

P-737.1SL, P-737.2SL, P-737.5SL

PIFOC® Specimen-Focusing Z Stage



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About this Document

Symbols and Typographic Conventions

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.

The following symbols and markings are used in the user manuals of PI:

Symbol	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
S. 5	Cross-reference to page 5
	Warning sign affixed to the product that refers to detailed information in this user manual.

Safety

Intended Use

P-737 PIFOC® high-speed vertical positioning systems are designed for use with XY microscopy stages – OEM manual stages as well as aftermarket motorized stages.

While the XY stage positions the sample, the piezo-actuator-based P-737 moves the sample along the optical axis to quickly and precisely adjust the focus. Vertical stepping with an accuracy in the nanometer range takes only a few milliseconds.

The large aperture is designed to accommodate microtiter plates as well as a variety of sample holders (e.g., holders for microscope slides or Petri dishes).

The P-737 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.

The intended use of the P-737 is only possible in combination with suitable electronics (p. 8) that are available from PI.

For information about the digital piezo controller refer to its separate documentation.

Safety Precautions

CAUTION



Dangerous voltage and residual charge on piezo actuators!

The P-737 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-737 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-737.
- Discharge the piezo actuators of the P-737 before installation:
Connect the P-737 to the switched-off PI controller for 10 seconds.
- Do **not** pull the connector out of the electronics during 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 on the P-737 in the case of malfunction or failure of the system. If touch voltages exist, touching the P-737 can result in minor injury from electric shock.

- Connect the P-737 to a protective earth conductor (p. 8) 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-737 to the protective earth conductor before starting it up again.

NOTICE



Mechanical overload due to transport without transport lock!

An impermissible mechanical load on the P-737 due to transportation without transport lock can damage the P-737 as well as cause loss of accuracy.

- Do **not** remove any parts of the transport lock as long as the P-737 is to be transported.
- Reinstall all parts of the transport lock every time the P-737 is to be transported.
- Only ship the P-737 in the original packaging and with the transport lock installed.

NOTICE



Damage due to transport lock that has not been removed!

Damage can occur to the P-737 if the transport lock has not been removed and a motion is commanded.

- Remove the transport lock (p. 9) before you start up the P-737!

NOTICE



Impermissibly high forces on the motion platform!

Impermissibly high forces that are applied to the motion platform (e.g., during installation or demounting) can damage the stage.

- Avoid forces on the motion platform (p. 6) of the stage.
- Only hold the stage externally by the base body (p. 6).

NOTICE



Unsuitable cables!

Unsuitable cables can damage the electronics.

- Only use cables from PI for connecting the P-737 to the electronics.

INFORMATION

Extended cables can affect the performance of the P-737.

- Do **not** use cable extensions. If you need longer cables, contact our customer service department (p. 17).

Product Description

Model Overview

Product number	Description
P-737.1SL	PIFOC® nanofocusing stage for microscope sample holder, 100 µm, SGS, LEMO connectors
P-737.2SL	PIFOC® nanofocusing stage for microscope sample holder, 250 µm, SGS, LEMO connectors
P-737.5SL	PIFOC® nanofocusing stage for microscope sample holder, 500 µm, SGS, LEMO connectors

