

## MP125E N-470 Linear Actuator User Manual

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**This document describes the following products:**

- **N-470.x10/.x10Y, N-470.x1V/.x1VY**  
PiezoMike linear actuator, M10×1 thread
- **N-470.x20/.x20Y, N-470.x2V**  
PiezoMike linear actuator, 9.5 mm (0.375") clamping shank

**Models:**

x stands for the travel range:

1 = 7 mm

2 = 13 mm

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 This manual is superseded by any new release.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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Symbols and Typographic Conventions ..... 1

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### 1.1 Objective and Target Audience of this User Manual

This user manual contains the information needed for using the N-470 as intended.

Basic knowledge of motion control concepts and applicable safety measures is assumed.

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

### 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-872.401 Q-Motion® piezo motor / PiezoMike drive electronics	PZ279 user manual
N-45x / N-47x / N-48x PiezoMike linear actuators	MP171EK short instructions
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-470).
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

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### 2.1 Intended Use

The N-470 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-470 is a linear actuator for integration into mechanical and optomechanical components. For integration, the mechanics, in which the N-470 is to be installed, must have suitable mountings.

A piezoelectric motor is installed in the N-470 linear actuator that acts on the fine-threaded screw and moves it.

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

The N-470 is not intended for continuous operation. Refer to the "Technical Data" (p. 35) for further information on the operating conditions of the N-470.

It is only possible to use the N-470 as intended in conjunction with suitable electronics (p. 13) that provide the required operating voltages. The electronics are not in the scope of delivery of the N-470.

### 2.2 General Safety Instructions

The N-470 is built according to state-of-the-art technology and recognized safety standards. Improper use of the N-470 may result in personal injury and/or damage to the N-470.

- Use the N-470 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-470 correctly.

## 2.2.1 Organizational Measures

### User manual

- Always keep this user manual together with the N-470. 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-470 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-470 only after you have read and understood this user manual.

### Personnel qualification

The N-470 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

### In this Chapter

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### 3.1 Model Overview

The models differ with respect to the following features:

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

These features are coded in the product number by the character after the period as follows:

Character following the period	Meaning	Possible values
First character	Travel range	1 = 7 mm 2 = 13 mm
Second character	Type of installation	1 = M10 thread×1 2 = 9.5 mm clamping shank
Third character	Suitability for use in a vacuum	0 = not suitable V = up to 10 <sup>-6</sup> hPa
Fourth character	Position of the cable exit	No entry = standard cable exit Y = turned cable exit (i.e., turned by 180°)

**PiezoMike linear actuators with M10×1 thread**

Model	Description
N-470.110	PiezoMike linear actuator, 7 mm, M10×1 thread
N-470.110Y	PiezoMike linear actuator, 7 mm, M10×1 thread, turned cable exit
N-470.210	PiezoMike linear actuator, 13 mm, M10×1 thread
N-470.210Y	PiezoMike linear actuator, 13 mm, M10×1 thread, turned cable exit

**PiezoMike linear actuators with M10×1 thread, vacuum-compatible to 10<sup>-6</sup> hPa**

Model	Description
N-470.11V	PiezoMike linear actuator, 7 mm, M10×1 thread, vacuum compatible to 10 <sup>-6</sup> hPa
N-470.11VY	PiezoMike linear actuator, 7 mm, M10×1 thread, vacuum compatible to 10 <sup>-6</sup> hPa, turned cable exit
N-470.21V	PiezoMike linear actuator, 13 mm, M10×1 thread, vacuum compatible to 10 <sup>-6</sup> hPa
N-470.21VY	PiezoMike linear actuator, 13 mm, M10×1 thread, vacuum compatible to 10 <sup>-6</sup> hPa, turned cable exit

**PiezoMike linear actuators with clamping shank**

Model	Description
N-470.120	PiezoMike linear actuator, 7 mm, 9.5 mm (0.375") clamping shank
N-470.120Y	PiezoMike linear actuator, 7 mm, 9.5 mm (0.375") clamping shank, turned cable exit
N-470.220	PiezoMike linear actuator, 13 mm, 9.5 mm (0.375") clamping shank
N-470.220Y	PiezoMike linear actuator, 13 mm, 9.5 mm (0.375") clamping shank, turned cable exit

**PiezoMike linear actuators with clamping shank, vacuum-compatible to 10<sup>-6</sup> hPa**

Model	Description
N-470.12V	PiezoMike linear actuator, 7 mm, 9.5 mm (0.375") clamping shank, vacuum compatible to 10 <sup>-6</sup> hPa
N-470.22V	PiezoMike linear actuator, 13 mm, 9.5 mm (0.375") clamping shank, vacuum compatible to 10 <sup>-6</sup> hPa

## 3.2 Product View

### N-470 models with M10×1 thread

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

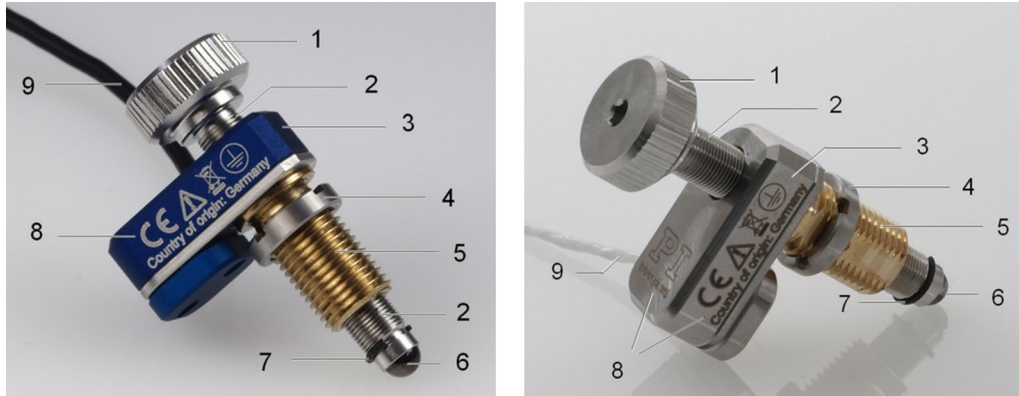


Figure 1: Models with thread and standard cable exit (left: N-470.x10; right: N-470.x1V)

