MP144E

N-472 Linear Drive

User Manual

Version: 1.2.0 Date: 28.08.2018

This document describes the following products:

- **N-472.x10/.x10Y, N-472.x1V/.x1VY**
  PiezoMike linear actuator, M10×1 thread
- **N-472.x20/.x20Y, N-472.x2V/.x2VY**
  PiezoMike linear actuator, 9.5 mm (0.375") clamping shank

Models:

x represents the travel range:
1 = 7.5 mm
2 = 13 mm

Y: Offset cable exit

0: Not suitable for use in a vacuum
V: Vacuum-compatible to 10^{-6} hPa

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Contents

1 About this Document

In this Chapter

1.1 Objective and Target Audience of this User Manual

This manual contains information necessary for the intended use of the N-472.

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 (p. 2) on our website.

1.2 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 injury.

➢ Actions to take to avoid the situation.

NOTICE

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

➢ Actions to take to avoid the situation.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/Label	Meaning
1. 2.	Action consisting of several steps whose sequential order must be observed
➢	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 on the product which refers 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 their own manuals.

Description	Document
E-871.1A1N Compact PiezoMike - Q-Motion® controller, 1 axis, TCP/IP, USB, RS-232	PZ285D user manual (available soon)
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. 35).

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., N-472) or the product family (e.g., PiezoMike) 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.

2 Safety

In this Chapter

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 of 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-thread 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. 37).

The intended use of the N-472 is only possible in conjunction with a suitable controller (p. 12), 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 can result in personal injury and/or damage to the N-472.

- Only use the N-472 for its intended purpose, and only use it if it is in a good working order.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for the correct installation and operation of the N-472.

2.2.1 Organizational Measures

User manual

- Always keep this user manual available with the N-472.
  The latest versions of the user manuals are available for download (p. 2) on our website.
- Add all information from the manufacturer to the user manual, for example supplements or technical notes.
- If you give the N-472 to other users, also 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 result in minor injury and damage to equipment.
- Only install and operate the N-472 after you have read and understood this user manual.

Personnel qualification

The N-472 may only be installed, started up, 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

In this Chapter

3.1 Model Overview

The models differ as follows:

- Travel range
- Type of installation
- Suitability for use in a vacuum
- Position of the cable exit

In the product number, these are coded as follows by the position after the period:

Character following the period	Meaning	Possible values
First position	Travel range	1 = 7.5 mm 2 = 13 mm
Second position	Type of installation	1 = thread M10×1 2 = clamping shank 9.5 mm
Third position	Suitability for use in a vacuum	0 = not suitable V = up to 10^{-6} hPa
Fourth position	Position of the cable exit	No entry = standard cable exit Y = offset cable exit (i.e., offset by 180°)

PiezoMike linear actuators with M10×1 thread

Model	Description
N-472.110	Closed loop PiezoMike linear actuator, 7.5 mm, M10×1 thread
N-472.110Y	Closed loop PiezoMike linear actuator, 7.5 mm, M10×1 thread, offset cable exit

Model	Description
N-472.210	Closed loop PiezoMike linear actuator, 13 mm, M10×1 thread
N-472.210Y	Closed loop PiezoMike linear actuator, 13 mm, M10×1 thread, offset 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, 7.5 mm, M10×1 thread, vacuum compatible to 10^{-6} hPa
N-472.11VY	Closed loop PiezoMike linear actuator, 7.5 mm, M10×1 thread, vacuum compatible to 10^{-6} hPa, offset cable exit
N-472.21V	Closed loop PiezoMike linear actuator, 13 mm, M10×1 thread, vacuum compatible to 10^{-6} hPa
N-472.21VY	Closed loop PiezoMike linear actuator, 13 mm, M10×1 thread, vacuum compatible to 10^{-6} hPa, offset cable exit

PiezoMike linear actuators with clamping shank

Model	Description
N-472.120	Closed loop PiezoMike linear actuator, 7.5 mm, 9.5 mm (0.375") clamping shank
N-472.120Y	Closed loop PiezoMike linear actuator, 7.5 mm, 9.5 mm (0.375") clamping shank, offset cable exit
N-472.220	Closed loop PiezoMike linear actuator, 13 mm, 9.5 mm (0.375") clamping shank
N-472.220Y	Closed loop PiezoMike linear actuator, 13 mm, 9.5 mm (0.375") clamping shank, offset cable exit

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

Model	Description
N-472.12V	Closed loop PiezoMike linear actuator, 7.5 mm, 9.5 mm (0.375") clamping shank, vacuum compatible to 10^{-6} hPa
N-472.12VY	Closed loop PiezoMike linear actuator, 7.5 mm, 9.5 mm (0.375") clamping shank, vacuum compatible to 10^{-6} hPa, offset cable exit
N-472.22V	Closed loop PiezoMike linear actuator, 13 mm, 9.5 mm (0.375") clamping shank, vacuum compatible to 10^{-6} hPa
N-472.22VY	Closed loop PiezoMike linear actuator, 13 mm, 9.5 mm (0.375") clamping shank, vacuum compatible to 10^{-6} hPa, offset cable exit

3.2 Product View

N-472 models with M10x1 thread

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

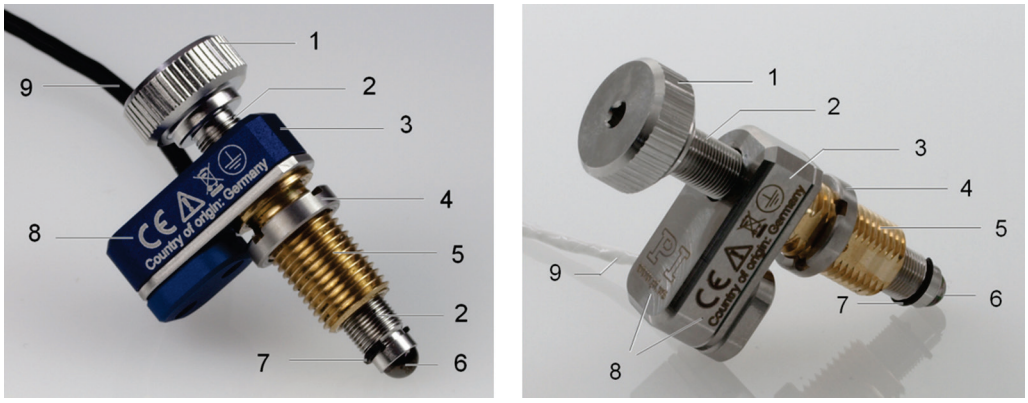

Figure 1: Models with thread and standard cable exit (example illustration): Standard version (left) and vacuum version (right)

1 Screw head
2 Fine-thread 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 Circlip, hard stop for fine-thread screw
8 Product labeling
9 Cable for connection 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 offset cable exit.

