



User Manual

N-470 Linear Actuator

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 up to 10^{-6} hPa

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1 About this document

1.1 Objective and target group of this user manual

This user manual contains the information necessary for using the N-470 as intended.
Basic knowledge of motion control concepts and applicable safety measures is assumed.

1.2 Symbols and typographic conventions

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

DANGER



Immediate threat of danger
Failure to comply can result in death or serious injuries.
➤ Precautions to avoid the risk.

NOTICE



Dangerous situation
Failure to comply can result in damage to the equipment.
➤ Precautions to avoid the risk.

Information

Information for easier handling, tricks, tips, etc.

| Symbol / Label | Meaning |
|----------------|--|
| 1. | Action consisting of several steps with strict sequential order |
| 2. | |
| ➤ | Action consisting of one or more steps without relevant sequential order |
| – | Enumeration |
| ⚠ | Warning sign on the product which refers to detailed information in this manual. |

1.3 Figures

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

1.4 Other applicable documents

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

| Product | Document |
|---|----------------------------|
| E-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 |

2 Downloading manuals

Information

If a manual is missing or problems occur while downloading:

- Contact our [customer service](#) (p. 42).

Downloading manuals

1. Open the website www.pi.ws.
2. Search for the product number (e.g., N-470) on the website.
3. Select the corresponding product to open the product page.
4. Select the **Downloads** tab.
 - The manuals are shown under **Documentation**. Software manuals are shown under **General Software Documentation**.
5. For the desired manual, select **ADD TO LIST** and then **REQUEST**.
6. Fill out the request form and select **SEND REQUEST**.
 - The download link will then be sent to the email address entered.

3 Safety

3.1 Intended use

The N-470 is a laboratory device according to DIN EN 61010-1. It is intended for indoor use and use in an environment free from dirt, oil, and lubricants.

The N-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. This motor acts on the fine-threaded screw and moves it.

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

The N-470 is not intended for continuous operation. Refer to [Specifications \(p. 31\)](#) for further information on the operating conditions of the N-470.

The N-470 can only be used as intended in conjunction with [suitable electronics \(p. 15\)](#) that provide the required operating voltages. The electronics are not in the scope of delivery of the N-470.

3.2 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 can result in personal injury and/or damage to the N-470.

- Use the N-470 only for its intended purpose and when it is in perfect technical condition.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for installing and operating the N-470 correctly.

3.2.1 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 \(p. 7\)](#) from our website.
- Add all information from the manufacturer, such as supplements or technical notes, to the user manual.
- If you pass on the N-470 to a third party, include this user manual as well as other relevant information provided by the manufacturer.

- Only use the device on the basis of the complete user manual. Missing information due to an incomplete user manual can lead to serious or fatal injuries as well as damage to equipment.
- Install and operate the N-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.

3.2.2 Measures for handling vacuum-compatible products

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

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

4 Product description

4.1 Model overview

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 = thread M10×1 2 = 9.5 mm clamping shank |
| Third character | Suitability for use in a vacuum | 0 = not suitable V = up to 10^{-6} hPa |
| Fourth character | Position of the cable exit | No entry = standard cable exit Y = turned cable exit (i.e., rotated 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 up to 10^{-6} hPa

| Model | Description |
|-----------|--|
| N-470.11V | PiezoMike linear actuator, 7 mm, M10×1 thread, vacuum compatible up to 10^{-6} hPa |

| Model | Description |
|------------|--|
| N-470.11VY | PiezoMike linear actuator, 7 mm, M10×1 thread, vacuum compatible up to 10^{-6} hPa, turned cable exit |
| N-470.21V | PiezoMike linear actuator, 13 mm, M10×1 thread, vacuum compatible up to 10^{-6} hPa |
| N-470.21VY | PiezoMike linear actuator, 13 mm, M10×1 thread, vacuum compatible up to 10^{-6} hPa, turned cable exit |

PiezoMike linear actuators with clamping shaft

| Model | Description |
|------------|---|
| N-470.120 | PiezoMike linear actuator, 7 mm, 9.5 mm (0.375") clamping shaft |
| 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 up to 10^{-6} hPa

| Model | Description |
|-----------|---|
| N-470.12V | PiezoMike linear actuator, 7 mm, 9.5 mm (0.375") clamping shank, vacuum compatible up to 10^{-6} hPa |
| N-470.22V | PiezoMike linear actuator, 13 mm, 9.5 mm (0.375") clamping shank, vacuum compatible up to 10^{-6} hPa |

4.2 Product view

Models with M10×1 thread

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

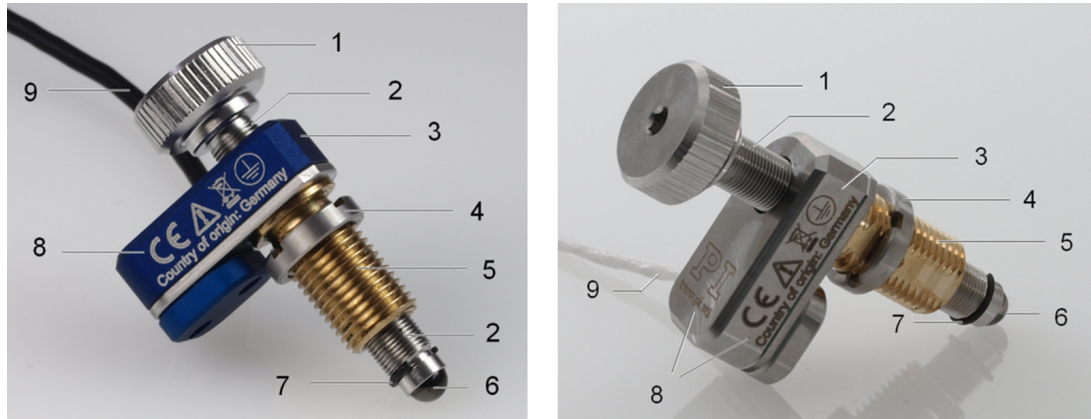


Fig. 1: Models with thread and standard cable exit (example illustration)

