MP142E

N-111 NEXLINE® Linear Actuator

User Manual

Version: 1.0.3 Date: 22.1.2019

This document describes the following products:

- **N-111.201**
  NEXLINE® OEM piezo stepping actuator,
  10 mm, 50 N
- **N-111.2A1**
  NEXLINE® OEM piezo stepping actuator,
  10 mm, 50 N, linear encoder, 5 nm resolution

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Contents

1 About this Document

In this Chapter

1.1 Objective and Target Audience of this User Manual

This manual contains information on the intended use of the N-111.

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

The latest versions of the user manuals are available for download (p. 2) on our website.

1.2 Symbols and Typographic Conventions

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

CAUTION

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

➢ Actions to take to avoid the situation.

NOTICE

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

➢ Actions to take to avoid the situation.

INFORMATION

Information for easier handling, tricks, tips, etc.

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

1.3 Figures

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

1.4 Other Applicable Documents

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

Product	Document
E-712 Digital Piezo Controller	PZ195E User Manual
PIMikroMove	SM148E Software Manual

1.5 Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

➢ Contact our customer service department (p. 35).

INFORMATION

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

You need the product CD to get the access data.

For products with CD: Get access data

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

Downloading manuals

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

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

General procedure:

1. Open the website **www.pi.ws**.
2. If access to the manuals is protected by a password:
   a) Click ***Login***.
   b) Log in with the user name and password.
3. Click ***Search***.
4. Enter the product number up to the period (e.g., P-882) or the product family (e.g., PICMA® Bender) into the search field.
5. Click ***Start search*** or press the Enter key.
6. Open the corresponding product detail page in the list of search results:
   a) If necessary: Scroll down the list.
   b) If necessary: Click ***Load more results*** at the bottom of the list.
   c) Click the corresponding product in the list.
7. Click the ***Downloads*** tab.

   The manuals are shown under ***Documentation***.
8. Click the desired manual and save it to the hard disk of your PC or to a data storage medium.

2 Safety

In this Chapter

2.1 Intended Use

Based on its design and realization, the N-111 is intended for single-axis positioning, adjusting and shifting of loads at various velocities.

The N-111 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 intended use of the N-111 is only possible when installed and in connection with a suitable controller (p. 11). The controller is not included in the scope of delivery of the N-111.

2.2 General Safety Instructions

The N-111 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-111.

- Only use the N-111 for its intended purpose, and only use it if it is in a good working order.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for the correct installation and operation of the N-111.

2.3 Organizational Measures

User manual

- Always keep this user manual available with the N-111.
  The latest versions of the user manuals are available for download (p. 2) on our website.
- Add all information from the manufacturer to the user manual, for example supplements or technical notes.
- If you give the N-111 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-111 after you have read and understood this user manual.

Personnel qualification

The N-111 may only be installed, started up, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

3 Product Description

In this Chapter

3.1 Features and Applications

- Travel range 10 mm
- High drive and holding forces (50 N / 70 N)
- High position resolution
- PiezoWalk® principle
- Self-locking, thus no holding currents and no heat generation at rest
- Non-magnetic function principle
- Can also be used in environments with:
  - Clean room requirements
  - Strong magnetic fields
  - Strong UV radiation
  - Vacuum (modified products up to 0.1 hPa, on request)

The N-111 NEXLINE® OEM linear actuator is a compact drive for nanopositioning technology. The feed is generated by coordinated shearing and clamping motions of strongly preloaded piezo elements that are coupled to a runner (PiezoWalk® principle). In this way, NEXLINE® drives combine relatively long travel ranges with the nanometer precision of piezo actuators.

The N-111.2A1 is equipped with a linear encoder for direct measurement of the runner position. The resolution here is 5 nm over the entire travel range (closed-loop operation).

In highly dynamic analog operation, position resolutions up to 25 pm can be achieved (open-loop operation).

The linear actuator supports the following modes of operation for positioning a load:

Operating Mode	Advantages
Full step mode	▪ Long travel ranges ▪ High velocity ▪ High dynamic forces

Operating Mode	Advantages
Nanostepping mode	▪ Long travel ranges ▪ Low vibration ▪ Uniformity of motion
Analog mode	▪ Travel ranges in the µm range ▪ High dynamics ▪ High resolution

➢ Further details on the operating modes are found in the manual of the controller used.

3.2 Model Overview

Two standard versions of the N-111 NEXLINE® OEM linear actuator are available. They differ regarding the presence of an integrated sensor and thus in height.

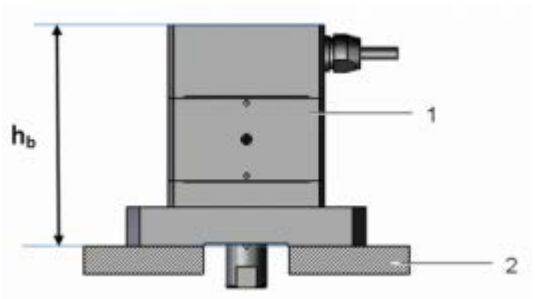

Figure 1: Height hb

1 Actuator
2 Surface (part of the application)
h_b Height

Model	Characteristics
N-111.201	NEXLINE® OEM piezo stepping actuator, travel range 10 mm, max. drive force 50 N, overall height h_b 42.5 mm
N-111.2A1	NEXLINE® OEM piezo stepping actuator, travel range 10 mm, max. drive force 50 N, with linear encoder, 5 nm resolution, overall height h_b 62 mm

➢ For further technical data, see the specifications (p. 37).

PI also produces custom designs upon request. Custom designs can differ from the described standard products in respect to dimensions, characteristics or other technical data.

➢ If necessary, contact our customer service department (p. 35) directly.

3.3 Product View

3.3.1 Overview

Figure 2: Linear actuators N-111.2A1 (left) and N-111.201 (right)

3.3.2 Product Details

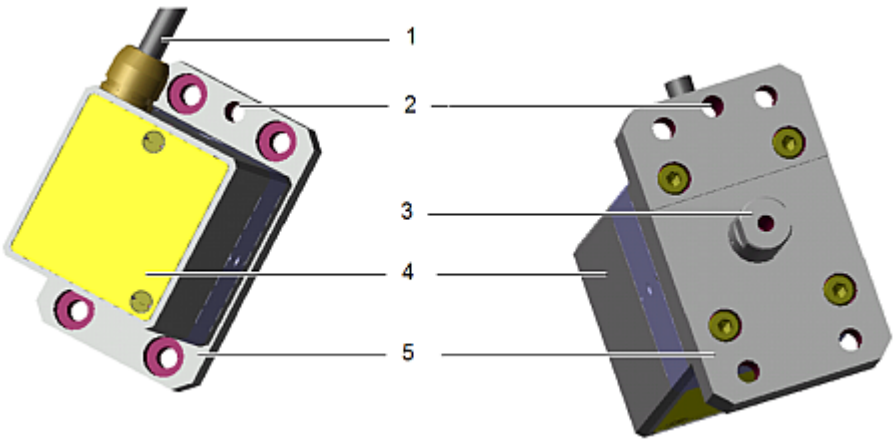

Figure 3: Position of important elements, top and bottom view of actuator case (schematic, components marked in color)

