User Manual

V-408.232020 PIMAG® LINEAR STAGE
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2 About this Document

2.1 Objective and Target Group

This user manual contains the information needed for the intended use of the V-408.232020. Basic knowledge of closed-loop systems, motion control concepts, and applicable safety measures is assumed.

2.2 Other Applicable Documents

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

<table>
<thead>
<tr>
<th>Document number</th>
<th>Document type</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS251E</td>
<td>User Manual</td>
<td>C-891.130300</td>
</tr>
<tr>
<td>SM148E</td>
<td>User Manual</td>
<td>PIMikroMove</td>
</tr>
</tbody>
</table>

The latest versions of the user manuals can be downloaded (p. 6) at www.pi.ws.

2.3 Explanation of Symbols

This chapter explains the symbols and markings used by PI in their user manuals.

2.3.1 Typographic Conventions

<table>
<thead>
<tr>
<th>Symbol / Label</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Action consisting of several steps whose sequential order must be observed</td>
</tr>
<tr>
<td>2</td>
<td>List item</td>
</tr>
<tr>
<td>■</td>
<td>Cross-reference to page 5</td>
</tr>
<tr>
<td>p. 5</td>
<td>Cross-reference to page 5</td>
</tr>
<tr>
<td>RS-232</td>
<td>Labeling of an operating element on the product (example: socket of the RS-232 interface)</td>
</tr>
<tr>
<td>Start &gt; Settings</td>
<td>Menu path in the PC software (example: to open the menu, the Start and Settings menus must be clicked successively)</td>
</tr>
<tr>
<td>POS?</td>
<td>Command line or a command from PI’s General Command Set (GCS) (example: command to get the axis position)</td>
</tr>
<tr>
<td>Device S/N</td>
<td>Parameter name (example: parameter where the serial number is stored)</td>
</tr>
<tr>
<td>5</td>
<td>Value that must be entered or selected via the PC software</td>
</tr>
</tbody>
</table>
### 2.3.2 Symbols Used

<table>
<thead>
<tr>
<th>Symbol / Label</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>!</td>
<td>General hazard symbol</td>
</tr>
<tr>
<td>!</td>
<td>Risk of crushing</td>
</tr>
<tr>
<td>!</td>
<td>Warning of cut injuries</td>
</tr>
<tr>
<td>!</td>
<td>Prohibition sign for heart pacemakers, defibrillators, and other active implants</td>
</tr>
</tbody>
</table>

| **DANGER**    | Dangerous situation  
Failure to observe can lead to death or serious injury.  
► Measures for avoiding the risk. |
|---------------|------------------------------------------------------------------|

| **WARNING**   | Dangerous situation  
Failure to observe can lead to serious injury.  
► Action to take to avoid the risk. |
|---------------|------------------------------------------------------------------|

| **CAUTION**   | Dangerous situation  
Failure to observe can lead to minor injury.  
► Actions to take to avoid the risk. |
|---------------|------------------------------------------------------------------|

| **NOTICE**    | Dangerous situation  
Failure to observe can lead to material damage.  
► Action to take to avoid the risk. |
|---------------|------------------------------------------------------------------|

**Information**  
Additional information on the V-408.232020 that can affect your application.

### 2.4 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.

### 2.5 Downloading Manuals

The latest versions of the user manuals can be [downloaded (p. 6)](www.pi.ws) at www.pi.ws.
For products that are supplied with software (data storage device in the scope of delivery), access to the manuals is protected by a password. Protected content is only displayed on the website after entering the access data. You need the data storage device for the product to get the access data.

If a manual is missing or problems occur with downloading, contact our customer service department (p. 31).

**Downloading Manuals**

1. Open the website [www.pi.ws](http://www.pi.ws).
2. If the product was shipped with a data storage device: Log into the website:
   a) Click Login.
   b) Enter the login data.
      The login data is in the `[...]_Releasenews_[...]_.pdf` in the Manuals directory on the data storage device.
      If necessary: Follow the link and register yourself to get the login data.
   c) Click Login or press the Enter key.
3. Search for the product:
   a) Click Search.
   b) Enter the product number up to the period (e.g., V-408) into the search field.
   c) Click Start search or press the Enter key.
   d) If necessary: Click Load more results at the bottom of the list.
4. Click the corresponding product in the list of search results.
5. Click the Downloads tab.
   ➔ The manuals are shown under Documentation.
6. Click the desired manual and save it.
3 Safety

3.1 Intended Use

The V-408.232020 positioner is a laboratory device as defined by DIN EN 61010-1. It is intended for indoor use and use in an environment that is free of dirt, oil, and lubricants. In accordance with its design, the V-408.232020 is intended for positioning, adjusting and shifting loads in one axis at various velocities. It is not for applications in areas where failure would result in considerable risks for human beings or the environment.

The positioner is intended for operation with a horizontally aligned motion axis. A vertically aligned motion axis may only be operated with suitable gravity compensation (not in the scope of delivery).

The intended use of the positioner is only possible when completely mounted and connected. The positioner must be operated with suitable electronics. The electronics are not in the scope of delivery of the positioner.

The positioner may not be used for purposes other than those stated in this user manual. It may only be used in compliance with the technical specifications and instructions in this user manual.

3.2 General Safety Instructions

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

► Use the positioner only for its intended purpose, and only when it is in perfect technical condition.
► Read the user manual.
► Eliminate any faults and malfunctions that are likely to affect safety immediately.

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

3.3 Organizational Measures

3.3.1 User Manual

► Always keep this user manual available when using the positioner. The latest versions of the user manuals can be downloaded (p. 6) at www.pi.ws.
► Add all information from the manufacturer such as supplements or technical notes to the user manual.
► If you give the positioner to other users, also include this user manual as well as all 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 damage to equipment.
► Only install and operate the positioner after you have read and understood this user manual.

