

MP144E N-472 Linear Actuator User Manual

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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 to 10^{-6} hPa



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The patents held by PI are found in our patent list: <https://www.physikinstrumente.com/en/about-pi/patents>

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Subject to change without notice. This manual is superseded by any new release. The latest release is available for download on our website (p. 3).

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1 About this Document

In this Chapter

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1.1 Objective and Target Audience of this User Manual

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

It assumes that the reader has a fundamental understanding of basic servo systems as well as motion control concepts and applicable safety procedures.

The latest versions of the user manuals are available for download on our website (p. 3).

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 could lead to death or serious injury.

- Precautionary measures for avoiding the risk.

NOTICE




Dangerous situation

Failure to comply could cause damage to equipment.

- Precautionary measures 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.	
➤	Action consisting of one or more steps without relevant sequential order
▪	Bullet point
p. 5	Cross-reference to page 5
RS-232	Label on the product indicating an operating element (example: RS-232 interface socket)
	Warning sign on the product referring to detailed information in this manual.

1.3 Figures

For better understandability, the colors, proportions, and degree of detail in illustrations can deviate from the actual circumstances. Photographic illustrations may also differ and must not be seen as guaranteed properties.

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 joystick	PZ273 user manual
PIMikroMove	SM148E software manual

1.5 Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

- Contact our customer service department (p. 33).

Downloading manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., N-472).
3. Click the corresponding product to open the product detail page.
4. Click the **Downloads** tab.

The manuals are shown under **Documentation**. Software manuals are shown under **General Software Documentation**.

5. Click the **ADD TO LIST** button for the desired manual and then click **REQUEST**.
6. Fill out the request form and click **SEND REQUEST**.

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

2 Safety

In this Chapter

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2.1 Intended Use

The N-472 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 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 that acts on the fine-threaded screw and moves it.

When at rest, the drive is self-locking and therefore requires no current and generates no heat. It holds the position with maximum force.

The N-472 is not intended for continuous operation. For further information on the operating conditions of the N-472, see "Technical Data" (p. 35).

The intended use of the N-472 is only possible in conjunction with a suitable controller (p. 11), 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.

2.2 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 may result in personal injury and/or damage to the N-472.

- Use the N-472 for its intended purpose only, and only when it is in perfect 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.

2.2.1 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 on our website (p. 3).
- Add all information from the manufacturer such as supplements or technical notes to the user manual.
- If you give the N-472 to other users, include this user manual as well as all other relevant information provided by the manufacturer.
- Do the work only if the user manual is complete. Missing information due to an incomplete user manual can lead to serious or fatal injuries as well as damage to the 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.

2.2.2 Measures for Handling Vacuum-Compatible Products

When handling the vacuum version of the linear actuator, attention must be paid to appropriate cleanliness. At PI, all parts are cleaned before assembly. During assembly and measurement, powder-free gloves are worn. Afterwards, the linear actuator is cleaned once again by wiping and shrink-wrapped twice in vacuum-compatible film.

- Touch the linear actuator only with powder-free gloves.

3 Product Description

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Suitable Controllers	11
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3.1 Model Overview

PiezoMike linear actuators with M10×1 thread

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

PiezoMike linear actuators with M10×1 thread, vacuum-compatible to 10⁻⁶ hPa

Model	Description
N-472.11V	Closed loop PiezoMike linear actuator, 7 mm, M10×1 thread, vacuum compatible to 10 ⁻⁶ hPa

PiezoMike linear actuators with clamping shank

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

PiezoMike linear actuators with clamping shank, vacuum-compatible to 10⁻⁶ hPa

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

3.2 Product View

N-472 models with M10x1 thread

The description of the product components is also valid for models with turned cable exit.

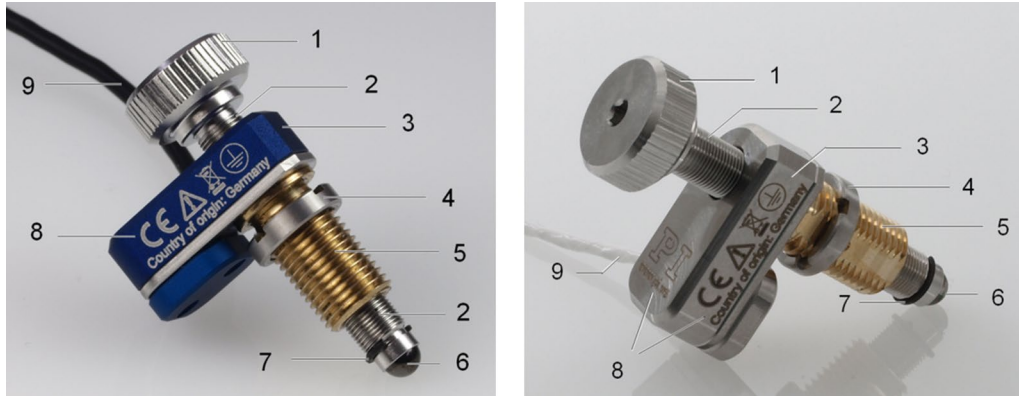


Figure 1: Models with thread and standard cable exit (example illustration):
Standard version (left) and vacuum version (right)

- 1 Screw head
- 2 Fine-threaded screw (rotating)
- 3 Base body
- 4 M10x1 mounting nut
- 5 M10x1 mounting thread
- 6 Ball tip for connecting to the movable part of the mechanical mounting
- 7 Unscrew lock (circlip) for fine-threaded screw
- 8 Product labeling
- 9 Cable for connecting to the controller (sensor cable not illustrated)

N-472 models with clamping shank

The description of the product components is also valid for models with turned cable exit.

