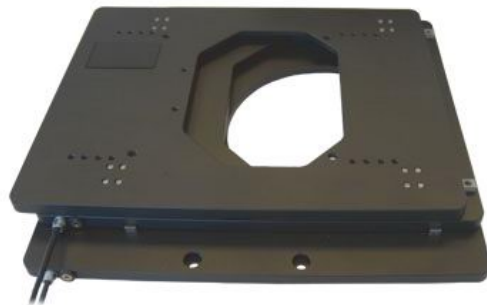
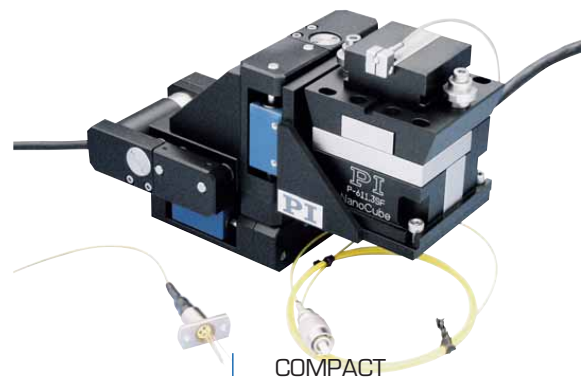
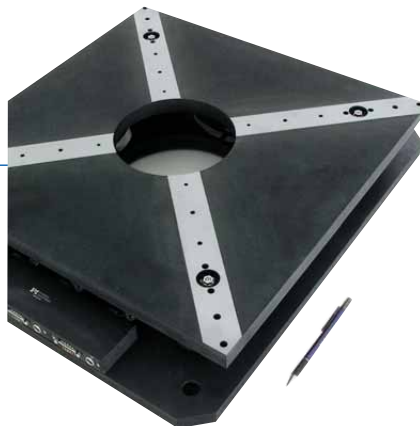


Multi-Axis Stages

FOR MICROSCOPY



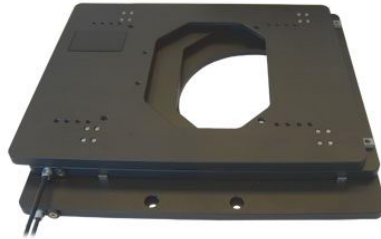
HIGH LOAD



XY, XYZ, Multi-Axis Micropositioning Stages



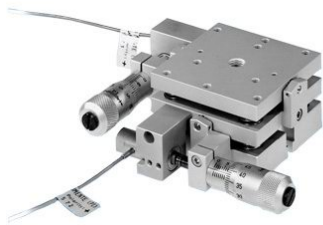
XY Micropositioning Stage for High-Resolution Microscopes



XY Microscope Micropositioning Stage: Manual & Motorized



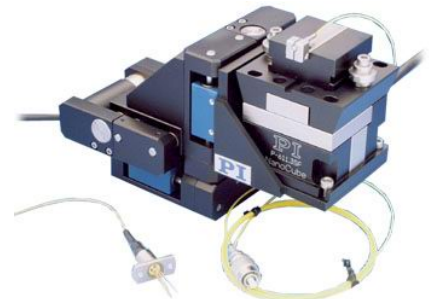
Tip/Tilt Stage with Piezo Drive Option for Nanometer Precision



Miniature Tip/Tilt Stage with Piezo Drive Option



Cross-Roller Guided Linear Slide



Coarse/Fine XYZ Photonics Alignment System



OEM Planar XY Micropositioning Scanner System



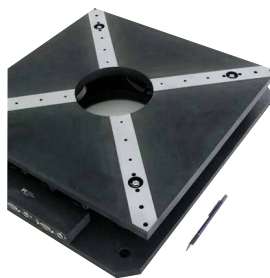
XY Sub-Miniature Linear Micropositioning Slide with Piezo Linear



M-116 Worm-Gear Drive Rotary Stages combined with M-110 XY Linear Stages



M-605 XYZ Stage Combination with Linear Encoders and Bellows



M-880.PD for planar load positioning up to 20 kg with sub-micron accuracy



The M-811.STV vacuum-compatible Hexapod comes complete with software and a highly specialized Hexapod controller. It combines small size with high-load capacity and high accuracy.

M-900K OEM Planar XY Micropositioning Scanner

High-Precision XY Positioning System



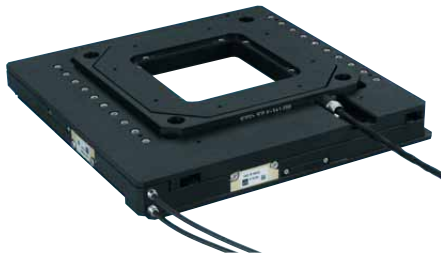
Fast and with high guiding accuracy: the M-900KOPS planar scanner was developed for OEM applications e.g. inside whitelight interferometers

- Max. Velocity 10 mm/s
- Linear encoder with 0.1 μm Resolution
- Self-Locking
- Load Capacity to 660 N
- Low-Backlash, Direct Drive
- DC-Servo or Stepper Motor Drives

Model	Travel range	Min. incremental motion	Bidirectional repeatability
M-900 KOPS planar scanner	50 x 50 mm	0.3 μm	$\pm 0.1 \mu\text{m}$

M-686K PLine[®] Microscopy XY Micropositioning Stage

Low Profile, Large Aperture, High Speed



The customized M-686KPMS stage offers a larger footprint, to sink the optional P-541 piezo scanner by 10 mm. The system height together with the P-541 piezo scanner is reduced to only 34 mm

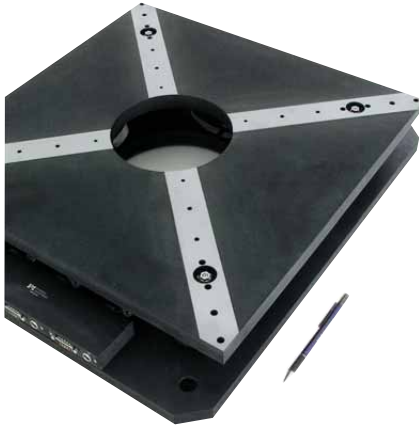
- Integrated Closed-Loop Piezomotor Drives Provide High Speed to 100 mm/s
- Travel Ranges 25 x 25 mm
- Integrated Linear Encoders with 0.1 μm Resolution
- Low-Profile Combinations with PI Piezo Nanopositioning / Scanning Stages
- Clear Aperture 78 x 78 mm, 66 x 66 mm in Extreme Position
- Self-Locking at Rest

Model	Active Axes	Travel	Max. velocity	Load capacity	Dimensions
M-686KPMS PLine [®] Microscopy Stage	X, Y	50 x 50 mm	100 mm/s	50 N (10 N for max. velocity)	210 x 210 x 28 mm

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M-880 3-Axis Planar Precision Micro-Positioning System

XY-Rot-Z Parallel Kinematics System with Very High Holding Force



- Travel Ranges 20 x 20 mm / 8°
- Static Load Capacity to 150 kg
- ActiveDrive Servo Motors
- Low Profile through Parallel Kinematics
- Min. Incremental Motion to 0.75 μm
- Large Clear Aperture
- Sophisticated Controller Included

Model	Active Axes	Travel range	Max. velocity	Stiffness (linear axes)	Dynamic load capacity	Static load capacity
M-880.PD	X, Y, θ_z	± 10 mm, $\pm 4^\circ$	20 mm/s	5 N/ μm	200 N	1500 N

XY Micropositioning Stage

Fast, Low Profile and Large Aperture with Direct Position Measurement



The M-686.D64 open-frame stage with closed-loop piezo motors provides 25 x 25 mm travel range

- **Integrated Closed-Loop Piezomotor Drives Provide High Speed to 100 mm/s**
- **Travel Ranges 25 x 25 mm**
- **Integrated Linear Encoders with 0.1 µm Resolution**
- **Compact Design:**
32 mm Profile Height, 170 x 170 mm Footprint
- **Clear Aperture 78 x 78 mm, 66 x 66 mm in Extreme Position**
- **Self-Locking at Rest**
- **Compatible with PI Piezo Nanopositioning / Scanning Stages**

M-686 open-frame piezomotor stages are mainly designed for automated positioning applications in microscopy. The optimized form factor with a low profile height of only 32 mm and the standardized mounting pattern allows the combination with many PI standard nanopositioning systems.

Application Examples

- Biotechnology
- Microscopy
- Scanning microscopy
- Confocal microscopy
- Semiconductor testing
- Handling

Space Saving Piezomotors

Compared to conventional motorized translation stages, the M-686 provides a lower profile and smaller footprint. The compact PLine® piezoelectric linear motors and high-resolution linear encoders make both, the lead screw duct and the flanged, bulky stepper motor employed in traditional stages obsolete. In addition, the piezomotors are self-locking at rest and hold the stage in a stable position without heating up.

Compatibility to PI Nanopositioning and Scanning Stages

A number of standard PI piezo flexure stages (150 x 150 mm footprint) can be mounted directly on the M-686 open-

frame stage. Depending on the application, these highly specialized, ultra-precise nanopositioning systems are available as fast XY scanners (for fluorescence microscopy), as vertical Z positioners (3D imaging), or with up to 6 degrees of freedom.

Limit and Reference Switches

For the protection of your equipment, non-contact Hall-effect limit and reference switches are installed. The direction-sensing reference switch supports advanced automation applications with high precision.

Advantages of PLine® Micropositioning Systems

The ultrasonic piezoceramic drives used in PLine® micropositioners have a number of advantages over classical drives:

- Higher Accelerations, up to 5 g
- Speeds up to 500 mm/s
- Small Form Factor
- Self-Locking When Powered Down
- No Shafts, Gears or Other Rotating Parts
- Non-Magnetic and Vacuum-Compatible Drive Principle

Ordering Information

M-686.D64
XY Open-Frame Stage with Closed-Loop PLine® Piezomotor Drives, 25 x 25 mm, 7 N, 0.1 µm Linear Encoder

Ask about custom designs!

