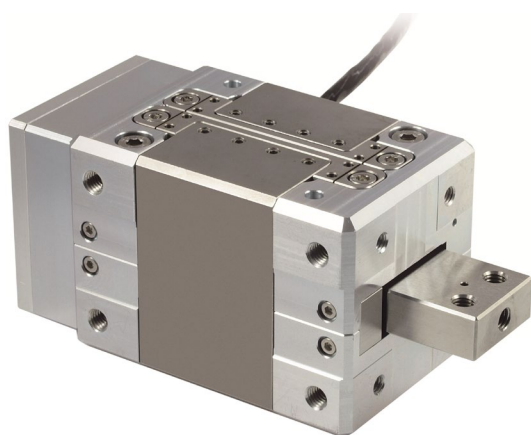


MP120E N-216 NEXLINE® Linear Actuator User Manual

Version: 1.1.0

Date: 08.11.2022



This document describes the following products:

- **N-216.101**
NEXLINE® piezo-walking high-load actuator,
20 mm, 300 N, open loop
- **N-216.1A1**
NEXLINE® piezo-walking high-load actuator,
20 mm, 300 N, linear encoder, 5 nm resolution
- **N-216.201**
NEXLINE® piezo-walking high-load actuator,
20 mm, 600 N, open loop
- **N-216.2A1**
NEXLINE® piezo-walking high-load actuator,
20 mm, 600 N, linear encoder, 5 nm resolution



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The patents held by PI are found in our patent list: <https://www.physikinstrumente.com/en/about-pi/patents>

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Original instructions

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Subject to change. This manual is superseded by any new release. The latest respective release is available for download (p. 3) on our website.

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1 About this Document

In this Chapter

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Symbols and Typographic Conventions	1
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1.1 Objective and Target Audience of this User Manual

This manual contains information on using the N-216 as intended.

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. 3) on our website.

1.2 Symbols and Typographic Conventions

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

DANGER



Immediate threat of danger

Failure to comply could lead to death or serious injury.

- Precautionary measures for avoiding the risk.

CAUTION



Dangerous situation

Failure to comply could lead to minor injuries or damage to equipment.



- Precautionary measures for avoiding the risk.

NOTICE



Dangerous situation



Failure to comply could cause damage to equipment.

- Precautionary measures for avoiding the risk.

INFORMATION

Information for easier handling, tricks, tips, etc.

**Symbol/
Label****Meaning**

1.	Action consisting of several steps with strict sequential order
2.	
➤	Action consisting of one or more steps without relevant sequential order.
▪	Bullet
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 Definition of Terms

Term	Explanation
Linear actuator	Electrically driven mechanics (here: N-216) with one motion axis
Electronics	Amplifier or controller that supplies the operating voltage for the mechanics
Amplifier	Electronics without sensor evaluation, suitable for operating mechanics in open-loop mode
Controller	Electronics with sensor evaluation, suitable for operating mechanics in open-loop and closed-loop mode

1.4 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.

1.5 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	PZ195E User Manual
PIMikroMove	SM148E Software Manual

1.6 Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

- Contact our customer service department (p. 27).

Downloading Manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., N-216).
3. Click the corresponding product to open the product detail page.
4. Click the **Downloads** tab.

The manuals are shown under **Documentation**. Software manuals are shown under **General Software Documentation**.

5. Click the desired manual and fill out the inquiry form.

The download link will then be sent to the email address entered.

2 Safety

In this Chapter

Intended Use.....	4
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Organizational Measures.....	5

2.1 Intended Use

The N-216 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 of dirt, oil, and lubricants.

In accordance with its design, the N-216 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 (p. 10). The electronics are not included in the scope of delivery of the linear actuator.

2.2 General Safety Instructions

The N-216 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-216.

- Use the N-216 for its intended purpose only, and only when it is in perfect technical condition.
- Read the user manual.
- Eliminate any malfunctions that may affect safety immediately.

The operator is responsible for the correct installation and operation of the N-216.

2.3 Organizational Measures

User manual

- Always keep this user manual together with the N-216.
The latest versions of the user manuals are available for download (p. 3) on our website.
- Add all information from the manufacturer to the user manual, for example supplements or technical notes.
- If you give the N-216 to a third party, include this user manual as well as 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-216 only after you have read and understood this user manual.

Personnel qualification

The N-216 may only be installed, started, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

3 Product Description

In this Chapter

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Model Overview.....	7
Product View.....	8
Scope of Delivery	9
Suitable Electronics.....	10
N-216.xA1 Only: Technical Features for Closed-Loop Operation	10

3.1 Features and Applications

- Travel range 20 mm
- Holding force to 800 N
- Resolution to 0.03 nm (open loop) respectively 5 nm (closed loop)
- 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-216 NEXLINE® 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). NEXLINE® drives therefore combine relatively long travel ranges with the nanometer precision of piezo actuators.

The N-216.1A1 and N-216.2A1 models are equipped with a linear encoder for acquiring the position of the runner directly. The resolution here is 5 nm over the entire travel range (closed-loop operation).

Position resolutions up to 30 pm can be achieved in high dynamics analog mode (open-loop operation).

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

Operating mode	Advantages
Full-step mode	<ul style="list-style-type: none"> ▪ Long travel ranges ▪ High velocity ▪ High dynamic forces
Nanostepping mode	<ul style="list-style-type: none"> ▪ Long travel ranges ▪ Low vibration ▪ Uniformity of motion
Analog mode	<ul style="list-style-type: none"> ▪ Travel ranges in the μm range ▪ High dynamics ▪ High resolution

- Obtain further details on the operating modes from the manual for the electronics (p. 2).

3.2 Model Overview

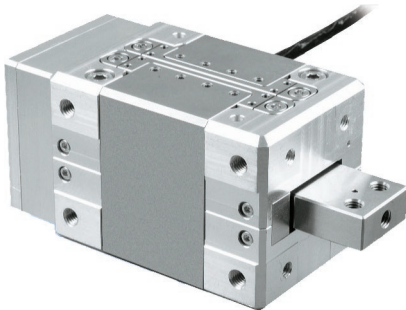


Figure 1: Product view of the N-216 (all models)

Four standard versions of the N-216 NEXLINE® linear actuator are available. They differ with respect to the presence of an integrated sensor (linear encoder) and the drive force.

Model	Description
N-216.101	NEXLINE® piezo-walking high-load actuator, 20 mm, 300 N, open loop
N-216.1A1	NEXLINE® piezo-walking high-load actuator, 20 mm, 300 N, linear encoder, 5 nm resolution
N-216.201	NEXLINE® piezo-walking high-load actuator, 20 mm, 600 N, open loop
N-216.2A1	NEXLINE® piezo-walking high-load actuator, 20 mm, 600 N, linear encoder, 5 nm resolution

- For further technical data, refer to the specifications (p. 28).

