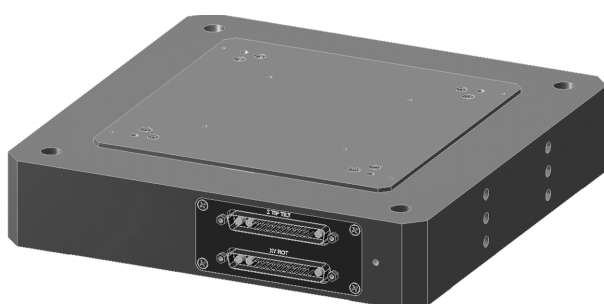


PZ251E
P-587 Positioner
User Manual

Version: 1.1.0

Date: 22.04.2022



This document describes the following product:

- **P-587.6CD**
6-axis nanopositioner with long travel range,
800 μm \times 800 μm \times 200 μm , ± 0.5 mrad, parallel
metrology, capacitive sensors, D-sub 25W3
panel plugs



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The patents held by PI are found in our patent list:
<https://www.physikinstrumente.com/en/about-pi/patents>

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Subject to change without notice. This manual is superseded by any new release. The latest release is available for download (p. 3) on our website.

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1 About this Document

In this Chapter

Objective and Target Audience of this User Manual 1

Symbols and Typographic Conventions 1

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1.1 Objective and Target Audience of this User Manual

This manual contains the information required for using the P-587 as intended.

Basic knowledge of control technology, drive technologies, and suitable safety measures is assumed.

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

1.2 Symbols and Typographic Conventions

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

CAUTION



Dangerous situation
Failure to comply could lead to minor injury.

- Precautionary measures for avoiding the risk.

NOTICE





Dangerous situation
Failure to comply could cause damage to equipment.

- Precautionary measures for avoiding the risk.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/Label	Meaning
1.	Action consisting of several steps with strict sequential order
2.	
➤	Action consisting of one or more steps without relevant sequential order.
▪	Bullet
p. 5	Cross-reference to page 5
RS-232	Label on the product indicating an operating element (example: RS-232 interface socket)
 	Warning signs on the product that refer to detailed information in this manual.

1.3 Figures

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

1.4 Other Applicable Documents

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

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

Product	Document
E-712 digital piezo controller	PZ195E User Manual
P-5xx / P-6xx / P-7xx piezo positioners	PZ240EK Short Instructions

1.5 Downloading Manuals

INFORMATION

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**.
2. Search the website for the product number (e.g., P-587) or the product family (e.g., nanopositioner).
3. Click the corresponding product to open the product detail page.
4. Click the **Downloads** tab.

The manuals are shown under **Documentation**. Software manuals are shown under **General Software Documentation**.

5. Click the desired manual and fill out the inquiry form.

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

2 Safety

In this Chapter

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2.1 Intended Use

The P-587 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.

According to its design, the P-587 is intended for fine positioning as well as moving small objects quickly and precisely. The specifications for the P-587 apply to horizontal mounting. The motion takes place horizontally in two axes (X, Y), vertically in one axis (Z) and rotationally in three axes (θ_x , θ_y , θ_z).

The P-587 can only be used as intended in conjunction with suitable electronics (p. 11) available from PI. The electronics are not included in the scope of delivery of the P-587.

The electronics must provide the required operating voltages. To ensure proper performance of the servo control system, the electronics must be able to read out and process the signals from the capacitive sensors.

2.2 General Safety Instructions

The P-587 is built according to state-of-the-art technology and recognized safety standards. Improper use can result in personal injury and/or damage to the P-587.

- Use the P-587 for its intended purpose only, and only when it is in perfect technical condition.
- Read the user manual.
- Eliminate any malfunctions that may affect safety immediately.

The operator is responsible for the correct installation and operation of the P-587.

The P-587 is driven by piezo actuators. Temperature changes and compressive stress can induce charges in piezo actuators. Piezo actuators can remain charged for several hours after disconnecting the electronics. Touching or short-circuiting the contacts in the P-587's D-sub panel plugs can lead to minor injuries from electric shock. The piezo actuators can be destroyed by an abrupt contraction.

- Do **not** open the P-587.
- Discharge the positioner's piezo actuators before installing:
Connect the positioner to the switched-off PI electronics equipped with an internal discharge resistor.
- Do **not** pull out the connecting cables while the positioner or the electronics are in operation.

Touching the contacts in the D-sub panel plugs can lead to an electric shock (max. 130 V DC) and minor injuries.

- Do **not** touch the contacts in the D-sub panel plugs of the P-587 or the connecting cables connected to them.
- Use screws to secure the positioner's connecting cables from being pulled out of the positioner and electronics.

If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the P-587 in the case of malfunction or failure of the system. If there are touch voltages, touching the P-587 can result in minor injuries from electric shock.

- Connect the P-587 to a protective earth conductor (p. 16) before starting.
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e.g., in the case of modifications), reconnect the P-587 to the protective earth conductor before restarting.

Mechanical forces can damage or misalign the P-587.

- Avoid impacts that affect the P-587.
- Do **not** drop the P-587.
- Do **not** exceed the maximum permissible stress and load capacities according to the specifications (p. 33).
- Do **not** touch any sensitive parts (e.g., motion platform) when handling the P-587.

The P-587 is maintenance-free and achieves its positioning accuracy as a result of the optimal alignment of mechanical components and piezo actuators. Loosened screws cause a loss in positioning accuracy.

- Loosen screws only when instructed in this manual.
- Do **not** open the P-587.

2.3 Organizational Measures

User manual

- Always keep this user manual together with the P-587.
The latest versions of the user manuals are available for download (p. 3) on our website.
- Add all information from the manufacturer to the user manual, for example supplements or technical notes.
- If you give the P-587 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 P-587 only after you have read and understood this user manual.