Product View

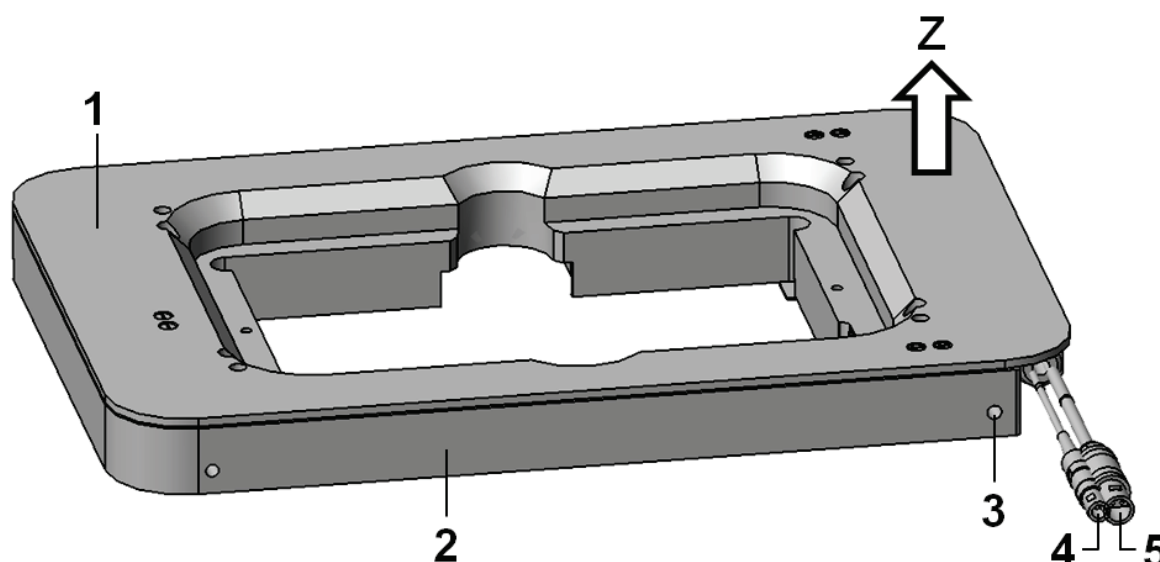


Figure 1: Example view of P-737.xSL

- 1 Motion platform
- 2 Base body
- 3 Protective earth connection
- 4 Piezo connector (LEMO, coaxial)
- 5 Sensor connector (LEMO, 4 pins)
- Z arrow: Positive direction of motion

Product Labeling

Labeling	Description
P-737.2SL	Product number (example), the characters following the period refer to the stage model
SN 117147601	Serial number (example), individual for each P-737 Meaning of the places (counting from left): 1 = internal information 2 and 3 = year of manufacture 4 to 9 = consecutive numbers
PIFOC®	Brand name
	Manufacturer's logo
	Warning sign "Observe manual!"
	Old equipment disposal (p. 24)
Country of origin: Germany	Country of origin
WWW.PI.WS	Manufacturer's address (website)
	CE conformity mark
	Symbol for the protective earth conductor, marks the protective earth connection of the P-737 (p. 6)

Scope of Delivery

Product number	Description
P-737	PIFOC® nanofocusing stage according to order (p. 6)
000036450	M4 protective earth screw set, consisting of: 1 M4x8 flat-head screw with cross recess, ISO 7045 2 safety washers 2 flat washers
PZ240EK	Short instructions for piezo positioning systems
P737T0004	Technical note for P-737 (unpacking and removing the transport lock)

Suitable Controllers

Product number	Description
E-610	Servo controller / amplifier
E-625	Servo controller, bench-top
E-665	Powerful servo controller, bench-top
E-709.SRG*	Digital piezo controller, bench-top

* E-709.03 adapter cable required (to be ordered separately)

- To order, contact our customer service department (p. 17).

Accessories

Product number	Description
P-737.AP1	Insertable holder for microscope slides, for P-737 piezo sample Z positioner
P-737.AP2	Insertable holder for Petri dishes, for P-737 piezo sample Z positioner

- To order, contact our customer service department (p. 17).

Installation

Connecting the P-737 to the Protective Earth Conductor

INFORMATION

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

The P-737 features a protective earth connection (p. 6) which is marked with the symbol for the protective earth conductor .

Requirements

- ✓ You have read and understood the safety precautions (p. 4).
- ✓ The P-737 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 set (p. 7) for protective earth connection
- Suitable screwdriver

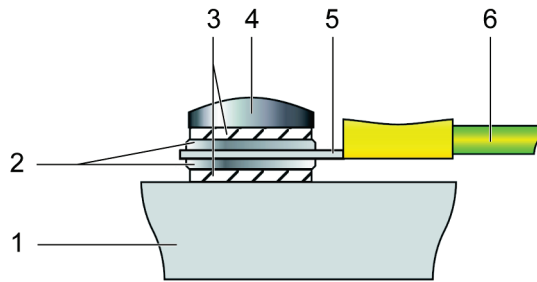


Figure 2: Connecting the protective earth conductor (profile view)

