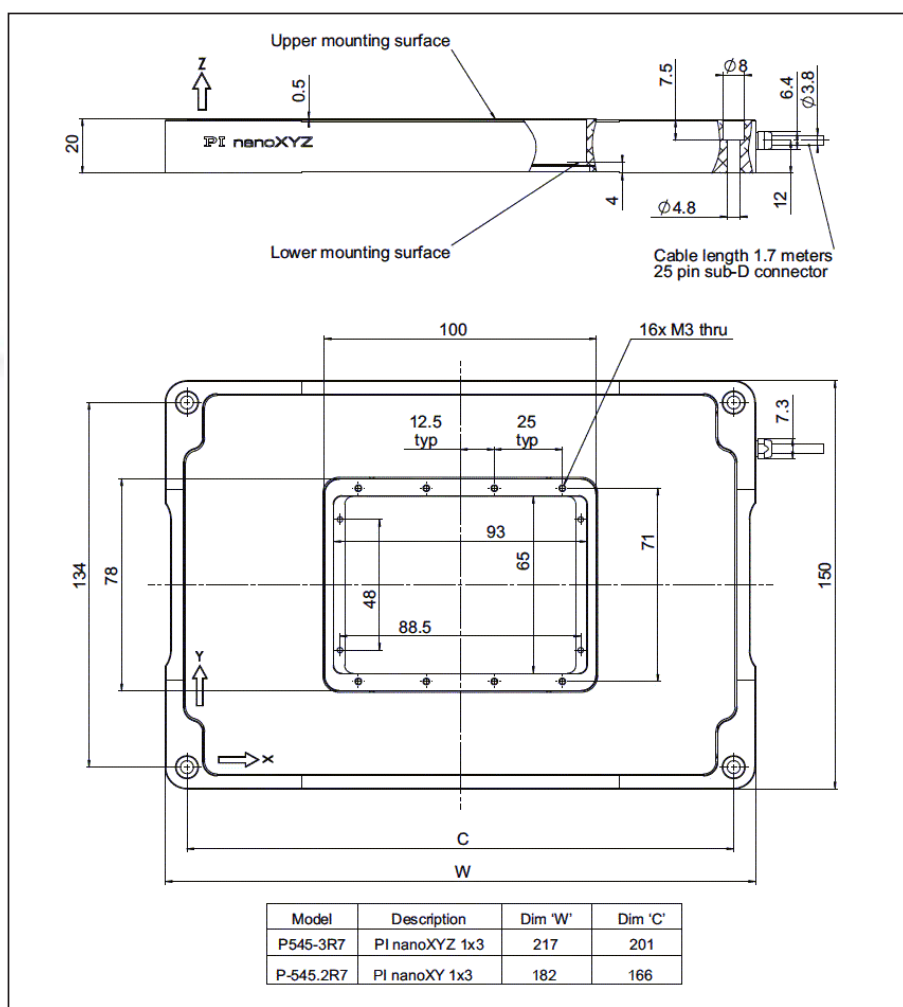
Technical Data

Model	Plnano XY	Plnano XYZ	Units	Tolerance
Active axes	X, Y	X, Y, Z		
Motion and positioning				
Integrated sensor	Piezoresistive	Piezoresistive		
Closed-loop travel	200 x 200	200 x 200 x 200	μm	
*Resolution	<1	<1	nm	typ.
Linearity	+/- 0.1	+/- 0.1	%	typ.
Repeatability	<5	<5	nm	typ.
Mechanical properties				
Push/pull force capacity in motion direction	100 / 30	100 / 30	N	Max.
Max. payload	500	500	g	Max.
Drive properties				
Ceramic type	PICMA® P-885	PICMA® P-885		
Electrical capacitance per axis	6	6 (X, Y), 12 (Z)	μF	±20%
Miscellaneous				
Recommended operating temperature range	20 to 30	20 to 30	°C	
Material	Aluminum	Aluminum		
Mass	1	1.2	kg	±5%
Cable length	1.7	1.7	m	±10 mm
Sensor / voltage connection	Sub-D 25	Sub-D 25		

*Resolution of PI Piezo Nanopositioners is not limited by friction or stiction.
Value given is noise equivalent motion measured with interferometer.

