H-860.S2H
Magnetic drive hexapod system
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**System Overview**

**Device Components**

1. Platform (with mounting holes for load)
2. Strut
3. Heat sink
4. Base plate (with mounting holes for device fixation)
5. Drive unit

Figure 1: Parts of the transport lock, overview
Additional Items in the Scope of Delivery

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Quantity</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>000023547</td>
<td>6</td>
<td>Screw ISO 4762 M6x40</td>
</tr>
<tr>
<td>000036450</td>
<td>1</td>
<td>Screw set for connection to the protective earth system: 1 M4x8 flat-head screw with cross recess ISO 7045 2 washers, form A-4.3 DIN 7090 2 safety washers Ø 4 mm</td>
</tr>
<tr>
<td>435</td>
<td>1</td>
<td>Hex key DIN 911 AF 2.5</td>
</tr>
<tr>
<td>437</td>
<td>1</td>
<td>Hex key DIN 911 AF 5</td>
</tr>
<tr>
<td>000022838</td>
<td>1</td>
<td>Hex key DIN 911 AF 6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transport lock, see p. 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packaging material</td>
</tr>
</tbody>
</table>

Other Applicable Documents

<table>
<thead>
<tr>
<th>MS204Equ</th>
<th>Short version of the user manual for the C-887 (detailed version is on the C-887.CD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C887T0008</td>
<td>Technical Note for the C-887.52 hexapod controller</td>
</tr>
<tr>
<td>C887T0013</td>
<td>Technical Note for wave generator functionality of C-887.5x / C-887.5xx hexapod controllers</td>
</tr>
<tr>
<td>A000T0028</td>
<td>Technical Note on using the PI update finder</td>
</tr>
<tr>
<td>A000T0032</td>
<td>Technical Note on updating the PI software using the PI Update Finder</td>
</tr>
<tr>
<td>MS204E</td>
<td>User Manual of the C-887.11/21 hexapod controller</td>
</tr>
</tbody>
</table>

Manuals for standard products can be downloaded from [www.pi.ws](http://www.pi.ws).

The functionality of the C-887.52 controller is based on that of the C-887.21 standard model. In general, see the MS204E user manual of the C-887.11/21 hexapod controller for descriptions of the commands and functionality supported by the C-887.52 hexapod controller. For the most important differences between C-887.21 and C-887.52, see the C887T0008 Technical Note.

Descriptions of commands for the wave generator can be found in the C887T0013 Technical Note (C887T0013_WaveGenerator_for_C-887_5xx.pdf).

Descriptions of commands for hexapod coordinate systems can be found in the C887T0007 Technical Note (C887T0007_Hexapod_Coordinate_Systems_EN.pdf).
Safety

Intended Use

The product 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 product is intended for positioning, adjusting and shifting of loads in six axes at various velocities. It is only intended for horizontal mounting.

The intended use of the product is only possible in connection with the corresponding motion controller.

General Safety Instructions

The product 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 system.

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

The operator is responsible for the correct installation and operation of the product.

Organizational Measures

User Documentation

- Always keep the user documentation available by the product.
- Add all information given by the manufacturer to the user documentation, for example supplements or Technical Notes.
- If you pass the product on to other users, also turn over the user documentation as well as other relevant information provided by the manufacturer.
- Only use the product on the basis of the complete user documentation. Missing information due to incomplete user documentation can result in minor injury and property damage.
- Only install and operate the product after having read and understood the user documentation.

Personnel Qualification

The product may only be unpacked or repacked, installed, started up, operated, maintained and cleaned by authorized and qualified staff.
Safety Measures during Transport

An impermissible mechanical load can damage the product.

- Only hold the product by the four handles of the transport lock.
- Remove the transport lock only after positioning the product at its place of installation.
- Do not hold the product by the struts or the moving platform.
- Only send the product with installed transport lock and in the original packaging.

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 four handles of the transport lock.
- Remove the transport lock only after positioning the hexapod at its place of installation.
- Make sure that the installed load observes the specified limit.
- Avoid high forces and torques on the moving platform during installation of the hexapod and the load. When affixing the load to the moving platform of the hexapod using screws M4, do not exceed a maximum torque of 2.8 Nm.
- Ensure an uninterruptible power supply in order to prevent an unintentional deactivation of the hexapod 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.

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 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.

Power supply for hexapod and hexapod controller:

- Install the power supply near the power source so that the power plug can be quickly and easily disconnected from the mains.
If the power cord of the power supply must be extended, use a power cord with sufficient ratings.

Safety Measures during Start-Up and Operation

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.

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.

