

# M-511 · M-521 · M-531 Heavy-Duty Micropositioning Stage

## 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

### Application Examples

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

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

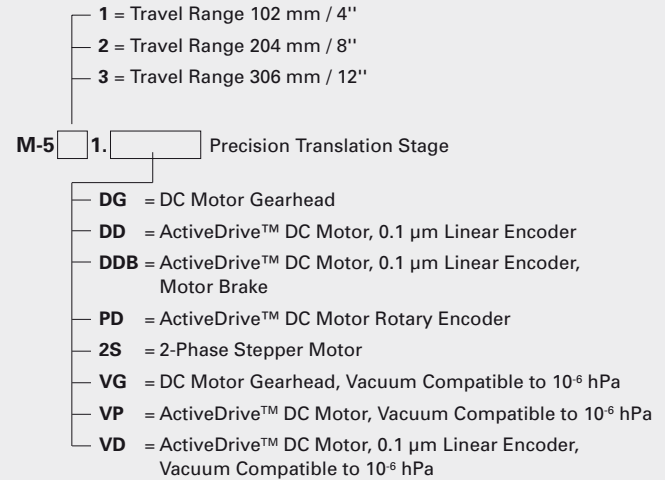
### Heavy Duty and Maintenance Free

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 life-time.

### Four Drive Options

Maximum dynamic performance is possible with versions featuring the highly efficient Ac-

### Ordering Information



tiveDrive™ direct-drive system, 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

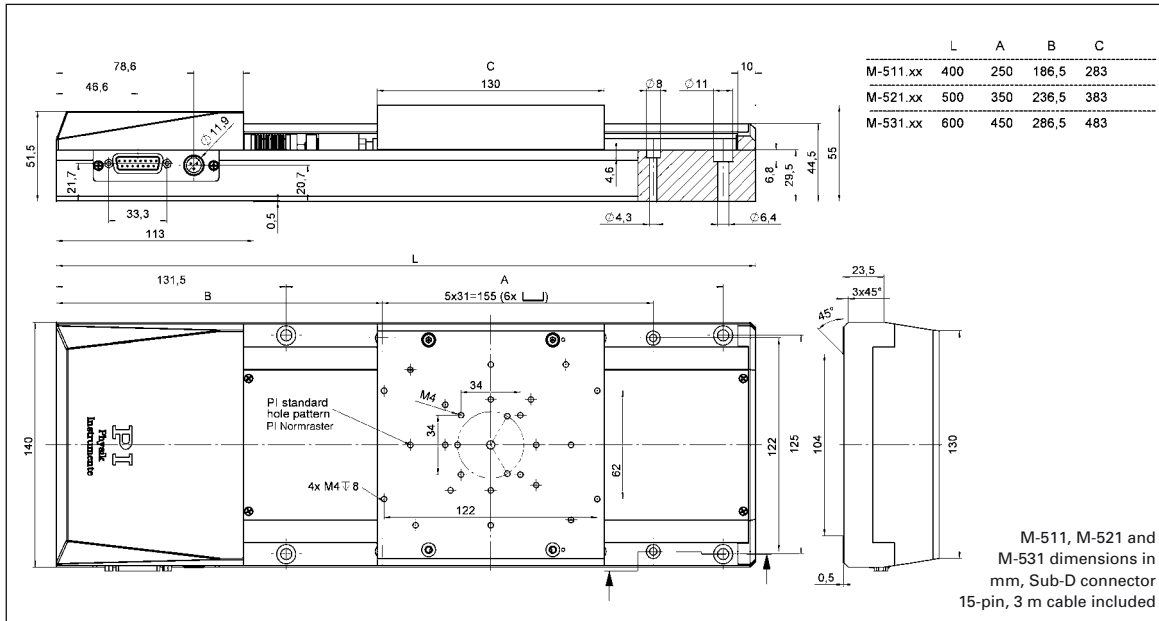
The stages are individually tested and optimized using a laser interferometer.

