MP142E

N-111 NEXLINE® Linear Actuator

User Manual

Version: 1.0.5 Date: 07.05.2024

This document describes the following products:

- **N-111.201**
  NEXLINE® OEM linear actuator; NEXLINE® piezo walking drive; 10 mm travel range; 50 N feed force; 1.5 m cable length
- **N-111.2A1**
  NEXLINE® OEM linear actuator; NEXLINE® piezo walking drive; 10 mm travel range; 50 N feed force; incremental linear encoder; 1.5 m cable length

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Contents

1 About this Document

In this Chapter

1.1 Objective and Target Group of this User Manual

This user manual contains the information necessary for using the N-111 as intended.

We assume that the user has basic knowledge of closed-loop systems, motion control concepts, and applicable safety measures.

1.2 Symbols and Typographic Conventions

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

DANGER

Immediate threat of danger
Failure to comply could result in death or serious injuries.

➢ Precautions to avoid the risk.

CAUTION

Dangerous situation
Failure to comply could result in minor injury or damage to the equipment.

➢ Precautions to avoid the risk.

NOTICE

Dangerous situation
Failure to comply could result in damage to the equipment.

➢ Precautions to avoid the risk.

INFORMATION
Information for easier handling, tricks, tips, etc.

Symbol/ Label	Meaning
1. 2.	Action consisting of several steps with strict sequential order
➢	Action consisting of one or more steps without relevant sequential order.
▪	Bullet point
p. 5	Cross-reference to page 5
RS-232	Label on the product indicating an operating element (example: RS-232 interface socket)
	Warning signs on 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 separate manuals.

Product	Document
E-712.1AM Digital Motion Controller	PZ195 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. 33).

Downloading manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., N-111).
3. In the search results, select the product to open the product detail page.
4. Select ***Downloads***.

   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 be sent to the email address entered in the form.

2 Safety

In this Chapter

2.1 Intended Use

The N-111 is a laboratory device as defined by DIN EN 61010-1. It is intended for indoor use and use in an environment that is free from dirt, oil, and lubricants.

In accordance with its design, the N-111 is intended for positioning, adjusting and shifting loads in one axis at various velocities.

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

The linear actuator is not intended for applications in areas where failure would be a considerable risk for people or the environment.

The linear actuator can only be used as intended when it is installed and in conjunction with suitable electronics. The electronics are not included in the scope of delivery of the linear actuator.

2.2 General Safety Instructions

The N-111 is built according to state-of-the-art technology and recognized safety standards. Improper use of the N-111 may result in personal injury and/or damage to the N-111.

- Use the N-111 for its intended purpose only, and only when it is in perfect condition.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for installing and operating the N-111 correctly.

2.3 Organizational Measures

User manual

- Always keep this user manual together with the N-111. The latest versions of the user manuals are available for download on our website (p. 3).
- Add all information from the manufacturer such as supplements or technical notes to the user manual.
- If you give the N-111 to other users, include this user manual as well as all other relevant information provided by the manufacturer.
- Do the work only if the user manual is complete. Missing information due to an incomplete user manual can result in minor injury and damage to equipment.
- Install and operate the N-111 only after you have read and understood this user manual.

Personnel qualification

The N-111 may only be installed, started, 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 lifting and holding forces (50 N / 70 N)
- High position resolution
- PiezoWalk® principle
- Self-locking, therefore no holding currents and no heat generation at rest
- Nonmagnetic function principle
- Can also be used in environments with:
  - Cleanroom 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 motion 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 measuring of the runner's position. The resolution here is 5 nm over the entire travel range (closed-loop operation).

Position resolutions up to 25 pm can be achieved in highly dynamic analog mode (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
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 for the controller.

3.2 Model Overview

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

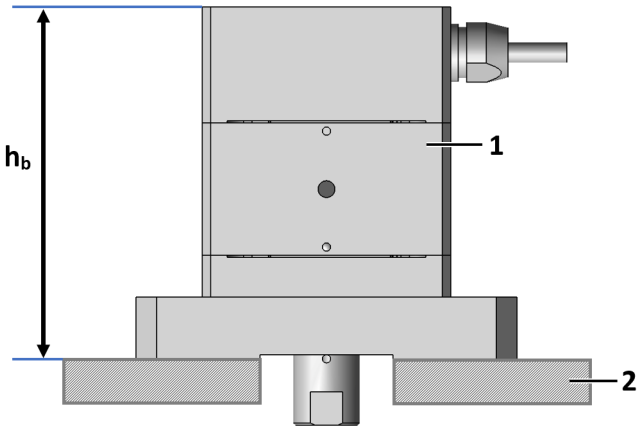

Figure 1: Height hb

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

Model	Description
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, refer to the specifications (p. 35).