1 Connection cable
2 Protective earth connection
3 Runner (non rotating)
4 Actuator case
5 Mounting plate

3.3.3 Product Labeling

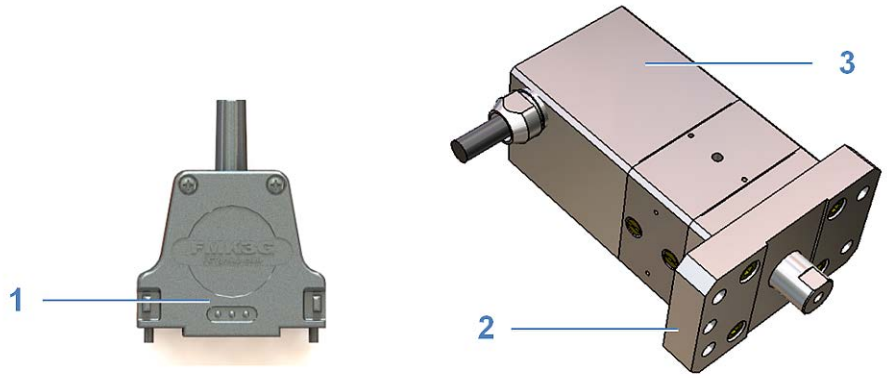

Figure 4: Position and appearance of the product labels

Position	Labeling	Description
1	⚠	Warning sign "Attention! Residual voltage"
2	⏚	Symbol for the protective earth conductor, marks the protective earth connection of the N-111 (p. 21)
3	N-111.2A1	Product name (example), the characters following the period refer to the model
3	113055789	Serial number (example), individual for each N-111 Meaning of the places (counting from left): 1 = internal information, 2 and 3 = year of manufacture, 4 to 9 = consecutive numbers
3	⚠	Warning sign "Pay attention to the manual!"
3		Old equipment disposal (p. 47)
3	Country of origin: Germany	Country of origin
3	WWW.PI.WS	Manufacturer's address (website)
3	PI	Manufacturer's logo
3	CE	CE conformity mark

3.4 Scope of Delivery

The N-111 is delivered with the following components:

Order number	Component
N-111.2x1	Linear actuator according to order
000036450	M4 screw set for protective earth connection
MP142E	User manual (this document) in printed form
	Packaging materials

3.5 Suitable Controllers

Controller	Description
E-712.1AM	Digital controller for NEXLINE® nanopositioning linear drives with incremental encoder, 1 axis, TCP/IP, USB, RS-232 interfaces for communication

3.6 Only N-111.2A1: Technical Features for Closed-Loop Operation

3.6.1 Linear Encoder (Sensor)

The linear actuator is equipped with an optical linear encoder. For the encoder resolution, refer to the table in the "Specifications" section (p. 37).

Optical linear encoders measure the actual position directly (direct metrology). Therefore, errors occurring in the drivetrain such as nonlinearity, backlash or elastic deformation, cannot influence the measurement of the position.

3.6.2 Reference Point Switch

The linear actuator is equipped with a direction-sensing reference point switch, which is located at about the midpoint of the travel range. This sensor sends a TTL signal indicating whether the linear actuator is on the positive or negative side of the reference point switch.

See the controller user manual and/or associated software manuals for the commands that make use of the reference point signal.

4 Unpacking

1. Unpack the N-111 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 (p. 35) immediately.
4. Keep all packaging materials in case the product needs to be returned.

5 Installation

In this Chapter

5.1 Providing a Suitable Installation Environment

Installation recommendation

The N-111 is intended for being screwed into a level surface, a base body or a case (referred to in general as "surface" in the following).

Alternatives for mounting holes (see also the following figures):

- **Threaded holes** in the surface
- **Through holes** in the surface

The following instructions for preparing and carrying out the fastening refer to an installation with threaded holes.

➢ If you use other designs, proceed correspondingly.

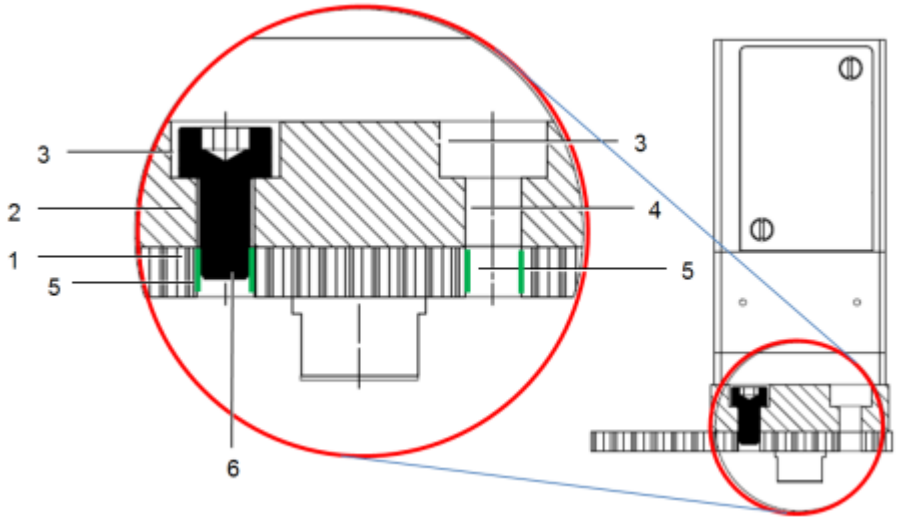

Figure 5: Recommended fastening on the surface (cross sectional drawing, only one screw is screwed in for better representation)

1 Surface
2 Mounting plate of the linear actuator
3 Counterbore
4 Through hole for M3 (in the mounting plate of the linear actuator)
5 M3 threaded hole (in the surface)
6 Fastening screw: Cylinder head, M3 (ISO 4762)

