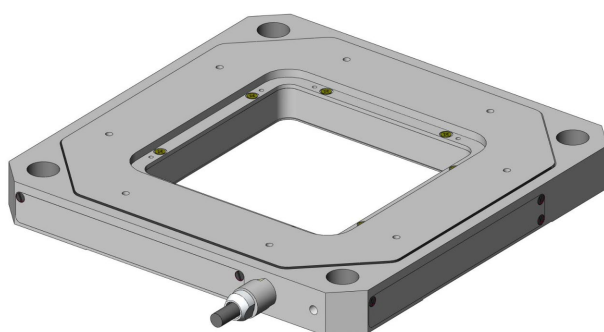


PZ244E P-54x Nanopositioner User Manual

Version: 1.2.0

Date: 27.07.2020



This document describes the following products:

- **P-541.2 / P-542.2**
XY nanopositioning system with large aperture
P-541.2xx, 100 μm \times 100 μm
P-542.2xx, 200 μm \times 200 μm
P-541.2DD, 45 μm \times 45 μm , direct drive
- **P-541.Z**
Nanopositioner Z stage with large aperture
P-541.ZCD, 100 μm , direct position measuring
P-541.ZSL, 100 μm
P-541.ZOL, 150 μm
- **P-541.T**
Nanopositioner and tip/tilt stage with large aperture
P-541.TCD, 100 μm / 0.8 mrad, parallel metrology
P-541.TSL, 100 μm / 0.8 mrad
P-541.TOL, 150 μm / 1.2 mrad

Model-specific properties:

Integrated sensor:

Capacitive sensors: 2CD, 2CL, 2DD, ZCD, TCD

Strain gauge sensors: 2SL, ZSL, TSL

Without sensor: 2OL, ZOL, TOL

Sensor / voltage connector:

D-sub 25W3 (m): 2CD, 2DD, TCD

D-sub 7W2 (m): ZCD

LEMO: 2CL, 2SL, 2OL, ZSL, ZOL, TSL, TOL



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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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Original instructions

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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 This manual is superseded by any new release.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

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1.1 Objective and Target Group of this User Manual

This user manual contains the information required for using the P-54x as intended ("x" stands for the different models (p. 9)).

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 attached to the product that refer to detailed information in this manual.

1.3 Definition of Terms

Term	Explanation
Positioner	Electrically driven mechanics (here: P-54x) 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 operating of positioners and piezo actuators
Piezo controller	Electronics with sensor evaluation for closed-loop operating 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.

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-663 Piezo Amplifier	PZ69 User Manual
E-712 Digital Piezo Controller (Modular System)	PZ195E User Manual
E-727.x • E-727.xAP Digital Multi-Channel Piezo Controller	E727T0005 User Manual
E-727.xF Digital Multi-Channel Piezo Controller	
E-754 Digital Piezo Controller	E754T0001 User Manual
PIMikroMove	SM148E Software Manual
P-5xx / P-6xx / P-7xx Piezo Positioning Systems	PZ240EK Short Instructions

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

1.6 Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

- Contact our customer service department (p. 33).

Downloading manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., P-541) 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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General Safety Instructions	5
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2.1 Intended Use

The P-54x 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-54x is intended for fine positioning as well as moving small objects quickly and precisely. The specifications for the P-54x apply to horizontal mounting. Depending on the version, moving is done as follows:

Model	Motion	Axis
.2xx	In two axes horizontally	X, Y
.Zxx	In one axis vertically	Z
.Txx	In one axis vertically and in two axes rotationally	Z, θ_x , θ_y

The P-54x can only be used as intended in conjunction with suitable electronics (p. 12) available from PI. The electronics are not in the P-54x'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-54x 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-54x.

- Use the P-54x 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-54x.

The P-54x is driven by piezo actuators. Temperature changes and compressive stresses can induce charges in piezo actuators. After disconnection from the electronics, piezo actuators can remain charged for several hours. Touching or short-circuiting the contacts in the connector of the P-54x can lead to minor injuries from electric shock. The piezo actuators can be destroyed by an abrupt contraction.

- Do **not** open the P-54x.
- 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 a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the P-54x in the case of malfunction or failure of the system. If there are touch voltages, touching the P-54x can result in minor injuries from electric shock.

- Connect the P-54x 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-54x to the protective earth conductor before restarting.

Mechanical forces can damage or misalign the P-54x.

- Avoid impacts that affect the P-54x.
- Do **not** drop the P-54x.
- Do **not** exceed the maximum permissible stress and load capacities according to the specifications (p. 35).
- Do **not** touch any sensitive parts (e.g., platform) when handling the P-54x.

The P-54x 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-54x.

2.3 Organizational Measures

User manual

- Always keep this user manual together with the P-54x.
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-54x 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-54x only after you have read and understood this user manual.

Personnel qualification

The P-54x may only be installed, started, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

3 Product Description

In this Chapter

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Product View.....	10
Product Labeling.....	11
Scope of Delivery	11
Suitable Electronics.....	12
Accessories.....	12
Technical Features	13

3.1 Model Overview

The following standard versions of the P-54x are available:

XY nanopositioning system with large aperture

Model	Description
P-541.2CD	XY nanopositioning system with large aperture, 100 μm \times 100 μm , parallel kinematics, capacitive sensors, D-sub connector
P-541.2CL	XY nanopositioning system with large aperture, 100 μm \times 100 μm , parallel kinematics, capacitive sensors, LEMO connectors
P-541.2SL	XY nanopositioning system with large aperture, 100 μm \times 100 μm , strain gauge sensors, LEMO connectors
P-541.20L	XY nanopositioning system with large aperture, 100 μm \times 100 μm , without sensors, LEMO connectors
P-541.2DD	XY nanopositioning system with large aperture, high dynamics direct drive, 45 μm \times 45 μm , parallel kinematics, capacitive sensors, D-sub connector
P-542.2CD	XY nanopositioning system with large aperture, 200 μm \times 200 μm , parallel kinematics, capacitive sensors, D-sub connector
P-542.2CL	XY nanopositioning system with large aperture, 200 μm \times 200 μm , parallel kinematics, capacitive sensors, LEMO connectors
P-542.2SL	XY nanopositioning system with large aperture, 200 μm \times 200 μm , strain gauge sensors, LEMO connectors
P-542.20L	XY nanopositioning system with large aperture, 200 μm \times 200 μm , without sensors, LEMO connectors

Nanopositioner Z stage with large aperture

Model	Description
P-541.ZCD	Vertical nanopositioning stage with large aperture, 100 μm , direct position measuring, capacitive sensors
P-541.ZSL	Vertical nanopositioning stage with large aperture, 100 μm , strain gauge sensors
P-541.ZOL	Vertical nanopositioning stage with large aperture, 150 μm , without sensor

Nanopositioner Z and tip/tilt stage with large aperture

Model	Description
P-541.TCD	Nanopositioner Z and tip/tilt stage with large aperture, 100 μm / 0.8 mrad, parallel metrology, capacitive sensors
P-541.TSL	Nanopositioner Z and tip/tilt stage with large aperture, 100 μm / 0.8 mrad, strain gauge sensors
P-541.TOL	Nanopositioner Z and tip/tilt stage with large aperture, 150 μm / 1.2 mrad, without sensor

3.2 Product View

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

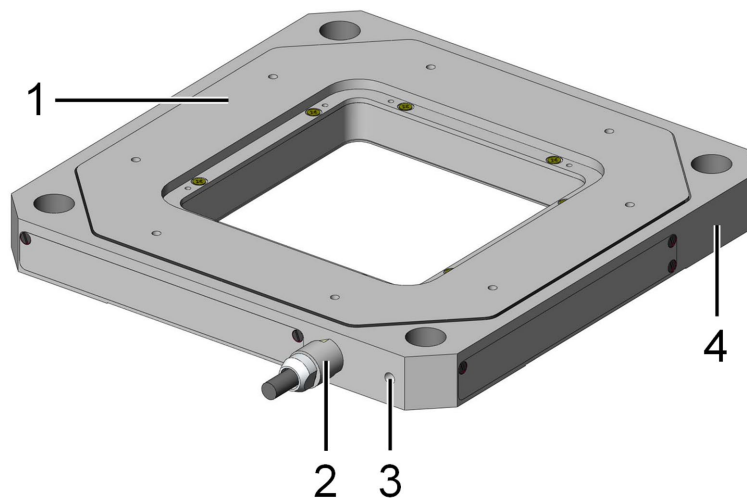


Figure 1: Exemplary product view

- 1 Platform
- 2 Cable exit
- 3 Protective earth connector
- 4 Base body

3.3 Product Labeling






Labeling	Description
P-541.2SL	Product number (example), the digits after the period refer to the model
123456789	Serial number (example), individual for each P-54x 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. 47)
Country of origin: Germany	Country of origin
WWW.PI.WS	Manufacturer's address (website)
	CE conformity mark
	Symbol for the protective earth conductor, marks the protective earth connection of the P-54x (p. 18)
X	Positive direction of motion of the X axis (P-54x.2xx models only)
Y	Positive direction of motion of the Y axis (P-54x.2xx models only)



Figure 2: "Residual Voltage" warning sign on the connector of the P-54x

"Residual Voltage" warning: Risk of electric shock (p. 5) for models with D-sub plug connector

3.4 Scope of Delivery

Product number	Description
P-54x	Positioner according to order (p. 9)
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
PZ240EK	Short instructions for piezo positioning systems

3.5 Suitable Electronics

You need suitable electronics to operate a P-54x. Selecting the device depends on the application and the connectors available.

Electronics	Connector*	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-663 Piezo Amplifier***	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.

*** For P-541.TOL only

3.6 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. 33).

3.7 Technical Features

3.7.1 PICMA® Piezo Actuators

P-54x 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-54x 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 Position Sensors

Depending on the model (p. 9), the P-54x is equipped with capacitive or strain gauge sensors for closed-loop operation.

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.

Strain gauge sensors (SGS)

Strain gauge sensors derive the position information from their expansion. They are attached at a suitable position in the drivetrain, where they measure the displacement of the positioner's moving part against the base body. This type of position measuring is indirect and requires contact, because the position of the platform is derived from a measurement on the lever, guide or piezo stack.

The sensors operate in thermally drift-free full bridge circuitry and therefore ensure optimum position stability in the nanometer range.

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

An ID chip is located in the D-sub connector of the P-54x. When the P-54x is calibrated at the factory with digital electronics, the calibration data is saved on the ID chip together with specific product information. During switch-on, the digital electronics read the data from the ID chip of the P-54x connected. A P-54x 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 platform of the P-54x can cause damage to the piezo actuators, sensors, and flexures of the P-54x as well as loss of accuracy.

➤ Do **not** touch any sensitive parts (e.g., platform) when handling the P-54x.

1. Unpack the P-54x 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. 33) immediately.
4. Keep all packaging materials in case the product needs to be returned.

5 Installation

In this Chapter

General Notes on Installation	17
Connecting the P-54x to the Protective Earth Conductor	18
Mounting the P-54x	20
Fixing the Load	21
Connecting the P-54x to the Electronics.....	24

5.1 General Notes on Installation

CAUTION



Dangerous voltage and residual charge in piezo actuators!

