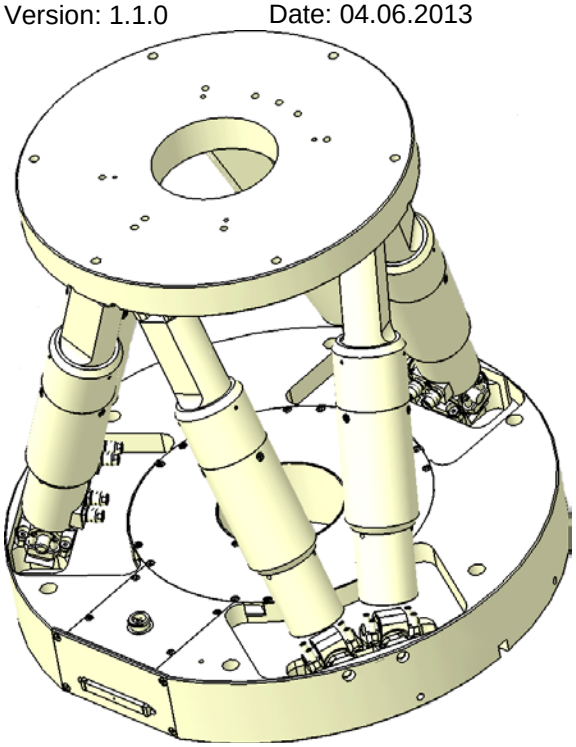
MS202E

H-850 Hexapod Microrobot

User Manual

Version: 1.1.0 Date: 04.06.2013



This document describes the following products:

- **H-850.H1**
  Hexapod Microrobot with Excellent Position Repeatability, DC Motor Gearhead, 0.5 mm/s, 250 kg Load
- **H-850.HV**
  Hexapod Microrobot with Excellent Position Repeatability, DC Motor Gearhead, 0.15 mm/s, 80 kg Load, Vacuum Compatible to 10^{-6} hPa
- **H-850.G1**
  Hexapod Microrobot with Excellent Position Repeatability, DC Motor Gearhead, 8 mm/s, 50 kg Load
- **H-850.GV**
  Hexapod Microrobot with Excellent Position Repeatability, DC Motor Gearhead, 2.5 mm/s, 25 kg Load, Vacuum Compatible to 10^{-6} hPa

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Contents

1 About this Document

In this Chapter

1.1 Goal and Target Audience of this User Manual

This manual contains information on the intended use of the H-850.

It assumes that the reader has a fundamental understanding of basic servo systems as well as motion control concepts and applicable safety procedures.

The latest versions of the user manuals are available for download (p. 3) on our website.

1.2 Symbols and Typographic Conventions

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

CAUTION

Dangerous situation

If not avoided, the dangerous situation will result in minor injury.

➢ Actions to take to avoid the situation.

NOTICE

Dangerous situation

If not avoided, the dangerous situation will result in damage to the equipment.

➢ Actions to take to avoid the situation.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/Label	Meaning
1. 2.	Action consisting of several steps whose sequential order must be observed
➢	Action consisting of one or several steps whose sequential order is irrelevant
▪	List item
p. 5	Cross-reference to page 5
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 Other Applicable Documents

The devices and software tools which are mentioned in this documentation are described in their own manuals.

Description	Document
C-887 Hexapod controller	MS204E User Manual
C-887 Hexapod controller	MS204Equ User Manual Short Version

1.4 Downloading Manuals

INFORMATION

If a manual is missing on our website or if there are problems in downloading:

➢ Contact our customer service department (p. 47).

The current versions of the manuals are found on our website. To download a manual, proceed as follows:

1. Open the website **http://www.pi-portal.ws**.
2. Click ***Downloads***.
3. Click the corresponding category (e. g. ***H-Hexapods***).
4. Click the corresponding product code (e. g. ***H-850***).

   An overview of the available file types is shown for the selected product.
5. If ***(0 Files)*** is shown in the ***Documents*** line, log in as follows to display and download the documents:

   a) Insert the product CD in the corresponding PC drive.
   b) Open the ***Manuals*** directory.
   c) Open the Release News (e. g. ***C-887_Releasenews_V_x_x_x.pdf***) on the CD of the product.
   d) Find the user name and password in the **User login for software download** section in the Release News.
   e) In the ***User login*** area on the left margin in the website, enter the user name and the password in the corresponding fields.
   f) Click ***Login***.

   If ***Documents (0 Files)*** is still being displayed, no manuals are available:

   – Contact our customer service department (p. 47).
6. Click ***Documents***.
7. Click the desired manual and save it on the hard disk of your PC or on a data storage medium.

2 Safety

In this Chapter

2.1 Intended Use

The Hexapod microrobot (in short: "Hexapod") is a laboratory device in accordance with DIN EN 61010-1. It is intended to be used in interior spaces and in an environment that is free of dirt, oil and lubricants.

Based on its design and realization, the Hexapod is intended for positioning, adjusting and shifting of loads in six axes at various velocities.

The Hexapod is part of a Hexapod system. The intended use of the Hexapod is only possible in connection with the Hexapod controller, which is part of the Hexapod system and coordinates all motions of the Hexapod.

2.2 General Safety Instructions

The H-850 is built according to state-of-the-art technology and recognized safety standards. Improper use can result in personal injury and/or damage to the H-850.

- Only use the H-850 for its intended purpose, and only use it if it is in a good working order.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for the correct installation and operation of the H-850.

2.2.1 Organizational Measures

User manual

- Always keep this user manual available by the H-850.
  The latest versions of the user manuals are available for download (p. 3) on our website.
- Add all information given by the manufacturer to the user manual, for example supplements or Technical Notes.
- If you pass the H-850 on to other users, also turn over this user manual as well as other relevant information provided by the manufacturer.
- Only use the device on the basis of the complete user manual. Missing information due to an incomplete user manual can result in minor injury and property damage.
- Only install and operate the H-850 after having read and understood this user manual.

Personnel qualification

The H-850 may only be started up, operated, maintained and cleaned by authorized and qualified staff.

2.2.2 Measures for Handling Vacuum-Compatible Products

When handling the vacuum version 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.

- Only touch the Hexapod with powder-free gloves.
- If necessary, wipe the Hexapod clean after unpacking.

2.2.3 Safety Measures during Transport

An impermissible mechanical load can damage the Hexapod.

- Only send the Hexapod in the original packaging.
- Only hold the Hexapod by the transport lock or the base plate.

2.2.4 Safety Measures during Installation

Impermissible mechanical load and collisions between the Hexapod, the load to be moved and the environment can damage the Hexapod.

- Only hold the Hexapod by the base plate.
- Before installing the load, determine the limit value for the load of the Hexapod with a simulation program (p. 24).
- Before installing the load, determine the work space of the Hexapod with a simulation program (p. 24).
- Make sure that the installed load observes the limit value determined with the simulation program.
- Avoid high forces and torques on the moving platform during installation of the Hexapod and the load.
- Ensure an uninterruptible power supply in order to prevent an unintentional deactivation of the Hexapod system and resulting unintentional position changes of the Hexapod.
- Make sure that no collisions between the Hexapod, the load to be moved and the environment are possible in the work space of the Hexapod.

Incorrect mounting can warp the base plate. Warping of the base plate reduces the accuracy.

- Mount the Hexapod on an even surface. The recommended evenness of the surface is 300 µm.

The Hexapod can be damaged by excessively long screws.

- When selecting the screw length, observe the thickness of the moving platform (p. 53) or the depth of the mounting holes together with the load to be mounted.
- Only use screws that do not project under the moving platform after being screwed in.
- Only mount the Hexapod and a load on the mounting fixtures (holes) intended for this purpose.

2.2.5 Safety Measures during Start-Up

There is a risk of minor injuries caused by crushing which can occur between the moving parts of the Hexapod and a stationary part or obstacle.

- Keep your fingers away from areas where they can get caught by moving parts.

The geometrical data used by the Hexapod controller must be adapted to the Hexapod. If incorrect geometrical data is used, the Hexapod can be damaged by uncontrolled motions or collisions. The geometrical data is adapted before delivery.

- Check whether the Hexapod controller matches the Hexapod.
  A label on the rear panel of the controller indicates for which Hexapod the controller is intended.
- Only operate the Hexapod with a Hexapod controller whose geometrical data is adapted to the Hexapod.

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

- Make sure that no collisions between the Hexapod, the load to be moved, and the surroundings are possible in the working space of the Hexapod.
- Do not place any objects in areas where they can get caught by moving parts.
- Immediately stop the motion if a malfunction occurs in the Hexapod controller (see user manual of the Hexapod controller).

Damage can occur to the Hexapod if the transport lock of the Hexapod has not been removed and a motion is commanded.

- Remove the transport lock before you start up the Hexapod system.

2.2.6 Safety Measures during Maintenance

The Hexapod can become misaligned as a result of improper maintenance. The specifications (p. 49) can change as a result.

- Do not loosen any screws.

3 Product Description

In this Chapter

3.1 Features and Applications

The H-850 Hexapod is offered in four models that have different maximum velocities, load capacities as well as different suitability for use in a vacuum.

Models for higher velocities:

- Velocities of up to 8 mm/s are possible with the H-850.G1 model.
- The version H-850.GV, which is suitable for use in a vacuum, achieves velocities of up 2.5 mm/s.

Models with a higher load capacity:

- The H-850.H1 with a higher gear ratio achieves a load capacity of 250 kg vertically and 50 kg in any orientation.
- The version H-850.HV, which is suitable for use in a vacuum, can be loaded with up to 80 kg vertically and 40 kg in any orientation.

The parallel kinematics structure and the free choice of the pivot point offer the following advantages:

- Positioning operations in six independent axes (three translation axes, three rotation axes) with short settling times
- Pivot point is maintained for rotations and moves along with linear motions
- High accuracy and step resolution in all axes
- No addition of the errors of individual axes
- No friction and torques from moving cables

The Hexapod is controlled with the Hexapod controller, which is part of the Hexapod system. The position commands to the Hexapod controller are entered in Cartesian coordinates.

3.2 Model Overview

Hexapod and Hexapod controller are only available together as a system.