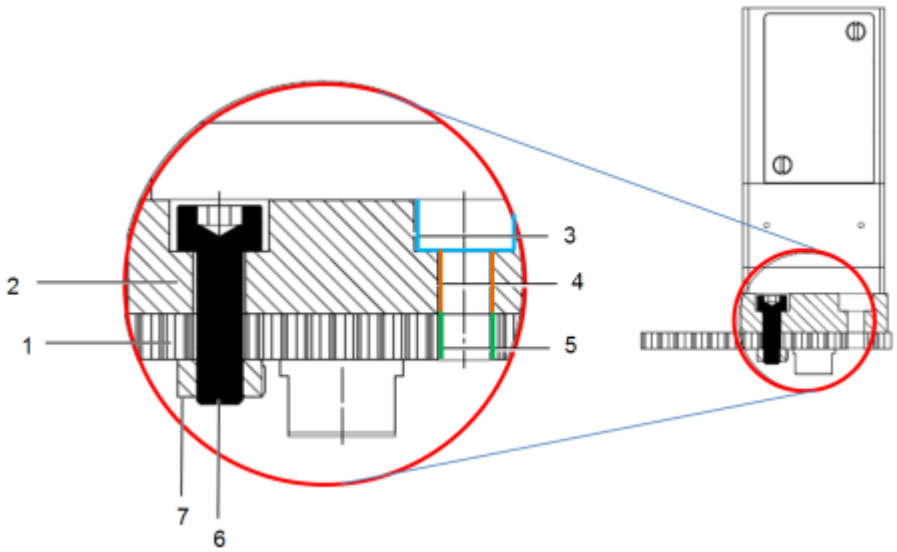

Figure 6: Example of alternative to recommended fastening (with through hole in the surface and nut)

1 Surface
2 Mounting plate of the linear actuator
3 Counterbore
4 Through hole for M3 (in t he mounting plate of the linear actuator)
5 Through hole for M3 (in the surface)
6 Fastening screw: Cylinder head, M3 (ISO 4762)
7 M3 nut

Providing a suitable installation environment

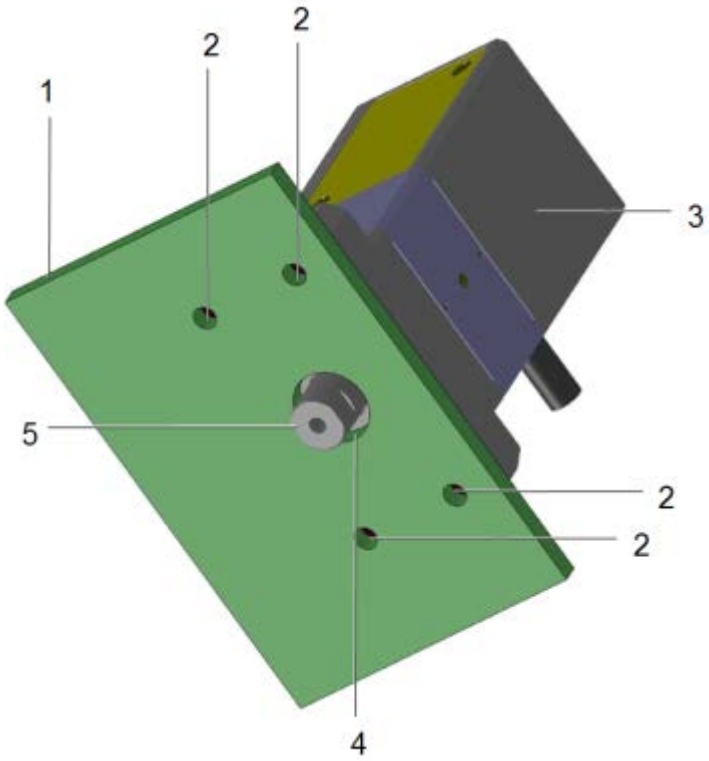

Figure 7: Linear actuator on surface (schematic); relevant components

1 Surface (section)
2 M3 threaded hole
3 Case of the linear actuator
4 Feedthrough for runner (here: hole 10 mm coaxial to the motion axis of the runner)
5 Runner of the linear actuator

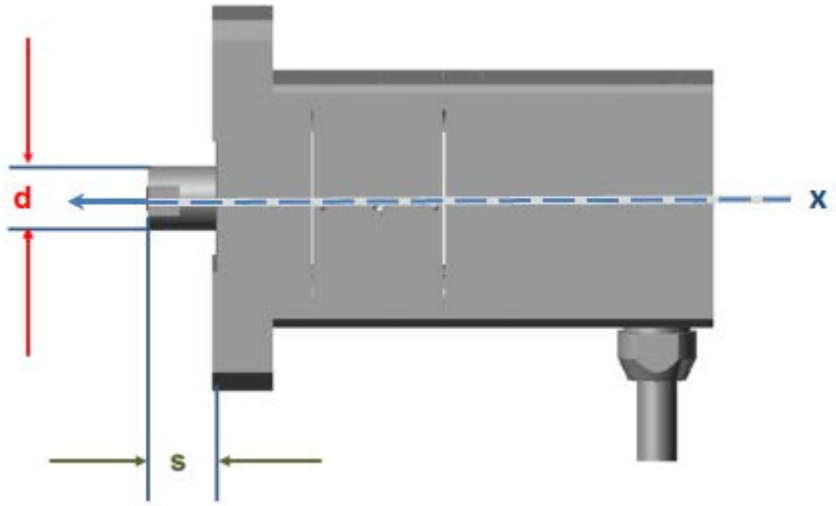

Figure 8: Relevant runner dimensions

d Diameter of the runner: 8 mm

s Distance between runner end - lower edge of the mounting plate
- with full use of the travel range: 3 mm to 13 mm,
- at center position: 8 mm (delivery state, switching point for reference point switch in the N-111.2A1)

x Motion axis of the runner

You can obtain all dimensions of the linear actuator and relevant individual parts in the section "Dimensions" (p. 42).

The intended use of the linear actuator requires a suitable installation environment.

- Make sure that the following conditions are met:
  - Material and statics of the surface and the screw connections (fastening screw / hole system) are designed so that the static and dynamic forces that occur can be safely and continuously managed.
  - Four M3 threaded holes and a feedthrough for the runner have been made in the surface.
  - The distances between the holes in the surface match the distances between the mounting holes of the linear actuator (dimensions see p. 42).
  - The depth of each hole is adapted to the length of the screws so that the linear actuator can be completely screwed in.
  - The position and size of the feedthrough for the runner prevent the runner from touching the surface after mounting (position and dimensions of the runner see p. 42 and above figure).
  - The ambient conditions do not exceed the ranges that are given in the specification for the N-111 (see Technical Data (p. 37)).
- When planning the application and installing the linear actuator, take account of the space required for routing the cables without kinks and in accordance with regulations:
  - Length of the connection cable: approx. 1.5 m

- If necessary, provide measures to limit or compensate for undesirable forces and torques (example: gravity compensation in the case of vertical mounting).
- If possible, perform a graphic simulation of the intended actuator motions with a mounted load or suitable calculations, in order to identify possible collisions within the application.
- If necessary, implement suitable design- or control-related measures to avoid collisions during operation of the linear actuator.
  Example:
  Collisions of the load with the surface when the runner is moved inwards can be avoided by the following measures:
  - Spacers (flat washers or sleeves) between the runner and load
  - Reduced thickness of the surface
  - Limitation of the travel range in the PC software
- In accordance with legal regulations, avoid or label danger areas that result from installation of the linear actuator and from use (e.g., risk of crushing in the case of heavy moving loads, fast actuator motions and/or high drive torques).