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. 27) directly.

3.3 Product View

3.3.1 Product Details

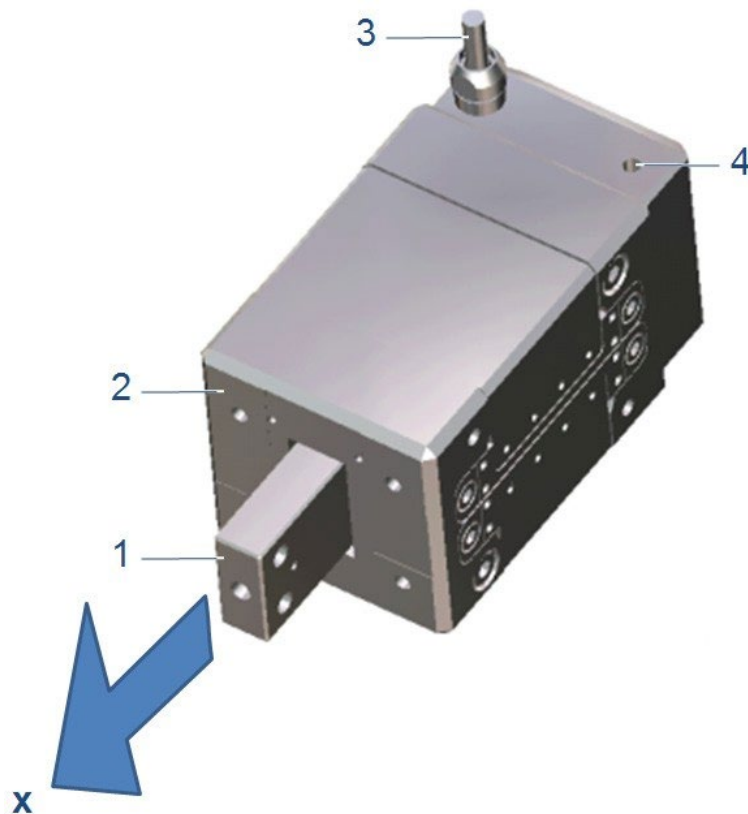


Figure 2: Position of important elements

- 1 Runner
- 2 Actuator housing
- 3 Connecting cable
- 4 Protective earth connector
- x Positive direction of motion of the runner

3.3.2 Product Labeling

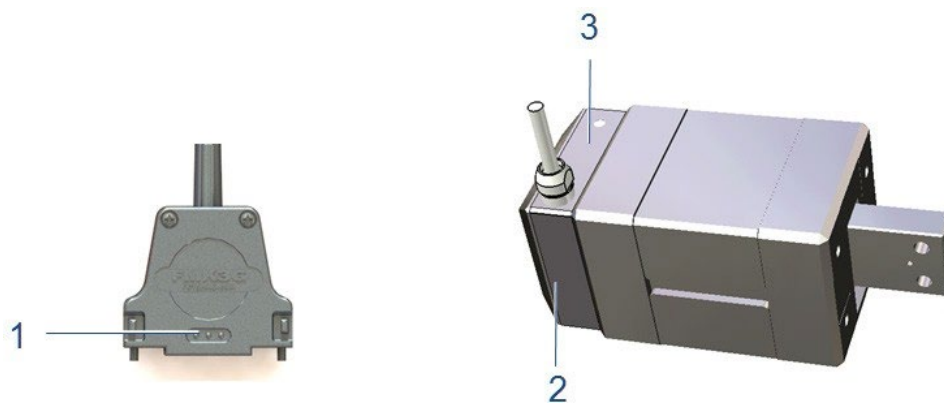








Figure 3: Position and appearance of the product labels

Labeling	Description
N-216.1A1	Product name (example), the characters following the period refer to the model
123456789	Serial number (example), individual for each N-216 Meaning of each position (from the left): 1 = internal information, 2 and 3 = year of manufacture, 4 to 9 = consecutive number
	Manufacturer's logo
Country of origin: Germany	Country of origin
WWW.PI.WS	Manufacturer's address (website)
	Warning sign "Pay attention to the manual!"
	Old equipment disposal (p. 37)
	CE conformity mark
	"High voltage" warning sign
	Symbol for the protective earth conductor (p. 17); indicates the protective earth connector

3.4 Scope of Delivery

The N-216 is delivered with the following components:

Product no.	Description
N-216.xx1	NEXLINE® linear actuator according to order (p. 7)
N216E0006	Mounting flange A
N216E0008	Mounting flange B
000036450	M4 screw set for protective earth, consisting of: <ul style="list-style-type: none"> 1 flat-head screw with cross recess, M4x8, ISO 7045 2 lock washers 2 flat washers
2175	DIN EN ISO 4762-M4x8-A2 mounting screws (4 screws)
2176	DIN 7984-M5x10-A4-70 mounting screws (4 screws)
MP120E	User manual (this document) in printed form
	Packaging materials

3.5 Suitable Electronics

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 N-216.xA1 Only: 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. 28).

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-216 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. 27) immediately.
4. Keep all packaging materials in case the product needs to be returned.

5 Installation

In this Chapter

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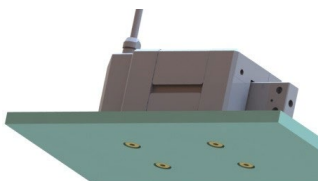
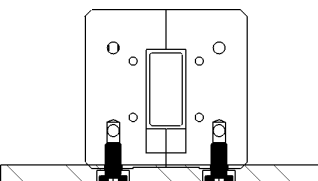
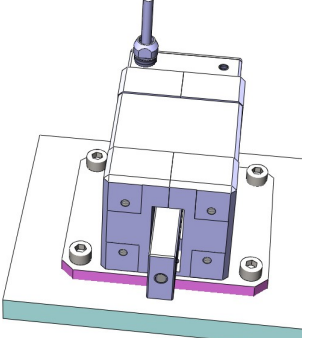
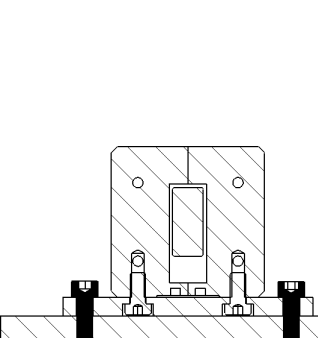
5.1 Mounting the N-216

