PZ280E

P-612 Positioners

User Manual

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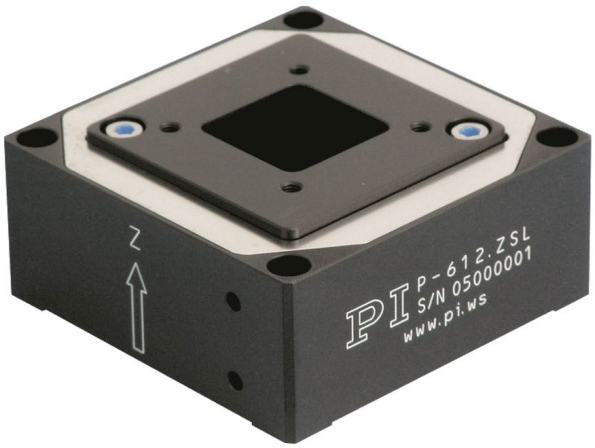

This document describes the following products:

- **P-612.2**
  XY piezo nanopositioner
- **P-612.Z**
  Piezo Z stage

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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-612 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
RS-232	Label on the product indicating an operating element (example: RS-232 interface socket)
	Warning sign on the product referring to detailed information in this manual.

1.3 Figures

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

1.4 Other Applicable Documents

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

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

Product	Document
E-500 • E-501 modular piezo controller	PZ62 user manual
E-503 piezo amplifier module (plug-in module)	
E-505 piezo amplifier module (plug-in module)	
E-509 sensor/servo controller module (plug-in module)	
E-610 piezo amplifier/servo controller (OEM module)	PZ70 user manual
E-621 piezo amplifier/servo controller module (plug-in module)	PZ115 user manual
E-625 piezo amplifier/servo controller	PZ166 user manual
E-665 piezo amplifier / servo controller	PZ127 user manual
PIMikroMove	SM148E software manual
P-5xx / P-6xx / P-7xx piezo positioners	PZ240EK short instructions

1.5 Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

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

Downloading manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., P-612).
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-612 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 from dirt, oil, and lubricants.

According to its design, the P-612 is intended for fine positioning as well as moving small objects quickly and precisely. The specifications for the P-612 apply to horizontal mounting. Depending on the version, moving is done as follows:

Model	Motion	Axis
P-612.2SL	In two axes horizontally	X, Y
P-612.ZSL	In one axis vertically	Z

Vertical mounting is only possible under certain conditions.

The P-612 can only be used as intended in conjunction with suitable electronics (p. 12) available from PI. The electronics are not in the P-612's scope of delivery.

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

2.2 General Safety Instructions

The P-612 is built according to state-of-the-art technology and recognized safety standards. Improper use of the P-612 may result in personal injury and/or damage to the P-612.

- Use the P-612 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-612 correctly.

The P-612 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-612'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-612.
- Discharge the P-612's piezo actuators before installing (p. 27).
- Do **not** disconnect the plug connector from the electronics during operation.

If the protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the P-612 in the event of a malfunction or failure of the system. If there are touch voltages, touching the P-612 can result in minor injuries from electric shock.

- Connect the P-612 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-612 to the protective earth conductor before restarting.

Mechanical forces can damage or misalign the P-612.

- Avoid impacts that affect the P-612.
- Do **not** drop the P-612.
- Do **not** exceed the maximum permissible stress and load capacities according to the specifications (p. 35).
- Do **not** touch any sensitive parts (e.g., motion platform) when handling the P-612.

The P-612 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-612.

2.3 Organizational Measures

User manual

- Always keep this user manual together with the P-612. 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-612 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-612 only after you have read and understood this user manual.

Personnel qualification

The P-612 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

Product number	Description
P-612.2SL	XY piezo nanopositioner; 100 µm × 100 µm travel range (X × Y); aperture 20 mm × 20 mm; SGS, indirect position measuring; LEMO connector; 1.5 m cable length
P-612.ZSL	Piezo Z stage; 100 µm travel range; SGS, indirect position measuring; LEMO connector; 1.5 m cable length