### 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



## 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
<b>Motion and positioning</b>					
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
<b>Mechanical properties</b>					
Thread pitch	2	2	2	2	mm
Gear ratio	–	–	(28/12) <sup>4</sup> : 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
<b>Drive properties</b>					
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	
<b>Miscellaneous</b>					
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

Linear Actuators & Motors

Nanopositioning/Piezoelectrics

Nanometrology

**Micropositioning**

Hexapod 6-Axis Systems /  
Parallel Kinematics

Linear Stages

**Translation (X)**

Vertical (Y)

Multi-Axis

Rotary & Tilt Stages

Accessories

Servo & Stepper  
Motor Controllers

Single-Channel

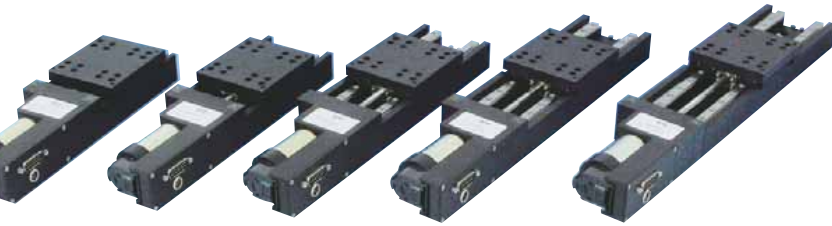
Hybrid

Multi-Channel

Micropositioning  
Fundamentals

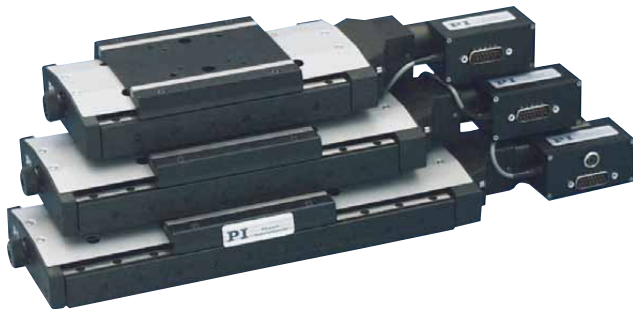
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M-403 linear stage versions (from left) M-403.1PD, M-403.2PD, M-403.4PD, M-403.6PD und M-403.8PD provide travel ranges from 25 to 200 mm



- For Cost-Sensitive Precision Positioning Applications
- Travel Ranges 25 to 200 mm
- Resolution to 0.012  $\mu\text{m}$
- Min. Incremental Motion to 0.1  $\mu\text{m}$
- 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

M-405.DG, M-410.DG and M-415.PD high-precision translation stages



- Travel Ranges up to 150 mm
- Stress-Relieved Aluminum Base for Highest Stability
- Crossed Roller Bearings
- Manual, DC-Servo and Stepper-Motor Drives
- Knob for Convenient Manual Position Adjustment
- Direction-Sensing Reference Switch

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  $\mu\text{m}$  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-605.2DD high precision translation stage



- Integrated 0.1  $\mu\text{m}$  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

## PILine<sup>®</sup> M-663 micropositioning stages with integrated linear encoder



- 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  $\mu\text{m}$  Resolution
- XY Combination Possible
- Vacuum-Compatible Versions Available

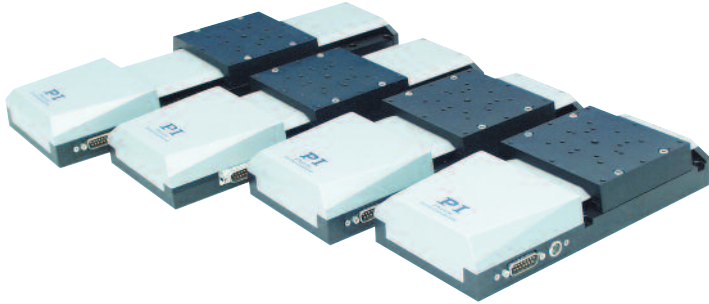
## Reference-class translation stage with linear motor



### N-664

- Travel range 30 mm
- Encoder resolution 0.5 nm
- Minimal incremental motion 2 nm
- Excellent guiding accuracy
- Max. velocity 10 mm/s

