



HEXAPODS



A hexapod is a robotic manipulator capable of moving a payload in all six degrees of freedom: lateral, longitudinal, and vertical translations as well as roll, pitch, and yaw rotations. Motions can be made simultaneously in multiple axes or independently in a single axis while preventing movement in the others. A hexapod's parallel actuator arrangement provides high load capacity, stiffness, and accuracy compared to serial robotic manipulator architectures.

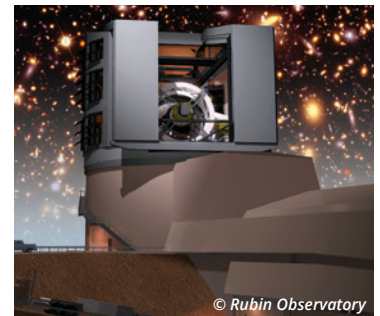
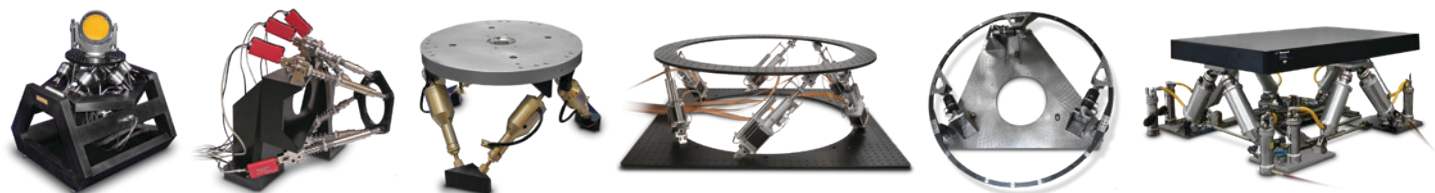
Other motion control devices typically provide positioning, motion simulation, or vibration isolation in only one or two degrees of freedom making hexapods the ideal solution when multiple degrees of freedom motion is required.

THREE PRIMARY CATEGORIES OF HEXAPODS

- Precision Positioning
- Motion Simulation
- Vibration Isolation

CUSTOM HEXAPODS

Sometimes the hexapod needs to match the application rather than trying to make the application match the hexapod. We are able and willing to modify our standard hexapods to meet specific customer requirements including extreme environments. For unique applications, we also build custom hexapods that leverage off our heritage designs. If you cannot find a standard hexapod that meets your needs, please contact our engineering team to discuss.



PRECISION POSITIONING HEXAPODS

Precision positioning hexapods are used for point-and-hold or slow tracking operation where minimum incremental step size, repeatability, and/or accuracy are critical. The HX-P400 incorporates flexure end-joints and absolute linear encoders on each actuator to optimize repeatability and accuracy. The HX-P500 is vacuum-compatible and uses preloaded bearing end-joints to accommodate a relatively large range of motion. Both systems are designed for stiffness to achieve high resonant frequencies and fast settling times. Customization is commonly done to meet program-specific requirements.

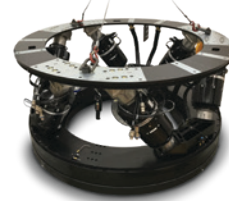
APPLICATIONS

- Alignment of telescope optics
- Testing of precision optical systems
- Beam/laser pointing

PERFORMANCE CHARACTERISTICS

Features

HX-P400



HX-P500



	HX-P400	HX-P500
Payload mass	Up to 8000 kg	Up to 8000 kg
Dimensions ¹	1650 mm D x 720 mm H	2000 mm L x 2000 mm W x 810 mm H
Hexapod mass	625 kg	684 kg
Range of motion ²	X (lateral)	±20 mm
	Y (longitudinal)	±20 mm
	Z (vertical)	±15 mm
	Roll	±1.2°
	Pitch	±1.2°
	Yaw	±0.5°
Minimum incremental step size	X (lateral)	1 µm
	Y (longitudinal)	1 µm
	Z (vertical)	1 µm
	Roll	<1 µrad
	Pitch	<1 µrad
	Yaw	1 µrad
Repeatability (bidirectional) ³	X (lateral)	10 µm
	Y (longitudinal)	10 µm
	Z (vertical)	3 µm
	Roll	3 µrad
	Pitch	3 µrad
	Yaw	10 µrad
Actuation type	Brushless motor-driven roller screw	Brushless motor-driven roller screw
Sensor type	Absolute linear encoder	Rotary encoder
End-joint type	Flexures	Preloaded Bearings
Vacuum-compatibility	w/ customization	Yes
Heritage usage	Rubin Observatory/Large Synoptic Survey Telescope (LSST)	James Webb Space Telescope testing

1. Envelope dimensions and interfaces are typically customized to meet program-specific requirements

2. The ranges of motion of the six axes are interdependent. Listed values represent the maximum range with all other axes at their zero positions and the center of rotation at the center of the payload interface.

