

User Manual

P736T0002, applies to P-736.ZRxS Plnano® Piezo Scanner Systems
CBo, 2021-09-20



P-736.ZRxS Plnano® Piezo Scanner Systems



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About this Document

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 or cause damage to equipment.

- Precautionary measures for avoiding.

NOTICE



Dangerous situation

Failure to comply could cause damage to equipment.

- Precautionary measures for avoiding.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/Label

1.

Meaning
Action consisting of several steps with strict sequential order

2.



Action consisting of one or more steps without relevant sequential order



List item

p. 5

Cross-reference to page 5

RS-232

Operating element labeling on the product (example: socket of the RS-232 interface)



Warning signs on the products that refer to detailed information in the documentation.



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.

Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

- Contact our customer service department (p. 19).

Downloading manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., P-736) or the product family (e.g., PInano®).
3. Click the corresponding product to open the product detail page.
4. Click **Downloads**.

The manuals are shown under **Documentation**.

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

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

Other Applicable Documents

The devices which are mentioned in this user manual are described in their own manuals.

Product	Document
E-709 digital piezo controller	PZ222E user manual

Safety

Intended Use

The P-736.ZRxs PInano® Z piezo scanners and the E-709.PRG digital piezo controllers are laboratory devices as defined by DIN EN 61010-1. They are intended to be used in interior spaces and in an environment which is free of dirt, oil and lubricants.

Based on their design and realization, the Z piezo scanners are intended to position in Z direction. They are designed to position a sample holder with suitable dimensions (e.g., a microscope slide holder or a Petri dish holder).

The Z piezo scanners can carry a maximum load of 0.5 kg. They are intended to be used with M-545 microscope stages or with other suitable microscope stages.

The Z piezo scanners are to be mounted horizontally.

The intended use of the Z piezo scanner is only possible in combination with the E-709.PRG digital piezo controller. The E-709.PRG controller provides the required operating voltages. To ensure proper performance of the servo-control system, the controller is able to read out and process the signals from the piezoresistive sensors.

Safety Precautions

Electrical dangers

CAUTION



Dangerous voltage and residual charge on piezo actuators!

The P-736.ZRx 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-736.ZRx can lead to minor injuries from electric shock. In addition, the piezo actuators can be destroyed by an abrupt contraction.

- Do **not** open the P-736.ZRx.
- Discharge the piezo actuators before installation:
Connect the P-736.ZRx to the switched-off PI controller.
- Do **not** pull the connector out of the controller during operation.



For piezo scanners with D-sub 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 piezo scanner with screws against being pulled out of the controller.

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 event of malfunction or failure of the system, touching the P-736.ZRx can result in minor injuries.

- Connect the P-736.ZRx to a protective earth conductor (p. 11) before startup.
- 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-736.ZRx to the protective earth conductor before starting it up again.

NOTICE



Destruction of the piezo actuators by electric flashovers!

The use of the P-736.ZRx in environments that increase the electrical conductivity can lead to the destruction of the piezo actuators 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-736.ZRx in environments that can increase the electric conductivity.
- Only operate the P-736.ZRx within the permissible ambient conditions and classifications (p. 21).

NOTICE



Destruction of the piezo actuators by continuously high voltage!

The constant application of high voltage to piezo actuators can lead to leakage currents and flashovers that destroy the ceramic.

If the P-736.ZRx is not used, but the controller is to remain switched on to ensure temperature stability:

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

NOTICE



Unsuitable cables!

Unsuitable cables can damage the controller.

- Only use cables from PI for connecting the P-736.ZRx to the controller.

INFORMATION

Extended cables can affect the performance of the P-736.ZRx.

- Do **not** use cable extensions. If you need longer cables, contact our customer service department (p. 19).

Mechanical dangers

NOTICE



Mechanical overload due to high torque and high loads!

High torque and high loads can overload the motion platform of the P-736.ZRx. Mechanical overload can cause damage to the piezo actuators, sensors, and flexures of the P-736.ZRx and lead to loss in accuracy.

- Only hold the P-736.ZRx externally by the base body.
- Do **not** exceed a push force of 50 N on the motion platform.
- Do **not** exceed a pull force of 30 N on the motion platform.
- Avoid torques >0.5 Nm on the motion platform.
- Pay attention to the torque range (p. 26) given for the screws used during installation.
- Do **not** exceed the maximum permissible stress and load capacities according to the specifications (p. 20).

NOTICE



Excessively long screws!

The P-736.ZRx may be damaged by excessively long screws.

- Pay attention to the depth of the mounting holes in the motion platform (p. 22).
- Only use screws of the correct length for the respective mounting holes.

NOTICE



Lubricants, dirt, condensation!

Dirt, oil, lubricants and condensation will render the motor/drive inoperable.

- Ensure that the piezo actuators of the P-736.ZRx do not come into contact with lubricants.
- Keep the P-736.ZRx free from dirt and condensation.

NOTICE



Warping of the P-736.ZRx due to mounting onto uneven surfaces!

Mounting the P-736.ZRx onto an uneven surface can warp the P-736.ZRx. Warping reduces the accuracy.

- Mount the P-736.ZRx onto a flat surface. The recommended flatness of the surface is $\leq 10 \mu\text{m}$.
- For applications with large temperature changes: Only mount the P-736.ZRx onto surfaces that have the same or similar thermal expansion properties as the P-736.ZRx (e.g., surfaces made of aluminum).

NOTICE



Uncontrolled oscillation!

Oscillation can cause irreparable damage to the P-736.ZRx. Oscillation is indicated by a humming and can be caused by the following:

- The load and/or dynamics of operation differ too much from the calibration settings.
- The P-736.ZRx is operated near its resonant frequency.
- If you notice oscillation, stop the P-736.ZRx immediately.