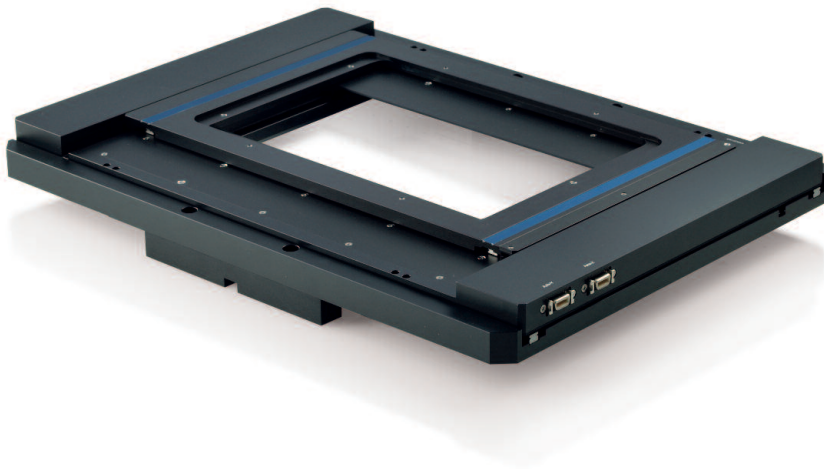


The P-545 piezo stage can be mounted on the optional M-545 manual XY stage. This high-stability stage is recommended as a basis for the piezo stage, especially when the highest step-and-settle performance is required. It is available for Olympus, Nikon, Zeiss and Leica microscopes and can also be upgraded with motorized micrometers.



XY Microscope Stage with PILine® Motor, Controller and Joystick

STABLE, DYNAMIC, LOW PROFILE



M-687

- Highest stability
- 0.1 μm resolution
- Travel range up to 135 mm \times 85 mm
- For inverted microscopes, free rotation of turret
- Suitable Z sample scanner available

Reference-class XY microscope stage

Controller and joystick included. 160 mm \times 110 mm clear aperture. Versions for inverted microscopes:

- Nikon Eclipse Ti-E/Ti-U/Ti-S (M-687.UN)
- Olympus IX2 (M-687.UO)

High-resolution piezo linear drive

Self-locking at rest. Low noise. Highest stability due to low thermal load and no need for lubricants. Large dynamics range of 10 $\mu\text{m/s}$ to 100 mm/s, ideal for operation via joystick and automated high-content methods

Direct-metrology linear encoder

High resolution and repeatability

User software

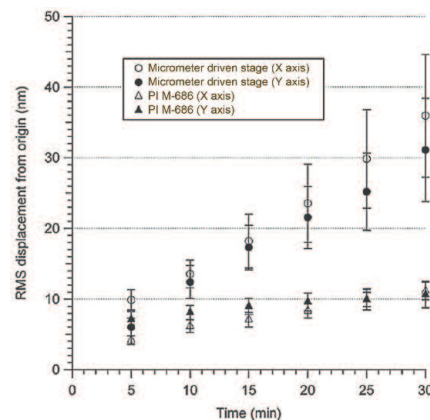
PIMikroMove. PI General Command Set (GCS). Drivers for LabVIEW. Compatible with μ Manager, MetaMorph, Andor iQ, MATLAB

Possible accessories

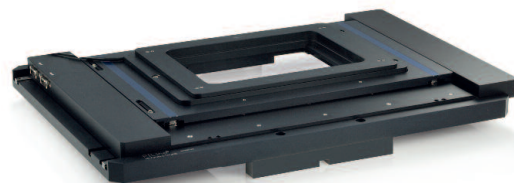
M-687.AP1 universal holder for slides and petri dishes

Fields of application

For inverted microscopes made by Nikon and Olympus, versions for other microscopes are available on request. For super-resolution microscopy, tiling, automated scanning microscopy