3.2 Product View

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

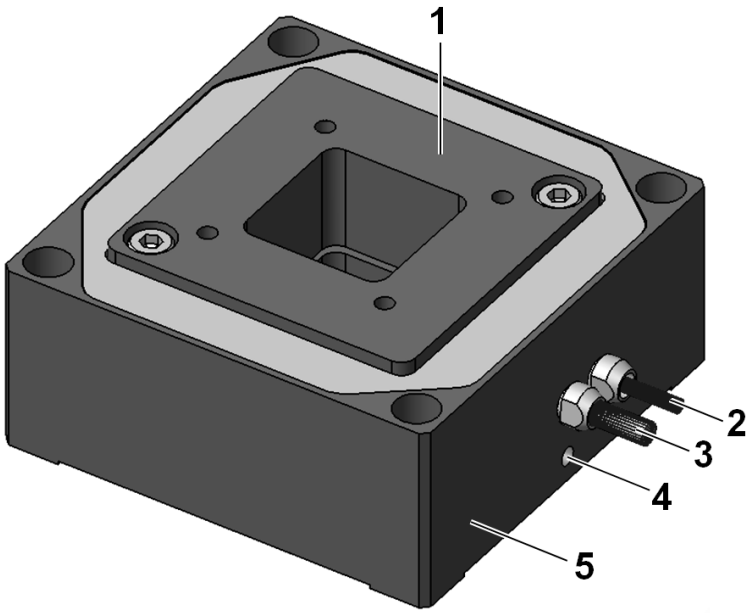

Figure 1: Exemplary product view of a P-612.2SL

1 Motion platform
2 Piezo voltage connecting cable
3 Sensor connecting cable (depending on model)
4 Protective earth connector
5 Base body

Directions of motion of the P-612

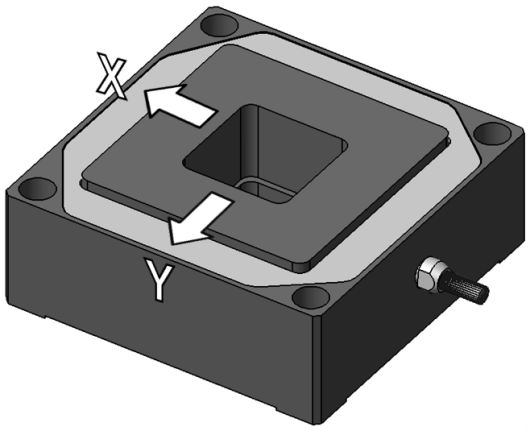

Figure 2:
Positive direction of motion of the X axis and Y axis (P-612.2SL)

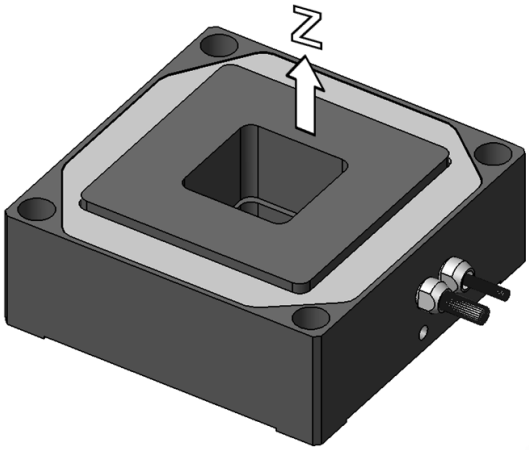

Figure 3:
Positive direction of motion of the Z axis (P-612.ZSL)

3.3 Product Labeling

Labeling	Description
P-612.2SL	Product number (example), the digits after the period refer to the model
123456789	Serial number (example), individual for each P-612 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. 43)
Country of origin: Germany	Country of origin
WWW.PI.WS	Manufacturer's address (website)
CE	CE conformity mark
⏚	Symbol for the protective earth conductor (p. 18)

3.4 Scope of Delivery

Product number	Description
P-612	Positioner according to order (p. 9)
000036450	M4 screw set for protective earth, consisting of: ▪ 1 flat-head screw with cross recess, M4x8, ISO 7045 ▪ 2 lock washers ▪ 2 flat washers
PZ240EK	Short instructions for P-5xx / P-6xx / P-7xx piezo positioners

3.5 Suitable Electronics

You need suitable electronics to operate a P-612. The device is selected depending on the type of application.

Electronics	Channels*
E-505 piezo amplifier module (plug-in module) Also required: ▪ E-500/E-501 modular piezo controller ▪ E-509.S1 sensor/servo controller module (plug-in module)	1
E-503 piezo amplifier module (plug-in module) Also required: ▪ E-500/E-501 modular piezo controller ▪ E-509.S3 sensor/servo controller module (plug-in module)	3
E-610.S0 piezo amplifier/servo controller (OEM module)	1
E-621.SR piezo amplifier/servo controller module (plug-in module) Also required: ▪ E-500/E-501 modular piezo controller	1
E-625.SR piezo amplifier/servo controller	1
E-665.SR piezo amplifier/servo controller	1

* When using single-channel electronics, each motion axis requires its own individual electronics.

