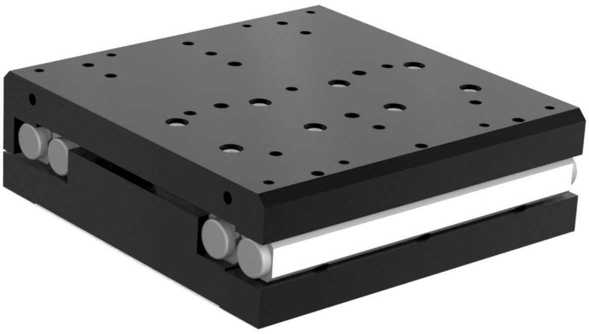

User Manual

V-408.132020 PIMAG® LINEAR STAGE

Contents

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2 About this Document

2.1 Objective and Target Group

This user manual contains the information required for using the V-408.132020 linear stage (hereinafter abbreviated to V-408) as intended.

Basic knowledge of closed-loop systems, motion control concepts, and applicable safety measures is assumed.

This document is intended for persons installing, operating, and maintaining the V-408.

2.2 Other Applicable Documents

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

Document number	Document type	Product
MS251E	User Manual	C-891.130300
SM148E	User Manual	PIMikroMove

The latest versions of the user manuals can be downloaded (p. 7) 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

Symbol / label	Meaning
1. 2.	Action consisting of one or several steps with strict sequential order
►	Action consisting of one or more steps without relevant sequential order
■	Lists
p. 5	Cross-reference to page 5
RS-232	Label on the product indicating an operating element (example: RS-232 interface socket)
Start > Settings	Menu path in the PC software (example: to open the menu, *Start* and *Settings* must be clicked successively)
`POS?`	Command line or a command from PI's General Command Set (GCS) (example: command to get the axis position)
Device S/N	Parameter name (example: parameter where the serial number is stored)
`5`	Value that must be entered or selected via the PC software

2.3.2 Symbols Used

Symbol / Label	Meaning
	General hazard symbol
	Risk of crushing
	Warning of cut injuries
	Magnetic field
	Prohibition sign for heart pacemakers, defibrillators, and other active implants

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 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

Information

If a manual is missing or problems occur with downloading:

► Contact our customer service department (p. 32).

Downloading Manuals

1. Open the website www.pi.ws.
2. Search the website for the product number (e.g., P-882) or the product family (e.g., PICMA® bender).
3. Click the corresponding product to open the product detail page.
4. Click the ***Downloads*** tab.

➔ *The manuals are shown under* **Documentation**.

5. Click the "Get download link by email" for the desired manual and fill out the enquiry form.

➔ *The download link will then be sent to the email address entered.*

3 Safety

3.1 Intended Use

The V-408 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 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 V-408 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).

It is only possible to use the V-408 as intended when it is completely mounted and connected. It needs to be operated with suitable electronics (p. 11). The electronics are not in the V-408's scope of delivery.

The V-408 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 V-408 is built according to state-of-the-art technology and recognized safety standards. Improper use of the V-408 may result in personal injury and/or damage to the V-408.

- ► Use the V-408 only for its intended purpose and if it is in perfect condition.
- ► Read the user manual.
- ► Eliminate any malfunctions that may affect safety immediately.

The operator is responsible for installing and operating the V-408 correctly.

3.3 Organizational Measures

3.3.1 User Manual

- ► Always keep this user manual together with the V-408. The latest versions of the user manuals can be downloaded (p. 7) at www.pi.ws.
- ► Add all information from the manufacturer such as supplements or technical notes to the user manual.
- ► If you give the V-408 to a third party, include this user manual as well as other relevant information provided by the manufacturer.
- ► Do the work only if the user manual is complete. Missing information due to an incomplete user manual can result in minor injury and damage to equipment.
- ► Install and operate the V-408 only after you have read and understood this user manual.

3.3.2 General Personnel Qualification

The V-408 may only be installed, started, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

4 Product Description

4.1 Product Labeling

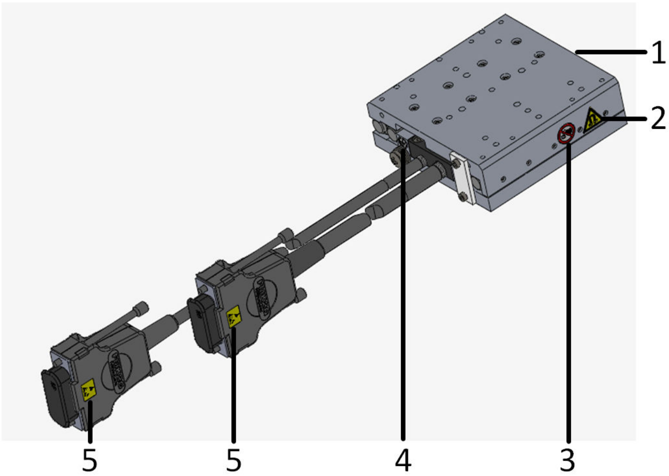


Figure 1: Product label on the V-408

1. Type plate
2. Warning symbol: Magnetic field
3. Prohibition sign for heart pacemakers, defibrillators, and other active implants
4. Symbol for the protective earth conductor
5. Warning symbol: Electrostatic-sensitive device

4.1.1 Type Plate

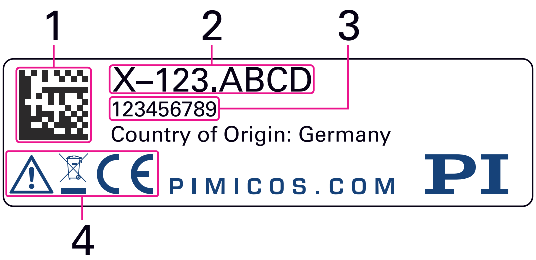


Figure 2: Type plate of the V-408.132020

1. Product number (example)
2. Serial number (example), individual for each V-408.132020
   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. 38), CE mark (p. 43))

4.2 Scope of Delivery

Each component can be identified according to its item number.