- 1 Base body of the P-737
- 2 Flat washer
- 3 Safety washer
- 4 Screw
- 5 Cable lug
- 6 Protective earth conductor

Connecting the P-737 to the protective earth conductor

1. If necessary, fasten a suitable cable lug to the protective earth conductor.
2. Use the M4 screw (together with the washers and self-locking washers) to affix the cable lug of the protective earth conductor to the protective earth connection of the P-737 as shown in the profile view.
3. Tighten the M4 screw with a torque of 1.2 Nm to 1.5 Nm.
4. Make sure that the contact resistance at all connection points relevant for mounting the protective earth conductor is $<0.1 \Omega$ at 25 A.

Removing the Transport Lock

NOTICE



Impermissibly high forces on the motion platform!

Impermissibly high forces that are applied to the motion platform (e.g., during installation or demounting) can damage the stage.

- Avoid forces on the motion platform (p. 6) of the stage.
- Only hold the stage externally by the base body (p. 6).

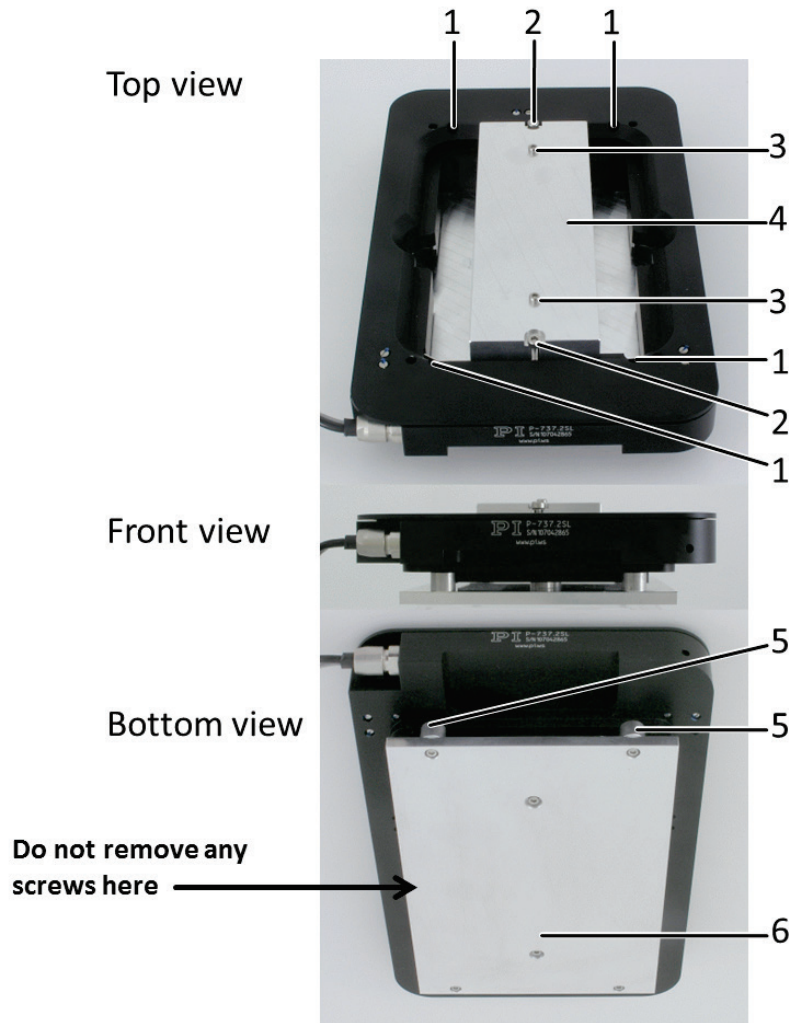


Figure 3: P-737 with transport lock

- 1 M2.5x8 socket head screw (4x)
- 2 M3x16 socket head screw (2x)
- 3 M2.5x20 socket head screw (2x)
- 4 Fixing plate
- 5 Spacer (2 of 6 visible here)
- 6 Base plate

Tools and accessories

- Suitable screwdrivers for M2.5 and M3 socket head screws

Removing the transport lock

1. Remove the fixing plate (4):
To do this, unscrew and remove the two M3x16 screws (2) and the two M2.5x20 screws (3).
2. Remove the base plate (6):
To do this, unscrew and remove the four M2.5x8 screws (1) from the top side.
It is not necessary to remove the six spacers from the base plate.
3. Keep the transport lock in case the product needs to be transported again later.

