

User Manual

P725T0010, applies to P-725

CBo/KSch, 2021-08-31

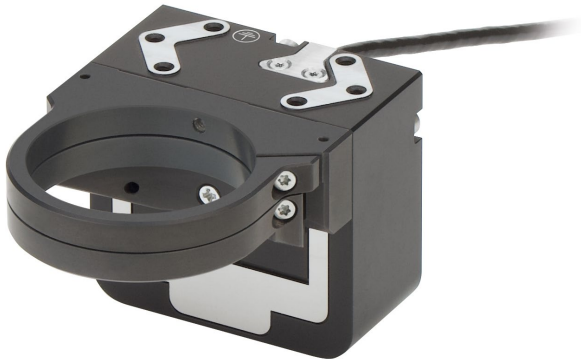
PI

P-725

P-725 PIFOC Long-Travel Objective Scanner



P-725.xCDE2 PIFOC Piezo Nanofocusing System for Long Travel Ranges and Fast Step-and-Settle



P-725.xDD PIFOC High Dynamics Scanner



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About this Document

This user manual contains the information required for using the P-725 (hereinafter referred to as "scanner" or "positioner") as intended. The letter x in the piezo actuator's product number stands for the various models (p. 8).

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

Typographic Conventions

Symbol/Label	Meaning
1.	Action consisting of several steps with strict sequential order
2.	
➤	Action consisting of one or more steps without relevant sequential order
▪	Lists
p. 5	Cross-reference to page 5

Symbols Used

CAUTION



Dangerous situation

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

- Measures for avoiding the risk.

NOTICE



Dangerous situation

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

- Measures for avoiding the risk.

INFORMATION

Additional information that can affect your application.

Symbol/Labeling



Meaning

Warning signs attached to the product referring to detailed information in this manual.

"Residual Voltage" warning sign: Risk of electric shock (p. 6) for models with D-sub connector

Figures

For better understandability, the colors, proportions and degree of detail in illustrations can deviate from the actual circumstances. Photographic images may also differ and do not represent guaranteed properties.

Other Applicable Documents

Product	Document
P-5xx / P-6xx / P-7xx piezo positioning systems	PZ240EK short instructions

Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

- Contact our customer service department (p. 31).

Downloading manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., P-725) or the product family (e.g., PIFOC).
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.

Safety

Intended Use

The P-725 scanner is a laboratory device as defined by DIN EN 61010-1. It is intended for indoor use and use in an environment that is free of dirt, oil, and lubricants.

According to its design, the P-725 is intended for positioning and shifting microscope objectives in one axis.

The P-725 can be mounted horizontally or vertically. The specifications refer to a vertically mounted P-725.

It is only possible to use the P-725 as intended when it is completely mounted and connected. It must be operated with a suitable controller that is available from PI (p. 10). The controller is not included in the scope of delivery of the P-725.

The P-725 may only be started, operated, maintained and cleaned by authorized and qualified staff.

Safety Precautions

CAUTION



Dangerous voltage and residual charge in piezo actuators!

The P-725 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-725's connector 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-725.
- Discharge the piezo actuators before installing (p. 28).
- Do **not** pull the connector out of the electronics while it is operating.



For P-725 with D-sub connector:

Touching the contacts in the plug connector could lead to an electric shock (max. 120 V DC) and minor injuries.

- Do **not** touch the contacts in the plug connector.
- Use screws to secure the P-725's connector against being pulled out of the controller.

CAUTION



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

If the protective earth conductor is missing or not properly connected, dangerous touch voltages can occur on the P-725 in the event of malfunction or failure of the system. If there are touch voltages, touching the P-725 can result in minor injury due to electric shock.

- Connect the P-725 to a protective earth conductor before startup (p. 14).
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e.g., for modification), reconnect the P-725 to the protective earth conductor before restarting.

NOTICE



Falling down when removing the thread adapters!

The P-725 could fall down while removing the upper thread adapter (microscope side) if it is not secured or tightly screwed. The thread adapter and the objective screwed in could fall down while removing the lower thread adapters (objective side).

- Secure all parts against falling down while removing the thread adapters:
 - Screw the objective out before removing.
 - Hold the P-725 firmly when you loosen the upper thread adapter.

NOTICE



Unsuitable cables!

Unsuitable cables can damage the electronics.

- Only use cables from PI for connecting the P-725 to the electronics.

INFORMATION

Cable extensions can affect the performance of the P-725.

- Do not use extension cables. If you need longer cables, contact our customer service department (p. 31).

Product Description

Model Overview

The P-725 is available in the following versions:

Model	Description
P-725.1CDE2	PIFOC piezo nanofocusing system for long travel ranges and fast step-and-settle, 100 µm, capacitive sensors, D-sub connectors
P-725.1CD	PIFOC piezo nanofocusing system for long travel ranges, 100 µm, capacitive sensors, D-sub connector, for QuickLock adapter
P-725.2CD	PIFOC piezo nanofocusing system for long travel ranges, 250 µm, capacitive sensors, D-sub connector, for QuickLock adapter
P-725.4CDE2	PIFOC piezo nanofocusing system for long travel ranges and fast step-and-settle, 400 µm, capacitive sensors, D-sub connectors
P-725.4CD	PIFOC piezo nanofocusing system for long travel ranges, 400 µm, capacitive sensors, D-sub connector, for QuickLock adapter
P-725.1CL	PIFOC piezo nanofocusing system for long travel ranges, 100 µm, capacitive sensors, LEMO connector, for QuickLock adapters
P-725.2CL	PIFOC piezo nanofocusing system for long travel ranges, 250 µm, capacitive sensors, LEMO connector, for QuickLock adapters
P-725.4CL	PIFOC piezo nanofocusing system for long travel ranges, 400 µm, capacitive sensors, LEMO connector, for QuickLock adapters
P-725.1CA	PIFOC piezo nanofocusing system for long travel ranges, 100 µm, capacitive sensors, D-sub connectors, for QuickLock adapters with large apertures
P-725.2CA	PIFOC piezo nanofocusing system for long travel ranges, 250 µm, capacitive sensors, D-sub connector, for QuickLock adapter with large apertures
P-725.4CA	PIFOC piezo nanofocusing system for long travel ranges, 400 µm, capacitive sensors, D-sub connectors, for QuickLock adapters with large apertures
P-725.10L	PIFOC piezo nanofocusing system for long travel ranges, 150 µm, without sensor, LEMO connector, for QuickLock adapter
P-725.20L	PIFOC piezo nanofocusing system for long travel ranges, 330 µm, without sensor, LEMO connector, for QuickLock adapters
P-725.40L	PIFOC piezo nanofocusing system for long travel ranges, 460 µm, without sensor, LEMO connector, for QuickLock adapters
P-725.8CDE2	PIFOC piezo nanofocusing system for long travel ranges and fast step-and-settle, 800 µm, capacitive sensors, D-sub connectors
P-725.CDD	Fast PIFOC piezo nanofocusing system, 18 µm, capacitive sensor, D-sub connector, for QuickLock adapters
P-725.SDD	Fast PIFOC piezo nanofocusing system, 18 µm, strain gauge sensor, LEMO connector, for QuickLock adapters

Product View

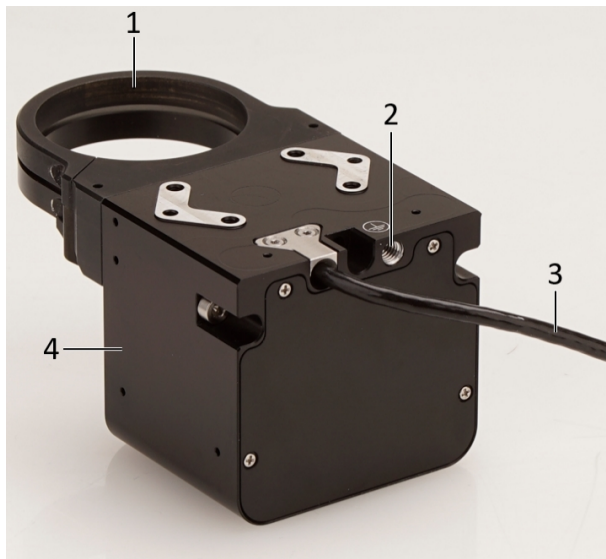







Fig. 1: Example of a P-725.8CDE2

- 1 Aperture for thread insert (screwed in or clamped depending on the model)
- 2 M4 hole for connecting the protective earth conductor
- 3 Cable exit
- 4 Base body

Product Labeling

Labeling	Description
P-725.2CD	Product name (example), the characters after the period refer to the model
123456789	Serial number (example), individual for each P-725 Meaning of each position (from the left): 1 = internal information 2 and 3 = manufacturing year 4 to 9 = consecutive numbers
PIFOC	Brand name
Country of origin: Germany	Country of origin
	Warning sign "Pay attention to the manual!"
	Old equipment disposal (p. 43)
WWW.PI.WS	Manufacturer's address (website)
	CE conformity mark
	Manufacturer's logo
	Symbol for the protective earth conductor (p. 14), indicates the protective earth connector on the P-725

Scope of Delivery

Product no.	Description
P-725	PIFOC piezo nanofocusing system according to order (p. 8)
000036450	M4 screw set for protective earth, consisting of: <ul style="list-style-type: none"> One 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 positioning systems
000044198	Torx T6 right-angle screwdriver for aperture (P-725.xCDE2 only)

Suitable Electronics

Mechanics			Electronics
Product no.	Sensor	Connector	
P-725.xCDE2	Capacitive sensor	D-sub	E-709 single-channel digital controller
			E-754 single-channel digital controller
P-725.xCD P-725.xCA P-725.CDD	Capacitive sensor	D-sub	E-621 controller module
			E-625 servo controller, benchtop device
			E-665 servo controller, with digital interface, benchtop device
			E-709 single-channel digital controller
			E-754 single-channel digital controller
P-725.xCL	Capacitive sensor	LEMO	E-610 servo controller / amplifier
			E-500 modular piezo controller system with E-505 high-performance amplifier module and E-509 controller
P-725.SDD	Strain gauge sensor	LEMO	E-610 servo controller / amplifier
			E-625 servo controller, benchtop device
			E-665 servo controller, with digital interface, benchtop device
			E-709 single-channel digital controller
P-725.x0L	-	LEMO	E-500 modular piezo controller system with E-505 high-performance amplifier module
			E-610.00 amplifier

➤ To order, contact the customer service department (p. 31).

