

Micropositioning Linear Slides

FAST



PRECISE



LOW PROFILE

Micropositioning Linear Slides



Fast Mini Slide with Linear Encoder



High Resolution Mini Slides



Ultra-High Speed Mini Slides



High Speed Mini Slide with Linear Motor and Linear Encoder



High Speed Low-Profile Slide with Linear Motor and Linear Encoder



High-Dynamics Voice-Coil Scanning System



Highly Precise Crossed-Roller Bearings Stage



Cost Efficient Industrial Linear Slides



Compact & Precise Slide w/ Linear Encoders & Bellows



Ballscrew-Drives, Low-Profile Stages



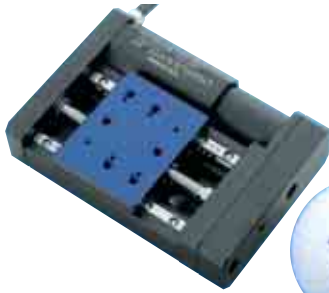
XY Stage w/ Piezo Motor & Linear Encoders



Ultra-Highly Precise Side-Drive Stage

Mini High Precision Micropositioning Stage w/Linear Encoder

Fast & Compact with Direct Position Measurement



The M-122.2DD miniature translation stage features an optical linear encoder with 0.1 μm position resolution and a highly efficient ballscrew

- Travel Range 25 mm
- 0.1 μm Optical Linear Encoder for Highest Accuracy & Repeatability
- Min. Incremental Motion to 0.2 μm
- Max. Velocity 20 mm/s
- Cross-Roll Bearings
- Recirculating Ball Screw Drives Provide High Speeds & Long Lifetimes

The M-122 palm-top-sized translation stage combines small dimensions, high speeds and very high accuracy at a competitive price. It features a space-saving, folded drive train with the servo motor and drive screw side-by-side. Equipped with a non-contacting optical linear encoder and a preloaded, precision-ground, ball-screw, these stages can provide much higher accuracy and better repeatability than conventional stepper motor stages or rotary encoder-equipped servo motor stages.

Low Friction, High Speed, Maintenance-Free

Due to its low-friction, the backlash-free ball screw yields significantly higher mechanical

efficiency than leadscrews, and allows maintenance-free, high duty-cycle operation at high velocities up to 20 mm/sec.

XY and XYZ Combinations

M-122 stages can be combined to very compact XY and XYZ systems. The M-122.AP1 mounting bracket is available to mount the Z-axis.

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.

Low Cost of Ownership

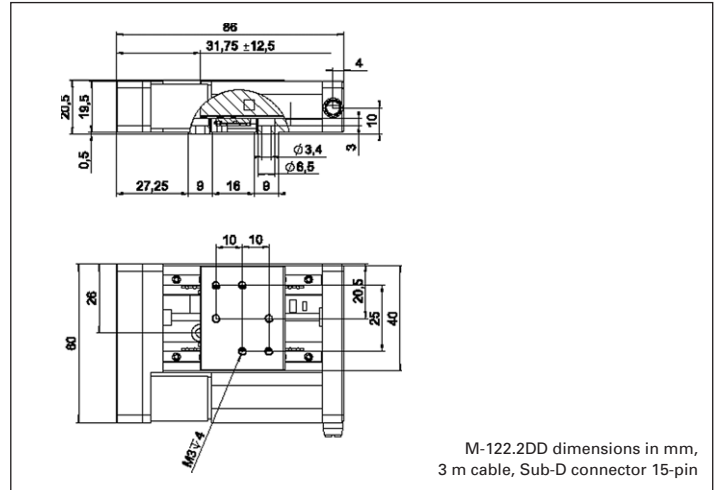
The combination of these positioners with the networkable, single-channel C-863 Mercury™ servo motor controller (s. p. 4-114) offers high performance for a very competitive price in both single- and multi-axis configurations. For multi-axis applications, the C-843 PC plug-in controller board with on-board servo amplifiers (s. p. 4-120) is another cost-effective alternative.

Ordering Information

M-122.2DD
High-Precision Translation Stage,
25 mm, Direct-Drive DC Motor,
Ballscrew

Accessories

M-122.AP1
Angle bracket for vertical
mounting of M-122 stages
Ask about custom designs



M-122.2DD dimensions in mm, 3 m cable, Sub-D connector 15-pin

Technical Data

Model	M-122.2DD
Active axes	X
Motion and positioning	
Travel range	25 mm
Integrated sensor	Linear encoder
Sensor resolution	0.1 μm
Design resolution	0.1 μm
Min. incremental motion	0.2 μm
Backlash	0.2 μm
Unidirectional repeatability	0.15 μm
Pitch	$\pm 150 \mu\text{rad}$
Yaw	$\pm 150 \mu\text{rad}$
Max. velocity	20 mm/s
Origin repeatability	1 μm
Mechanical properties	
Drive screw	Recirculating ballscrew
Thread pitch	0.5 mm
Stiffness in motion direction	0.25 N/ μm
Max. load	50 N
Max. push/pull force	20 N
Max. lateral force	25 N
Drive properties	
Motor type	DC motor
Operating voltage	0 to ± 12 V
Electrical power	2.25 W
Limit and reference switches	Hall-effect
Miscellaneous	
Operating temperature range	-20 to +65
Material	Aluminum, steel
Dimensions	86 x 60 x 20.5 mm
Mass	0.3 kg
Recommended controller/driver	C-863 (single-axis) C-843 PCI board (up to 4 axes)

Application Examples

- Photonics packaging
- Fiber positioning
- Metrology
- Quality assurance testing
- Testing equipment
- Micromachining

Miniature High Precision Micropositioning Slide

Choice of Drives & Travel Ranges, XY(Z) Combinations Possible



M-112.2DG, M-111.2DG, M-110.2DG
(from front to back) providing 25 mm,
15 mm and 5 mm travel range

- Travel Ranges 5, 15 and 25 mm
- Very Cost Effective
- Min. Incremental Motion to 50 nm
- Max. Velocity 2 mm/s
- Closed-Loop DC Motors and Stepper Motors
- Non-Contact Limit and Reference Switches
- Optional Recirculating Ball Screw Drives Provide High Speeds & Long Lifetimes
- Vacuum-Compatible Versions Available to 10^{-6} hPa

M-110, M-111 and M-112 are ultra-high resolution motorized translation stages providing linear motion of 5 to 25 mm in an extremely compact package. They feature a precision lead-screw with sub-micron resolu-

tion and precision linear ball bearings guaranteeing $<0.5 \mu\text{m}$ straightness of travel.

Compact Dimensions, High Performance

To meet industrial demands, the M-11x.2 linear translation stages are equipped with a recirculating ball screw for precise motion with reduced friction. This allows 24/7 duty cycles. M-110, M-111 and M-112 can be combined to XY and XYZ systems for multiaxis alignment applications.

Stepper and Servo Motors

A miniature DC or stepper motor actuates motion via a backlash-compensated screw /

Ordering Information

Translation stage

- 0 Travel Range 5 mm
 - 1 Travel Range 15 mm
 - 2 Travel Range 25 mm
- M-11
- 1 Leadscrew
 - 2 Ball screw

- DG DC Motor Gearhead
- 2S Stepper Motor with Gearhead

Ask about custom designs!

nut system and gearhead. Both drive options provide a cost-effective solution for industrial and OEM environments. To meet the most critical positioning demands, the DC motor is equipped with a high resolution encoder featuring resolution down to $0.007 \mu\text{m}$ per count.



F-130 fiber alignment system consisting of an M-110 XYZ positioning system and a P-611 XYZ Piezo-Nano Positioning system. This combination can be operated by the C-880 controller or NI controllers (request our technote!)

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.

Note

See "Accessories" (see p. 4-89 ff) for adapters, brackets, etc.

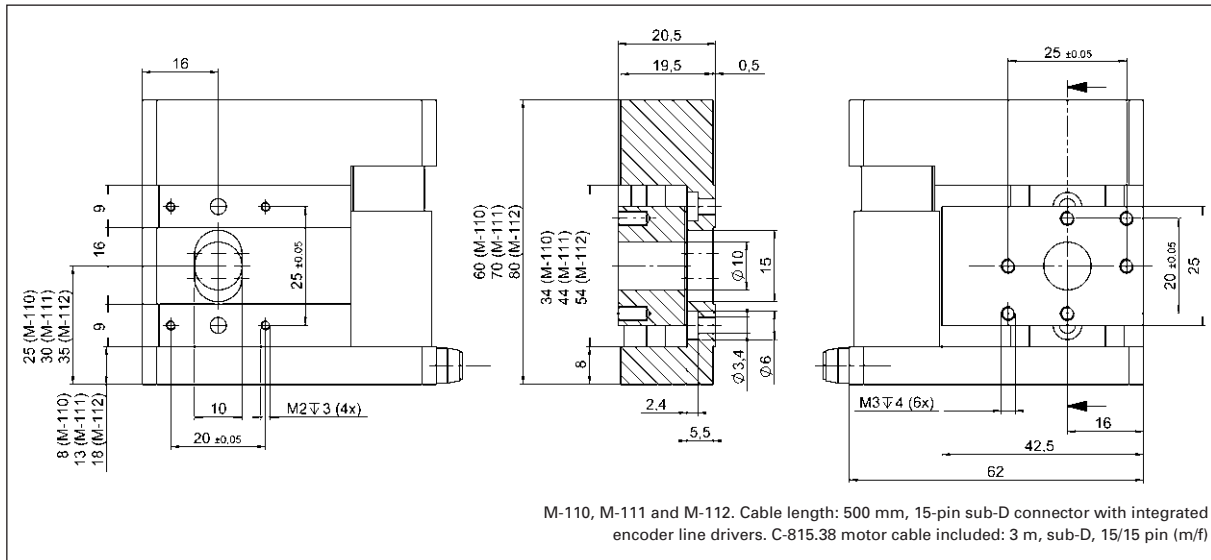
All stages include an integral 0.5 m cable with 15-pin sub-D connector and come with a 3 m extension cable. On the DC servo versions, the connector features integrated line drivers for cable lengths up to 10 meters between stage and controller (DC-motors only).

Low Cost of Ownership

The combination of these positioners with the networkable, single-channel C-863 Mercury™ (DC-Motor, see p. 4-114) or C-663 Mercury™ Step (see p. 4-112) controller offers high performance for a very competitive price in both single- and multi-axis configurations. For 3 or 4 axes, the C-843 PC plug-in board for DC motors (see p. 4-120) can also be recommended.

Application Examples

- Fiber optics testing
- Fiber positioning
- Metrology
- Micromachining
- Photonics packaging
- Quality assurance testing
- Testing equipment



Technical Data

Model	M-110.1DG / M-111.1DG / M-112.1DG	M-110.12S / M-111.12S / M-112.12S	M-110.2DG / M-111.2DG / M-112.2DG	M-110.22S / M-111.22S / M-112.22S	Units
Motion and positioning					
Travel range	5 / 15 / 25	5 / 15 / 25	5 / 15 / 25	5 / 15 / 25	mm
Integrated sensor	Rotary encoder	–	Rotary encoder	–	
Sensor resolution	2048		2048		Cts./rev.
Design resolution	0.0069	0.038*	0.0086	0.046*	µm
Min. incremental motion	0.05	0.05	0.2	0.2	µm
Backlash	2	2	4	4	µm
Unidirectional repeatability	0.1	0.1	0.5	0.5	µm
Pitch / Yaw	±50 / ±150 / ±150	±50 / ±150 / ±150	±50 / ±150 / ±150	±50 / ±150 / ±150	µrad
Max. velocity	1 / 1.5 / 1.5	1 / 1 / 1	1.5 / 2 / 2	1 / 1 / 1	mm/s
Mechanical properties					
Drive screw	Leadscrew	Leadscrew	Recirculating ballscrew	Recirculating ballscrew	
Thread pitch	0.4	0.4	0.5	0.5	mm
Gear ratio	28.44444:1	28.44444:1	28.44444:1	28.44444:1	
Motor resolution*	–	384*	–	384*	
Max. load	30 / 30 / 20	30 / 30 / 20	30 / 30 / 20	30 / 30 / 20	N
Max. push / pull force	10	10	10	10	N
Max. holding force	10	10	10	10	N
Max. lateral force	15 / 10 / 10	15 / 10 / 10	15 / 10 / 10	15 / 10 / 10	N
Drive properties					
Motor type	DC-motor, gearhead	2-phase stepper motor	DC-motor, gearhead	2-phase stepper motor	
Operating voltage	0 to ±12	24	0 to ±12	24	V
Electrical power	0.52 / 1.75 / 1.75	1.5	0.52 / 1.75 / 1.75	1.5	W
Current consumption	160 / 320 / 320**		160 / 320 / 320**		mA
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	0.3 / 0.4 / 0.3	0.3 / 0.4 / 0.3	0.3 / 0.4 / 0.3	0.3 / 0.4 / 0.3	kg
Recommended controller/driver	C-863 single-axis C-843 PCI board, for up to 4 axes	C-663 single-axis	C-863 single-axis C-843 PCI board, for up to 4 axes	C-663 single-axis	

*2-phase stepper motor, 24 V chopper voltage, max. 0.25 A/phase, 24 full steps/rev., motor resolution with C-663 stepper motor controller

**thermally limited

Linear-Motor Driven Mini Micropositioning Slide

With Ultrasonic Piezo Linear Drives



PILine® M-662 (left side) and M-661 stages are the smallest piezo-motor-driven translation stages available on the market that achieve speeds of up to 500 mm/s

- **Smallest Translation Stages with Linear Motor Drive**
- **Travel Ranges to 20 mm**
- **Max. Velocity 500 mm/s**
- **Acceleration to 5 g**
- **Incremental Motion to 50 nm**
- **Self Locking at Rest**
- **XY-Combination Possible**
- **MTBF 20.000 h**
- **Vacuum Versions to 10⁻⁷ hPa**

M-661 and M-662 PILINE® translation stages offer accelerations to 5 g with millisecond response and velocities to 500 mm/sec in an extremely compact package. Providing travel ranges to 20 mm, they

are among the smallest motorized translation stages currently on the market. Both models are designed for open-loop operation (a similar closed-loop stage with linear encoder is available as model M-663). The M-662, with its square footprint, is also suitable for use in XY configurations. For applications where the smallest dimensions are essential, the P-652 micro stage is offered.