Possible system components

Standard versions of the H-850 Hexapod:

Model	Name
H-850.H1	Hexapod Microrobot, with Excellent Position Repeatability, DC Motor Gearhead, 0.5 mm/s, 250 kg Load
H-850.HV	Hexapod Microrobot, with Excellent Position Repeatability, DC Motor Gearhead, 0.15 mm/s, 80 kg Load, Vacuum Compatible to 10^{-6} hPa
H-850.G1	Hexapod Microrobot, with Excellent Position Repeatability, DC Motor Gearhead, 8 mm/s, 50 kg Load
H-850.GV	Hexapod Microrobot, with Excellent Position Repeatability, DC Motor Gearhead, 2.5 mm/s, 25 kg Load, Vacuum Compatible to 10^{-6} hPa

Standard versions of the C-887 Hexapod controller:

Model	Name
C-887.11	6-D Hexapod Controller, Control of 2 Additional Servo-Motor Axes Included, TCP/IP and RS-232 Interface, 19" Chassis
C-887.21	6-D Hexapod Controller, TCP/IP and RS-232 Interface, Bench-Top

Standard cable sets:

Model	Name
C-887.A03	Cable Set for Hexapod, 3 m, consisting of: ▪ Data transmission cable, MDR68 to MDR68, 1:1 (K040B0034) ▪ Power supply cable, M12m 180° to M12f 90°(K060B0111)

Model	Name
C-887.V02	Cable Set for Hexapod, 2 m Vacuum-Side Cable, Feedthrough, 3 m Air-Side Cable, consisting of: ▪ Data transmission cable on the vacuum side, MDR68m to HD Sub-D 78m, 2 m (M824B0010) ▪ Power supply cable on the vacuum side, LEMO 2-pin to LEMO 2-pin, 2 m (K060B0132) ▪ Vacuum feedthrough for data transmission, HD Sub-D 78m/f (4668) ▪ Vacuum feedthrough for power supply, LEMO 2-pin to M12m (C887B0002) ▪ Data transmission cable on the air side, HD Sub-D 78f to MDR68m, 3 m (K040B0092) ▪ Power supply cable on the air side, M12m to M12f, 3 m (K060B0112)

Available Hexapod systems

The following Hexapod systems are available as combinations of Hexapod, Hexapod controller and cable set:

System	Hexapod				Hexapod Controller		Cable Set	
–	H-850.H1	H-850.HV	H-850.G1	H-850.GV	C-887.11	C-887.21	C-887.A03	C-887.V02
H-850.H11	**X**	**–**	**–**	**–**	**X**	**–**	**X**	**–**
H-850.H12	**X**	**–**	**–**	**–**	**–**	**X**	**X**	**–**
H-850.HV1	**–**	**X**	**–**	**–**	**X**	**–**	**–**	**X**
H-850.HV2	**–**	**X**	**–**	**–**	**–**	**X**	**–**	**X**
H-850.G11	**–**	**–**	**X**	**–**	**X**	**–**	**X**	**–**
H-850.G12	**–**	**–**	**X**	**–**	**–**	**X**	**X**	**–**
H-850.GV1	**–**	**–**	**–**	**X**	**X**	**–**	**–**	**X**
H-850.GV2	**–**	**–**	**–**	**X**	**–**	**X**	**–**	**X**

3.3 Product View

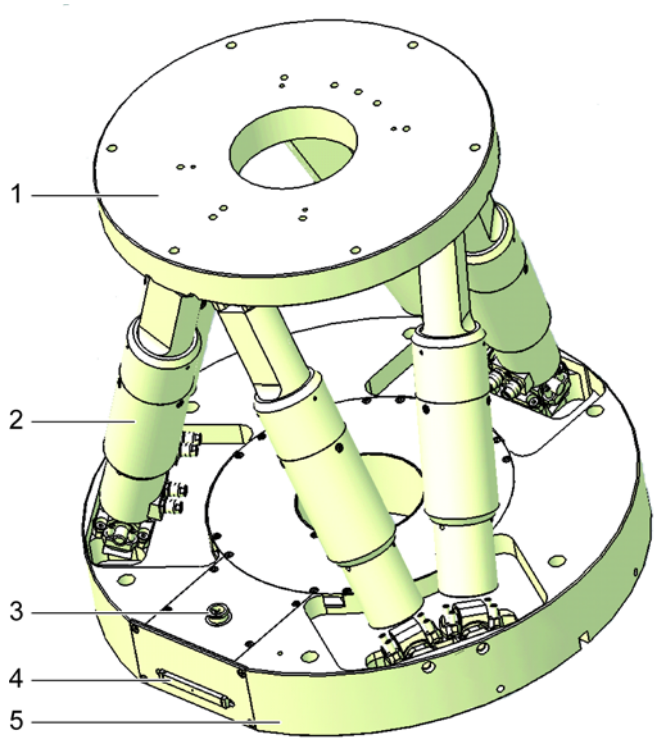


Figure 1: Product view

1 Moving platform
2 Strut
3 Panel plug for power supply cable
4 Socket for data transmission cable
5 Base plate

3.4 Scope of Delivery

The following table contains the scope of delivery of the Hexapod.

The scope of delivery of the Hexapod controller is listed in the user manual of the Hexapod controller.

For the scope of delivery of the cable set that belongs to the Hexapod system, see the listing of the standard cable sets in "Model Overview" (p. 10).

Order Number	Items
H-850	Hexapod according to your order (p. 10)
000015165	Steward snap-on ferrite suppressor
Packaging, consisting of:	
–	Transport lock with following accessories: ▪ 4 M6x20 screws ▪ 2 M6x30 screws ▪ 6 plastic flat washers
2512	Inner cushion set
000012899	Inner box with handle, 560 mm x 560 mm x 400 mm
000012323	Outer box with soft foam cushions
2026	Pallet
Documentation, consisting of:	
H850T0001	Technical note in printed form on unpacking the Hexapod
MS202E	User manual for the Hexapod (this document)
Screw sets:	
000034605	Mounting accessories: ▪ 6 M6x30 hex-head cap screws ISO 4762 ▪ 1 Allen wrench 5.0 DIN 911
000036450	Accessories for connection to the grounding system: ▪ 1 M4x8 flat-head screw with cross recess ISO 7045 ▪ 2 washers, form A-4.3 DIN 7090 ▪ 2 safety washers, Schnorr Ø 4 mm N0110

3.5 Accessories

<table>
<tr><th>Order Number</th><th>Description</th></tr>
<tr><td>C-887.A20</td><td>Hexapod cable set 20 m, consisting of:

<table>
<tr><th>Name</th><th>Length</th><th>Item ID</th></tr>
<tr><td>Line driver box for data transmission cable, controller-side</td><td>-</td><td>C030B0011</td></tr>
<tr><td>Line driver box for data transmission cable, Hexapod-side</td><td>-</td><td>C030B0012</td></tr>
<tr><td>Short data transmission cable MDR68 to MDR68 1:1; 2 pieces</td><td>3 m</td><td>K040B0034</td></tr>
<tr><td>Long data transmission cable MDR68 to MDR68 1:1</td><td>14 m</td><td>K040B0186</td></tr>
<tr><td>Power supply cable for line driver box,
with M12 coupling/M12 connector</td><td>17 m</td><td>K060B0126</td></tr>
<tr><td>Power supply cable for Hexapod,
with M12 coupling/M12 connector</td><td>20 m</td><td>K060B0127</td></tr>
</table></td></tr>
<tr><td>C-887.A30</td><td>Hexapod cable set 30 m, consisting of:

<table>
<tr><th>Name</th><th>Length</th><th>Item ID</th></tr>
<tr><td>Line driver box for data transmission cable, controller-side</td><td>-</td><td>C030B0011</td></tr>
<tr><td>Line driver box for data transmission cable, Hexapod-side</td><td>-</td><td>C030B0012</td></tr>
<tr><td>Short data transmission cable MDR68 to MDR68 1:1; 2 pieces</td><td>3 m</td><td>K040B0034</td></tr>
<tr><td>Long data transmission cable MDR68 to MDR68 1:1</td><td>24 m</td><td>K040B0440</td></tr>
<tr><td>Power supply cable for line driver box,
with M12 coupling/M12 connector</td><td>27 m</td><td>K060B0160</td></tr>
<tr><td>Power supply cable for Hexapod,
with M12 coupling/M12 connector</td><td>30 m</td><td>K060B0161</td></tr>
</table></td></tr>
</table>

To order, contact our customer service department (p. 47).

3.6 Technical Features

3.6.1 Struts

The Hexapod has six adjustable-length struts. Each strut carries out linear motions. Each set of settings of the six struts defines a position of the moving platform in six degrees of freedom (three translational axes and three rotational axes).

Each strut is equipped with the following components:

- One actuator
- Reference and limit switches
- Joints for connecting to the base plate and moving platform

The actuator contains the following components:

- DC motor with rotary encoder
- Gearhead
- Drive screw

3.6.2 Reference Point Switch and Limit Switches

The reference point 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.

3.6.3 Control

The Hexapod is intended for operation with the Hexapod controller which belongs to the Hexapod system. The Hexapod controller makes it possible to command motion of individual axes, combinations of axes or all six axes at the same time in a single motion command.

The Hexapod controller calculates the settings for the individual struts from the target positions given for the translational and rotational axes. The velocities and accelerations of the struts are calculated in such a way that all struts start and stop at the same time.

After the Hexapod controller has been switched on or restarted, the Hexapod has to complete a reference move in which each strut moves to its reference point switch. After the reference move, the moving platform is in the reference position and can be commanded to move to absolute target positions.

For more information, see the user manual of the Hexapod controller.

3.6.4 Motion

The platform moves along the translational axes X, Y and Z and around the rotational axes U, V and W.

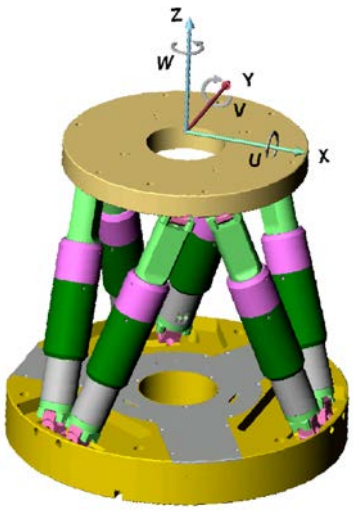


Figure 2: XYZ coordinate system and rotations to the rotation coordinates U, V and W. The coordinate system is depicted above the platform for better clarity.

Translation

Translations are described in the spatially-fixed XYZ coordinate system. The translational axes meet at the origin of the XYZ coordinate system (0,0,0). For more information, see the glossary (p. 59).