Optional Accessories

- To order, contact the customer service department (p. 31).

Thread Adapters

P-721.xxQ QuickLock thread adapter set

Product no.	Description	Suitability P-725 models
P-721.02Q	QuickLock thread adapter set, M26 × 0.75, for objective and microscope	P-725.xxD and P-725.xxL
P-721.03Q	QuickLock thread adapter set, M27 × 0.75, for objective and microscope	
P-721.04Q	QuickLock thread adapter set, M28 × 0.75, for objective and microscope	
P-721.05Q	QuickLock thread adapter set, M32 × 0.75, for objective and microscope	
P-721.06Q	QuickLock thread adapter set, M26 × 1/36", for objective and microscope	
P-721.08Q	QuickLock thread adapter set, M19 × 0.75, for objective and microscope	
P-721.11Q	QuickLock thread adapter set, M25 × 0.75, for objective and microscope	
P-721.12Q	QuickLock thread adapter set, W0.8 × 1/36", for objective and microscope	

P-721.xxA QuickLock thread adapter set

Product no.	Description	Suitability P-725 models
P-721.02A	QuickLock thread adapter set with large aperture, M26 × 0.75, for objective and microscope	P-725.xCA
P-721.03A	QuickLock thread adapter set with large aperture, M27 × 0.75, for objective and microscope	
P-721.04A	QuickLock thread adapter set with large aperture, M28 × 0.75", for objective and microscope	
P-721.05A	QuickLock thread adapter set with large aperture, M32 × 0.75, for objective and microscope	
P-721.06A	QuickLock thread adapter set with large aperture, M26 × 1/36", for objective and microscope	
P-721.11A	QuickLock thread adapter set with large aperture, M25 × 0.75, for objective and microscope	

P-725.xxM thread adapters

Product no.	Description	Suitability P-725 models
P-725.02M	Thread adapter for microscope, M26 × 0.75	P-725.xCDE2 (microscope side)
P-725.03M	Thread adapter for microscope, M27 × 0.75	
P-725.04M	Thread adapter for microscope, M28 × 0.75	
P-725.05M	Thread adapter for microscope, M32 × 0.75	
P-725.06M	Thread adapter for microscope, M26 × 1/36"	
P-725.08M	Thread adapter for microscope, M19 × 0.75	
P-725.11M	Thread adapter for microscope, M25 × 0.75	
P-725.12M	Thread adapter for microscope, W0.8 × 1/36"	
P-725.13M	Thread adapter for microscope, SM1 (1.035"-40)	
P-725.14M	Thread adapter for microscope, M34 × 1	

P-725.xxl thread adapters

Product no.	Description	Suitability P-725 models
P-725.02L	Thread adapter for objective, M26 × 0.75	P-725.xCDE2 (objective side)
P-725.03L	Thread adapter for objective, M27 × 0.75	
P-725.04L	Thread adapter for objective, M28 × 0.75	
P-725.05L	Thread adapter for objective, M32 × 0.75	
P-725.06L	Thread adapter for objective, M26 × 1/36"	
P-725.08L	Thread adapter for objective, M19 × 0.75	
P-725.11L	Thread adapter for objective, M25 × 0.75	
P-725.12L	Thread adapter for objective, W0.8 × 1/36"	
P-725.13L	Thread adapter for objective, SM1 /1.035"-40)	
P-725.14L	Thread adapter for objective, M34 × 1	

P-725.xxS spacers

Product no.	Description	Suitability P-725 models
P-725.02S	Spacer for P-725.xCDE2 series, M26x0.75	P-725.xCDE2 (objective side)
P-725.03S	Spacer for P-725.xCDE2 series, M27x0.75	
P-725.04S	Spacer for P-725.xCDE2 series, M28x0.75	
P-725.05S	Spacer for P-725.xCDE2 series, M32x0.75	
P-725.06S	Spacer for P-725.xCDE2 series, M26x1/36"	
P-725.08S	Spacer for P-725.xCDE2 series, M19x0.75	
P-725.11S	Spacer for P-725.xCDE2 series, M25x0.75	
P-725.12S	Spacer for P-725.xCDE2 series, W0.8x1/36"	
P-725.13S	Spacer for P-725.xCDE2 series, SM1 (1.035"-40)	
P-725.14S	Spacer for P-725.xCDE2 series, M34x1	

Adapter Cable with D-sub (Mechanics) to LEMO (Electronics)

Product no.	Description
P-895.1DLC	Adapter cable, D-sub 7W2 (f) to LEMO for piezo actuator nanopositioning systems with capacitive sensors, 1 channel, 0.3 m.

Adapter Cable with LEMO (Mechanics) to D-sub (Electronics)

Product no.	Description
P-895.1LDC	Adapter cable LEMO to D-sub 7W2 (m) for piezo actuator nanopositioning systems with capacitive sensor, 1 channel, 0.3 m.

Unpacking

1. Unpack the P-725 with care.
2. Compare the contents with the scope of delivery according to the contract and the delivery note.
3. If any parts are damaged or missing, contact our customer service department immediately (p. 31).
4. Keep all packaging materials in case the product needs to be returned.

Installing

Connecting the P-725 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 liquid adhesive) to prevent it from unscrewing by itself.

There is an M4 hole in the P-725 for connecting the protective earth conductor. This hole is marked with the symbol for the protective earth conductor \oplus . Refer to "Dimensions" (p. 36).

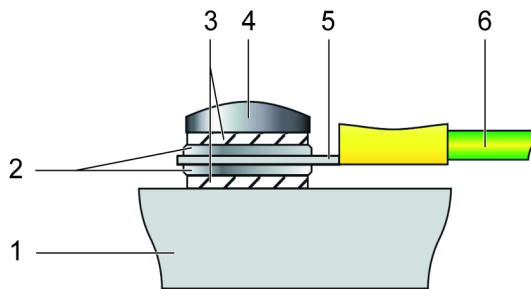


Fig. 2: Protective earth conductor mounting (profile view)

- 1 P-725 base body
- 2 Flat washer
- 3 Lock washer
- 4 Screw
- 5 Cable lug
- 6 Protective earth conductor

Requirements

- ✓ You have read and understood the safety precautions (p. 6).
- ✓ The P-725 is **not** connected to the electronics.

Tools and accessories

- Suitable protective earth conductor: Cable cross section $\geq 0.75 \text{ mm}^2$
- M4 protective earth conductor screw set for connecting the protective earth conductor (p. 10)
- Suitable screwdriver

Connecting the P-725 to the protective earth conductor

1. If necessary, attach a suitable cable lug to the protective earth conductor.
2. Use the M4 screw (together with the flat and lock washers) to attach the cable lug of the protective earth conductor to the threaded hole in the P-725 as shown in the profile view.
3. Tighten the M4 screw with a torque of 1.2 Nm to 1.5 Nm.
4. Make sure that the contact resistance at all points relevant for attaching the protective earth conductor is $<0.1 \Omega$ at 25 A.

Mounting the P-725 with Thread Adapters to the Microscope (Depending on Model)

The PIFOC objective positioners are inserted with thread adapters between the microscope's revolving nosepiece and objective (p. 11). In addition, it is possible to mount the P-725 base body via the mounting holes (p. 25).