Working Principle

PILine® piezo motors use a new, patented, ultrasonic drive developed by PI. At the heart of the system is a piezo ceramic plate, which is excited with 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 execute 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

Choice of Drive Electronics

Special driver electronics are required to create the ultrasonic oscillations for PILINE® piezo-

Ordering Information

M-661.370
PILine® Translation Stage, 18 mm, Open-Loop

M-662.470
PILine® Translation Stage, 20 mm, Open-Loop, XY Mountable

Accessories:

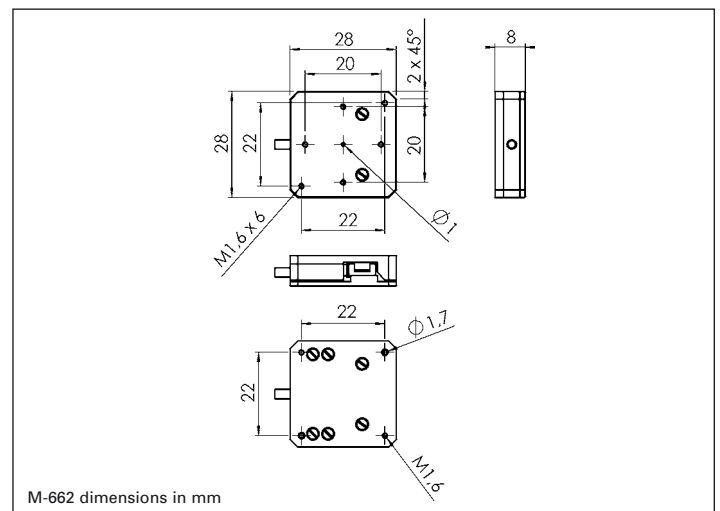
C-184.161
Analog OEM Driver Board for PILINE® P-661 Motors

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

motors. The driver controls the motor speed as a function of an analog ± 10 V signal. The driver is not included, as it is available in different versions, from the low-priced C-184.161 OEM-board to the C-185.161 bench-top unit. The stage and the driver electronics, however, must be ordered together, so that they can be tuned to one-another for optimum performance.

Notes

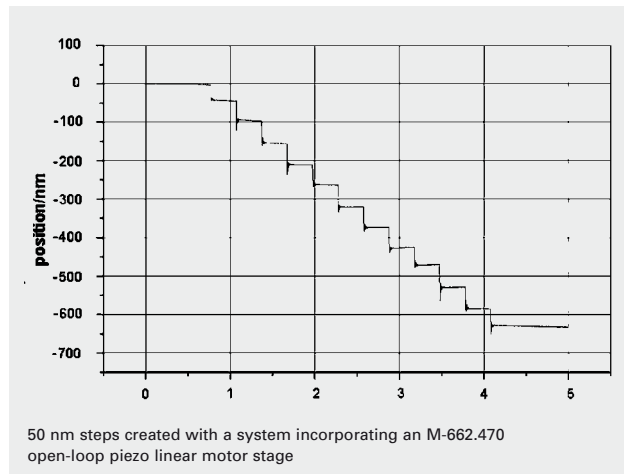
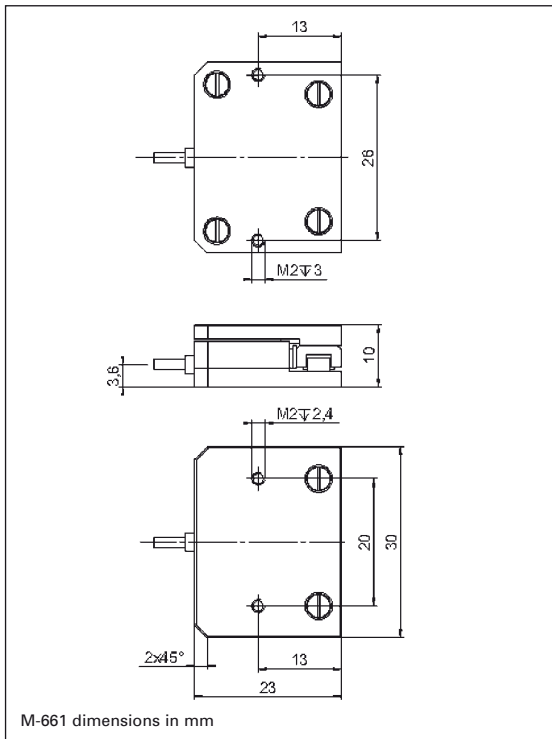
The products described in this document are in part protected by the following patents: US Pat. No. 6,765,335
German Patent No. 10154526



M-662 dimensions in mm

Application Examples

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



Technical Data

Model	M-661.370	M-662.470	Units	Tolerance
Motion and positioning				
Travel range	18	20	mm	
Min. incremental motion	0.05*	0.05*	µm	typ.
Max. velocity	500	500	mm/s	
Mechanical properties				
Max. load	5	5	N	
Max. push/pull force	1	1	N	
Max. holding force	2	2	N	
Drive properties				
Motor type	P-661 PLine® ultrasonic piezomotor drive	P-661 PLine® ultrasonic piezomotor drive		
Operating voltage	120 (Peak-Peak)**	120 (Peak-Peak)**	V	
Electrical power	42 (RMS)**	42 (RMS)**	W	nominal
Current	400***	400***	mA	
Miscellaneous				
Operating temperature range	-20 to +50	-20 to +50	°C	
Material	Al (black anodized)	Al (black anodized)		
Dimensions	30 x 23 x 10	28 x 28 x 8		
Mass	0.03	0.03	kg	±5%
Cable length	1.5	1.5	m	±10 mm
Connector	LEMO connector	LEMO connector		
Recommended controller/driver	C-184.161 OEM board C-185.161 Bench-top	C-184.161 OEM board C-185.161 Bench-top (p. 1-36)		

*The minimum incremental motion is a typical value that can be achieved in the open-loop mode of a piezomotor stage.

To obtain it, it is important to follow the mounting guidelines in the motor documentation.

**The stage supply power is drawn from the drive electronics, which runs on 12 VDC.

***For drive electronics.

Linear-Motor Driven Mini Micropositioning Slide

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



PILine® M-663 micropositioning stages with integrated linear encoder and C-867 controller/driver in the background

- **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 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

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 PLine® 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 PLine® Systems with P-661 Motors

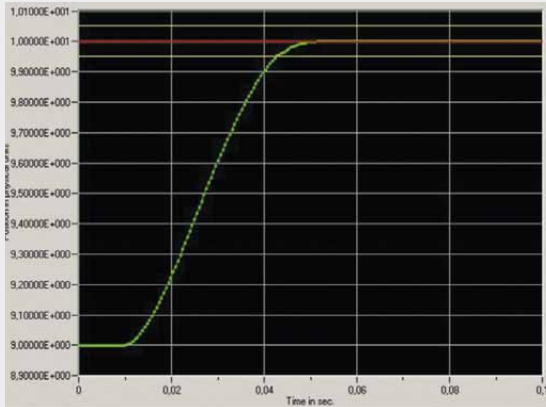
Driver for use with separate controller:

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

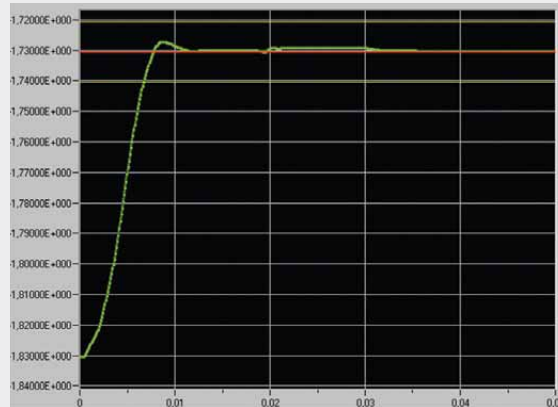
optimum performance the driver must be tuned together with the mechanics and should be ordered at the same time as the motor/stage.

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



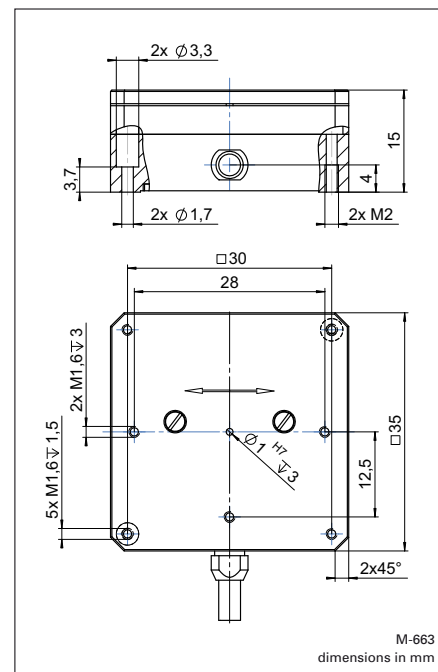
A 1 mm step performed by an M-663 stage with 300 g load controlled by a C-867 controller/driver reaches the end position in less than 40 ms



An M-663 with 100 g load settles to 0.1 μ m accuracy in 10 ms after a 100 μ m 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	μ m	
Min. incremental motion	0.3	μ m	typ.
Bidirectional repeatability	± 0.3	μ m	typ.
Unidirectional repeatability	0.2	μ m	typ.
Pitch	300	μ rad	typ.
Yaw	300	μ rad	typ.
Max. velocity	400	mm/s	
Reference switch repeatability	1	μ m	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	$^{\circ}$ 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)		



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

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

**For drive electronics

Linear-Motor Driven Micropositioning Slide

Low-Profile & High-Speed with Ultrasonic Piezomotors, Direct Position Metrology



M-683.2U4 (50 mm) low-profile translation stage with integrated high-speed ceramic linear motors

- Max. Velocity 350 mm/s
- Low Profile: Only 21 mm Height
- Compact XY Combination Possible
- Up to 6 N Force Generation
- Direct Metrology Linear Encoder, 0.1 μm Resolution
- Travel Range 50 mm
- Excellent Guiding Accuracy Through Crossed Roller Bearings
- PLine®: Non-Magnetic and Vacuum-Compatible Working

Principle

- Self Locking at Rest

M-683 precision micropositioning stages make use of PLine® ultrasonic piezo linear motors enabling a compact design and low profile. An integrated linear encoder enables closed-loop control with 0.1 μm resolution. The M-683 translation stages use paired

crossed-roller bearings mounted on ground-aluminum profiles for better guiding accuracy. Integrated U-164 PLine® linear motors provide push forces to 6 N and a maximum velocity of up to 350 mm/s. A vacuum version is available. The stages can be arranged to form compact XY systems. If an additional Z-axis is required, the M-110 micro-stage series (see page 4-22) is recommended due to its higher holding force. The M-683 design is scalable and can be extended to provide longer travel ranges to 300 mm.

Limit and Reference Switches

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

Advantages of PLine® Micro Positioning Systems

PLine® ultrasonic ceramic drives provide several advantages over classical motors and drivers:

- 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
- No Lubricants
- Non-Magnetic and Vacuum Compatible Operating Principle

Optimized Controller and Drive Electronics

For optimum performance the highly specialized C-867 motion controller (see page 4-116) is recommended. This dedicated piezo motor controller also integrates the drive electronics which PLine® motors require to generate the ultrasonic oscillations for the piezo-ceramic element.

Furthermore, the controller has a number of special characteristics, including continuous automatic drive frequency adjustment, dynamic parameter switching for optimized high-speed motion and settling behavior and some other features to address the requirements of ultrasonic motors. The broad-band encoder input (50 MHz) supports the outstanding high accelerations and velocities of PLine® drives at high resolutions.

Optionally, for use with third party servo controllers, the C-185 analog drive electronics (stand-alone unit) (see page 1-36) is available. It accepts an analog ± 10 V signal to control the motor velocity. For optimum performance the driver must be tuned together with

Ordering Information

M-683.2U4
PLine® High-Speed Linear Stage, 50 mm, 6 N

M-683.2V4
PLine® High-Speed Linear Stage, 50 mm, 6 N, Vacuum Compatible to 10⁻⁶ hPa

Accessories:

M-110.05
Adapter bracket for vertical mount of M-110 stages on M-683 stages

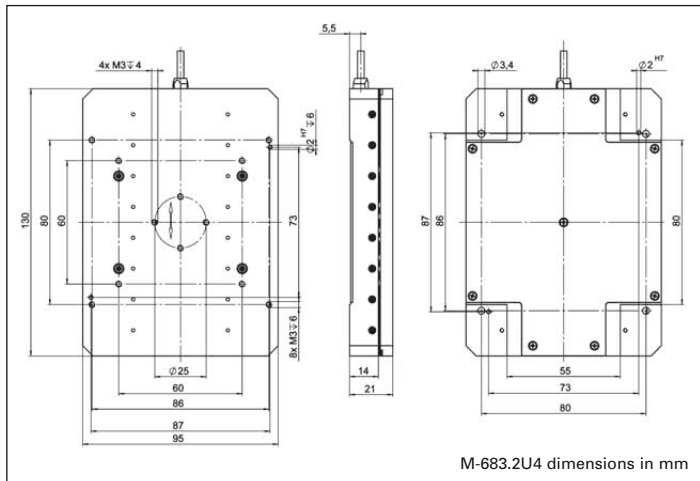
the mechanics and should be ordered at the same time as the motor/stage.