Notes

Nanopositioning stages that fit directly on the M-686:

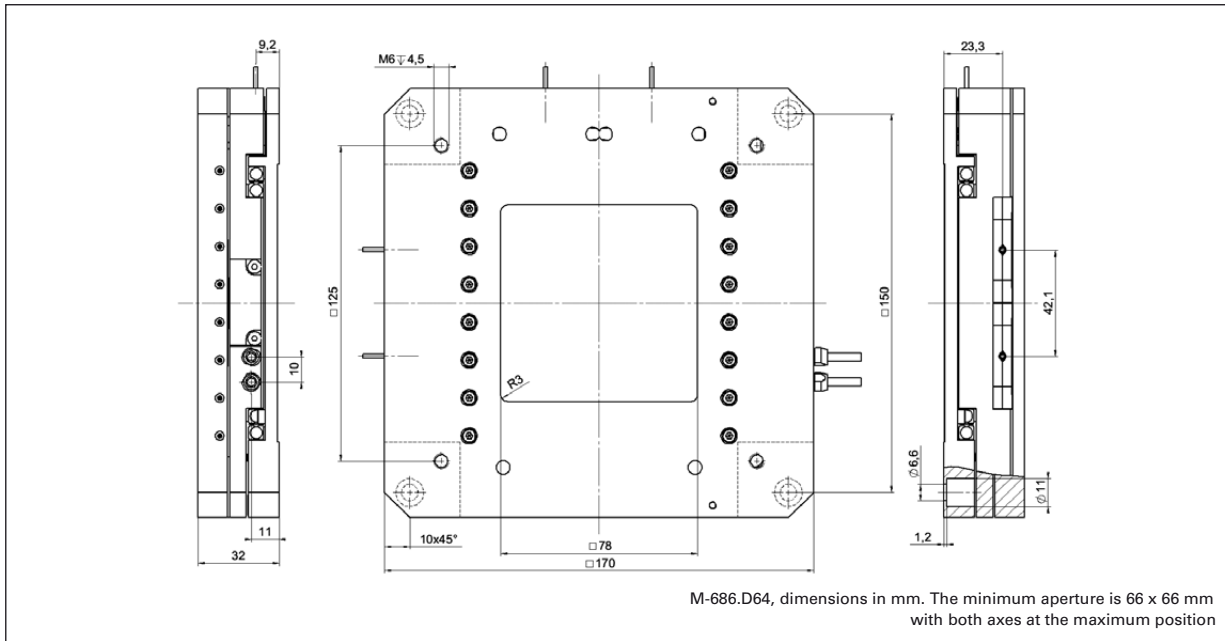
P-561 to P-563
PIMars™ XYZ Nanopositioning systems with up to 300 µm travel

P-541.2 to P-542.2
Low-profile microscopy XY scanners

P-541.Z
Low-profile Z/tip/tilt piezo nanopositioning stages for microscopy

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





Technical Data

Model	M-686.D64
Active axes	XY
Motion and positioning	
Travel range	25 x 25 mm
Integrated sensor	Linear encoder
Sensor resolution	0.1 μm
Design resolution	0.1 μm
Min. incremental motion	0.3 μm
Bidirectional repeatability	0.3 μm
Pitch / yaw	$\pm 50 \mu\text{rad}$
Max. velocity	100 mm/s
Mechanical properties	
Load Capacity*	50 N
Max. push/pull force	7 N
Max. lateral force	4 N
Drive properties	
Motor type	2 x PILine® P-664 per axis
Operating voltage	190 V (Peak-Peak)** 67 V (RMS)**
Electrical power	10 W / axis***
Miscellaneous	
Operating temperature range	-20 to +50 °C
Material	Aluminium (black anodized)
Mass	1.2 kg
Cable length	1.5 m
Connector	2 x MDR connector, 14-pin
Recommended controller/driver	2 x C-867.D64 single-axis controller / driver 2 x C-185.D64 single-axis drive electronics for external servo-controllers (p. 4-116, p. 1-36)

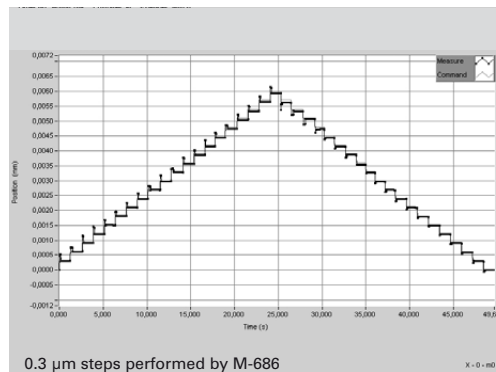
*10 N for max. velocity

**The operating voltage or the piezomotor is supplied by the drive electronics which requires 12 VDC

***For drive electronics

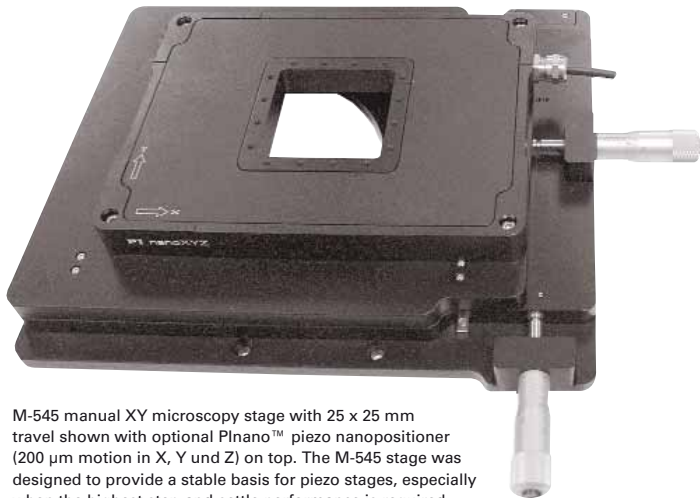


M-686 open-frame stage with P-541.2DD piezo scanner on top, providing a resolution of 0.1 nm and a scanning range of 30 x 30 μm . The system height of the combination with the P-541 XY (or Z) piezo scanner is only 48 mm



XY Microscope Micropositioning Stage

Long-Range Motion for Sample Positioning



M-545 manual XY microscopy stage with 25 x 25 mm travel shown with optional PInano™ piezo nanopositioner (200 µm motion in X, Y und Z) on top. The M-545 stage was designed to provide a stable basis for piezo stages, especially when the highest step-and-settle performance is required

- **Stable Platform for P-545 PInano™ Piezo Nanopositioning Systems**
- **Low Profile for Easy Integration: 30 mm**
- **25 mm x 25 mm Travel Range**
- **Micrometer Screws, Motor Upgrade Available**
- **For Nikon, Zeiss, Leica and Olympus Mikroskopes**

The M-545, 25 x 25 mm microscope stage, is designed to provide a stable platform for piezo scanning stages of the P-545 PInano™ series. These high-speed, high-resolution XY / XYZ piezo stages allow nanometer-precision adjustment of the specimen holder in up to three dimensions over 200 µm. The M-545 is also compatible with the following capacitive-feedback type piezo stages: P-733, P-5x7, P-5x8, P-54x and P-56x (s. p. 2-72).

The basic M-545 model is equipped with manual micrometers.

Motorizing for Automated Tasks

The M-545 XY-stage can be supplemented with motorized actuators M-229 (s.p. 1-44). The product number M-545.USC comprises the complete package of two stepper linear actuators with controller and joystick. M-545.USG includes two stepper linear actuators with mounting

Ordering Information

M-545.2MO

XY Microscope Stage, 25 x 25 mm, Micrometer Drive, High Stability, Compatible with PI Piezo Stages, for Olympus Microscopes

M-545.2MN

XY Microscope Stage, 25 x 25 mm, Micrometer Drive, High Stability, Compatible with PI Piezo Stages, for Nikon Microscopes

M-545.2ML

XY Microscope Stage, 25 x 25 mm, Micrometer Drive, High Stability, Compatible with PI Piezo Stages, for Leica Microscopes

M-545.2MZ

XY Microscope Stage, 25 x 25 mm, Micrometer Drive, High Stability, Compatible with PI Piezo Stages, for Zeiss Microscope

Versions for other microscopes on request.

Accessories

M-545.USC

Factory Installed Stepper-Mike Upgrade for M-545 XY Microscope Stages: Includes Stepper-Mikes, Joystick and Controller

M-545.USG

Factory Installed Stepper-Mike Upgrade for M-545 XY Microscope Stages: Includes Stepper-Mikes, Joystick

M-545.SHP

Adapter Plate for Sample Holders for M-545 XY Microscope Stages

Accommodates the following PI nanopositioning stage series:

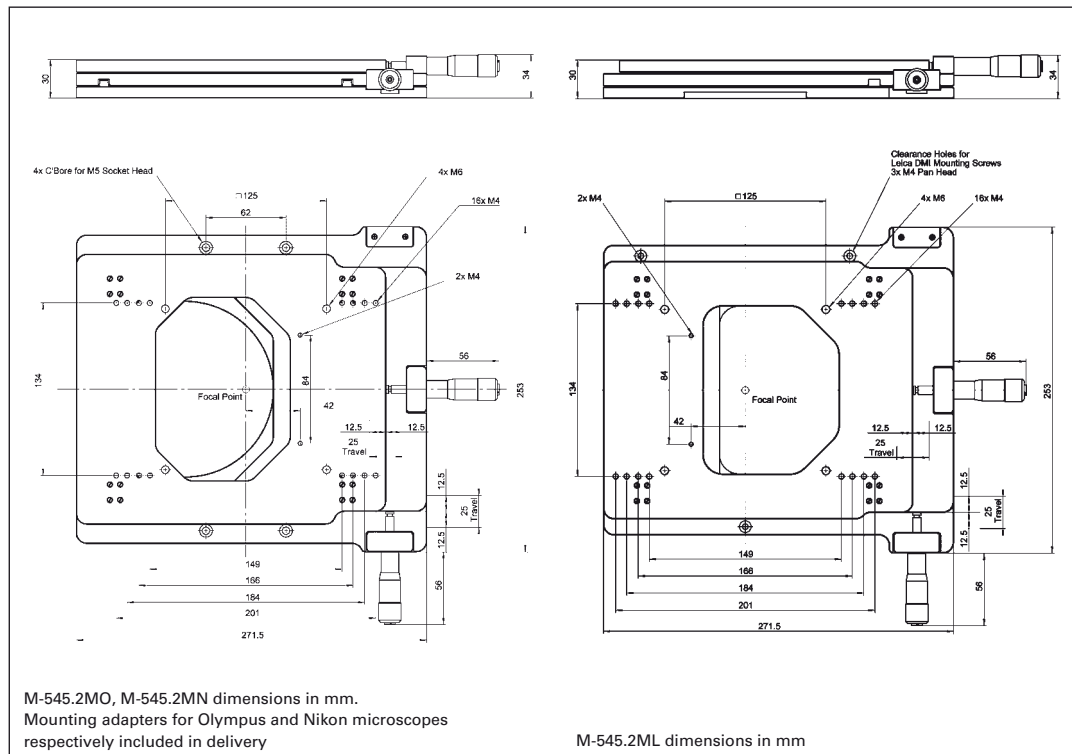
P-517/518/527/528, P-541/542, P-560 PIMars and P-545 PInano™