P-721.xxQ Thread Adapter Set (for P-725.xxD/.xxL and P-721.xxQ/.SL2)

The P-721.xxQ QuickLock thread adapters are available with apertures that have various different inner diameters:

QuickLock thread adapter set	Thread size	Aperture diameter
P-721.02Q	M26 × 0.75 mm	21 mm
P-721.03Q	M27 × 0.75 mm	21 mm
P-721.04Q	M28 × 0.75 mm	21 mm
P-721.05Q	M32 × 0.75 mm	21 mm
P-721.06Q	M26 × 1/36"	21 mm
P-721.08Q	M19 × 0.75 mm	14 mm

Component Overview

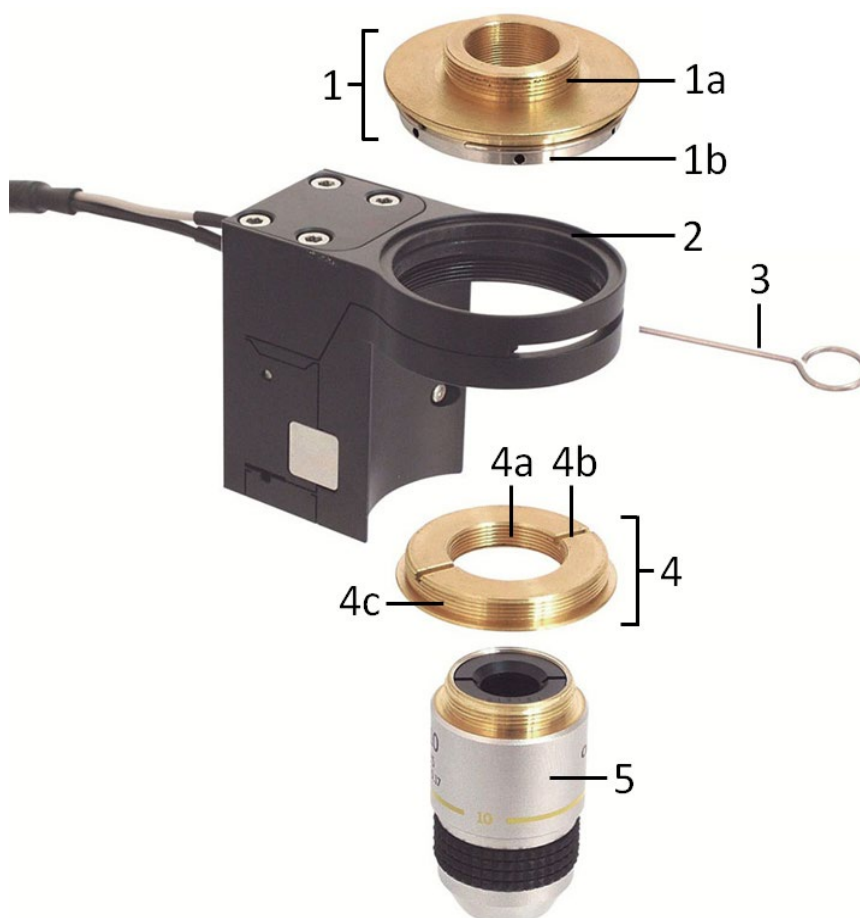


Fig. 3: P-721.xxQ thread adapter with PIFOC positioner and microscope objective

- 1: Thread adapter, microscope side:
 - 1a: Thread for microscope
 - 1b: Clamping ring
- 2: PIFOC positioner
- 3: Tightening tool (included in the thread adapter's scope of delivery)
- 4: Thread adapter, objective side:
 - 4a: Inner thread for objective
 - 4b: Recesses for key tool
 - 4c: Outer thread for PIFOC positioners
- 5: Objective (not included in the scope of delivery)

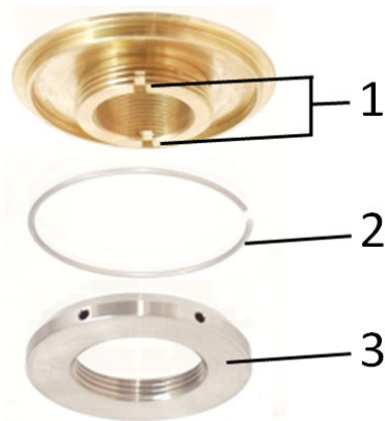


Fig. 4: P-721.xxQ: Thread adapter, microscope side (view from below)

- 1: Recesses for key tool (narrow side)
- 2: Spring washer
- 3: Clamping ring

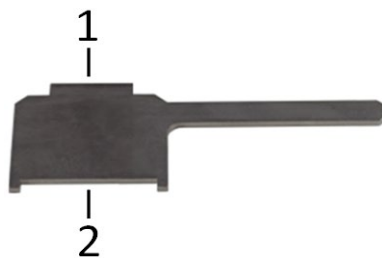


Fig. 5: P-721.xxQ: Flat wrench (included in the scope of delivery of the thread adapter set)

- 1: Narrow side of the key tool
- 2: Wide side of the key tool

Mounting the P-721.xxQ thread adapter set

NOTICE



Possible damage due to excessive torque!

Only moderate torque is required to fix the thread adapter in the PIFOC positioner on the objective side.

- Use the key tool supplied for tightening the thread adapter on the objective side.

Requirements

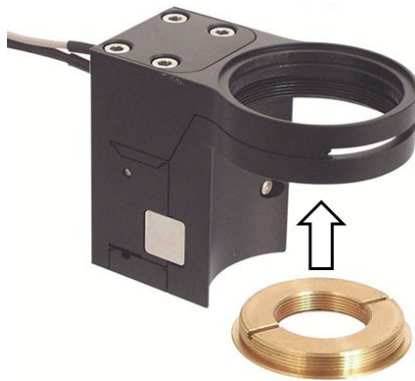
- ✓ You have read and understood the safety precautions (p. 6).
- ✓ The P-725 is **not** connected to the electronics.

Tools and accessories

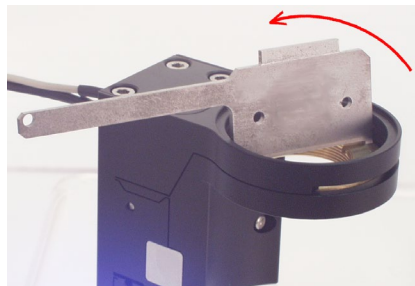
- P-721.xxQ QuickLock thread adapter set (p. 11)
- Key tool supplied (see Fig. 5, p. 17)
- Tightening tool supplied (see Fig. 3, p. 16)

Mounting the P-721.xxQ thread adapter set

1. Screw the thread adapter for the objective side into the aperture of the PIFOC positioner from below.



2. Tighten the thread adapter on the objective side using the wide face of the key tool as shown in the figure below.



3. Screw the thread adapter on the microscope side into the microscope.
4. Tighten the thread adapter on the microscope side with the narrow side of the key tool.
5. Make sure that the thread adapter's spring washer on the microscope side is neither too tight nor loose. If necessary, set the tension of the spring washer by turning the clamping ring. Only unscrew the clamping ring as far as necessary.
6. Push the PIFOC positioner slowly into the thread adapter on the microscope side until it snaps in completely.
7. Insert the tightening tool into one of the holes in the clamping ring for the thread adapter on the microscope side and lightly tighten the ring. The clamping ring will be visible through the slot in the PIFOC positioner. Make sure the clamping tool is well seated before applying any pressure.
8. Align the PIFOC positioner as required.
9. Tighten the clamping ring for the thread adapter on the microscope side with the tightening tool.
10. Screw the objective from below into the thread adapter on the objective side of the PIFOC positioner. Do not exceed the maximum torque of 0.6 Nm.

P-721.xxA Thread Adapter Set (for P-721.xxA and P-725.xCA)

The P-721.xxA QuickLock thread adapters with large apertures are available with various different inner diameters:

QuickLock thread adapter set	Thread size	Aperture diameter
P-721.02A	M26 × 0.75 mm	23 mm
P-721.03A	M27 × 0.75 mm	24 mm
P-721.04A	M28 × 0.75 mm	25 mm
P-721.05A	M32 × 0.75 mm	29 mm
P-721.06A	M26 × 1/36"	23 mm
P-721.11A	M25 × 0.75 mm	22 mm

Component Overview

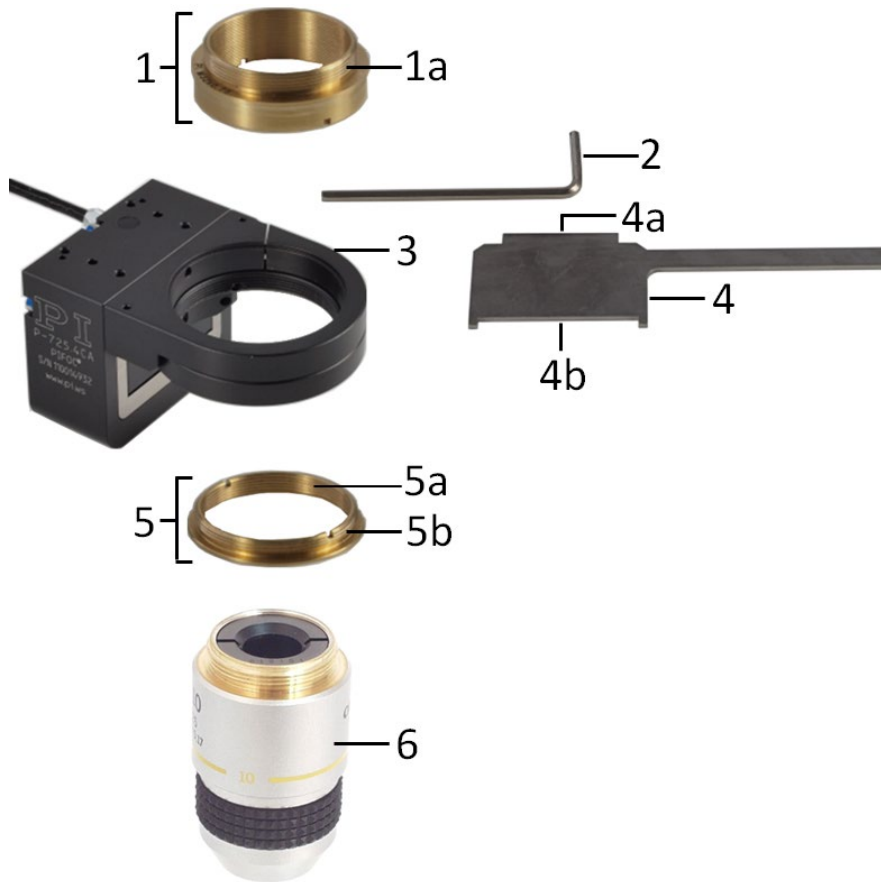


Fig. 6: P-721.xxA thread adapter with PIFOC positioner and microscope objective

- 1: Thread adapter, microscope side:
 - 1a: Thread for microscope
- 2: Hex key (included in the thread adapter set's scope of delivery)
- 3: PIFOC positioner
- 4: Key tool (included in the thread adapter set's scope of delivery):
 - 4a: Narrow side of the key tool
 - 4b: Wide side of the key tool
- 5: Thread adapter, objective side:
 - 5a: Inner thread for microscope objective
 - 5b: Outer thread for PIFOC positioner
- 6: Microscope objective (not included in the scope of delivery)

Mounting the P-721.xxA thread adapter set

NOTICE



Possible damage due to excessive torque!

