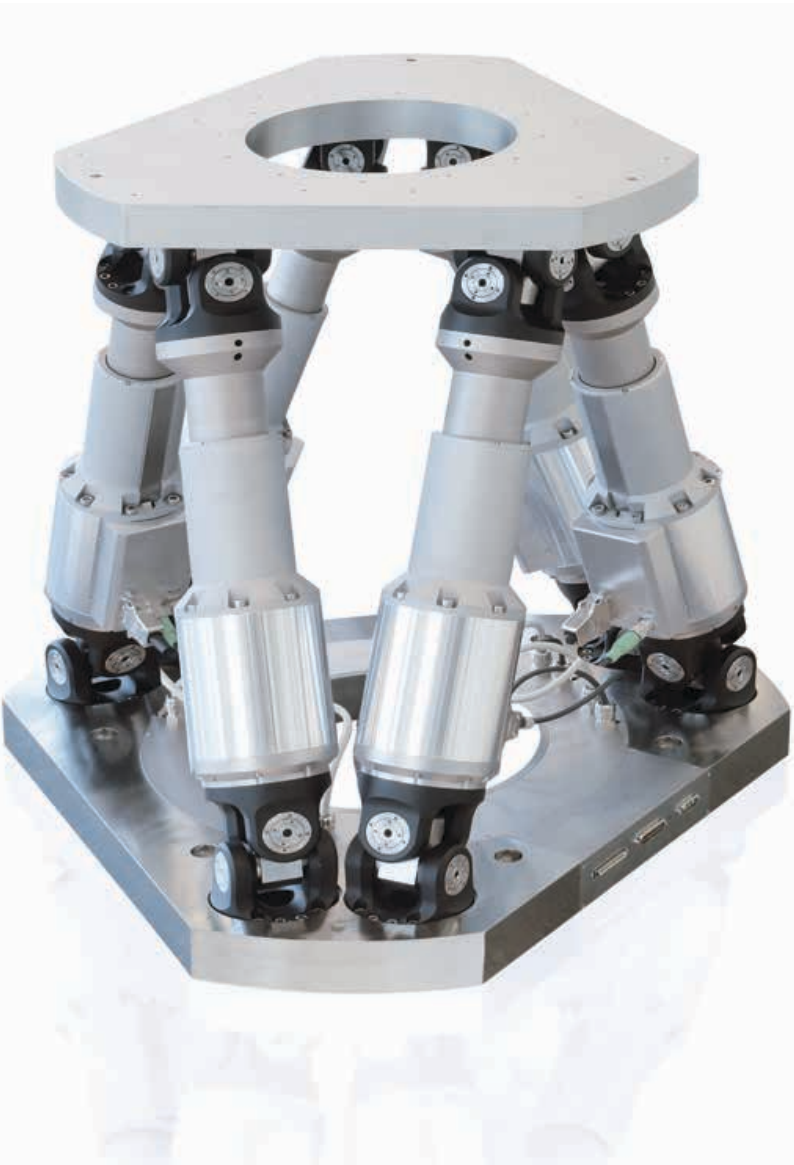


## High-Load Hexapod

POSITIONING 1 TON WITH MICROMETER PRECISION



### H-845

- Load capacity to 1000 kg
- Velocity to 20 mm/s
- Repeatability to  $\pm 2 \mu\text{m}$
- Travel ranges to 220 mm / 60°
- Scalable design: Dimensions, travel ranges and loads

#### Reference-class 6-axis positioning system

Parallel-kinematic design for six degrees of freedom making it significantly more compact and stiff than serial-kinematic systems, higher dynamic range, no moved cables: Higher reliability, reduced friction. Large clear aperture. Brushless DC motors with brakes

#### Rapid implementation of customer requests

The high-load Hexapod has a modular structure and uses a set of different modules for motor/drive unit and joint. The platforms can be adapted to the customer's application. This allows for rapid implementation of special customer requirements

#### Powerful digital controller, open software architecture

6D vector motion controller for Hexapods, incl. two additional servo axes. Arbitrary, stable pivot point, software-selectable. Positions commanded in Cartesian coordinates. Macro command language. Open-source LabVIEW driver and libraries. Determination of the workspace. Virtual machine for Hexapod emulation. Optional: Software for avoiding collisions in restricted workspace