Personnel qualification

The P-587 may only be installed, started, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

3 Product Description

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Suitable Electronics	11
Technical Features	11

3.1 Product View

The figure serves as an example and can differ from your positioner model.

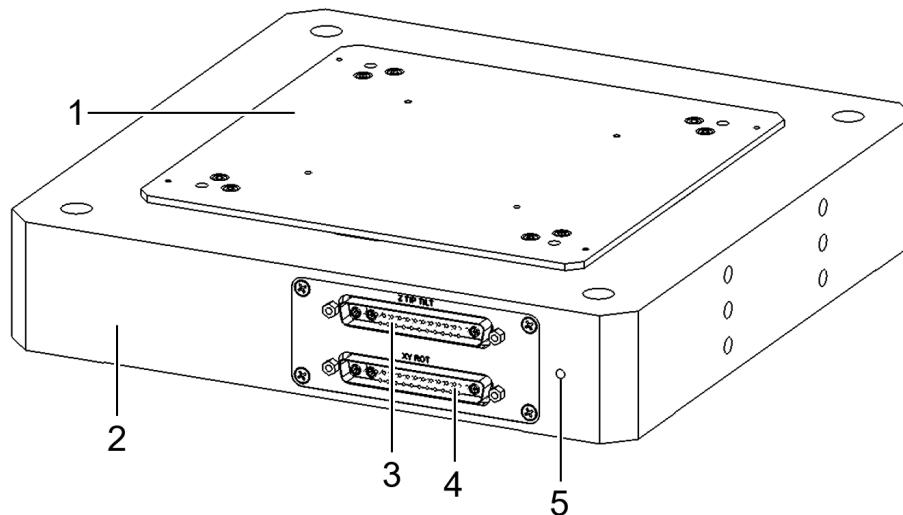








Figure 1: Example of product view

- 1 Motion platform
- 2 Base body
- 3 "Z TIP TILT" connector for controller cable
- 4 "XY ROT" connector for controller cable
- 5 M4 hole for connecting the protective earth conductor

3.2 Product Labeling

The P-587 is labeled on the side with the connectors as follows:

Labeling	Description
P-587.6CD	Product name (example), the characters following the period refer to the model
123456789	Serial number (example), individual for each P-587 Meaning of each position (from the left): 1 = internal information 2 and 3 = year of manufacture 4 to 9 = consecutive number
	Manufacturer's logo
	Warning sign "Pay attention to the manual!"
	Old equipment disposal (p. 41)
	CE conformity mark
Country of origin: Germany	Country of origin
WWW.PI.WS	Manufacturer's address (website)
Z TIP TILT	"Z TIP TILT" connector for controller cable
XY ROT	"XY ROT" connector for controller cable
	Warning sign "Attention! Residual voltage": Indicates risk of electric shock (p. 5)
	Symbol for the protective earth conductor, marks the protective earth connector of the P-587 (p. 16)

3.3 Scope of Delivery

Product number	Description
P-587.6CD	6-axis nanopositioner with long travel range, 800 μm \times 800 μm \times 200 μm , ± 0.5 mrad, parallel metrology, capacitive sensors
000036450	M4 screw set for protective earth, consisting of: <ul style="list-style-type: none"> 1 M4x8 flat-head screw with cross recess, ISO 7045 2 lock washers 2 flat washers
K030B0055	Cable set for connecting the P-587 to the controller, consisting of: <ul style="list-style-type: none"> 2 cables, D-sub 25W3 (m/w), drag chain compatible, 3 m
PZ240EK	Short instructions for P-5xx / P-6xx / P-7xx piezo positioners

3.4 Suitable Electronics

Product number	Description
E-712.6CD	<p>Modular digital piezo controller, 6 axes, capacitive sensors, TCP/IP, USB, RS-232, SPI interfaces for communication. consisting of:</p> <p>1 × E-712.M1 Digital processor and interface module, TCP/IP, USB, RS-232, SPI</p> <p>2 × E-711.SC3H Module for capacitive sensors, 3 channels</p> <p>2 × E-711.AL4P High-power amplifier module, 4 channels 8 W, -30 to +135 V</p> <p>1 × E-712.R1 9.5" housing with power adapter, for piezo voltages up to 135 V, 3 to 6 axes</p>

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

3.5 Technical Features

3.5.1 PICMA® Piezo Actuators

P-587 positioners are driven by PICMA® piezo actuators. PICMA® actuators have all-ceramic insulation and their performance and lifetime are therefore far superior to conventional actuators. The ceramic insulation layer protects the monolithic piezoceramic block against humidity and failure due to increased leakage current. In this way, an especially high reliability is achieved even under extreme ambient conditions. In contrast to motorized drives, there are no rotating parts or friction. The piezo actuators are therefore free of backlash, maintenance, and wear.

3.5.2 Flexure Guides

P-587 positioners have flexure guides for friction-free motion and high guiding accuracy.

A flexure guide is an element that is free of static and sliding friction. It is based on the elastic deformation (bending) of a solid (e.g., steel) and does not have any rolling or sliding parts. Flexure elements have a high stiffness and load capacity. Flexure guides are maintenance and wear free. They are 100% vacuum compatible, function in a wide temperature range and do not require any lubricants.

3.5.3 Capacitive Sensors

Capacitive sensors measure the position directly on the platform (direct metrology) and work without contact. Neither friction nor hysteresis interferes with the motion, which allows excellent linearity values to be achieved together with the high position resolution. In conjunction with suitable electronics, capacitive sensors achieve the best resolution, stability, and bandwidth.

3.5.4 ID Chip

An ID chip is in the D-sub connector of the P-587. When the P-587 is calibrated at the factory with digital electronics, the calibration data is saved on the ID chip together with specific product information. After switching on, the digital electronics read the data from the ID chip of the P-587 connected. A P-587 with an ID chip containing calibration data can therefore be connected to any suitable digital electronics without renewed calibration.

