M-238 High-Load, High-Resolution Linear Actuator

Forces to 400 N, Optional Direct Position Measurement

M-238.5PL Heavy-Duty Mike actuator (with CD for size comparison)

- **High Load Capacity to 400 N**
- **Travel Range 50 mm**
- **Resolution to 0.1 µm**
- **Max. Velocity 30 mm/s**
- **Preloaded Frictionless Ball Screw**
- **Optional 0.1 µm Direct-Metrology Linear Encoder for Exceptional Precision**
- **MTBF >20,000 h**
- **Vacuum-Compatible Versions Available for 10^{-6} hPa**

The M-238 is a high-load, high-precision actuator providing linear motion up to 50 mm, a load capacity to 400 N and high velocity to 30 mm/s. It consists of a low-friction, heavy-duty ballscrew, driven by a closed-loop, ActiveDrive™ DC-Motor with gearbox. The M-238 is therefore well suited for high duty-cycle operation in industrial environments. An optional linear encoder provides exceptional accuracy and repeatability.

Application Examples

- Quality assurance testing
- Testing equipment
- Precision machining
- Astronomy
- Flexible automation
- Metrology

Direct Metrology Linear Encoder to Compensate Mechanical Play

The M-238.5PL model is equipped with a non-contact, optical, linear encoder (direct metrology) with an output resolution of 0.1 µm. Because the encoder measures the actual position of the non-rotating actuator tip, drive-train errors like backlash and elastic deformations are eliminated. A lower-cost version with a rotary encoder is available as model number M-238.5PG.

ActiveDrive™ DC-Motor

DC motor drives offer several advantages, such as high dynamics, high torque at low rotational speed, low heat and low vibration.

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

Non-Rotating Tip

Compared to conventional rotating-tip micrometer drives, the non-rotating-tip design offers several advantages:

- Elimination of torque-induced positioning errors
- Elimination of sinusoidal motion errors
- Elimination of wear at the contact point
- Elimination of tip-angle dependent wobble

The lateral guiding of the tip withstands lateral forces of up to 100 N.

Ordering Information

M-238.5PG
Heavy-Duty DC-Mike Actuator, 400 N, 50 mm, ActiveDrive™

M-238.5PL*
Heavy-Duty DC-Mike Actuator, 400 N, 50 mm, ActiveDrive™, Direct-Metrology Encoder

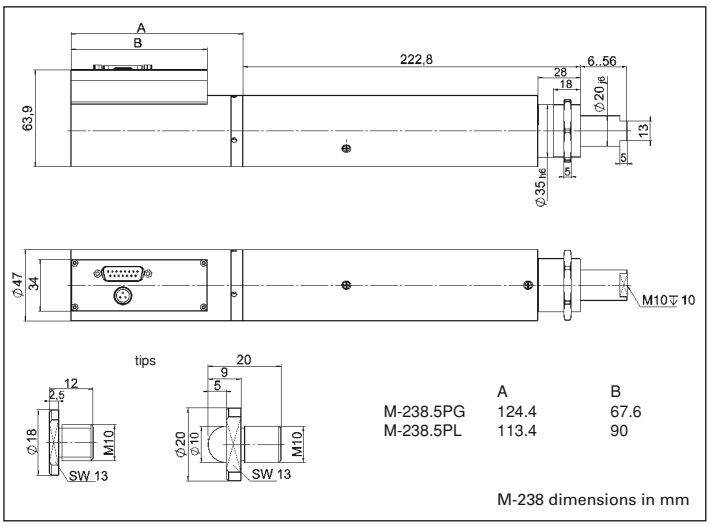
*Ask for availability in your region

Ballscrews for High Speed, Precision and Lifetime

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

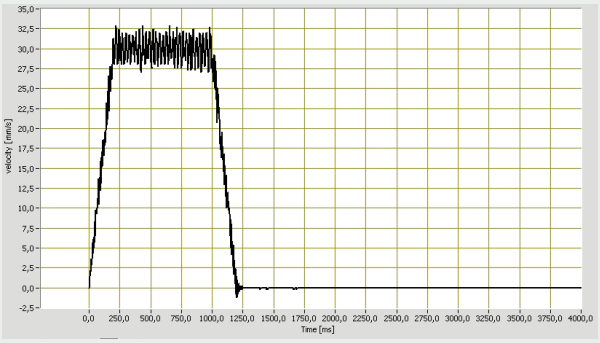
Limit and Reference Switches

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.