3.3.2 General Personnel Qualification

The positioner may only be installed, started up, operated, maintained, and cleaned by authorized and appropriately qualified personnel.
4 Product Description

4.1 Product Labeling

4.1.1 Type Plate

Figure 1: Type plate of the V-408.232020

1. Product number (example)
2. Serial number, individual for each positioner
   Meaning of the position (counting from the left):
   1 = internal information,
   2 and 3 = year of manufacture,
   4 to 9 = consecutive numbers
3. Warning and conformity symbols (old equipment disposal (p. 37), CE mark (p. 42))

4.2 Scope of Delivery

Each component can be identified according to its item number.

<table>
<thead>
<tr>
<th>Product number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V-408.232020</td>
<td>Positioner according to order</td>
</tr>
<tr>
<td>000036450</td>
<td>M4 screw set for protective earth, consisting of:</td>
</tr>
<tr>
<td></td>
<td>■ 1 flat-head screw with cross recess, ISO 7045 M4x8</td>
</tr>
<tr>
<td></td>
<td>■ 2 safety washers</td>
</tr>
<tr>
<td></td>
<td>■ 2 flat washers</td>
</tr>
<tr>
<td>MP163EK</td>
<td>Short instructions for PIMag® linear stages</td>
</tr>
</tbody>
</table>
4.3 V-408 Product View

Figure 2: Example view of the V-408.132020
1. Position of the protective earth conductor symbol
2. Screw for the protective earth conductor connector
3. Cable exit of the motor cable (with Sub-D 15 (f) connector)
4. Cable exit sensor cable (with HD Sub-D 26 (m) connector)
5. Transport safeguard
6. Base body
7. Motion platform
X: The arrow shows the positive direction of motion

4.3.1 Base Body

The base body is the basis of the positioner. The V-408.232020 is mounted onto a surface via the base body (p. 13).
The base body comprises the following subassembly (subassemblies):

Drive
The drive of the positioner is a 3-phase magnetic linear motor. The linear motor transfers the drive force to the motion platform directly and free of friction.

Reference switch
The reference switch is a sensor whose fixed position serves as the reference point for incremental sensor signals.
The positioner is equipped with an incremental, optical reference switch (p. 39).
See the controller user manual and/or associated software manuals for the commands that make use of the reference point signal.

Limit switches
The limit switches are sensors at each end of the travel range that enable the electronics to abort motion in order to prevent the motion platform from colliding with the mechanical hard stop.
The positioner is equipped with noncontact Hall effect limit switches (p. 40).
Position sensor

The sensor measures the position of the motion platform incremental to a known reference point. Optical linear encoders measure the actual position directly (direct position measuring). Therefore, errors in the drive, such as nonlinearity, backlash or elastic deformations cannot influence the measurement of the position.

4.3.2 Drive Connection

The drive connector transmits the supply voltage and the signals for the drive.

4.3.3 Sensor Connector

The sensor connector transmits the sensor signals of the positioner.

4.4 Suitable Electronics

The positioner must be connected to suitable electronics that supply the necessary voltage for operating the positioner and if required, to evaluate the sensor and limit switch signals. The following electronics are suitable for operating the positioner:

<table>
<thead>
<tr>
<th>Product number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-891.130300</td>
<td>PIMag® Motion Controller for Magnetic Direct Drives</td>
</tr>
<tr>
<td></td>
<td>ACS modular controller</td>
</tr>
</tbody>
</table>

To order, contact our customer service department (p. 31).

4.5 Accessories

<table>
<thead>
<tr>
<th>Product number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V-500.AP1</td>
<td>Adapter for mounting the positioner onto an optical table. Material: Aluminum alloy, anodized; mass: 464 g.</td>
</tr>
<tr>
<td>V-408.AP1</td>
<td>Adapter for setting up an XY system when the upper positioner is a V-408.232020. Material: Aluminum alloy, anodized; mass: 65 g.</td>
</tr>
</tbody>
</table>

To order, contact our customer service department (p. 31).
5 Unpacking

The positioner is delivered with the transport safeguard installed.

Figure 3: Positioner with transport safeguard
1. Plastic part with 2 M2 screws

Tools and Accessories
- Hex key, across flats 1.5

Unpack the positioner and remove the transport safeguard
1. Unpack the positioner with care.
2. Compare the contents with the scope of delivery according to the contract and the delivery note. If any of the parts are wrong or are missing, contact PI immediately.
3. Inspect the contents for signs of damage. If there is any sign of damage, contact PI immediately.
4. Remove the transport safeguard:
   a) Loosen and remove both M2 screws.
   b) Remove the plastic part.
5. Keep all packaging materials and the transport safeguard in case the product needs to be returned.
6 Installation

6.1 Mounting the Positioner

The positioner can be mounted onto a surface or an optical table via the V-500.AP1 adapter. The positioner can be mounted onto a surface from below or from above.

Overview

Figure 4: Holes for mounting onto a surface or onto the V-500.AP1 adapter

The arrows point to the following holes in the underneath of the positioner:

<table>
<thead>
<tr>
<th>Arrows</th>
<th>Holes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black arrows (align):</td>
<td>Locating holes Ø 3 mm H7, depth 3.5 mm</td>
</tr>
<tr>
<td>White arrows (mounting from above):</td>
<td>Countersunk holes M2.5 (Ø 2.9 mm / Ø 5.5 mm), depth 2.9 mm</td>
</tr>
<tr>
<td>Gray arrows (mounting from below):</td>
<td>Threaded holes M3, depth 6 mm</td>
</tr>
</tbody>
</table>

Tools and Accessories

- Optional: 2 locating pins of suitable length with Ø3 mm h8
- For mounting from above: 4 M2.5 screws of suitable length
- For mounting from below: At least 4 M6 screws of suitable length
- Suitable screwdriver

Requirements

✓ You have read and understood the general safety instructions (p. 8).
✓ You have provided a suitable surface with the holes necessary for the screws and if required, locating pins (p. 34).
- The surface flatness is ≤ μm.
For applications with large temperature changes: The surface should have the same or similar thermal expansion properties as the positioner (e.g., surface made of aluminum).

✓ You have accounted for the space required to route cables without bending and according to regulations.