Mounting the P-737 onto a Base

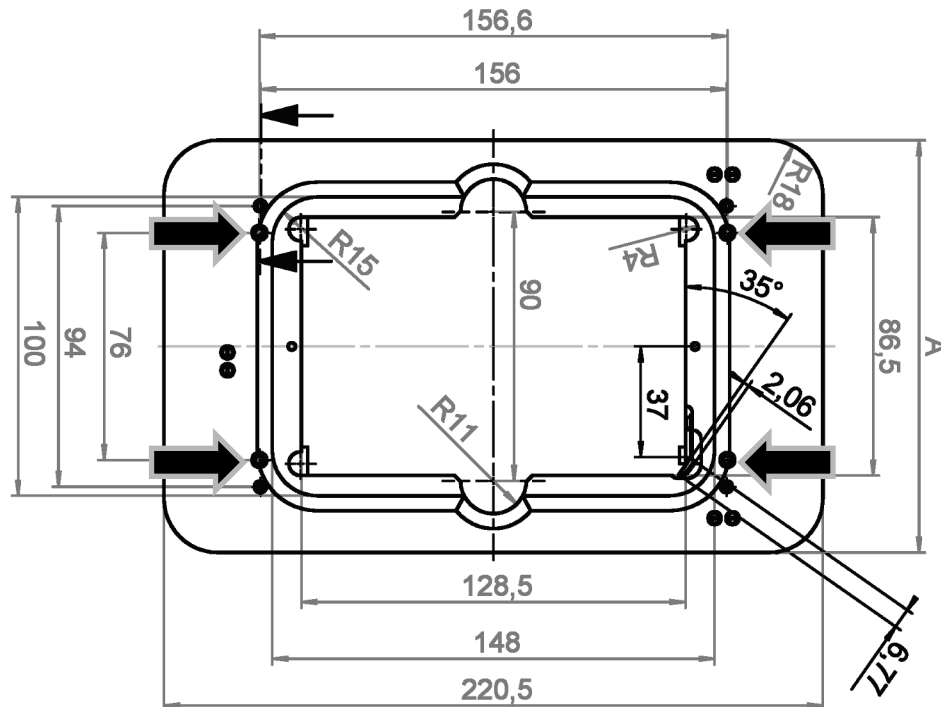


Figure 4: The mounting holes with a diameter of 3 mm must be used for mounting the P-737 onto a base.

Requirements

- ✓ You have provided a suitable installation environment.
- ✓ The P-737 is **not** connected to the controller.

Tools and accessories

- Four M2.5 screws of suitable length
- Suitable surface
- Suitable tools

Mounting the P-737 onto a base

- Mount the P-737 onto the base using four suitable M2.5 socket head screws and the four holes marked by arrows, see Figure 4.

Technical drawing of a rectangular plate with rounded corners. The drawing includes the following dimensions and features:

- Overall Dimensions:**
 - Width: 156,6 (top) and 156 (middle)
 - Height: 100 (left) and 86,5 (right)
- Internal Dimensions and Features:**
 - Inner width: 128,5 (bottom)
 - Inner height: 90 (middle)
 - Distance from left edge to inner left corner: 76
 - Distance from left edge to inner left corner: 94
 - Distance from bottom edge to inner bottom corner: 148
 - Distance from bottom edge to inner bottom corner: 220,5
 - Distance from right edge to inner right corner: 6,77
 - Distance from right edge to inner right corner: 2,06
 - Distance from right edge to inner right corner: 35°
 - Distance from right edge to inner right corner: 37
- Curved Features:**
 - Top-left corner: R15
 - Top-right corner: R18
 - Bottom-left corner: R11
 - Bottom-right corner: R4
- Other Features:**
 - Two small circles on the left edge.
 - Two small circles on the right edge.
 - Two small circles on the bottom edge.
 - Two small circles on the top edge.
 - Two small circles on the inner left edge.
 - Two small circles on the inner right edge.
 - Two small circles on the inner bottom edge.
 - Two small circles on the inner top edge.
 - Two small circles on the inner left edge.
 - Two small circles on the inner right edge.
 - Two small circles on the inner bottom edge.
 - Two small circles on the inner top edge.