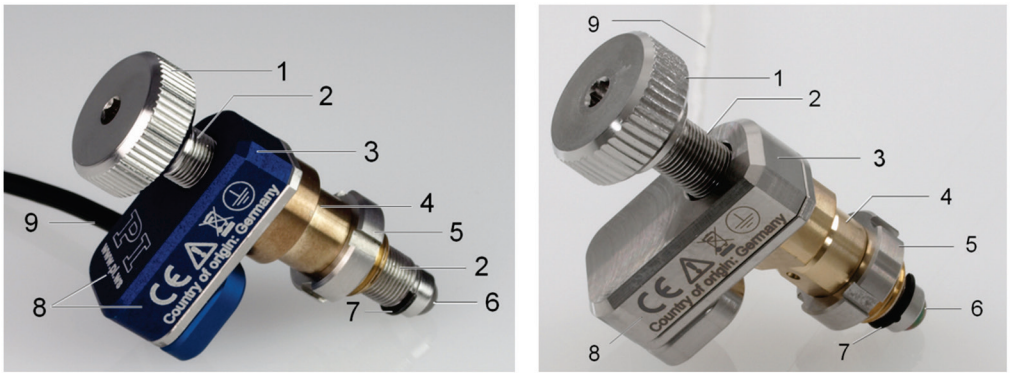

Figure 2: Models with clamping shank and standard cable exit (example illustration): Standard version (left) and vacuum version (right)

1 Screw head
2 Fine-thread 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 Circlip, hard stop for fine-thread screw
8 Product labeling
9 Cable for connection 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. 37).

3.3 Product Labeling

Figure 4: N-472: Product labeling

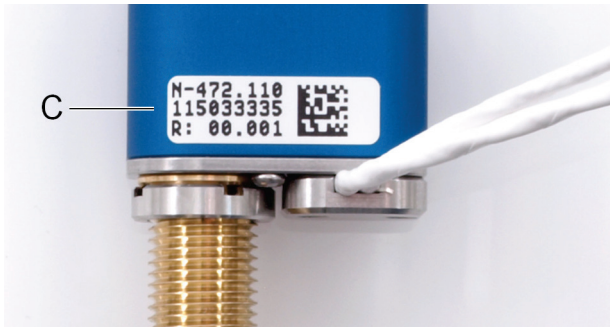

Figure 5: Type plate (N-472.110 as example)

Figure 6: Laser marking (for vacuum-compatible models, N-470.41U as an example)

Position	Labeling	Description
A	PI	Manufacturer's logo
A	WWW.PI.WS	Manufacturer's address (website)
B	CE	CE conformity mark
B	⚠	Warning sign "Observe manual!"
B		Old equipment disposal (p. 51)
B		Symbol for the protective earth conductor (p. 19)
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 the places (counting from left): 1 = internal information 2 and 3 = year of manufacture 4 to 9 = consecutive numbers
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, Sub-D 15 (m) to open end, 2 m, on the air side

3.5 Suitable Controllers

Product number	Description
E-871.1A1N	Compact PiezoMike - Q-Motion® controller, 1 axis, TCP/IP, USB, RS-232

3.6 Technical Features

3.6.1 ID Chip

An ID chip is in the Sub-D 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 items listed in the contract and the packing list.
3. Inspect the contents for signs of damage. If parts are missing or you notice signs of damage, contact PI immediately.
4. Keep all packaging materials in case the product needs to be returned.

5 Installation

In this Chapter

5.1 General Notes on Installation

NOTICE

Friction due to lateral forces!

Lateral forces that act on the fine-thread 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-thread screw and increases the wear of the drive components.

- Avoid lateral forces on the fine-thread screw and on the ball tip of the N-472.
- Install the N-472 so that the fine-thread 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 µm 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.
- Observe the operating conditions (duty cycle, ambient temperature) according to the specifications in "Technical Data" (p. 37).

NOTICE

Damage from unsuitable cables!
Unsuitable cables can cause damage to 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 from dirt and condensation.
- Do **not** remove the lubricant that was applied to the fine-thread screw of the N-472 at the factory.
- Do **not** lubricate the fine-thread 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-thread screw from the base body leads to damage to the N-472.

- Do **not** unscrew the fine-thread screw from the base body of the N-472.

NOTICE

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

- Prevent the fine-thread 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 contact of the N-472 to the protective earth conductor is established via the contact of the mounting nut or thread or clamping shank 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 mounting the protective earth conductor.

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

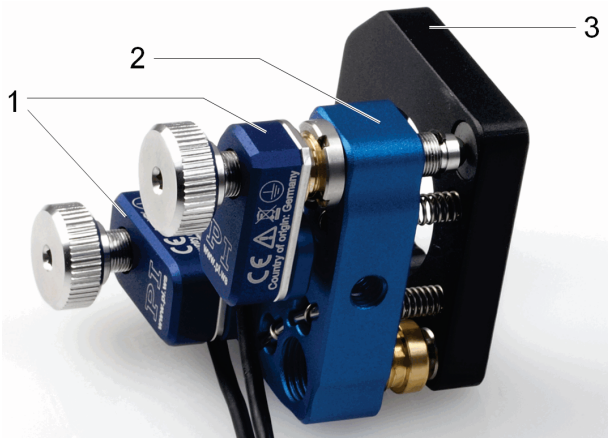

Figure 9: Two linear actuators on a mirror mount (example illustration)

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. 17).
- ✓ The N-472 is **not** connected to the controller.
- ✓ You have provided a suitable mechanical mounting (for dimensions of the linear actuator see "Dimensions" (p. 45)):
  - The mechanical mounting must be connected to the protective earth conductor.
  - The contact surface of the mechanical mounting to the mounting nut or thread or clamping shank of the N-472 must be electrically conductive.
  - The contact resistance at all connection points relevant for mounting the protective earth conductor is <0.1 Ω at 25 A.
  - 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 a hardness of at least 500 HV.
  - For models with mounting thread: An M10×1 through-hole is present in the mechanical mounting.
  - For models with clamping shank: There is a through-hole with a suitable diameter in the mechanical mounting.
- ✓ You have accounted for the space required to route cables without bending and according to regulations.

