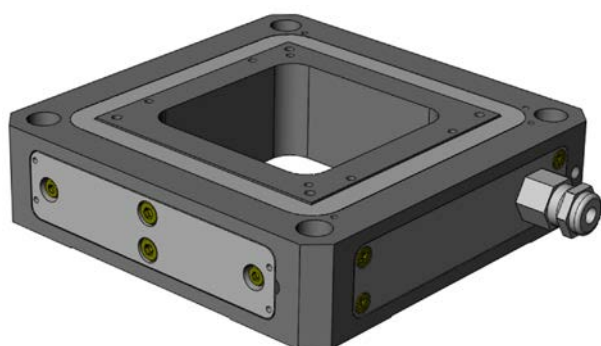


PZ103E P-73x Nanopositioners User Manual

Version: 1.0.0

Date: 10.12.2012



This document describes the following products:

- **P-733, P-734**
Piezo XY stage
P-733.2CD/.2CL
P-733.2DD direct drive
P-734.2CD/.2CL ultra-straight motion
- **P-733**
Piezo XYZ stage
P-733.3CD/.3CL
P-733.3DD direct drive
- **P-733**
Precision Z stage
P-733.ZCD/.ZCL

.2CD/.3CD/.ZCD/.2DD/.3DD with Sub-D connector
.2CL/.3CL/.ZCL with LEMO connector



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The products described in this document are in part protected by the following patents:

German patent no. 10021919C2

German patent no. 10234787C1

German patent no. 10348836B3

German patent no. 102005015405B3

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US patent no. 7,449,077

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Subject to change without notice. This manual is superseded by any new release. The latest release is available for download on our website (<http://www.pi.ws>).



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1 About this Document

In this Chapter

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Symbols and Typographic Conventions	1
Other Applicable Documents	2
Downloading Manuals	3

1.1 Goal and Target Audience of this User Manual

This user manual contains the necessary information for the intended use of the P-73x (x stands for the different models (p. 10)).

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

If not avoided, the dangerous situation will result in minor injury.



- Actions to take to avoid the situation.

NOTICE




Dangerous situation

If not avoided, the dangerous situation will result in damage to the equipment.

- Actions to take to avoid the situation.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/ Label	Meaning
1.	Action consisting of several steps whose sequential order must be observed
2.	
➤	Action consisting of one or several steps whose sequential order is irrelevant
▪	List item
p. 5	Cross-reference to page 5
RS-232	Labeling of an operating element on the product (example: socket of the RS-232 interface)
	Warning signs affixed to the product that refer to detailed information in this manual.

1.3 Other Applicable Documents

The devices and software tools which are mentioned in this documentation are described in their own manuals.

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

Product	Document
E-625.CR Controller	PZ166E
E-665.CR Controller	PZ127E
E-610.C0 Piezo Controller OEM Board	PZ72E
E-609 OEM Piezo Controller	E609T0001
E-709.CRG Digital Single-Channel Piezo Controller	PZ222E
E-753 Digital Piezo Controller	PZ193E

Product	Document
E-500 Modular Piezo Controller	PZ62E
E-509.C3A Control Module for Capacitive Sensors	PZ77E
E-503 3-Channel Amplifier	PZ62E
E-505 Single-Channel High-Performance Amplifier	PZ62E
E-517 Interface and Display Module	PZ214E
E-712 Digital Piezo Controller	PZ195E
E-725 Digital Piezo Controller	PZ197E
E-761 Digital Piezo Controller	PZ164E
PIMikroMove	SM148E Software Manual
NanoCapture	SM71E Software Manual
P-5xx / P-6xx / P-7xx Piezo Positioning Systems	PZ240EK Short Instructions

1.4 Downloading Manuals

1. Open the PI website <http://www.pi-portal.ws>.
2. Click **Downloads**.
3. Click the corresponding category (e. g. **P Piezo Actuators, Nanopositioning & Scanning Systems**).
4. Click the corresponding product code (e. g. **P-733**).
5. Click **Documents**.
6. Click the desired manual and save it on the hard disk of your PC.
7. If no manual is available:
 - a) Log in as follows:
 - Enter username and password from the file **X-xxx_Releasenews_V_x_x_x.pdf** on the product CD in the **User login** field on the left margin.
 - Click **Login**.
 - b) Repeat step 6.

2 Safety

In this Chapter

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2.1 Intended Use

The P-73x is a laboratory device as defined by DIN EN 61010-1. It is intended to be used in interior spaces and in an environment which is free of dirt, oil, and lubricants.

Based on its design and realization, the P-73x is intended for fine positioning as well as the fast and precise motion of small objects. The specifications of the P-73x apply to horizontal mounting. Depending on the model, the motion is performed as follows:

- in two axes horizontally,
- in three axes horizontally and vertically,
- in one axis vertically.

The intended use of the P-73x is only possible in combination with suitable drive and control electronics (p. 50) available from PI. The electronics is not included in the scope of delivery of the P-73x.

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

2.2 General Safety Instructions

The P-73x 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-73x.

- Only use the P-73x for its intended purpose, and only use it if it is in a good working order.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for the correct installation and operation of the P-73x.

Mechanical forces can damage or misalign the P-73x.

- Avoid impacts that affect the P-73x.
- Do not drop the P-73x.
- Do **not** exceed the maximum permissible compressive/tensile stress.

The P-73x is maintenance-free and achieves its positioning accuracy as a result of the optimum alignment of mechanical components and piezo actuators. Loosened screws cause a loss in positioning accuracy.

- Only loosen screws according to the instructions in this manual.
- Do not open the P-73x.

2.3 Organizational Measures

User manual

- Always keep this user manual available by the P-73x.
The latest versions of the user manuals are available for download (p. 3) on our website.
- Add all information given by the manufacturer to the user manual, for example supplements or Technical Notes.
- If you pass the P-73x on to other users, also turn over this user manual as well as other relevant information provided by the manufacturer.
- Only use the device on the basis of the complete user manual. Missing information due to an incomplete user manual can result in minor injury and property damage.
- Only install and operate the P-73x after having read and understood this user manual.

Personnel qualification

The P-73x may only be started up, operated, maintained and cleaned by authorized and qualified staff.

3 Product Description

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3.1 Features and Applications

P-73x stages are piezo-actuator-driven precision positioning systems with up to three motion axes.

Piezo actuators expand when an electric voltage is applied. The motion of the piezo actuators and levers is used by the P-73x to achieve travel ranges of up to 100 μm with resolutions in the nanometer range.

In order to achieve the specifications stated in the data table (p. 37), the stage is calibrated at the factory as a system component with suitable electronics. The electronics and mechanical system only offer optimum performance as a complete calibrated system.

The electronics must be ordered separately. For suitable electronics, see "Recommended Piezo Controllers" (p. 50).