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 required, contact our customer service department (p. 33) 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

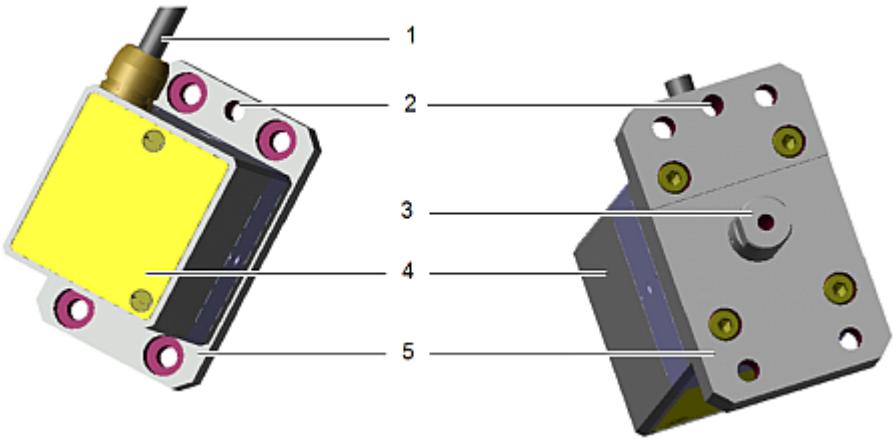

Figure 3: Position of important elements, top and bottom view of actuator case (schematic, components marked in color)

1 Connecting cable
2 Protective earth connector
3 Rod (nonrotating)
4 Actuator housing
5 Mounting plate

3.3.3 Product Labeling

Labeling	Description
N-111.2A1	Product name (example), the characters following the period refer to the model
123456789	Serial number (example), individual for each N-111 Meaning of each position (from the left): 1 = internal information, 2 and 3 = year of manufacture, 4 to 9 = consecutive number
PI	Manufacturer's logo
⚠	Warning sign "Pay attention to the manual!"
	Old equipment disposal (p. 45)
Country of origin: Germany	Country of origin
WWW.PI.WS	Manufacturer's address (website)
CE	CE conformity mark
⏚	Symbol for the protective earth conductor, marks the protective earth connector of the N-111 (p. 20)
⚠	Warning sign "Attention! Residual voltage"

3.4 Scope of Delivery

The N-111 is delivered with the following components:

Product no.	Description
N-111.2x1	NEXLINE® linear actuator according to order (p. 8)
000036450	M4 screw set for protective earth, consisting of: ▪ 1 flat-head screw with cross recess, M4x8, ISO 7045 ▪ 2 lock washers ▪ 2 flat washers
MP142E	User manual (this document) in printed form
	Packaging material

3.5 Suitable Controllers

Product no.	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. 35).

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 Switch

The linear actuator is equipped with a direction-sensing reference 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 switch.

For the commands that make use of the reference point signal, refer to the controller user manual and/or associated software manuals.

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 immediately (p. 33).
4. Keep all packaging materials in case the product needs to be returned.

5 Installing

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.

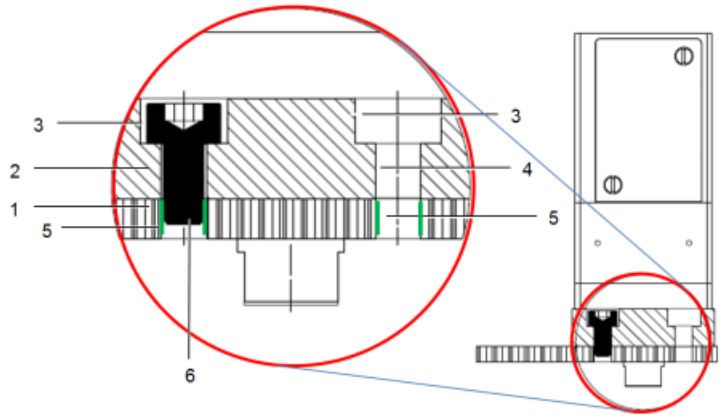

Figure 4: Recommended fastening on the surface (cross sectional drawing, only one screw is screwed in for better representation)

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)

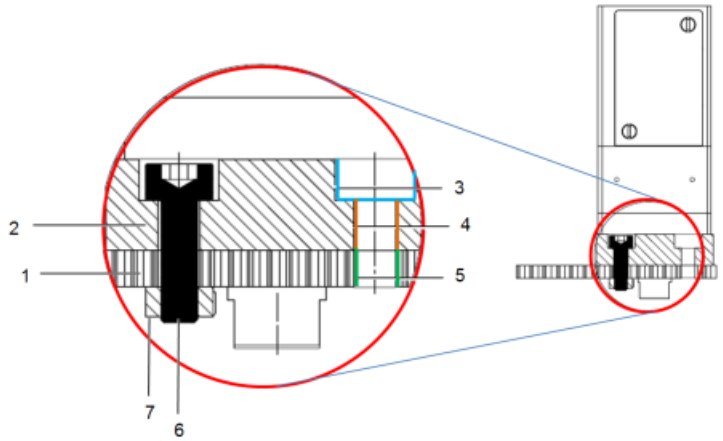

Figure 5: Example of alternative to recommended fastening (with through hole in the surface and nut)