- 1 Screw head
- 2 Fine-threaded screw (rotating)
- 3 Base body
- 4 M10×1 mounting nut
- 5 M10×1 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 electronics

**N-470 models with clamping shank**

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

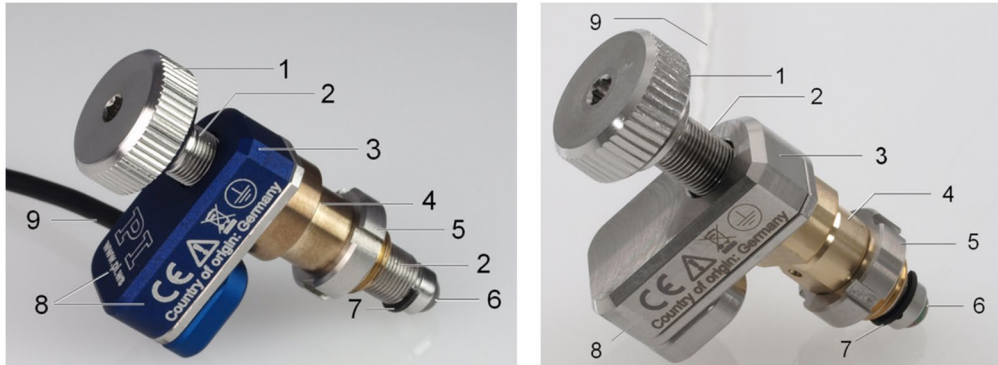


Figure 2: Models with clamping shank and standard cable exit (left: N-470.x20; right: N-470.x2V)

- 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 electronics

**Directions of Motion**

Figure 3: Directions of motion of the N-470

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

### 3.3 Product Labeling









Figure 4: N-470: Product labeling



Figure 5: Type plate (N-470.410 as an 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. 49)
B		Symbol for the protective earth conductor (p. 19)
B	Country of origin: Germany	Country of origin
C	N-470.410	Product number (example), the digits after the period refer to the model
C	123456789	Serial number (example), individual for each N-470 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	Description
N-470	Linear actuator according to order (p. 7)
000049906	Hook wrench
MP171EK	Short instructions for PiezoMike linear actuators
For vacuum-compatible models only:	
K030B1279	LEMO cable, 3-pin to open end, 2 m, on the air side



### 3.5 Suitable Electronics

You need suitable electronics for operating the N-470 (not in the scope of delivery). The following electronics are available:

Product number	Description
E-872.401	Q-Motion® piezomotor / PiezoMike drive electronics, benchtop device, drives up to 4 linear actuators via one amplifier channel, TCP/IP, USB, USB for joystick, digital I/O

- To order, contact our customer service department (p. 33).

### 3.6 Optional Accessories

Product number	Description
N-400.A02	Extension cable, 3-pole LEMO connector to 3-pole LEMO connector, 2 m
N-400.A05	Extension cable, 3-pole LEMO connector to 3-pole LEMO connector, 5 m
N-400.A08	Extension cable, 3-pole LEMO connector to 3-pole LEMO connector, 8 m
N-400.ALM	Adapter, LEMO 3-pole to mini-DIN (for connecting the N-470 to older E-870 drive electronics)
N-400.AML	Adapter, mini-DIN to LEMO 3-pole (for connecting older N-470 to the E-872.401 drive electronics)

- To order, contact our customer service department (p. 33).



## 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-470 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 .....	17
Installing the Linear Actuator into a Mechanical Mounting and Connecting it to the Protective Earth Conductor .....	19
Preparing a Vacuum-Compatible N-470 for Connecting to the Electronics .....	22

### 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-470.
- Install the N-470 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-470 during operation!

The N-470 emits up to 5 watts of heat during operation, which can interfere with your application.

- Install the N-470 so that the application is not impaired by the dissipated 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 damage the electronics.

- Only use the cables provided by PI for connecting the N-470 to the electronics.

**NOTICE****Dirt, condensation, lubricants!**

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

- Keep the N-470 free from dirt and condensation.
- Do **not** remove the lubricant that was applied to the fine-threaded screw of the N-470 at the factory.
- Do **not** lubricate the fine-threaded screw of the N-470.

**NOTICE****Damage from opening the base body!**

Opening the base body destroys the N-470.

- Do **not** open the N-470.

**NOTICE****Damage from unscrewing!**

Completely unscrewing the fine-threaded screw from the base body leads to damage to the N-470.

- Do **not** unscrew the fine-threaded screw from the base body of the N-470.

**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-470 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 in the mechanical mounting (presently: N-470.x10)

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



Figure 8: Models with clamping shank: Relevant components for installation in the mechanical mounting (presently: N-470.x20)

- 1 Clamping shank, diameter: 9.5 mm, clamping width: 6 mm
- 2 M9x1 mounting nut
- 3 Ball tip

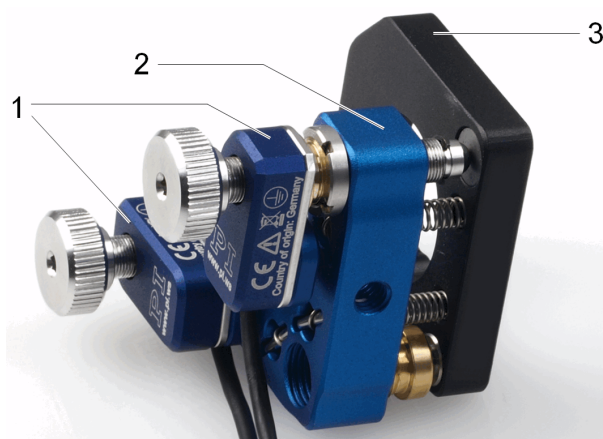


Figure 9: Example of the installation of two N-470.x10s on a mirror mount

- 1 N-470.x10 linear actuators with mounting thread
- 2 Mechanical mounting for linear actuators (fixed part of the mirror holder)
- 3 Mechanical mounting for mirror (movable part of the mirror holder)

### Requirements

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ The N-470 is **not** connected to the electronics.
- ✓ 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-470 must be electrically conductive.



