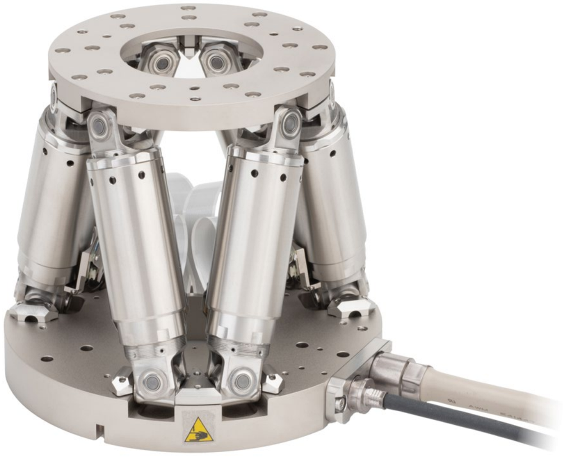
MS235E

H-811 Miniature Hexapod

User Manual

Version: 4.0.0 Date: 03.02.2025



This document describes the following products:

- **H-811.I2**
  Miniature hexapod, BLDC motor, 5 kg payload, 20 mm/s max. velocity
- **H-811.I2V**
  Miniature hexapod, vacuum compatible up to 10^{-6} hPa, BLDC motor, 5 kg payload, 10 mm/s max. velocity
- **H-811.F2**
  Miniature hexapod for optical alignment, removable magnetic plate, BLDC motor, 5 kg payload, 20 mm/s max. velocity
- **H-811.S2**
  Motion hexapod for highly dynamic applications, direct drive, 2.5 kg payload, 25 mm/s max. velocity
- **H-811.S2IHP**
  Miniature hexapod for highest precision, BLDC motor, 2.5 kg payload, 20 mm/s max. velocity

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Subject to change. This manual is superseded by any new release. The latest respective release is available for download (p. 2) on our website.

Contents

1 About this Document

1.1 Objective and Target Group of this User Manual

This user manual contains the information necessary for using the H-811 as intended.

We assume that the user has basic knowledge of closed-loop systems, motion control concepts, and applicable safety measures.

1.2 Symbols and Typographic Conventions

The following symbols and typographic conventions are used in this user manual:

CAUTION

Dangerous situation
Failure to comply could result in minor injuries.

➢ Precautions to avoid the risk

NOTICE

Dangerous situation
Failure to comply could result in damage to the equipment.

➢ Precautions to avoid the risk

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/Label	Meaning
RS-232	Labeling of an operating element on the product (example: socket of the RS-232 interface)
	Warning sign on the product which refers to detailed information in this manual.

1.3 Figures

For better understandability, the colors, proportions, and degree of detail in illustrations can deviate from the actual circumstances. Photographic illustrations may also differ and must not be seen as guaranteed properties.

1.4 Other Applicable Documents

The devices and software tools from PI mentioned in this documentation are described in separate manuals.

Device/Program	Document no.	Document content
C-887.5xx controller	MS247EK	Short instructions for hexapod systems
	MS244E	User manual
	C887T0011	EtherCAT interface of the C-887.53 controller series
	C887T0007	Coordinate systems for hexapods
	C887T0021	Hexapod motion, position and orientation in space, center of rotation
PIVirtualMove	SM163E	Determining the valid poses of the hexapod by simulation
PC software included in the controller's scope of delivery	Various	Refer to the user manual for the C-887.5xx controller for details

1.5 Handbücher herunterladen

INFORMATION

If a manual is missing or problems occur with downloading:

➢ Contact PI's customer service (p. 53).

Downloading manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., H-811).
3. In the search results, select the product to open the product details page.
4. Select ***Downloads***.

   Manuals are shown under ***Documentation***. Software manuals are shown under ***General Software Documentation***.
5. For the desired manual, select ***ADD TO LIST*** and then ***REQUEST***.

6. Fill out the request form and select ***SEND REQUEST***.
   The download link will then be sent to the email address entered.

2 Safety

2.1 Intended Use

The hexapod is a laboratory device according to DIN EN 61010-1. It is intended for indoor use and use in an environment free from dirt, oil, and lubricants.

According to its design, the hexapod is intended for positioning, adjusting, and shifting loads in 6 axes at different velocities.

The hexapod can only (p. 14) be used as intended in conjunction with a suitable controller from PI, which coordinates all hexapod motion.

2.2 General Safety Instructions

The H-811 is built according to state-of-the-art technology and recognized safety standards. Improper use of the H-811 may result in personal injury and/or damage to the H-811.

- Use the H-811 for its intended purpose only, and only when it is in perfect condition.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for installing and operating the H-811 correctly.

2.3 Organizational Measures

User manual

- Always keep this user manual together with the H-811. The latest versions of the user manuals are available for download on our website (p. 2).
- Add all information from the manufacturer such as supplements or technical notes to the user manual.
- If you give the H-811 to other users, include this user manual as well as all other relevant information provided by the manufacturer.
- Do the work only if the user manual is complete. Missing information due to an incomplete user manual can result in minor injury and damage to equipment.
- Install and operate the H-811 only after you have read and understood this user manual.

Personnel qualification

The H-811 may only be installed, started, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

2.4 Measures for Handling Vacuum-Compatible Products

When handling the vacuum model of the hexapod, attention must be paid to appropriate cleanliness. At PI, all parts are cleaned before assembly. During assembly and measurement, powder-free gloves are worn. Afterwards, the hexapod is cleaned once again by wiping and shrink-wrapped twice in vacuum-compatible film.

- Touch the hexapod only with powder-free gloves.
- If necessary, wipe the hexapod clean after unpacking.

3 Product Description

3.1 Model Overview

Model	Designation
H-811.F2	Miniature hexapod for optical alignment; removable magnetic plate; brushless DC motor; 5 kg load capacity; 20 mm/s velocity; 0.5 m cable length
H-811.I2	Miniature hexapod; brushless DC motor; 5 kg load capacity; 20 mm/s maximum velocity; 0.5 m cable length
H-811.I2V	Miniature hexapod; vacuum compatible to 10^{-6}hPa; brushless DC motor; 5 kg load capacity; 10 mm/s velocity; 2 m cable length (vacuum side); feedthroughs
H-811.S2	Miniature hexapod for highly dynamic applications; direct drive; 25 mm/s maximum velocity; 2.5 kg load capacity; 0.5 m cable length
H-811.S2IHP	Miniature hexapod; brushless DC motor; 2.5 kg load capacity; 20 mm/s maximum velocity; 0.5 m cable length

3.2 Product View

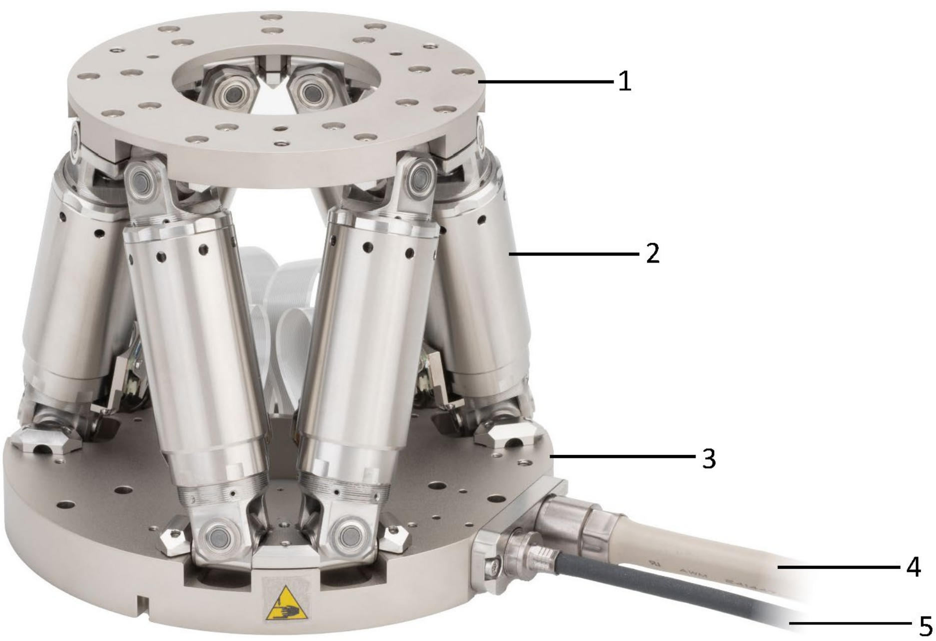


Figure 1: Elements of H-811.I2 and H-811.S2

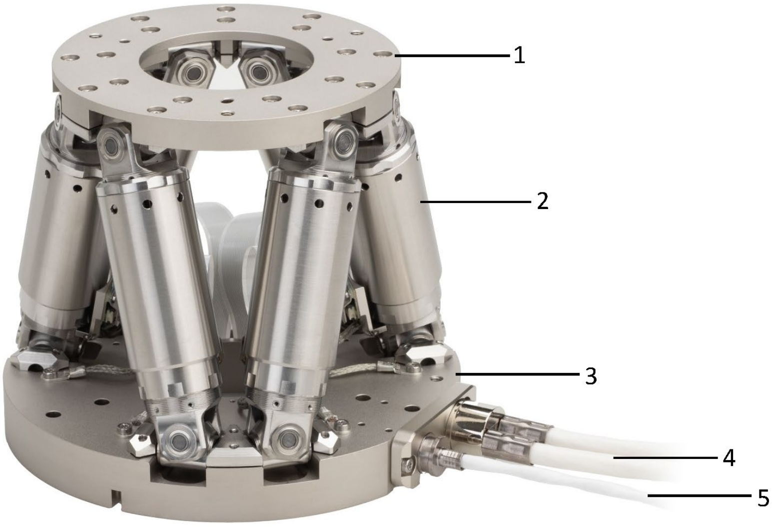


Figure 2: Elements of the H-811.I2V

1 Motion platform
2 Strut
3 Base plate
4 Data transmission cable
5 Power supply cable

Figure 3: Elements of the H-811.S2IHP

1 Motion platform
2 Strut
3 Hard stop

4 Base plate
5 Data transmission cable
6 Power supply cable

Figure 4: Elements of the H-811.F2

1 Motion platform
2 Strut
3 Data transmission cable
4 Power supply cable
5 Base plate
6 Mounting plate, held by a magnet

3.3 Technical Features

3.3.1 Struts

The hexapod has 6 adjustable-length struts. Each strut carries out linear motion. Each set of settings of the 6 struts defines a position of the motion platform in 6 degrees of freedom (3 translational axes and 3 rotational axes).

Each strut is equipped with the following components:

- Actuator
- Reference and limit switches
- Joints for connecting to the base plate and motion platform

- External hard stop (only with certain models)

The actuator contains a brushless DC motor with an incremental rotary encoder and a drive screw.

Reference Switch and Limit Switches

The reference switch of a strut functions independently of the angular positions of the strut ends and the lengths of the other struts.

When a limit switch is activated, the power source of the motor is switched off to protect the hexapod against damage from malfunctions.

External hard stop

The external hard stop prevents external forces from displacing the strut beyond the maximum permissible position. This avoids damage to the hexapod.

3.3.2 Motion control

The hexapod is intended for operation with a suitable controller from PI (p. 14). The controller makes it possible to command motion of individual axes, combinations of axes, or all 6 axes at the same time in a single motion command.

The controller calculates the configuration of the individual struts from the target positions specified for the translational and rotational axes. The velocities and accelerations of the struts are calculated so that all struts start and stop at the same time.

Every time the controller of a hexapod equipped with incremental encoders is switched on or rebooted, the hexapod must complete a referencing move, in which each strut moves to its reference switch. After the referencing move, the motion platform is in the reference position and can be commanded to move to absolute target positions.

A referencing move is not required for a hexapod with absolute measuring sensors.

For further information, refer to the user manual for the controller.

3.3.3 Motion

The platform moves along the translational axes and around the rotational axes.

The translation axes are labeled X, Y, and Z.

The axes of rotation can have the following designations:

Application	**Rotation around X**	**Rotation around Y**	**Rotation around Z**
Controller, PIHexapodEmulator, PIVirtualMove, manuals If available: Coordinate cube	U	V	W
Data table of the hexapod	θX	θY	θZ
Measurement report of the hexapod, figures of the coordinate systems	A A (rot X)	B B (rot Y)	C C (rot Z)

Using the controller, custom coordinate systems can be defined and used instead of the default coordinate system.

Default and user-defined coordinate systems are always right-handed systems. It is **not** possible to convert a right-handed system to a left-handed system.

The following is a description of how the hexapod behaves with the default coordinate system. Work with user-defined coordinate systems is described in the C887T0007 User Manual.

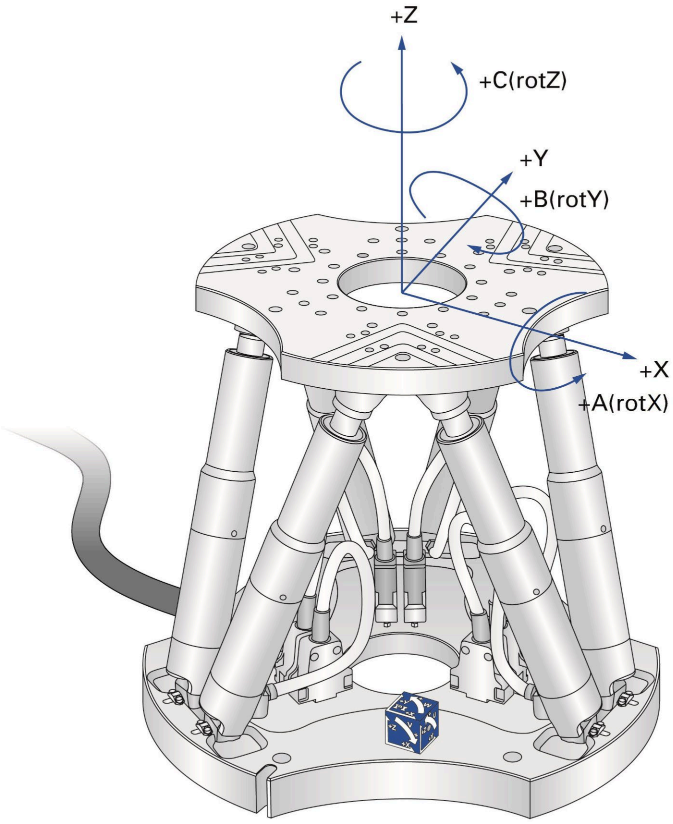


Figure 5: Coordinate system of a hexapod. For better clarity, the coordinate system is depicted above the platform.

Translation

Translations are described in the spatially-fixed coordinate system. The translational axes X, Y, and Z meet at the origin of the coordinate system (0,0,0). For further information, refer to the glossary (p. 99).

Rotation

Rotations take place around the rotational axes U, V, and W. The rotational axes meet at the center of rotation (also referred to as "pivot point"). The rotational axes and therefore also the center of rotation always move together with the platform of the hexapod (see also the example below for consecutive rotations).

A specified rotation in space is calculated from the individual rotations in the order U -> V- > W.

For further information on the center of rotation, refer to the glossary (p. 99).

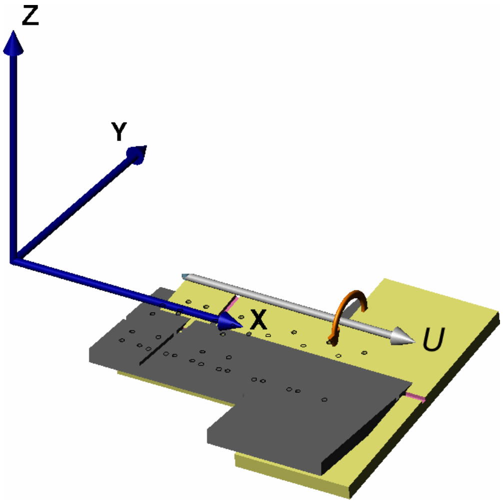
Example: Consecutive rotations

For a clearer view, the figures have been adapted as follows:

- Round platform replaced by T-shaped platform
- Coordinate system shown shifted
- Center of rotation in the top left corner of the platform

1. The U axis is commanded to move to position 10.

   The rotation around the U axis tilts the rotational axes V and W.

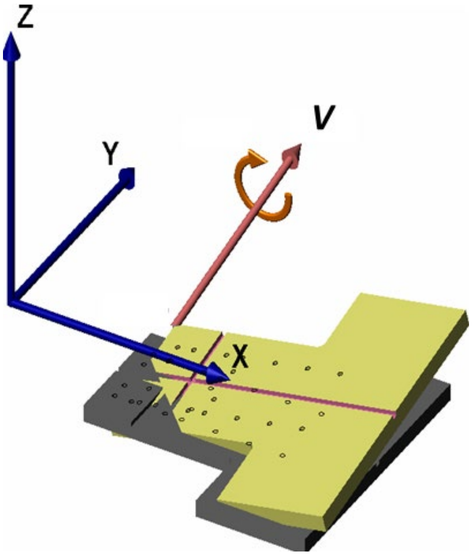


Platform in reference position

Platform position: U = 10 (U parallel to spatially fixed Xaxis)

2. The V axis is commanded to move to position –10.

   The rotation takes place around rotational axis V, which was tilted during the previous rotation.
   Die Rotation um die V-Achse verkippt die Rotationsachsen U und W.



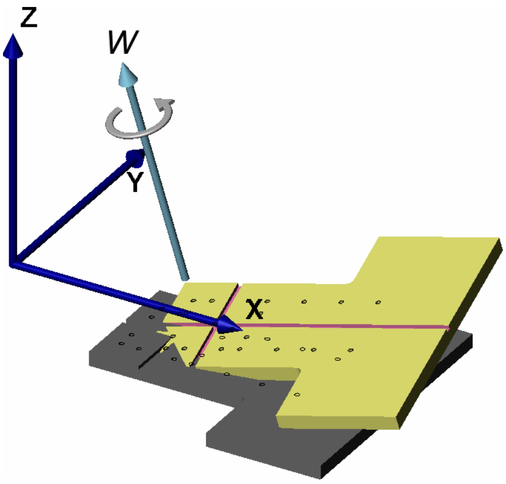
Platform in reference position

Platform position: U = 10, V = –10 (U and V parallel to the platform level)

3. The Waxis is commanded to move to position 10.

   The rotation takes place around the rotational axis W, which was tilted during the previous rotations. The Waxis is always vertical to the platform level.

   The rotation around the Waxis tilts the rotational axes U and V.



Platform in reference position

Platform position: U = 10, V = –10, W = 10 (U and V parallel to the platform level, W vertical to the platform level)

For further data on the travel ranges, refer to the "Specifications" (p. 55) section.

3.3.4 ID Chip

The hexapod has an ID chip that contains data on the type of hexapod, its serial number, and the manufacturing date. The data is loaded from the ID chip when the controller is switched on or rebooted. Depending on the data loaded, the controller keeps the current configuration or installs a new configuration.

For simple replacement, the configuration data for all standard hexapods is stored at the factory in every standard controller (e.g., geometry data and control parameters). The configuration data for customized hexapods is only stored on the controller if the hexapod and controller are delivered together, or if PI was correspondingly informed before delivery of the controller.

For further information and application notes, refer to the documentation for the controller.

3.4 Suitable Controllers

Model	Designation
C-887.52	6-axis controller for hexapods, TCP/IP, RS-232, benchtop device, incl. control of 2 additional axes
C-887.521	6-axis controller for hexapods, TCP/IP, RS-232, benchtop device, incl. control of 2 additional axes, analog inputs
C-887.522	6-axis controller for hexapods, TCP/IP, RS-232, benchtop device, incl. control of 2 additional axes, motion stop
C-887.523	6-axis controller for hexapods, TCP/IP, RS-232, benchtop device, incl. control of 2 additional axes, motion stop, analog inputs
C-887.53	6-axis controller for hexapods, TCP/IP, RS-232, benchtop device, incl. control of 2 additional axes, EtherCAT interface
C-887.531	6-axis controller for hexapods, TCP/IP, RS-232, benchtop device, incl. control of 2 additional axes, EtherCAT interface, analog inputs
C-887.532	6-axis controller for hexapods, TCP/IP, RS-232, benchtop device, incl. control of 2 additional axes, EtherCAT interface, motion stop
C-887.533	6-axis controller for hexapods, TCP/IP, RS-232, benchtop device, incl. control of 2 additional axes, EtherCAT interface, motion stop, analog inputs

To order, contact our customer service (p. 53).

3.5 Optional Accessories

Order number	Data transmission cable, available lengths
C-815.82D02	Data transmission cable for hexapods, drag chain compatible, HD D-sub 78 m/f, 2 m
C-815.82D03	Data transmission cable for hexapods, drag chain compatible, HD D-sub 78 m/f, 3 m
C-815.82D05	Data transmission cable for hexapods, drag chain compatible, HD D-sub 78

Order number	Data transmission cable, available lengths
	m/f, 5 m
C-815.82D07	Data transmission cable for hexapods, drag chain compatible, HD D-sub 78 m/f, 7.5 m
C-815.82D10	Data transmission cable for hexapods, drag chain compatible, HD D-sub 78 m/f, 10 m
C-815.82D20	Data transmission cable for hexapods, drag chain compatible, HD D-sub 78 m/f, 20 m

Order number	Power supply cable, available lengths
C-815.82P02E	Power supply cable for hexapods, drag chain compatible, M12 m/f straight, 2 m
C-815.82P03E	Power supply cable for hexapods, drag chain compatible, M12 m/f straight, 3 m
C-815.82P05E	Power supply cable for hexapods, drag chain compatible, M12 m/f straight, 5 m
C-815.82P07E	Power supply cable for hexapods, drag chain compatible, M12 m/f straight, 7.5 m
C-815.82P10E	Power supply cable for hexapods, drag chain compatible, M12 m/f straight, 10 m
C-815.82P20E	Power supply cable for hexapods, drag chain compatible, M12 m/f straight, 20 m

Order number	Description
H-811.12PS	Separate 12 V wide input range power supply (60 W/5 A) for use with line voltages from 100 to 240 V AC and voltage frequencies of 50 or 60 Hz, with 4-pole M12 connector (f) Optional power supply for the hexapod. Replaces the power supply from the controller. Ideal for static applications that require increased position stability. For further information, refer to "Optional: Operating the hexapod with a separate 12 V power adapter" (p. 38).
F-206.TMU	H-811.F2 model only: Mounting plate for fast replacement of different assemblies
R-FMP-GSM	Fast, multichannel gradient search routines Available for hexapod mechanics H-811.F2 and H-811.I2 in combination with a C-887 hexapod controller that features a high-resolution analog input.

To order, contact our customer service (p. 53).

4 Unpacking

4.1 Scope of Delivery

Order number	Components
H-811	Hexapod according to your order (p. 7). H-811.I2, .F2, .S2, .S2IHP: Cables with a length of 0.5 m are installed permanently. H-811.I2V: Cables with a length of 2 m are installed permanently.
H-811.I2V vacuum-compatible model only:	
4668	Vacuum feedthrough for data transmission, HD D-sub 78 m/f
C887B0002	Vacuum feedthrough for power supply, LEMO 2-pole (f) to M12 (m)
H-811.I2, .F2, .S2, .S2IHP models only:	
000067899	Connector holder for fixing the data transmission cable
Packaging, consisting of:	
	▪ Outer box ▪ Inner box ▪ Foam inserts ▪ Pallet
Documentation, consisting of:	
H811T0001	Instructions on unpacking the hexapod
MS247EK	Short instructions for hexapod systems
E712T0016	H-811.F2 model only: Fast multi-channel photonics alignment
Screw sets:	
000020110	Mounting kit: ▪ 6 socket head screws, M4×25 ISO 4762 ▪ 1 hex key 3.0 DIN 911
000036450	Accessories for connecting to the grounding system: ▪ 1 flat-head screw with cross recess, M4×8 ISO 7045 ▪ 2 flat washers, form A-4.3 DIN 7090 ▪ 2 lock washers, Schnorr Ø 4 mm N0110
000070600	H-811.I2, .F2, .S2, .S2IHP models only: Accessory for fixing the connector holder for the data transmission cable:

Order number	Components
	▪ 2 socket head screws, M6×30 ISO 4762 ▪ 1 hex key 5.0 DIN 911
435	H-811.S2IHP model only: Tool for demounting/mounting the transport safeguard: ▪ Hex key 2.5 DIN 911

Note that the cables required for connecting the H-811 to the electronics must be ordered separately.

4.2 Unpacking the hexapod

The hexapod is delivered in a special packaging with adapted foam inserts.

Certain H-811 models are delivered with a transport safeguard installed. To avoid damage to the product, the transport safeguard may only be removed after installation of the H-811.

NOTICE

Impermissible mechanical load

An impermissible mechanical load can damage the hexapod.

➢ Only hold the hexapod by the transport safeguard (if present) or the base plate.

NOTICE

Mechanical overload due to incorrect handling

For models of the H-811 that are delivered with a transport safeguard, the following applies:

An impermissible mechanical load on the H-811 due to transportation without a transport safeguard can damage the H-811 and lead to loss of precision.

➢ Do not remove the transport safeguard until **after** installation of the H-811 at its place of use.

➢ Transport the H-811 only with the transport safeguard attached.

INFORMATION

The hexapod is delivered airtight packed and sealed in an ESD film. In addition, a desiccant sachet is included to absorb humidity from the air.

Storage in a humid environment can cause staining of the surface of the hexapod. This does not limit the functionality or suitability of the hexapod.

INFORMATION

When handling the vacuum model of the hexapod, attention must be paid to appropriate cleanliness. At PI, all parts are cleaned before assembly. Powder-free gloves are worn during assembly and measuring. In addition, the hexapod is wipe cleaned afterwards and then shrink-wrapped twice in vacuum-compatible film.

- Touch the hexapod only with powder-free gloves.
- If necessary, wipe the hexapod clean after unpacking.

Unpacking the hexapod

- Proceed as described in H811T0001 (in the scope of delivery (p. 17)).
- Compare the contents with the scope of delivery according to the contract and the delivery note.
- Inspect the contents for signs of damage. If any parts are damaged or missing, contact our customer service (p. 53) immediately.

Keeping the packaging

- Keep **all** packaging material in case the product needs to be transported later.