On left: Version suitable for atmospheric conditions

On right: Vacuum version

- 1 Screw head
- 2 Fine-threaded screw (rotating)
- 3 Base body
- 4 Mounting nut M10×1
- 5 Mounting thread M10×1
- 6 Ball tip for connecting to the moving part of the mounting
- 7 Unscrew lock (circlip) for fine-threaded screw
- 8 Product labeling
- 9 Cable for connecting to electronics

Models with clamping shank

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

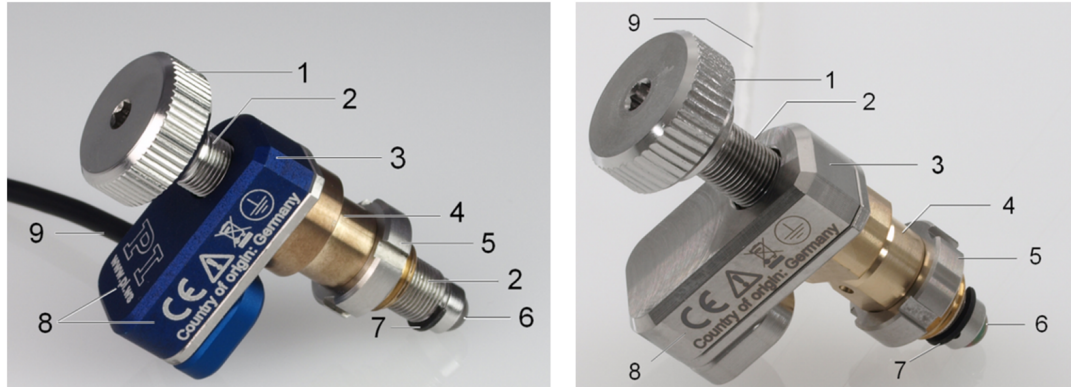


Fig. 2: Models with clamping shank and standard cable exit (example illustration)

On left: Version suitable for atmospheric conditions

On right: Vacuum version

- 1 Screw head
- 2 Fine-threaded screw (rotating)
- 3 Base body
- 4 Clamping shaft (diameter 9.5 mm, clamping width 6 mm)
- 5 Mounting nut M9×1
- 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 electronics

Directions of motion



Fig. 3: Directions of motion of the linear actuator

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

4.3 Product labeling



Fig. 4: N-470: Product labeling








Fig. 5: Type plate (N-470.410 as an example)



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

| Position | Label | Description |
|----------|---|----------------------------------|
| A |  | Manufacturer's logo |
| A | WWW.PI.WS | Manufacturer's address (website) |

| Position | Label | Description |
|--|---|--|
| B |  | CE conformity mark |
| B |  | Warning sign "Pay attention to the manual!" |
| B |  | Old equipment disposal (p. 43) |
| B |  | Protective earth conductor symbol (p. 20) |
| 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 digit (from the left): 1 = internal information, 2 and 3 = year of manufacture, 4 to 9 = consecutive number |
| For models only 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) |

4.4 Scope of delivery

| Product number | Description |
|------------------------------------|--|
| N-470 | Linear actuator according to order (p. 10) |
| 000049906 | Hook wrench |
| MP171EK | Short instructions for PiezoMike linear actuators |
| For vacuum-compatible models only: | |
| K030B1279 | Cable 3-pole LEMO connector to open end, 2 m, air side |

4.5 Suitable electronics

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

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

➤ To order, contact our [customer service \(p. 42\)](#).

4.6 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, 3-pole LEMO to mini-DIN (for connecting the N-470 to older E-870 drive electronics) |
| N-400.AML | Adapter, mini-DIN to 3-pole LEMO (for connecting older N-470s to the E-872.401 drive electronics) |

➤ To order, contact our [customer service](#) (p. 42).

5 Unpacking

Information

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

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

1. Unpack the N-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 \(p. 42\)](#) immediately.
4. Keep all packaging materials in case the product needs to be returned.

6 Installation

6.1 General notes on installation

NOTICE

**Friction due to lateral forces!**

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

- Avoid lateral forces on the fine-threaded screw and on the ball tip of the N-470.
- Install the N-470 so that the fine-threaded screw is aligned vertically to the contact surface of the movable part on the mechanical mounting.

NOTICE

**Increased wear due to friction!**

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

- Make sure that the contact surface of the mechanical mounting has a roughness of $R_a < 0.1 \mu\text{m}$ 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!**

During operation, the N-470 emits up to 5 Watts of heat that can affect your application.

- Install the N-470 so that your application is not impaired by dissipating heat.
- Ensure sufficient ventilation at the place of application.
- Pay attention to the operating conditions (duty cycle, ambient temperature) according to the data in [Specifications \(p. 31\)](#).

NOTICE**Damage from unsuitable cables!**

Unsuitable cables can damage the electronics.

- Use cables from PI only 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 of dirt and condensation.
- Do not remove the lubricant that was applied to the fine-threaded screw of the N-470 by the manufacturer.
- 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 causes 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 failure of the linear actuator.

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

NOTICE**Damage from overtightening the mounting nut!**

Overtightening the mounting nut can damage the linear actuator.

- Hand-tighten the mounting nut.