Product number	Description
V-408.132020	Positioner according to order
V408B9900	Mounting hardware for the V-408, consisting of ■ 2 dowel pins, ISO 2338, 3 h8 × 8 ■ 4 socket head screws, ISO 4762 M2.5×8 For securing extension cables: ■ 4 spacer bolts, 4-40 UNC-2B, 4.5 mm across flats, 6.3 mm height
000036450	M4 screw set for protective earth, consisting of: ■ 1 flat-head screw with cross recess, ISO 7045 M4×8 ■ 2 safety washers ■ 2 flat washers
MP163EK	Short instructions for PIMag® linear stages

4.3 V-408 Product View

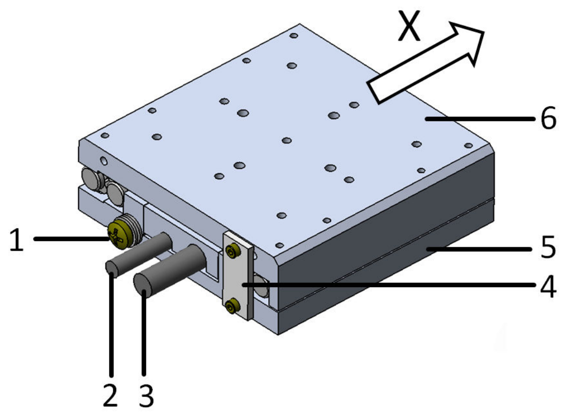


Figure 3: Example view of the V-408.132020

1. Screw for the protective earth conductor connector
2. Cable exit of the motor cable (with HD Sub-D 26 (m) connector)
3. Cable exit sensor cable (with Sub-D 15 (f) connector)
4. Transport safeguard
5. Base body
6. Motion platform

X: The arrow shows the positive direction of motion

4.3.1 Base Body

The base body is the basis of the V-408. The V-408 is mounted onto an underlying surface via the base body (p. 14).

The base body comprises the following subassembly or subassemblies:

Drive

A 3-phase magnetic motor drives the V-408. The motor transfers the drive force to the 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 V-408 is equipped with an incremental, optical reference switch (p. 40).

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 V-408 is equipped with noncontact Hall effect limit switches (p. 41).

Position sensor

The position sensor is an incremental sensor: It measures the position of the motion platform relative 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 Connector

The drive connector transmits the supply voltage for the drive.

4.3.3 Sensor Connector

The sensor connector transmits the sensor signals of the V-408.

4.4 Suitable Electronics

The V-408 must be connected to suitable electronics that supply the necessary voltage for operating the V-408 and if required, to evaluate the sensor and limit switch signals. The following electronics are suitable:

Product number	Description
C-891.130300	PIMag® Motion Controller for Magnetic Direct Drives
	ACS modular controller

To order, contact our customer service department (p. 32).

4.5 Optional Accessories

Product number	Description
V-500.AP1	Adapter for mounting the positioner onto an optical table. Material: Aluminum alloy, anodized; mass: 464 g.
V-408.AP1	Adapter for setting up an XY system when the upper positioner is a V-408.232020. Material: Aluminum alloy, anodized; mass: 65 g.
C-815.00SA0302-0300	Extension cable for motor signals, HD D-sub 26 (m/f), 3 m
C-815.00SA4041-0300	Extension cable for sensor signals, D-sub 15 (m/f), 3 m

To order, contact our customer service department (p. 32).

5 Unpacking

The V-408 is delivered with the transport safeguard installed.

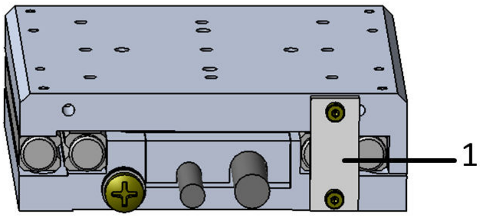


Figure 4: Positioner with transport safeguard

1. Plastic part with 2 M2 screws

Tools and Accessories

- Hex key, across flats 1.5

Unpack the V-408 and remove the transport safeguard

1. Unpack the V-408 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 V-408

The V-408 can be mounted onto a surface or an optical table via the V-500.AP1 adapter.

The V-408 can be mounted onto a surface from below or from above.

Overview

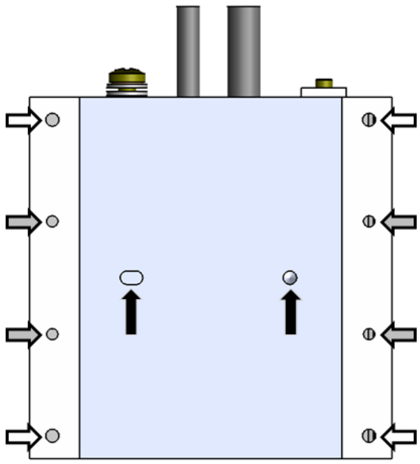


Figure 5: Holes for mounting onto a surface or onto the V-500.AP1 adapter

The arrows point to the following holes in the underneath of the V-408:

Black arrows (align):	Locating holes Ø 3 mm H7, depth 3.5 mm
White arrows (mounting from above):	Countersunk holes M2.5 (Ø 2.9 mm / Ø 5.5 mm), depth 2.9 mm
Gray arrows (mounting from below):	Threaded holes M3, depth 6 mm

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: 4 M3 screws of suitable length
- Suitable screwdriver

Requirements

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

✓ You have provided a suitable underlying surface with the holes necessary for the screws and, if required, locating pins. For the position and depth required for the holes, see "Dimensions" (p. 35).

- The surface flatness is ≤ 20 µm.
- For applications with large temperature fluctuations: The surface should have the same thermal expansion properties as the V-408 (e.g., underlying surface made of aluminum).

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

DANGER

Strong magnetic fields affect heart pacemakers!

The V-408 contains permanent magnets that could impair the function of heart pacemakers and electronic implants.

- ▶ Make sure that people with heart pacemakers and / or electronic implants do not have access to the V-408.

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 V-408'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 V-408's motion platform can attract magnetizable objects such as loose screws. Objects attracted can damage the V-408.

- ▶ Make sure that there are no movable, magnetizable objects within a radius of at least 10 cm around the motion range of the V-408's platform.

NOTICE

Damage to magnetically sensitive objects!

The magnets on the bottom of the V-408'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 V-408's platform.

NOTICE

V-408 heating up during operation!

High temperatures can overheat the V-408.

- ▶ Install the V-408 so that there is a gap of 10 cm above the platform and a gap of 5 cm to each side of the V-408 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 V-408 is in contact with the surface which it is mounted on.