➢ To order, contact the customer service department (p. 33).

3.6 Optional Accessories

Product number	Description
P-891.01	Extension cable for piezo voltage, LEMO connectors, 1 m
P-891.02	Extension cable for piezo voltage, LEMO connectors, 2 m
P-891.03	Extension cable for piezo voltage, LEMO connectors, 3 m
P-891.05	Extension cable for piezo voltage, LEMO connectors, 5 m
P-891.10	Extension cable for piezo voltage, LEMO connectors, 10 m
P-892.01	Extension cable, for strain gauge sensors, LEMO connectors, 1 m
P-892.02	Extension cable, for strain gauge sensors, LEMO connectors, 2 m
P-892.03	Extension cable, for strain gauge sensors, LEMO connectors, 3 m
P-892.05	Extension cable, for strain gauge sensors, LEMO connectors, 5 m
P-892.10	Extension cable, for strain gauge sensors, LEMO connectors, 10 m

➢ To order, contact our customer service department (p. 33).

3.7 Technical Features

3.7.1 PICMA® Piezo Actuators

P-612 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-612 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 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.

4 Unpacking

NOTICE

Mechanical overload due to incorrect handling!

An impermissible mechanical load on the motion platform of the P-612 can cause damage to the piezo actuators, sensors, and flexures of the P-612 as well as loss of accuracy.

➢ Do **not** touch any sensitive parts (e.g., motion platform) when handling the P-612.

1. Unpack the P-612 with care.
2. Compare the contents of the shipment with the items listed in the contract and the delivery note.
3. Inspect the contents for signs of damage. If parts are missing or you notice signs of damage, contact PI immediately.
4. Keep all packaging materials 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-612 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-612'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-612.
- Discharge the P-612's piezo actuators before installing (p. 27).
- Do **not** disconnect the plug connector from the electronics during operation.

NOTICE

Mechanical overload due to incorrect handling!
An impermissible mechanical load on the motion platform of the P-612 can cause damage to the piezo actuators, sensors, and flexures of the P-612 as well as loss of accuracy.

- Do **not** touch any sensitive parts (e.g., motion platform) when handling the P-612.

NOTICE

Damage due to unsuitable cables!
Unsuitable cables can damage the P-612 and the electronics.

- Use cables provided by PI only to connect the P-612 to the electronics.

NOTICE

Damage due to improper mounting!
Improper mounting of the P-612 or incorrectly mounted parts can damage the P-612.

- Only use the holes or threads intended for the purpose of fixing the P-612 and loads.
- Install the P-612 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. 41) specified for the screws used during installation.

INFORMATION

Extension cables can reduce the positioning accuracy of the P-612 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-612 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 (e.g., with conductive liquid adhesive) 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.

The P-612 has an M4 hole for attachingthe protective earth conductor. This hole is marked with the symbol for the protective earth conductor ⏚. For the exact position of the hole, refer to "Dimensions" (p. 39).

Requirements

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ The P-612 is **not** connected to the electronics.

Tools and accessories

- Suitable protective earth conductor:
  - Cable cross section ≥ 0.75 mm²
  - Contact resistance at all points relevant for attaching the protective earth conductor < 0.1 Ω at 25 A
- Supplied M4 protective earth conductor screw set (p. 12) for attaching the protective earth conductor
- Suitable screwdriver

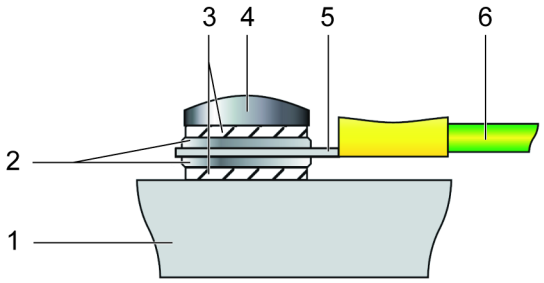

Figure 4: Connecting the protective earth conductor (profile view)

1 Base body of the P-612
2 Flat washer
3 Lock washer
4 Screw
5 Cable lug
6 Protective earth conductor

Attaching the P-612 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-612 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-612

NOTICE

Warping the P-612 when mounting onto uneven surfaces!
Fixing the P-612 onto an uneven surface can warp the P-612. Warping reduces the accuracy.

- ➢ Fix the P-612 onto a flat surface. The recommended flatness of the surface is ≤ 100 µm.
- ➢ For applications with large temperature fluctuations:
  Only fix the P-612 onto surfaces that have the same or similar thermal expansion properties as the P-612 (e.g., surfaces made of aluminum).