Requirements

- ## Tools and accessories

- ## Affixing a sample holder to the P-737

- Physik Instrumente (PI) GmbH & Co. KG, Auf der Roemerstrasse 1, 76228 Karlsruhe, Germany
Phone +49 721 4846-0, Fax +49 721 4846-1019, Email info@pi.ws, www.pi.ws

Start-Up and Operation

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 on the P-737 in the case of malfunction or failure of the system. If touch voltages exist, touching the P-737 can result in minor injury from electric shock.

- Connect the P-737 to a protective earth conductor (p. 8) 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-737 to the protective earth conductor before starting it up again.

NOTICE



Damage from transport lock that has not been removed!

Damage can occur to the P-737 if the transport lock has not been removed and a motion is commanded.

- Remove the transport lock completely (p. 9) before you start up the P-737!

NOTICE



Destruction of the piezo actuator by electric flashovers!

The use of the P-737 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-737 in environments that can increase the electric conductivity.
- Only operate the P-737 within the permissible ambient conditions and classifications (p. 20).

NOTICE



Destruction of the piezo actuator 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-737 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



Uncontrolled oscillation!

Oscillations can cause irreparable damage to the P-737. Oscillations are indicated by a humming and can result from the following causes:

- The load and/or dynamics of operation differ too much from the calibration settings.
- The P-737 is operated near its resonant frequency.
- If you notice oscillations, stop the P-737 immediately.

Starting Up and Operating the P-737

The P-737 may only be started up, operated, maintained and cleaned by authorized and qualified staff.

Requirements

- ✓ The transport lock is removed.
- ✓ You have connected the P-737 to the protective earth conductor (p. 8).
- ✓ You have read and understood the following sections:
 - Safety Precautions (p. 4)
 - General Notes on Start-Up and Operation (p. 13)

Starting up and operating the P-737

- Follow the instructions in the user manual of the piezo controller used for start-up and operation of the P-737.

Discharging the P-737

The P-737 must be discharged before demounting. Demounting is necessary e.g., before cleaning or transporting the P-737 as well as for modifications.

Discharging a P-737 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-737 that is not connected to the controller

- Connect the P-737 to the switched-off PI controller for 10 seconds.

Maintenance

NOTICE



Damage due to improper maintenance!

The P-737 is maintenance-free and precisely aligned.

- Only loosen screws according to the instructions in this manual.
- Do **not** open the P-737.

Preparing the P-737 for Transport

NOTICE



Mechanical overload due to transport without transport lock!

An impermissible mechanical load on the P-737 due to transportation without transport lock can damage the P-737 as well as cause loss of accuracy.

- Do **not** remove any parts of the transport lock as long as the P-737 is to be transported.
- Reinstall all parts of the transport lock every time the P-737 is to be transported.
- Only ship the P-737 in the original packaging and with the transport lock installed.

NOTICE



Damage due to screws that are too long!

Screws that are inserted too deeply damage the P-737.

- Use only M3x16 screws with the holes in the stage frame (2) to avoid damage to the stage, see Figure 6 below.