NOTICE

Damage due to collisions!

Collisions can damage the V-408, the load to be moved, and the surroundings.

► Make sure that no collisions are possible between the V-408, the load to be moved, and the surroundings in the motion range of the V-408.

► 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.

► Make sure that the screw heads are fully countersunk and cannot interfere with motion.

NOTICE

Excessively long screws!

The V-408 can be damaged by screws that are inserted too deeply.

► Pay attention to the depth of the mounting holes (p. 35) in the V-408.

► Only use screws with the correct length for the respective mounting holes.

Mounting the V-408 onto a Surface

1. Place the V-408 on the surface so that the corresponding mounting holes in the V-408 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 V-408's motion platform by hand until the countersunk holes in the base body are accessible.
   b) Mount the V-408 over the four countersunk holes in its base body.
   - **Maximum torque: 0.6 Nm**

   For mounting from below:
   a) Mount the V-408 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 V-408 is affixed firmly to the surface.

6.2 Mounting the V-408 with Adapter onto the Optical Table

Tools and Accessories

- V-500.AP1 adapter, available as optional accessory (p. 12)
- 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 ≤ 20 µm.

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

Mounting the V-408 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. 36) for the position of the holes.
   - **Maximum torque: 8.8 Nm**

   c) Check that the adapter is fixed firmly.
2. Mount the V-408 onto the adapter
   a) Align the V-408 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 V-408 with four M2.5×10 screws; see "V-500.AP1 and V-408.AP1 flatness Dimensions" (p. 36) 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 V-408 is fixed firmly.

6.3 Connecting the V-408 to the Protective Earth Conductor

The V-408 is supplied with a grounding screw set that is already fixed to the V-408. The position for attaching the protective earth conductor is marked with the appropriate symbol (see "Dimensions" (p. 35)).

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 V-408, it can block the table and cause damage to the table 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 V-408 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-408.132020 can be used in XY systems. If a V-408.232020 is used as upper positioner, an adapter is necessary, see "Optional Accessories" (p. 12).

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

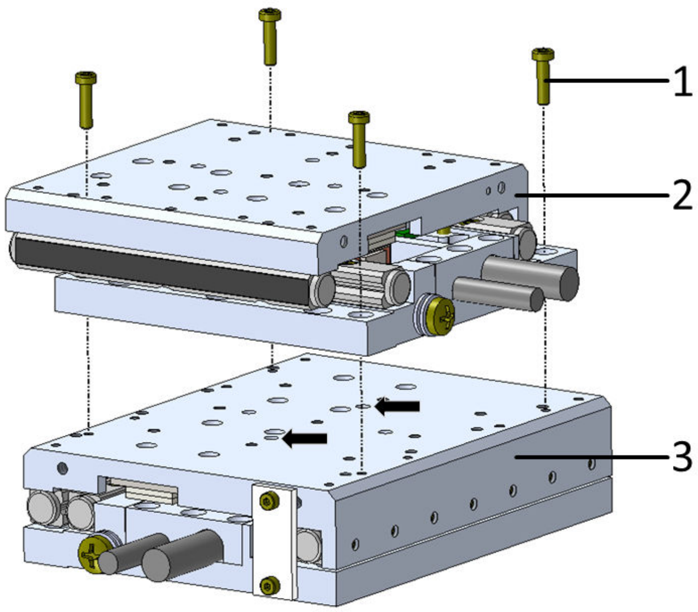


Figure 6: Example of a V-408.132020 on a V-408.232020

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

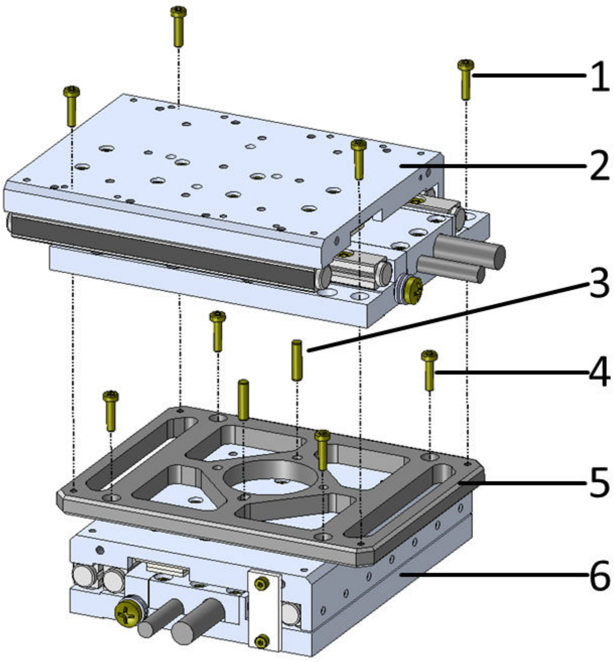


Figure 7: Example of a V-408.232020 on a V-408.232020

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. 35) 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. 12)
- 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. 14) or an optical table (p. 16).

✓ The motion platform of the lower positioner is suitably fixed, e.g., by attaching the transport safeguard (p. 31).

✓ 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. 33) 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

Unwanted changes in position when mounted vertically!

If the load exceeds the holding force of the V-408 when the stage is mounted vertically, unwanted changes in the position of the motion platform will occur. Unwanted changes in the position of the motion platform can damage the drive, the load or the surroundings.

- ► If the V-408 is mounted vertically, make sure that the installed load is lower than the holding force of the drive. (see Specifications (p. 33))

NOTICE

Excessively long screws!

The V-408 can be damaged by screws that are inserted too deeply.

- ► Pay attention to the depth of the mounting holes (p. 35) in the V-408.
- ► Only use screws with the correct length for the respective mounting holes.

NOTICE

Protruding screw heads!

Protruding screw heads can damage the V-408.

- ► 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. 35).

- **Maximum torque: 0.6 Nm**

d) Check that the upper positioner is fixed firmly.

