

User Manual

P603T0001, valid for P-603
CBo, 2019-05-06

P-603

Inexpensive PiezoMove Linear Actuator



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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

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



- Actions to take to avoid the situation.

NOTICE



Dangerous situation

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

- Actions to take to avoid the situation.

INFORMATION

Information for easier handling, tricks, tips, etc.

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

Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

- Contact our customer service department (p. 16).

INFORMATION

For products that are supplied with software (CD in the scope of delivery), access to the manuals is protected by a password. Protected content is only displayed on the website after entering the access data.

You need the product CD to get the access data.

For products with CD: Get access data

1. Insert the product CD into the PC drive.
2. Switch to the Manuals directory on the CD.
3. In the Manuals directory, open the Release News (file including **releasenews** in the file name).
4. Get the access data for downloading protected content in the "User login for software download" section of the Release News. Possible methods for getting the access data:
 - Link to a page for registering and requesting the access data
 - User name and password is specified
5. If the access data needs to be requested via a registration page:
 - a) Follow the link in the Release News.
 - b) Enter the required information in the browser window.
 - c) Click **Show login data** in the browser window.
 - d) Note the user name and password shown in the browser window.

Downloading manuals

If you have requested access data for protected contents via a registration page (see above):

- Click the links in the browser window to change to the content for your product and log in using the access data that you received.

General procedure:

1. Open the website www.pi.ws.
2. If access to the manuals is protected by a password:
 - a) Click **Login**.
 - b) Log in with the user name and password.
3. Click **Search**.
4. Enter the product number up to the period (e.g., P-603) or the product family (e.g., PiezoMove) into the search field.
5. Click **Start search** or press the Enter key.

6. Open the corresponding product detail page in the list of search results:
 - a) If necessary: Scroll down the list.
 - b) If necessary: Click **Load more results** at the bottom of the list.
 - c) Click the corresponding product in the list.
7. Click the **Downloads** tab.
The manuals are shown under **Documentation**.
8. Click the desired manual and save it to the hard disk of your PC or to a data storage medium.

Safety

Intended Use

The P-603 PiezoMove linear actuator is intended to be used in an environment which is free of dirt, oil, and lubricants.

In accordance with its design, the P-603 is intended for the following applications:

- Positioning of loads
- Dynamic positioning
- Vibration damping
- Force generation

The P-603 is designed to be integrated into systems that meet the EN 61010-1 safety standard and the EN 61326-1 EMC standard. The operator is responsible for electrical safety and electromagnetic compatibility when integrating the P-603 into the overall system. The P-603 complies with the RoHS directive, i.e., the standards defined by EN 50581.

The motion of the P-603 takes place on one axis. The P-603.xSx versions are equipped with position sensors.

The intended use of the P-603 is only possible in combination with suitable drive and control electronics available from PI. The electronics are not included in the scope of delivery of the P-603.

The electronics must provide the required operating voltages. To ensure proper performance of the servo-control system (P-603.xSx only), the electronics must also be able to read out and process the signals from the position sensors.

For information about the electronics refer to their separate documentation.

Safety Precautions

Electrical dangers

CAUTION



Dangerous voltage and residual charge in piezo actuators!

Temperature changes and compressive stresses can induce charges in the piezo actuator of the P-603. After disconnection from the electronics, the piezo actuator can remain charged for several hours. Touching the live parts of the P-603 can result in minor injury from electric shock.

- Do **not** touch the P-603 unless it is discharged (p. 14).
- Keep the P-603 short-circuited (p. 15) when it is not connected to the electronics.
- Remove shorting clamps (p. 10) or shorting plugs (p. 11) only when this is required for installation or operation.
- Do **not** disconnect the P-603 from the electronics during operation.
- Do **not** disassemble the P-603.

CAUTION



Dangerous voltage in piezo actuators during operation!

During operation, the piezo actuator of the P-603 carries voltages of up to 120 V. Touching the P-603 can lead to minor injuries from electric shock.

- Do **not** touch the P-603 during operation.
- Before start-up, insulate the piezo actuator of the P-603 electrically from the surrounding mechanical system to prevent direct or indirect contact with live parts. Observe the clearances and creepage distances required for the operating voltage, and observe the standards applicable to your application.