The P-54x is driven by piezo actuators. Temperature changes and compressive stresses can induce charges in piezo actuators. After disconnection from the electronics, piezo actuators can remain charged for several hours. Touching or short-circuiting the contacts in the connector of the P-54x can lead to minor injuries from electric shock. The piezo actuators can be destroyed by an abrupt contraction.

- Do **not** open the P-54x.
- 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 platform of the P-54x can cause damage to the piezo actuators, sensors, and flexures of the P-54x as well as loss of accuracy.

- Do **not** touch any sensitive parts (e.g., platform) when handling the P-54x.

NOTICE**Damage due to unsuitable cables!**

Unsuitable cables can damage the P-54x and the electronics.

- Use cables provided by PI only to connect the P-54x to the electronics.

NOTICE**Damage due to improper mounting!**

Improper mounting of the P-54x or incorrectly mounted parts can damage the P-54x.

- Only use the holes or threads intended for the purpose of fixing the P-54x and loads.
- Install the P-54x 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. 42) specified for the screws used during installation.

INFORMATION

Extension cables can reduce the positioning accuracy of the P-54x or affect sensor processing by the electronics.

- Do **not** use extension cables. If you need longer cables, contact our customer service department (p. 33).

5.2 Connecting the P-54x to the Protective Earth Conductor

INFORMATION

In the case of P-54x 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. 33).

INFORMATION

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

The P-54x has an M4 hole for attaching the protective earth conductor. This hole is marked with the symbol for the protective earth conductor (⏏). Refer to "Dimensions" (p. 40) for the exact position of the hole.

Requirements

- ✓ You have read and understood the general notes on installation (p. 17).
- ✓ The P-54x 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. 11) supplied for connecting the protective earth conductor
- Suitable screwdriver

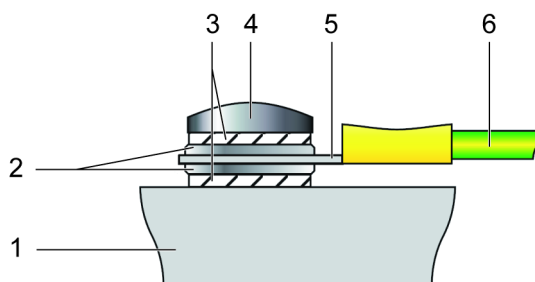


Figure 3: Connecting the protective earth conductor (profile view)

- | | |
|---|----------------------------|
| 1 | Base body of the P-54x |
| 2 | Flat washer |
| 3 | Lock washer |
| 4 | Screw |
| 5 | Cable lug |
| 6 | Protective earth conductor |

Connecting the P-54x 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-54x 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-54x

NOTICE

**Distorting the P-54x when mounted on uneven surfaces!**

Fixing the P-54x onto an uneven surface can distort the P-54x. Distortion reduces the accuracy.

- Fix the P-54x onto an even surface. The recommended flatness of the surface is $\leq 20 \mu\text{m}$.
- For applications with large temperature fluctuations:
Only fix the P-54x onto surfaces that have the same or similar thermal expansion properties as the P-54x (e.g., surfaces made of aluminum).

NOTICE

**Tensile stress when mounted vertically!**

When the P-54x is mounted vertically, certain alignments can cause tensile stress that reduces the preload and destroys the piezo actuator.

- If you want to mount the P-54x vertically, contact our customer service department (p. 33).

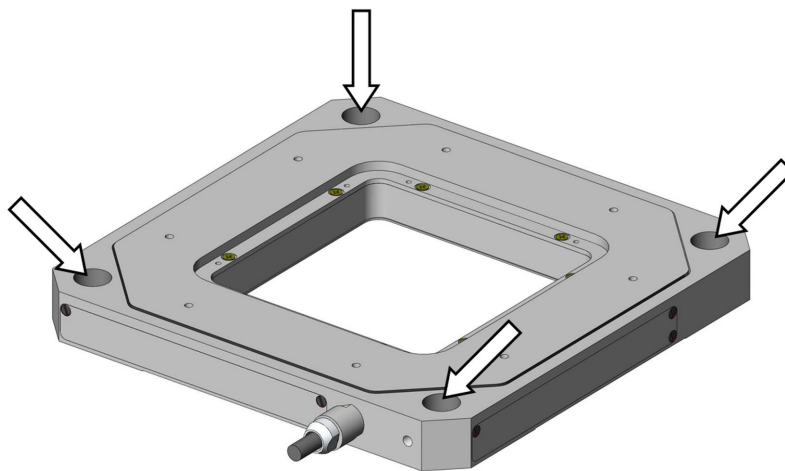


Figure 4: Mounting holes in the base body

Requirements

- ✓ You have read and understood the general notes on installation (p. 17).
- ✓ You have provided a suitable surface for fixing the P-54x:
 - The surface has four suitable threaded holes for the mounting screws (refer to "Dimensions" (p. 40)).
 - The surface flatness is $\leq 20 \mu\text{m}$.

- For applications with large temperature fluctuations: The surface should have the same or similar thermal expansion properties as the P-54x (e.g., aluminum surface).

Tools and accessories

- Screws of suitable size and length (refer to "Dimensions" (p. 40))
- Suitable screwdriver

Mounting the P-54x

1. Align the P-54x so that the mounting holes in the base body (see figure) are in line with the corresponding holes in the surface.
2. Fix the P-54x using the screws:
 - a) Insert a screw into each hole.
 - b) Tighten the screws. Pay attention to the specified torque range (p. 42).
3. Check that the P-54x is sitting firmly on the surface.

5.4 Fixing the Load

NOTICE



Mechanical overload of the platform!

