



User Manual

N-472 Linear Actuator

This document describes the following products:

- N-472.110/.110Y, N-472.11V
 PiezoMike linear actuator, 7 mm travel range, M10×1 thread
- N-472.120/.120Y, N-472.12V
 PiezoMike linear actuator, 7 mm travel range, 9.5 mm (0.375") clamping shank

Models:

Y: turned cable exit

0: not suitable for use in a vacuum

V: vacuum compatible up to 10⁻⁶ hPa

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1 About this document

1.1 Objective and target group of this user manual

This user manual contains the information necessary for using the N-472 as intended.

We assume that the user has basic knowledge of closed-loop systems, motion control concepts, and applicable safety measures.

1.2 Symbols and typographic conventions

The following symbols and typographic conventions are used in this user manual:

DANGER



Immediate threat of danger

Failure to comply can result in death or serious injuries.

Precautions to avoid the risk.

NOTICE



Dangerous situation

Failure to comply can result in damage to the equipment.

Precautions to avoid the risk.

Information

Information for easier handling, tricks, tips, etc.

Symbol / Label	Meaning
1.	Action consisting of several steps with strict sequential order
2.	
\triangleright	Action consisting of one or more steps without relevant sequential order
-	Enumeration
	Warning sign on the product which refers to detailed information in this man- ual.



1.3 Figures

For better clarity, the illustrations can vary in color, proportions, and level of detail compared to actual circumstances. Photographic illustrations can also differ and must not be seen as guaranteed properties.

1.4 Other applicable documents

The devices and software tools from PI mentioned in this documentation are described in separate manuals.

Product	Document
E-873.1AT Q-Motion [®] controller for piezoelectric inertia drives, 1 axis, benchtop device (industry), SPI, TCP/IP, USB, RS-232, I/O, connector for joy- stick	PZ273 user manual
N-45x / N-47x / N-48x PiezoMike linear actua- tors	MP171EK short instructions
PIMikroMove [®]	SM148E software manual



2 Downloading manuals

Information

If a manual is missing or problems occur while downloading:

Contact our customer service (p. 41).

Downloading manuals

- 1. Open the website <u>www.pi.ws</u>.
- 2. Search for the product number (e.g., N-472) on the website.
- 3. Select the corresponding product to open the product page.
- 4. Select the **Downloads** tab.
 - → The manuals are shown under Documentation. Software manuals are shown under General Software Documentation.
- 5. For the desired manual, select ADD TO LIST and then REQUEST.
- 6. Fill out the request form and select **SEND REQUEST**.
- \rightarrow The download link will then be sent to the email address entered.



3 Safety

3.1 Intended use

The N-472 is a laboratory device according to DIN EN 61010-1. It is intended for indoor use and use in an environment free from dirt, oil, and lubricants.

The N-472 is a linear actuator for integration into mechanical and optomechanical components. For integration, the mechanics, in which the N-472 is to be installed, must have suitable mountings.

A piezoelectric motor is installed in the N-472 linear actuator. This motor acts on the fine-threaded screw and moves it.

At rest, the drive is self-locking, requires no current, and does not generate any heat. It holds the position with maximum force.

The N-472 is not intended for continuous operation. Refer to Specifications (p. 31).

The N-472 can only be used as intended in conjunction with a suitable controller (p. 14), which is available from PI. The controller is not included in the scope of delivery of the N-472.

The controller must provide the required operating voltages. It must also be able to read out and process the signals from the position sensors so that the servo control system can function properly.

3.2 General safety instructions

The N-472 is built according to state-of-the-art technology and recognized safety standards. Improper use of the N-472 can result in personal injury and/or damage to the N-472.

- > Use the N-472 only for its intended purpose and when it is in perfect technical condition.
- Read the user manual.
- > Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for installing and operating the N-472 correctly.

3.2.1 Organizational measures

User manual

- Always keep this user manual together with the N-472. The latest versions of the user manuals are available for download (p. 7) from our website.
- Add all information from the manufacturer, such as supplements or technical notes, to the user manual.



- If you pass on the N-472 to a third party, include this user manual as well as other relevant information provided by the manufacturer.
- Only use the device on the basis of the complete user manual. Missing information due to an incomplete user manual can lead to serious or fatal injuries as well as damage to equipment.
- > Install and operate the N-472 only after you have read and understood this user manual.