1 Surface
2 Mounting plate of the linear actuator
3 Counterbore
4 Through hole for M3 (in the 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

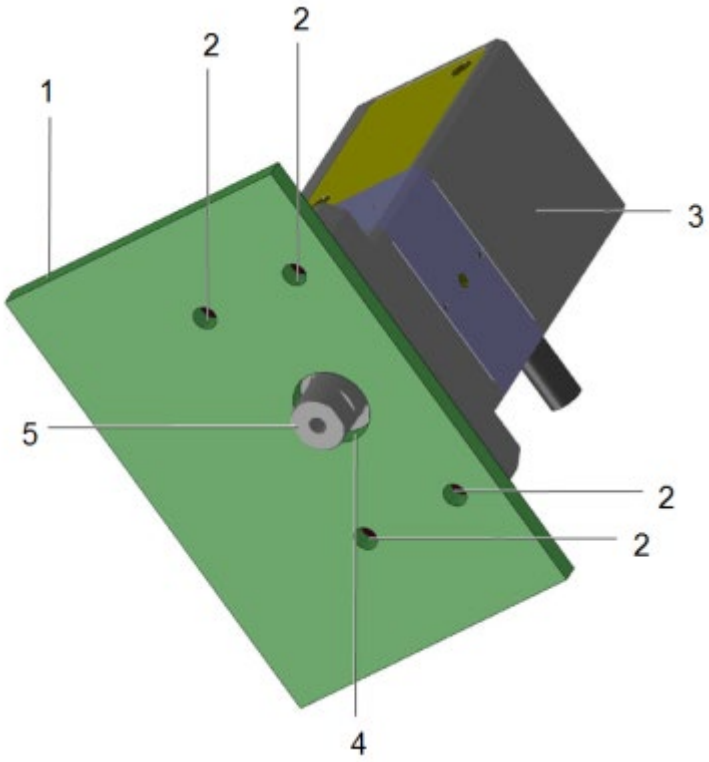

Figure 6: Linear actuator on surface (schematic); relevant components

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

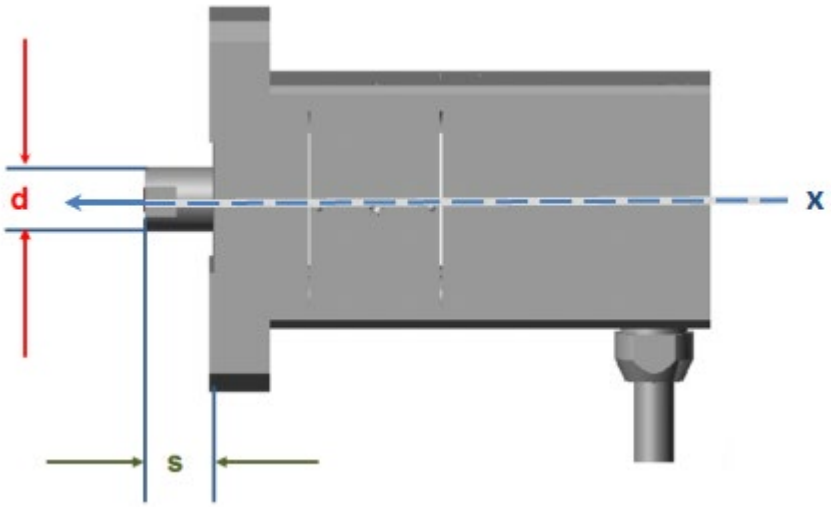

Figure 7: Relevant rod dimensions

d Diameter of the rod: 8 mm

s Distance between rod 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 switch in the N-111.2A1)

x Motion axis of the rod

You can obtain all dimensions of the linear actuator and relevant individual parts in the "Dimensions" (p. 40) section.

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 rod have been made in the surface.
  - The spaces between the holes in the surface match the spaces between the mounting holes of the linear actuator (see Dimensions p. 40).
  - 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 rod prevent the rod from touching the surface after mounting (position and dimensions of the rod see p. 40 and above figure).
  - The ambient conditions do not exceed the ranges that are specified for N-111 (see Technical Data (p. 35)).
- 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, do a graphic simulation of the intended actuator motions with a mounted load or suitable calculations 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 rod is moved inwards can be avoided by the following measures:
  - Spacers (flat washers or sleeves) between the rod 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

The N-111 actuator's runner is not connected to protective earth. Therefore, the runner must not be accessible anymore after the N-111 has been integrated. When installing the N-111 in the overall system, the operator is responsible for the electrical safety of the N-111, including the actuator's runner.