5 Installing

5.1 General Notes on Installation

CAUTION

Burning from hot base plate of H-811.S2IHP

The hexapod model H-811.S2IHP, especially the bottom of the base plate, heats up during operation. Touching the base plate can result in minor injuries from burning.

- Do not install the base plate of the H-811.S2IHP thermally insulated.
- If sufficient cooling is not possible: Make sure that the hot base plate of the H-811.S2IHP and its surrounding parts **cannot** be touched.
- If sufficient cooling and protection against contact are not possible: Mark the danger zone in accordance with the legal regulations.

HINWEIS

Impermissible mechanical load and collisions

Impermissible mechanical load and collisions between the hexapod, the load to be moved, and the surroundings can damage the hexapod.

- Only hold the hexapod by the base plate.
- Use the PIVirtualMove simulation program to determine the valid poses before installing the hexapod and load. See "Determining Valid Poses" (p. 22) for the definition of a valid pose.
- Repeat the determination of valid poses if you change the hexapod type and before any change to the installation position, load to be moved, external forces and torques, or the coordinate system used.
- If you define your own coordinate system and use it instead of the factory-set coordinate system: Note that the PIVirtualMove simulation program calculates narrower travel range limits than the controller when using user-defined coordinate systems. If you want to avoid commanding poses that lie outside the travel range limits calculated by PIVirtualMove:
  - Use the controller to determine if poses can be commanded that lie outside the travel range limits calculated by PIVirtualMove by querying with the `TRA?` command.
  - If necessary, use the commands `NLM` and `PLM` to set soft limits in the controller according to the travel range limits calculated by PIVirtualMove.
- While installing the hexapod and the load, make sure that the actual system setup corresponds to the system setup for which you determined the valid poses in the PIVirtualMove simulation program.
- Avoid high forces and torques on the motion platform during installation.
- To avoid unintentional deactivation of the hexapod system and resulting position changes of the hexapod system, make sure that the power supply is not interrupted.

- Make sure that no collisions between the hexapod, the load to be moved, and the surroundings are possible in the workspace of the hexapod.

NOTICE

Cable break due to excessively bent or crushed cable

A cable break leads to failure of the hexapod.

- Ensure that your application fulfills the following requirements for the cables permanently installed at your hexapod:
  - The cables are **not** subject to tensile stress.
  - The cables are **not** being moved.
- Secure the cables in a suitable manner.
- Fix the permanently installed data transmission cable with the supplied connector holder (p. 17) to underlying surface.

5.2 Determining Valid Poses

To avoid damaging the hexapod, only valid poses may be commanded. The PIVirtualMove simulation program is intended for determining the valid poses according to the following definition:

A pose is valid if it can be reached by all 6 axes X, Y, Z, U, V, W with the coordinate system used, and the system setup used (installation position of the hexapod, load to be moved, external forces, and torques) **and** the permissible load of the struts is **not** exceeded.

Tools and accessories

- PC with a Windows operating system on which the PIVirtualMove simulation program is installed.

Determining valid poses of the hexapod

- Follow the instructions in the PIVirtualMove user manual (SM163E).

INFORMATION

The PIVirtualMove simulation program calculates the valid poses based on the maximum payload of the hexapod (= limit value when servo mode is switched on). With the servo mode switched off, the maximum holding force is based on the self-locking of the actuators in the hexapod struts and is lower than the maximum payload.

INFORMATION

The load of the hexapod struts varies depending on the following factors:

- Activation state of the servo mode in the controller
- Installation position of the hexapod
- Load to be moved: mass and position of the center of mass on the motion platform
- Forces and torques acting on the motion platform
- Poses to be approached by the motion platform during operation (coordinates for translation and rotation)

5.3 Mounting the Hexapod on a Surface

NOTICE

Impermissible mechanical load

An impermissible mechanical load can damage the hexapod.

➢ Only hold the hexapod by the base plate.

NOTICE

Warping of the base plate

Incorrect mounting can warp the base plate. A warped base plate reduces the accuracy.

➢ Mount the hexapod onto a flat surface. The recommended flatness of the surface is 20 µm.

NOTICE

Unfavorable mounting orientation

The H-811 can be mounted in any orientation.

It is however recommended to mount the **H-811.S2IHP** model with a **horizontal orientation** (= horizontal base plate) due to the weak holding force when the device is powered off. Unfavorable mounting orientation and loads in the upper specification range may lead to unwanted motion or even damage to the H-811.S2IHP when it is powered off.

➢ Mount the H-811.S2IHP with a horizontal orientation.

Requirements

✓ You have read and understood the General Notes on Installation (p. 21).

Tools and accessories

- Hex key 3.0 and 3 of the supplied M4×25 screws (p. 17)
- Optional: 2 Ø 3 mm m6 locating pins for easy alignment of the hexapod on the surface, not included in the scope of delivery

Mounting the hexapod

1. Bore the required holes into the surface:
   - 3 M4 threaded holes for mounting with M4×25 screws
   - Optional: 2 locating holes for accommodating Ø 3 mm m6 locating pins

   The arrangement of the 3 mounting holes as well as the 2 locating holes in the hexapod's base plate can be found in the dimensional drawing (p. 69). The locating holes are on the bottom of the base plate.
2. If you use locating pins to align the hexapod:
   a) Insert the locating pins into the locating holes in the surface.
   b) Put the hexapod onto the surface so that the locating pins are inserted into the corresponding locating holes in the hexapod's base plate.
3. Use the screws provided to fix the hexapod to the 3 mounting holes in the base plate.

5.4 Grounding the Hexapod

INFORMATION

➢ If there is any vibration in your application, secure the screw connection for the protective earth conductor in a suitable manner (e.g., with conductive liquid adhesive) to prevent it from unscrewing by itself.

The hexapod is not grounded via the power supply cable. If a functional grounding is required for potential equalization:

1. Connect the base plate to the grounding system:
   - For connection, use the supplied accessories (p. 17) and the M4 hole with an 8 mm depth marked with the ground connection symbol (p. 69).
2. Connect the motion platform to the grounding system:
   - Use one of the mounting holes in the motion platform (p. 69) for connection.
     or
   - If the motion platform and the load are connected conductively to each other, connect the load to the grounding system.

5.5 Fixing the Data Transmission Cable with the Connector Holder

NOTICE

Impermissible mechanical load
The data transmission cable that is permanently installed on the hexapod is **not** drag chain-compatible. Impermissible forces can damage the cable or the hexapod.

➢ Ensure the following in your application for the permanently installed data transmission cable:
  – The cable is **not** subject to tensile stress.
  – The cable is **not** moved.

➢ Fix the permanently installed data transmission cable with the supplied connector holder (p. 17) to underlying surface.

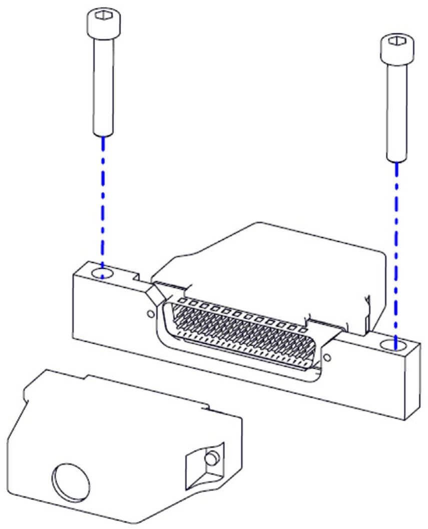


Figure 6: Mount the connector holder onto underlying surface

Requirements

✓ You have read and understood the General Notes on Installation (p. 21).

Tools and accessories

- Connector holder supplied including mounting kit:
  – 2 screws M6x30
  – Hex key 5.0

Fixing the data transmission cable with the connector holder

1. Attach the connector holder to the HD D-sub 78 connector (m) of the data transmission cable that is permanently installed on the hexapod:

a) Remove both hexagonal nuts from the screws of the connector.

b) Fix the connector to the connector holder with the screws.

2. Drill 2 M6 threaded holes into the surface for mounting with M6x30 screws:
   - Pay attention to the arrangement of the 2 mounting holes in the connector holder, refer to dimensional drawing (p. 69).
   - Put the connector holder on the surface so that the data transmission cable that is permanently installed to the hexapod, is **not** moved in your application and is **not** subject to tensile stress.
3. Fix the connector holder onto the surface with the screws supplied.

   The free side of the connector holder is intended for connecting a suitable data transmission cable. Refer to "Connecting the hexapod to the controller" (p. 28) for further information.

5.6 Fixing the Load to the Hexapod

NOTICE

Impermissible mechanical load and collisions

Impermissible mechanical load and collisions between the hexapod, the load to be moved, and the surroundings can damage the hexapod.

- ➢ While installing the hexapod and the load, make sure that the actual system setup corresponds to the system setup for which you determined the valid poses in the PIVirtualMove simulation program.
- ➢ Avoid high forces and torques on the motion platform during installation.
- ➢ Make sure that no collisions between the hexapod, the load to be moved, and the surroundings are possible in the workspace of the hexapod.

NOTICE

Excessively long screws

The hexapod can be damaged by screws that are inserted too deeply.

- ➢ When selecting the screw length, observe the thickness of the motion platform or the depth of the mounting holes (p. 69) together with the load to be mounted.
- ➢ Only use screws that do not project under the motion platform after being screwed in.
- ➢ Only mount the hexapod and the load on the mounting fixtures (holes) intended for this purpose.

INFORMATION

H-811.F2 model only:

The load to be aligned can be fixed to the mounting plate or directly to the motion platform. Fixing to the mounting plate is recommended.

The mounting plate is held on to the motion platform by 2 magnets. The following adjusting elements guarantee accurate fitting of the mounting plate:

- 3 guides on the top of the motion platform
- 3 balls are located on the bottom of the mounting plate

Additional mounting plates are available (p. 14) as optional accessories. Therefore, it is possible to replace the load to be aligned quickly.

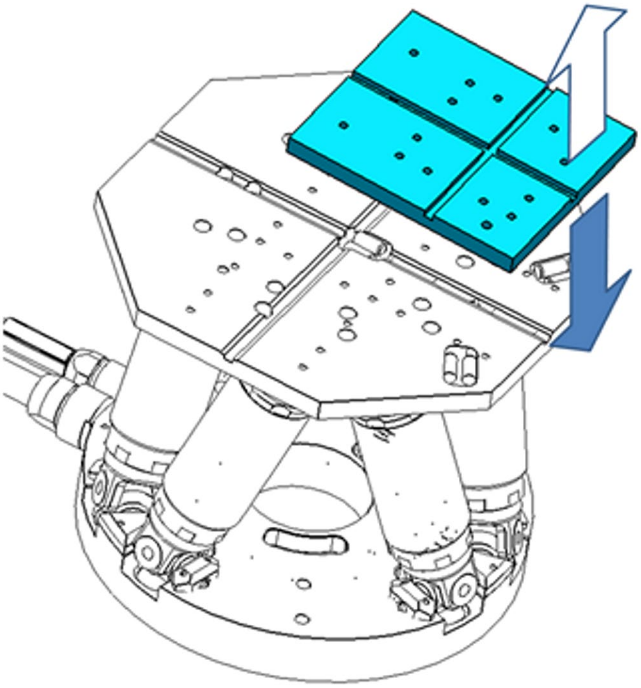


Figure 7: H-811.F2 model only: Mounting plate

Light-colored arrow: Lift to remove the mounting plate
Dark-colored arrow: Put the mounting plate onto the motion platform carefully to attach it

Requirements

- ✓ You have read and understood the General Notes on Installation (p. 21).
- ✓ You have determined the permissible load and the workspace of the hexapod (p. 22).
- ✓ You have designed the load and the surroundings of the hexapod so that the permissible load of the hexapod is adhered to and no collisions can occur.
- ✓ If you want to use locating pins to align the load: You have drilled 2 locating holes for accommodating Ø 3 mm m6 locating pins.

Tools and accessories

- 3 suitably long M4 screws
- Suitable tool for tightening the screws
- Optional: 2 Ø 3 mm m6 locating pins for easy alignment of the load on the hexapod, not included in the scope of delivery

- H-811.F2 model only: If you want to fix several loads to be aligned in quick succession: one additional mounting plate each per assembly, available as optional accessory (p. 14).

Fixing the load

1. H-811.F2 model only: If necessary, remove the mounting plate from the motion platform (see figure).
2. Align the load so that the selected mounting holes can be used to fix it.

   The layout for the holes in the motion platform of the hexapod and the mounting plate can be found in the dimensional drawing (p. 69).
3. If you use locating pins to align the load:
   a) Insert the locating pins into the locating holes in the load.
   b) Put the load onto the platform so that the locating pins are inserted into the corresponding locating holes in the hexapod's motion platform.
4. To fix the load, tighten the screws in the selected mounting holes of the motion platform or the mounting plate.
5. H-811.F2 model only:
   – If necessary, place the mounting plate carefully onto the motion platform so that the 3 balls on the bottom of the mounting plate are in the guides on the top of the motion platform (see figure).

5.7 Connecting the Hexapod to the Controller

Cables with a length of 0.5 m (H-811.I2., .F2, .S2, .S2IHP) or 2 m (811.I2V) are installed permanently on the hexapod.

Connecting cables are not included in the scope of delivery and must be ordered separately (p. 17).

Vacuum feedthroughs are also included in the scope of delivery of a vacuum-compatible hexapod (p. 17).

NOTICE

Cable break due to excessively bent or crushed cable
A cable break leads to failure of the hexapod.

➢ Ensure that your application fulfills the following requirements for the cables permanently installed at your hexapod:
   – The cables are **not** subject to tensile stress.
   – The cables are **not** being moved.

➢ Secure the cables in a suitable manner.

➢ Fix the permanently installed data transmission cable with the supplied connector holder (p. 17) to underlying surface.

Requirements

- ✓ The controller is **switched off**, i.e., the on/off switch is in the position **O**.
- ✓ You have fixed (p. 25) the data transmission cable, which is permanently installed on the hexapod, to the surface using the connector holder supplied.

Tools and accessories

- Data transmission cable and power supply cable, available separately (p. 17)
- If you want to operate a vacuum-compatible hexapod in a vacuum chamber: Suitable tools for installing the vacuum feedthrough

If necessary: Installing vacuum feedthroughs

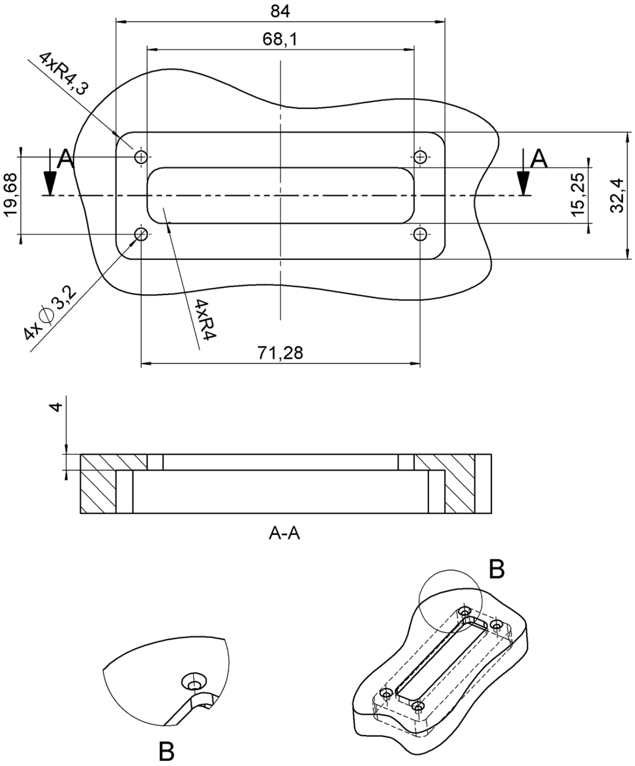


Figure 8: Vacuum feedthrough for data transmission (4668), dimensions in mm

B 4 holes, Ø6 x 45° for M3 countersunk screw

- ➢ Install the vacuum feedthrough for data transmission (4668) so that the HD Sub-D 78 socket is in the vacuum chamber.

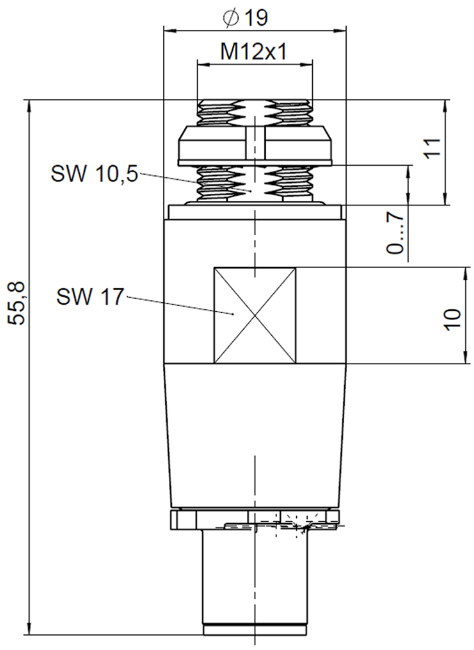


Figure 9: Vacuum feedthrough for the power supply of the hexapod (C887B0002), dimensions in mm

- Install the vacuum feedthrough for the power supply (C887B0002) so that the 2-pin LEMO connection is in the vacuum chamber.

Connecting the hexapod to the controller

- Connect the hexapod and the controller to each other:
  - Pay attention to the assignment specified on the labeling of the sockets, plug connectors, and cables.
  - Pay attention to the mechanical coding of connectors and sockets.
  - Do not use force.
  - Use the integrated screws to secure the connections against accidental disconnection.

Standard Cabling

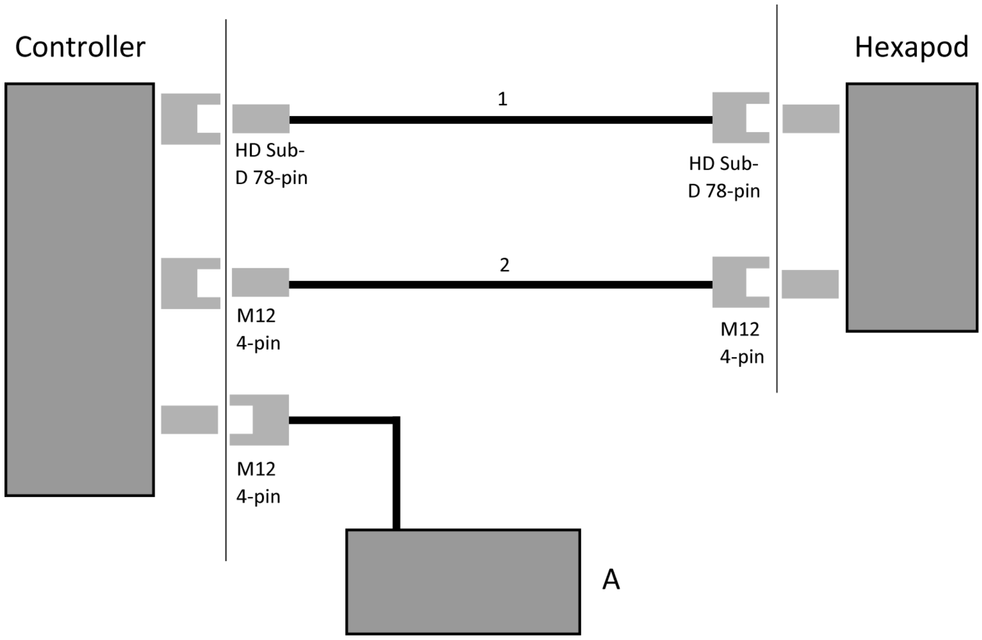


Figure 10: Connection diagram

	Panel plug / connector, male
	Socket / connector, female
Controller	Refer to "Suitable Controllers (p. 14)"
Hexapod	H-811.x2
A	Power adapter, from the scope of delivery of the controller, 24 V DC output
1	Data transmission cable
2	Power supply cable

Cabling for vacuum

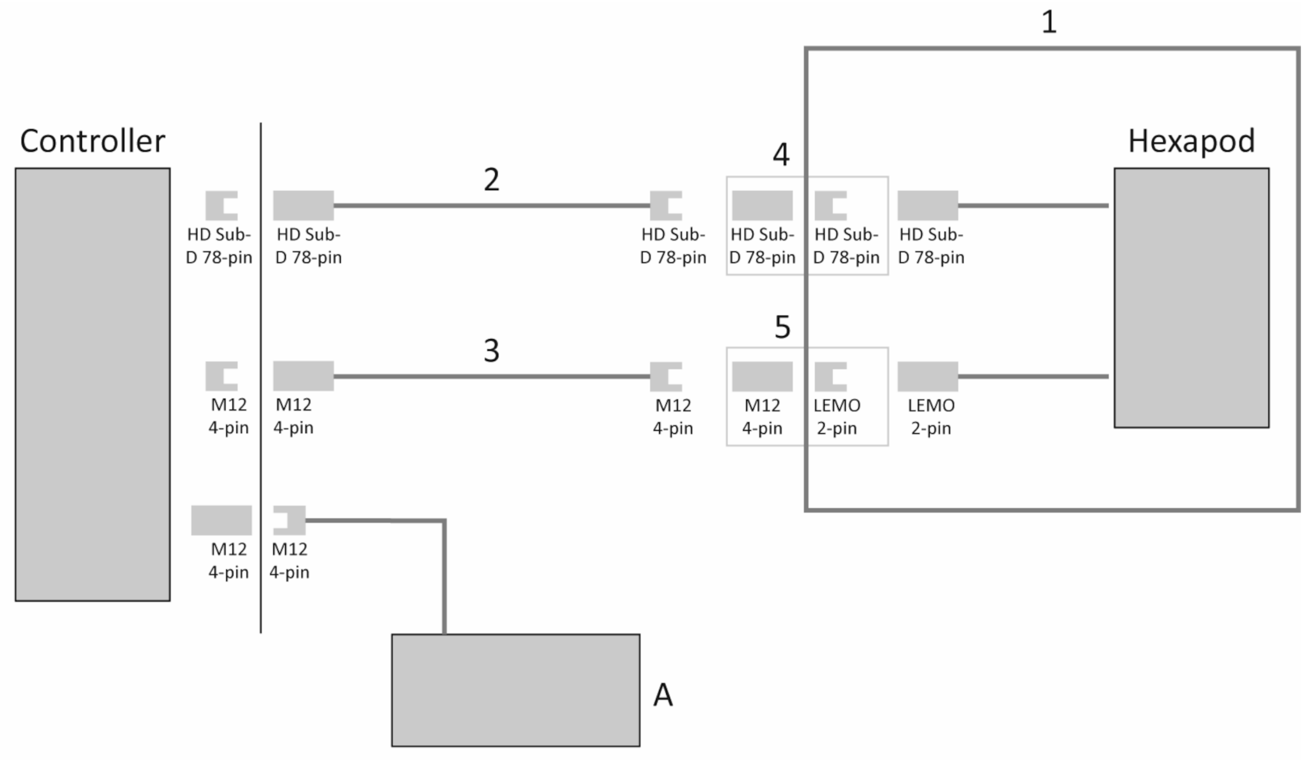


Figure 11: Connection diagram of the cable set for the vacuum-compatible hexapod

	Panel plug / connector, male
	Socket / connector, female
Controller	See "Suitable Controller (p. 14)s"
Hexapod	H-811.I2V
A	Power adapter, from the scope of delivery of the controller, 24 V DC output
1	Vacuum chamber
2	Data transmission cable
3	Power supply cable
4	Vacuum feedthrough for data transmission
5	Vacuum feedthrough for power supply

5.8 Removing the Transport Safeguard

With models of the H-811 that are delivered with a transport safeguard, the transport safeguard must now be removed.

NOTICE

Damage from transport safeguard that has not been removed
Damage can occur to the hexapod if the transport safeguard (p. 17) of the hexapod has not been removed and a motion is commanded.

➢ Remove the transport safeguard before you start up the hexapod system.

Overview

The following figure shows a H-811 hexapod with the transport safeguard installed. For a better overview, the hexapod is shown without grounding, mounted load, and connecting cables.