NOTICE

Tensile stress on piezo actuator due to mounting in wrong orientation!
The P-612 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-612 in a different orientation to that intended (e.g., vertically or upside down), contact our customer service department (p. 33).

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

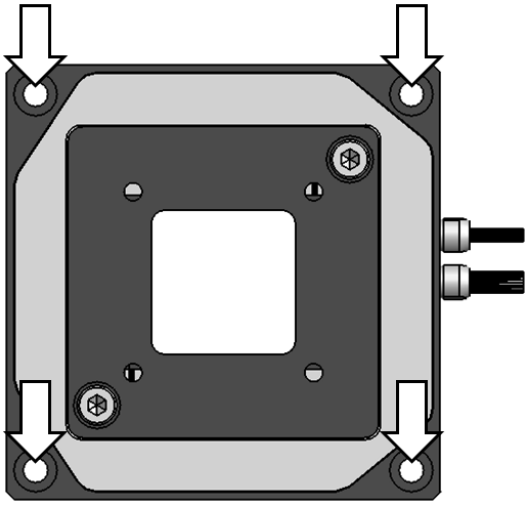

Figure 5: Mounting holes in the base body of the P-612 (example view from above)

Requirements

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ You have provided a suitable surface for fixing the P-612:
  - The surface has four threaded holes for M3 screws. For the required position and depth of the holes, refer to "Dimensions" (p. 39).
  - The surface flatness is ≤ 100 µm.
  - For applications with large temperature fluctuations: The surface should have the same thermal expansion properties as the P-612 (e.g., surface made of aluminum).

Tools and accessories

- Four M3 screws of a suitable length (p. 39)
- Suitable screwdriver

Mounting the P-612

1. Align the P-612 on the surface so that the corresponding mounting holes in the base body (see figure) and the surface are in line.
2. Fix the P-612 with the screws:
   a) Insert a screw into each hole.
   b) Tighten the screws crosswise. Pay attention to the specified torque range (p. 41).
3. Check that the P-612 is securely attached to the surface.

5.4 Fixing the Load

NOTICE

Mechanical overload of the motion platform!
High torques during fastening of the load as well as heavy loads can overload the motion platform of the P-612. Mechanical overload can cause damage to the piezo actuators, sensors, and flexures of the P-612 and lead to loss of accuracy.

- ➢ Avoid torques > 0.8 Nm on the motion 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. 41) when tightening (or loosening) the screws.

NOTICE

Warping of the P-612 when fixing loads with an uneven contact surface!

Fixing loads with an uneven contact surface could warp the P-612. Warping reduces the accuracy.

- ➢ Fix loads to the P-612 only when the surface contacting the P-612's platform has a flatness of at least 100 µm.
- ➢ For applications with large temperature fluctuations:
  Fix loads to the P-612 only when they have the same or similar thermal expansion properties as the P-612 (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-612 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. 33).

NOTICE

Excessively long screws!

The P-612 could be damaged by screws inserted too deeply.

- ➢ Pay attention to the depth of the mounting holes in the motion platform (p. 39).
- ➢ Use screws of the correct length for the respective mounting holes only.

INFORMATION

Positive direction of axis motion is specified in the product view (p. 10).

Center of load at the optimal position:

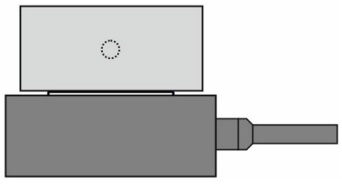

Figure 6: Example of an optimally placed load

Center of load at an unsuitable position:

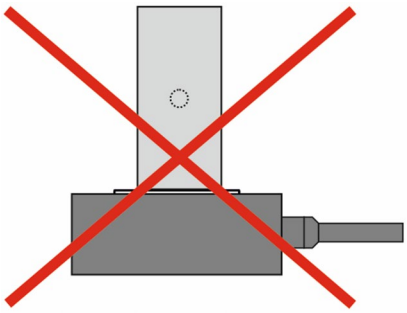

Figure 7: Tall load and center of load too far above the platform

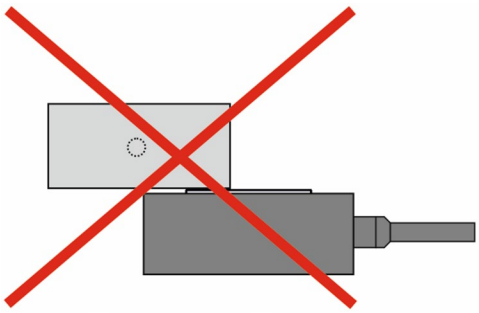

Figure 8: Unwanted lever effect and center of load on the side of the platform

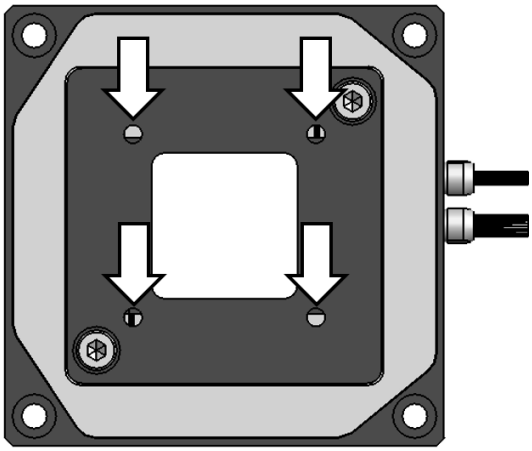

Figure 9: Mounting holes in the motion platform of the P-612 (example view from above)

Requirements

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ The P-612 is **not** connected to the electronics.

Tools and accessories

- Four M3 screws of a suitable length (p. 39)
- Suitable screwdriver

Fixing the load

1. Align the load on the P-612 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-612.
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. 41) 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-612 in the event of a malfunction or failure of the system. If there are touch voltages, touching the P-612 can result in minor injuries from electric shock.

- Connect the P-612 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-612 to the protective earth conductor before restarting.

NOTICE

Destruction of the piezo actuator due to electric flashovers!

Using the P-612 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-612 in environments that can increase the electric conductivity.
- Operate the P-612 only within the permissible ambient conditions and classifications (p. 38).

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-612 is not used but the electronics remain switched on to ensure temperature stability, discharge the P-612 (p. 27).

NOTICE

Operating voltage excessively high or incorrectly connected!

Excessively high or wrongly connected operating voltages can damage the P-612.

- ➢ Operate the P-612 with controllers/drivers and original accessories from PI.
- ➢ Do **not** exceed the operating voltage range (p. 38) specified for the P-612.
- ➢ Operate the P-612 only when the operating voltage is properly connected; see "Pin Assignment" (p. 41).

NOTICE

Uncontrolled oscillation!

Oscillation can cause irreparable damage to the P-612. 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-612 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-612 immediately.

INFORMATION

Positive direction of axis motion is specified in the product view (p. 10).

INFORMATION

Sound and vibration (e.g., footfall, knocks) can be transmitted to the P-612 and can affect its performance with regard to position stability.

- ➢ Avoid sound and vibration while the P-612 is being operated.

6.2 Operating the P-612

- ➢ For starting up and operating the P-612, follow the instructions in the manual for the electronics (p. 12) used.

6.3 Discharging the P-612

The P-612 must be discharged in the following cases:

- Before Installation
- When the P-612 is not used but the electronics remain switched on to ensure temperature stability
- Before demounting (e.g., before cleaning and transporting the P-612 and for modifications)

The P-612 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-612 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-612.

7.2 Cleaning the P-612

NOTICE

Damage from ultrasonic cleaning!
Ultrasonic cleaning can damage the P-612.

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

NOTICE

Short-circuiting due to cleaning fluid getting into the housing!
Cleaning fluid getting into the P-612's housing can short-circuit the piezo actuators and the electronics.

- ➢ Disconnect the P-612 from the electronics before cleaning.
- ➢ Prevent cleaning fluid from getting into the P-612's housing.

Requirements

- ✓ You have discharged the piezo actuators of the P-612 (p. 27).
- ✓ You have disconnected the P-612 from the electronics.

Cleaning the P-612

- Clean the surfaces of the P-612 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: ▪ 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 motion platform is warped	➢ Mount the P-612 onto surfaces with the following characteristics only: – Flatness of at least 100 µm – The thermal expansion properties are similar to those of the P-612 (e.g., surfaces made of aluminum). ➢ Mount loads onto the P-612 with the following characteristics only: – The contact surface of the load has a flatness of at least 100 µm. – The thermal expansion properties are similar to those of the P-612 (e.g., loads made of aluminum).
	P-612 or controller has been replaced	It is necessary to recalibrate the axis displacement after replacing the P-612 or controller. ➢ Recalibrate the axis displacement (refer to the controller manual) or contact our customer service department (p. 33).
	Axes were mixed up during connection	➢ When connecting the P-612 to the controller, pay attention to the assignment of the axes. This assignment is indicated by labels on the devices.