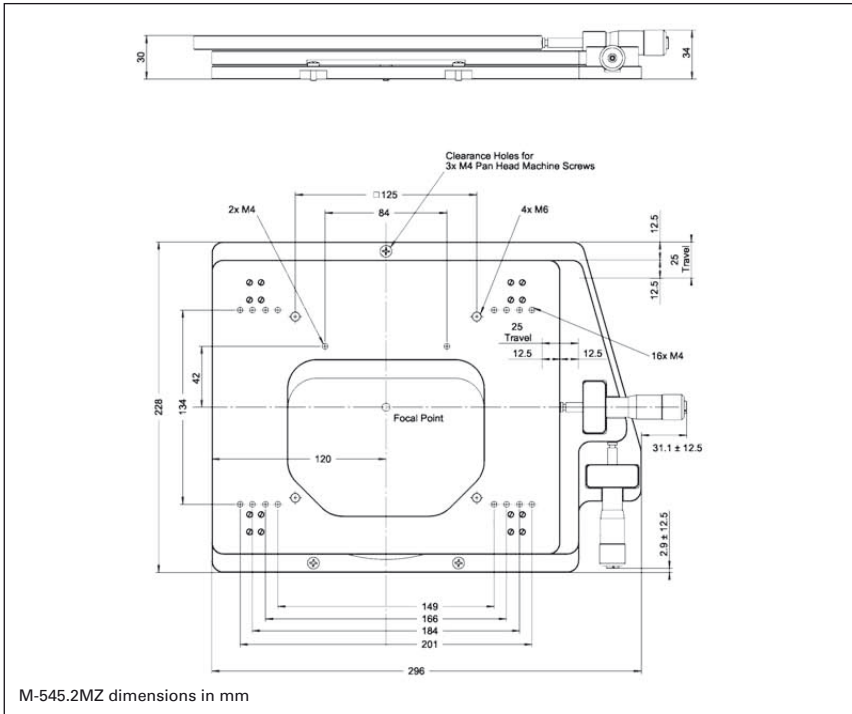
Adapter available for P-733 nanopositioners:

P-733.AP1

Adapter Plate for Mounting of P-733 Piezo Stages on M-545 XY Microscope Stage

Additional accessories on request.





Technical Data

Model	M-545.2M	Unit	Tolerance
Active axes	XY		
Motion and positioning			
Displacement	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	
Preload	10	N	
Miscellaneous			
Material	Aluminum, stainless steel		
Mass	4	kg	±5%

Find further specifications on M-229 stepper linear actuators in the datasheet (s. p. 1-44)

Compact XYZ Micropositioning Stage for Alignment

DC/Piezo Drive System for Nanometer Precision



- Up to 15 mm Travel
- 1 nm Resolution
- Closed-Loop Piezo Drives Available
- Stepper- & DC-Motor Drives

F-130 are compact computer-controllable XYZ alignment and positioning systems combining the advantages of ultra-high-resolution piezo drives with the long travel range of motorized stages.

They are based on the M-110/ M-111 micropositioning stages (see page 4-22) and the P-611

Application Examples

- Photonics packaging
- Optical device testing
- MEMS positioning/alignment
- Fiber alignment
- Micromachining
- Micromanipulation (life sciences)
- Semiconductor test systems

rapid piezo NanoAlignment units (see page 2-20).

The F-130/F-131 is available in 8 different versions, with stepper- and DC-motor coarse drives, and open- and closed-loop piezoelectric fine drives. (see Ordering Information).

The motor drives provide better than 0.05 μm resolution over a travel range of 5 and 15 mm. The piezo fine drives feature a 100 μm travel range in X, Y and Z, with zero-stiction, zero-friction flexure guiding systems and 1 nm resolution.

Several fiber, waveguide and optics adapters are available from PI (e.g. model F-603.60, see "Fiber, Objective and Waveguide Holders").

The C-880 multi-axis automation platform (see page 4-124) is recommended as controller.

Ordering Information

- F-130.3SD**
XYZ Alignment System, 5 mm / 100 μm , DC Motor/Encoder, C/L Piezo
- F-130.3SS**
XYZ Alignment System, 5 mm / 100 μm , Stepper Motor, C/L Piezo
- F-130.3OD**
XYZ Alignment System 5 mm / 100 μm , DC Motor/Encoder, O/L Piezo
- F-130.3OS**
XYZ Alignment System, 5 mm / 100 μm , Stepper Motor, O/L Piezo
- F-131.3SD**
XYZ Alignment System, 15 mm / 100 μm , DC Motor/Encoder, C/L Piezo
- F-131.3SS**
XYZ Alignment System, 15 mm / 100 μm , Stepper Motor, C/L Piezo
- F-131.3OD**
XYZ Alignment System, 15 mm / 100 μm , DC Motor/Encoder, O/L Piezo
- F-131.3OS**
XYZ Alignment System, 15 mm / 100 μm , Stepper Motor, O/L Piezo

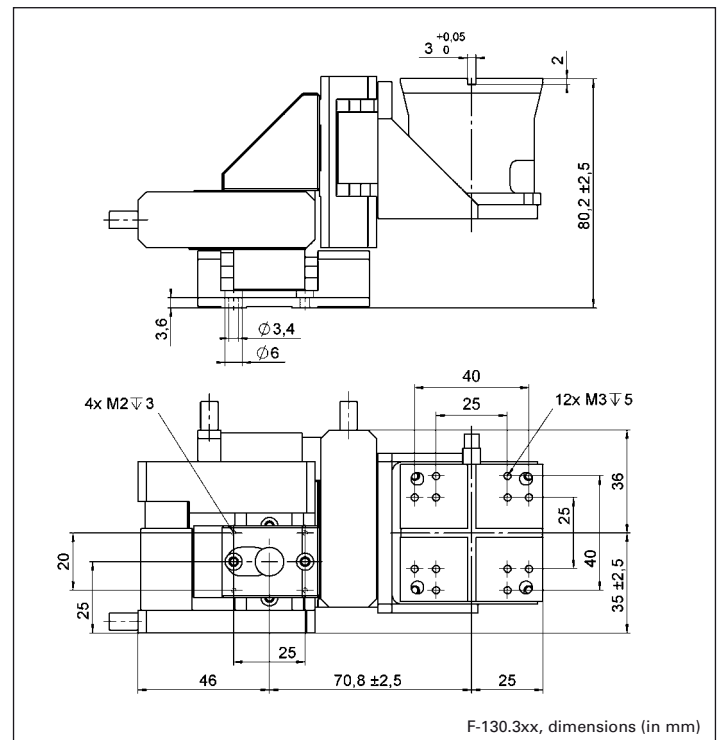
Ask about custom designs!



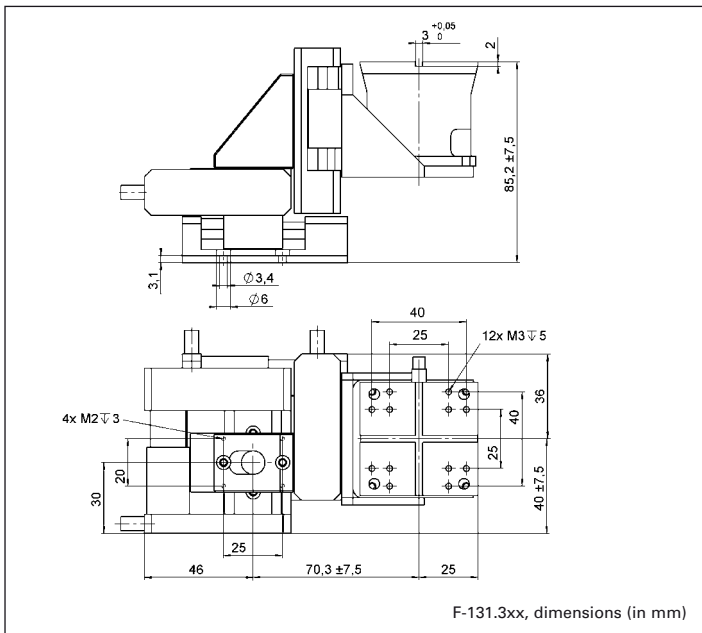
M-116.DG micro rotary stage



XY θ_z micropositioning combination consisting of (from top to bottom) M-116 micro rotary stage and two M-111 translation stages (M-110.01 adapter for mounting the M-111 on a honeycomb breadboard with M6 on 25 mm centers)



F-130.3xx, dimensions (in mm)



Technical Data

Model	F-130.3SD	F-130.3SS	F-130.3OD	F-130.3OS	F-131.3SD	F-131.3SS	F-131.3OD	F-131.3OS	Units
Key features	Closed-loop DC motors, closed-loop PZT drives	Stepper motors, closed-loop PZT drives	Closed-loop DC motors, open-loop PZT drives	Stepper motors, open-loop PZT drives	Closed-loop DC motors, closed-loop PZT drives	Stepper motors, closed-loop PZT drives	Closed-loop DC motors, open-loop PZT drives	Stepper motors, open-loop PZT drives	
Piezo travel range (XYZ)	100	100	100	100	100	100	100	100	µm
Design resolution (motor)	0.007	0.006	0.007	0.006	0.007	0.006	0.007	0.006	µm
Min. incremental motion (motor)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	µm
Closed-loop / open-loop resolution (PZT)	2/1	2/1	- / 1	- / 1	2/1	2/1	- / 1	- / 1	nm
Motorized stage	M-110.3DG	M-110.32S	M-110.3DG	M-110.32S	M-111.3DG	M-111.32S	M-111.3DG	M-111.32S	
Piezo drive	P-611.3SF	P-611.3SF	P-611.3OF	P-611.3OF	P-611.3SF	P-611.3SF	P-611.3OF	P-611.3OF	
Material	Al / S	Al / S	Al / S	Al / S	Al / S	Al / S	Al / S	Al / S	
Recommended controller	C-880	-	C-880	-	C-880	-	C-880	-	

M-605 High-Accuracy Micropositioning Stage

Ultra-Compact, with Direct Position Measurement



M-605.2DD XYZ-combination

- **Integrated 0.1 μm Linear Encoder for Highest Accuracy**
- **Travel Ranges 25 mm (1") and 50 mm (2")**
- **Max. Velocity 50 mm/s with ActiveDrive Motor**
- **High Load Capacity up to 30 kg**
- **Zero-Backlash Recirculating Ballscrews**
- **Non-contact Limit and Reference Switches**
- **Stress-Relieved Aluminum Base for Highest Stability**
- **Flexible Bellows Protects the Mechanics from Dust and Spray**
- **XY & XYZ Combinations Possible**
- **MTBF >20,000 h**

M-605 series translation stages are designed to meet the most demanding positioning requirements in applications where space is limited.