Patent Protection

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Application Examples

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



Technical Data

Model	M-683.2U4	Tolerance
Active axes	X	
Motion and positioning		
Travel range	50 mm	
Integrated sensor	Linear encoder	
Sensor resolution	0.1 μm	
Min. incremental motion	0.3 μm	typ.
Bidirectional repeatability	$\pm 1 \mu\text{m}$	typ.
Unidirectional repeatability	0.2 μm	typ.
Pitch	$\pm 150 \mu\text{rad}$	typ.
Yaw	$\pm 50 \mu\text{rad}$	typ.
Max. velocity	350 mm/s	
Reference switch repeatability	1 μm	typ.
Mechanical properties		
Max. load capacity	50 N	
Max. push / pull force	6 N	
Max. holding force	6 N	
Drive properties		
Motor type	2 x U-164 PILine® ultrasonic piezo drive	
Operating Voltage	60 V_{rms} *	
Electrical power	15 W**	nominal
Power consumption	1.5 A**	
Reference Switch	optical	
Limit Switches	Hall-effect	
Miscellaneous		
Operating temperature range	0 to +50 °C	
Material	Al (black anodized)	
Dimensions	130 x 95 x 21 mm	
Mass	0.65 kg	$\pm 5 \%$
Cable length	1.5 m	$\pm 10 \text{ mm}$
Connector	MDR, 14-pin	
Recommended controller	C-867 PILine® controller incl. drive electronics	

*Power to the motor is supplied by the drive electronics, which runs on 12 V DC, or by the controller (24 V).

**For drive electronics

Data for vacuum version may differ. M-683.2V4: Delivery includes 1 m cable (vacuum), feedthrough an 1.5 m cable (air).

High Speed Micropositioning Scanner

Voice-Coil Drive with Direct Position Measurement



V-106.11S and V-106.14S high-dynamics scanning stages with voice coil drives

- **Fast Scanning and Positioning**
- **Travel Ranges of 20 mm and 6 mm**
- **Linear Encoder Provides 0.1 μm Resolution, 0.2 μm Repeatability**
- **Scanning Frequency to Tens of Hz**
- **Velocity up to 270 mm/s**
- **PCI-Card Controller with On-Board Amplifiers Available**

QuickScan™ micropositioning stages of the V-106 series were designed for high-dynamics precision scanning and positioning applications, like those in biotechnology and fiber optics. They are based on zero-friction voice coil drives (linear motors), which, combined with high-precision linear encoders, offer a position resolution of 0.1 μm and minimal step size of 0.2 μm .

V-106 micropositioning stages achieve significantly higher dynamics than leadscrew-based units. The specially design-

ed voice coil drive system makes possible scanning frequencies of some tens of hertz. With an applied load of 90 grams, the scan frequency of the V-106.11S is still 20 Hz over a travel range of 1 mm. The excellent dynamic characteristics are advantageous not only for scanning applications: positioning tasks see them as short settling times like 75 ms for 5 mm with a 90 gram load.

Direct Drive and Direct Metrology—Precise Motion

The design of the V-106 is based on three key precision components:

- A frictionless voice-coil (linear motor) drive
- A non-contacting direct-motion metrology linear encoder for sub-micron repeatability
- Precision cross-roller bearings for ultra-straight and smooth motion

Unlike leadscrew-driven translation stages, the voice-coil lin-

ear-motor in the V-106 is frictionless, quiet and not subject to wear and tear. In addition, it provides higher dynamics, speed, acceleration and responsiveness (step-and-settle)—ideal features for high-throughput applications. The embedded drive also reduces the length considerably compared to conventional motor/screw-driven stages.

For highly repeatable motion, a non-contacting optical linear encoder with 0.1 μm resolution is mounted inside the stage and feeds position information back to the motion controller.

The integrated, non-contact reference switch increases versatility in automation applications.

Versatile PCI Board Controller

V-106 voice coil stages can be controlled by the C-843 digital controller in PCI plug-in-board format. C-843 controllers are equipped with on-board linear servo-amplifiers for precise control of up to four axes. This lowers system costs and simplifies setup by eliminating additional external amplifiers and cables.

Ordering Information

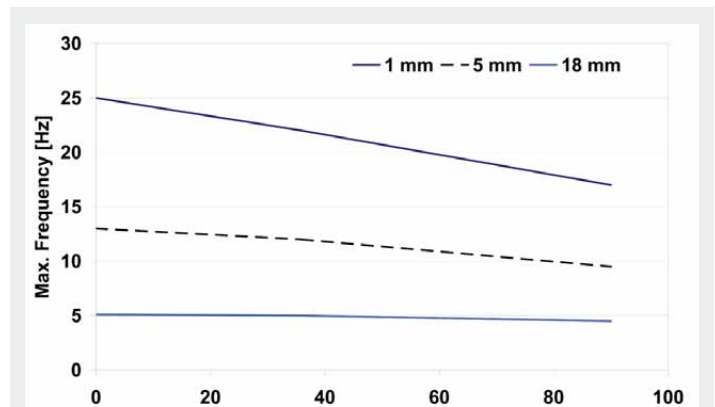
V-106.11S
QuickScan Voice Coil Scanning Stage, 6 mm

V-106.14S
QuickScan Voice Coil Scanning Stage, 20 mm

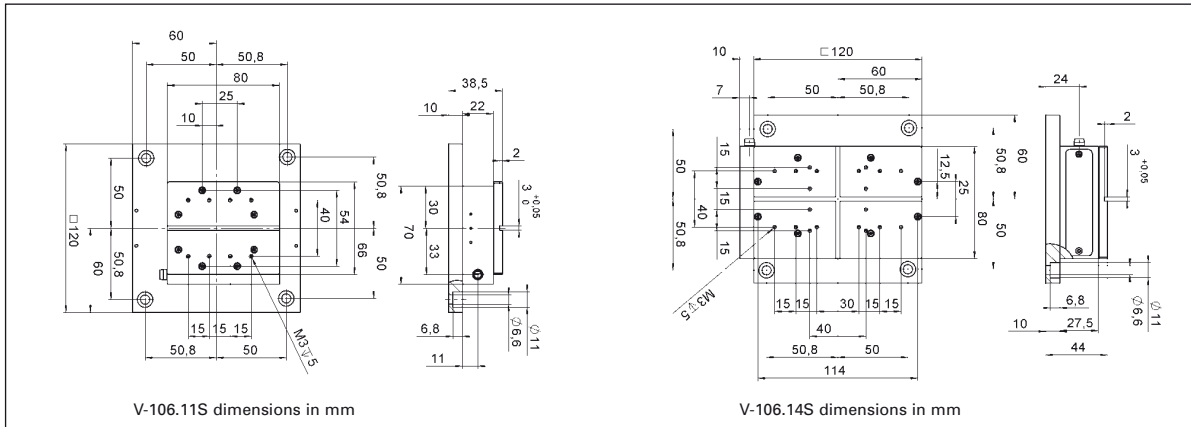
Frictionless Voice Coil Linear Drives

High-accuracy voice coil linear drives work on the same principle as electromagnetic loudspeakers. However, for precision positioning applications, they must provide much higher forces and high stability to hold a position without jitter. They must also be designed for closed-loop operation to allow for precise positioning.

These zero-friction magnetic linear drives, characterized by their excellent dynamics, are ideally suited for scanning applications requiring travel ranges in the millimeter to centimeter range. PI offers voice coil drives in V-106 standard systems; custom systems are available on request.



V-106.14S maximum scanning frequency for different loads and scan amplitudes for example 18 mm scans with up to 90 g load at >4 Hz frequency are feasible. The velocity is up to 270 mm/s



Technical Data

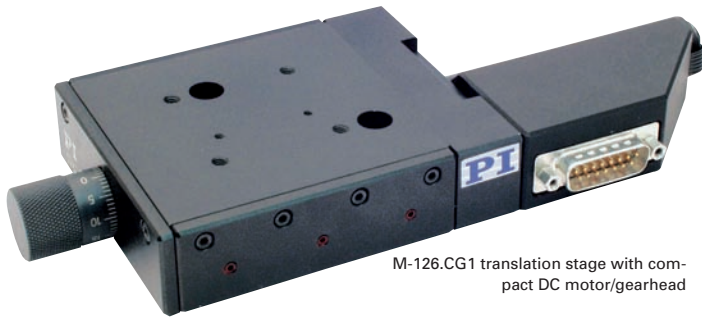
Model	V-106.11S	V-106.14S	Units	Tolerances
Active axes	X	X		
Motion and positioning				
Travel range	6	20	mm	
Integrated sensor	Linear encoder	Linear encoder		
Sensor resolution	0.1	0.1	µm	
Design resolution	0.1	0.1	µm	
Minimum incremental motion	0.2	0.2	µm	typ.
Backlash	0.2	0.2	µm	typ.
Unidirectional repeatability	0.2	0.2	µm	typ.
Pitch	50	50	µrad	typ.
Yaw	50	50	µrad	typ.
Max. velocity*	240	270	mm/s	
Reference repeatability	1	1	µm	typ.
Mechanical properties				
Mass moved	102	172	g	typ.
Load	36	81	N	max.
Push-/pull force**	5	3.3	N	max.
Push-/pull force with C-843**	2.3	1.5	N	max.
Lateral force	18	40	N	max.
Drive properties				
Drive type	Voice coil	Voice coil		
Continuous average current	0.42	0.42	A	nominal
Peak current	1.8	1.8	A	max. (3s)
Average force	1.2	0.8	N	nominal
Coil resistance	10	10	Ω	typ.
Coil inductance	100	100	µH	typ.
Force constant	2.88	1.92	N/A	
Voltage generation constant	36.1	24	Vs/m	
Miscellaneous				
Operating temperature range	0–55	0–55	°C	
Body material	Al	Al		
Mass (without cable)	800	1000	g	±5%
Cable length	0.3	0.3	m	±10 mm
Connectors	Sub-D 15 (m)	Sub-D 15 (m)		
Recommended controller / driver	C-843	C-843 (p. 4-120)		

*With C-843 controller

**The C-843 controller provides 8 V and 0.8 A max. and therefore limits the push/pull force
See Notes (Technical Data) for further information page 4-67 ff

M-126 High-Resolution Micropositioning Slide

Compact Linear Stage with Crossed Roller Bearings



M-126.CG1 translation stage with compact DC motor/gearhead

- **Min. Incremental Motion to 0.1 μm (3.5 nm Resolution)**
- **Repeatability to 0.1 μm**
- **Velocity to 50 mm/s**
- **Travel Ranges 20 and 25 mm**
- **Manual, DC-Servo and Stepper-Motor Drives**
- **ActiveDrive™ Option**
- **Crossed Roller Bearings**
- **Ballscrew and Leadscrew Versions**
- **XY and XYZ Combinations**
- **Direction-Sensing Reference Switch**
- **Variety of Cost-Effective Motion Controllers**

M-126 micropositioning systems are compact, high-precision translation stages with preloaded leadscrew and ballscrew drives for excellent resolution and repeatability. All models are equipped with precision crossed roller bearings providing straightness of travel of better than 2 μm .

Five motorized versions are available: M-126.CG1 utilizes a compact closed-loop DC motor with shaft-mounted high-resolution position encoder and a precision gearhead providing 0.1 μm minimum incremental motion, M-126.DG1 is equipped with a larger motor than M-126.CG1 and provides higher velocity. The M-126.2S1 stepper motor version has a 2-phase stepper motor that provides a minimum incremental motion of 0.1 μm (controller depending).

Higher Speed with ActiveDrive™ and Ballscrews

The top-of-the-line M-126.PD2 is equipped with a low friction ballscrew and provides ve-

locities to 50 mm/sec. Model M-126.PD1 features a leadscrew and is recommended for lower speeds to 15 mm/sec and/or duty cycle applications. Both versions boast the high-performance ActiveDrive™. PI's ActiveDrive™ design, 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**

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.

XY and XYZ Combinations

All stages can be cross-stacked and combined with the M-125.90 Z-axis mounting bracket to provide multi-axis motion.

Notes

For adapters, bracket, etc. see p. 4-90 ff.

Ordering Information

M-126.CG1
Translation Stage, 25 mm, Compact DC Motor Gearhead

M-126.DG1
Translation Stage, 25 mm, DC Motor Gearhead

M-126.PD1
Translation Stage, 25 mm, ActiveDrive™ DC Motor (includes 24 V power supply)

M-126.PD2
Translation Stage, 20 mm, ActiveDrive™ DC Motor, Ballscrew (includes 24 V power supply)

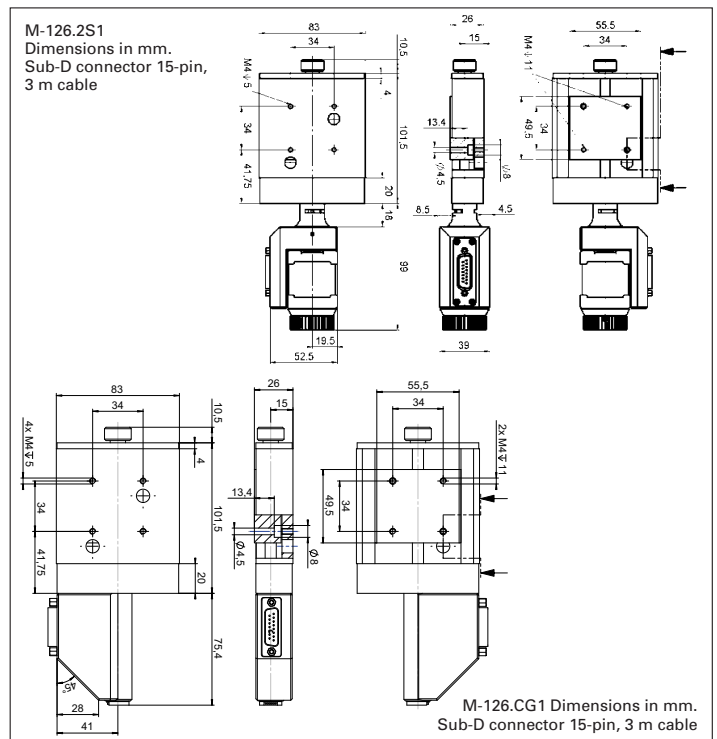
M-126.2S1
Translation Stage, 25 mm, 2-Phase Stepper Motor