High torques during fastening of the load as well as high loads can overload the platform of the P-54x. Mechanical overload can cause damage to the piezo actuators, sensors, and flexures of the P-54x and lead to loss of accuracy.

- Avoid torques > 1 Nm on the platform.
- Do **not** exceed the maximum permissible loads according to the specifications (p. 35).
- Hold the load and adhere to the specified torque range (p. 42) when tightening (or loosening) the screws.

NOTICE



Distorting the P-54x when fixing loads with an uneven contact surface!

Fixing loads with an uneven contact surface could distort the P-54x. Distortion reduces the accuracy.

- Fix loads to the P-54x only when the surface contacting the positioner's platform has a flatness of at least 20 µm.
- For applications with large temperature fluctuations:
Mount loads onto the P-54x only if they have the same or similar thermal expansion properties as the P-54x (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 platform (e.g., tall loads and unwanted lever effect), the P-54x can be damaged by high strain on the flexure guides, high torques, and oscillation, especially when operated dynamically.

- If the center of the load to be affixed is too far above or to the side of the platform, adjust the controller settings before startup or contact our customer service department (p. 33).

NOTICE**Excessively long screws!**

The P-54x could be damaged by screws inserted too deeply.

- Pay attention to the depth of the mounting holes in the platform (p. 40).
- 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. 40) by arrows.

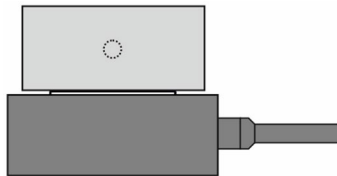
Center of load at the optimal position:

Figure 5: Example of an optimally placed load

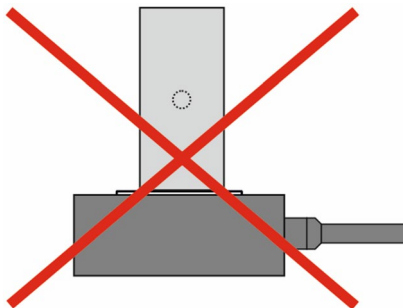
Center of load at an unsuitable position:

Figure 6: Tall load and center of load too far above the platform

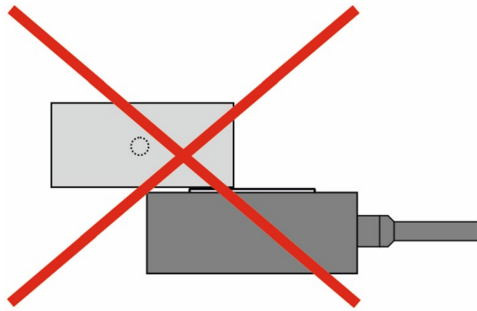


Figure 7: Unwanted lever effect and center of load on the side of the platform

Requirements

- ✓ You have read and understood the general notes on installation (p. 17).
- ✓ The P-54x is **not** connected to the electronics.

Tools and accessories

- Screws of suitable size and length (p. 40)
- Suitable screwdriver

Fixing the Load

1. Align the load on the P-54x so that the mounting holes in the load and the holes in the platform are in line.
2. Hold the load so that it cannot move while tightening the screws.
3. Fix the load by tightening the screws in the mounting holes (p. 40) provided. Do not exceed the maximum torque while tightening the screws:
 - Maximum torque on the platform: 1 Nm
 - Torque range (p. 42) for the screws
4. Check that the load is sitting firmly on the platform.

5.5 Connecting the P-54x 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 installation (p. 17).
- ✓ You have installed suitable electronics (p. 12).
- ✓ You have read and understood the user manual for the electronics.
- ✓ The electronics are switched off.

Tools and accessories

- If intended for your system: Adapter cable (p. 12)

Connecting the P-54x to the electronics

1. If adapter cables are intended, connect the adapter cable to the P-54x.
2. Insert all of the P-54x's connectors (or those on the adapter cable) to the corresponding socket on the electronics (refer to the user manual for the electronics).
3. If possible, secure the connectors against accidental disconnection.

6 Starting and Operating

In this Chapter

General Notes on Starting and Operating	25
Operating the P-54x (All Models Except the P-541.T0L).....	27
Operating the P-541.T0L	27
Discharging the P-54x	28

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-54x in the case of malfunction or failure of the system. If there are touch voltages, touching the P-54x can result in minor injuries from electric shock.

- Connect the P-54x 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-54x to the protective earth conductor before restarting.

NOTICE



Destruction of the piezo actuator due to electric flashovers!

Using the P-54x 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-54x in environments that can increase the electric conductivity.
- Operate the P-54x only within the permissible ambient conditions and classifications (p. 39).

NOTICE**Decreased lifetime due to permanently high voltage!**

Applying a continuous high static voltage to piezo actuators reduces the lifetime of the piezo ceramic.

- When the P-54x is not used but the electronics remain switched on to ensure temperature stability, discharge the P-54x (p. 28).

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

Operating voltages that are too high or incorrectly connected can cause damage to the P-54x.

- Operate the P-54x only with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating voltage range (p. 38) for which the P-54x is specified.
- Operate the P-54x only when the operating voltage is properly connected; see "Pin Assignment" (p. 42).

NOTICE**Uncontrolled oscillation!**

Oscillation can cause irreparable damage to the P-54x. 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-54x is operated near to its resonant frequency.

If you notice oscillation:

- In closed-loop operation, switch off the servo mode immediately.
- In open-loop operation, stop the P-54x immediately.

INFORMATION

The P-54x's direction of motion is indicated in the product view (p. 10).

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-54x or the controller:

- Recalibrate the axis displacement (refer to the controller manual) or contact our customer service department (p. 33).