5.2 Mounting the N-111

INFORMATION

For optimum repeatability, all components must be firmly affixed to each other.

Tools and accessories

- Four M3 cylinder head screws (ISO 4762) with suitable length
- Suitable screwdriver or hex key

Requirements

- ✓ You have provided a suitable installation environment (p. 15).
- ✓ The linear actuator is **not** connected to the controller.

Mounting the N-111

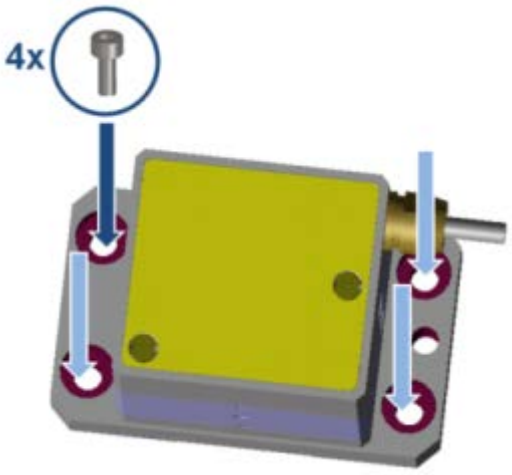

Figure 9: Position of the mounting holes, schematic

1. Position the mounting holes in the mounting plate of the linear actuator (see figure) over the corresponding holes in the surface.
2. Completely screw in the cylinder head screws at all mounting holes.
3. Check that the linear actuator fits on the surface without backlash.

5.3 Connecting the N-111 to the Protective Earth Conductor

INFORMATION

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

INFORMATION

➢ The hole for the protective earth connection is marked on the product p. 10.

Tools and accessories

- Suitable protective earth conductor: conductor cross-section ≥ 0.75 mm^2, insulation green/yellow
- M4 screw set (included in the scope of delivery of the linear actuator)
- Philips-head screwdriver (PH 2)

Connecting the N-111 to the protective earth conductor

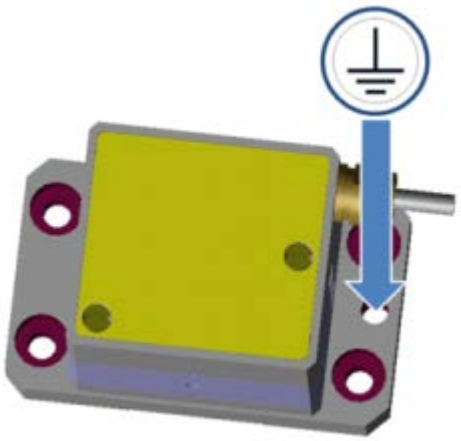

Figure 10: Position of the protective earth connection

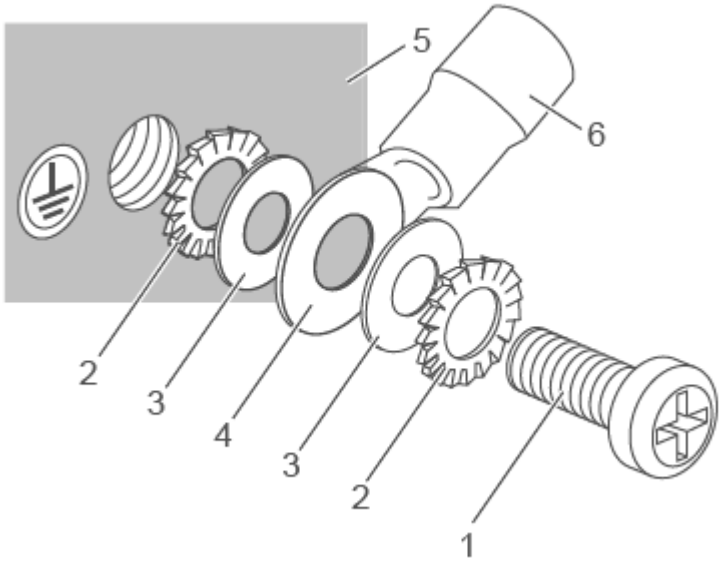

Figure 11: Mounting of protective earth connection (schematic)

1	M4 screw
2	Toothed washer
3	Flat washer
4	Cable lug
5	linear actuator case with protective earth connection (M4 threaded hole) and protective earth conductor symbol
6	Protective earth conductor

1. If necessary, fasten a suitable cable lug to the protective earth conductor.
2. Remove the screw, the toothed washers and flat washers from the package of the screw set.

3. As shown in the above figure: fasten one flat washer and one toothed washer each above and below the protective earth conductor or its cable lug with the screw on the protective earth connection of the linear actuator (position of the protective earth connection on the linear actuator: see figure above).
4. Tighten the screw with a torque of 1.2 Nm to 1.5 Nm.
5. Make sure that the protective earth conductor of the linear actuator is properly connected with the existing protective earth system within your application at all times.

5.4 Affixing the Load to the N-111

NOTICE

Impermissibly high load on the linear actuator

Impermissibly high loads inhibit the motion of the runner and can damage or destroy the linear actuator.

➢ With respect to mass and fastening type of the load, observe the maximum permissible active and passive forces and the resulting torques that are allowed to act on the runner according to the specification (p. 37).

INFORMATION

For optimum repeatability, all components must be firmly affixed to each other.

Requirements

✓ You have properly fastened the linear actuator according to the corresponding instructions (p. 20).

✓ The linear actuator is **not** connected to the controller.

