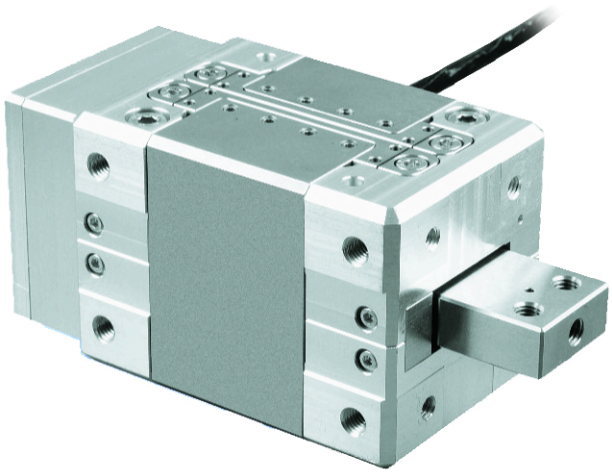


User Manual

N-216 NEXLINE® Linear Actuator

This document describes the following products:

- **N-216.1A1**
  NEXLINE® linear actuator; NEXLINE® piezo walking drive; 20 mm travel range; 300 N feed force; incremental linear encoder; 2 m cable length
- **N-216.2A1**
  NEXLINE® linear actuator; NEXLINE® piezo walking drive; 20 mm travel range; 600 N feed force; incremental linear encoder; 2 m cable length

Original instructions
Release date: 4/3/2025
Document information: MP120EN (CBo)

Contents

1 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

2 Downloading manuals

Information

If a manual is missing or problems occur while downloading:

➢ Contact our customer service (p. 45).

Downloading manuals

1. Open the website www.pi.ws.
2. Search for the product number (e.g., N-216) on the website.
3. Select the corresponding product to open the product page.
4. Select the **Downloads** tab.
   → The manuals are shown under **Documentation**. Software manuals are shown under **General Software Documentation**.
5. For the desired manual, select **ADD TO LIST** and then **REQUEST**.
6. Fill out the request form and select **SEND REQUEST**.

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

3 About this document

3.1 Objective and target group of this user manual

This user manual contains the information necessary for using the N-216 as intended.

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

3.2 Symbols and typographic conventions

The following symbols and markings are used in the user manuals of PI.

DANGER

Immediate threat of danger

Failure to comply can result in death or serious injuries.

➢ Precautions to avoid the risk.

WARNING

Possibly hazardous situation

Failure to comply can result in serious injuries.

➢ Precautions to avoid the risk.

CAUTION

Dangerous situation

Failure to comply can result in minor injuries.

➢ 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 the user

Tips and additional information

Symbol	Meaning
1.	Action consisting of several steps with strict sequential order
2.	
➢	Action consisting of one step

Warning signs can be placed on PI products which refer to detailed information in this manual. The following symbols and markings are used in the user manuals of PI.


Warning of general danger


Warning of laser beams


Warning of strong magnetic fields


Warning of electrical voltage


Warning of hot surfaces


Warning of sharp objects or sharp edges


Warning of crush injuries


Warning of pull-in hazard due to counter-rotating rollers


Prohibition of pacemakers and implanted defibrillators

3.3 Figures

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

3.4 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 connected mechanics
Amplifier	Electronics without sensor evaluation, suitable for operating mechanics in open-loop mode
Controller	Electronics with sensor evaluation, suitable for operating mechanics in closed-loop and open-loop mode

4 Safety

4.1 General safety instructions

The N-216 is built according to state-of-the-art technology and recognized safety standards. Improper use of the N-216 can result in personal injury and/or damage to the N-216.

- Use the N-216 only for its intended purpose and when it is in perfect technical condition.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for installing and operating the N-216 correctly.

4.2 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.

According to its design, the N-216 is intended for positioning, adjusting, and shifting loads in one axis at different velocities.

In the ideal application, the linear actuator is operated quasi statically. The load is mainly kept at a particular position in quasi-static 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. 15). The electronics are not included in the scope of delivery of the linear actuator.

4.3 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 applied standards certifying the conformity are listed below.

- Safety (Low Voltage Directive): EN 61010-1
- EMC: EN 61326-1
- RoHS: EN IEC 63000

4.4 Organizational measures

User manual

- Always keep this user manual together with the N-216. You can download the current versions of the documents from www.pi.ws (p. 6).
- Add all information from the manufacturer such as supplements or technical notes to the user manual.
- If you give the N-216 to a third party, include this manual as well as all other relevant information provided by the manufacturer.
- 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 and operated, maintained, and cleaned by authorized and appropriately qualified personnel.