Rotation

Rotations take place around the rotational axes U, V and W. The rotational axes meet at the pivot point. For more information on the pivot point, see the glossary (p. 59).

In contrast to the spatially-fixed translational axes, the rotational axes and thus the pivot point as well move along with the platform (see also the example below for consecutive rotations).

A given rotation in space is calculated from the individual rotations in the sequence U > V > W.

INFORMATION

The dimensional drawing (p. 53) contains the following:

- Alignment of the XYZ coordinate system
- Position of the pivot point after the reference move, when the standard settings of the Hexapod controller are used

Example: Consecutive rotations

INFORMATION

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

- Round platform replaced by T-shaped platform
- XYZ coordinate system shown shifted
- Pivot point 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.

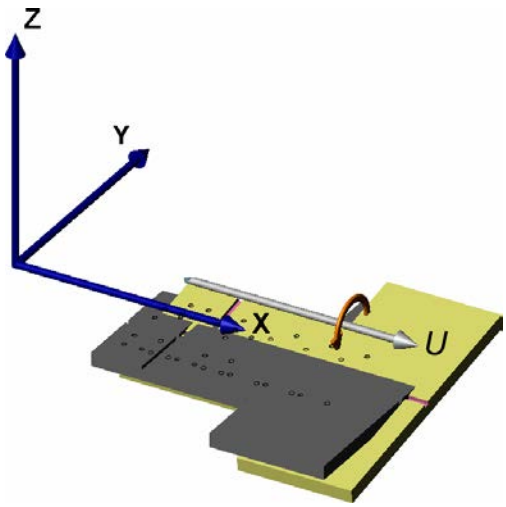


Figure 3: Rotation around the U axis

Platform in reference position

Platform position: U = 10 (U parallel to spatially-fixed X axis)

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.

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

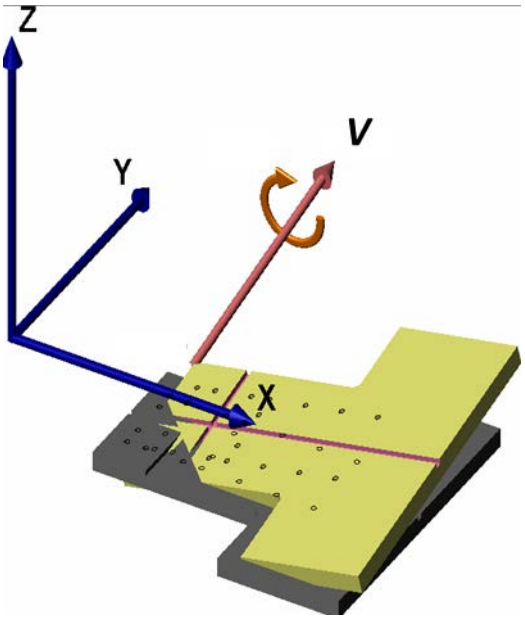


Figure 4: Rotation around the V axis

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

3. The W axis is commanded to move to position 10.

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

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

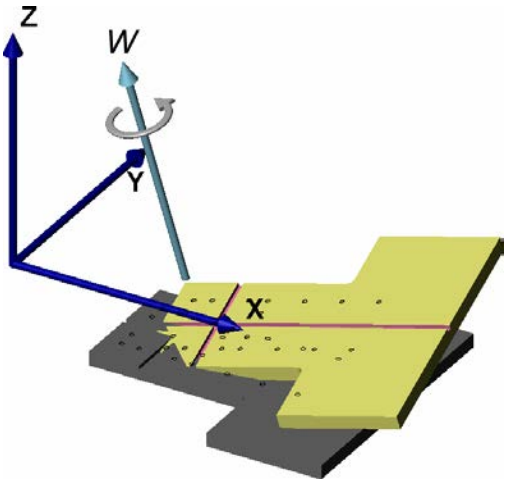


Figure 5: Rotation around the W axis

- 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 more data on the travel ranges, see the "Specifications" section (p. 49).

4 Unpacking

The Hexapod is delivered in a special packaging with adapted foam inserts and with a transport lock installed.

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 lock or the base plate.

INFORMATION

When handling the vacuum version 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.

- ➢ Only touch the Hexapod with powder-free gloves.
- ➢ If necessary, wipe the Hexapod clean after unpacking.

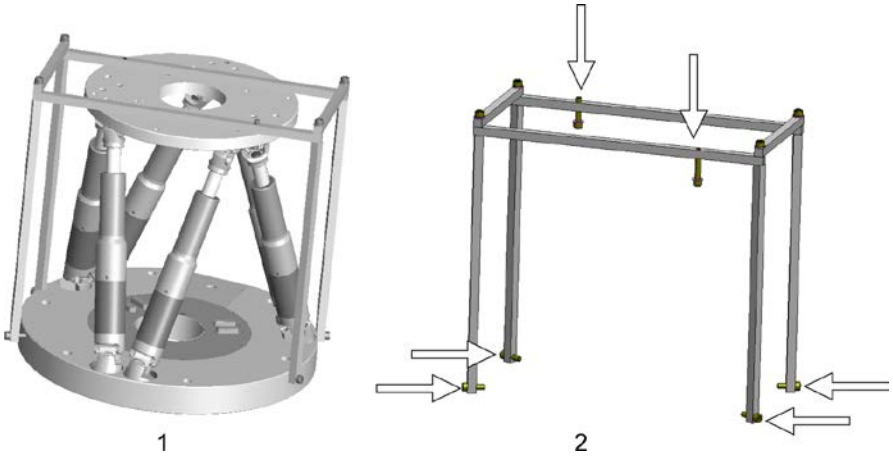


Figure 6: Transport lock of the Hexapod

1 Hexapod with installed transport lock

2 Transport lock with fixing screws

Tools and accessories

- Allen wrench 5.0 from the supplied screw set (p. 13).

Unpacking the Hexapod

1. Open the outer box.
2. Remove the foam cover.
3. Open the inner box.
4. Remove the foam cover.
5. Hold the Hexapod by the transport lock and take it out of the foam insert.
6. Compare the contents against the items covered by the contract and against the packing list. If parts are incorrectly supplied or missing, contact PI immediately.
7. Inspect the Hexapod for signs of damage. If you notice signs of damage, contact PI immediately.
8. Remove the transport lock:
   a) Use the Allen wrench to loosen the 4 screws (M6x20) with which the transport lock is laterally fastened to the base plate.
   b) Use the Allen wrench to loosen the 2 screws (M6x30) with which the transport lock is fastened to the moving platform. The screw heads are located on the bottom side of the moving platform.
   c) Remove the 6 loosened screws and the corresponding plastic flat washers.
   d) Remove the transport lock.
9. Keep all packaging materials and the transport lock in case the product needs to be transported again later.

5 Installation

In this Chapter

5.1 General Notes on Installation

The Hexapod can be mounted in any orientation.

NOTICE

Impermissible mechanical load and collisions!

Impermissible mechanical load and collisions between the Hexapod, the load to be moved and the environment can damage the Hexapod.

- Only hold the Hexapod by the base plate.
- Before installing the load, determine the limit value for the load of the Hexapod with a simulation program (p. 24).
  The limit values determined with the simulation program are only valid when the Hexapod controller has the servo mode switched on for the axes of the moving platform of the connected Hexapod.
- Before installing the load, determine the working space of the Hexapod with a simulation program (p. 24).
  The limits of the working space vary depending on the current position of the Hexapod (translation and rotation coordinates) and the current coordinates of the pivot point.
- Avoid high forces and torques on the moving platform during installation.
- Ensure an uninterruptible power supply in order to prevent an unintentional deactivation of the Hexapod system and resulting unintentional position changes of the Hexapod.
- Make sure that no collisions between the Hexapod, the load to be moved and the environment are possible in the working space of the Hexapod.

INFORMATION

The optionally available PIVeriMove software for collision checking can be used to mathematically check possible collisions between the Hexapod, the load and the environment. The use of the software is recommended when the Hexapod is located in a limited installation space and/or operated with a spatially limiting load. For details regarding the activation and configuration of the PIVeriMove software for collision checking, see Technical Note C887T0002 (included in the scope of delivery of the software).

5.2 Determining the Permissible Load and Working Space

Tools and accessories

- PC with Windows operating system on which the simulation program Hexapod Simulation Software is installed. For more information, see the manual of the Hexapod controller.

Determining the working space and permissible load of the Hexapod

➢ Follow the instructions in the manual of the Hexapod controller to determine the working space and the limit value for the load of the Hexapod with the simulation program.

The limit values in the following table are for orientation. They only apply when the center of mass is at the origin of the XYZ coordinate system (0,0,0).

	Servo mode switched on for Hexapod – Max. load capacity		**Servo mode switched off for Hexapod – Max. holding force**	
Mounting position of the base plate	Mounted horizontally	Mounted as desired	Mounted horizontally	Mounted as desired
H-850.H1	250 kg	50 kg	2000 N	500 N
H-850.HV	80 kg	40 kg	2000 N	400 N
H-850.G1	50 kg	20 kg	250 N	85 N
H-850.GV	25 kg	10 kg	250 N	85 N

If you need help in determining the limit value for the load or determining the working space:

➢ Contact our customer service department (p. 47).

5.3 Attaching the snap-on ferrite suppressor

Figure 7: Power supply cable of the Hexapod with snap-on ferrite suppressor

1 Power supply cable of the Hexapod
2 Snap-on ferrite suppressor 000015165
3 Connector M 12 (for connection to the controller)

INFORMATION

The snap-on ferrite suppressor 000015165 is included in the scope of delivery of the Hexapod system. The snap-on ferrite suppressor is for permanent attachment to the power supply cable of the Hexapod. The snap-on ferrite suppressor ensures the electromagnetic compatibility of the Hexapod system.

- ➢ When attaching the snap-on ferrite suppressor, make sure that it is correctly positioned on the cable. The snap-on ferrite suppressor can only be removed with special tools (not included in the scope of delivery).
- ➢ Attach the snap-on ferrite suppressor to the power supply cable of the Hexapod before you connect the Hexapod to the Hexapod controller for the first time.

