

# Compact High-Precision Direct Drive Linear Stage

Ideal for Scanning, Measuring, Imaging, Alignment



## V-141

- 40 mm, 60 mm, and 100 mm travel range
- Very compact footprint
- Direct drive motor for efficient, dynamic performance
- 1 m/s max. velocity
- Crossed-roller bearings for true straightness and flatness
- Direct-measuring incremental encoder for the best accuracy and repeatability

### Product overview

V-141 direct-drive linear stages are designed for accuracy, precision, long life, ease of use, and can be mounted in any orientation. A model with integrated counterbalance is available for vertical operation.

Even though compact, V-141 linear stages offer superior travel accuracy, flatness, and performance compared to bigger stages. With a powerful, non-cogging, direct drive motor, the V-141 linear stage family performs well in production environments. The ultra-precision cross roller bearings are intended to be low maintenance for the life of the stage. The V-141 is designed for XY and XYZ mounting. The Z model comes with a magnetic counterbalance.

### Three phase motors for higher dynamics and friction-free, maintenance-free operation

The three-phase linear motors driving the V-141 stage family transfer their force directly and friction-free to the motion platform. This eliminates backlash and play that can result from mechanical components like gears and screws in the drivetrain. Ideal for high-velocity, high-acceleration applications, these motors feature a maintenance-free, frictionless design, ensuring longevity in demanding 24/7 operations. The controller's current limit settings allow easy motor disablement, preventing damage to the stage or the application.

### Crossed roller bearings improve load capacity, accuracy and lifetime

Crossed roller bearings offer a superior level of smoothness, straightness, and flatness, close to air bearing performance. By replacing the point contact of ball bearings with a line contact, rollers become considerably stiffer, requiring less preload. The resulting reduction in friction enables smoother running and higher accuracy. Crossed roller bearings can also support higher vertical and moment loads. The anti-creep mechanism prevents roller drift, enhancing reliability. Cleanroom grease is applied for low-maintenance operation.

## Order Information

### V-141.040A1

Compact high-precision direct drive linear stage; ironless 3-phase linear motor; 40 mm travel range; 5 kg load capacity; 500 mm/s maximum velocity; incremental linear encoder, 100 nm sensor resolution, sin/cos, 1 V peak-peak

### V-141.040A1Z

Compact high-precision direct drive linear stage for vertical mounting; ironless 3-phase linear motor; 40 mm travel range; 1.5 kg load capacity; 500 mm/s maximum velocity; incremental linear encoder, 100 nm sensor resolution, sin/cos, 1 V peak-peak; magnetic counterbalance

### V-141.060A1

Compact high-precision direct drive linear stage; ironless 3-phase linear motor; 60 mm travel range; 5 kg load capacity; 800 mm/s maximum velocity; incremental linear encoder, 100 nm sensor resolution, sin/cos, 1 V peak-peak

### V-141.100A1

Compact high-precision direct drive linear stage; ironless 3-phase linear motor; 100 mm travel range; 5 kg load capacity; 1000 mm/s maximum velocity; incremental linear encoder, 100 nm sensor resolution, sin/cos, 1 V peak-peak

### Incremental encoder

V-141 stages are equipped with incremental sin/cos linear encoders that measure position with utmost accuracy directly at the motion platform, enhancing linearity and ensuring immunity to mechanical play and elastic deformation which can result from indirect measuring methods. A home signal is built in to initiate the stage.

### Choosing the right precision linear stage and motion controller

Selecting the right linear stage is pivotal for optimal performance in high-precision motion applications, such as semiconductor inspection and photonics alignment. Factors such as resolution, guiding accuracy, and repeatability must be carefully considered. These linear stages offer excellent geometric accuracy (flatness, straightness, pitch, and yaw) along with 0.12  $\mu\text{m}$  bi-directional repeatability in a very compact package. With high dynamic properties, including up to 2 g acceleration and 1 m/sec velocity, these compact motorized stages are ideal for 24/7 automation of highly accurate positioning tasks required for micro-assembly, alignment, or mass production of precision devices. Partnered with PI's A-8xx series motion controllers, these stages achieve unparalleled motion performance. PI's EtherCAT-based controllers offer remarkable flexibility, facilitating the seamless integration of third-party equipment compatible with EtherCAT. Advanced algorithms in the A-8xx series motion controllers, such as PILOT allow for higher dynamics with reduced motor currents, virtually increasing the motor's force constant. Choose the compact V-141 for precision, reliability, and efficiency in your motion applications.