Vacuum-compatible versions of the P-73x are available on request.

3.2 Model Overview

The following standard versions of the P-733 and P-734 are available:

3.2.1 Piezo XY Stage

Model	Description
P-733.2CD	High-Precision XY Nanopositioning System, 100 μm \times 100 μm , Capacitive Sensors, Parallel Metrology, Sub-D Connector
P-733.2CL	High-Precision XY Nanopositioning System, 100 μm \times 100 μm , Capacitive Sensors, Parallel Metrology, LEMO Connector
P-733.2DD	High-Dynamics High-Precision XY Nanopositioning System, 30 μm \times 30 μm , Direct Drive, Capacitive Sensors, Parallel Metrology, Sub-D Connector
P-734.2CD	High-Precision XY Nanopositioning System with Minimum Runout, 100 μm \times 100 μm , Capacitive Sensors, Parallel Metrology, Sub-D Connector
P-734.2CL	High-Precision XY Nanopositioning System with Minimum Runout, 100 μm \times 100 μm , Capacitive Sensors, Parallel Metrology, LEMO Connector

3.2.2 Piezo XYZ Stage

Model	Description
P-733.3CD	Precision XYZ Nanopositioning System, 100 μm \times 100 μm \times 10 μm , Capacitive Sensors, Parallel Metrology, Sub-D Connector
P-733.3CL	Precision XYZ Nanopositioning System, 100 μm \times 100 μm \times 10 μm , Capacitive Sensors, Parallel Metrology, LEMO Connector
P-733.3DD	High-Dynamics Precision XYZ Nanopositioning System, 30 μm \times 30 μm \times 10 μm , Direct Drive, Capacitive Sensors, Parallel Metrology, Sub-D Connector

3.2.3 Precision Z Stage

Model	Description
P-733.ZCD	Compact Precision Nanopositioning Vertical Stage, 100 μm , Capacitive Sensor, Sub-D Connector
P-733.ZCL	Compact Precision Nanopositioning Vertical Stage, 100 μm , Capacitive Sensor, LEMO Connector

3.3 Product View

The illustration serves as an example and can differ from your stage model.

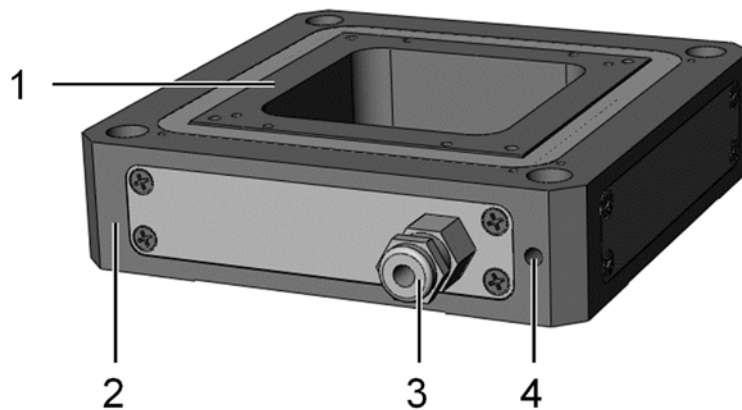


Figure 1: Example of product view

- 1 Moving platform
- 2 Base body
- 3 Cable outlet
- 4 Protective earth connection

3.4 Scope of Delivery

Order Number	Items
P-73x	Stage according to order (p. 10)
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 safety washers ▪ 2 flat washers
PZ240EK	Short instructions for piezo positioning systems

3.5 Technical Features

3.5.1 PICMA® Piezo Actuators

P-73x stages are driven by PICMA® piezo actuators. PICMA® actuators have all-ceramic insulation and are therefore far superior to conventional actuators in respect to performance and lifetime. The monolithic piezoceramic block is protected against humidity and failure due to increased leakage current by a ceramic insulation layer. 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 backlash-, maintenance- and wear-free.

3.5.2 Flexure Guides

P-73x stages have flexure guides (flexures) for frictionless motion and high guiding accuracies.

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

3.5.3 Capacitive Sensors

The capacitive sensors of the P-73x measure the position directly at the moving platform (direct metrology) and work without contact. Neither friction nor hysteresis interferes with the measurement, which allows excellent linearity values to be achieved in combination with the high position resolution. In connection with suitable electronics, capacitive sensors achieve the best resolution, stability and bandwidth.

3.5.4 ID Chip (Only Models with Sub-D Connector)

An ID chip is located in the Sub-D connector of the stage. When the stage is calibrated at the factory with digital electronics, the calibration data is saved together with specific product information on the ID chip. When switched on, digital electronics read the data from the ID chip of the connected stage. Stages whose ID chip contains the calibration data can therefore be connected to any suitable digital electronics without a new calibration.

For more information on the ID chip, see the manual of the controller used.

4 Unpacking

1. Unpack the P-73x with care.
2. Compare the contents against the items covered by the contract and against the packing list.
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 Installation

In this Chapter

General Notes on Installation	17
Connecting the P-73x to a Protective Earth Conductor	19
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5.1 General Notes on Installation

CAUTION



Dangerous voltage and residual charge on piezo actuators!

The P-73x is driven by piezo actuators. Temperature changes and compressive stresses can induce charges in piezo actuators. After being disconnected from the electronics, piezo actuators can also stay charged for several hours. Touching or short-circuiting the contacts in the connector of the P-73x can lead to minor injuries. In addition, the piezo actuators can be destroyed by an abrupt contraction.

- Do **not** open the P-73x.
- Discharge the piezo actuators of the stage before installation:
Connect the stage to the switched-off PI controller, which is equipped with an internal discharge resistor.
- Do **not** pull out the connector from the electronics during operation.



For stages with Sub-D connector:

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

- Do **not** touch the contacts in the connector.
- Secure the connector of the stage with screws against being pulled out of the controller.

NOTICE**Unsuitable cables!**

Unsuitable cables can damage the electronics.

- Only use cables from PI for connecting the P-73x to the electronics.

NOTICE**Damage from incorrect mounting!**

Incorrect mounting of the P-73x or incorrectly mounted parts can damage the P-73x.

- Only mount the P-73x and the loads on the mounting fixtures (holes) intended for this purpose.

NOTICE**Damage due to incorrectly tightened screws**

Incorrectly tightened screws can cause damage.

- Observe the torque range (p. 46) given for the screws used during installation.

INFORMATION

Extended cables can affect the performance of the P-73x.

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

5.2 Connecting the P-73x to a Protective Earth Conductor


INFORMATION

In the case of P-73x stages with Sub-D connectors, ground loops can occur when the stage is grounded via its protective earth connector as well as by the shield of the connection cable for the electronics.

- If a ground loop occurs, contact our customer service department (p. 35).

INFORMATION

- Observe the applicable standards for mounting the protective earth conductor.