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

Information

The N-470 is connected to the protective earth conductor via a mounting nut, thread, or clamping shank fixed to a sufficiently conductive mechanical mounting. The mechanical mounting must be connected to the protective earth conductor.

Information

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

Information

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



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

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



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

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

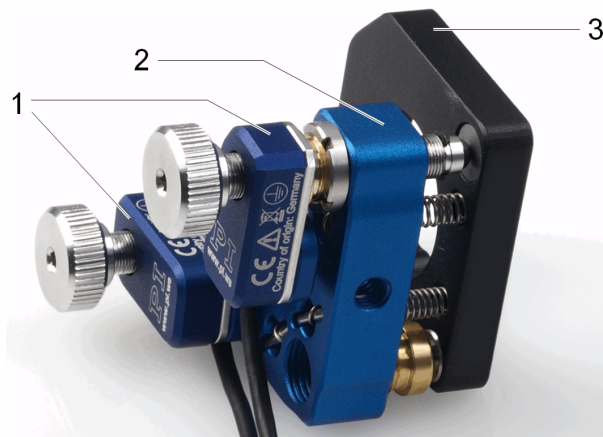


Fig. 9: Two linear actuators installed in a kinematic mirror mount (example illustration)

- 1 Linear actuators with mounting thread
- 2 Mechanical mounting for linear actuators (stationary part of the kinematic mirror mount)
- 3 Mechanical mounting for mirror (moving part of the kinematic mirror mount)

Requirements

- You have read and understood the [general notes on installation \(p. 18\)](#).
- The N-470 is not connected to the electronics.
- You have provided a suitable mechanical mounting that fulfills the following requirements:
 - For models with mounting thread: There is an M10×1 through-hole in the mechanical mounting. For more details, refer to [Dimensions \(p. 39\)](#).
 - For models with clamping shank: There is a through-hole with a suitable diameter in the mechanical mounting. For more details, refer to [Dimensions \(p. 39\)](#).
 - The mechanical mounting including its contact surface to the mounting nut, thread, or clamping shank of the N-470 is electrically conductive.

- The mechanical mounting is connected to a suitable protective earth conductor: Cable cross-section $\geq 0.75 \text{ mm}^2$.
- The contact surface of the mechanical mounting to the ball tip of the N-470 has a roughness of $R_a < 0.1 \text{ }\mu\text{m}$ and at least a hardness of 500 HV.
- You have accounted for the space required to route cables according to regulations and without bending them.

Tools and accessories

- [Hook wrench \(p. 15\)](#)

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

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

Installing a model with mounting thread

1. Screw the mounting nut of the N-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. Make sure that the contact resistance is $< 0.1 \text{ }\Omega$ at 25 A at all points relevant for attaching the protective earth conductor.
7. Check that the linear actuator is fixed firmly in the mounting.
8. Optional: Turn the screw head of the linear actuator's fine-threaded screw into the desired position by hand to avoid longer travel to this position.

Installing model with clamping shank

1. Optional: Apply a small amount of lubricant to the contact surface of the movable part of the mechanical mounting.
2. Remove the mounting nut from the clamping shank of the N-470.
3. Position the N-470 in the mechanical mounting of your application.

4. Turn the mounting nut of the N-470 a few times by hand onto the thread of the clamping shank.
5. Align the base body with the mechanical mounting.
6. Clamp the N-470 firmly in the mounting:
 - Hold the base body and at the same time hand-tighten the mounting nut of the N-470 with the hook wrench.
7. Make sure that the contact resistance is $< 0.1 \Omega$ at 25 A at all points relevant for attaching the protective earth conductor.
8. Check that the linear actuator is fixed firmly in the mounting.
9. Optional: Turn the screw head of the linear actuator's fine-threaded screw into the desired position by hand to avoid longer travel to this position.

6.3 Preparing a vacuum-compatible linear actuator for connecting to the electronics

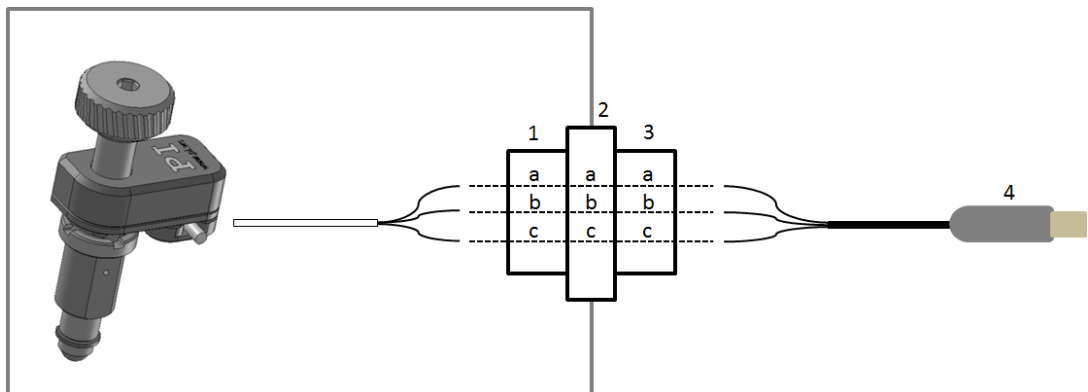


Fig. 10: Vacuum-compatible N-470: Connectors for the vacuum feedthrough

- 1 Vacuum-side connector for cables of the N-470
- 2 Vacuum feedthrough
- 3 Connector for [air-side K030B1279 cable](#) (p. 15)
- 4 LEMO connector, 3-pole, see [Pin assignment](#) (p. 38)

Assignment of 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 \(p. 18\)](#).
- The air-side cable 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 \(p. 15\)](#)
- 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 bare wire strands 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.