Product Description

Model Overview

The following Plnano® piezo scanner systems are available as combinations of Z piezo scanner and digital piezo controller:

System	Z piezo scanner	Digital piezo controller
P-736.ZR1S	P-736.ZR1 Plnano® Z piezo slide scanner, 100 μm , clear aperture for microscope slides, piezoresistive sensors	E-709.PRG Digital piezo controller, 1 channel, -30 to 130 V, piezoresistive sensor, bench- top
P-736.ZR2S	P-736.ZR2 Plnano® Z piezo slide scanner, 200 μm , clear aperture for microscope slides, piezoresistive sensors	E-709.PRG Digital piezo controller, 1 channel, -30 to 130 V, piezoresistive sensor, bench- top

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Product View of P-736.ZRx

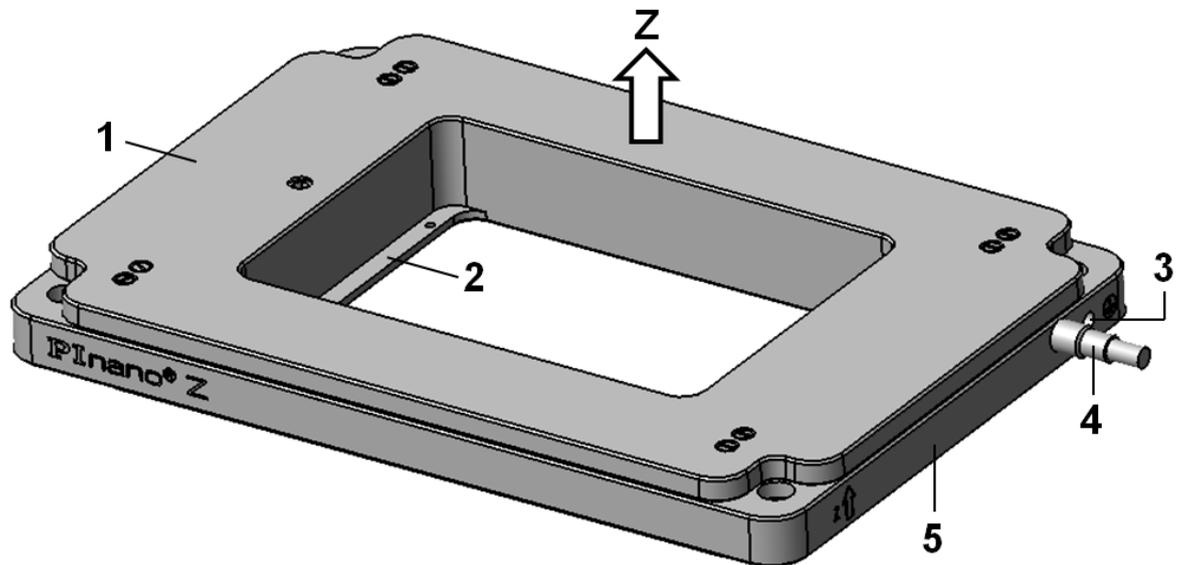


Figure 1: Example view of P-736.ZRx

- 1 Motion platform
- 2 Sample holder mounting plane of the motion platform
- 3 Protective earth connector
- 4 Cable exit
- 5 Base body
- Z arrow: Positive direction of motion

Product View of E-709



Figure 2: Example view of E-709 (refer to the E-709 user manual for details)

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Scope of Delivery

A Plnano® piezo scanner system is delivered with the following components:

Product number	Description
P-736.ZRx	Plnano® Z piezo slide scanner according to order (p. 8), including four M3x10 hex socket head screws
E-709.PRG	Digital piezo controller (p. 8)
C-501.24050H	Wide-range-input power supply, 24 V / 50 W
3763	Power cord
000036360	USB cable (3 m, USB-A (m)/USB Mini-B (m)) for PC connection
E709B0002	RS-232 adapter HD D-sub 26 (m) to D-sub 9 (m) for PC connection via RS-232
C-815.34	Null-modem cable for PC connection via RS-232
E-709.04	Adapter cable for analog I/O (1 m, HD D-sub 26 / 2 × BNC)
Documentation, consisting of:	
PZ240EK	Short instructions for piezo positioning systems
PZ222E	User manual for E-709 digital piezo controllers
E-709.CD	CD with PC software and documentation of the E-709 digital piezo controller

Accessories

Product number	Description
P-545.PD3	Petri dish holder, 35 mm, for Plnano® piezo stages
P-545.SH3	Microscope slide holder for Plnano® piezo stages
P-545.C18	Coverslip holder with opening for 18 mm × 18 mm coverslips, suitable for P-545.SH3
P-545.C22	Coverslip holder with opening for 22 mm × 22 mm coverslips, suitable for P-545.SH3
P-545.C25	Coverslip holder with opening for 25 mm × 25 mm coverslips, suitable for P-545.SH3
P-545.PP3	Universal holding plate for Plnano® piezo stage accessories
P-736.AP1	Adapter plate for mounting P-736.ZRx Plnano® Z piezo scanners onto M-545 XY stages
U-761.AP1	Adapter plate for mounting the P-736.ZRxS Plnano® Z microscope scanner stage onto the U-760 XY stage

➤ To order, contact our customer service department (p. 19).

Unpacking

NOTICE



Mechanical overload due to incorrect handling!

An impermissible mechanical load on the motion platform of the P-736.ZRx can cause damage to the piezo actuators, sensors, and flexures of the P-736.ZRx as well as loss of accuracy.

- Only hold the P-736.ZRx externally by the base body.

1. Unpack the P-736.ZRx 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. 19) immediately.
4. Keep all packaging materials in case the product needs to be returned.

Installation

Connecting the P-736.ZRx to the Protective Earth Conductor

INFORMATION

- Pay attention to the applicable standards for mounting 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 liquid adhesive) to prevent it from unscrewing by itself.

INFORMATION

In the case of P-736.ZRx stages with D-sub connectors, ground loops can occur when the stage is grounded via its protective earth connector or the mounting holes as well as by the shield of the connecting cable for the controller.

- If a ground loop occurs, contact our customer service department (p. 19).

The P-736.ZRx features a protective earth connector (p. 9) which is marked with the symbol for the protective earth conductor

Requirements

- You have read and understood the safety precautions (p. 6).
- The P-736.ZRx is **not** connected to the controller.