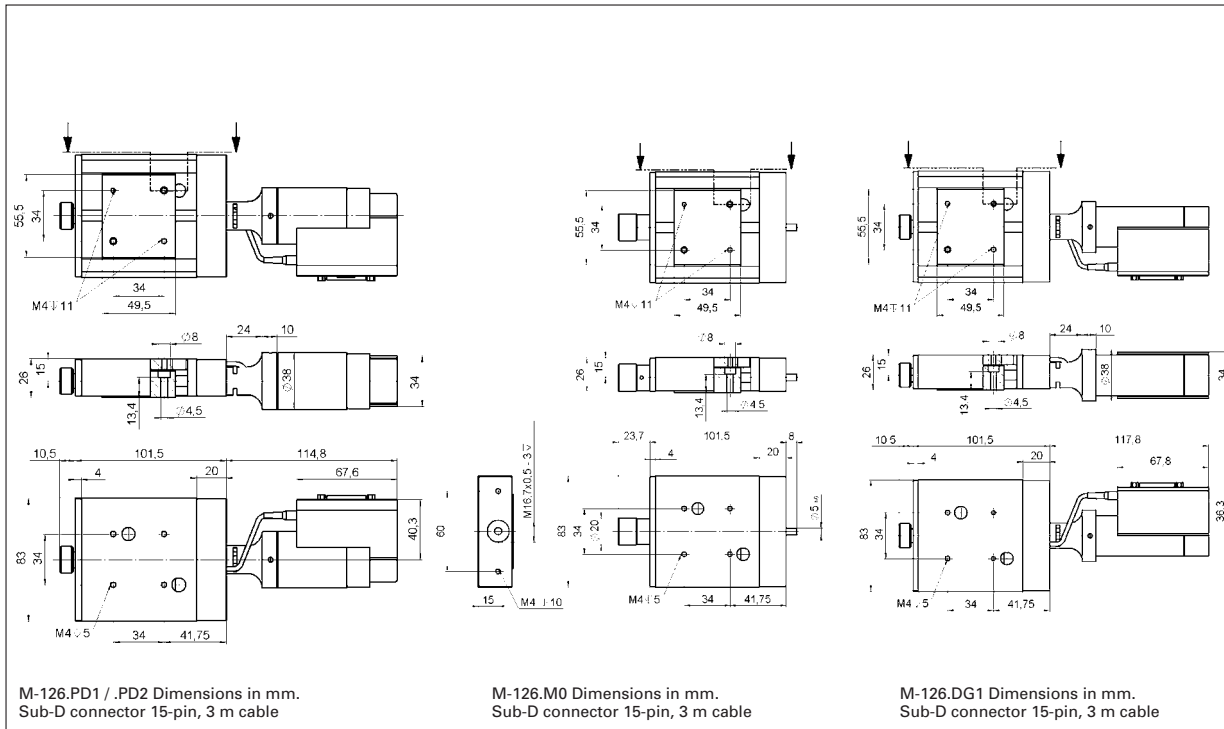
M-126.M0
Translation Stage, 25 mm, Manual Drive, Leadscrew

M-125.90
Z-axis Mounting Bracket for Vertical Mount of M-126 Stages

M-126.80
Adapter Plate for Honeycomb Tables

Ask about custom designs!





Technical Data

Model	M-126.M0	M-126.CG1	M-126.DG1	M-126.PD1	M-126.PD2	M-126.2S1	Units
Active Axes	X	X	X	X	X	X	
Motion and positioning							
Travel range	25	25	25	25	20	25	mm
Integrated sensor	-	Rotary encoder	Rotary encoder	Rotary encoder	Rotary encoder	-	
Sensor resolution	-	2048	2000	4000	4000	-	Cts./rev
Design resolution	-	0.0035	0.0085	0.125	0.25	0.08**	µm
Min. incremental motion	1	0.1	0.1	0.25	0.5	0.1**	µm
Unidirectional repeatability	-	0.2	0.1	0.1	0.3	0.1**	µm
Bidirectional repeatability	-	2	1	1	1	1**	µm
Accuracy	-	2.5	2.5	2.5	2.5	2.5	µm
Pitch / Yaw	±50	±50	±50	±50	±50	±50	µrad
Straightness / Flatness	2	2	2	2	2	2	µm
Max. velocity	-	0.7	1.5	15*	50	6**	mm/s
Origin repeatability	-	1	1	1	1	1	µm
Mechanical properties							
Drive Screw	Leadscrew	Leadscrew	Leadscrew	Leadscrew	Recirculating ballscrew	Leadscrew	
Thread pitch	0.5	0.5	0.5	0.5	1	0.5	mm
Gear ratio	-	69.12:1	(28/12) ^{±0.1} ~ 29.6:1	-	-	-	
Motor resolution	-	-	-	-	-	6400**	steps/rev.
Max. load	200	200	200	200	200	200	N
Max. push / pull force	50 / 50	40 / 40	50 / 50	50 / 50	40 / 40	50 / 50	N
Max. lateral force	100	100	100	100	100	100	N
Drive properties							
Motor type	-	DC Motor, gearhead	DC Motor, gearhead	ActiveDrive™ DC Motor	ActiveDrive™ DC Motor	2-phase stepper motor	
Operating voltage	-	0 to ±12	0 to ±12	24 (PWM)	24 (PWM)	24	V
Electrical power	-	2	3	30	30		W
Limit and reference switches	-	Hall-effect	Hall-effect	Hall-effect	Hall-effect	Hall-effect	
Miscellaneous							
Operating temperature range	-20 to +65	-20 to +65	-20 to +65	-20 to +65	-20 to +65	-20 to +65	°C
Material	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	
Mass	0.6	0.8	0.9	0.9	0.9	1	kg
Recommended controller/driver	-	C-863 single-axis C-843 PCI board, for up to 4 axes	C-863 single-axis C-843 PCI board, for up to 4 axes	C-863 single-axis C-843 PCI board, for up to 4 axes	C-863 single-axis (p. 4-114) C-843 PCI board (p. 4-120), for up to 4 axes	C-663 single-axis (p. 4-112)	

*Max. recommended velocity

**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

Low Cost Precision Micropositioning Stages: 25 - 200 mm

Cost-Effective, Large Choice of Drives & Travel Ranges



M-403 linear stage versions (from left) M-403.1PD, M-403.2PD, M-403.4PD, M-403.6PD und M-403.8PD provide travel ranges from 25 to 200 mm

- For Cost-Sensitive Precision Positioning Applications
- Travel Ranges 25 to 200 mm
- Resolution to 0.012 μm
- Min. Incremental Motion to 0.1 μm
- Preloaded Precision Leadscrew or Recirculating Ball Screw Drives Provide High Speeds & Long Lifetimes
- Stress-Relieved Aluminum Base for Highest Stability
- Vacuum-Compatible Versions Available
- M-413 and M-414 Versions for Higher Load Requirements

The M-403 and M-404 linear translation stage series provide cost-effective solutions for precision positioning of loads up to 20 kg over travel ranges to 200 mm. They are designed with high-value components and feature a precision-machined, high-density, stress-relieved aluminum base for exceptional stability with minimum weight.

The highly precise M-403 drive includes a preloaded lead screw, providing a minimum incremental motion of 0.2 μm . For higher velocities and long lifetime, the M-404 versions feature a low-friction ball screw

offering a minimum incremental motion down to 0.1 μm . Three motor drive options allow easy adaptation to different automation applications. Five travel ranges from 25 to 200 mm are offered. The stages can carry up to 20 kg and push/pull up to 50 N. Special versions for vacuum applications are also available (see ordering information).

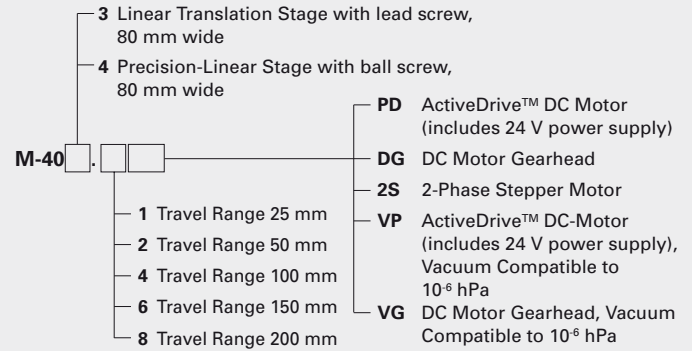
Maintenance-Free, High Guiding Precision

All models are equipped with high-precision linear guiding rails and recirculating ball bearings. The recirculating ball bearings are maintenance free and immune to cage migration. The choice of components and careful mounting guarantees high load capacity, longer lifetime and high guiding accuracy. Additionally, in the M-404 series the bearings are polished to achieve the optimum guiding accuracy.

Application Examples

- Automation
- R&D
- Semiconductor technology
- Metrology
- Quality assurance testing

Ordering Information



Ask about custom designs!

Low Cost of System Ownership

The combination of these stages with the networkable single-axis C-863 Mercury™ (see p. 4-114) and C-663 Mercury™ Step (see p. 4-112) controllers offers high performance for a very competitive price in both single and multi-axis configurations. Alternatively, the C-843 motion controller PCI card with on-board servo amplifiers is available.

Three Motor Drive Options

The top-of-the-line M-40x.xPD high-speed versions come equipped with the high-performance ActiveDrive™ system. 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

M-40x.xDG models are equipped with a DC motor and a shaft-mounted optical encoder, providing a minimum incremental motion of down to 0.1 μm . M-40x.x2S models feature a cost-effective direct-drive, 2-phase stepper motor, providing very smooth operation and a resolution of 0.16 μm .

Limit and Reference Switches

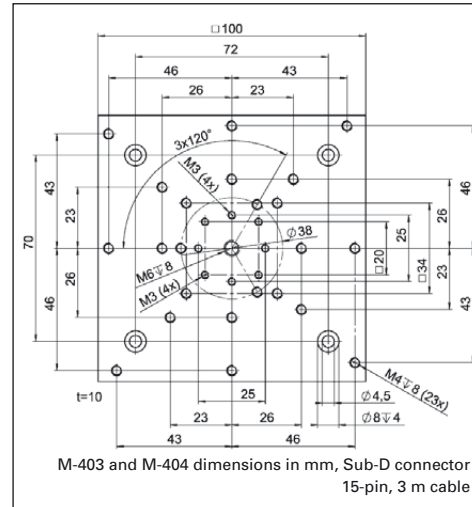
For the protection of your equipment, non-contact Hall-effect limit and reference switches are installed. The direction-sensing reference switch supports advanced automation applications with high precision.

Other Family Members

The M-403/M-413 and M-404/M-414 series of linear stages form a modular system. The M-403 is the basic family, providing travel ranges from 25 to 200 mm. M-413 is designed for higher loads with travel ranges from 100 to 300 mm. The M-404 and M-414 stages have the same travel ranges and load capacities, but offer higher precision and more speed.



Different motor versions of the M-403 linear stage family with 100 mm travel range (from left) M-403.4PD (DC-motor/ActiveDrive™), M-403.4DG (DC-motor/gearhead) and M-403.42S (stepper motor)



Technical Data

Model	M-404.xPD	M-404.xDG	M-404.x2S	M-403.xPD	M-403.xDG	M-403.x2S	Units
Motion and positioning							
Travel range	for all models: 25 / 50 / 100 / 150 / 200 mm (see Order Information)						
Integrated sensor	Rotary encoder	Rotary encoder	–	Rotary encoder	Rotary encoder	–	
Sensor resolution	4000	2000	–	4000	2000	–	Cts./rev.
Design resolution	0.25	0.012	0.16**	0.25	0.018	0.16**	µm
Min. incremental motion	0.25	0.1	0.2	0.25	0.2	0.2	µm
Backlash	0.5	2	2	6	10	6	µm
Unidirectional repeatability	0.5	1	1	1	1	1	µm
Pitch***	±75	±75	±75	±200	±200	±200	µrad
Yaw***	±75	±75	±75	±200	±200	±200	µrad
Max. velocity	50	1.5	3	10*	2.5	3	mm/s
Origin repeatability	1	1	1	1	1	1	µm
Mechanical properties							
Spindle	Recirculating ballscrew	Recirculating ballscrew	Recirculating ballscrew	Leadscrew	Leadscrew	Leadscrew	
Spindle pitch	1	1	1	1	1	1	mm
Gear ratio	–	42.92063:1	–	–	28.44444:1	–	
Motor resolution**	–	–	6400**	–	–	6400**	steps/rev.
Stiffness in motion direction	3500	3500	3500	3500	3500	3500	N/µm
Max. load	200	200	200	200	200	200	N
Max. push/pull force	100	100	100	50	50	50	N
Max. lateral force	100	100	100	100	100	100	N
Drive properties							
Motor type	ActiveDrive™ DC Motor	DC-motor, gearhead	2-phase stepper motor**	ActiveDrive™ DC Motor	DC-motor, gearhead	2-phase stepper motor**	
Operating voltage	24	0–12	24	24	0–12	24	V
Electrical power	26	2.5	4.8	26	2.5	4.8	W
Torque	50	3	200	50	3	200	Ncm
Limit and reference switches	Hall-effect	Hall-effect	Hall-effect	Hall-effect	Hall-effect	Hall-effect	
Miscellaneous							
Operating temperature range	-20 to +65	-20 to +65	-20 to +65	-20 to +65	-20 to +65	-20 to +65	°C
Material	for all models: Aluminum (black anodized)						
Mass (depends on dimensions/travel range)	1.7 / 1.8 / 2.1 / 2.2 / 2.5 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-663 (single-axis)	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-663 (single-axis)	

*Max. recommended velocity

**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

*** For travels > 100 mm, the pitch/yaw value is valid for every 100 mm.

Data for vacuum versions may differ.