6.5 Mounting the Load onto the V-408

Overview

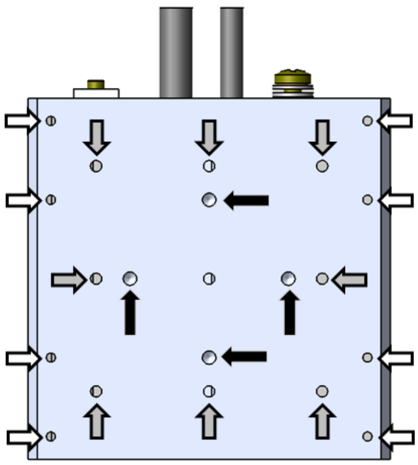


Figure 8: Position of the mounting holes for fixing the load

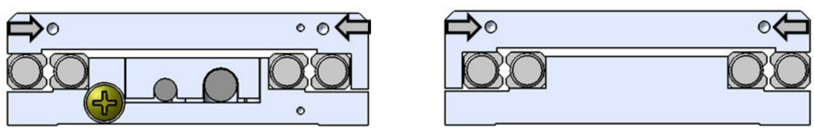


Figure 9: Mounting holes for fixing the load onto the side

The arrows mark the following holes in the sides and in the platform of the V-408:

Black arrows (aligning):	Locating holes Ø 3mm H7, depth 3 mm
White arrows (mounting):	Threaded holes M2.5, depth 9 mm
Gray arrows (mounting):	Threaded holes M3, depth 6 mm

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

Requirements

✓ You have read and understood the general safety instructions (p. 8).
✓ You have mounted the V-408 onto a surface (p. 14) properly.
✓ The motion platform of the V-408 is suitably fixed, e.g., by attaching the transport safeguard (p. 31).
✓ The V-408 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 V-408

An impermissible high load on the motion platform impairs the motion and can damage the V-408.

► Pay attention to the maximum permissible forces (p. 33) 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 V-408 can be damaged by screws that are inserted too deeply.

► Pay attention to the depth of the mounting holes (p. 35).
► 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 V-408

Tools and Accessories

- Optional: extension cable (p. 12)
  - C-815.00SA0302-0300 extension cable for motor signals, HD D-sub 26-pole (m/f), 3 m
  - C-815.00SA4041-0300 extension cable for sensor signals, D-sub 15-pole (m/f), 3 m
  - 4 space bolts, included with V408B9900 mounting hardware (p. 9)

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 V-408!

Connecting unsuitable electronics or a wrong cable can damage the V-408 or the electronics.

► Make sure that the electronics support the drive type of the V-408 and are configured accordingly.
► Use cables from PI miCos only to connect the V-408 to the electronics.
► Pay attention to correct pin assignment (p. 39).

Connecting the V-408

1. Optional: Use extension cable.
   a) Fix the space bolts onto the extension cable's connectors.
   b) Connect the extension cable for the motor signals to the V-408's HD D-sub 26-pole connector and the corresponding socket on the electronics.
   c) Connect the extension cable for the sensor signals to the V-408's D-sub 15-pole socket and the corresponding connector on the electronics.
2. Connect the motor cable's HD D-sub 26-pole connector to the corresponding socket on the electronics.
3. Connect the sensor cable's D-sub 15-pole socket to the corresponding connector on the electronics.
4. Secure the connectors against unintentional removal.

7 Startup / Operation

7.1 Temperature Dependency of the Nominal Current: Calculating the Nominal Current

The nominal current in the data table (p. 33) only applies when operating at room temperature. The nominal current needed for operating the positioner must be adjusted when the ambient temperature rises.

Calculating the nominal current

1. Calculate the nominal current according to the ambient temperature as follows:

$$I(T) = I(T_{ref}) \cdot \sqrt{\frac{T_{max} - T}{T_{max} - Tref}}$$

With:

$I(T)$	=	Nominal current, depending on ambient temperature T
T	=	Ambient temperature
$I(T_{ref})$	=	Nominal current, determined at reference temperature T_{ref}, see specifications
T_{ref}	=	Reference temperature (22 °C)
T_{max}	=	Maximum temperature of positioner components, see specifications

7.2 Starting and Operating the V-408

Tools and Accessories

- Electronics from PI (p. 11)

Requirements

✓ You have read and understood the general safety instructions (p. 8).
✓ You have installed the V-408 (p. 14) properly.
✓ You have removed the transport safeguard (p. 13).
✓ 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 V-408'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

Overheating caused by unfavorable nominal current

The specified nominal current (p. 33) applies when operating at room temperature. The nominal current needed for operating the V-408 must be adjusted when the ambient temperature rises. Otherwise the V-408 could be damaged by overheating.

► Calculate the nominal current according to the ambient temperature.

► Adapt your application (acceleration, speed, load) so that the calculated nominal current is not exceeded. If you have any questions, contact our customer service department (p. 32).

NOTICE

Excessively high or wrongly connected operating voltage!

Excessively high or wrongly connected operating voltages can cause damage to the V-408.

► Pay attention to the operating voltage range (p. 34), which is specified for the V-408.

► Pay attention to correct pin assignment (p. 39).

NOTICE

Heating up of the V-408 during operation!

The heat produced during operation of the V-408 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 V-408 if the transport safeguard of the V-408 has not been removed and a motion is commanded.

► Remove the transport safeguard before you start up the V-408 and electronics system.

NOTICE

Unintentional change in position due to missing self-locking!

The drive of the V-408 does not have self-locking. The V-408 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 V-408, the load to be moved, and the surroundings.

► Operate the V-408 only with a horizontally aligned motion axis.

► If you want to operate the V-408 with a vertically aligned motion axis: Attach suitable gravity compensation (not in the scope of delivery). Contact our customer service department (p. 32) 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 V-408, 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 V-408.

- ▶ 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 V-408'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. 32).

NOTICE

Uncontrolled oscillation!

Oscillation can cause irreparable damage to the V-408 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 V-408 is operated near to its resonant frequency.
- ▶ If you notice oscillations, stop the V-408 immediately.

NOTICE

Unintentional motion!

Unintentional motion of the V-408 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 V-408, 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 V-408 is not satisfactory:

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

Starting and Operating the V-408

1. Start the electronics (refer to the user manual for the electronics).
2. Configure the electronics for the V-408 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 V-408.132020 exactly.
   - If you are using electronics from another manufacturer: Configure the electronics according to the parameters of the V-408.132020.
3. If the V-408 has an incremental sensor as reference switch (p. 40): Carry out a reference move (refer to the user manual for the electronics).
4. Optional: Correct the phase with the FPH command (refer to the user manual for the electronics (p. 5)).
5. Start a few motion cycles for testing purposes (refer to the user manual for the electronics).