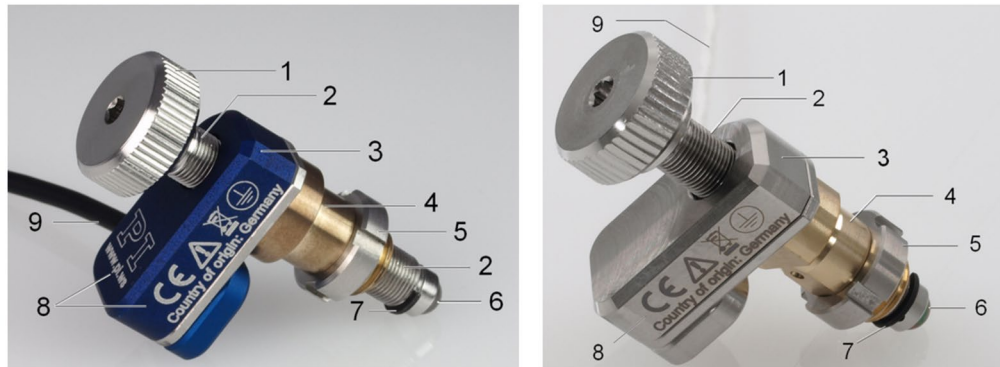


Figure 2: Models with clamping shank and standard cable exit (example illustration):
Standard version (left) and vacuum version (right)

- 1 Screw head
- 2 Fine-threaded screw (rotating)
- 3 Base body
- 4 Clamping shank (9.5 mm diameter, 6 mm clamping width)
- 5 M9x1 mounting nut
- 6 Ball tip for connecting to the movable part of the mechanical mounting
- 7 Unscrew lock (circlip) for fine-threaded screw
- 8 Product labeling
- 9 Cable for connecting to the controller (sensor cable not illustrated)

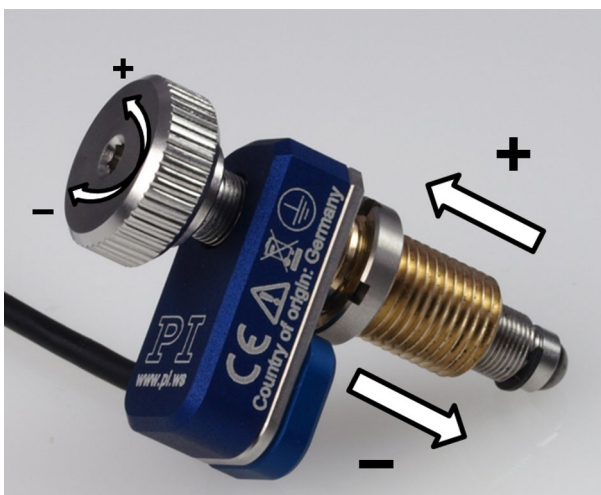
Directions of Motion

Figure 3: Directions of motion of the N-472

Pay attention to further information on the operating conditions in the "Technical Data" section (p. 35).

3.3 Product Labeling









Figure 4: N-472: Product labeling



Figure 5: Type plate (N-472.110 as example)



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

Position	Labeling	Description
A		Manufacturer's logo
A	WWW.PI.WS	Manufacturer's address (website)
B		CE conformity mark
B		Warning sign "Pay attention to the manual!"
B		Old equipment disposal (p. 47)
B		Symbol for the protective earth conductor (p. 17)
B	Country of origin: Germany	Country of origin
C	N-472.110	Product name (example), the characters following the period refer to the model
C	123456789	Serial number (example), individual for each N-472 Meaning of each position (from the left): 1 = internal information, 2 and 3 = year of manufacture, 4 to 9 = consecutive number
Only with models that are not suitable for use in a vacuum:		
C	R: 00.001	Revision number (example)
C		Data matrix code (example; contains the serial number)

3.4 Scope of Delivery

Product number	Components
N-472	Linear actuator according to order (p. 7)
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

3.5 Suitable Controllers

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

3.6 Technical Features

3.6.1 ID Chip

An ID chip is in the D-sub connector (m) of the linear actuator, in which the data on the linear actuator is stored (e.g., linear actuator type, serial number, date of manufacture, hardware version).

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

For more information on the ID chip recognition, see the manual of the controller used.

4 Unpacking

INFORMATION

When handling the vacuum version of the linear actuator, attention must be paid to appropriate cleanliness. At PI, all parts are cleaned before assembly. During assembly and measurement, powder-free gloves are worn. Afterwards, the linear actuator is cleaned once again by wiping and is then shrink-wrapped twice in vacuum-compatible film.

➤ Touch the linear actuator only with powder-free gloves.

1. Unpack the N-472 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 (p. 33).
4. Keep all packaging materials in case the product needs to be returned.

5 Installing

In this Chapter

General Notes on Installation	15
Installing the Linear Actuator into a Mechanical Mounting and Connecting it to the Protective Earth Conductor	17
Preparing a Vacuum-Compatible N-472 for Connection to the Controller	20

5.1 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 of 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 $R_a < 0,1 \mu\text{m}$ 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!

During operation, the N-472 emits up to 5.2 watts of heat that can affect your application.

- Install the N-472 so that your application is not affected by the dissipating heat.
- Ensure sufficient ventilation at the place of installation.
- Pay attention to the operating conditions (duty cycle, ambient temperature) according to the specifications in "Technical Data" (p. 35).

NOTICE**Damage from unsuitable cables!**

Unsuitable cables can cause damage to the controller.

- Use cables from PI only 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 from dirt and condensation.
- Do **not** remove the lubricant that was applied to the fine-threaded screw of the N-472 at the factory.
- 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 leads to damage to the N-472.

- 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 the 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.

5.2 Installing the Linear Actuator into a Mechanical Mounting and Connecting it to the 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.

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 to prevent it from unscrewing by itself. If this is not possible, check the screw connection at regular intervals and retighten the screw(s) if necessary.