**DANGER**

**Strong magnetic fields affects heart pacemakers!**

The positioner contains permanent magnets that could impair the function of heart pacemakers.

► Make sure that people with heart pacemakers do not have access to the positioner.

**CAUTION**

**Risk of cuts and crushing!**

If the motion platform moves back to the middle of the travel range, the force exerted by it can be very high. Risk of minor injury from cuts and crushing if fingers or limbs get caught between the positioner’s platform and the base body or a fixed part or obstacle.

► Use safeguards to protect limbs areas where they could be caught by moving parts.

► Observe the safety distances in accordance with DIN EN ISO 13857 when installing protective structures.

**NOTICE**

**Attraction of magnetizable objects!**

The magnets on the bottom of the positioner’s motion platform can attract magnetizable objects such as loose screws. Objects attracted can damage the positioner.

► Make sure that there are no movable, magnetizable objects within a radius of at least 10 cm around the motion range of the positioner’s platform.

**NOTICE**

**Damage to magnetically sensitive objects!**

The magnets on the bottom of the positioner’s motion platform can damage magnetically sensitive objects such as magnetic data carriers and electronic devices.

► Make sure that there are no magnetically sensitive objects within a radius of at least 10 cm around the motion range of the positioner’s platform.

**NOTICE**

**Positioner heating up during operation!**

High temperatures can overheat the positioner.

► Install the positioner so that there is a gap of 10 cm above the platform and a gap of 5 cm to each side of the positioner for ventilation.

► If this is not possible, make sure that the surroundings are cooled sufficiently.

► Ensure sufficient ventilation at the place of installation.

► Keep the ambient temperature at a noncritical level.

► Make sure that the entire bottom of the positioner is in contact with the surface which it is mounted on.
NOTICE

Damage due to collisions!
Collisions can damage the positioner, the load to be moved, and the surroundings.
► Make sure that no collisions are possible between the positioner, the load to be moved,
and the surroundings in the motion range of the positioner.
► Do not place any cables or other objects in areas where they could be caught by moving
parts.

NOTICE

Protruding screw heads!
Protruding screw heads can damage the V-408.232020.
► Make sure that the screw heads are fully countersunk and cannot interfere with motion.

NOTICE

Excessively long screws!
The positioner can be damaged by screws that are inserted too deeply.
► Pay attention to the depth of the mounting holes (p. 34) in the positioner.
► Only use screws with the correct length for the respective mounting holes.

Mounting the Positioner onto a Surface
1. Place the positioner on the surface so that the corresponding mounting holes in the
positioner and the surface are in line.
   Optional: Use the locating holes provided for aligning.
2. Insert the screws into all accessible mounting holes and tighten.
   For mounting from above:
   a) Move the positioner’s motion platform by hand until the countersunk holes in the base
   body are accessible.
   b) Mount the positioner over the four countersunk holes in its base body.
   ■ Maximum torque: 0.6 Nm
   For mounting from below:
   a) Mount the positioner over the M3 holes, see the gray arrows in the figure above.
   ■ Maximum screw-in depth: 6 mm
   ■ Maximum torque: 1.1 Nm
3. Check that the positioner is affixed firmly to the surface.

6.2 Mount the Positioner with Adapter onto the Optical Table

Tools and Accessories
■ V-500.AP1 adapter, available as optional accessory (p. 11)
■ Screws in the scope of delivery of the adapter:
  ■ 4 screws ISO 4762, M6x10, A2
  ■ 4 screws ISO 4762, M2.5x10, A4-70
  ■ 2 locating pins ISO 2338, 3h8x6, A2
■ Suitable screwdriver

Requirements
✓ You have read and understood the general safety instructions (p. 8).
✓ The optical table flatness is ≤ μm.
✓ You have accounted for the space required to route cables without bending and according to regulations.

**Mount the Positioner with Adapter onto the Optical Table**

1. Mount the adapter on the optical table:
   a) Align the adapter on the optical table. Use the locating holes and locating pins provided for aligning.
   b) Mount the adapter with four M6×10 screws; see "V-500.AP1 and V-408.AP1 Adapter Dimensions" (p. 35) for the position of the holes.
   ■ **Maximum torque: 8.8 Nm**
   c) Check that the adapter is fixed firmly.

2. Mount the positioner onto the adapter
   a) Align the positioner on the adapter. For aligning, use the two locating pins with Ø3 mm h8×6 and the locating hole provided, see the figure on p. 21.
   b) Mount the positioner with four M2.5×10 screws; see "V-500.AP1 and V-408.AP1 flatness Dimensions" (p. 35) for the position of the holes.
   Push the motion platform to the end of the travel range to make the mounting holes accessible.
   ■ **Maximum torque: 0.6 Nm**
   a) Check that the positioner is fixed firmly.

### 6.3 Connecting the Positioner to the Protective Earth Conductor

The positioner is supplied with a grounding screw set that is already fixed to the positioner. The position for attaching the protective earth conductor is marked with the appropriate symbol (see "Dimensions" (p. 34)).

**Overview**

![Figure 5: Protective earth connector on the V-408.232020](image)

1. Connector for the protective earth conductor on the V-408.232020, indicated by the protective earth symbol
2. Safety washer
3. Flat washer
4. Protective earth conductor lug
5. Screw, ISO 7045 M4×8

**Tools and Accessories**

- Suitable protective earth conductor:
  - Cable cross section ≥ 0.75 mm²
■ Contact resistance <0.1 Ω at 25 A at all connection points relevant for attaching the protective earth conductor
■ Suitable screwdriver

Requirements
✓ You have read and understood the general safety instructions (p. 8).

NOTICE
Damage to the protective earth conductor
If the protective earth conductor gets between the motion platform and base body of the positioner, it can block the positioner and cause damage to the positioner and the protective earth conductor.
▶ Make sure that the protective earth conductor cannot touch the motion platform.

Information
▶ Observe the applicable standards for connecting the protective earth conductor.