Tools and accessories

- Suitable protective earth conductor: Cross-sectional area of the cable $\geq 0.75 \text{ mm}^2$
- M4 screw which is preassembled on the protective earth connector of the P-736.ZRx
- Alternatively, if there is enough installation space:
 - Other electrically conductive M4 screw of suitable length
 - Two flat washers
 - Two lock washers
- Suitable screwdriver

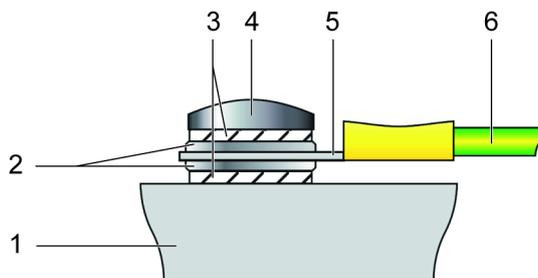


Figure 3: Connecting the protective earth conductor (profile view)

- 1 Base body of the P-736.ZRx
- 2 Flat washer
- 3 Lock washer
- 4 Screw
- 5 Cable lug
- 6 Protective earth conductor

Connecting the P-736.ZRx to the protective earth conductor

1. If necessary, attach a suitable cable lug to the protective earth conductor.
2. Use the M4 screw to fix the cable lug of the protective earth conductor to the protective earth connector of the P-736.ZRx as shown in the profile view. If possible, use suitable flat and lock washers.
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.

Mounting the P-736.ZRx onto a Surface

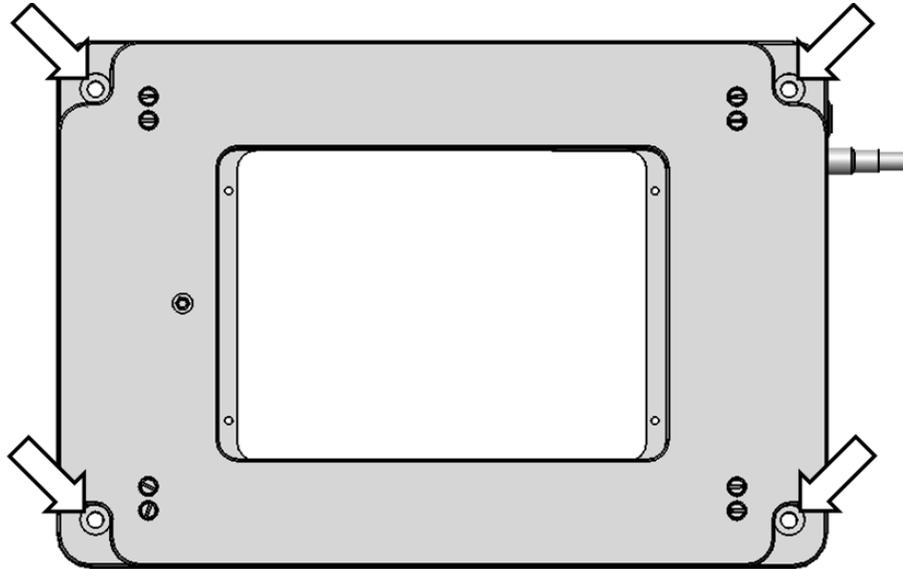


Figure 4: Mounting holes in the base body of the P-736.ZRx

Requirements

- You have read and understood the safety precautions (p. 6).
- The P-736.ZRx is **not** connected to the controller.
- You have provided a suitable surface:
 - The surface has four suitable M3 holes. See “Dimensions” (p. 22) for details.
 - The flatness of the surface is $\leq 10 \mu\text{m}$.
 - For applications with large temperature changes: The surface should have the same thermal expansion properties as the P-736.ZRx (e.g., surface made of aluminum).
- You have accounted for the space required to route cables without bending and according to regulations.

Tools and accessories

- Four M3x10 hex socket head screws (included with P-736.ZRx)
- Suitable hex key for M3x10 hex socket head screws

Mounting the P-736.ZRx onto a surface

1. Align the P-736.ZRx on the surface so that the mounting holes in the P-736.ZRx (see figure above) are in line with the corresponding holes in the surface.
2. Insert a mounting screw into each mounting hole in the base body of the P-736.ZRx.
3. Tighten the mounting screws with a torque between 0.8 Nm and 1.1 Nm.
4. Check that the P-736.ZRx is affixed firmly to the surface.

Mounting the P-736.ZRx onto an M-545 Stage

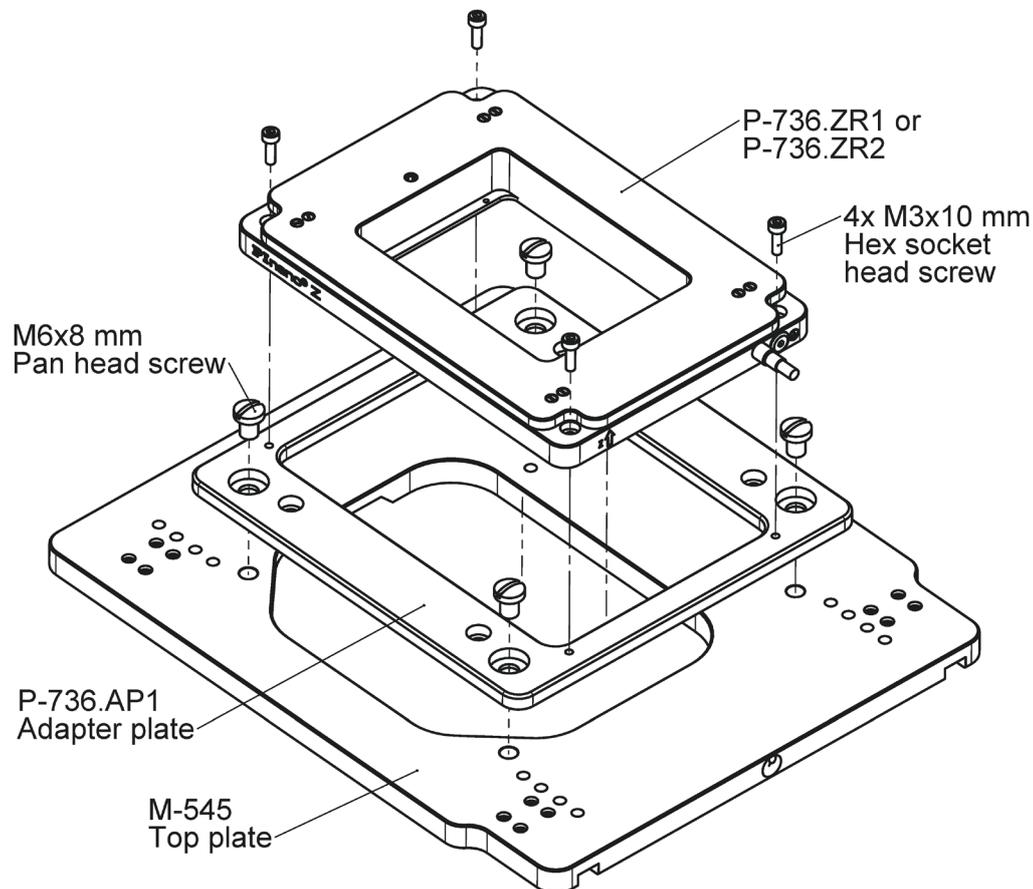


Figure 5: Mounting of the P-736.ZRx onto an M-545 stage using the P-736.AP1 adapter plate

Requirements

- ✓ You have read and understood the safety precautions (p. 6).
- ✓ The P-736.ZRx is **not** connected to the controller.

