N412T0001

# N-412 Piezo Motor Rod Drive

## User Manual

Version: 1.2.1 Date: 02/28/2019


**This document describes the following products:**

- **N-412.50**
  OEM linear drive, 13 mm travel range, 7 N feed force, silent operation, 9.5 mm (0.375") clamping shank
- **N-412.51**
  OEM linear drive, 13 mm travel range, 7 N feed force, silent operation, M10x1 thread

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# Contents

# 1 About this Document

## 1.1 Objective and Target Audience of this User Manual

This user manual contains the information necessary for the intended use of the N-412.

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

The latest versions of the user manuals are available for download (p. 6) on our website.

## 1.2 Symbols and Typographic Conventions

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

***CAUTION***

**Dangerous situation**
If not avoided, the dangerous situation will result in minor injury.

➢ Measures for avoiding the risk.

***NOTICE***

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

➢ Measures for avoiding the risk.

***INFORMATION***

Information for easier handling, tricks, tips, etc.

| Symbol/Label | Meaning |
|---|---|
| 1.<br>2. | Action consisting of several steps whose sequential order must be observed |
| ➢ | Action consisting of one or several steps whose sequential order is irrelevant |
| ▪ | List item |
| p. 5 | Cross-reference to page 5 |
| **RS-232** | Labeling of an operating element on the product (example: socket of the RS-232 interface) |
|  | Warning sign on the product which refers to detailed information in this manual. |

## 1.3 Figures

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

## 1.4 Other Applicable Documents

The devices that are mentioned in this documentation are described in their own manuals.

| Product | Document |
|---|---|
| E-872.401 Q-Motion® piezo motor / PiezoMike drive electronics (benchtop device) | PZ279EN user manual |

## 1.5 Downloading Manuals

***INFORMATION***

If a manual is missing or problems occur with downloading:

➢ Contact our customer service department (p. 19).

***INFORMATION***

For products that are supplied with software (CD in the scope of delivery), access to the manuals is protected by a password. Protected content is only displayed on the website after entering the access data.

You need the product CD to get the access data.

**For products with CD: Get access data**

1. Insert the product CD into the PC drive.
2. Switch to the Manuals directory on the CD.
3. In the Manuals directory, open the Release News (file including ***releasenews*** in the file name).
4. Get the access data for downloading protected content in the "User login for software download" section of the Release News. Possible methods for getting the access data:
   - Link to a page for registering and requesting the access data
   - User name and password is specified
5. If the access data needs to be requested via a registration page:
   a) Follow the link in the Release News.
   b) Enter the required information in the browser window.
   c) Click ***Show login data*** in the browser window.
   d) Note the user name and password shown in the browser window.

### Downloading manuals

If you have requested access data for protected contents via a registration page (see above):

- ➢ Click the links in the browser window to change to the content for your product and log in using the access data that you received.

General procedure:

1. Open the website www.pi.ws.
2. If access to the manuals is protected by a password:
   a) Click ***Login***.
   b) Log in with the user name and password.
3. Click ***Search***.
4. Enter the product number up to the period (e.g., N-412) or the product family (e.g., rod drive) into the search field.
5. Click ***Start search*** or press the Enter key.
6. Open the corresponding product detail page in the list of search results:
   a) If necessary: Scroll down the list.
   b) If necessary: Click ***Load more results*** at the bottom of the list.
   c) Click the corresponding product in the list.
7. Click the ***Downloads*** tab.
   The manuals are shown under ***Documentation***.
8. Click the desired manual and save it to the hard disk of your PC or to a data storage medium.

# 2 Safety

## 2.1 Intended Use

The N-412 is a laboratory device as defined by DIN EN 61010-1. It is intended to be used in interior spaces and in an environment which is free of dirt, oil, and lubricants.

The N-412 is a linear drive for integration in motion systems that are used for positioning, adjustment and motion of an object (load) in one axis. For integration, the mechanics in which the N-412 is to be installed must have suitable guides. The N-412 can be mounted horizontally or vertically.

The N-412 linear drive uses the principle of inertia (stick-slip effect). The feed of the moving part is produced by alternating static and sliding friction between the moving part and a cyclically activated piezo actuator. The object to be moved (load) is coupled to the moving part of the N-412.