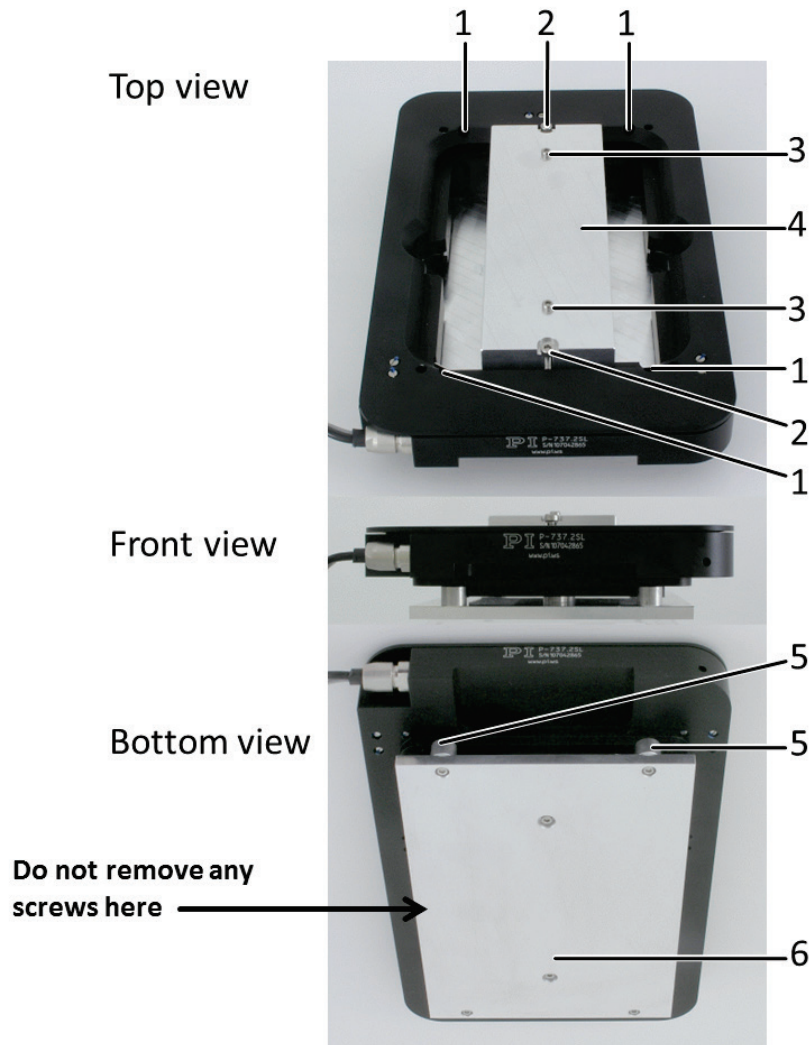


Figure 6: P-737 with transport lock affixed

- 7 M2.5x8 socket head screw (4x)
- 8 M3x16 socket head screw (2x)
- 9 M2.5x20 socket head screw (2x)
- 10 Fixing plate
- 11 Spacer (2 of 6 visible here)
- 12 Base plate

Tools and accessories

- Transport lock consisting of:
 - Four M2.5x8 screws
 - Two M3x16 screws
 - Two M2.5x20 screws
 - Fixing plate
 - Six spacers
 - Base plate
- Suitable screwdrivers for M2.5 and M3 socket head screws

Preparing the P-737 for transport

1. Put the P-737 stage on the base plate (6) which has the six spacers (5) fixed and upturned. Align the four holes (1) with the four subjacent, short spacers.
2. Affix the stage to the short spacers by screwing the four M2.5x8 screws (1) from the top side.

Maximum torque: 0.6 Nm

3. Carefully put the fixing plate (4) onto the two long spacers and align it with the spacers and the holes in the stage frame (2).
4. Screw the fixing plate using the two M3x16 screws (2) and the two M2.5x20 screws (3).

Maximum torque of M3 screws: 1.1 Nm

Maximum torque of M2.5 screws: 0.6 Nm

Cleaning the P-737

NOTICE



Wrong cleaning can damage the P-737!

When liquids enter the P-737, the integrated piezo actuators can be destroyed by electric flashovers.

- Ensure that no liquid can enter the P-737.
- Only clean the P-737 in accordance with the instructions in this user manual.

Requirements

- ✓ You have discharged the piezo actuators of the P-737.
- ✓ You have disconnected the P-737 from the controller.