Tools and accessories

- P-736.AP1 adapter plate (see “Accessories”, p. 10)
- Four M6x8 pan head screws (included with P-736.AP1)
- Four M3x10 hex socket head screws (included with P-736.ZRx)
- Suitable screwdrivers

Mounting the P-736.ZRx onto an M-545 stage

- Mount the P-736.ZRx onto the M-545 stage as depicted in the figure.

Mounting the P-736.ZRx onto a U-761 Stage

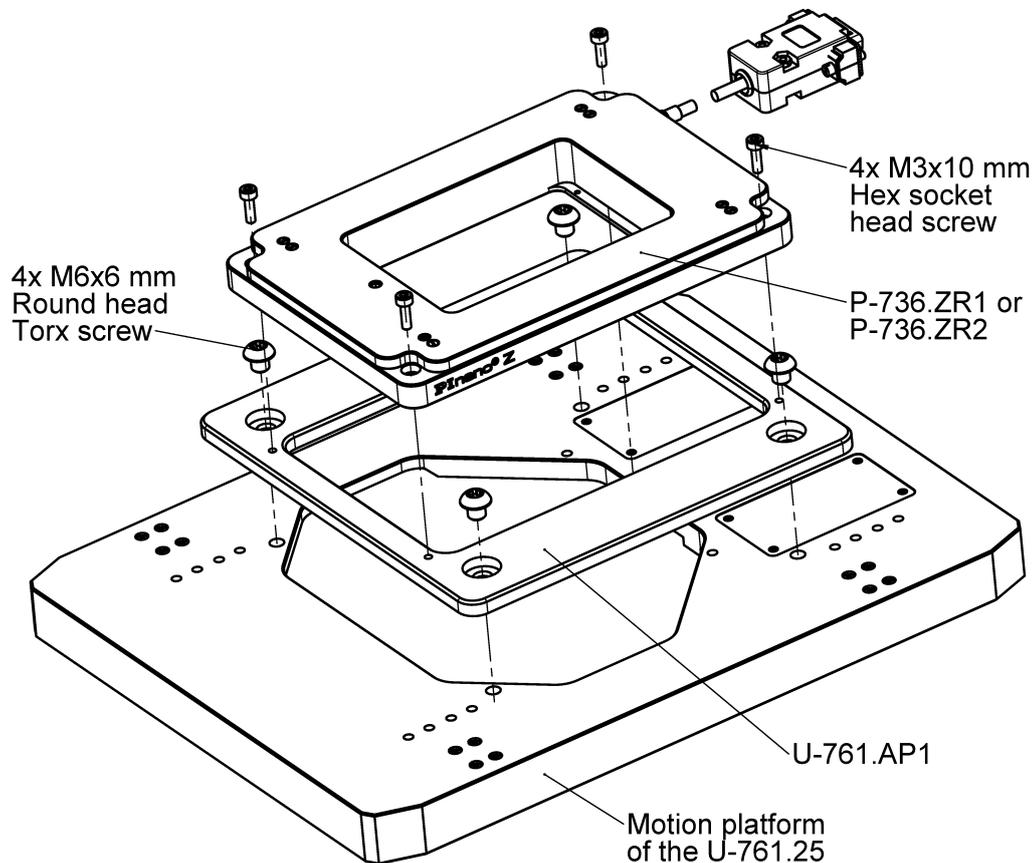


Figure 6: Mounting of the P-736.ZRx onto a U-761 stage using the U-761.AP1 adapter plate

Requirements

- ✓ You have read and understood the safety precautions (p. 6).
- ✓ The P-736.ZRx is **not** connected to the controller.

Tools and accessories

- U-761.AP1 adapter plate (see “Accessories”, p. 10)
- Four M6x6 round head Torx screws (included with U-761.AP1)
- Torx screwdriver T30 (included with U-761.AP1)
- Four M3x10 hex socket head screws (included with P-736.ZRx)
- Suitable hex key for M3x10 hex socket head screws

Mounting the P-736.ZRx onto a U-761 stage

- Mount the P-736.ZRx onto the U-761 stage as depicted in the figure.

Mounting Holders for Petri Dishes, Microscope Slides and Accessories

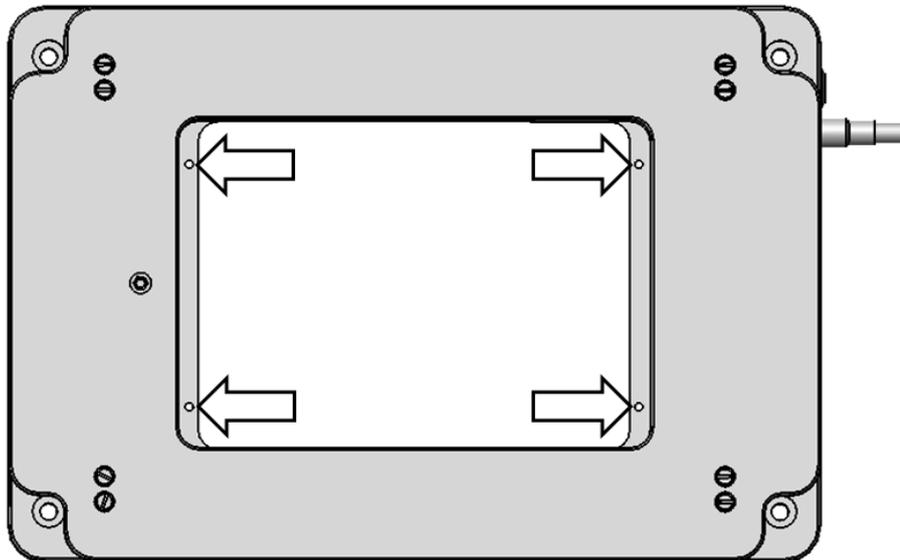


Figure 7: M2 threaded holes in the sample holder mounting plane (p. 9) of the motion platform

Requirements

- ✓ You have read and understood the safety precautions (p. 6).
- ✓ The P-736.ZRx is **not** connected to the controller.