- Follow the instructions in “Unpacking the hexapod” (p. 8) to remove the transport lock.

The voice coil drives of the hexapod do not feature self-locking. Switching off the servo mode for the hexapod or switching off the hexapod controller therefore can lead to unexpected motions (the struts of the hexapod will move to their hard stops abruptly).

- Ensure an uninterruptible power supply in order to prevent an unintentional deactivation of the hexapod and resulting unintentional position changes of the hexapod’s platform.
- Avoid blocking of platform: When the moving platform of the hexapod is blocked by an obstacle, a motion error can occur, and the servo mode is switched off automatically.
- Before you switch off the servo mode or the hexapod controller, send the DBG? EXIT command to move the hexapod platform in a safe position.
Unpacking the Hexapod

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 hold the hexapod by the four handles of the transport lock.
- Remove the transport lock only after positioning the hexapod at its place of installation.
- Do not hold the hexapod by the struts or the by the platform.
- Keep the parts of the transport lock and the original packaging.

NOTICE

Damage from transport lock that has not been removed!
Damage can occur to the hexapod if the transport lock of the hexapod has not been removed and a motion is commanded.
- Follow the instructions in this section to remove the transport lock.

Required tools
- Hex key AF 2.5
- Hex key AF 7
- Torx key T 10
Figure 2: Parts of the transport lock, overview

1. Handle (total: 4), affixed to the base plate using M8 screws
2. Metal ring
3. Acrylic half-sphere
4. Foam spacer
5. Locking plate

1. Remove the packaging:
   a) Open the outer box.
   b) Remove the foam cover.
   c) Open the inner box.
   d) Remove the foam cover.
   e) Hold the hexapod by the handles of the transport lock and remove it from the inner box.
   f) Position the hexapod at its final place of installation using the handles of the transport lock.
2. Remove the handles (optional):

![Figure 3: Removing the handles](image)

- With the hex key AF 5, loosen the screws.
- Lift the handles.
- Keep the handles in a safe place for later re-alignment or transport.
3. Remove the metal ring and acrylic half-sphere:

   a. With the Torx key T10, loosen the M3 screws as shown in the diagram.
   b. Lift the ring incl. the mounted half-sphere.
   c. Keep the ring with half-sphere in a safe place for later packaging, storing, or transport.
4. Remove the locking plates of the struts. For any of the 6 locking plates, proceed as follows:

Figure 5: Location of the locking plates

Figure 6: Loosening the M3 screw / removing the locking plate

- a. With a hex key 2.5, loosen the M3 screw.
- b. Pull out the locking plate as shown in the diagram.
5. Remove the foam parts:

![Figure 7: Removing the foam parts](image)

a. **Hold the platform safely of the hexapod while performing the following step:**
   b. Pull out the foam part with a horizontal move as shown in the diagram.
   c. Ensure that the controller is switched on.
   d. Lower the platform carefully until the platform is in lowest position.

**Mount the Hexapod onto a Surface**

Depending on the number of removed handles, the number of available holes for surface mounting varies. Both M8 and M6 screw types are applicable. For the positions of the corresponding mounting holes, see the drawing in the “Dimensions” section (p. 17).

**Mount a Load onto the Platform**

**NOTICE**

- **Impermissible mechanical load!**
  An impermissible mechanical load can damage the hexapod.
  
  - When affixing the load to the moving platform of the hexapod using screws M4, do **not** exceed a maximum torque of 2.8 Nm.
  - Do not exceed the 2.8 Nm.

For mounting a load onto the hexapod platform, M4 screws can be used. For the positions and types of mounting holes, see the drawing in the “Dimensions” section (p. 17).
Interconnecting the System

Interconnect the system as shown in the diagram below.

![Connection Diagram](image)

Preparing the Hexapod System for Start-Up

**NOTICE**

**Unexpected motions (no self-locking)!**

The voice coil drives of the hexapod do **not** have any self-locking. Switching off the servo mode for the hexapod or switching off the hexapod controller therefore can lead to unexpected motions (the struts of the hexapod will move to their hard stops abruptly).

- Before you switch off the servo mode or the hexapod controller, send the `DBG? EXIT` command to move the hexapod platform in a safe position.
NOTICE

Damage from transport lock that has not been removed!
Damage can occur to the hexapod if the transport lock of the hexapod has **not** been removed and a motion is commanded.

- Follow the instructions in the corresponding section (p. 8) to remove the transport lock.

1. Install PIMikroMove on a PC. For details, see „Installing PC Software“ in the MS204E user manual of the C-887.11/.21 hexapod controller.