CAUTION



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

The system into which the P-603 is integrated (e.g., housing or surrounding mechanical system) must be connected to a protective earth conductor. If the protective earth conductor is not or not properly connected, touching the system in which the piezo actuator was incorporated can lead to minor injury from electric shock in the case of a malfunction.

- Before start-up, connect the overall system to a protective earth conductor in accordance with the applicable standards.
- 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 overall system to the protective earth conductor before starting it up again.

NOTICE



Destruction of the piezo actuator by electric flashovers!

The use of the P-603 in environments that increase the electrical conductivity can lead to the destruction of the piezo actuator by electric flashovers. Electric flashovers can be caused by moisture, high humidity, liquids and conductive materials such as metal dust. In addition, electric flashovers can also occur in certain air pressure ranges due to the increased conductivity of the air.

- Avoid operating the P-603 in environments that can increase the electric conductivity.
- Only operate the P-603 within the permissible ambient conditions and classifications (p. 18).

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-603 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.

Mechanical dangers

NOTICE



External push or pull forces!

External push or pull forces acting on the moving part (p. 10) in the direction of motion can cause damage to the P-603.

The maximum permissible forces depend on the model:

P-603.1xx:

- Do **not** exceed the **maximum push force of 40 N** on the moving part.
- Do **not** exceed the **maximum pull force of 20 N** on the moving part.

P-603.3xx:

- Do **not** exceed the **maximum push force of 35 N** on the moving part.
- Do **not** exceed the **maximum pull force of 13 N** on the moving part.

P-603.5xx:

- Do **not** exceed the **maximum push force of 30 N** on the moving part.
- Do **not** exceed the **maximum pull force of 10 N** on the moving part.

In dynamic operation, take special care not to exceed the maximum push/pull forces.

NOTICE



Mechanical overload due to high torques!

High torques can damage the P-603 and lead to loss in accuracy.

When affixing the P-603 onto a surface:

- Do **not** exceed a torque of **0.7 Nm** for the mounting holes in the mounting interface (p. 10).

When affixing a load to the P-603:

- Do **not** exceed a torque of **0.5 Nm** for the mounting holes in the moving part (p. 10).

NOTICE



Destruction of the piezo actuator due to rapid discharging!

If the P-603 is not connected to the electronics, it must be short-circuited in order to prevent the piezo actuator from becoming charged during temperature changes and compressive stresses. Unsuitable short-circuiting leads to an abrupt contraction of the piezo actuator due to excessively fast discharging. Abrupt contraction can destroy the piezo actuator.

- Remove shorting clamps (p. 10) or shorting plugs (p. 11) only when this is required for installation or operation.

If the piezo actuator is not short-circuited:

- Ensure adequate protection against touching live parts.
- Discharge the piezo actuator in a suitable way before short-circuiting again (p. 15).

NOTICE



Uncontrolled oscillation!

Oscillations can cause irreparable damage to the P-603. 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-603 is operated near to its resonant frequency.
- If you notice oscillations, stop the P-603 immediately.

NOTICE



Damage after reconnecting due to a charged P-603!

The P-603 can remain charged if its connecting cable is pulled out of the electronics during operation. Reconnecting a charged P-603 to electronics during operation can cause a mechanical impulse that will damage the P-603.

- Do **not** pull the connecting cable of the P-603 out of the electronics during operation.

If the connecting cable of the P-603 is accidentally pulled out of the electronics during operation:

- Switch off the electronics before you reconnect the P-603.

Thermal dangers

CAUTION



Burning from hot surface!

The surface of the P-603 and the surrounding area can heat up during operation. Touching the P-603 and surrounding parts can result in minor injuries from burning.

- Make sure that the hot P-603 and its surrounding parts cannot be touched.

NOTICE



Heating up of the P-603 during operation!

The heat produced during dynamic operation of the P-603 can affect your application.

- Install the P-603 so that your application is not affected by the dissipating heat.