Tools and accessories

- Hook wrench (included in the scope of delivery (p. 12))

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. Check that the linear actuator is affixed firmly in the mounting.
7. Optional: Manually turn the screw head of the linear actuator's fine-thread screw into the desired position 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. Manually screw the mounting nut of the N-472 a few turns 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. Check that the linear actuator is affixed firmly in the mounting.
8. Optional: Manually turn the screw head of the linear actuator's fine-thread screw into the desired position to avoid longer travel to this position.

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

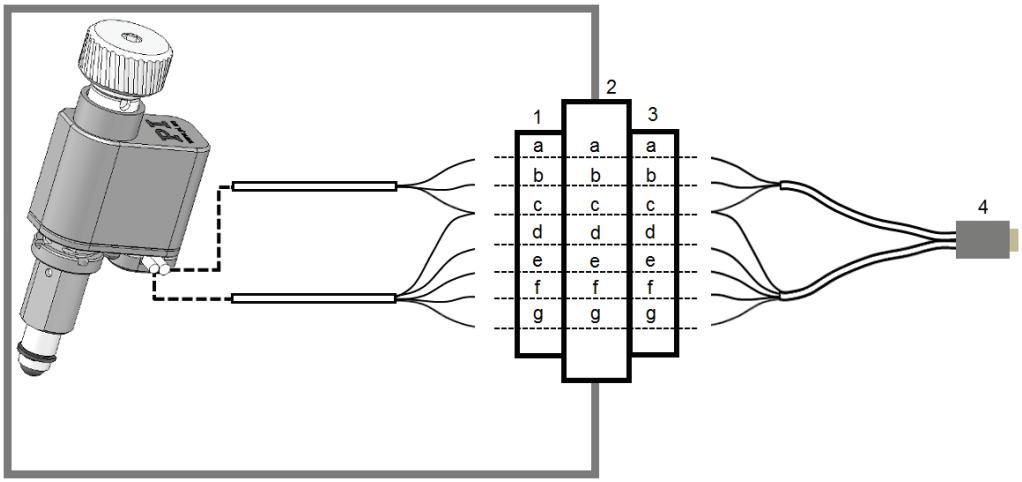

Figure 10: Vacuum compatible N-472: Connecting to a vacuum feedthrough

1 Vacuum-side connection for the cables of the N-472
2 Vacuum feedthrough
3 Connector for the N472B0001 motor / sensor cable (p. 12)
4 Motor / sensor connector Sub-D 15 (m), see "Pin Assignment" (p. 50)

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. 17).
- ✓ The N472B0001 motor / sensor cable (p. 12) 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. 12)
- 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 Startup and Operation

In this Chapter

6.1 General Notes on Startup and Operation

CAUTION

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

If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the N-472 in the case of malfunction or failure of the system. If touch voltages exist, touching the N-472 can result in minor injuries from electric shock.

- Connect the N-472 to a protective earth conductor before startup.
- Do **not** remove the protective earth conductor during operation.
- Establish contact between the N-472 and the protective earth conductor via a sufficiently conductive mechanical mounting (p. 19).
- Make sure that the contact resistance is <0.1 Ω at 25 A at all connection points relevant for mounting the protective earth conductor.
- 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 starting it up again.

NOTICE

Operating voltage too high or incorrectly connected!

Operating voltages that are too high or incorrectly connected can cause damage to the N-472.

- Only operate the N-472 with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating voltage range (p. 39) for which the N-472 is specified.
- Only operate the N-472 when the operating voltage is properly connected; see "Pin Assignment" (p. 50).

NOTICE

Operating frequency too high!
An operating frequency that is too high can cause damage to the N-472.

- Only operate the N-472 with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating frequency range (p. 39) for which the N-472 is specified.

NOTICE

Reduced lifetime of the piezo actuator due to permanently high voltage!
The permanent application of a high static voltage to piezo actuators leads to a considerable reduction in the lifetime of the piezo ceramic.

- When the N-472 is not used, switch off the the controller.

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. 40).
- When using in a vacuum under 0.1 hPa:
  Do **not** operate the N-472 during evacuating or ventilation.

NOTICE

Friction due to lateral forces!
Lateral forces that act on the fine-thread 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-thread screw and increases the wear of the drive components.

- Avoid lateral forces on the fine-thread screw and on the ball tip of the N-472.
- Install the N-472 so that the fine-thread 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 µm 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-thread screw from contact with hard objects!

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

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

NOTICE

Damage from unscrewing!

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

- Do **not** unscrew the fine-thread screw from the base body of the N-472.

NOTICE

Getting stuck at the hard stop!

The fine-thread screw of the N-472 can get stuck at the hard stop. Getting stuck can reduce the lifetime of the linear actuator.

- Stop the N-472 when it reaches the hard stop or command a motion away from the hard stop.
- If the fine-thread screw of the N-472 has become stuck: Manually loosen the fine-thread screw by turning the screw head.

INFORMATION

The N-472 is a linear actuator without reference point or limit switch. Therefore, a reference move to the reference point switch or limit switch is not possible. However, you can determine a reference position (p. 29) 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. 37).

The N-472 is put into operation with a suitable controller (p. 12) from PI.

