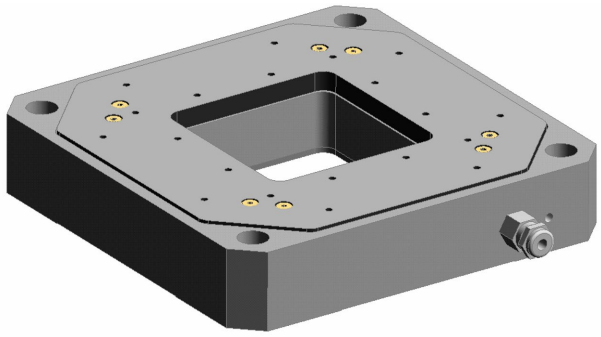
PZ82E

P-5x7/P-5x8 Positioners

User Manual

Version: 3.3.0 Date: 22.07.2024



This document describes the following products:

- **P-517, P-527**
  Precision XY nanopositioner
  P-517.2CD/.2CL, 100 µm × 100 µm
  P-527.2CD/.2CL, 200 µm × 200 µm
- **P-517, P-527**
  Precision XYZ nanopositioner
  P-517.3CD/.3CL, 100 µm × 100 µm × 20 µm
  P-527.3CD/.3CL, 200 µm × 200 µm × 20 µm
- **P-517, P-527**
  Precision XY / rotation nanopositioner
  P-517.RCD, 100 µm × 100 µm, 2 mrad
  P-527.RCD, 200 µm × 200 µm, 4 mrad
- **P-518, P-528**
  Precision nanopositioning Z stage
  P-518.ZCD/.ZCL, 100 µm
  P-528.ZCD/.ZCL, 200 µm
- **P-518, P-528**
  Precision nanopositioning Z and tip/tilt stage
  P-518.TCD, 100 µm, 1 mrad
  P-528.TCD, 200 µm, 2 mrad

  .2CD/.3CD/.ZCD/.RCD/.TCD with D-sub connector
  .2CL/.3CL/.ZCL with LEMO connectors

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Contents

1 About this Document

In this Chapter

1.1 Objective and Target Group of this User Manual

This user manual contains the information required for using the P-5x7/P-5x8 as intended ("x" stands for the different models (p. 9)).

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

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 result in minor injuries.

➢ Precautions to avoid the risk.

NOTICE

Dangerous situation
Failure to comply could result in damage to the equipment.

➢ Precautions to avoid the risk.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/Label	Meaning
1. 2.	Action consisting of several steps with strict sequential order
➢	Action consisting of one or more steps without relevant sequential order.
▪	Bullet point
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 Definition of Terms

Term	Explanation
Positioner	Electrically driven mechanics (here: P-5x7/P-5x8) with one or more motion axes
Electronics	Piezo amplifier or piezo controller that supplies the operating voltage for positioners or piezo actuators
Piezo amplifier	Electronics without sensor evaluation for open-loop operation of positioners and piezo actuators
Piezo controller	Electronics with sensor evaluation for closed-loop operation of positioners and piezo actuators

1.4 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.

1.5 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 on our website (p. 3).

Product	Document
E-503 piezo amplifier module	PZ62E user manual
E-505 piezo amplifier module	
E-610 piezo amplifier/servo controller (OEM module)	PZ70E user manual PZ72E user manual
E-621 piezo amplifier/servo controller module	PZ160E user manual
E-625 piezo servo controller (benchtop device)	PZ166E user manual
E-712 digital piezo controller (modular system)	PZ195E user manual
E-727 digital multi-channel piezo controller	E727T0005 user manual
E-754 digital piezo controller	E754T0001 user manual
PIMikroMove	SM148E software manual
P-5xx / P-6xx / P-7xx piezo positioners	PZ240EK short instructions

1.6 Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

- ➢ Contact our customer service department (p. 35).

Downloading manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., P-517).
3. In the search results, select the product to open the product detail page.
4. Select ***Downloads***.

   The manuals are shown under ***Documentation***. Software manuals are shown under ***General Software Documentation***.
5. For the desired manual, select ***ADD TO LIST*** and then ***REQUEST***.
6. Fill out the request form and select ***SEND REQUEST***.

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

2 Safety

In this Chapter

2.1 Intended Use

The P-5x7/P-5x8 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-5x7/P-5x8 is intended for fine positioning as well as moving small objects quickly and precisely. The specifications for the P-5x7/P-5x8 apply to horizontal mounting. Depending on the version, moving is done as follows:

Model	Motion	Axis
.2CD / .2CL	In two axes horizontally	X, Y
.3CD / .3CL	In two axes horizontally and in one axis vertically	X, Y, Z
.ZCD / .ZCL	In one axis vertically	Z
.RCD	in two axes horizontally and in one axis rotationally	X, Y, θZ
.TCD	In one axis vertically and in two axes rotationally	Z, θX, θY

The P-5x7/P-5x8 can only be used as intended in conjunction with suitable electronics (p. 12) available from PI. The electronics are not in the P-5x7/P-5x8's scope of delivery.

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

2.2 General Safety Instructions

The P-5x7/P-5x8 is built according to state-of-the-art technology and recognized safety standards. Improper use of the P-5x7/P-5x8 may result in personal injury and/or damage to the P-5x7/P-5x8.

- Use the P-5x7/P-5x8 for its intended purpose only, and only when it is in perfect condition.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for installing and operating the P-5x7/P-5x8 correctly.

The P-5x7/P-5x8 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-5x7/P-5x8's connector can lead to minor injuries from electric shock. In addition, the piezo actuators can be destroyed due to excessively fast discharging and the subsequent abrupt contraction.

- Do **not** open the P-5x7/P-5x8.
- 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 the plug connector out of the electronics during operation.

Positioners with D-sub plug connector:

Touching the contacts in the plug connector can lead to an electric shock (max. 130 V DC) and minor injuries.

- Do **not** touch the contacts in the plug connector.
- Use screws to secure the positioner's connector against being pulled out of the electronics.

If the protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the P-5x7/P-5x8 in the event of a malfunction or failure of the system. If there are touch voltages, touching the P-5x7/P-5x8 can result in minor injuries from electric shock.

- Connect the P-5x7/P-5x8 to a protective earth conductor (p. 18) 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-5x7/P-5x8 to the protective earth conductor before restarting.

Mechanical forces can damage or misalign the P-5x7/P-5x8.

- Avoid impacts that affect the P-5x7/P-5x8.
- Do **not** drop the P-5x7/P-5x8.
- Do **not** exceed the maximum permissible stress and load capacities according to the specifications (p. 37).
- Do **not** touch any sensitive parts (e.g., motion platform) when handling the P-5x7/P-5x8.

The P-5x7/P-5x8 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-5x7/P-5x8.

2.3 Organizational Measures

User manual

- Always keep this user manual together with the P-5x7/P-5x8. The latest versions of the user manuals are available for download on our website (p. 3).
- Add all information from the manufacturer such as supplements or technical notes to the user manual.
- If you give the P-5x7/P-5x8 to other users, include this user manual as well as all 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-5x7/P-5x8 only after you have read and understood this user manual.

Personnel qualification

The P-5x7/P-5x8 may only be installed, started, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

3 Product Description

In this Chapter

3.1 Model Overview

The following standard versions of the P-5x7/P-5x8 are available:

Model	Description
P-517.2CD	Precision XY nanopositioner, 100 µm × 100 µm, capacitive sensors, parallel metrology, D-sub connector
P-517.2CL	Precision XY nanopositioner, 100 µm × 100 µm, capacitive sensors, parallel metrology, LEMO connectors
P-527.2CD	Precision XY nanopositioner, 200 µm × 200 µm, capacitive sensors, parallel metrology, D-sub connector
P-527.2CL	Precision XY nanopositioner, 200 µm × 200 µm, capacitive sensors, parallel metrology, LEMO connectors
P-517.3CD	Precision XYZ nanopositioner, 100 µm × 100 µm × 20 µm, capacitive sensors, parallel metrology, D-sub connector
P-517.3CL	Precision XYZ nanopositioner, 100 µm × 100 µm × 20 µm, capacitive sensors, parallel metrology, LEMO connectors
P-527.3CD	Precision XYZ nanopositioner, 200 µm × 200 µm × 20 µm, capacitive sensors, parallel metrology, D-sub connector
P-527.3CL	Precision XYZ nanopositioner, 200 µm × 200 µm × 20 µm, capacitive sensors, parallel metrology, LEMO connectors
P-517.RCD	Precision XY / rotation nanopositioner, 100 µm × 100 µm, 2 mrad, capacitive sensors, parallel metrology, D-sub connector
P-527.RCD	Precision XY / rotation nanopositioner, 200 µm × 200 µm, 4 mrad, capacitive sensors, parallel metrology, D-sub connector
P-518.ZCD	Precision nanopositioning Z stage, 100 µm, direct position measuring, capacitive sensors, D-sub connector
P-518.ZCL	Precision nanopositioning Z stage, 100 µm, direct position measuring, capacitive sensors, LEMO connectors