Refer to the manual for the controller for more information on the ID chip.

4 Unpacking

NOTICE

**Mechanical overload due to incorrect handling!**

An impermissible mechanical load on the motion platform of the P-587 can cause damage to the piezo actuators, sensors, and flexures of the P-587 as well as loss of accuracy.

- Do **not** touch any sensitive parts (e.g., motion platform) when handling the P-587.

1. Unpack the P-587 with care.
2. Compare the contents with the scope of delivery according to the contract and the delivery note.
3. Inspect the contents for signs of damage. If any parts are damaged or missing, contact our customer service department (p. 31) immediately.
4. Keep all packaging materials in case the product needs to be returned.

5 Installation

In this Chapter

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Mounting the P-587	18
Fixing the Load	19
Connecting the P-587 to the Electronics	22

5.1 General Notes on Installing

CAUTION



Dangerous voltage and residual charge in piezo actuators!

The P-587 is driven by piezo actuators. Temperature changes and compressive stress can induce charges in piezo actuators. Piezo actuators can remain charged for several hours after disconnecting the electronics. Touching or short-circuiting the contacts in the P-587's D-sub panel plugs can lead to minor injuries from electric shock. The piezo actuators can be destroyed by an abrupt contraction.

- Do **not** open the P-587.
- Discharge the positioner's piezo actuators before installing:
Connect the positioner to the switched-off PI electronics equipped with an internal discharge resistor.
- Do **not** pull out the connecting cables while the positioner or the electronics are in operation.



Touching the contacts in the D-sub panel plugs can lead to an electric shock (max. 130 V DC) and minor injuries.

- Do **not** touch the contacts in the D-sub panel plugs of the P-587 or the connecting cables connected to them.
- Use screws to secure the positioner's connecting cables from being pulled out of the positioner and electronics.

NOTICE



Mechanical overload due to incorrect handling!

An impermissible mechanical load on the motion platform of the P-587 can cause damage to the piezo actuators, sensors, and flexures of the P-587 as well as loss of accuracy.

- Do **not** touch any sensitive parts (e.g., motion platform) when handling the P-587.

NOTICE**Damage due to unsuitable cables!**

Unsuitable cables can damage the P-587 and the electronics.

- Use cables provided by PI only to connect the P-587 to the electronics.

NOTICE**Damage due to improper mounting!**

Improper mounting of the P-587 or incorrectly mounted parts can damage the P-587.

- Only use the holes or threads intended for the purpose of fixing the P-587 and loads.
- Install the P-587 so that the platform and all parts attached to it can move freely within the entire travel range.

NOTICE**Damage due to incorrectly tightened screws!**

Incorrectly tightened screws can cause damage.

- Pay attention to the torque range (p. 36) specified for the screws used during installation.

INFORMATION

Extension cables can reduce the positioning accuracy of the P-587 or affect sensor processing by the electronics.

- Do **not** use extension cables. If you need longer cables, contact our customer service department (p. 31).

5.2 Connecting the P-587 to the Protective Earth Conductor

INFORMATION

- Pay attention to the applicable standards for connecting the protective earth conductor.

INFORMATION

- If there is any vibration in your application, secure the screw connection for the protective earth conductor in a suitable manner to prevent it from unscrewing by itself. If this is not possible, check the screw connection at regular intervals and retighten the screw if necessary.

INFORMATION

In the case of P-587 positioners with D-sub connectors, ground loops can occur when the positioner is grounded via its protective earth connector as well as via the connecting cable's shielding for the electronics.

- If a ground loop occurs, contact our customer service department (p. 31).

The P-587 has an M4 hole for connecting the protective earth conductor. This hole is marked with the symbol for the protective earth conductor (⏏). Refer to "Dimensions" (p. 36) for the exact position of the hole.

Requirements

- ✓ You have read and understood the general notes on installing (p. 15).
- ✓ The P-587 is **not** connected to the electronics.

Tools and accessories

- Suitable protective earth conductor: Cable cross section $\geq 0.75 \text{ mm}^2$
- M4 protective earth screw set (p. 10) supplied for connecting the protective earth conductor
- Suitable screwdriver

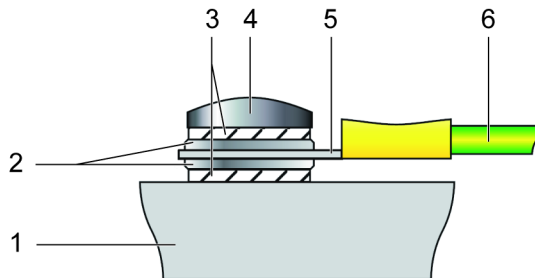


Figure 2: Connecting the protective earth conductor (profile view)

- | | |
|---|----------------------------|
| 1 | Base body of the P-587 |
| 2 | Flat washer |
| 3 | Lock washer |
| 4 | Screw |
| 5 | Cable lug |
| 6 | Protective earth conductor |

Connecting the P-587 to the protective earth conductor

1. If necessary, attach a suitable cable lug to the protective earth conductor.
2. Use the M4 screw (together with the flat and lock washers) to attach the cable lug of the protective earth conductor to the threaded hole in the P-587 as shown in the profile view.
3. Tighten the M4 screw with a torque of 1.2 Nm to 1.5 Nm.
4. Make sure that the contact resistance at all connection points relevant for connecting the protective earth conductor is $< 0.1 \Omega$ at 25 A.

5.3 Mounting the P-587

NOTICE



Warping the P-587 when mounting onto uneven surfaces!

The P-587 could warp if mounted on an uneven surface. Warping reduces the accuracy.