- The contact resistance at all connection points relevant for attaching the protective earth conductor is  $<0.1 \Omega$  at 25 A.
  - The contact surface of the mechanical mounting to the ball tip of the N-470 has a roughness of  $R_a < 0.1 \mu\text{m}$  and a hardness of at least 500 HV.
  - For models with mounting thread: An M10×1 through-hole is 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 according to regulations and without bending them.

### Tools and accessories

- Hook wrench (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-470 with mounting thread

1. Screw the mounting nut of the N-470 as far as necessary in the direction of the base body of the N-470.
2. Optional: Apply a small amount of lubricant to the contact surface of the movable part of the mechanical mounting.
3. Screw the N-470 as far as necessary into the M10×1 through-hole of the mechanical mounting.
4. Align the base body of the N-470 with the mechanical mounting.
5. Fix the N-470 in the mechanical mounting:
  - a) Hold the base body and screw the mounting nut of the N-470 in the direction of the mechanical mounting.
  - b) Hand-tighten the mounting nut with the hook wrench.
6. Check that the linear actuator is fixed firmly in the mounting.
7. 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-470 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-470.
3. Position the N-470 in the mechanical mounting of your application.
4. Manually screw the mounting nut of the N-470 a few turns into the thread of the clamping shank.

5. Align the base body with the mechanical mounting.
6. Clamp the N-470 firmly in the mounting:
  - Hold the base body and hand-tighten the mounting nut of the N-470 with the hook wrench.
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.

### 5.3 Preparing a Vacuum-Compatible N-470 for Connecting to the Electronics

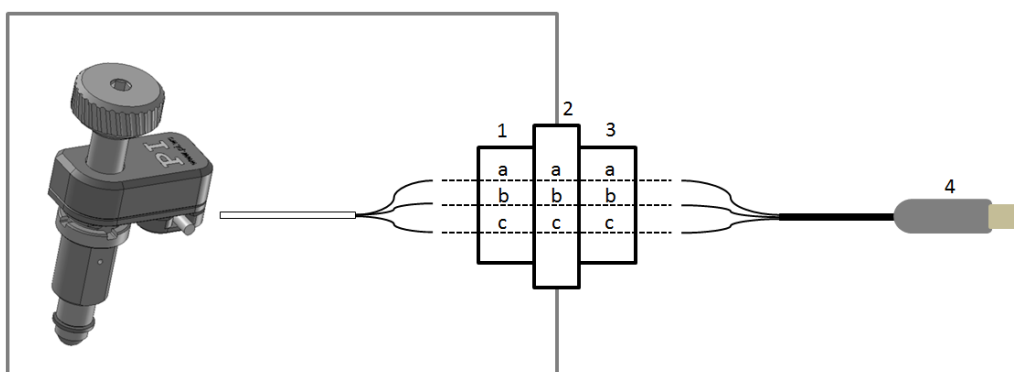


Figure 10: Vacuum-compatible N-470: Connections for the vacuum feedthrough

- 1 Vacuum-side connector for the N-470's cables
- 2 Vacuum feedthrough
- 3 Connector for the K030B1279 air side cable (p. 12)
- 4 LEMO connector, 3-pin, see "Pin Assignment" (p. 47)

#### Assigning the stranded wires and the cable shield

Letter	Wire color		Function	Signal
	Vacuum-side actuator cable	Air-side connecting cable		
a	Red	White	Piezo voltage 0 to 80 V	PIEZO+
b	Black	Brown	Piezo voltage ground	PIEZO-
c	---	---	Bare cable shield	---

**Requirements**

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ The cable on the air side of the N-470 is **not** connected to the electronics.

**Tools and accessories**

- Suitable vacuum feedthrough
- Air side and vacuum side connector (male or female) for vacuum feedthrough
- K030B1279 air side cable (p. 12)
- Suitable tools for wiring the connectors

**Preparing a vacuum-compatible N-470 for connecting to the electronics**

1. Attach the respective connectors for the vacuum feedthrough to the stranded wire ends of the N-470'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 according to the figure above. If the cable shield cannot be connected to a pin, connect the respective cable shield to 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-470 in the event of a malfunction or failure of the system. If there are touch voltages, touching the N-470 can result in serious injury or death from electric shock.

- Connect the N-470 to a protective earth conductor (p. 19) 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-470 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-470.

- Operate the N-470 with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating voltage range (p. 38) specified for the N-470.
- Operate the N-470 only when the operating voltage is properly connected; see "Pin Assignment" (p. 47).

#### **NOTICE**



#### **Operating frequency too high!**

An excessively high operating frequency can damage the N-470.

- Operate the N-470 with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating frequency range (p. 38) specified for the N-470.

**NOTICE****Destruction of the piezo actuator due to electric flashovers!**

Using the N-470 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-470 in environments that can increase the electric conductivity.
- Operate the N-470 only within the permissible ambient conditions and classifications (p. 39).

**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-470.
- Install the N-470 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-470.

- Do **not** unscrew the fine-threaded screw from the base body of the N-470.

**NOTICE****Fine-threaded screw gets stuck!**

The N-470'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-470 after reaching the end of the travel range or command motion away from the end of the travel range.
- If the N-470'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**

Temperature changes lead to a change in the length of the N-470's material. Depending on the application, drift compensation may be required to keep the position stable in the case of larger temperature fluctuations.

Possible compensatory measures are:

- Reducing the transfer of heat by adapting the drive's duty cycle
- Monitoring the temperature with a sensor (air conditioning or cooling)

Reduce the measuring period if the above-mentioned compensatory measures are not possible.

**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-470 is put into operation with suitable electronics (p. 13) from PI.

## 6.2 Operating Parameters

If you use the software from the scope of delivery of the electronics (p. 13), the operating parameters can be loaded from the positioner database. The records in the positioner database are updated regularly.

- Install the PI Update Finder onto your PC and update the positioner database on your PC. You can find the PI Update Finder on the data storage device which is included in the electronics' scope of delivery.

For more information on the positioner database, refer to the user manual for the electronics (p. 13).

## 6.3 Operating the N-470

### Requirements

- ✓ You have read and understood the general notes on starting and operating (p. 25).
- ✓ 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. 17) the N-470 and connected it to the protective earth conductor (p. 19).
- ✓ 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-470

- Follow the instructions for starting and operating the N-470 in the manual for the electronics (p. 13) used.