Model	Description
P-528.ZCD	Precision nanopositioning Z stage, 200 µm, direct position measuring, capacitive sensors, D-sub connector
P-528.ZCL	Precision nanopositioning Z stage, 200 µm, direct position measuring, capacitive sensors, LEMO connectors
P-518.TCD	Precision nanopositioning Z and tip/tilt stage, 100 µm, 1 mrad, parallel metrology, capacitive sensors, D-sub connector
P-528.TCD	Precision nanopositioning Z and tip/tilt stage, 200 µm, 2 mrad, parallel metrology, capacitive sensors, D-sub connector

3.2 Product View

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

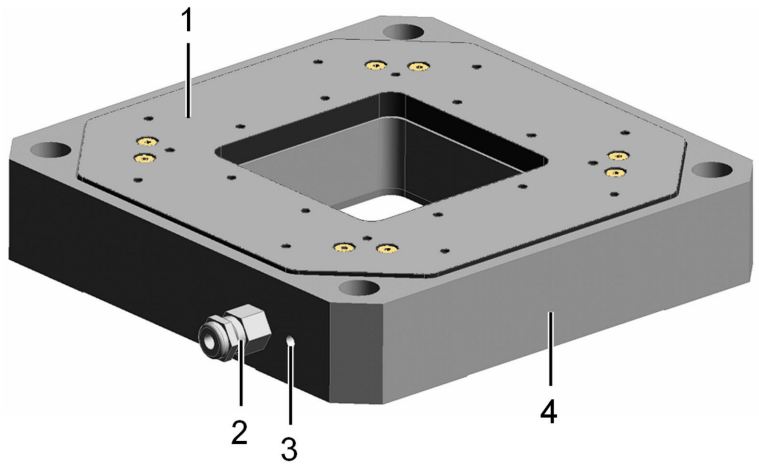


Figure 1: Example of product view

1 Platform
2 Cable exit
3 Protective earth connector (M4 hole)
4 Base body

3.3 Product Labeling

Labeling	Description
P-517.2CD	Product number (example), the digits after the period refer to the model
123456789	Serial number (example), individual for each P-5x7/P-5x8 Meaning of each position (from the left): 1 = internal information, 2 and 3 = year of manufacture, 4 to 9 = consecutive number
PI	Manufacturer's logo
⚠	Warning sign "Pay attention to the manual!"
	Old equipment disposal (p. 49)
CE	CE conformity mark
Country of origin: Germany	Country of origin
WWW.PI.WS	Manufacturer's address (website)
⏚	Symbol for the protective earth conductor, marks the protective earth connector of the P-5x7/P-5x8 (p. 18)

Figure 2: "Residual Voltage" warning sign on the connector of the P-5x7/P-5x8
Risk of electric shock (p. *6*) for models with D-sub plug connector

3.4 Scope of Delivery

Product number	Description
P-5x7/P-5x8	Positioner according to order (p. 9)
-	Transport safeguard, consisting of: ▪ Support frame ▪ 4 plastic screws
000036450	M4 screw set for protective earth, consisting of: ▪ 1 M4x8 flat-head screw with cross recess, ISO 7045 ▪ 2 lock washers ▪ 2 flat washers
P500T0002	Technical Note with instructions on unpacking and packing P-5xx positioners
PZ240EK	Short instructions for P-5xx / P-6xx / P-7xx piezo positioners

3.5 Suitable Electronics

You need suitable electronics to operate a P-5x7/P-5x8. Selecting the device depends on the application and the connectors available.

Electronics	Connector(s)*	Channels**
E-505 piezo amplifier module	LEMO	1
E-610 piezo amplifier/servo controller (OEM module)	LEMO	1
E-503 piezo amplifier module	LEMO	3
E-621 piezo amplifier/servo controller module	D-sub 7W2	1
E-625 piezo servo controller (benchtop device)	D-sub 7W2	1
E-754 digital piezo controller	D-sub 7W2	1
E-727.x • E-727.xAP digital multi-channel piezo controller	D-sub 25W3	3
E-727.xF digital multi-channel piezo controller	D-sub 25W3	3
E-712 digital piezo controller (modular system)	D-sub 25W3	3/6

* In some cases, adapter cables (p. 12) are necessary for connecting.
** When using single-channel electronics, each motion axis requires its own individual electronics.

3.6 Optional Accessories

Adapter cable with LEMO (mechanics) to D-sub (electronics)

Product number	Description
P-895.1LDC	Adapter cable LEMO to D-sub 7W2 (m) for piezo actuator nanopositioning systems with capacitive sensors, 1 channel, length: 0.3 m.
P-895.3LDC	Adapter cable LEMO to D-sub 25W3 (m) for piezo actuator nanopositioning systems with capacitive sensors, 3 channels, length: 0.3 m.

Adapter cable with D-sub (mechanics) to LEMO (electronics)

Product number	Description
P-895.1DLC	Adapter cable D-sub 7W2 (f) to LEMO for piezo actuator nanopositioning systems with capacitive sensors, 1 channel, length: 0.3 m.
P-895.3DLC	Adapter cable D-sub 25W3 (f) to LEMO for piezo actuator nanopositioning systems with capacitive sensors, 3 channels, length: 0.3 m.

Adapter cable with D-sub (mechanics) to D-sub (electronics)

Product number	Description
P-895.2D1DDC*	Adapter cable D-sub 25W3 (f) and D-sub 7W2 (f) to D-sub 25W3 (m) for piezo actuator nanopositioning systems with capacitive sensors, 3 channels, length: 0.3 m.
P-895.2DDC	Adapter cable 2× D-sub 7W2 (f) to D-sub 25W3 (m) for piezo actuator nanopositioning systems with capacitive sensors, 2 channels, length: 0.3 m.
P-895.3DDC	Adapter cable 3× D-sub 7W2 (f) to D-sub 25W3 (m) for piezo actuator nanopositioning systems with capacitive sensors, 3 channels, length: 0.3 m.

* 2 channels to D-sub 25W3 (f) and 1 channel to D-sub 7W2 (f) available.

➢ To order, contact our customer service department (p. 35).

3.7 Technical Features

3.7.1 PICMA® Piezo Actuators

P-5x7/P-5x8 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.

3.7.2 Flexure Guides

P-5x7/P-5x8 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.

3.7.3 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.

3.7.4 ID Chip (Models with D-sub Connector Only)

An ID chip is in the D-sub connector of the P-5x7/P-5x8. When the P-5x7/P-5x8 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-5x7/P-5x8 connected. A P-5x7/P-5x8 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!
Impermissible mechanical overload of the motion platform of the P-5x7/P-5x8 can cause damage to the piezo actuators, sensors, and flexures of the P-5x7/P-5x8 as well as loss of accuracy.

- ➢ Ship the P-5x7/P-5x8 in the original packaging only.
- ➢ Do **not** touch any sensitive parts (e.g., motion platform) when handling the P-5x7/P-5x8.

The P-5x7/P-5x8 is delivered with a transport safeguard attached. The following figures serve as examples and can differ from your positioner model.

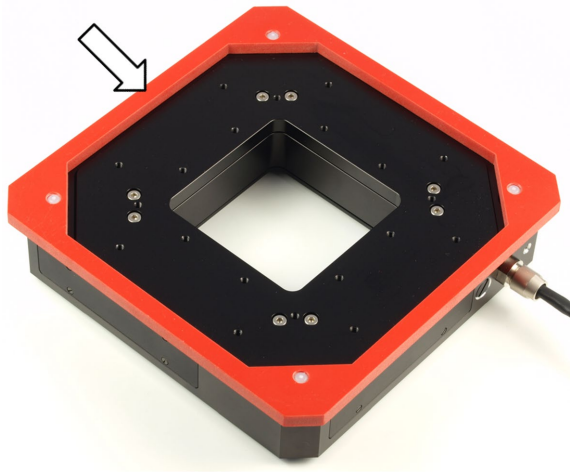


Figure 3: Exemplary view: Positioner with transport safeguard (supporting frame marked with arrow) for protecting the motion platform

Tools and accessories

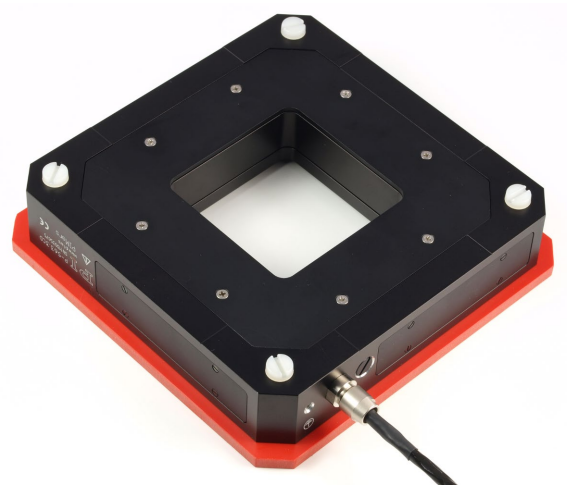
- Suitable screwdriver

Unpacking the P-5x7/P-5x8

1. Unpack the P-5x7/P-5x8 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. 35) immediately.

4. Remove the transport safeguard:

   a) Put the P-5x7/P-5x8 onto a surface with the support frame facing downwards.



   b) Release the four plastic screws with a screwdriver. In the following figure, one of the screws is marked with an arrow.

   c) Remove the plastic screws and the support frame.