M-605 High-Accuracy Micropositioning Stage

Ultra-Compact, with Direct Position Measurement



M-605.2DD high precision translation stage

- **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 me-chemical 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



M-605.2DD XYZ-combination

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

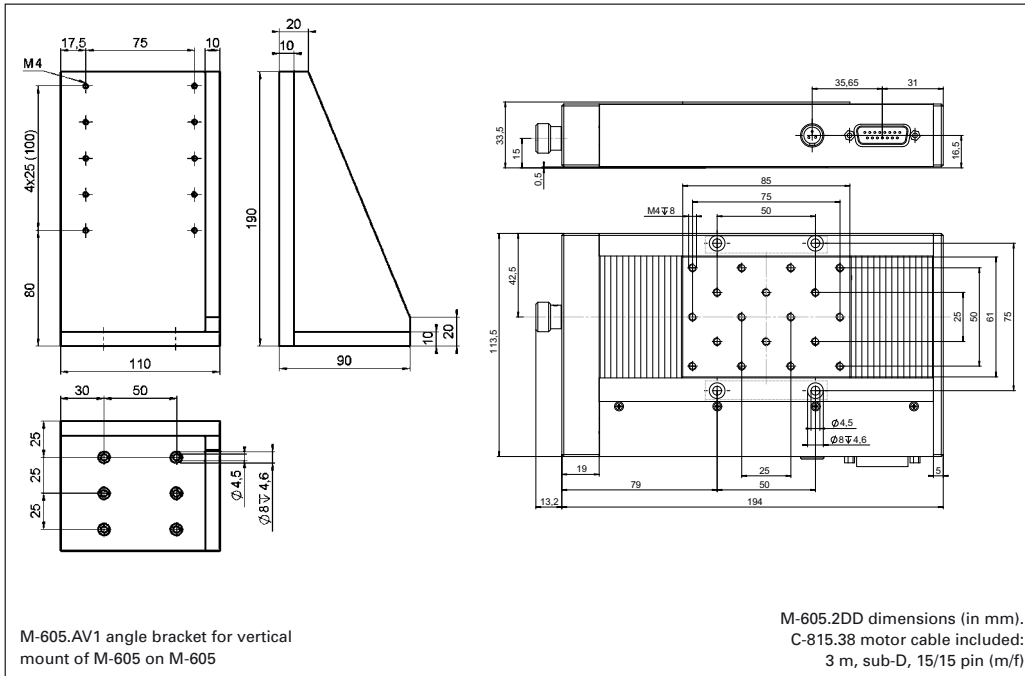
For the protection of your equipment, non-contact Hall-effect limit and reference switches are installed. The direction-sensing reference switch supports advanced automation applications with high precision.

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

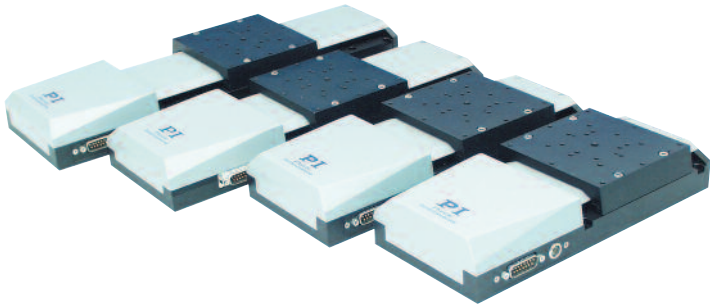


Technical Data

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)	

Ball-Screw Driven Precision Micropositioning Stages

Low-Profile Translation Stages with Ballscrew Drives



M-505 translation stages with ballscrew drives

- Travel Ranges to 150 mm (6")
- Velocity up to 50 mm/sec.
- ActiveDrive™ Motors
- Compatible with Leading Industrial Motion Controllers
- Stress-Relieved Aluminum Stage Base for Highest Stability
- Zero-Backlash Recirculating Ballscrews
- Non-Contact Direction-Sensing Origin Switch
- Non-Contact Limit Switches
- Load Capacity 100 kg
- >20,000 Hours MTBF

The new M-505 family of translation stages is based on the successful M-510 series. These new stages provide one of the lowest profiles on the market of high-performance translation stages, making them ideally suited for applications where space is limited. The stages feature a precision-machined base of high-density, stress-relieved aluminum for exceptional stability and minimum weight. Precision-ground recirculating ballscrews (better

accuracy than rolled ballscrews) with preloaded nuts provide low-friction, maintenance-free and backlash-free positioning.

Maintenance Free

High-precision linear guiding rails with recirculating ball bearings guarantee 1 µm / 100 mm straightness and flatness. They are also immune to cage migration problems of crossed roller bearings (can be an issue where small ranges are scanned repeatedly) and are maintenance free.

Three motor drives are currently available:

Models M-505.xPD with ActiveDrive™

This version features a direct-coupled motor/encoder providing 0.25 µm minimum incremental motion and a max.

velocity of 50 mm/sec. For superior dynamic performance, we integrated our unsurpassed ActiveDrive™ system. This unique design features a high-efficiency PWM servo-amplifier mounted side-by-side with the motor. It provides several decisive 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, because the amplifier and motor are mounted together in the same electrically shielded case

Models M-505.xDG are equipped with 3-watt DC motors with zero-backlash gearhead and shaft-mounted optical encoders (2048 counts / rev.). The gear ratio is 29.6:1, providing minimum incremental motion of 50 nanometers (design resolution 17 nm).

Models M-505.x2S are equipped with direct-drive, micro-stepped, 2-phase, stepper motors (20,000 counts/rev.) providing 0.1 µm minimum incremental motion and ultra-smooth, vibration-free positioning.

Direction-Sensing Origin Switch

Integrated, high-precision, non-contact Hall-effect origin and limit switches with direction sensing on the origin switch protect your equipment and increase versatility in automation applications.

Ordering Information

- M-505.1DG**
Translation Stage, 25 mm, DC Motor / Gearhead
- M-505.1PD**
Translation Stage, 25 mm, ActiveDrive™ DC Motor
- M-505.1S2**
Translation Stage, 25 mm, 2-Phase Stepper Motor
- M-505.2DG**
Translation Stage, 50 mm, DC Motor / Gearhead
- M-505.2PD**
Translation Stage, 50 mm, ActiveDrive™ DC Motor
- M-505.2S2**
Translation Stage, 50 mm, 2-Phase Stepper Motor
- M-505.4DG**
Translation Stage, 100 mm, DC Motor / Gearhead
- M-505.4PD**
Translation Stage, 100 mm, ActiveDrive™ DC Motor
- M-505.4S2**
Translation Stage, 100 mm, 2-Phase Stepper Motor
- M-505.6DG**
Translation Stage, 150 mm, DC Motor / Gearhead
- M-505.6PD**
Translation Stage, 150 mm, ActiveDrive™ DC Motor
- M-505.6S2**
Translation Stage, 150 mm, 2-Phase Stepper Motor

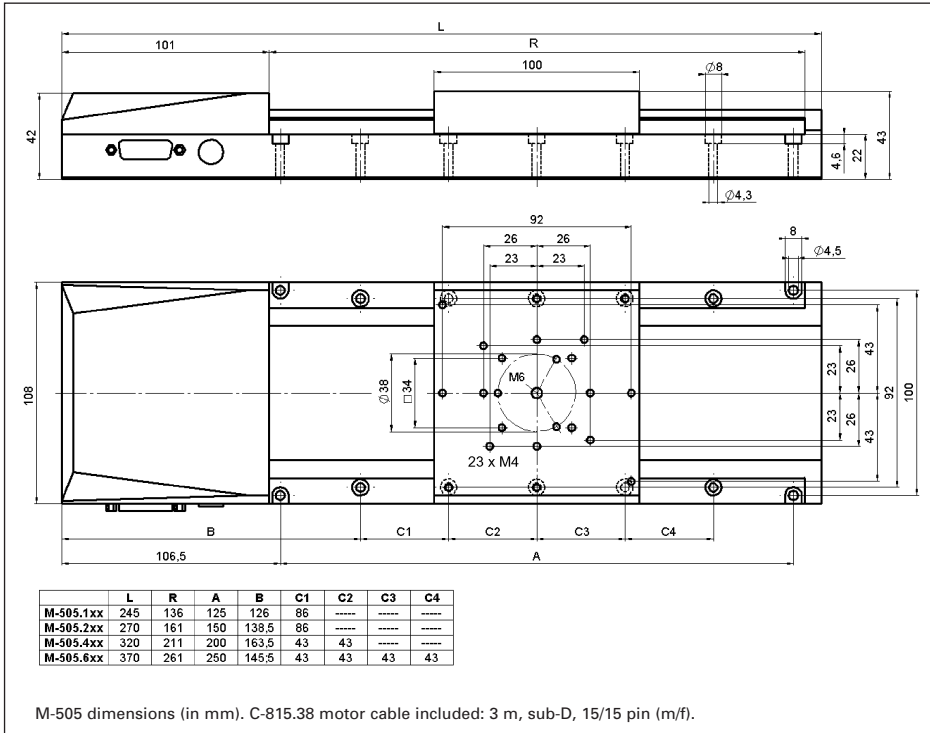
Ask about custom designs!

Notes

See "Accessories", page 7-92 ff. for adapters, brackets, etc.

Application Examples

- Photonics packaging
- Quality control
- Semiconductor test equipment
- Metrology
- Disk drive test assemblies
- R&D



Technical Data

Models	M-505.1PD	M-505.1DG	M-505.1S2	M-505.2PD	M-505.2DG	M-505.2S2	M-505.4PD	M-505.4DG	M-505.4S2	M-505.6PD	M-505.6DG	M-505.6S2	Units [#]
Travel range	25	25	25	50	50	50	100	100	100	150	150	150	mm
Design resolution	0.25	0.017	0.05	0.25	0.017	0.05	0.25	0.017	0.05	0.25	0.017	0.05	µm
Min. incremental	0.25	0.05	0.1	0.25	0.05	0.1	0.25	0.05	0.1	0.25	0.05	0.1	µm
Unidirectional	0.25	0.1	0.1	0.25	0.1	0.1	0.25	0.1	0.1	0.25	0.1	0.1	µm
Bidirectional	1	1	1	1	1	1	1	1	1	1	1	1	µm
Accuracy per 25 mm	1	1	1	1	1	1	1	1	1	1	1	1	µm
Straightness	1	1	1	1	1	1	1	1	1	1	1	1	µm
Flatness	1	1	1	1	1	1	1	1	1	1	1	1	µm
Pitch (θ_y)	50	50	50	50	50	50	50	50	50	50	50	50	µrad
Yaw (θ_z)	50	50	50	50	50	50	50	50	50	50	50	50	µrad
Max. velocity	50	3	10	50	3	10	50	3	10	50	3	10	mm/s
Max. normal	100	100	100	100	100	100	100	100	100	100	100	100	kg
Max. push/pull force	50 / 50	50 / 50	50 / 50	50 / 50	50 / 50	50 / 50	50 / 50	50 / 50	50 / 50	50 / 50	50 / 50	50 / 50	N
Max. lateral force	200	200	200	200	200	200	200	200	200	200	200	200	N
Encoder resolution	4000	2048	-	4000	2048	-	4000	2048	-	4000	2048	-	counts/rev.
Motor resolution	-	-	20,000**	-	-	20,000**	-	-	20,000**	-	-	20,000**	steps/rev.
Ballscrew pitch	1	1	1	1	1	1	1	1	1	1	1	1	mm/rev.
Gear ratio	-	(28/12) ⁴ :1 ≈29.6:1	-	-	(28/12) ⁴ :1 ≈29.6:1	-	-	(28/12) ⁴ :1 ≈29.6:1	-	-	(28/12) ⁴ :1 ≈29.6:1	-	
Nominal motor power 17*	3	- **	17*	3	- **	17*	3	- **	17*	3	- **		W
Motor voltage	24	12	24 **	24	12	24 **	24	12	24 **	24	12	24 **	V
Weight	1.5	1.5	1.5	1.8	1.8	1.8	2.5	2.5	2.5	3.2	3.2	3.2	kg
Body material	Al	Al	Al	Al	Al	Al	Al	Al	Al	Al	Al	Al	
Recommended motor controller	C-843, C-848, C-862	C-843, C-848, C-862	C-600, C-630	C-843, C-848, C-862	C-843, C-848, C-862	C-600, C-630	C-843, C-848, C-862	C-843, C-848, C-862	C-600, C-630	C-843, C-848, C-862	C-843, C-848, C-862	C-600, C-630	

* ActiveDrive™ (integrated PWM servo-amplifier), 24 V power supply included;
 ** 2-phase stepper, 24 V chopper voltage, max. 0.8 A / phase, 20,000 microsteps with C-600, C-630 controllers
[#] See page 7-106 for notes and explanations.

Ball-Screw Driven High Load Precision Micropositioning Stages

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)

- 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.