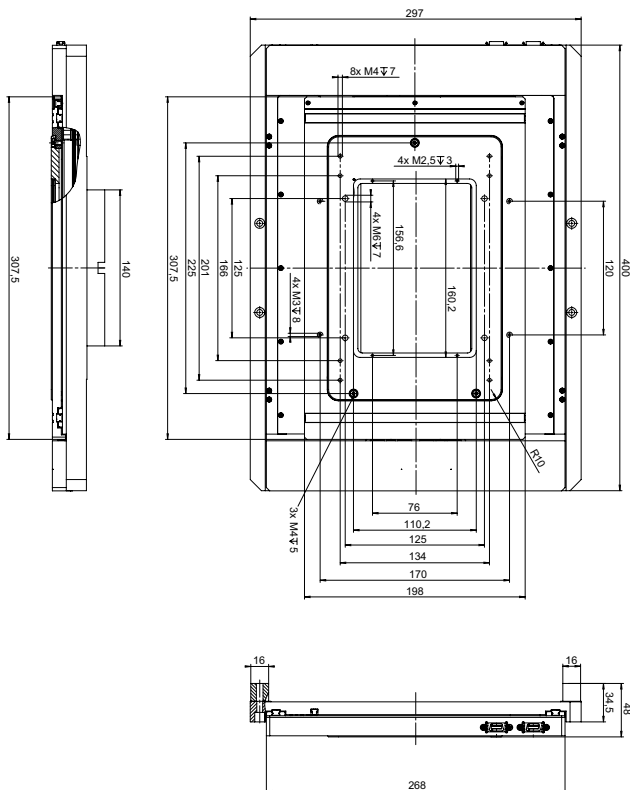


Stability of an M-686 XY stage in comparison to a stage with micrometer screw. Source: S.C. Jordan/P.C. Anthony: Design Considerations for Micro- and Nanopositioning: Leveraging the Latest for Biophysical Applications, Current Pharmaceutical Biotechnology, 2009, 10, 515-521

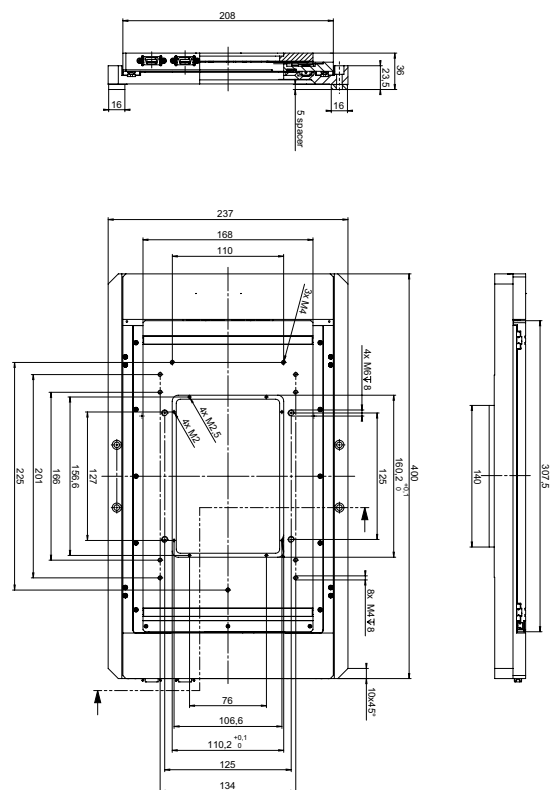


Suitable Z piezo stage with 200 μm stroke and 60 mm \times 110 mm clear aperture available on request

	M26821LNJ	M26821LOJ	Unit	Tolerance
Active axes	System with M-687.UN for Nikon microscopes	System with M-687.UO for Olympus microscopes		
	X, Y	X, Y		
Motion and positioning				
Travel range	135 mm × 85 mm	100 mm × 75 mm		
Integrated sensor	Linear encoder	Linear encoder		
Sensor resolution	0.1	0.1	μm	
Repeatability	0.3	0.3	μm	
Pitch / yaw	±300	±300	μrad	typ.
Velocity	120	120	mm/s	max.
Reference point switches	Optical, 1 μm repeatability	Optical, 1 μm repeatability		
Limit switches	Hall-effect	Hall-effect		
Mechanical properties				
Load	50	50	N	max.
Push / pull force	7	7	N	max.
Miscellaneous				
Operating temperature range	20 to 40	20 to 40	°C	
Material	Al (black anodized)	Al (black anodized)		
Mass	3.2	3.8	kg	±5%
Piezomotor controller				
	C-867.262 with USB joystick (included in delivery)			
Communication interfaces	USB, RS-232, Ethernet			
I/O connector	4 analog/digital in; 4 digital out (Mini-DIN, 9-pin); digital: TTL; analog: 0 to 5 V; USB joystick			
Command set	PI General Command Set (GCS)			
User software	PiMikroMove			
Software drivers	LabVIEW drivers, GCS-DLL, dynamic link libraries for Windows (DLL) and Linux			
Supported functionality	Start-up macro, macro, data recorder / trace memory, MetaMorph, μManager, Andor iQ, MATLAB			
Controller dimensions	320 mm × 150 mm × 80.5 mm (including mounting rails)			



M-687.UN for Nikon microscopes, dimensions in mm



M-687.UO for Olympus microscopes, dimensions in mm