#### Fields of application

Research and industry. For astronomy, aviation and aerospace



## 500 kg High-Load Hexapod

HIGH-PRECISION AND REPEATABLE POSITIONING



### H-850KMLD

- Min. incremental motion 1  $\mu\text{m}$  (X, Y), 0.5  $\mu\text{m}$  (Z)
- Travel ranges to 100 mm / 60°
- Optionally with absolute encoders

#### Reference-class 6-axis positioning system

Parallel-kinematic design for six degrees of freedom making it significantly more compact and stiff than serial-kinematic systems, higher dynamic range, no moved cables: Higher reliability, reduced friction. Large clear aperture

#### Optional feature: Absolute position measurement

Optionally, the position is measured using absolute encoders. The exact position of the axes is determined after the Hexapod has been switched on. A reference move is not necessary

#### Powerful digital controller, open software architecture

6D vector motion controller for Hexapods, plus two additional servo axes. Arbitrary, stable pivot point,

software-selectable. Positions commanded in Cartesian coordinates. Macro command language. Open-source LabVIEW driver and libraries. Determination of the workspace. Virtual machine for Hexapod emulation. Optional: Software for avoiding collisions in restricted workspace

#### Fields of application

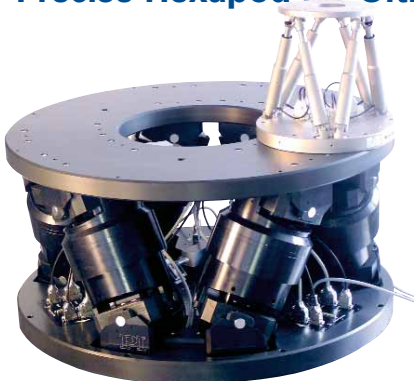
Research and industry. For astronomy, aviation and aerospace

#### Related products

H-850 6-Axis Hexapod  
H-845 High-Load Hexapod

## M-850K Ultra-High-Load Hexapod, 1 Ton

### Precise Hexapod for Ultra-High Loads up to 1 Ton



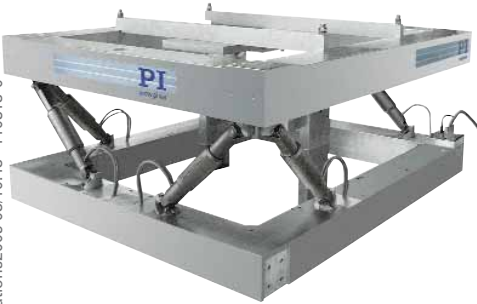
The vacuum compatible Hexapod M-850KHLH provides six degrees of freedom for loads up to 1 t, here with a standard M-840 hexapod for size comparison

- Six Degrees of Freedom
- Max. Load Capacity to 1000 kg
- Repeatability to 2  $\mu\text{m}$
- Drive: Brushless Motors with Brake
- Vacuum Compatible up to  $10^{-6}$  hPa

Model	Travel range X / Y / Z	Rotation range $\theta_x / \theta_y / \theta_z$	Max. velocity X/Y/Z	Dimensions
M-850KHLH	$\pm 12$ mm	$\pm 3^\circ / \pm 3^\circ / \pm 4^\circ$	0.5 mm/s	$\varnothing$ outside 1 m height 0.5 m

## M-850K Large-Aperture High-Load Hexapod, 200 kg

### 6-Axis Precision Positioning & Alignment System for Inspection Systems



Dimensions of 100 x 84 x 40 cm and a load capacity of up to 200 kg makes this custom Hexapod system suitable for all kinds of fine-positioning tasks, as in TV-screen inspection

- 200 kg Load Capacity (Vertical)
- Very Large Aperture (640 x 820 mm)
- Six Degrees of Freedom
- No Moving Cables for Improved Reliability and Precision
- Parallel-Kinematics Design—Significantly Smaller and Stiffer than Serial-Kinematics Systems, Better Dynamics
- Virtual Pivot Point
- Sophisticated Controller Using Vector Algorithms Included