Tools and accessories

- M3 fastening screw with suitable length (depth of the threaded hole: 5 mm; further dimensions see p. 42).
- If necessary: Spring washer(s) or M3 flat washer(s)
- Open-end wrench, AF 7
- Suitable screwdriver, hex key or open-end wrench for the fastening screw

Affixing load to the N-111

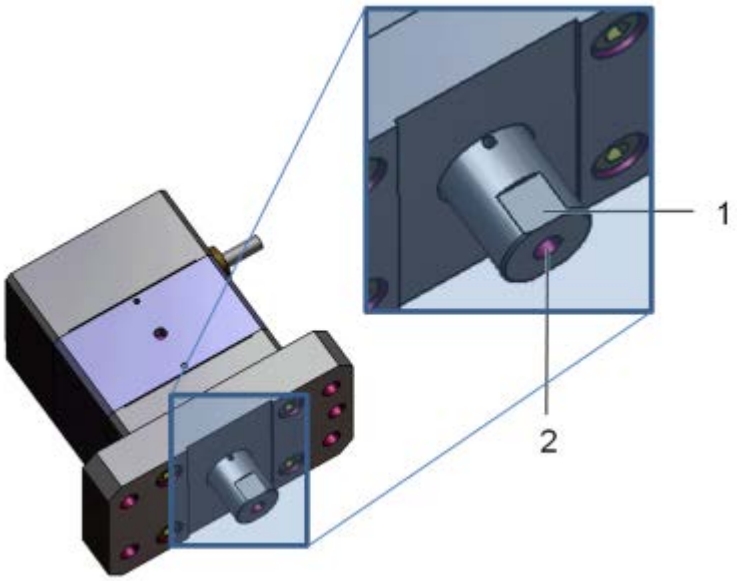

Figure 12: Relevant components of the runner for affixing the load

1 Wrench flat* of the runner
2 M3 threaded hole for affixing the load
* There is a further, parallel wrench flat on the runner that is symmetrical to the threaded hole and at a distance of 7 mm from the wrench flat shown (hidden in the above view).

1. Attach the runner: Apply the open-end wrench to the wrench flats of the runner.
2. Affix the load on the threaded hole in the runner of the linear actuator with the fastening screw and, if necessary, attached spacers, safety washers or spring washers: Screw in the screw until you feel a resistance and tighten the screw with a torque of 1.1 Nm.
3. Check that the load is affixed firmly.

5.5 Connecting the N-111 to the Controller

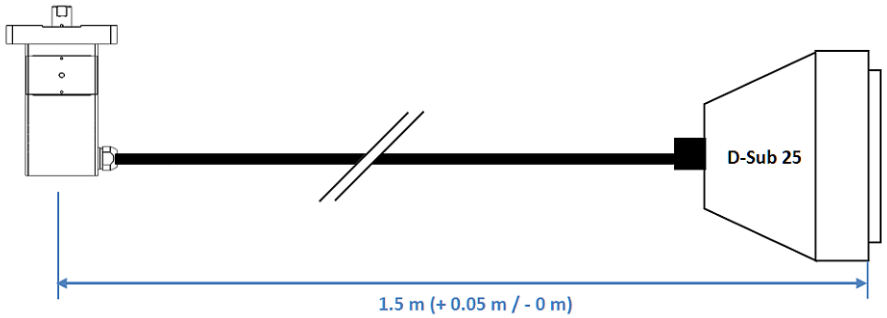

Figure 13: Cabling diagram

Requirements

- ✓ You have mounted the linear actuator properly (p. 15) and have connected the protective earth conductor (p. 21).
- ✓ You have installed a suitable controller (p. 11).
- ✓ You have read and understood the user manual of the controller.

Connecting the N-111 to the controller

1. Connect the connector of the linear actuator to the corresponding socket of the controller (see user manual of the controller).
2. Secure the connection with the integrated screws against accidental disconnection.
3. Eliminate or label resulting danger areas in accordance with the valid regulations and recommendations.

6 Startup and Operation

In this Chapter

6.1 General Notes on Startup and Operation

CAUTION

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

If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the N-111 in the case of malfunction or failure of the system. If touch voltages exist, touching the N-111 can result in minor injuries from electric shock.

- Connect the N-111 to a protective earth conductor before startup (p. 21).
- 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-111 to the protective earth conductor before starting it up again.

CAUTION

Dangerous voltage and residual charge on piezo actuators!

The N-111 is driven by piezo actuators. Temperature changes and compressive stresses can induce charges in piezo actuators. After disconnection from the electronics, piezo actuators can remain charged for several hours. Touching or short-circuiting the contacts in the connector of the N-111 can lead to minor injuries from electric shock. The piezo actuators can be destroyed by an abrupt contraction.

- Do **not** open the N-111.
- Do **not** touch the contacts in the connector of the linear actuator.
- Secure the connector of the linear actuator with screws against being pulled out of the controller.

If you want to pull out the connector of the linear actuator:

- Do **not** pull the connector out of the controller during operation.
- Discharge the linear actuator **before pulling out the connector (p. 29).**
- If possible: Switch off the controller and wait at least 10 seconds **before pulling out the connector**.

NOTICE

Destruction of the drive at the end position due to continuous high voltage!

High voltages that are applied to the piezo actuators can damage the NEXLINE® drive.

If it is necessary to hold a constant position for one hour or longer:

- After reaching the target position, set the voltage at the drive to 0 V either manually or with the "RNP" command.
- Afterwards, make sure that the desired operating mode (open loop / closed loop) is maintained.

NOTICE

Heating up of the N-111 during operation!

The heat produced during operation of the N-111 can affect your application.

- Install the N-111 so that your application is not affected by the dissipating heat.

NOTICE

Uncontrolled oscillation!

Your application and the N-111 can be damaged by uncontrolled oscillation. Uncontrolled oscillations can be identified by the fact that the linear actuator approaches the target position too slowly or too fast or does not keep it stable (servo jitter).

If uncontrolled oscillation occurs during the operation of the N-111:

- Switch off the servo control system of the affected axis immediately.
- Check the settings of the servo control parameters.

NOTICE

Increased friction due to lateral forces on the runner!

Lateral forces that act on the runner of the N-111 increase the friction between the runner and internal drive components. Increased friction impairs the motion of the runner and increases the wear of the drive components.

- Avoid lateral forces on the runner of the N-111.

INFORMATION

For sending commands to the linear actuator, the outward motion of the runner is defined as positive direction of motion.

INFORMATION

In the ideal application case, the linear actuator is operated quasi-statically. In quasi-static operation, the load is mainly kept at a particular position and only temporarily positioned (stepping mode).

For the N-111.2A1, the following also applies:

INFORMATION

The repeatability of the positioning is only ensured when the reference point switch is always approached from the same side. Recommended controllers from PI fulfill this requirement with their automatic direction detection for reference moves to the reference point switch.

6.2 Operating the N-111

Requirements

- ✓ You have read and understood the user manual of the controller.
- ✓ You have read and understood the user manual of the PC software.
- ✓ You have properly mounted the linear actuator (p. 15) and connected the protective earth conductor (p. 21).
- ✓ The controller and the required PC software have been installed. All connections with the controller have been established (see user manual of the controller).

Operating the N-111

- ➢ Follow the instructions in the manual for the electronics (p. 11) used for startup and operation of the N-111.