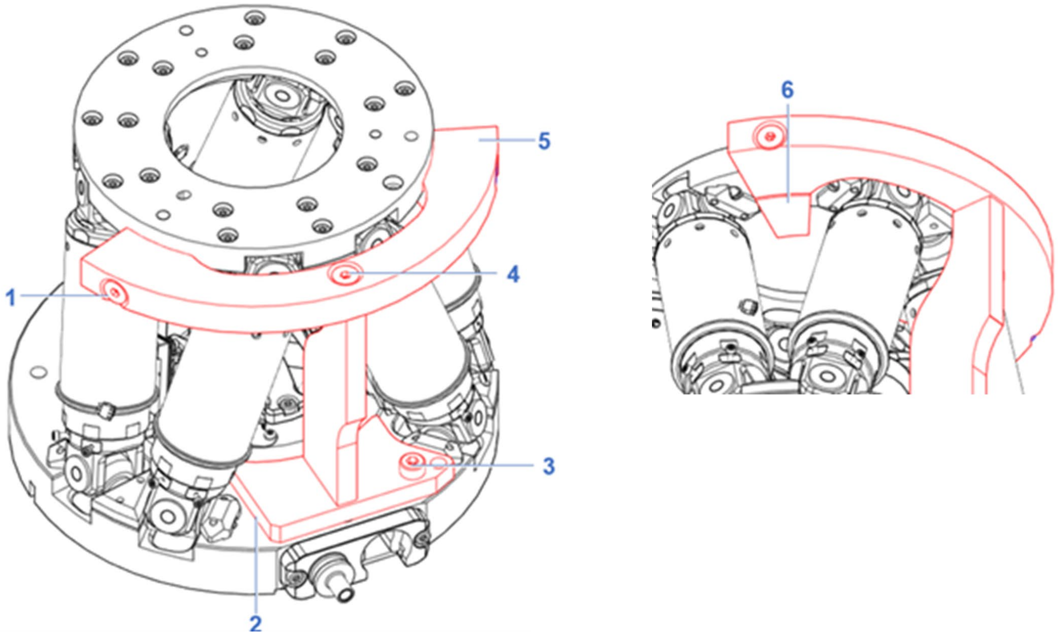


Figure 12: Elements of the transport safeguard (red), viewed at an angle from above (left) and at an angle from below (right)

1 Lateral ISO 10642 M4×30 mounting screw
2 Lower part of the transport safeguard
3 ISO 4762 M4×12 socket head screw
4 Upper ISO 10642 M4×12 mounting screw
5 Upper part of the transport safeguard
6 Holding block

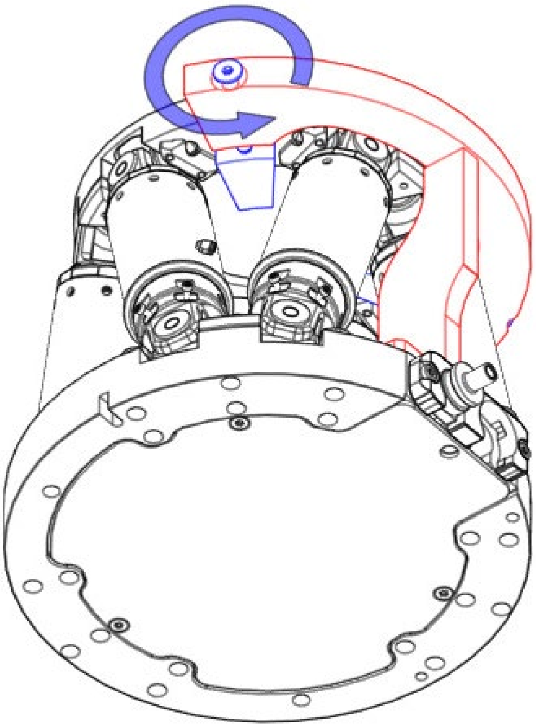
Tools and accessories

- Hex key AF 3

Removing the transport safeguard

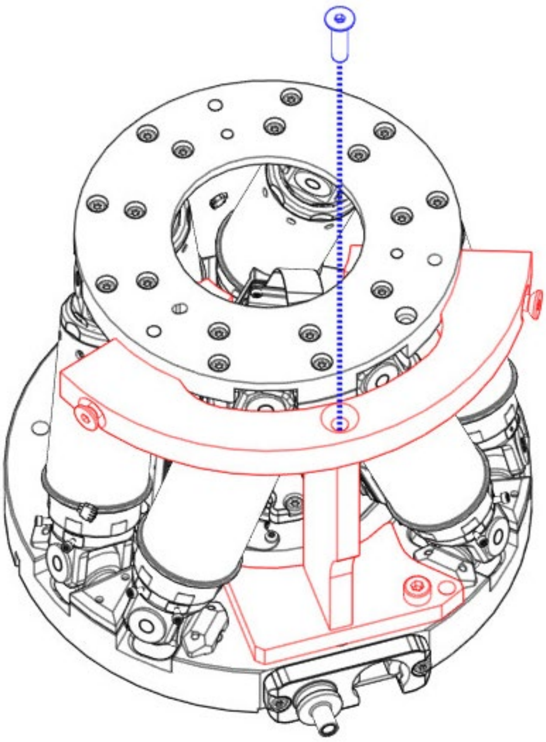
For a better overview, the hexapod is shown in the following figures unmounted, without grounding, mounted load, and connecting cables.

1. Left side: Unscrew the lateral mounting screw until the holding block is loosened.

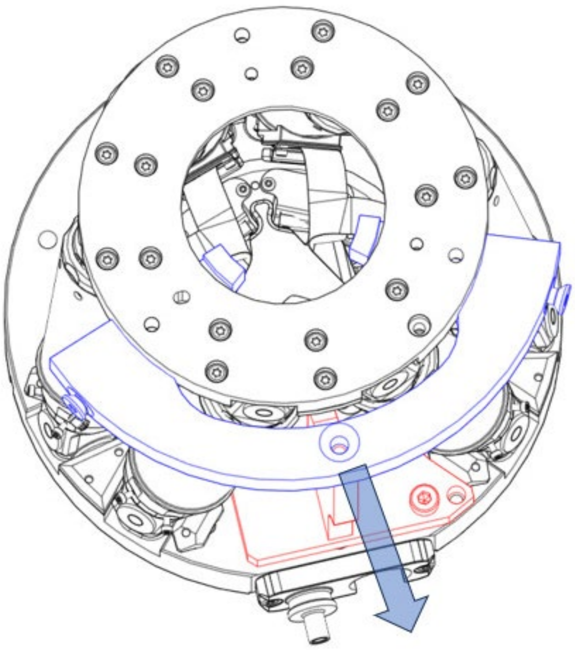


2. Repeat step 1 for the right side.

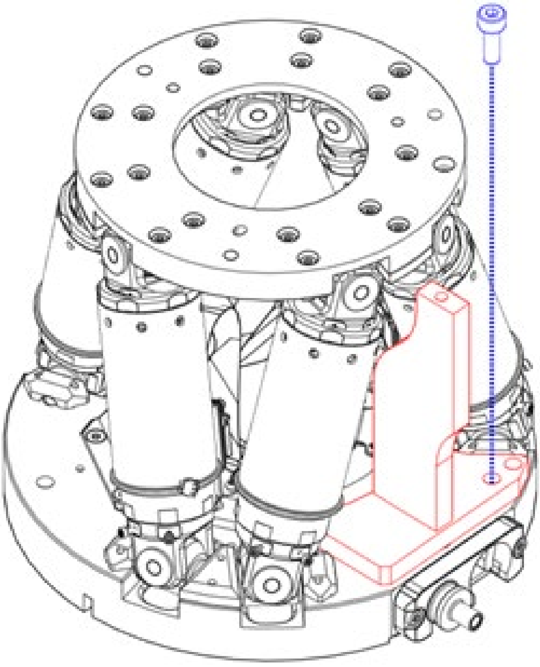
3. Unscrew and remove the upper mounting screw.



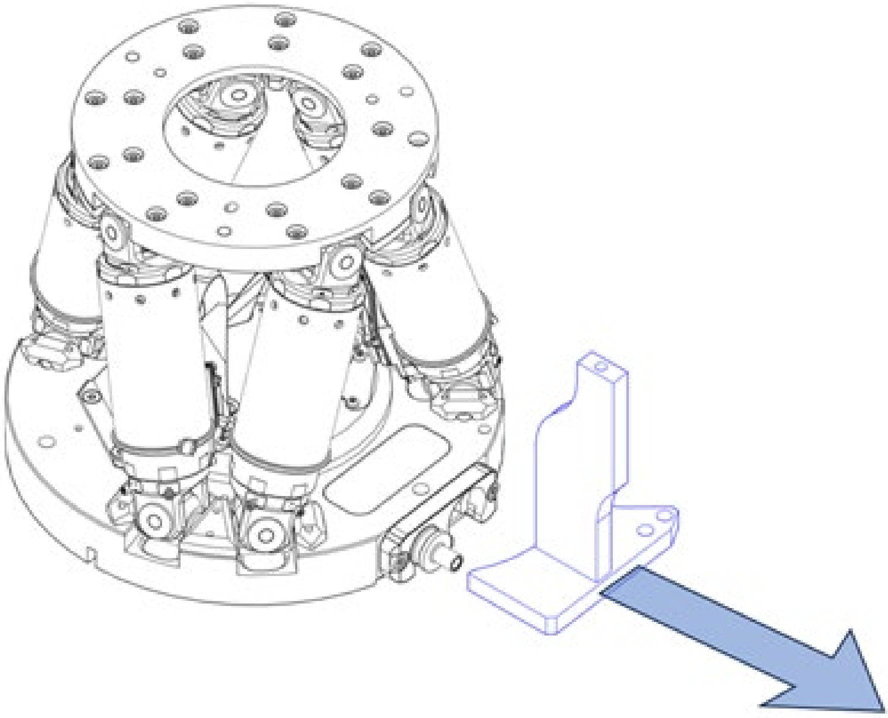
4. Remove the upper part of the transport safeguard.



5. Unscrew and remove the socket head screw on the lower part of the transport safeguard.



6. Remove the lower part of the transport safeguard.



Keeping the transport safeguard

➢ Keep all parts of the transport safeguard including all screws in case the product needs to be transported again later on.

6 Startup

6.1 General Notes on Startup

CAUTION

Risk of crushing by moving parts

Risk of minor injuries from crushing between the moving parts of the hexapod and a stationary part or obstacle.

- Keep your fingers away from areas where they could be caught by moving parts.

NOTICE

Incorrect configuration of the controller

The configuration data used by the controller (e.g., geometry data and servo control parameters) must be adapted to the hexapod. If incorrect configuration data is used, the hexapod can be damaged by uncontrolled motion or collisions.

When the controller is switched on or rebooted, the configuration data is adapted using the data that is loaded from the ID chip.

- Once you have established communication via TCP/IP or RS-232, send the `CST?` command. The response shows the hexapod, to which the controller is adapted.
- Only operate the hexapod with a controller whose configuration data is adapted to the hexapod.

NOTICE

Damage due to collisions

Collisions can damage the hexapod, the load to be moved, and the surroundings.

- Make sure that no collisions are possible between the hexapod, the load to be moved, and the surroundings in the workspace of the hexapod.
- Do not place any objects in areas where they can be caught by moving parts.
- Only command valid poses. See "Determining Valid Poses" (p. 22) for the definition of a valid pose.
- Stop the motion immediately if a controller malfunction occurs.

NOTICE

Damage due to unwanted changes in position
The self-locking of the hexapod struts is very low. Although the hexapod is in a permissible pose, the installed load can trigger an unintentional change in the position of the hexapod if the servo mode or controller is off and one of the following conditions is also met:

- The hexapod is **not** mounted with a horizontally oriented base plate but in any other orientation.
- The hexapod is mounted with a horizontally oriented base plate, but the weight of the load exceeds the maximum holding force.

As a result of unintentional position changes, the actuators in the hexapod struts can be damaged, and collisions between the hexapod, the load to be moved, and the surroundings are possible. Collisions can damage the hexapod, the load to be moved, or the surroundings.

➢ Support the motion platform or the load appropriately when the servo mode or the controller is switched off.

NOTICE

Heating up of the hexapod in the vacuum
The hexapod heats up during operation in the vacuum.

➢ Allow the heat to dissipate accordingly.

6.2 Starting Up the Hexapod System

Requirements

- ✓ You have read and understood the General Notes on Startup (p. 37).
- ✓ You have correctly installed the hexapod, i.e., you have mounted the hexapod onto a surface, fixed the load to the hexapod and connected the hexapod to the controller according to the instructions in "Installation" (p. 21).
- ✓ If necessary: You have removed the transport safeguard (p. 32).
- ✓ You have read and understood the user manual of the controller.

Accessories

- PC with suitable software (refer to the user manual of the controller)

Starting up the hexapod system

1. Start up the controller (refer to the user manual of the controller).
2. Run a few motion cycles for test purposes (refer to the user manual of the controller).

6.3 Optional: Operating the Hexapod with a Separate 12 V Power Adapter

The hexapod can be supplied via a separate 12 V power supply in static applications that require increased position stability.

If you did **not** order the 12 V power supply together with your hexapod system, the controller's settings have to be adapted to the 12 V power supply.

INFORMATION

If your controller has an **E-Stop socket** (C-887.522, .523, .532, and .533 models):

Disabling the 24 V output on the controller via the **E-Stop** socket remains ineffective when the hexapod is supplied via a separate power supply.

➢ If you want to actively use the **E-Stop** socket, connect the hexapod's power supply accordingly. Refer to "Using the E-Stop socket" in the C-887.5xx controller (MS244) user manual for further information.

Requirements

- ✓ You have read and understood the General Notes on Startup (p. 37).
- ✓ You have read and understood the user manual for the controller.
- ✓ You have fixed the hexapod to a surface according to the instructions in "Installation" (p. 21) and also fixed the load onto the hexapod.
- ✓ The 12 V power supply is **not** connected to the power socket via the power cord.
- ✓ The controller is switched off, i.e., the on/off switch is in the O position.

Accessories

- C-501.12060M12 12 V wide input range power supply (60 W / 5 A), included with the H-811.12PS option, which is available as optional accessory (p. 14).
- PC where the program PITerminal is installed (refer to the user manual for the controller)

Adapting the controller settings to the 12 V power adapter

1. Connect the C-887.5xx controller to the power supply (24 V) and the PC. Follow the instructions in the user manual for the controller (MS244).
2. Switch on the controller.
3. Use the program PITerminal to establish communication between the controller and the PC via the TCP/IP interface or the RS-232 interface.
4. Send the following commands to adapt the controller's settings permanently to the 12 V power supply of the hexapod and to reboot the controller:

```
SVO X 0
```

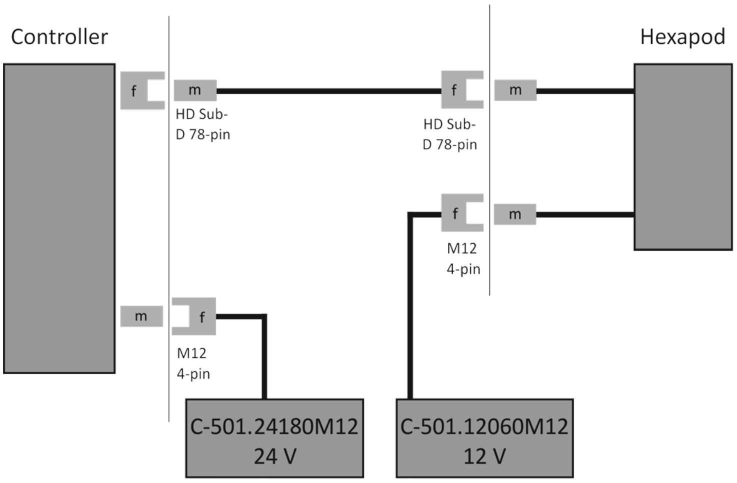
```
CCL 1 advanced
SPA 1 0x19004000 0
WPA 101 1 0x19004000
SPA 1 0x5a 50000 2 0x5a 50000 3 0x5a 50000 4 0x5a 50000 5
0x5a 50000 6 0x5a 50000
WPA 101 1 0x5a 2 0x5a 3 0x5a 4 0x5a 5 0x5a 6 0x5a
RBT
```

5. Close PITerminal.
6. Switch off the controller.

Operating the hexapod with a separate 12 V power adapter

1. Connect the hexapod to the controller and the 12 V power supply:

   Follow the instructions in "Connecting the hexapod to the controller" (p. 28); do **not**, however, connect the hexapod's power supply cable to the 24 V output of the controller but to the 12 V power supply instead. See figure for an example.



2. Plug the power cord of the 12 V power supply into the power socket.
3. Start up the controller (see user manual of the controller).
4. Start a few motion cycles for testing purposes (refer to the user manual for the controller).

Resetting to 24 V operation

If the hexapod is to be supplied by the controller's 24 V output again, proceed as follows:

1. Switch off the controller.
2. Disconnect the hexapod from the C-501.12060M12 power supply.
3. Switch on the controller.
4. Use the program PITerminal to establish communication between the controller and the PC via the TCP/IP interface or the RS-232 interface.

5. Send the following commands to adapt the controller's settings permanently to the hexapod's 24 V supply:

   `SVO X 0`

   `CCL 1 advanced`

   `SPA 1 0x19004000 1`

   `WPA 101 1 0x19004000`

   `SPA 1 0x5a 80000 2 0x5a 80000 3 0x5a 80000 4 0x5a 80000 5 0x5a 80000 6 0x5a 80000`

   `WPA 101 1 0x5a 2 0x5a 3 0x5a 4 0x5a 5 0x5a 6 0x5a`

6. Close PITerminal.
7. Switch off the controller.
8. If there is an M12 screw plug, remove it from the controller's 24 V output (**24 V Out 7 A**).
9. Connect the hexapod to the 24 V output of the controller. Refer to "Connecting the hexapod to the controller" (p. 28) for further information.

7 Maintenance

PI offers a range of wraparound services for all their products, many of which are designed to increase the system’s lifetime and uptime:

- Remote system setup: An expert ensures that your system is optimized and runs perfectly.
- Return-to-base preventative maintenance programs: Proactive verification of your system’s condition and performance.
- Customer training: Ensures that the system continues to perform optimally throughout its lifetime.

Contact your PI representative to learn more about PI’s wraparound service benefits.

NOTICE

Damage due to improper maintenance

The hexapod can become misaligned as a result of improper maintenance. The specifications can change as a result.

➢ Only loosen screws according to the instructions in this manual.

Depending on the operating conditions and the period of use of the hexapod, the following maintenance measures are required.

7.1 Performing a Maintenance Run

Frequent motion over a limited travel range can cause the lubricant to be distributed unevenly on the drive screw.

➢ Perform a maintenance run over the entire travel range at regular intervals (see user manual of the controller). The more often motion is performed over a limited travel range, the shorter the time has to be between the maintenance runs.

7.2 Cleaning the Hexapod

Requirements

✓ You have disconnected the hexapod from the controller.

Cleaning the hexapod

Only when the hexapod is **not** used in vacuum:

- If necessary, clean the surfaces of the hexapod with a cloth that is dampened with a mild cleanser or disinfectant.

Only when the hexapod is used in vacuum:

- Touch the hexapod only with powder-free gloves.
- If necessary, wipe the hexapod clean.

7.3 Transporting and Packing the Hexapod

NOTICE

Mechanical overload due to incorrect handling
For models of the H-811 that are delivered with a transport safeguard, the following applies:

An impermissible mechanical load on the H-811 due to transportation without a transport safeguard can damage the H-811 and lead to loss of precision.

- Transport the H-811 only with the transport safeguard attached.

NOTICE

Impermissible mechanical load
An impermissible mechanical load can damage the hexapod.

- Only send the hexapod in the original packaging.
- Only hold the hexapod by the transport safeguard (if present) or the base plate.

NOTICE

Damage from applying high forces
Hexapod struts with direct drive can be carefully moved by hand in the case of an error. Blocked struts can be damaged by the use of force.

- If one or more struts of the hexapod are blocked, do **not** move the hexapod by hand.
- If you move the hexapod by hand, do not use high forces.

7.3.1 Preparing the hexapod for uninstallation

1. Command hexapod motion to the transport position:

   X = Y = Z = U = V = W = 0

2. Switch the controller off.

7.3.2 Mounting the transport safeguard

For models supplied with the transport safeguard installed, the transport safeguard must first be mounted.

The maximum torque for tightening the screws is 2 Nm.

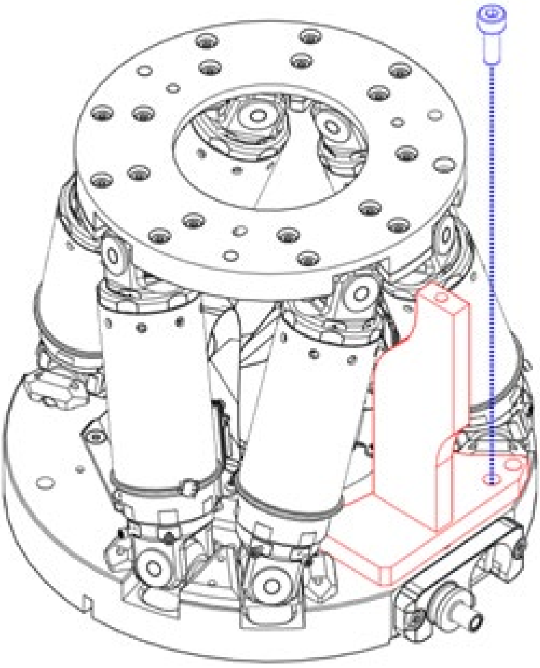
Tools and accessories

- Transport safeguard, incl. mounting screws
- Hex key AF 3

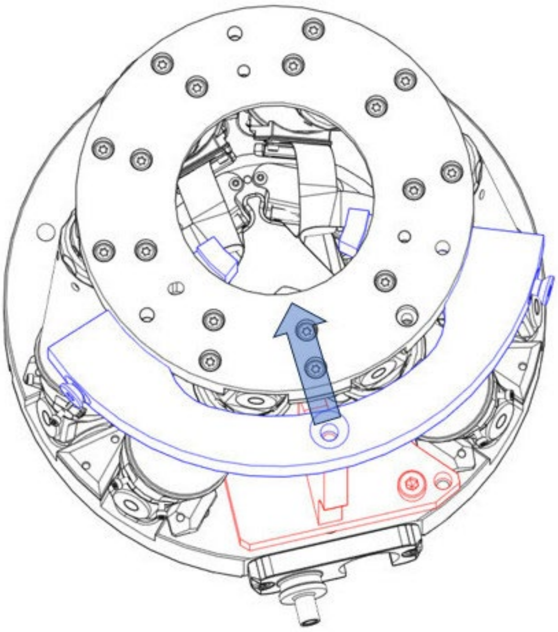
Mounting the transport safeguard (if applicable)

For a better overview, the hexapod is shown in the following figures unmounted, without grounding, mounted load, and connecting cables.

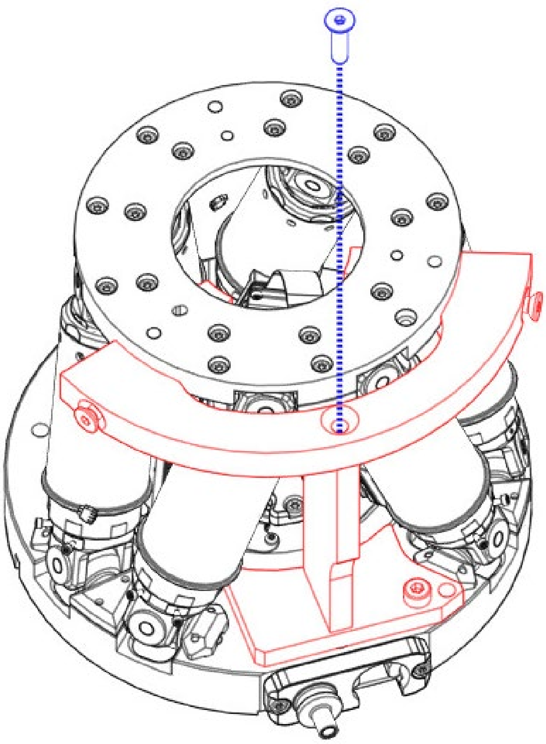
1. Place the lower part of the transport safeguard on the base plate of the hexapod and tighten it with the socket head screw.



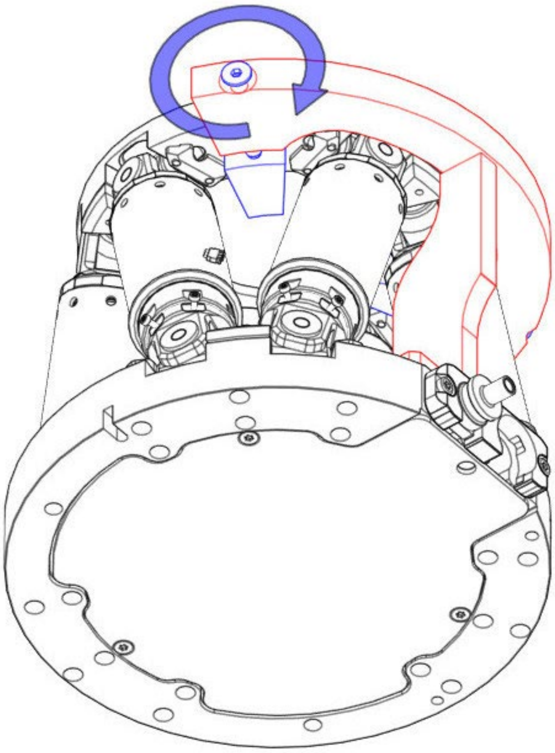
2. Place the upper part of the transport safeguard on the lower part so that the hole for the upper mounting screw is located precisely over the corresponding hole in the lower part.



3. Screw the upper part of the transport safeguard tightly to the lower part using the mounting screw.



4. Left side: Screw the upper part of the transport safeguard to the holding block using the lateral mounting screw.



5. Repeat step 4 for the right side.

7.3.3 Uninstalling the hexapod

1. Remove the load from the motion platform of the hexapod.
2. Remove the data transmission cable and the power supply cable from the controller.
3. Loosen all connections between the cables attached permanently to the hexapod and the cable set used, and remove the cables from all attachments (e.g., connector holder (p. 25)).
4. Remove the hexapod from the underlying surface.

7.3.4 Packing the hexapod

Accessory

- Original packaging (p. 17)

Packing the hexapod

➢ Proceed as described in H811T0001 (in the scope of delivery (p. 17)).

8 Troubleshooting

Fault: Unexpected hexapod behavior	
Possible causes	**Remedial measures**
■ Defective cable ■ Bent pin ■ Connector or soldered joints loosened	➢ Check the data transmission and power supply cables. ➢ Replace the cables by cables of the same type and test the function of the hexapod. ➢ Contact our customer service department (p. 53).

Fault: Hexapod does not achieve the specified repeatability	
Possible causes	**Troubleshooting**
■ Motion platform is warped ■ Warped base plate	➢ Mount the hexapod on an even surface (p. 23). ➢ Only mount loads with a flat surface. The recommended flatness of the surface is 20 µm.
■ Poor lubrication because of small motions over a long period of time	➢ Perform a maintenance run over the entire travel range (p. 43).
■ External disturbances	➢ Make sure that no vibrations are transmitted to the system. ➢ Make sure that no forces, e.g., also through dragged cables, affect the movement of the cover plate. ➢ Make sure that the system is in a thermal equilibrium.

Fault: Travel accuracy is poor	
Possible causes	**Remedial measures**
■ Unsuitable control parameters for the application ■ The system behavior has changed due to an increasing ease of operation.	➢ Carry out a tuning of the parameters. ➢ Contact our customer service department (p. 53).