Only moderate torque is required to fix the thread adapter in the PIFOC positioner on the objective side.

- Use the key tool supplied for tightening the thread adapter on the objective side.

Requirements

- ✓ You have read and understood the safety precautions (p. 6).
- ✓ The P-725 is **not** connected to the electronics.

Tools and accessories

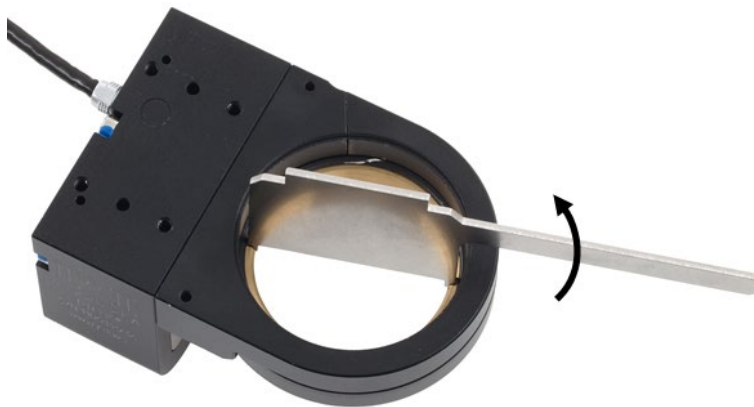
- P-721.xxA QuickLock thread adapter set (p. 11)
- Hex key supplied (see Fig. 6, p. 20)
- Key tool supplied (see Fig. 6, p. 20)

Mounting the P-721.xxA thread adapter set

1. Screw the thread adapter for the objective side into the aperture of the PIFOC positioner from below.



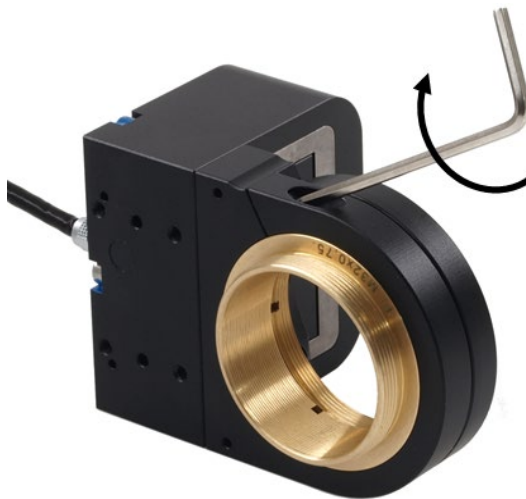
2. Tighten the thread adapter on the objective side using the wide face of the key tool as shown in the figure below.



3. Screw the thread adapter on the microscope side into the microscope.
4. Tighten the thread adapter on the microscope side with the wide side of the key tool.
5. Loosen the clamping screw of the aperture using the hex key supplied as shown in the figure below.



6. Insert the PIFOC positioner into the thread adapter screwed on the microscope.
7. Tighten the thread adapter on the microscope side in the PIFOC positioner using the hex key supplied, as shown in the following figure.



Note: The figure above shows the mounting without microscope.

8. Screw the objective from below into the thread adapter on the objective side of the PIFOC positioner. Do not exceed the maximum torque of 0.6 Nm.

P-725.xxM and P-725.xxL Thread Adapters (for P-725.xCDE2)

The P-725.xxM and P-725.xxL thread adapters are available with apertures that have various different inner diameters:

Thread size	Thread adapter for microscope side		Thread adapter for objective/lens side	Objective spacer for correcting the parfocal length
	P-725.xxM	ID [mm]	P-725.xxL	P-725.xxS
M26 x 0.75	P-725.02M	22	P-725.02L	P-725.02S
M27 x 0.75	P-725.03M	22	P-725.03L	P-725.03S
M28 x 0.75	P-725.04M	22	P-725.04L	P-725.04S
M32 x 0.75	P-725.05M	25	P-725.05L	P-725.05S
M26 x 1/36"	P-725.06M	22	P-725.06L	P-725.06S
M19 x 0.75	P-725.08M	15	P-725.08L	P-725.08S
M25 x 0.75	P-725.11M	22	P-725.11L	P-725.11S
W0.8 x 1/36"	P-725.12M	16	P-725.12L	P-725.12S
SM1 (1.035"-40)	P-725.13M	22	P-725.13L	P-725.13S
M34 x 1	P-725.14M	28	P-725.14L	P-725.14S

Component Overview

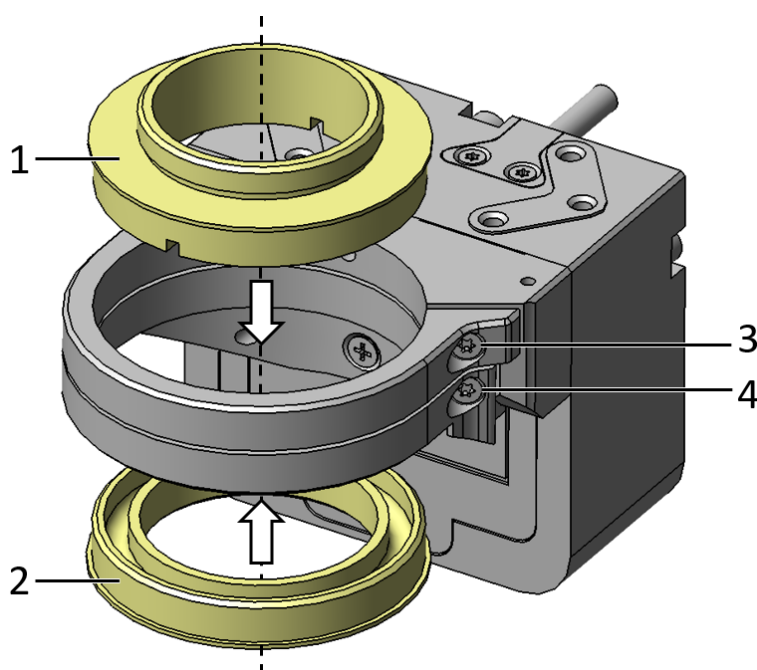


Fig. 7: Schematic diagram of parts relevant for mounting the P-725

- 1: Thread adapter, microscope side:
- 2: Thread adapter, objective side:
- 3: Screw for thread adapter in the microscope side
- 4: Screw for thread adapter in the objective side

Arrows: Direction for mounting the respective thread adapter into the P-725's aperture

Mounting the P-725.xxM and P-725.xxL thread adapters

Requirements

- ✓ You have read and understood the safety precautions (p. 6).
- ✓ The P-725 is **not** connected to the electronics.

Tools and accessories

- P-725.xxM thread adapter, microscope side (p. 12)
- P-725.xxL thread adapter, objective side (p. 12)
- Supplied right-angle Torx screwdriver (p. 10)
- Key tool (in the scope of delivery for the P-725.xxM thread adapter)

Mounting the P-725.xxM and P-725.xxL thread adapters

1. Insert the thread adapter for the objective side into the aperture of the PIFOC positioner from below.
2. Use the Torx screwdriver to tighten the screw for the thread adapter on the objective side (see figure).
3. Screw the thread adapter on the microscope side into the microscope.
4. Tighten the thread adapter on the microscope side with the wide side of the key tool.
5. Insert the PIFOC positioner into the thread adapter on the microscope side.
6. Use the Torx screwdriver to tighten the screw for the thread adapter on the microscope side (see figure).
7. Screw the objective from below into the thread adapter on the objective side of the PIFOC positioner. Do not exceed the maximum torque of 0.6 Nm.

Mounting the P-725 using the Mounting Holes in the Base Body (Optional)

NOTICE



Warping of the P-725 when mounted on uneven surfaces!

Mounting the P-725 on an uneven surface could warp the P-725. Warping reduces the accuracy.

- Mount the P-725 onto a flat surface. The recommended flatness of the surface is $\leq 10 \mu\text{m}$.
- For applications with large temperature fluctuations:
Mount the P-725 onto surfaces only when they have the same or similar thermal expansion properties as the P-725.

INFORMATION

- Note that only the thread adapter on the objective side is required when mounting the P-725 using the mounting holes in the base body.