Product Description

Model Overview

Model	Travel range	Sensor	Connection to electronics
P-603.101	100 µm	-	Stranded wires
P-603.1S1	100 µm	SGS	Stranded wires
P-603.1S2	100 µm	SGS	LEMO
P-603.301	300 µm	-	Stranded wires
P-603.3S1	300 µm	SGS	Stranded wires
P-603.3S2	300 µm	SGS	LEMO
P-603.501	500 µm	-	Stranded wires
P-603.5S1	500 µm	SGS	Stranded wires
P-603.5S2	500 µm	SGS	LEMO

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Product View

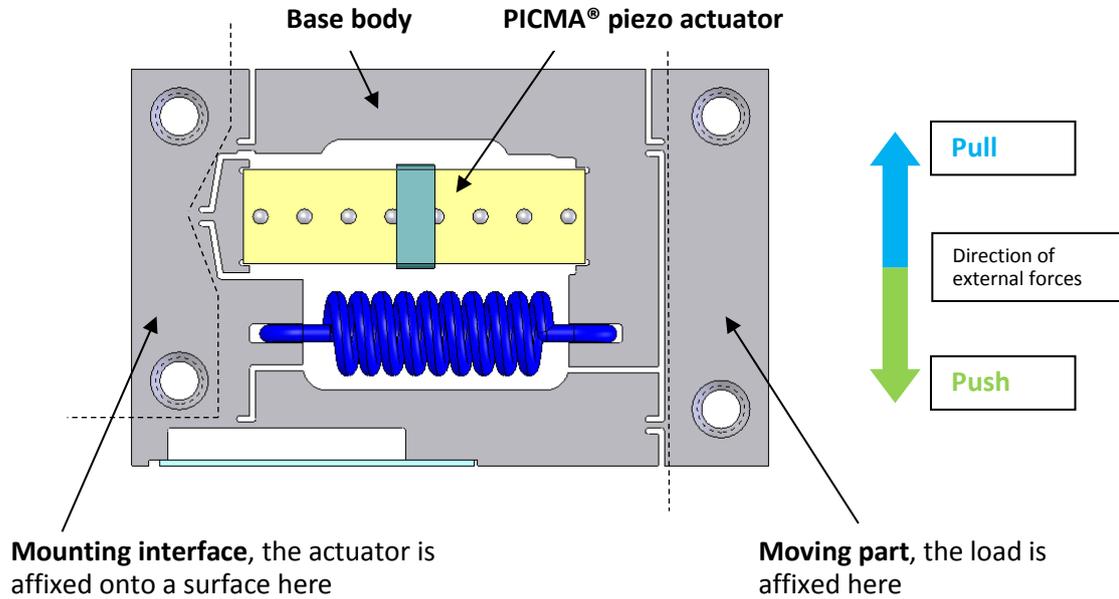


Figure 1: Overview of the P-603 actuator

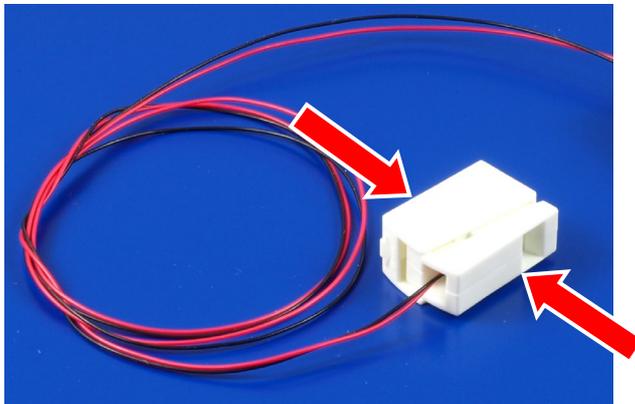


Figure 2: P-603.xx1 only: Example of a shorting clamp that is attached to stranded wires. The arrows indicate how to release the stranded wires.

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Figure 3: P-603.xS2 only: Example of PZT connector with attached shorting plug.

- 1 PZT connector
- 2 Shorting plug (in the scope of delivery)

Scope of Delivery

Product number	Description
P-603	PiezoMove OEM linear actuator according to order (p. 9)
P603T0001	User manual for P-603 (this document)
Additional scope of delivery for models with stranded wires:	
INYY-0005	Shorting clamp, 2.5 mm ² for the stranded wires of the piezo actuator
Additional scope of delivery for models with LEMO connector(s):	
P-210.01	Shorting plug for actuators with single-pole LEMO PZT connector

Unpacking

NOTICE



Damage due to pull forces on the connecting cable or stranded wires!

Pull forces on the connecting cable or stranded wires can damage the P-603.

- Avoid pull forces on the connecting cable or stranded wires.

NOTICE



Destruction of the piezo actuator due to contamination!

Contamination on the surface of the piezo actuator of the P-603 can result in the destruction of the piezo actuator by electric flashovers during operation.