5. Keep all packaging materials and the transport safeguard in case the product needs to be returned.

5 Installing

In this Chapter

5.1 General Notes on Installation

CAUTION

Dangerous voltage and residual charge in piezo actuators!

The P-5x7/P-5x8 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-5x7/P-5x8's connector can lead to minor injuries from electric shock. In addition, the piezo actuators can be destroyed due to excessively fast discharging and the subsequent abrupt contraction.

- Do **not** open the P-5x7/P-5x8.
- 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 the plug connector out of the electronics during operation.

Positioners with D-sub plug connector:

Touching the contacts in the plug connector can lead to an electric shock (max. 130 V DC) and minor injuries.

- Do **not** touch the contacts in the plug connector.
- Use screws to secure the positioner's connector against being pulled out of the electronics.

NOTICE

Mechanical overload due to incorrect handling!

An impermissible mechanical load on the motion platform of the P-5x7/P-5x8 can cause damage to the piezo actuators, sensors, and flexures of the P-5x7/P-5x8 as well as loss of accuracy.

- Do **not** touch any sensitive parts (e.g., motion platform) when handling the P-5x7/P-5x8.

NOTICE

Damage due to unsuitable cables!
Unsuitable cables can damage the P-5x7/P-5x8 and the electronics.

- Use cables provided by PI only to connect the P-5x7/P-5x8 to the electronics.

NOTICE

Damage due to improper mounting!
Improper mounting of the P-5x7/P-5x8 or incorrectly mounted parts can damage the P-5x7/P-5x8.

- Only use the holes or threads intended for the purpose of fixing the P-5x7/P-5x8 and loads.
- Install the P-5x7/P-5x8 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. 44) specified for the screws used during installation.

INFORMATION

Extension cables can reduce the positioning accuracy of the P-5x7/P-5x8 or affect sensor processing by the electronics.

- Do **not** use extension cables. If you need longer cables, contact our customer service department (p. 35).

5.2 Connecting the P-5x7/P-5x8 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-5x7/P-5x8 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. 35).

The P-5x7/P-5x8 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. 42) for the exact position of the hole.

Requirements

✓ You have read and understood the General Notes on Installation (p. 17).

✓ The P-5x7/P-5x8 is **not** connected to the electronics.

Tools and accessories

- Suitable protective earth conductor:
  - Cable cross section ≥0.75 mm²
  - Contact resistance at all connection points relevant for connecting the protective earth conductor <0.1 Ω at 25 A
- M4 protective earth screw set (p. 11) supplied for connecting the protective earth conductor
- Suitable screwdriver

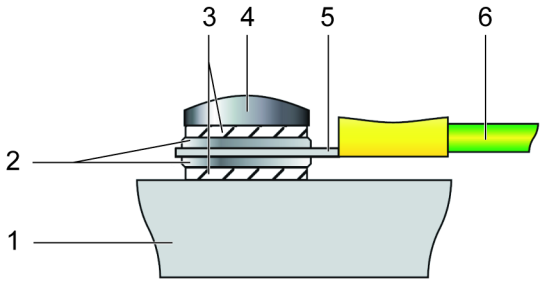


Figure 4: Connecting the protective earth conductor (profile view)

1 Base body of the P-5x7/P-5x8
2 Flat washer
3 Lock washer
4 Screw
5 Cable lug
6 Protective earth conductor

Connecting the P-5x7/P-5x8 to the protective earth conductor

1. If necessary, firmly 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-5x7/P-5x8 as shown in the profile view.
3. Tighten the M4 screw with a torque of 1.2 Nm to 1.5 Nm.

5.3 Mounting the P-5x7/P-5x8

NOTICE

Warping the P-5x7/P-5x8 when mounting onto uneven surfaces!

The P-5x7/P-5x8 could warp if mounted on an uneven surface. Warping reduces the accuracy.

- ➢ Mount the P-5x7/P-5x8 onto a flat surface. The recommended flatness of the surface is ≤20 µm.
- ➢ For applications with large temperature fluctuations:
  Mount the P-5x7/P-5x8 only onto surfaces that have the same or similar thermal expansion properties as the P-5x7/P-5x8 (e.g., surfaces made of aluminum).

NOTICE

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

The P-5x7/P-5x8 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-5x7/P-5x8 in a different orientation to that intended (e.g., vertically or upside down), contact our customer service department (p. 35).

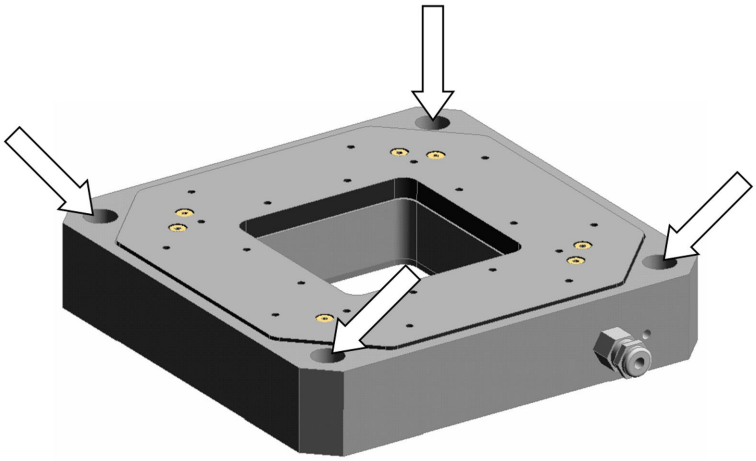


Figure 5: Mounting holes in the base body

Requirements

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ You have provided a suitable surface for fixing the P-5x7/P-5x8:
  - – The surface has four threaded holes for M6 screws. Refer to "Dimensions" (p. 42) for the position and depth required for the holes.
  - – The surface flatness is ≤20 µm.
  - – For applications with large temperature fluctuations: The surface should have the same thermal expansion properties as the P-5x7/P-5x8 (e.g., surface made of aluminum).

Tools and accessories

- Four M6 screws of suitable length (p. 42)
- Suitable screwdriver

Mounting the P-5x7/P-5x8

1. Align the P-5x7/P-5x8 on the underlying surface so that the corresponding mounting holes in the base body (see figure) and the surface are in line.
2. Fix the P-5x7/P-5x8 with the screws:
   a) Insert a screw into each hole.
   b) Tighten the screws crosswise. Pay attention to the specified torque range (p. 44) while doing so.
3. Check that the P-5x7/P-5x8 is sitting firmly 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-5x7/P-5x8. Mechanical overload can damage the piezo actuators, sensors, and flexures of the P-5x7/P-5x8 and lead to loss of accuracy.

- ➢ Avoid torques on the platform.
- ➢ Do **not** exceed the maximum permissible loads according to the specifications (p. 37).
- ➢ Hold the load and adhere to the specified torque range when tightening (or loosening) the screws (p. 44).

NOTICE

Warping the P-5x7/P-5x8 when fixing loads with an uneven contact surface!
Fixing loads with an uneven contact surface could warp the P-5x7/P-5x8. Warping reduces the accuracy.

- ➢ Fix loads on the P-5x7/P-5x8 only when the surface contacting the P-5x7/P-5x8's motion platform has a flatness of at least 20 µm.
- ➢ For applications with large temperature fluctuations:
  Fix loads to the P-5x7/P-5x8 only when they have the same or similar thermal expansion properties as the P-5x7/P-5x8 (e.g., loads made of aluminum).

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-5x7/P-5x8 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 or contact our customer service department (p. 35).

NOTICE

Excessively long screws!

The P-5x7/P-5x8 could be damaged by screws inserted too deeply.

- ➢ Pay attention to the depth of the mounting holes in the motion platform (p. 42).
- ➢ Use screws of the correct length for the respective mounting holes only.