### Accessories and options

- Magnetic counterbalance for vertical use
- Single or multi-axis, ACS motion controllers and servo drives, integrated or distributed
- Cables compatible with ACS-powered controllers of the A-8xx series
- Multi-axis assemblies

### Controllers and cables

A-81x: ACS based controllers (2, 4 axis models, various configurations) for medium power requirements

A-82x: ACS based controllers (4, 6, 8 axis models, various configurations) for high power requirements

A-851.VA03: Cable set, V-xxx to A-8xx controllers, sin/cos encoder signals, 3 m length

### Application fields

Precision micro-assembly. Research. Biotechnology. General Automation. Device assembly. Laser Micro-processing. Pick and place. Photonics Alignment and Assembly.

Motion	Unit	Tolerance	V-141.040A1	V-141.040A1Z	V-141.060A1	V-141.100A1
Active axes			X	Z	X	X
Travel range in X	mm		40	—	60	100
Travel range in Z	mm		—	40	—	—
Acceleration in X, unloaded	m/s <sup>2</sup>	Max.	20	—	20	20
Acceleration in Z, unloaded	m/s <sup>2</sup>	Max.	—	20	—	—
Maximum velocity in X, unloaded	mm/s		500	—	800	1000
Maximum velocity in Z, unloaded	mm/s		—	500	—	—
Straightness error E <sub>XZ</sub>	$\mu\text{m}$	Typ.	—	$\pm 2$	—	—
Straightness error in Y (straightness)	$\mu\text{m}$	Typ.	$\pm 2$	—	$\pm 3$	$\pm 4$
Straightness error E <sub>YZ</sub>	$\mu\text{m}$	Typ.	—	$\pm 3$	—	—
Straightness error in Z (flatness)	$\mu\text{m}$	Typ.	$\pm 3$	—	$\pm 4$	$\pm 5$
Angular error E <sub>AZ</sub>	$\mu\text{rad}$	Typ.	—	$\pm 150$	—	—
Angular error around Y (pitch)	$\mu\text{rad}$	Typ.	$\pm 150$	—	$\pm 175$	$\pm 200$
Angular error E <sub>BZ</sub>	$\mu\text{rad}$	Typ.	—	$\pm 150$	—	—
Angular error around Z (yaw)	$\mu\text{rad}$	Typ.	$\pm 150$	—	$\pm 175$	$\pm 200$
Angular error E <sub>CZ</sub>	$\mu\text{rad}$	Typ.	—	$\pm 150$	—	—

Positioning	Unit	Tolerance	V-141.040A1	V-141.040A1Z	V-141.060A1	V-141.100A1
Positioning accuracy in X, calibrated	$\mu\text{m}$	Typ.	$\pm 2$	—	$\pm 2.5$	$\pm 3$
Positioning accuracy in Z, calibrated	$\mu\text{m}$	Typ.	—	$\pm 2$	—	—
Bidirectional repeatability in X	$\mu\text{m}$	Max.	0.12	—	0.12	0.12
Bidirectional repeatability in Z	$\mu\text{m}$	Max.	—	0.12	—	—
Integrated sensor			Incremental linear encoder	Incremental linear encoder	Incremental linear encoder	Incremental linear encoder
Sensor signal			Sin/cos, 1 V peak-peak	Sin/cos, 1 V peak-peak	Sin/cos, 1 V peak-peak	Sin/cos, 1 V peak-peak
Sensor resolution	nm		100	100	100	100

Drive Properties	Unit	Tolerance	V-141.040A1	V-141.040A1Z	V-141.060A1	V-141.100A1
Drive type			Ironless 3-phase linear motor	Ironless 3-phase linear motor	Ironless 3-phase linear motor	Ironless 3-phase linear motor
Operating voltage	V		48 bis 80	48 bis 80	48 bis 80	48 bis 80
Nominal current, RMS	A	Typ.	1.8	1.8	1.8	1.8
Peak current, RMS	A	Typ.	5	5	5	5
Drive force in X	N	Typ.	8	—	8	16
Drive force in Z	N	Typ.	—	8	—	—
Peak force in X	N		22	—	22	45
Peak force in Z	N		—	22	—	—
Force constant	N/A		4.5	4.5	4.5	9
Resistance phase-phase	$\Omega$	Typ.	4	4	4	10
Inductance phase-phase	mH		0.6	0.6	0.6	1.4
Back EMF phase-phase	V·s/m	Max.	4.5	4.5	4.5	9
Magnet pitch	mm		19.05	19.05	19.05	19.05