The P-73x is equipped with an M4 hole for fastening the protective earth conductor. This hole is located next to the cable exit and is marked with the protective earth conductor symbol  (see "Dimensions" (p. 41)).

Prerequisite

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

Tools and accessories

- Suitable protective earth conductor: Cross-sectional area of the cable $\geq 0.75 \text{ mm}^2$
- Supplied M4 protective earth screw set (p. 12) for connecting the protective earth conductor
- Suitable screwdriver

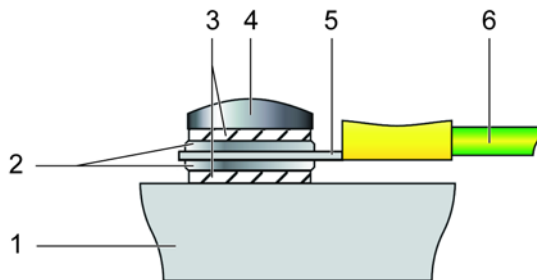


Figure 2: Mounting of the protective earth conductor (profile view)

- 1 Base body of the P-73x
- 2 Flat washer
- 3 Safety washer
- 4 Screw
- 5 Cable lug
- 6 Protective earth conductor

1. If necessary, fasten a suitable cable lug to the protective earth conductor.
2. Fasten the cable lug of the protective earth conductor using the M4 screw on the protective earth connection of the P-73x as shown in the profile view.
3. Tighten the M4 screw with at least three rotations and a torque of 1.2 Nm to 1.5 Nm.
4. Make sure that the contact resistance at all connection points relevant for mounting the protective earth conductor is $<0.1 \Omega$ at 25 A.

5.3 Mounting the P-73x

NOTICE



Warping of the P-73x due to mounting on uneven surfaces!

Mounting the P-73x on an uneven surface can warp the P-73x. Warping reduces the accuracy.

- Mount the P-73x on an even surface. The recommended evenness of the surface is $\leq 20 \mu\text{m}$.
- For applications with great temperature changes:
Only mount the P-73x on surfaces that have the same or similar thermal expansion properties as the P-73x (e.g. surfaces made of aluminum).

NOTICE



Tensile stress on piezo actuator with vertical mounting!

When the stage is mounted vertically, a tensile stress can result in particular alignments that destroys the piezo actuator.

- If you want to mount the P-73x vertically, contact our customer service department (p. 35).

NOTICE



Protruding screw heads!

Protruding screw heads can damage the P-73x.

- Ensure that the screw heads do not protrude from counter-sunk holes so that they do not interfere with the stage motion.

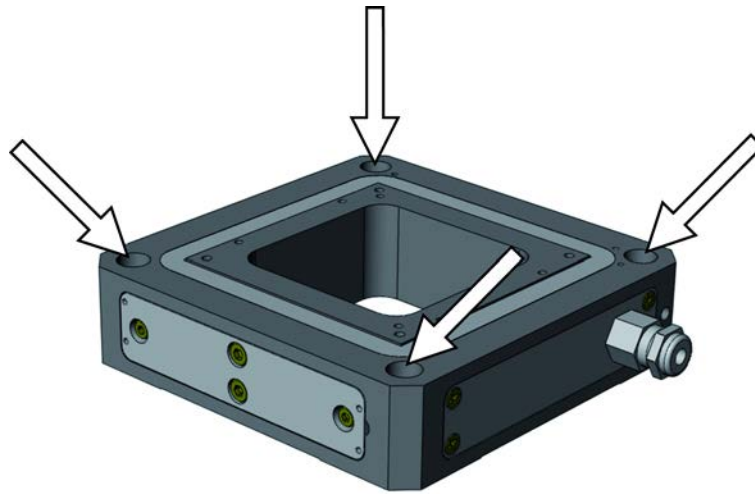


Figure 3: Mounting holes in the base body

Prerequisite

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

Tools and accessories:

- Screws of appropriate size and length (see "Dimensions" (p. 41))
- Suitable tools

Mounting the stage on a surface

1. Position the stage on an even surface.
2. For the P-73x.2Cx and P-733.3Cx models:
Ensure a distance of at least 0.5 mm between the stage and the surrounding objects.
3. Fasten the stage to the mounting holes (see figure) with suitable screws.
Observe the specified torque range (p. 46) while doing so.

5.4 Affixing the Load

NOTICE



Mechanical overload due to high torques!

When affixing the load, high torques can damage the piezo actuators, sensors and piezo levers of the P-73x and can cause losses in accuracy.

- Observe the torque range (p. 46) given for the used screws when affixing the load.

NOTICE



Warping of the P-73x due to affixing of loads with uneven contact surface!

Affixing loads with an uneven contact surface can warp the P-73x. Warping reduces the accuracy.

- Only affix loads on the P-73x whose contact surface with the moving platform of the stage has an evenness of at least 20 µm.
- For applications with great temperature changes:
Only affix loads on the P-73x that have the same or similar thermal expansion properties as the P-73x (e.g. loads made of aluminum).

NOTICE



Center of load at unsuitable position!

If the center of load is located far outside of the moving platform (e. g. high set-ups and long levers), the P-73x can be damaged from high strain on the flexure guides, high torques and oscillations.

- If the center of the load to be affixed is far above or to the side of the moving platform, adjust the controller settings before start-up or contact our customer service department (p. 35).

NOTICE



Screws that are too long!

The P-73x can be damaged by screws that are too long.

- Note the depth of the mounting holes in the moving platform (p. 41).
- Only use screws of the correct length for the respective mounting holes.

INFORMATION

The arrows in the figures (see "Dimensions" (p. 41)) show the positive direction of motion.

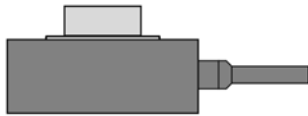
Center of load at the optimum position:

Figure 4: Example of an optimally affixed load

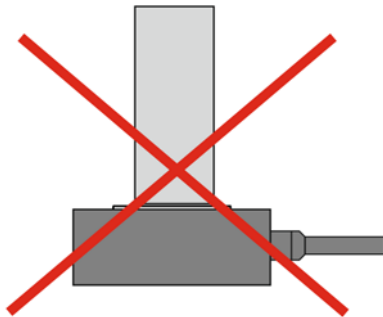
Center of load at an unsuitable position:

Figure 5: High set-up and center of load far above the moving platform

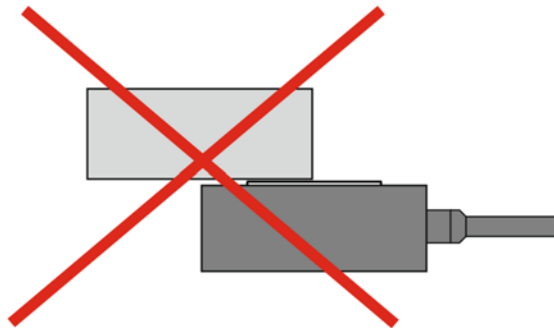


Figure 6: Long lever and center of load on the side of the moving platform

Prerequisite

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

Tools and accessories:

- Screws of appropriate size and length (see "Dimensions" (p. 41))
- Suitable tools

Affixing the Load

- Only affix loads to the threaded holes intended for this purpose (see "Dimensions" (p. 41)) and with suitable screws. Observe the specified torque range (p. 46) while doing so.
- Affix the load so that it is centered and that the center of load is on the moving platform.
- Avoid high set-ups with the center of load far above the moving platform.
- Avoid long levers with the center of load on the side of the moving platform.