8 Maintenance

NOTICE

Damage due to improper maintenance!

Improper maintenance could lead to misalignment and failure of the V-408.

► Loosen screws only according to the instructions in this manual or the instructions of our customer service department (p. 32).

8.1 Maintenance Run

Frequent motion along a limited travel range can case 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 V-408, the load to be moved, and the surroundings are not possible over the entire travel range of the V-408. If necessary, remove the load from the V-408's motion platform for the maintenance run.
2. Perform a maintenance run over the entire travel range:
   a) Command the V-408 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 V-408 to a position where the load can be mounted onto the motion platform again and mount the load back onto the V-408 (p. 21).

8.2 Cleaning

Requirements

✓ You have disconnected the V-408 from the electronics.

Auxiliary Materials Required

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

If you have any questions on the materials recommended for the V-408 contact our customer service department (p. 32).

NOTICE

Damage due to unsuitable cleaning agents!

Some cleaning agents can cause rusting on the V-408 or dissolve plastics, paints or adhesives.

► Do **not** clean with water or acetone.

Cleaning the V-408

1. Dampen the cloth with the cleaning agent or disinfectant.
2. Wipe the surfaces of the V-408 carefully.

8.3 Moving the Motion Platform by Hand

It may be necessary to move the motion platform by hand

- to allow access to the mounting holes in the V-408's base body for the screws
- to move the motion platform away from the mechanical hard stop and make the V-408 operational again.

Requirements

✓ You have disconnected the V-408 from the electronics.

Moving the Motion Platform by Hand

1. Exert a steady force on the motion platform to move it.

9 Troubleshooting

The V-408 does not move, no operating noise can be heard	
Defective electronics	▶ Check the electronics.
Electronics not connected correctly	▶ Check all connecting cables (p. 23).
Excessive load	▶ Reduce the acceleration and velocity. ▶ Adapt the servo-control parameters, see the user manual for the electronics. ▶ Reduce the load, see "Specifications" (p. 33).
Excessive counterforces in the direction of motion	▶ Reduce the counterforces in the direction of motion.
Transport safeguard has not been removed	▶ Remove the transport safeguard (p. 13).
When operating with the C-891 controller: Overheating protection was activated	▶ Wait a few minutes until the positioner has cooled down. ▶ Restore operational readiness of the system; see documentation for the controller.
When operating with the C-891 controller: Overcurrent protection was activated	▶ Restore operational readiness of the system; see documentation for the controller. ▶ Reduce the acceleration and/or velocity in the application; see documentation for the controller.
Reduced positioning accuracy	
Warped base body	▶ Mount the V-408 onto a flat surface (p. 14).
Lateral forces on motion platform too high	▶ Avoid lateral forces on the V-408's motion platform.
Target position is approached too slowly or with overshoot	▶ Check whether the servo control parameter settings correspond to the selected closed-loop control mode; see user manual for the controller. ▶ If necessary, correct the settings of the servo control parameters.
The target position is not kept stable due to inappropriately set speed / acceleration	▶ Correct the corresponding servo control parameter settings (see the user manual for the controller).
Uncontrolled oscillation	
Large changes to the load or the alignment of the V-408	▶ Switch off the servo control system or the controller immediately. ▶ Check whether the servo control parameter settings correspond to the selected control mode; refer to the user manual for the controller. ▶ If necessary, correct the settings of the servo control parameters.
Increased wear	
Increased wear due to small motion over a long period of time	▶ Perform a maintenance run (p. 28).
Traveling to the hard stop with maximum force	▶ Ensure that the end of the travel range is approached at low velocity and with low force.

10 Transportation

10.1 Attaching the Transport Safeguard

Tools and Accessories

- Transport safeguard, including 2 M2×5 screws (p. 13)
- Hex key AF 1.5

NOTICE

Mechanical overload due to incorrect handling

An impermissible mechanical load on the V-408 due to transportation without a transport safeguard can damage the V-408's motion platform and also lead to loss of accuracy.

► Ship the V-408 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 for Transportation

1. Pay attention to the ambient conditions and classifications (p. 34).
2. Pack the V-408 into the original packaging.
3. If the V-408 is to be sent, use a stable outer box.

11 Customer Service Department

For enquiries and orders, contact your PI miCos 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

12 Technical Data

12.1 Specifications

	V-408.132020	Unit	Tolerance
Motion and positioning			
Active axes	X		
Travel range	25	mm	
Integrated sensor	Incremental linear encoder		
Sensor signal periods	80	µm	
Sensor resolution	10 *	Nm	Typ.
Minimum incremental motion	20	Nm	Typ.
Bidirectional repeatability	±0.1	µm	Typ.
Pitch / yaw	±150	µrad	Typ.
Straightness / flatness	±4	µm	Typ.
Velocity	0.5	m/s	Max.
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	0.23	kg	
Mass without cable	0.5	kg	
Overall mass	0.79	kg	
Guide type	Crossed roller guide with anti-creep system		
Drive properties			
Drive Type	PIMag® linear motor, iron core, 3-phase		
Intermediate circuit voltage	48	V DC	Max.
Peak force	14	N	Typ.
Nominal force	5	N	Typ.
Peak current, RMS	3.2	A	Typ.
Nominal current, RMS	1.1	A	Typ.
Permissible temperature for positioner components	80	°C	Max.
Force constant, RMS	4.60	N/A	Typ.
Resistance phase-phase	2.46	Ω	Typ.

	V-408.132020	Unit	Tolerance
Inductance phase-phase	1.94	mH	Typ.
Back EMF phase-phase	2.81	V s/m	Max.
Pole pitch N-N	18	mm	
Miscellaneous			
Operating temperature range	10 to 50	°C	
Humidity	20 – 90% rel., not condensing		
Material	Aluminum, black anodized		
Motor connector	HD D-sub 26 (m)		
Sensor connector	D-sub 15 (f)		
Cable length	2	m	

* interpolated

The specifications apply to room temperature (22 °C ±3 °C) and may deviate outside of this range.