Tools and accessories

- Snap-on ferrite suppressor 000015165, in the scope of delivery (p. 13)

Permanently attaching the snap-on ferrite suppressor

1. Place the power supply cable of the Hexapod close behind the M12 connector, that is intended for connection to the controller, into the opened snap-on ferrite suppressor (see figure).
2. Close the snap-on ferrite suppressor:
   a) Align the cable so that it is not squeezed when the snap-on ferrite suppressor is closed.
   b) Carefully press the two halves of the snap-on ferrite suppressor around the cable until the lock engages.

5.4 Grounding the Hexapod

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. 13) and the M4 hole with an 8 mm depth (p. 53) marked with the ground connection symbol.
   - If there is no M4 hole with an 8 mm depth in the base plate, connect using one of the M6 holes on the side for fastening the transport lock (p. 21).
2. Connect the moving platform to the grounding system:
   - Use one of the mounting holes in the moving platform (p. 53) for connection.
     or
   - If the moving platform and the load are conductively connected with each other, connect the load to the grounding system.

5.5 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. Warping of the base plate reduces the accuracy.

➢ Mount the Hexapod on an even surface. The recommended evenness of the surface is 300 µm.

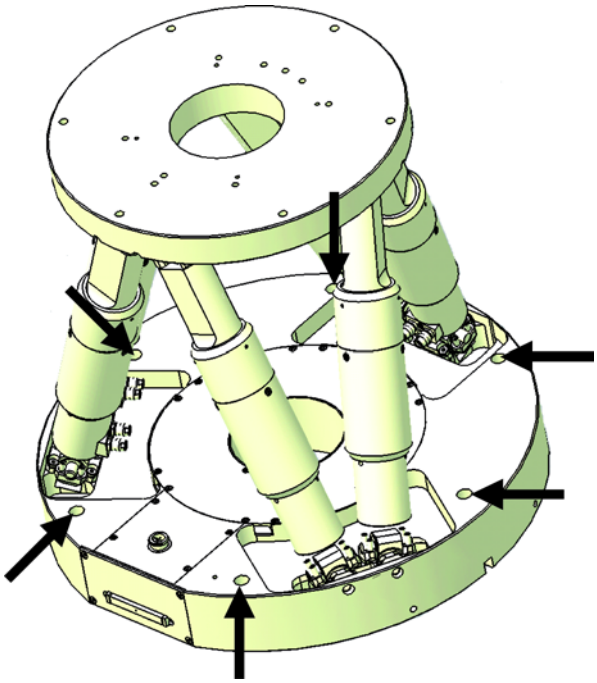


Figure 8: Mounting holes in the base plate

Prerequisite

✓ You have read and understood the General Notes on Installation (p. 23).

Tools and accessories

- Allen wrench 5.0 and six of the supplied screws (p. 13).
- Optional: two locating pins for easy alignment of the Hexapod, suitable for holes with Ø 8 mm H7, not included in the scope of delivery

Mounting the Hexapod

1. Make the necessary holes in the surface
   - Six M6 threaded holes for mounting with M6x30 screws
   - Optional: Two locating holes with Ø 8 mm H7 to accommodate locating pins

     The arrangement of the six mounting holes as well as the two locating holes in the base plate of the Hexapod can be found in the dimensional drawing (p. 53). The locating holes are on the bottom side of the base plate (labeled in the dimensional drawing as "bottom side").
2. If you use locating pins to align the Hexapod:
   a) Insert the locating pins into the locating holes in the Hexapod or the surface.
   b) Place the Hexapod on the surface in such a way that the locating pins are inserted into the corresponding locating holes on the other side.
3. Mount the Hexapod on the six mounting holes in the base plate using the included screws.

5.6 Affixing 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.

- ➢ Make sure that the installed load observes the limit value resulting from the load test (p. 24).
- ➢ Avoid high forces and torques on the moving platform during installation.
- ➢ Make sure that no collisions between the Hexapod, the load to be moved, and the surroundings are possible in the working space of the Hexapod.

NOTICE

Screws that are too long!

The Hexapod can be damaged by excessively long screws.

- When selecting the screw length, observe the thickness of the moving platform or the depth of the mounting holes (p. 53) together with the load to be mounted.
- Only use screws that do not project under the moving platform after being screwed in.
- Only mount the Hexapod and the load on the mounting fixtures (holes) intended for this purpose.

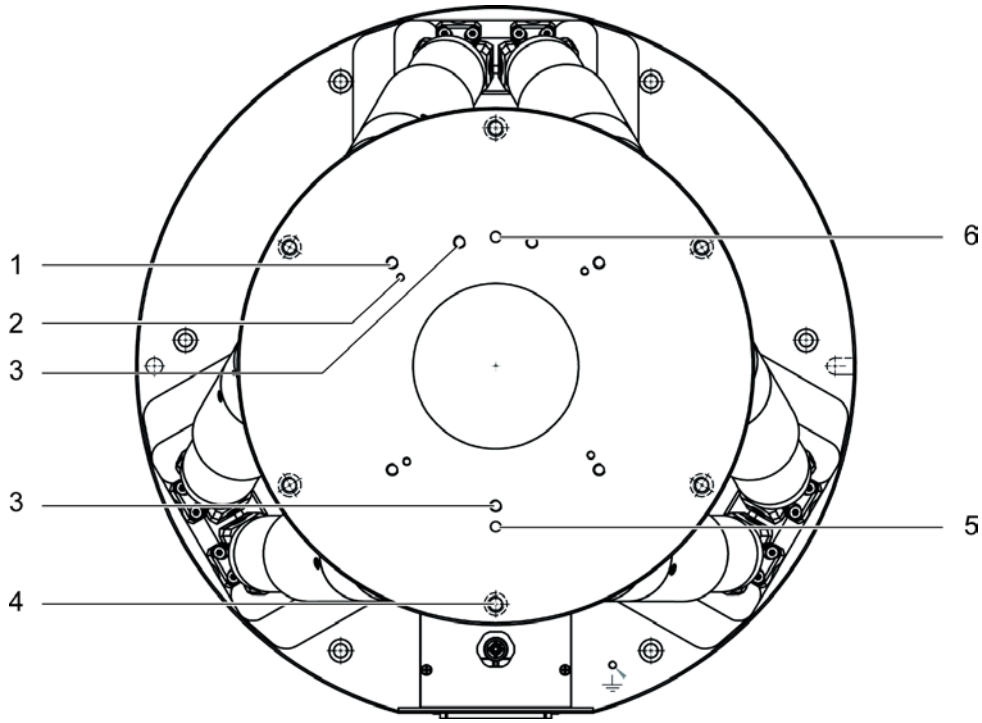


Figure 9: Mounting and locating holes in the moving platform

1 4 x M6 holes with 8 mm depth
2 4 x M4 holes with 8 mm depth
3 3 x M6 holes with 12 mm depth
4 6 x M8 through holes
5 Locating hole Ø 5 mm G6 with 14 mm depth
6 Locating hole Ø 5 mm H8 with 14 mm depth

Prerequisites

- ✓ You have read and understood the General Notes on Installation (p. 23).
- ✓ You have determined the permissible load and the working space of the Hexapod (p. 24).
- ✓ You have designed the load and the environment of the Hexapod so that the permissible load of the Hexapod is observed and no collisions can occur.

Tools and accessories

- Suitably long screws. Options:
  - 4 M4 screws
  - 3 or 4 M6 screws
  - 6 M8 countersunk head screws
- Suitable tools for fastening the screws
- Optionally: Two locating pins for easy alignment of the load on the Hexapod, suitable for holes with Ø 5 mm; for tolerance values, see the mounting and locating holes in the moving platform which are depicted in the figure; locating pins not included in the scope of delivery

Affixing the Load

1. Align the load so that the selected mounting holes in the moving platform can be used for affixing it.

   If you use locating pins to align the load:

   a) Make two locating holes with Ø 5 mm and a suitable tolerance in the load to accommodate locating pins.
   b) Insert the locating pins into the locating holes in the moving platform or the load.
   c) Place the load on the moving platform in such a way that the locating pins are inserted into the corresponding locating holes on the other side.

   The arrangement of the mounting and locating holes in the moving platform of the Hexapod as well as the tolerance values can be found in the corresponding figure as well as in the dimensional drawing (p. 53).

2. Affix the load to the selected mounting holes in the moving platform using the screws.

5.7 Connecting the Cable Set to the Hexapod

5.7.1 Connecting the C-887.A03 Standard Cable Set

Prerequisites

✓ The cable set is **not** connected to the Hexapod controller.

Tools and accessories

- Cable set C-887.A03 that belongs to the Hexapod system (p. 10)

Connecting the C-887.A03 standard cable set to the Hexapod

1. Connect the data transmission cable to the MDR68 socket in the base plate of the Hexapod:

   a) Press the latches together on both sides of the connector.
   b) Insert the connector into the socket on the Hexapod.
   c) Check that the connector correctly fits.
   d) Release the latches.

2. Connect the 90° angled M12 coupling of the power supply cable to the 4-pin M12 panel plug in the base plate of the Hexapod.

   – Observe the mechanical coding of the coupling and panel plug.

   – Do not use force.