Fault: Hexapod does not move	
Possible causes	**Remedial measures**
▪ Foreign body has entered the drive spindle ▪ Faulty motor ▪ Sensor defective ▪ Blocked or broken joint ▪ Load too big	➢ Carry out a strut test (refer to the user manual for the controller). The strut test should be carried out in the reference position, unless the malfunction occurs with maximum or minimum displacement of the platform in Z. ➢ Contact our customer service department (p. 53).
▪ The mechanics is not supplied with voltage.	➢ Check the power supply cable. ➢ If applicable, check the power adapter of the mechanics. ➢ Check the Power Good signal of the hexapod. Options: – In PIMikroMove, open the Diagnostic Information window by selecting the C-887 > Show diagnostic information... menu item. – Send the `DIA?` command. Meaning of the displayed information: ▪ 1 (Hexapod Powered): – = 1 - power supply for the drives of the hexapod exists – = 0 - power supply for the drives of the hexapod has been interrupted ▪ 2 (controller E-Stop activated): – = 1 - 24-V output of the C-887.5xx controller is active – = 0 - 24-V output of the C-887.5xx controllers is inactive For further information, refer to the user manual for the C-887.5xx controller.
▪ The servo mode was switched off due to a malfunction.	1. Send the `SVO?` command to check the activation state of the servo mode. 2. Send the `ERR?` command and check the error code that is returned. For details on possible error codes and their causes, see "Protective Functions of the C-887" in the user manual of the C-887.5xx controller.
▪ Controller with **E-Stop** socket: Connection of the E-Stop socket prevents motion from being triggered	➢ Connect the E-Stop socket with external hardware according to the requirements of your application, e.g., with the C887B0038 shorting plug. For details, see "Using the E-Stop Socket" in the user manual of the C-887.5xx controller. ➢ Check the Power Good signal and the activation state of the 24-V output for the hexapod (24 V Out 7 A). Options: – In PIMikroMove, open the ***Diagnostic Information*** window by selecting the C-887 > Show diagnostic information... menu item.

Fault: Hexapod does not move	
Possible causes	**Remedial measures**
	– Send the `DIA?` command. Meaning of the displayed information: ▪ 1 (Hexapod Powered): – = 1 - power supply for the drives of the hexapod exists – = 0 - power supply for the drives of the hexapod has been interrupted ▪ 2 (controller E-Stop activated): – = 1 - 24-V output of the C-887.5xx controller is active – = 0 - 24-V output of the C-887.5xx controllers is inactive For further information, refer to the user manual for the C-887.5xx controller.
▪ Incorrect or missing configuration data	➢ Connect the hexapod only when the controller is switched off. ➢ When the firmware has finished booting, send the `CST?` command to check whether the installed configuration has to be activated by rebooting the controller. A reboot is necessary when the response is "NOSTAGE" for the X, Y, Z, U, V, and W axes. The controller can be rebooted with the `RBT` command. ➢ Send the `ERR?` command. If the response to `ERR?` contains the error code 233 or 211, the configuration for the new hexapod is not in the controller. Contact our customer service department in order to receive a suitable configuration file. For the installation of the new configuration file, see "Updating Firmware and Configuration Files". ➢ Send the `VER?` command to check the information for the hexapod type, serial number, and manufacturing date saved on the ID chip. Example of the response: IDChip: H-811.F2 SN123456789 20/1/2016 Send the `CST?` command. The response shows the hexapod, to which the controller is adapted. ➢ If the hexapod does not have an ID chip, you must load the suitable configuration manually if needed. For further information, refer to the user manual for the C-887.5xx controller.
▪ The motion platform is located at a position outside the travel range limits. Commanding a permitted target position generates error code 7 ("Position out of limits").	1. Send the `ERR?` command and check the error code that is returned. 2. Send the `POS?` command to check the current position of the motion platform. If error code 7 is reported and the current position is outside the travel range limits for at least one axis, the following steps

Fault: Hexapod does not move	
Possible causes	**Remedial measures**
	are necessary depending on the sensor type of the hexapod (incremental or absolute measuring). ➢ Use the `FRF` command to set the target positions to the current position values.

Fault: Hexapod does not start a referencing move	
Possible causes	**Remedial measures**
▪ Motion is generally not possible	➢ Check if one of the causes mentioned in the "Hexapod does not move" section applies to your problem.

If the problem with your hexapod is not listed here or cannot be solved as described, contact our customer service department (p. 53).

9 Customer Service

For inquiries and orders, contact your PI representative or send us an email (mailto:service@pi.de).

- If you have questions concerning your system, provide the following information:
  - Product and serial numbers of all products in the system
  - Firmware version of the controller (if applicable)
  - Version of the driver or the software (if applicable)
  - PC operating system (if applicable)

If possible: Take photographs or make videos of your system that can be sent to our customer service if requested.

10 Technical Data

Subject to change. You can find the latest product specifications on the product web page at www.pi.ws (https://www.physikinstrumente.com/en/).

10.1 Specifications

10.1.1 H-811.F2

Motion	H-811.F2	Tolerance
Active axes	X | Y | Z | θX | θY | θZ	
Travel range in X	± 17 mm	
Travel range in Y	± 16 mm	
Travel range in Z	± 6.5 mm	
Rotation range in θX	± 10°	
Rotation range in θY	± 10°	
Rotation range in θZ	± 21°	
Maximum velocity in X	20 mm/s	
Maximum velocity in Y	20 mm/s	
Maximum velocity in Z	20 mm/s	
Maximum angular velocity in θX	500 mrad/s	
Maximum angular velocity in θY	500 mrad/s	
Maximum angular velocity in θZ	500 mrad/s	
Typical velocity in X	10 mm/s	
Typical velocity in Y	10 mm/s	
Typical velocity in Z	10 mm/s	
Typical angular velocity in θX	250 mrad/s	
Typical angular velocity in θY	250 mrad/s	
Typical angular velocity in θZ	250 mrad/s	

Positioning	H-811.F2	Tolerance
Minimum incremental motion in X	0.2 µm	typ.
Minimum incremental motion in Y	0.2 µm	typ.
Minimum incremental motion in Z	0.08 µm	typ.
Minimum incremental motion in θX	2 µrad	typ.

Positioning	H-811.F2	Tolerance
Minimum incremental motion in θY	2 µrad	typ.
Minimum incremental motion in θZ	3 µrad	typ.
Unidirectional repeatability in X	± 0.15 µm	typ.
Unidirectional repeatability in Y	± 0.15 µm	typ.
Unidirectional repeatability in Z	± 0.06 µm	typ.
Unidirectional repeatability in θX	± 2 µrad	typ.
Unidirectional repeatability in θY	± 2 µrad	typ.
Unidirectional repeatability in θZ	± 3 µrad	typ.
Backlash in X	0.2 µm	typ.
Backlash in Y	0.2 µm	typ.
Backlash in Z	0.06 µm	typ.
Backlash in θX	2 µrad	typ.
Backlash in θY	2 µrad	typ.
Backlash in θZ	3 µrad	typ.
Integrated sensor	Incremental rotary encoder	

Drive properties	H-811.F2	Tolerance
Drive type	Brushless DC motor	

Mechanical properties	H-811.F2	Tolerance
Stiffness in X	0.7 N/µm	
Stiffness in Y	0.7 N/µm	
Stiffness in Z	8 N/µm	
Maximum load capacity, base plate in any orientation	2.5 kg	
Maximum load capacity, base plate horizontal	5 kg	
Maximum holding force, base plate in any orientation	2 N	
Maximum holding force, base plate horizontal	12 N	
Overall mass	2.2 kg	
Material	Stainless steel, aluminum	

Miscellaneous	H-811.F2	Tolerance
Operating temperature range	0 to 50 °C	
Connector for data transmission	HD D-sub 78 (m)	
Connector for supply voltage	M12 4-pole (m)	
Cable length	0.5 m	
Outer diameter power supply cable	4.95 mm	
Minimum bending radius for fixed installation, power supply	25 mm	
Outer diameter data transmission cable	9.5 mm	
Minimum bending radius for fixed installation, data transmission	95 mm	
Recommended controllers / drivers	C-887.5x	

10.1.2 H-811.I2

Motion	H-811.I2	Tolerance
Active axes	X | Y | Z | θX | θY | θZ	
Travel range in X	± 17 mm	
Travel range in Y	± 16 mm	
Travel range in Z	± 6.5 mm	
Rotation range in θX	± 10°	
Rotation range in θY	± 10°	
Rotation range in θZ	± 21°	
Maximum velocity in X	20 mm/s	
Maximum velocity in Y	20 mm/s	
Maximum velocity in Z	20 mm/s	
Maximum angular velocity in θX	500 mrad/s	
Maximum angular velocity in θY	500 mrad/s	
Maximum angular velocity in θZ	500 mrad/s	
Typical velocity in X	10 mm/s	
Typical velocity in Y	10 mm/s	
Typical velocity in Z	10 mm/s	
Typical angular velocity in θX	250 mrad/s	
Typical angular velocity in θY	250 mrad/s	
Typical angular velocity in θZ	250 mrad/s	

Positioning	H-811.I2	Tolerance
Minimum incremental motion in X	0.2 µm	typ.
Minimum incremental motion in Y	0.2 µm	typ.
Minimum incremental motion in Z	0.08 µm	typ.
Minimum incremental motion in θX	2.5 µrad	typ.
Minimum incremental motion in θY	2.5 µrad	typ.
Minimum incremental motion in θZ	5 µrad	typ.
Unidirectional repeatability in X	± 0.15 µm	typ.
Unidirectional repeatability in Y	± 0.15 µm	typ.
Unidirectional repeatability in Z	± 0.06 µm	typ.
Unidirectional repeatability in θX	± 2 µrad	typ.
Unidirectional repeatability in θY	± 2 µrad	typ.
Unidirectional repeatability in θZ	± 3 µrad	typ.
Backlash in X	0.2 µm	typ.
Backlash in Y	0.2 µm	typ.
Backlash in Z	0.06 µm	typ.
Backlash in θX	2 µrad	typ.
Backlash in θY	2 µrad	typ.
Backlash in θZ	4 µrad	typ.

Drive properties	H-811.I2	Tolerance
Drive type	Brushless DC motor	

Mechanical properties	H-811.I2	Tolerance
Stiffness in X	0.7 N/µm	
Stiffness in Y	0.7 N/µm	
Stiffness in Z	8 N/µm	
Maximum load capacity, base plate in any orientation	2.5 kg	
Maximum load capacity, base plate horizontal	5 kg	
Maximum holding force, base plate in any orientation	2.5 N	
Maximum holding force, base plate horizontal	15 N	
Overall mass	2.2 kg	
Material	Stainless steel, aluminum	

Miscellaneous	H-811.I2	Tolerance
Operating temperature range	0 to 50 °C	
Connector for data transmission	HD D-sub 78 (m)	
Connector for supply voltage	M12 4-pole (m)	
Cable length	0.5 m	
Outer diameter power supply cable	4.95 mm	
Minimum bending radius for fixed installation, power supply	25 mm	
Outer diameter data transmission cable	9.5 mm	
Minimum bending radius for fixed installation, data transmission	95 mm	
Recommended controllers / drivers	C-887.5x	

10.1.3 H-811.I2V

Motion	H-811.I2V	Tolerance
Active axes	X | Y | Z | θX | θY | θZ	
Travel range in X	± 17 mm	
Travel range in Y	± 16 mm	
Travel range in Z	± 6.5 mm	
Rotation range in θX	± 10°	
Rotation range in θY	± 10°	
Rotation range in θZ	± 21°	
Maximum velocity in X	10 mm/s	
Maximum velocity in Y	10 mm/s	
Maximum velocity in Z	10 mm/s	
Maximum angular velocity in θX	250 mrad/s	
Maximum angular velocity in θY	250 mrad/s	
Maximum angular velocity in θZ	250 mrad/s	
Typical velocity in X	5 mm/s	
Typical velocity in Y	5 mm/s	
Typical velocity in Z	5 mm/s	
Typical angular velocity in θX	120 mrad/s	
Typical angular velocity in θY	120 mrad/s	
Typical angular velocity in θZ	120 mrad/s	

Positioning	H-811.I2V	Tolerance
Minimum incremental motion in X	0.2 µm	typ.
Minimum incremental motion in Y	0.2 µm	typ.
Minimum incremental motion in Z	0.08 µm	typ.
Minimum incremental motion in θX	2.5 µrad	typ.
Minimum incremental motion in θY	2.5 µrad	typ.
Minimum incremental motion in θZ	5 µrad	typ.
Unidirectional repeatability in X	± 0.15 µm	typ.
Unidirectional repeatability in Y	± 0.15 µm	typ.
Unidirectional repeatability in Z	± 0.06 µm	typ.
Unidirectional repeatability in θX	± 2 µrad	typ.
Unidirectional repeatability in θY	± 2 µrad	typ.
Unidirectional repeatability in θZ	± 3 µrad	typ.
Backlash in X	0.2 µm	typ.
Backlash in Y	0.2 µm	typ.
Backlash in Z	0.06 µm	typ.
Backlash in θX	2 µrad	typ.
Backlash in θY	2 µrad	typ.
Backlash in θZ	4 µrad	typ.

Drive properties	H-811.I2V	Tolerance
Drive type	Brushless DC motor	

Mechanical properties	H-811.I2V	Tolerance
Stiffness in X	0.7 N/µm	
Stiffness in Y	0.7 N/µm	
Stiffness in Z	8 N/µm	
Maximum load capacity, base plate in any orientation	2.5 kg	
Maximum load capacity, base plate horizontal	5 kg	
Maximum holding force, base plate in any orientation	2.5 N	
Maximum holding force, base plate horizontal	15 N	
Overall mass	2.2 kg	

Mechanical properties	H-811.I2V	Tolerance
Material	Stainless steel, aluminum	

Miscellaneous	H-811.I2V	Tolerance
Operating temperature range	0 to 50 °C	
Vacuum class	10^{-6} | hPa	
Maximum bakeout temperature	80 °C	
Connector for data transmission	HD D-sub 78 (m)	
Connector for supply voltage	LEMO	
Cable length	2 m	
Outer diameter power supply cable	4.7 mm	
Minimum bending radius for fixed installation, power supply	50 mm	
Outer diameter data transmission cable	6.6 mm	
Minimum bending radius for fixed installation, data transmission	70 mm	
Recommended controllers / drivers	C-887.5x	

10.1.4 H-811.S2

Motion	H-811.S2	Tolerance
Active axes	X | Y | Z | θX | θY | θZ	
Travel range in X	± 17 mm	
Travel range in Y	± 16 mm	
Travel range in Z	± 6.5 mm	
Rotation range in θX	± 10°	
Rotation range in θY	± 10°	
Rotation range in θZ	± 21°	
Maximum velocity in X	25 mm/s	
Maximum velocity in Y	25 mm/s	
Maximum velocity in Z	25 mm/s	
Maximum angular velocity in θX	625 mrad/s	
Maximum angular velocity in θY	625 mrad/s	
Maximum angular velocity in θZ	625 mrad/s	
Typical velocity in X	10 mm/s	
Typical velocity in Y	10 mm/s	

Motion	H-811.S2	Tolerance
Typical velocity in Z	10 mm/s	
Typical angular velocity in θX	250 mrad/s	
Typical angular velocity in θY	250 mrad/s	
Typical angular velocity in θZ	250 mrad/s	
Amplitude-frequency product in X	11.99 mm·Hz	
Amplitude-frequency product in Y	10.88 mm·Hz	
Amplitude-frequency product in Z	4.2 mm·Hz	
Amplitude-frequency product in θX	6.36 °·Hz	
Amplitude-frequency product in θY	6.45 °·Hz	
Amplitude-frequency product in θZ	16.23 °·Hz	
Amplitude-frequency^2 product in X	72 mm·Hz^2	
Amplitude-frequency^2 product in Y	57.3 mm·Hz^2	
Amplitude-frequency^2 product in Z	24 mm·Hz^2	
Amplitude-frequency^2 product in θX	52 °·Hz^2	
Amplitude-frequency^2 product in θY	28.5 °·Hz^2	
Amplitude-frequency^2 product in θZ	138.5 °·Hz^2	
Amplitude error	10 %	max.
Phase error	60 °	max.
Maximum frequency	30 Hz	

Positioning	H-811.S2	Tolerance
Minimum incremental motion in X	1 µm	typ.
Minimum incremental motion in Y	1 µm	typ.
Minimum incremental motion in Z	0.5 µm	typ.
Minimum incremental motion in θX	12 µrad	typ.
Minimum incremental motion in θY	12 µrad	typ.
Minimum incremental motion in θZ	25 µrad	typ.
Unidirectional repeatability in X	± 0.5 µm	typ.
Unidirectional repeatability in Y	± 0.5 µm	typ.
Unidirectional repeatability in Z	± 0.2 µm	typ.
Unidirectional repeatability in θX	± 6 µrad	typ.
Unidirectional repeatability in θY	± 6 µrad	typ.
Unidirectional repeatability in θZ	± 10 µrad	typ.
Backlash in X	0.5 µm	typ.
Backlash in Y	0.5 µm	typ.

Positioning	H-811.S2	Tolerance
Backlash in Z	0.15 µm	typ.
Backlash in θX	5 µrad	typ.
Backlash in θY	5 µrad	typ.
Backlash in θZ	10 µrad	typ.
Integrated sensor	Incremental rotary encoder	

Drive properties	H-811.S2	Tolerance
Drive type	Brushless DC motor	

Mechanical properties	H-811.S2	Tolerance
Stiffness in X	0.7 N/µm	
Stiffness in Y	0.7 N/µm	
Stiffness in Z	8 N/µm	
Maximum load capacity, base plate in any orientation	0.9 kg	
Maximum load capacity, base plate horizontal	2.5 kg	
Maximum holding force, base plate in any orientation	2.5 N	
Maximum holding force, base plate horizontal	15 N	
Overall mass	2.2 kg	
Material	Stainless steel, aluminum	

Miscellaneous	H-811.S2	Tolerance
Operating temperature range	0 to 50 °C	
Connector for data transmission	HD D-sub 78 (m)	
Connector for supply voltage	M12 4-pole (m)	
Cable length	0.5 m	
Outer diameter power supply cable	4.95 mm	
Minimum bending radius for fixed installation, power supply	25 mm	
Outer diameter data transmission cable	9.5 mm	
Minimum bending radius for fixed installation, data transmission	95 mm	
Recommended controllers / drivers	C-887.5x	

10.1.5 H-811.S2IHP

Motion	H-811.S2IHP	Tolerance
Active axes	X | Y | Z | θX | θY | θZ	
Travel range in X	± 17 mm	
Travel range in Y	± 16 mm	
Travel range in Z	± 6.5 mm	
Rotation range in θX	± 10 °	
Rotation range in θY	± 10 °	
Rotation range in θZ	± 21 °	
Maximum velocity in X	20 mm/s	
Maximum velocity in Y	20 mm/s	
Maximum velocity in Z	20 mm/s	
Maximum angular velocity in θX	500 mrad/s	
Maximum angular velocity in θY	500 mrad/s	
Maximum angular velocity in θZ	500 mrad/s	
Typical velocity in X	10 mm/s	
Typical velocity in Y	10 mm/s	
Typical velocity in Z	10 mm/s	
Typical angular velocity in θX	240 mrad/s	
Typical angular velocity in θY	240 mrad/s	
Typical angular velocity in θZ	240 mrad/s	
Amplitude-frequency product in X	9.35 mm·Hz	
Amplitude-frequency product in Y	9.12 mm·Hz	
Amplitude-frequency product in Z	3.45 mm·Hz	
Amplitude-frequency product in θX	5 °·Hz	
Amplitude-frequency product in θY	5 °·Hz	
Amplitude-frequency product in θZ	12.6 °·Hz	
Amplitude-frequency² product in X	152 mm·Hz²	
Amplitude-frequency² product in Y	106 mm·Hz²	
Amplitude error	10 %	max.
Phase error	60 °	max.
Maximum frequency	30 Hz	

Positioning	H-811.S2IHP	Tolerance
Minimum incremental motion in X	0.04 µm	
Minimum incremental motion in Y	0.04 µm	
Minimum incremental motion in Z	0.02 µm	
Minimum incremental motion in θX	0.5 µrad	
Minimum incremental motion in θY	0.5 µrad	
Minimum incremental motion in θZ	0.75 µrad	
Unidirectional repeatability in X	± 0.2 µm	
Unidirectional repeatability in Y	± 0.2 µm	
Unidirectional repeatability in Z	± 0.1 µm	
Unidirectional repeatability in θX	± 2 µrad	
Unidirectional repeatability in θY	± 2 µrad	
Unidirectional repeatability in θZ	± 3 µrad	
Backlash in X	0.2 µm	typ.
Backlash in Y	0.2 µm	typ.
Backlash in Z	0.06 µm	typ.
Backlash in θX	2 µrad	typ.
Backlash in θY	2 µrad	typ.
Backlash in θZ	4 µrad	typ.

Drive properties	H-811.S2IHP	Tolerance
Drive type	Brushless DC motor	

Mechanical properties	H-811.S2IHP	Tolerance
Stiffness in X	0.7 N/µm	
Stiffness in Y	0.7 N/µm	
Stiffness in Z	8 N/µm	
Maximum load capacity, base plate in any orientation	1 kg	
Maximum load capacity, base plate horizontal	2.5 kg	
Maximum holding force, base plate horizontal	7.5 N	
Overall mass	2.3 kg	
Material	Stainless steel, aluminum	

Miscellaneous	H-811.S2IHP	Tolerance
Operating temperature range	0 to 40 °C	
Connector for data transmission	HD D-sub 78 (m)	
Connector for supply voltage	M12 4-pole (m)	
Cable length	0.5 m	
Outer diameter power supply cable	4.95 mm	
Minimum bending radius for fixed installation, power supply	25 mm	
Outer diameter data transmission cable	9.5 mm	
Minimum bending radius for fixed installation, data transmission	95 mm	
Recommended controllers / drivers	C-887.5x with BISS communication	

H-811.F2:
Scanning times: typical time span for scanning the entire area and moving to the highest intensity
The specified values for maximum payload and maximum holding force apply to the hexapod without the removable magnetic plate.

H-811.I2V:
Air-side connecting cables are not included in the scope of delivery and must be ordered separately.
Note on outer diameter data transmission cable: The data transmission connection consists of 2 cables that end in one connector. The specified diameter applies for each cable.
With continuous operation in a vacuum, heat generation may necessitate limiting the operating parameters.

H-811.S2IHP:
Note on amplitude-frequency^2 product in Z, ΘX, ΘY, ΘZ: no limitations

H-811 (except vacuum model):
The cables fixed to the H-811 are 0.5 m long respectively.
Connecting cables are not in the scope of delivery and must be ordered separately.

H-811:
The cables fixed to the H-811 are not suitable for drag chains.
When measuring position specifications, typical velocity is used. The data is included in the delivery of the product in the form of a measurement report and is stored at PI.
The maximum travel ranges of the individual coordinates (X, Y, Z, θX, θY, θZ) are interdependent. The data for each axis shows its maximum travel range when all other axes are in the zero position of the nominal travel range and the default coordinate system is in use, or rather when the pivot point is set to 0,0,0.

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.

10.1.6 Specifications for Vacuum-Compatible Models

Materials used	
Machine-made parts	> 95 % of the machine-made parts, i.e., base plate, struts, motion platform: AlMgSi (3.2315) and AlMg4.5Mn (3.3547) chemically nickel-plated, stainless steel type 303 (1.4305)

Materials used	
	Remaining parts, e.g., coupling elements: Various vacuum-compatible materials
Bearings	Stainless steel
Drive elements	Stainless steel (drive screw)
Electrical components	Cable insulation: PTFE (Teflon), FEP Shrink tube: PVDF (Kynar) Solder: Sn95.5Ag3.8Cu0.7 PCB (main board) Flexible printed circuit board (limit switch, pulse width modulation) Aramid insulating paper Polyimide film strip Connector: DD78 (Positronic), FFA type (LEMO)
Grease	Brayco Micronic 815Z, Fluorstatic
Sealing compound and adhesive	Araldite 2014-2, Loctite 243, Loctite 648, Loctite 3321

TeflonTM is a trademark of DuPont de Nemours, Inc.

Kynar® is a registered trademark of Arkema.

Brayco® is a registered trademark of Castrol Limited.

Araldite® is a registered trademark of Huntsman International LLC.

Loctite® is a registered trademark of Henkel AG & Co. KGaA.

10.1.7 Specifications for Data Transmission and Power Supply Cables

The following table lists the technical data of the data transmission and power supply cables (to be ordered separately).