7 Starting and operating

7.1 General notes on starting and operating

DANGER



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

If the protective earth conductor is not connected or is not connected properly, hazardous touch voltages can occur on the N-470 during system malfunction or failure. If there are touch voltages, touching the N-470 can lead to serious injury or death by electric shock.

- Connect the N-470 to a [protective earth conductor \(p. 20\)](#) before startup.
- Do not remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e.g., for modifications), reconnect the N-470 to the protective earth conductor before restarting.

NOTICE



Operating voltage excessively high or incorrectly connected!

Excessively high or incorrectly connected operating voltages can cause damage to the N-470.

- Operate the N-470 only with controllers/drivers and original accessories from PI.
- Do not exceed the [operating voltage range \(p. 34\)](#) specified for the N-470.
- Operate the N-470 only when the operating voltage is properly connected; see [Pin assignment \(p. 38\)](#).

NOTICE



Operating frequency too high!

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

- Operate the N-470 only with controllers/drivers and original accessories from PI.
- Do not exceed the [operating frequency range \(p. 34\)](#) specified for the N-470.

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

- Avoid operating the N-470 in environments that can increase the electrical conductivity.
- Operate the N-470 only under permissible [ambient conditions and classifications](#) (p. 34).

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 on the mechanical mounting.

NOTICE**Increased wear due to friction!**

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

- Make sure that the contact surface of the mechanical mounting has a roughness of $R_a < 0.1 \mu\text{m}$ 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 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 fine-threaded screw of the N-470 may get stuck at the physical end of the travel range (hard stop or circlip). Getting stuck can reduce the lifetime of the linear actuator.

- Stop the N-470 after reaching the end of the travel range or command motion away from the end of the travel range.
- If the fine-threaded screw of the N-470 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 material of the N-470. Depending on the application, drift compensation may be required to keep the position stable in the case of larger temperature fluctuations.

Possible compensatory measures include:

- Reducing the transfer of heat by adapting the duty cycle of the drive
- 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 emission depends on the current step frequency.

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

The N-470 is put into operation with [suitable electronics \(p. 15\)](#) from PI.

7.2 Operating parameters

When using the software included in the scope of delivery of the [electronics \(p. 15\)](#), the operating parameters can be loaded from the positioner database. The entries in the positioner database are updated regularly.

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

For more information on the positioner database, refer to the user manual for the [electronics \(p. 15\)](#).

7.3 Operating the linear actuator

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 \(p. 18\)](#) the N-470 and connected it to the [protective earth conductor \(p. 20\)](#).
- 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 on starting and operating the N-470 in the user manual for the [electronics \(p. 15\)](#).

8 Maintenance

If the N-470 is operated in a clean environment, no maintenance work is necessary.

- If you would like your device to be serviced, please contact our [customer service \(p. 42\)](#).

9 Troubleshooting

| Malfunction | Possible causes | Solution |
|--|--|---|
| Functional impairment after system modifications | The electronics were replaced | ➤ Load the parameter set from the positioner database corresponding to the N-470 model. |
| | The mechanics were replaced | ➤ If necessary: In the PIMikroMove® program for PCs, set the parameters for the electronics so that they correspond to the application (load, alignment) of the N-470 model (refer to the user manual for the electronics). |
| No or limited motion | The cable is not connected correctly or is defective | ➤ Check the connecting cable. |
| | Excessive counterforces in the direction of motion | ➤ Reduce the load. Pay attention to the information in the Technical data (p. 31) section. |
| | Operating parameters incorrectly set | ➤ Check the settings for the operating parameters on the electronics (for details, refer to the manual for the electronics used). |
| | Motor/drive is blocked | ➤ Loosen the fine-threaded screw by turning the screw head backwards and forwards by hand. |

- If the problem with your system is not listed in the table above or cannot be solved as described, contact our [customer service \(p. 42\)](#).

10 Specifications

10.1 Technical data

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

10.1.1 Models that are not suitable for use in a vacuum

| Motion | Unit | | N-470.110 | N-470.110Y | N-470.120 | N-470.120Y | N-470.210 | N-470.210Y | N-470.220 | N-470.220Y |
|---------------------------------|--------|--|-----------|------------|-----------|------------|-----------|------------|-----------|------------|
| Active axes | | | X | X | X | X | X | X | X | X |
| Travel range in X | mm | | 7 | 7 | 7 | 7 | 13 | 13 | 13 | 13 |
| Maximum velocity in X, unloaded | mm/min | | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 |

| Positioning | Unit | | N-470.110 | N-470.110Y | N-470.120 | N-470.120Y | N-470.210 | N-470.210Y | N-470.220 | N-470.220Y |
|---|------|--|-----------|------------|-----------|------------|-----------|------------|-----------|------------|
| Incremental motion in partial-step mode | nm | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Step size in full step mode | nm | | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |

| Drive Properties | Unit | Tolerance | N-470.110 | N-470.110Y | N-470.120 | N-470.120Y | N-470.210 | N-470.210Y | N-470.220 | N-470.220Y |
|---|------|-----------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Drive type | | | Piezoelectric inertia drive | Piezoelectric inertia drive | Piezoelectric inertia drive | Piezoelectric inertia drive | Piezoelectric inertia drive | Piezoelectric inertia drive | Piezoelectric inertia drive | Piezoelectric inertia drive |
| Operating voltage, peak-to-peak | V | | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 |
| Maximum power consumption | W | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Drive force in positive direction of motion in X | N | Max. | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| Maximum operating frequency during continuous operation | Hz | | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 |
| Short-term maximum operating frequency | Hz | | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 |