Personnel qualification

The N-472 may only be installed, started, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

3.2.2 Measures for handling vacuum-compatible products

Attention must be paid to appropriate cleanliness when handling the vacuum version of the linear actuator. All parts are cleaned at PI before assembly. Powder-free gloves are worn during assembly and measuring. Afterwards, the linear actuator is wipe-cleaned again and then shrink wrapped twice in vacuum-compatible film.

> Touch the linear actuator only when wearing powder-free gloves.



4 Product description

4.1 Model overview

PiezoMike linear actuators with M10×1 thread

Model	Description
N-472.110	Position-controlled PiezoMike linear actuator, 7 mm, M10×1 thread
N-472.110Y	Position-controlled PiezoMike linear actuator, 7 mm, M10×1 thread, turned cable exit

PiezoMike linear actuators with M10×1 thread, vacuum compatible up to 10^{-6} hPa

Model	Description
N-472.11V	Position-controlled PiezoMike linear actuator, 7 mm, M10×1 thread, vacuum compatible up to 10^{-6} hPa

PiezoMike linear actuators with clamping shaft

Model	Description
N-472.120	Position-controlled PiezoMike linear actuator, 7 mm, 9.5 mm (0.375") clamping shank
N-472.120Y	Position-controlled PiezoMike linear actuator, 7 mm, 9.5 mm (0.375") clamping shank, turned cable exit

PiezoMike linear actuators with clamping shank, vacuum compatible up to 10^{-6} hPa

Model	Description
N-472.12V	Position-controlled PiezoMike linear actuator, 7 mm, 9.5 mm (0.375") clamping
	shank, vacuum compatible up to 10 ⁻⁶ hPa



4.2 Product view

Models with M10×1 thread

The description of the product components also applies to models with turned cable exit.



Fig. 1: Models with thread and standard cable exit (example illustration) On left: Version suitable for atmospheric conditions On right: Vacuum version

- 1 Screw head
- 2 Fine-threaded screw (rotating)
- 3 Base body
- 4 Mounting nut M10×1
- 5 Mounting thread M10×1
- 6 Ball tip for coupling to the moving part of the mechanical mounting
- 7 Unscrew lock (circlip) for fine-threaded screw
- 8 Product labeling
- 9 Cable for connecting to controller (sensor cable not shown)



Models with clamping shank

The description of the product components also applies to models with turned cable exit.



Fig. 2: Models with clamping shank and standard cable exit (example illustration) On left: Version suitable for atmospheric conditions On right: Vacuum version

- 1 Screw head
- 2 Fine-threaded screw (rotating)
- 3 Base body
- 4 Clamping shank (diameter 9.5 mm, clamping width 6 mm)
- 5 Mounting nut M9×1
- 6 Ball tip for coupling to the moving part of the mechanical mounting
- 7 Unscrew lock (circlip) for fine-threaded screw
- 8 Product labeling
- 9 Cable for connecting to controller (sensor cable not shown)

Directions of motion



Fig. 3: Directions of motion of the linear actuator



Pay attention to further information on the operating conditions in the Specifications (p. 31) section.

4.3 Product labeling



Fig. 4: N-472: Product labeling



Fig. 5: Type plate (N-472.110 as example)



Fig. 6: Laser inscription (for vacuum-compatible models, N-470.21V as an example)

Position	Label	Description
А	PI	Manufacturer's logo
А	WWW.PI.WS	Manufacturer's address (website)



Position	Label	Description
В	CE	CE conformity mark
В	\triangle	Warning sign "Pay attention to the manual!"
В	X	Old equipment disposal (p. 42)
В		Protective earth conductor symbol (p. 19)
В	Country of origin: Germany	Country of origin
С	N-472.110	Product number (example), the digits after the period refer to the model
С	123456789	Serial number (example), individual for each N-472
		Meaning of each digit (from the left):
		1 = internal information, 2 and 3 = year of manufac- ture, 4 to 9 = consecutive number
For models only that are not suitable for use in a vacuum:		
С	R: 00.001	Revision number (example)
С		Data matrix code (example; contains the serial number)

4.4 Scope of delivery

Product number	Description	
N-472	Linear actuator according to order (p. 10)	
000049906	Hook wrench	
MP171EK	Short instructions for PiezoMike linear actuators	
For vacuum-compatible models only:		
N472B0001	Motor / sensor cable, D-sub 15 (m) to open end, 2 m, on the air side	

4.5 Suitable electronics

Product number	Description
E-873.1AT	Q-Motion [®] controller for piezoelectric inertia drives, 1 axis, benchtop device
	(industry), SPI, TCP/IP, USB, RS-232, I/O, connector for joystick

> To order, contact our customer service (p. 41).