6 Start-up and Operation

In this Chapter

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Discharging the P-73x	30

6.1 General Notes on Start-Up and Operation

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 and there is a risk of electric shock. In the case of malfunction or failure of the system, touching the P-73x can result in minor injuries.

- Connect the P-73x to a protective earth conductor (p. 19) before start-up.
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be temporarily removed (e.g. for modifications), reconnect the P-73x to the protective earth conductor before starting it up again.

NOTICE



Destruction of the piezo actuator by electric flashovers!

The use of the P-73x 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 such as 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-73x in environments that can increase the electric conductivity.
- Only operate the P-73x within the permissible ambient conditions and classifications (p. 40).

NOTICE**Reduced lifetime of the piezo actuator due to permanently high voltage!**

The permanent application of a high static voltage to piezo actuators leads to a considerable reduction in the lifetime of the piezo ceramics of the actuator.

- When the P-73x is not used but the controller remains switched on to ensure temperature stability, discharge the P-73x (p. 30).

NOTICE**Operating voltages that are too high or incorrectly connected can cause damage!**

Operating voltages that are too high or incorrectly connected can cause damage to the P-73x.

- Only operate the P-73x with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating voltage range (p. 39) for which the P-73x is specified.
- Only operate the P-73x when the operating voltage is properly connected; see "Pin Assignment" (p. 47).

NOTICE**Uncontrolled oscillation!**

Oscillations can cause irreparable damage to the stage. Oscillations are indicated by a humming and can result from the following causes:

- A change in the load and/or dynamics requires the servo-control parameters to be adjusted.
- The stage is operated near its resonant frequency.

If you notice oscillations:

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

INFORMATION

The arrows in the figures (see "Dimensions" (p. 41)) show the positive direction of motion.

INFORMATION

Systems are calibrated at the factory to achieve optimum performance. Replacing the system components will cause a loss in performance when stages are used, whose ID chip (p. 13) does not contain any calibration data, or when analog controllers are used.

- Note the assignment of the stage axes to the controller channels, which is given by the calibration label of the piezo servo controller.
- If the piezo servo controller or the stage has to be replaced, recalibrate the axis displacement (see controller manual) or contact our customer service department (p. 35).

INFORMATION

Sound and vibration (e.g. footfall, impacts) can be transmitted to the stage and can affect its performance with regard to position stability.

- Avoid transmitting sound and vibration while the stage is being operated.

6.2 Operating the P-73x

- Follow the instructions in the manual of the used piezo controller for start-up and operation of the P-73x.

6.3 Discharging the P-73x

The P-73x must be discharged in the following cases:

- If the P-73x is not used but the controller remains switched on to ensure temperature stability
- Before demounting (e.g. before cleaning and transporting the P-73x and for modifications)

The P-73x is discharged through the internal discharge resistor of the controller from PI.

Discharging a P-73x that is connected to the controller

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 controller.

Discharging a P-73x that is not connected to the controller

- Connect the stage to the switched-off controller from PI.

7 Maintenance

In this Chapter

General Notes on Maintenance.....	31
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7.1 General Notes on Maintenance

NOTICE



Misalignment from loosening screws!

The P-73x is maintenance-free and achieves its positioning accuracy as a result of the optimum alignment of mechanical components and piezo actuators. Loosened screws cause a loss in positioning accuracy.

- Only loosen screws according to the instructions in this manual.
- Do not open the P-73x.

7.2 Cleaning the P-73x

Prerequisites

- ✓ You have discharged the piezo actuators of the P-73x (p. 30).
- ✓ You have disconnected the P-73x from the controller.

Cleaning the P-73x

- Clean the surfaces of the P-73x with a cloth slightly dampened with a mild cleanser or disinfectant (e.g. alcohol or isopropanol).
- Do **not** do any ultrasonic cleaning.

8 Troubleshooting

Problem	Possible Causes	Solution
No or limited motion	The cable is not connected correctly	➤ Check the cable connections.
	Excessive load	➤ Do not exceed the permissible compressive/tensile stress capacity according to the specifications (p. 37).
	The load was changed	➤ After changing the load to be moved, perform a zero-point adjustment (see controller manual).
Reduced accuracy	Warping of the base body or the moving platform	<ul style="list-style-type: none"> ➤ Only mount the P-73x on surfaces with the following characteristics: <ul style="list-style-type: none"> – Evenness of at least 20 µm – The thermal expansion properties are similar to those of the P-73x (e. g. surfaces made of aluminum). ➤ Only affix loads with the following characteristics on the P-73x: <ul style="list-style-type: none"> – The contact surface of the load with the moving platform of the stage has an evenness of at least 20 µm. – The thermal expansion properties are similar to those of the P-73x (e. g. loads made of aluminum).

Problem	Possible Causes	Solution
	P-73x or controller has been replaced	<p>When stages, whose ID chip (p. 13) does not contain any calibration data, or analog controllers are used, the axis displacement has to be recalibrated after the P-73x or the controller has been replaced.</p> <ul style="list-style-type: none"> ➤ Perform a recalibration of the axis displacement (see controller manual) or contact our customer service department (p. 35).
	Axes were mixed up during connection (only with LEMO connectors)	<ul style="list-style-type: none"> ➤ Observe the assignment of the axes when connecting the stage to the controller. This assignment is indicated by labels on the devices.
The stage starts oscillating or is positioned inaccurately	Servo-control parameters incorrectly set because e. g. the load was changed	<ol style="list-style-type: none"> 1. Immediately switch off the servo mode of the corresponding stage axes. 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	<ul style="list-style-type: none"> ➤ In open-loop operation, only operate the stage with a frequency that is below the resonant frequency.

If the problem that occurred with your system is not listed in the table above or it cannot be solved as described, contact our customer service department (p. 35).

9 Customer Service

For inquiries and orders, contact your PI sales engineer or send us an e-mail (info@pi.ws).

If you have questions concerning your system, have the following information ready:

- Product codes and serial numbers of all products in the system
- Firmware version of the controller (if present)
- Version of the driver or the software (if present)
- Operating system on the PC (if present)

The latest versions of the relevant user manuals for your system are available for download on our website (<http://www.pi.ws>).