12.2 Maximum Ratings

The V-408.132020 is designed for the following operating data:

Maximum operating voltage	Maximum operating frequency	Maximum power consumption
48 V	⎓	45 W

12.3 Ambient Conditions and Classifications

Pay attention to the following ambient conditions and classifications for the V-408.132020:

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

12.4 V-408.132020 Dimensions

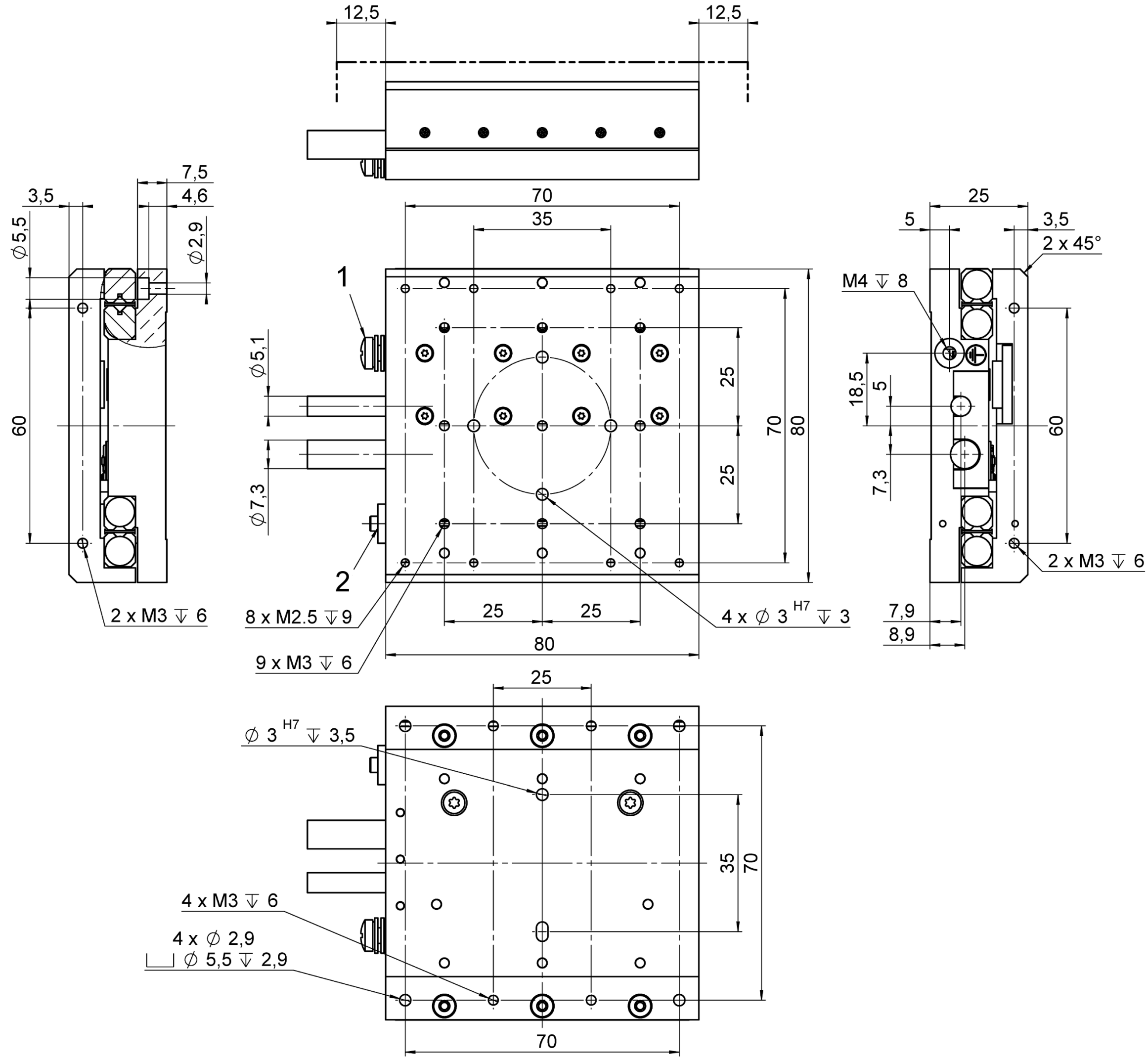


Figure 10: Dimensions of the V-408.132020

1. Grounding stud