- Mount the P-587 onto a flat surface. The recommended flatness of the surface is $\leq 20 \mu\text{m}$.
- For applications with large temperature fluctuations:
Mount the P-587 only onto surfaces that have the same or similar thermal expansion properties as the P-587.

NOTICE



Tensile stress on piezo actuator due to mounting in wrong orientation!

The P-587 is intended for mounting in horizontal orientation (standing on a surface, not suspended). Mounting in other orientations can cause tensile stress that reduces the preload and destroys the piezo actuator.

- If you want to mount the P-587 in a different orientation to that intended (e.g., vertically or upside down), contact our customer service department (p. 31).

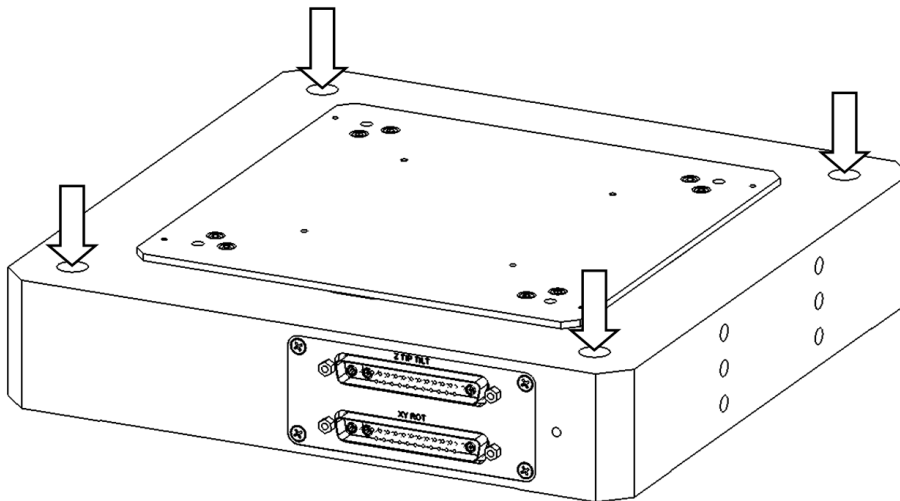


Figure 3: Mounting holes in the base body

Requirements

- ✓ You have read and understood the general notes on installing (p. 15).
- ✓ The P-587 is **not** connected to the electronics.
- ✓ You have provided a suitable surface. Refer to "Dimensions" for the position and depth required for the holes (p. 36).
- ✓ You have accounted for the space required to route cables according to regulations and without bending them.

Tools and accessories

- Four screws of suitable size and length (p. 36)
- Suitable screwdriver

Mounting the P-587

1. Align the P-587 on the surface so that the corresponding holes in the P-587 and surface are in line.
2. From above, introduce the screws into the mounting holes in the base body of the P-587 into the surface.
3. Tighten the screws crosswise:
 - When tightening the screws, pay attention to the specified torque range (p. 36).
 - Make sure that the screw heads are fully sunken.
4. Check that the P-587 is firmly mounted on the surface.

5.4 Fixing the Load**NOTICE****Mechanical overload of the platform!**

Fixing loads with high torques and heavy loads in general can overload the platform of the P-587. Mechanical overload can damage the piezo actuators, sensors, and flexures of the P-587 and lead to loss of accuracy.

- Avoid torques on the platform.
- Do **not** exceed the maximum permissible loads according to the specifications (p. 33).
- Hold the load and adhere to the specified torque range when tightening (or loosening) the screws (p. 36).

NOTICE**Warping the P-587 when fixing loads with an uneven contact surface!**

Fixing loads with an uneven contact surface could warp the P-587. Warping reduces the accuracy.

- Fix loads on the P-587 only when the surface contacting the P-587's motion platform has a flatness of at least 20 µm.
- For applications with large temperature fluctuations:
Fix loads to the P-587 only when they have the same or similar thermal expansion properties as the P-587.

NOTICE**Center of load at unsuitable position!**

If the center of load is located too far away from the center of the motion platform (e.g., tall load and unwanted lever effect), the P-587 can be damaged, especially in dynamic operation, by high strain on the flexure guides, high torques, and oscillations.

- If the center of the load to be fixed is too high or to the side of the motion platform, adjust the controller settings before starting and operating or contact our customer service department (p. 31).

NOTICE**Excessively long screws!**

The P-587 could be damaged by screws inserted too deeply.

- Pay attention to the depth of the mounting holes in the motion platform (p. 36).
- Use screws of the correct length for the respective mounting holes only.

INFORMATION

Positive direction of axis motion is specified in the product view (p. 9).

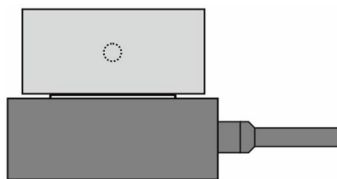
Center of load at the optimal position:

Figure 4: Example of an optimally placed load

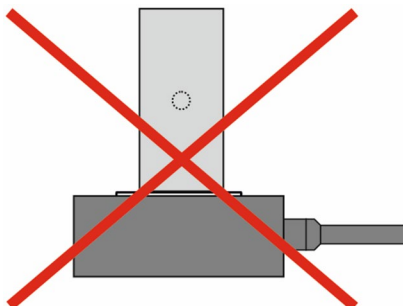
Center of load at an unsuitable position:

Figure 5: Tall load and center of load too far above the platform

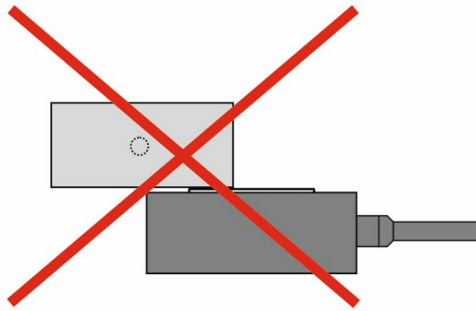


Figure 6: Unwanted lever effect and center of load on the side of the platform

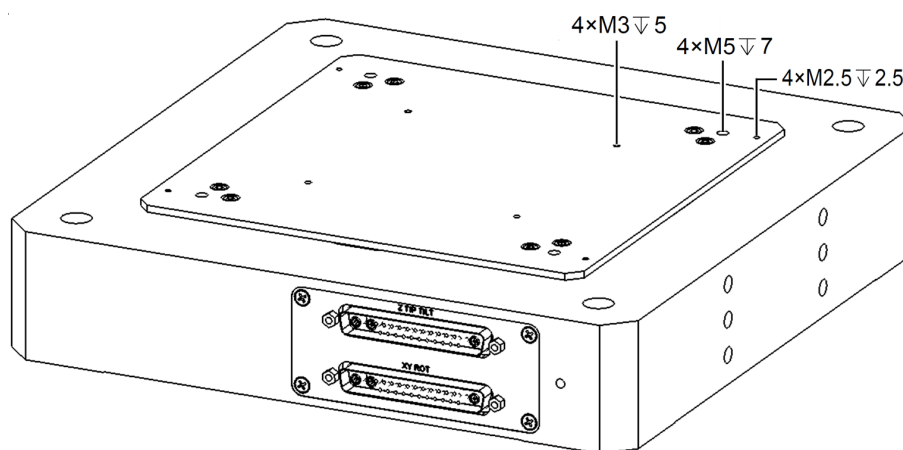


Figure 7: Mounting holes in the motion platform

Requirements

- ✓ You have read and understood the general notes on installing (p. 15).
- ✓ The P-587 is **not** connected to the electronics.

Tools and accessories

- Screws of suitable size and length (p. 36)
- Suitable screwdriver

Fixing the load

1. Align the load on the P-587 so that the mounting holes in the load and motion platform are in line.
2. Insert the screws through the holes in the load into the selected mounting holes in the motion platform of the P-587.
3. Hold the load so that it cannot move while tightening the screws.
4. Tighten the screws. When tightening the screws, pay attention to the torque range (p. 36) specified, and avoid torques to the motion platform.
5. Check that the load is firmly mounted on the motion platform.

5.5 Connecting the P-587 to the Electronics

INFORMATION

- When connecting, pay attention to the assignment specified on the labeling of the sockets, plug connectors, and cables.

Requirements

- ✓ You have read and understood the general notes on installing (p. 15).
- ✓ You have installed suitable electronics (p. 11).
- ✓ You have read and understood the user manual for the electronics.
- ✓ The electronics are switched off.

Tools and accessories

- Cable set K030B0055 (p. 10)

Connecting the P-587 to the electronics

1. Connect the first connecting cable in the following way:
 - D-sub 25W3 connector **XY ROT** of the cable to the D-sub 25W3 panel plug **XY ROT** of the P-587
 - D-sub 25W3 connector **CH1/CH2/CH3** of the cable to the D-sub 25W3 socket of the electronics (sensor module **1**)
2. Connect the second connecting cable in the following way:
 - D-sub 25W3 connector **Z TIP TILT** of the cable to the D-sub 25W3 panel plug **Z TIP TILT** of the P-587
 - D-sub 25W3 connector **CH4/CH5/CH6** of the cable to the D-sub 25W3 socket of the electronics (sensor module **2**)
3. If possible, secure the connectors against accidental disconnection.

6 Starting and Operating

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Operating the P-587	25
Discharging the P-587	25

6.1 General Notes on Starting and Operating

CAUTION



Risk of electric shock if the protective earth conductor is not connected!

If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the P-587 in the case of malfunction or failure of the system. If there are touch voltages, touching the P-587 can result in minor injuries from electric shock.

- Connect the P-587 to a protective earth conductor (p. 16) before starting.
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e.g., in the case of modifications), reconnect the P-587 to the protective earth conductor before restarting.

NOTICE



Destruction of the piezo actuator due to electric flashovers!

Using the P-587 in environments that increase the electrical conductivity can lead to the destruction of the piezo actuator by electric flashovers. Electric flashovers can be caused by moisture, high humidity, liquids, and conductive materials (e.g., metal dust). In addition, electric flashovers can also occur in certain air pressure ranges due to the increased conductivity of the air.

- Avoid operating the P-587 in environments that can increase the electric conductivity.
- Operate the P-587 only within the permissible ambient conditions and classifications (p. 35).

NOTICE



Decreased lifetime due to permanently high voltage!

Applying a continuous high static voltage to piezo actuators leads to a considerable reduction in the lifetime of the piezo ceramic.

- When the P-587 is not used but the electronics remain switched on to ensure temperature stability, discharge the P-587 (p. 25).

NOTICE**Operating voltage too high or incorrectly connected!**

Operating voltages that are too high or incorrectly connected can cause damage to the P-587.

- Operate the P-587 only with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating voltage range (p. 35) specified for the P-587.
- Operate the P-587 only when the operating voltage is properly connected; refer to "Pin Assignment" (p. 37).

NOTICE**Uncontrolled oscillation!**

Oscillation can cause irreparable damage to the P-587. Oscillation is indicated by a humming noise and can be caused by the following:

- A change in the load and/or dynamics requires the servo control parameters to be adjusted.
- The P-587 is operated close to its resonant frequency, or with too high operating frequency.

If you notice oscillation:

- In closed-loop operation, switch off the servo mode immediately.
- In open-loop operation, stop the P-587 immediately.

INFORMATION

Positive direction of axis motion is specified in the product view (p. 9).

INFORMATION

Sound and vibration (e.g., footfall, knocks) can be transmitted to the P-587 and can affect its performance with regard to position stability.