General	C-815.82Dxx, C-815.82Pxxx	Unit
Cable length L	2 / 3 / 5 / 7.5 / 10 / 20	m
Maximum velocity	3	m/s
Maximum acceleration	5	m/s^2
Maximum number of bending cycles	1 million	
Operating temperature range	-10 to +70	°C

Data transmission cable	C-815.82Dxx	Unit
Minimum bending radius in a drag chain	107	mm
Minimum bending radius with the fixed installation	81	mm

Data transmission cable	**C-815.82Dxx**	**Unit**
Outer diameter	10.7	mm
Connectors	HD D-sub 78 m/f	

Power supply cable	**C-815.82.Pxxx**	**Unit**
Minimum bending radius in a drag chain	49	mm
Minimum bending radius with the fixed installation	25	mm
Outer diameter	4.9	mm
Connectors	M12 m/f	

10.2 Maximum Ratings

The hexapod is designed for the following operating data:

Maximum operating voltage	**Maximum operating frequency (unloaded)**	**Maximum current consumption**
24 V DC	⎓	5 A

10.3 Ambient Conditions and Classifications

Degree of pollution	2
Air pressure	1100 hPa to 780 hPa Vacuum-compatible models: 1100 hPa to 10^{-6} hPa
Transport temperature	–25 °C to +85 °C
Storage temperature	0 °C to 70 °C
Bakeout temperature	Vacuum-compatible models only: 80 °C (176 °F)
Humidity:	Highest relative humidity of 80% at temperatures of up to 31°C, decreasing linearly to a relative humidity of 50% at 40°C
Degree of protection according to IEC 60529	IP20
Area of application	For indoor use only
Maximum altitude	2000 m

10.4 Dimensions

10.4.1 H-811 Hexapod

dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

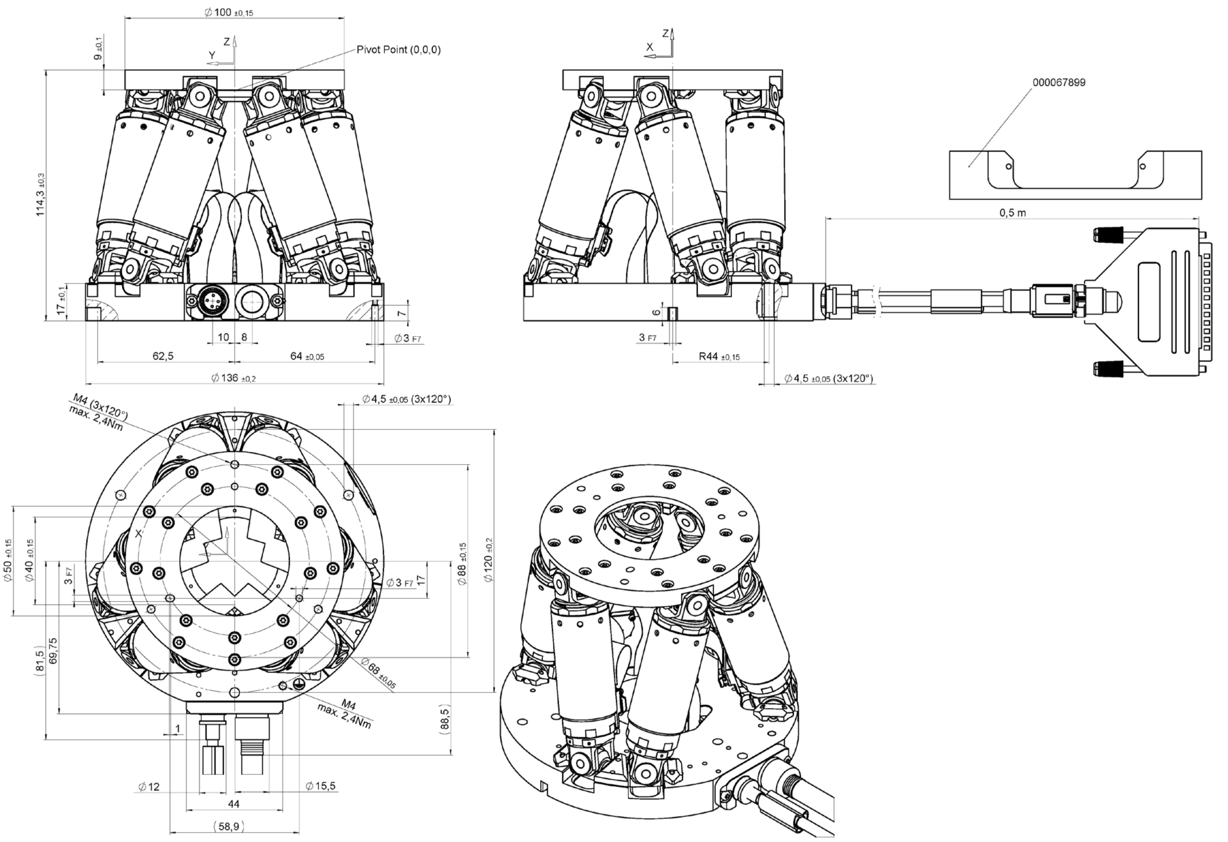


Figure 13: H-811.I2, at zero position of nominal travel range

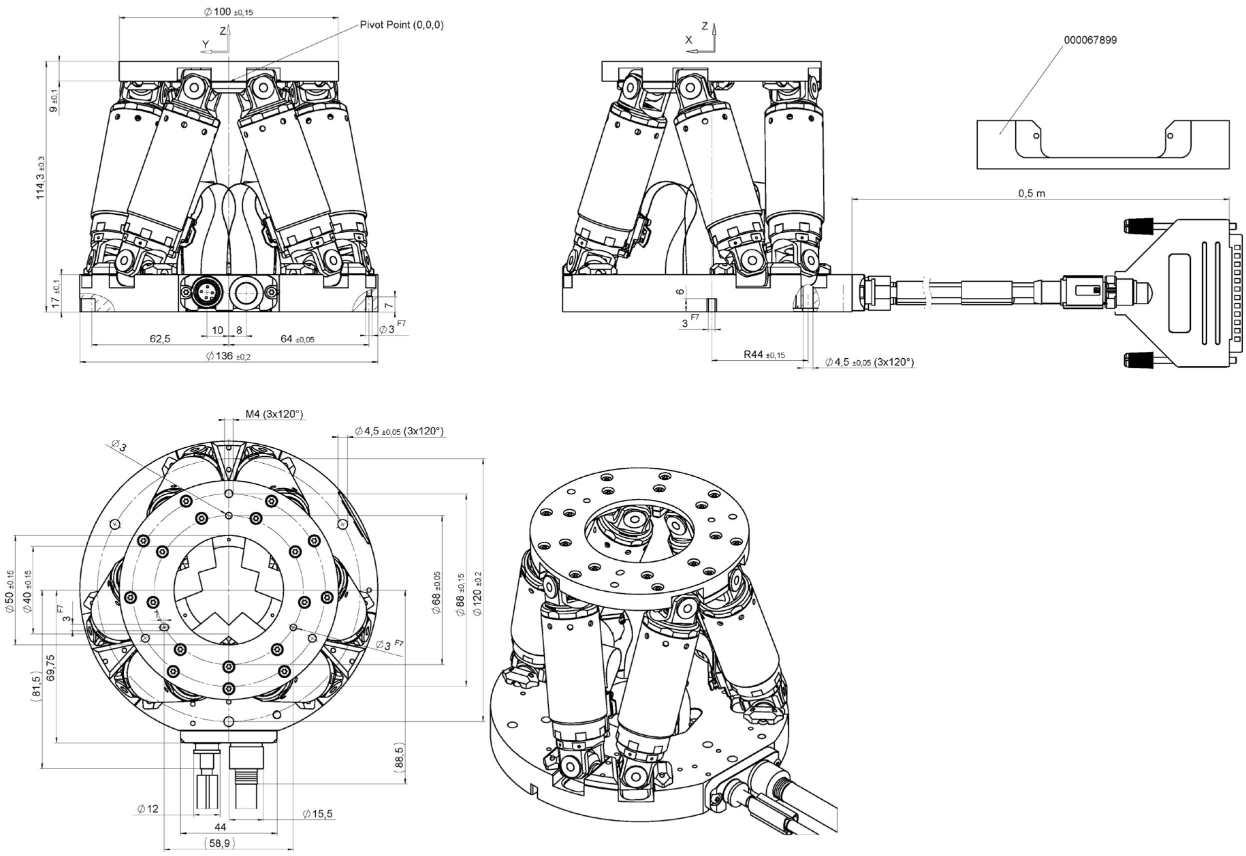


Figure 14: H-811.S2, at zero position of nominal travel range

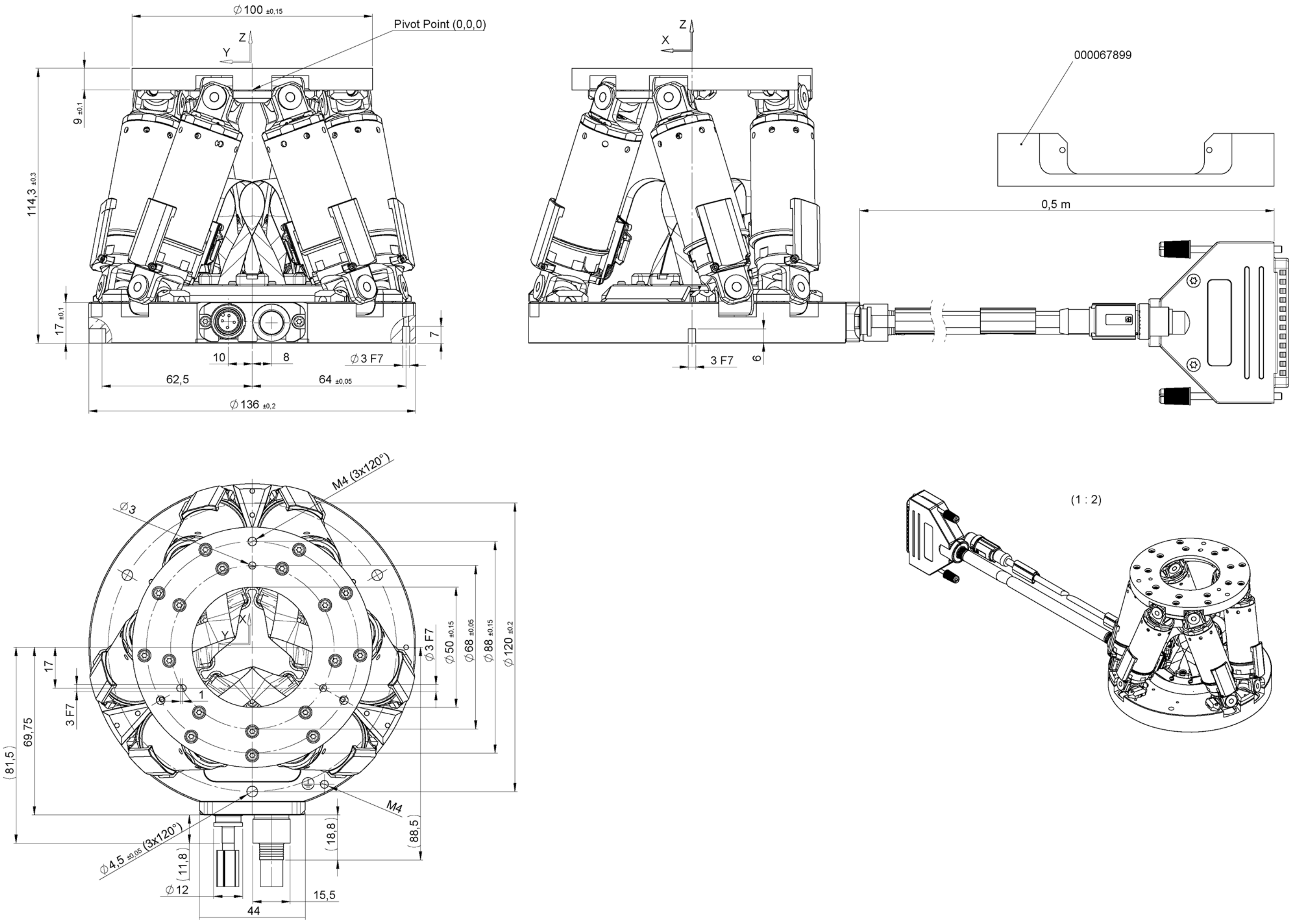


Figure 15: H-811.S2IHP, at zero position of nominal travel range

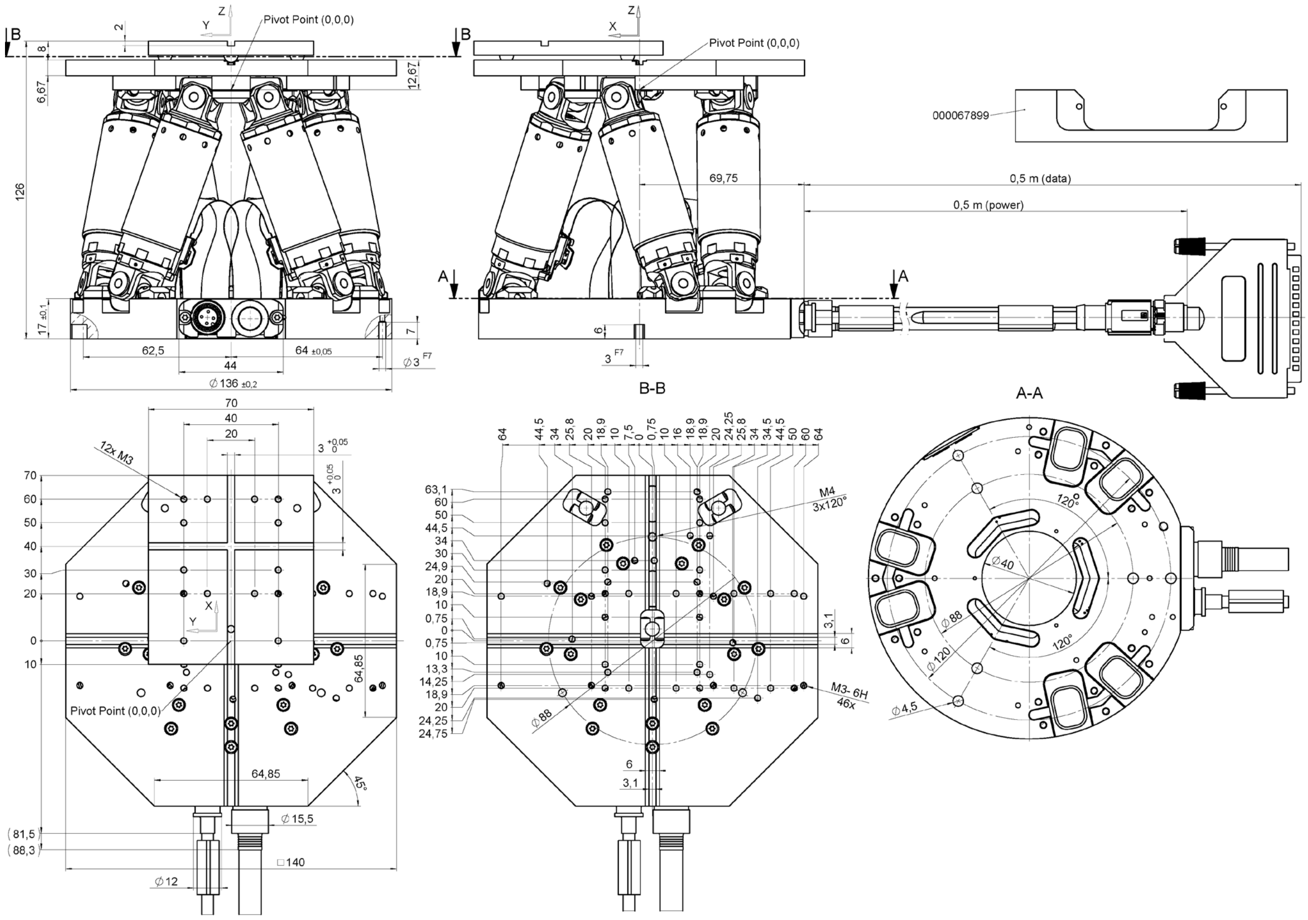


Figure 16: H-811.F2, at zero position of nominal travel range

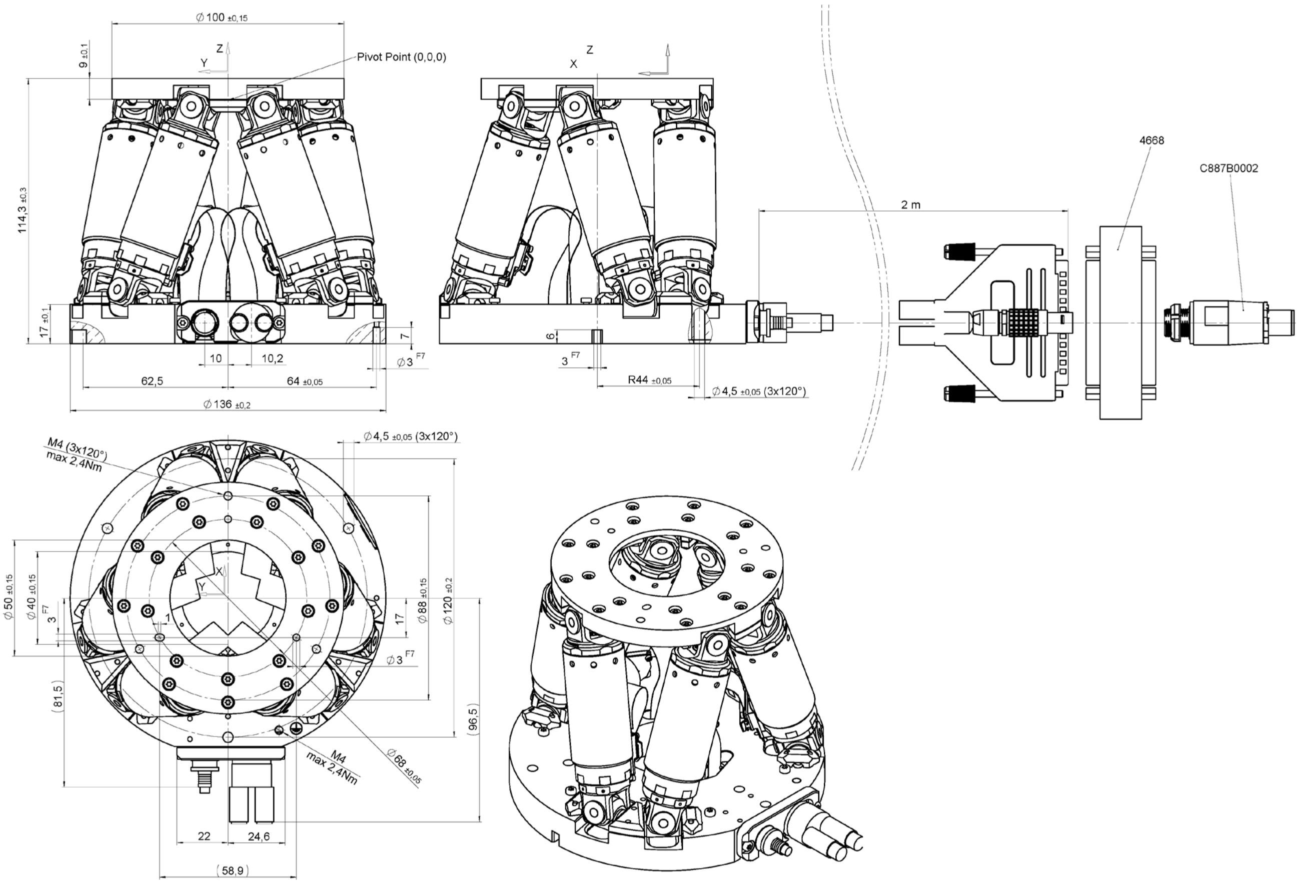


Figure 17: H-811.I2V, at zero position of nominal travel range

If the controller's factory settings are used for the coordinate system and the center of rotation, the hexapod in the figure corresponds to the position X=Y=Z=U=V=W=0.

The (0,0,0) coordinates indicate the origin of the coordinate system. When the default settings for the coordinate system and center of rotation are used, and the hexapod is at position X=Y=Z=U=V=W=0, the center of rotation is at the origin of the coordinate system.

10.4.2 000067899 Connector Holder

dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

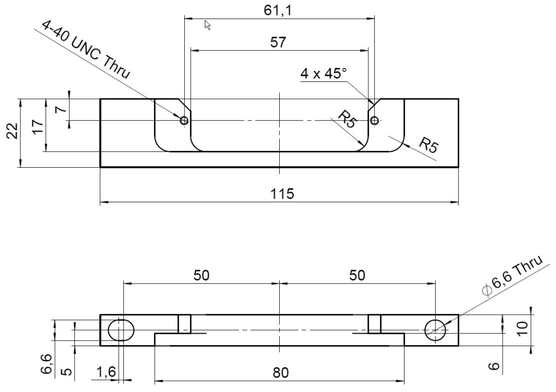


Figure 18: 000067899 connector holder for strain relief

10.5 Load Curves

The load curves in the following figures only apply when the hexapod is connected to the controller and the servo mode is switched on.

10.5.1 H-811.I2

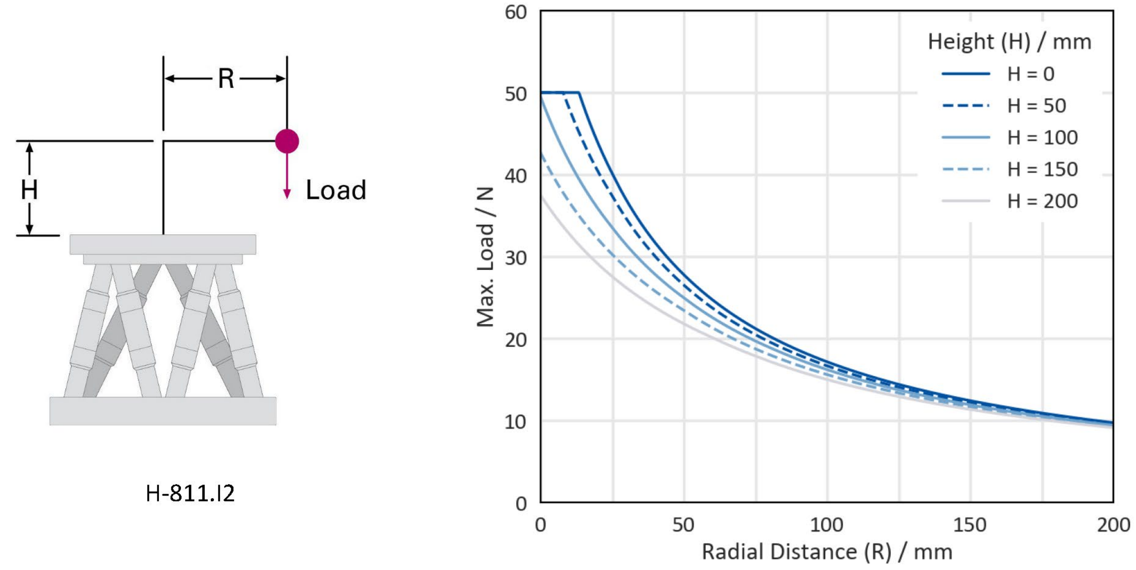


Figure 19: Maximum loads on the H-811.I2 when mounted horizontally

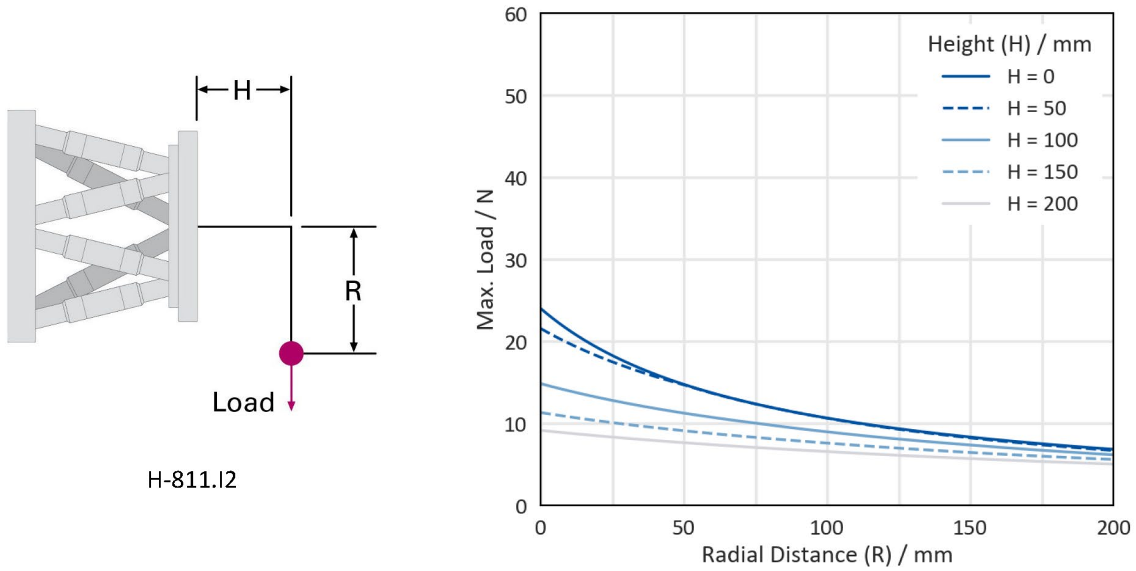


Figure 20: Maximum loads on the H-811.I2 when mounted vertically

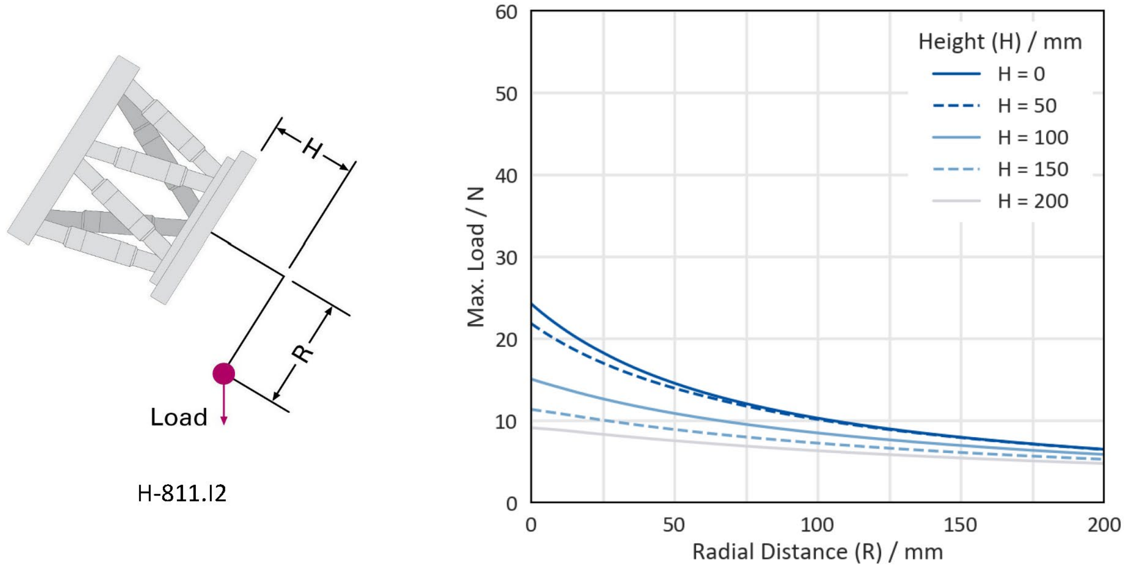


Figure 21: Maximum loads on the H-811.I2 when mounted at the most unfavorable angle