2. Transport safeguard

Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

12.4.1 V-500.AP1 and V-408.AP1 Dimensions

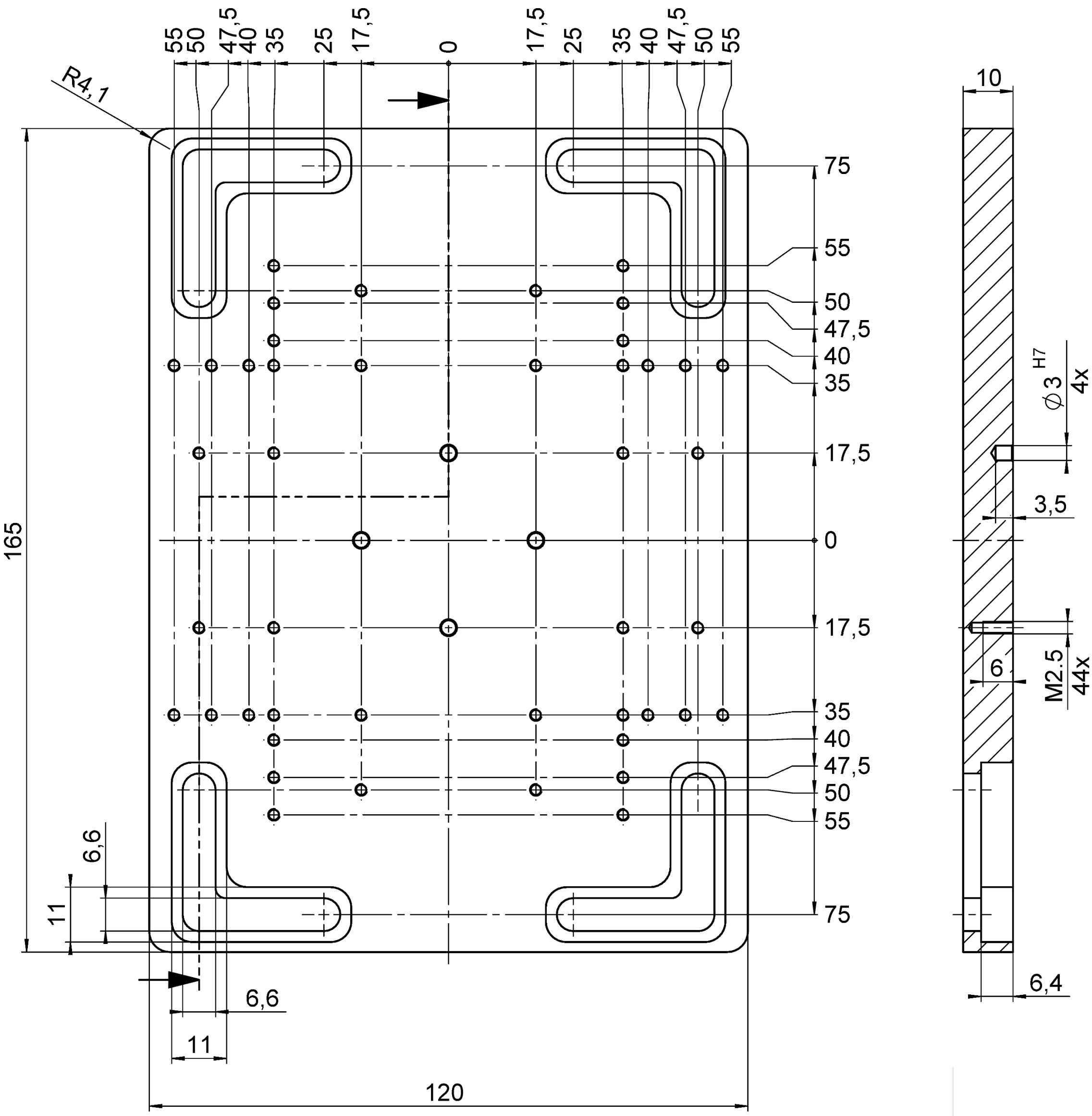


Figure 11: V-500.AP1

Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

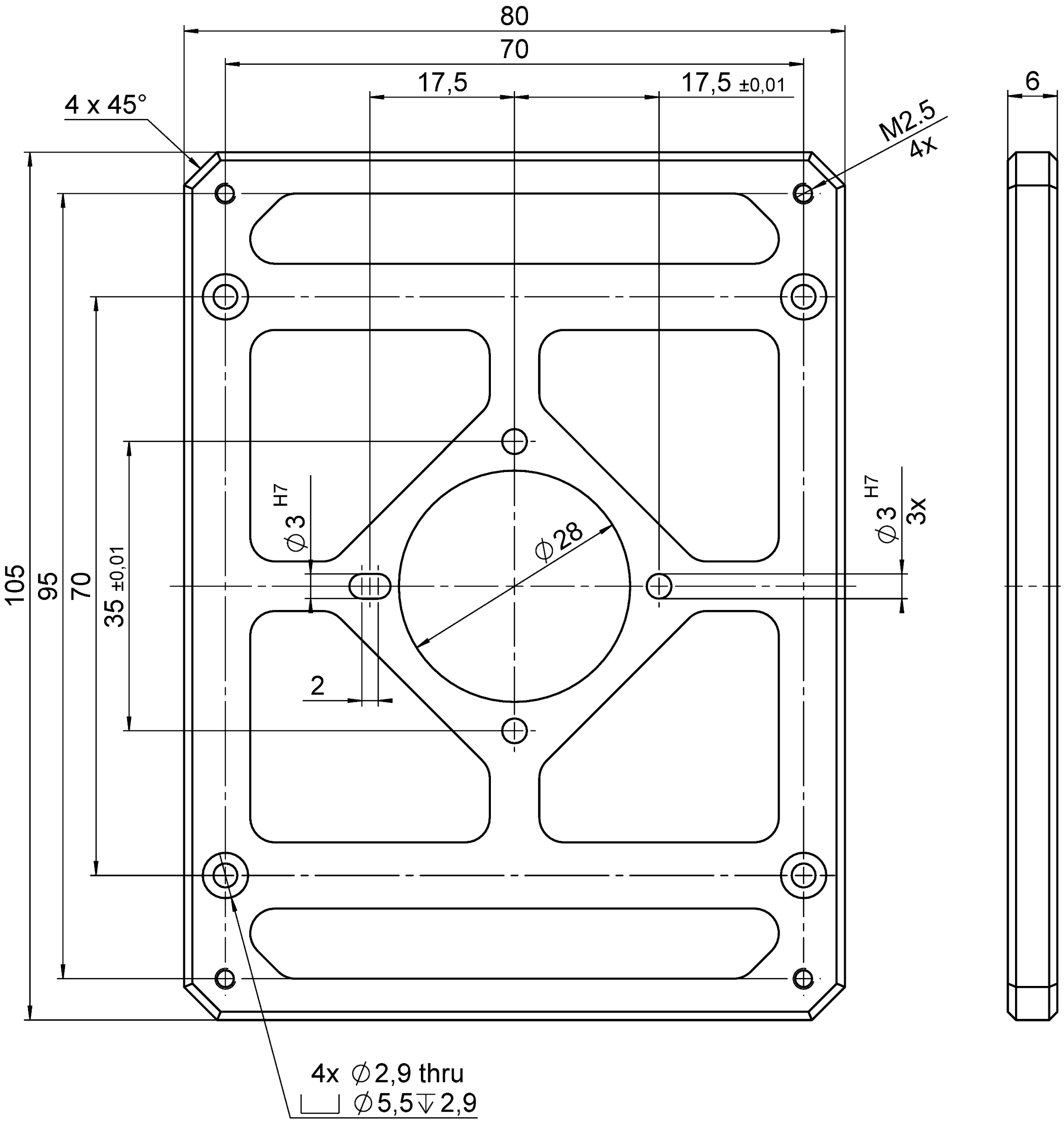


Figure 12: V-408.AP1

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.

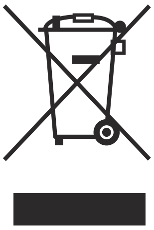
Dispose of your old equipment according to international, national, and local rules and regulations.