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

The N-412 is not intended for continuous operation. For further information on the operating conditions of the N-412, see “Technical Data” (p. 20).

The intended use of the N-412 is only possible in connection with suitable drive electronics that provide the required operating voltages. The drive electronics are not in the scope of delivery of the N-412. PI offers suitable drive electronics (p. 11).

External position sensors and a position controller are required for the closed-loop operation of a motion system with N-412 drive and drive electronics.

## 2.2 General Safety Instructions

The N-412 is built according to state-of-the-art technology and recognized safety standards. Improper use can result in personal injury and/or damage to the N-412.

- Use the N-412 only for its intended purpose, and only 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 the correct installation and operation of the N-412.

### Organizational Measures

#### User manual

- Always keep this user manual available with the N-412.
  The latest versions of the user manuals are available for download (p. 6) on our website.
- Add all information from the manufacturer to the user manual, for example supplements or technical notes.
- If you give the N-412 to other users, also include this user manual as well as other relevant information provided by the manufacturer.
- Only use the device on the basis of the complete user manual. Missing information due to an incomplete user manual can result in minor injury and damage to equipment.
- Only install and operate the N-412 after you have read and understood this user manual.

#### Personnel qualification

The N-412 may only be installed, started up, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

# 3 Product Description

## 3.1 Model Overview

| Product number | Description |
|---|---|
| N-412.50 | OEM linear drive, 13 mm travel range, 7 N feed force, silent operation, 9.5 mm (0.375") clamping shank |
| N-412.51 | OEM linear drive, 13 mm travel range, 7 N feed force, silent operation, M10x1 thread |

## 3.2 Product View

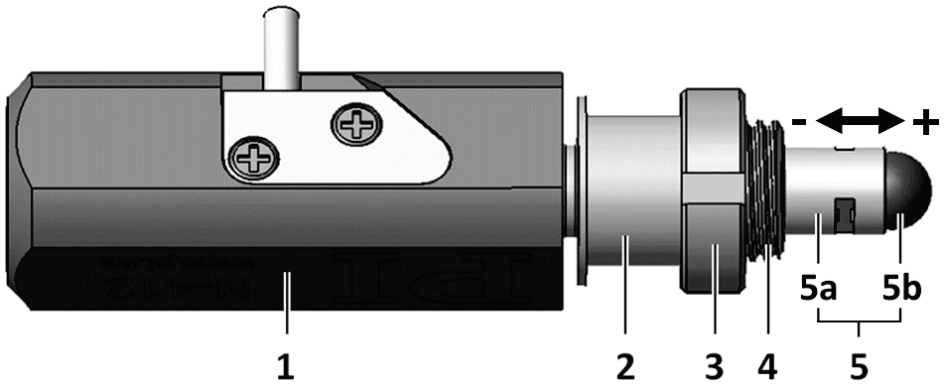


Figure 1: N-412.50 product view

1 Base body
2 Clamping shank (9.5 mm diameter, 6 mm clamping width)
3 M9×1 mounting nut
4 Thread of the clamping shank
5 Moving part of the linear drive, consisting of a ceramic rod (not depicted), a ball tip holder (5a) and a ball tip (5b)

The double arrow indicates the direction of motion when a positive voltage (+) or a negative voltage (-) is applied.

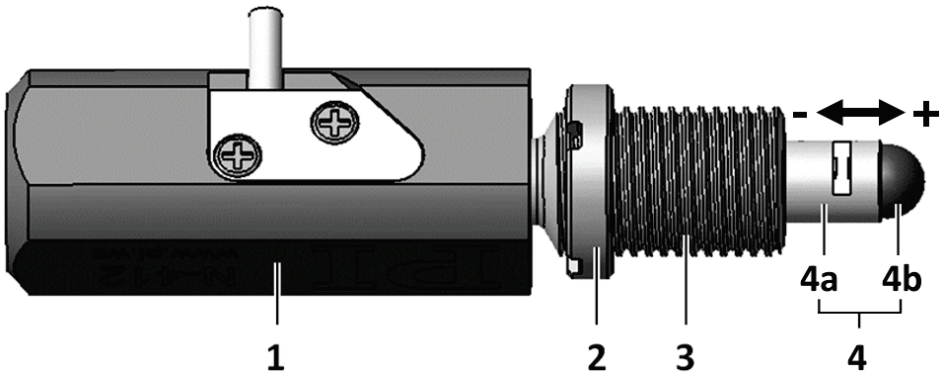


Figure 2: N-412.51 product view

1 Base body
2 M10×1 mounting nut
3 Mounting thread
4 Moving part of the linear drive, consisting of a ceramic rod (not depicted), a ball tip holder (4a) and a ball tip (4b)

The double arrow indicates the direction of motion when a positive voltage (+) or a negative voltage (-) is applied.