INFORMATION

The positive direction of motion is specified in the dimensional drawing (p. 42) by arrows.

Center of load at the optimal position:

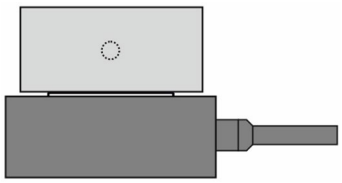


Figure 6: Example of an optimally placed load

Center of load at an unsuitable position:

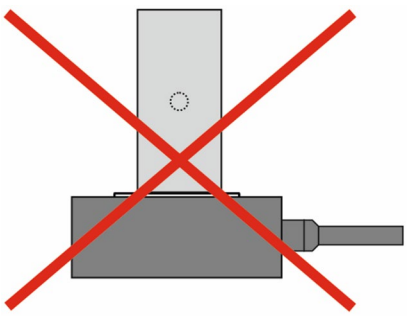


Figure 7: Tall load and center of load too far above the platform

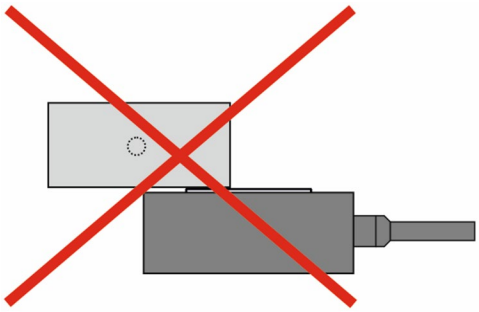


Figure 8: Unwanted lever effect and center of load on the side of the platform

Requirements

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ The P-5x7/P-5x8 is **not** connected to the electronics.

Tools and accessories

- Screws of suitable size and length (p. 42)
- Suitable screwdriver

Fixing the load

1. Align the load on the P-5x7/P-5x8 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-5x7/P-5x8.
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. 44) specified, and avoid torques to the motion platform.
5. Check that the load is firmly mounted on the motion platform.

6 Starting and Operating

In this Chapter

6.1 General Notes on Starting and Operating

CAUTION

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

If the protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the P-5x7/P-5x8 in the event of a malfunction or failure of the system. If there are touch voltages, touching the P-5x7/P-5x8 can result in minor injuries from electric shock.

- Connect the P-5x7/P-5x8 to a protective earth conductor (p. 18) 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-5x7/P-5x8 to the protective earth conductor before restarting.

NOTICE

Destruction of the piezo actuator due to electric flashovers!

Using the P-5x7/P-5x8 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-5x7/P-5x8 in environments that can increase the electric conductivity.
- Operate the P-5x7/P-5x8 only within the permissible ambient conditions and classifications (p. 41).

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-5x7/P-5x8 is not used but the electronics remain switched on to ensure temperature stability, discharge the P-5x7/P-5x8 (p. 28).

NOTICE

Operating voltage excessively high or incorrectly connected!

Excessively high or wrongly connected operating voltages can damage the P-5x7/P-5x8.

- Operate the P-5x7/P-5x8 with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating voltage range (p. 40) specified for the P-5x7/P-5x8.
- Operate the P-5x7/P-5x8 only when the operating voltage is properly connected; see "Pin Assignment" (p. 45).

NOTICE

Short-circuiting due to condensation!

Condensation can lead to short-circuiting and failure of the P-5x7/P-5x8.

- Wait for a sufficient period of time to allow the P-5x7/P-5x8 to reach room temperature in the following cases:
  - After unpacking or before starting for the first time
  - If the P-5x7/P-5x8 has been brought from a cold into a warm environment or from a warm into a cold environment
- Keep the P-5x7/P-5x8 free of condensation.

NOTICE

Uncontrolled oscillation!

Oscillation can cause irreparable damage to the P-5x7/P-5x8. 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-5x7/P-5x8 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-5x7/P-5x8 immediately.

INFORMATION

The positive direction of motion is specified in the dimensional drawing (p. 42) by arrows.

INFORMATION

Systems are calibrated at the factory to achieve optimum positioning accuracy. Replacing the system components can lead to a reduction of position accuracy when positioners are used with an ID-chip (p. 14) that does not contain calibration data or when LEMO plug connectors are used.

- ➢ When connecting the positioner, pay attention to the assignment of the motion axes to the controller channels, which is specified on the calibration label of the controller.

If position accuracy is reduced after replacing the P-5x7/P-5x8 or the controller:

- ➢ Recalibrate the axis displacement (refer to the controller manual) or contact our customer service department (p. 35).

INFORMATION

Sound and vibration (e.g., footfall, knocks) can be transmitted to the P-5x7/P-5x8 and can affect its performance with regard to position stability.

- ➢ Avoid sound and vibration while the P-5x7/P-5x8 is being operated.

6.2 Operating the P-5x7/P-5x8

Requirements

- ✓ You have read and understood the general notes on starting and operating (p. 25).
- ✓ 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. 17) the P-5x7/P-5x8 and connected it to the protective earth conductor (p. 18).
- ✓ 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-5x7/P-5x8

- ➢ Follow the instructions for starting and operating the P-5x7/P-5x8 in the manual for the electronics (p. 12) used.

6.3 Discharging the P-5x7/P-5x8

The P-5x7/P-5x8 must be discharged in the following cases:

- Before Installation
- When the P-5x7/P-5x8 is not used but the electronics remain switched on to ensure temperature stability
- Before demounting (e.g., before cleaning and transporting the P-5x7/P-5x8 and for modifications)

The P-5x7/P-5x8 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

7.1 General Notes on Maintenance

NOTICE

Misalignment due to loosening screws!
The P-5x7/P-5x8 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-5x7/P-5x8.

7.2 Packing the P-5x7/P-5x8 for Transport

NOTICE

Mechanical overload due to incorrect handling!
Impermissible mechanical overload of the motion platform of the P-5x7/P-5x8 can cause damage to the piezo actuators, sensors, and flexures of the P-5x7/P-5x8 as well as loss of accuracy.

- Ship the P-5x7/P-5x8 in the original packaging only.
- Do **not** touch any sensitive parts (e.g., motion platform) when handling the P-5x7/P-5x8.

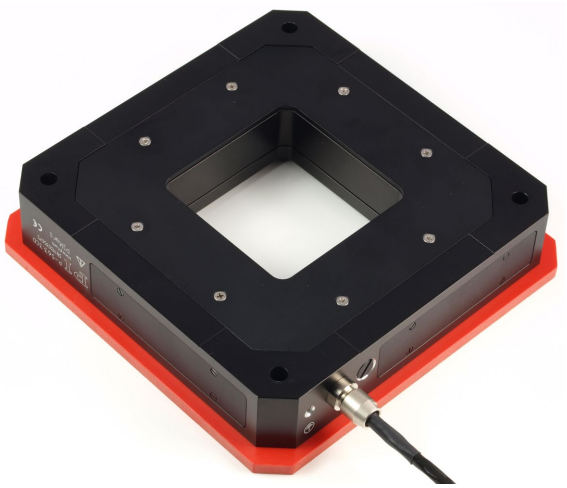
The following figures serve as examples and can differ from your positioner model.

Tools and accessories

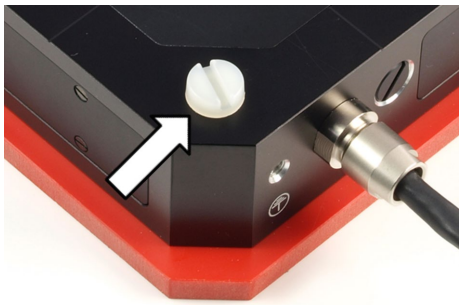
- Original packaging
- Transport safeguard, consisting of:
  - Support frame
  - 4 plastic screws
- Suitable screwdriver

Packing the P-5x7/P-5x8

1. Attach the transport safeguard:
   a) Put the supporting frame onto a surface.
   b) Put the positioner onto the support frame with its top facing downwards.



   c) Align the positioner so that the mounting holes in the positioner are in line with the mounting holes in the supporting frame.
   d) Attach the support frame to the positioner using the four plastic screws. In the following figure, one of the screws is marked with an arrow.



2. Pack the positioner into the original packaging.

7.3 Cleaning the P-5x7/P-5x8

NOTICE

Damage from ultrasonic cleaning!
Ultrasonic cleaning can damage the P-5x7/P-5x8.

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

NOTICE

Short-circuiting due to cleaning fluid getting into the housing!
Cleaning fluid getting into the P-5x7/P-5x8's housing can short-circuit the piezo actuators and the electronics.

- ➢ Disconnect the P-5x7/P-5x8 from the electronics before cleaning.
- ➢ Prevent cleaning fluid from getting into the P-5x7/P-5x8's housing.