4.6 Technical features

4.6.1 ID chip

There is an ID chip located in the D-sub connector of the linear actuator that contains the data on the linear actuator (e.g., type of linear actuator, serial number, date of manufacture, hardware version).

When switched on or rebooted, controllers from PI read the data from the ID chip.

You will find further information on ID chip recognition in the manual for the controller.



5 Unpacking

Information

Attention must be paid to appropriate cleanliness when handling the vacuum version of the linear actuator. All parts are cleaned at PI before assembly. Powder-free gloves are worn during assembly and measuring. Afterwards, the linear actuator is wipe-cleaned again and then shrink wrapped twice in vacuum-compatible film.

- > Touch the linear actuator only when wearing powder-free gloves.
- 1. Unpack the N-472 with care.
- 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 (p. 41) immediately.
- 4. Keep all packaging materials in case the product needs to be returned.

6 Installation

6.1 General notes on installation

NOTICE



Friction due to lateral forces!

Lateral forces acting on the fine-threaded screw and the ball tip of the linear actuator increase the friction on the internal drive components. Increased friction impairs the motion of the fine-threaded screw and increases wear on the drive components.

- > Avoid lateral forces on the fine-threaded screw and on the ball tip of the N-472.
- Install the N-472 so that the fine-threaded screw is aligned vertically to the contact surface of the movable part on the mechanical mounting.

NOTICE



Increased wear due to friction!

Increased friction on the contact surface between the ball tip and the movable part of the mechanical mounting increases wear.

- > Make sure that the contact surface of the mechanical mounting has a roughness of $R_a < 0.1 \mu m$ and a hardness of at least 500 HV (corresponds to hardened steel).
- Optional: Decrease the friction by applying a small amount of lubricant to the contact surface of the mechanical mounting.

NOTICE



Heating up of the N-472 during operation!

The N-472 emits up to 5.2 Watts of heat that can affect your application during operation.

- ▶ Install the N-472 so that your application is not impaired by dissipating heat.
- > Ensure sufficient ventilation at the place of application.
- Pay attention to the operating conditions (duty cycle, ambient temperature) according to the data in Specifications (p. 31).



NOTICE

Damage from unsuitable cables!

Unsuitable cables can damage the controller.

> Only use cables from PI to connect the N-472 to the controller.

NOTICE



Dirt, condensation, lubricants!

Dirt, condensation, and inappropriately applied lubricant render the drive inoperable.

- ➢ Keep the N-472 free of dirt and condensation.
- Do not remove the lubricant that was applied to the fine-threaded screw of the N-472 by the manufacturer.
- > Do not lubricate the fine-threaded screw of the N-472.

NOTICE

Damage from opening the base body!

Opening the base body destroys the N-472.

Do not open the N-472.

NOTICE

Damage from unscrewing!

Completely unscrewing the fine-threaded screw from the base body causes damage to the N-472.

 \succ Do not unscrew the fine-threaded screw from the base body of the N-472.

NOTICE



Damage to the fine-threaded screw from contact with hard objects!

Contact with hard objects can damage the thread of the fine-threaded screw. A damaged thread can lead to failure of the linear actuator.

Prevent the fine-threaded screw from coming into contact with hard objects.

NOTICE



Damage from overtightening the mounting nut!

Overtightening the mounting nut can damage the linear actuator.

➤ Hand-tighten the mounting nut.



6.2 Installing the linear actuator onto a mechanical mounting and connecting it to a protective earth conductor

Information

The N-472 is connected to the protective earth conductor via a mounting nut, thread, or clamping shank fixed to a sufficiently conductive mechanical mounting. The mechanical mounting must be connected to the protective earth conductor.

Information

> Pay attention to the applicable standards for connecting the protective earth conductor.

Information

If vibrations occur in your application, secure the screw connection for the protective earth conductor in a suitable manner to prevent it from unscrewing. If this is not possible, check the screw connection at regular intervals and retighten the screw(s) if necessary.