5 Product description

5.1 Features and applications

- Travel range 20 mm
- Holding force to 800 N
- Resolution to 0.03 nm (open loop) or 5 nm (closed loop), respectively
- PiezoWalk® principle
- Self-locking, therefore no holding currents and no heat generation at rest
- Nonmagnetic functional 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). In this way, NEXLINE® drives combine relatively long travel ranges with the nanometer precision of piezo actuators.

The N-216 is equipped with a linear encoder for direct measurement of runner positions. 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 operating modes 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

➢ Obtain further details on the operating modes from the manual for the electronics used (p. 5).

5.2 Model overview

Two standard versions of the N-216 NEXLINE® linear actuator are available. They differ with respect to the drive force.

Model	Description
N-216.1A1	NEXLINE® linear actuator; NEXLINE® piezo walking drive; 20 mm travel path; 300 N feed force; incremental linear encoder; 2 m cable length
N-216.2A1	NEXLINE® linear actuator; NEXLINE® piezo walking drive; 20 mm travel path; 600 N feed force; incremental linear encoder; 2 m cable length

➢ For further technical data, refer to the specifications (p. 36).

PI also produces customized versions on request. Customized versions can differ from the described standard products in respect to dimensions, properties, or other technical data.

➢ If required, contact our customer service (p. 45) directly.

5.3 Product labeling

Label	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 numbers
PI	Manufacturer's logo
⚠	Warning sign "Pay attention to the manual!"
	Old equipment disposal (p. 44)
Country of origin: Germany	Country of origin
WWW.PI.WS	Manufacturer's address (website)
CE	CE conformity mark (p. 10)
	"High voltage" warning sign
	Protective earth symbol, indicates the protective earth connector (p. 17)

5.4 Product view

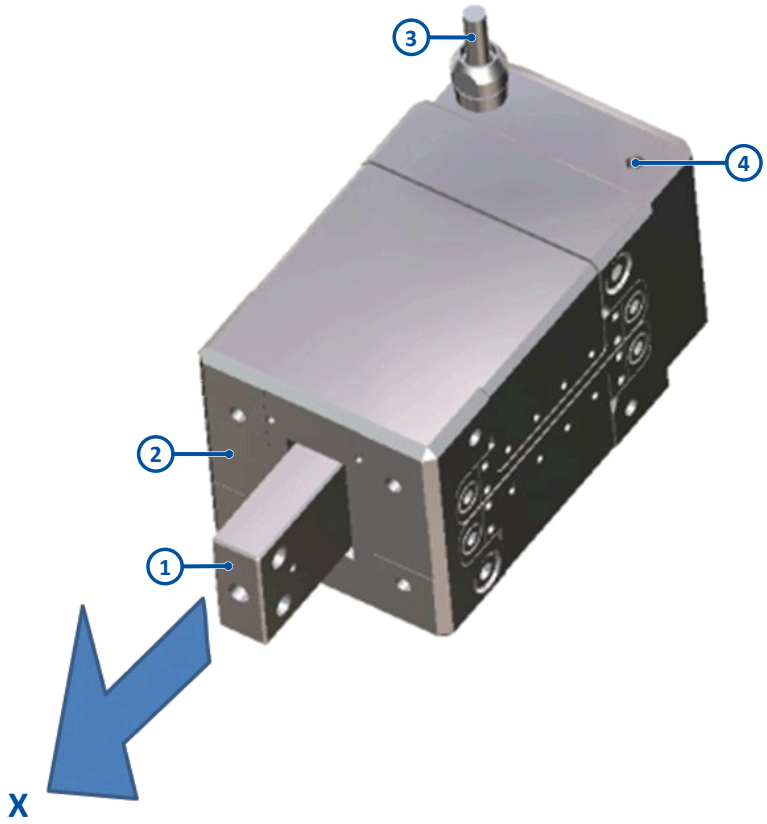


Fig. 1: N-216, position of important elements

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

5.5 Technical features

5.5.1 Linear encoder (sensor)

The linear actuator is equipped with an optical encoder. For the resolution, refer to the table in the specifications (p. 36) section.

Optical linear encoders measure the actual position directly (direct metrology). Errors in the drive-train, such as nonlinearity, backlash, or elastic deformations cannot influence measuring of the position.

5.5.2 Reference switch

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

The commands that use the reference signal are described in the user manual for the controller and/or in the corresponding software manuals.

5.6 Suitable electronics

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

➢ To order, contact our customer service (p. 45).

6 Unpacking the product

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 (p. 45) immediately.
4. Keep all packaging materials in case the product needs to be returned.