| Mechanical Properties | Unit | Tolerance | N-470.110 | N-470.110Y | N-470.120 | N-470.120Y | N-470.210 | N-470.210Y | N-470.220 | N-470.220Y |
|-----------------------------|------|-----------|--|--|--|--|--|--|--|--|
| Stiffness in X | N/μm | ±10 % | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Permissible push force in Y | N | Max. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Holding force in X, passive | N | Min. | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Overall mass | g | | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 |
| 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. | 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 | M10×1 mounting thread | M10×1 mounting thread | 9.5 mm clamping shank | 9.5 mm clamping shank |

| Miscellaneous | Unit | | N-470.110 | N-470.110Y | N-470.120 | N-470.120Y | N-470.210 | N-470.210Y | N-470.220 | N-470.220Y |
|---------------------------------|------|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Operating temperature range | °C | | 10 to 40 | 10 to 40 | 10 to 40 | 10 to 40 | 10 to 40 | 10 to 40 | 10 to 40 | 10 to 40 |
| Connector | | | LEMO FFA. OS.303. CLAC32 | LEMO FFA. OS.303. CLAC32 | LEMO FFA. OS.303. CLAC32 | LEMO FFA. OS.303. CLAC32 | LEMO FFA. OS.303. CLAC32 | LEMO FFA. OS.303. CLAC32 | LEMO FFA. OS.303. CLAC32 | LEMO FFA. OS.303. CLAC32 |
| Cable length | m | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Recommended controllers/drivers | | | E-872.401 | E-872.401 | 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. 36)).
Ask about customized versions.

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

10.1.2 Vacuum-compatible models

| Motion | Unit | | N-470.11V | N-470.11VY | N-470.12V | N-470.21V | N-470.21VY | N-470.22V |
|---------------------------------|--------|--|-----------|------------|-----------|-----------|------------|-----------|
| Active axes | | | X | X | X | X | X | X |
| Travel range in X | mm | | 7 | 7 | 7 | 13 | 13 | 13 |
| Maximum velocity in X, unloaded | mm/min | | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 |

| Positioning | Unit | | N-470.11V | N-470.11VY | N-470.12V | N-470.21V | N-470.21VY | N-470.22V |
|---|------|--|-----------|------------|-----------|-----------|------------|-----------|
| Incremental motion in partial-step mode | nm | | 20 | 20 | 20 | 20 | 20 | 20 |
| Step size in full step mode | nm | | 50 | 50 | 50 | 50 | 50 | 50 |

| Drive Properties | Unit | Tolerance | N-470.11V | N-470.11VY | N-470.12V | N-470.21V | N-470.21VY | N-470.22V |
|---|------|-----------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| 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 | V | | 80 | 80 | 80 | 80 | 80 | 80 |
| Maximum power consumption | W | | 5 | 5 | 5 | 5 | 5 | 5 |
| Drive force in positive direction of motion in X | N | Max. | 22 | 22 | 22 | 22 | 22 | 22 |
| Maximum operating frequency during continuous operation | Hz | | 200 | 200 | 200 | 200 | 200 | 200 |
| Short-term maximum operating frequency | Hz | | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 |

| Mechanical Properties | Unit | Tolerance | N-470.11V | N-470.11VY | N-470.12V | N-470.21V | N-470.21VY | N-470.22V |
|-----------------------------|------|-----------|---|---|---|---|---|---|
| Stiffness in X | N/μm | ±10 % | 15 | 15 | 15 | 15 | 15 | 15 |
| Permissible push force in Y | N | Max. | 1 | 1 | 1 | 1 | 1 | 1 |
| Holding force in X, passive | N | Min. | 100 | 100 | 100 | 100 | 100 | 100 |
| Overall mass | g | | 80 | 80 | 80 | 85 | 85 | 85 |
| 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 |

| Miscellaneous | Unit | | N-470.11V | N-470.11VY | N-470.12V | N-470.21V | N-470.21VY | N-470.22V |
|---------------------------------|------|--|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Operating temperature range | °C | | 10 to 40 | 10 to 40 | 10 to 40 | 10 to 40 | 10 to 40 | 10 to 40 |
| Vacuum class | hPa | | 10 ⁻⁶ | 10 ⁻⁶ | 10 ⁻⁶ | 10 ⁻⁶ | 10 ⁻⁶ | 10 ⁻⁶ |
| Connector | | | Bare wire strands | Bare wire strands | Bare wire strands | Bare wire strands | Bare wire strands | Bare wire strands |
| Cable length | m | | 1 | 1 | 1 | 1 | 1 | 1 |
| 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. 36)).

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.

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




10.2 Materials used for vacuum-compatible models

The following materials were used for the vacuum-compatible models of the N-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 tubes: Kynar, PTFE Solder: Sn95.5 Ag3.8 Cu0.7 |
| Lubricant | High vacuum oil |
| Glue | Epoxy-based vacuum adhesive |

10.3 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-peak) | 400 Hz | 5 W |
| N-470.xxV N-470.xxVY | 80 V (peak-peak) | 200 Hz | 5 W |

* Up to 2000 Hz are permissible for short periods of time. Refer to [Operating time and duty cycle \(p. 36\)](#).

10.4 Ambient conditions and classifications

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

| | |
|---------------------|-----------------|
| Area of application | Indoor use only |
| Maximum altitude | 2000 m |

| | |
|--|---|
| Air pressure | Models that are not suitable for use in a vacuum: |
| | 1100 hPa to 0.1 hPa |
| | Vacuum-compatible models: |
| | 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 |
| Maximum bakeout temperature for vacuum-compatible models | 120 °C, for 12 hours, only in switched-off state |
| Overvoltage category | II |
| Protection class | I |
| Degree of pollution | 1 |
| Degree of protection according to IEC 60529 | IP30 |

10.5 Step size and axial force

The following graph shows the step size of the N-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 (refer to [Specifications \(p. 31\)](#)).