- When handling the P-603, wear powder-free nitrile or latex gloves.
- Prevent the P-603 from coming into contact with conductive liquids (e.g., finger sweat) and conductive materials (e.g., metal dust).
- If the piezo actuator of the P-603 has been accidentally contaminated, contact our customer service department (p. 16).

NOTICE



Destruction of the piezo actuator by mechanical overload!

Mechanical forces can damage the piezo actuator of the P-603.

- Avoid impacts that affect the P-603.
- Do **not** drop the P-603.

Unpacking the P-603

1. Unpack the P-603 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 immediately.
4. Keep all packaging materials in case the product needs to be returned.

Installation

Preventing the Risk of Electric Shock

The P-603 actuator does not feature a separate protective earth connection, but must be installed in a way that a risk of electric shock is prevented.

You have the following options:

- Mount the actuator onto an electrically conductive surface that is connected to a protective earth conductor.
- Connect the actuator to a protective earth conductor via its mounting interface.
- Install the actuator such that it is electrically insulated according to protection class II.

When you choose the first or the second option:

1. Make sure that the contact resistance is **<0.1 Ω at 25 A** at all connection points relevant for mounting the protective earth conductor.
2. Observe the applicable standards for mounting the protective earth conductor.

Preparing a P-603 with Stranded Wires for Connection to a Controller

When you prepare a P-603 actuator with stranded wires for connection to a controller, pay attention to the assignment of the stranded wires as specified in “Color coding of stranded wires” (p. 21).

Mounting the P-603 and Mounting a Load

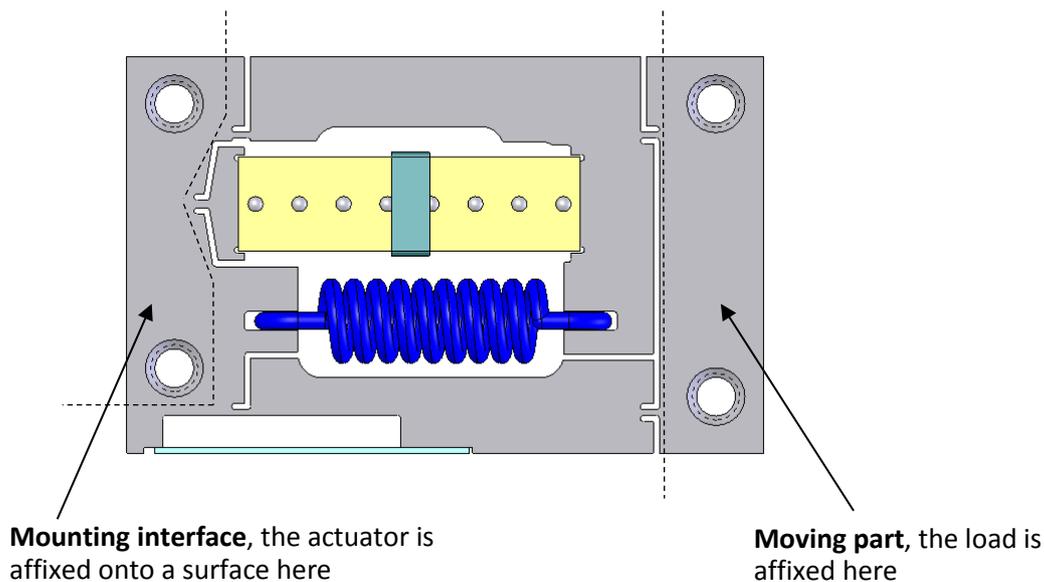


Figure 4: Mounting interface and moving part

Requirements

- You have read and understood the safety precautions (p. 6).
- You have provided a suitable surface onto which the P-603 can be affixed:
 - The surface is connected to a protective earth conductor (p. 12).
 - Two suitable through holes are present. See “Dimensions” (p. 19) for details.
 - The holes for accommodating the screws are sufficiently conductive to ensure proper function of the protective earth conductor.
 - The evenness of the surface is $\leq 40 \mu\text{m}$.