## **7 Maintenance**

If the N-470 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
Function impairment after system modification	<ul style="list-style-type: none"> <li>▪ The electronics were replaced</li> <li>▪ The mechanics were replaced</li> </ul>	<ul style="list-style-type: none"> <li>➤ Load the parameter set from the positioner database that corresponds to the N-470 model.</li> <li>➤ If necessary: Set the parameters for the electronics in PIMikroMove so that they correspond to the application (load, orientation) of the N-470 model (see user manual for the electronics).</li> </ul>
No or limited motion	<ul style="list-style-type: none"> <li>▪ The cable is not connected correctly or is defective</li> </ul>	<ul style="list-style-type: none"> <li>➤ Check the connecting cable.</li> </ul>
	<ul style="list-style-type: none"> <li>▪ Excessive counterforces in the direction of motion</li> </ul>	<ul style="list-style-type: none"> <li>➤ Reduce the load. Pay attention to the information in the "Technical Data" section (p. 35).</li> </ul>
	<ul style="list-style-type: none"> <li>▪ Operating parameters wrongly set</li> </ul>	<ul style="list-style-type: none"> <li>➤ Check the settings for the operating parameters of the electronics (for details, see the manual for the electronics).</li> </ul>
	<ul style="list-style-type: none"> <li>▪ Motor/drive is blocked</li> </ul>	<ul style="list-style-type: none"> <li>➤ Loosen the fine-threaded screw by turning the screw head backwards and forwards by hand.</li> </ul>

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](mailto: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) (<https://www.pi.ws>).

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### 10.1 Specifications

#### 10.1.1 Data Table

##### Models that are not suitable for use in a vacuum

Motion	N-470.110	N-470.110Y	N-470.120	N-470.120Y	Tolerance
Active axes	X	X	X	X	
Travel range in X	7 mm	7 mm	7 mm	7 mm	
Maximum velocity in X, unloaded	2.4 mm/min	2.4 mm/min	2.4 mm/min	2.4 mm/min	
Typical velocity in X, unloaded	0.5 mm/min	0.5 mm/min	0.5 mm/min	0.5 mm/min	
Drive properties	N-470.110	N-470.110Y	N-470.120	N-470.120Y	Tolerance
Drive type	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	
Maximum power consumption	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	max.
Maximum operating frequency during continuous operation	400 Hz	400 Hz	400 Hz	400 Hz	
Short-term maximum operating frequency	2000 Hz	2000 Hz	2000 Hz	2000 Hz	
Mechanical properties	N-470.110	N-470.110Y	N-470.120	N-470.120Y	Tolerance
Stiffness in X	15 N/μm	15 N/μm	15 N/μm	15 N/μm	±10 %
Permissible push force in Y	1 N	1 N	1 N	1 N	max.
Holding force in X, passive	100 N	100 N	100 N	100 N	min.
Overall mass	80 g	80 g	80 g	80 g	
Material	Screw: Stainless steel. Housing: Aluminum (anodized). Nut: Bronze.	Screw: Stainless steel. Housing: Aluminum (anodized). Nut: Bronze.	Screw: Stainless steel. Housing: Aluminum (anodized). Nut: Bronze.	Screw: Stainless steel. Housing: Aluminum (anodized). Nut: Bronze.	

Mechanical interface	M10×1 mounting thread	M10×1 mounting thread	9.5 mm clamping shank	9.5 mm clamping shank	
<b>Miscellaneous</b>	<b>N-470.110</b>	<b>N-470.110Y</b>	<b>N-470.120</b>	<b>N-470.120Y</b>	<b>Tolerance</b>
Operating temperature range	10 to 40 °C	10 to 40 °C	10 to 40 °C	10 to 40 °C	
Connector	LEMO FFA.0S.303.CLAC 32	LEMO FFA.0S.303.CLAC 32	LEMO FFA.0S.303.CLAC 32	LEMO FFA.0S.303.CLAC 32	
Cable length	2 m	2 m	2 m	2 m	
Recommended controllers / drivers	E-872.401	E-872.401	E-872.401	E-872.401	

<b>Motion</b>	<b>N-470.210</b>	<b>N-470.210Y</b>	<b>N-470.220</b>	<b>N-470.220Y</b>	<b>Tolerance</b>
Active axes	X	X	X	X	
Travel range in X	13 mm	13 mm	13 mm	13 mm	
Maximum velocity in X, unloaded	2.4 mm/min	2.4 mm/min	2.4 mm/min	2.4 mm/min	
Typical velocity in X, unloaded	0.5 mm/min	0.5 mm/min	0.5 mm/min	0.5 mm/min	
<b>Drive properties</b>	<b>N-470.210</b>	<b>N-470.210Y</b>	<b>N-470.220</b>	<b>N-470.220Y</b>	<b>Tolerance</b>
Drive type	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	
Maximum power consumption	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	max.
Maximum operating frequency during continuous operation	400 Hz	400 Hz	400 Hz	400 Hz	
Short-term maximum operating frequency	2000 Hz	2000 Hz	2000 Hz	2000 Hz	
<b>Mechanical properties</b>	<b>N-470.210</b>	<b>N-470.210Y</b>	<b>N-470.220</b>	<b>N-470.220Y</b>	<b>Tolerance</b>
Stiffness in X	15 N/μm	15 N/μm	15 N/μm	15 N/μm	±10 %
Permissible push force in Y	1 N	1 N	1 N	1 N	max.
Holding force in X, passive	100 N	100 N	100 N	100 N	min.
Overall mass	80 g	80 g	80 g	80 g	
Material	Screw: Stainless steel. Housing: Aluminum (anodized). Nut: Bronze.	Screw: Stainless steel. Housing: Aluminum (anodized). Nut: Bronze.	Screw: Stainless steel. Housing: Aluminum (anodized). Nut: Bronze.	Screw: Stainless steel. Housing: Aluminum (anodized). Nut: Bronze.	
Mechanical interface	M10×1 mounting thread	M10×1 mounting thread	9.5 mm clamping shank	9.5 mm clamping shank	
<b>Miscellaneous</b>	<b>N-470.210</b>	<b>N-470.210Y</b>	<b>N-470.220</b>	<b>N-470.220Y</b>	<b>Tolerance</b>
Operating temperature range	10 to 40 °C	10 to 40 °C	10 to 40 °C	10 to 40 °C	
Connector	LEMO FFA.0S.303.CLAC 32	LEMO FFA.0S.303.CLAC 32	LEMO FFA.0S.303.CLAC 32	LEMO FFA.0S.303.CLAC 32	
Cable length	2 m	2 m	2 m	2 m	
Recommended controllers / drivers	E-872.401	E-872.401	E-872.401	E-872.401	

Maximum velocity in X, unloaded: Not suitable for continuous operation (refer to "Operating Time and Duty Cycle" (p. 42)).