6.3 Discharging the N-111

The N-111 must be discharged in the following cases:

- When the N-111 is not used but the controller remains switched on to ensure temperature stability
- Before pulling out the connector of the N-111 (e.g., before cleaning and transport of the N-111 and for modifications of the application)

Discharging the N-111

1. If you are working in closed-loop operation: Switch off the servo mode on the controller.
2. Set the piezo voltage to 0 V on the controller.
3. If you want to disconnect the N-111 from the controller:
   - If possible: Switch off the controller.
   - Wait at least 10 seconds before disconnection

7 Maintenance

In this Chapter

7.1 General Notes on Maintenance

NOTICE

Damage due to improper maintenance!
The linear actuator can become misaligned as a result of improper maintenance. The specifications can change as a result (p. 37).

➢ Only loosen screws according to the instructions in this manual.

7.2 Cleaning the N-111

Requirements

✓ You have discharged the piezo actuators of the N-111 (p. 29).

✓ You have disconnected the N-111 from the controller.

Cleaning the N-111

➢ Clean the surfaces of the N-111 with a cloth dampened with a mild cleanser or disinfectant (e.g., isopropyl alcohol).

➢ Do **not** do any ultrasonic cleaning.

8 Troubleshooting

Problem	Possible Causes	Solution
Target position is approached too slowly or with overshoot Target position is not kept stable Uncontrolled oscillation of the N-111	▪ Servo control parameters are not set optimally ▪ Large changes in the load	1. Switch off the servo control system immediately. 2. Check the settings of the servo control parameters. 3. If necessary, correct the settings of the servo control parameters.
Increased wear Reduced accuracy	Excessive lateral forces on the runner	➢ Avoid lateral forces on the runner of the N-111.
No or limited motion	▪ Excessive load ▪ Excessive counterforces in the direction of motion	➢ Reduce the load (see "Mechanical Load Capacity" (p. 39)). In the case of vertical mounting: ➢ Ensure gravity compensation so that the maximum load (p. 39) is not exceeded.

If the problem that occurred with your system is not listed in the table above or cannot be solved as described, contact our customer service department (p. 35).

9 Customer Service

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

- If you have any 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)
  - 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 department if requested.

The latest versions of the user manuals are available for download (p. 2) on our website.

10 Technical Data

In this Chapter

10.1 Specifications

10.1.1 Data Table

	N-111.201	N-111.2A1	Unit	Tolerance
Active axes	X	X		
Motion and positioning				
Travel range	10	10	mm	
Travel range in analog mode	±2	±2	µm	
Integrated sensor	–	Linear encoder		
Resolution, open loop	0.025	0.025	nm	typ.
Resolution, closed loop	–	5 nm		
Velocity (10 % duty cycle, full step mode)*	1.0	1.0	mm/s	max.
Velocity (100 % duty cycle, full step mode)*	0.6	0.6	mm/s	max.
Velocity (100 % duty cycle, nanostepping mode)**	0.4	0.4	mm/s	max.
Mechanical properties				
Drive force (active)***	50	50	N	max.
Holding force (passive)	70	70	N	min.
Drive properties				
Motor type	NEXLINE®	NEXLINE®		
Operating voltage	-250 to +250	-250 to +250	V	

	N-111.201	N-111.2A1	Unit	Tolerance
Miscellaneous				
Operating temperature range	0 to 55	0 to 55	°C	
Material	Aluminum, stainless steel, titanium	Aluminum, stainless steel, titanium		
Mass	245	325	g	
Cable length	1.5	1.5	m	±10 mm
Connector	Sub-D 25 (m)	Sub-D 25 (m)		
Recommended electronics	E-712.1AM	E-712.1AM		

* Depending on drive electronics.

** Depending on drive electronics. The maximum velocity in nanostepping mode is designed for the best possible constancy so that no velocity variations occur when executing the steps.

*** Data refer to operation in full step mode.

All specifications based on room temperature (22 °C ±3 °C).

10.1.2 Ambient Conditions and Classifications

Pay attention to the following ambient conditions and classifications for the N-111:

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 to 31°C, non-condensing Decreasing linearly to 50% relative humidity at 40 °C, non-condensing
Storage temperature	-20°C to 70°C
Transport temperature	-20°C to 70°C
Overvoltage category (in acc. with EN 60664-1 / VDE 0110-1)	II
Protection class (acc. to EN 61140 / VDE 0140-1)	I
Degree of pollution (acc. to EN 60664-1 / VDE 0110-1)	1
Degree of protection (acc. to IEC 60529)	IP20

10.2 Maximum Ratings

The N-111 is designed for the following maximum ratings:

Operating mode	Maximum operating voltage	Maximum operating frequency or velocity (unloaded)	Maximum power consumption*
Analog mode	+250 V; -250 V	700 Hz	1.65 W**
Full step mode		600 µm/s	2.6 W
Nanostepping mode		400 µm/s	

* for dynamic continuous operation (**not** recommended!)

** at full amplitude and a max. frequency of 250 Hz

10.3 Mechanical Load Capacity

Maximum values for torque and forces

Negative values in the table correspond to a reversal of the effective direction according to the following figure.

Parameter	Permissible values
Passive force (holding force, linear actuator currentless) F_h	- 70 N to 70 N
Active force (drive force) F_p	- 50 N to 50 N
Lateral force F_l	- 5 N to 5 N
Torque M_{rot} in the direction of the runner axis	- 0.2 Nm to 0.2 Nm
Torque M_l generated by lateral force (radial; not shown)	- 0.15 Nm to 0.15 Nm

The following figure shows the directions of acting forces and torques as examples. Depending on the orientation of the setup, effects of gravity must be included in the calculation.

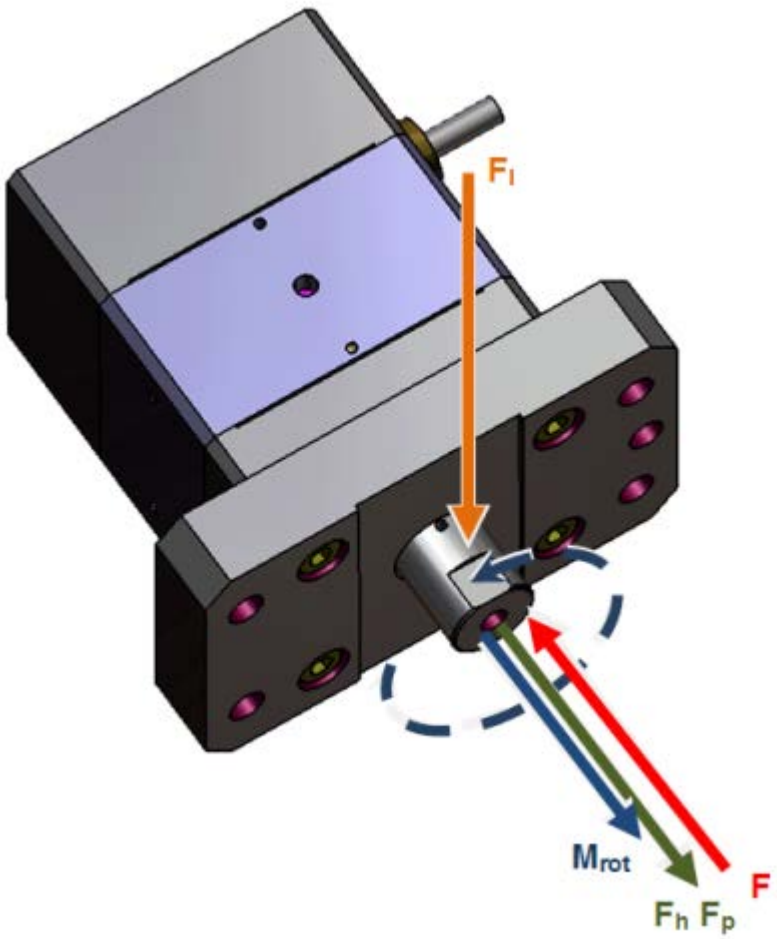

Figure 14: Forces and torques potentially affecting the runner (schematic)