6.2 Operating Parameters

If you use the software that is in the scope of delivery of the controller (p. 12), the operating parameters of the can be loaded from the stage database. The entries in the stage database are updated regularly.

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

For more information on the stage database, see the user manual for the controller (p. 12).

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 startup and operation (p. 25).
- ✓ You have read and understood the user manual of the controller.
- ✓ You have read and understood the user manual of the PC software.
- ✓ You have properly mounted the N-472 (p. 17).
- ✓ The controller and the required PC software have been installed. All connections with the controller have been established (see user manual of the controller).

Operating the N-472

- ➢ Follow the instructions in the manual for the electronics (p. 12) used for startup and operation of the N-472.

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. 28).
- ✓ You have turned the head of linear actuator's fine-thread 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

When 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 department (p. 35).

8 Troubleshooting

Problem	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 information in the "Technical Data" section (p. 37).
	▪ Parameters of the controller incorrectly set	➢ Load the parameter set from the stage 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).
	▪ Motor/drive is blocked	➢ Loosen the fine-thread 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. 35).

9 Customer Service

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

- 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 available)
  - Version of the driver or the software (if available)
  - Operating system on the PC (if available)
- 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 (p. 2) on our website.

10 Technical Data

In this Chapter

10.1 Specifications

10.1.1 Data Table

	N-472.110 **N-472.110Y** **N-472.120** **N-472.120Y**	**N-472.11V** **N-472.11VY** **N-472.12V** **N-472.12VY**	**N-472.210** **N-472.210Y** **N-472.220** **N-472.220Y**	**N-472.21V** **N-472.21VY** **N-472.22V** **N-472.22VY**	**Unit**
Motion and positioning					
Active axis	X	X	X	X	
Travel range	7.5	7.5	13	13	mm
Integrated sensor	Incremental, optical	Incremental, optical	Incremental, optical	Incremental, optical	
Sensor signal, analog	1	1	1	1	V_{pp}
Reference point definition using reference point or limit switch	-	-	-	-	
Design resolution	5	5	5	5	nm
Minimum incremental motion*	50	50	50	50	nm
Unidirectional repeatability*	200	200	200	200	nm
Linearity error**	2	2	2	2	µm
Typical velocity***	2	2	2	2	mm/min
Operating frequency	2000	2000	2000	2000	Hz
Maximum permissible operating frequency during continuous operation	400	200	400	200	Hz

	N-472.110 N-472.110Y N-472.120 N-472.120Y	N-472.11V N-472.11VY N-472.12V N-472.12VY	N-472.210 N-472.210Y N-472.220 N-472.220Y	N-472.21V N-472.21VY N-472.22V N-472.22VY	Unit
Mechanical properties					
Mechanical interface	M10×1 mounting thread (N-472.110; N-472.110Y) 9.5 mm clamping shank (N-472.120; N-472.120Y)	M10×1 mounting thread (N-472.11V; N-472.11VY) 9.5 mm clamping shank (N-472.12V; N-472.12VY)	M10×1 mounting thread (N-472.210; N-472.210Y) 9.5 mm clamping shank (N-472.220; N-472.220Y)	M10×1 mounting thread (N-472.21V; N-472.21VY) 9.5 mm clamping shank (N-472.22V; N-472.22VY)	
Holding force, power off	>100	>100	>100	>100	N
Feed force	22	22	22	22	N
Drive properties					
Drive type	Inertia drive	Inertia drive	Inertia drive	Inertia drive	
Maximum operating voltage	80	80	80	80	V
Miscellaneous					
Operating temperature range	10 to 40	10 to 40	10 to 40	10 to 40	°C
Vacuum operation	-	To 10^{-6} hPa	-	To 10^{-6} hPa	
Material	Screw: Stainless steel Housing: Aluminum, bronze	Screw: Stainless steel Housing: Stainless steel, bronze	Screw: Stainless steel Housing: Aluminum, bronze	Screw: Stainless steel Housing: Stainless steel, bronze	
Weight	200	250	210	260	g
Cable length	2 m	1 m inside the vacuum, bare stranded wires; 2 m outside the vacuum, bare stranded wires to Sub-D 15	2 m	1 m inside the vacuum, bare stranded wires; 2 m outside the vacuum, bare stranded wires to Sub-D 15	
Motor / sensor connection	Sub-D 15 (m)	Sub-D 15 (m)	Sub-D 15 (m)	Sub-D 15 (m)	
Recommended electronics	E-871.1A1N	E-871.1A1N	E-871.1A1N	E-871.1A1N	

* 20 N preload, measured at 100 µm stroke, compensated for temperature drift

** 20 N preload, measured over the entire stroke, compensated for temperature drift

*** **Not** suitable for continuous operation

Ask about customized versions.

10.1.2 Materials Used for Vacuum-Compatible Models

Materials used for vacuum-compatible models	
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-thread 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.xx0 N-472.xx0Y	80 V	400 Hz	5 W
N-472.xxV N-472.xxVY	80 V	200 Hz	5 W

* Up to 2000 Hz is permissible for short periods of time. See the "Operating Time and Duty Cycle" (p. 42).

10.1.4 Ambient Conditions and Classifications

The following ambient conditions and classifications for the N-472 must be observed:

Area of application	For indoor use only
Maximum altitude	2000 m
Air pressure	Models N-472.xx0 and N-472.xx0Y: 1100 hPa to 0.1 hPa
	Models N-472.xxV and N-472.xxVY: 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 to 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").