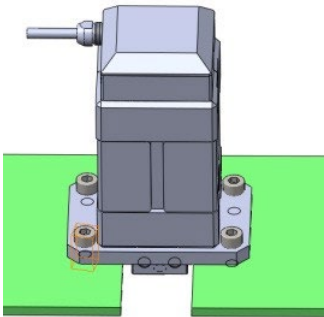
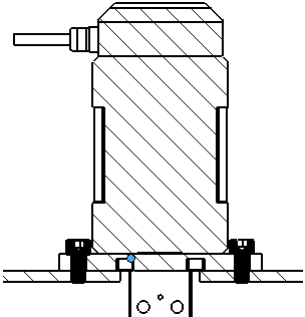
INFORMATION

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

5.1.1 Options

Depending on the application environment, the following options are available for mounting the actuator onto a surface:

Option	Example illustration		Preparing the actuator for mounting onto a surface
	Spatial view	Sectional view (Note the highlighted screws.)	
Direct mounting (here mounting on the "underneath"*; see "Mounting the N-216" (p. 16) for details)			None
Mounting using flange A			Fixing flange A onto the actuator (p. 13)

Option	Example illustration		Preparing the actuator for mounting onto a surface
	Spatial view	Sectional view (Note the highlighted screws.)	
Mounting using flange B			Fixing flange B onto the actuator (p. 14)

* It is also possible to use the threaded hole on the "runner side" of the actuator housing; refer to "Mounting the N-216" (p. 16).

5.1.2 Fixing the Mounting Flange A to the Actuator

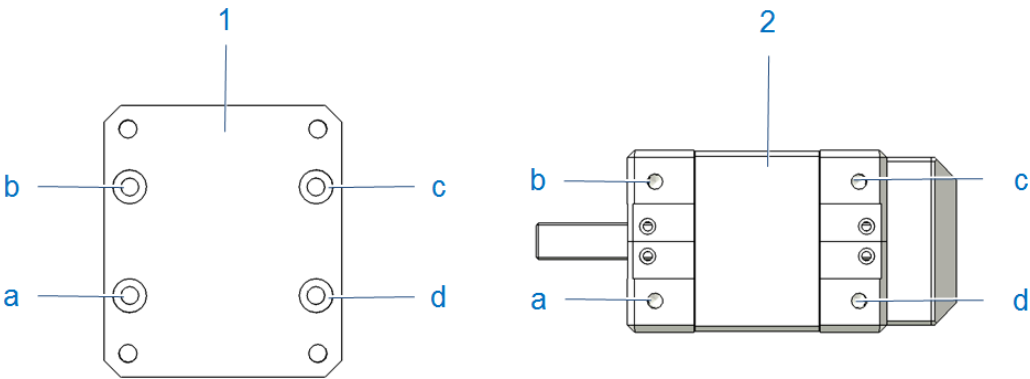


Figure 4: Overview of the mounting holes for mounting flange A

- 1 Mounting flange with holes a to d
 - 2 Actuator with threaded holes a to d
- Holes that cover each other during mounting are indicated by the same letter.

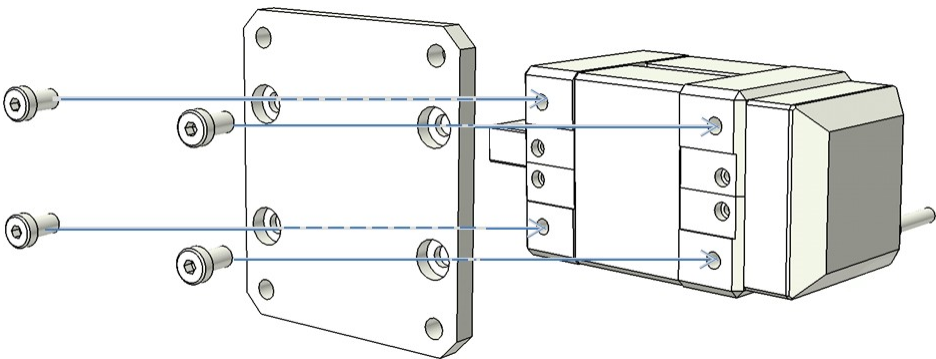


Figure 5: Mounting flange A (exploded view)

Requirements

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

Tools and accessories

- Mounting flange A, N216E0006 (p. 9)
- Four socket head screws, M5x10, DIN 7984 (p. 9)
- Suitable hex key AF 4 (or comparable screwdriver)

Fixing the mounting flange A to the actuator

1. Position the holes in the mounting flange over the corresponding holes in the actuator. Note that the countersunk holes must be visible (i.e., facing upwards). For details on correct alignment, refer to the mounting hole overview and exploded view.
2. Tighten the socket head screws in all mounting holes.
3. Check that the seating of the mounting flange on the N-216 is free of play.

5.1.3 Fixing the Mounting Flange B to the Actuator

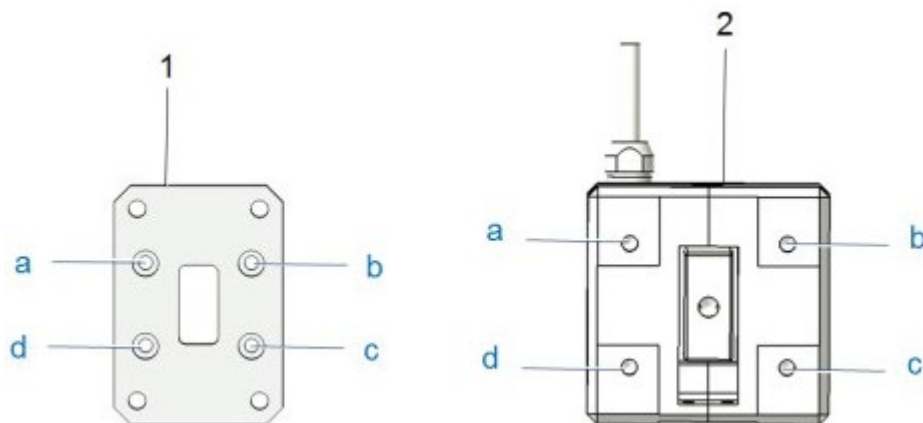


Figure 6: Overview of the mounting holes for mounting flange B

- 1 Mounting flange B with holes a to d
 - 2 Actuator with threaded holes a to d
- Holes that cover each other during mounting are indicated by the same letter.