F_p: Active force (direction for forward motion of the runner) or
F_h: Holding force (when the runner is at rest)
F: Force generated by load (positioning or holding)
F_l: Lateral force
M_{rot}: Torque (e.g. in the case of load mounting;
dashed: direction of action of the causal force)

Velocities and step sizes when the drive is loaded

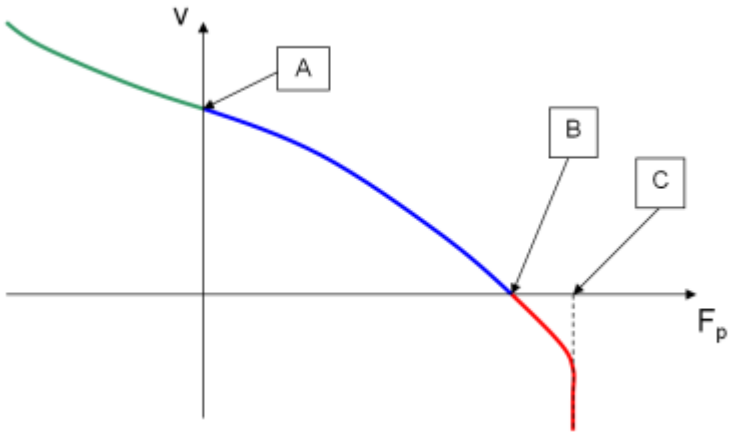

Figure 15: Velocity v as a function of the active force Fp (qualitative)

F_p: Active force
v: Velocity of the runner
Special conditions:
A: No load
B: Stop
C: Slippage

With increasing mass of the load (and thus the active force to be generated), the achievable step size of the drive elements and thus also the maximum velocity of the runner decrease (see explanations of the operation of the NEXLINE drive in the manual of the controller). The relationships are qualitatively shown in the above diagram.

In the unloaded state (point A), maximum step size and velocity are attained for horizontal mounting of linear actuator and load when no pull force acts in the direction of the runner axis.

Pull forces acting on the runner (e.g. gravity in the case of vertical mounting or, in relation to the horizontal line, inclined mounting of the system) can support the runner motion and cause the velocity to increase further (area left of point A).

On the contrary, the linear actuator applies the maximum active force to compensate for the maximum permissible load (point B). In this state, the velocity drops to 0.

In the currentless state of the linear actuator, the runner is clamped (holding force; generated by the preloaded piezo assemblies). Consequently, the position of a coupled load is held with a permissible load. If the holding force is overcompensated by an impermissibly high load, the clamping effect of the piezo assemblies on the runner is lost (slippage, point C).

Compared to the velocity, analog conditions result for the step sizes in normal operation (see graph, range to the left of B).