INFORMATION

For optimum repeatability, all components must be connected firmly together.

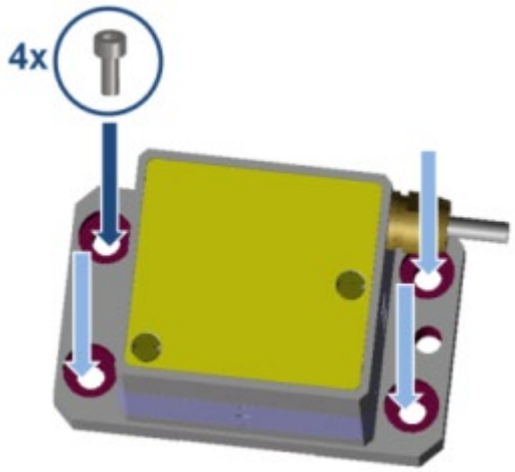

Figure 8: Position of the mounting holes, schematic

Requirements

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

Tools and accessories

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

Mounting the N-111

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 connector is marked on the product (p. 10).

INFORMATION

➢ If there is any vibration in your application, secure the screw connection for the protective earth conductor in a suitable manner (e.g., with conductive liquid adhesive) to prevent it from unscrewing by itself. If this is not possible, check the screw connection at regular intervals and retighten the screw if necessary.

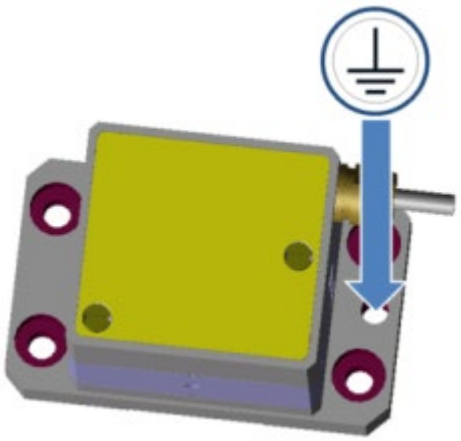

Figure 9: Position of the protective earth connector

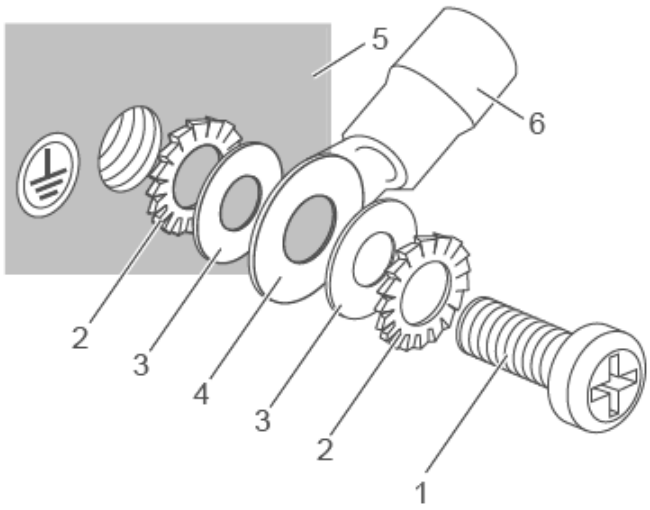

Figure 10: Mounting of the protective earth conductor (schematic)

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

Requirements

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

Tools and accessories

- Suitable protective earth conductor: Conductor cross section ≥ 0.75 mm², green/yellow insulation
- 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

1. If necessary, attach 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: Put one flat washer and one toothed washer each above and below the protective earth conductor or its cable lug and use a screw to fix it to the linear actuator's protective earth connector (for the position of the protective earth connector 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 linear actuator's protective earth conductor is always properly connected to the existing protective earth system in your application.

5.4 Fixing 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 the mass and type of mounting for the load, pay attention to the maximum permissible active and passive forces as well as the resulting torques that may act on the runner according to the specifications (p. 35).

INFORMATION

For optimum repeatability, all components must be connected firmly together.