Requirements

- ✓ You have discharged the piezo actuators of the P-5x7/P-5x8 (p. 28).
- ✓ You have disconnected the P-5x7/P-5x8 from the electronics.

Cleaning the P-5x7/P-5x8

- ➢ Clean the surfaces of the P-5x7/P-5x8 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. 37).
	Zero shift of the sensor for the following reasons: ▪ Load in direction of motion ▪ Ambient/operating temperature of the positioner is far above or below the calibration temperature (21 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-5x7/P-5x8 onto surfaces with the following characteristics only: – Flatness of at least 20 µm – The thermal expansion properties are similar to those of the P-5x7/P-5x8 (e.g., surface made of aluminum). ➢ Mount loads onto the P-5x7/P-5x8 with the following characteristics only: – 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-5x7/P-5x8 (e.g., load made of aluminum).
	P-5x7/P-5x8 or controller has been replaced	When using positioners with an ID chip (p. 14) that does not contain any calibration data, or with LEMO plug connectors, axis displacement has to be recalibrated after the P-5x7/P-5x8 or the controller has been replaced. ➢ Recalibrate the axis displacement (refer to the controller manual) or contact our customer service department (p. 35).

Problem	Possible causes	Solution
	Axes were mixed up during connection (LEMO connectors only)	➢ Pay attention to the assignment of the axes when connecting the positioner to the controller. This assignment is indicated by labels on the devices.
The positioner starts oscillating or positions inaccurately	Servo control parameters incorrectly set because for example, the load was changed	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. 35).

9 Customer Service Department

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

- If you have 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)
  - PC operating system (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 on our website (p. 3).

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).

In this Chapter

10.1 Specifications

10.1.1 P-5x7 Data Table

Motion	P-517.2CL	P-517.2CD	P-527.2CL	P-527.2CD	P-517.3CL	P-517.3CD	P-527.3CL	P-527.3CD	P-517.RCD	P-527.RCD	Tolerance
Active axes	X | Y	X | Y	X | Y	X | Y	X | Y | Z	X | Y | Z	X | Y | Z	X | Y | Z	X | Y | θZ	X | Y | θZ	
Travel range in X	100 µm	100 µm	200 µm	200 µm	100 µm	100 µm	200 µm	200 µm	100 µm	200 µm	
Travel range in Y	100 µm	100 µm	200 µm	200 µm	100 µm	100 µm	200 µm	200 µm	100 µm	200 µm	
Travel range in X, open loop	130 µm	130 µm	250 µm	250 µm	130 µm	130 µm	250 µm	250 µm	130 µm	250 µm	±20 %
Travel range in Y, open loop	130 µm	130 µm	250 µm	250 µm	130 µm	130 µm	250 µm	250 µm	130 µm	250 µm	±20 %
Linearity error in X	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	typ.
Linearity error in Y	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	typ.
Travel range in Z	—	—	—	—	20 µm	20 µm	20 µm	20 µm	—	—	
Travel range in Z, open loop	—	—	—	—	25 µm	25 µm	25 µm	25 µm	—	—	±20 %
Linearity error in Z	—	—	—	—	0.03 %	0.03 %	0.03 %	0.03 %	—	—	typ.
Rotation range in θZ	—	—	—	—	—	—	—	—	1 mrad	2 mrad	
Rotation range in θZ, open loop	—	—	—	—	—	—	—	—	2.6 mrad	5 mrad	±20 %
Linearity error in θZ	—	—	—	—	—	—	—	—	0.15 %	0.15 %	typ.

Positioning	P-517.2CL	P-517.2CD	P-527.2CL	P-527.2CD	P-517.3CL	P-517.3CD	P-527.3CL	P-527.3CD	P-517.RCD	P-527.RCD	Tolerance
Bidirectional repeatability in X	5 nm	5 nm	10 nm	10 nm	5 nm	5 nm	10 nm	10 nm	5 nm	10 nm	typ.
Bidirectional repeatability in Y	5 nm	5 nm	10 nm	10 nm	5 nm	5 nm	10 nm	10 nm	5 nm	10 nm	typ.
Resolution in X, open loop	0.3 nm	0.3 nm	0.5 nm	0.5 nm	0.3 nm	0.3 nm	0.5 nm	0.5 nm	0.3 nm	0.5 nm	typ.
Resolution in Y, open loop	0.3 nm	0.3 nm	0.5 nm	0.5 nm	0.3 nm	0.3 nm	0.5 nm	0.5 nm	0.3 nm	0.5 nm	typ.
Integrated sensor	Capacitive, direct position measuring	Capacitive, direct position measuring	Capacitive, direct position measuring	Capacitive, direct position measuring	Capacitive, direct position measuring	Capacitive, direct position measuring	Capacitive, direct position measuring	Capacitive, direct position measuring	Capacitive, indirect position measuring	Capacitive, indirect position measuring	
System resolution in X	1 nm	1 nm	2 nm	2 nm	1 nm	1 nm	2 nm	2 nm	1 nm	2 nm	
System resolution in Y	1 nm	1 nm	2 nm	2 nm	1 nm	1 nm	2 nm	2 nm	1 nm	2 nm	
Bidirectional repeatability in Z	—	—	—	—	1 nm	1 nm	1 nm	1 nm	—	—	typ.
Resolution in Z, open loop	—	—	—	—	0.1 nm	0.1 nm	0.1 nm	0.1 nm	—	—	typ.

Positioning	P-517.2CL	P-517.2CD	P-527.2CL	P-527.2CD	P-517.3CL	P-517.3CD	P-527.3CL	P-527.3CD	P-517.RCD	P-527.RCD	Tolerance
System resolution in Z	—	—	—	—	0.1 nm	0.1 nm	0.1 nm	0.1 nm	—	—	
Bidirectional repeatability in θZ	—	—	—	—	—	—	—	—	0.5 µrad	1 µrad	typ.
Resolution in θZ, open loop	—	—	—	—	—	—	—	—	0.1 µrad	0.1 µrad	typ.
System resolution in θZ	—	—	—	—	—	—	—	—	0.3 µrad	0.3 µrad	

Drive properties	P-517.2CL	P-517.2CD	P-527.2CL	P-527.2CD	P-517.3CL	P-517.3CD	P-527.3CL	P-527.3CD	P-517.RCD	P-527.RCD	Tolerance
Drive type	PICMA®	PICMA®	PICMA®	PICMA®	PICMA®	PICMA®	PICMA®	PICMA®	PICMA®	PICMA®	
Electrical capacitance in X	9.2 µF	9.2 µF	9.2 µF	9.2 µF	9.2 µF	9.2 µF	9.2 µF	9.2 µF	4.6 µF	4.6 µF	±20 %
Electrical capacitance in Y	9.2 µF	9.2 µF	9.2 µF	9.2 µF	9.2 µF	9.2 µF	9.2 µF	9.2 µF	4.6 µF	4.6 µF	±20 %
Electrical capacitance in Z	—	—	—	—	6 µF	6 µF	6 µF	6 µF	—	—	±20 %

Mechanical properties	P-517.2CL	P-517.2CD	P-527.2CL	P-527.2CD	P-517.3CL	P-517.3CD	P-527.3CL	P-527.3CD	P-517.RCD	P-527.RCD	Tolerance
Stiffness in X	2 N/µm	2 N/µm	1 N/µm	1 N/µm	2 N/µm	2 N/µm	1 N/µm	1 N/µm	2 N/µm	1 N/µm	±20 %
Stiffness in Y	2 N/µm	2 N/µm	1 N/µm	1 N/µm	2 N/µm	2 N/µm	1 N/µm	1 N/µm	2 N/µm	1 N/µm	±20 %
Resonant frequency in X, unloaded	450 Hz	450 Hz	350 Hz	350 Hz	450 Hz	450 Hz	350 Hz	350 Hz	450 Hz	350 Hz	±20 %
Resonant frequency in X, under load with 500 g	250 Hz	250 Hz	190 Hz	190 Hz	250 Hz	250 Hz	190 Hz	190 Hz	250 Hz	190 Hz	±20 %
Resonant frequency in X, under load with 2500 g	140 Hz	140 Hz	110 Hz	110 Hz	140 Hz	140 Hz	110 Hz	110 Hz	140 Hz	110 Hz	±20 %
Resonant frequency in Y, unloaded	450 Hz	450 Hz	350 Hz	350 Hz	450 Hz	450 Hz	350 Hz	350 Hz	450 Hz	350 Hz	±20 %
Resonant frequency in Y, under load with 500 g	250 Hz	250 Hz	190 Hz	190 Hz	250 Hz	250 Hz	190 Hz	190 Hz	250 Hz	190 Hz	±20 %
Resonant frequency in Y, under load with 2500 g	140 Hz	140 Hz	110 Hz	110 Hz	140 Hz	140 Hz	110 Hz	110 Hz	140 Hz	110 Hz	±20 %
Permissible push force in Z	50 N	50 N	50 N	50 N	50 N	50 N	50 N	50 N	50 N	50 N	max.
Permissible pull force in Z	20 N	20 N	20 N	20 N	20 N	20 N	20 N	20 N	20 N	20 N	max.
Guide	Flexure guide with lever amplification	Flexure guide with lever amplification	Flexure guide with lever amplification	Flexure guide with lever amplification	Flexure guide with lever amplification	Flexure guide with lever amplification	Flexure guide with lever amplification	Flexure guide with lever amplification	Flexure guide with lever amplification	Flexure guide with lever amplification	
Overall mass	1400 g	1400 g	1400 g	1400 g	1450 g	1450 g	1450 g	1450 g	1400 g	1400 g	
Material	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	
Stiffness in Z	—	—	—	—	15 N/µm	15 N/µm	15 N/µm	15 N/µm	—	—	±20 %
Resonant frequency in Z, unloaded	—	—	—	—	1100 Hz	1100 Hz	1100 Hz	1100 Hz	—	—	±20 %
Stiffness in θZ	—	—	—	—	—	—	—	—	2 N·m / µrad	1 N·m / µrad	±20 %
Resonant frequency in θZ, unloaded	—	—	—	—	—	—	—	—	400 Hz	300 Hz	±20 %