Ask about customized versions.



## Vacuum-compatible models

<b>Motion</b>	<b>N-470.11V</b>	<b>N-470.11VY</b>	<b>N-470.12V</b>	<b>N-470.21V</b>	<b>N-470.21VY</b>	<b>N-470.22V</b>	<b>Tolerance</b>
Active axes	X	X	X	X	X	X	
Travel range in X	7 mm	7 mm	7 mm	13 mm	13 mm	13 mm	
Maximum velocity in X, unloaded	2.4 mm/min	2.4 mm/min	2.4 mm/min	2.4 mm/min	2.4 mm/min	2.4 mm/min	
Typical velocity in X, unloaded	0.5 mm/min	0.5 mm/min	0.5 mm/min	0.5 mm/min	0.5 mm/min	0.5 mm/min	
<b>Positioning</b>	<b>N-470.11V</b>	<b>N-470.11VY</b>	<b>N-470.12V</b>	<b>N-470.21V</b>	<b>N-470.21VY</b>	<b>N-470.22V</b>	<b>Tolerance</b>
Incremental motion in partial-step mode	20 nm	20 nm	20 nm	20 nm	20 nm	20 nm	
Step size in full step mode	50 nm	50 nm	50 nm	50 nm	50 nm	50 nm	
<b>Drive properties</b>	<b>N-470.11V</b>	<b>N-470.11VY</b>	<b>N-470.12V</b>	<b>N-470.21V</b>	<b>N-470.21VY</b>	<b>N-470.22V</b>	<b>Tolerance</b>
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	200 Hz	200 Hz	200 Hz	200 Hz	200 Hz	200 Hz	
Short-term maximum operating frequency	2000 Hz	2000 Hz	2000 Hz	2000 Hz	2000 Hz	2000 Hz	
<b>Mechanical properties</b>	<b>N-470.11V</b>	<b>N-470.11VY</b>	<b>N-470.12V</b>	<b>N-470.21V</b>	<b>N-470.21VY</b>	<b>N-470.22V</b>	<b>Tolerance</b>
Stiffness in X	15 N/μm	15 N/μm	15 N/μm	15 N/μm	15 N/μm	15 N/μm	±10 %
Permissible push force in Y	1 N	1 N	1 N	1 N	1 N	1 N	max.
Holding force in X, passive	100 N	100 N	100 N	100 N	100 N	100 N	min.
Overall mass	80 g	80 g	80 g	85 g	85 g	85 g	
Material	Screw: Stainless steel. Housing: Stainless steel.	Screw: Stainless steel. Housing: Stainless steel.	Screw: Stainless steel. Housing: Stainless steel.	Screw: Stainless steel. Housing: Stainless steel.	Screw: Stainless steel. Housing: Stainless steel.	Screw: Stainless steel. Housing: Stainless steel.	
Mechanical interface	M10×1 mounting thread	M10×1 mounting thread	9.5 mm clamping shank	M10×1 mounting thread	M10×1 mounting thread	9.5 mm clamping shank	
<b>Miscellaneous</b>	<b>N-470.11V</b>	<b>N-470.11VY</b>	<b>N-470.12V</b>	<b>N-470.21V</b>	<b>N-470.21VY</b>	<b>N-470.22V</b>	<b>Tolerance</b>
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	
Vacuum class	10 <sup>-6</sup> hPa	10 <sup>-6</sup> hPa	10 <sup>-6</sup> hPa	10 <sup>-6</sup> hPa	10 <sup>-6</sup> hPa	10 <sup>-6</sup> hPa	
Connector	Bare wire strands	Bare wire strands	Bare wire strands	Bare wire strands	Bare wire strands	Bare wire strands	
Cable length	1 m	1 m	1 m	1 m	1 m	1 m	
Recommended controllers / drivers	E-872.401	E-872.401	E-872.401	E-872.401	E-872.401	E-872.401	

Maximum velocity in X, unloaded: Not suitable for continuous operation (refer to "Operating Time and Duty Cycle" (p. 42)).

Cable length / connector: 1 m connecting cable from the actuator, cable end with bare wire strands; 2 m separate connecting cable, bare wire strands to 3-pole LEMO connector.

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-470:

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-470 linear actuators are designed for the following operating data:

Model	Maximum operating voltage 	Maximum operating frequency during continuous operation* 	Maximum power consumption 
N-470.xx0 N-470.xx0Y	80 V (peak-to-peak)	400 Hz	5 W
N-470.xxV N-470.xxVY	80 V (peak-to-peak)	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

Pay attention to the following ambient conditions and classifications for the N-470:

Area of application	For indoor use only
Maximum altitude	2000 m
Air pressure	Models not suitable for use in a vacuum: 1100 hPa to 0.1 hPa
	Models N-470.xxV, .xxVY: 1100 hPa to 10 <sup>-6</sup> 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
Maximum bakeout temperature for N-470.xxV, .xxVY models	120 °C, for 12 hours, only in <b>switched-off</b> state
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-470 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").