Figure 7: Models with thread: Relevant components for installation into the mechanical mounting (example illustration)

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



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

- 1 Clamping shank (9.5 mm diameter, 6 mm clamping width)
- 2 M9×1 mounting nut
- 3 Ball tip

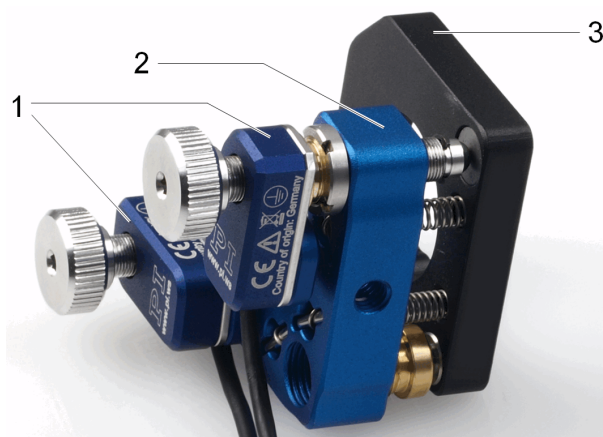


Figure 9: Two linear actuators on a mirror mount (example illustration)

- 1 Linear actuators with mounting thread
- 2 Mechanical mounting for linear actuators (fixed part of the mirror mounting)
- 3 Mechanical mounting for mirror (movable part of the mirror mounting)

Requirements

- ✓ You have read and understood the General Notes on Installation (p. 15).
- ✓ The N-472 is **not** connected to the controller.
- ✓ You have provided a suitable mechanical mounting that fulfills the following requirements:
 - For models with mounting thread: An M10×1 through-hole is in the mechanical mounting. For more details, refer to "Dimensions" (p. 43).
 - 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. 43).

- The mechanical mounting including its contact surface to the mounting nut or 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 $\geq 0.75 \text{ mm}^2$.
 - The contact surface of the mechanical mounting to the ball tip of the N-472 has a roughness of $R_a < 0,1 \text{ } \mu\text{m}$ and a hardness of at least 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. 11)

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 an N-472 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 $< 0.1 \text{ } \Omega$ 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 an N-472 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 into 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 hand-tighten the mounting nut of the N-472 with the hook wrench.
7. Make sure that the contact resistance is $<0.1\ \Omega$ 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.

5.3 Preparing a Vacuum-Compatible N-472 for Connection to the Controller

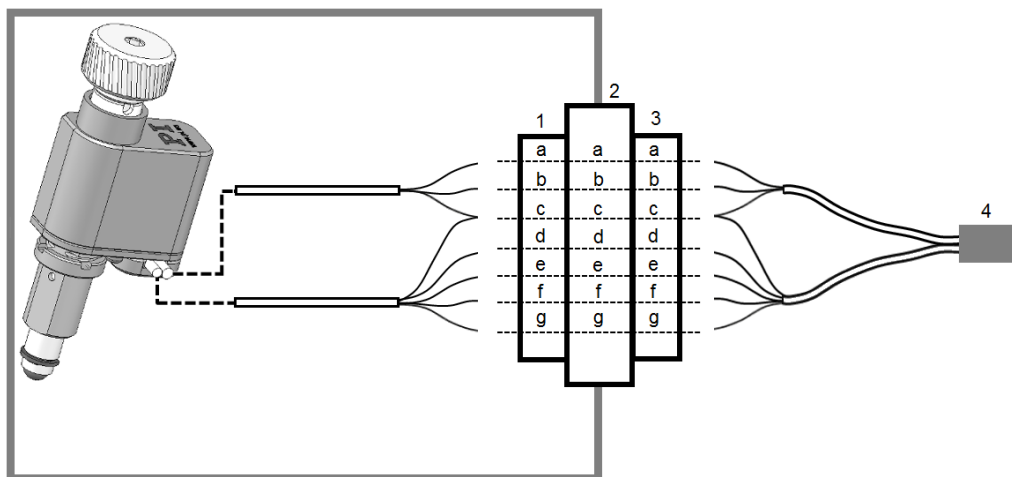


Figure 10: Vacuum compatible N-472: Connecting to a vacuum feedthrough

- 1 Vacuum-side connection for the cables of the N-472
- 2 Vacuum feedthrough
- 3 Connector for the N472B0001 motor / sensor cable (p. 11)
- 4 Motor / sensor connector D-sub 15 (m), see "Pin Assignment" (p. 46)

Assignment of the stranded wires and the cable shield

Letter	Wire color	Function	Signal
a	Red	Piezo voltage 0 to 80 V	PIEZO+
b	Black	Piezo voltage ground	PIEZO-
c	---	Exposed cable shield of the motor cable and the sensor cable	---
d	Yellow	Sensor signal, sine	ENCA+
e	Green	Sensor signal, cosine	ENCB+
f	Red	+5 V supply voltage for sensor	5 V
g	Black	Sensor ground	GND

Requirements

- ✓ You have read and understood the General Notes on Installation (p. 15).
- ✓ The N472B0001 motor / sensor cable (p. 11) is **not** connected to the controller.

Tools and accessories

- Suitable vacuum feedthrough
- Connection on the air side and on the vacuum side (connector male or female) for the vacuum feedthrough
- N472B0001 motor / sensor cable (p. 11)
- Suitable tools for wiring the connections

Preparing a Vacuum-Compatible N-472 for Connection to the Controller

1. Attach the respective connectors for the vacuum feedthrough to the bare stranded wires of the N-472 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.

6 Starting and Operating

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6.1 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 or not properly connected, dangerous touch voltages can occur on the N-472 in the event of a malfunction or failure of the system. If there are touch voltages, touching the N-472 can result in serious injury or death from electric shock.

- Connect the N-472 to a protective earth conductor (p. 17) before starting.
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e.g., in the case of modifications), reconnect the N-472 to the protective earth conductor before restarting.

NOTICE



Operating voltage excessively high or incorrectly connected!

Excessively high or wrongly connected operating voltages can damage the N-472.

- Operate the N-472 with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating voltage range (p. 37) specified for the N-472.
- Operate the N-472 only when the operating voltage is properly connected; see "Pin Assignment" (p. 46).

NOTICE**Operating frequency too high!**

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

- Operate the N-472 with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating frequency range (p. 37) specified for the N-472.

NOTICE**Destruction of the piezo actuator due to 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 also occur in certain air pressure ranges due to the increased conductivity of the air.