Tools and accessories

- P-545.PD3, P-545.SH3 or P-545.PP3 holder (p. 10)
- Four M2 screws of suitable length (included with the P-545.xx3 holder)
- Suitable screwdriver

Mounting a holder

1. Align the holder so that the holding clamps (P-545.PD3 and P-545.SH3) are pointing upwards or the larger surface of the base body (P-545.PP3) is pointing upwards. Refer to "Dimensions" (p. 23ff.) for details.
2. Place the holder into the aperture of the P-736.ZRx from above, so that the mounting holes in the holder and the sample holder mounting plane (see Figure 7 above) of the P-736.ZRx are in line.
3. Mount the holder with the M2 screws to the provided M2 threaded holes (see Figure 7 above). Pay attention to the specified torque range (p. 23) while doing so.

Connecting the P-736.ZRx to the Controller

Requirements

- ✓ You have read and understood the safety precautions (p. 6).
- ✓ The controller is switched off, i.e., **not** connected to the power source.
- ✓ You have connected the P-736.ZRx to the protective earth conductor (p. 11).

Connecting the P-736.ZRx to the controller

- Connect the D-sub 9 connector of the P-736.ZRx to the corresponding D-sub 9 socket of the controller.

Startup and Operation

Starting and Operating the P-736.ZRx

INFORMATION

Systems are calibrated at the factory to achieve optimum performance. Replacing the system components will cause a loss in performance.

- Note the assignment of the stage axes to the controller channels, which is specified 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 (refer to the controller manual) or contact our customer service department (p. 19).

Requirements

- ✓ You have read and understood the safety precautions (p. 6).
- ✓ You have connected the P-736.ZRx to the protective earth conductor (p. 11) and to the controller (p. 17).

Starting and operating the P-736.ZRx

- Follow the instructions in the user manual for the piezo controller used for startup and operation of the P-736.ZRx.

Discharging the P-736.ZRx

The P-736.ZRx must be discharged before demounting. Demounting is necessary e.g., before cleaning or transporting the P-736.ZRx as well as for modifications.

Requirements

- ✓ You have read and understood the safety precautions (p. 6).

Discharging a P-736.ZRx 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-736.ZRx not connected to the controller

- Connect the P-736.ZRx to the switched-off PI controller for 10 seconds.

Maintenance

NOTICE



Damage due to improper maintenance!

The P-736.ZRx is maintenance-free and precisely aligned.

- Loosen any screws only when instructed in this manual.
- Do **not** open the P-736.ZRx.

Cleaning the P-736.ZRx

NOTICE



Damage from ultrasonic cleaning!

Ultrasonic cleaning can damage the P-736.ZRx.

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

Requirements

- ✓ You have discharged (p. 17) the piezo actuators of the P-736.ZRx.
- ✓ You have disconnected the P-736.ZRx from the controller.

Cleaning the P-736.ZRx

- Clean the surface of the P-736.ZRx with a cloth that is dampened with a mild cleanser or disinfectant (e.g., alcohol or isopropyl alcohol).

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. 5) on our website.

Technical Data

Specifications

	P-736.ZR1S	P-736.ZR2S	Unit	Tolerance
Active axes	Z	Z		
Motion and positioning				
Integrated sensor	Piezoresistive	Piezoresistive		
Travel range, closed-loop	100	200	µm	
Resolution, open-loop	0.2	0.4	nm	typ.
Resolution, closed-loop	0.4	0.7	nm	typ.
Mechanical properties				
Settling time (10 % step width)	5	7	ms	
Load capacity	500	500	g	max.
Drive properties				
Piezo ceramic	PICMA® P-885	PICMA® P-885		
Miscellaneous				
Operating temperature range	15 to 40	15 to 40	°C	
Material	Aluminum	Aluminum		
Mass	550	550	g	±5 %
Cable length	1.5	1.5	m	±10 mm
Piezo controller	E-709 digital servo (in the scope of delivery)			
Communication interfaces	USB, RS-232, SPI			
I/O connector	HD D-sub 26 1× analog input 0 to 10 V 1× sensor monitor 0 to 10 V 1× digital input (LVTTTL, programmable) 1× analog output 5× digital outputs (LVTTTL, 3× predefined, 2× programmable)			
Command set	PI General Command Set (GCS)			
User software	PIMikroMove			
Software drivers	NI LabVIEW driver, dynamic libraries for Windows and Linux			
Supported functions	Wave generator, data recorder, autozero, trigger I/O, MATLAB, MetaMorph, µManager			
Controller dimensions	160 mm × 96 mm × 33 mm			

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).

Maximum Ratings

P-736.ZRx piezo scanners are designed for the following maximum ratings:

Model	Maximum operating voltage 	Maximum operating frequency (unloaded) 	Maximum power consumption 
P-736.ZR1	-30 to 130 V	100 Hz	20 W
P-736.ZR2	-30 to 130 V	100 Hz	20 W

Ambient Conditions and Classifications

Pay attention to the following ambient conditions and classifications for the P-736.ZRx:

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*	15 °C to 40 °C
Storage temperature	0 °C to 70 °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

* Specifications assured from 17 °C to 23 °C, performance may be reduced outside this range.

