High-Precision, Low-Profile Linear Motor Stage

Nanopositioning Performance and High Speed in a Compact, Affordable Stage Design

V-508

- Linear travel ranges 170 and 250 mm
- Minimum incremental linear motion to 1 nm
- High precision position encoder options: Incremental and absolute measuring
- Compact size: 80 mm × 25 mm cross section
- Crossed roller guides for high load capacity and high geometric performance
- Choice of iron core and ironless 3-phase linear motors

Compact Linear Translation Stage with Linear Motor and Ultra-Low-Profile Design
The V-508 family of high-precision linear motor stages provides high speed and accuracy in a very compact, low-profile package. These closed-loop, motorized nanopositioning stages are well suited for high-dynamics 24/7 industrial automation applications, based on a concept that was designed with reliability in mind – high performance bearings, zero-friction linear motors, non-contact optical position sensors, and an FEA (finite element analysis) optimized body for stiffness and thermal stability.

Frictionless Direct Drive Linear Motors – Very High Resolution
Driven by in-house developed, frictionless, brushless 3-phase linear motors and controlled by direct-measuring linear encoders, the V-508 series linear translation stages can provide high resolution linear motion with minimum increments down to 1 nanometer, for the highest performance variants.

Direct Metrology Encoders with Sub-nm Sensitivity
There is a choice of cost-efficient incremental encoders, PIOne metrology-class interferometric encoders and absolute measuring encoders (no referencing on power up required). Since the linear position of the stage is measured directly at the moving platform against the stationary base, without contact (direct metrology), backlash, mechanical play, or deformation in the drive train as common with motor / leadscrew combinations have no influence on position accuracy.

Precision Cross Roller Guides for High Load and Smooth Motion
Equipped with precision, long-life, crossed-roller guides with anti-cage creep mechanism, the V-508 translation stages provide excellent straightness and flatness specs. Crossed-roller bearings also provide higher load capacity compared to ball bearings and very smooth motion. Together with the high-performance linear motor and sensor, they make the V-508 compact linear motion stage series an ideal solution for alignment, test, manufacturing, measuring and delay line applications.

Load Capacity / Travel Ranges
These compact linear motion stages can carry loads to 10 kg (100 N). The moving platform of the translation stage covers the whole stage base and provides travel ranges of 80 mm, 170 mm, and 250 mm. Higher load capacities and longer travel range stages, up to 1 m and more, are available in a variety of direct drive and screw-drive linear translation stages offered by PI, including air bearing linear slides and stepper motor stages.

Choice of 3-Phase Direct Drive Linear Motors
V-508 precision linear positioning stages are available with ironless linear motors and iron-core linear motors. Ironless linear motors are particularly suitable for positioning tasks with the highest demands on precision because there is no undesirable interaction (cogging) with the permanent magnets. This allows for smoother running with better constant velocity control even at very low speed and at the same time, eliminates vibration at high velocities. Due to the lack of hysteresis, the controller does not have to deal with nonlinearity and the drive force can be set freely and can be controlled precisely.

On the other hand, when the highest force and acceleration in the smallest stage design is required, iron core linear motors provide an advantage. The iron core design maximizes the magnetic forces and ensures high thermal stability of the motor with high loads. PI offers high performance motion controllers with special algorithms that reduce the cogging effects of iron-core 3-phase motors and can also reduce the peak current requirements in highly dynamic applications.

24/7 Performance Automation

These fast, motorized precision servo stages are designed to meet high duty cycle automation requirements for advanced applications, where reliable, high accuracy motion with nanometer precision and high velocity is required.

Multi-Axis Stage Combinations: XY and XYZ

2-axis and 3-axis stage combinations are feasible. XY tables can be built by stacking two single-axis stages, while a custom Z-axis with weight force compensation can be used for XYZ translation stage combinations. Another Z-axis option is the very compact V-308 vertical linear stage with user-adjustable integrated magnetic counterbalance.

Closed-Loop Motion Controllers for the Highest Performance

A selection of advanced, single-axis and multi-axis motor and automation controllers with extensive software packages are available to extract the maximum performance from these high precision linear positioning stages (see controller recommendations in the specification tables). For the highest performance requirements, we recommend our EtherCat®-based closed-loop ACS controller families (A-8xx and G-9xx series). They allow for dynamic error compensation in one or more axes, further enhancing the performance of the compact V-508 linear motion stages. Especially when path accuracy, tight velocity regulation and motion synchronization of multiple axes are critical, as well as ultra-low position noise and the fastest step-and-settle dynamics, these ACS-based motor controllers provide superior performance. For synchronization with external events or triggering, several options including a special Laser Control Module are available. ACS is a global leader in motion control solutions and part of the PI Group.

Application Fields of V-508 Linear Translation Stages

V-508 high precision linear translation stages are employed in industry and research in fields such as measuring technology, photonics alignment, semiconductor scanning / wafer inspection, optics and sensor calibration, laser inscription and processing, micro-assembly, medical engineering and other applications where high precision motion and 24/7 reliability are required. Due to the compact size and nanometer resolution, V-508 systems also provide excellent performance as delay line stages and in other high stability nanopositioning applications.