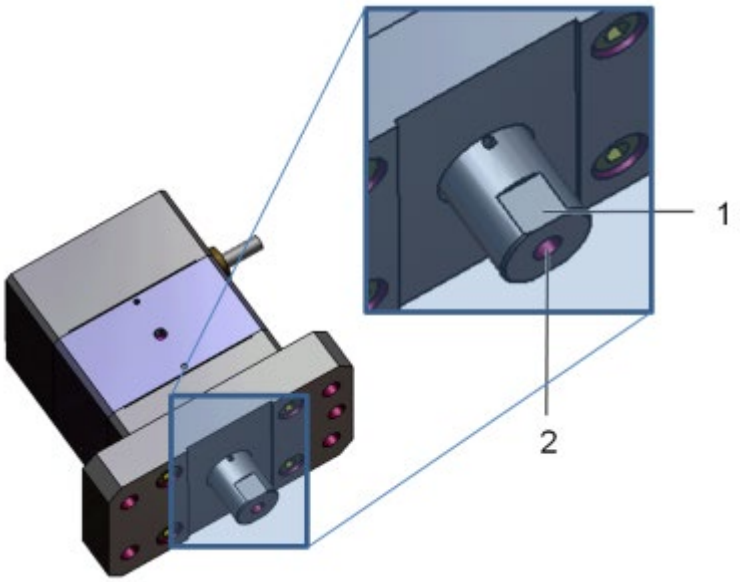

Figure 11: Relevant components of the rod for fixing the load

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

Requirements

- ✓ You have properly fastened the linear actuator according to the corresponding instructions (p. 19).
- ✓ The linear actuator is **not** connected to the controller.

Tools and accessories

- M3 fastening screw of a suitable length (depth of the threaded hole: 5 mm; further dimensions see p. 40).
- If necessary: Spring washer(s) or M3 flat washer(s)
- Open-end wrench, AF 7
- Suitable screwdriver, hexagonal key, or open-end wrench for the fastening screw

Fixing the load to the N-111

1. Hold the rod: Apply the open-end wrench to the wrench flats of the rod.
2. Fix the load on the threaded hole in the rod 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 maximum torque of 1.1 Nm.
3. Check that the load is fixed firmly.

5.5 Connecting the N-111 to the Controller

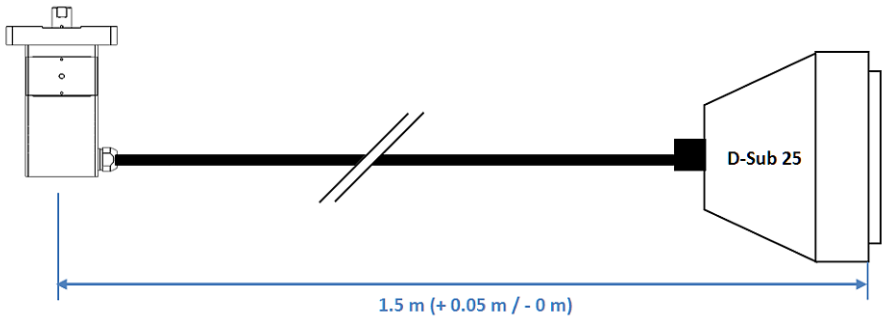

Figure 12: Cabling diagram

Requirements

- ✓ You have mounted the linear actuator properly (p. 15) and have connected the protective earth conductor (p. 20).
- ✓ You have installed a suitable controller (p. 10).
- ✓ You have read and understood the user manual for 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 for the controller).
2. Secure the connection with the integrated screws against accidental disconnection.
3. Eliminate or mark resulting danger zones according to applicable legal regulations and recommendations.

6 Starting and Operating

In this Chapter

6.1 General Notes on Starting and Operating

DANGER

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

If the protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the N-111 in the event of a malfunction or failure of the system. If there are touch voltages, touching the N-111 can result in serious injury or death from electric shock.

- Connect the N-111 to a protective earth conductor before starting (p. 20).
- 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 restarting.

CAUTION

Dangerous voltage and residual charge on piezo actuators!

The N-111 is driven by piezo actuators. Temperature changes and compressive stress can induce charges in piezo actuators. Piezo actuators can remain charged for several hours after disconnecting the electronics. Touching or short-circuiting the contacts in the N-111's connector 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. 27).**
- 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!

The NEXLINE® drive can be damaged if high voltages are applied to the piezo actuators over a longer period.

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 oscillation 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 operation of the N-111:

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

NOTICE

Increased friction due to lateral forces on the runner!

Lateral forces acting 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 wear on the drive components.

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

INFORMATION

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

INFORMATION

Ideally, the linear actuator is operated quasi statically in the application. The load is mainly kept at a particular position in quasistatic operation and only positioned temporarily (stepping mode).

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

INFORMATION

The repeatability of the positioning is only ensured when the reference 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 switch.

6.2 Operating the N-111

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. 15) the N-111 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-111

- ➢ Follow the instructions for starting and operating the N-111 in the manual for the electronics (p. 10) used.

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. 35).

➢ 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. 27).