Fig. 7: Model with thread: Relevant components for installation into the mechanical mounting (example illustration)

- 1 Mounting nut M10×1
- 2 Mounting thread
- 3 Ball tip





Fig. 8: Models with clamping shank: Relevant components for installation into the mechanical mounting (example illustration)

- 1 Clamping shank, diameter: 9.5 mm, clamping width: 6 mm
- 2 Mounting nut M9×1

3 Ball tip



Fig. 9: Two linear actuators installed in a kinematic mirror mount (example illustration)1 Linear actuators with mounting thread

2 Mechanical mounting for linear actuators (stationary part of the kinematic mirror mount)3 Mechanical mounting for mirror (moving part of the kinematic mirror mount)

Requirements

- You have read and understood the general notes on installation (p. 17).
- The N-472 is not connected to the electronics.
- You have provided a suitable mechanical mounting that fulfills the following requirements:
 - For models with mounting thread: There is an M10×1 through-hole in the mechanical mounting. For more details, refer to Dimensions (p. 38).
 - For models with clamping shank: There is a through-hole with a suitable diameter in the mechanical mounting. For more details, refer to Dimensions (p. 38).
 - The mechanical mounting including its contact surface to the mounting nut, thread, or clamping shank of the N-472 is electrically conductive.



- The mechanical mounting is connected to a suitable protective earth conductor: Cable cross-section ≥ 0.75 mm².
- $-\,$ The contact surface of the mechanical mounting to the ball tip of the N-472 has a roughness of R_a < 0.1 μm and at least a hardness of 500 HV.
- You have accounted for the space required to route cables according to regulations and without bending them.

Tools and accessories

- Hook wrench (p. 14)

When lubricant is to be applied to the contact surface of the movable part of the mechanical mounting:

- Models that are not suitable for use in a vacuum: PTFE-based grease containing no additive
- Vacuum-compatible models: Vacuum-compatible PTFE-based grease containing no additive

Installing a model with mounting thread

- 1. Screw the mounting nut of the N-472 as far as necessary in the direction of the base body of the N-472.
- 2. Optional: Apply a small amount of lubricant to the contact surface of the movable part of the mechanical mounting.
- 3. Screw the N-472 as far as necessary into the M10×1 through-hole of the mechanical mounting.
- 4. Align the base body of the N-472 with the mechanical mounting.
- 5. Fix the N-472 in the mechanical mounting:
 - a) Hold the base body and screw the mounting nut of the N-472 in the direction of the mechanical mounting.
 - b) Hand-tighten the mounting nut with the hook wrench.
- 6. Make sure that the contact resistance is < 0.1 Ω at 25 A at all points relevant for attaching the protective earth conductor.
- 7. Check that the linear actuator is fixed firmly in the mounting.
- 8. Optional: Turn the screw head of the linear actuator's fine-threaded screw into the desired position by hand to avoid longer travel to this position.

Installing model with clamping shank

- 1. Optional: Apply a small amount of lubricant to the contact surface of the movable part of the mechanical mounting.
- 2. Remove the mounting nut from the clamping shank of the N-472.
- 3. Position the N-472 in the mechanical mounting of your application.



- 4. Turn the mounting nut of the N-472 a few times by hand onto the thread of the clamping shank.
- 5. Align the base body with the mechanical mounting.
- 6. Clamp the N-472 firmly in the mounting:
 - Hold the base body and at the same time hand-tighten the mounting nut of the N-472 with the hook wrench.
- 7. Make sure that the contact resistance is < 0.1 Ω at 25 A at all points relevant for attaching the protective earth conductor.
- 8. Check that the linear actuator is fixed firmly in the mounting.
- 9. Optional: Turn the screw head of the linear actuator's fine-threaded screw into the desired position by hand to avoid longer travel to this position.

6.3 Preparing vacuum-compatible linear actuator for

connecting to controller



Fig. 10: Vacuum-compatible model: Connecting a vacuum feedthrough

1 Vacuum-side connector for cables of the N-472

2 Vacuum feedthrough

3 Connector for N472B0001 motor / sensor cable (p. 14)

4 Motor / D-sub 15 (m) sensor connector, refer to Pin assignment (p. 37).

Assignment of the stranded wires and the cable shield

Letter	Wire color	Function	Signal
а	Red	Piezo voltage 0 to 80 V	PIEZO+
b	Black	Piezo voltage ground	PIEZO-



Letter	Wire color	Function	Signal
с		Bare cable shield	
d	Yellow	Sensor signal, sine	ENCA+
е	Green	Sensor signal, cosine	ENCB+
f	Red	+5 V supply voltage for sensor	5V
g	Black	Sensor ground	GND

Requirements

- You have read and understood the general notes on installation (p. 17).
- The N472B0001 motor / sensor cable is not connected to the controller.