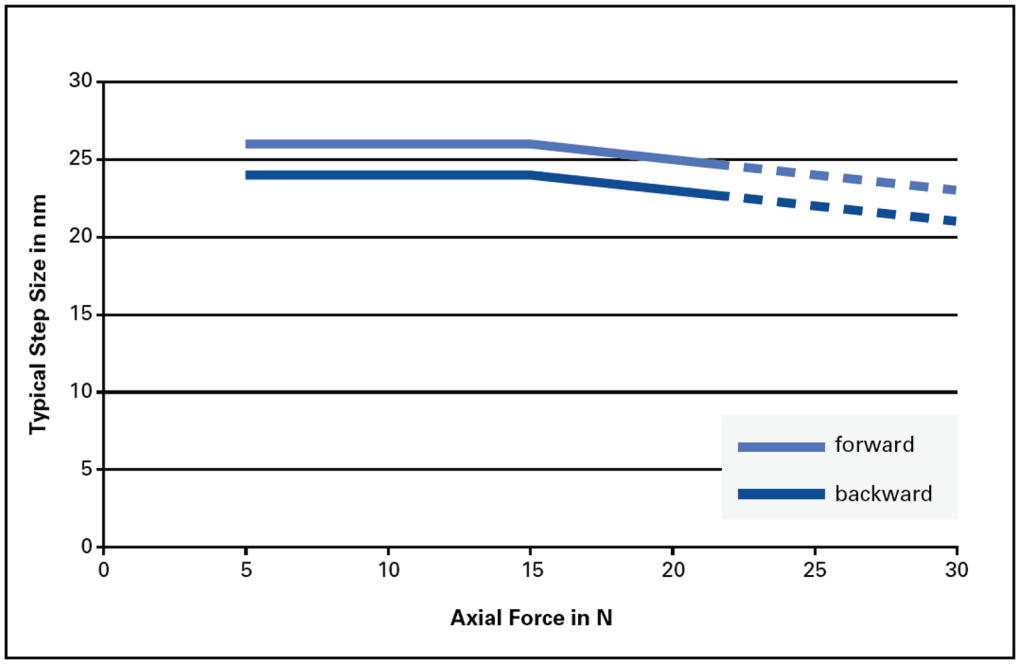

Figure 11: Typical step size in nm vs. axial force in N

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. Over this time, the typical step size decreases by maximum 30 %.

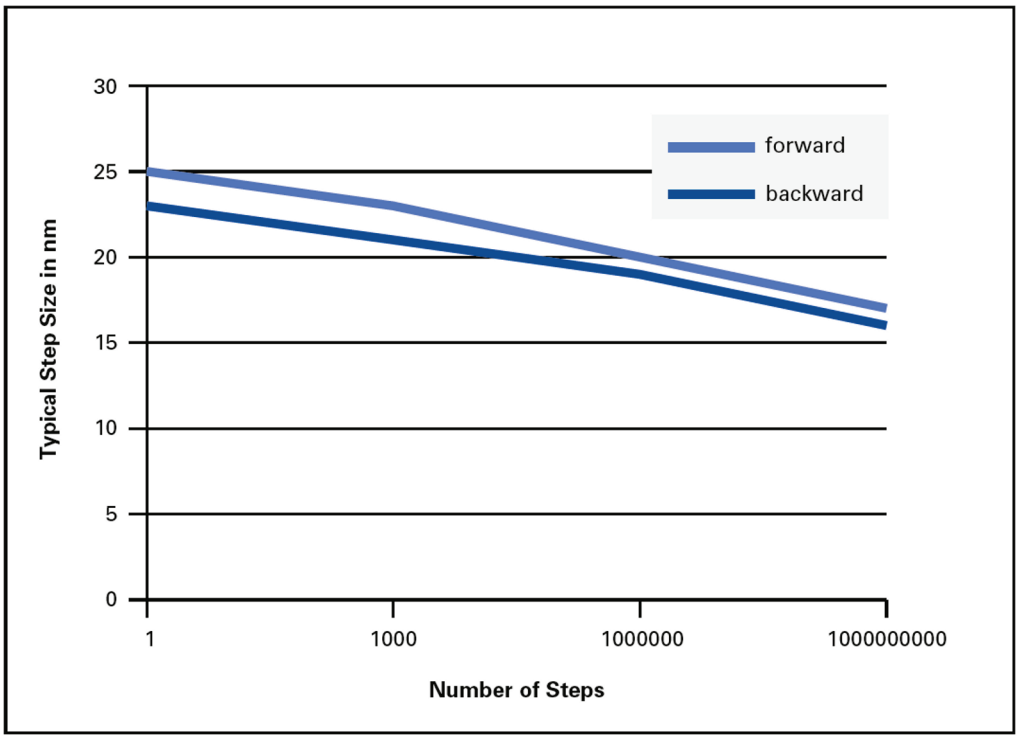

Figure 12: Typical step size in nm vs. number of steps

10.4 Operating Time and Duty Cycle

The operating time and duty cycle influence the lifetime of the linear actuator. 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.