Cleaning the P-737

- Clean the surface of the P-737 with a cloth that is lightly dampened with a mild cleanser or disinfectant (e.g., ethanol or isopropyl alcohol).
- Do **not** do any ultrasonic cleaning.

Customer Service

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

- If you have questions concerning your system, have the following information ready:
 - Product 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)
- If possible: Take photographs or make videos of your system that can be sent to our customer service department if requested.

The latest versions of the user manuals are available for download on our website (www.pi.ws).

Technical Data

Specifications

	P-737.1SL	P-737.2SL	P-737.5SL	Unit	Tolerance
Active axes	Z	Z	Z		
Motion and positioning					
Integrated sensor	SGS	SGS	SGS		
Open-loop travel, -20 to 120 V	150	280	550	μm	min. (20 % / -0 %)
Closed-loop travel	100	250	500	μm	
Open-loop resolution	0.8	1	1.6	nm	typ.
Closed-loop resolution	2.5	4	5	nm	typ.
Closed-loop linearity error	0.2	0.5	0.8	%	typ.
Repeatability	6	12	15	nm	typ.
Angular runout θ_x	±36	±36	±36	μrad	typ.
Angular runout θ_y	±36	±100	±100	μrad	typ.
Mechanical properties					
Unloaded resonant frequency	270	210	122	Hz	±20 %
Resonant frequency at 100 g	230	180	115	Hz	±20 %
Resonant frequency at 200 g	210	155	100	Hz	±20 %
Push/pull force capacity in motion direction	50 / 20	50 / 20	50 / 20	N	max.
Drive properties					
Piezo ceramic	PICMA® P-885	PICMA® P-885	PICMA® P-885		
Electrical capacitance	6.3	9.3	13.8	μF	±20 %
Dynamic operating current coefficient	7.9	4.6	3.5	μA / (Hz × μm)	±20 %
Miscellaneous					
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	°C	
Material	Aluminum	Aluminum	Aluminum		
Dimensions	220.5 mm × 138 mm × 27.3 mm	220.5 mm × 138 mm × 27.3 mm	220.5 mm × 150 mm × 27.3 mm		
Mass	0.7	0.7	0.85	kg	±5 %
Cable length	2	2	2	m	±10 mm
Sensor / voltage connection	LEMO	LEMO	LEMO		

	P-737.1SL	P-737.2SL	P-737.5SL	Unit	Tolerance
System properties					
System configuration	E-500 system with E-503 amplifier (6 W) E-509 servo module	E-500 system with E-503 amplifier (6 W) E-509 servo module	E-665.SR controller / driver (12 W)		
Closed-loop amplifier bandwidth, small signal	60	30	15	Hz	typ.
Settling time (10 % step width)	24	30	50	ms	typ.

Versions with directly measuring, high-resolution capacitive sensors and custom versions on request!

Maximum Ratings

Model	Maximum operating voltage 	Maximum operating frequency (no load) ¹ 	Maximum power consumption ² 
P-737.1SL	-20 to +120 V	90 Hz	19.35 W
P-737.2SL	-20 to +120 V	70 Hz	25.8 W
P-737.5SL	-20 to +120 V	40 Hz	38.7 W

¹ To ensure stable operation, the maximum operating frequency is defined as approximately 1/3 of the mechanical resonant frequency.

² The heat generated by the piezo actuator during dynamic operation limits the value for maximum power consumption.

Details can be found online:

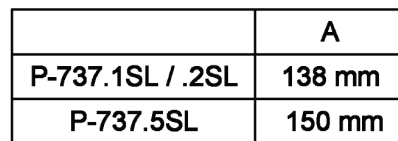
<http://piceramic.com/piezo-technology/properties-piezo-actuators/electrical-operation.html>

Ambient Conditions and Classifications

Area of application	For indoor use only
Maximum altitude	2000 m
Air pressure	1100 hPa to 0.1 hPa
Relative humidity	Highest relative humidity 80 % for temperatures up to 31 °C Decreasing linearly to 50 % relative humidity at 40 °C
Operating temperature*	−20 °C to 80 °C
Storage temperature	−20 °C to 80 °C
Transport temperature	−25 °C to 85 °C
Overvoltage category	II
Protection class	I
Degree of pollution	1
Degree of protection according to IEC 60529	IP20