Tools and accessories

- Suitable vacuum feedthrough
- Air-side and vacuum-side connector (male or female) for vacuum feedthrough
- N472B0001 motor / sensor cable (p. 14)
- Suitable tools for wiring the connectors

Preparing a vacuum-compatible N-472 for connecting to the controller

- Attach the respective connectors for the vacuum feedthrough to the bare wire strands of the N-472's cables on the vacuum side and on the air side:
 - Make sure that the stranded wires are assigned to each other as shown in the connection diagram.
 - Connect the cable shield: The cable shielding from the motor and sensor cable in the vacuum feedthrough can be routed together to Pin c or the housing.
- 2. Check the lines for contacting and short-circuiting using a suitable measuring device.



7 Starting and operating

7.1 General notes on starting and operating

DANGER



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

If the protective earth conductor is not connected or is not connected properly, hazardous touch voltages can occur on the N-472 during system malfunction or failure. If there are touch voltages, touching the N-472 can lead to serious injury or death by electric shock.

- > Connect the N-472 to a protective earth conductor (p. 19) before startup.
- > Do not remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e.g., for modifications), reconnect the N-472 to the protective earth conductor before restarting.

NOTICE



Operating voltage excessively high or incorrectly connected!

Excessively high or incorrectly connected operating voltages can cause damage to the N-472.

- Operate the N-472 only with controllers/drivers and original accessories from PI.
- > Do not exceed the operating voltage range (p. 33) specified for the N-472.
- Operate the N-472 only when the operating voltage is properly connected; see Pin assignment (p. 37).

NOTICE



Operating frequency too high!

An excessively high operating frequency can damage the N-472.

- Operate the N-472 only with controllers/drivers and original accessories from PI.
- > Do not exceed the operating frequency range (p. 33) specified for the N-472.



NOTICE



Destruction of the piezo actuator by electric flashovers!

Using the N-472 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 (e.g., metal dust). In addition, electric flashovers can occur due to increased air conductivity in certain air pressure ranges.

- > Avoid operating the N-472 in environments that can increase the electrical conductivity.
- > Operate the N-472 only under permissible ambient conditions and classifications (p. 33).
- When using in a vacuum under 0.1 hPa:
 Do not operate the N-472 while evacuating or ventilating.

NOTICE



Friction due to lateral forces!

Lateral forces acting on the fine-threaded screw and the ball tip of the linear actuator increase the friction on the internal drive components. Increased friction impairs the motion of the fine-threaded screw and increases wear on the drive components.

- > Avoid lateral forces on the fine-threaded screw and on the ball tip of the N-472.
- Install the N-472 so that the fine-threaded screw is aligned vertically to the contact surface of the movable part on the mechanical mounting.

NOTICE



Increased wear due to friction!

Increased friction on the contact surface between the ball tip and the movable part of the mechanical mounting increases wear.

- > Make sure that the contact surface of the mechanical mounting has a roughness of $R_a < 0.1 \mu m$ and a hardness of at least 500 HV (corresponds to hardened steel).
- Optional: Decrease the friction by applying a small amount of lubricant to the contact surface of the mechanical mounting.

NOTICE



Damage to the fine-threaded screw from contact with hard objects!

Contact with hard objects can damage the thread of the fine-threaded screw. A damaged thread can lead to failure of the linear actuator.

Prevent the fine-threaded screw from coming into contact with hard objects.



NOTICE



Damage from unscrewing!

Completely unscrewing the fine-threaded screw from the base body leads to damage to the N-472.

> Do not unscrew the fine-threaded screw from the base body of the N-472.

NOTICE



Fine-threaded screw gets stuck!

The fine-threaded screw of the N-472 may get stuck at the physical end of the travel range (hard stop or circlip). Getting stuck can reduce the lifetime of the linear actuator.

- Stop the N-472 after reaching the end of the travel range or command motion away from the end of the travel range.
- If the fine-threaded screw of the N-472 gets stuck at the end of the travel range: Turn the head of the fine-threaded screw by hand to loosen it.

Information

The N-472 is a linear actuator without reference or limit switch. Therefore, a reference move to the reference switch or limit switch is not possible. However, you can determine a reference position manually (p. 27) and do positioning moves relative to this reference position.

Information

The inertia drive generates noise in step mode, The noise emission depends on the current step frequency.

Pay attention to further information on the operating conditions in the Specifications (p. 31) section.

The N-472 is started and operated with a suitable controller (p. 14) from PI.

7.2 Operating parameters

When using the software included in the scope of delivery of the controller (p. 14), the operating parameters can be loaded from the positioner database. The entries in the positioner database are updated regularly.