INFORMATION

Sound and vibration (e.g., footfall, knocks) can be transmitted to the P-54x and can affect its performance with regard to position stability.

- Avoid sound and vibration while the P-54x is being operated.

6.2 Operating the P-54x (All Models Except the P-541.T0L)

- Follow the instructions on starting and operating the P-54x in the user manual for the electronics (p. 12).

6.3 Operating the P-541.T0L

INFORMATION

To prevent the X or Y rotational axes from creeping, the output voltage of the electronics on channels 1, 2, and 3 must be changed in proportion to each other. Details and examples are in the following instructions.

Requirements

- ✓ You have installed (p. 17) the P-541.T0L correctly and connected it to the electronics (p. 24).

Tools and accessories

- Suitable electronics (p. 12)

Starting and operating the P-541.T0L with the E-663 electronics

1. Control the tilting motion of the X axis as follows:
 - a) Set the output voltage on channel 1, channel 2, and channel 3 on the electronics to 50 V DC in order to move the P-541.T0L's piezo actuators to the center position.
 - b) Change the output voltage on channel 2 and channel 3 inversely to each other by an equal amount. Leave the output voltage on channel 1 unchanged at 50 V DC.

Example: If you increase the voltage on channel 2 from 50 V DC to 70 V DC, the voltage on channel 3 must be decreased from 50 V DC to 30 V DC at the same time.
2. Control the tilting motion of the Y axis as follows:
 - a) Set the output voltage on channel 1, channel 2, and channel 3 on the electronics to 50 V DC in order to move the P-541.T0L's piezo actuators to the center position.

- b) Change the output voltage on channel 2 and channel 3 inversely to the output voltage on channel 1. The voltage change on channel 2 and channel 3 may only be half as large as the voltage change on channel 1.

Example: If you increase the voltage on channel 2 and channel 3 from 50 V DC to 70 V DC, the voltage on channel 1 must be decreased from 50 V DC to 10 V DC at the same time.

6.4 Discharging the P-54x

The P-54x must be discharged in the following cases:

- Before Installation
- When the P-54x is not in use but the electronics remain switched on to ensure temperature stability
- Before demounting (e.g., before cleaning and transporting the P-54x and for modifications)

The P-54x 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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Cleaning the P-54x	29

7.1 General Notes on Maintenance

NOTICE

**Misalignment due to loosening screws!**

The P-54x 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-54x.

7.2 Cleaning the P-54x

NOTICE

**Damage from ultrasonic cleaning!**

Ultrasonic cleaning can damage the P-54x.

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

Requirements

- ✓ You have discharged the piezo actuators of the P-54x (p. 28).
- ✓ You have disconnected the P-54x from the electronics.

Cleaning the P-54x

- Clean the surfaces of the P-54x 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. 35).
	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 distorted	➤ Mount the P-54x 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-54x (e.g., surface made of aluminum). ➤ Mount loads onto the P-54x 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-54x (e.g., load made of aluminum).
	P-54x 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-54x or the controller has been replaced. ➤ Recalibrate the axis displacement (refer to the controller manual) or contact our customer service department (p. 33).

Problem	Possible causes	Solution
	Axes were mixed up during connection (only with LEMO connectors)	➤ 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	<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. 33).

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

In this Chapter

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10.1 Specifications

10.1.1 Data Table

	P-541.2CD / P-541.2CL	P-542.2CD / P-542.2CL	P-541.2DD	P-541.2SL	P-542.2SL	P-541.20L / P-542.20L	Unit	Tolerance
Active axes	X, Y	X, Y	X, Y	X, Y	X, Y	X, Y		
Motion and positioning								
Integrated sensor	Capacitive	Capacitive	Capacitive	SGS	SGS	–		
Travel range at -20 to +120 V, open loop	150 µm × 150 µm	250 µm × 250 µm	60 µm × 60 µm	150 µm × 150 µm	250 µm × 250 µm	See P-541.2CD / P-542.2CD		+20 % / -0 %
Travel range, closed loop	100 µm × 100 µm	200 µm × 200 µm	45 µm × 45 µm	100 µm × 100 µm	200 µm × 200 µm	–		
Resolution, open loop / closed loop	0.2 / 0.3	0.4 / 0.7	0.1 / 0.3	0.2 / 2.5	0.4 / 4	Open loop 0.2 / 0.4	nm	typ.
Linearity error	0.03	0.03	0.03*	0.2	0.2	–	%	typ.
Repeatability	<5	<5	<5	<10	<10	–	nm	typ.
Pitch	<5	<5	<3	<5	<5	<5	µrad	typ.
Yaw	<10	<10	<3	<10	<10	<10	µrad	typ.
Mechanical properties								
Stiffness in motion direction	0.47	0.4	10	0.47	0.4	0.47 / 0.4	N/µm	±20 %
Resonant frequency, no load	255	230	1550	255	230	255 / 230	Hz	±20 %
Resonant frequency, under load, 100 g	200	190	–	200	190	200 / 190	Hz	±20 %
Resonant frequency, under load, 200 g	180	–	1230	180	–	180 / –	Hz	±20 %
Resonant frequency, under load, 300 g	150	145	–	150	145	150 / 145	Hz	±20 %
Push/pull force capacity in motion direction	100 / 30	100 / 30	100 / 30	100 / 30	100 / 30	100 / 30	N	max.
Load capacity	20	20	20	20	20	20	N	max.