- Avoid operating the N-472 in environments that can increase the electrical conductivity.
- Only operate the N-472 within the permissible ambient conditions and classifications (p. 38).
- When using in a vacuum under 0.1 hPa:
Do **not** operate the N-472 during evacuation or ventilation.

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 of 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 $R_a < 0,1 \mu\text{m}$ 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 the 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 N-472's fine-threaded screw can 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 N-472's fine-threaded screw 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 point or limit switch. Therefore, a reference move to the reference switch or limit switch is not possible. However, you can determine a reference position (p. 27) manually and perform positioning moves relative to this reference position.

INFORMATION

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

Pay attention to further information on the operating conditions in the "Technical Data" section (p. 35).

The N-472 is started and operated with a suitable controller (p. 11) from PI.

6.2 Operating Parameters

If you use the software that is in the scope of delivery of the controller (p. 11), the operating parameters of the can be loaded from the positioner database. The entries in the positioner database are updated regularly.

- Install the PI Update Finder from the product CD of the controller onto your PC and update the positioner database on your PC.

For more information on the positioner database, see the user manual for the controller (p. 11).

6.3 Operating the N-472

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 the target position is reached, the analog control mode switches on for fine positioning. Control remains active.

Requirements

- ✓ You have read and understood the general notes on starting and operating (p. 23).
- ✓ 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 mounted the N-472 (p. 15) properly.
- ✓ 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

Requirements

- ✓ You have read and understood the general notes on starting and operating (p. 23).
- ✓ You have read and understood the user manual for the electronics.
- ✓ You have read and understood the user manual for the PC software.
- ✓ You have correctly installed (p. 15) the N-472 and connected it to the protective earth conductor (p. 17).
- ✓ The electronics and the required PC software were installed. All connections to the electronics were made (refer to the user manual for the electronics).

Operating the N-472

- Follow the instructions for starting and operating the N-472 in the manual for the electronics (p. 11) used.

6.4 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. 26).
- ✓ You have turned the head of 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.
3. 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.

7 Maintenance

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

If you would like your device to be serviced, please contact our customer service department (p. 33).

8 Troubleshooting

Problem	Possible causes	Solution
No or limited motion	<ul style="list-style-type: none"> ▪ The cable is not connected correctly or is defective 	<ul style="list-style-type: none"> ➤ Check the connecting cables.
	<ul style="list-style-type: none"> ▪ Excessive counterforces in the direction of motion 	<ul style="list-style-type: none"> ➤ Reduce the load. Pay attention to the information in the "Technical Data" section (p. 35).
	<ul style="list-style-type: none"> ▪ Parameters of the controller incorrectly set 	<ul style="list-style-type: none"> ➤ Load the parameter set from the positioner database that corresponds to the N-472 model. ➤ If necessary: In the PIMikroMove PC program, set the parameters of the controller so that they correspond to the application (load, orientation) of the N-472 model (see user manual for the controller).
	<ul style="list-style-type: none"> ▪ Motor/drive is blocked 	<ul style="list-style-type: none"> ➤ Loosen the fine-threaded screw by turning the screw head backwards and forwards by hand.

If the problem that occurred with your system is not listed in the table above or cannot be solved as described, contact our customer service department (p. 33).

9 Customer Service Department

For inquiries and orders, contact your PI sales engineer 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 latest versions of the user manuals are available for download on our website (p. 3).

10 Technical Data

Subject to change. You can find the latest product specifications on the product web page at www.pi.ws (<https://www.pi.ws>).

In this Chapter

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10.1 Specifications

10.1.1 Data Table

Motion	N-472.110	N-472.110Y	N-472.11V	N-472.120	N-472.120Y	N-472.12V	Tolerance
Active axes	X	X	X	X	X	X	
Travel range in X	7 mm	7 mm	7 mm	7 mm	7 mm	7 mm	
Maximum velocity in X, unloaded	2 mm/min	2 mm/min	2 mm/min	2 mm/min	2 mm/min	2 mm/min	
Typical velocity in X, unloaded	0.4 mm/min	0.4 mm/min	0.4 mm/min	0.4 mm/min	0.4 mm/min	0.4 mm/min	
Linearity error in X	0.3 %	0.3 %	0.3 %	0.3 %	0.3 %	0.3 %	typ.

Positioning	N-472.110	N-472.110Y	N-472.11V	N-472.120	N-472.120Y	N-472.12V	Tolerance
Minimum incremental motion in X	50 nm	50 nm	50 nm	50 nm	50 nm	50 nm	typ.
Unidirectional repeatability in X	± 200 nm	± 200 nm	± 200 nm	± 200 nm	± 200 nm	± 200 nm	typ.
Integrated sensor	Incremental angle-measuring system	Incremental angle-measuring system	Incremental angle-measuring system	Incremental angle-measuring system	Incremental angle-measuring system	Incremental angle-measuring system	
Sensor signal	Sin/cos, 1 V peak-peak	Sin/cos, 1 V peak-peak	Sin/cos, 1 V peak-peak	Sin/cos, 1 V peak-peak	Sin/cos, 1 V peak-peak	Sin/cos, 1 V peak-peak	

Drive properties	N-472.110	N-472.110Y	N-472.11V	N-472.120	N-472.120Y	N-472.12V	Tolerance
Drive type	Piezoelectric inertia drive	Piezoelectric inertia drive	Piezoelectric inertia drive	Piezoelectric inertia drive	Piezoelectric inertia drive	Piezoelectric inertia drive	
Operating voltage, peak-to-peak	80 V	80 V	80 V	80 V	80 V	80 V	
Maximum power consumption	5 W	5 W	5 W	5 W	5 W	5 W	
Drive force in positive direction of motion in X	22 N	22 N	22 N	22 N	22 N	22 N	max.
Maximum operating frequency during continuous operation	400 Hz	400 Hz	200 Hz	400 Hz	400 Hz	200 Hz	
Short-term maximum operating frequency	2000 Hz	2000 Hz	2000 Hz	2000 Hz	2000 Hz	2000 Hz	