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

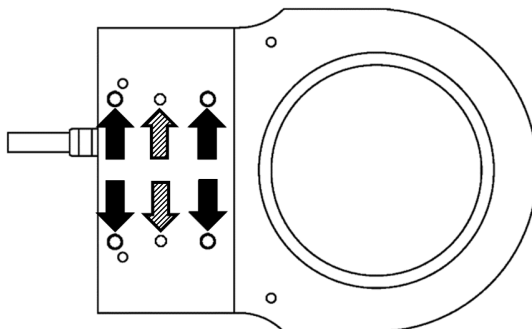


Fig. 8: P-725.xxx (example view from above):
Mounting holes (black arrows) and locating holes (hatched arrows) in the base body

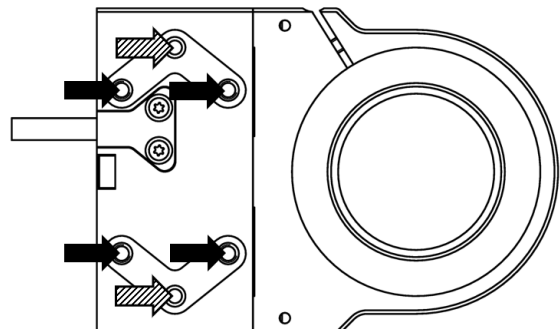


Fig. 9: P-725.xCDE2 (example view from above):
Mounting holes (black arrows) and locating holes (hatched arrows) in the base body

Requirements

- ✓ You have read and understood the safety precautions (p. 6).
- ✓ The P-725 is **not** connected to the electronics.
- ✓ The flatness of the mounting surface is $\leq 10 \mu\text{m}$.

Tools and accessories

- Four M2.5 screws of suitable length (p. 36) for fixing the P-725 to the microscope
- Optional: Two suitable locating pins (p. 36) for aligning the P-725
- Thread adapter, objective side (refer to "Optional Accessories", p. 11).
- Suitable screwdriver

Mounting the P-725 using the mounting holes in the base body

1. Mount the thread adapter for the objective side to the P-725 (depending on model):
 - P-721.xxQ thread adapter set:
Screw the thread adapter for the objective side into the aperture of the P-725 from below. For details, refer to "P-721.xxQ Thread Adapter Set (for P-725.xxD/.xxL and P-721.xxQ/.SL2)" (p. 15).
 - P-721.xxA thread adapter set:
Screw the thread adapter for the objective side into the aperture of the P-725 from below. For details, refer to "P-721.xxA Thread Adapter Set (for P-721.xxA and P-725.xCA)" (p. 19).
 - P-725.xxL thread adapter:
Clamp the thread adapter in the aperture of the P-725. For details, refer to "P-725.xxM and P-725.xxL Thread Adapters (for P-725.xCDE2)" (p. 23).
2. Optional: Align the P-725 to the microscope. Use suitable locating pins and the locating holes in the base body of the P-725.
3. Fix the P-725 to the microscope. Use four suitable M2.5 screws and the mounting holes in the base body of the P-725 for fixing.
4. Screw the objective from below into the thread adapter on the objective side of the PIFOC positioner. Do not exceed the maximum torque of 0.6 Nm.

Connecting the P-725 to the Electronics

Requirements

- ✓ You have read and understood the safety precautions (p. 6).
- ✓ You have read and understood the user manual for the electronics.
- ✓ The electronics are switched off, i.e., **not** connected to the power supply.

Connecting the P-725 to the Electronics

- Connect the plug(s) of the P-725 to the corresponding socket(s) on the electronics (refer to the user manual for the electronics).

Starting and Operating

General Notes on Starting

CAUTION



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

If the protective earth conductor is missing or not properly connected, dangerous touch voltages can occur on the P-725 in the event of malfunction or failure of the system. If there are touch voltages, touching the P-725 can result in minor injury due to electric shock.

- Connect the P-725 to a protective earth conductor before startup (p. 14).
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e.g., for modification), reconnect the P-725 to the protective earth conductor before restarting.

NOTICE



Destruction of the piezo actuator due to electric flashovers!

The use of the P-725 in environments that increase the electrical conductivity could 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 are also possible as a result of increased conductivity in certain air pressure ranges.

- Avoid operating the P-725 in environments that can increase the electric conductivity.
- Operate the P-725 only under permissible ambient conditions and classifications (p. 35).

NOTICE



Destruction of the piezo actuator due to continuously high voltage!

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

- Set the piezo voltage to 0 V on the controller if the P-725 is not used, but the controller should remain switched on to ensure the temperature stability.

NOTICE



Uncontrolled oscillation!

Oscillation can cause irreparable damage to the P-725. Oscillation is indicated by a humming noise and can be caused by the following:

- The load and/or dynamics during operation differ considerably from the calibration settings.
- The P-725 is operated near to its resonant frequency.
- If you notice oscillations, stop the P-725 immediately.

INFORMATION

Systems are calibrated at the factory to achieve optimal positioning accuracy. Replacing the system components could lead to a reduction of position accuracy when positioners are used that have ID chips without calibration data or when LEMO plug connectors are used.

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

If position accuracy is reduced after replacing the P-725 or the controller:

- Recalibrate the axis displacement (see controller manual) or contact our customer service department (p. 31).

Starting and Operating the P-725

Requirements

- ✓ You have read and understood the safety precautions (p. 6).
- ✓ You have read and understood the instructions on starting and operating (p. 27).
- ✓ You have installed the P-725 correctly (p. 14) and connected it to the electronics (p. 26).
- ✓ You have read and understood the user manual for the electronics (p. 10).

Starting and Operating the P-725

- Follow the instructions on starting and operating the P-725 in the user manual for the electronics.

Discharging the P-725

The P-725 must be discharged in the following cases:

- When the P-725 is not used but the electronics remain switched on to ensure temperature stability
- Before demounting (e.g., before cleaning and transporting the P-725) and for modifications
- If the connecting cable of the P-725 is accidentally pulled out of the electronics during operation

Requirements

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

Discharging a P-725 Connected to the Electronics

In closed-loop operation:

1. Switch off the servo mode on the electronics.
2. Set the piezo voltage to 0 V on the electronics.

In open-loop operation:

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

Discharging a P-725 not Connected to the Electronics

- Connect the P-725's voltage connector to the **switched-off** electronics from PI for 10 seconds.

Maintenance

NOTICE



Misalignment from loosening screws!

The P-725 is maintenance-free and precision adjusted.

- Loosen screws only when instructed in this user manual.
- Do **not** open the P-725.

Cleaning the P-725

NOTICE



Short-circuiting due to cleaning fluid penetrating the housing!

Liquid intruding into the housing of the P-725 could lead to the destruction of the piezo actuator by electric flashovers.

- Discharge the P-725 before cleaning (p. 28).
- Disconnect the P-725 from the electronics before cleaning.
- Prevent any cleaning fluid from penetrating the housing of the P-725.

NOTICE



Damage from ultrasonic cleaning!

Ultrasonic cleaning can damage the P-725.

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

NOTICE



Damage due to use of unsuitable cleaning agents!

Some cleaning agents may cause damage to the P-725.

- Use mild cleaning agents only (e.g., isopropyl alcohol or ethanol).

Requirements

- ✓ You have discharged the P-725 (p. 28).
- ✓ You have disconnected the P-725 from the electronics.

Other materials required

- Soft, lint-free cloth
- Mild cleaning agent or disinfectant (e.g., isopropyl alcohol or ethanol)

Cleaning the P-725

1. Dampen the cloth with the cleaning agent or disinfectant.
2. Wipe the surfaces of the P-725 carefully.

Demounting

NOTICE



Falling down when removing the thread adapters!

The P-725 could fall down while removing the upper thread adapter (microscope side) if it is not secured or tightly screwed. The thread adapter and the objective screwed in could fall down while removing the lower thread adapters (objective side).

- Secure all parts against falling down while removing the thread adapters:
 - Screw the objective out before removing.
 - Hold the P-725 firmly when you loosen the upper thread adapter.
- To demount the objective and the PIFOC positioner, reverse the steps of the relevant installation instructions in "Installing" (p. 14).

Customer Service

For inquiries and orders, contact your PI sales 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 current versions of the user manuals can be downloaded at www.pi.ws.

Technical Data

Specifications

Motion	P-725.1CDE2	P-725.4CDE2	P-725.8CDE2	Tolerance
Active axes	Z	Z	Z	
Travel range in Z	100 µm	400 µm	800 µm	+20 / -0 %
Travel range in Z, open loop	120 µm	420 µm	840 µm	±20%
Linearity error in Z	0.01 %	0.01 %	0.02 %	
Yaw (Rotational crosstalk in θ_X with motion in Z)	± 10 µrad	± 10 µrad	± 50 µrad	
Pitch (Rotational crosstalk in θ_Y with motion in Z)	± 10 µrad	± 45 µrad	± 50 µrad	

Positioning	P-725.1CDE2	P-725.4CDE2	P-725.8CDE2	Tolerance
Resolution in Z, open loop	0.1 nm	0.1 nm	0.4 nm	typ.
Minimum incremental motion in Z	1 nm	4 nm	5 nm	
Settling time for 10% step in Z	14 ms	22 ms	39 ms	±10 %
Position noise in Z	0.1 nm	0.1 nm	0.4 nm	max.
Integrated sensor	Capacitive, direct position measuring	Capacitive, direct position measuring	Capacitive, direct position measuring	
Sensor noise, 1 sigma	0.2 nm	0.2 nm	0.8 nm	
Point repeatability, 10% step, 1 sigma	10 nm	10 nm	50 nm	

Drive properties	P-725.1CDE2	P-725.4CDE2	P-725.8CDE2	Tolerance
Drive type	PICMA®	PICMA®	PICMA®	
Electrical capacitance in Z	3.2 µF	6.4 µF	12.8 µF	±20%