	P-541.2CD / P-541.2CL	P-542.2CD / P-542.2CL	P-541.2DD	P-541.2SL	P-542.2SL	P-541.20L / P-542.20L	Unit	Tolerance
Drive properties								
Piezo ceramic	PICMA® P-885	PICMA® P-885	PICMA® P-885	PICMA® P-885	PICMA® P-885	PICMA® P-885		
Electrical capacitance per axis	4.2	7.5	9	4.2	7.5	4.2 / 7.5	μF	±20 %
Miscellaneous								
ID chip functionality	P-541.2CD	P-542.2CD	Yes	–	–	–		
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 80	°C	
Material	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum		
Mass	0.75	0.75	0.75	0.73	0.73	0.7	kg	±5 %
Cable length	1.5	1.5	1.5	1.5	1.5	1.5	m	±10 mm
Sensor / voltage connection	CD versions: D-sub 25W3 (m) CL versions: LEMO	CD versions: D-sub 25W3 (m) CL versions: LEMO	D-sub 25W3 (m)	LEMO	LEMO	LEMO (no sensor)		
Recommended electronics	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		

* With digital controller. With analog controllers, the typical linearity error for direct drive positioners can be up to 0.1 %.

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 °C ±3 °C).

	P-541.ZCD	P-541.TCD*	P-541.ZSL	P-541.TSL*	P-541.Z0L	P-541.T0L*	Unit	Tolerance
Active axes	Z	Z, θ _x , θ _y	Z	Z, θ _x , θ _y	Z	Z, θ _x , θ _y		
Motion and positioning								
Integrated sensor	Capacitive	Capacitive	SGS	SGS	–	–		
Travel range in Z at -20 to 120 V, open loop	150	150	150	150	150	150	μm	+20 % / -0 %
Tip/tilt angle in θ _x , θ _y at -20 to 120 V, open loop	–	±0.6	–	±0.6	–	±0.6	mrad	+20 % / -0 %
Travel range in Z, closed loop	100	100	100	100	–	–	μm	
Tip/tilt angle in θ _x , θ _y , closed loop	–	±0.4	–	±0.4	–	–	mrad	
Resolution Z, open loop	0.2	0.2	0.2	0.2	0.2	0.2	nm	typ.
Resolution in θ _x , θ _y , open loop	–	0.02	–	0.02	–	0.02	μrad	typ.
Resolution in Z, closed loop	0.5	0.5	2.5	2.5	–	–	nm	typ.
Closed-loop resolution in θ _x , θ _y	–	0.08	–	0.25	–	–	μrad	typ.
Linearity error Z, θ _x , θ _y	0.03	0.03	0.2	0.2	–	–	%	typ.
Repeatability Z	<2	<2	<10	<10	–	–	nm	typ.

	P-541.ZCD	P-541.TCD*	P-541.ZSL	P-541.TSL*	P-541.ZOL	P-541.TOL*	Unit	Tolerance
Repeatability θ_x, θ_y	–	0.01	–	0.05	–	–	μrad	typ.
Tilt θ_x, θ_y (motion in Z)	± 15	± 15	± 15	± 15	± 15	± 15	μrad	typ.
Mechanical properties								
Stiffness Z	0.8	0.8	0.8	0.8	0.8	0.8	N/ μm	$\pm 20\%$
Resonant frequency Z, no load	410	410	410	410	410	410	Hz	$\pm 20\%$
Resonant frequency θ_x, θ_y , no load	–	330	–	330	–	330	Hz	$\pm 20\%$
Resonant frequency Z, 200 g	250	250	250	250	250	250	Hz	$\pm 20\%$
Resonant frequency θ_x, θ_y , 200 g	–	270	–	270	–	270	Hz	$\pm 20\%$
Push/pull force capacity	50 / 20	50 / 20	50 / 20	50 / 20	50 / 20	50 / 20	N	max.
Drive properties								
Ceramic type	PICMA® P-885	PICMA® P-885	PICMA® P-885	PICMA® P-885	PICMA® P-885	PICMA® P-885		
Electrical capacitance	6.3	6.3	6.3	6.3	6.3	6.3	μF	$\pm 20\%$
Miscellaneous								
Operating temperature range	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	$^{\circ}\text{C}$	
Material	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum		
Mass	750	750	730	730	700	700	g	$\pm 5\%$
Cable length	1.5	1.5	1.5	1.5	1.5	1.5	m	$\pm 10\text{ mm}$
Sensor connection	D-sub 7W2 (m)	D-sub 25W3 (m)	LEMO	3 × LEMO	–	–		
Voltage connection	D-sub 7W2 (m)	D-sub 25W3 (m)	LEMO	3 × LEMO	LEMO	3 × LEMO		
Recommended electronics	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	E-503, E-505, E-610, E-621, E-625, E-712, E-727, E-754	




* Parallel kinematics design; the maximum displacement for translation motion and tip/tilt motion cannot be achieved simultaneously.

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 ($22\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$).

10.1.2 Maximum Ratings

P-54x positioners are designed for the following operating data:

Model	Maximum operating voltage 	Maximum operating frequency (unloaded) ¹ 	Maximum power consumption ² 
P-541.2DD	-20 to 120 V	517 Hz	25 W
P-541.2CD P-541.2CL P-541.2SL P-541.20L	-20 to 120 V	85 Hz	12 W
P-542.2CD P-542.2CL P-542.2SL P-542.20L	-20 to 120 V	77 Hz	20 W
P-541.ZCD P-541.ZSL P-541.Z0L	-20 to 120 V	136 Hz	19 W
P-541.TCD P-541.TSL P-541.T0L	-20 to 120 V	136 Hz	19 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/>

10.1.3 Ambient Conditions and Classifications

Pay attention to the following ambient conditions and classifications for the P-54x:

Area of application	For indoor use only
Maximum altitude	2000 m
Air pressure	1100 hPa to 0.1 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