Install PIUpdateFinder onto your PC and use it to update the positioner database on your PC. You can find the PIUpdateFinder on the data storage device included in the scope of delivery of the controller.

For more information on the positioner database, refer to the user manual for the controller (p. 14).



7.3 Operating the linear actuator

Information

Two modes of operation are available for the N-472:

Servo mode switched off:

Motion is commanded with the OMA command. The target position is approached in stepping mode. When the target position is reached, stepping mode is switched off and the N-472 stops.

Servo mode switched on:

Motion is commanded with the MOV command. The target position is approached in stepping mode. When the target position is reached, the analog control mode switches on for fine position-ing. Control remains active.

Requirements

- You have read and understood the general notes on starting and operating (p. 24).
- You have read and understood the user manual for the controller.
- You have read and understood the user manual for the PC software.
- You have fixed the N-472 properly (p. 17).
- The controller and the required PC software have been installed. All connections to the controller have been established (refer to the user manual for the controller).

Operating the N-472

Follow the instructions in the manual for the controller (p. 14) used for starting and operating the N-472.

7.4 Determining the reference position manually

You must determine the reference position manually in order to be able to perform positioning moves relative to a reference position.

Requirements

- You have put the N-472 into operation (p. 24).
- You have turned the head of the linear actuator's fine-threaded screw into the desired reference position manually.

Determining the reference position manually

1. Open PIMikroMove[®] and establish communication with the controller in the **Start up controller** window.



2. Click the Advanced... button in the Start up axes step.

Enter the value 0 under Define absolute position > New absolute position. Optional: Enter another value to determine a reference position different from the current position. The reference position will then differ from the current position by the value entered.

4. Click the **OK** button.



8 Maintenance

If the N-472 is operated in a clean environment, no maintenance work is necessary.

> If you would like your device to be serviced, please contact our customer service (p. 41).

9 Troubleshooting

Malfunction	Possible causes	Solution
No or limited motion	The cable is not connected correctly or is defective	Check the connecting cables.
	Excessive counterforces in the direction of motion	Reduce the load. Pay attention to the informa- tion in the Technical Data (p. 31) section.
	Parameters of the con- troller incorrectly set	Load the parameter set from the positioner database corresponding to the N-472 model.
		If necessary: In the PIMikroMove® program for PCs, set the parameters of the controller so that they correspond to the application (load, orien- tation) of the N-472 model (refer to the user manual for the controller).
	Motor/drive is blocked	Loosen the fine-threaded screw by turning the screw head backwards and forwards by hand.

If the problem with your system is not listed in the table above or cannot be solved as described, contact our customer service (p. 41).



10 Specifications

10.1 Technical data

Subject to change without notice. You can find the latest product specifications on the product web page at <u>www.pi.ws</u>.



Motion	Unit	Tolerance	N-472.110	N-472.110Y	N-472.11V	N-472.120	N-472.120Y	N-472.12V
Active axes			x	x	x	x	x	x
Travel range in X	mm		7	7	7	7	7	7
Maximum velocity in X, un- loaded	mm/min		2	2	2	2	2	2
Linearity error in X	%	Тур.	0.3	0.3	0.3	0.3	0.3	0.3

Positioning	Unit	Tolerance	N-472.110	N-472.110Y	N-472.11V	N-472.120	N-472.120Y	N-472.12V
Minimum incremental moti- on in X	nm	Тур.	50	50	50	50	50	50
Unidirectional repeatability in X	nm	Тур.	±200	±200	±200	±200	±200	±200
Integrated sensor			Incremental an- gle-measuring system					
Sensor signal			Sin/cos, 1 V peak- peak					

Drive Properties	Unit	Tolerance	N-472.110	N-472.110Y	N-472.11V	N-472.120	N-472.120Y	N-472.12V
Drive type			Piezoelectric iner- tia drive					
Operating voltage, peak-to- peak	v		80	80	80	80	80	80
Maximum power consumpti- on	w		5	5	5	5	5	5
Drive force in positive direc- tion of motion in X	N	Max.	22	22	22	22	22	22
Maximum operating fre- quency during continuous operation	Hz		400	400	200	400	400	200
Short-term maximum opera- ting frequency	Hz		2000	2000	2000	2000	2000	2000