Miscellaneous	P-517.2CL	P-517.2CD	P-527.2CL	P-527.2CD	P-517.3CL	P-517.3CD	P-527.3CL	P-527.3CD	P-517.RCD	P-527.RCD	Tolerance
Operating temperature range	-20 to 80 °C	-20 to 80 °C	-20 to 80 °C	-20 to 80 °C	-20 to 80 °C	-20 to 80 °C	-20 to 80 °C	-20 to 80 °C	-20 to 80 °C	-20 to 80 °C	
Connector	LEMO LVPZT	D-sub 25W3 (m)	LEMO LVPZT	D-sub 25W3 (m)	LEMO LVPZT	D-sub 25W3 (m)	LEMO LVPZT	D-sub 25W3 (m)	D-sub 25W3 (m)	D-sub 25W3 (m)	
Cable length	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m	
Recommended controllers/ drivers	E-503, E-505, E-621, E-712, E-727	E-503, E-505, E-621, E-712, E-727	E-503, E-505, E-621, E-712, E-727	E-503, E-505, E-621, E-712, E-727	E-503, E-505, E-621, E-712, E-727	E-503, E-505, E-621, E-712, E-727	E-503, E-505, E-621, E-712, E-727	E-503, E-505, E-621, E-712, E-727	E-503, E-505, E-621, E-712, E-727	E-503, E-505, E-621, E-712, E-727	

Permissible push/pull force in Z: When mounted horizontally (standing on a surface, not suspended).

Electrical capacitance: Specified per channel (refer to "Pin Assignment" (p. 45)).

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.

At PI, technical data is specified at 22 ±3 °C. Unless otherwise stated, the values are for unloaded conditions. Some properties are interdependent. The designation "typ." indicates a statistical average for a property; it does not indicate a guaranteed value for every product supplied. During the final inspection of a product, only selected properties are analyzed, not all. Please note that some product characteristics may deteriorate with increasing operating time.

10.1.2 P-5x8 Data Table

Motion	P-518.ZCD	P-518.ZCL	P-528.ZCD	P-528.ZCL	P-518.TCD	P-528.TCD	Tolerance
Active axes	Z	Z	Z	Z	Z | θX | θY	Z | θX | θY	
Travel range in Z	100 µm	100 µm	200 µm	200 µm	100 µm	200 µm	
Travel range in Z, open loop	140 µm	140 µm	240 µm	240 µm	140 µm	240 µm	±20 %
Linearity error in Z	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	0.03 %	typ.
Angular error E_AZ	± 25 µrad	± 25 µrad	± 50 µrad	± 50 µrad	± 25 µrad	± 50 µrad	max.
Angular error E_BZ	± 25 µrad	± 25 µrad	± 50 µrad	± 50 µrad	± 25 µrad	± 50 µrad	max.
Angular error E_CZ	± 5 µrad	± 5 µrad	± 10 µrad	± 10 µrad	± 5 µrad	± 10 µrad	max.
Rotation range in θX	—	—	—	—	1 mrad	2 mrad	
Rotation range in θY	—	—	—	—	1 mrad	2 mrad	
Rotation range in θX, open loop	—	—	—	—	1.4 mrad	2.4 mrad	±20 %
Rotation range in θY, open loop	—	—	—	—	1.4 mrad	2.4 mrad	±20 %
Linearity error in θX	—	—	—	—	0.15 %	0.15 %	typ.
Linearity error in θY	—	—	—	—	0.15 %	0.15 %	typ.

Positioning	P-518.ZCD	P-518.ZCL	P-528.ZCD	P-528.ZCL	P-518.TCD	P-528.TCD	Tolerance
Bidirectional repeatability in Z	5 nm	5 nm	10 nm	10 nm	5 nm	10 nm	typ.
Resolution in Z, open loop	0.2 nm	0.2 nm	0.6 nm	0.6 nm	0.4 nm	0.6 nm	typ.
Integrated sensor	Capacitive, direct position measuring	Capacitive, direct position measuring	Capacitive, direct position measuring	Capacitive, direct position measuring	Capacitive, indirect position measuring	Capacitive, indirect position measuring	
System resolution in Z	0.8 nm	0.8 nm	1 nm	1 nm	0.8 nm	1 nm	
Bidirectional repeatability in θX	—	—	—	—	0.05 µrad	0.1 µrad	typ.
Bidirectional repeatability in θY	—	—	—	—	0.05 µrad	0.1 µrad	typ.
Resolution in θX, open loop	—	—	—	—	0.04 µrad	0.06 µrad	typ.
Resolution in θY, open loop	—	—	—	—	0.04 µrad	0.06 µrad	typ.
System resolution in θX	—	—	—	—	0.05 µrad	0.1 µrad	
System resolution in θY	—	—	—	—	0.05 µrad	0.1 µrad	

Drive properties	P-518.ZCD	P-518.ZCL	P-528.ZCD	P-528.ZCL	P-518.TCD	P-528.TCD	Tolerance
Drive type	PICMA®	PICMA®	PICMA®	PICMA®	PICMA®	PICMA®	
Electrical capacitance in Z	8.4 µF	8.4 µF	14.8 µF	14.8 µF	2.1 µF	3.7 µF	±20 %

Mechanical properties	P-518.ZCD	P-518.ZCL	P-528.ZCD	P-528.ZCL	P-518.TCD	P-528.TCD	Tolerance
Stiffness in Z	2.7 N/µm	2.7 N/µm	1.5 N/µm	1.5 N/µm	2.7 N/µm	1.5 N/µm	±20 %
Resonant frequency in Z, unloaded	500 Hz	500 Hz	350 Hz	350 Hz	500 Hz	350 Hz	±20 %
Resonant frequency in Z, under load with 500 g	350 Hz	350 Hz	210 Hz	210 Hz	350 Hz	210 Hz	±20 %
Resonant frequency in Z, under load with 2500 g	200 Hz	200 Hz	130 Hz	130 Hz	200 Hz	130 Hz	±20 %
Permissible push force in Z	50 N	50 N	50 N	50 N	50 N	50 N	max.
Permissible pull force in Z	40 N	40 N	40 N	40 N	40 N	40 N	max.
Guide	Flexure guide with lever amplification	Flexure guide with lever amplification	Flexure guide with lever amplification	Flexure guide with lever amplification	Flexure guide with lever amplification	Flexure guide with lever amplification	
Overall mass	1400 g	1400 g	1420 g	1420 g	1400 g	1420 g	
Material	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	
Resonant frequency in θX, unloaded	—	—	—	—	530 Hz	390 Hz	±20 %
Resonant frequency in θX, under load with 500 g	—	—	—	—	370 Hz	250 Hz	±20 %
Resonant frequency in θX, under load with 2500 g	—	—	—	—	190 Hz	115 Hz	±20 %
Resonant frequency in θY, unloaded	—	—	—	—	530 Hz	390 Hz	±20 %
Resonant frequency in θY, under load with 500 g	—	—	—	—	370 Hz	250 Hz	±20 %
Resonant frequency in θY, under load with 2500 g	—	—	—	—	190 Hz	115 Hz	±20 %

Miscellaneous	P-518.ZCD	P-518.ZCL	P-528.ZCD	P-528.ZCL	P-518.TCD	P-528.TCD	Tolerance
Operating temperature range	-20 to 80 °C	-20 to 80 °C	-20 to 80 °C	-20 to 80 °C	-20 to 80 °C	-20 to 80 °C	
Connector	D-sub 7W2 (m)	LEMO LVPZT	D-sub 7W2 (m)	LEMO LVPZT	D-sub 25W3 (m)	D-sub 25W3 (m)	
Cable length	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m	
Recommended controllers / drivers	E-503, E-505, E-610, E-621, E-625, E-712, E-727, E-754	E-503, E-505, E-610, E-621, E-625, E-712, E-727, E-754	E-503, E-505, E-610, E-621, E-625, E-712, E-727, E-754	E-503, E-505, E-610, E-621, E-625, E-712, E-727, E-754	E-503, E-505, E-610, E-621, E-625, E-712, E-727, E-754	E-503, E-505, E-610, E-621, E-625, E-712, E-727, E-754	

Permissible push/pull force in Z: When mounted horizontally (standing on a surface, not suspended).