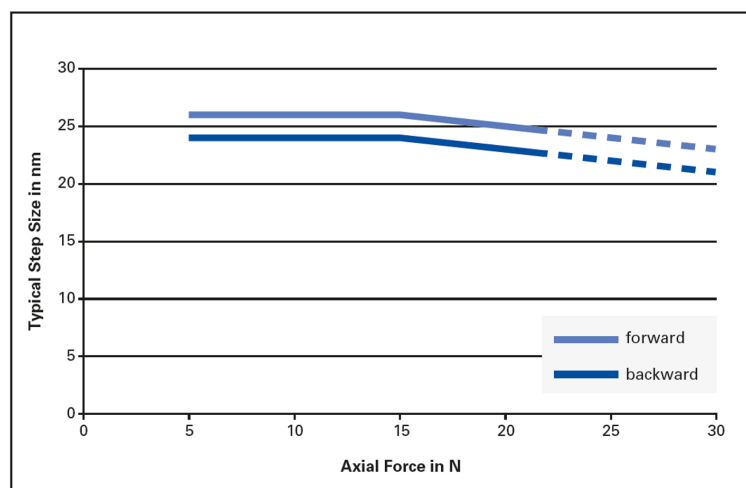


Fig. 11: Typical step size in nm vs. axial force in N

10.6 Lifetime

The following graph shows the decrease in the step size over the lifetime of the N-470. The lifetime of the N-470 linear actuator is specified as > 1,000,000,000 steps under atmospheric conditions (> 50,000,000 steps under vacuum conditions). Over this time, the typical step size decreases by maximum 30 %.

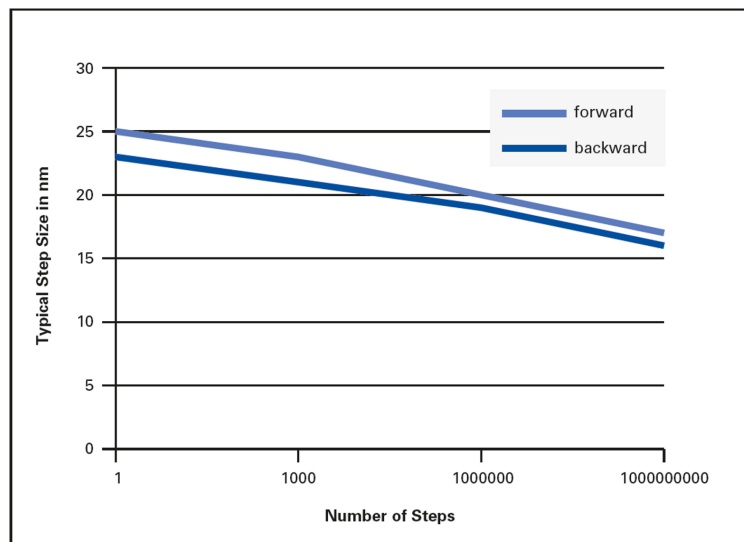


Fig. 12: Typical step sizes in nm vs. number of steps

10.7 Operating time and duty cycle

The operating time and the duty cycle influence the lifetime of the N-470. In order to prevent overheating and excessive wear, the operating time and the duty cycle must not exceed the values specified in the respective tables. The limit values depend on the following factors:

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

10.7.1 Operating time and duty cycle outside the vacuum

Models that are not suitable for use in a vacuum

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

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

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

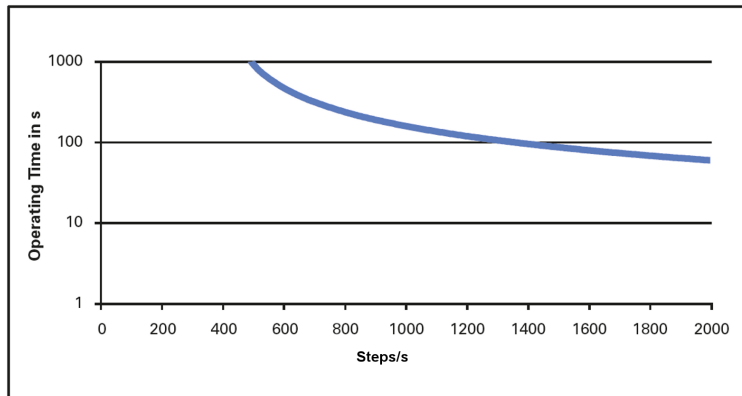


Fig. 13: Operating time in s vs. steps/s

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

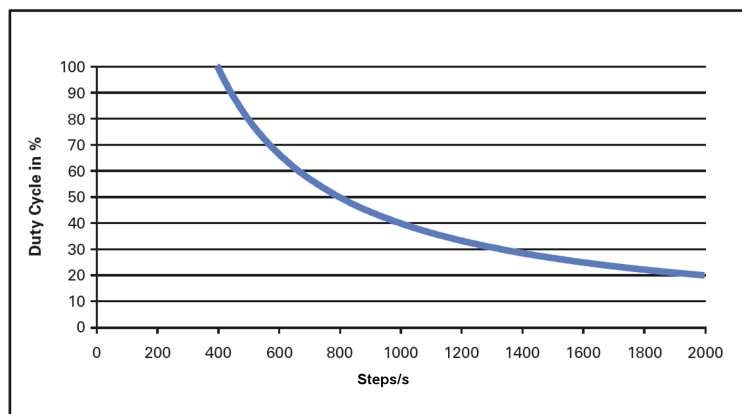


Fig. 14: Duty cycle in % vs. steps/s

10.7.2 Operating time and duty cycle inside the vacuum

Vacuum-compatible models

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

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

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

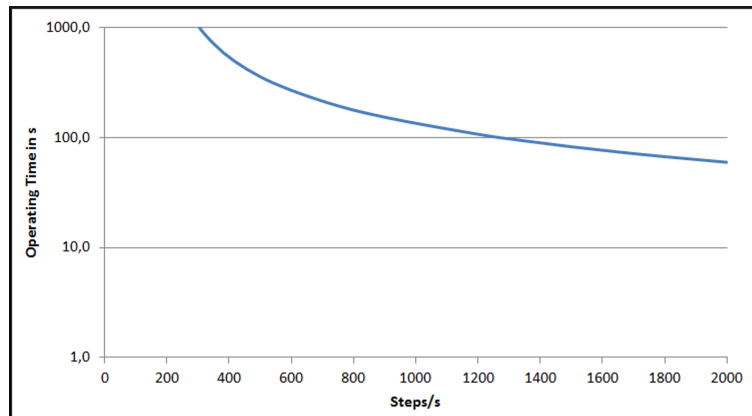


Fig. 15: Operating time in s vs. steps/s (vacuum-compatible models)

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

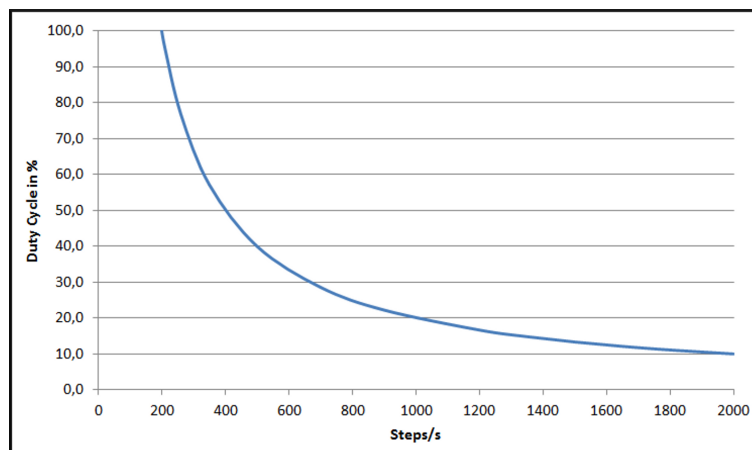


Fig. 16: Duty cycle in % vs. steps/s (vacuum-compatible models)

10.8 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 N-470.
- Vacuum-compatible models: The connector is located on the [air-side cable \(p. 15\)](#). The cable on the vacuum side of the N-470 and the separate cable have bare wire strands for [connecting to a vacuum feedthrough \(p. 23\)](#).

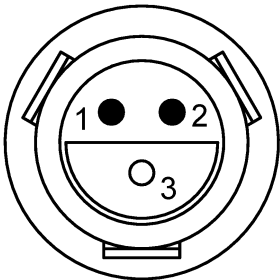


Fig. 17: LEMO connector, 3-pole

| 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 | Uncoated | Uncoated |

10.9 Dimensions

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 offset cable exit.

- 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.