Mechanical properties	N-472.110	N-472.110Y	N-472.11V	N-472.120	N-472.120Y	N-472.12V	Tolerance
Holding force in X, passive	100 N	100 N	100 N	100 N	100 N	100 N	min.
Overall mass	200 g	200 g	250 g	200 g	200 g	250 g	
Material	Screw: Stainless steel. Housing: Aluminum, bronze.	Screw: Stainless steel. Housing: Aluminum, bronze.	Screw: Stainless steel. Housing: Stainless steel, bronze.	Screw: Stainless steel. Housing: Aluminum, bronze.	Screw: Stainless steel. Housing: Aluminum, bronze.	Screw: Stainless steel. Housing: Stainless steel, 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	N-472.110	N-472.110Y	N-472.11V	N-472.120	N-472.120Y	N-472.12V	Tolerance
Operating temperature range	10 to 40 °C	10 to 40 °C	10 to 40 °C	10 to 40 °C	10 to 40 °C	10 to 40 °C	
Connector	D-sub 15-pin (m)	D-sub 15-pin (m)	D-sub 15-pin (m)	D-sub 15-pin (m)	D-sub 15-pin (m)	D-sub 15-pin (m)	
Cable length	2 m	2 m	1 m	2 m	2 m	1 m	
Recommended controllers / drivers	E-873.1AT	E-873.1AT	E-873.1AT	E-873.1AT	E-873.1AT	E-873.1AT	
Vacuum class			10 ⁻⁶ hPa			10 ⁻⁶ hPa	

Maximum velocity not suitable for continuous operation (refer to "Operating Time and Duty Cycle" (p. 40)).

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 stranded wires.

Ask about customized versions.




10.1.2 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 tubing: Kynar, PTFE Solder: Sn95.5 Ag3.8 Cu0.7
Lubricant	High vacuum oil
Adhesive	Epoxy-based vacuum adhesive

10.1.3 Maximum Ratings

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

Model	Maximum operating voltage 	Maximum operating frequency during continuous operation* 	Maximum power consumption 
N-472.110(Y) N-472.120(Y)	80 V (peak-to-peak)	400 Hz	5 W
N-472.11V N-472.12V	80 V (peak-to-peak)	200 Hz	5 W

* Up to 2000 Hz is permissible for short periods of time. Refer to "Operating Time and Duty Cycle" (p. 40).

10.1.4 Ambient Conditions and Classifications

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

Area of application	For 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 °C Decreasing linearly to 50 % relative humidity at 40 °C
Operating temperature	10 °C bis 40 °C
Storage temperature	-20 °C to 75 °C
Transport temperature	-20 °C to 75 °C
Overvoltage category	II
Protection class	I
Degree of pollution	1
Degree of protection according to IEC 60529	IP30

10.2 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 (see "Technical Data").

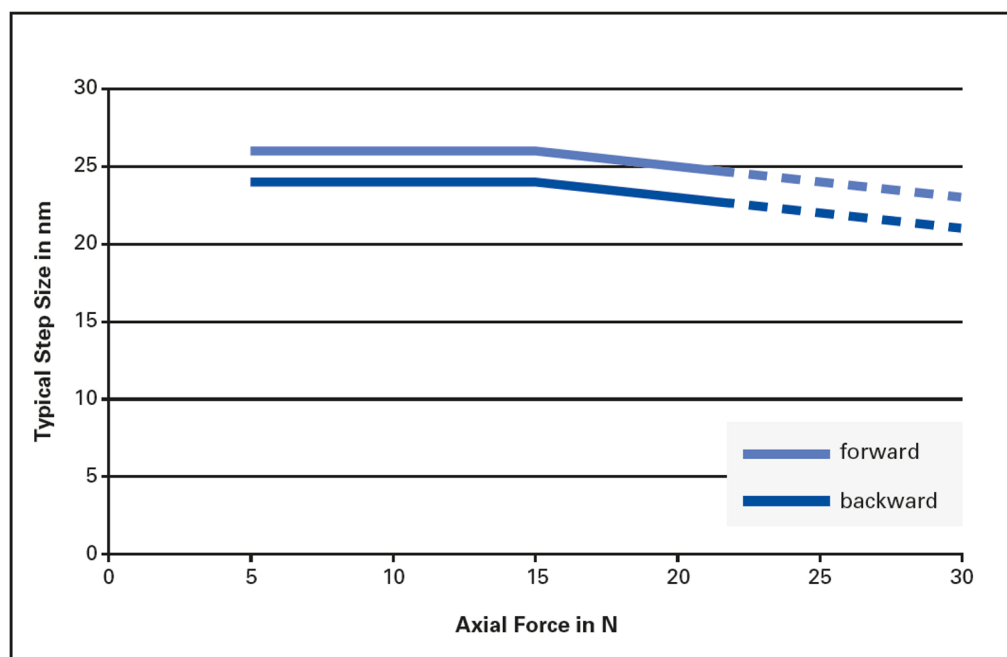


Figure 11: Typical step size in nm vs. axial force in N

10.3 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 at ambient conditions (>50,000,000 steps under vacuum conditions). Over this time, the typical step size decreases by maximum 30 %.