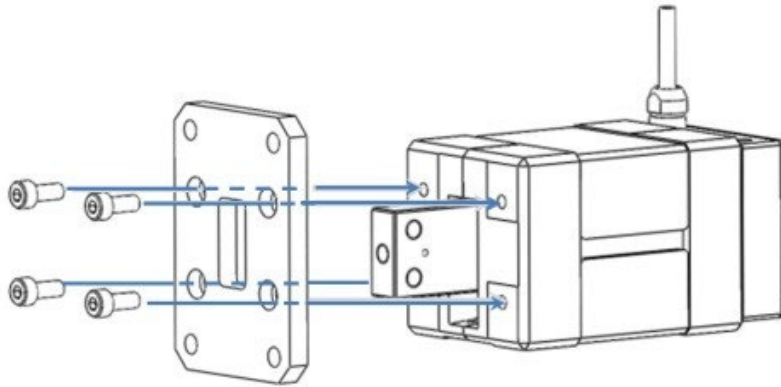


Figure 7: Mounting flange B (exploded view)

Requirements

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

Tools and accessories

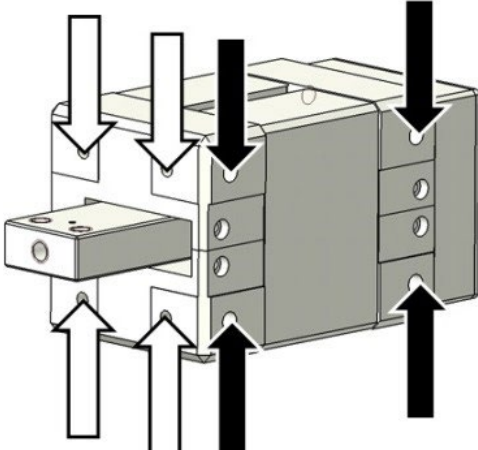
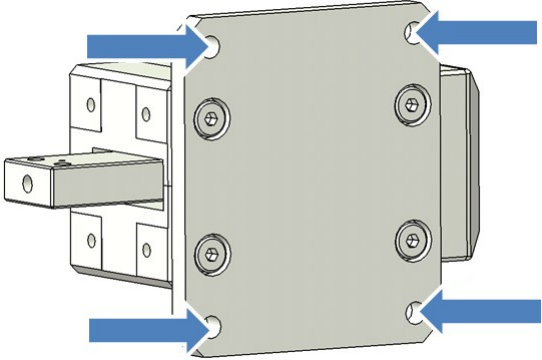
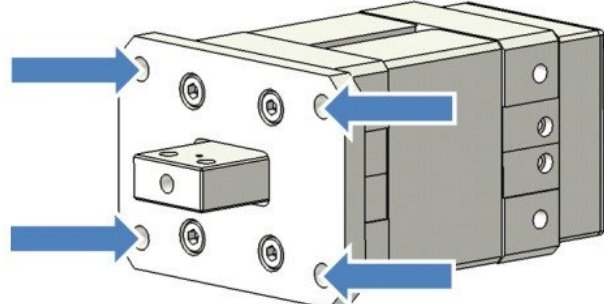
- Mounting flange B, N216E0008 (p. 9)
- Four socket head screws, M4x8, ISO 4762 (p. 9)
- Suitable hex key AF 3 (or comparable screwdriver)

Fixing the mounting flange B to the actuator

1. Position the holes in the mounting flange over the corresponding holes in the actuator. Note that the countersunk holes must be visible (i.e., facing upwards). For details on correct alignment, refer to the mounting hole overview and exploded view.
2. Tighten the socket head screws in all mounting holes.
3. Check that the seating of the mounting flange on the N-216 is free of play.

5.1.4 Mounting the N-216

Depending on the mounting option selected, the following holes are used for mounting the N-216 onto a surface:

Mounting option	Position of the mounting holes (see arrows)
Direct mounting: Use either the holes marked with white arrows or those marked with black arrows.	
Mounting using flange A	
Mounting using flange B	

INFORMATION

The thickness of the mounting surface determines the suitability of the screws supplied for mounting the N-216 directly.

Requirements

- ✓ You provided a surface with four suitable holes where the gaps match the gaps between the corresponding holes in the mounting flange or in the N-216 (depends on the mounting option selected; refer to "Dimensions" (p. 33)).
- ✓ The linear actuator is **not** connected to the electronics.

Tools and accessories

- Four M5 screws (exception: M4 screws when mounting directly to the runner side of the actuator housing); the length of the screws must fit the depth of the threaded holes in the surface.
- Suitable screwdriver or hex key (e.g., AF 4 for tightening M5 socket head screws)

Mounting the N-216

1. Position either the mounting holes in the actuator or the mounting flange for the actuator according to the mounting option selected over the corresponding holes in the surface (see the figures above).
2. Tighten the screws in all mounting holes.
3. Check that the linear actuator is fixed firmly to the surface.

5.2 Connecting the N-216 to the Protective Earth Conductor

INFORMATION

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

INFORMATION


- If there is any vibration in your application, secure the screw connection for the protective earth conductor in a suitable manner (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.

Requirements

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

Tools and accessories

- Suitable protective earth conductor: Conductor cross section $\geq 0.75 \text{ mm}^2$, resistance $< 0.1 \Omega$ at 25 A, green-yellow insulation
- M4 screw set for protective earth (p. 9)
- Philips-head screwdriver (PH 2)

The N-216 has an M4 hole for attaching the protective earth conductor. This hole is marked with the symbol for the protective earth conductor .

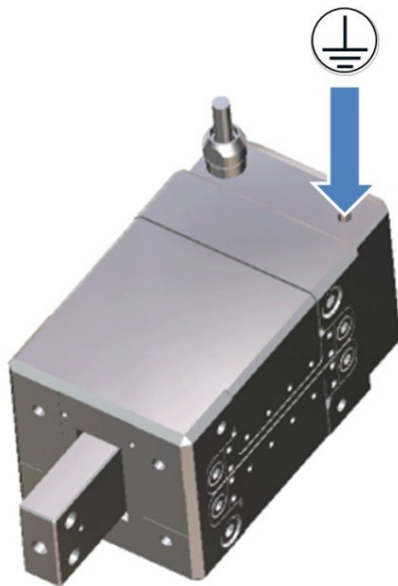


Figure 8: Position of the protective earth connector

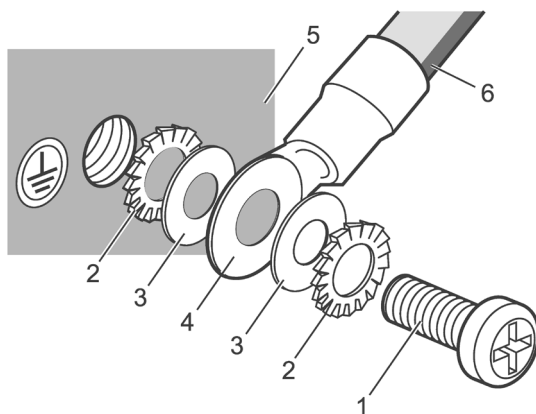


Figure 9: Protective earth conductor mounting (schematic)

- | | |
|---|--|
| 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 symbol |
| 6 | Protective earth conductor |

Connecting the N-216 to the Protective Earth Conductor

1. If necessary, attach a suitable cable lug to the protective earth conductor.
2. Use the M4 screw (together with the flat and lock washers) to attach the cable lug of the protective earth conductor to the threaded hole in the N-216 as shown in the previous view.
3. Tighten the M4 screw with a torque of 1.2 Nm to 1.5 Nm.
4. Make sure that the contact resistance at all points relevant for attaching the protective earth conductor is $<0.1 \, \Omega$ at 25 A.