2. Interconnect hexapod and hexapod controller as described on p. 14.

3. Connect the hexapod controller to the PC. For details, see „Connecting the C-887 to a PC“ in the MS204E user manual of the C-887.11/.21 hexapod controller.

4. Perform a reference move for the platform of the hexapod. Proceed as follows:
   a) Switch on the system using the power on/off switch on the front panel of the hexapod controller.
   a) Establish communication between the hexapod controller and the PC. Depending on the interface used, see „Establishing Communication via the TCP/IP Interface“ or „Establishing Communication via the RS-232 Interface“ in the MS204E user manual of the C-887.11/.21 hexapod controller.
   b) Carry out the reference move for the moving platform of the hexapod. For details, see „Starting Motions of the Platform of the Hexapod“ in the MS204E user manual of the C-887.11/.21 hexapod controller.
Start-up and Operation

General Notes on Start-up and Operation

**NOTICE**

**Unexpected motions (no self-locking)!**

The voice coil drives of the hexapod do not have any self-locking. Switching off the servo mode for the hexapod or switching off the hexapod controller therefore can lead to unexpected motions (the struts of the hexapod will move to their hard stops abruptly).

- Ensure an uninterruptible power supply in order to prevent an unintentional deactivation of the hexapod system and resulting unintentional position changes of the hexapod.
- Avoid blocking of the moving platform: When the moving platform of the hexapod is blocked by an obstacle, a motion error can occur, and the servo mode is switched off automatically.
- Before you switch off the servo mode or the hexapod controller, send the DBG? EXIT command to move the hexapod platform in a safe position.

**NOTICE**

**Damage from transport lock that has not been removed!**

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

- Follow the instructions in “Unpacking the Hexapod” (p. 8) to remove the transport lock.

Velocity and Acceleration in Static and Dynamic Operation

Depending on the type of operation, the hexapod requires different settings for velocity and acceleration:

<table>
<thead>
<tr>
<th>Type of operation</th>
<th>Velocity</th>
<th>Acceleration</th>
<th>Application example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static operation</td>
<td>20 mm/s</td>
<td>2000 mm/s²</td>
<td>Reference move</td>
</tr>
<tr>
<td>Dynamic operation</td>
<td>200 mm/s</td>
<td>10000 mm/s²</td>
<td>Axis controlled by wave generator output</td>
</tr>
</tbody>
</table>

When the hexapod controller is switched on or rebooted, velocity and acceleration are automatically set to the values for static operation in order to allow for a successful reference move.

The velocity can be changed using the VLS command, see the MS204E user manual of the C-887.11/.21 hexapod controller for more information.
Switch-off Procedure

Before you switch off the servo mode or the hexapod controller, always perform a “switch-off” procedure to move the hexapod platform in a safe position. In this position, all actuators are at their hard stops. To start the switch-off procedure, send the following command:

DBG? EXIT

If DBG? EXIT is not sent, the actuators will move to their hard stops abruptly since there is no self-locking.

1. The switch-off procedure started with DBG? EXIT is as follows:
2. User-defined coordinate systems are disabled (KEN 0 is executed).
3. Soft limits are disabled.
4. The hexapod moves to the „middle“ (position of axis Z is maintained, all other axes are moved to 0).
5. The hexapod moves to the negative limit of the Z-axis.
6. The hexapod moves to the lower hard stops with reduced velocity.
7. The servo mode is switched off.
8. The controller outputs a sound indicating that the switch-off procedure is finished, and the controller can now be switched off.

Packing the Hexapod for Transport

For packing the hexapod, reverse the procedure described in the paragraph “Unpacking the Hexapod” (p. 8).

Specifications

Technical Data

<table>
<thead>
<tr>
<th>Active axes</th>
<th>X, Y, Z, θx, θy, θz</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motion and positioning</strong></td>
<td></td>
</tr>
<tr>
<td>Travel range* in X, Y, Z</td>
<td>±7.5 mm</td>
</tr>
<tr>
<td>Travel range* in θx, θy, θz</td>
<td>±4°</td>
</tr>
<tr>
<td>Actuator design resolution</td>
<td>5 nm</td>
</tr>
<tr>
<td>Minimum incremental motion in X, Y</td>
<td>1 µm typ.</td>
</tr>
<tr>
<td>Minimum incremental motion in Z</td>
<td>1 µm typ.</td>
</tr>
</tbody>
</table>
### H-860.S2H