10.2 Dimensions

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

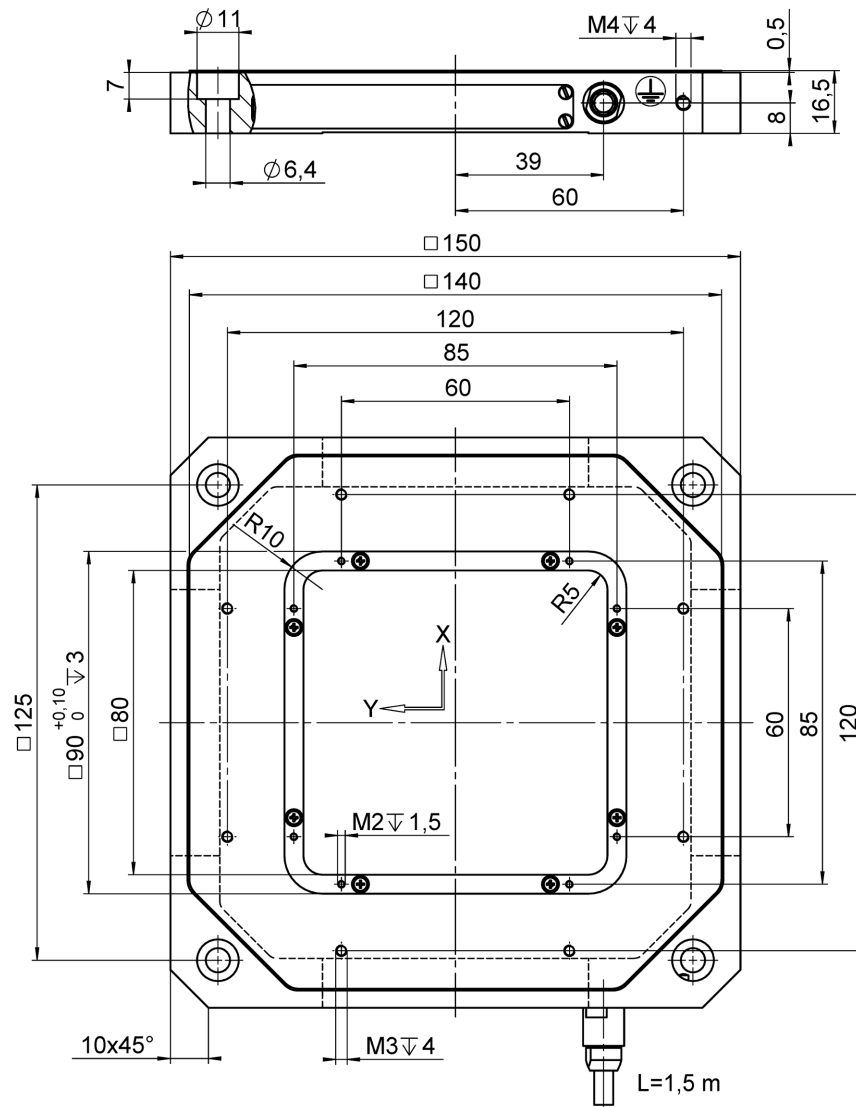


Figure 8: P-541.2 / P-542.2

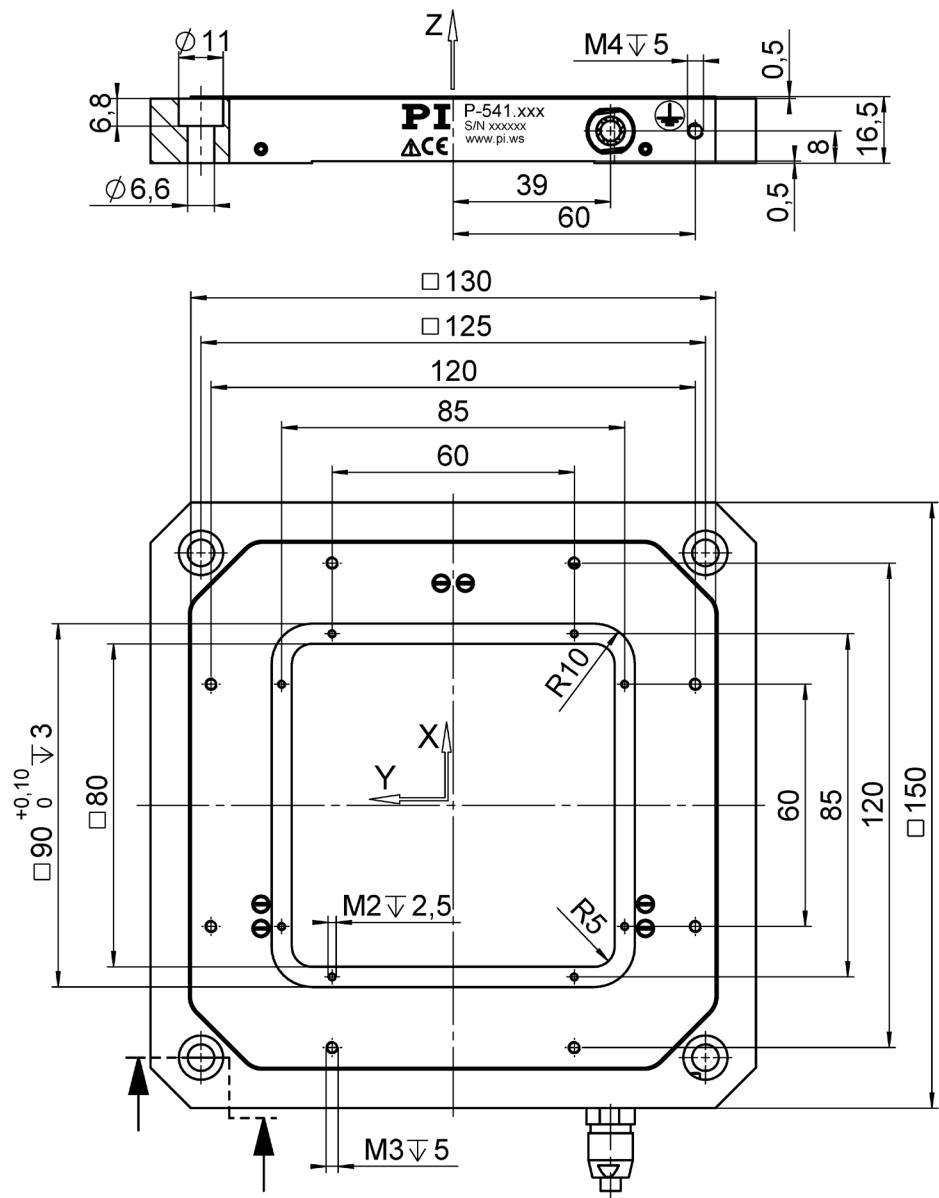


Figure 9: P-541.Z / P-541.T

10.3 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.

10.4 Pin Assignment

D-sub connector 25W3

For P-54x.2CD/.2DD/.TCD only:

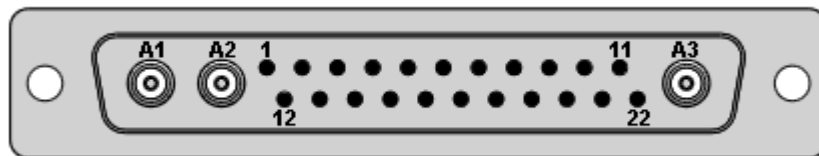


Figure 10: D-sub 25W3 connector (m): Front with connections

Pin assignment for P-54x.2CD/.2DD models:

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	---	(not connected)
A2 outer conductor	---	(not connected)
A3 inner conductor	Output	Probe sensor signal, channel 1 (immovable part of the capacitive sensor)
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	---	(not connected)
3	GND	ID chip ground
4	Bidirectional	Data line for ID chip
5	---	(not connected)
6	---	(not connected)
7	---	(not connected)
8	---	(not connected)
9	Input	Piezo voltage +, channel 2, -20 to 120 V
10	Input	Piezo voltage +, channel 1, -20 to 120 V
11	Input	Target sensor signal, channel 1 (movable part of the capacitive sensor)
12	GND	Shielding for target sensor signal, channel 2
13	---	(not connected)
14	---	(not connected)
15	---	(not connected)
16	---	(not connected)
17	---	(not connected)
18	---	(not connected)
19	---	(not connected)
20	Input	Piezo voltage –, channel 2
21	Input	Piezo voltage –, channel 1
22	GND	Shielding for target sensor signal, channel 1

Pin assignment for the P-54x.TCD models:

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)
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	---	(not connected)
6	---	(not connected)