Mechanical properties	P-725.1CDE2	P-725.4CDE2	P-725.8CDE2	Tolerance
Guide	Flexure guide with lever amplification	Flexure guide with lever amplification	Flexure guide with lever amplification	
Stiffness in Z	0.5 N/μm	0.25 N/μm	0.07 N/μm	±20 %
Resonant frequency in Z, under load with 150 g	290 Hz	175 Hz	110 Hz	±20%
Resonant frequency in Z, unloaded	680 Hz	400 Hz	230 Hz	±20%
Objective diameter	39 mm	39 mm	39 mm	max.
Permissible push force in Z	100 N	100 N	100 N	max.
Permissible pull force in Z	20 N	20 N	20 N	max.
Overall mass	280 g	280 g	350 g	±5 %
Material	Stainless steel, aluminum	Stainless steel, aluminum	Stainless steel, aluminum	

Miscellaneous	P-725.1CDE2	P-725.4CDE2	P-725.8CDE2	Tolerance
Connector	D-sub 7W2 (m)	D-sub 7W2 (m)	D-sub 7W2 (m)	
Recommended controllers / drivers	E-709.1C1L - economic choice, suitable for most use cases; E-754.1CD - high performance choice for highest precision	E-709.1C1L - economic choice, suitable for most use cases; E-754.1CD - high performance choice for highest precision	E-709.1C1L - economic choice, suitable for most use cases; E-754.1CD - high performance choice for highest precision	
Cable length	1.5 m	1.5 m	1.5 m	+50 / -0 mm
Operating temperature range	-20 to 80 °C	-20 to 80 °C	-20 to 80 °C	

The resolution of the system is limited only by the noise of the amplifier and the measuring technology because PI piezo nanopositioning systems are free of friction.

All specifications based on room temperature (22 °C ±3 °C).

	P-725.1CL P-725.1CD P-725.1CA	P-725.2CL P-725.2CD P-725.2CA	P-725.4CL P-725.4CD P-725.4CA	P-725.x0L open-loop version	Unit	Tolerance
Active axes	Z	Z	Z	Z		
Motion and positioning						
Integrated sensor	Capacitive	Capacitive	Capacitive	-		
Travel range at -20 to +120 V, open loop	150	330	460	as P-725.xCL	µm	+20 % / -0 %
Travel range, closed loop	100	250	400	-	µm	
Resolution, open loop	0.3	0.4	0.5	as P-725.xCL	nm	Typ.
Resolution, closed loop	0.65	0.75	1.25	-	nm	Typ.
Linearity, closed loop	0.03	0.03	0.03	-	%	Typ.
Repeatability	±5	±5	±5	-	nm	Typ.
Tilt θ_x	1	6	10	as P-725.xCL	µrad	Typ.
Tilt θ_y	20	45	45	as P-725.xCL	µrad	Typ.
Crosstalk in X	20	20	60	as P-725.xCL	nm	Typ.
Crosstalk in Y	20	40	60	as P-725.xCL	nm	Typ.
Mechanical properties						
Stiffness in motion direction	0.23	0.17	0.12	as P-725.xCL	N/µm	±20 %
Resonant frequency, unloaded	470	330	230	as P-725.xCL	Hz	±20 %
Resonant frequency, under load, 150 g	185	140	120	as P-725.xCL	Hz	±20 %
Push/pull force capacity in positioning direction	100 / 20	100 / 20	100 / 20	as P-725.xCL	N	Max.
Drive properties						
Ceramic type	PICMA®	PICMA®	PICMA®	as P-725.xCL		
Electrical capacitance	4.2	6.2	6.2	as P-725.xCL	µF	±20 %
Miscellaneous						
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	-20 to 80	°C	
Material	Aluminum	Aluminum	Aluminum	Aluminum		
Objective diameter	39	39	39	39	mm	Max.
Assembly	QuickLock	QuickLock	QuickLock	QuickLock		
Mass	0.215	0.23	0.23	as P-725.xCL	kg	±5 %
Sensor/voltage connector	CL version: LEMO Other: D-sub 7W2 (m)	CL version: LEMO Other: D-sub 7W2 (m)	CL version: LEMO Other: D-sub 7W2 (m)	LEMO (no sensor)		
Cable length	1.5	1.5	1.5	1.5	m	+50 mm / -0 mm
Recommended electronics	E-505, E-610, E-621, E-625, E-665, E-709, E-754	E-505, E-610, E-621, E-625, E-665, E-709, E-754	E-505, E-610, E-621, E-625, E-665, E-709, E-754	E-505, E-610, E-621, E-625, E-665, E-709, E-754		

The resolution of the system is limited only by the noise of the amplifier and the measuring technology because PI piezo nanopositioning systems are free of friction.

All specifications based on room temperature (22 °C ±3 °C).

	P-725.CDD	P-725.SDD	Unit	Tolerance
Active axes	Z	Z		
Motion and positioning				
Integrated sensor	Capacitive	SGS		
Travel range at -20 to +120 V, open loop	18	18	μm	+20 % / -0 %
Travel range, closed loop	18	18	μm	
Resolution, open loop	0.2	0.2	nm	Typ.
Resolution, closed loop	0.2	0.2	nm	Typ.
Linearity error, closed loop	0.04*	0.5	%	Typ.
Repeatability	±1.5	±5	nm	Typ.
Tilt θ_x , θ_y	2	2	μrad	Typ.
Crosstalk in X, Y	150	150	nm	Typ.
Mechanical properties				
Stiffness in motion direction	1.5	1.5	N/μm	±20 %
Resonant frequency, unloaded	1180	1180	Hz	±20 %
Resonant frequency under load, 200 g	450	450	Hz	±20 %
Push/pull force capacity in positioning direction	100 / 20	100 / 20	N	Max.
Drive properties				
Ceramic type	PICMA® P-887	PICMA® P-887		
Electrical capacitance	3.1	3.1	μF	±20 %
Miscellaneous				
Operating temperature range	-20 to 80	-20 to 80	°C	
Material	Aluminum	Aluminum		
Mass	0.21	0.2	kg	±5 %
Cable length	1.5	1.5	m	±10 mm
Sensor/voltage connector	D-sub 7W2 (m)	LEMO		
Recommended electronics	E-610, E-625, E-665, E-709.CHG, E-754	E-610, E-625, E-665		




* The linearity error of directly driven positioners measured with analog controllers is typically up to 0.1 %.

The resolution of the system is limited only by the noise of the amplifier and the measuring technology because PI piezo nanopositioning systems are free of friction.

All specifications based on room temperature (22 °C ±3 °C).

Maximum Ratings

The P-725 objective scanners are designed for the following operating data:

Model	Maximum operating voltage 	Maximum operating frequency (unloaded) ¹ 	Maximum power consumption ² 
P-725.1xx	-20 to 120 V	155 Hz	13 W
P-725.2xx	-20 to 120 V	110 Hz	17.4 W
P-725.4xx	-20 to 120 V	75 Hz	17.4 W
P-725.xDD	-20 to 120 V	390 Hz	4.7 W
P-725.1CDE2	-20 to 120 V	225 Hz	8.6 W
P-725.4CDE2	-20 to 120 V	132 Hz	17.4 W
P-725.8CDE2	-20 to 120 V	75 Hz	35 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:

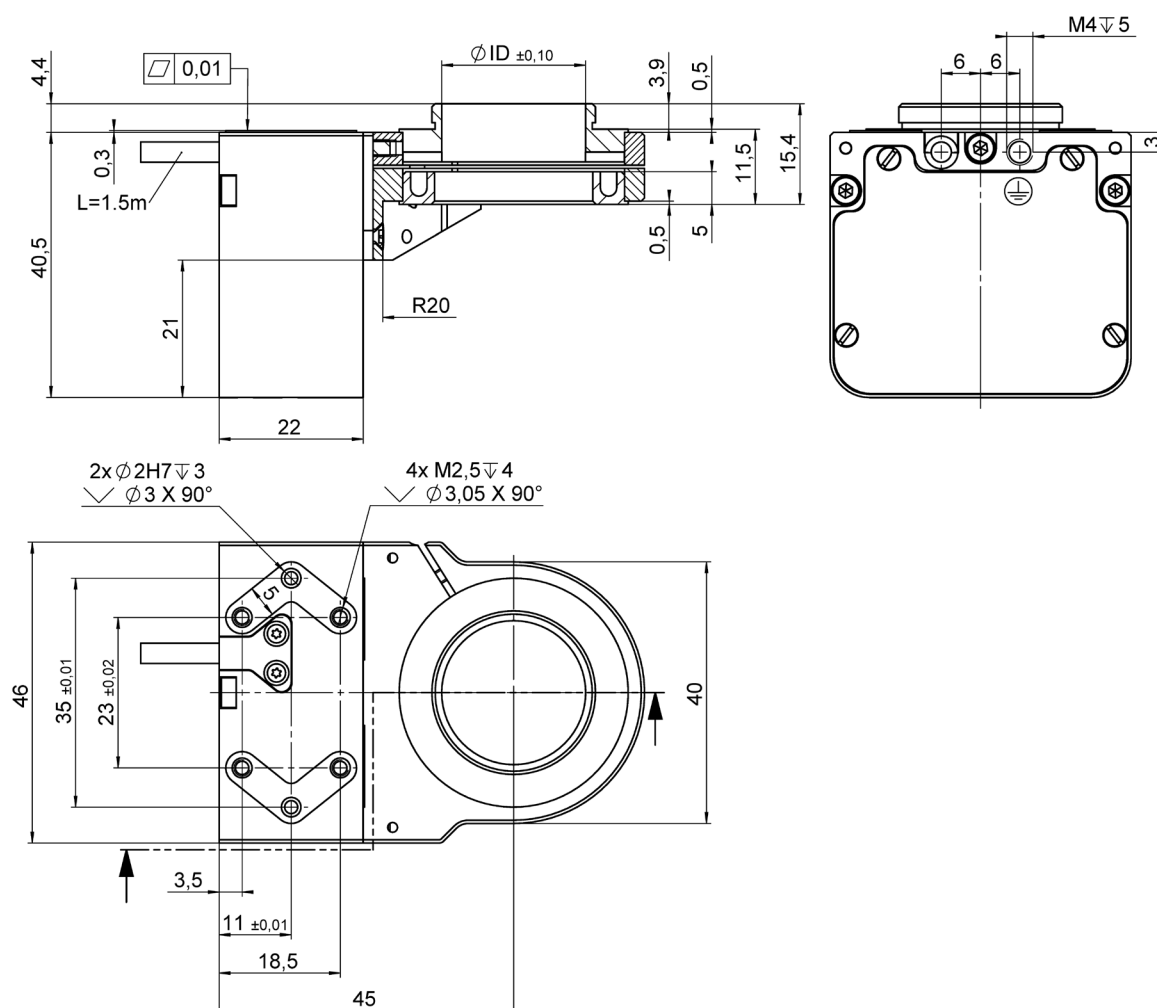
<https://www.physikinstrumente.com/en/technology/piezo-technology/properties-piezo-actuators/electrical-operation/>