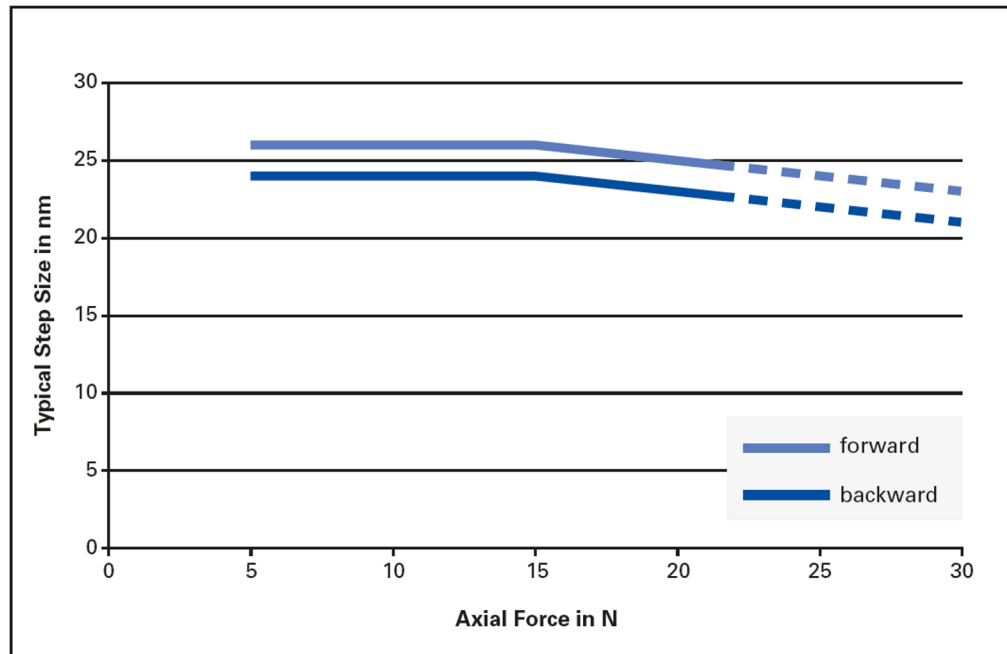


Figure 11: Typical step size in nm vs. axial force in N

### 10.3 Lifetime

The following graph shows the decrease in the step size over the lifetime of the N-470. The lifetime of the N-470 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 %.

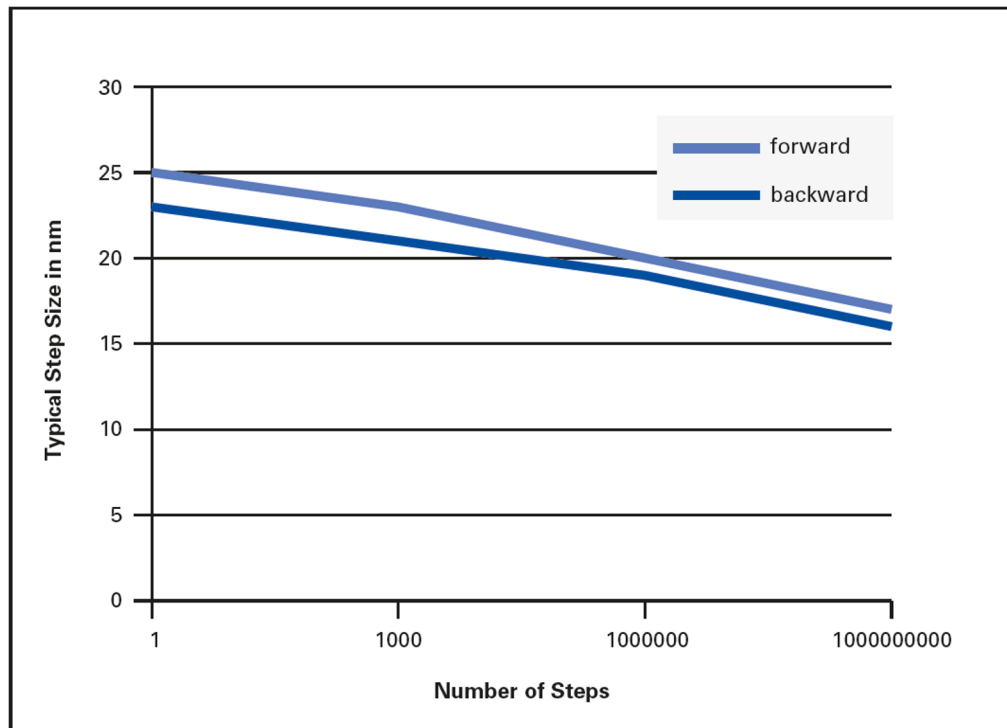


Figure 12: Typical step size in nm vs. number of steps

## 10.4 Operating Time and Duty Cycle

The operating time and duty cycle influence the lifetime of the N-470. 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

\* To be set via the **Maximum Motor Output** operating parameter (0x9) for the E-872.401 respectively **PIShift Steps per Second** for the E-870.