5.3 Fixing the Load to the N-216

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. 28).

INFORMATION

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

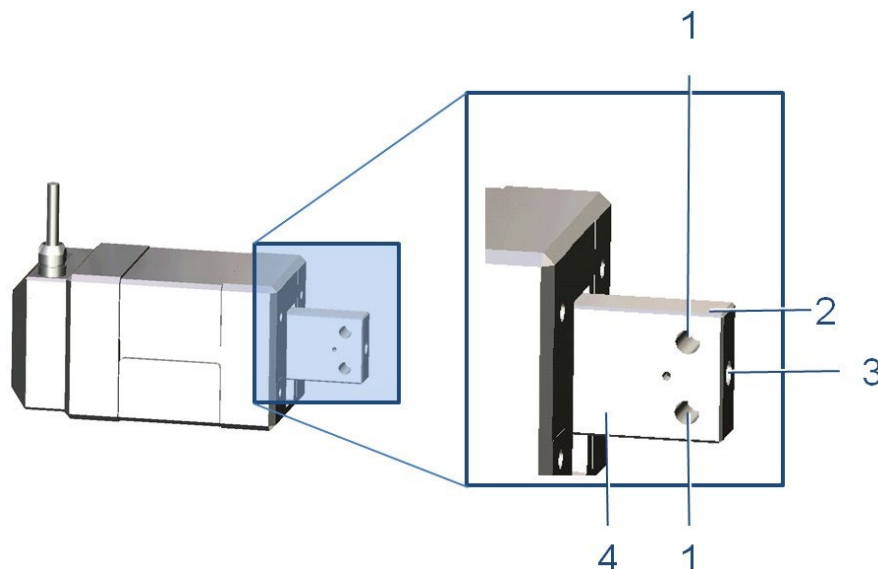


Figure 10: Relevant runner components for fixing the load

- 1 M5 through hole for fixing the load
 - 2 Narrow surface area of the runner*
 - 3 M5 blind hole (8 mm depth) for fixing the load
 - 4 Wide surface area of the runner*
- * There is a corresponding (parallel) surface area but it is not shown in the view.

Requirements

- ✓ You have fixed the linear actuator according to the corresponding instructions.
- ✓ The linear actuator is **not** connected to the electronics.

Tools and accessories

- M5 fixing screw(s) of suitable length (threaded hole depth: 8 mm; for details, refer to "Dimensions" (p. 33))
- If necessary: M5 spring washer(s) or M5 flat washer(s)
- Open-end wrench AF 10 respectively AF 22
- Suitable screwdriver, hex key, or open-end wrench for the fixing screw(s)

Fixing the load to the N-216

1. Use the open-end wrench on the wrench flats to hold the runner in place.
Options:
 - Put the open-end wrench AF 22 onto the narrow surfaces of the runner.
 - Put the open-end wrench AF 10 onto the wide surfaces of the runner.
2. Fix the load by tightening the screws in the threaded holes in the linear actuator's runner.
 - If necessary, use additional spacers, lock washers, or spring washers.
 - Turn the screw(s) until you notice resistance and tighten them with a torque between 3.5 Nm and 5 Nm.
3. Check that the connection is free of play at all times.

5.4 Connecting the N-216 to the Electronics

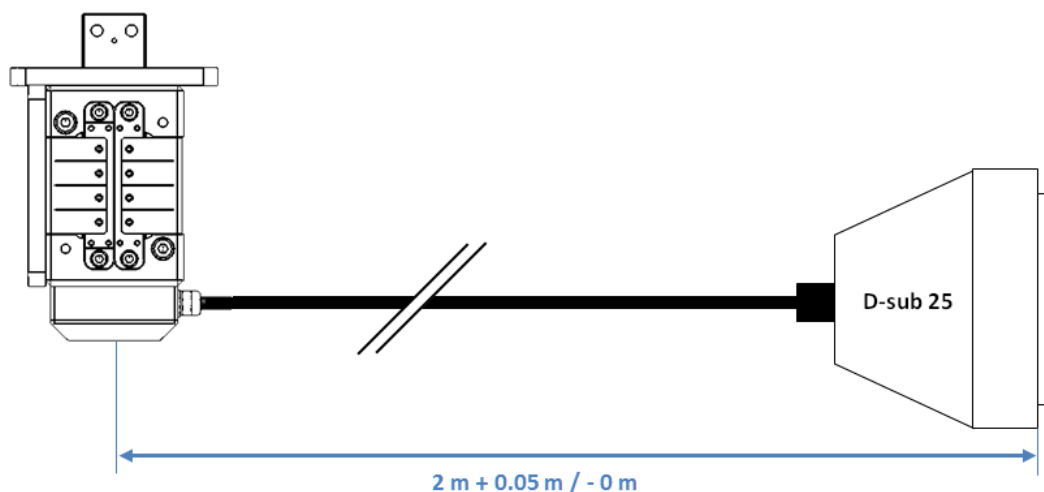


Figure 11: Cabling diagram

Requirements

- ✓ You have mounted the linear actuator properly (p. 12) and have connected the protective earth conductor (p. 17).
- ✓ You have installed suitable electronics (p. 10).
- ✓ You have read and understood the user manual for the electronics.

Connecting the N-216 to the electronics

1. Insert the connector of the linear actuator into the corresponding socket on the electronics (refer to the user manual for the electronics).
2. Use the integrated screws to secure the connector against accidental disconnection.
3. Eliminate or mark resulting danger zones according to applicable legal regulations and recommendations.

6 Starting and Operating

In this Chapter

General Notes on Starting and Operating	22
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6.1 General Notes on Starting and Operating

DANGER



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

If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the N-216 in the case of malfunction or failure of the system. If there are touch voltages, touching the N-216 can result in serious injury or death from electric shock.

- Connect the N-216 to a protective earth conductor (p. 17) before starting.
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e.g., in the case of modifications), reconnect the N-216 to the protective earth conductor before restarting.

CAUTION



Dangerous voltage and residual charge in piezo actuators!

The N-216 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-216'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-216.
- Do **not** touch the contacts in the connector of the N-216.
- Use the screws to secure the N-216's connector against being pulled out of the electronics.

If you want to pull out the the connector of the N-216:

- Do **not** pull out the connector of the electronics during operation.
- Discharge the N-216 **before pulling out the connector (p. 24)**.
- If possible: Switch the electronics off **before pulling out the connector** and wait at least 10 seconds.