10.9.1 Models with M10×1 thread

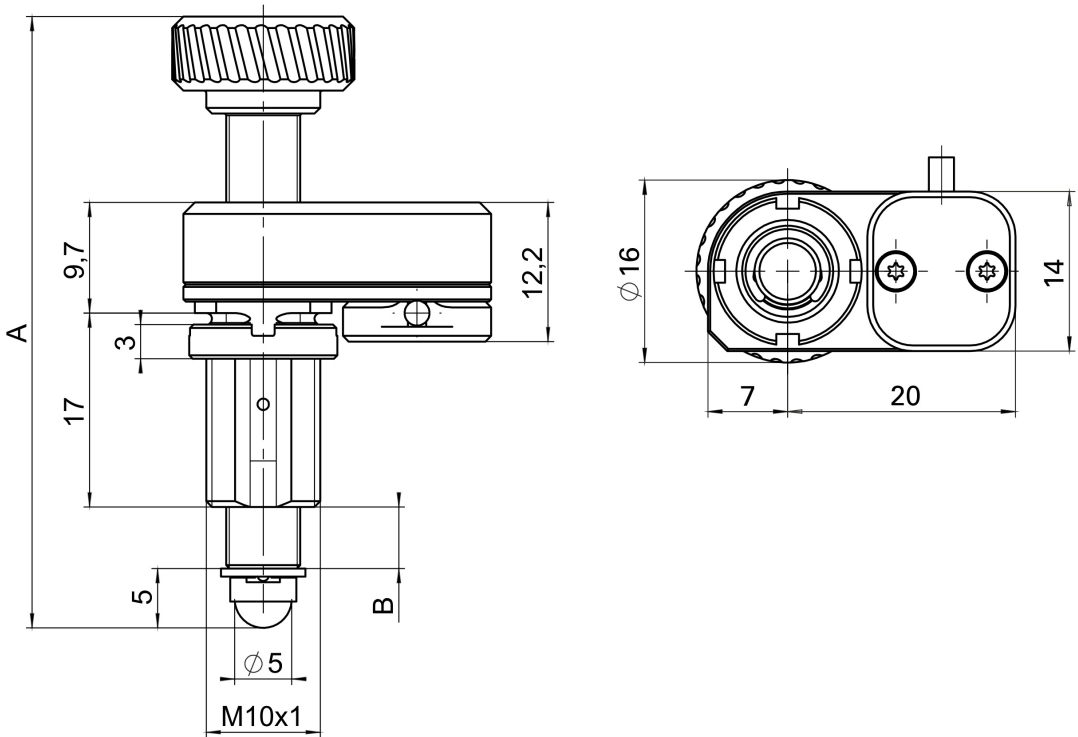


Fig. 18: N-470.x1x, dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

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

10.9.2 Models with clamping shank

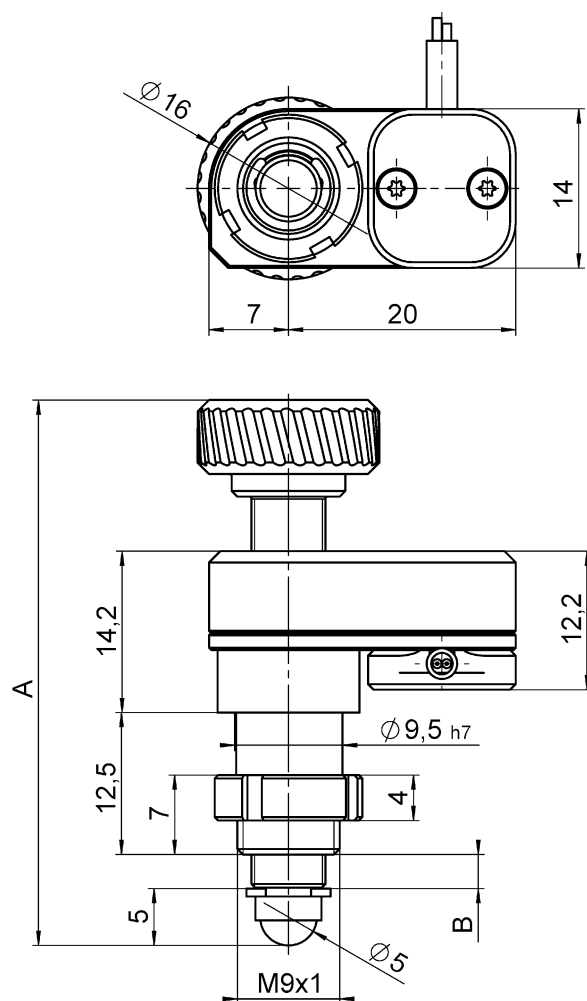


Fig. 19: N-470.x2x, dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

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

11 Customer service

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

If you have questions regarding your system, provide us with the following information:

- Product and serial numbers of all products in the system
- Firmware version of the controller (if applicable)
- Version of the driver or the PC software (if applicable)
- Operating system on the PC (if applicable)

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

Customer service address:

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

12 Old equipment disposal

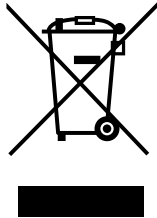
In accordance with EU law, electrical and electronic equipment may not be disposed of in EU member states via the municipal residual waste.

Dispose of your old device according to international, national, and local rules and regulations.

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

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

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



13 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

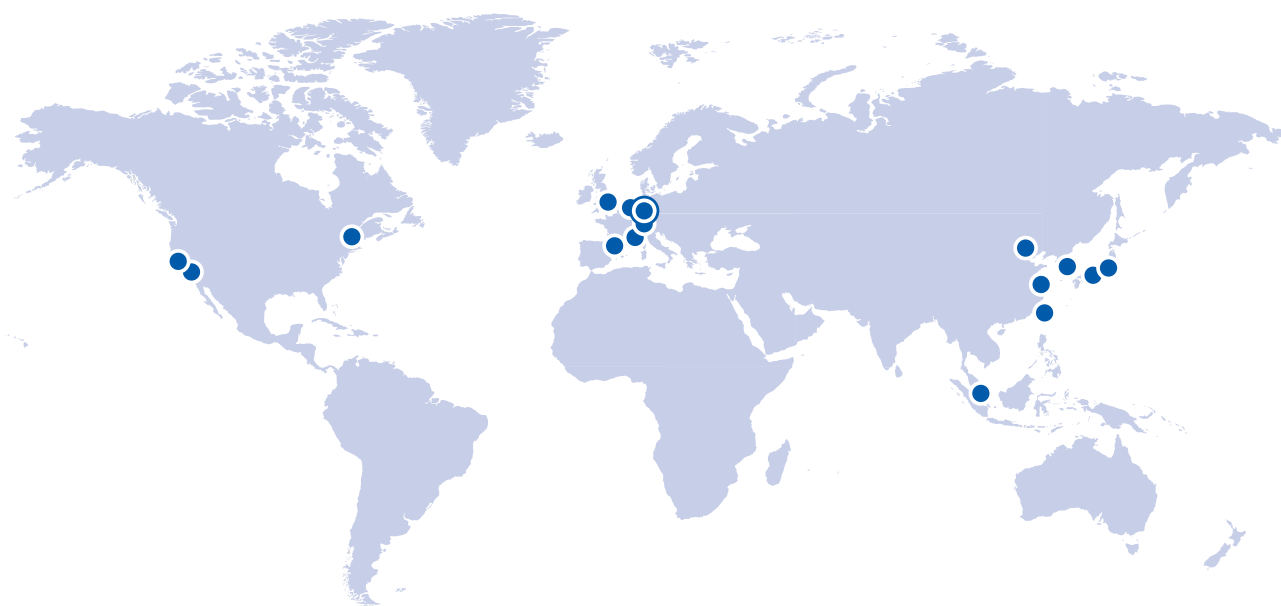
The applied standards certifying the conformity are listed below.

Safety (Low Voltage Directive): EN 61010-1

EMV: EN 61326-1

RoHS: EN IEC 63000

PI



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