- Avoid sound and vibration while the P-587 is being operated.

6.2 Operating the P-587

Requirements

- ✓ You have read and understood the general notes on starting and operating.
- ✓ You have read and understood the user manual for the electronics.
- ✓ You have read and understood the user manual for the PC software.
- ✓ You have correctly installed (p. 15) the P-587, and connected it to the protective earth conductor (p. 16).
- ✓ The electronics and the required PC software were installed. All connections to the electronics were made (refer to the user manual for the electronics).

Operating the P-587

- Follow the instructions for starting and operating the P-587 in the manual for the electronics (p. 11) used.

6.3 Discharging the P-587

The P-587 must be discharged in the following cases:

- Before Installation
- When the P-587 is not used but the electronics remain switched on to ensure temperature stability
- Before demounting (e.g., before cleaning and transporting the P-587 and for modifications)

The P-587 is discharged via the discharge resistor inside the electronics from PI.

Discharging a positioner connected to the electronics

In closed-loop operation:

1. Switch off the servo mode on the controller.
2. Set the piezo voltage to 0 V on the controller.

In open-loop operation:

- Set the piezo voltage to 0 V on the electronics.

Discharging a positioner not connected to the electronics

- Connect the positioner to the switched-off electronics from PI.

7 Maintenance

In this Chapter

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7.1 General Notes on Maintenance

NOTICE

**Misalignment due to loosening screws!**

The P-587 is maintenance-free and achieves its positioning accuracy as a result of the optimal alignment of mechanical components and piezo actuators. Loosened screws cause a loss in positioning accuracy.

- Loosen screws only when instructed in this manual.
- Do **not** open the P-587.

7.2 Cleaning the P-587

NOTICE

**Damage from ultrasonic cleaning!**

Ultrasonic cleaning can damage the P-587.

- Do **not** do any ultrasonic cleaning.

NOTICE

**Damage due to penetrating cleaning liquids!**

Cleaning liquids penetrating the housing can damage the P-587 and lead to electric short circuiting.

- Disconnect the P-587 from the electronics before cleaning.
- Prevent any cleaning liquid from penetrating the P-587's housing.

Requirements

- ✓ You have discharged the piezo actuators of the P-587 (p. 25).
- ✓ You have disconnected the P-587 from the electronics.

Cleaning the P-587

- Clean the surfaces of the P-587 with a cloth dampened with a mild cleanser or disinfectant (e.g., isopropyl alcohol).

8 Troubleshooting

Problem	Possible causes	Solution
No or limited motion	Cable not connected correctly	➤ Check the cable connections.
	Excessive load	➤ Do not exceed the maximum permissible stress and load capacities according to the specifications (p. 33).
	Zero shift of the sensor for the following reasons: <ul style="list-style-type: none"> ▪ Load in direction of motion ▪ Ambient/operating temperature of the positioner is far above or below the calibration temperature (21 °C to 24 °C) 	➤ Adjust the zero-point of the sensor (refer to the controller manual).
Reduced accuracy	The base body or the platform is warped	➤ Mount the P-587 onto surfaces with the following characteristics only: <ul style="list-style-type: none"> – Flatness of at least 20 µm – The thermal expansion properties are similar to those of the P-587 (e.g., surface made of aluminum). ➤ Mount loads onto the P-587 with the following characteristics only: <ul style="list-style-type: none"> – The contact surface of the load has a flatness of at least 20 µm. – The thermal expansion properties are similar to those of the P-587 (e.g., load made of aluminum).
The positioner starts oscillating or positions inaccurately	Servo control parameters incorrectly set because for example, the load was changed	<ol style="list-style-type: none"> 1. Switch off the servo mode of the corresponding motion axes immediately. 2. Check the settings of the servo control parameters on the controller. 3. Adjust the servo control parameters on the controller according to the load change.
	Open-loop operation near the resonant frequency	➤ In open-loop operation, operate the positioner only with a frequency that is below the resonant frequency.

If the problem with your system is not listed in the table above or cannot be solved as described, contact our customer service department (p. 31).

9 Customer Service

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

- 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.

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

10 Technical Data

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

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10.1 Specifications

10.1.1 Data Table

	P-587.6CD	Unit	Tolerance
Active axes	X, Y, Z, θ_x , θ_y , θ_z		
Motion and positioning			
Integrated sensor	Capacitive		
Travel range in X, Y, closed loop	800	μm	
Travel range in Z, closed loop	200	μm	
Tip/tilt angle in θ_x , θ_y , closed loop	± 0.5	mrad	
Tip/tilt angle in θ_z , closed loop	± 0.5	mrad	
Resolution in X, Y, open loop / closed loop	0.9 / 2.2	nm	typ.
Resolution in Z, open loop / closed loop	0.4 / 0.7	nm	typ.
Resolution in θ_x , θ_y , open loop / closed loop	0.05 / 0.1	μrad	typ.
Resolution in θ_z , open loop / closed loop	0.1 / 0.3	μrad	typ.
Linearity error in X, Y, Z	0.01	%	typ.
Linearity error θ_x , θ_y , θ_z	0.1	%	typ.
Repeatability X, Y	± 3	nm	typ.
Repeatability in Z	± 2	nm	typ.
Repeatability in θ_x , θ_y	± 0.1	μrad	typ.
Repeatability in θ_z	± 0.15	μrad	typ.
Flatness	<15	nm	typ.