Electrical capacitance: Specified per channel (refer to "Pin Assignment" (p. 45)).

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.

At PI, technical data is specified at 22 ±3 °C. Unless otherwise stated, the values are for unloaded conditions. Some properties are interdependent. The designation "typ." indicates a statistical average for a property; it does not indicate a guaranteed value for every product supplied. During the final inspection of a product, only selected properties are analyzed, not all. Please note that some product characteristics may deteriorate with increasing operating time.

10.1.3 Maximum Ratings

P-5x7/P-5x8 positioners are designed for the following operating data:

Model	Maximum operating voltage	Maximum operating frequency (unloaded)[1]	Maximum power consumption[2]
P-517.2CD P-517.2CL P-517.RCD	-20 to 120 V	150 Hz (in X and Y)	27 W (in X and Y)
P-527.2CD P-527.2CL P-527.RCD	-20 to 120 V	117 Hz (in X and Y)	21 W (in X and Y)
P-517.3CD P-517.3CL	-20 to 120 V	150 Hz (in X and Y) 367 Hz (in Z)	27 W (in X and Y) 43 W (in Z)
P-527.3CD P-527.3CL	-20 to 120 V	117 Hz (in X and Y) 367 Hz (in Z)	21 W (in X and Y) 43 W (in Z)
P-518.ZCD P-518.ZCL P-518.TCD	-20 to 120 V	167 Hz	28 W
P-528.ZCD P-528.ZCL P-528.TCD	-20 to 120 V	117 Hz	34 W

[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-5x7/P-5x8:

Area of application	For indoor use only
Maximum altitude	2000 m
Air pressure	1100 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 to 80 °C
Storage temperature	-20 to 80 °C
Transport temperature	-25 to 85 °C
Overvoltage category	II
Protection class	I
Degree of pollution	1
Degree of protection according to IEC 60529	IP20

10.3 Dimensions

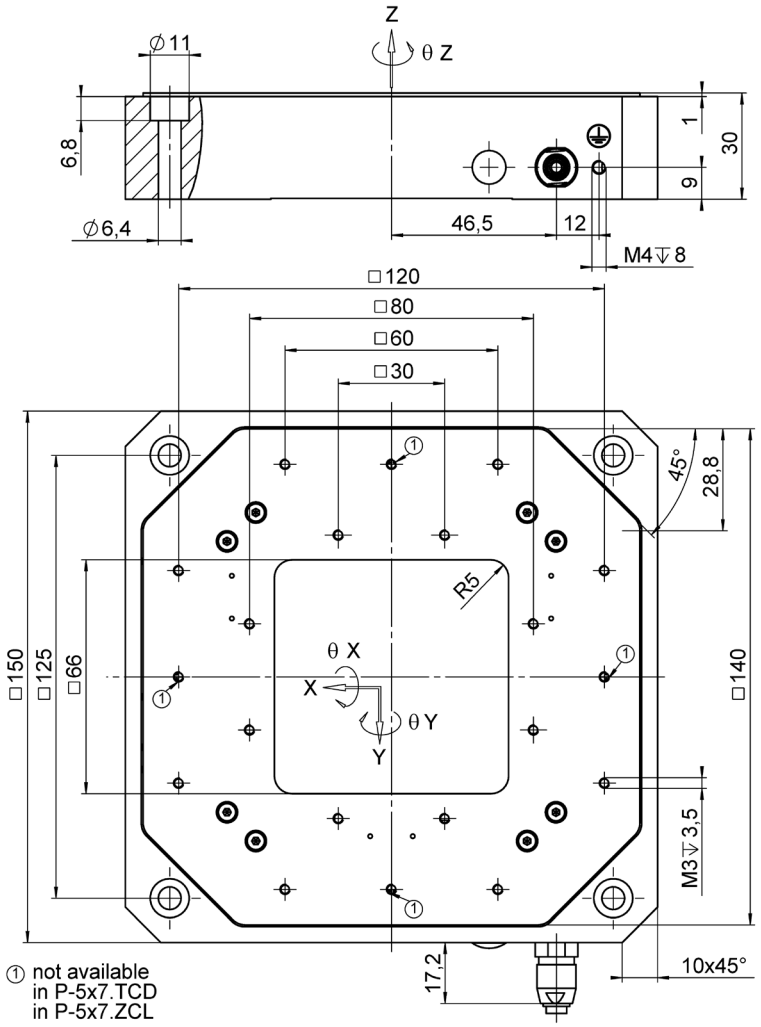


Figure 9: P-5x7, dimensions in mm.
Note that a comma is used in the drawings instead of a decimal point.

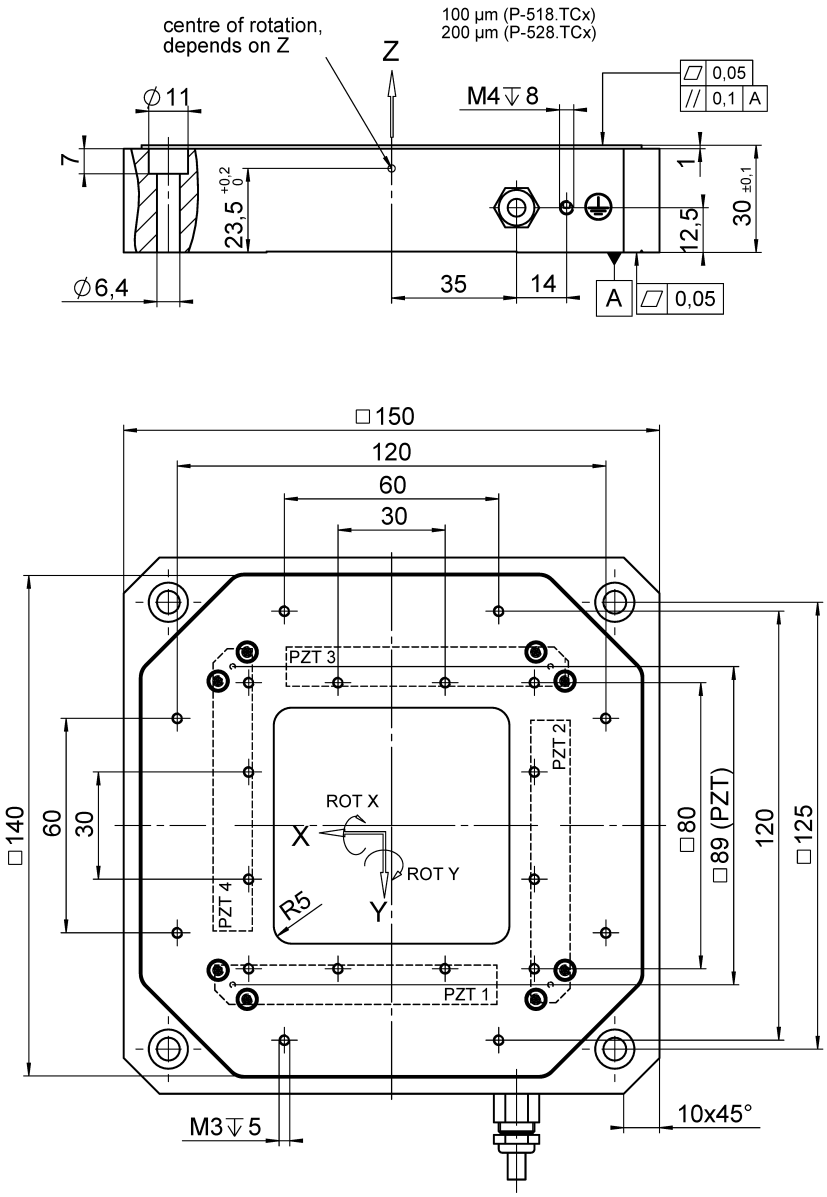


Figure 10: P-5x8.TCx, dimensions in mm.
Note that a comma is used in the drawings instead of a decimal point.