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

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	▪ Servo control parameters are not optimally set ▪ 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.
Target position is not kept stable		
Uncontrolled oscillation of the N-111		
Increased wear	Excessive lateral forces on the runner	➢ Avoid lateral forces on the runner of the N-111.
Reduced accuracy		
No or limited motion	▪ Excessive load ▪ Excessive counterforces in the direction of motion	➢ Reduce the load (see "Mechanical Load Capacity" (p. 37)). In the case of vertical mounting: ➢ Ensure gravity compensation so that the maximum load (p. 37) is not exceeded.

If the problem with your system is not listed in the table above or cannot be solved as described, contact our customer service department (p. 33).

9 Customer Service Department

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

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

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

10 Technical Data

Subject to change. You can find the latest product specifications on the product web page at www.pi.ws (https://www.pi.ws).

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	D-sub 25 (m)	D-sub 25 (m)		
Recommended electronics	E-712.1AM	E-712.1AM		

* Depending on the drive electronics.

** Depending on the 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 refers to operation in full-step mode.

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 to 0.1 hPa
Relative humidity	Highest relative humidity of 80 % for temperatures up to 31 °C, noncondensing Decreasing linearly to 50 % relative air humidity at 40 °C, noncondensing
Storage temperature	-20 to 70 °C
Transport temperature	-20 to 70 °C
Overvoltage category (according to EN 60664-1 / VDE 0110-1)	II
Protection class (according to EN 61140 / VDE 0140-1)	I
Degree of pollution (according to EN 60664-1 / VDE 0110-1)	1
Degree of protection (according 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 no current) 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 setup orientation, gravitational effects must be included in the calculation.

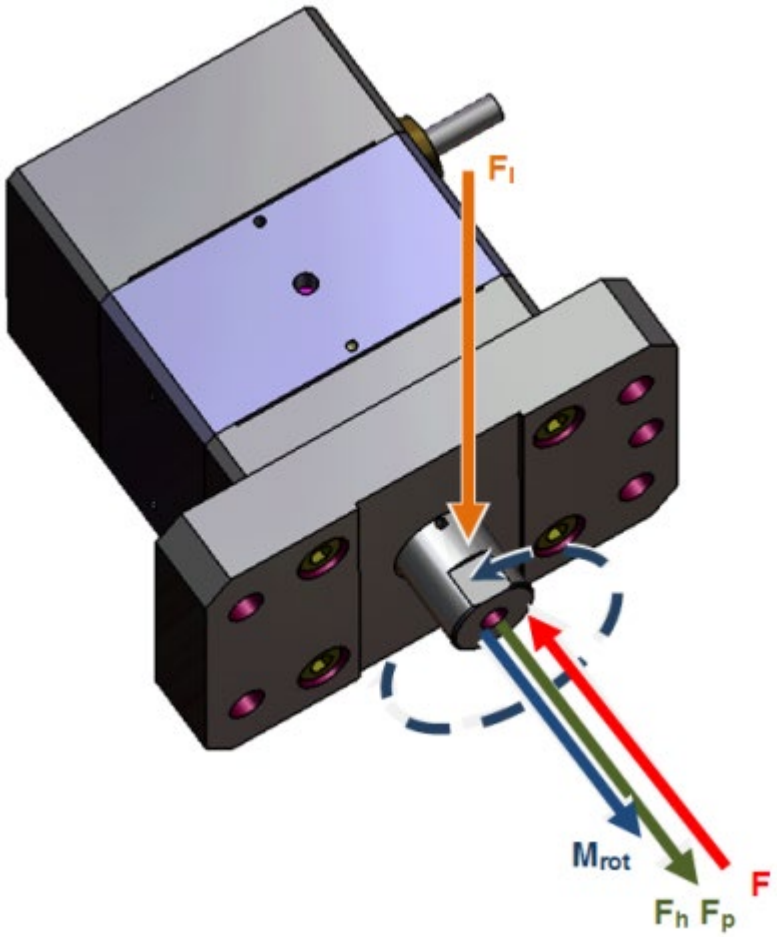

Figure 13: Forces and torques potentially affecting the rod (schematic)

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_I: Lateral force
M_{rot}: Torque (e.g., in the case of load mounting;
dashed: Effective direction of the causal force)

Velocities and step sizes when the drive is loaded

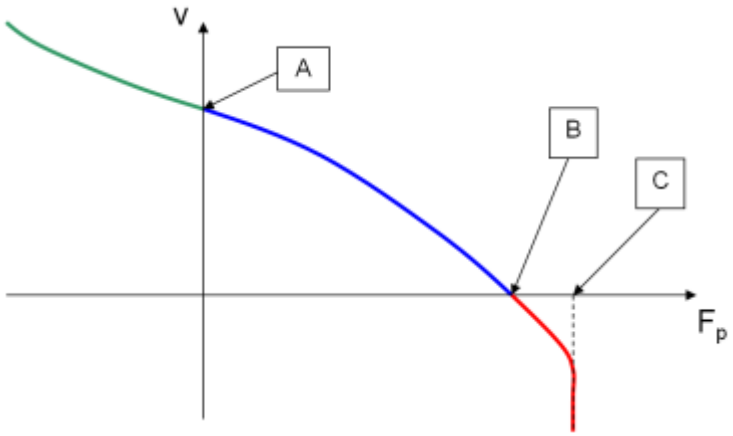

Figure 14: Velocity v as a function of the active force Fp (qualitative)

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

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

The maximum step size and velocity in an unloaded state (point A) for mounting the linear actuator and load horizontally are achieved if a pushing/pulling force is not acting in the direction of the runner axis.