Connecting the Positioner to the Protective Earth Conductor
1. If necessary, attach a suitable cable lug to the protective earth conductor.
2. Attach the cable lug of the protective earth conductor to the protective earth connection as illustrated in the figure.
3. Tighten the screw with a torque of 1.2 Nm to 1.5 Nm.
4. Make sure that the contact resistance is <0.1 Ω at 25 A at all connection points relevant for attaching the protective earth conductor.

6.4 Building a Multi-Axis System
The V-408.232020 can be used in XY systems. If a V-408.232020 is used as upper positioner, an adapter is necessary, see “Optional Accessories” (p. 11).

Designations in these instructions:
■ **Lower positioner**: Forms the basis of the multi-axis system, is attached to an underlying surface
■ **Upper positioner**: Forms the upper axis of the multi-axis system, is attached to the lower positioner rotated by 90°
Overview

Figure 6: Example of a V-408.132020 on a V-408.232020
1. 4 M2.5×10 screws
2. Upper positioner
3. Lower positioner
Black arrows: Holes for aligning, Ø 3 mm H7, depth 3.5 mm

Figure 7: Example of a V-408.232020 on a V-408.232020
1. 4 M2.5×10 screws
2. Upper positioner
3. 2 3h8×12 locating pins
4. 4 M2.5×10 screws
5. V-408.AP1 adapter
6. Lower positioner
See "Dimensions" (p. 34) for the exact position of the mounting holes.

Tools and Accessories
If the upper positioner is a V-408.132020:
■ 4 M2.5×10 screws (not in the scope of delivery)
■ Optional: 2 3h8×6 locating pins (not in the scope of delivery)
■ Suitable screwdriver
If the upper positioner is a V-408.232020:
■ V-408.AP1 adapter, available as optional accessory (p. 11)
■ Screws in the scope of delivery of the adapter:
  ■ 4 (from 8) screws, ISO 14580, M2.5×10, A2
  ■ 2 locating pins, ISO 2338, 3h8×12, A2
■ Suitable screwdriver

Requirements
✓ You have read and understood the safety instructions.
✓ The positioners are not connected to the electronics.
✓ The lower positioner is properly mounted on a surface (p. 13) or an optical table (p. 15).
✓ The motion platform of the lower positioner is suitably fixed, e.g., by attaching the transport safeguard (p. 30).
✓ You have accounted for the space required to route cables without bending and according to regulations.

**NOTICE**
Impermissibly high load on the positioners!
In a multi-axis system, the stage used for the upper axis must also be moved. Impermissibly high loads impair the motion and can damage the positioners.
► Pay attention to the maximum permissible forces (p. 32) that may act on the motion platform.
► In the case of multi-axis systems, include the masses of the positioners to be moved when calculating the load.

**NOTICE**
Excessively long screws!
The positioner can be damaged by screws that are inserted too deeply.
► Pay attention to the depth of the mounting holes (p. 34) in the positioner.
► Only use screws with the correct length for the respective mounting holes.

**NOTICE**
Protruding screw heads!
Protruding screw heads can damage the V-408.232020.
► Make sure that the screw heads are fully countersunk and cannot interfere with motion.
6.4.1 Setting Up a Multi-Axis System Without Adapter

If the upper positioner is a V-408.132020:

1. Put the upper positioner on the lower positioner so that the corresponding mounting holes in the upper and lower positioners are in line.
   Optional: For aligning, use the two 3h8×6 locating pins and the locating hole provided, see the black arrows in the figure above.
2. Mount the upper positioner onto the lower positioner as shown in the figure above.
   a) Move the positioner’s motion platform by hand until the countersunk holes in the base body are accessible.
   b) Mount the positioner over the four countersunk holes in the base body.
      ■ Maximum torque: 0.6 Nm
3. Check that the upper positioner is fixed firmly.

6.4.2 Setting Up a Multi-Axis System With Adapter

If the upper positioner is a V-408.232020:

1. Mount the adapter onto the lower positioner.
   a) Put the adapter on the lower positioner so that the corresponding mounting holes in the adapter and the lower positioner are in line.
      Optional: For aligning, use the two locating pins and the locating holes provided, see the figure above.
   b) Mount the adapter onto the lower positioner with four M2.5×10 screws.
      ■ Maximum torque: 0.6 Nm
   c) Check that the adapter is fixed firmly.
2. Mount the upper positioner onto the adapter, see the figure above.
   a) Put the upper positioner on the adapter so that the corresponding mounting holes in the upper positioner and the adapter are on line.
      Optional: For aligning, use two locating pins and the locating holes provided, see the figure above.
   b) Move motion platform of the upper positioner by hand until the countersunk holes in the base body are accessible.
   c) Mount the positioner with four M2.5×10 screws over the four countersunk holes in the base body, see Dimensions (p. 34).
      ■ Maximum torque: 0.6 Nm
   d) Check that the upper positioner is fixed firmly.
6.5 Mounting the Load on the Positioner

Overview

Figure 8: Position of the mounting holes for affixing the load

Figure 9: Mounting holes for fixing the load onto the side

The arrows mark the following holes in the sides and in the platform of the V-408.232020:

<table>
<thead>
<tr>
<th>Arrows (aligning)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Locating holes Ø 3mm H7, depth 3 mm</td>
</tr>
<tr>
<td>White</td>
<td>Threaded holes M2.5, depth 9 mm</td>
</tr>
<tr>
<td>Gray</td>
<td>Threaded holes M3, depth 6 mm</td>
</tr>
</tbody>
</table>

Tools and Accessories

- At least 3 screws with suitable dimensions
- Suitable tools for tightening the screws
- Optional: 2 dowel pins with suitable dimensions as locating pins for aligning the load on the V-408.232020

Requirements

✓ You have read and understood the general safety instructions (p. 8).
✓ You have mounted the positioner onto a surface (p. 13) properly.
The motion platform of the lower positioner is suitably fixed, e.g., by attaching the transport safeguard (p. 30).

✓ The positioner is not connected to the electronics.
✓ You have prepared the load so that it can be fixed to the mounting holes on the motion platform:
  ■ The distance between the center of gravity of the load and the center of the motion platform is as small as possible in all directions.
  ■ At least three points are provided for fixing the load on the motion platform.