Mechanical Properties	Unit		V-141.040A1	V-141.040A1Z	V-141.060A1	V-141.100A1
Maximum load capacity, horizontal orientation	kg		5	—	5	5
Maximum load capacity, vertical orientation	kg		—	1.5	—	—
Moved mass in X, unloaded	g		320	—	450	650
Moved mass in Z, unloaded	g		—	320	—	—
Bearing type			Crossed roller bearings	Crossed roller bearings	Crossed roller bearings	Crossed roller bearings
Overall mass	g		600	600	800	1100
Material			Aluminum	Aluminum	Aluminum	Aluminum

Miscellaneous	Unit		V-141.040A1	V-141.040A1Z	V-141.060A1	V-141.100A1
Operating temperature range	°C		5 to 50	5 to 50	5 to 50	5 to 50
Connector			D-sub 15 (m)	D-sub 15 (m)	D-sub 15 (m)	D-sub 15 (m)
Recommended controllers/drivers			A-81x, A-82x	A-81x, A-82x	A-81x, A-82x	A-81x, A-82x

Note on straightness and angular errors: Dependent on the quality of the mounting surface, the payload, orientation, and external forces that act on the stage. Please contact PI for application-specific parameters. The specified values are static (no rotary motion during measuring) and without load.

Note on positioning accuracy: The specified values are without error compensation. The positioner must be ordered with a controller from PI to reach better accuracy values, usually 2-3 times the repeatability values. Accuracy values assume short-term duration and do not consider the long-term effects of thermal drift on the stage.

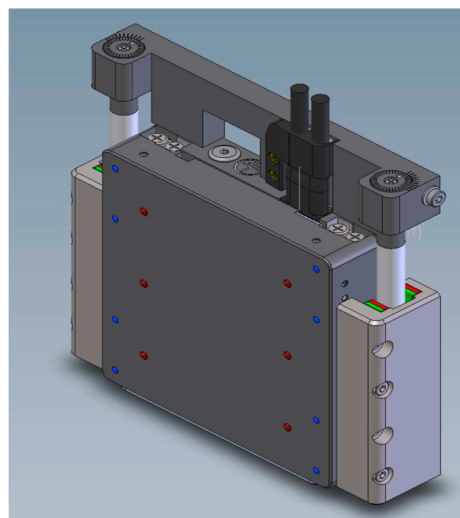
Note on velocity, acceleration, and permissible push force in Z: Can be limited by imbalance of the payload or the controller and the drive.

Note on the velocity of V-141.100A1: To reach the maximum velocity an operating voltage of at least 72 V is required.

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.