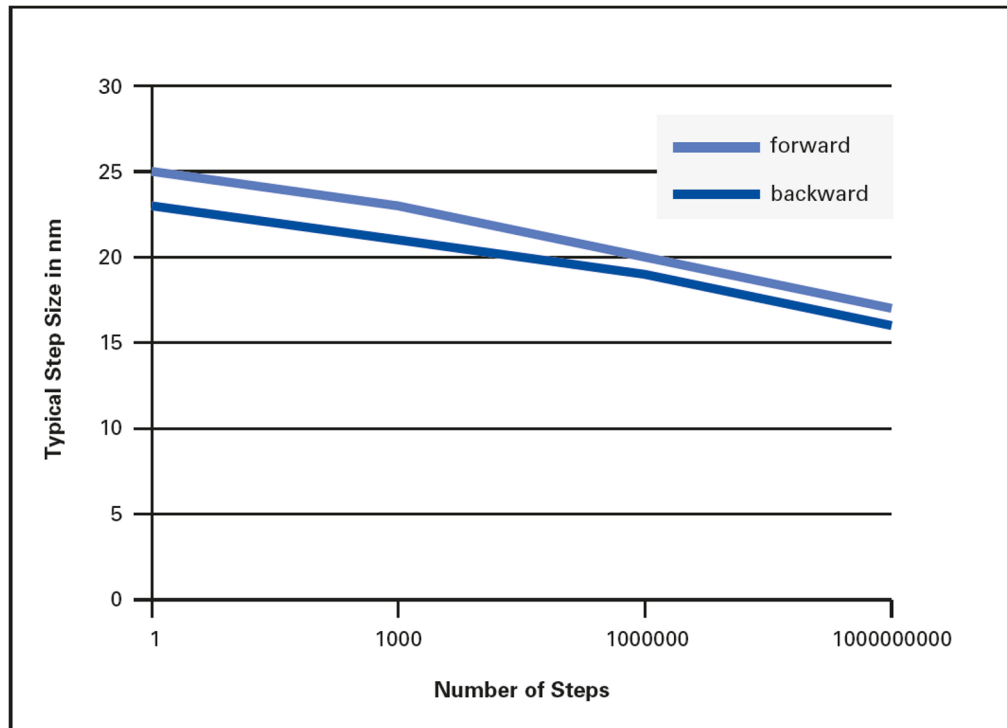


Figure 12: Typical step size in nm vs. number of steps

10.4 Operating Time and Duty Cycle

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

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

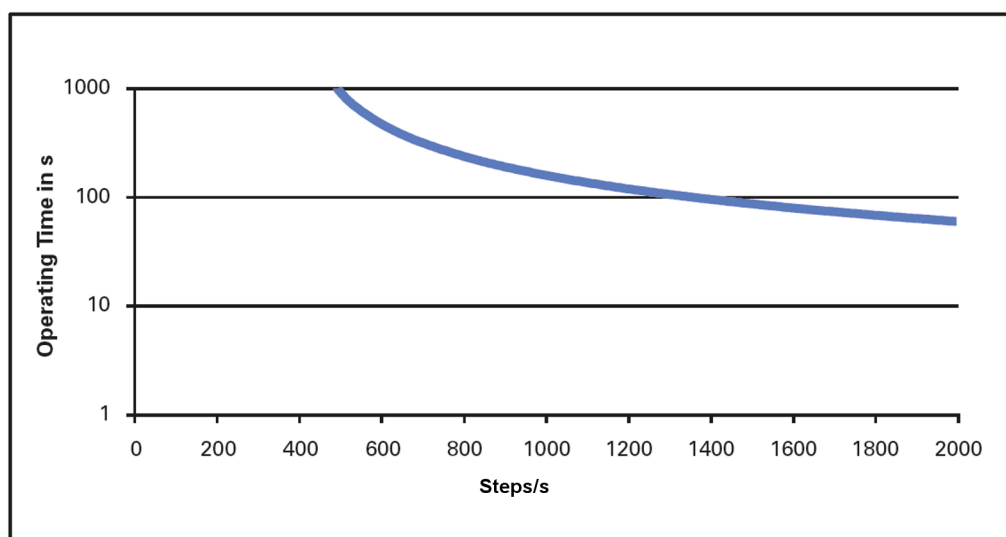


Figure 13: Operating time in s vs. steps/s

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

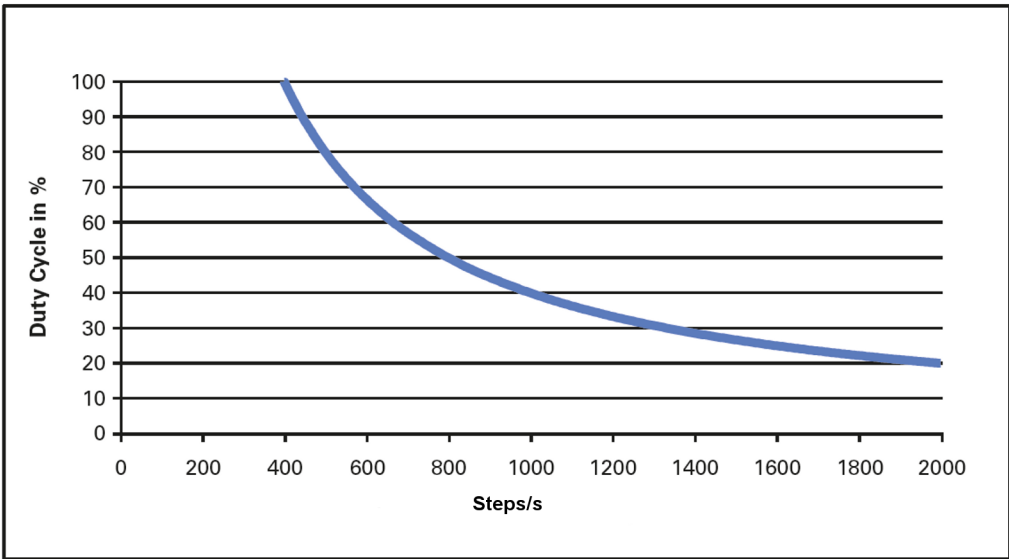


Figure 14: Duty cycle in % vs. steps/s

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.