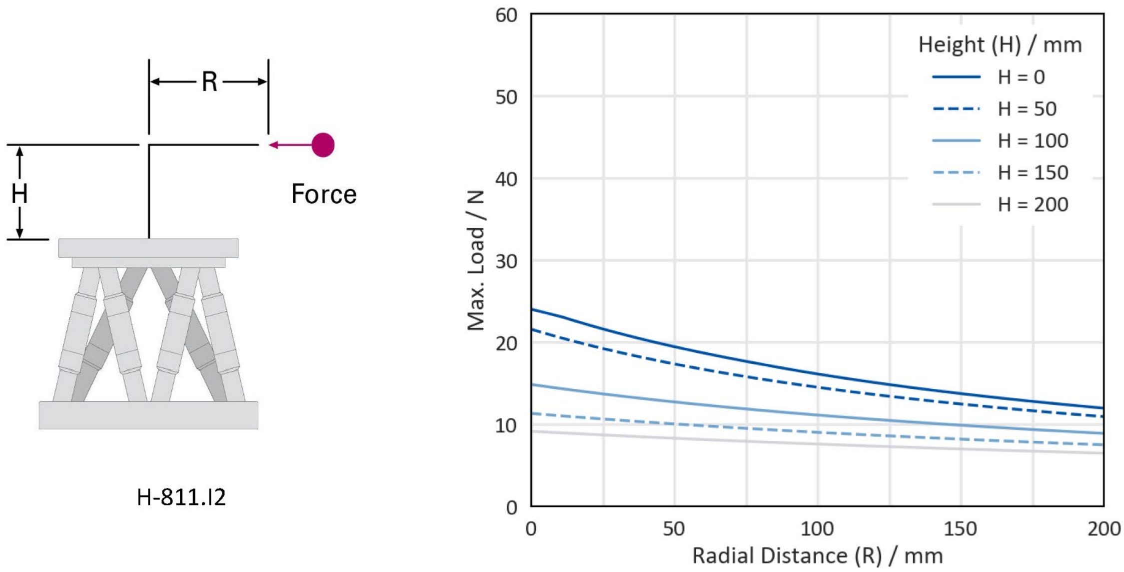


Figure 22: Maximum permissible force acting on the H-811.I2 when mounted horizontally

10.5.2 H-811.I2V

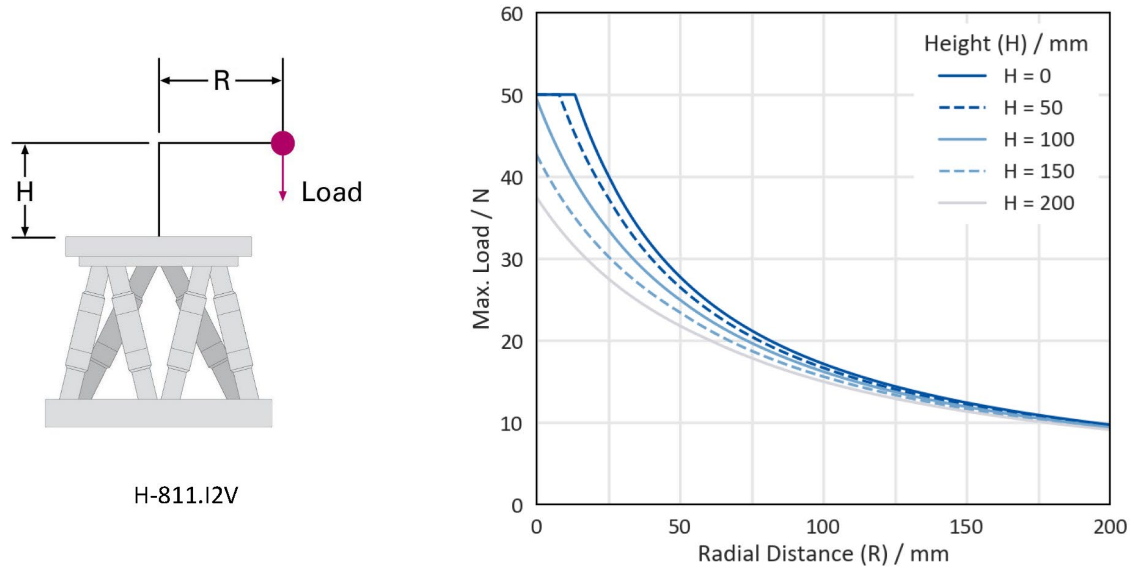


Figure 23: Maximum loads on the H-811.I2V when mounted horizontally

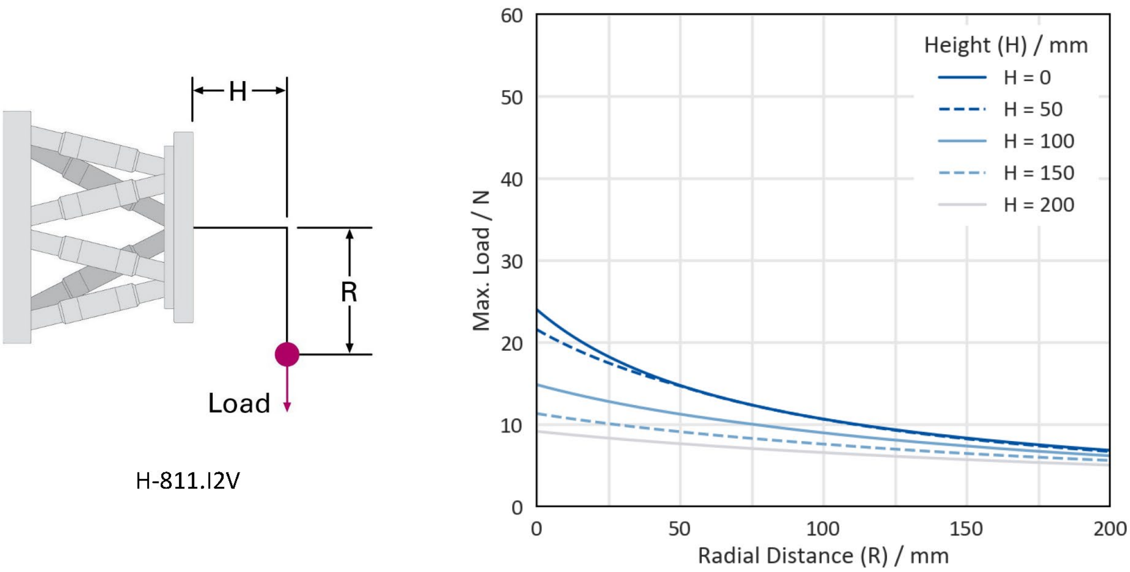


Figure 24: Maximum loads on the H-811.I2V when mounted vertically

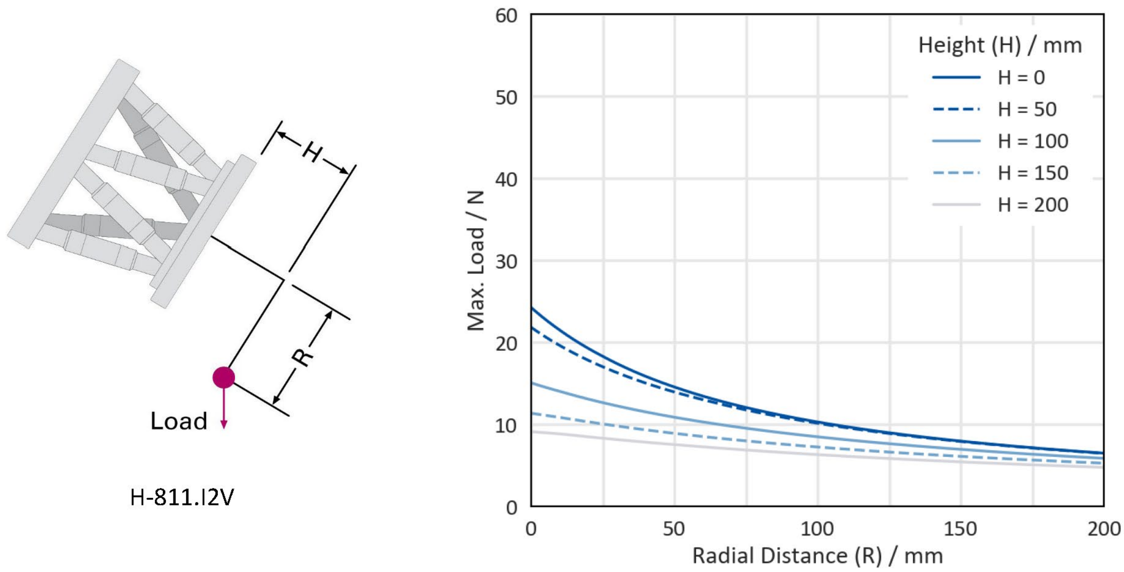


Figure 25: Maximum loads on the H-811.I2V when mounted at the most unfavorable angle

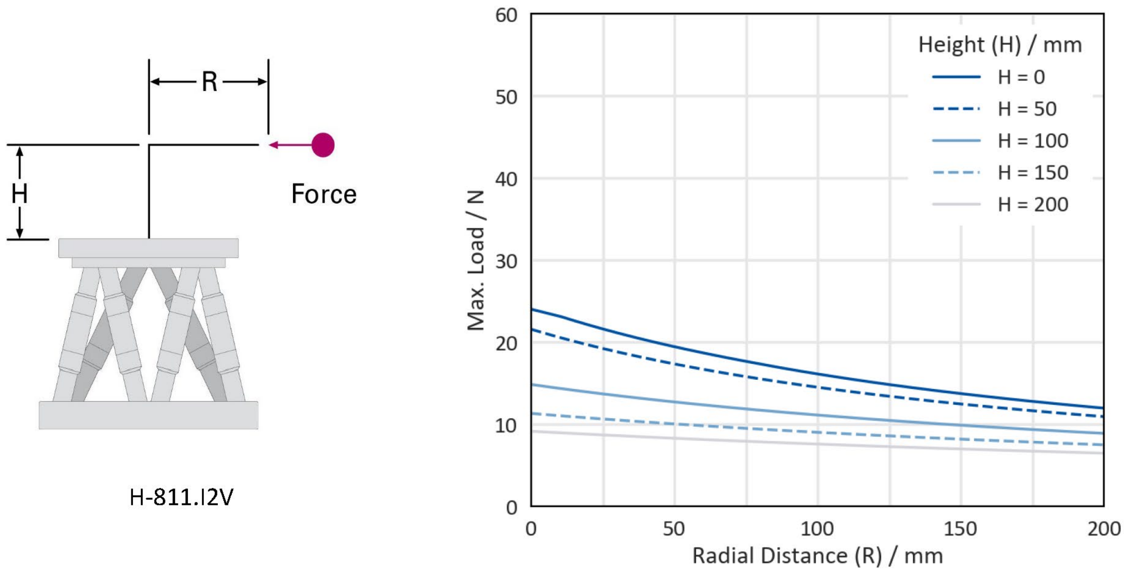
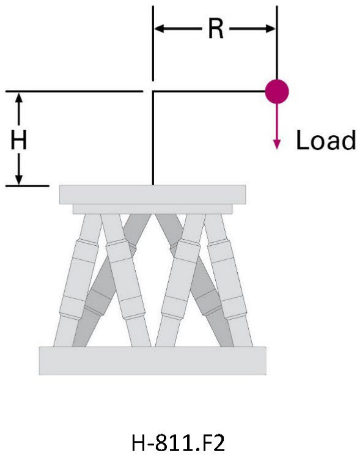


Figure 26: Maximum permissible force acting on the H-811.I2V when mounted horizontally

10.5.3 H-811.F2



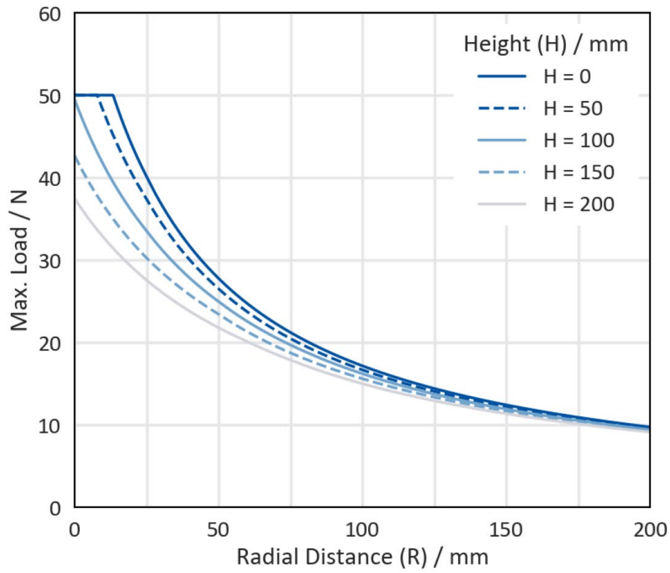
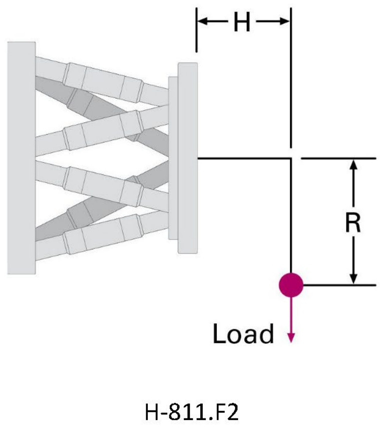


Figure 27: Maximum loads on the H-811.F2 when mounted horizontally



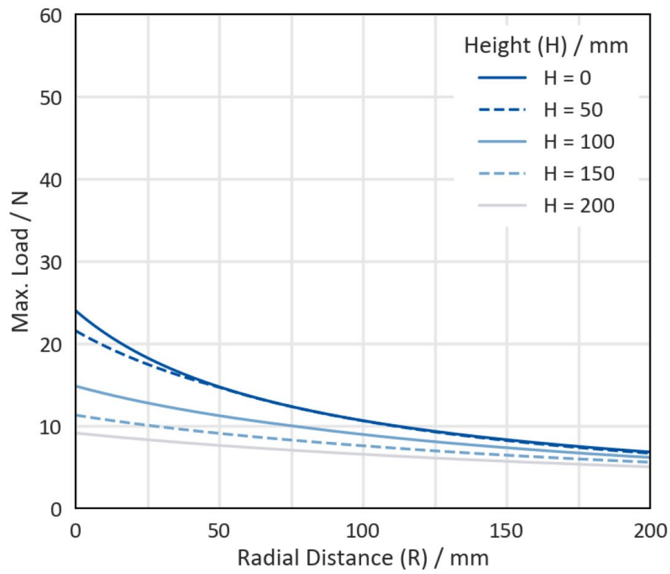


Figure 28: Maximum loads on the H-811.F2 when mounted vertically

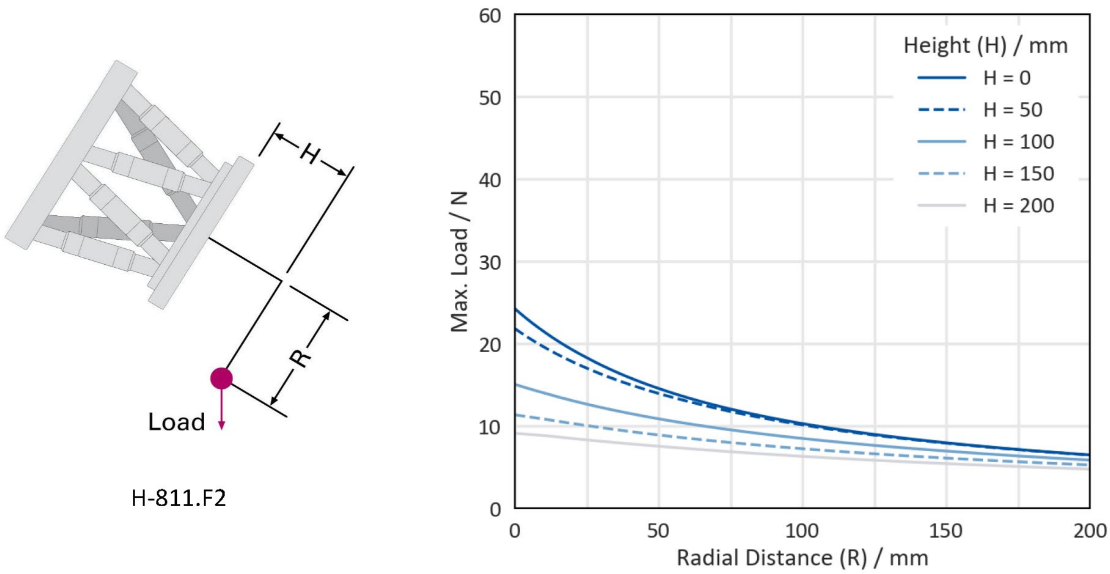


Figure 29: Maximum loads on the H-811.F2 when mounted at the most unfavorable angle

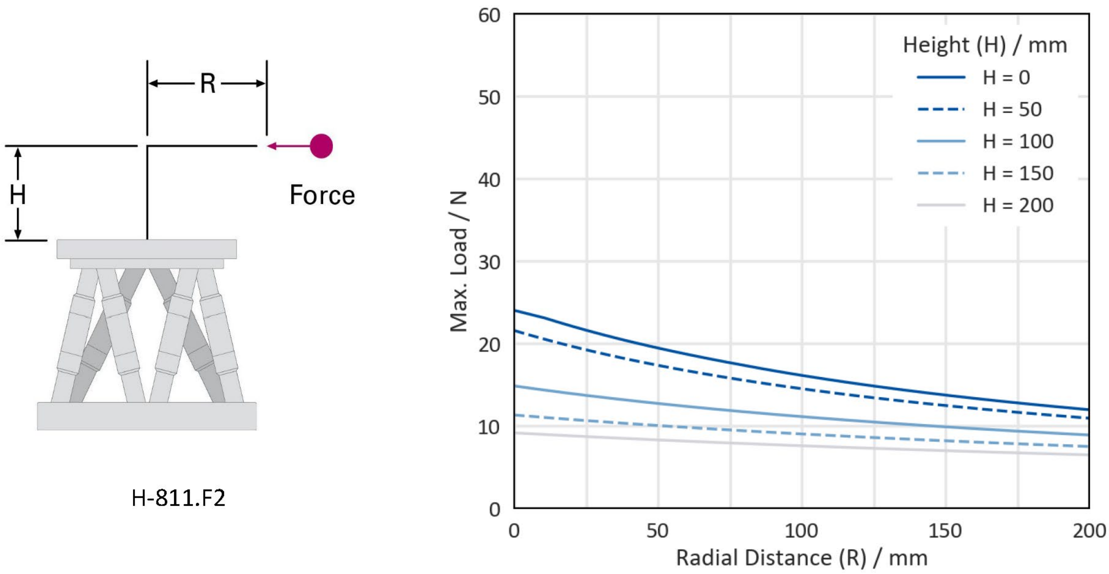


Figure 30: Maximum permissible force acting on the H-811.F2 when mounted horizontally

10.5.4 H-811.S2IHP

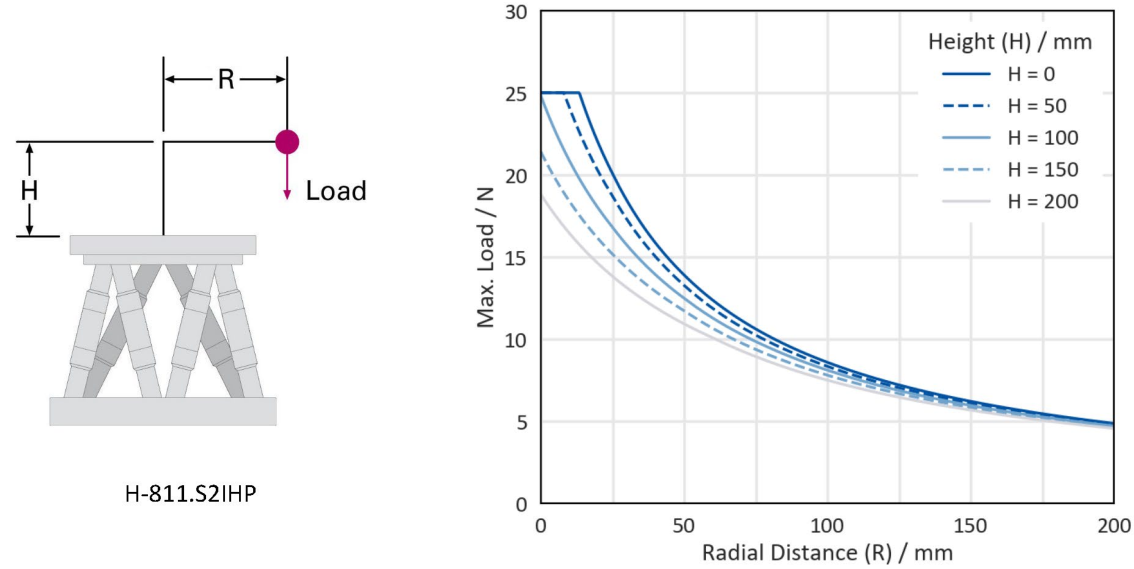


Figure 31: Maximum loads of the H-811.S2IHP when mounted horizontally

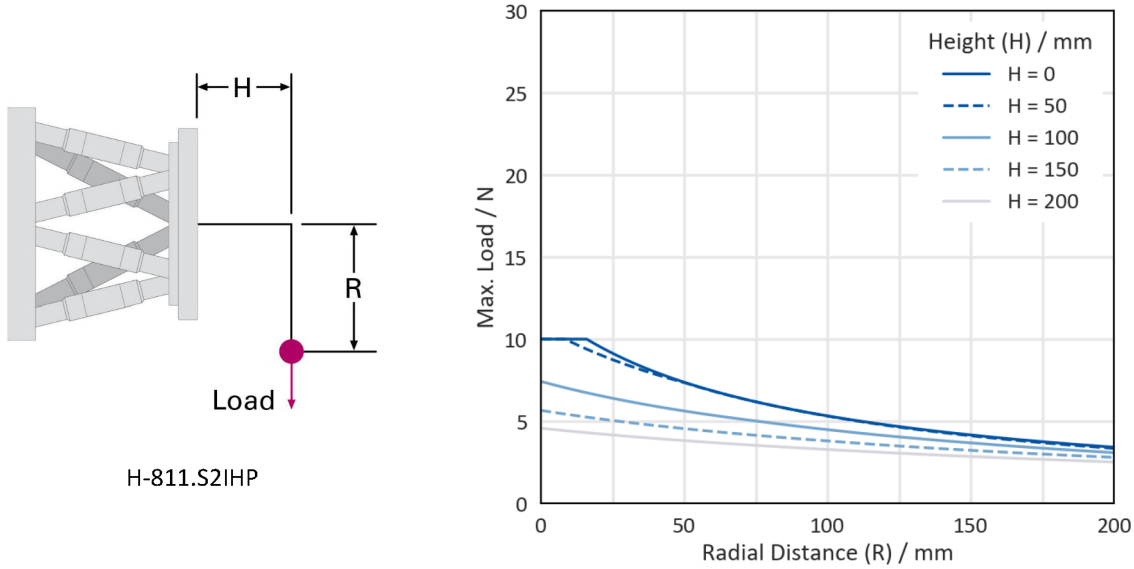


Figure 32: Maximum loads of the H-811.S2IHP when mounted vertically

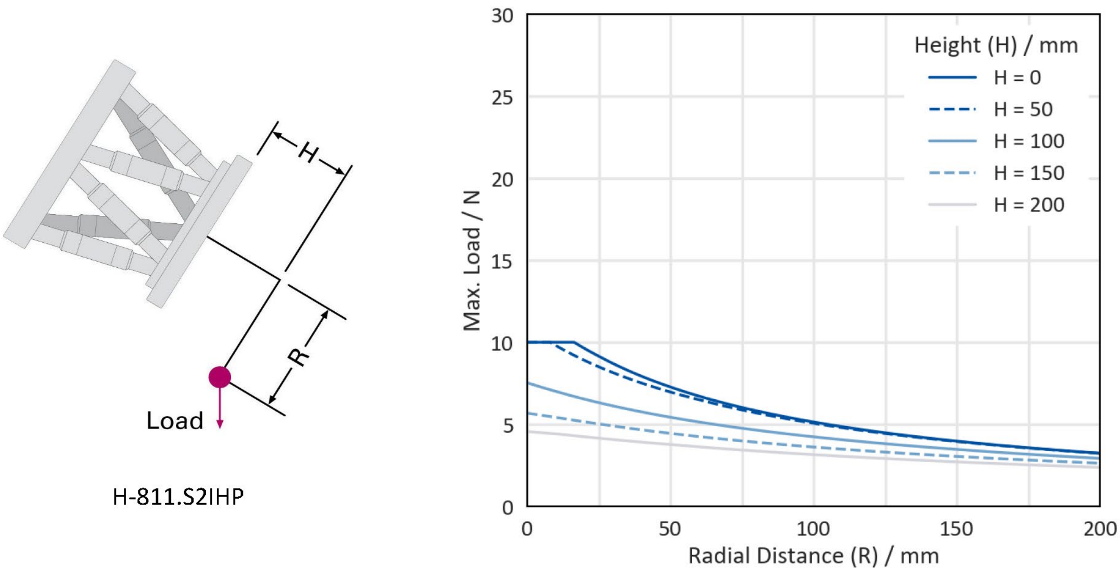


Figure 33: Maximum loads of the H-811.S2IHP when mounted at the most unfavorable angle

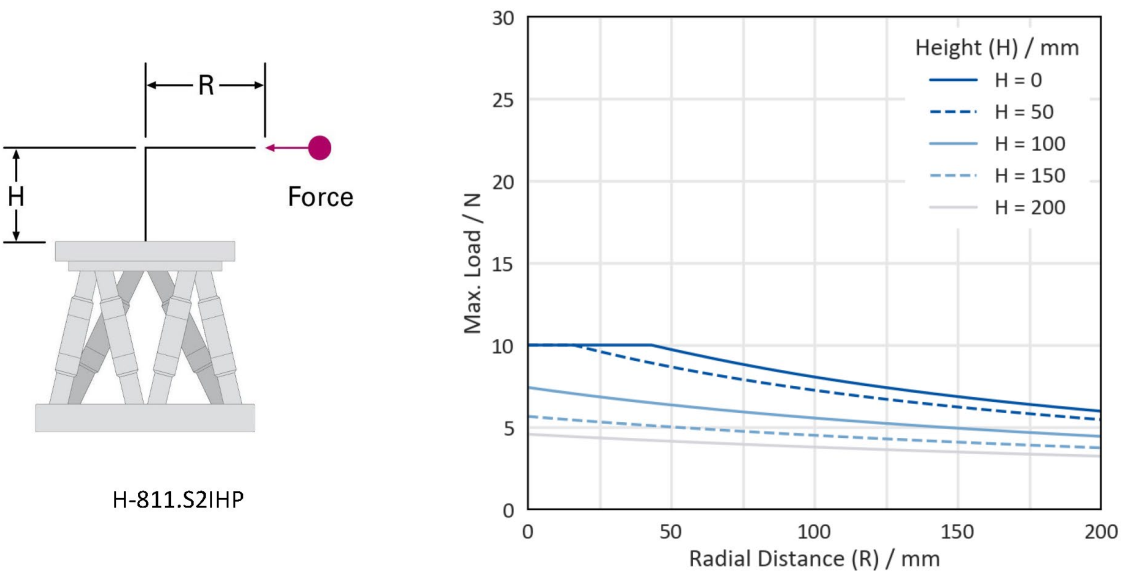


Figure 34: Maximum permissible force acting on the H-811.S2IHP when mounted horizontally

10.6 Dynamic Working Range

The graphs mark the dynamic working ranges of the H-811.S2 and H-811.S2IHP. The following requirements apply:

- A compact load is mounted centrically.
- The base plate of the hexapod is in the horizontal mounting position.
- A single-axis movement is always performed.