Problem	Possible causes	Solution
	P-612 is not connected to the corresponding controller (only when there are several systems)	➢ Pay attention to the assignment of the devices when several systems are connected. The assignment is indicated on the calibration label of the controller (see rear panel or underside), which contains the serial number of the positioner to be connected.
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. 33).

9 Customer Service Department

For inquiries and orders, contact your PI representative 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.physikinstrumente.com/en/).

In this Chapter

10.1 Specifications

10.1.1 Data Table

Motion	P-612.2SL	Tolerance
Active axes	X | Y	
Travel range in X	100 µm	
Travel range in Y	100 µm	
Travel range in X, open loop, at -20 to 120 V	130 µm	+20/-0 %
Travel range in Y, open loop, at -20 to 120 V	130 µm	+20/-0 %
Linearity error	0.4 %	typ.
Angular deviation E_AY (pitch)	±10 µrad	typ.
Angular deviation E_BX (pitch)	±10 µrad	typ.
Angular deviation E_CX (yaw)	±10 µrad	typ.
Angular deviation E_CY (yaw)	±50 µrad	typ.

Positioning	P-612.2SL	Tolerance
Unidirectional repeatability in X	±10 nm	typ.
Unidirectional repeatability in Y	±10 nm	typ.
Resolution in X, open loop	0.8 nm	typ.
Resolution in Y, open loop	0.8 nm	typ.
Integrated sensor	SGS, indirect position measuring	
System resolution in X	5 nm	
System resolution in Y	5 nm	

Drive properties	P-612.2SL	Tolerance
Drive type	PICMA®	
Electrical capacitance	1.5 µF	±20 %

Mechanical properties	P-612.2SL	Tolerance
Stiffness in X	0.15 N/µm	±20 %
Stiffness in Y	0.15 N/µm	±20 %
Resonant frequency in X, unloaded	400 Hz	±20 %
Resonant frequency in X, under load with 100 g	200 Hz	±20 %
Resonant frequency in Y, unloaded	400 Hz	±20 %
Resonant frequency in Y, under load with 100 g	200 Hz	±20 %
Permissible push force in X	15 N	max.
Permissible push force in Y	15 N	max.
Permissible push force in Z	15 N	max.
Permissible pull force in X	5 N	max.
Permissible pull force in Y	5 N	max.
Guide	Flexure guide with lever amplification	
Overall mass	150 g	±5 %
Material	Aluminum, steel	

Miscellaneous	P-612.2SL	Tolerance
Operating temperature range	-20 to 80 °C	
Connector	LEMO FFA.00.250.CTAC22	
Sensor connector	LEMO FFA.0S.304.CLAC32	
Cable length	1.5 m	±10 mm
Recommended controllers/drivers	E-503, E-505, E-610, E-621, E-625, E-665	

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.

Ask about custom versions.

Motion	P-612.ZSL	Tolerance
Active axes	Z	
Travel range in Z	100 µm	
Travel range in Z, open loop, at -20 to 120 V	110 µm	+20/-0 %
Linearity error in Z	0.2 %	typ.
Straightness deviation in X	±20 nm	typ.
Straightness deviation in Y	±20 nm	typ.
Angular deviation around X	±10 µrad	typ.
Angular deviation around Y	±10 µrad	typ.

Positioning	P-612.ZSL	Tolerance
Unidirectional repeatability in Z	±4 nm	typ.
Resolution in Z, open loop	0.2 nm	typ.
Integrated sensor	SGS, indirect position measuring	
System resolution in Z	1.5 nm	

Drive properties	P-612.ZSL	Tolerance
Drive type	PICMA®	
Electrical capacitance in Z	3 µF	±20 %

Mechanical properties	P-612.ZSL	Tolerance
Stiffness in Z	0.63 N/µm	±20 %
Resonant frequency in Z, unloaded	490 Hz	±20 %
Resonant frequency in Z, under load with 30 g	420 Hz	±20 %
Permissible push force in Z	15 N	max.
Permissible pull force in Z	10 N	max.
Guide	Flexure guide with lever amplification	
Overall mass	280 g	±5 %
Material	Aluminum	

Miscellaneous	P-612.ZSL	Tolerance
Operating temperature range	-20 to 80 °C	
Connector	LEMO FFS.00.250.CTCE24	
Sensor connector	LEMO FFA.0S.304.CLAC32	
Cable length	1.5 m	±10 mm
Recommended controllers/drivers	E-503, E-505, E-610, E-621, E-625, E-665	