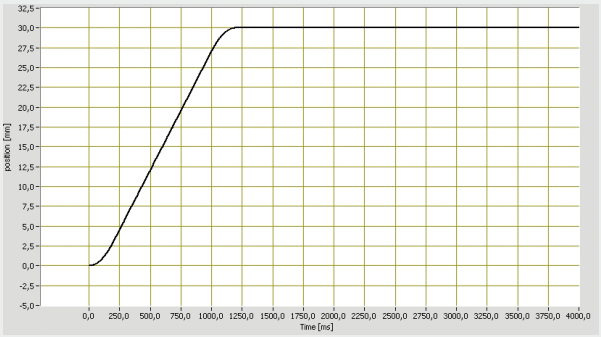


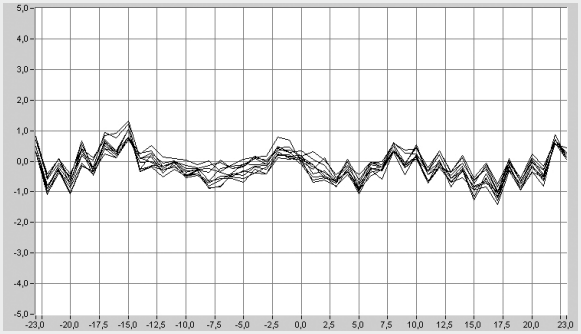
	A	B
M-238.5PG	124.4	67.6
M-238.5PL	113.4	90

M-238 dimensions in mm



M-238.5PL velocity at 30 mm/s is highly constant.





M-238.5PL repeatability is better than 0.3 µm.

The settling time for a 30 mm step is less than 1.5 seconds.

Technical Data

Model	M-238.5PG	M-238.5PL	Units	Tolerance
Active axes	X	X		
Motion and positioning				
Travel range	50	50	mm	
Integrated sensor	Rotary encoder	Linear encoder		
Sensor resolution	4000 cts/rev.	0.1 µm		
Design resolution	0.13	0.1	µm	typ.
Min. incremental motion	0.5	0.3	µm	typ.
Backlash	3	1	µm	typ.
Unidirectional repeatability	1	0.3	µm	typ.
Max. velocity	30	30	mm/s	
Origin repeatability	1	1	µm	±20 %
Mechanical properties				
Spindle pitch	2	2	mm/rev.	
Gear ratio	3.71:1	3.71:1		
Push/pull force	400	400	N	Max.
Lateral force	100	100	N	Max.
Drive properties				
Motor type	DC-motor, ActiveDrive™	DC-motor, ActiveDrive™		
Operating voltage	24 (PWM)	24 (PWM)	V	
Electrical power	80	80	W	nominal
Miscellaneous				
Operating temperature range	-10 to 50	-10 to 50	°C	
Material	Al (anodized), steel	Al (anodized), steel		
Mass	2.4	2.4	kg	±5 %
Cable length	3	3	m	±10 mm
Connector	D-Sub 15 (m)	D-Sub 15 (m)		
Recommended controller/driver	C-863, C-843	C-863 (p. 4-114), C-843 (p. 4-120)		

M-228 · M-229 Stepper Motorized Precision Linear Actuator Series

High-Load, Compact and Highly Cost-Efficient, with Limit Switches

M-228 and M-229 series linear actuators are driven by powerful direct-drive stepper motors, or are equipped with more compact, gearhead stepper motors: M-229.26S, M-228.11S, M-229.25S, M-228.10S (from left)