	P-587.6CD	Unit	Tolerance
Mechanical properties			
Stiffness in X / Y / Z	0.55 / 0.55 / 1.35	N / μm	
Resonant frequency in X / Y / Z, no load	103 / 103 / 235	Hz	$\pm 20 \%$
Resonant frequency in X / Y / Z, under load, 500 g	88 / 88 / 175	Hz	$\pm 20 \%$
Resonant frequency in X / Y / Z, under load, 2000 g	65 / 65 / 118	Hz	$\pm 20 \%$
Load capacity*	5	kg	max.
Drive properties			
Ceramic type	PICMA [®]		
Electrical capacitance in X / Y / Z	81 / 81 / 18.4	μF	$\pm 20 \%$
Miscellaneous			
Operating temperature range	-20 to 80	$^{\circ}\text{C}$	
Material	Aluminum		
Mass	7.2	kg	$\pm 5 \%$
Cable length	3.0	m	$\pm 10 \text{ mm}$
Sensor / voltage connection	2 × D-sub 25W3 (m)		
Recommended electronics	E-712		

* When mounted horizontally (standing on a surface, not suspended).

The maximum rotational angle in θ_z is 8 mrad, the tip/tilt angles in X and Y are 3 mrad.




Due to the parallel kinematics design, simultaneous linear motion in X or Y is not possible in the extreme position of the tip/tilt angle.

The resolution of the system is limited only by the noise of the amplifier and the measuring technology because PI piezo nanopositioning systems are free of friction.

All specifications based on room temperature ($22^{\circ}\text{C} \pm 3^{\circ}\text{C}$).

10.1.2 Maximum Ratings

The P-587 is designed for the following operating data:

Maximum operating voltage 	Maximum operating frequency (unloaded) ¹ 	Maximum power consumption ² 
-20 to +120 V	X axis: 23 Hz Y axis: 23 Hz Z axis: 44 Hz	X1, X2, Y1, Y2: 40 W each Z1, Z2, Z3, Z4: 8.5 W each

¹ To ensure stable operation, the maximum operating frequency has been defined as around one third of the mechanical resonant frequency.

² The heat that is generated by the piezo actuator during dynamic operation limits the value for maximum power consumption.

Details can be found at the following website:

<https://www.physikinstrumente.com/en/technology/piezo-technology/properties-piezo-actuators/electrical-operation/>

10.2 Ambient Conditions and Classifications

Pay attention to the following ambient conditions and classifications for the P-587:

Area of application	For indoor use only
Maximum altitude	2000 m
Air pressure	1100 hPa to 700 hPa
Relative humidity	Highest relative humidity 80 % for temperatures up to 31 °C Decreasing linearly to 50 % relative humidity at 40 °C
Operating temperature	-20 °C to 80 °C
Storage temperature	-20 °C to 80 °C
Transport temperature	-25 °C to 85 °C
Overvoltage category	II
Protection class	I
Degree of pollution	1
Degree of protection according to IEC 60529	IP20

10.3 Dimensions

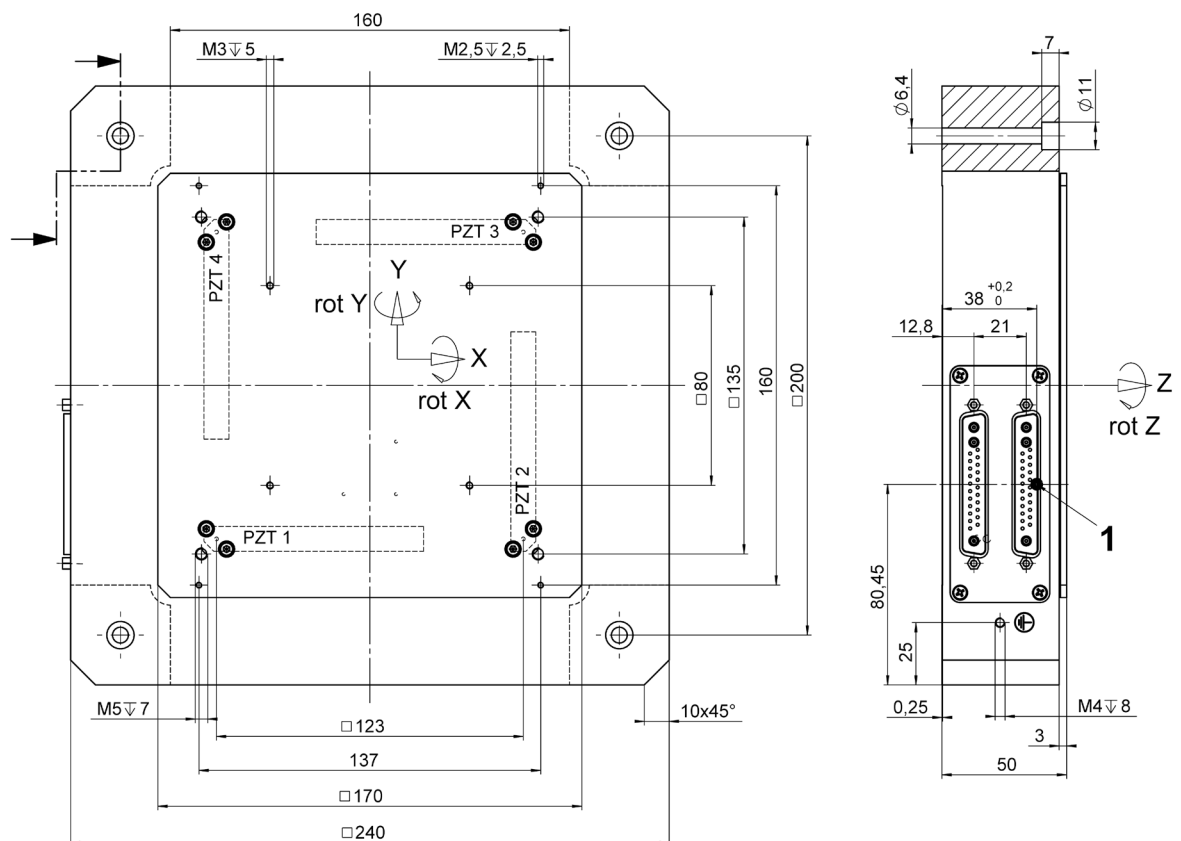


Figure 8: P-587.6CD, dimensions in mm. Note that the decimal points are separated by a comma in the drawings.