They feature a space-saving design with the ballscrew side-by-side to the motor and an extremely flat, precision-ma-

chined base of high-density, stress-relieved aluminum providing exceptional stability and minimum weight.

Integrated Linear Scale Encoder

For highest accuracy and repeatability, M-605 stages are equipped with integrated linear-scale encoders (direct metrology) providing 0.1 μm minimum incremental motion and 1 μm full-travel accuracy.

Heavy Duty and Maintenance Free

All models are equipped with high-precision linear guiding rails and recirculating ball bearings. The choice of components and careful mounting guarantees high load capacity, longer lifetime and high guiding accuracy.

Ballscrews for High Speed, Precision and Lifetime

The precision-ground ballscrew is maintenance-free and pre-loaded to eliminate mechanical play. Its significantly reduced friction, compared to conventional leadscrews, allows for higher velocity, lower power consumption and longer lifetime.

A flexible bellows protects the mechanics from dust and spray.

ActiveDrive

For maximum dynamic performance, the M-605 series stages are equipped with the highly efficient ActiveDrive direct-drive system, which can achieve speeds of up to 50 mm/s. The ActiveDrive design, developed by PI, features a high-efficiency PWM (pulse width modulation) servo-amplifier mounted side-by-side with the DC motor and offers several advantages:

- Increased efficiency, by eliminating power losses between the amplifier and motor
- Reduced cost of ownership and improved reliability, because no external driver is required
- Elimination of PWM amplifier noise radiation, by mounting the amplifier and

Ordering Information

M-605.1DD
Compact Precision Linear Stage, 25 mm, 0.1 μm Linear Encoder, ActiveDrive DC Motor

M-605.2DD
Compact Precision Linear Stage, 50 mm, 0.1 μm Linear Encoder, ActiveDrive DC Motor

Accessories:

M-605.AV1
Angle Bracket for Vertical Mount of M-605 on M-605

M-110.01
Adapter Plate for Horizontal Mount of M-605 on Honeycomb Tables, M-400- and M-500 Series Translation Stages and Several Rotation Stages

Ask about custom designs!

motor together in a single, electrically shielded case

Limit and Reference Switches

For the protection of your equipment, non-contact Hall-effect limit and reference switches are installed. The direction-sensing reference switch supports advanced automation applications with high precision.

Precision Assembly

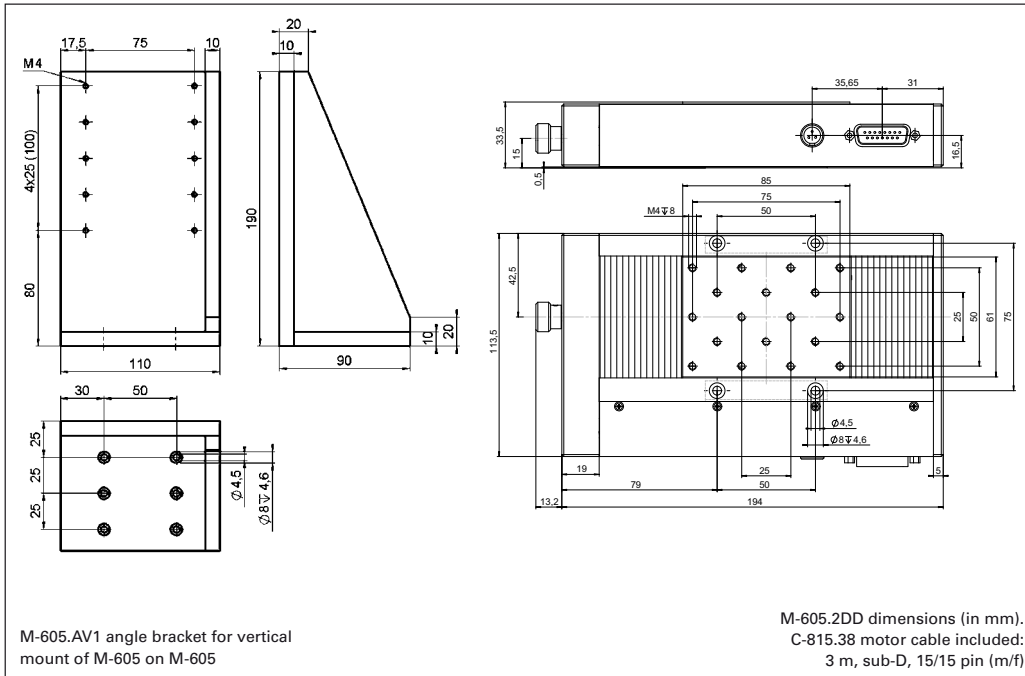
Each M-605 stage is precision assembled and optimized using laser interferometers for performance testing.

Application Examples

- R&D
- Semiconductor testing
- Mass storage device testing
- Metrology
- Photonics packaging
- Quality assurance testing
- Precision Linear Motion Control



M-605.2DD high precision translation stage



Technical Data

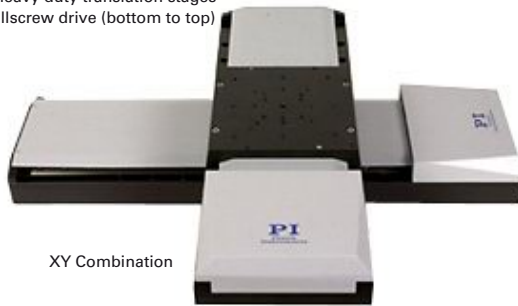
Model	M-605.1DD	M-605.2DD	Units
Active Axes	X	X	
Motion and positioning			
Travel range	25	50	mm
Integrated sensor	Linear encoder	Linear encoder	
Sensor resolution	0.1	0.1	μm
Design resolution	0.1	0.1	μm
Min. incremental motion	0.3	0.3	μm
Unidirectional repeatability	0.1	0.1	μm
Bidirectional repeatability	0.2	0.2	μm
Accuracy	1	1	μm
Pitch	±30	±30	μrad
Yaw	±30	±30	μrad
Max. velocity	50	50	mm/s
Origin repeatability	1	1	μm
Mechanical properties			
Thread pitch	1	1	mm
Max. load	300	300	N
Max. push / pull force	20 / 20	20 / 20	N
Max. lateral force	100	100	N
Drive properties			
Motor type	ActiveDrive DC Motor	ActiveDrive DC Motor	
Operating voltage	24 (PWM)	24 (PWM)	V
Electrical power	6	6	W
Limit and reference switches	Hall-effect	Hall-effect	
Miscellaneous			
Operating temperature range	-20 to +65	-20 to +65	°C
Material	Al (black anodized)	Al (black anodized)	
Mass	1.5	1.8	kg
Recommended controller/driver	C-863 single-axis C-843 PCI board (up to 4 axes)	C-863 single-axis (p. 4-114) C-843 PCI board (p. 4-120) (up to 4 axes)	

Micropositioning Stages, X, XY, XZ, XYZ Combinations

High-Precision Linear Guiding, Long Travel, Direct Position Measurement



M-531.DD, M-521.DD, M-511.DD and M-505.2DG heavy duty translation stages with recirculating ballscrew drive (bottom to top)



XY Combination

- Travel Ranges 102, 204 and 306 mm (4", 8", 12")
- Max. Velocity 125 mm/s with ActiveDrive™ Motors
- Optional 0.1 μm Linear Encoder for Highest Accuracy
- Load Capacity of 100 kg
- Stress-Relieved Aluminum Base for Highest Stability
- Zero-Backlash Recirculating Ballscrews
- Non-contact Limit and Reference Switches
- XY & XYZ Combinations (Special Z-Stages Available)
- MTBF >20,000 h

M-5x1-series translation stages are designed to meet the most demanding positioning requirements and are available in a number of different models. They boast an extremely low profile design to allow multiaxis combinations (see also page 4-58 and page 4-60) and feature

a precision-machined base of high-density, stress-relieved aluminum for exceptional stability and minimum weight.

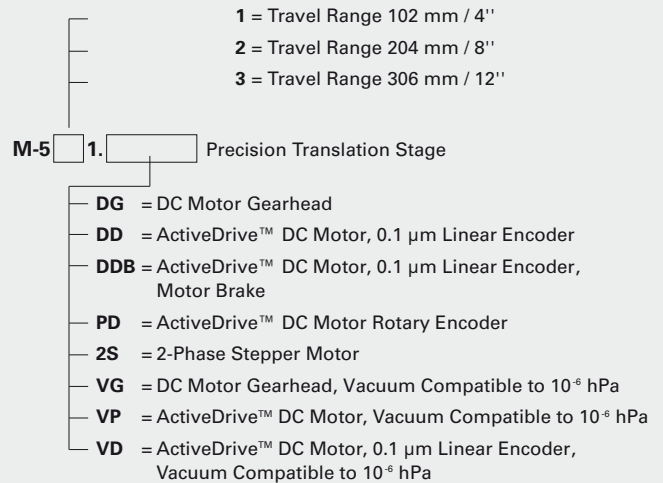
Heavy Duty and Maintenance Free

The stages are equipped with high-precision linear guiding rails with recirculating ball bearings to guarantee 1 μm/100 mm straightness and flatness. Precision-ground recirculating ball screws with preloaded nuts provide low-friction, maintenance-free and backlash-free positioning. This equipment provides high load capacity and guiding accuracy with long lifetime.

Four Drive Options

Maximum dynamic performance is possible with versions featuring the highly efficient ActiveDrive™ direct-drive sys-

Ordering Information



tem, which can achieve speeds of up to 125 mm/s.

The ActiveDrive™ design, developed by PI, features a high-efficiency PWM (pulse width modulation) servo-amplifier mounted side-by-side with the DC motor and offers several advantages:

- Increased efficiency, by eliminating power losses between the amplifier and motor
- Reduced cost of ownership and improved reliability, because no external driver is required
- Elimination of PWM amplifier noise radiation, by mounting the amplifier and motor together in a single, electrically shielded case

The M-5x1.PD version provides velocities up to 125 mm/sec. It is equipped with an ActiveDrive™ DC motor and rotary encoder.

The M-5x1.DD models provide superior repeatability of only 0.2 μm by means of integrated optical linear encoders. A motor brake which assures maintenance of the stage position after power-down is also available. The M-5x1.DG versions feature

closed-loop DC motors with shaft-mounted position encoders and precision gearheads providing minimum incremental motion to 0.1 μm with velocities up to 6 mm/s.

The M-5x1.2S versions models feature a cost-effective direct-drive, 2-phase stepper motor, providing very smooth operation and a resolution of 0.1 μm.