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-216 during operation!**

The heat produced during operation of the N-216 can affect your application.

- Install the N-216 so that your application is not affected by the dissipating heat.

NOTICE**Uncontrolled oscillation!**

Your application and the N-216 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-216:

- 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-216 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-216.

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).

The following also applies to the N-216.1A1 / N-216.2A1:

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-216

Requirements

- ✓ You have read and understood the general notes on starting and operating (p. 22).
- ✓ 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 mounted (p. 12) the N-216 properly, connected the protective earth conductor (p. 17), and fixed the load (p. 19).
- ✓ The electronics and the required PC software were installed. All connections to the electronics were made (refer to the user manual for the electronics).

6.3 Discharging the N-216

The N-216 must be discharged in the following cases:

- When the N-216 is not in use but the electronics remain switched on to ensure temperature stability
- Before pulling out the connector (e.g., before cleaning and transport of the N-216 and for modifications in the application)

Discharging an N-216 connected to the electronics

If you are working in closed-loop operation:

1. Switch off the servo mode on the controller.
2. Set the piezo voltage to 0 V on the controller.

If you are working in open-loop operation:

- Set the piezo voltage on the electronics to 0 V.

Discharging an N-216 not connected to the electronics

- Connect the N-216 to the switched-off electronics from PI.

7 Maintenance

In this Chapter

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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. 28).

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

NOTICE



Damage from ultrasonic cleaning!

Ultrasonic cleaning can damage the N-216.

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

7.2 Cleaning the N-216

Requirements

- ✓ You have discharged the piezo actuators of the N-216 (p. 24).
- ✓ You have disconnected the N-216 from the electronics.

Cleaning the N-216

- Clean the surfaces of the N-216 with a cloth dampened with a mild cleanser or disinfectant (e.g., isopropyl alcohol).

8 Troubleshooting

Problem	Possible causes	Solution
Target position is approached too slowly or with overshoot	<ul style="list-style-type: none"> ▪ Servo control parameters are not optimally set ▪ Large changes in the load 	<ol style="list-style-type: none"> 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-216		
Increased wear	Excessive lateral forces on the runner	➤ Avoid lateral forces on the runner of the N-216.
Reduced accuracy		
No or limited motion	<ul style="list-style-type: none"> ▪ Excessive load ▪ Excessive counterforces in the direction of motion 	➤ Reduce the load (see "Mechanical Load Capacity" (p. 30)). In the case of vertical mounting: ➤ Ensure gravity compensation so that the maximum load (p. 30) 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. 27).

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. 3) on our website.

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>).

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10.1 Specifications

10.1.1 Data Table

	N-216.101 / N-216.1A1	N-216.201 / N-216.2A1	Tolerance
Active axes	X	X	
Motion and positioning			
Travel range	20 mm	20 mm	
Travel range in analog mode	±3 µm	±3 µm	
Integrated sensor	N-216.101: Without N-216.1A1: Linear encoder	N-216.201: Without N-216.2A1: Linear encoder	
Resolution, open loop	0.03 nm	0.03 nm	typ.
Resolution, closed loop	- / 5 nm (N-216.1A1)	- / 5 nm (N-216.2A1)	
Velocity (10 % duty cycle, full-step mode)*	1.0 mm/s	1.0 mm/s	max.
Velocity (100 % duty cycle, full-step mode)*	0.6 mm/s	0.6 mm/s	max.
Velocity (100 % duty cycle, nanostepping mode)**	0.4 mm/s	0.4 mm/s	max.
Mechanical properties			
Drive force (active)***	300 N	600 N	max.
Holding force (passive)	400 N	800 N	min.
Drive properties			
Motor type	NEXLINE®	NEXLINE®	
Operating voltage	-250 V to +250 V	-250 V to +250 V	

	N-216.101 / N-216.1A1	N-216.201 / N-216.2A1	Tolerance
Miscellaneous			
Operating temperature range	0 to 55 °C	0 to 55 °C	
Material	Aluminum, stainless steel	Aluminum, stainless steel	
Mass	1150 g	1250 g	
Cable length	2.0 m	2.0 m	
Connector	D-sub 25 (m)	D-sub 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 performing the steps.

*** Data refers to full-step mode operation.




10.1.2 Ambient Conditions and Classifications

Pay attention to the following ambient conditions and classifications for the N-216:

Area of application	For indoor use only
Maximum altitude	2000 m
Air pressure	1100 hPa 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 °C to 70 °C
Transport temperature	-20 °C 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 linear actuator is designed for the following operating data:

Model	Operating mode	Maximum operating voltage 	Maximum operating frequency or velocity (unloaded) 	Maximum power consumption ¹ 
N-216.101 / N-216.1A1	Analog mode	+250 V; -250 V	1500 Hz	3.5 W ²
	Full-step mode		600 µm/s	6.6 W
	Nanostepping mode		400 µm/s	
N-216.201 / N-216.2A1	Analog mode		2000 Hz	7 W ²
	Full-step mode		600 µm/s	13.2 W
	Nanostepping mode		400 µm/s	

¹ for continuous, dynamic operation (not recommended!)

² at full amplitude and a max. frequency of 100 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.

Parameters	Permissible values	
	N-216.101 / N-216.1A1	N-216.201 / N-216.2A1
Passive force (holding force, linear actuator no current) F_h	-400 N to 400 N	-800 N to 800 N
Active force (drive force) F_p	-300 N to 300 N	-600 N to 600 N
Lateral force F_l	-20 N to 20 N	-20 N to 20 N
Torque M_{rot} in the direction of the runner axis	-0.5 Nm to 0.5 Nm	-0.5 Nm to 0.5 Nm
Torque M_l generated by lateral force (radial; not shown)	-0.5 Nm to 0.5 Nm	-0.5 Nm to 0.5 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.