Tools and accessories

- Two M2.5 screws of suitable length (p. 19) for mounting the actuator onto a surface
- Two M2.5 screws of suitable length (p. 19) for mounting a load to the actuator
- Suitable tools

Mounting the P-603 and mounting a load

1. Only affix the P-603 onto a surface using the mounting holes intended for this purpose (see Figure 4, p. 13).
Maximum torque: 0.7 Nm
2. Only affix a load to the P-603 using the mounting holes intended for this purpose (see Figure 4, p. 13).
Maximum torque: 0.5 Nm
3. With P-603.xx1 models:
When the actuator is installed, release the stranded wires from the shorting clamp by pressing it together in the direction shown by the arrows in Figure 2 (p. 10).

INFORMATION

If the shorting clamp needs to be used again, make sure that the stranded wires are stripped before inserting them.

Starting-Up and Operating the P-603

Requirements

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

Starting up and operating the P-603

- Follow the instructions in the user manual of the piezo controller used for start-up and operation of the P-603.

Discharging the P-603

The P-603 must be discharged in the following cases:

- When the P-603 is not in use but the electronics remains switched on to ensure temperature stability
- When the stranded wires of the P-603 are to be short-circuited without a discharge resistor, e.g. with the shorting clamp (p. 10) or shorting plug (p. 11) supplied
- If the connecting cable of the P-603 is accidentally pulled out of the electronics during operation

Requirements

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

Tools and accessories

If the P-603 is **not** connected to the electronics:

- Only for P-603 **without** connector:
 - 10 k Ω discharge resistor (not included in scope of delivery), the touchable parts must be adequately insulated for the actuator's operating voltage range (p. 18)
- Only for P-603 **with** connector:
 - Electronics from PI

Discharging a P-603 connected to the electronics

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

Discharging a P-603 not connected to the electronics

If the P-603 does **not** have a connector:

1. Ensure adequate protection against touching live parts.
2. Short-circuit the stranded wires of the P-603 for at least a few seconds using a **10 k Ω discharge resistor**.

If the P-603 has a connector:

- Connect the voltage connector of the P-603 to the switched off PI electronics, which has an internal discharge resistor, for at least a few seconds.

Short-Circuiting the P-603

The P-603 must be discharged (p. 14) and short-circuited before demounting (e.g., before cleaning and transportation of the P-603) as well as for modifications.

Requirements

- ✓ You have read and understood the safety precautions (p. 6).
- ✓ You have discharged (p. 14) the P-603 and disconnected it from the electronics.

Tools and accessories

- Models with stranded wires: Shorting clamp (p. 10)
- Models with LEMO connectors: Shorting plug (p. 11)

Short-circuiting P-603 models featuring stranded wires

- Short-circuit the stranded wires of the **discharged** piezo actuator with the shorting clamp.

Short-circuiting P-603 models featuring LEMO connectors

- Connect the PZT connector of the **discharged** piezo actuator to the shorting plug.

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Maintenance

The P-603 is maintenance-free.

Cleaning the P-603

Requirements

- ✓ You have discharged (p. 14) and short-circuited (p. 15) the P-603.
- ✓ You have disconnected the P-603 from the controller.

Cleaning the P-603

- Touch the piezo actuator only with powder-free nitrile or latex gloves.
- Use pH-neutral cleansers only.
- Do **not** use acetone and do **not** use water for cleaning.
- When necessary, clean the base body (**not** the actuator!) of the P-603 with a lint-free cloth that is slightly dampened with a mild cleanser (e.g., isopropanol or ethanol).

Customer Service

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

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

- Product 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)

Technical Data

Specifications

	P-603.1S1 P-603.1S2	P-603.3S1 P-603.3S2	P-603.5S1 P-603.5S2	P-603.x01 Open-loop versions	Unit
Active axes	Z	Z	Z	Z	
Motion and positioning					
Integrated sensor	SGS	SGS	SGS	–	
Travel range at -20 to 120 V, open loop	120	380	550	as P-603.xS1	µm
Travel range, closed loop	100	300	500	–	µm
Resolution, open loop, 180 g	2	3	5	as P-603.xS1	nm
Resolution, closed loop, 180 g	10	20	25	–	nm
Linearity error, closed loop	0.2	0.2	0.2	–	%
Unidir. Repeatability, 10%, 1 Sigma	7	10	20	–	nm