Precision Assembly

The stages are individually tested and optimized using a laser interferometer.

Notes

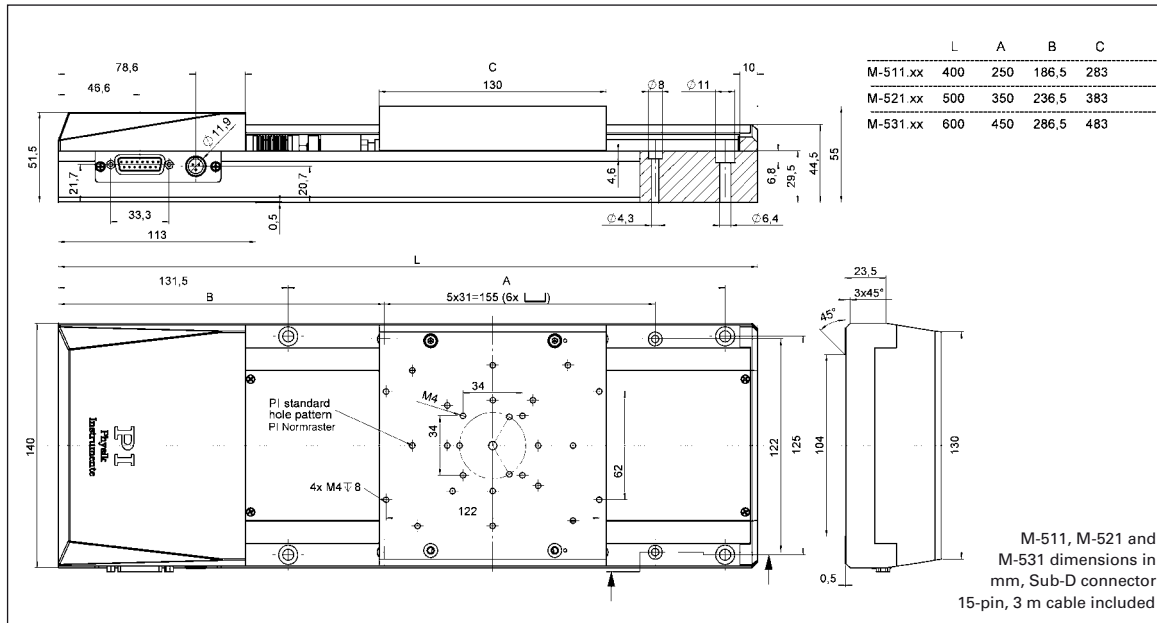
For adapters, bracket, etc. (see page 4-90 ff).



XYZ combination with two M-511.DD linear stages and an M-501.1PD precision vertical stage

Application Examples

- R&D
- Semiconductor testing
- Mass storage device testing
- Metrology
- Photonics packaging
- Quality assurance testing
- Precision Linear Motion Control



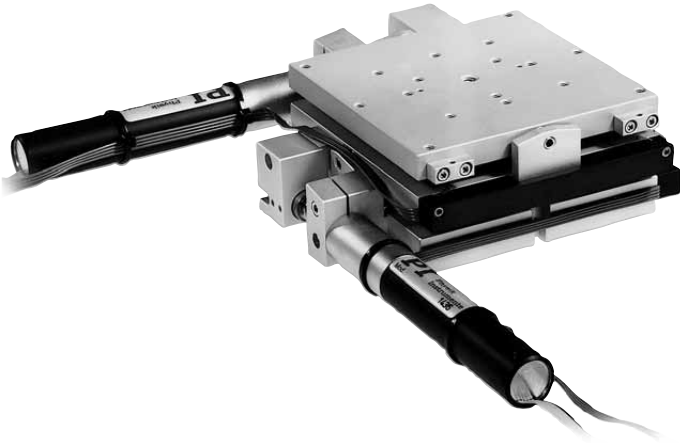
Technical Data

Model	M-511.DD / M-521.DD / M-531.DD	M-511.PD / M-521.PD / M-531.PD	M-511.DG / M-521.DG / M-531.DG	M-511.2S / M-521.2S / M-531.2S	Unit
Motion and positioning					
Travel range	102 / 204 / 306	102 / 204 / 306	102 / 204 / 306	102 / 204 / 306	mm
Integrated sensor	Linear encoder	Rotary encoder	Rotary encoder	–	
Sensor resolution	0.1 μm	4000	2048	–	cts./rev.
Design resolution	0.1	0.5	0.033	0.31	μm
Min. incremental motion	0.1	0.5	0.1	0.1	μm
Unidirectional repeatability	±0.1	±0.5	±0.2	±0.2	μm
Bidirectional repeatability	±0.2	–	–	–	μm
Backlash	–	1	1	1	μm
Pitch/Yaw	±25 / ±35 / ±50	±25 / ±35 / ±50	±25 / ±35 / ±50	±25 / ±35 / ±50	μrad
Straightness/Flatness per 100 mm	1	1	1	1	μm
Max. velocity	50	125	6	20	mm/s
Mechanical properties					
Thread pitch	2	2	2	2	mm
Gear ratio	–	–	(28/12) ⁴ : 1 ≈ 29.6:1	–	
Motor resolution*	–	–	–	6400*	steps/rev.
Max. load	1000	1000	1000	1000	N
Max. push/pull force	80 / 80	80 / 80	80 / 80	80 / 80	N
Max. lateral force	200	200	200	200	N
Drive properties					
Motor type	ActiveDrive™ DC Motor	ActiveDrive™ DC Motor	DC-motor, gearhead	2-phase stepper motor*	
Operating voltage	24 (PWM)	24 (PWM)	0 to ±12	24	V
Electrical power	30	30	3		W
Limit and reference switches	Hall-effect	Hall-effect	Hall-effect	Hall-effect	
Miscellaneous					
Operating temperature range	-20 to +65	-20 to +65	-20 to +65	-20 to +65	°C
Material	Al (black anodized)	Al (black anodized)	Al (black anodized)	Al (black anodized)	
Mass	5 / 6.1 / 7.2	5 / 6.1 / 7.2	4.9 / 6 / 7.1	4.9 / 6 / 7.1	kg
Recommended controller/driver	C-863 (single-axis) C-843 PCI board (up to 4 axes)	C-863 (single-axis) C-843 PCI board (up to 4 axes)	C-863 (single-axis, p. 4-1149) C-843 PCI board (up to 4 axes)	C-663 (single-axis) (p. 4-112)	

*2-phase stepper motor, 24 V chopper voltage, max. 0.8 A/phase, 400 full steps/rev., motor resolution with C-663 stepper motor controller

Tip/Tilt Stage Micropositioning Stage

Piezo Drive Option for Nanometer Precision



M-044.D01 tip/tilt stage

- One- & Two-Axis Tilt Stages
- Zero Backlash
- Sub- μ rad Resolution
- Manual and DC-Motor Drives
- Compatible with Leading Industrial Motion Controllers
- Optional Piezo Drives for Tracking and Scanning

M-041 through M-044 are one- and two-axis (θ_x , θ_y) tip/tilt stages for small loads. They are spring preloaded for elimination of backlash and feature resolution and repeatability superior to that of goniometric cradles. Versions with piezo translators allow ultra-high-resolution dynamic scanning and tracking. See the "Fast Steering Mirrors / Active Optics" section for fast, ultra-high-resolution, tip/tilt platforms (p. 2-79 ff).

The two basic versions (with part number extension .00) are equipped with manual micrometer drives providing 65 and 80 μ rad minimum incremental motion, respectively. The versions with extension .D01 are equipped with closed-loop, DC-servo-motor drives (model M-227.10 (see p. 1-42) for fur-

ther details and recommended motor controllers) providing 15 and 12 μ rad minimum incremental motion, respectively. Sets of limit switches eliminate the possibility of overtravel.

High-Resolution Piezo Option

For sub- μ rad resolution and dynamic tracking or scanning, optional open-loop/closed-loop piezo drive upgrade kits are available. See the P-840 and P-841 (see p. 1-74) in the "Piezo Actuators & Components" section for further details and recommended controllers. The piezo drives can also be ordered subsequently to upgrade manual or motorized systems.

Notes

See "Accessories", page 4-90 ff. for adapters, brackets, etc.