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Dimensions

Dimensions in mm

P-736.ZRx Plnano® Z Piezo Scanner

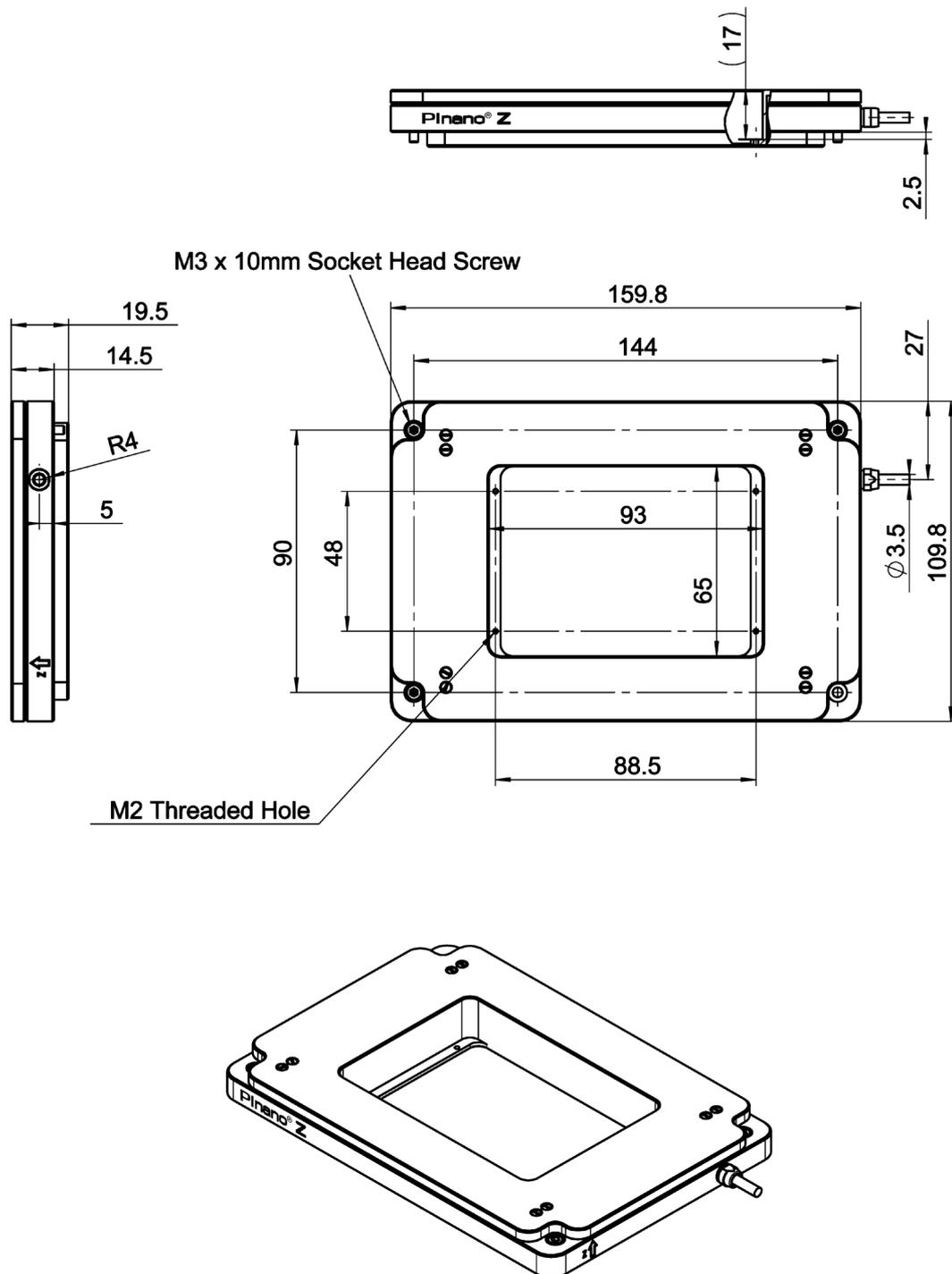


Figure 8: P-736.ZRx Plnano® Z piezo scanner

P-545.SH3 Microscope Slide Holder

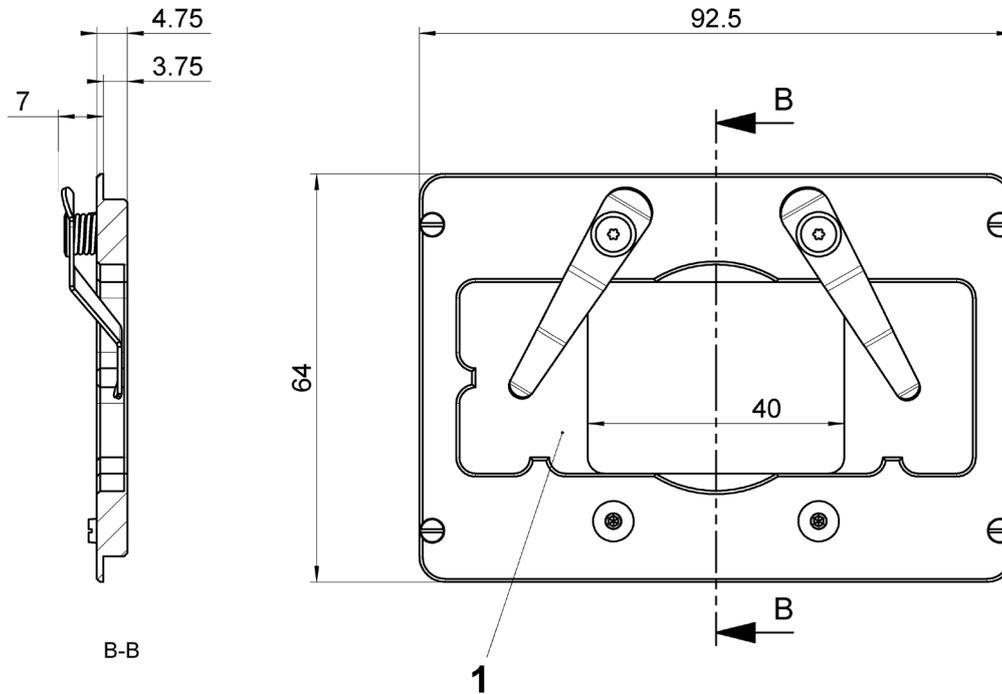


Figure 9: P-545.SH3: Microscope slide holder, suitable for Plnano® piezo stages
1: Recess for standard microscope slides (25 mm × 75 mm)