10.4 Dimensions

10.4.1 N-111.201

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

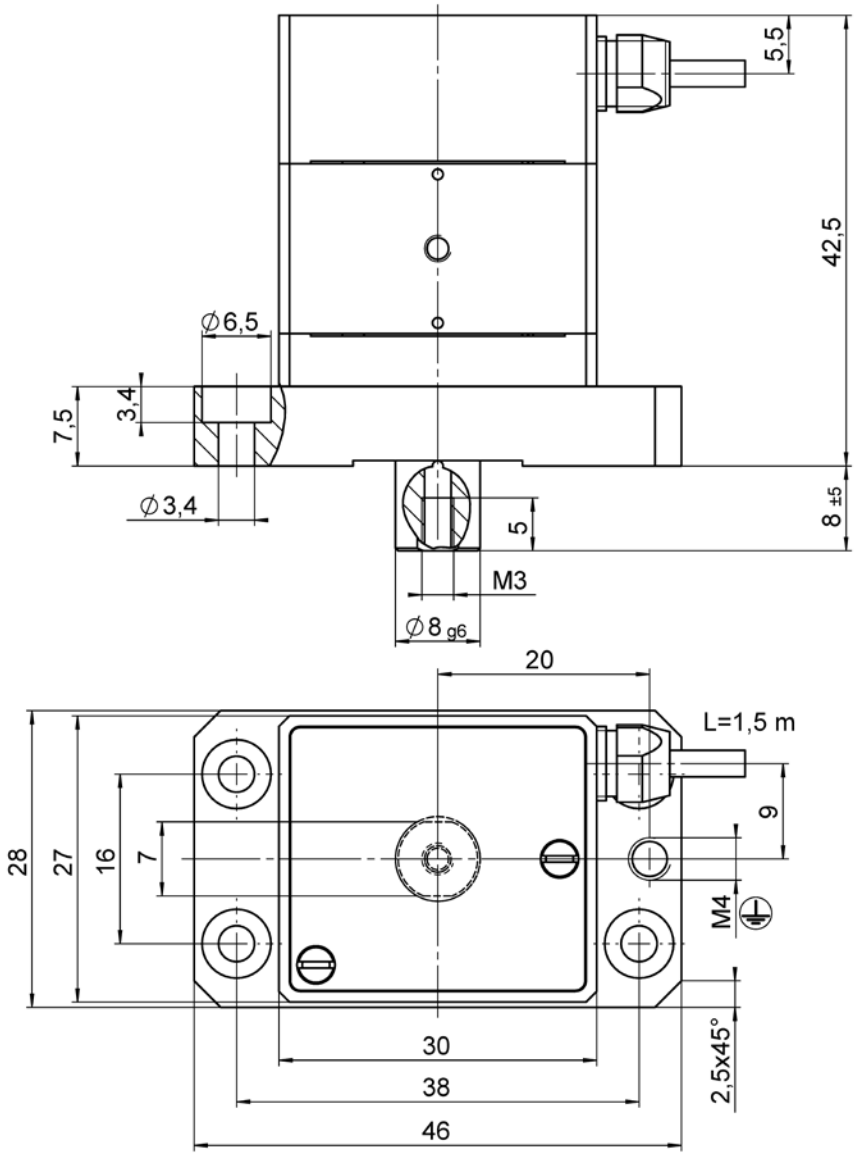

Figure 16: N-111.201 dimensions, runner at center position

10.4.2 N-111.2A1

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

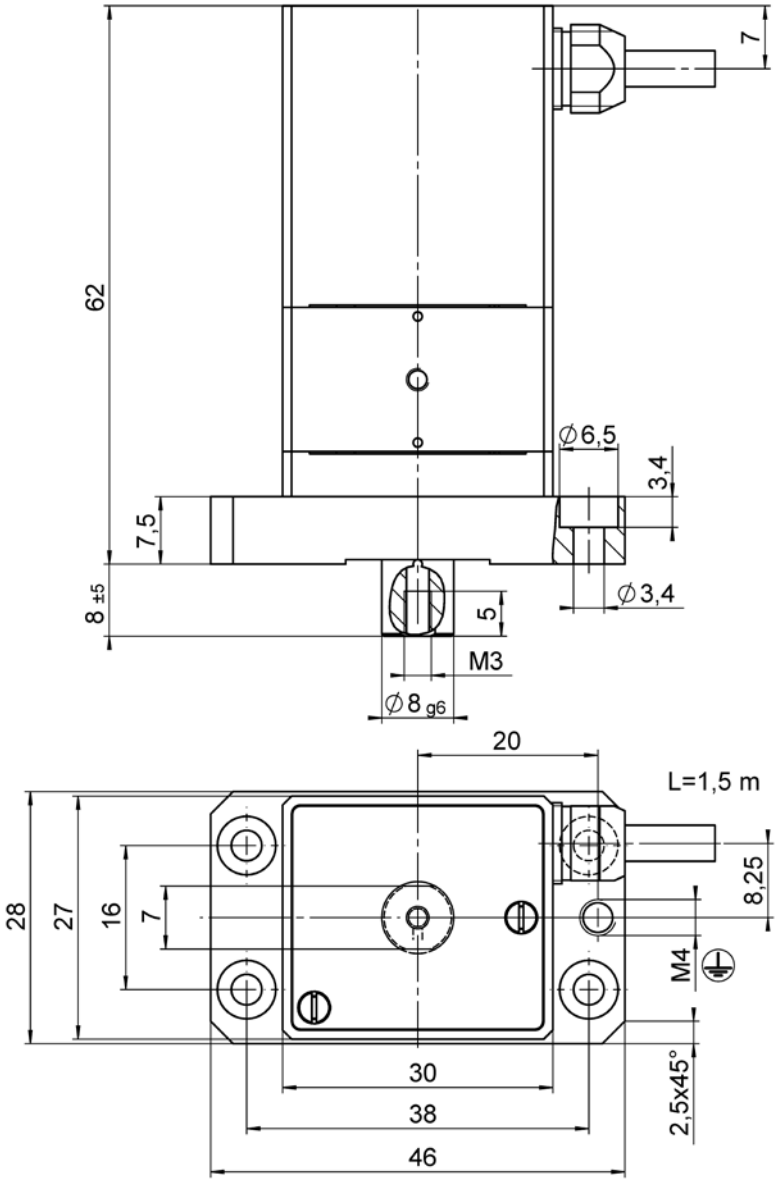

Figure 17: N-111.2A1 dimensions, runner at center position

10.5 Pin Assignment

10.5.1 N-111.201

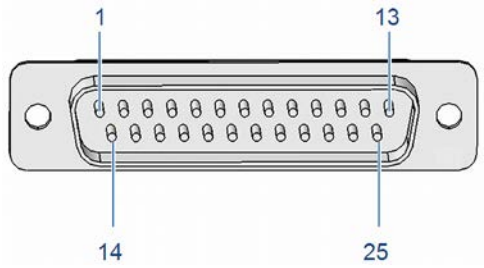

Figure 18: Sub-D 25 connector

Pin	Signal*	Function	Direction
1	D1+	Supply voltage for shearing group 1 (-250 V to 250 V)	Input
2	-		
3	-		
4	D2+	Supply voltage for shearing group 2 (-250 V to 250 V)	Input
5	-		
6	-		
7	-		
8	-		
9	-		
10	C+	Supply voltage for clamping group (-250 V to 250 V)	Input
11	-		
12	-		
13	-		
14	-		
15	D1-	Ground of shearing group 1	
16	-		
17	-		
18	D2-	Ground of shearing group 2	
19	-		
20	-		
21	-		
22	-		
23	-		

Pin	Signal*	Function	Direction
24	C-	Ground of clamping group	
25	-		

* The "-" sign indicates that the corresponding pin has not been assigned.

10.5.2 N-111.2A1

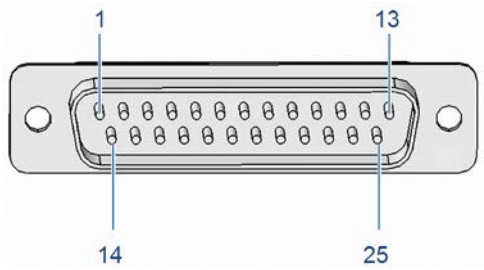

Figure 19: Sub-D 25 connector

Pin	Signal*	Function	Direction
1	D1+	Supply voltage for shearing group 1 (-250 V to 250 V)	Input
2	+5V (sensor)	Supply voltage for encoder	Input
3	+5V (ref)	Supply voltage for reference point switch	Input
4	D2+	Supply voltage for shearing group 2 (-250 V to 250 V)	Input
5	-		
6	-		
7	-		
8	GND (sensor)	Encoder ground	
9	GND (ref)	Ground of reference point switch	
10	C+	Supply voltage for clamping group (-250 V to 250 V)	Input
11	-		
12	Ref-	Reference point switch	Output
13	Ref+	Reference point switch	Output
14	-		
15	D1-	Ground of shearing group 1	
16	Sin+	Encoder signal 1 (sine)	Output
17	Sin-	Encoder signal 1 (sine)	Output
18	D2-	Ground of shearing group 2	
19	Cos+	Encoder signal 2 (cosine)	Output

Pin	Signal*	Function	Direction
20	Cos-	Encoder signal 2 (cosine)	Output
21	-		
22	-		
23	-		
24	C-	Ground of clamping group	
25	-		

* The "-" sign indicates that the corresponding pin has not been assigned.

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-111, an EU Declaration of Conformity has been issued in accordance with the following European directives:

Low Voltage Directive

EMC Directive

RoHS Directive

The applied standards certifying the conformity are listed below.

Safety (Low Voltage Directive): EN 61010-1

EMC: EN 61326-1

RoHS: EN 50581