Ordering Information

M-041.00
Small Tilt Stage, Manual Micrometer Drive

M-041.D01
Small Tilt Stage, DC-Motor Drive

M-042.00
Small Tip/Tilt Stage, Manual Micrometer Drive

M-042.D01
Small Tip/Tilt Stage, DC-Motor Drive

M-043.00
Tilt Stage, Manual Micrometer Drive

M-043.D01
Tilt Stage, DC-Motor Drive

M-044.00
Tip/Tilt Stage, Manual Micrometer Drive

M-044.D01
Tip/Tilt Stage, DC-Motor Drive

Upgrades

M-041.U0
Open-Loop Piezo Drive Upgrade Kit for M-041 Tilt Stages

M-041.US
Closed-Loop Piezo Drive Upgrade Kit for M-041 Tilt Stages

M-042.U0
Open-Loop Piezo Drive Upgrade Kit for M-042 Tip/Tilt Stages

M-042.US
Closed-Loop Piezo Drive Upgrade Kit for M-042 Tip/Tilt Stages

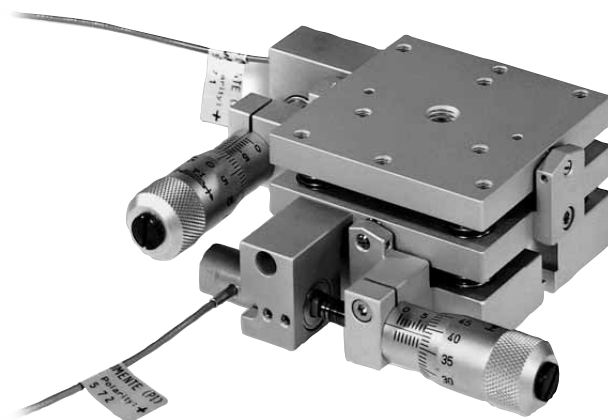
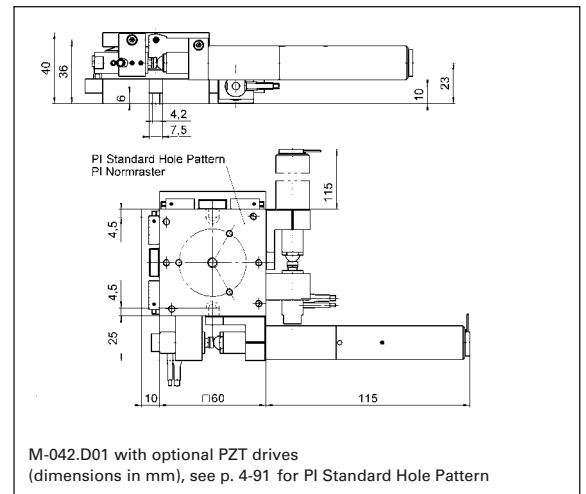
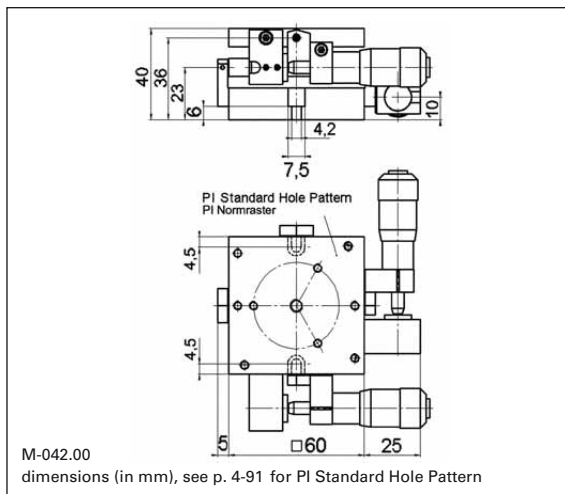
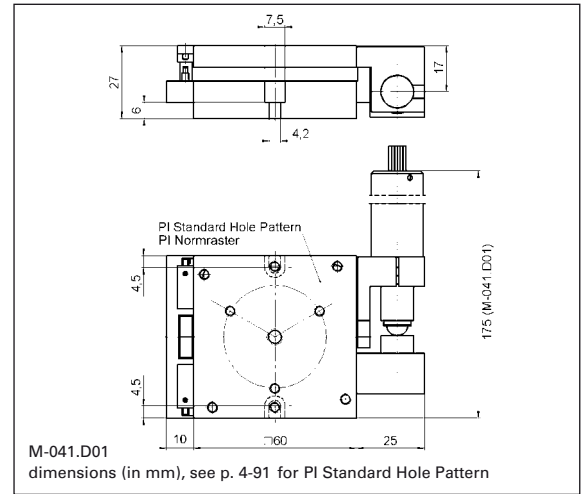
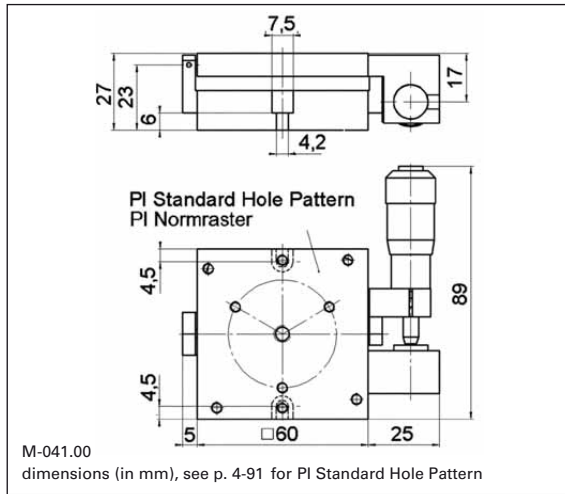
M-043.U0
Open-Loop Piezo Drive Upgrade Kit for M-043 Tilt Stages

M-043.US
Closed-Loop Piezo Drive Upgrade Kit for M-043 Tilt Stages

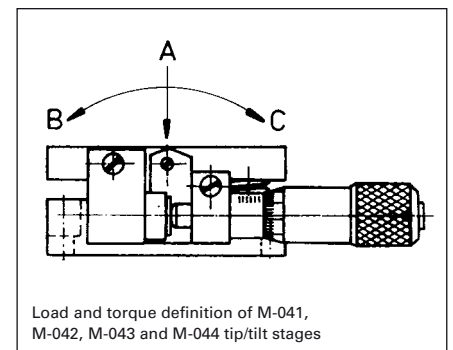
M-044.U0
Open-Loop Piezo Drive Upgrade Kit for M-044 Tip/Tilt Stages

M-044.US
Closed-Loop Piezo Drive Upgrade Kit for M-044 Tip/Tilt Stages

Ask about custom designs!

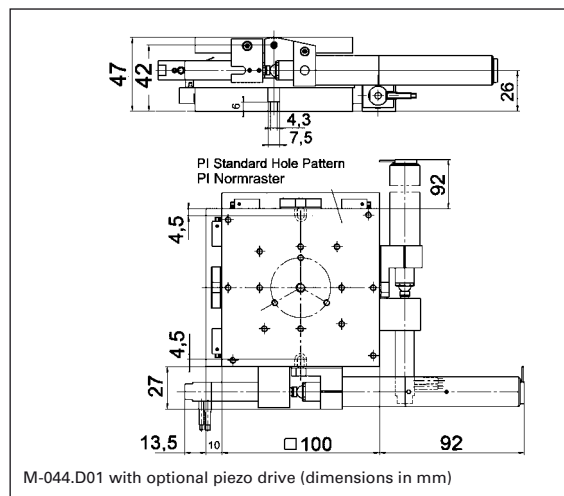
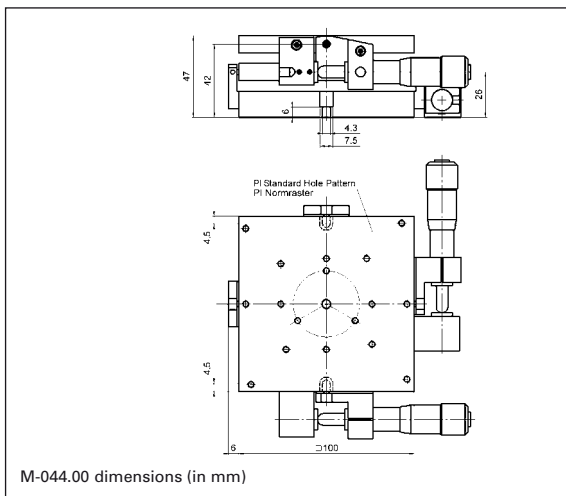
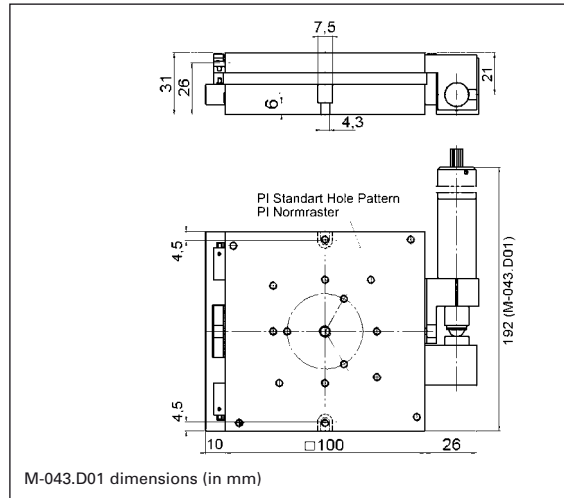
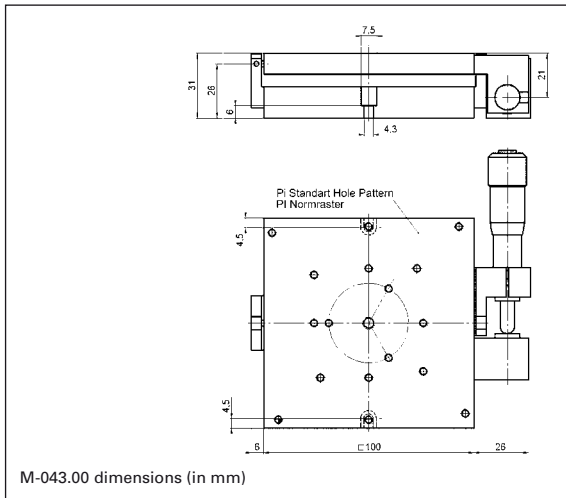


M-042.00 tip/tilt stage with optional PZT drives



Tip/Tilt Stage Micropositioning Stage

Piezo Drive Option for Nanometer Precision

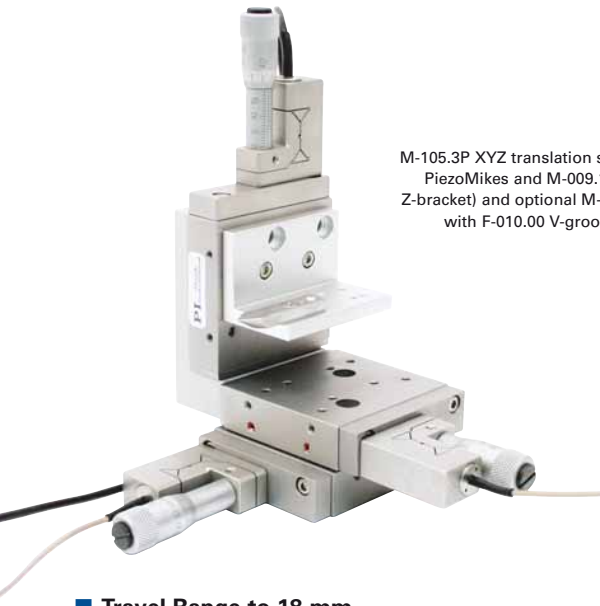


Technical Data

Model	M-041.00	M-042.00	M-043.00	M-044.00	M-041.D01	M-042.D01	M-043.D01	M-044.D01	Units
Tilt axes	θ_x	θ_x, θ_y	θ_x	θ_x, θ_y	θ_x	θ_x, θ_y	θ_x	θ_x, θ_y	
Tilt range	± 9	± 9	± 7	± 7	± 9	± 9	± 7	± 7	$^\circ$ (axis)
Fine range (piezo option)	± 1.2	± 0.6	± 1.4	± 1.4	± 1.2	± 0.6	± 1.4	± 1.4	mrad (axis)
Design resolution	-	-	-	-	0.28	0.28	0.23	0.23	μ rad
Min. incremental motion	80	80	65	65	5	5	5	5	μ rad
Min. incremental motion (piezo option)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	μ rad
Rotation / linear input	80	80	65	65	80	80	65	65	μ rad/ μ m
Unidirectional repeatability	-	-	-	-	20	20	15	15	μ rad
Backlash	-	-	-	-	200	200	175	175	μ rad
Max. velocity (motor)	-	-	-	-	4.5	4.5	3.6	3.6	$^\circ$ /s
Max. load (A)	4	4	5	5	4	4	5	5	kg
Max torque (B, C)	450, 150	450, 150	750, 250	750, 250	450, 150	450, 150	750, 250	750, 250	mNm
Drive	M-622 Micrometer	M-622 Micrometer	M-624 Micrometer	M-624 Micrometer	M-227.10 DC-Mike	M-227.10 DC-Mike	M-227.10 DC-Mike	M-227.10 DC-Mike	
Piezo drive (optional) M-04x.U0 / M-04x.US	P-840.20 / P-841.20	P-840.10 / P-841.10	P-840.30 / P-841.30	P-840.30 / P-841.30	P-840.20 / P-841.20	P-840.10 / P-841.10	P-840.30 / P-841.30	P-840.30 / P-841.30	
Mass	0.4	0.6	0.8	1.2	0.5	0.7	0.9	1.5	kg
Body material	Al	Al	Al	Al	Al	Al	Al	Al	

