M-850 Hexapod 6-Axis Positioning System

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 ±1 µm**
- **Encoder Resolution to 0.005 µm**
- **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 arcsecond 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 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.

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).

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

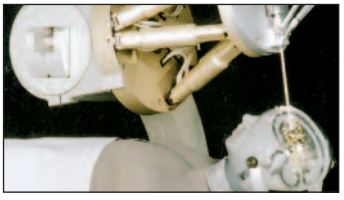
M-850.50
Hexapod Microrobot with Controller, Direct Drive

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

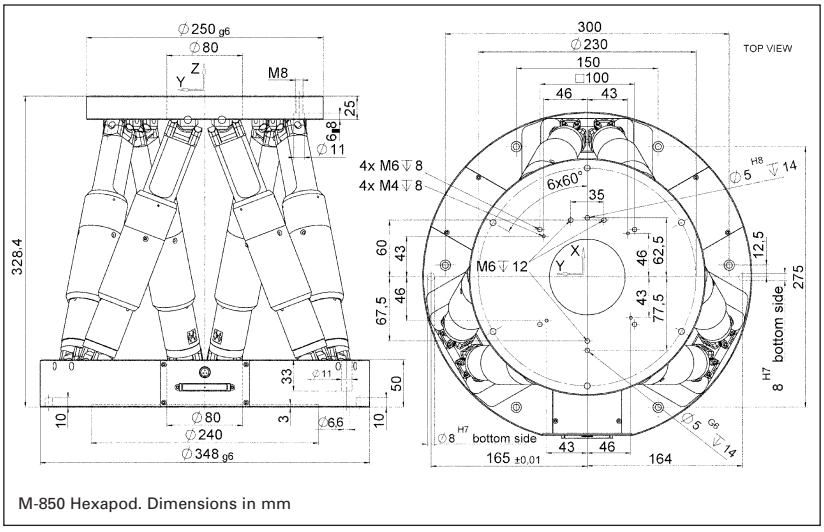
Optional Photometers

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

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


Custom Hexapod designed for neurosurgery Photo: IPA

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



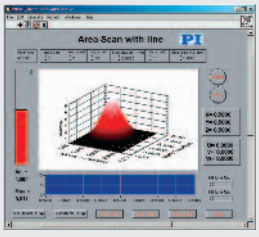
M-850 Hexapod. Dimensions in mm

Technical Data

Model	M-850.11	M-850.50	Units
Active axes	X, Y, Z, θ_X, θ_Y, θ_Z	X, Y, Z, θ_X, θ_Y, θ_Z	
Motion and positioning			
*Travel range X, Y	±50	±50	mm
*Travel range Z	±25	±25	mm
*Travel range θ_X, θ_Y	±15	±15	°
*Travel range θ_Z	±30	±30	°
Actuator drive	DC-motor	DC-motor	
Actuator stroke	±25	±25	mm
Integrated sensor	Rotary encoder	Rotary encoder	
Sensor resolution	2048	2048	
Actuator design resolution	0.005	0.05	µm
**Min. incremental motion X, Y, Z	1 (XY), 0.5 (Z)	1 (XY), 0.5 (Z)	µm (6-axis move!)
**Min. incremental motion θ_X, θ_Y, θ_Z	5	5	µrad (6-axis move!)
Repeatability X, Y	±2	±2	µm
Repeatability Z	±1	±1	µm
Repeatability θ_X, θ_Y, θ_Z	±10	±10	µrad
Max. velocity X, Y, Z	0.5	8	mm/s
Max. velocity θ_X, θ_Y, θ_Z	6	100	mrad/s
Typ. velocity X, Y, Z	0.3	5	mm/s
Typ. velocity θ_X, θ_Y, θ_Z	3	50	mrad/s
Mechanical properties			
Stiffness (k_x, k_y)	3	3	N/µm
Stiffness (k_z)	100	100	N/µm
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
Miscellaneous			
Operating temperature range	-10 to +50	-10 to +50	°C
Material	Aluminum	Aluminum	
Mass	17	17	kg
Controller			
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 ±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, θ_X, θ_Y, θ_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 θ_X : +10°
Y: +20 mm θ_Y : +10°
Z: +5 mm θ_Z : -2°

***Baseplate mounted horizontally with 10 kg load