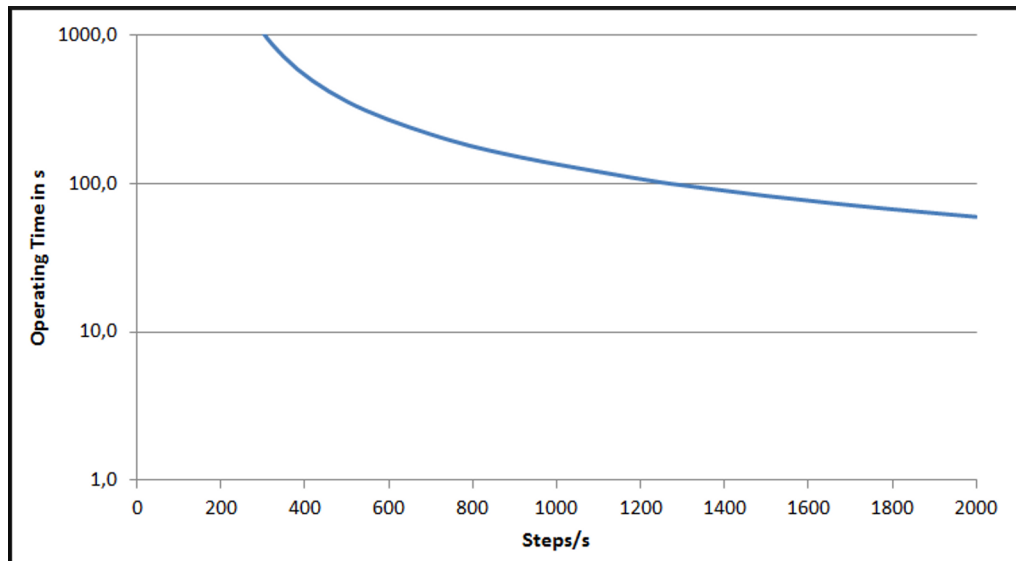


Figure 15: Operating time in s vs. steps/s (vacuum versions of the N-472)

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

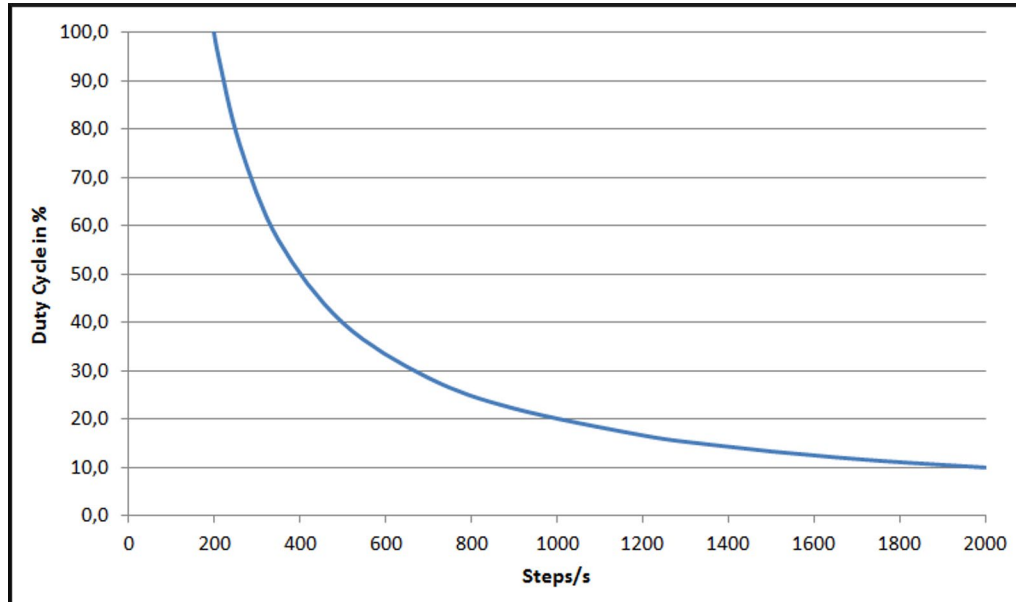


Figure 16: Duty cycle in % vs. steps/s (vacuum versions of the N-472)

10.5 Dimensions

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

10.5.1 Models with Turned Cable Exit

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 turned cable exit.

- Take 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.