10 Technical Data

In this Chapter

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10.1 Specifications

10.1.1 Data Table

	Unit	P-733.2CD P-733.2CL	P-733.3CD P-733.3CL	P-733.2DD	P-733.3DD	P-734.2CD P-734.2CL	P-733.ZCD P-733.ZCL
Active axes		X, Y	X, Y, Z	X, Y	X, Y, Z	X, Y	Z
Motion and positioning							
Integrated sensor		Capacitive	Capacitive	Capacitive	Capacitive	Capacitive	Capacitive
Open-loop travel in X, Y, -20 to +120 V	µm	115	115	33	33	110	–
Open-loop travel in Z, -20 to +120 V	µm	–	12	–	14	–	115
Closed-loop travel in X, Y	µm	100	100	30	30	100	–
Closed-loop travel in Z	µm	–	10	–	10	–	100
Open-loop resolution in X, Y	nm	0.2	0.2	0.1	0.1	0.2	–
Open-loop resolution in Z	nm	–	0.1	–	0.1	–	0.2
Closed-loop resolution in X, Y	nm	0.3	0.3	0.1	0.1	0.3	–
Closed-loop resolution in Z	nm	–	0.2	–	0.1	–	0.3
Linearity deviation in X, Y	%	0.03	0.03	0.03*	0.03*	0.03	–
Linearity deviation in Z	%	–	0.03	–	0.03*	–	0.03
Repeat-ability in X, Y	nm	<2	<2	< 2	<2	<2.5	–




	Unit	P-733.2CD P-733.2CL	P-733.3CD P-733.3CL	P-733.2DD	P-733.3DD	P-734.2CD P-734.2CL	P-733.ZCD P-733.ZCL
Repeat-ability in Z	nm	–	< 1	–	<1	–	<2
Pitch in X, Y	μrad	<5	<5	<5	<5	<3	–
Tilt around X, Y (with motion in Z)	μrad	–	<5	–	<5	–	<5
Yaw in X, Y	μrad	<10	<10	<10	<10	<10	–
Straightness in X, Y	nm	<20	<20	<5	<5	–	–
Crosstalk in X, Y (with motion in Z)	nm	–	<20	–	<20	–	<80
Evenness in X, Y	nm	<15	<15	<5	<5	typ. <5, max. 10	–
Mechanical properties							
Stiffness in X, Y	N/μm	1.5	1.4	20	4	3	–
Stiffness in Z	N/μm	–	9	–	10	–	2.5
Unloaded resonant frequency in X, Y	Hz	500	460	2230	1200	500	–
Unloaded resonant frequency in Z	Hz	–	1400	–	1100	–	700
Loaded resonant frequency in X, Y	Hz	370 (120 g)	340 (120 g)	1800 (50 g)	–	350 (200 g)	–
Loaded resonant frequency in Z	Hz	–	1060 (120 g)	–	–	–	530 (120 g)
Loaded resonant frequency in X, Y	Hz	340 (200 g)	295 (200 g)	1550 (200 g)	530 (200 g)	250 (500 g)	–
Loaded resonant frequency in Z	Hz	–	650 (200 g)	–	635 (200 g)	–	415 (200 g)
Compressive/tensile stress capacity in the direction of travel	N	300 / 100	300 / 100	300 / 100	300 / 100	300 / 100	50 / 20
Load capacity	N	20	20	20	20	20	20
Drive properties							
Piezo ceramics		PICMA® P-885	PICMA® P-885	PICMA® P-885	PICMA® P-885	PICMA® P-885	PICMA® P-885
Electrical capacitance in X, Y	μF	6	6	6.2	6.2	6.2	–
Electrical capacitance in Z	μF	–	2.4	–	3.3	–	6
Dynamic operating current coefficient in X, Y	μA / (Hzx μm)	7.5	7.5	25	25	7.8	–
Dynamic operating current coefficient in Z	μA / (Hzx μm)	–	30	–	41	–	7.5
Miscellaneous							
Operating temperature range	°C	–20 to 80	–20 to 80	–20 to 80	–20 to 80	–20 to 80	–20 to 80




	Unit	P-733.2CD P-733.2CL	P-733.3CD P-733.3CL	P-733.2DD	P-733.3DD	P-734.2CD P-734.2CL	P-733.ZCD P-733.ZCL
Material		Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum
Dimensions		100 mm x 100 mm x 25 mm	100 mm x 100 mm x 25 mm	100 mm x 100 mm x 20 mm	100 mm x 100 mm x 25 mm	130 mm x 130 mm x 30 mm	100 mm x 100 mm x 25 mm
Mass	kg	0.58	0.675	0.58	0.675	1.04	0.58
Cable length	m	1.5	1.5	1.5	1.5	1.5	1.5
Sensor connection		CD version: Sub-D special connector CL version: 4x LEMO connectors	CD version: Sub-D special connector CL version: 6x LEMO connectors	Sub-D special connector	Sub-D special connector	CD version: Sub-D special connector CL version: 4x LEMO connectors	CD version: Sub-D special connector CL version: 2x LEMO connectors
Voltage connection		CD version: Sub-D special connector CL version: 2x LEMO connectors	CD version: Sub-D special connector CL version: 3x LEMO connectors	Sub-D special connector	Sub-D special connector	CD version: Sub-D special connector CL version: 2x LEMO connectors	CD version: Sub-D special connector CL version: 1x LEMO connector
Recommended controller / amplifier	See "Suitable Piezo Controllers" (p. 50).						

*With digital controller. In the case of analog controllers, the linearity deviation for directly driven stages can be typically up to 0.1 %.

10.1.2 Maximum Ratings

P-73x stages are designed for the following operating parameters:

Stage	Maximum Operating Voltage 	Maximum Operating Frequency (Unloaded) 	Maximum Power Consumption 
P-733.2CD P-733.2CL	-20 to +120 V	167 Hz (in X and Y)	20 W (in X and Y)
P-733.2DD	-20 to +120 V	743 Hz (in X and Y)	86 W (in X and Y)
P-734.2CD P-734.2CL	-20 to +120 V	167 Hz (in X and Y)	20 W (in X and Y)

Stage	Maximum Operating Voltage 	Maximum Operating Frequency (Unloaded) 	Maximum Power Consumption 
P-733.3CD P-733.3CL	-20 to +120 V	153 Hz (in X and Y) 467 Hz (in Z)	18 W (in X and Y) 24 W (in Z)
P-733.3DD	-20 to +120 V	400 Hz (in X and Y) 367 Hz (in Z)	46 W (in X and Y) 29 W (in Z)
P-733.ZCD P-733.ZCL	-20 to +120 V	233 Hz	28 W

10.1.3 Ambient Conditions and Classifications

The following ambient conditions and classifications must be observed for the P-73x:

Area of application	For indoor use only
Maximum altitude	2000 m
Air pressure	1100 hPa to 0.1 hPa (corresponds to roughly 825 Torr to 0.075 Torr)
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.