Model	Max. load base-plate horizontal optional)	Travel range X / Z / Z	Travel range $\theta_x / \theta_y / \theta_z$	Typ. velocity	Dimensions
M-850KLAH Large Hexapod	200 / 50 kg	$\pm 25$ mm	$\pm 5^\circ$	2 mm/s lin. 25 mrad/s rot.	100 x 84 x 40 cm

## M-850K Ultra-High Load Hexapod

### 6-Axes, Long Travel, Micron Precision, 1 Ton in Any Orientation



This custom parallel-kinematics system positions loads up to one ton in any orientation with micron accuracy

- Load Capacity to 1000 kg in Any Orientation
- Six Degrees of Freedom
- Travel Ranges to  $\pm 200$  mm, to  $\pm 20^\circ$
- Resolution to 0.8  $\mu\text{m}$ , to 0.5  $\mu\text{rad}$
- Drive: Brushless Motors with Brake
- Sophisticated Controller Using Vector Algorithms

Model	Travel ranges	Push/pull force	Max. velocity	Unidirectional Repeatability	Dimensions
M-850KHTH High-Load Hexapod with Long Travel Range	$\pm 200$ mm (X, Y), $\pm 100$ mm (Z), $\pm 20^\circ$ ( $\theta_x, \theta_y$ ), $\pm 5^\circ$ ( $\theta_z$ )	10,000 N	1 mm/s	$\pm 1$ $\mu\text{m}$ ; $\pm 3$ $\mu\text{rad}$	Baseplate: 900 mm $\varnothing$ Upper platform: 800 mm $\varnothing$ height 714 mm aperture: $\varnothing$ 500 mm

# M-850 Hexapod 6-Axis Parallel Positioning System, 200 kg High-Load Parallel-Kinematics Micropositioner with Controller, to 2000 N



M-850 Hexapod Microrobot

- Six Degrees of Freedom
- Works in Any Orientation
- No Moving Cables for Improved Reliability and Precision
- 200 kg Load Capacity (Vertical)
- Heavy-Duty, Ultra-High-Resolution Bearings for 24/7 Applications
- Repeatability to  $\pm 1 \mu\text{m}$
- Encoder Resolution to 0.005  $\mu\text{m}$
- Significantly Smaller and Stiffer than Serial-Kinematics Systems, Better Dynamics
- Vacuum-Compatible Versions Available
- Linear and Rotary Multi-Axis Scans
- Virtual Pivot Point
- Sophisticated Controller Using Vector Algorithms
- MTBF 20,000 h

## Application Examples

- Alignment of secondary mirrors
- Semiconductor technology
- Optics alignment
- Medical technology
- Micromachining
- Micromanipulation
- X-ray diffraction measurements
- Satellite testing equipment
- Tool control

The M-850 is the ideal micropositioning system for all complex positioning tasks which depend upon high load capacity and accuracy in six independent axes. The use of extremely stiff and accurate components for the M-850 Hexapod results in an unusually high natural frequency of 500 Hz with a 10 kg load. It can withstand loads of 200 kg vertically, and at least 50 kg in any direction. In addition to positioning all axes with resolutions in the submicron and arc-second ranges, it allows the user to define the center of

rotation (pivot point) anywhere inside or outside the system envelope by one simple software command.

Two models are available: The M-850.50 featuring higher speed and direct-drive actuators, and the M-850.11 with a gear ratio that makes it self-locking even with large loads.

## Hexapod vs. Serial Kinematics Systems

The Hexapod is driven by six high-resolution actuators all connected directly to the same moving platform. This design provides a high system stiffness and a large clear aperture.

Because of the low mass of the moving platform, positioning operations can be performed with far lower settling times than with conventional, stacked multi-axis systems. In such systems, runout, guiding errors, and the friction and inertia of moving cables all accumulate to limit accuracy and repeatability—problems which do not affect parallel kinematic systems like the Hexapod.

## Fixed Virtual Pivot Point

For optics and other alignment tasks, it is important to be able to define a fixed pivot point. The sophisticated Hexapod controller allows choosing any point in space as the pivot point for the rotation axes by software command. The pivot point remains fixed relative to the platform.