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

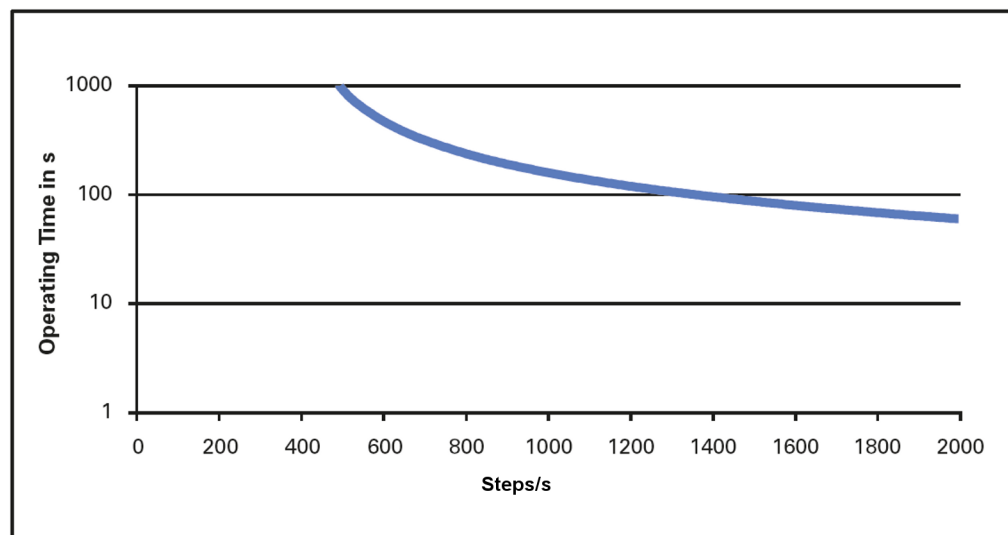


Figure 13: Operating time in s vs. steps/s

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

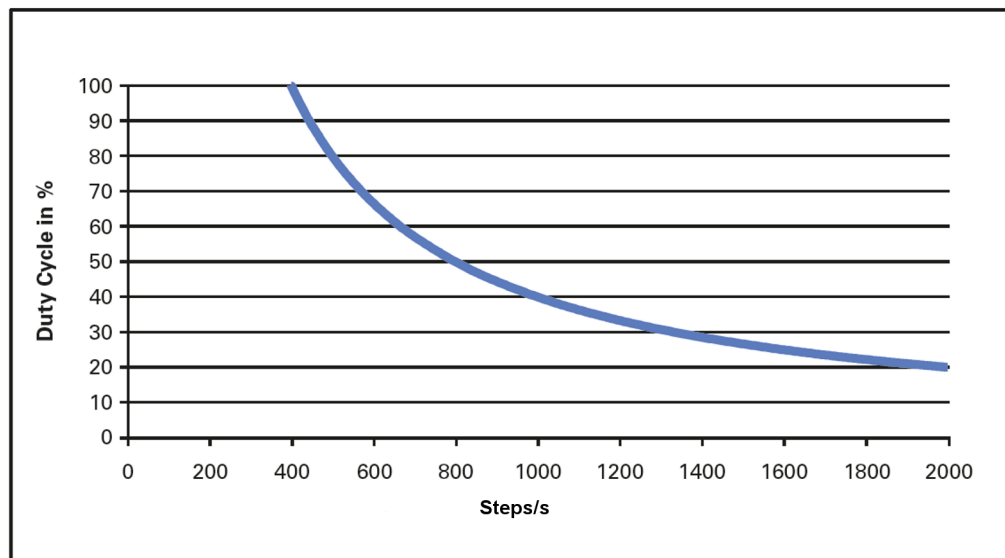


Figure 14: Duty cycle in % vs. steps/s

#### 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

\* To be set via the **Maximum Motor Output** operating parameter (0x9) for the E-872.401 respectively **PIShift Steps per Second** for the E-870.

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

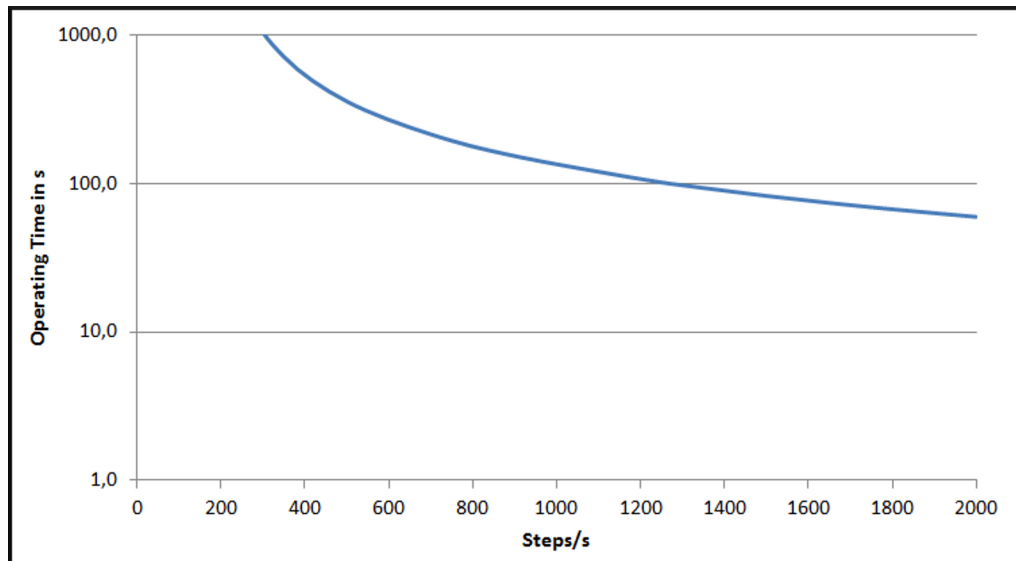


Figure 15: Operating time in s vs. steps/s (vacuum versions of the N-470)

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

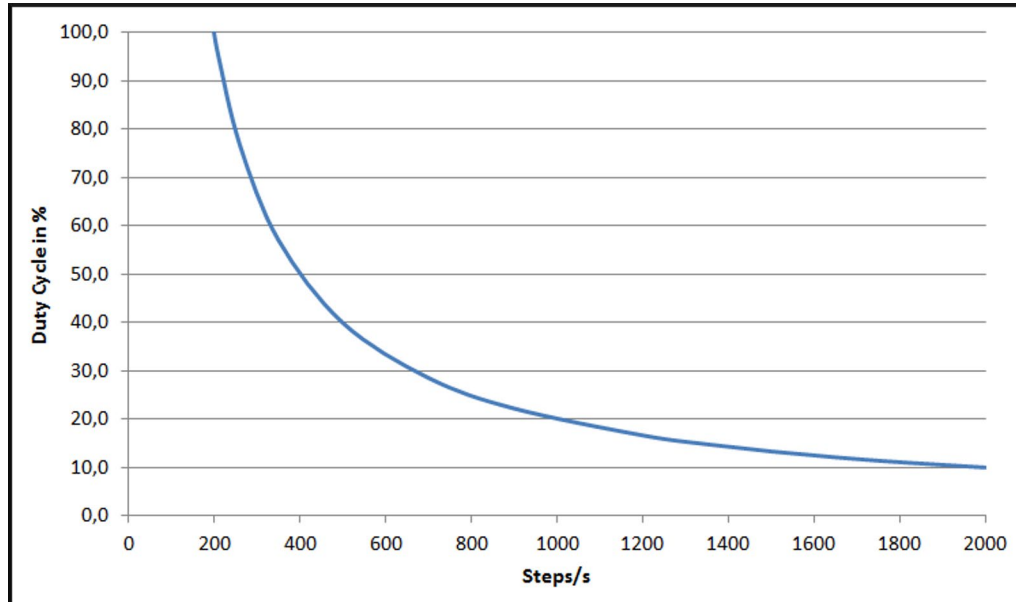


Figure 16: Duty cycle in % vs. steps/s (vacuum versions of the N-470)



## 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-470.xxx models with standard cable exit, but also apply to the N-470.xxxY models with turned cable exit.