6.1 Scope of delivery

Product number	Description
N-216.xA1	NEXLINE® linear actuator according to order (p. 13)
N216E0006	Mounting flange A
N216E0008	Mounting flange B
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
2175	DIN EN ISO 4762-M4x8-A2 mounting screws (4 screws)
2176	DIN 7984-M5x10-A4-70 mounting screws (4 screws)
MP120EN	User manual (this document) in printed form
	Packaging material

7 Installation

7.1 Connecting the product 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, additionally 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 regularly and tighten the screw if necessary.

Requirements

– The linear actuator is not connected to the electronics.

Tools and accessories

– Suitable protective earth conductor: Conductor cross-section ≥0.75 mm^2, resistance <0.1 Ω at 25 A, green-yellow insulation
– M4 screw set for protective earth (p. 16)
– Cross-recess screwdriver (PH 2)

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

Fig. 2: N-216, position of protective earth connector

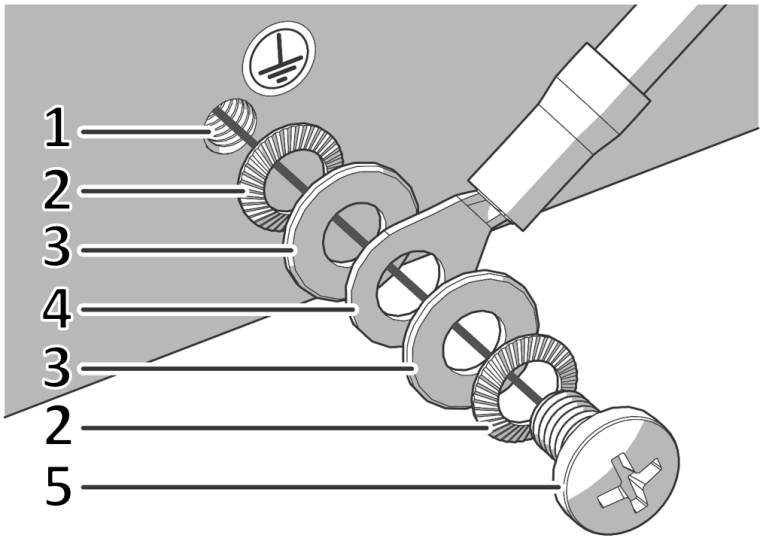


Fig. 3: Mounting of the protective earth conductor (schematic)

1 Protective earth connector (M4 threaded hole)

2 Lock washer

3 Flat washer

4 Cable lug of the protective earth conductor

5 M4 screw

Connecting the N-216 to the protective earth conductor

1. If necessary, firmly 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 protective earth connector of 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.

7.2 Mounting the product

Information

The N-216 actuator's runner is not connected to the protective earth conductor. Therefore, the runner must not be accessible anymore after the N-216 has been integrated. When installing the N-216 in the overall system, the operator is responsible for the electrical safety of the N-216, including the actuator's runner.

Information

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

7.2.1 Mounting options

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

Mounting directly to bottom or runner side (p. 24)

– Securing the actuator using the 4 M5 mounting holes on the bottom of the actuator housing
– Securing the actuator using the 4 M4 mounting holes on the runner side of the actuator housing

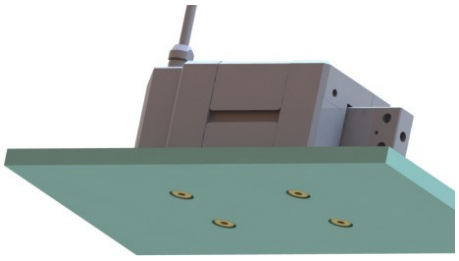


Fig. 4: Example of mounting directly on bottom (spatial view)

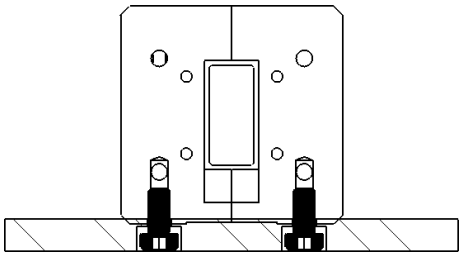


Fig. 5: Example of mounting directly on bottom (sectional view with highlighted screws)

Mounting using mounting flange A (p. 22)

Before mounting the actuator onto a surface, the mounting flange A must be attached to the actuator.