Ambient Conditions and Classifications

Pay attention to the following ambient conditions and classifications for the P-725:

Area of application	For indoor use only
Maximum altitude	2000 m above msl
Air pressure	1070 hPa to 780 hPa
Relative humidity	Highest relative humidity 80% for temperatures up to 31 °C Decreasing linearly to 50 % relative humidity at 40 °C
Operating temperature	-20 °C to 80 °C
Storage temperature	-20 °C to 80 °C
Transport temperature	-25 °C to 85 °C
Overvoltage category	II
Protection class	I
Degree of pollution	1
Degree of protection according to IEC 60529	IP20

Dimensions



Thread	Microscope Side Thread Adapter	Objective / Lens Side Thread Adapter	Objective Spacer for Correcting the Parfocal Length
	P-725.xxM	ID in mm	P-725.xxL
M26 x 0.75	P-725.02M	22	P-725.02L
M27 x 0.75	P-725.03M	22	P-725.03L
M28 x 0.75	P-725.04M	22	P-725.04L
M32 x 0.75	P-725.05M	25	P-725.05L
M26 x 1/36"	P-725.06M	22	P-725.06L
M19 x 0.75	P-725.08M	15	P-725.08L
M25 x 0.75	P-725.11M	22	P-725.11L
W0.8 x 1/36"	P-725.12M	16	P-725.12L
SM1 (1.035"-40)	P-725.13M	22	P-725.13L
M34 x 1	P-725.14M	28	P-725.14L

Fig. 10: P-725.1CDE2 and P-725.4CDE2, dimensions in mm (please order adapters and spacers separately)

User Manual

P725T0010, applies to P-725

CBo/KSch, 2021-08-31

PI

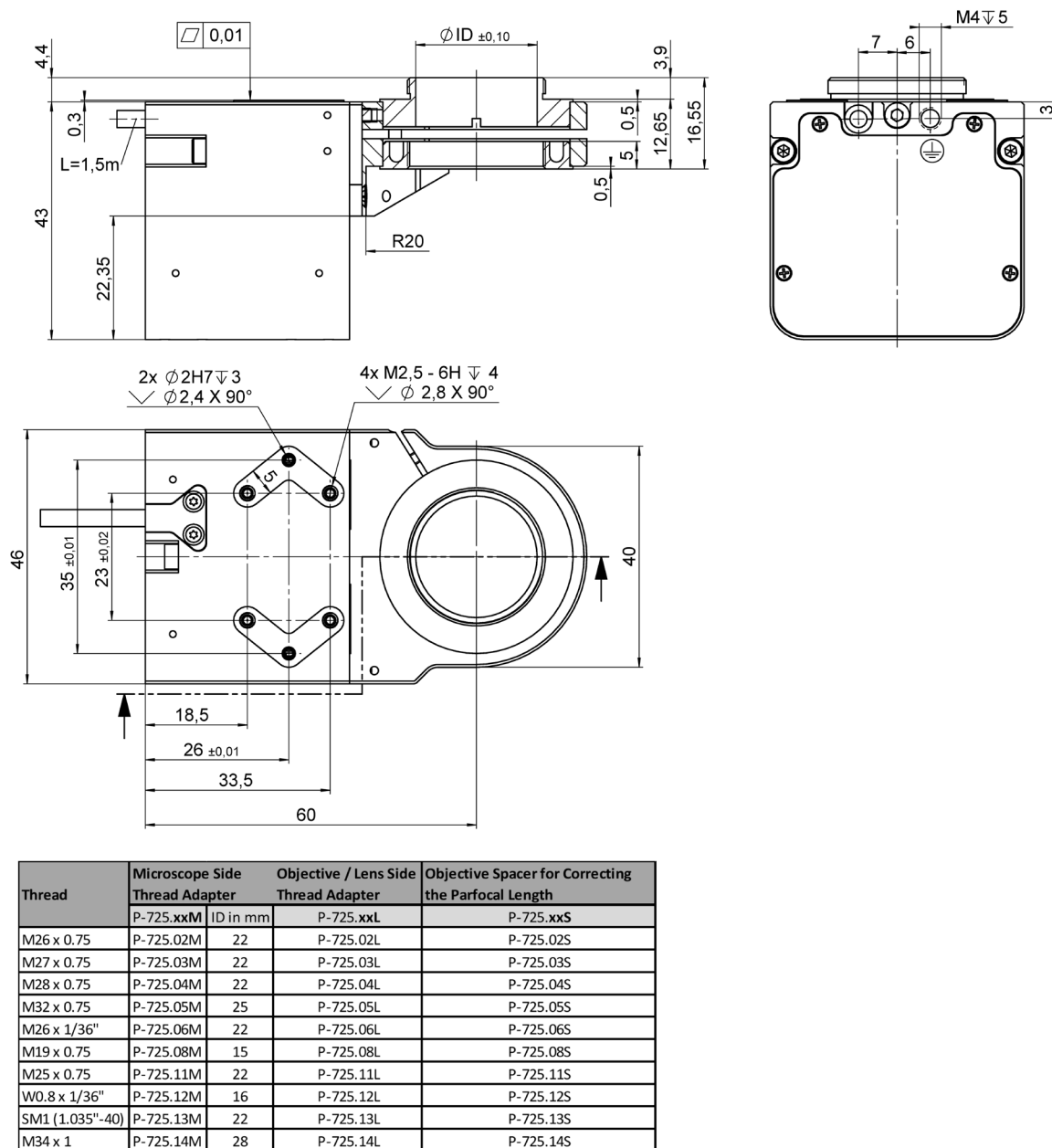
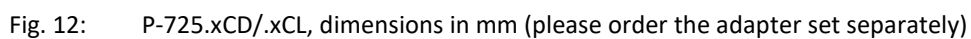


Fig. 11: P-725.8CDE2, dimensions in mm (please order adapters and spacers separately)