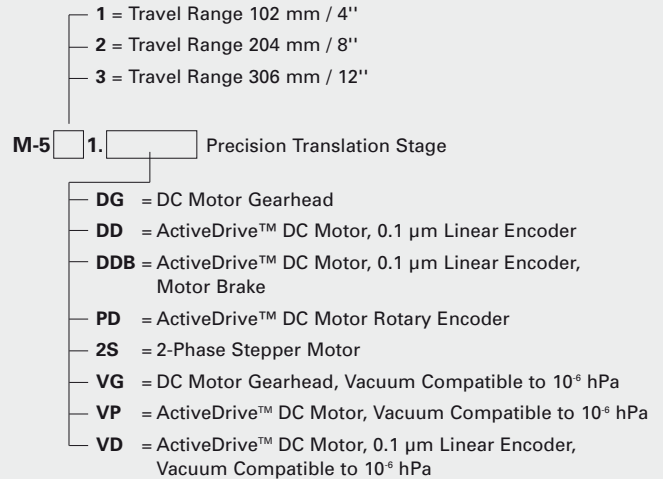
Heavy Duty and Maintenance Free

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

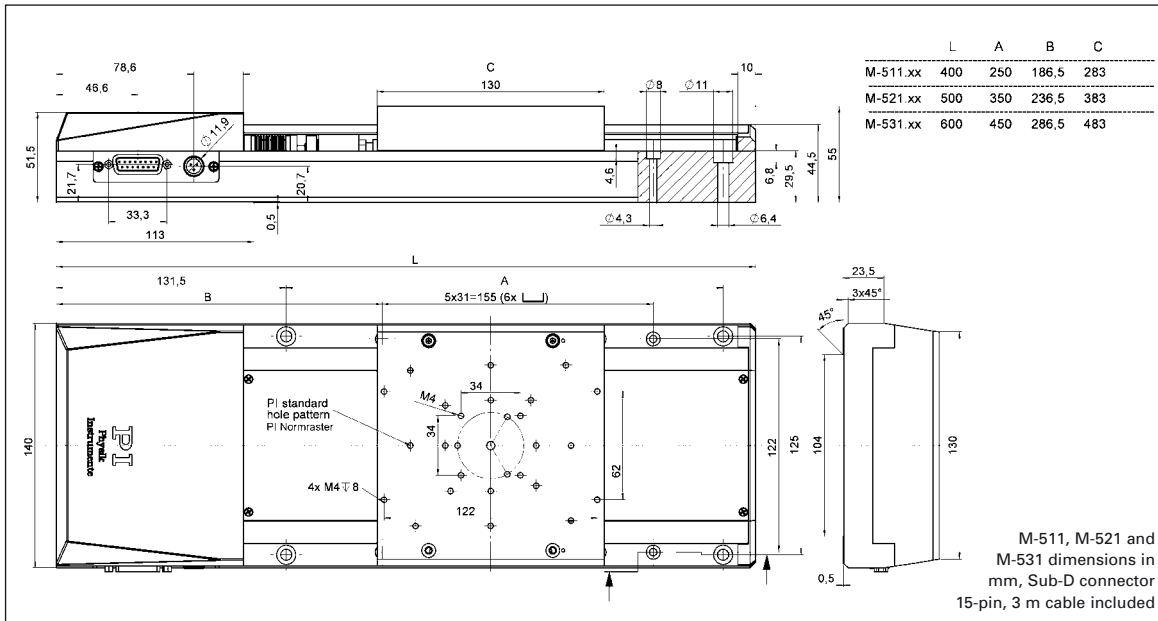
For adapters, bracket, etc. (see page 4-90 ff).



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 (p. 4-120) (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

M-511.HD High Load Hybrid Nanopositioning Stage

Hybrid DC/Piezo Precision Stage, High Speed, 2 nm Resolution



M-511.HD hybrid nanopositioner

- **Simultaneous Control of Piezo-Flexure Drives & DC-Servo/Ballscrew Drives**
- **100 mm Travel Range, 50 mm/sec Max. Velocity**
- **Reliable Execution of Nanometer Level Increments**
- **2 nm Linear Encoder Resolution**
- **Millisecond Settling Time to Nanometer Precision**
- **Frictionless Piezo Drive and Flexure-Decoupled Ballscrew**
- **Active Compensation of Backlash and Stick/Slip Effects**
- **Excellent Velocity Control**

The M-511.HD is an advancement on PI's proven M-5x1 precision micropositioning stage series. The new hybrid system overcomes the limitations of conventional precision positioning systems by combining the well-known advantages of piezo-flexure-drives (unlimited resolution and very rapid response) with the long travel ranges and high holding forces of a servo-motor/ballscrew arrangement. The M-511.HD

allows velocities to 50 mm/s with an encoder resolution of 2 nm and load capacity of 50 kg for horizontal operation.

Long Travel Ranges with Nanometer Precision

The challenge of implementing hybrid technology is not only the positioning stage design, but also the use of high-resolution sensors over large travel ranges, the processing of the resulting high-frequency signals and the design of special control algorithms to take full advantage of the hybrid concept.

On the mechanical side, this is accomplished by decoupling the moving platform from the positioner's motor-ballscrew-drive by frictionless flexures and stiff, highly responsive piezo actuators.

Due to its high stiffness and instantaneous, sub-millisecond range response, the integrated piezo flexure drive provides active stick/slip compensation during startup and settling and is the key to achieving consistent and repeatable nanometer level positioning increments. It also cancels out motion irregularities caused by the ball screw and significantly improves velocity control.

Servo-control of the system employs a single high-resolution position feedback sensor (direct metrology) which means that the inherent piezo precision is available over the entire travel range of 100 mm, and longer travel ranges are basically feasible. The resolution and the positioning accuracy mainly depend on the choice of the feedback sensor.

Hybrid Controller Technology is Key to Success

PI's highly specialized C-702 hybrid nanopositioning controller (see p. 4-118) compares the actual platform position (by reading the integrated linear

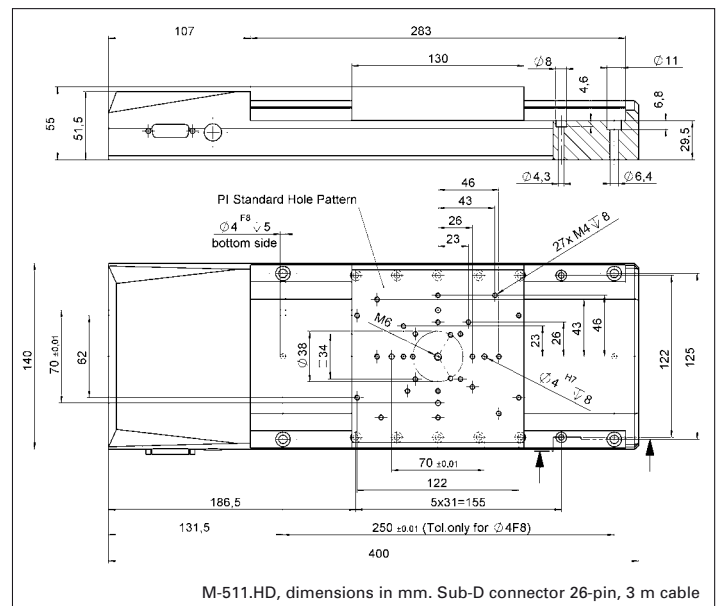
Ordering Information

M-511.HD
Ultra-High-Precision Hybrid Translation Stage, 100 mm Travel, 2 nm Linear Encoder Resolution

Ask about custom designs!

encoder) with a calculated, smooth trajectory in real time. Its complex control algorithms continuously actuate both the piezoelectric and servo motor drives in a way to provide the best possible overall performance.

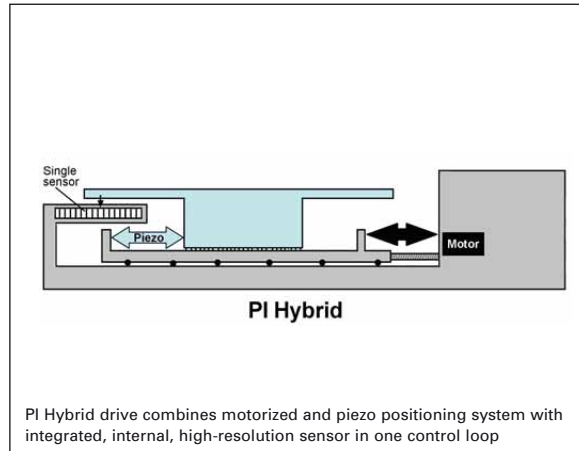
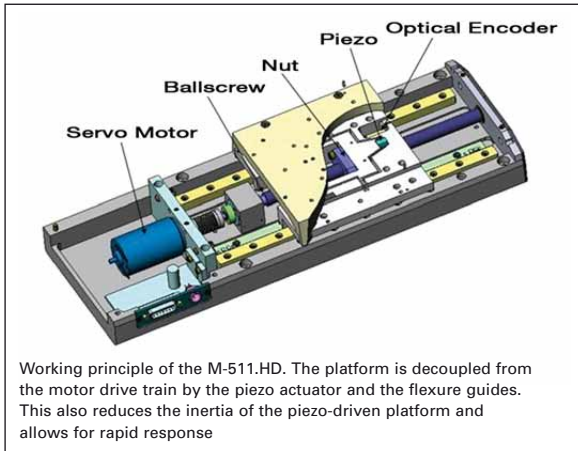
This makes hybrid systems ideal for applications where extremely smooth motion is required, where the position of an incident needs to be read and refound precisely, or where an externally specified target position needs to be hit within few a nanometers, such as in surface inspection or metrology.



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Application Examples

- Surface Inspection
- Microscopy
- Laser technology
- Interferometry
- Metrology



Technical Data

Model	M-511.HD
Active axes	X
Motion and positioning	
Travel range	100 mm
Integrated sensor	Linear encoder
Sensor resolution	0.002 μm
Design resolution	0.002 μm
Min. incremental motion	0.004 μm
Hysteresis at the platform	0.01 μm
Unidirectional repeatability	0.01 μm
Accuracy	<0.05 μm
Pitch	$\pm 25 \mu\text{rad}$
Yaw	$\pm 25 \mu\text{rad}$
Straightness	1 μm
Flatness	1 μm
Max. velocity	50 mm/s
Origin repeatability	1 μm
Mechanical properties	
Drive screw	Recirculating ballscrews
Guiding	Precision linear guiding rails, recirculating ball bearings
Screw pitch	2 mm/rev.
Max. load	200 N
Max. push/pull force	80/80 N
Max. lateral force	200 N
Drive properties	
Drive type	Hybrid drive: DC motor with low-inertia, flexure-decoupled and piezo actuated stage platform
Motor type	DC motor
Operating voltage (motor)	24 V
Electrical power	30 W
Piezo drive type	PICMA® Multilayer piezo with flexure
Piezo voltage	$\pm 36 \text{ V}$
Limit and reference switches	Hall-effect
Miscellaneous	
Operating temperature range	-20 to +65 °C
Material	Al (black anodized)
Mass	5.1 kg
Recommended controller/driver	C-702 hybrid motor controller (p. 4-118)

XY Piezo Linear-Motor Driven Precision 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

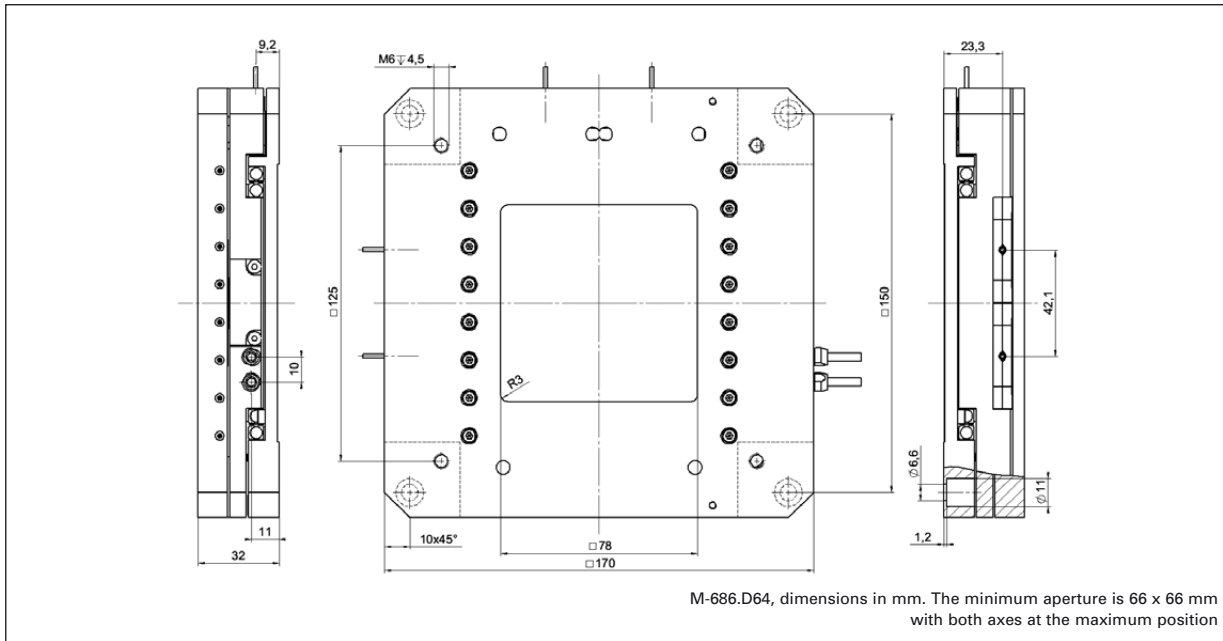
Low-profile microscopy XY scanners

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



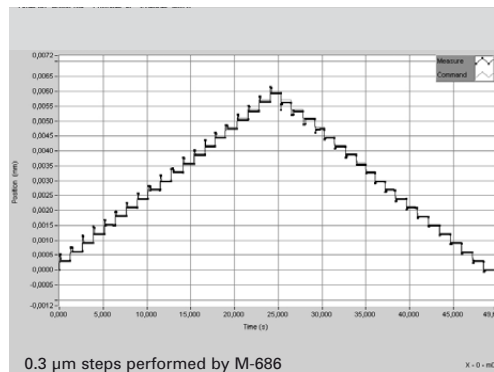


Technical Data

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)



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



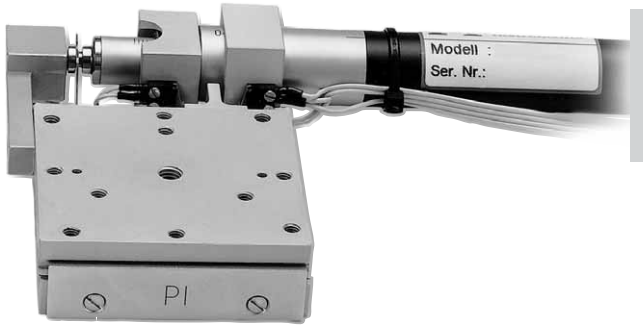
*10 N for max. velocity

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

***For drive electronics

Precision Micropositioning Linear Slide w/ Motor & Piezo Option

Compact, Nanometer-Precise Piezo Drive, High-Accuracy Guiding



M-011.D01 translation stage

- Travel Range to 15 mm
- Compact Side Drive
- Straightness/Flatness $\leq 0.2 \mu\text{m}$
- PZT Drive for Scanning and Tracking Applications
- 0.1 μm Resolution with Closed-Loop DC Motor
- 5 nm Resolution with Closed-Loop PZT Drive

M-011 ultra-high-precision magnetically-coupled stages use the force of integrated magnets to preload the bearing. This magnetic preload results in extremely uniform and smooth motion with minimum friction. Unlike conventional stages, where two bearings with limited parallelism guide the carriage (inducing runout and rotational errors) in M-011 stages, only one of the two linear bearings has a guiding function (V-groove) while the second bearing is for support only (U-groove).