- **Highly Cost-Efficient, Compact Design**
- **10 and 25 mm Travel Range**
- **High Load Capacity to 80 N**
- **Gearhead Version: 46 nm Resolution (with C-663 Controller)**
- **Direct Drive: Max. Velocity 5 mm/s**
- **Non-Rotating Tip**
- **Non-Contact Limit and Reference Switches**

M-228 and M-229 series linear actuators provide a travel range of 10, resp. 25 mm, and are equipped with high-resolution stepper motors. The stepper mikes can push or pull loads up to 80 N, and provide speeds up to 5 mm/s. Models featuring gearhead/stepper motor combinations offer the same stroke in a more compact package.

Cost-Effective Design, Valuable Features

The cost-effective design offers many useful features such as a non-rotating tip, limit and reference switches and a mechanical position display.

A spherical tip and a 3 m extension cable are included in the delivery. The more compact gearhead versions include an additional flat tip.

Application Examples

- Quality assurance testing
- Testing equipment
- Alignment of secondary mirrors
- Automation
- Metrology
- Precision machining

Non-Rotating Tip

Compared to conventional rotating-tip micrometer drives, the non-rotating tip design offers several advantages:

- Elimination of torque-induced positioning errors
- Elimination of sinusoidal motion errors
- Elimination of wear at the contact point
- Elimination of tip-angle-dependent wobble

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 actuators with the networkable C-663 Mercury Step controller (s. p. 4-112) offers high performance for a very competitive price in both single and multi-axis configurations.

Ordering Information

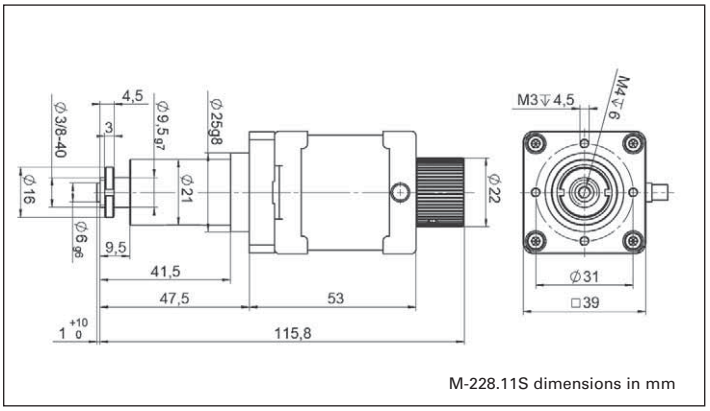
M-228.10S
Stepper-Mike Linear Actuator, 10 mm, Stepper Motor, Gearhead, Limit Switches

M-228.11S
Stepper-Mike Linear Actuator, 10 mm, Stepper Motor, Direct Drive, Limit Switches

M-229.25S
Stepper-Mike Linear Actuator, 25 mm, Stepper Motor, Gearhead, Limit Switches

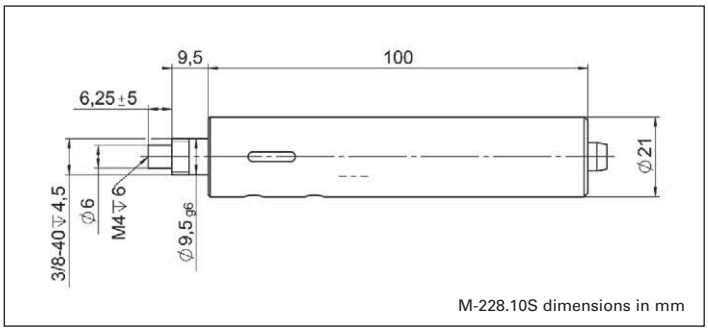
M-229.26S
Stepper-Mike Linear Actuator, 25 mm, Stepper Motor, Direct Drive, Limit Switches

Ask about custom designs!