5.7.2 Connecting the C-887.V02 Standard Cable Set for Vacuum Versions

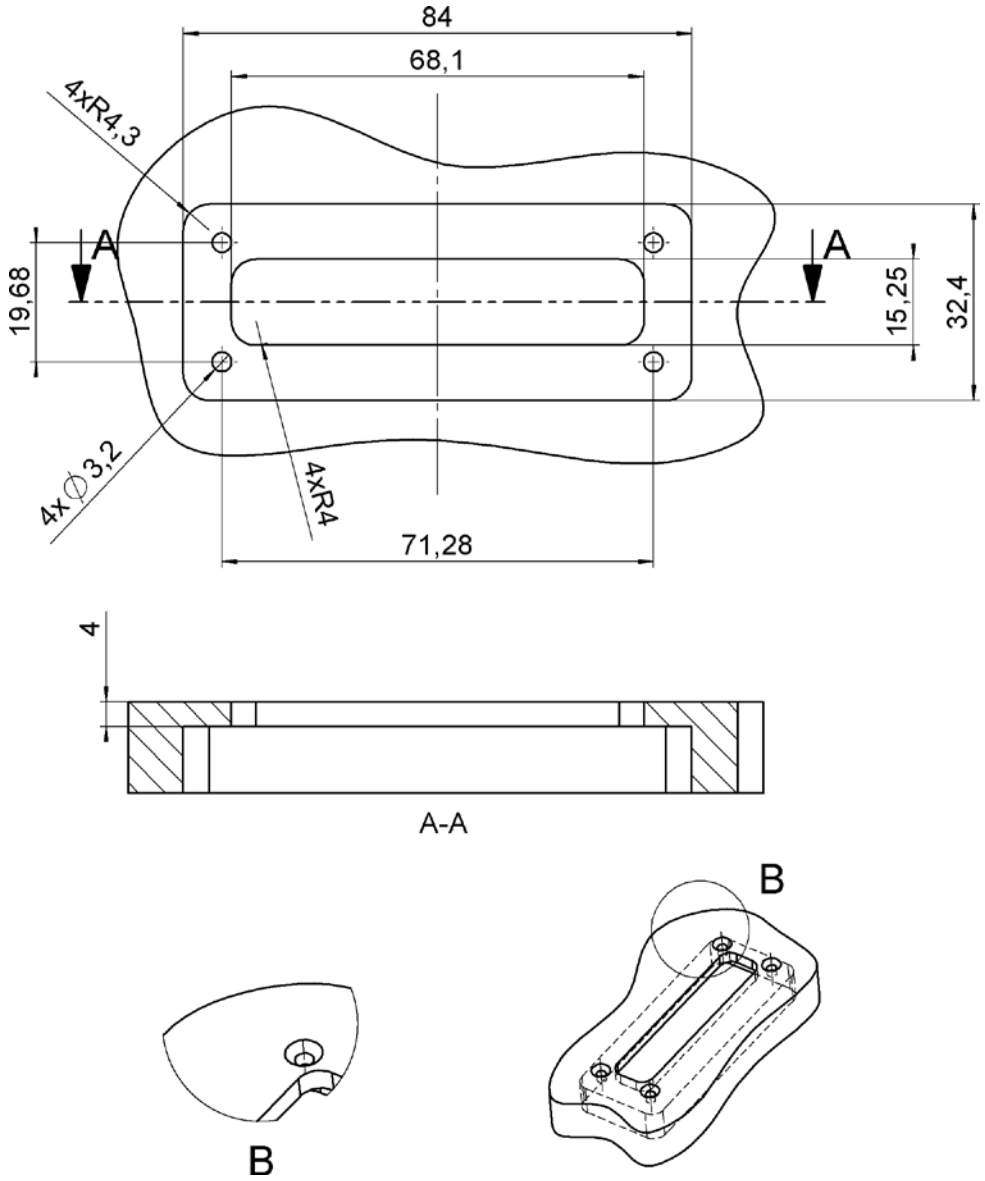


Figure 10: Dimensions of the vacuum feedthrough for data transmission (4668) (dimensions in mm)

B 4 holes 45°xØ6 for M3 countersunk screw

Prerequisites

✓ The cable set is **not** connected to the Hexapod controller.

Tools and accessories

- Cable set C-887.V02 that belongs to the Hexapod system (p. 10)
- Suitable tools for installing the vacuum feedthrough

Installing vacuum feedthroughs

1. Install the vacuum feedthrough for data transmission (4668):
   a) See the above figure for the dimensions of the vacuum feedthrough.
   b) Provide the vacuum chamber with a suitable opening.
   c) Install the vacuum feedthrough so that the HD Sub-D socket 78f is in the vacuum chamber.
2. Install the vacuum feedthrough for the power supply (C887B0002):
   a) Provide the vacuum chamber with an opening of 12 mm in diameter. The flange must not be more than 28 mm thick.
   b) Install the vacuum feedthrough so that the 2-pin LEMO connection is in the vacuum chamber.

Connecting the C-887.V02 standard cable set to the Hexapod

➢ Connect the Hexapod, cable set and vacuum feedthroughs with each other as shown in the connection diagram below.
   – Observe the assignment that is specified by the labeling on the sockets, connectors and cables.
   – When handling MDR68 connectors, proceed as described in "Connecting the C-887.A03 Standard Cable Set" (p. 31).
   – Observe the mechanical coding of connectors and sockets.
   – Do not use force.

➢ Do **not** connect the cable set to the Hexapod controller yet.

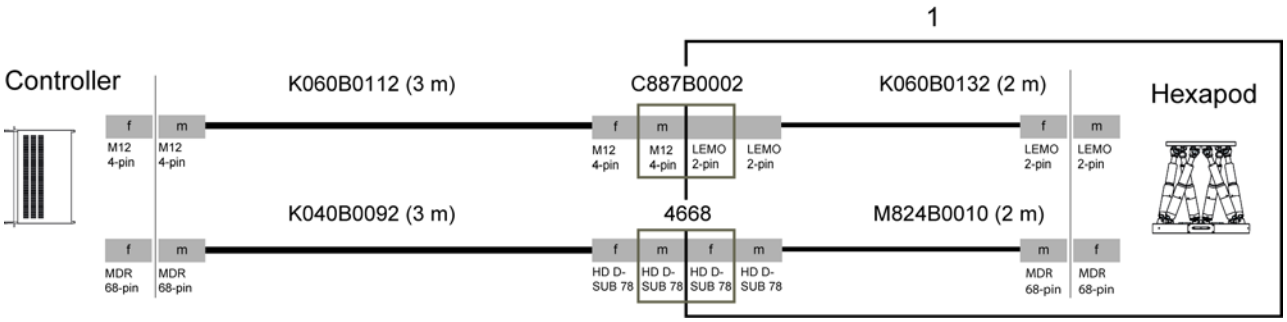


Figure 11: Connection diagram for C-887.V02 standard cable set for vacuum versions

K060B0112	*Power supply cable on the air side, M12m to M12f, 3 m*
K040B0092	*Data transmission cable on the air side, HD Sub-D 78f to MDR68m, 3 m*
C887B0002	*Vacuum feedthrough for power supply, LEMO 2-pin to M12m*
4668	*Vacuum feedthrough for data transmission, HD Sub-D 78m/f*
K060B0132	*Power supply cable on the vacuum side, LEMO 2-pin to LEMO 2-pin, 2 m*
M824B0010	*Data transmission cable on the vacuum side, MDR68m to HD Sub-D 78m, 2 m*
1	*Vacuum chamber*

5.7.3 Connecting the cable set with line driver boxes to the Hexapod

Prerequisites

✓ The cable set is **not** connected to the Hexapod controller.

Tools and accessories

- Long cable set with two line driver boxes; available as optional accessories (p. 14).

Connecting the cable set with line driver boxes to the Hexapod

➢ Connect the Hexapod and cable set with each other as shown in the connection diagram below.

  – Observe the assignment that is given by the labeling on the sockets, connectors and cables.

  – When handling the connectors, proceed as described in "Connecting the C-887.A03 Standard Cable Set" (p. 31).

➢ Do **not** connect the cable set to the Hexapod controller yet.

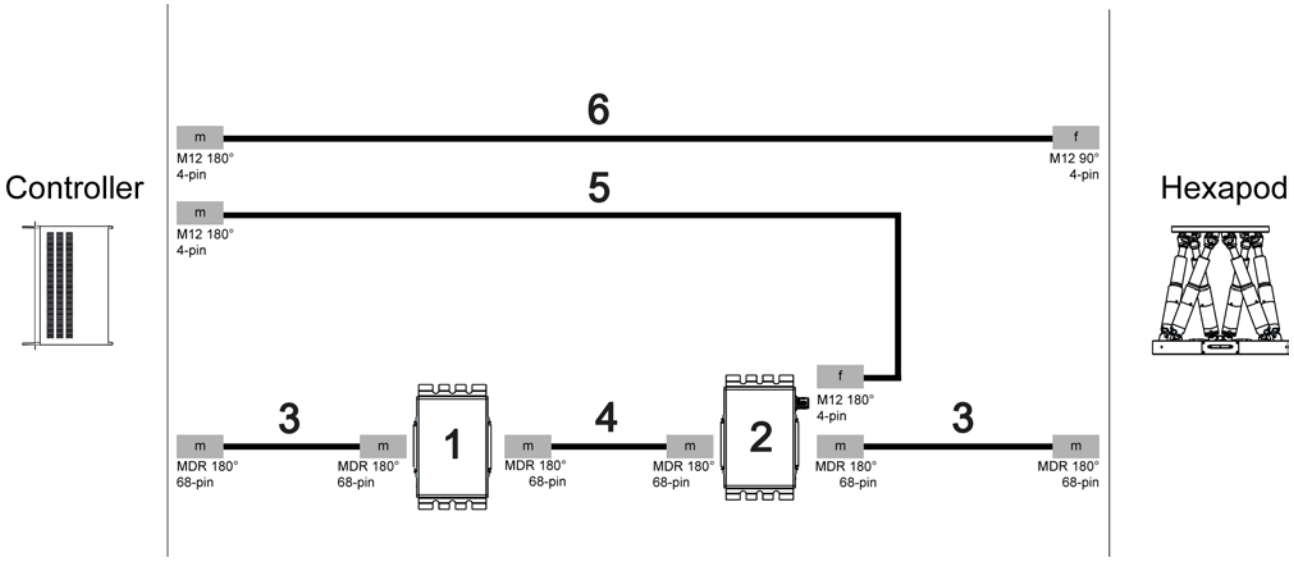


Figure 12: Connection diagram of cable set with line driver boxes

1 *Line driver box for data transmission cable, controller-side*

2 *Line driver box for data transmission cable, Hexapod-side*

3 *Short data transmission cable MDR68 to MDR68 1:1 (3 m)*

4 *Long data transmission cable MDR68 to MDR68 1:1*

5 *Power supply cable for line driver box, with M12 coupling/M12 connector*

6 *Power supply cable for Hexapod, with M12 coupling/M12 connector*

➢ For the length of the cables 4, 5 and 6 and the item IDs of the components, see "Optional Accessories" (p. 14).

6 Start-Up

In this Chapter

6.1 General Notes on Start-Up

CAUTION

Risk of crushing by moving parts!

There is a risk of minor injuries caused by crushing which can occur between the moving parts of the Hexapod and a stationary part or obstacle.

- ➢ Keep your fingers away from areas where they can get caught by moving parts.

NOTICE

Incorrect configuration of the Hexapod controller!

The configuration data used by the Hexapod controller (e. g. geometrical data and servo-control parameters) must be adapted to the Hexapod. If incorrect configuration data is used, the Hexapod can be damaged by uncontrolled motions or collisions. The configuration data is adapted before delivery.