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

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

The runner is clamped when current is not being supplied to the linear actuator (holding force; generated by preloaded piezo assemblies). Consequently, the position of a coupled load is held with a permissible load. If the holding force is overcompensated by an impermissible 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 points are separated by a comma in the drawings.

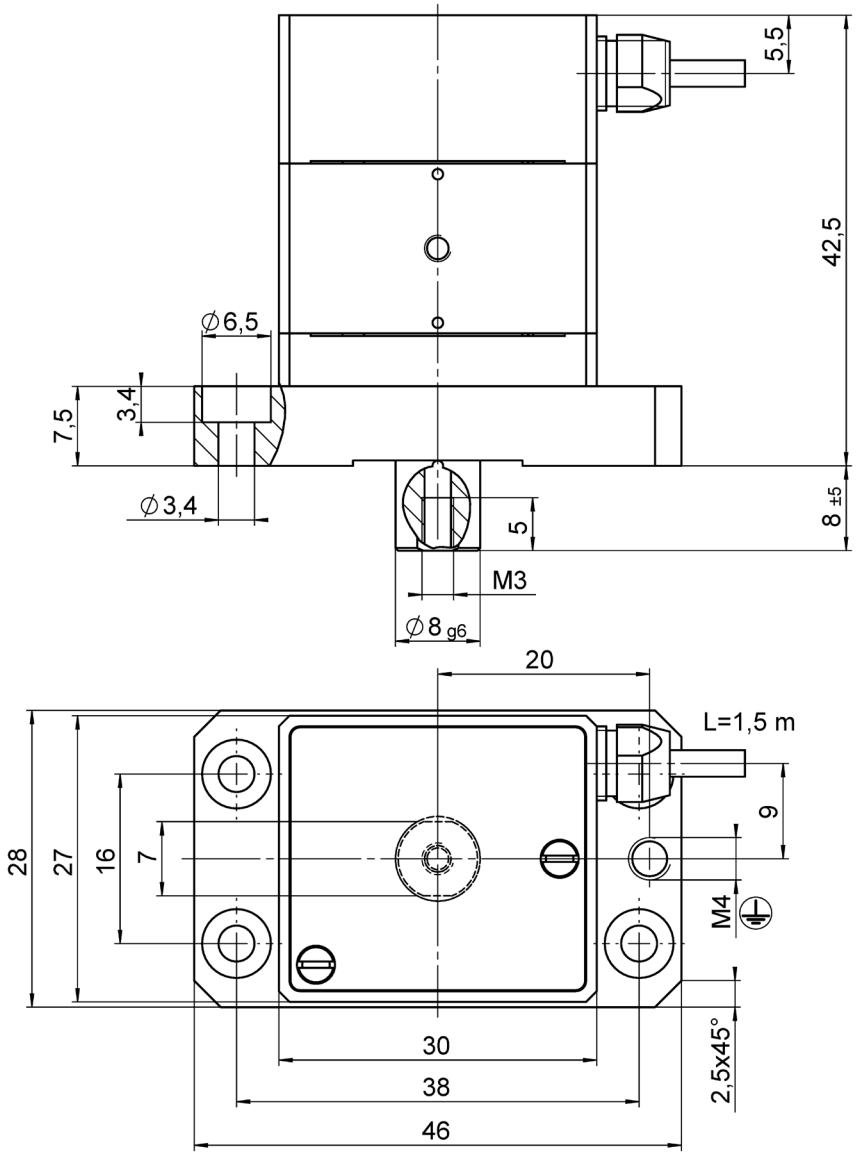

Figure 15: N-111.201 dimensions, runner at center position

10.4.2 N-111.2A1

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

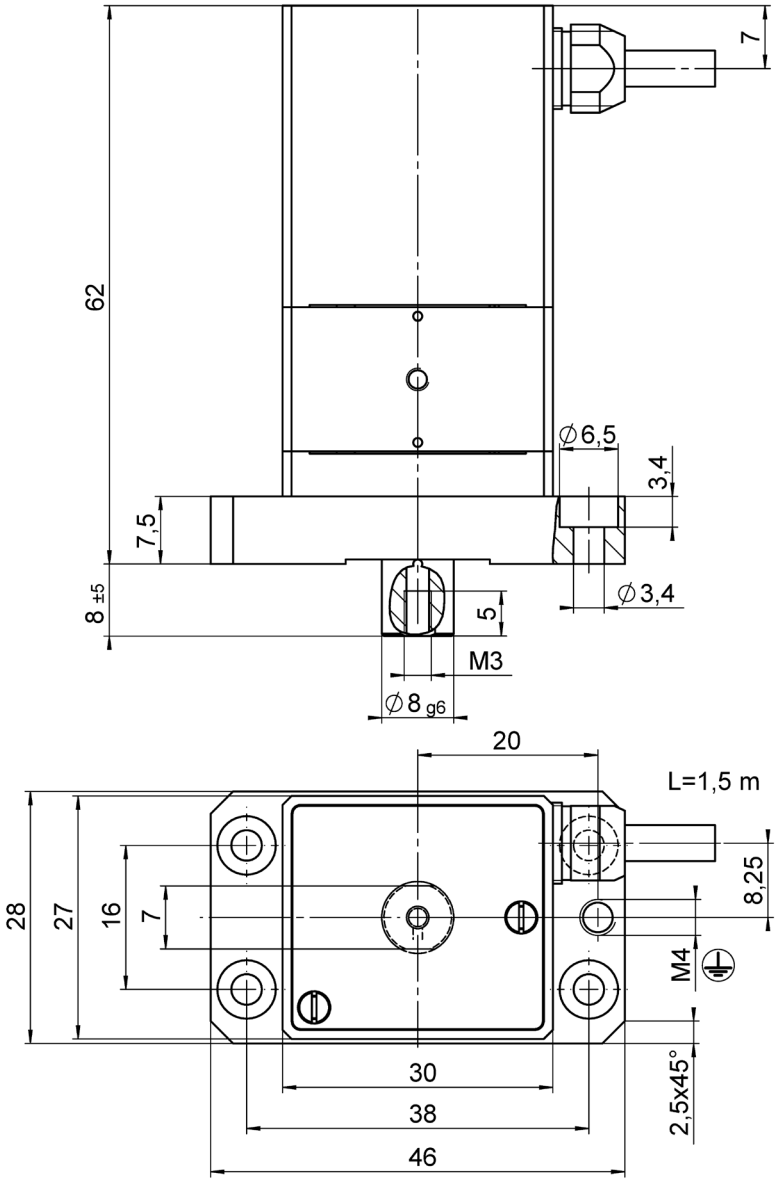

Figure 16: N-111.2A1 dimensions, runner at center position

10.5 Pin Assignment

10.5.1 N-111.201

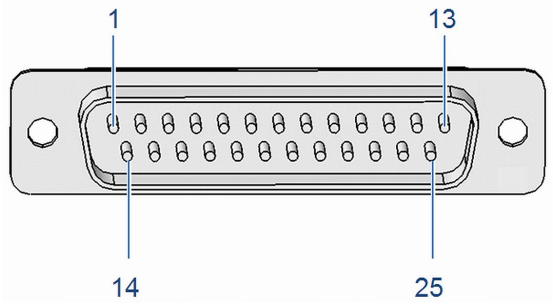

Figure 17: D-sub 25 connector (m), front view

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	-		
24	C-	Ground of clamping group	
25	-		

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