Mechanical Properties	Unit	Tolerance	N-472.110	N-472.110Y	N-472.11V	N-472.120	N-472.120Y	N-472.12V
Holding force in X, passive	N	Min.	100	100	100	100	100	100
Overall mass	g		200	200	250	200	200	250
Material			Screw: stainless steel; housing: aluminum, bronze					
Mechanical interface			M10×1 mounting thread	M10×1 mounting thread	M10×1 mounting thread	9.5 mm clamping shank	9.5 mm clamping shank	9.5 mm clamping shank

Miscellaneous	Unit	N-472.110	N-472.110Y	N-472.11V	N-472.120	N-472.120Y	N-472.12V
Operating temperature ran- ge	°C	10 to 40					
Vacuum class	hPa	-	-	10-6	-	-	10-6
Connector		D-sub 15 (m)					
Cable length	m	2	2	1	2	2	1
Recommended controllers/ drivers		E-873.1AT	E-873.1AT	E-873.1AT	E-873.1AT	E-873.1AT	E-873.1AT

Maximum velocity not suitable for continuous operation (refer to "Operating time and duty cycle" (p. 35)). Linearity error: 20 N preload, measured over the entire stroke, compensated for temperature drift. Unidirectional repeatability / minimum incremental motion: 20 N preload, measured at 100 µm stroke, compensated for temperature drift. Cable length of vacuum-compatible models: 1 m connecting cable on the actuator, with stranded wires on the cable end; 2 m separate connecting cable, D-sub 15 (m) to stran-ded wires. Ask about customized versions.

At Pl, technical data is specified at 22 ±3 °C. Unless otherwise stated, the values are for unloaded conditions. Some properties are interdependent. The designation "typ." indicates a statistical average for a property; it does not indicate a guaranteed value for every product supplied. During the final inspection of a product, only selected properties are analyzed, not all. Please note that some product characteristics may deteriorate with increasing operating time.



10.2 Materials used for vacuum-compatible models

The following materials were used for the vacuum-compatible models of the N-472:

Component	Material
Machine-made parts	Stainless steel type 316L (1.4404) (housing) Stainless steel type 301 (1.4310) (spring)
	Remaining parts: Vacuum-compatible lead-free bronze (drive component), rolling bearing steel (ball tip), stainless steel (mounting screws), spring steel (circlip)
Drive elements	Stainless steel (fine-threaded screw) PZT (piezoceramic actuator)
Electrical components	Cable insulation: Teflon (PTFE, FEP) Shrink tubes: Kynar, PTFE Solder: Sn95.5 Ag3.8 Cu0.7
Lubricant	High vacuum oil
Glue	Epoxy-based vacuum adhesive

10.3 Maximum ratings

N-472 linear actuators are designed for the following operating data:

Model	Maximum operating voltage	Maximum operating fre- quency during continu- ous operation*	Maximum power con- sumption
	\triangle	\triangle	\wedge
N-472.110(Y)	80 V (peak-peak)	400 Hz	5 W
N-472.120(Y)			
N-472.11V	80 V (peak-peak)	200 Hz	5 W
N-472.12V			

* Up to 2000 Hz are permissible for short periods of time. Refer to Operating time and duty cycle (p. 35).

10.4 Ambient conditions and classifications

Pay attention to the following ambient conditions and classifications for the N-472:

Area of application	Indoor use only
Maximum altitude	2000 m



Air pressure	Models N-472.110(Y) and N-472.120(Y):				
	1100 hPa to 0.1 hPa				
	Models N-472.11V(Y) and N-472.12V(Y):				
	1100 hPa to 10 ⁻⁶ hPa (high vacuum)				
Relative humidity	Highest relative humidity 80 % for temperatures up to 31 $^\circ\mathrm{C}$				
	Decreasing linearly to 50 % relative humidity at 40 $^\circ C$				
Operating temperature	10 °C to 40 °C				
Storage temperature	-20 °C to 75 °C				
Transport temperature	-20 °C to 75 °C				
Overvoltage category	П				
Protection class	1				
Degree of pollution	1				
Degree of protection according to IEC 60529	IP30				

10.5 Step size and axial force

The following graph shows the step size of the N-472 against various axial forces. The influence of different axial forces on the step size is relatively minor. The active feed force is specified as 22 N (refer to Specifications (p. 31)).



Fig. 11: Typical step size in nm vs. axial force in N



10.6 Lifetime

The following graph shows the decrease in the step size over the lifetime of the N-472. The lifetime of the N-472 linear actuator is specified as > 1,000,000,000 steps under atmospheric conditions (> 50,000,000 steps under vacuum conditions). Over this time, the typical step size decreases by maximum 30 %.