**NOTICE**

Impermissibly high load on the positioner

An impermissible high load on the motion platform impairs the motion and can damage the positioner.

► Pay attention to the maximum permissible forces (p. 32) that may act on the motion platform.
► In the case of multi-axis systems, include the masses of the positioners to be moved when calculating the load.

**NOTICE**

Excessively long screws

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

► Pay attention to the depth of the mounting holes (p. 34).
► Only use screws with the correct length for the respective mounting holes.

**Fixing the Load**

1. If necessary: Insert the locating pins into the corresponding holes in the motion platform.
2. Align the load on the motion platform so that the mounting holes selected in the motion platform can be used for mounting the load.
3. Place the load onto the motion platform so that the locating pins are inserted into the corresponding locating holes in the load.
4. Tighten the screws in all mounting holes.
5. Check that the load is fixed firmly to the motion platform.

**6.6 Connecting the Positioner**

**Tools and Accessories**

■ If necessary: Suitable screwdriver for the locking screws of the connectors.

**Requirements**

✓ You have read and understood the general safety instructions (p. 8).
✓ You have read and understood the user manual for the electronics used.
✓ You have installed the electronics properly.
✓ The electronics are switched off.
**NOTICE**

**Damage due to incorrect connection of the positioner!**

Connecting unsuitable electronics or a wrong cable can damage the positioner or the electronics.

- Make sure that the electronics support the drive type of the positioner and are configured accordingly.
- Use cables from PI only to connect the positioner to the electronics.
- Pay attention to correct pin assignment (p. 38).

**Connecting the Positioner**

1. Connect the drive plug of the positioner to the drive socket on the electronics.
2. Connect the sensor connector on the positioner to the sensor connector on the electronics.
3. Secure the connector against unintentional removal.
7 Startup / Operation

7.1 Starting and Operating the Positioner

Tools and Accessories
- Electronics from PI (p. 11)

Requirements
✓ You have read and understood the general safety instructions (p. 8).
✓ You have installed the positioner (p. 13) properly.
✓ You have removed the transport safeguard (p. 12).
✓ You have read and understood the user manual for the electronics used.
✓ If a digital controller is used: You have read and understood the manual for the PC software used.
✓ The electronics and if required, the PC software, have been installed (see the user manual for the electronics).

⚠️ CAUTION

Risk of cuts and crushing!
If the motion platform moves back to the middle of the travel range, the force exerted by it can be very high. Risk of minor injury from cuts and crushing if fingers or limbs get caught between the positioner's platform and the base body or a fixed part or obstacle.
► Use safeguards to protect limbs areas where they could be caught by moving parts.
► Observe the safety distances in accordance with DIN EN ISO 13857 when installing protective structures.

⚠️ NOTICE

Operating voltage excessively high or incorrectly connected!
Operating voltages that are excessively high or incorrectly connected can cause damage to the positioner.
► Pay attention to the operating voltage range (p. 33), which is specified for the positioner.
► Pay attention to correct pin assignment (p. 38).

⚠️ NOTICE

Positioner heating up during operation!
The heat produced during operation of the positioner can affect your application.
► Ensure sufficient ventilation at the place of installation.
► Ensure that the effective nominal current and the peak current do not exceed the permissible values.

⚠️ NOTICE

Damage from transport safeguard that has not been removed!
Damage can occur to the positioner if the transport safeguard of the positioner has not been removed and a motion is commanded.
► Remove the transport safeguard before you start up the positioner and electronics system.
NOTICE

Unintentional change in position due to missing self-locking!

The drive of the positioner does not have self-locking. The positioner can therefore move unintentionally in the following cases:

- Switching off the controller
- Rebooting the controller
- Switching off the servo mode for the axis
- Switching off the drive for the axis
- Safety switch-off by the controller due to overtemperature or overcurrent

Unintentional changes of position can damage the positioner, the load to be moved, and the surroundings.

► Operate the positioner only with a horizontally aligned motion axis.
► If you want to operate the positioner with a vertically aligned motion axis: Attach suitable gravity compensation (not in the scope of delivery). Contact our customer service department (p. 31) for details on gravity compensation.
► Before switching off or rebooting the controller, take suitable measures to ensure that unintentional changes in the position of the motion platform are not possible.

NOTICE

Damage due to collisions!

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

► Stop the motion immediately if a controller malfunction occurs.
► If possible, adapt the travel range limits of your mechanical system in the software that you use for commanding the motion.

NOTICE

Damage due to the high acceleration!

High acceleration can cause considerable wear and damage the positioner.

► Stop motion immediately if a malfunction occurs.
► Avoid collisions with objects in the workspace or the end of the travel range.
► Approach the end of the travel range always at a low velocity.
► Set the control signal so that the moving part does not stop abruptly or try to continue motion at the end of the travel range.
► Determine the maximum velocity for your application.

NOTICE

Damage due to unsuitable servo-control parameters!

If unsuitable servo-control parameters are used, the positioner’s drive can be damaged by excessive heat or the platform can hit the hard stop at high velocity. In addition, unsuitable servo-control parameters reduce the positioning accuracy.

► Check whether the servo-control parameters are suitable for the specified load, i.e., whether excessive heating occurs or the platform hits the hard stop at high velocity.
► If necessary, adapt the servo-control parameters. To find out how to change parameters in general, refer to manual for the controller.
► If you have questions on adapting the servo-control parameters, contact our customer service department (p. 31).
**NOTICE**

**Uncontrolled oscillation!**

Oscillation can cause irreparable damage to the positioner and/or the load. Oscillation is indicated by a humming noise and can be caused by the following:

- The load and/or dynamics during operation differ considerably to the calibration settings.
- The positioner is operated near to its resonant frequency.
- If you notice oscillations, stop the positioner immediately.

**NOTICE**

**Unintentional motion!**

Unintentional motion of the positioner is possible when it is connected to the electronics. Defective or incorrect operation of the software can also result in unintentional motion.