How Do Motorized Linear Stages Work?

Linear positioning stages are sometimes also referred to as linear slides and rodless linear actuators. A single-axis motorized linear stage can move a workpiece or sample in one degree of freedom. Its moving platform is guided by a mechanical, magnetic or air bearing system against the stationary base. Motorized linear translation stages provide higher precision than manual stages and are often used to automate industrial processes. Motorized stages come in many different variations - most common drive systems consist of a rotary motor (stepper motor or servo motor) coupled to a drive screw that is connected via a nut to the moving platform. Direct drive linear translation stages replace the rotary motor / screw combination with a noncontact electromagnetic coil (forcer) and magnet track. The lack of friction eliminates wear and allows for higher velocity, acceleration and reliability. For highest precision, a position sensor (usually an optical linear encoder) is integrated in the stage base and moving platform, providing exact position information to a computer programmable motion controller.

For very high force/load applications, screw-driven stages can be advantageous, however at the cost of accuracy and speed.

Why PIMag® Brushless Direct Drive Motors

PI develops proprietary brushless electromagnetic voice-coil and 3-phase motors for applications where a precision positioning system needs to achieve specific performance characteristics that cannot be met by a commercially available motor. Typical examples would be higher force density requirements or ultra-compact designs for space limited environments. The motors developed by PI are identified by the PIMag® brand name and are used in linear motor stages, linear actuators and direct drive rotary tables.

Motion	Unit	Tolerance	V-508.6B2020	V-508.952020	V-508.9B1020
Active axes			X	X	X
Travel range in X	mm		170	250	250
Acceleration in X, unloaded	m/s²	Max.	5	5	5
Maximum velocity in X, unloaded	mm/s		700	700	600
Straightness error in Y (straightness)	µm	Typ.	±10	±20	±20
Straightness error in Z (flatness)	µm	Typ.	±10	±20	±20
Angular error around Y (pitch)	µrad	Typ.	±200	±300	±300
Angular error around Z (yaw)	µrad	Typ.	±200	±300	±300

Positioning	Unit	Tolerance	V-508.6B2020	V-508.952020	V-508.9B1020
Minimum incremental motion in X	µm	Typ.	0.16	0.001	0.16
Bidirectional repeatability in X	µm	Typ.	0.3	0.1	0.3
Reference switch			—	Encoder index	—
Limit switches			—	Hall effect	—
Integrated sensor			Absolute linear encoder	PIOne: Incremental linear encoder	Absolute linear encoder
Sensor signal			BiSS-C	Sin/cos, 1 V peak-peak	BiSS-C
Sensor signal period	µm		—	2	—
Sensor resolution	nm		78	0.2	78