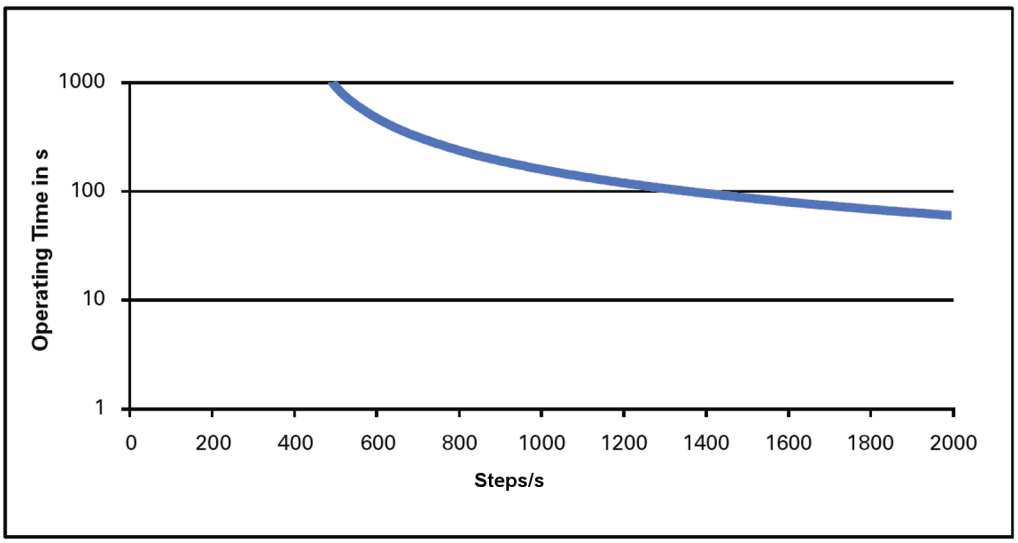

Figure 13: Operating time in s vs. steps/s

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

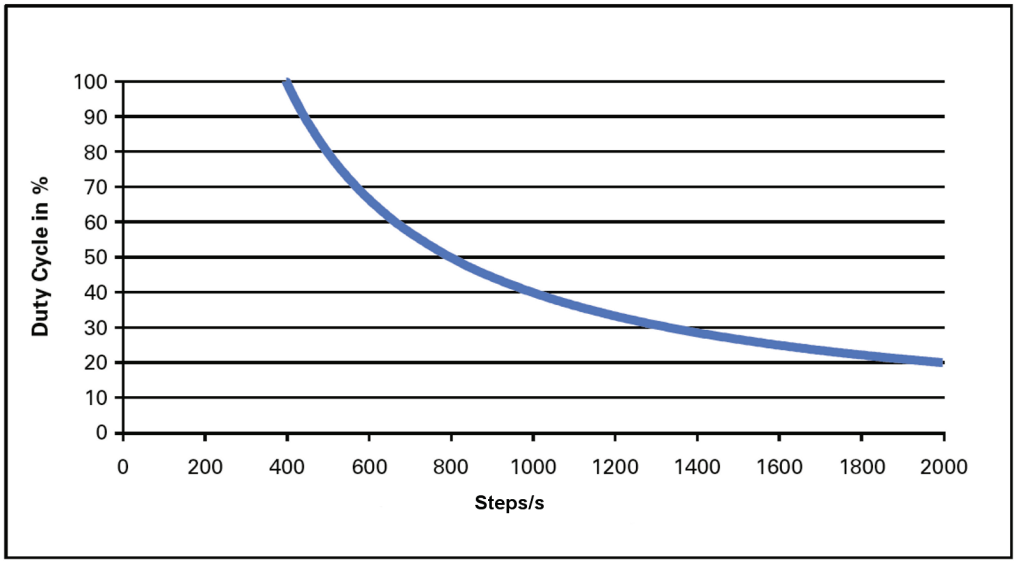

Figure 14: Duty cycle in % vs. steps/s

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.

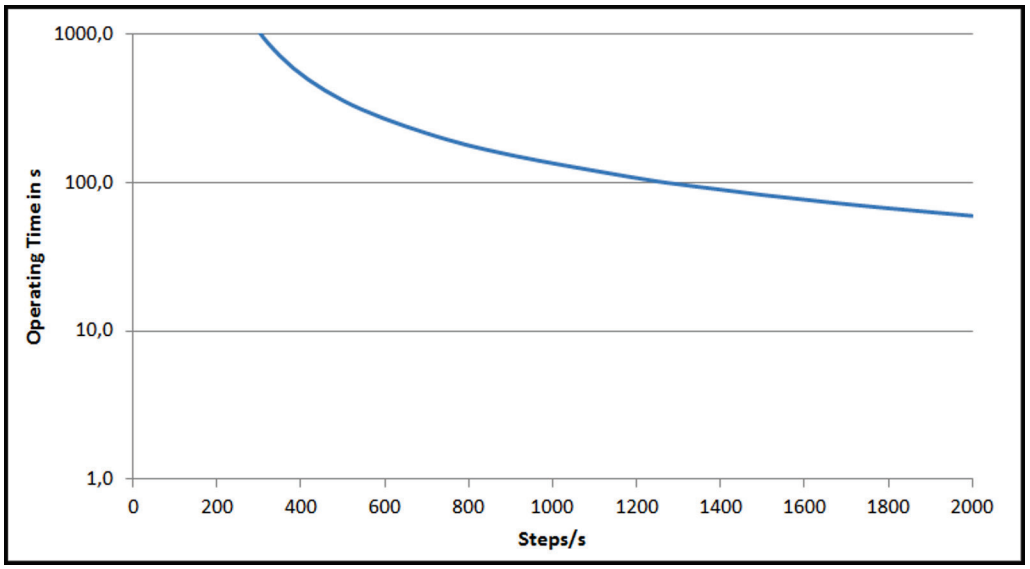

Figure 15: Operating time in s vs. steps/s (vacuum versions of the N-472)

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

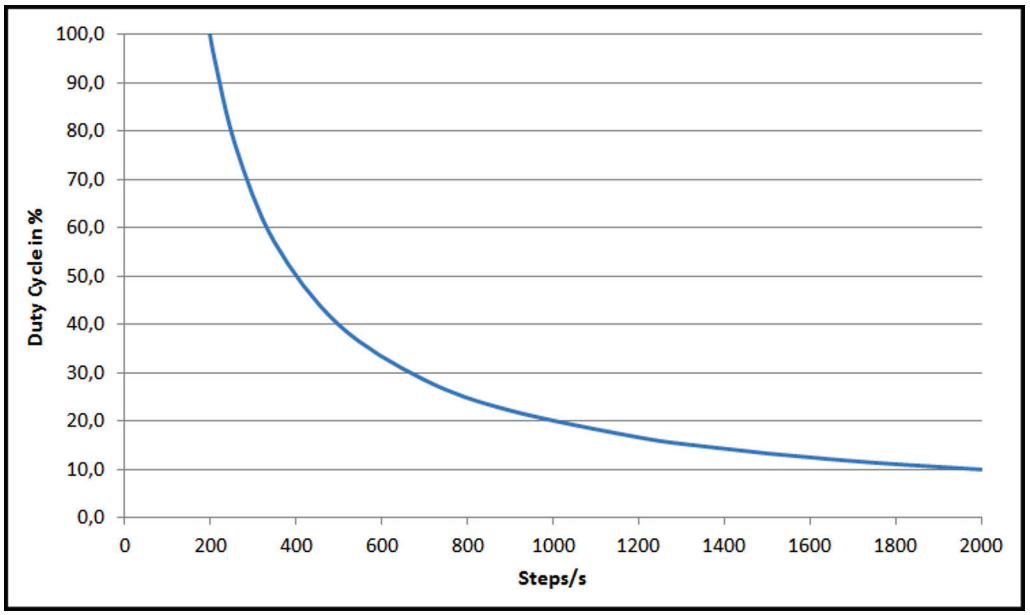

Figure 16: Duty cycle in % vs. steps/s (vacuum versions of the N-472)