- ➢ Check whether the Hexapod controller matches the Hexapod. A label on the rear panel of the controller indicates for which Hexapod the controller is intended.
- ➢ When you have established the communication via TCP/IP or RS-232 or use the user interface of the C-887, send the `CST?` command. The response shows the Hexapod to which the controller is adapted.
- ➢ Only operate the Hexapod with a Hexapod controller whose configuration data is adapted to the Hexapod.

NOTICE

Damage from collisions!

Collisions can damage the Hexapod, the load to be moved, and the environment.

- ➢ Make sure that no collisions between the Hexapod, the load to be moved and the environment are possible in the work space of the Hexapod.
- ➢ Do not place any objects in areas where they can get caught by moving parts.
- ➢ If the Hexapod controller malfunctions, stop the motion immediately.

NOTICE

Damage from transport lock that has not been removed!

Damage can occur to the Hexapod if the transport lock (p. 21) of the Hexapod has not been removed and a motion is commanded.

- ➢ Remove the transport lock before you start up the Hexapod system.

6.2 Starting Up the Hexapod System

Prerequisite

- ✓ You have read and understood the General Notes on Start-Up (p. 37).
- ✓ You have correctly installed the Hexapod, i.e. you have mounted the Hexapod on a surface and affixed the load to the Hexapod according to the instructions in "Installation" (p. 23).
- ✓ You have read and understood the user manual of the Hexapod controller.

Accessories

- Hexapod controller belonging to the Hexapod system
- PC with suitable software (see user manual of the Hexapod controller)

Starting up the Hexapod system

1. Connect the Hexapod to the Hexapod controller (see user manual of the Hexapod controller).
2. Start up the Hexapod controller (see user manual of the Hexapod controller).
3. Operate a few motion cycles for testing purposes (see user manual of the Hexapod controller).

7 Maintenance

In this Chapter

NOTICE

Damage due to improper maintenance!

The Hexapod can become misaligned as a result of improper maintenance. The specifications can change as a result (p. 49).

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

Depending on the operational conditions and the period of use of the Hexapod, the following maintenance measures are required.

7.1 Carrying out a Maintenance Run

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

- Carry out a maintenance run over the entire travel range at regular intervals (see user manual of the Hexapod controller). The more often motions are carried out over a limited travel range, the shorter the time between the maintenance runs has to be.

7.2 Packing the Hexapod for Transport

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 lock or the base plate.

INFORMATION

The figures in the following section show an H-840 Hexapod. The transport lock of the H-840 is attached the same way as with the H-850.

Accessories

- Original packaging (p. 13)
- Transport lock (p. 21)

Packing the Hexapod

1. Command the Hexapod to move to the reference position:
   X = Y = U = V = 0
   Z = – 23
   W = – 6
2. Uninstall the Hexapod system.
   a) Remove the load from the moving platform of the Hexapod.
   b) Power down the Hexapod controller.
   c) Remove the data transmission cable and the power supply cable from the Hexapod controller and the Hexapod.
   d) Loosen the six M6x30 screws with which the Hexapod is mounted on a surface.
   e) Remove the six M6x30 screws.

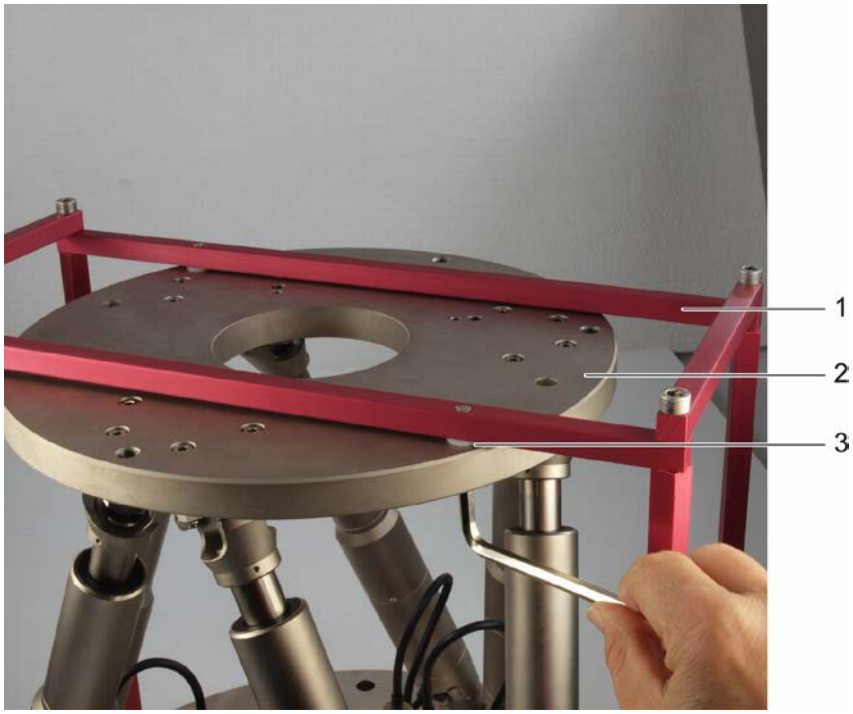


Figure 13: Transport lock on the moving platform

1 Transport lock
2 Moving platform
3 Plastic flat washer

3. Position the transport lock (1) on the Hexapod so that the holes in the braces of the transport lock are above the corresponding holes in the moving platform (2) and the base plate of the Hexapod (see figures in "Unpacking" (p. 21)).

   If the Hexapod system is defective, the holes in the Hexapod and transport lock may not be congruent because the Hexapod has not reached the transport position. Do not attach the transport lock, and continue with step 7.

4. Push the plastic flat washers (3) between the holes in the Hexapod and the transport lock.

5. Fasten the transport lock with 2 screws (M6x30) to the moving platform. The screw heads must be located on the bottom side of the moving platform.

Figure 14: Transport lock on the base plate

6. Fasten the transport lock with 4 screws (M6x20) on the side of the base plate (see figure).
7. Pack the Hexapod in a plastic foil to protect it against dirt.
8. Open the outer box.
9. Remove the foam cover.
10. Open the inner box.
11. Remove the foam cover.
12. Hold the Hexapod by the transport lock or the base plate and place it in the foam insert of the inner box.

    If the transport lock could not be attached, stabilize the Hexapod by adding additional packaging material, e.g. foam inserts.
13. Insert the foam cover in the inner box.
14. Close the inner box.
15. Insert the foam cover in the outer box.
16. Close the outer box.
17. Secure the box on the pallet.

7.3 Cleaning the Hexapod

Prerequisites

✓ You have disconnected the Hexapod from the controller.

Cleaning the Hexapod

➢ Do **not** use any organic solvents.

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

➢ When necessary, clean the surfaces of the Hexapod with a cloth slightly dampened with a mild cleanser or disinfectant.

Only when the Hexapod is used in vacuum:

➢ Only touch the Hexapod with powder-free gloves.

➢ If necessary, wipe the Hexapod clean.

8 Troubleshooting

Problem	Possible Causes	Solution
Unexpected Hexapod behaviour.	▪ Cable broken ▪ 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. 47).
The Hexapod does not achieve the specified accuracy.	Warped base plate	➢ Mount the Hexapod on an even surface (p. 26). The recommended evenness of the surface is 300 µm.
	Increased wear due to small motions over a long period of time	➢ Carry out a maintenance run over the entire travel range (p. 39).
The Hexapod does not move.	▪ Worn drive screw ▪ Foreign body has entered the drive screw ▪ Faulty motor ▪ Blocked or broken joint ▪ Dirty encoder	➢ Carry out a strut test (see user manual of the Hexapod 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. 47).

If the problem with your Hexapod is not listed in the table or cannot be solved as described, contact our customer service department (p. 47).

9 Customer Service

For inquiries and orders, contact your PI sales engineer or send us an e-mail (mailto:info@pi.ws).

If you have questions concerning your system, have the following information ready:

- Product codes and serial numbers of all products in the system
- Firmware version of the controller (if present)
- Version of the driver or the software (if present)
- Operating system on the PC (if present)

The latest versions of the user manuals are available for downloading (p. 3) on our website.

10 Technical Data

In this Chapter

10.1 Specifications

10.1.1 Data Table

	H-850.H1x	H-850.G1x	Unit	Tolerance
	for higher loads and holding forces	for higher velocity and precision		
Active axes	X, Y, Z, θ_X, θ_Y, θ_Z	X, Y, Z, θ_X, θ_Y, θ_Z		
Motion and positioning				
Travel range* X, Y	±50	±50	mm	
Travel range* Z	±25	±25	mm	
Travel range* θ_X, θ_Y	±15	±15	°	
Travel range* θ_Z	±30	±30	°	
Single-actuator design resolution	0.005	0.05	µm	
Min. incremental motion X, Y	1	1	µm	typ.
Min. incremental motion Z	0.5	0.5	µm	typ.
Min. incremental motion θ_X, θ_Y, θ_Z	5	5	µrad	typ.
Backlash X, Y	4	5	µm	typ.
Backlash Z	1	1.5	µm	typ.
Backlash θ_X, θ_Y	15	25	µrad	typ.
Backlash θ_Z	30	45	µrad	typ.
Repeatability X, Y	±1	±0.5	µm	typ.
Repeatability Z	±0.3	±0.2	µm	typ.
Repeatability θ_X, θ_Y	±5	±3	µrad	typ.
Repeatability θ_Z	±9	±6	µrad	typ.

Max. velocity X, Y, Z	0.5	8	mm/s	
Max. velocity θ_X, θ_Y, θ_Z	6	100	mrad/s	
Typ. velocity X, Y, Z	0.3	5	mm/s	
Typ. velocity θ_X, θ_Y, θ_Z	3	50	mrad/s	
Mechanical properties				
Stiffness X, Y	7	7	N/µm	
Stiffness Z	100	100	N/µm	
Load (base plate horizontal / any orientation)	250 / 50	50 / 20	kg	max.
Holding force, de-energized (base plate horizontal / any orientation)	2000 / 500	250 / 85	N	max.
Motor type	DC motor, gearhead	DC motor, gearhead		
Miscellaneous				
Operating temperature range	-10 to 50	-10 to 50	°C	
Material	Aluminum	Aluminum		
Mass	17	17	kg	±5%
Cable length	3	3	m	±10 mm

Vacuum versions to 10^{-6} hPa are available under the following ordering number: H-850.xV. Specifications for vacuum versions can differ.

Technical data specified at 20±3°C.

Ask about custom designs!