Miniature Micropositioning Stage w/Piezo Option

Precision Crossed Roller Guides, PiezoMike Option, XY(Z) Combinations



M-105.3P XYZ translation stage (includes PiezoMikes and M-009.10, side mount Z-bracket) and optional M-009.20 bracket with F-010.00 V-groove fiber holder

- Travel Range to 18 mm
- All-Stainless-Steel Construction
- XY and XYZ Combinations
- Resolution up to 0.1 μm
- Optional PiezoMike with 10 nm Resolution
- Optional Motor Drives

M-105 and M-106 are micrometer-driven translation stages with travel ranges of 18 mm and 5 mm, respectively. The carriage is spring preloaded against the micrometer tip for excellent repeatability and elimination of backlash. M-105 and M-106 stages are available in one-, two- or three-axis configurations. Precision crossed roller bearings guarantee straightness of travel of better than 2 μm . The M-106 is equipped with a differential micrometer drive providing resolution of 0.1 μm .

PiezoMike Option

Versions with PiezoMike drive provide additional 30 μm fine range for remotely controlled ultra-high-resolution (e.g. scanning or tracking, (see p. 1-54) for further details and recommended controllers).

The vertical stage in the XYZ assembly supports the load through the micrometer spin-

dle (not the preload springs) providing excellent stability.

Motor Drive Upgrades

Two motor drives are available, the M-231.17 and the M 232.17 actuators (see p. 1-48 and p. 1-49). Both provide resolution a resolution of 0.1 μm .

Technical Data

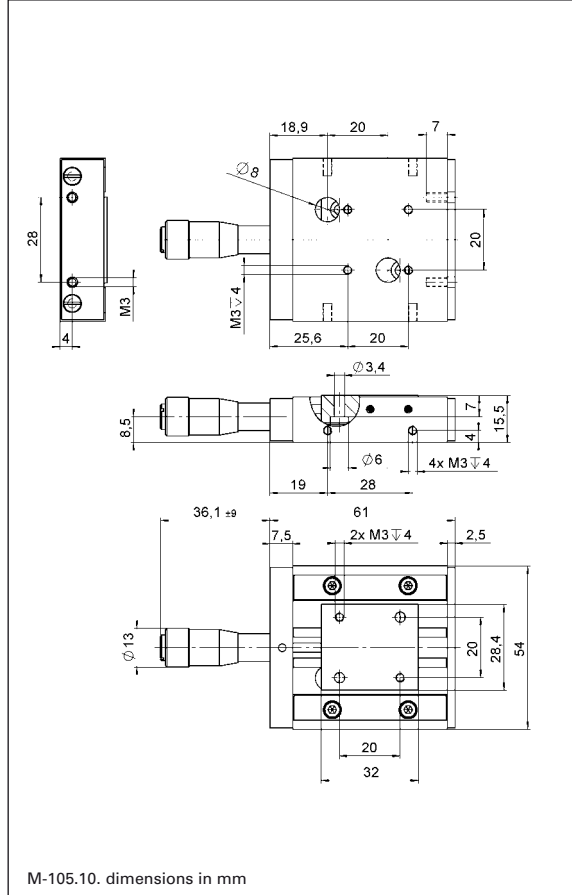
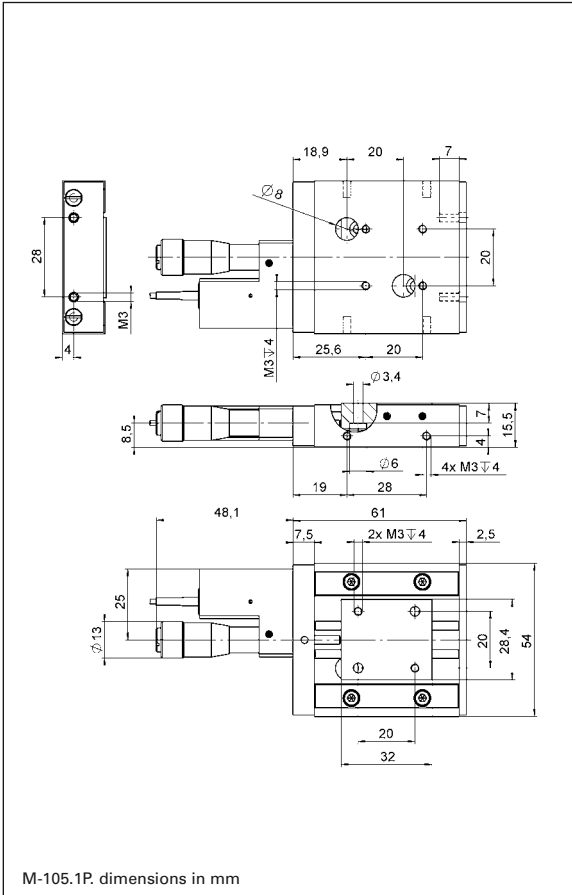
Model	M-105.10*	M-105.1P*	M-106.10*	Unit
Travel range	18	18	5	mm
Piezo fine travel range	-	30	-	μm
Min. incremental motion (piezo drive)	-	0.01	-	μm
Min. incremental motion (micrometer drive)**	1	1	0.1	μm
Backlash	2	2	2	μm
Straightness	2	2	2	μm
Flatness	2	2	2	μm
Max. normal load capacity	100	100	100	kg
Max. push/pull force	20 / 4	20 / 4	20 / 4	N
Max. lateral force	4	4	4	N
Drive	M-626.00	P-854.00	M-653.00	
Micrometer pitch	0.5 / -	0.5 / -	0.4 / 0.02	mm/rev.
Mass	0.32	0.38	0.33	kg
Body material	St	St	St	
Recommended piezo driver	-	E-660 (p. 2-119), E-610 (p. 2-110) E-500 System (p. 2-142)	-	

*Versions M-105.2x, M-106.2x and M-105.3x M-106.x0 are combinations of basic .1x. versions

**Motorized versions achieve up to 100 nm.

Ordering Information

- | | |
|---|--|
| <p>M-105.10
Translation Stage, 18 mm</p> <p>M-105.11
Translation Stage, 18 mm, with Lockable Micrometer Drive</p> <p>M-105.20
XY-Translation Stage, 18 mm</p> <p>M-105.30
XYZ-Translation Stage, 18 mm, (Includes M-009.10, Side Mount Z-Bracket)</p> <p>M-105.1P
Translation Stage, 18 mm, PiezoMike Drive</p> <p>M-105.2P
XY-Translation Stage, 18 mm, PiezoMike Drive</p> <p>M-105.3P
XYZ-Translation Stage, 18 mm, PiezoMike- Drive (Includes M-009.10, Side Mount Z-Bracket)</p> <p>M-106.10
Translation Stage, 5 mm, Differential Micrometer Drive</p> <p>M-106.20
XY-Translation Stage, 5 mm, Differential Micrometer Drive</p> <p>M-106.30
XYZ-Translation Stage, 5 mm, Differential Micrometer Drive (Includes M-009.10, Side Mount Z-Bracket)</p> <p>M-105.1B
Translation Stage, Basic Unit, Order Drives Separately</p> | <p>M-105.2B
XY-Translation Stage, Basic Unit, Order Drives Separately</p> <p>M-105.3BA
XYZ-Translation Stage, Basic Unit (Includes M-105.VB1, Top Mount Z-Bracket), Order Drives Separately</p> <p>M-105.3BB
XYZ-Translation Stage, Basic Unit (Includes M-009.10, Side Mount Z-Bracket), Order Drives Separately</p> <p>Accessories</p> <p>M-232.17
DC-Mike, Linear Actuator</p> <p>M-009.10
Z-axis Mounting Bracket for Vertical Mount of M-105/6 (Attaches to Side of M-105)</p> <p>M-105.VB1
Z-axis Mounting Bracket for Vertical Mount of M-105/6 (Attaches to Top of M-105)</p> <p>M-009.20
Mounting Bracket for Mounting P-280 PZT NanoPositioning Systems or F-010 Fiber Holders</p> <p>M-009.30
Z-axis Mounting Bracket for Vertical Mount of M-105/6 Stages on PI Standard Hole Pattern</p> |
|---|--|



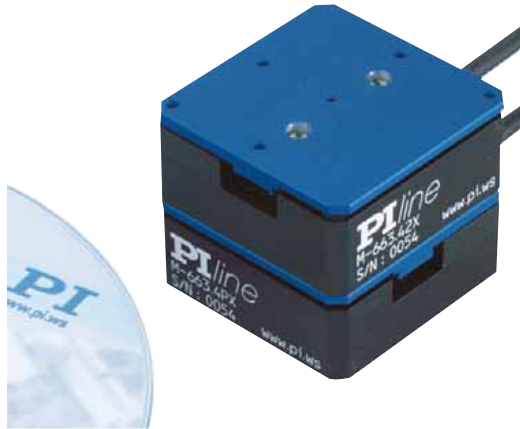
M-106.10 translation stage with differential micrometer drive



Combination of M-105.1B basic unit and M-232.17 high-resolution DC-Mike actuator

Linear-Motor Driven Mini Micropositioning Slide

Compact, Fast, with Ultrasonic Piezo Linear Drives, Direct Position Measurement



XY combination of two M-663s; CD for size comparison

- **Smallest Translation Stage with Closed-Loop Linear Motor and Encoder**
- **Travel Range 19 mm**
- **Max. Velocity 400 mm/s**
- **Acceleration up to 10 g**
- **Direct Metrology Linear Encoder**
- **0.1 μm Resolution**
- **XY Combination Possible**
- **Vacuum-Compatible Versions Available**

PILine[®] M-663 micropositioning systems offer high velocities of up to 400 mm/s and travel ranges of 19 mm in a compact package. The M-663 is the smallest closed-loop trans-

lation stage with piezomotor drives currently on the market. Its square footprint makes it suitable for use in compact XY configurations.