Fig. 12: Typical step sizes in nm vs. number of steps

10.7 Operating time and duty cycle

The operating time and the duty cycle influence the lifetime of the N-472. In order to prevent overheating and excessive wear, the operating time and the duty cycle must not exceed the values specified in the respective tables. The limit values depend on the following factors:

- Setting of the number of steps per second
- Use outside or inside the vacuum

10.7.1 Operating time and duty cycle outside the vacuum

Models that are not suitable for use in a vacuum

Number of steps per second*	Operating time	Duty cycle (max.) / idle time
2000	60 s (max.)	20 % / 4 min
2000	10 s	20 % / 40 s
1000	120 s (max.)	40 % / 180 s
1000	10 s	40 % / 15 s
≤ 400	unlimited	unlimited



* Set via the *Maximum Motor Output* operating parameter.

The following graph shows the operating time in seconds depending on the number of steps per second.



Fig. 13: Operating time in s vs. steps/s

The following graph shows the duty cycle in % depending on the number of steps per second.



Fig. 14: Duty cycle in % vs. steps/s

10.7.2 Operating time and duty cycle inside the vacuum

Vacuum-compatible models

Number of steps per second*	Operating time	Duty cycle (max.) / idle time
2000	60 s (max.)	10 % / 9 min
2000	10 s	10 % / 90 s
1000	120 s (max.)	20 % / 8 min
1000	10 s	20 % / 40 s
≤ 200	unlimited	unlimited

* Set via the *Maximum Motor Output* operating parameter.





The following graph shows the operating time in seconds depending on the number of steps per second.

Fig. 15: Operating time in s vs. steps/s (vacuum-compatible models)





Fig. 16: Duty cycle in % vs. steps/s (vacuum-compatible models)

10.8 Pin assignment

D-sub 15 connector



Fig. 17: D-sub 15 connector (contact side)

Pin	Signal	Function	Direction
1	NC	Not connected (reserved for reference switch, differential (-))	
2	PIEZO-	Motor signal (-)	Input



Pin	Signal	Function	Direction
3	PIEZO+	Motor signal (+)	Input
4	5V	Supply voltage +5 V	Input
5	NC	Not connected	
6	ID CHIP	ID chip data	Bidirectional
7	ENCA-	Encoder channel A, differential (-)	Output
8	ENCB-	Encoder channel B, differential (-)	Output
9	PIEZO-	Motor signal (-)	Input
10	GND	GND	GND
11	PIEZO+	Motor signal (+)	Input
12	NC	Not connected	
13	NC	Not connected (reserved for reference switch, differential (+))	
14	ENCA+	Encoder channel A, differential (+)	Output
15	ENCB+	Encoder channel B, differential (+)	Output

The cable shield is connected to the connector shell.

10.9 Dimensions

Information

The dimensional drawings in the subsequent sections show the N-472.xxx models with standard cable exit, but also apply to the N-472.xxxY models with offset cable exit.

Note: In the case of the N-472.xxxY models, the cable exit is located exactly opposite to the position shown in the dimensional drawings.



10.9.1 Models with M10×1 thread



Fig. 18: N-472.11x dimensions (* travel range). Note that a comma is used in the drawings instead of a decimal point.



10.9.2 Models with clamping shank



Fig. 19: N-472.12x dimensions (* travel range). Note that a comma is used in the drawings instead of a decimal point.



11 Customer service

For inquiries and orders, contact your PI sales engineer or send us an email: service@pi.de

If you have questions regarding your system, provide us with 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 PC software (if applicable)
- Operating system on the PC (if applicable)

If possible: Take photographs or make videos of your system that can be sent to our customer service if requested.

Customer service address:

Physik Instrumente (PI) SE & Co. KG Auf der Römerstraße 1 76227 Karlsruhe Germany



12 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 device according to international, national, and local rules and regulations.

In order to fulfill the responsibility as the product manufacturer, Physik Instrumente (PI) SE & Co.KG undertakes environmentally correct disposal of all old PI equipment made available on the market after August 13, 2005 without charge.

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

Physik Instrumente (PI) SE & Co. KG Auf der Römerstraße 1 76227 Karlsruhe Germany



MOTION | POSITIONING



13 European declarations of conformity

For the N-472, declarations of conformity were issued according to the following European statutory requirements:

Low Voltage Directive

EMC Directive

RoHS Directive

The applied standards certifying the conformity are listed below.

Safety (Low Voltage Directive): EN 61010-1

EMV: EN 61326-1

RoHS: EN IEC 63000





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