10.5 Dimensions

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

10.5.1 Models with Offset 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 offset 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

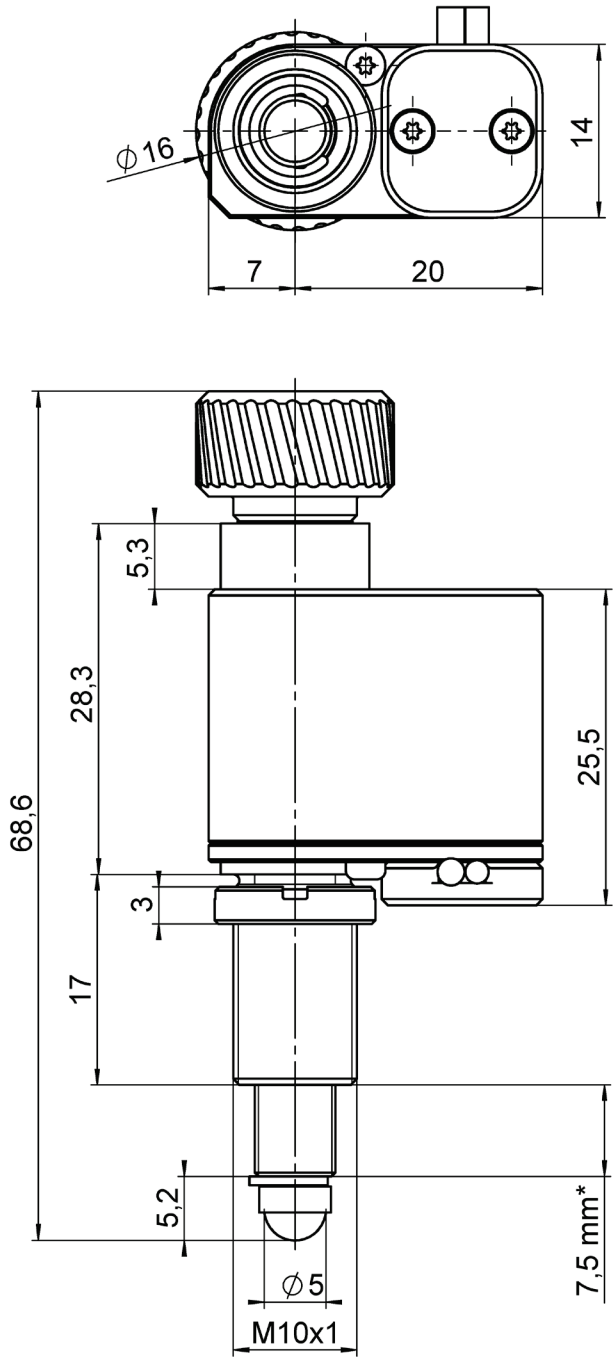

Figure 17: N-472.11x dimensions (* travel range)

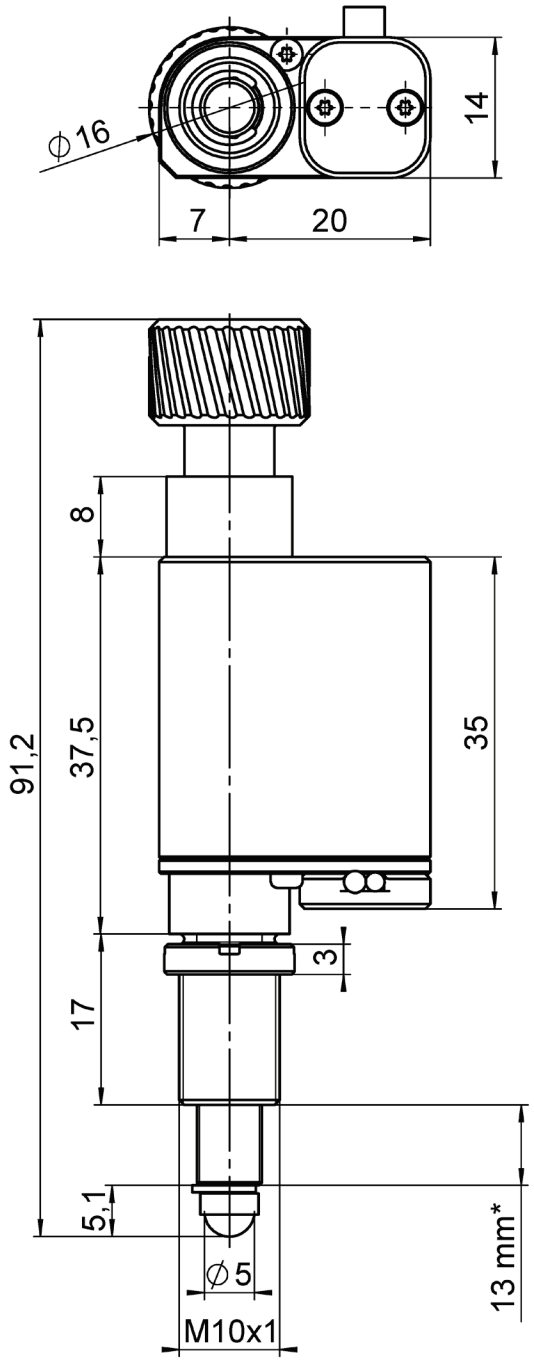

Figure 18: N-472.21x dimensions (* travel range)