10.6.1 H-811.S2

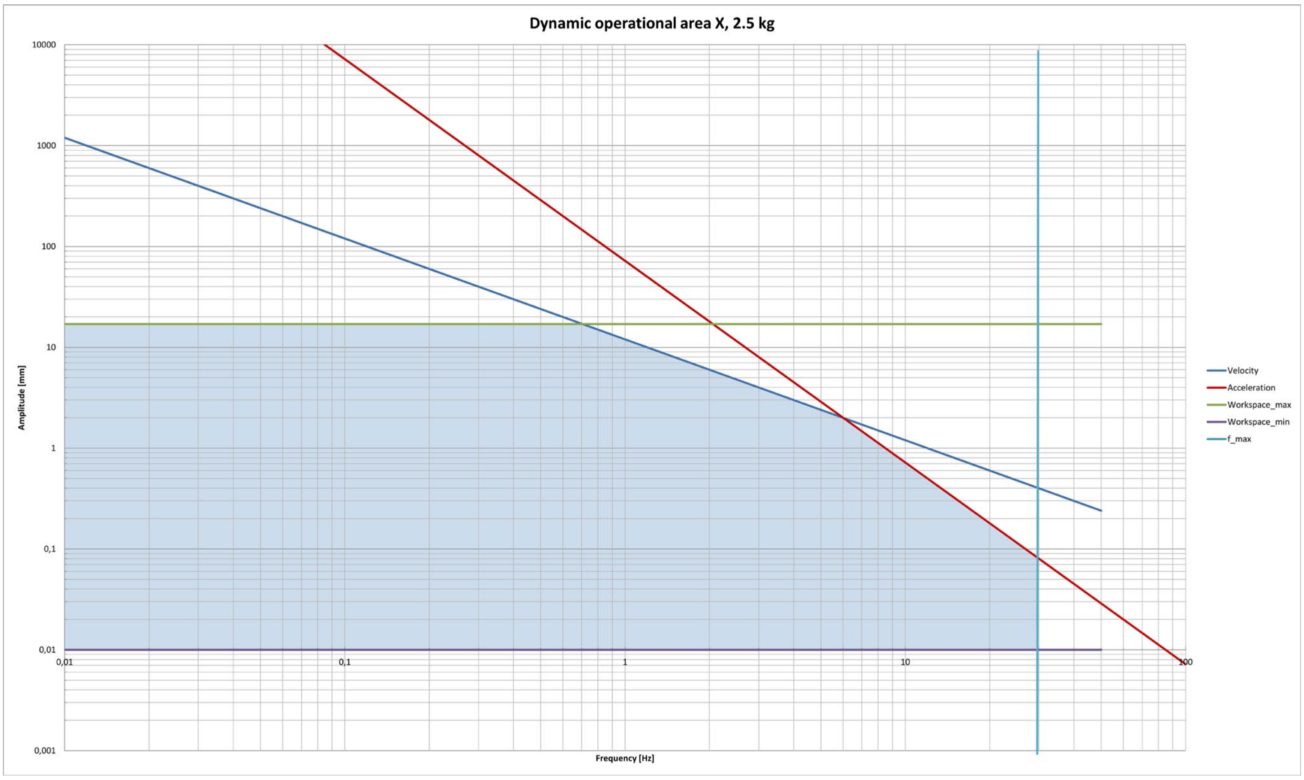


Figure 35: Dynamic working range of the H-811.S2, X, 2.5 kg

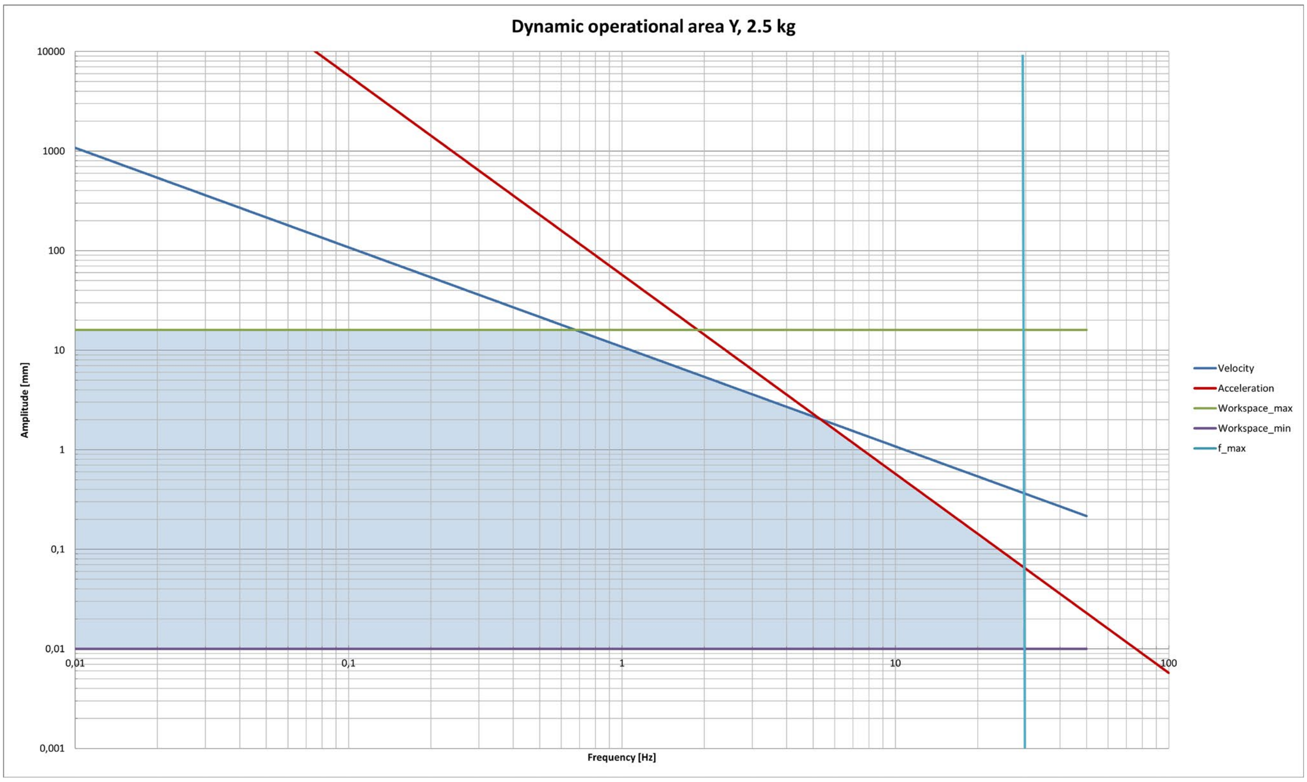


Figure 36: Dynamic working range of the H-811.S2, Y, 2.5 kg

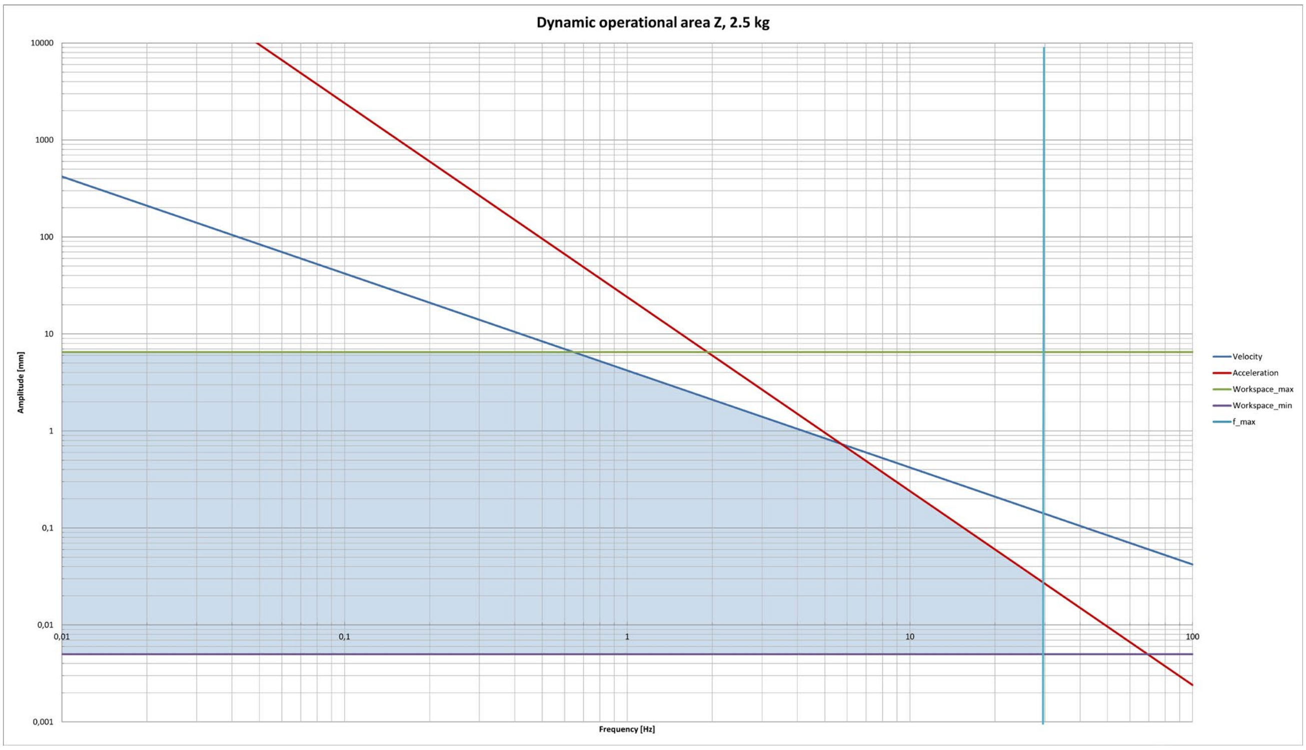


Figure 37: Dynamic working range of the H-811.S2, Z, 2.5 kg

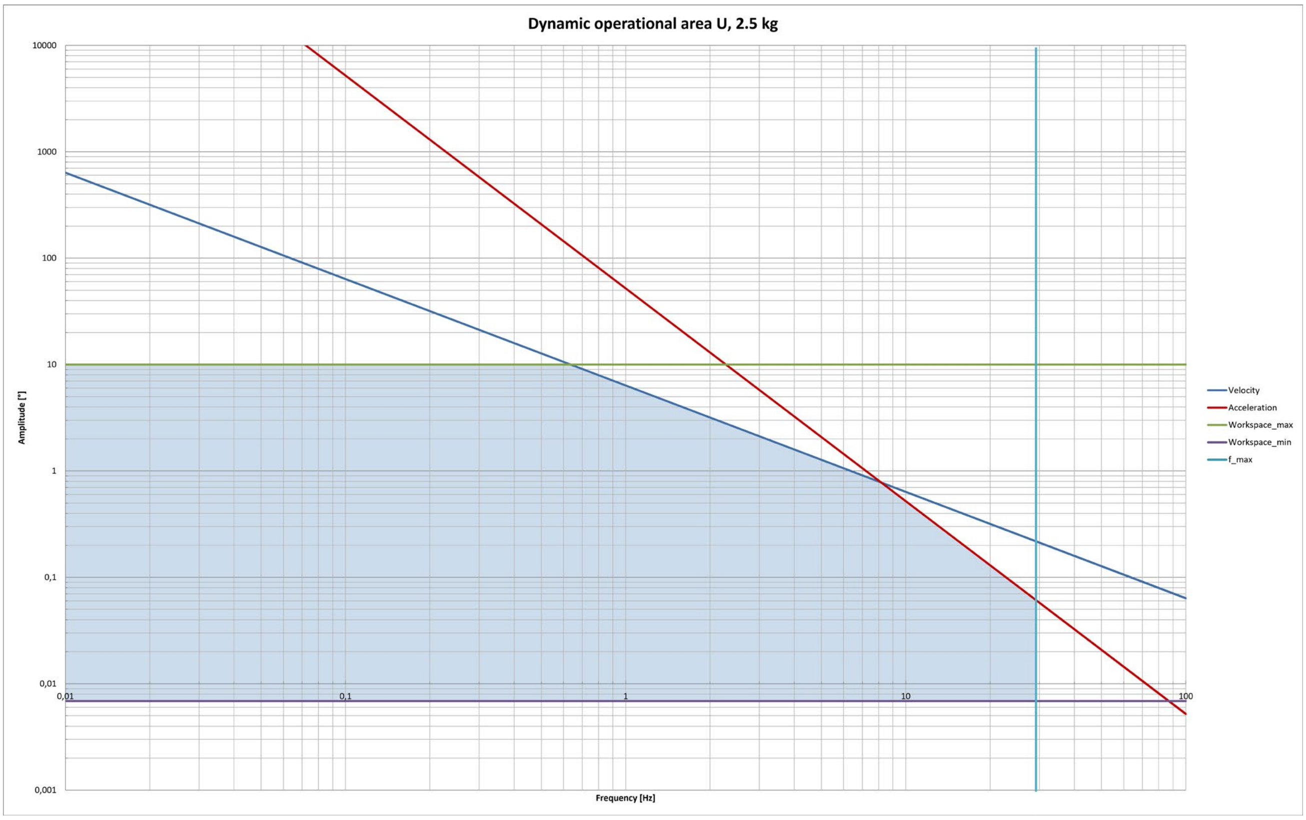


Figure 38: Dynamic working range of the H-811.S2, U (ΘX), 2.5 kg

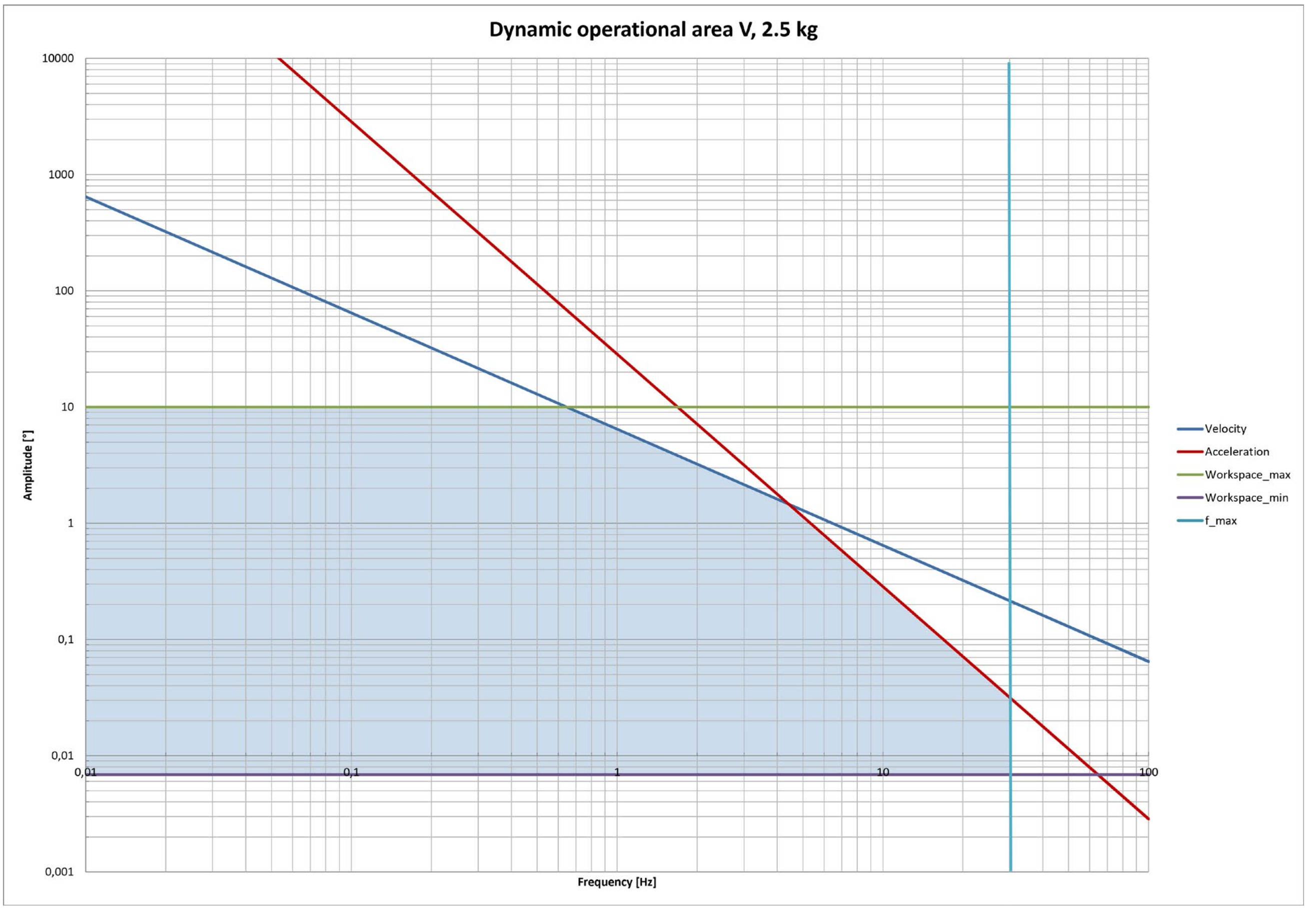


Figure 39: Dynamic working range of the H-811.S2, V (ΘY), 2.5 kg

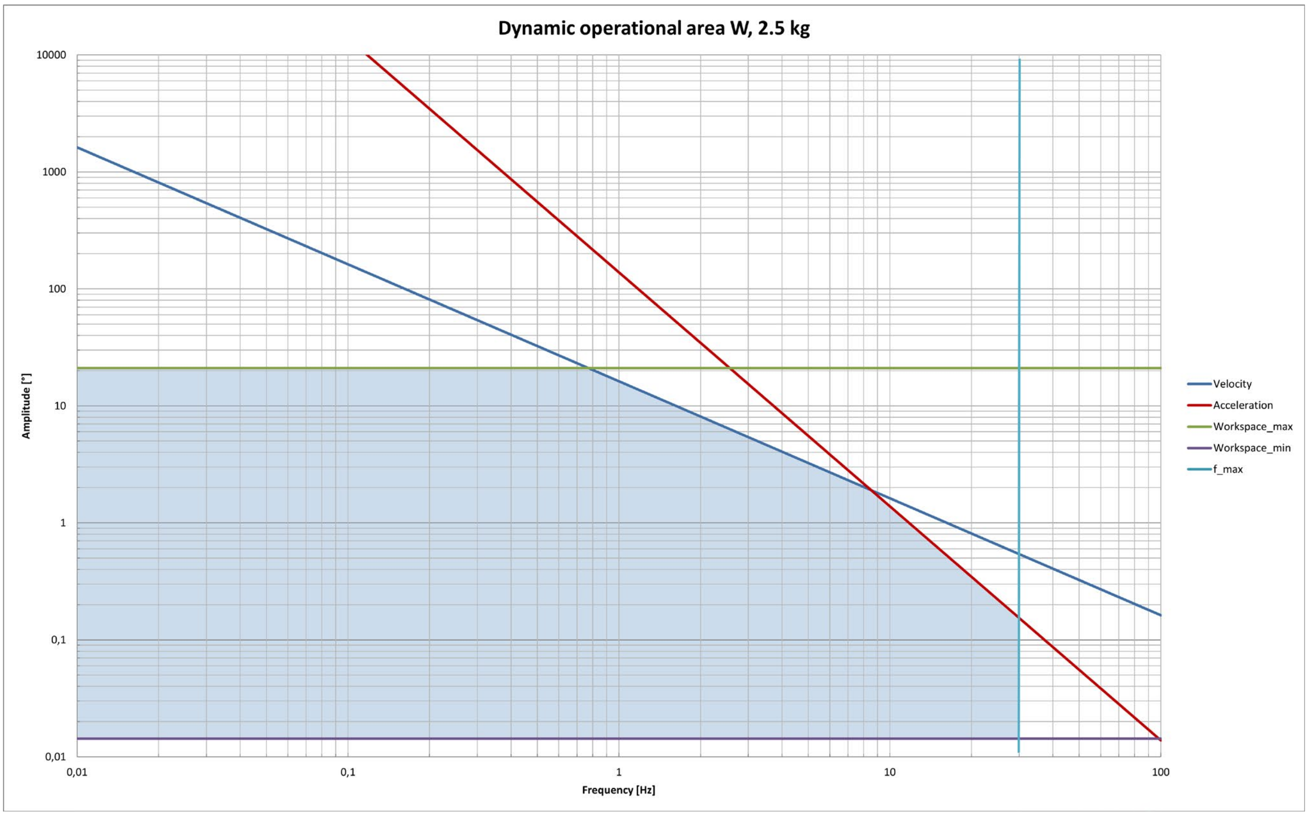


Figure 40: Dynamic working range of the H-811.S2, W (ΘZ), 2.5 kg

10.6.2 H-811.S2IHP

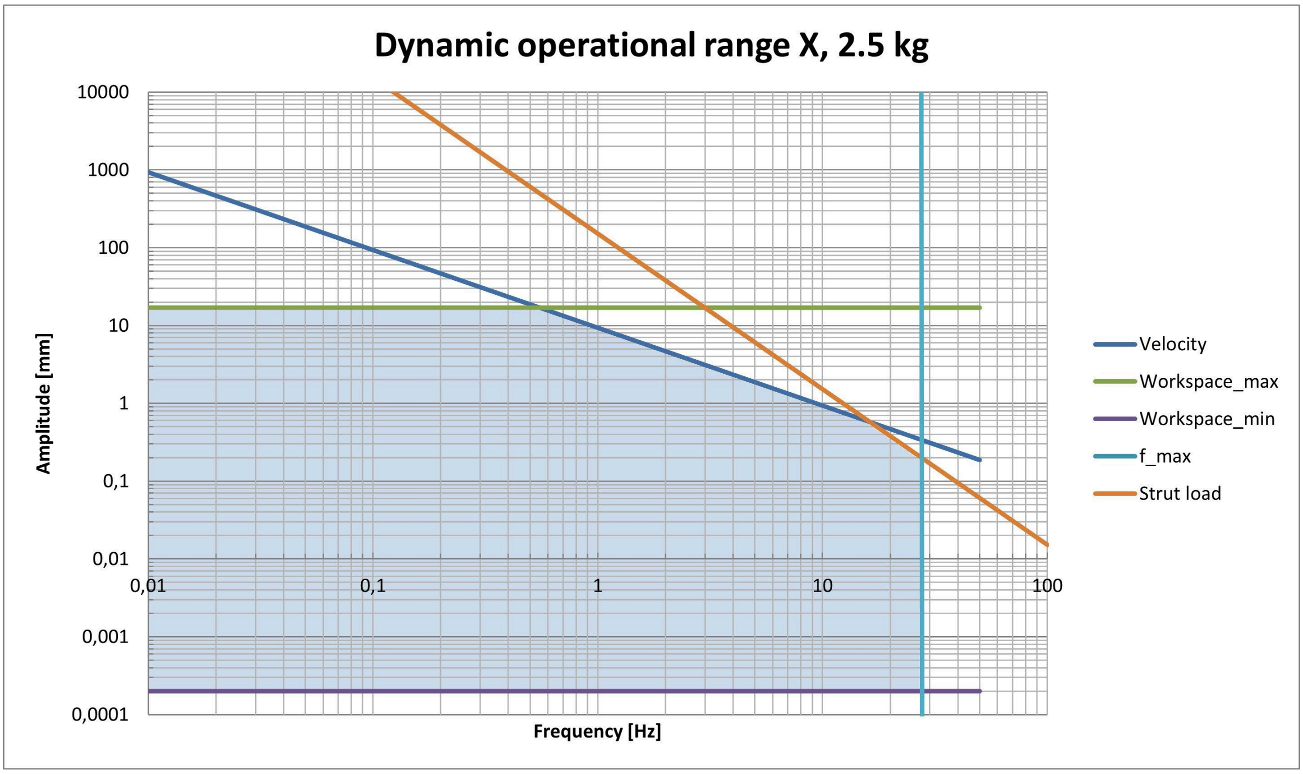


Figure 41: Dynamic working range of the H-811.S2IHP, X, 2.5 kg

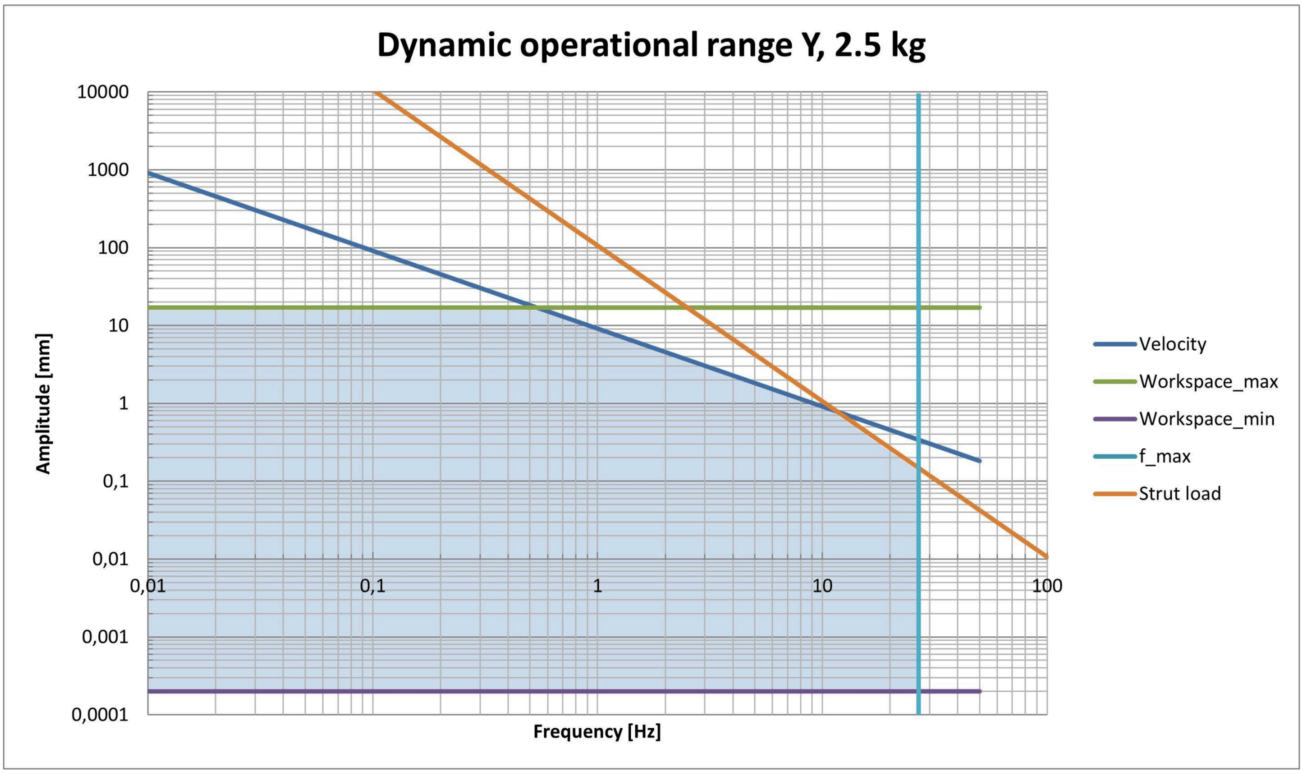


Figure 42: Dynamic working range of the H-811.S2IHP, Y, 2.5 kg

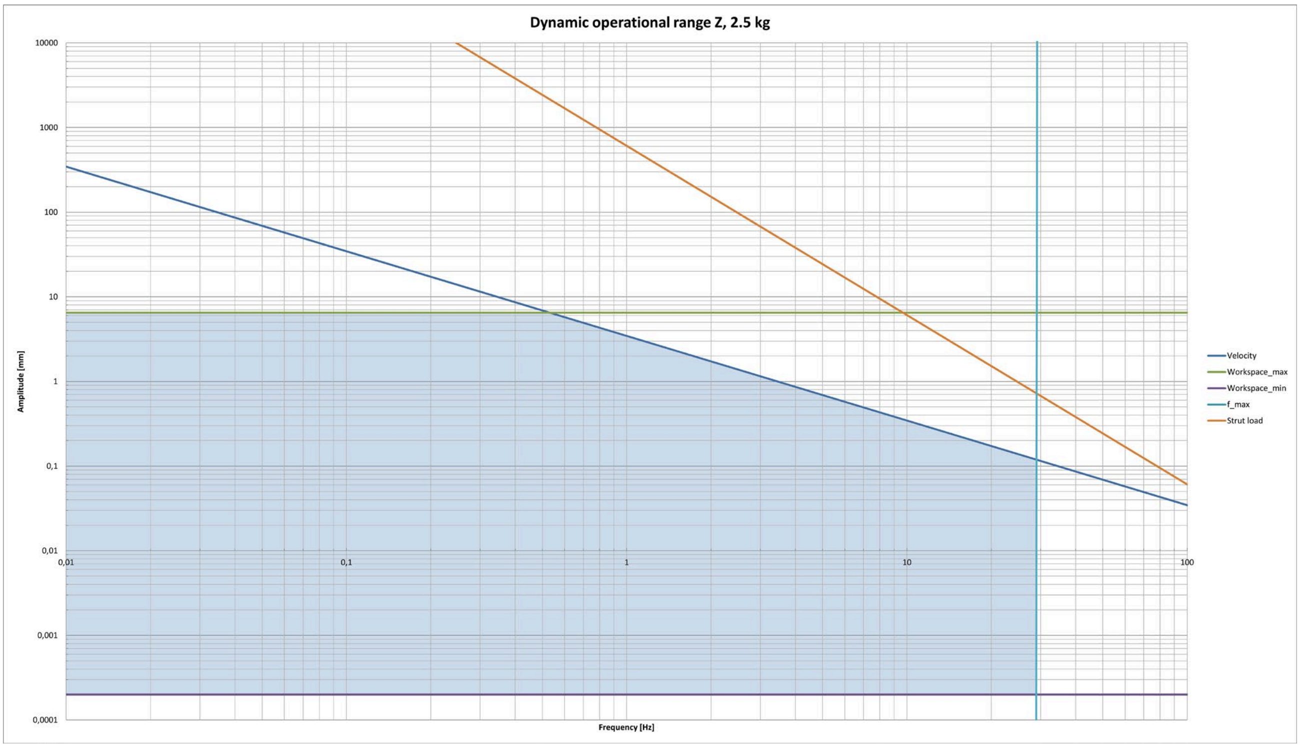


Figure 43: Dynamic working range of the H-811.S2IHP, Z, 2.5 kg

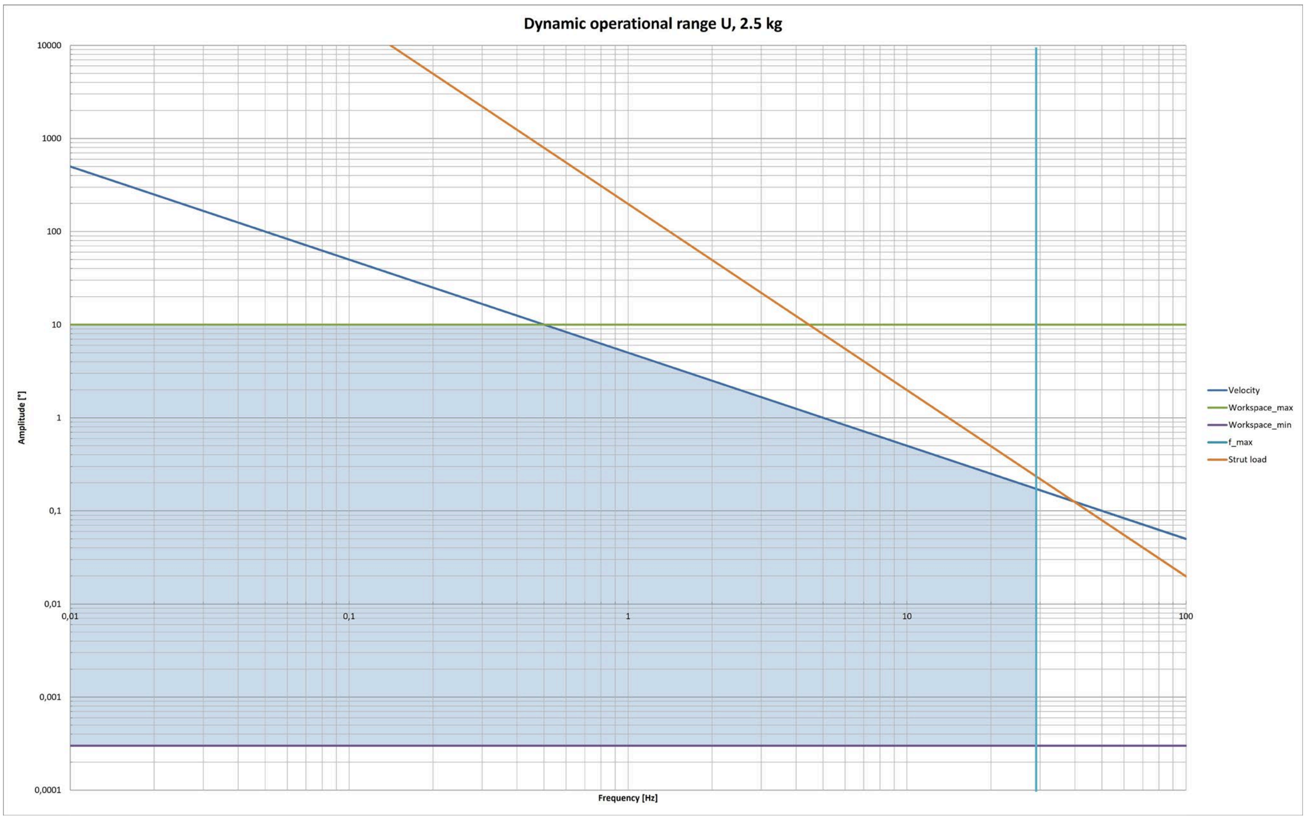


Figure 44: Dynamic working range of the H-811.S2IHP, U (ϴX), 2.5 kg

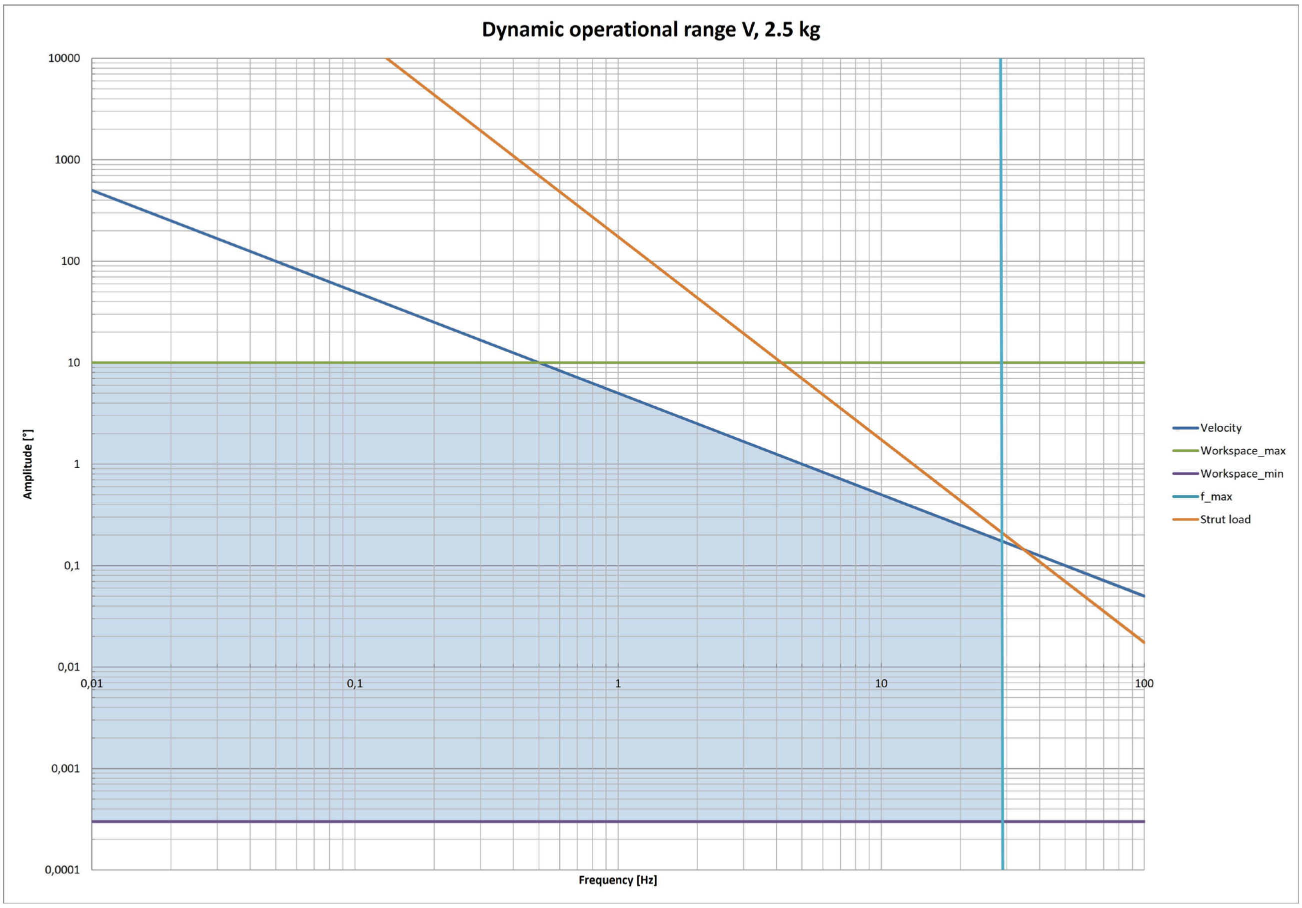


Figure 45: Dynamic working range of the H-811.S2IHP, V (ΘY), 2.5 kg

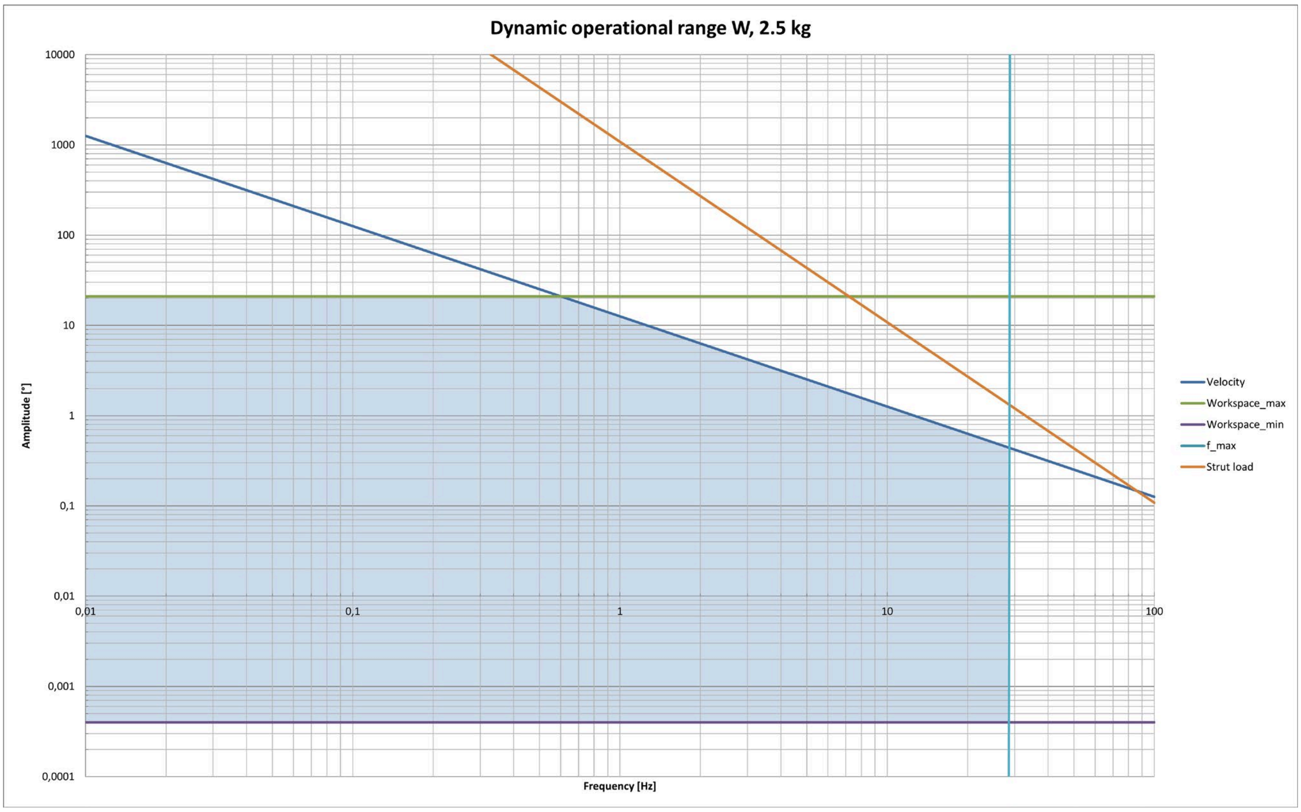
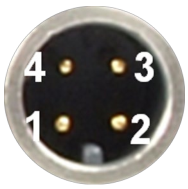


Figure 46: Dynamic working range of the H-811.S2IHP, W (ΘZ), 2.5 kg

10.7 Pin Assignment

10.7.1 Power Supply Connector

Not for vacuum models:
Power supply via 4-pin M12 connector

Pin	Function	
1	GND	
2	GND	
3	24 V DC	
4	24 V DC	

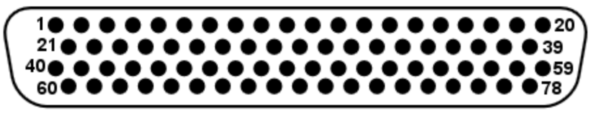
Only for vacuum models:
Power supply via 2-pin LEMO panel plug, male, type ECJ.1B.302.CLD

Pin	Function	
1	GND	
2	24 V DC	

10.7.2 Data Transmission Connector

Data transmission between hexapod and controller

HD D-sub 78 connector

Function	
All signals: TTL	

Pin Assignment

Pin	Pin	Signal
1		CH1 Sign IN
	21	CH1 Ref OUT
2		nc
	22	CH1 A+ OUT
3		CH1 A- OUT
	23	GND
4		CH2 Sign IN
	24	CH2 Ref OUT
5		nc
	25	CH2 A+ OUT
6		CH2 A- OUT
	26	GND
7		CH3 Sign IN
	27	CH3 Ref OUT
8		nc
	28	CH3 A+ OUT

Pin	Pin	Signal
40		CH1 MAGN IN
	60	CH1 LimP OUT
41		CH1 LimN OUT
	61	CH1 B+ OUT
42		CH1 B- OUT
	62	GND
43		CH2 MAGN IN
	63	CH2 LimP OUT
44		CH2 LimN OUT
	64	CH2 B+ OUT
45		CH2 B- OUT
	65	GND
46		CH3 MAGN IN
	66	CH3 LimP OUT
47		CH3 LimN OUT
	67	CH3 B+ OUT

Pin	Pin	Signal
9		CH3 A- OUT
	29	GND
10		CH4 Sign IN
	30	CH4 Ref OUT
11		nc
	31	CH4 A+ OUT
12		CH4 A- OUT
	32	GND
13		CH5 Sign IN
	33	CH5 Ref OUT
14		nc
	34	CH5 A+ OUT
15		CH5 A- OUT
	35	GND
16		CH6 Sign IN
	36	CH6 Ref OUT
17		nc
	37	CH6 A+ OUT
18		CH6 A- OUT
	38	GND
19		ID Chip
	39	GND
20		24 V input

Pin	Pin	Signal
48		CH3 B- OUT
	68	GND
49		CH4 MAGN IN
	69	CH4 LimP OUT
50		CH4 LimN OUT
	70	CH4 B+ OUT
51		CH4 B- OUT
	71	GND
52		CH5 MAGN IN
	72	CH5 LimP OUT
53		CH5 LimN OUT
	73	CH5 B+ OUT
54		CH5 B- OUT
	74	GND
55		CH6 MAGN IN
	75	CH6 LimP OUT
56		CH6 LimN OUT
	76	CH6 B+ OUT
57		CH6 B- OUT
	77	GND
58		Brake/Enable drive
	78	GND
59		Power Good 24 V output

11 Old Equipment Disposal

In accordance with EU law, electrical and electronic equipment may not be disposed of in EU member states via the municipal residual waste.

Dispose of your old device according to international, national, and local rules and regulations.

To fulfill the responsibility as the product manufacturer, Physik Instrumente (PI) SE & Co. KG undertakes environmentally correct disposal of all old PI equipment made available on the market after 13 August 2005 without charge.

If you have an old device from PI, you can send it to the following address free of charge:

Physik Instrumente (PI) SE & Co. KG

Auf der Römerstraße 1

76228 Karlsruhe, Germany

12 Glossary

User-defined coordinate system

Using the controller, custom coordinate systems can be defined and used instead of the factory-set coordinate systems.

Work with user-defined coordinate systems and the work-and-tool concept is described in the C887T0007 technical note.