## 3.3 Product Labeling

| Labeling | Description |
|---|---|
| N-412.50 | Product number (example), the digits after the period refer to the model |
| 123456789 | Serial number (example), individual for each N-412<br>Meaning of the places (counting from left):<br>1 = internal information<br>2 and 3 = year of manufacture<br>4 to 9 = consecutive numbers |
| ⚠ | Warning sign “Observe manual!” |
| | Old equipment disposal (p. 24) |
| Country of origin: Germany | Country of origin |
| WWW.PI.WS | Manufacturer's address (website) |
| PI | Manufacturer's logo |
| CE | CE conformity mark |

## 3.4 Scope of Delivery

| Product number | Description |
|---|---|
| N-412 | OEM linear drive according to order (p. 9) |
| 000049906 | Hook wrench |
| N412T0001 | User manual for N-412 (this document in printed form) |

## 3.5 Suitable Electronics

To operate the N-412, you need suitable drive electronics (not in the scope of delivery). The following drive electronics are available:

| Product number | Description |
|---|---|
| E-872.401 | Q-Motion® piezo motor / 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. 19).

## 3.6 Accessories

| Product number | Description |
|---|---|
| N-400.A02 | Extension cable, LEMO connector 3-pin to LEMO connector 3-pin, 2 m |
| N-400.A05 | Extension cable, LEMO connector 3-pin to LEMO connector 3-pin, 5 m |
| N-400.A08 | Extension cable, LEMO connector 3-pin to LEMO connector 3-pin, 8 m |
| N-400.A12 | Extension cable, LEMO connector 3-pin to LEMO connector 3-pin, 12 m |
| N-400.ALM | Adapter, LEMO 3-pin to Mini DIN<br>(for connecting the N-412 to older E-870 electronics) |
| N-400.AML | Adapter, Mini DIN to LEMO 3-pin<br>(for connecting older N-412 to the E-872.401 electronics) |

➢ To order, contact our customer service department (p. 19).

# 4 Unpacking

1. Unpack the N-412 with care.
2. Compare the contents with the items listed in the contract and the packing list.
3. Inspect the contents for signs of damage. If parts are missing or you notice signs of damage, contact PI immediately.
4. Keep all packaging materials in case the product needs to be returned.

# 5 Installation

## 5.1 General Notes on Installation

**NOTICE**

**Increased friction due to lateral forces on the moving part!**

Lateral forces that act on the moving part and the ball tip of the linear drive increase the friction on the internal drive components. Increased friction impairs the motion of the moving part and increases the wear of the drive components.

- ➢ Avoid lateral forces on the moving part and on the ball tip of the N-412.
- ➢ Install the N-412 so that the moving part is aligned vertically to the contact surface of the moving part of the mechanical mounting.

**NOTICE**

**Damage from overtightening the mounting nut!**

Overtightening the mounting nut can damage the linear drive.

- ➢ Hand-tighten the mounting nut.

**NOTICE**

**Damage from opening the N-412!**

Opening the base body causes damage to the N-412.

- ➢ Loosen screws only when instructed in this manual.
- ➢ Do **not** open the N-412.

**NOTICE**

**Heating up of the N-412 during operation!**

During operation, the N-412 emits up to 15 watts of heat, which can interfere with your application.

- ➢ Install the N-412 so that the application is not impaired by the emitted heat.
- ➢ Ensure sufficient ventilation at the place of installation.
- ➢ Pay attention to the operating conditions (duty cycle, ambient temperature), see “Lifetime” (p. 22).

**NOTICE**

**Damage from unsuitable cables!**

Unsuitable cables can damage the electronics.