- Do not place any objects in areas where they can be caught by moving parts.
- Before connecting the positioner, check whether a macro is defined as the startup macro in the electronics and if necessary, cancel the selection.

**Information**

Unsuitable servo-control parameters settings can be perceived as follows:

- Oscillation
- Imprecise positioning
- Positioning is too slow

If the performance of the positioner is not satisfactory:

- Check the servo-control parameter settings of your electronics.

**Starting and Operating the Positioner**

1. Start the electronics (see the user manual for the electronics).
2. Configure the electronics for the positioner during startup:
   - If you are using a digital controller from PI: In the PC software, select the entry in the positioner database that matches the positioner exactly.
   - If you are using electronics from another manufacturer: Configure the electronics according to Parameters of the Positioner.
3. If the positioner has an incremental sensor as reference point switch (p. 39): Do a reference move (see user manual for the electronics).
4. Optional: Correct the phase with the FPH command (see user manual for the electronics).
5. Start a few motion cycles for testing purposes (see the user manual for the electronics).
8  Maintenance

**NOTICE**

**Damage due to improper maintenance!**

Improper maintenance can lead to misalignment and failure of the V-408.232020.

- Loosen screws only according to the instructions in this manual or the instructions of our customer service department (p. 31).

8.1  Maintenance Run

Frequent motion along a limited travel range can cause uneven distribution of the lubricant. The maintenance run serves the purpose of distributing the existing lubricant.

- Perform a maintenance run at regular intervals, at the latest after a period of six months. The more often motion is performed over a limited travel range, the shorter the interval has to be between the maintenance runs.

**Performing a Maintenance Run**

1. Make sure that collisions between the positioner, the load to be moved, and the surroundings are not possible over the entire travel range of the positioner. If necessary, remove the load from the positioner’s motion platform for the maintenance run.
2. Perform a maintenance run over the entire travel range:
   a) Command the positioner to the end of a travel range and from there to the opposite end of the travel range (see manual for the electronics).
   b) If necessary: Command the positioner to a position where the load can be mounted onto the motion platform again and mount the load back onto the positioner (p. 21).

8.2  Cleaning

**Requirements**

✓ You have disconnected the positioner from the electronics.

**Other Materials Required**

- Soft, lint-free cloth
- Mild cleaning agent or disinfectant

If you have any questions on the auxiliary materials recommended for the positioner, contact our customer service department (p. 31).

**NOTICE**

**Damage due to unsuitable cleaning agents!**

Some cleaning agents can cause rusting on the V-408.232020 or dissolve plastics, paints or adhesives.

- Do not clean with water or acetone.

**Cleaning the Positioner**

1. Dampen the cloth with the cleaning agent or disinfectant.
2. Wipe the surfaces of the positioner carefully.
8.3 Moving the Motion Platform by Hand

It can be necessary to move the motion platform manually to provide access to mounting holes for mounting screws in the base body of the positioner.

Requirements
✓ You have disconnected the V-408.232020 from the electronics.

Moving the Motion Platform by Hand
1. Exert a steady force on the motion platform to move it.
# Troubleshooting

## The positioner does not move, no operating noise can be heard

<table>
<thead>
<tr>
<th>Issue</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defective electronics</td>
<td>▶ Check the electronics.</td>
</tr>
<tr>
<td>Electronics not connected correctly</td>
<td>▶ Check all connecting cables (p. 22).</td>
</tr>
<tr>
<td>Excessive load</td>
<td>▶ Reduce the acceleration and velocity.</td>
</tr>
<tr>
<td></td>
<td>▶ Adapt the servo-control parameters, see the user manual for the electronics.</td>
</tr>
<tr>
<td></td>
<td>▶ Reduce the load, see &quot;Specifications&quot; (p. 32).</td>
</tr>
<tr>
<td>Excessive counterforces in the direction of motion</td>
<td>▶ Reduce the counterforces in the direction of motion.</td>
</tr>
<tr>
<td>Transport safeguard has not been removed</td>
<td>▶ Remove the transport safeguard (p. 12).</td>
</tr>
<tr>
<td>When operating with the C-891 controller: Overheating protection was activated</td>
<td>▶ Wait a few minutes until the positioner has cooled down.</td>
</tr>
<tr>
<td></td>
<td>▶ Restore operational readiness of the system; see documentation for the controller.</td>
</tr>
<tr>
<td>When operating with the C-891 controller: Overcurrent protection was activated</td>
<td>▶ Restore operational readiness of the system; see documentation for the controller.</td>
</tr>
<tr>
<td></td>
<td>▶ Reduce the acceleration and/or velocity in the application; see documentation for the controller.</td>
</tr>
</tbody>
</table>

### Reduced positioning accuracy

<table>
<thead>
<tr>
<th>Issue</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warped base body</td>
<td>▶ Mount the positioner onto a flat surface (p. 13).</td>
</tr>
<tr>
<td>Lateral forces on motion platform too high</td>
<td>▶ Avoid lateral forces on the positioner’s motion platform.</td>
</tr>
<tr>
<td>Target position is approached too slowly or with overshoot</td>
<td>▶ Check whether the servo control parameter settings correspond to the selected closed-loop control mode; see user manual for the controller.</td>
</tr>
<tr>
<td></td>
<td>▶ If necessary, correct the settings of the servo control parameters.</td>
</tr>
<tr>
<td>The target position is not kept stable due to inappropriately set speed / acceleration</td>
<td>▶ Correct the corresponding servo control parameter settings (see the user manual for the controller).</td>
</tr>
</tbody>
</table>

### Uncontrolled oscillation

<table>
<thead>
<tr>
<th>Issue</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large changes to the load or the alignment of the positioner</td>
<td>▶ Switch off the servo control system or the controller immediately.</td>
</tr>
<tr>
<td></td>
<td>▶ Check whether the servo control parameter settings correspond to the selected closed-loop control mode; see user manual for the controller.</td>
</tr>
<tr>
<td></td>
<td>▶ If necessary, correct the settings of the servo control parameters.</td>
</tr>
</tbody>
</table>

### Increased wear

<table>
<thead>
<tr>
<th>Issue</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased wear due to small motion over a long period of time</td>
<td>▶ Perform a maintenance run (p. 27).</td>
</tr>
<tr>
<td>Traveling to the hard stop with maximum force</td>
<td>▶ Ensure that the end of the travel range is approached at low velocity and with low force.</td>
</tr>
</tbody>
</table>
10 Transportation

10.1 Attaching the Transport Safeguard

Tools and Accessories
- Transport safeguard, including 2 M2x5 screws (p. 12)
- Hex key AF 1.5

**NOTICE**

**Mechanical overload due to incorrect handling**

An impermissible mechanical load on the positioner due to transportation without a transport safeguard can damage the positioner's motion platform and also lead to loss of accuracy.