Application Examples

- Biotechnology
- Micromanipulation
- Microscopy
- Quality assurance testing
- Metrology
- Mass storage device testing
- R&D
- Photonics packaging

Working Principle

PILine[®] motors have a new, patented, ultrasonic drive developed by PI. The core piece of the system is a piezoceramic plate, which is excited to produce high-frequency eigenmode oscillations. A friction tip attached to the plate moves along an inclined linear path at the eigenmode frequency. Through its contact with the friction bar, the moving part of the mechanics drives forward or backwards.

With each oscillatory cycle, the mechanics executes a step of a few nanometers; the macroscopic result is smooth motion with a virtually unlimited travel range.

Advantages of PILINE[®] Micropositioning Systems

The ultrasonic piezoceramic drives used in PILINE[®] micropositioners have a number of advantages over classical drives:

- Higher Accelerations, up to 5 g
- Speeds up to 500 mm/s
- Small Form Factor
- Self-Locking When Powered Down
- No Shafts, Gears or Other Rotating Parts
- Non-Magnetic and Vacuum-Compatible Drive Principle

Optimized Controller and Drive Electronics

PILine[®] motors require a special drive electronics to generate the ultrasonic oscillations for piezoceramic element. For optimum performance the highly specialized C-867 (see p. 4-116) motion controller is recommended. This sophisticated controller also integrates the drive electronics. Furthermore, the controller has a number of special features, including dynamic parameter switching for an optimized high-speed motion and settling behavior to take into account the motion characteristics typical of piezomotors. The broad-band encoder input (50 MHz) supports the outstanding high accelerations and velocities of PILINE[®] drives at high resolutions.

Optionally, for use with third party servo controllers, the C-185 analog drive electronics (stand-alone unit) is available. It controls the motor speed by an analog ± 10 V signal. For

Ordering Information

M-663.465
PILine[®] Translation Stage, 19 mm, Linear Encoder, 0.1 μm Resolution

M-663.Y65
PILine[®] Translation Stage, 19 mm, Linear Encoder, 0.1 μm Resolution, turned cable outlet, XY mountable

M-663.46V
PILine[®] Translation Stage, 19 mm, Linear Encoder, 0.1 μm Resolution, Vacuum Compatible to 10^{-6} hPa

Accessories:

C-867.161
Piezomotor Controller with Drive Electronics, 1 Channel, for PILINE[®] Systems with P-661 Motors

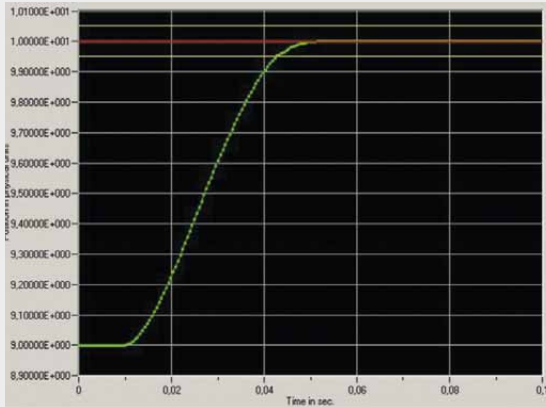
Driver for use with separate controller:

C-185.161
Analog Stand-Alone Drive Electronics with Power Supply for PILINE[®] P-661 Motors

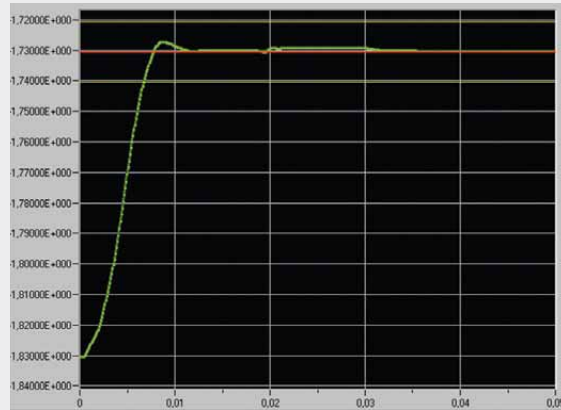
optimum performance the driver must be tuned together with the mechanics and should be ordered at the same time as the motor/stage.

Note

The products described in this document are in part protected by the following patents:
US Pat. No. 6,765,335
German Patent No. 10154526



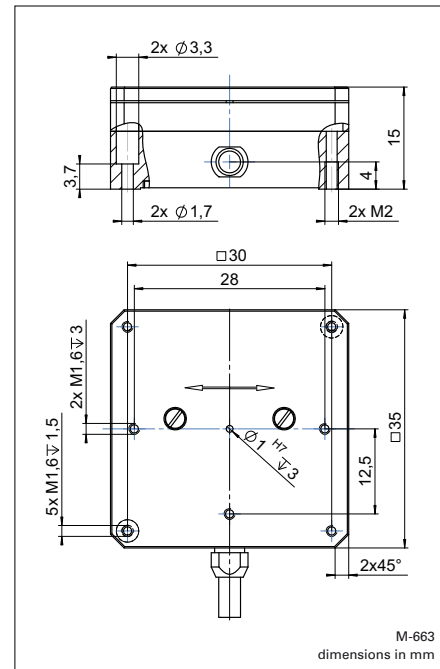
A 1 mm step performed by an M-663 stage with 300 g load controlled by a C-867 controller/driver reaches the end position in less than 40 ms



An M-663 with 100 g load settles to 0.1 µm accuracy in 10 ms after a 100 µm step, measured with C-867 controller/driver

Technical Data

Model	M-663.465	Units	Tolerance
Active axes	X		
Motion and positioning			
Travel range	19	mm	
Integrated sensor	Linear encoder		
Sensor resolution	0.1	µm	
Min. incremental motion	0.3	µm	typ.
Bidirectional repeatability	±0.3	µm	typ.
Unidirectional repeatability	0.2	µm	typ.
Pitch	300	µrad	typ.
Yaw	300	µrad	typ.
Max. velocity	400	mm/s	
Reference switch repeatability	1	µm	typ.
Mechanical properties			
Max. load	5	N	
Max. push/pull force	2	N	
Max. holding force	2	N	
Drive properties			
Motor type	P-661 PiLine® ultrasonic piezomotor		
Motor voltage range	120 (peak-peak)* 42 (RMS)*	V	
Electrical power	5**	W	nominal
Current	400**	mA	
Reference switch	Hall-effect		
Miscellaneous			
Operating temperature range	-20 to +50	°C	
Material	Al (black anodized)		
Dimensions	35 x 35 x 15	mm	
Mass	40	g	±5 %
Cable length	1.5	m	±10 mm
Connector	MDR, 14-pin		
Recommended controller/driver	C-867.161 Single-axis controller/driver (p. 4-116) C-185.161 Drive electronics (p. 1-36)		



*Power is supplied by the drive electronics which runs on 12 V DC

**For drive electronics

Parallel Kinematic Tripod / Goniometer Micro-Positioner

Precision Positioning in X, Z, θ_Y



The parallel-kinematics tripod is designed for precision positioning, offering elevation, translation and tilt motion around the (horizontal) y-axis, with a user-defined pivot point

- Goniometer Z Stage with Freely Selectable Pivot Point
- Travel Ranges ± 25 mm / ± 25 mm / $\pm 30^\circ$
- Load Capacity to 4 kg
- Min. Incremental Motion to 0.1 μ m
- ActiveDrive Servo Motors
- Compact Design with Parallel Kinematics

Model	Travel ranges	Max. velocity	Stiffness	Dimensions
Tripod	± 25 mm (X, Z),	10 mm/s	50 N/ μ m	223,2 x 110 x 192 mm
Goniometer-Stage	$\pm 30^\circ$ (θ_Y)	(linear)		

Program Overview

- Piezo Ceramic Actuators & Motors
- Piezo Nanopositioning Systems and Scanners
- Active Optics / Tip-Tilt Platforms
- Capacitive Nanometrology Sensors
- Piezo Electronics: Amplifiers and Controllers
- Hexapod 6-Axis Positioners / Robots
- Micropositioning Stages & Actuators
- Photonics Alignment Systems, Solutions for Telecommunications
- Motor Controllers
- Ultrasonic Linear Motors

Request or download the complete PI Nanopositioning & Piezo Actuator Catalog



USA (East) & CANADA

PI (Physik Instrumente) L.P.
16 Albert St.
Auburn, MA 01501
Tel: +1 (508) 832 3456
Fax: +1 (508) 832 0506
info@pi-usa.us
www.pi-usa.us

JAPAN

PI Japan Co., Ltd.
Akebono-cho 2-38-5
Tachikawa-shi
J-Tokyo 190
Tel: +81 (42) 526 7300
Fax: +81 (42) 526 7301
info@pi-japan.jp
www.pi-japan.jp

CHINA

**Physik Instrumente
(PI Shanghai) Co., Ltd.**
Building No. 7-301
Longdong Avenue 3000
201203 Shanghai, China
Tel: +86 (21) 687 900 08
Fax: +86 (21) 687 900 98
info@pi-china.cn
www.pi-china.cn

FRANCE

PI France S.A.S
244 bis, avenue Max Dormoy
92120 Montrouge
Tel: +33 (1) 55 22 60 00
Fax: +33 (1) 41 48 56 62
info.france@pi.ws
www.pi-france.fr

GERMANY

**Physik Instrumente (PI)
GmbH & Co. KG**
Auf der Römerstr. 1
D-76228 Karlsruhe/Palmbach
Tel: +49 (721) 4846-0
Fax: +49 (721) 4846-100
info@pi.ws · www.pi.ws

USA (West) & MEXICO

PI (Physik Instrumente) L.P.
5420 Trabuco Rd., Suite 100
Irvine, CA 92620
Tel: +1 (949) 679 9191
Fax: +1 (949) 679 9292
info@pi-usa.us
www.pi-usa.us

PI Japan Co., Ltd.
Hanahara Dai-ni Building, #703
4-11-27 Nishinakajima,
Yodogawa-ku, Osaka-shi
J-Osaka 532
Tel: +81 (6) 6304 5605
Fax: +81 (6) 6304 5606
info@pi-japan.jp
www.pi-japan.jp

UK & IRELAND

PI (Physik Instrumente) Ltd.
Trent House
University Way,
Cranfield Technology Park,
Cranfield,
Bedford MK43 0AN
Tel: +44 (1234) 756 360
Fax: +44 (1234) 756 369
uk@pi.ws
www.physikinstrumente.co.uk

ITALY

Physik Instrumente (PI) S.r.l.
Via G. Marconi, 28
I-20091 Bresso (MI)
Tel: +39 (02) 665 011 01
Fax: +39 (02) 873 859 16
info@pionline.it
www.pionline.it