1: Rotation center, depending on Z

10.4 Torque for Stainless Steel Screws (A2-70)

Screw size	Minimum torque	Maximum torque
M6	4 Nm	6 Nm
M5	2.5 Nm	3.5 Nm
M4	1.5 Nm	2.5 Nm
M3	0.8 Nm	1.1 Nm
M2.5	0.3 Nm	0.4 Nm
M2	0.15 Nm	0.2 Nm
M1.6	0.06 Nm	0.12 Nm

- Pay attention to the screw-in depth required for the respective material according to the VDI directive 2230.

10.5 Pin Assignment

D-sub 25W3 panel plug: XY ROT

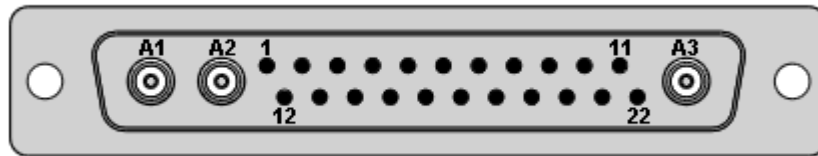


Figure 9: D-sub 25W3 connector (m): Front with connections

Pin	Signal	Function
A1 inner conductor	Output	Probe sensor signal, Y1 (immovable part of the capacitive sensor)
A1 outer conductor	GND	Shielding for Probe sensor signal, Y1
A2 inner conductor	Output	Probe sensor signal, Y2 (immovable part of the capacitive sensor)
A2 outer conductor	GND	Shielding for Probe sensor signal, Y2
A3 inner conductor	Output	Probe sensor signal, X (immovable part of the capacitive sensor)
A3 outer conductor	GND	Shielding for Probe sensor signal, X
1	Input	Target sensor signal, Y1 (movable part of the capacitive sensor)
2	Input	Target sensor signal, Y2 (movable part of the capacitive sensor)
3	GND	Ground of ID chip
4	Bidirectional	Data line for ID chip
5	Free	---
6	Free	---
7	Input	Piezo voltage +, Y1: -30 to +135 V
8	Input	Piezo voltage +, Y2: -30 to +135 V
9	Input	Piezo voltage +, X1: -30 to +135 V
10	Input	Piezo voltage +, X2: -30 to +135 V
11	Input	Target sensor signal, X (movable part of the capacitive sensor)
12	GND	Shielding for Target sensor signal, Y1
13	GND	Shielding for Target sensor signal, Y2
14	Free	---
15	Free	---
16	Free	---
17	Free	---

Pin	Signal	Function
18	Free	---
19	Input	Piezo voltage -, Y1 and Y2
20	Free	---
21	Input	Piezo voltage -, X1 and X2
22	GND	Shielding for Target sensor signal, X

D-sub 25W3 panel plug: Z TIP TILT

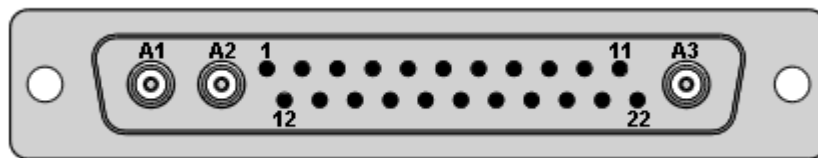


Figure 10: D-sub 25W3 connector (m): Front with connections

Pin	Signal	Function
A1 inner conductor	Output	Probe sensor signal, Z2 (immovable part of the capacitive sensor)
A1 outer conductor	GND	Shield of Probe sensor signal, Z2
A2 inner conductor	Output	Probe sensor signal, Z3 (immovable part of the capacitive sensor)
A2 outer conductor	GND	Shielding for Probe sensor signal, Z3
A3 inner conductor	Output	Probe sensor signal, Z1 (immovable part of the capacitive sensor)
A3 outer conductor	GND	Shielding for Probe sensor signal, Z1
1	Input	Target sensor signal, Z2 (movable part of the capacitive sensor)
2	Input	Target sensor signal, Z3 (movable part of the capacitive sensor)
3	GND	Ground of ID chip
4	Bidirectional	Data line for ID chip
5	Free	---
6	Free	---
7	Input	Piezo voltage +, Z4: -30 to +135 V
8	Input	Piezo voltage +, Z3: -30 to +135 V
9	Input	Piezo voltage +, Z2: -30 to +135 V
10	Input	Piezo voltage +, Z1: -30 to +135 V

Pin	Signal	Function
11	Input	Target sensor signal, Z1 (movable part of the capacitive sensor)
12	GND	Shielding for Target sensor signal, Z2
13	GND	Shielding for Target sensor signal, Z3
14	Free	---
15	Free	---
16	Free	---
17	Free	---
18	Free	---
19	Input	Piezo voltage -, Z3 and Z4
20	Free	---
21	Input	Piezo voltage -, Z1 and Z2
22	GND	Shielding for Target sensor signal, Z1

11 Old Equipment Disposal

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

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

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

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

Physik Instrumente (PI) GmbH & Co. KG
Auf der Roemerstr. 1
D-76228 Karlsruhe, Germany



12 European Declarations of Conformity

For the P-587, declarations of conformity were issued according to the following European statutory requirements:

Low Voltage Directive

EMC Directive

RoHS Directive

The standards applied for certifying conformity are listed below.

Safety (Low Voltage Directive): EN 61010-1

EMC: EN 61326-1

RoHS: EN IEC 63000