- ➢ Use cables from PI only to connect the N-412 to the electronics.

***INFORMATION***

If the N-412 becomes contaminated with dirt, oil, lubricant or condensation, the dynamic force and the velocity of the drive will decrease.

- If necessary, install the entire system in a housing to protect it against contamination.
- Prevent condensation from forming on the N-412. If condensation has formed on the N-412, let the drive dry before startup.

***INFORMATION***

When the N-412 is installed in a mechanical system that is to be operated in closed-loop mode, you need an external position sensor such as a linear encoder (not in the scope of delivery). Furthermore, the electronics must be able to read out and process the signals of the external position sensor.

- Pay attention to the installation instructions of the manufacturer when installing the position sensor.
- Mount the position sensor as closely as possible to the intended motion.
- Observe the input and output signals of the electronics used to operate the N-412.

***INFORMATION***

Ground loops can occur when the N-412 is grounded via the shield of the connecting cable as well as a separate protective earth conductor.

- If a ground loop occurs, contact our customer service department (p. 19).

For further information on the operating conditions, refer to the “Technical Data” section (p. 20).

## 5.2 Installing the Linear Drive onto a Mechanical Mounting and Connecting it to the Protective Earth Conductor

***INFORMATION***

The contact of the N-412 to the protective earth conductor is established via the contact of the mounting nut or thread or clamping shank to a sufficiently conductive mechanical mounting. The mechanical mounting must be connected to the protective earth conductor.

***INFORMATION***

- Observe the applicable standards for mounting the protective earth conductor.

**Requirements**

- ✓ You have read and understood the general notes on installation (p. 12).
- ✓ The N-412 is **not** connected to the electronics.

✓ You have provided a suitable mechanical mounting (for dimensions of the linear drive see “Dimensions”, p. 23):

- 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-412 must be electrically conductive.
- The contact resistance at all connection points relevant for mounting the protective earth conductor is <0.1 Ω at 25 A.
- The contact surface of the mechanical mounting to the ball tip of the N-412 has a roughness of Ra <0.1 µm and a hardness of at least 500 HV.
- For models with mounting thread: An M10×1 through-hole is present in the mechanical mounting.
- For models with clamping shank: There is a through-hole with a suitable diameter in the mechanical mounting.

✓ You have accounted for the space required to route cables without bending and according to regulations.

**Tools and accessories**

- Hook wrench (p. 11)
- When lubricant is to be applied to the contact surface of the moving part of the mechanical mounting: PTFE-based grease containing no additive

## 5.3 Installing an N-412.50 (with clamping shank)

1. Optional: Apply a small amount of lubricant to the contact surface of the moving part of the mechanical mounting.
2. Remove the mounting nut from the clamping shank of the N-412.
3. Position the N-412 in the mechanical mounting of your application.
4. Manually screw the mounting nut of the N-412 a few turns into the thread of the clamping shank.
5. Align the base body with the mechanical mounting.
6. Clamp the N-412 firmly in the mounting:
   - Hold the base body and hand-tighten the mounting nut of the N-412 with the hook wrench.
7. Check that the linear drive is affixed firmly in the mounting.
8. Make sure that the contact resistance at all connection points relevant for connecting the protective earth conductor is <0.1 Ω at 25 A.

## 5.4 Installing an N-412.51 (with mounting thread)

1. Screw the mounting nut of the N-412 as far as necessary in the direction of the base body of the N-412.
2. Optional: Apply a small amount of lubricant to the contact surface of the moving part of the mechanical mounting.
3. Screw the N-412 as far as necessary into the M10×1 through-hole of the mechanical mounting.
4. Align the base body of the N-412 with the mechanical mounting.
5. Fix the N-412 in the mechanical mounting:
   a) Hold the base body and screw the mounting nut of the N-412 in the direction of the mechanical mounting.
   b) Hand-tighten the mounting nut with the hook wrench.
6. Check that the linear drive is affixed firmly in the mounting.
7. Make sure that the contact resistance at all connection points relevant for connecting the protective earth conductor is <0.1 Ω at 25 A.