10.5.2 Models with M10x1 Thread

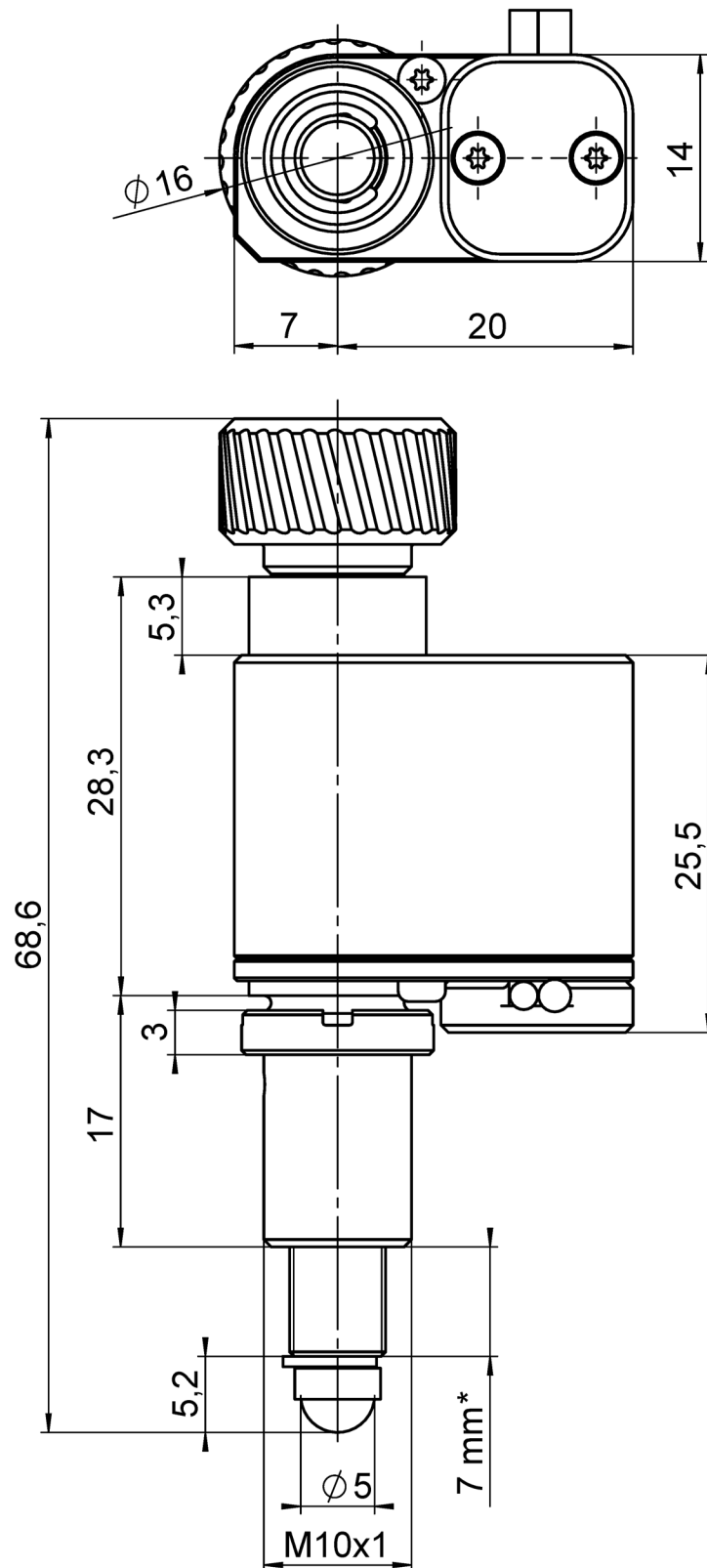


Figure 17: N-472.11x dimensions (* travel range)

10.5.3 Models with Clamping Shank

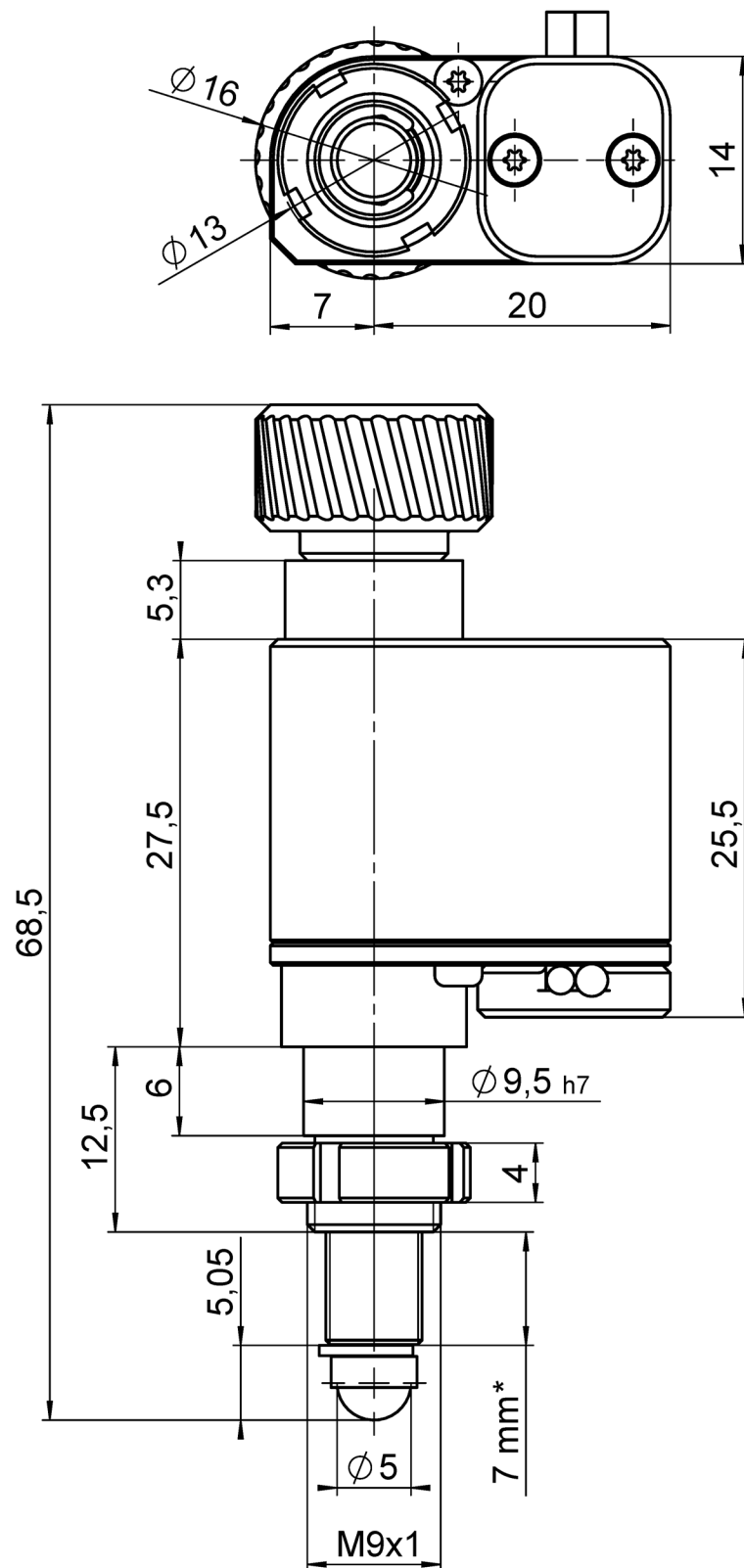


Figure 18: N-472.12x dimensions (* travel range)

10.6 Pin Assignment

D-sub 15 connector (m)

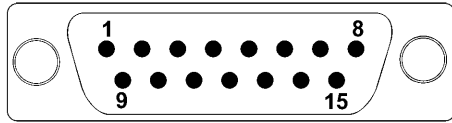


Figure 19: Front view of the D-sub 15 connector

Pin	Signal	Function	Direction
1	NC	Not connected (reserved for reference switch, differential (-))	-
2	PIEZO-	Motor signal (-)	Input
3	PIEZO+	Motor signal (+)	Input
4	5 V	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	Ground	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.

11 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.

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.

Any old PI equipment can be sent free of charge to the following address:

Physik Instrumente (PI) GmbH & Co. KG
Auf der Römerstraße 1
76228 Karlsruhe, Germany



12 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 standards applied for certifying conformity are listed below.

Safety (Low Voltage Directive): EN 61010-1

EMC: EN 61326-1

RoHS: EN IEC 63000