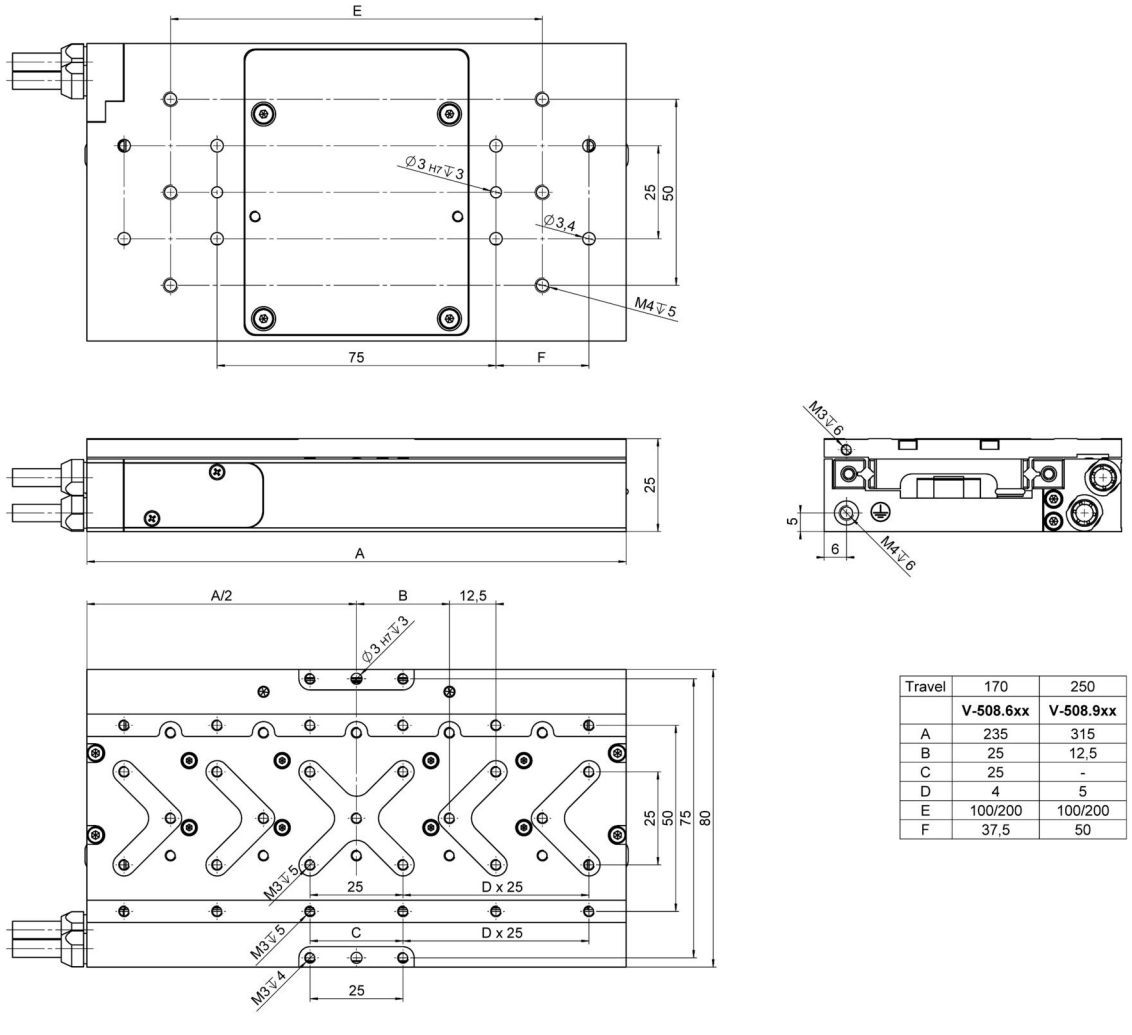
Drive Properties	Unit	Tolerance	V-508.6B2020	V-508.952020	V-508.9B1020
Drive type			Iron core 3-phase linear motor	Iron core 3-phase linear motor	Ironless 3-phase linear motor
Nominal voltage	V		48	48	48
Nominal current, RMS	A	Typ.	1.1	1.1	0.7
Peak current, RMS	A	Typ.	3.2	3.2	3.2
Drive force in X	N	Typ.	5	5	3
Peak force in X	N		14	14	12
Force constant	N/A		4.81	4.81	4.28
Motor constant	N/√W	Typ.	1.67	1.67	1.02
Time constant	ms		0.79	0.79	0.21
Resistance phase-phase	Ω	Typ.	2.46	2.46	5.92
Inductance phase-phase	mH		1.94	1.94	1.26
Back EMF phase-phase	V·s/m	Max.	3.02	3.02	5.36
Pole pitch N-N	mm		18	18	20
Permissible maximum temperature for drive components	°C		80	80	80

Mechanical Properties	Unit	Tolerance	V-508.6B2020	V-508.952020	V-508.9B1020
Permissible push force in Z	N	Max.	100	100	100
Moved mass in X, unloaded	g		600	790	1010
Guide			Crossed roller guide	Crossed roller guide	Crossed roller guide
Overall mass	g		1600	2100	2300
Material			Aluminum, black anodized	Aluminum, black anodized	Aluminum, black anodized

Miscellaneous	Unit		V-508.6B2020	V-508.952020	V-508.9B1020
Operating temperature range	°C		5 to 40	5 to 40	5 to 40
Connector			HD D-sub 26 (m)	HD D-sub 26 (m)	HD D-sub 26 (m)
Sensor connector			D-sub 15 (f)	D-sub 15 (f)	D-sub 15 (f)
Cable length	m		2	2	2
Recommended controllers/ drivers			C-891.130300	C-891.130300	C-891.130300

At PI, technical data is specified at 22 ±3 °C. Unless otherwise stated, the values are for unloaded conditions. Some properties are interdependent. The designation "typ." indicates a statistical average for a property; it does not indicate a guaranteed value for every product supplied. During the final inspection of a product, only selected properties are analyzed, not all. Please note that some product characteristics may deteriorate with increasing operating time.

Drawings / Images



Travel	170	250
	V-508.6xx	**V-508.9xx**
A	235	315
B	25	12,5
C	25	-
D	4	5
E	100/200	100/200
F	37,5	50

V-508 drawing, dimensions in mm

Order Information

V-508.6B2020
PIMag® precision linear stage, 80 mm × 25 mm cross section, 170 mm travel range, 100 N load capacity, absolute encoder, 78 nm sensor resolution, iron core 3-phase linear motor, 48 V

V-508.952020
PIMag® precision linear stage, 80 mm x 25 mm cross section, 250 mm travel range, 100 N load capacity, PIOne linear encoder with sin/cos signal transmission, 2 µm sensor signal period, iron core 3-phase linear motor, 48 V

V-508.9B1020
PIMag® precision linear stage, 80 mm × 25 mm cross section, 250 mm travel range, 100 N load capacity, absolute encoder, 78 nm sensor resolution, ironless 3-phase linear motor, 48 V