# 6 Startup and Operation

## 6.1 General Notes on Startup and Operation

***CAUTION***

**Risk of electric shock if the protective earth conductor is not connected!**
If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the N-412 in the event of malfunction or failure of the system. If touch voltages exist, touching the N-412 can result in minor injuries from electric shock.

- ➢ Connect the N-412 to a protective earth conductor (p. 13) before startup. To do this, install the N-412 onto a sufficiently conductive mechanical mounting that is connected to a protective earth conductor.
- ➢ 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-412 to the protective earth conductor before starting it up again.

***CAUTION***

**Risk of crushing by moving parts!**
There is a risk of minor injuries caused by crushing which can occur between the moving part of the linear drive and a stationary part or obstacle.

- ➢ Keep your fingers away from areas where they can get caught by moving parts.

**NOTICE**

**Operating voltage too high or incorrectly connected!**

Operating voltages that are too high or incorrectly connected can cause damage to the N-412.

- Only operate the N-412 with electronics and original accessories from PI.
- Do **not** exceed the maximum operating voltage (p. 21) for which the N-412 is specified.
- Operate the N-412 only when the operating voltage is properly connected; see "Pin Assignment" (p. 24).

**NOTICE**

**Operating frequency too high!**

An operating frequency that is too high can cause damage to the N-412.

- Only operate the N-412 with electronics and original accessories from PI.
- Do **not** exceed the maximum operating frequency (p. 21) for which the N-412 is specified.

**NOTICE**

**Increased friction due to lateral forces on the moving part!**

Lateral forces that act on the moving part and the ball tip of the linear drive increase the friction on the internal drive components. Increased friction impairs the motion of the moving part and increases the wear of the drive components.

- Avoid lateral forces on the moving part and on the ball tip of the N-412.
- Install the N-412 so that the moving part is aligned vertically to the contact surface of the moving part of the mechanical mounting.

**NOTICE**

**Damage from collision of the N-412 with the hard stop!**

When the hard stop has been reached or the drive is blocked, but the drive is still being operated, this can cause damage or lead to considerable wear on the drive.

- Do **not** place any objects in areas where they can get caught by moving parts.
- Do **not** continue to operate the N-412 at the end of the travel range.

**INFORMATION**

The drive electronics are adapted via parameters to the N-412. Changing parameter values can cause undesirable results.

- Operate the N-412 only when the parameters of the drive electronics have been correctly set, see "Operating Parameters of the N-412" (p. 17).

For further information on the operating conditions, refer to the "Technical Data" section (p. 20).

The N-412 is started up with the E-872.401 drive electronics (p. 11) from PI.

## 6.2 Starting Up the N-412 with the E-872.401 Drive Electronics

### Requirements

- ✓ You have read and understood the general notes on startup and operation (p. 15).
- ✓ The N-412 has been installed properly (p. 12).
- ✓ The E-872.401 drive electronics have been properly installed and all connections on the E-872.401 have been set up. See the documentation of the drive electronics (p. 6) for details.

### Starting up the N-412 with the E-872.401 drive electronics

1. Make sure that the parameters of the drive electronics have been correctly set, see “Operating Parameters of the N-412” below.
2. Provide the control signal required for operating the system. See the documentation of the drive electronics (p. 6) for details.

## 6.3 Operating Parameters of the N-412

The following table lists the settings for the parameters of the drive electronics.

| Parameter | Parameter in E-872.401 drive electronics | Value | Unit |
|---|---|---|---|
| Maximum control value | ***Maximum Motor Output***<br>0x9 | 20000 | --- |
| Operating frequency in step mode | ***PIShift Frequency***<br>ID 0x1F000400 | 25000 | Hz |
| Operating voltage, upper limit | ***PIShift Upper Supply Voltage***<br>ID 0x1F000000 | 48 | V |
| Operating voltage, lower limit | ***PIShift Lower Supply Voltage***<br>ID 0x1F000100 | 0 | V |
| Charging current during forward motion | ***PIShift Forward Current***<br>ID 0x1F000200 | 0.6 | A |
| Charging current during backward motion | ***PIShift Backward Current***<br>ID 0x1F000300 | -0.6 | A |
| Duty cycle of the current source during the output of one period of the modified sawtooth signal in step mode | ***PIShift Charge Cycle***<br>ID 0x1F000500 | 1 | --- |

# 7 Maintenance

**NOTICE**

**Damage from opening the N-412!**

Opening the base body causes damage to the N-412.