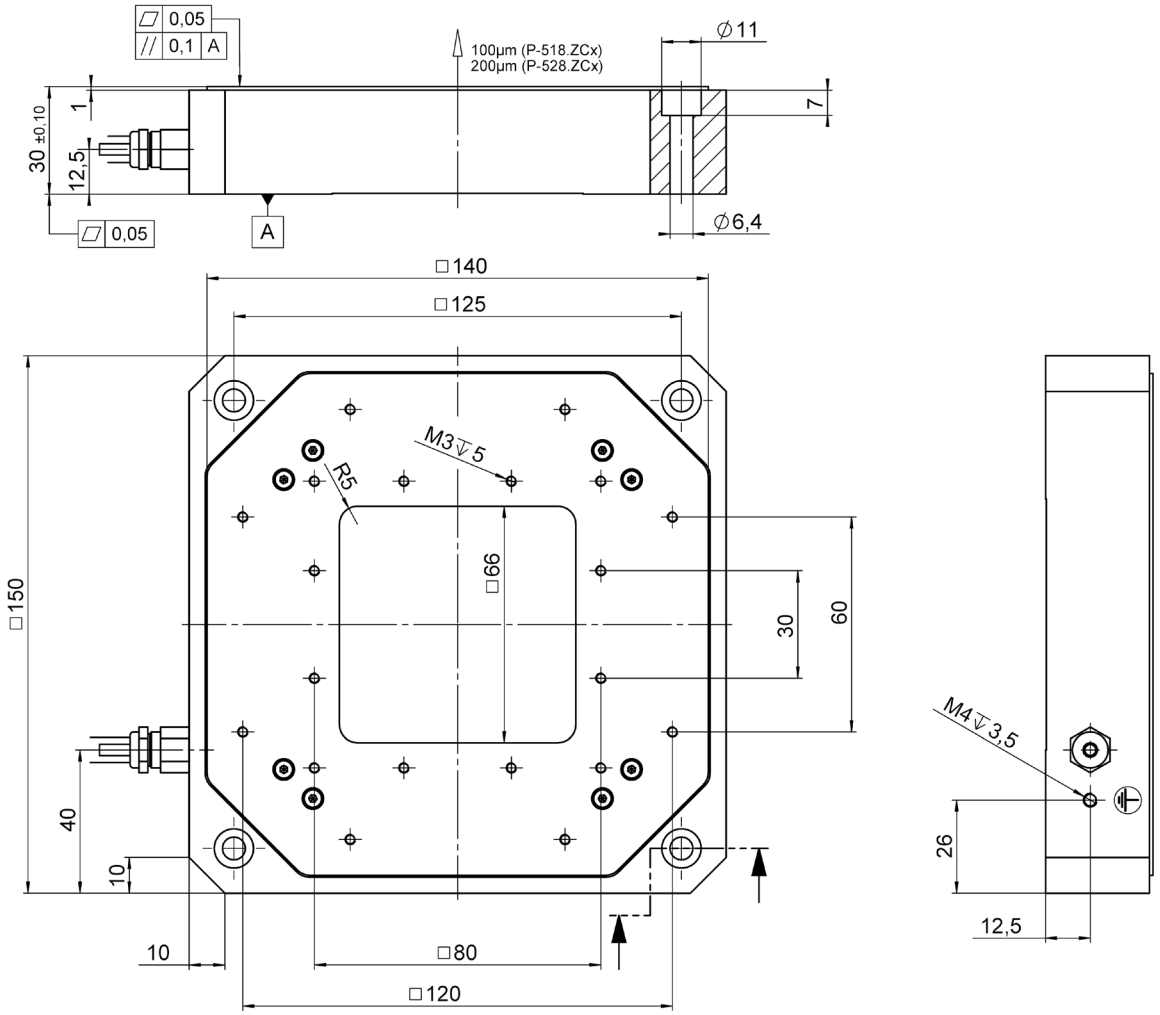


Figure 11: P-5x8.ZCx, dimensions in mm.
Note that a comma is used in the drawings instead of a decimal point.

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 7W2 connector (m)

For P-5x8.ZCD only

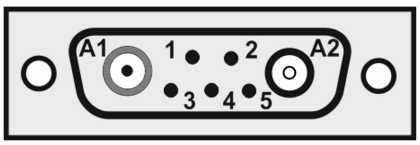


Figure 12: D-sub 7W2 (m) connector: Front with connections

Pin	Signal	Function
A1 inner conductor	Input	Piezo voltage +
A2 inner conductor	Output	Probe sensor signal (immovable part of the capacitive sensor)
A2 outer conductor	GND	Shield
1	Bidirectional	Data line for ID chip
2	GND	▪ Shield of Target ▪ Ground of ID chip when switched on
3	Input	Piezo voltage -
4	Vacant	–
5	Input	Target sensor signal (movable part of the capacitive sensor)

D-sub 25W3 connector (m)

Only for P-5x7.2CD/.3CD/.RCD and P-5x8.TCD

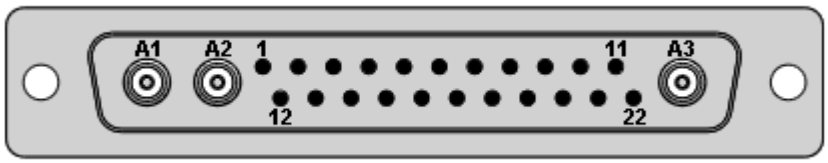


Figure 13: D-sub 25W3 (m) connector (contact side)

Pin	Signal	Function
A1 inner conductor	Output	Probe sensor signal, channel 2 (immovable part of the capacitive sensor)
A1 outer conductor	GND	Shielding for probe sensor signal, channel 2
A2 inner conductor	Output	Probe sensor signal, channel 3 (immovable part of the capacitive sensor)
A2 outer conductor	GND	Shielding for probe sensor signal, channel 3
A3 inner conductor	Output	Probe sensor signal, channel 1 (immovable part of the capacitive sensor)

Pin	Signal	Function
A3 outer conductor	GND	Shielding for probe sensor signal, channel 1
1	Input	Target sensor signal, channel 2 (movable part of the capacitive sensor)
2	Input	Target sensor signal, channel 3 (movable part of the capacitive sensor)
3	GND	ID chip ground
4	Bidirectional	Data line for ID chip
5	Vacant	–
6	Vacant	–
7	Input	Piezo voltage +, channel 4
8	Input	Piezo voltage +, channel 3
9	Input	Piezo voltage +, channel 2
10	Input	Piezo voltage +, channel 1
11	Input	Target sensor signal, channel 1 (movable part of the capacitive sensor)
12	GND	Shielding for target sensor signal, channel 2
13	GND	Shielding for target sensor signal, channel 3
14	Vacant	–
15	Vacant	–
16	Vacant	–
17	Vacant	–
18	Input	Piezo voltage -, channel 4
19	Input	Piezo voltage -, channel 3
20	Input	Piezo voltage -, channel 2
21	Input	Piezo voltage -, channel 1
22	GND	Shielding for target sensor signal, channel 1

Model-dependent assignment of the D-sub 25W3 connector (m) (X = used):

Model	Piezo voltage				Sensor signal (Probe / Target / shield)		
	Channel 1 Pins 10 and 21	Channel 2 Pins 9 and 20	Channel 3 Pins 8 and 19	Channel 4 Pins 7 and 18	Channel 1 Pins A3, 11 and 22	Channel 2 Pins A1, 1 and 12	Channel 3 Pins A2, 2 and 13
P-5x7.2CD	x	x	–	–	x	x	–
P-5x7.3CD	x	x	x	–	x	x	x
P-5x7.RCD P-5x8.TCD	x	x	x	x	x	x	x

LEMO coaxial connectors

Only for P-5x7.2CL/.3CL and P-5x8.ZCL (one PZT, P and T connector each per axis)

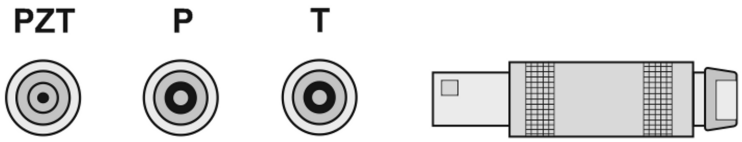


Figure 14: LEMO connectors: PZT, P and T

Connector	Signal	Function	Connector shell
P	Output	Probe sensor signal (immovable part of the capacitive sensor)	Cable shield
T	Input	Target sensor signal (movable part of the capacitive sensor)	Cable shield
PZT	Input	Piezo voltage	Mass

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.

To fulfill the 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 Römerstraße 1

76228 Karlsruhe, Germany

12 European Declarations of Conformity

For the P-5x7/P-5x8, 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