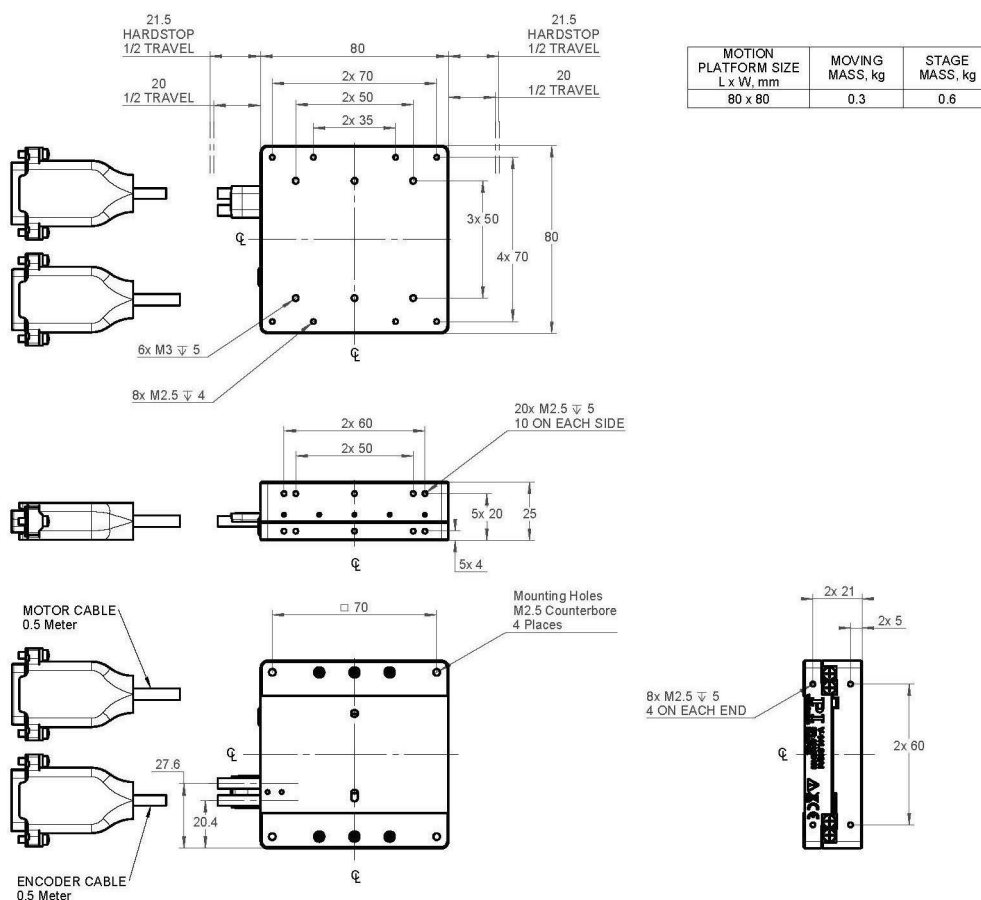


V-141 XY assembly

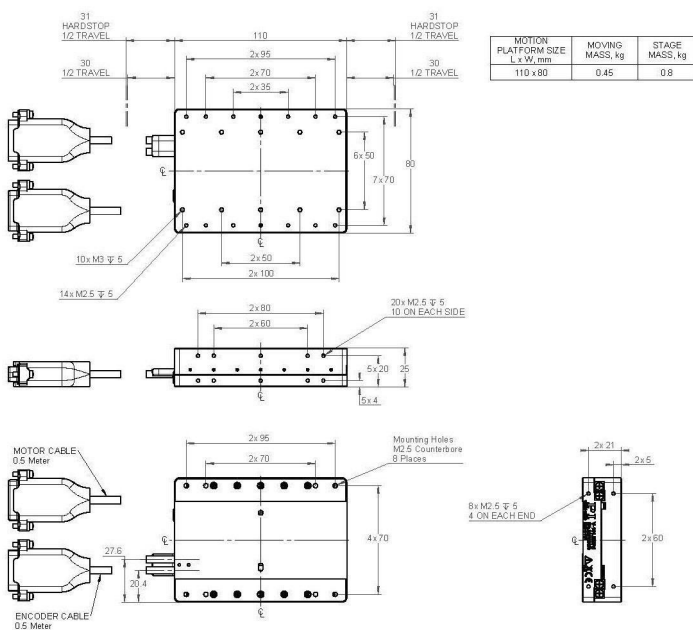


V-141.040A1Z, Z stage with integrated magnetic counter balance

## Drawings / Images

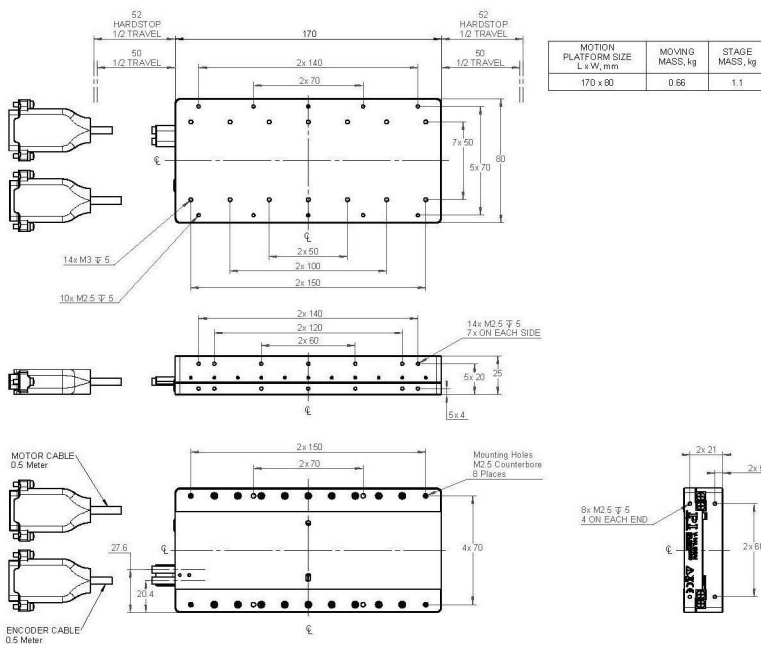