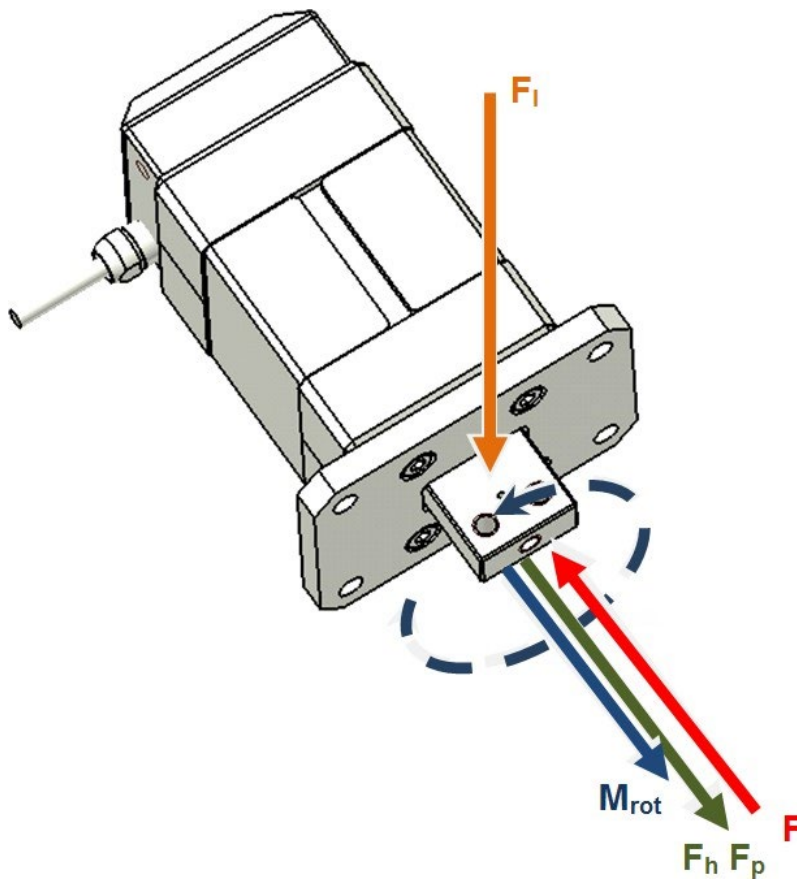


Figure 12: Forces and torques potentially affecting the runner (schematic)

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: Effective direction of the causal force)

Velocities and step sizes when the drive is loaded

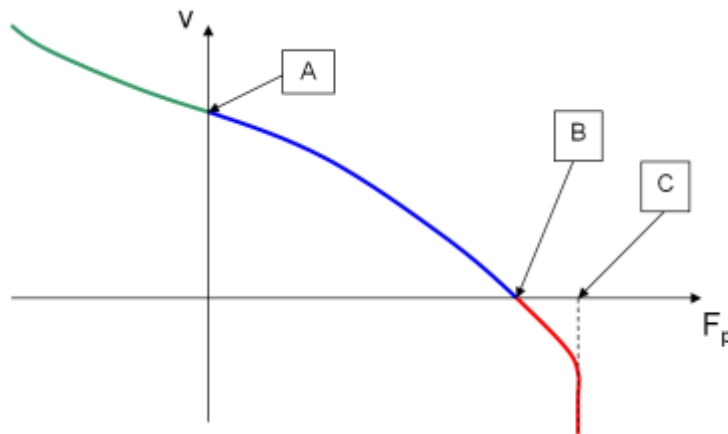


Figure 13: Velocity v as a function of the active force F_p (qualitative)

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 applied), the achievable step size of the drive elements and therefore also the maximum velocity of the runner decreases (see explanations on operating the NEXLINE® drive in the manual for the electronics). 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 push/pull force is not acting 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 runner 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 exceeded 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-216 Actuator

Dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

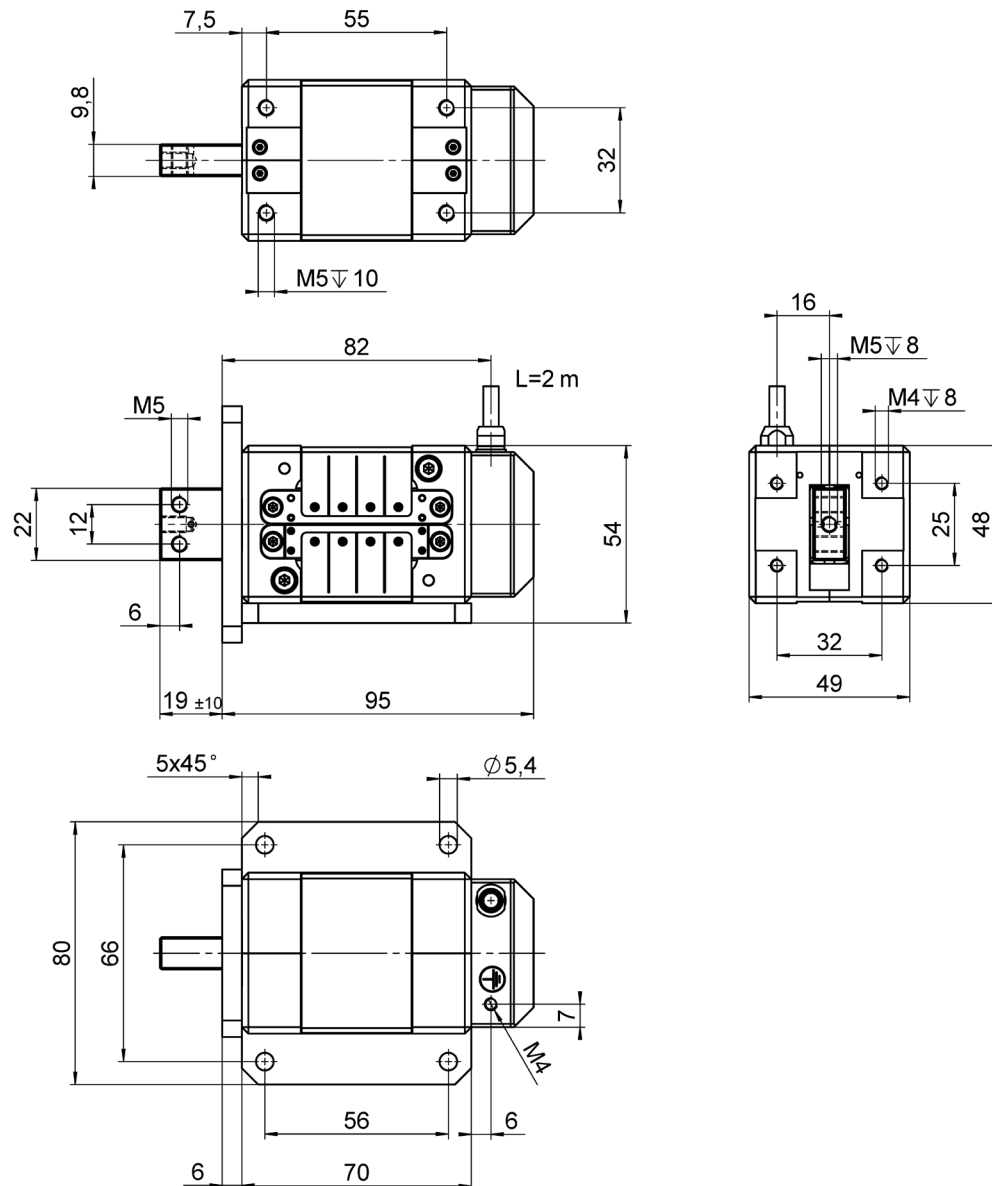


Figure 14: N-216 dimensions (all models), runner at center position. View sometimes with mounting flange.