* The travel ranges of the individual coordinates (X, Y, Z, θ_X, θ_Y, θ_Z) are interdependent. The data for each axis in this table shows its maximum travel, where all other axes are at their zero positions. If the other linear or rotational coordinates are not zero, the available travel may be less.

10.1.2 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

10.1.3 Specifications for Vacuum-Compatible Versions

	H-850.HV	H-850.GV	Unit	Tolerance
Motion and positioning				
Min. incremental motion X, Y	2	2	µm	typ.
Min. incremental motion Z	1	1	µm	typ.
Min. incremental motion θX, θY, θZ*	10	10	µrad	typ.
Repeatability Z	±2	±2	µm	typ.
Repeatability θX, θY, θZ	±20	±20	µrad	typ.
Velocity X, Y, Z	0.15	2.5	mm/s	max.
Velocity θX, θY, θZ	1.8	30	mrad/s	max.
Velocity X, Y, Z	0.1	2	mm/s	typ.
Velocity θX, θY, θZ	1.2	25	mrad/s	typ.
Mechanical properties				
Load (base plate horizontal / any orientation)	80 / 40	25 / 10	kg	max.
Holding force (base plate horizontal / any orientation)	2000 / 400	250 / 85	N	max.
Miscellaneous				
Cable length	2 m on the vacuum side, vacuum feedthrough, 3 m on the air side	2 m on the vacuum side, vacuum feedthrough, 3 m on the air side	m	±10 mm
Drive and sensor				
Motor	Manufacturer: Faulhaber Motor type: DC, 2342S024			
Gearhead	HDUC–8-100 Harmonic Drive for H-850.HV CS-8-50 Harmonic Drive for H-850.GV			
Encoder	Manufacturer: Faulhaber Encoder type: magnetic encoder, IE2-512			
Reference point switch	Optical, vacuum-compatible			
Materials used				
Machine-made parts	>95% of the machine-made parts, i.e. base plate, struts, moving platform: AlMgSi (3.2315) chemically nickel-plated, AlMg4.5Mn (3.3547), stainless steel type 303 (1.4305) Remaining parts, e.g. coupling elements: Various vacuum-compatible materials			

Bearing	Stainless steel
Drivetrain elements	Stainless steel (drive screw)
Electrical components	Cable insulation: Teflon (PTFE, FEP) Shrink tubing: Kynar, PTFE Solder: Sn95.5Ag3.8Cu0.7 Connectors: AMP HD20, Lemo PCB's (adapter board, limit switch board, PWM board): sealed with vacuum-compatible Torr seal
Grease	Molykote HP-300, Klüber Barrierta L55/2
Sealing compound and adhesive	Torr seal (Varian), TRA-CAST 3145, Araldite 2014-1 (Huntsmann), 5 Minute Epoxy (Devcon)
Other	
Bakeout temperature	80 °C (176 °F)

10.2 Ambient Conditions and Classifications

Degree of pollution:	2
Transport temperature:	–25°C to +85°C
Storage temperature:	0 °C to 70 °C
Humidity:	Maximum relative humidity of 80% at temperatures of up to 31°C, linearly decreasing until 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

10.3 Dimensions

All figures show the Hexapod in the reference position. Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

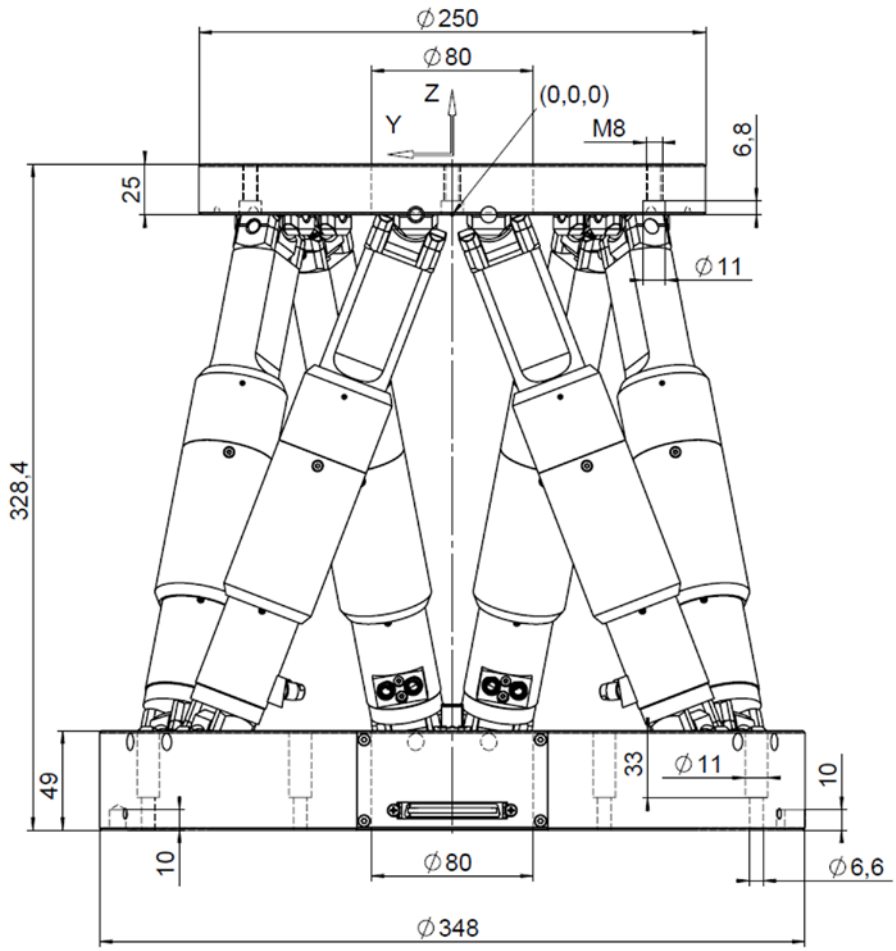


Figure 15: H-850 Hexapod front view (dimensions in mm)

The (0,0,0) coordinates refer to the origin of the XYZ coordinate system. When the default settings of the Hexapod controller are used and the Hexapod is in the reference position, the pivot point is located at the origin of the XYZ coordinate system.

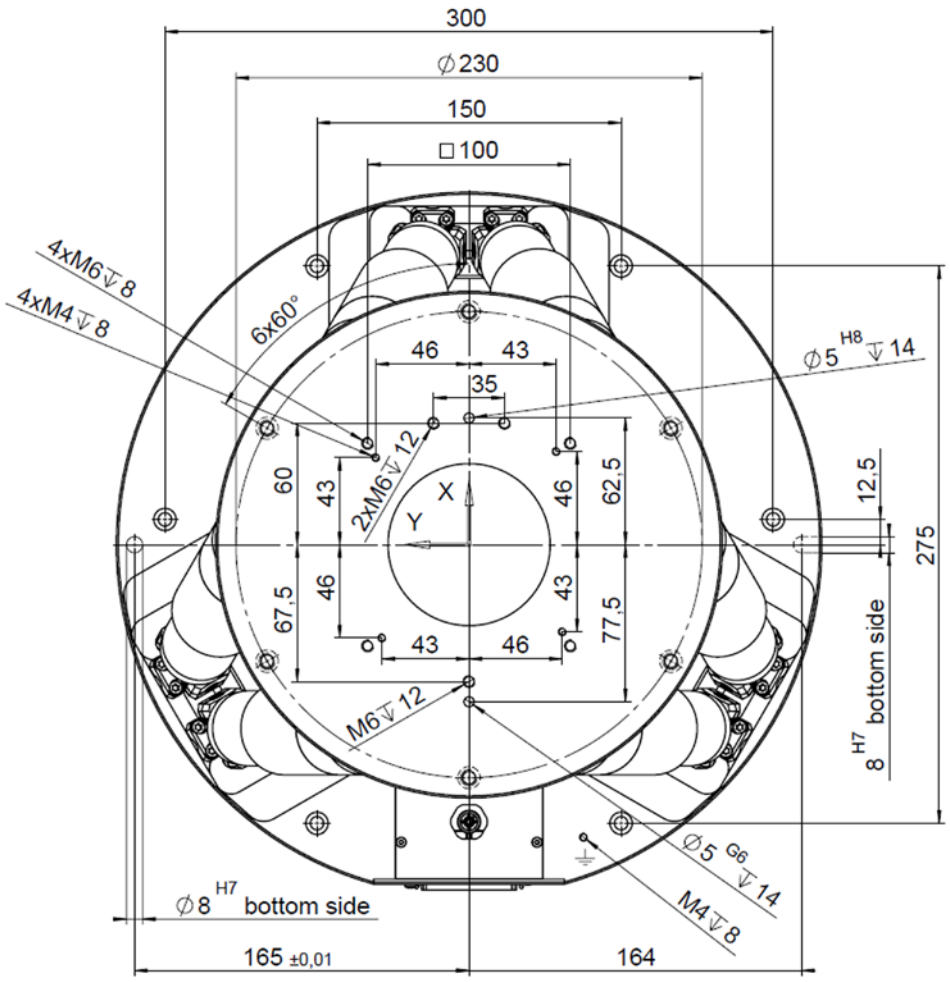
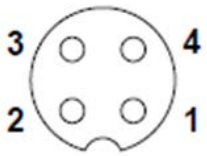


Figure 16: H-850 Hexapod top view (dimensions in mm)