Standard tolerance according to DIN ISO 2768 - f - H

Roughness Ra 1.6

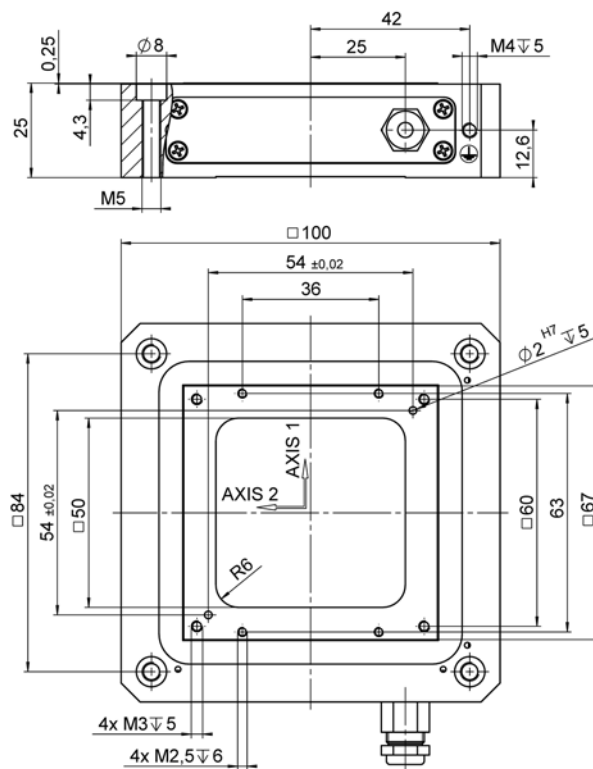


Figure 7: P-733.2Cx

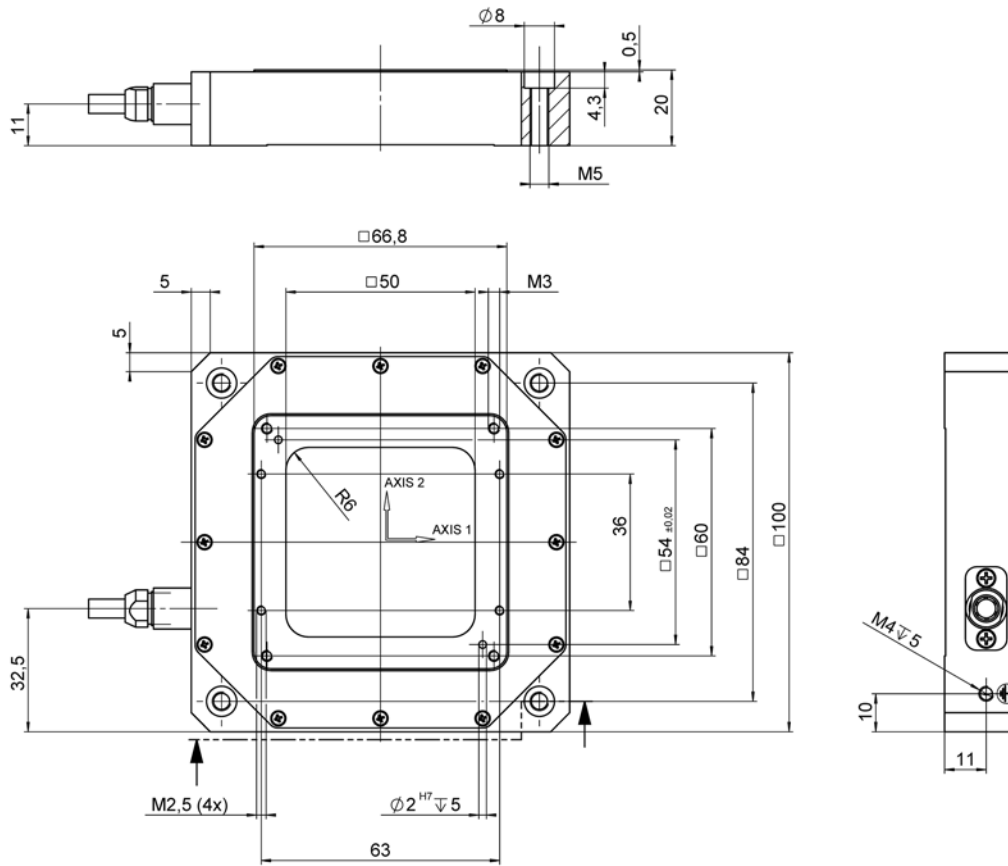


Figure 8: P-733.2DD

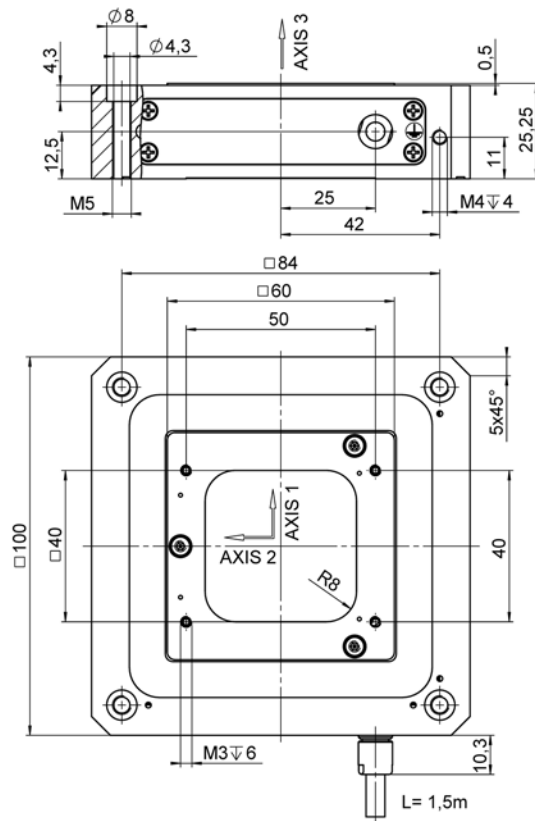


Figure 9: P-733.3Cx

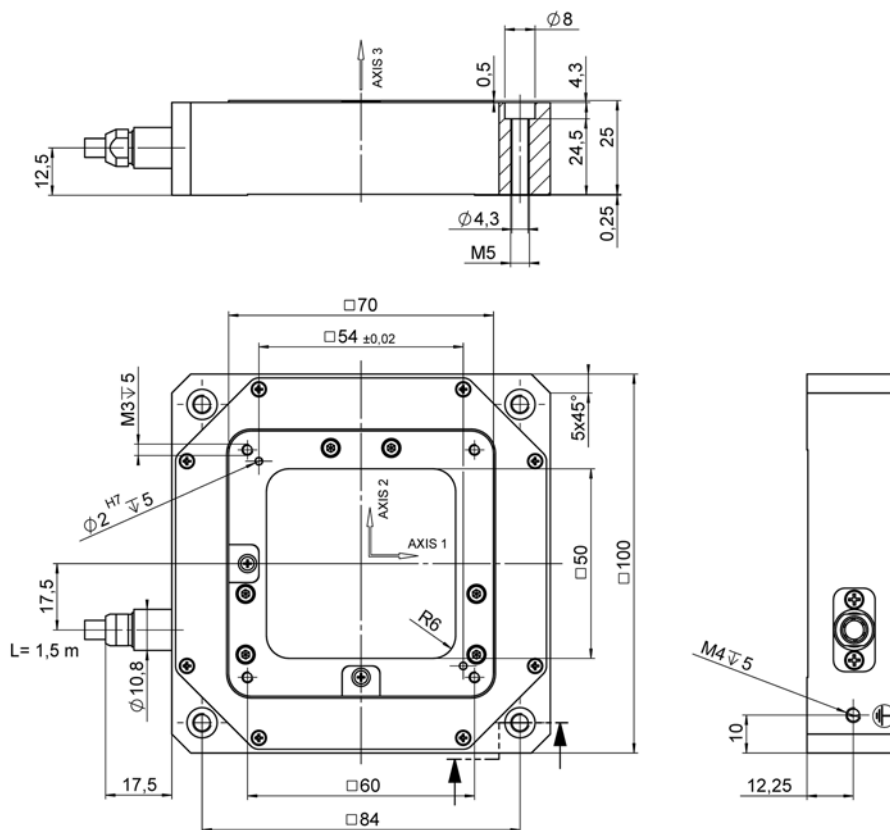


Figure 10: P-733.3DD

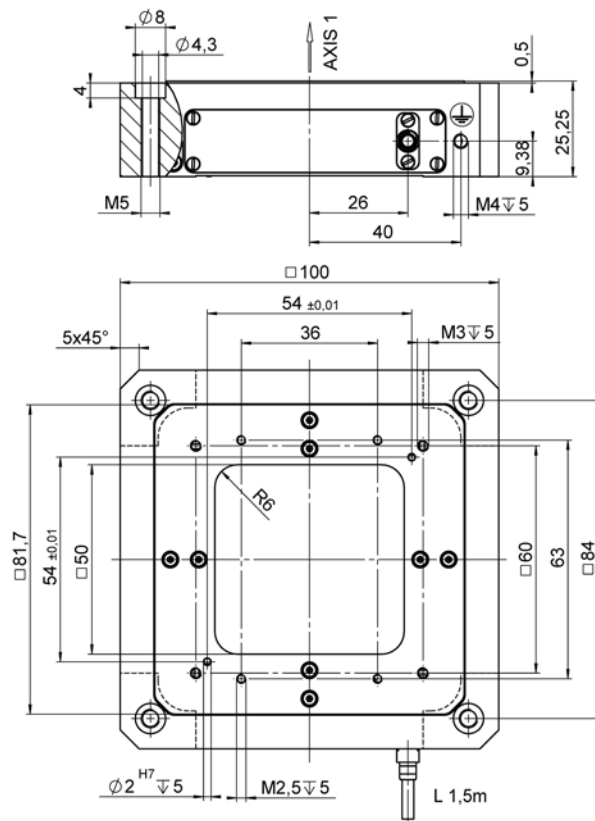


Figure 11: P-733.ZCx

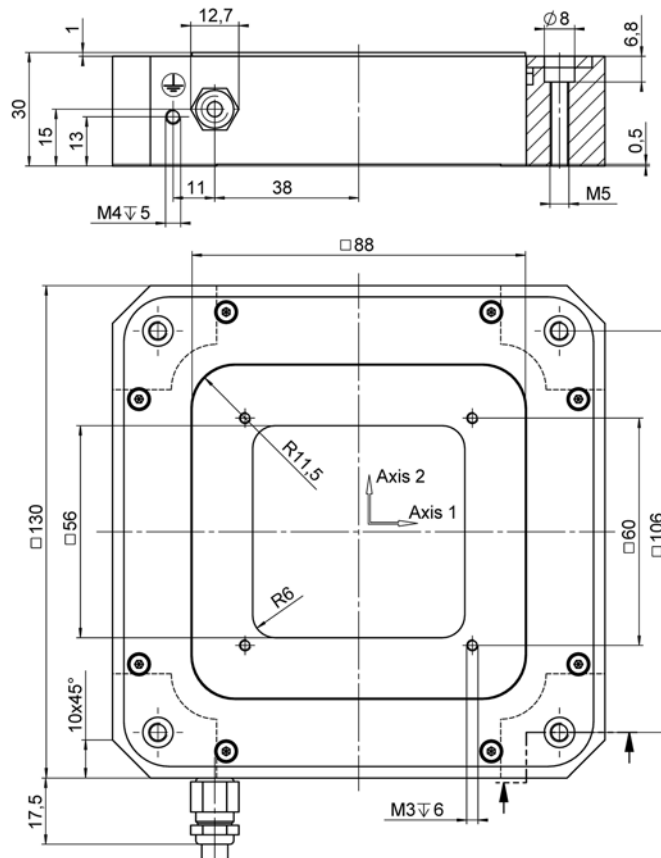


Figure 12: P-734.2Cx

10.3 Torque for Stainless Steel Screws (A2-70)

Screw Size	Minimum Torque	Maximum Torque
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

10.4 Pin Assignment

Sub-D mix connector 7W2

Only for P-733.ZCD:

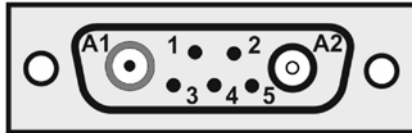


Figure 13: Sub-D mix connector 7W2: Front side with connections

Pin	Signal	Function
A1 inner conductor	Input	Piezo voltage +
A2 inner conductor	Output	Probe sensor signal (nonmoving part of the capacitive sensor)
A2 outer conductor	GND	Shield
1	Bidirectional	Data line for ID chip
2	GND	<ul style="list-style-type: none"> ▪ Shield of Target ▪ Ground of ID chip when switched on
3	Input	Piezo voltage –
4	Free	–
5	Input	Target sensor signal (movable part of the capacitive sensor)

Sub-D mix connector 25W3

Only for P-73x.2CD/.2DD/.3CD/.3DD:

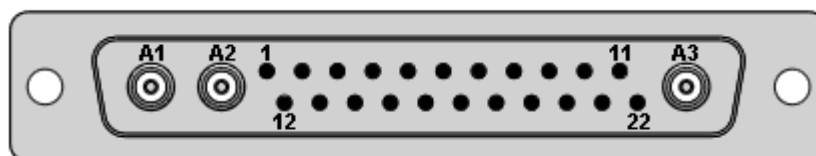


Figure 14: Sub-D mix connector 25W3: Front side with connections

Pin	Signal	Function
A1 inner conductor	Output	Probe sensor signal, channel 2 (nonmoving part of the capacitive sensor)
A1 outer conductor	GND	Shield of Probe sensor signal, channel 2
A2 inner conductor	Output	Probe sensor signal, channel 3 (nonmoving part of the capacitive sensor)
A2 outer conductor	GND	Shield of Probe sensor signal, channel 3
A3 inner conductor	Output	Probe sensor signal, channel 1 (nonmoving part of the capacitive sensor)
A3 outer conductor	GND	Shield of 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	Ground of ID chip
4	Bidirectional	Data line for ID chip
5	Free	–
6	Free	–
7	Input	Piezo voltage +, channel 4
8	Input	Piezo voltage +, channel 3
9	Input	Piezo voltage +, channel 2

Pin	Signal	Function
10	Input	Piezo voltage +, channel 1
11	Input	Target sensor signal, channel 1 (movable part of the capacitive sensor)
12	GND	Shield of Target sensor signal, channel 2
13	GND	Shield of Target sensor signal, channel 3
14	Free	–
15	Free	–
16	Free	–
17	Free	–
18	Input	Piezo voltage –, channel 4
19	Input	Piezo voltage –, channel 3
20	Input	Piezo voltage –, channel 2
21	Input	Piezo voltage –, channel 1
22	GND	Shield of Target sensor signal, channel 1

Stage-dependent assignment of the Sub-D mix connector 25W3 (X = used):

Stage	Piezo Voltage				Sensor Signal (Probe / Target / Shield)		
	Chan- nel 1 Pins 10 and 21	Chan- nel 2 Pins 9 and 20	Chan- nel 3 Pins 8 and 19	Chan- nel 4 Pins 7 and 18	Channel 1 Pins A3, 11 and 22	Channel 2 Pins A1, 1 and 12	Channel 3 Pins A2, 2 and 13
P-733.2CD	X	X	–	–	X	X	–
P-733.2DD	X	X	–	–	X	X	–
P-733.3CD	X	X	X	–	X	X	X
P-733.3DD	X	X	X	–	X	X	X
P-734.2CD	X	X	–	–	X	X	–

LEMO coaxial connector

Only for P-73x.2CL/.3CL/.ZCL (one PZT, P and T connector each per axis):



Figure 15: LEMO coaxial connectors

Connector	Signal	Function	Connector Shell
P	Output	Probe sensor signal (nonmoving part of the capacitive sensor)	Cable shield
T	Input	Target sensor signal (movable part of the capacitive sensor)	Cable shield
PZT	Input	Piezo voltage	Ground

10.5 Suitable Piezo Controllers

To operate a P-73x, you need a piezo controller. The device is selected depending on the type of application. The table below lists suitable controllers.

Controller	Channels	P-733.2CD	P-733.2DD	P-734.2CD	P-733. 2CL	P-734 2CL	P-733.3CD	P-733.3DD	P-733. 3CL	P-733. ZCD	P-733. ZCL
		E-625.CR / E-665.CR controller bench-top device with digital interface	1	-	-	-	-	-	-	-	X
E-610.C0 piezo controller OEM board	1	-	-	-	-	-	-	-	-	-	X
E-609 OEM piezo controller	1	-	-	-	-	-	-	-	X	-	
E-709.CRG digital single-channel piezo controller	1	-	-	-	-	-	-	-	X	-	
E-753 digital piezo controller (bench-top device)	1	-	-	-	-	-	-	-	X	-	

Controller	Channels	P-733.2CD	P-733.2DD	P-734.2CD	P-733. 2CL	P-734 2CL	P-733.3CD	P-733.3DD	P-733. 3CL	P-733. ZCD	P-733. ZCL
E-500 modular piezo controller with E-509.C1A control module for capacitive sensors and E-505 1-channel amplifier Optional: E-517 interface and display module	1	-	-	-	-	-	-	-	-	-	X
E-500 modular piezo controller with E-509.C3A control module for capacitive sensors and E-503 3-channel amplifier Optional: E-517 interface and display module	3	-	-	-	X	-	-	-	X	-	-
E-500 modular piezo controller with E-509.C3A control module for capacitive sensors and 3x E-505 1-channel high-performance amplifier Optional: E-517 interface and display module	3	-	-	-	X	-	-	-	X	-	-
E-500 modular piezo controller with E-509.C2A control module for capacitive sensors and 2x E-505 1-channel high-performance amplifier Optional: E-517 interface and display module	2	-	-	-	X	-	-	-	-	-	-
E-712 digital piezo controller, modular system for up to 6 axes	3 / 6	X	-	-	-	-	X	-	-	-	-
E-725 digital piezo controller for up to 3 axes	3	X	-	-	-	-	X	-	-	-	-
E-761 digital piezo controller for up to 3 axes, PCI card	3	X	-	-	-	-	X	-	-	-	-

11 Old Equipment Disposal

Since 13 August 2005, in accordance with the EU directive 2002/96/EC (WEEE), electrical and electronic equipment can no longer be disposed of in the member states of the EU with other wastes.

When disposing of your old equipment, observe the international, national and local rules and regulations.

To meet the manufacturer's product responsibility with regard to this product, Physik Instrumente (PI) GmbH & Co. KG ensures environmentally correct disposal of old PI equipment that was first put into circulation after 13 August 2005, free of charge.

If you have old PI equipment, you can send it postage-free to the following address:

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



12 EC Declaration of Conformity

PI

Declaration of Conformity

according to DIN EN ISO/IEC 17050-1:2005

Manufacturer:	Physik Instrumente (PI) GmbH & Co. KG	
Manufacturer's Address:	Auf der Roemerstrasse 1 D-76228 Karlsruhe, Germany	

The manufacturer hereby declares that the product

Product Name: **Piezo Nanopositioning System**
 Model Numbers: **P-733, P-734**
 Product Options: **all**

complies with the following European directives:

2006/95/EC, Low Voltage Directive (LVD)
 2004/108/EC, EMC Directive
 2011/65/EC, RoHS Directive


The applied standards certifying the conformity are listed below.

Electromagnetic Emission: EN 61000-6-3:2007, EN 55011:2009

Electromagnetic Immunity: EN 61000-6-1:2007

Safety (Low Voltage Directive): EN 61010-1:2010

August 16, 2012
 Karlsruhe, Germany


 Norbert Ludwig
 Managing Director

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PIEZO NANO POSITIONING