10.5.2 N-111.2A1

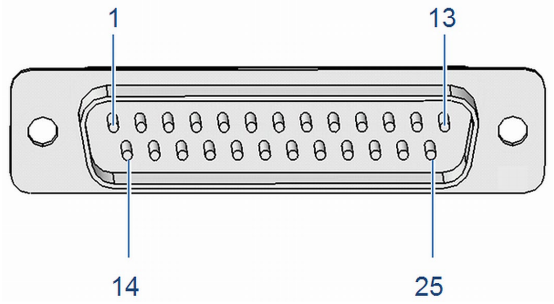

Figure 18: D-sub 25 connector (m), front view

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 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 switch	
10	C+	Supply voltage for clamping group (-250 V to 250 V)	Input
11	-		
12	Ref-	Reference switch	Output
13	Ref+	Reference 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
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.

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

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

Physik Instrumente (PI) GmbH & Co. KG

Auf der Römerstraße 1

76228 Karlsruhe, Germany

12 European Declarations of Conformity

For the N-111, declarations of conformity were issued according to the following European statutory requirements:

Low Voltage Directive

EMC Directive

RoHS Directive

The standards applied for certifying conformity are listed below.

Safety (Low Voltage Directive): EN 61010-1

EMC: EN 61326-1

RoHS: EN IEC 63000