V-141.040A1, dimensions in mm



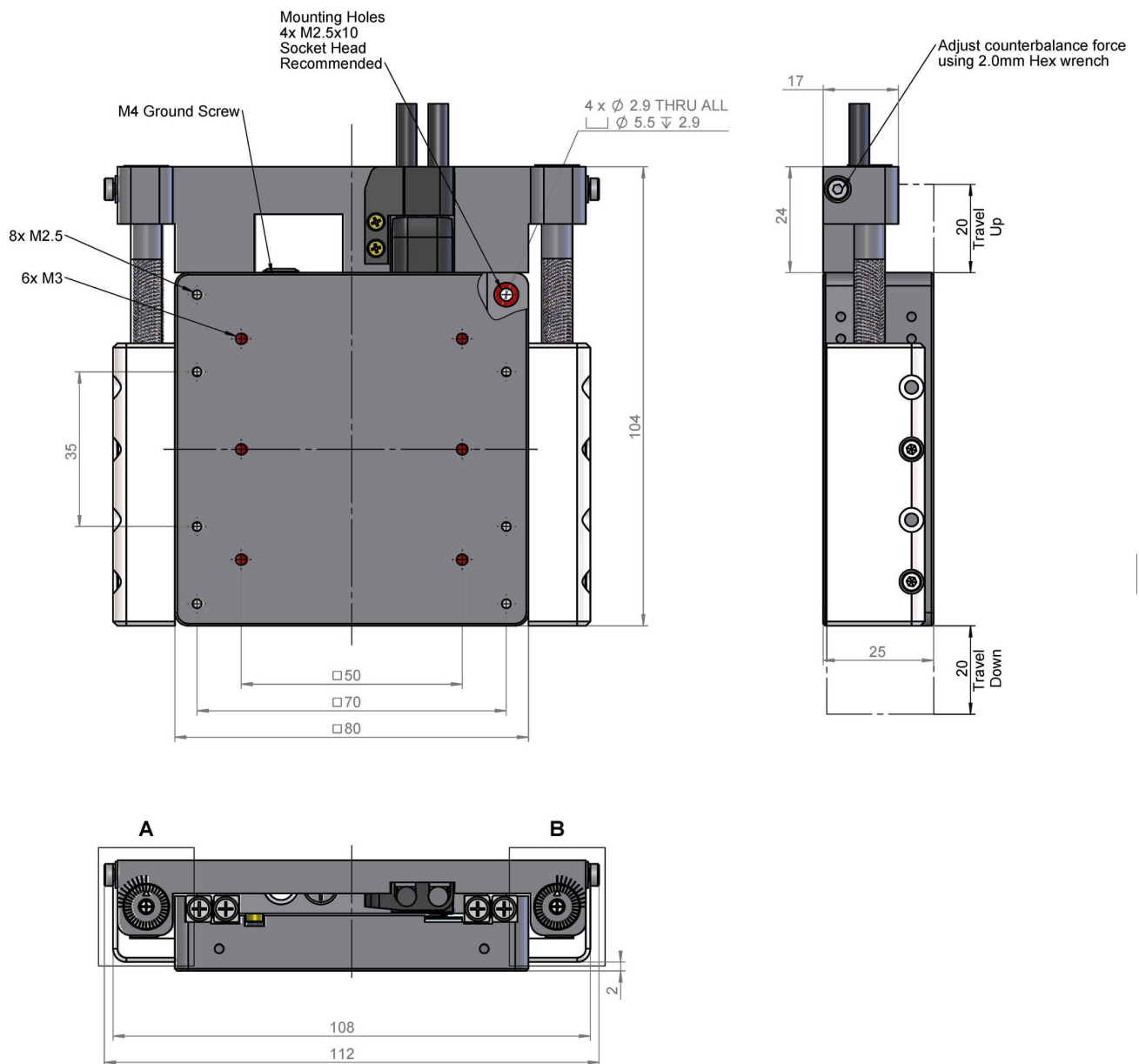
V-141.060A1, dimensions in mm

## Drawings / Images



V-141.100A1, dimensions in mm

## Drawings / Images



V-141.040A1Z, dimensions in mm