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 Maximum Ratings

P-612 positioners are designed for the following operating data:

Model	Maximum operating voltage	Maximum operating frequency (unloaded)[1]	Maximum power consumption[2]
	⚠	⚠	⚠
P-612.2SL	-20 to +120 V	130 Hz	8 W
P-612.ZSL	-20 to +120 V	160 Hz	4 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-612:

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

10.2 Dimensions

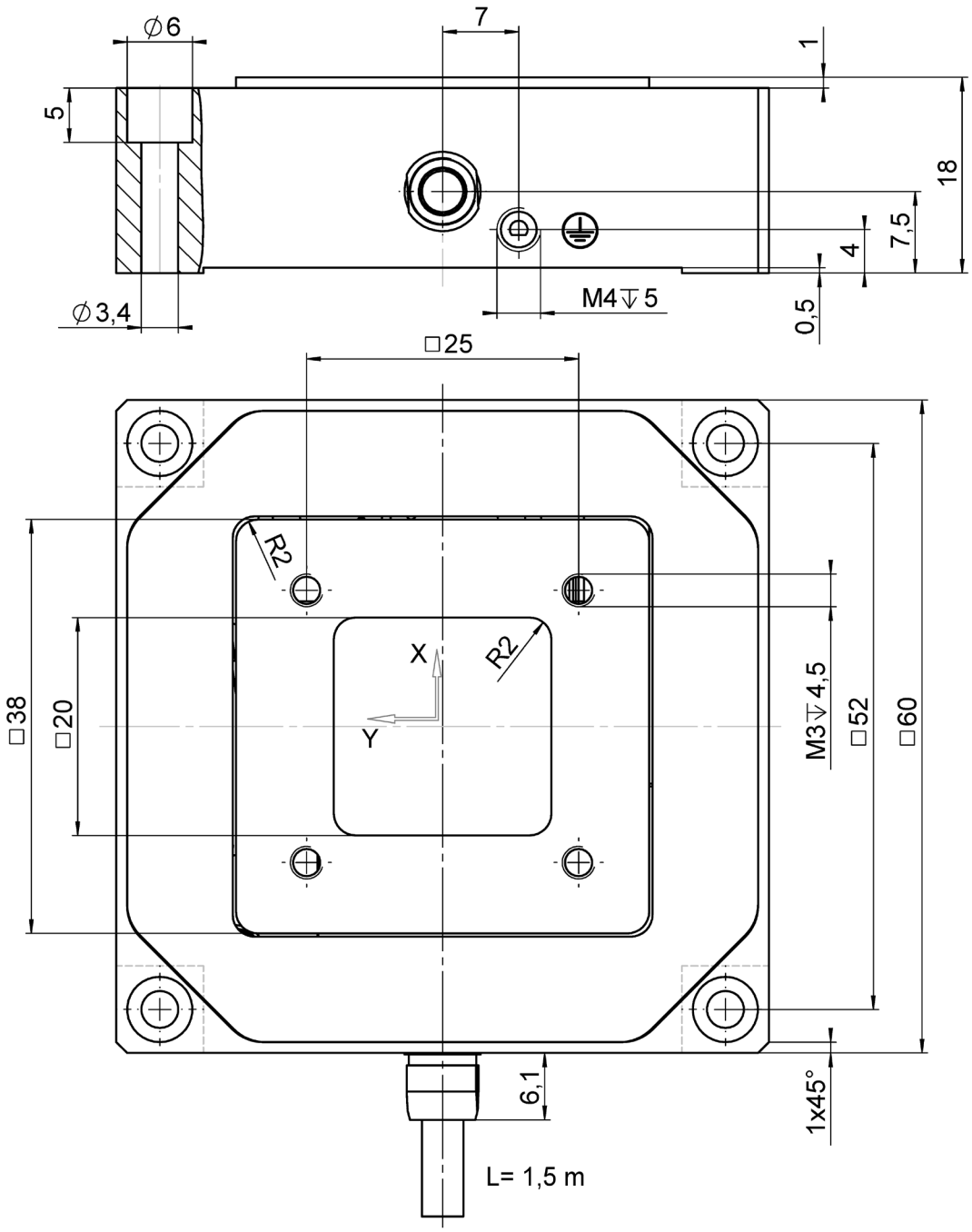

Figure 10: P-612.2SL, dimensions in mm.
Note that the decimal points are separated by a comma in the drawings.