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

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



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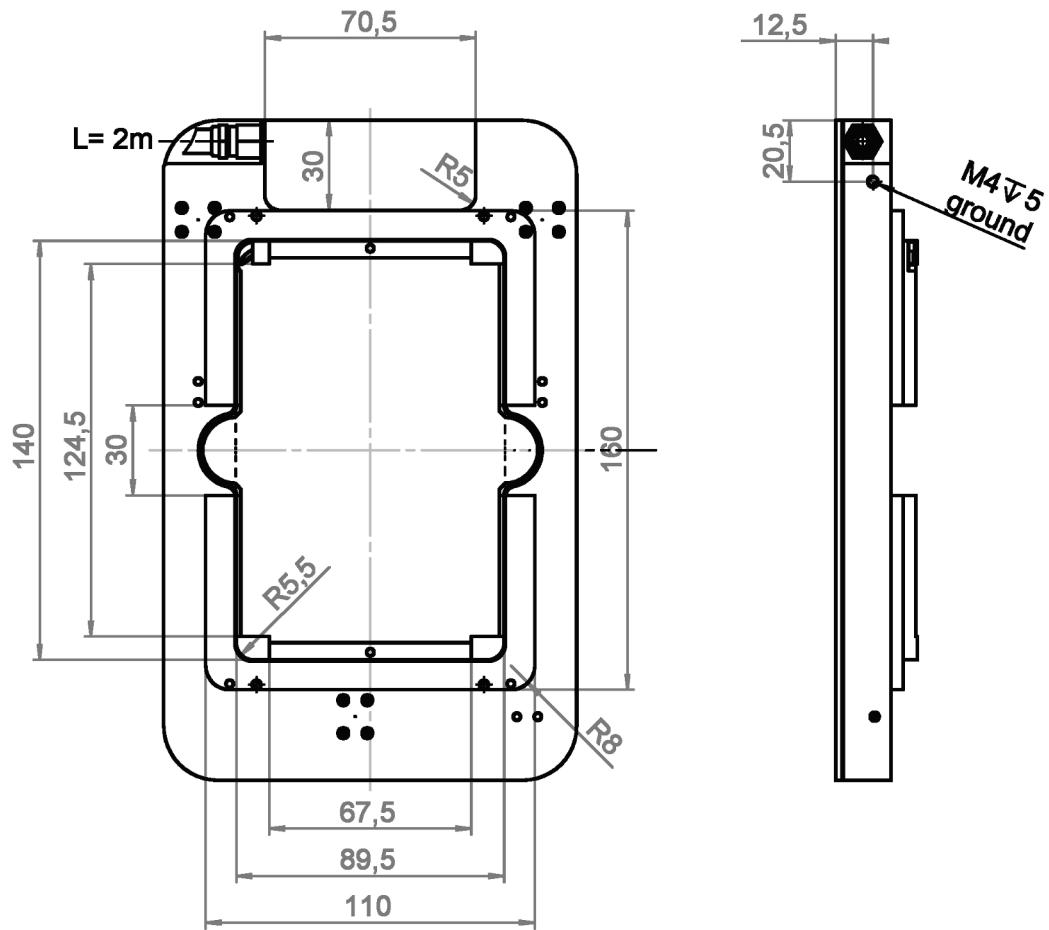


Figure 8: Bottom view and lateral view of P-737

Pin Assignments



Figure 9: Sensor connector: LEMO connector FFA.0S.304.CLAC32Y, contact side

Pin	Signal	Function
1	SGS Ref	SGS reference
2	SGS-	SGS signal (negative)
3	SGS+	SGS signal (positive)
4	SGS GND	Ground SGS signal

PZT

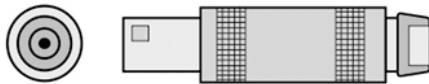


Figure 10: Piezo coaxial connector

Pin	Function
Inner contact	Piezo voltage (PZT)
Connector shell	Ground

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