3. Unidirectional repeatability is typically 3X-5X smaller than bidirectional repeatability.

MOTION SIMULATION HEXAPODS

Motion simulation hexapods are used for high frequency motion replication and disturbance generation. Our systems use voice coil actuators to provide large accelerations and high bandwidths. The HX-M300 and HX-M350 have similar designs and architectures. The HX-M300 is more compact while the HX-M350 can accommodate larger payloads. Custom control system tuning can be used to address unique requirements.

APPLICATIONS

- Hardware-in-the-loop simulation
- Missile tracker simulation
- Simultaneous multi-axis vibration testing
- Disturbance simulation for cryocoolers, stepper motors, etc.
- Fatigue testing

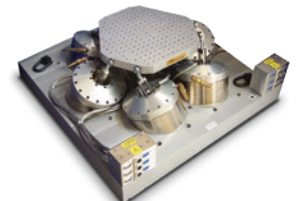
PERFORMANCE CHARACTERISTICS

Features

HX-M300



HX-M350



	HX-M300	HX-M350
Payload mass	Up to 50 kg	Up to 180 kg
Dimensions	564 mm D x 330 mm H	914 mm L x 914 mm W x 330 mm H
Range of motion ¹	X (lateral)	±15 mm
	Y (longitudinal)	±15 mm
	Z (vertical)	±10.5 mm
	Roll	±2.3°
	Pitch	±2.3°
	Yaw	±4.8°
Minimum incremental step size	X (lateral)	1 µm
	Y (longitudinal)	1 µm
	Z (vertical)	0.5 µm
	Roll	5 µrad
	Pitch	5 µrad
	Yaw	7 µrad
Disturbance frequencies ²	>500 Hz	>500 Hz
Electrical power	Standby	350 W
	Peak	1500 W
Actuation type	Voice coil	Voice coil
Sensor type	Linear encoder	Linear encoder

1. The ranges of motion of the six axes are interdependent. Listed values represent the maximum range with all other axes at their zero positions and the center of rotation at the center of the payload interface.

2. Closed-loop bandwidth depends on the axis and payload mass.

VIBRATION ISOLATION HEXAPODS

Vibration isolation hexapods are used to isolate a payload from a base disturbance source or isolate the base structure from a payload-induced disturbance. The HX-V500 is effectively a passive system using only pneumatics. Its suspension modes are clustered tightly together and payload translations and rotations are uncoupled for optimal isolation performance. The HX-MV500 includes hybrid pneumatic/voice coil actuators which allow it to also function as a jitter disturbance simulator for cryocoolers and stepper motors.

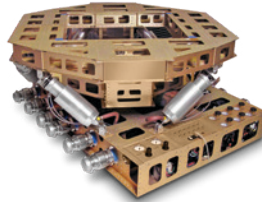
APPLICATIONS

- Camera image stabilization
- Weapons stabilization
- Optical jitter isolation
- Isolation of the base from noisy payloads such as rotating machinery
- Isolation of sensitive measurement equipment
- Protection of fragile items during shipping

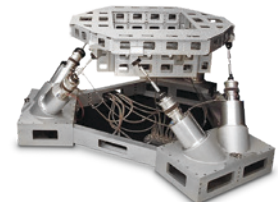
PERFORMANCE CHARACTERISTICS

Features

HX-V500



HX-MV500



Payload mass		Up to 225 kg	Up to 180 kg
Dimension (diameter x height)		1675 mm x 600 mm	2100 mm x 1000 mm
Range of motion ¹	X (lateral)	±25 mm	±25 mm
	Y (longitudinal)	±25 mm	±30 mm
	Z (vertical)	±20 mm	±15 mm
	Roll	±2°	±2.5°
	Pitch	±2°	±2.5°
	Yaw	±4°	±6°
Bandwidth		NA	40 Hz
Suspension frequency		< 3.3 Hz	< 5 Hz
Test payload mass		90 kg	90 kg
Electrical power	Standby	50 W	200 W
	Peak	50 W	1500 W
Actuation type		Pneumatic	Pneumatic and voice coil

1. The ranges of motion of the six axes are interdependent. Listed values represent the maximum range with all other axes at their zero positions and the center of rotation at the center of the payload interface.

MOOG
SPACE AND DEFENSE GROUP

Paul Zamprelli
pzamprelli2@moog.com
www.moog.com/space



Moog Space and Defense



@MoogSDG



@MoogSDG



@MoogSDG

Equipment described herein falls under the jurisdiction of the ITAR and requires US Government Authorization for export purposes. Diversion contrary to US law is prohibited.

©2023 Moog, Inc. All rights reserved.

Product and company names listed are trademarks or trade names of their respective companies.