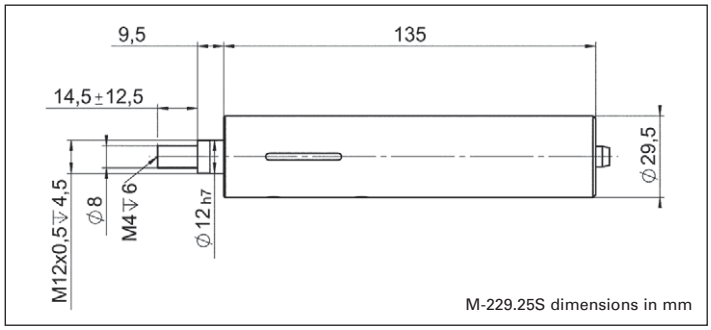


M-228.11S dimensions in mm

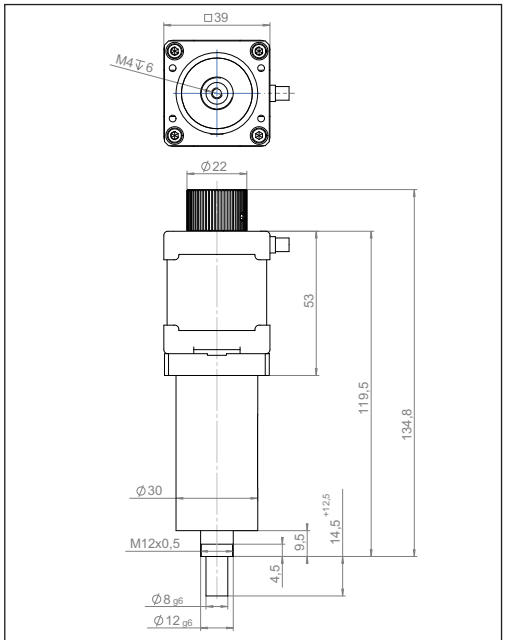
M-229 high-load stepper mike with gearhead, C-663 Mercury stepper motor controller (rear)



M-228.10S dimensions in mm



M-229.25S dimensions in mm



M-229.26S dimensions in mm

Technical Data

Model	M-228.10S	M-228.11S	M-229.25S	M-229.26S	Units
Active axes	X	X	X	X	
Motion and positioning					
Displacement	10	10	25	25	mm
Design resolution*	0.046	0.078	0.046	0.078	µm
Min. incremental motion*	1	1	1	1	µm
Backlash**	5	10	10	10	µm
Unidirectional repeatability	±2	±2	±2	±2	µm
Max. velocity*	1.5	5	1.5	5	mm / s
Reference switch repeatability	1	1	1	1	µm
Mechanical properties					
Drive screw	Leadscrew	Leadscrew	Leadscrew	Leadscrew	
Thread pitch	0.5	0.5	0.5	0.5	mm / rev.
Gear ratio	28.44444:1	–	28.44444:1	–	
Motor resolution*	384	6400	384	6400	steps / rev.
Max. push/pull force	20	50	50	80	N
Drive properties					
Motor type	2-phase stepper motor	2-phase stepper motor	2-phase stepper motor	2-phase stepper motor	
Operating voltage	24***	24#	24##	24#	V
Reference and limit 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·(anodized), steel, brass	Al·(anodized), steel, brass	Al·(anodized), steel, brass	Al·(anodized), steel, brass	
Mass	0.23	0.36	0.4	0.61	kg
Cable length	0.5	0.6	0.5	0.6	m
Connector	15-pin sub-D connector	15-pin sub-D connector	15-pin sub-D connector	15-pin sub-D connector	
Recommended controller	C-663 single-axis	C-663 single-axis	C-663 single-axis	C-663 single-axis	

Please avoid lateral forces at the tip.
* with C-663 stepper motor controller
** with preload
*** max. 0,25 A / phase; 24 full steps / rev.
# max. 0,85 A / phase; 400 full steps / rev.
max. 1 A / phase; 24 full steps / rev.