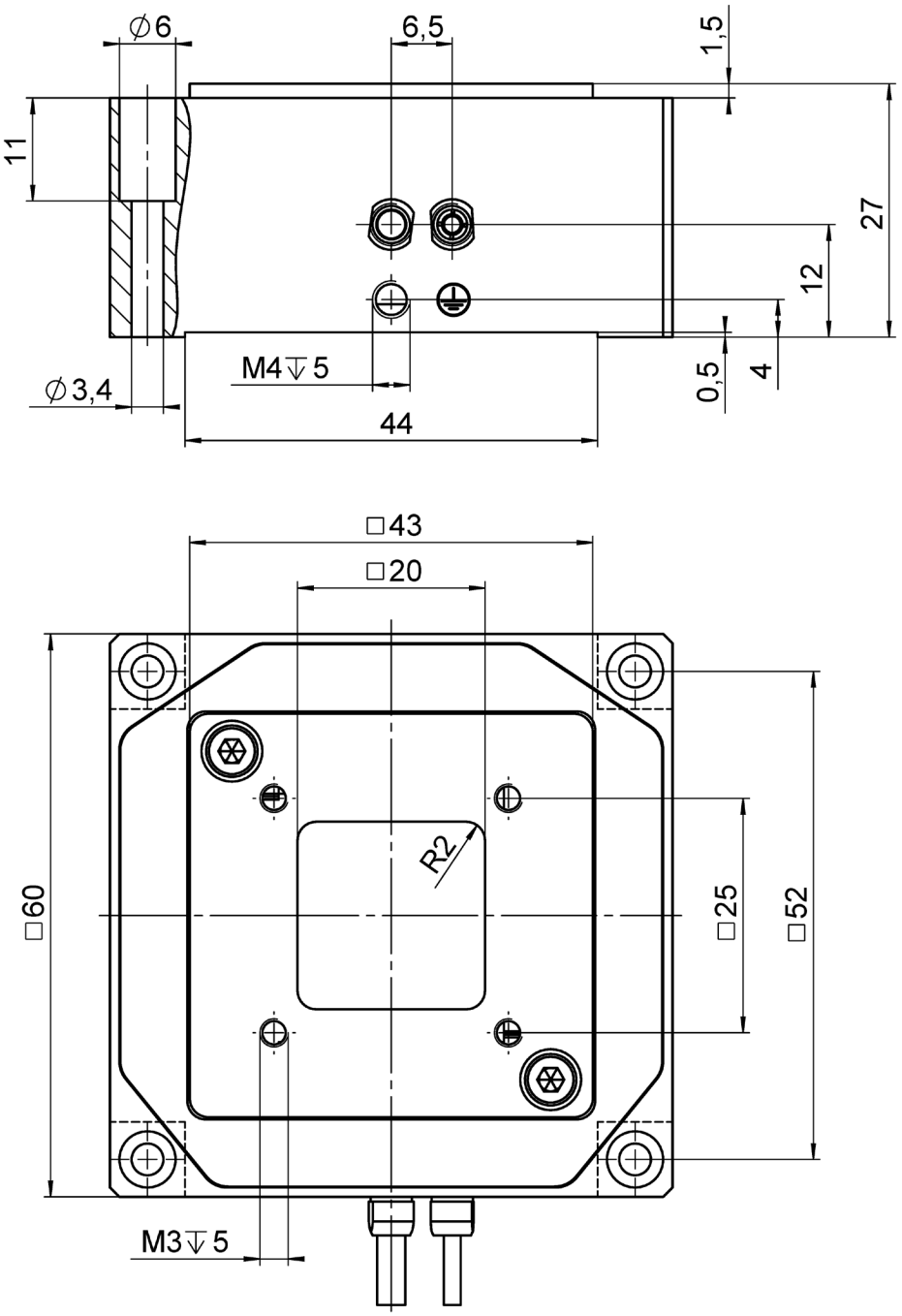

Figure 11: P-612.ZSL, dimensions in mm.
Note that the decimal points are separated by a comma in the drawings.

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

LEMO connectors

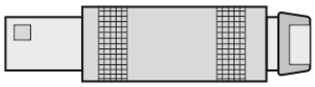

Figure 12: LEMO connector (side view)

LEMO connectors according to model (one connector per axis)

Connectors (contact side)	Pin	Signal	Function	Connector shell
PZT 	Inner conductor	Input	Piezo voltage -20 to 120 V	Ground
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 device 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.

If you have an old device from PI, you can send it to the following address free of charge:

Physik Instrumente (PI) GmbH & Co. KG

Auf der Roemerstrasse 1

76228 Karlsruhe, Germany

12 European Declarations of Conformity

For the P-612, 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