Workspace

The entirety of all poses that the hexapod can approach from its current position is referred to as workspace.

The workspace can be limited by the following external factors:

- Installation space
- Dimensions and position of the load

To avoid subjecting the hexapod to an impermissible mechanical load, the forces acting on the hexapod struts at the poses must be taken into consideration in addition to the workspace. Valid poses can be calculated with the PIVirtualMove simulation program.

Center of rotation

The center of rotation describes the intersection of the rotational axes U, V, and W. When the default settings for the coordinate system and the center of rotation are used, the center of rotation after a referencing move is located at the origin of the coordinate system (0,0,0), see the dimensional drawing of the hexapod (p. 69).

The center of rotation always moves together with the platform.

Depending on the active --> operating coordinate system, the center of rotation can be moved from the origin of the coordinate system in the X and/or Y and/or Z direction with the SPI command. The center of rotation that can be moved using the SPI command is also referred to as "pivot point".

Hexapod system

The combination of hexapod, controller, cables, and power adapter(s) is referred to as "hexapod system" in this manual.

Pose

The spatial position of the hexapod, i.e., the combination of its position and orientation in three-dimensional space is referred to as "pose". The pose of a hexapod is defined by 6 coordinates in relation to a right-handed Cartesian coordinate system:

- Translation axes (also referred to as "linear axes"): X, Y, Z
- Rotational axes: U, V, W

A pose is valid if it can be reached by all 6 axes X, Y, Z, U, V, W with the coordinate system used, and the system setup used (installation position of the hexapod, load to be moved, external forces, and torques) **and** the permissible load of the struts is **not** exceeded.

Valid poses can be calculated with the PIVirtualMove simulation program.

For other possible designations of the U, V, and W axes, see "Motion" (p. 10).

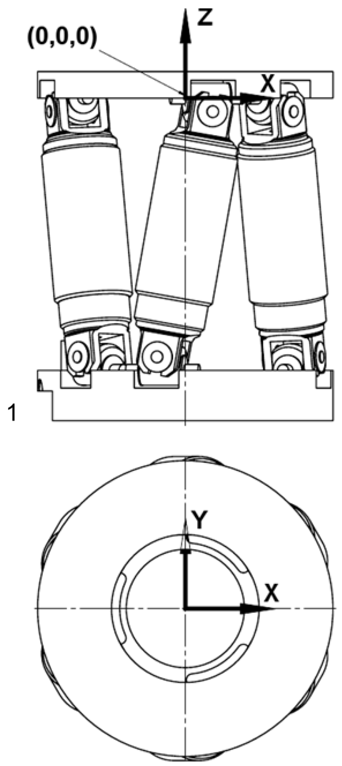
Default coordinate system

The X, Y, and Z axes of the Cartesian coordinate system are always spatially fixed, i.e., the coordinate system does not move when the platform of the hexapod moves. The X, Y and Z axes are also referred to as translational axes.

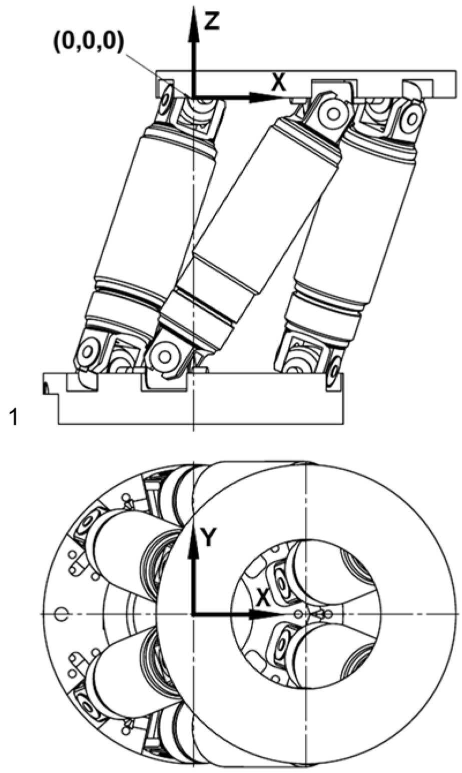
The intersection of the axes X, Y, and Z of the spatially fixed Cartesian coordinate system (0,0,0) is referred to as the origin.

The Z axis is perpendicular to the base plate of the hexapod.

The following example figures of the H-810 hexapod show that the coordinate system does not move along with motion of the platform.



Hexapod in the reference position



Hexapod with the platform moved in X

1 Cable exit

13 Appendix

13.1 Explanations of the performance test report

The hexapod is tested for the positioning accuracy of the translation axes prior to delivery. The performance test report is included in the scope of delivery.

The following figure shows the test setup used.

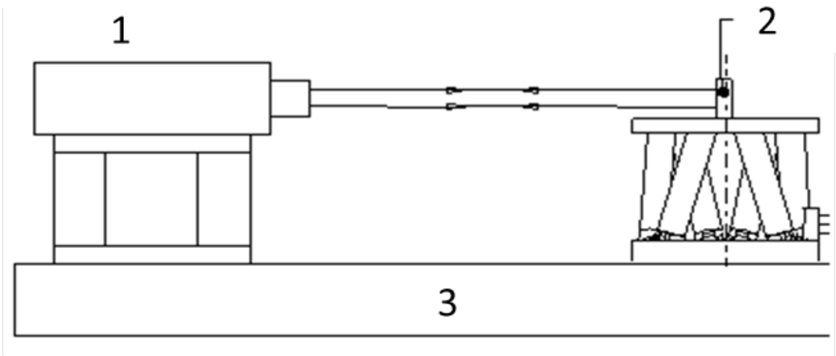


Figure 47: Test setup for measuring the X or Y axis.

1 Laser interferometer
2 Mirror
3 Stage

The following test cycles are performed:

- Motion over the entire travel range with at least 20 measuring points, in at least 5 cycles
- Motion over partial sections, for example, ±1 mm in increments of, for example, 10 µm

13.2 European Declarations of Conformity

For the H-811, declarations of conformity were issued according to the following European statutory requirements:

EMC Directive

RoHS Directive

The standards applied for certifying conformity are listed below.

EMC: EN 61326-1

Safety: EN 61010-1

RoHS: EN IEC 63000