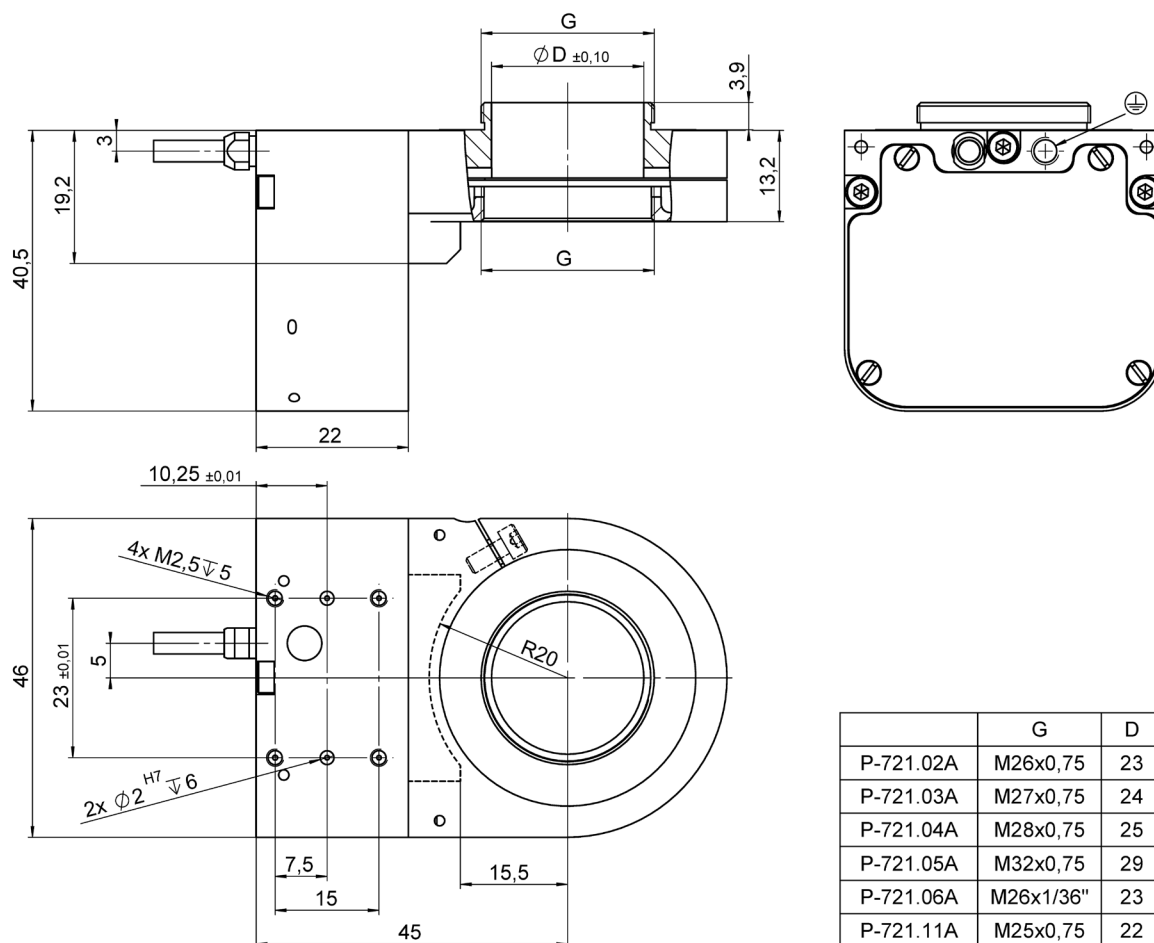


Fig. 13: P-725.xCA, dimensions in mm (please order the adapter set separately)

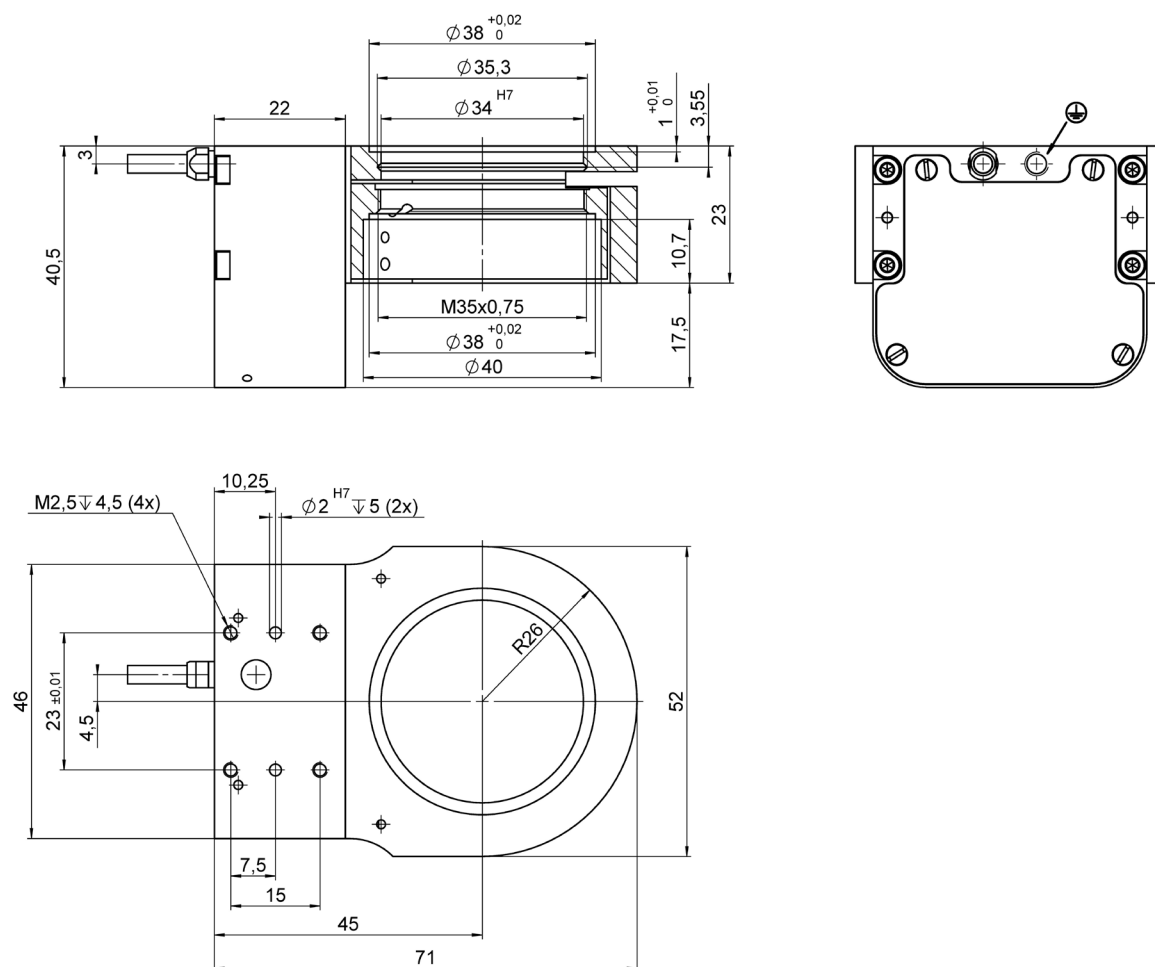


Fig. 14: P-725.xDD, dimensions in mm (please order the adapter set separately)

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

Pin Assignment

P-725.xCL, P-725.x0L

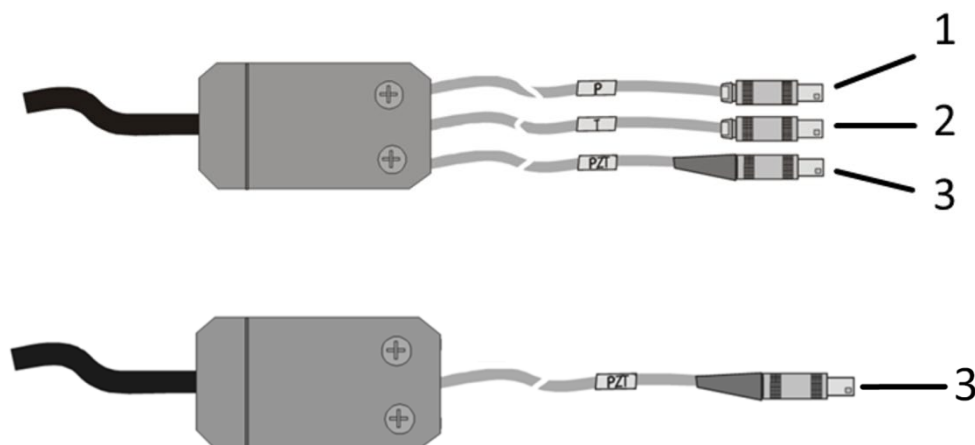


Fig. 15: LEMO connector for the P-725.xCL (above) and P-725.x0L (below)

- 1 LEMO coaxial connector for capacitive sensor (Probe)
- 2 LEMO coaxial connector for capacitive sensor (Target)
- 3 LEMO coaxial connector for piezo voltage

LEMO coaxial connectors



Fig. 16: LEMO coaxial connectors

Connector	Signal	Function	Connector shell
P	Probe	Probe sensor signal (immovable part of the capacitive sensor)	Cable shield
T	Target	Target sensor signal (movable part of the capacitive sensor)	Cable shield
PZT	PZT	Piezo voltage	Piezo voltage ground on cable shield

P-725.SDD

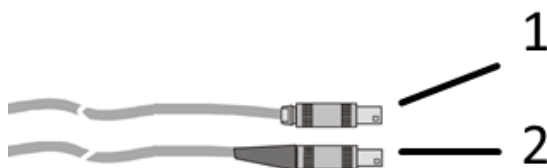


Fig. 17: LEMO connectors for the P-725.SDD

- 1 LEMO connector, 4-pole, for the strain gauge sensor
- 2 LEMO coaxial connector for piezo voltage

Sensor connector



Fig. 18: LEMO connector, 4-pole, for strain gauge sensor (front view)

Pin	Function
1	Reference (5 V)
2	Sensor -
3	Sensor +
4	GND

PZT connector

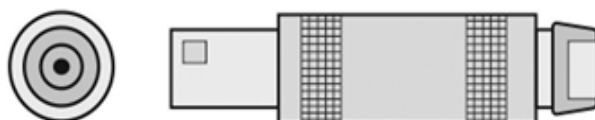


Fig. 19: LEMO coaxial connector for piezo voltage

Pin	Function
Inner contact	PZT + (-20 to 120 V)
Connector shell	PZT - (GND)

P-725.xCD, P-725.xCDE2, P-725.xCA, P-725.CDD

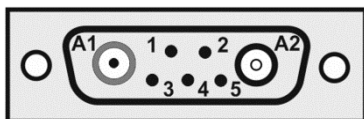


Fig. 20: D-sub 7W2 (m) plug connector (front view)

Pin	Signal	Function
A1 inner conductor	Input	Piezo voltage +
A2 inner conductor	Output	Probe sensor signal (immovable part of the capacitive sensor)
A2 line conductor	GND	Shield
1	Bidirectional	Data line for ID chip
2	GND	Shield of Target Ground of ID chip when switched on
3	Input	Piezo voltage –
4	---	Not connected
5	Input	Target sensor signal (movable part of the capacitive sensor)

The connector shell is connected to the cable shield.

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 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.

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