- ➢ Loosen screws only when instructed in this manual.
- ➢ Do **not** open the N-412.

When the N-412 is operated in a clean environment, no maintenance work is necessary.

- ➢ If you would like your device to be serviced, contact our customer service department (p. 19).

## 7.1 Cleaning the N-412

**NOTICE**

**Damage due to wrong cleaning!**

The ceramic rod (moving part of the N-412) is greased to ensure proper functioning of the drive. Cleaning the ceramic rod will remove the grease from the ceramic rod. Operation of the N-412 without grease on the ceramic rod will damage the drive.

- ➢ Do **not** clean the ceramic rod. If the ceramic rod has become soiled, contact our customer service department (p. 19).

### Requirements

- ✓ You have disconnected the N-412 from the electronics.

### Cleaning the N-412

- ➢ If necessary, clean the surfaces of the N-412 with a cloth that is dampened with a mild cleanser or disinfectant (e.g., alcohol or isopropyl alcohol).

# 8 Troubleshooting

| Problem | Possible causes | Solution |
|---|---|---|
| Reduced performance and increased wear | Increased friction due to lateral forces on the moving part and the ball tip of the linear drive | ➢ Avoid lateral forces on the moving part and on the ball tip of the N-412.<br>➢ Install the N-412 so that the moving part is aligned vertically to the contact surface of the moving part of the mechanical mounting. |
| No or limited motion | ▪ Excessive load<br>▪ Excessive counterforces in the direction of motion<br>▪ Parameters of the drive electronics incorrectly set | ➢ Reduce the load. Pay attention to the information in the “Drive Performance” section (p. 22).<br>➢ In the case of vertical mounting, ensure gravity compensation so that the load does not exceed the maximum push / pull force of the drive according to the specifications (p. 20). Contact our customer service department (p. 19) for details on gravity compensation.<br>➢ Check the settings for the parameters of the drive electronics. See “Operating Parameters of the N-412” (p. 17) and the documentation of the drive electronics (p. 6) for details. |

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. 19).

# 9 Customer Service

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

- ➢ If you have any questions concerning your system, provide the following information:
  - Product and serial numbers of all products in the system
  - Firmware version of the electronics (if present)
  - Version of the driver or the software (if present)
  - Operating system on the PC (if present)
- ➢ If possible: Take photographs or make videos of your system that can be sent to our customer service department if requested.

The latest versions of the user manuals are available for download (p. 6) on our website.

# 10 Technical Data

## 10.1 Specifications

### 10.1.1 Data Table

| Motion and positioning | N-412.50 | N-412.51 | Unit | Tolerance |
|---|---|---|---|---|
| Active axis | X | X | | |
| Travel range | 13 | 13 | mm | |
| Step size in step mode | 300 | 300 | nm | typ. |
| Step frequency* | 23 | 23 | kHz | max. |
| Max. velocity* | 3 | 3 | mm/s | min. |

| Mechanical properties | N-412.50 | N-412.51 | Unit | Tolerance |
|---|---|---|---|---|
| Mechanical interface | 9.5 mm clamping shank | M10x1 thread | | |
| Stiffness in motion direction | >4 | >4 | N/µm | ±20 % |
| Drive force | 7 | 7 | N | max. |
| Holding force | 10 | 10 | N | min. |

| Drive properties | N-412.50 | N-412.51 | Unit | Tolerance |
|---|---|---|---|---|
| Drive type | Inertia drive | Inertia drive | | |
| Operating voltage | 48 | 48 | $V_{pp}$ | max. |

| Miscellaneous | N-412.50 | N-412.51 | Unit | Tolerance |
|---|---|---|---|---|
| Operating temperature range | 0 to 50 | 0 to 50 | °C | |
| Material** | Stainless steel | Stainless steel | | |
| Dimensions | 58 mm length, 15 mm diameter | 58 mm length, 15 mm diameter | | |
| Mass without cable and connector | 45 | 45 | g | ±10 % |
| Mass with cable and connector | 70 | 70 | g | ±10 % |
| Cable length | 1.5 | 1.5 | m | ±10 mm |
| Connector | LEMO, 3-pin | LEMO, 3-pin | | |
| Recommended electronics | E-872.401 | E-872.401 | | |

* Depending on the drive electronics
** Ceramic runner
Ask about customized versions.