10.4.2 Mounting Flange A (N216E0006)

Dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

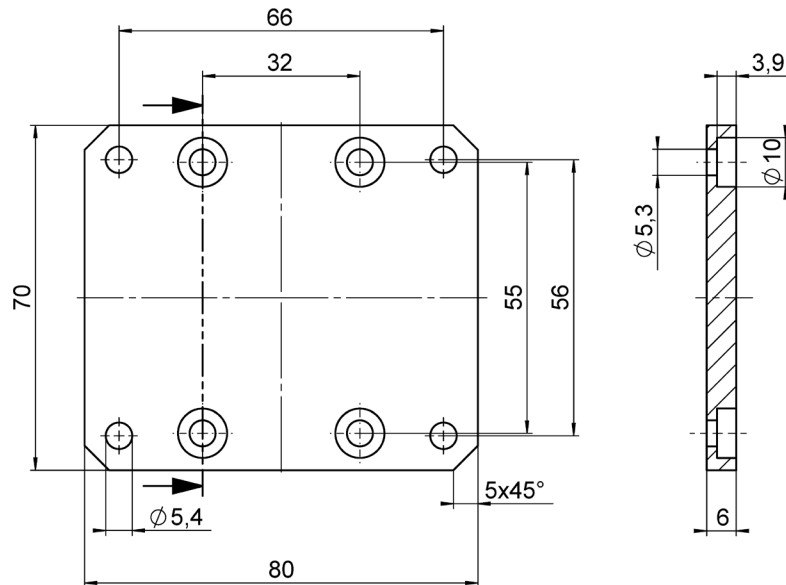


Figure 15: Mounting flange A (N216E0006)

10.4.3 Mounting Flange B (N216E0008)

Dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

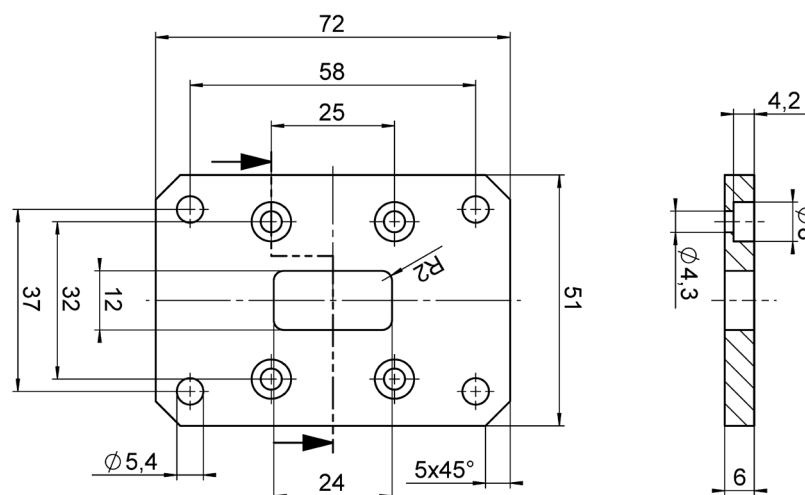


Figure 16: Mounting flange B (N216E0008)

10.5 Pin Assignment

10.5.1 N-216.101 / N-216.201

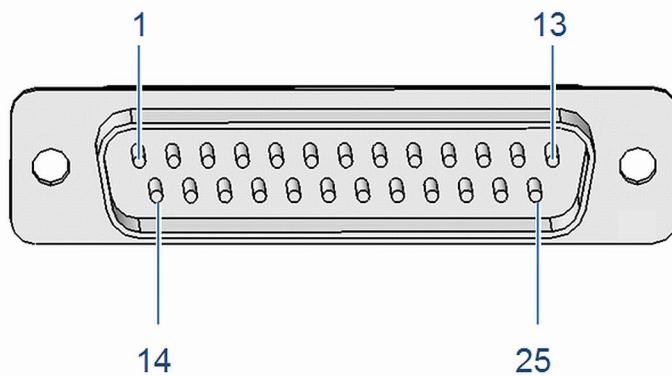


Figure 17: D-sub 25 connector (m), front view

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	C1+	Supply voltage for clamping group 1 (-250 V to 250 V)	Input
8	-		
9	-		
10	C2+	Supply voltage for clamping group 2 (-250 V to 250 V)	Input
11	-		
12	-		
13	-		
14	-		
15	D1-	Ground, shearing group 1	GND
16	-		
17	-		
18	D2-	Ground, shearing group 2	GND
19	-		
20	-		
21	C1-	Ground, clamping group 1	GND
22	-		
23	-		
24	C2-	Ground, clamping group 2	GND
25	-		

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

10.5.2 N-216.1A1 / N-216.2A1

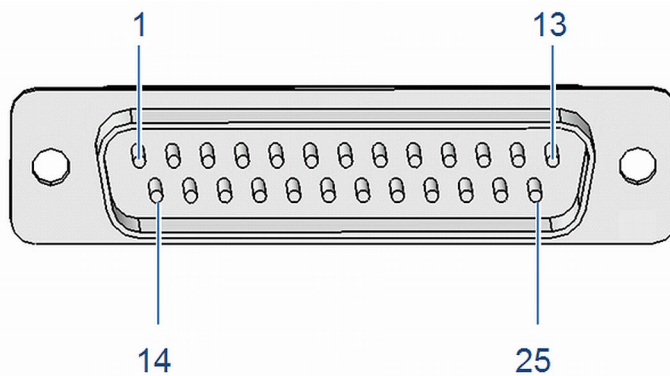


Figure 18: D-sub 25 connector (m), front view

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	C1+	Supply voltage for clamping group 1 (-250 V to 250 V)	Input
8	GND (sensor)	Ground, encoder	GND
9	GND (ref)	Ground, reference switch	GND
10	C2+	Supply voltage for clamping group 2 (-250 V to 250 V)	Input
11	-		
12	Ref-	Reference switch	Output
13	Ref+	Reference switch	Output
14	-		
15	D1-	Ground, shearing group 1	GND
16	Sin+	Encoder signal 1 (sine)	Output
17	Sin-	Encoder signal 1 (sine)	Output
18	D2-	Ground, shearing group 2	GND
19	Cos+	Encoder signal 2 (cosine)	Output
20	Cos-	Encoder signal 2 (cosine)	Output
21	C1-	Ground, clamping group 1	GND
22	-		
23	-		
24	C2-	Ground, clamping group 2	GND
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 fulfill 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 European Declarations of Conformity

For the N-216, 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