## 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

## M-501.1PD vertical stage



- Travel Range 12.5 mm (1/2")
- Ultra-High-Resolution Encoder
- ActiveDrive™ Motor
- Zero-Backlash Recirculating Ballscrews
- Non-Contact Limit and Reference Switches
- Stress-Relieved Aluminum Base for Highest Stability
- MTBF >20,000 h
- Self Locking to 10 kg

## 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

### M-116.DG micro rotary stage



- Compact Design
- Continuous Rotation Range
- Encoder Resolution 2.5  $\mu$ rad
- Clear Aperture
- Max. Velocity 20 degrees/second
- Preloaded Worm Drive for Zero Backlash
- Fits Directly on M-110 Micro Translation Stages
- Non-Contact Reference Switch
- Repeatability to  $\pm 10 \mu$ rad

### M-060.PD, M-061.PD and M-062.PD



- Continuous Rotation Range
- Ultra-High Resolution
- Max. Velocity 90 deg/sec
- Preloaded Worm Drive for Zero Backlash
- ActiveDrive DC-Servo, Stepper-Motor and Manual Drives
- Direction-Sensing Reference Switch

### M-660 PLine<sup>®</sup> Rotation Stage



- Unlimited Travel Range
- Max. Velocity 720  $^{\circ}$ /s
- Low Profile: Only 14 mm in Height
- Self-Locking Ceramic Direct Drive: Energy Saving & High Position Stability
- Direct Metrology Linear Encoder, up to 4  $\mu$ rad Resolution
- PLine<sup>®</sup> Direct Drive: Non-Magnetic and Vacuum-Compatible Working Principle
- Compact Combinations with Linear Stages

M-112.2DG, M-111.2DG, M-110.2DG  
25 mm, 15 mm and 5 mm travel range



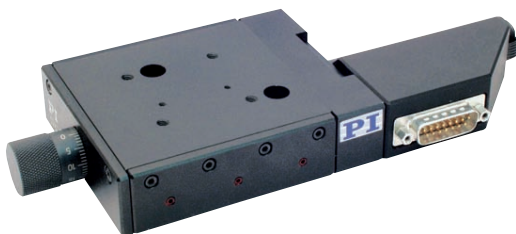
- Travel Ranges 5, 15 and 25 mm
- Very Cost Effective
- Min. Incremental Motion to 50 nm
- Max. Velocity 2 mm/s
- Closed-Loop DC Motors and Stepper Motors
- Non-Contact Limit and Reference Switches
- Optional Recirculating Ball Screw Drives Provide High Speeds & Long Lifetimes
- Vacuum-Compatible Versions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

M-122 Precision Micro-Translation Stage



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

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



- Min. Incremental Motion to 0.1  $\mu\text{m}$  (3.5 nm Resolution)
- Repeatability to 0.1  $\mu\text{m}$
- 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

## N-661 Miniature Linear Slide with NEXACT<sup>®</sup> Drive



- Travel Range 20 mm
- Self Locking at Rest, no Heat Generation, no Servo Dither
- Compact Design: 70 x 50 x 20 mm
- Zero-Wear Piezo Stepping Drive, Ideal for Micro- and Nano-Manipulation
- Integrated Linear Encoder Option for Highest Accuracy with 20 nm Resolution
- Two Operating Modes: Continuous Stepping Mode and Continuously Variable, High-Dynamics Analog Mode for 30 µm Resolution
- Up to 10 N Force Generation

## 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
- PIline<sup>®</sup>: Non-Magnetic and Vacuum-Compatible Working Principle
- Self Locking at Rest

## M-664 PIline<sup>®</sup> Linear Motor Stage



- Travel Range 25 mm
- Max. Velocity 400 mm/s
- Ultra-Low Profile, 15 mm
- Direct Metrology Linear Encoder with 0.1 µm Resolution
- High Guiding Accuracy with Crossed Roller Bearings
- Compact XY Combinations
- Piezo Linear Motor with 4 N Drive Force
- Self Locking at Rest