### 10.1.2 Maximum Ratings

N-412 linear drives are designed for the following operating data:

| **Maximum operating voltage** | **Maximum operating frequency** | **Maximum power consumption** |
|---|---|---|
| 48 $V_{pp}$ | 23 kHz | 15 W |

### 10.1.3 Ambient Conditions and Classifications

The following ambient conditions and classifications must be observed for the N-412:

| | |
|---|---|
| Area of application | For indoor use only |
| Maximum altitude | 2000 m |
| Air pressure | 1100 hPa to 0.1 hPa |
| Relative humidity | Highest relative humidity 80 % for temperatures up to 31 °C<br>Decreasing linearly to 50 % relative humidity at 40°C |
| Operating temperature | 0 °C to 50 °C |
| Storage temperature | -20 °C to 75 °C |
| Transport temperature | -20 °C to 75 °C |
| Overvoltage category | II |
| Protection class | I |
| Degree of pollution | 1 |
| Degree of protection according to IEC 60529 | IP30 |

## 10.2 Drive Performance

### Velocity and dynamic force

The following graph can be used to estimate the dynamic force (push/pull force, force in N) of the N-412 at different velocities.

**N-412.5x**

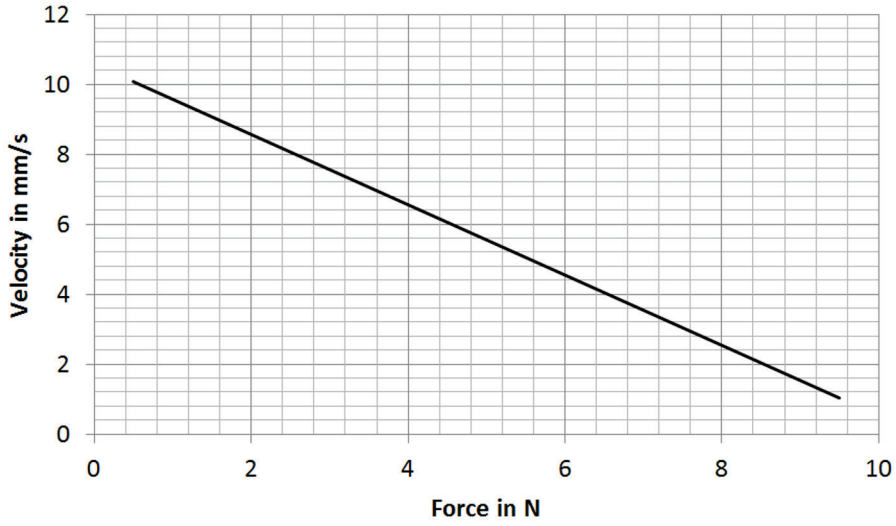


Figure 3: Velocity vs. dynamic force (push/pull force) of the N-412

## 10.3 Lifetime

The N-412 can achieve a lifetime of 2000 m under optimum operating conditions and with full use of the travel range. Optimum operating conditions of the N-412:

- Duty cycle: Maximum 50 %
- Running time: Maximum 10 seconds
- Ambient temperature: Room temperature
- Air pressure: Normal pressure
- Proper installation of the N-412 (p. 12)
- Proper settings of the drive electronics, see “Operating Parameters of the N-412” (p. 17)