<table>
<thead>
<tr>
<th>Parameter</th>
<th>H-860.S2H</th>
<th>Unit</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum incremental motion in $\theta_x$, $\theta_y$, $\theta_z$</td>
<td>9</td>
<td>$\mu$rad</td>
<td>typ.</td>
</tr>
<tr>
<td>Backlash in X, Y</td>
<td>0.2</td>
<td>$\mu$m</td>
<td>typ.</td>
</tr>
<tr>
<td>Backlash in Z</td>
<td>0.06</td>
<td>$\mu$m</td>
<td>typ.</td>
</tr>
<tr>
<td>Backlash in $\theta_x$, $\theta_y$</td>
<td>4</td>
<td>$\mu$rad</td>
<td>typ.</td>
</tr>
<tr>
<td>Backlash in $\theta_z$</td>
<td>4</td>
<td>$\mu$rad</td>
<td>typ.</td>
</tr>
<tr>
<td>Unidirectional repeatability in X, Y</td>
<td>$\pm$0.5</td>
<td>$\mu$m</td>
<td>typ.</td>
</tr>
<tr>
<td>Unidirectional repeatability in Z</td>
<td>$\pm$0.5</td>
<td>$\mu$m</td>
<td>typ.</td>
</tr>
<tr>
<td>Unidirectional repeatability in $\theta_x$, $\theta_y$</td>
<td>$\pm$9</td>
<td>$\mu$rad</td>
<td>typ.</td>
</tr>
<tr>
<td>Unidirectional repeatability in $\theta_z$</td>
<td>$\pm$9</td>
<td>$\mu$rad</td>
<td>typ.</td>
</tr>
<tr>
<td>Velocity in X, Y, Z</td>
<td>250</td>
<td>mm/s</td>
<td>max.</td>
</tr>
<tr>
<td>Max. frequency</td>
<td>30</td>
<td>Hz</td>
<td></td>
</tr>
<tr>
<td>Amplitude-frequency product in X, Y, Z</td>
<td>30</td>
<td>mm·Hz</td>
<td></td>
</tr>
<tr>
<td>Amplitude-frequency product in $\theta_x$, $\theta_y$, $\theta_z$</td>
<td>15</td>
<td>°·Hz</td>
<td></td>
</tr>
<tr>
<td>Amplitude error</td>
<td>10</td>
<td>%</td>
<td>max.</td>
</tr>
<tr>
<td>Phase error</td>
<td>60</td>
<td>°</td>
<td>max.</td>
</tr>
</tbody>
</table>

#### Mechanical properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stiffness in X, Y</td>
<td>0.7</td>
</tr>
<tr>
<td>Stiffness in Z</td>
<td>8</td>
</tr>
<tr>
<td>Load capacity (base plate horizontal / any orientation)</td>
<td>1 kg max.</td>
</tr>
<tr>
<td>Motor type</td>
<td>Voice coil</td>
</tr>
</tbody>
</table>

#### Miscellaneous

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature range</td>
<td>0 to 50 °C</td>
</tr>
<tr>
<td>Material</td>
<td>Stainless steel, aluminum</td>
</tr>
<tr>
<td>Mass</td>
<td>30 kg ±5 %</td>
</tr>
</tbody>
</table>

Technical data for the hexapod specified at 20±3°C.

* The travel ranges of the individual coordinates (X, Y, Z, $\theta_x$, $\theta_y$, $\theta_z$) are interdependent. The data for each axis in this table shows its maximum travel range, where all other axes and the pivot point are at the reference position.
## Ambient Conditions and Classifications

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of pollution</td>
<td>2</td>
</tr>
<tr>
<td>Transport temperature</td>
<td>–25 °C to +85 °C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>–10 °C to 70 °C</td>
</tr>
<tr>
<td>Humidity</td>
<td>Max. 80% at temperatures of up to 31 °C, linearly decreasing to 50% at 40 °C</td>
</tr>
<tr>
<td>Degree of protection according to IEC 60529</td>
<td>IP20</td>
</tr>
<tr>
<td>Area of application</td>
<td>For indoor use only</td>
</tr>
<tr>
<td>Maximum altitude</td>
<td>2000 m</td>
</tr>
<tr>
<td>Air pressure</td>
<td>0.1 hPa to 1100 hPa (approx. 0.075 Torr to 825 Torr)</td>
</tr>
</tbody>
</table>
Dimensions

Values in mm; decimal places separated by commas.
Figure 9: Hexapod dimensions
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 Roemerstr. 1
D-76228 Karlsruhe, Germany

EC Declaration of Conformity

For the H-860 hexapod series, an EC Declaration of Conformity has been issued in accordance with the following European directives:

- EMC Directive
- RoHS Directive

The applied standards certifying the conformity are listed below.

- Electrical Safety: EN 61010-1
- EMC: EN 61326-1
- RoHS: EN 50581