► Ship the positioner in the original packaging with installed transport safeguard only.

**Attaching the transport safeguard**

1. Tighten the transport safeguard to the base body and the motion platform (p. 10) with the screws.

10.2 Preparing the V-408.232020 for Transportation

**Preparing the Positioner for Transporting**

1. Pay attention to the ambient conditions and classifications (p. 33).
2. Pack the positioner into the original packaging.
3. If the positioner is to be sent, use a stable outer box.
11 Customer Service Department

For enquiries and orders, contact your PI representative or send us an email.

If you have any 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)
- Operating system on the PC (if applicable)

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

Customer service address:
Physik Instrumente (PI) GmbH & Co. KG
Auf der Roemerstrasse 1
76228 Karlsruhe
Germany

service@pi.de
www.pi.de
## Technical Data

### 12.1 Specifications

<table>
<thead>
<tr>
<th>Motion and positioning</th>
<th>V-408.232020</th>
<th>Unit</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active axes</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel range</td>
<td>50</td>
<td>mm</td>
<td></td>
</tr>
<tr>
<td>Integrated sensor</td>
<td>Incremental linear encoder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensor signal period</td>
<td>80</td>
<td>μm</td>
<td></td>
</tr>
<tr>
<td>Sensor resolution</td>
<td>10 *</td>
<td>nm</td>
<td>typ.</td>
</tr>
<tr>
<td>Minimum incremental motion</td>
<td>20</td>
<td>nm</td>
<td>typ.</td>
</tr>
<tr>
<td>Bidirectional repeatability</td>
<td>±0.1</td>
<td>μm</td>
<td>typ.</td>
</tr>
<tr>
<td>Pitch / yaw</td>
<td>±150</td>
<td>μrad</td>
<td>typ.</td>
</tr>
<tr>
<td>Straightness / flatness</td>
<td>±4</td>
<td>μm</td>
<td>typ.</td>
</tr>
<tr>
<td>Velocity</td>
<td>0.7</td>
<td>m/s</td>
<td>max.</td>
</tr>
</tbody>
</table>

### Mechanical properties

| Load capacity in Z       | 80           | N    | max.      |
| Permissible lateral force | 80           | N    | max.      |
| Permissible torque in θx | 2.3          | N·m  | max.      |
| Permissible torque in θy, θz | 1.3   | N·m  | max.      |
| Moved mass              | 0.3          | kg   |           |
| Mass without cable      | 0.65         | kg   |           |
| Overall mass            | 0.94         | kg   |           |

### Guide type

- Crossed roller guide with anti-creep system

### Drive properties

<table>
<thead>
<tr>
<th>Drive type</th>
<th>PI Mag® Linear motor, iron core, 3-phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediate circuit voltage</td>
<td>48</td>
</tr>
<tr>
<td>Peak force</td>
<td>14</td>
</tr>
<tr>
<td>Nominal force</td>
<td>5</td>
</tr>
<tr>
<td>Peak current, RMS</td>
<td>3.2</td>
</tr>
<tr>
<td>Nominal current, RMS</td>
<td>1.1</td>
</tr>
<tr>
<td>Force constant, RMS</td>
<td>4.60</td>
</tr>
<tr>
<td>Resistance phase-phase</td>
<td>2.46</td>
</tr>
<tr>
<td>Inductance phase-phase</td>
<td>1.94</td>
</tr>
<tr>
<td>Back EMF phase-phase</td>
<td>2.81</td>
</tr>
</tbody>
</table>
### 12.2 Maximum Ratings

The positioner is designed for the following operating data:

<table>
<thead>
<tr>
<th>Maximum operating voltage</th>
<th>Operating frequency</th>
<th>Maximum power consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>48 V</td>
<td></td>
<td>48 W</td>
</tr>
</tbody>
</table>

### 12.3 Ambient Conditions and Classifications

Pay attention to the following ambient conditions and classifications for the positioner:

<table>
<thead>
<tr>
<th>Area of application</th>
<th>For indoor use only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum altitude</td>
<td>2000 m above msl</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-20 °C to 60 °C</td>
</tr>
<tr>
<td>Transport temperature</td>
<td>-20 °C to 60 °C</td>
</tr>
<tr>
<td>Overvoltage category</td>
<td>II</td>
</tr>
<tr>
<td>Supply voltage fluctuations</td>
<td>Max. ±10 % of the nominal voltage</td>
</tr>
<tr>
<td>Protection class</td>
<td>I</td>
</tr>
<tr>
<td>Degree of pollution</td>
<td>1</td>
</tr>
<tr>
<td>Degree of protection according to IEC 60529</td>
<td>IP20</td>
</tr>
</tbody>
</table>
12.4 Dimensions

Figure 10: Dimensions of the V-408.232020

Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.
12.5 V-500.AP1 and V-408.AP1 Dimensions

Figure 11: V-500.AP1
Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.
Figure 12: V-408.AP1
Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.
13 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 equipment according to international, national, and local rules and regulations.

In order to fulfil the responsibility as the product manufacturer, PI undertakes environmentally correct disposal of all PI equipment free of charge, if it was made available to the market after August 13, 2005.