10.5.3 Models with Clamping Shank

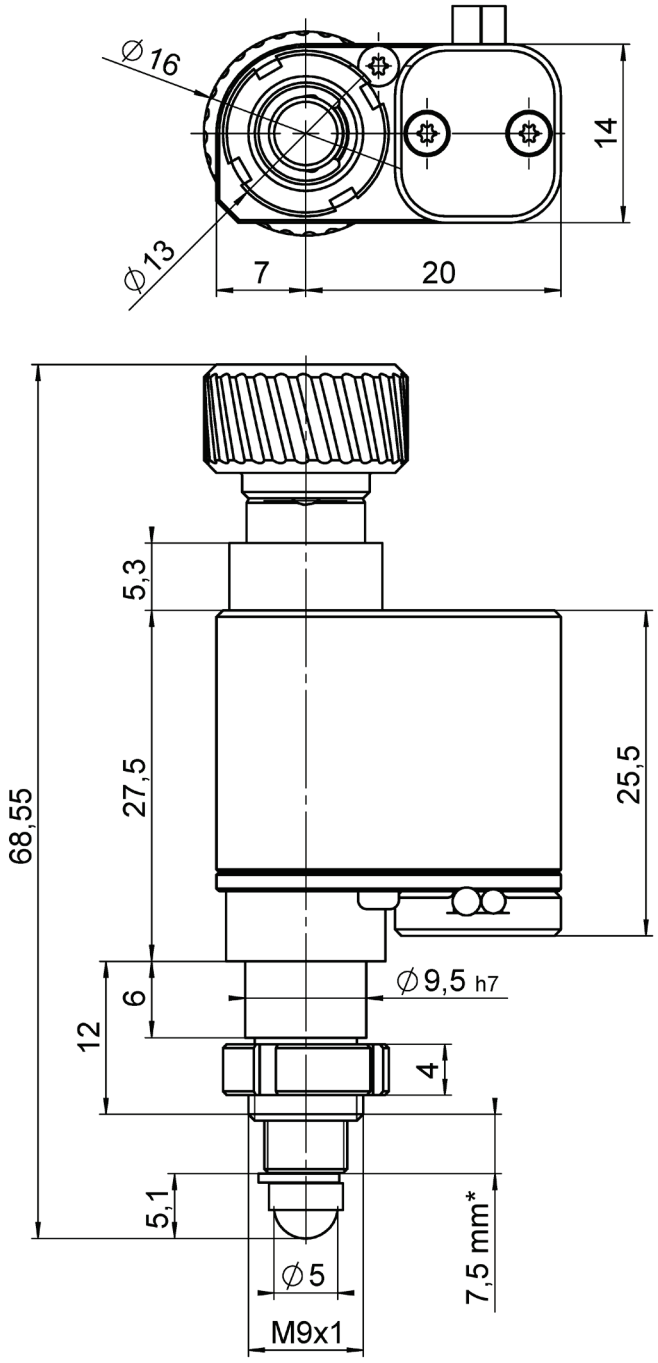

Figure 19: N-472.12x dimensions (* travel range)

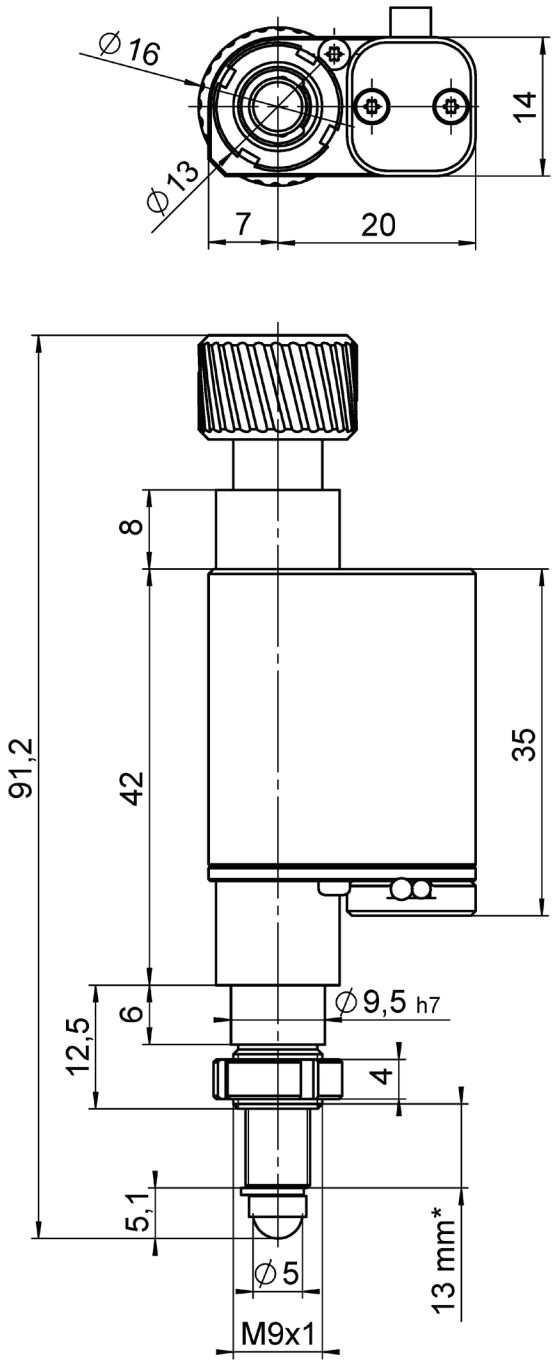

Figure 20: N-472.22x dimensions (* travel range)

10.6 Pin Assignment

Sub-D 15 connector (m)

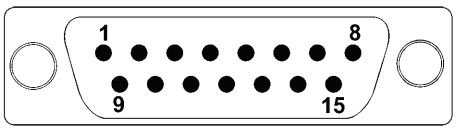

Figure 21: Front view of the Sub-D 15 connector

Pin	Signal	Function	Direction
1	NC	Not connected (reserved for reference point 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 point 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.

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

12 EU Declaration of Conformity

For the N-472, an EU Declaration of Conformity has been issued in accordance with the following European directives:

Low Voltage Directive

EMC Directive

RoHS Directive

The applied standards certifying the conformity are listed below.

Safety (Low Voltage Directive): EN 61010-1

EMC: EN 61326-1

RoHS: EN 50581