- Take note: In the case of the N-470.xxxY models, the cable exit is located exactly opposite to the position shown in the dimensional drawings.

### 10.5.2 Models with M10×1 Thread

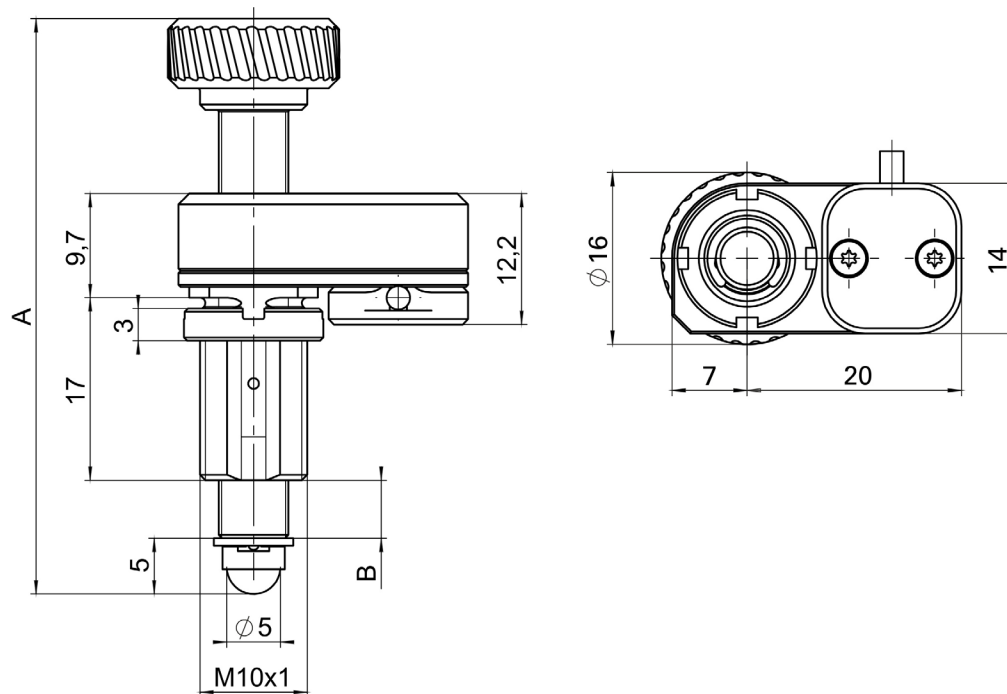


Figure 17: Dimensions N-470.x1x

	N-470.11x N-470.11xY	N-470.21x N-470.21xY	Unit
A	48	53.5	mm
B (travel range)	7	13	mm

### 10.5.3 Models with Clamping Shank

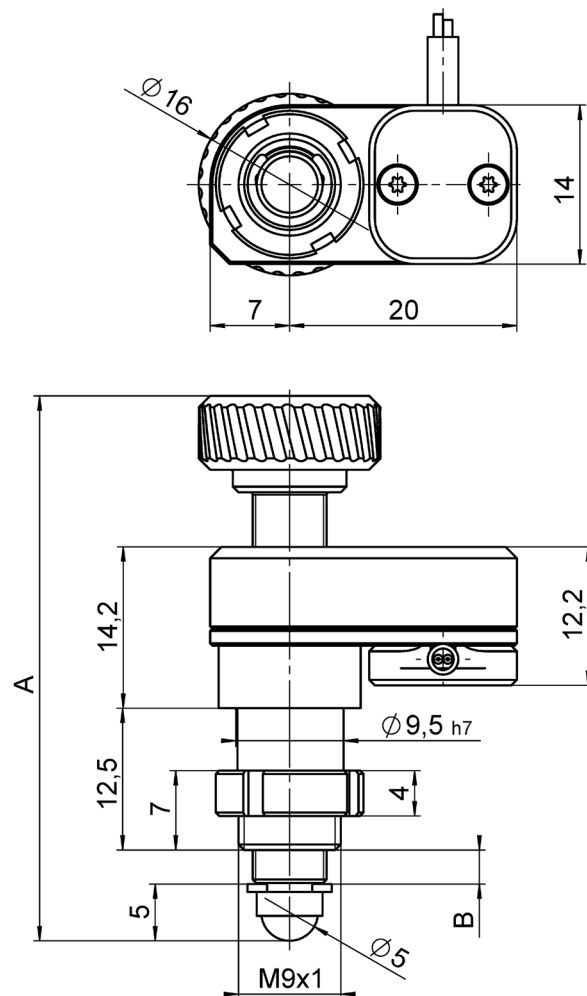


Figure 18: Dimensions N-470.x2x

	N-470.12x N-470.12xY	N-470.22x N-470.22xY	Unit
A	48	53.5	mm
B (travel range)	7	13	mm

## 10.6 Pin Assignment

A LEMO connector is used for connecting to the drive electronics:

- Models that are not suitable for use in a vacuum: The connector is located directly on the cable of the N-470.
- Vacuum-compatible models: The connector is on the air-side cable (p. 12). The ends of the cable on the vacuum and air side of the N-470 have stranded wires for connecting to a vacuum feedthrough (p. 22).

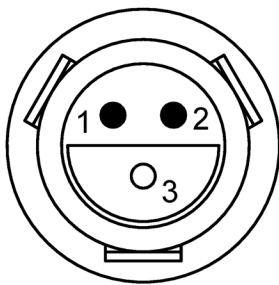


Figure 19: LEMO connector, 3-pole

Pin	Function	Wire colors for vacuum-compatible models	
		Cable on the vacuum side	Cable on the air side
1	Input: Piezo + (0 to 80 V)	Red	White
2	Input: Piezo - (GND)	Black	Brown
3	Not connected	---	---
Cable shield	Connected to the connector shell	Bare	Bare



## 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-470, 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