Target positions in 6-space are entered in user-friendly coordinates and reached by smooth vectorized motion.

## Open Architecture

Control of the hexapod is facilitated by the controller's open interface architecture, which

## Ordering Information

**M-850.11**  
Hexapod Microrobot with Controller, DC-Motor w/ Gearhead

**M-850.V11**  
Hexapod Microrobot with Controller, DC-Motor w/ Gearhead, Vacuum Compatible to  $10^{-6}$  hPa

**M-850.50**  
Hexapod Microrobot with Controller, Direct Drive

**M-850.V50**  
Hexapod Microrobot with Controller, Direct Drive, Vacuum Compatible to  $10^{-6}$  hPa

## Optional Photometers

**F-206.iiU**  
Photometer Card, IR Range, 2 Channels

**F-206.VVU**  
Photometer Card, Visual Range, 2 Channels



The Hexapod comes with a powerful 6D controller and sophisticated, user-friendly positioning and alignment software. Keypad and display are optional

provides a variety of high-level commands and includes a macro language for programming and storing command sequences.

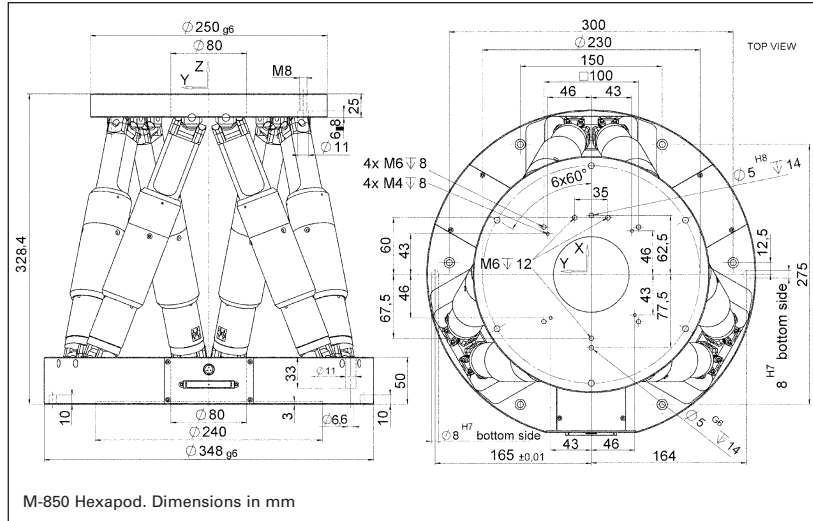
## Automatic Optical Alignment

With the internal or external photometer option and the integrated scanning routines, just a few commands are needed to perform an automated alignment of optical components. For more information on photometers / optical power meters, see [www.pi.ws](http://www.pi.ws).

A smaller, even-more-precise hexapod, specially developed for alignment of collimators, fiber bundles and I/O chips, is available as the F-206 (see p. 4-12).



Custom Hexapod designed for neurosurgery Photo: IPA



Custom "6+3" Hexapod with additional struts providing independent position feedback