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

Any old PI miCos equipment can be sent free of charge to the following address:

PI miCos GmbH
Freiburger Strasse 30
79427 Eschbach
Germany

info@pimicos.de
www.pi.de



14 Appendix

14.1 Pin Assignment

14.1.1 Drive Connection

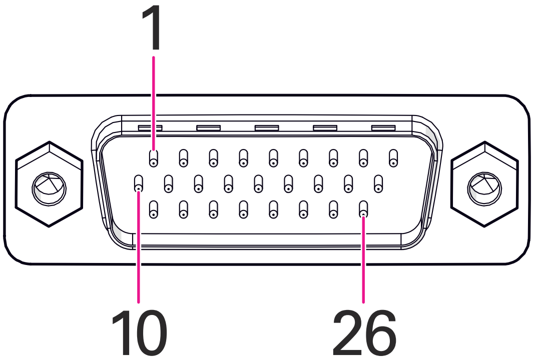


Figure 13: HD D-Sub 26 (m)

Pin	Signal	Function
1	Ph1	Phase 1
2	Ph1	Phase 1
3	Ph2	Phase 2
4	Ph2	Phase 2
5	Ph3	Phase 3
6	Ph3	Phase 3
7 - 26	NC	Not connected
Housing	GND	Ground

14.1.2 Encoder Connector

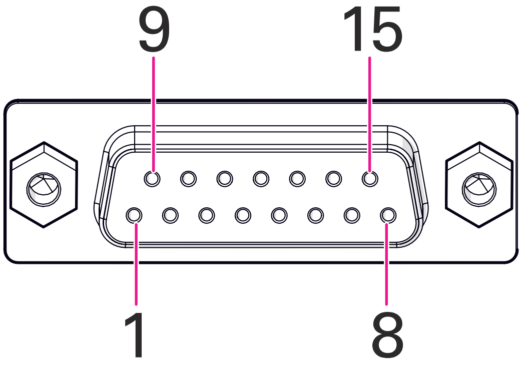


Figure 14: D-sub 15 (f)

Pin	Signal	Function
1	Vcc 5 V	Input: Power supply
2	AGND	Encoder Ground
3	SIN+	Encoder sine+
4	SIN-	Encoder sine-
5	-	Not connected
6	COS+	Encoder cosine+
7	COS-	Encoder cosine-
8	N-Limit	Output: Limit switch negative
9	-	Not connected
10	REF+	Output: Reference switch, positive
11	-	Not connected
12	REF-	Output: Reference switch, negative
13	Used	
14	GND	Ground
15	P-Limit	Output: Limit switch positive

14.2 Reference 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.

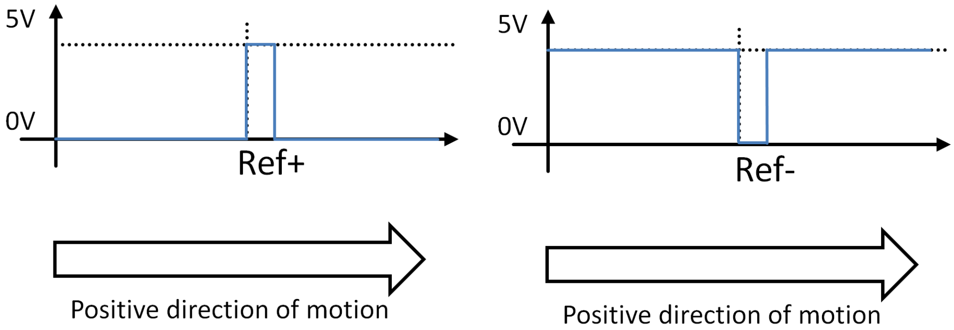


Figure 15: Reference signal of the V-408

14.3 Limit Switch Specifications

Type	Magnetic sensor (Hall effect)
Supply voltage	+5 V
Signal output	0 V / +5 V (TTL level)
Signal logic	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)

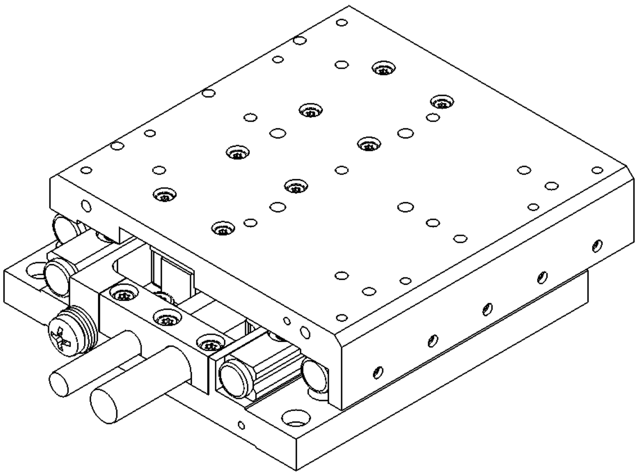


Figure 16: Example V-408.132020; V-408 at the positive limit switch, i.e., the signal to pin 15 of the encoder connector (PLIM) is high

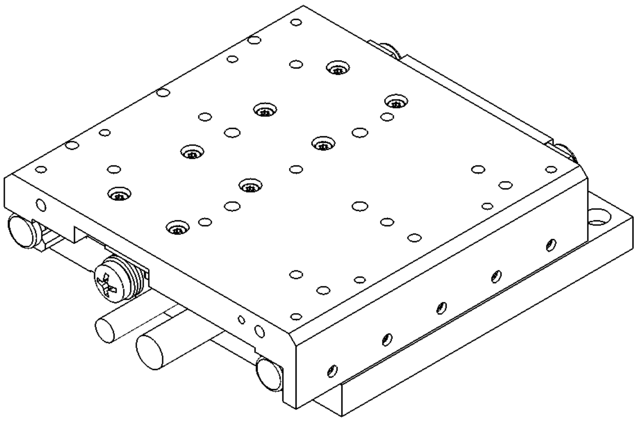


Figure 17: Example for V-408.132020; V-408 at the negative limit switch, i.e., the signal to pin 8 of the encoder connector (NLIM) is high

15 EU Declaration of Conformity

An EU Declaration of Conformity was issued for the V-408.132020 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

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 detecting changes in position. Signals from the sensor are used for axis position feedback. After the controller is switched on, referencing must be done before absolute target positions can be commanded and reached.

Load Capacity
Maximum load in the vertical direction when the V-408 is mounted horizontally. The contact point of the load is at the center of the motion platform.

Reference Switch
Many of the positioners are equipped with a direction sensing reference switch positioned approx. in the middle of the travel range. It is recommended to approach the reference 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.