Ultra-Straight Motion

The coupling between the stage and the space-saving side-drive units (DC-motor drives, PZTs, micrometer drives) is not rigid but via mag-

nets. This design allows only on-axis forces (drive direction) to be transmitted to the stage; torque-induced positioning errors resulting from non-parallelism between the drive axis and the guiding axis are eliminated.

Six Different Versions

The basic version, the M-011.00, is equipped with a precision manual micrometer providing a sensitivity of 1 μm . M-011.D01 is equipped with a closed-loop DC-motor drive providing 0.1 μm minimum incremental motion.

High-Resolution Piezo Option

For both the manual and motorized version, closed-loop and open-loop piezo drives are available. They provide 5 nm minimum incremental motion over a travel range of 30 μm and allow for dynamic operation such as scanning and tracking. The closed-loop piezo drive provides repeatability of 60 nm (see the "Piezo Actua-

tors" section for further details on piezo actuators and recommended controllers). All stages can be cross stacked and combined with the M-052 Z-axis mounting bracket to provide multi-axis motion (vertical use of the M-011 only permitted with loads less than 0.1 kg, no extended Z-axis bracket for motorized Z-stage available).

Upgrades

M-011 stages without piezo drives or DC-motor drives can be upgraded at a later date (see ordering information).

Notes

See "Accessories" (p. 4-90 ff) for adapters, brackets, etc.

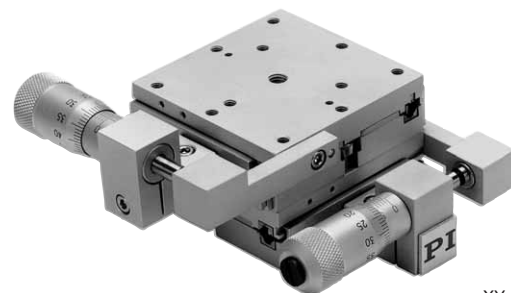
Ordering Information

- M-011.00**
Translation Stage, 15 mm
- M-011.P0**
Translation Stage, 15 mm, Manual + PZT Drive
- M-011.PS**
Translation Stage, 15 mm, Manual + Closed-Loop PZT Drive
- M-011.D01**
Translation Stage, 10 mm, DC-Motor Drive
- M-011.DP1**
Translation Stage, 10 mm, DC-Motor + PZT Drive
- M-011.DS1**
Translation Stage, 10 mm, DC-Motor + Closed-Loop PZT Drive

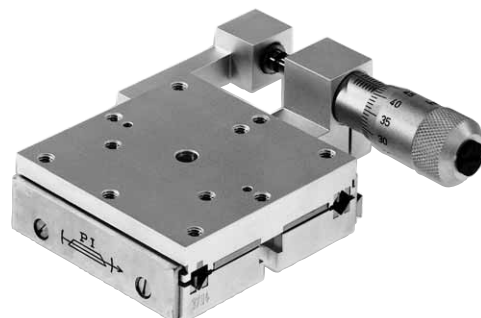
Upgrades

- M-011.U0** Upgrade Kit with Open-Loop PZT Drive
- M-011.US** Upgrade Kit with Closed-Loop PZT Drive
- M-011.UD1** Upgrade Kit with DC-Motor Drive and Limit Switches (Factory Installed)

Ask about custom designs!



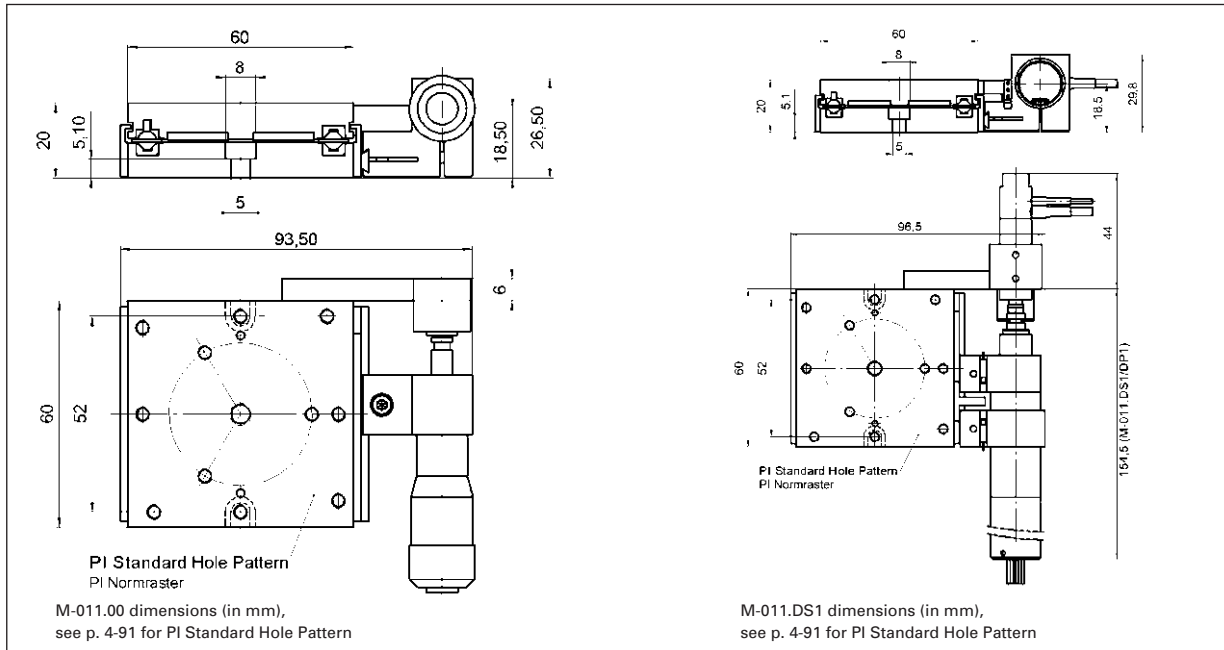
XY combination of two M-011.00 stages



M-011.00 translation stage

Application Examples

- Microscopy
- Quality control
- Metrology



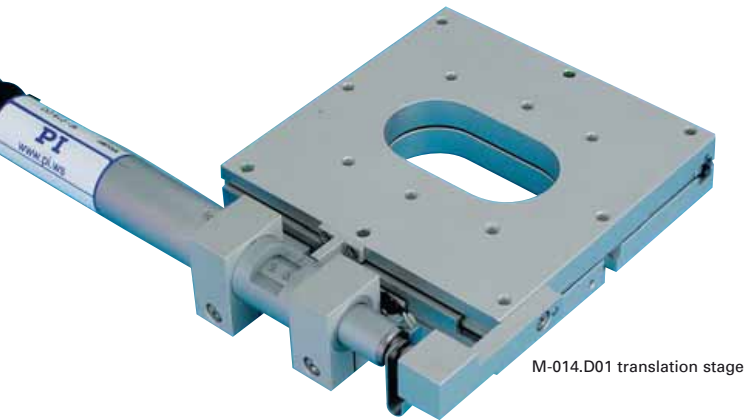
Technical Data

Model	M-011.00	M-011.P0	M-011.PS	M-011.D01	M-011.DP1	M-011.DS1	Units
Travel range	15	15	15	10	10	10	mm
Piezo fine travel range	–	30	30	–	30	30	µm
Min. incremental motion (piezo drive)	–	0.005	0.005	–	0.005	0.005	µm
Repeatability (piezo drive)	–	–	0.06	–	–	0.06	µm
Design resolution (DC Motor)	–	–	–	0.0035	0.0035	0.0035	µm
Min. incremental motion	1	1	1	0.1	0.1	0.1	µm
Unidirectional repeatability	–	–	–	0.1	0.1	0.1	µm
Bidirectional repeatability	–	–	–	2	2	2	µm
Backlash	–	–	–	2*	2*	2*	µm
Straightness / flatness per 5 mm	0.1	0.1	0.1	0.1	0.1	0.1	µm
Straightness / flatness full travel	0.2	0.2	0.2	0.2	0.2	0.2	µm
Max. velocity (motor)	–	–	–	0.7	0.7	0.7	mm/sec
Max. normal load capacity	1	1	1	1	1	1	kg
Max. push/pull force	7 / 5	7 / 5	7 / 5	7 / 5	7 / 5	7 / 5	N
Max. lateral force	5	5	5	5	5	5	N
Drive	M-623	M-623	M-623	M-227.10	M-227.10	M-227.10	
Piezo drive	–	P-840.20	P-841.20	–	P-840.20	P-841.20	
Encoder resolution	–	–	–	2048	2048	2048	counts/rev.
Drivescrew pitch	0.5	0.5	0.5	0.5	0.5	0.5	mm/rev.
Gear ratio	–	–	–	69.12:1	69.12:1	69.12:1	
Nominal motor power	–	–	–	2	2	2	W
Motor voltage	–	–	–	12	12	12	V
Mass	0.35	0.4	0.42	0.55	0.6	0.62	kg
Body material	Al, St	Al, St	Al, St	Al, St	Al, St	Al, St	
Recommended piezo controller	–	E-660, E-610	E-610	–	E-660 (p. 2-119), E-610 (p. 2-110)	E-610 (p. 2-110)	
		E-500 System	E-500 System		E-500 System	E-500 System (p. 2-142)	
Recommended motor controller	–	–	–	C-843, C-848, C-863	C-843, C-848, C-863	C-843, C-848 (p. 4-120 ff), C-863 (p. 4-114)	

*gearhead

Precision Micropositioning Linear Slide w/ Motor & Piezo Option

Nanometer-Precise Piezo Drive, High-Accuracy Guides



M-014.D01 translation stage

- Travel Range 25 mm
- Compact Side Drive
- Straightness/Flatness $\leq 0.3 \mu\text{m}$
- PZT Drive for Scanning and Tracking Applications
- 0.1 μm Resolution w/ Closed-Loop DC Motor
- 5 nm Resolution with Closed-Loop PZT Drive
- 30 mm \varnothing Clear Aperture

M-014 ultra-high-precision magnetically coupled stages use the force of integrated magnets to preload the bearing. This magnetic preload results in extremely uniform and smooth motion with minimum friction. Unlike conventional stages, where two bearings with limited parallelism guide the carriage (inducing runout and rotational errors) in M-014 stages, only one of the two linear bearings has a guiding function (V-groove) while the second bearing is for support only (U-groove).

Ultra-Straight Motion

The coupling between the stage and the space-saving side drive units (DC-motor drives, PZTs, micrometer drives) is not rigid but via magnets. This design allows only

on-axis forces (drive direction) to be transmitted to the stage; torque-induced positioning errors induced by non-parallelism between the drive axis and the guiding axis are eliminated.

Six Different Versions

The basic version, the M-014.00, is equipped with a precision manual micrometer providing a sensitivity of 1 μm . M-014.D01 is equipped with a closed-loop DC-motor drive providing 0.1 μm minimum incremental motion.

High-Resolution Piezo Option

For both the manual and motorized version, closed-loop and open-loop piezo drives are available. They provide 5 nm minimum incremental motion over a travel range of 45 μm and allow for dynamic operation such as scanning and tracking. The closed-loop piezo drive provides repeatability of 90 nm (see the "Piezo Actuators" section for further details on piezo actuators and recommended controllers).

All stages can be cross stacked and combined with the M-053.10 (manual versions) and M-053.20 (motorized versions) Z-axis mounting bracket to provide multi-axis motion. Vertical use of the M-014 is only permitted with loads less than 0.5 kg. For vertical positioning with loads in excess of 0.5 kg we recommend M-126 stages (see page 4-38) and the 125.90 Z-axis mounting bracket.

Upgrades

M-014 stages without PZT or DC-motor drives can be upgraded at a later date (see ordering information).

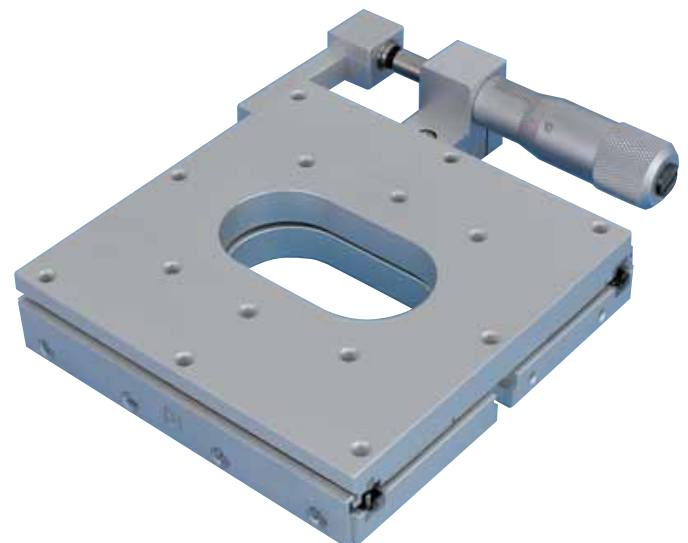
Notes

See "Accessories" (p. 4-90 ff) for adapters, brackets, etc.