7	---	(not connected)
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	---	(not connected)
15	---	(not connected)
16	---	(not connected)
17	---	(not connected)
18	---	(not connected)
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

D-sub 7W2 connector (m)

For P-541.ZCD only:

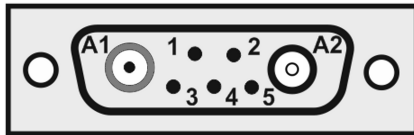


Figure 11: D-sub 7W2 connector (m): Front with connections

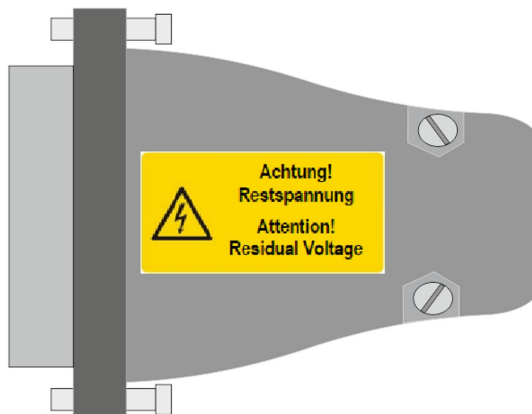


Figure 12: D-sub connector: Example top view

Pin	Signal	Function
A1	PZT	Piezo voltage
A2	Probe	Probe sensor signal (immovable part of the capacitive sensor)
1	Data ID chip	Data line for ID chip
2	GND Target and ID chip	Target and ID chip ground
3	GND PZT	Piezo voltage ground
4	---	(not connected)
5	Target	Target sensor signal (movable part of the capacitive sensor)
Housing	---	Shield

LEMO connectors

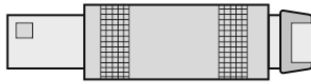


Figure 13: LEMO connector (side view)

LEMO connectors according to model (one connector per axis)

P-54x Model	Connector (front view)	Pin	Signal	Function	Connector shell
.2CL .2SL .20L .ZSL .Z0L .TSL .T0L	PZT 	Inner conductor	Input	Piezo voltage -20 to 120 V	Ground
.2CL	P 	Inner conductor	Output	Probe sensor signal (immovable part of the capacitive sensor)	Cable shield
.2CL	T 	Inner conductor	Input	Target sensor signal (movable part of the capacitive sensor)	Cable shield
.2SL .ZSL .TSL	SGS 	1	Input	Supply voltage for strain gauge sensor	Cable shield
		2	Output	Sensor signal 1	
		3	Output	Sensor signal 2	
		4	GND	Supply voltage ground	

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 fulfil 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