10.4 Pin Assignment

10.4.1 Power Supply Connection

Not for vacuum versions:
Power supply via 4-pin, A-coded M12 panel plug

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

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

Pin	Function	
1	GND	
2	24 V DC	

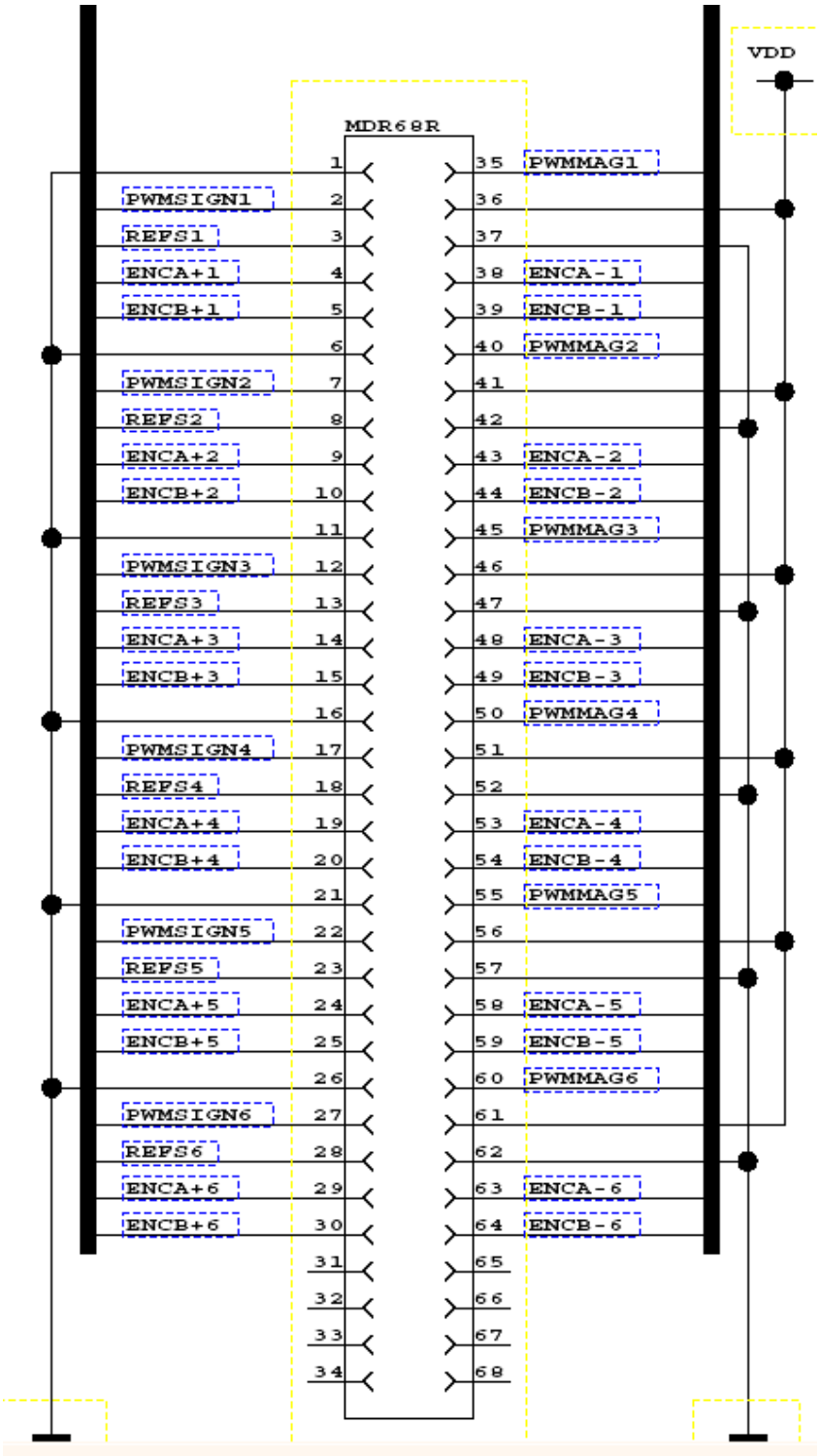
10.4.2 Data Transmission Connection

Data transmission between the Hexapod and the Hexapod controller

MDR68 socket

Function	Socket
All signals: TTL	

Pin assignment



11 Old Equipment Disposal

In accordance with the applicable EU law, electrical and electronic equipment may not be disposed of with unsorted municipal wastes in the member states of the EU.

When disposing of your old equipment, observe the international, national and local rules and regulations.

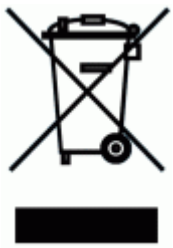
To meet the manufacturer's product responsibility with regard to this product, Physik Instrumente (PI) GmbH & Co. KG ensures environmentally correct disposal of old PI equipment that was first put into circulation after 13 August 2005, free of charge.

If you have old PI equipment, you can send it postage-free to the following address:

Physik Instrumente (PI) GmbH & Co. KG

Auf der Römerstr. 1

D-76228 Karlsruhe, Germany



12 Glossary

Work space

The entirety of all combinations of translations and rotations that the Hexapod can approach from the current position is referred to as the work space.

The work space can be limited by the following external factors:

- Installation space
- Dimensions and position of the load

Pivot point

The pivot point describes the center of rotation (intersection of the rotational axes U, V and W). When the standard settings for the pivot point coordinates are used, the pivot point is located at the origin of the XYZ coordinate system after a reference move, see the dimensional drawing (p. 53) for more information.

The pivot point is shifted along with the platform during translations. Rotations do not change the position of the pivot point. The pivot point coordinates remain unchanged in both cases.

The pivot point coordinates can be changed in the Hexapod controller.

XYZ coordinate system

The position and orientation of the Cartesian XYZ coordinate system cannot be changed, which is why the system is referred to as spatially fixed. The axes X, Y and Z are referred to as translational axes.

The intersection of the axes of the spatially-fixed Cartesian XYZ coordinate system (0,0,0) is referred to as the origin.

The Z axis is always perpendicular to the base plate of the Hexapod.

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

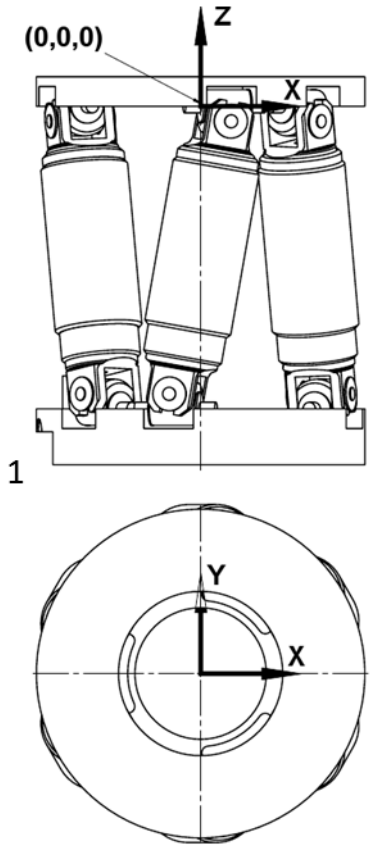


Figure 17: H-810 Hexapod in the reference position.

1 Cable outlet

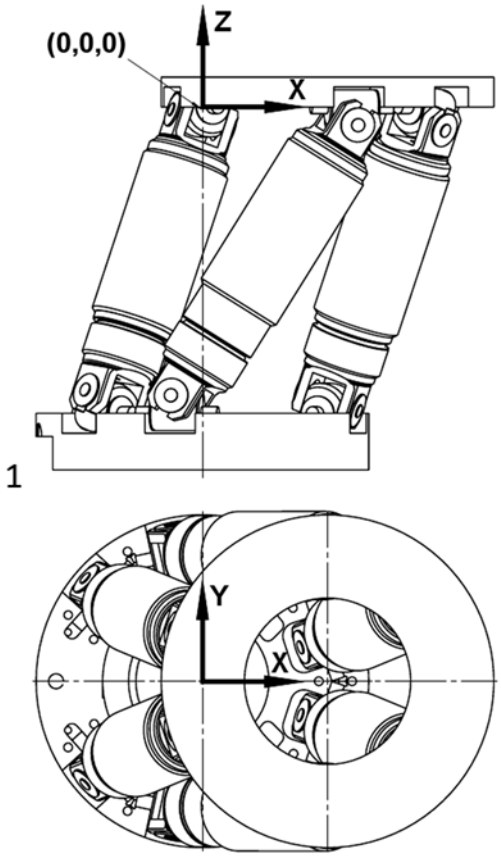


Figure 18: H-810 Hexapod, the platform of which has been moved in X.

1 Cable outlet

13 Appendix

In this Chapter

13.1 Explanations of the Performance Test Sheet

The Hexapod is tested for the positioning accuracy of the translational axes before delivery. The performance test sheet is included in the scope of delivery.

The following figure shows the test setup used.

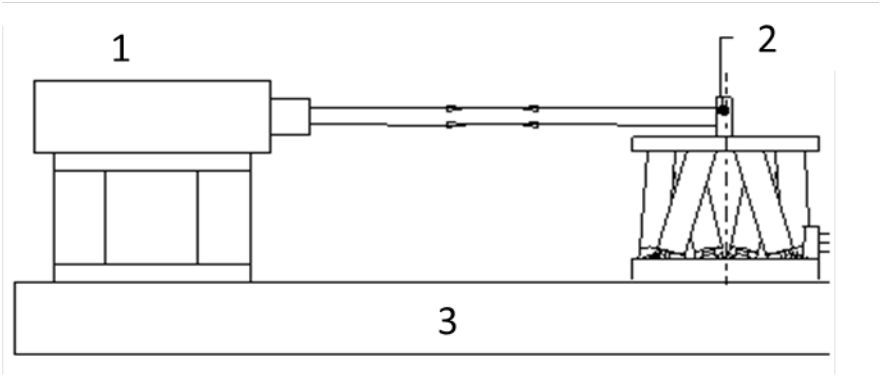


Figure 19: Test setup for measuring the X or Y axis.

1 Laser interferometer
2 Mirror
3 Bench

The following test cycles are performed:

- Movement over the entire travel range with at least 20 measuring points, in at least five cycles.
- Movement over partial sections, e. g. ±1 mm in increments of e. g. 10 µm

13.2 EC Declaration of Conformity

PI

Declaration of Conformity

according to DIN EN ISO/IEC 17050-1

Manufacturer:	**Physik Instrumente (PI) GmbH & Co. KG**
Manufacturer´s Address:	Auf der Roemerstraße 1 D-76228 Karlsruhe, Germany

CE

The manufacturer hereby declares that the product

Product Name: **Hexapod Microrobot**

Model Numbers: **H-850**

Product Options: **all**

complies with all relevant provisions of the **Machinery Directive (2006/42/EC)**.
Furthermore, it complies with all provisions of the **EMC Directive (2004/108/EC)**.

The applied standards certifying the conformity are listed below.

Safety of Machinery:	EN 12100-1: 2011-03, EN-12100-2: 2011-03
Electromagnetic Emission:	EN 61000-6-3: 2007-09, EN 55011: 2009
Electromagnetic Immunity:	EN 61000-6-1: 2007-10

The person authorized to compile the technical file is: Siegmar Klein
Address: see manufacturer's address

December 14, 2011
Karlsruhe, Germany

Dr. Karl Spanner
President

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