Any old PI equipment can be sent free of charge to the following address:
Physik Instrumente (PI) GmbH & Co. KG
Auf der Roemerstrasse 1
76228 Karlsruhe
Germany
info@pi.de
www.pi.de
14 Appendix

14.1 Pin Assignment

14.1.1 Drive Connection

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ph1</td>
<td>Phase 1</td>
</tr>
<tr>
<td>2</td>
<td>Ph1</td>
<td>Phase 1</td>
</tr>
<tr>
<td>3</td>
<td>Ph2</td>
<td>Phase 2</td>
</tr>
<tr>
<td>4</td>
<td>Ph2</td>
<td>Phase 2</td>
</tr>
<tr>
<td>5</td>
<td>Ph3</td>
<td>Phase 3</td>
</tr>
<tr>
<td>6</td>
<td>Ph3</td>
<td>Phase 3</td>
</tr>
<tr>
<td>7 - 26</td>
<td>NC</td>
<td>Not connected</td>
</tr>
<tr>
<td>Housing</td>
<td>GND</td>
<td>Ground</td>
</tr>
</tbody>
</table>

Figure 13: HD D-Sub 26 (m)
14.1.2 Encoder connector

Figure 14: Sub-D 15 (f)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vcc 5 V</td>
<td>Input: Power supply</td>
</tr>
<tr>
<td>2</td>
<td>AGND</td>
<td>Encoder Ground</td>
</tr>
<tr>
<td>3</td>
<td>SIN+</td>
<td>Encoder Sine+</td>
</tr>
<tr>
<td>4</td>
<td>SIN-</td>
<td>Encoder Sine-</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>Not connected</td>
</tr>
<tr>
<td>6</td>
<td>COS+</td>
<td>Encoder Cosine+</td>
</tr>
<tr>
<td>7</td>
<td>COS-</td>
<td>Encoder cosine-</td>
</tr>
<tr>
<td>8</td>
<td>N-Limit</td>
<td>Output: Limit switch negative</td>
</tr>
<tr>
<td>9</td>
<td>-</td>
<td>Not connected</td>
</tr>
<tr>
<td>10</td>
<td>REF+</td>
<td>Output: Reference switch, positive</td>
</tr>
<tr>
<td>11</td>
<td>-</td>
<td>Not connected</td>
</tr>
<tr>
<td>12</td>
<td>REF-</td>
<td>Output: Reference switch, negative</td>
</tr>
<tr>
<td>13</td>
<td>Used</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>15</td>
<td>P-Limit</td>
<td>Output: Limit switch positive</td>
</tr>
</tbody>
</table>

14.2 Reference Point Switch Specifications

Type Incremental, optical sensor
Supply voltage +5 V
Signal output 0 V / +5 V (TTL level)

The approximate position of the reference switch is the middle of the motion platform. The reference switch outputs a pulse signal.
14.3 Limit switch specifications

<table>
<thead>
<tr>
<th>Type</th>
<th>Magnetic sensor (Hall effect)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>+5 V</td>
</tr>
<tr>
<td>Signal output</td>
<td>0 V / +5 V (TTL level)</td>
</tr>
<tr>
<td>Signal logic</td>
<td>The signal level changes when passing the limit switch. The signal logic is active high. That means: Normal motor operation: low (0 V) Limit switch reached: high (+5 V)</td>
</tr>
</tbody>
</table>

Figure 15: Reference signal of the V-408
Figure 16: Example V-408.132020; V-408 at the positive limit switch, i.e., the signal to pin 15 of the encoder connector (PLIM) is high

Figure 17: Example for V-408.132020; V-408 at the negative limit switch, i.e., the signal to pin 8 of the encoder connector (NLIM) is high
15 EU Declaration of Conformity

An EU Declaration of Conformity was issued for the V-408.232020 in accordance with the following European directives:

- EMC Directive
- RoHS Directive

The applied standards certifying the conformity are listed below.

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

**Backlash**
Position error caused by mechanical play in that drivetrain that occurs when changing the direction. Backlash is caused by mechanical play in drivetrain components such as gearheads, bearings or by friction in the guides. In contrast to hysteresis, backlash can lead to instability in position-controlled systems because it causes dead time in the servo loop. Backlash depends on the temperature, acceleration, load, leadscrew position, positioning direction, wear etc. Backlash is suppressed by preloading the drivetrain. A position measuring method that can detect the position of the platform directly, eliminates all errors in the drivetrain (direct measuring). The data table shows typical measured values. Data for vacuum versions can differ.

**Design Resolution**
The theoretical minimum movement that can be made. Design resolution must not be confused with minimum incremental motion. In indirect position measurement methods, values for drive screw pitch, gear ratio, motor or sensor/encoder resolution, for example, are included in the calculation of the resolution. Normally, the design resolution is considerably below the minimum incremental motion of the mechanics. In direct measurement methods, the resolution of the sensor system is specified.

**Lateral Force**
Also: lateral load capacity
Maximum permissible force orthogonally to the positioning direction. This value is valid directly for the motion platform and is reduced when the force acts above the platform.

**Limit Switch**
Each limit switch sends its signal to the controller on a dedicated line. The controller then interrupts the motion avoiding that the positioner moves until the hard stop and gets damaged. PI positioners have mechanical, noncontact optical or Hall-effect limit switches.

**Linear Encoder**
The linear encoder is an incremental sensor for capturing changes in position. Signals from the sensor are used for axis position feedback. After the controller is switched on, a reference point definition must be performed before absolute target positions can be commanded and reached.

**Load Capacity**
Maximum load in the vertical direction when the V-408.232020 is mounted horizontally. The contact point of the load is at the center of the motion platform.

**Reference Point Switch**
Many of the positioners are equipped with a direction sensing reference point switch positioned approx. in the middle of the travel range. It is recommended to approach the reference point switch always from the same direction to obtain best position repeatability.
Function: Optical, magnetic

Sensor resolution
The sensor can be the critical element of position resolution so it may be necessary to specify the sensor resolution separately. Rotary encoder: Impulses per screw rotation. Linear encoder: Smallest motion still detected by the sensor system.

Travel range
The maximum possible travel range is limited by the length of the drive screw. A possible gap between the limit switches determines the travel range.