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	P-603.1S1 P-603.1S2	P-603.3S1 P-603.3S2	P-603.5S1 P-603.5S2	P-603.x01 Open-loop versions	Unit
Mechanical properties				–	
Stiffness in motion direction	0.3	0.14	0.06	as P-603.xS1	N/μm
Resonant frequency, no load	900	410	300	as P-603.xS1	Hz
Resonant frequency, under load, 180 g	160	110	80	as P-603.xS1	Hz
Push/pull force capacity in motion direction	40 / 20	35 / 13	30 / 10	as P-603.xS1	N
Drive properties					
Piezo ceramic	PICMA® P-885	PICMA® P-885	PICMA® P-885	as P-603.xS1	
Electrical capacitance	1.5	3.1	3.7	as P-603.xS1	μF
Miscellaneous					
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	as P-603.xS1	°C
Material	Stainless steel	Stainless steel	Stainless steel	as P-603.xS1	
Dimensions	33.5 mm × 21 mm × 6 mm	52 mm × 21 mm × 6 mm	62 mm × 21 mm × 6 mm	as P-603.xS1	
Mass	S1 version: 0.03 S2 version: 0.04	S1 version: 0.04 S2 version: 0.05	S1 version: 0.05 S2 version: 0.06	as P-603.xS1	kg
Cable length	0.5	0.5	0.5	as P-603.xS1	m
Voltage connection	S1 versions: Bare stranded wires S2 versions: LEMO (low voltage)	S1 versions: Bare stranded wires S2 versions: LEMO (low voltage)	S1 versions: Bare stranded wires S2 versions: LEMO (low voltage)	as P-603.xS1	
Sensor connection	S1 versions: Bare stranded wires S2 versions: LEMO (strain gauge sensor)	S1 versions: Bare stranded wires S2 versions: LEMO (strain gauge sensor)	S1 versions: Bare stranded wires S2 versions: LEMO (strain gauge sensor)	–	
Recommended electronics	E-610	E-610	E-610	E-610, E-831	

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

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

Ask about customized versions.

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Maximum Ratings

P-603 PiezoMove linear flexure actuators are designed for the following operating data:

Model	Maximum operating voltage 	Maximum operating frequency (unloaded) ¹ 	Maximum power consumption ² 
P-603.101	-20 to 120 V	40 Hz	6 W
P-603.1S1	-20 to 120 V	40 Hz	6 W
P-603.1S2	-20 to 120 V	40 Hz	6 W
P-603.301	-20 to 120 V	40 Hz	8 W
P-603.3S1	-20 to 120 V	40 Hz	8 W
P-603.3S2	-20 to 120 V	40 Hz	8 W
P-603.501	-20 to 120 V	40 Hz	10 W
P-603.5S1	-20 to 120 V	40 Hz	10 W
P-603.5S2	-20 to 120 V	40 Hz	10 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

The following ambient conditions and classifications must be observed for the models of the P-603:

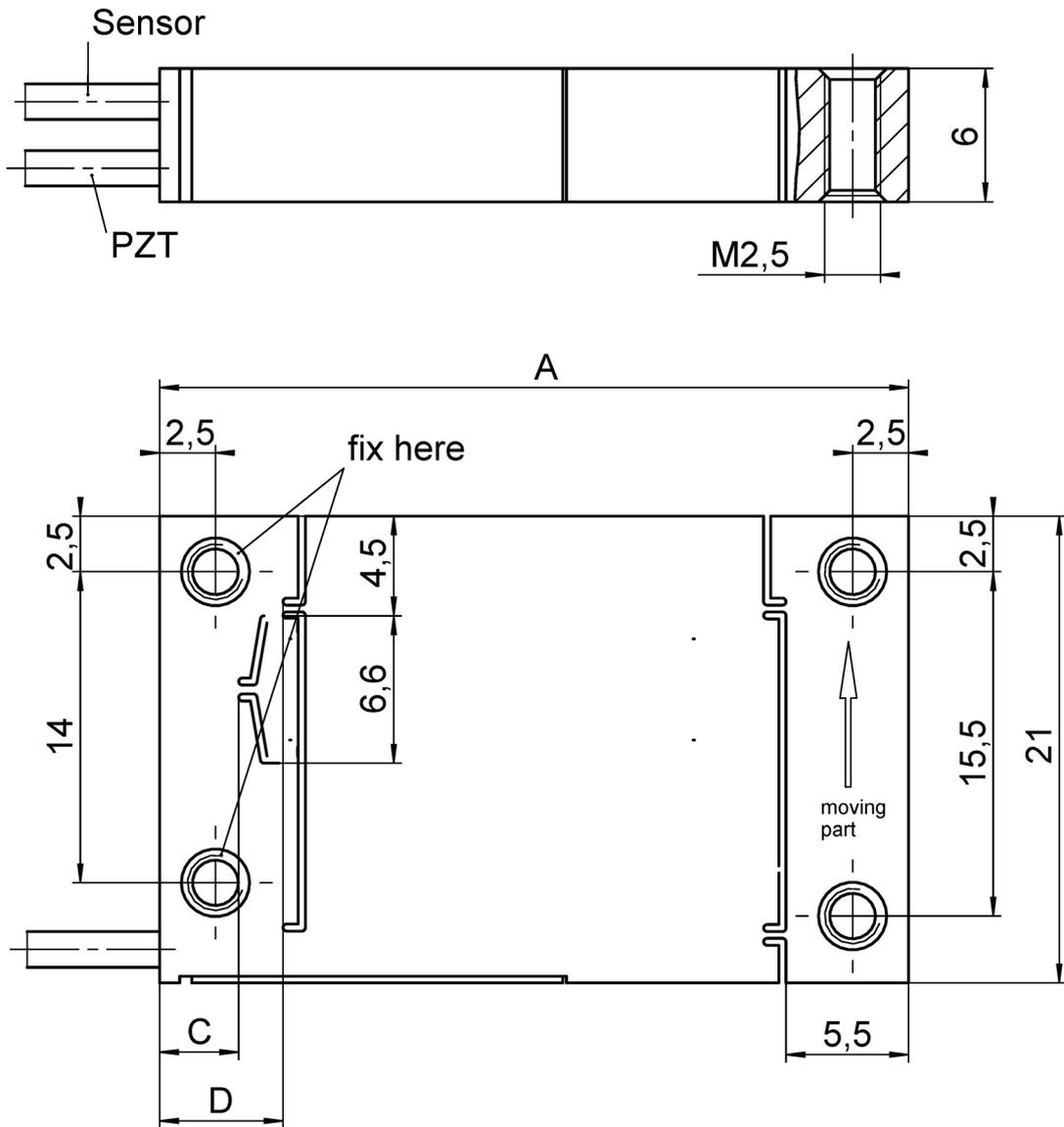
Area of application	For indoor use only
Maximum altitude	2000 m
Air pressure	1100 hPa to 0.1 hPa
Relative humidity	Highest relative humidity 80 % for temperatures up to 31 °C Decreasing linearly to 50 % relative humidity at 40 °C
Storage temperature	-20°C to 80°C
Transport temperature	-25°C to 85°C
Overvoltage category	II
Degree of pollution	1

The P-603 is intended for installation in devices that fulfil the following classifications:

Protection class	I
Degree of protection according to IEC 60529	IP20

Dimensions

Dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.



Model	A	C	D	Unit
P-603.1S1 / .1S2 / .101	33.5	3.5	5.5	mm
P-603.3S1 / .3S2 / .301	52	3.5	5.6	mm
P-603.5S1 / .5S2 / .501	62	4.5	6.2	mm

Figure 5: Dimensions of the P-603 (.x01 models without sensor)

Pin Assignment

Sensor connector

P-603.xS2 only



Figure 6: Sensor connector, LEMO FFA.05.304.CLAC32, front view

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

PZT connector

P-603.xS2 only

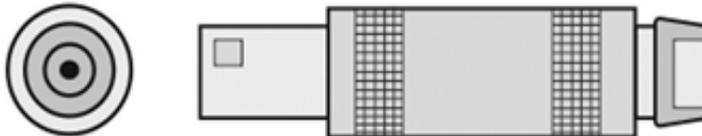


Figure 7: PZT connector, LEMO FFA.00.250.CTAC15, front view (left)

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

Color coding of stranded wires

Only for models that are equipped with stranded wires

Color	Function	Remarks
Black/white	PZT - (GND)	Both wires connected together for an increased cross-sectional area of the cable
Red/yellow	PZT + (-20 to 120 V)	Both wires connected together for an increased cross-sectional area of the cable
Black	Reference (5 V)	Only if the model has a sensor
Red	Sensor -	Only if the model has a sensor
Yellow	Sensor +	Only if the model has a sensor
White	GND	Only if the model has a sensor

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