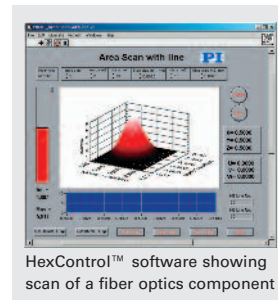
### Technical Data

Model	M-850.11	M-850.50	Units
Active axes	X, Y, Z, $\theta_x$ , $\theta_y$ , $\theta_z$	X, Y, Z, $\theta_x$ , $\theta_y$ , $\theta_z$	
<b>Motion and positioning</b>			
*Travel range X, Y	$\pm 50$	$\pm 50$	mm
*Travel range Z	$\pm 25$	$\pm 25$	mm
*Travel range $\theta_x$ , $\theta_y$	$\pm 15$	$\pm 15$	°
*Travel range $\theta_z$	$\pm 30$	$\pm 30$	°
Actuator drive	DC-motor	DC-motor	
Actuator stroke	$\pm 25$	$\pm 25$	mm
Integrated sensor	Rotary encoder	Rotary encoder	
Sensor resolution	2048	2048	
Actuator design resolution	0.005	0.05	$\mu\text{m}$
**Min. incremental motion X, Y, Z	1 (XY), 0.5 (Z)	1 (XY), 0.5 (Z)	$\mu\text{m}$ (6-axis move!)
**Min. incremental motion $\theta_x$ , $\theta_y$ , $\theta_z$	5	5	$\mu\text{rad}$ (6-axis move!)
Repeatability X, Y	$\pm 2$	$\pm 2$	$\mu\text{m}$
Repeatability Z	$\pm 1$	$\pm 1$	$\mu\text{m}$
Repeatability $\theta_x$ , $\theta_y$ , $\theta_z$	$\pm 10$	$\pm 10$	$\mu\text{rad}$
Max. velocity X, Y, Z	0.5	8	mm/s
Max. velocity $\theta_x$ , $\theta_y$ , $\theta_z$	6	100	mrad/s
Typ. velocity X, Y, Z	0.3	5	mm/s
Typ. velocity $\theta_x$ , $\theta_y$ , $\theta_z$	3	50	mrad/s
<b>Mechanical properties</b>			
Stiffness ( $k_x$ , $k_y$ )	3	3	N/ $\mu\text{m}$
Stiffness ( $k_z$ )	100	100	N/ $\mu\text{m}$
Max. load (baseplate horizontal/any orientation)	200 / 50	200 / 50	kg
Max. holding force (baseplate horizontal/any orientation)	2000 / 500	250 / 85	N
Resonant frequency*** $F_x, F_y$	90	90	Hz
Resonant frequency*** $F_z$	500	500	Hz
<b>Miscellaneous</b>			
Operating temperature range	-10 to +50	-10 to +50	°C
Material	Aluminum	Aluminum	
Mass	17	17	kg
<b>Controller</b>			
Controller included	M-850.502	M-850.502	
Operating voltage	100–240 VAC, 50/60 Hz	100–240 VAC, 50/60 Hz	

Technical data are specified at 20  $\pm 3$  °C. Data for vacuum versions may differ.



Custom water-resistant Hexapod



HexControl™ software showing scan of a fiber optics component

\*The max. travel of the several coordinates (X, Y, Z,  $\theta_x$ ,  $\theta_y$ ,  $\theta_z$ ) are interdependent. The data for each axis in this table shows its maximum travel, where all other axes are at their zero positions. If the other linear or rotational coordinates are not zero, the available travel may be less.

\*\*Six-axis move. No moving cables (unlike serial-kinematic stacked systems) to introduce bending forces, torque and friction which degrade positioning accuracy.

Example: The following position is in the workspace:  
 X: +20 mm  $\theta_x$ : +10°  
 Y: +20 mm  $\theta_y$ : +10°  
 Z: +5 mm  $\theta_z$ : -2°

\*\*\*Baseplate mounted horizontally with 10 kg load

# N-515K Non-Magnetic Piezo Hexapod

## 6-Axis Precision Positioning System with NEXLINE® Linear Drives



- Travel Ranges 10 mm Linear, 6° Rotation
- Large Clear Aperture Ø 202 mm
- Non-Magnetic
- Nanometer Resolution
- Low-Profile: 140 mm Height Only
- Parallel Kinematics for Enhanced Dynamics and Better Multi-Axis Accuracy
- Up to 500 N Force Generation
- Self Locking at Rest, No Heat Generation

6-axis parallel kinematics (Hexapod) with integrated N-215 NEXLINE® high-load actuators, suitable for applications in strong magnetic fields

## More Hexapods: <http://www.hexapods.net>



### Program Overview

- Piezo Ceramic Actuators & Motors
- Piezo Nanopositioning Systems and Scanners
- Active Optics / Tip-Tilt Platforms
- Capacitive Nanometrology Sensors
- Piezo Electronics: Amplifiers and Controllers
- Hexapod 6-Axis Positioners / Robots
- Micropositioning Stages & Actuators
- Photonics Alignment Systems, Solutions for Telecommunications
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### Request or download the complete PI Nanopositioning & Piezo Actuator Catalog



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