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P-545.PD3 Petri Dish Holder

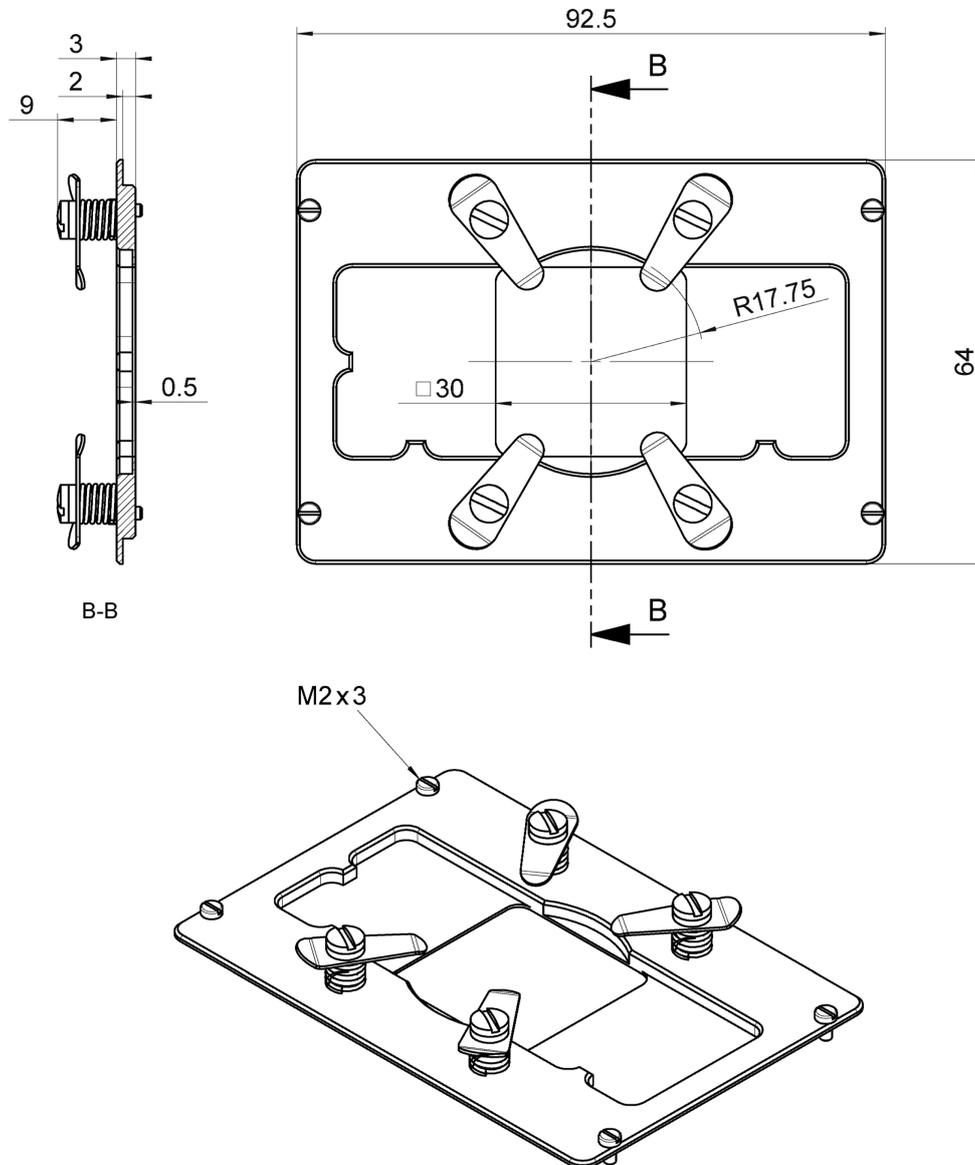


Figure 10: P-545.PD3: Petri dish holder, suitable for Plnano® piezo stages

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CBo, 2021-09-20



P-545.PP3 Universal Holding Plate

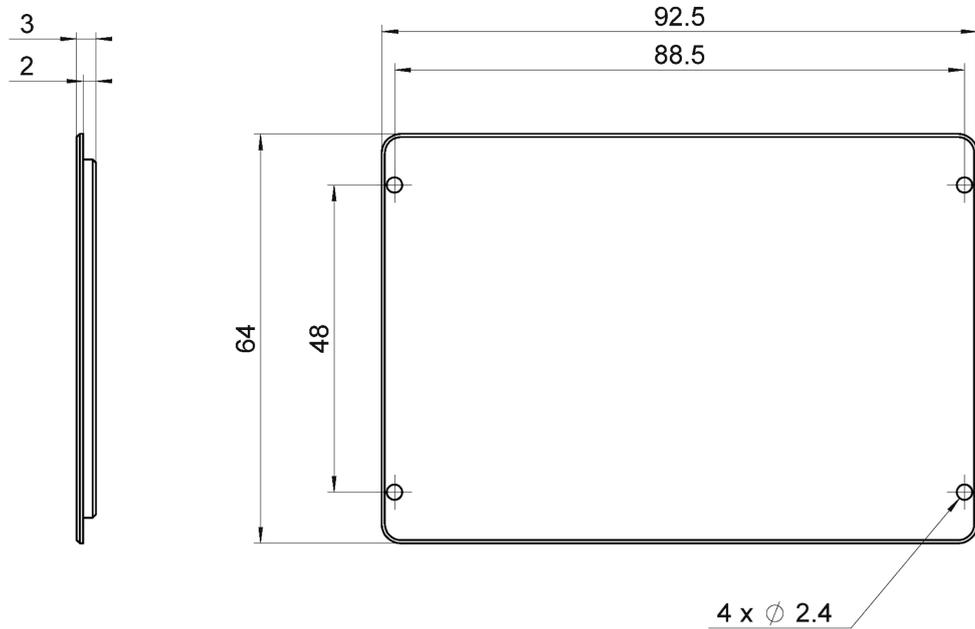


Figure 11: P-545.PP3: Universal holding plate for accessories, suitable for Plnano® piezo stages