## 10.4 Dimensions

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

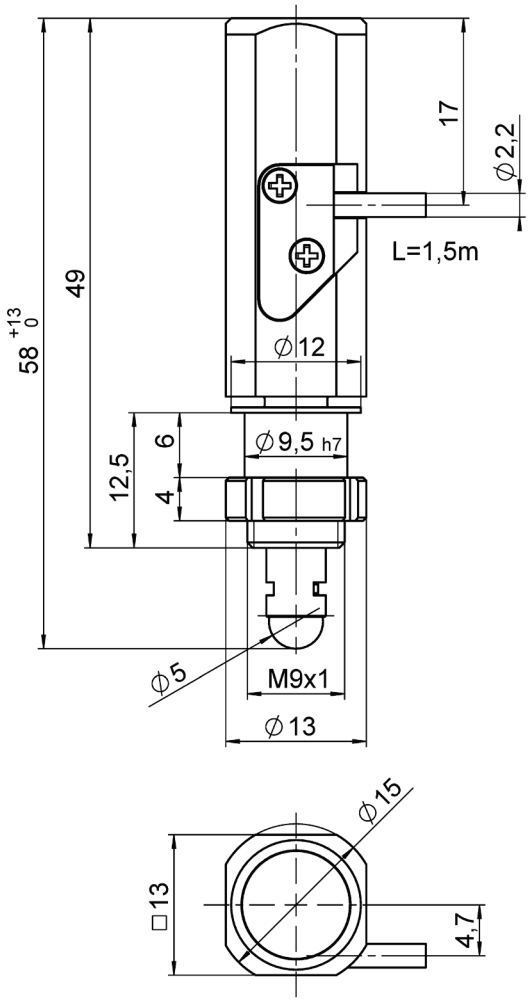


Figure 4: Dimensions of the N-412.50

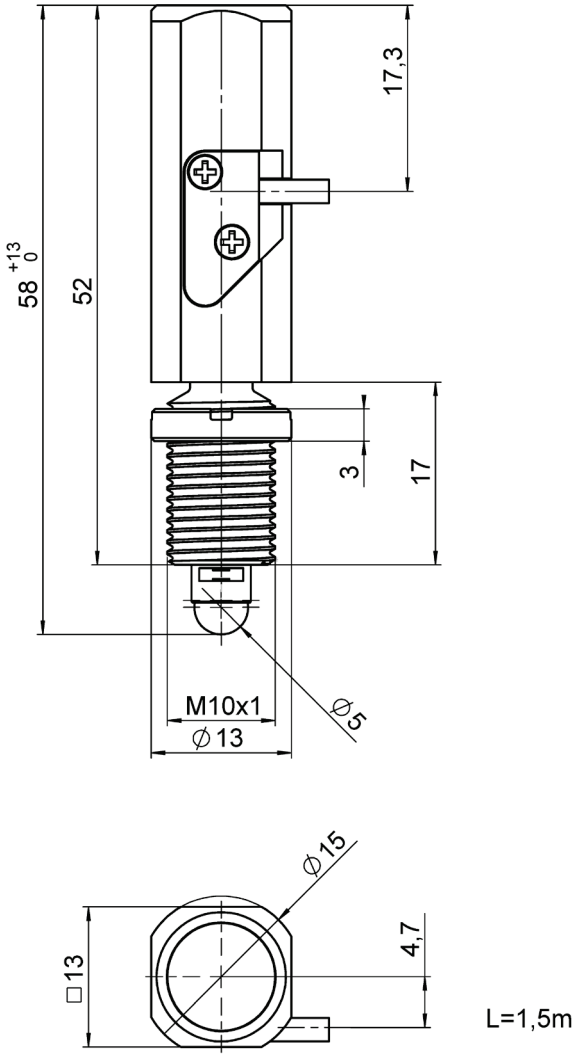


Figure 5: Dimensions of the N-412.51

## 10.5 Pin Assignment

**LEMO connector of the N-412**

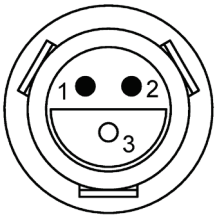


Figure 6: LEMO connector (3-pin)

| Pin | Function | Color of the wire in the connecting cable |
|---|---|---|
| 1 | Input: Piezo + (0 to 48 V) | Red |
| 2 | Input: Piezo - (GND) | Black |
| 3 | Not connected | --- |

The cable shield is connected to the connector shell.

# 11 Old Equipment Disposal

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

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

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

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

Physik Instrumente (PI) GmbH & Co. KG

Auf der Roemerstr. 1

D-76228 Karlsruhe, Germany

# 12 EU Declaration of Conformity

For the N-412, an EU Declaration of Conformity has been issued in accordance with the following European directives:

EMC Directive

RoHS Directive

The applied standards certifying the conformity are listed below.

EMC: EN 61326-1

Safety: EN 61010-1

RoHS: EN 50581