Ordering Information

- M-014.00**
Translation Stage, 25 mm
- M-014.P0**
Translation Stage, 25 mm, Manual + PZT Drive
- M-014.PS**
Translation Stage, 25 mm, Manual + Closed-Loop PZT Drive
- M-014.D01**
Translation Stage, 25 mm, DC-Motor Drive
- M-014.DP1**
Translation Stage, 25 mm, DC-Motor + PZT Drive
- M-014.DS1**
Translation Stage, 25 mm, DC-Motor + Closed-Loop PZT Drive
- Upgrades**
- M-014.U0**
Upgrade Kit with Open-Loop PZT Drive
- M-014.US**
Upgrade Kit with Closed-Loop PZT Drive
- M-014.UD**
Upgrade Kit with DC-Motor Drive and Limit Switches (Factory Installed)

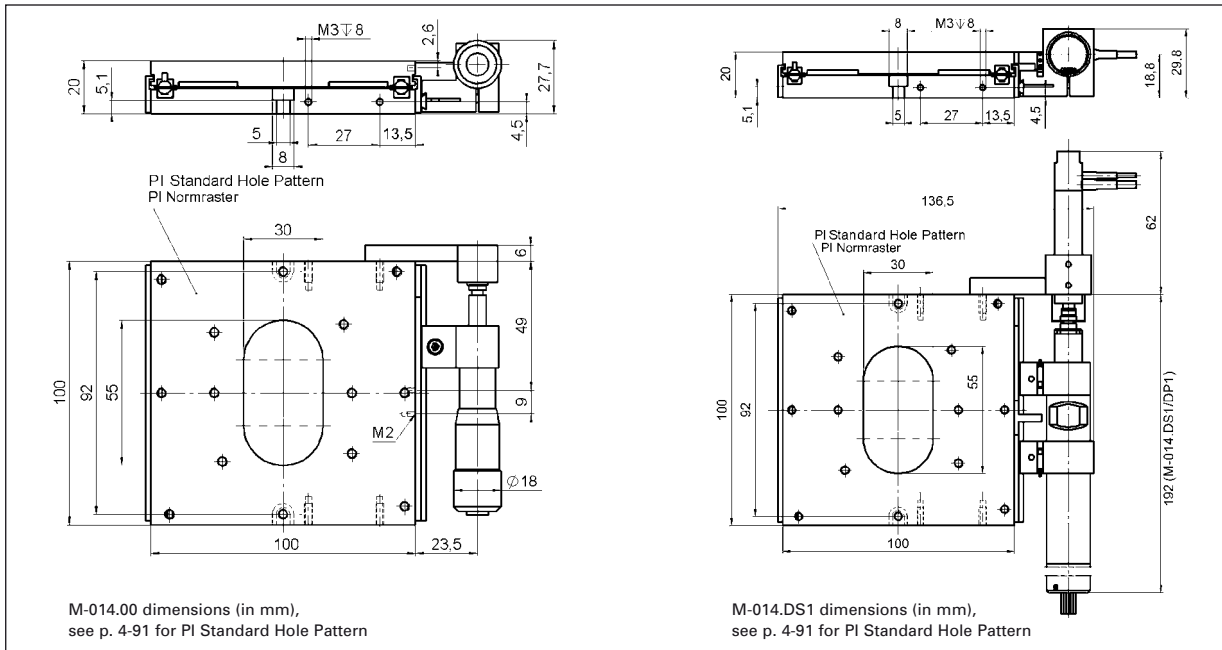
Ask about custom designs!



M-014.00 translation stage

Application Examples

- Microscopy
- Quality control
- Metrology



Technical Data

Model	M-014.00	M-014.P0	M-014.PS	M-014.D01	M-014.DP1	M-014.DS1	Units
Travel range	25	25	25	25	25	25	mm
Piezo fine travel range		45	45		45	45	µm
Min. incremental motion (piezo drive)	–	0.005	0.005	–	0.005	0.005	µm
Repeatability (piezo drive)	–	–	0.09	–	–	0.09	µm
Design resolution (DC Motor)	–	–	–	0.0035	0.0035	0.0035	µm
Min. incremental motion	1	1	1	0.1	0.1	0.1	µm
Unidirectional repeatability	–	–	–	0.1	0.1	0.1	µm
Bidirectional repeatability	–	–	–	2	2	2	µm
Backlash	–	–	–	2*	2*	2*	µm
Straightness / flatness per 5 mm	0.1	0.1	0.1	0.1	0.1	0.1	µm
Straightness / flatness full travel	0.3	0.3	0.3	0.3	0.3	0.3	µm
Max. normal load capacity	5	5	5	5	5	5	kg
Max. velocity (motor)	–	–	–	1	1	1	mm/sec
Max. push/pull force	15/5	15/5	15/5	15/5	15/5	15/5	N
Max. lateral force	10	10	10	10	10	10	N
Drive	M-624	M-624	M-624	M-227.25	M-227.25	M-227.25	
Piezo drive	–	P-840.30	P-841.30	–	P-840.30	P-841.30	
Encoder resolution	–	–	–	2048	2048	2048	counts/rev.
Drive screw pitch	0.5	0.5	0.5	0.5	0.5	0.5	mm/rev.
Gear ratio	–	–	–	69.12:1	69.12:1	69.12:1	
Nominal motor power	–	–	–	2	2	2	W
Motor voltage	–	–	–	12	12	12	V
Mass	0.72	0.78	0.8	0.98	1.04	1.06	kg
Body material	Al, St	Al, St	Al, St	Al, St	Al, St	Al, St	
Recommended piezo controller	–	E-660, E-610	E-610	–	E-660 (p. 2-119), E-610	E-610 (p. 2-110)	
		E-500 System	E-500 System		E-500 System	E-500 System (p. 2-142)	
Recommended motor controller	–	–	–	C-843, C-848, C-863	C-843, C-848, C-863	C-843, C-848 (p. 4-120 ff), C-863 (p. 4-114)	

*gearhead

Sub-Miniature Precision Micropositioning Slide w/ Piezo Option

X, XY, XYZ Miniature Translation Stages



M-311.00, M-312.00, M-313.00
miniature translation stage

- Extremely Compact
- All-Stainless-Steel Construction
- X, XY and XYZ Versions
- Optional PiezoMike for Nanometer Resolution
- 4 mm Clear Aperture
- Linear Ball Bearings

The M-310 series of translation stages are our smallest micrometer-driven positioners. The carriage is spring pre-loaded against the micrometer tip for elimination of backlash. M-310 series stages are available in one-, two- or three-axis

configurations. The latter consists of a two-axis stage, an angle bracket and a one-axis stage. Please note that an XY unit cannot be separated into two one-axis stages. The vertical stage in the M-313 XYZ assembly supports the load

through the micrometer spindle (not the preload springs) providing excellent stability.

PiezoMike Option

Versions with PiezoMike drive provide an additional 25 μm fine range for remotely controlled ultra-high resolution (e.g. scanning or tracking). See page 7-86 for further details.

A special version with piezo block NanoActuators is available as product number F-111 (see page 8-22 in the "Photonics" section, for more examples of M-310 series stages in photonics alignment and packaging).

Notes

See "Accessories", page 7-92 ff. for adapters, brackets, etc.

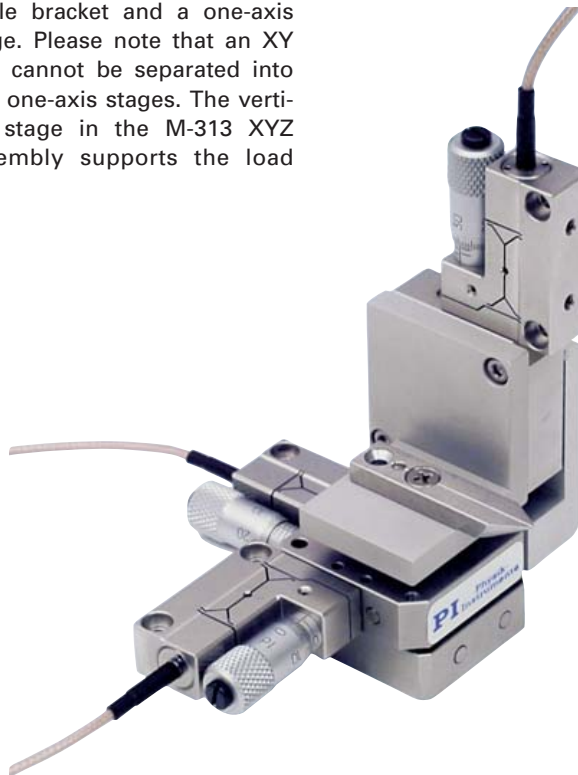
Ordering Information

- M-311.00**
Miniature Translation Stage, 6 mm
- M-312.00**
XY Miniature Translation Stage, 6 mm
- M-313.00**
XYZ Miniature Translation Stage, 6 mm
- M-311.80**
Miniature Translation Stage with PiezoMike Drive, 6 mm
- M-312.80**
XY Miniature Translation Stage with PiezoMike Drive, 6 mm
- M-313.80**
XYZ Miniature Translation Stage with PiezoMike Drive, 6 mm
- Accessories**
- M-318.20**
Angle Bracket (F-010 fiber holder \rightarrow M-313)
- M-318.30**
Combination Plate 30 x 30 mm
- M-318.00**
Z-axis Mounting Bracket (included in M-313)
- M-318.40**
Adapter Plate for Honeycomb Tables, 1" & 25 mm

Ask about custom designs!

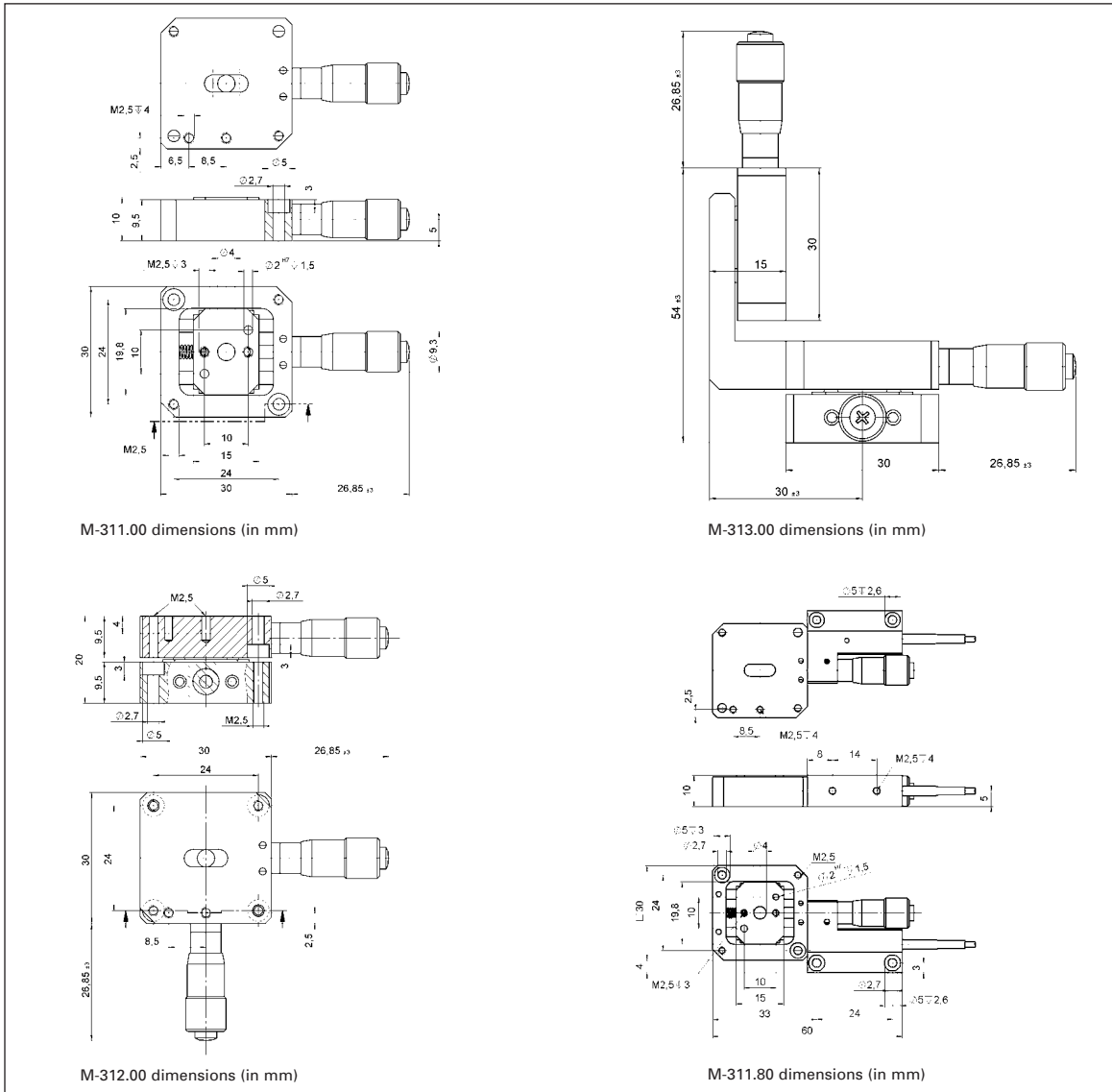


M-313.00 XYZ stage with M-318.20 angle bracket and F-010.00 fiber holder mounted on a pillar pin with M-318.30 adapter plate. See the F-111 on page 8-22 in the Photonics" section, for more examples of M-310 series stages in photonics alignment and packaging.



M-313.80 XYZ stage with P-853 PiezoMikes and optional M-318.20 angle bracket and F-010.00 fiber holder

More information: www.xyz-stage.com



Technical Data

Models	M-311.00	M-311.80	Units	Notes see page 7-106
Travel range	6	6	mm	
Piezo fine travel range	-	25	μm	
Min. incremental motion (piezo drive)	-	0.01	μm	A4
Min. incremental motion (micrometer drive)	1	1	μm	A4
Backlash	2	2	μm	
Straightness	0.4	0.4	μm	
Max. normal load capacity	4	4	kg	B1
Max. push/pull force	20 / 1	20 / 1	N	B2
Drive	M-619	P-853		
Micrometer pitch	0.5	0.5	mm/rev.	
Weight	58	100	g	
Body material	N -S	N -S		L
Recommended piezo driver (codes explained p. 6-11)	-	A, C, G		

More information: www.xyz-stage.com