P-736.AP1 Adapter Plate

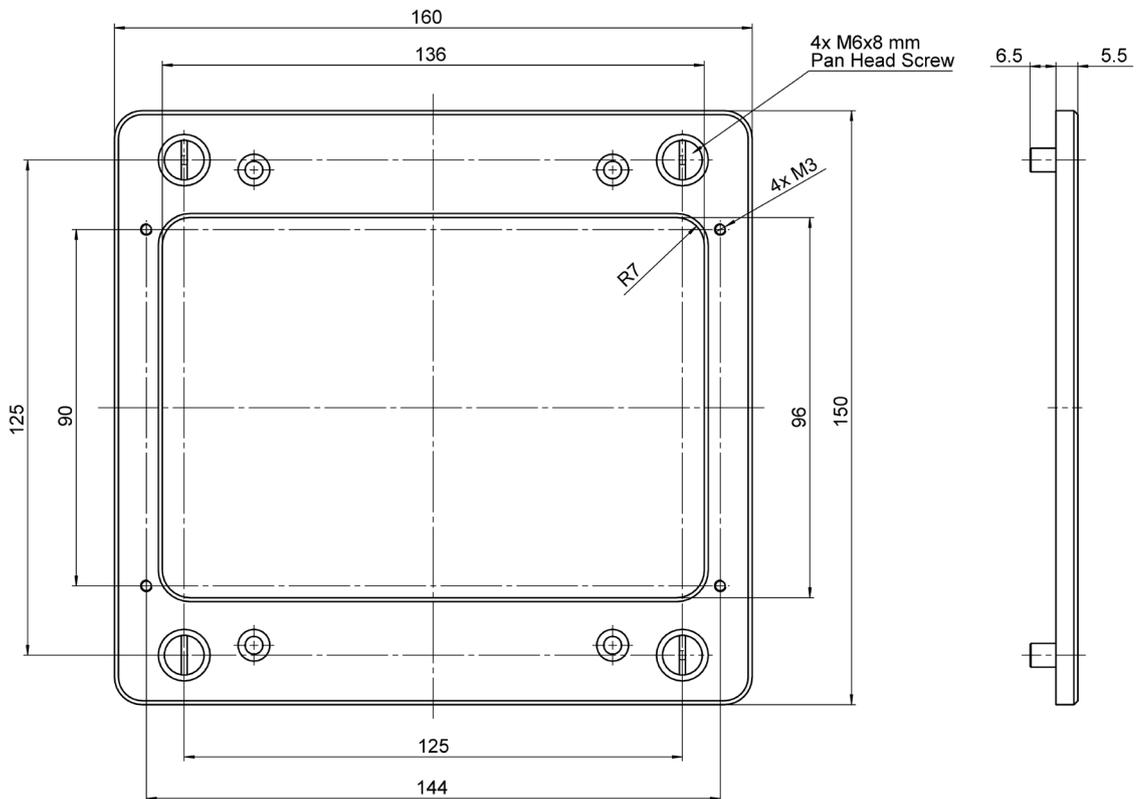


Figure 12: P-736.AP1 adapter plate (for mounting P-736.ZRxs Plnano® Z piezo scanners onto M 545 XY stages)

User Manual

P736T0002, applies to P-736.ZRxs Plnano® Piezo Scanner Systems
CBo, 2021-09-20



U-761.AP1 Adapter Plate

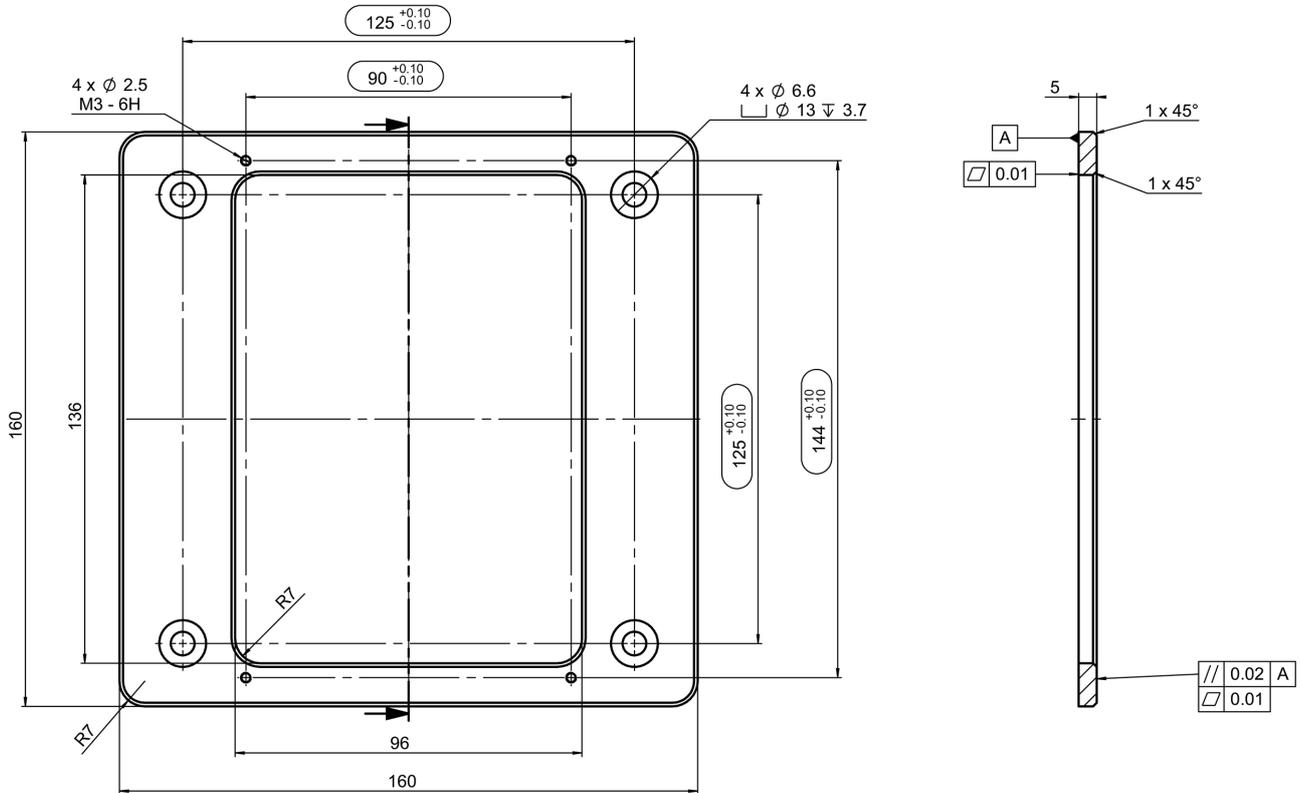


Figure 13: U-761.AP1 adapter plate (for mounting the P-736.ZRxs Plnano® Z microscope scanner stage onto the U-760 XY stage)

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
M6	4 Nm	6 Nm

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