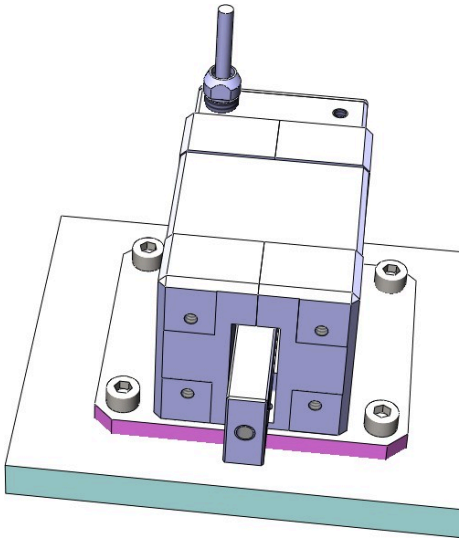


Fig. 6: Example of mounting using the mounting flange A (spatial view)

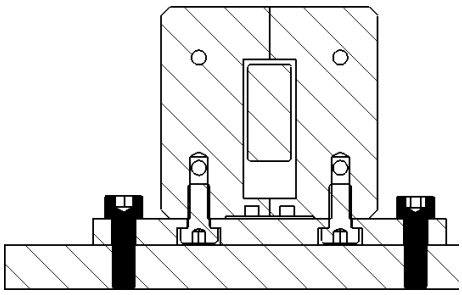


Fig. 7: Example of mounting using the mounting flange A (sectional view with highlighted screws)

Mounting using mounting flange B (p. 23)

Before mounting the actuator onto a surface, the mounting flange B must be attached to the actuator.

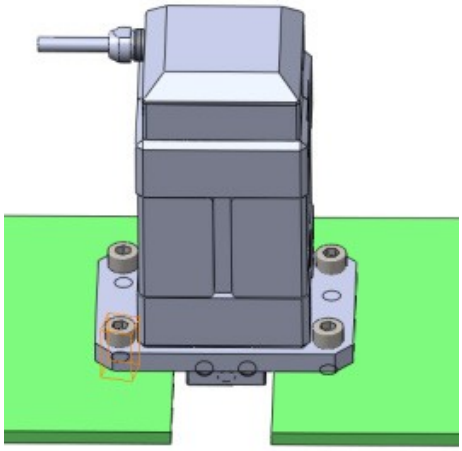


Fig. 8: Example of mounting using the mounting flange B (spatial view)

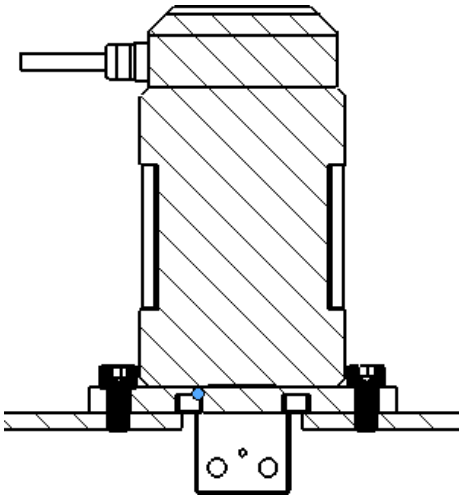


Fig. 9: Example of mounting using the mounting flange B (sectional view with highlighted screws)

7.2.2 Fixing the mounting flange A to the actuator

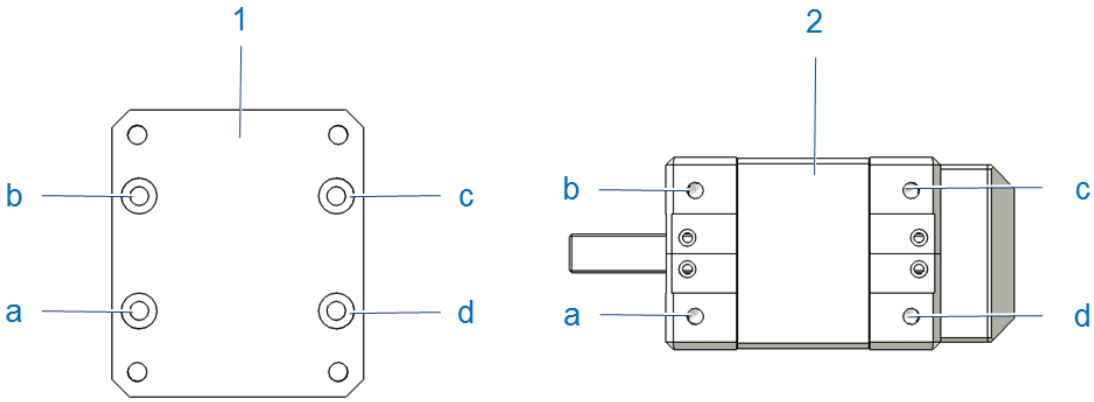


Fig. 10: Overview of the mounting holes for mounting flange A
Holes that cover each other during mounting are indicated by the same letter.

1 Mounting flange A with holes a to d

2 Actuator with threaded holes a to d

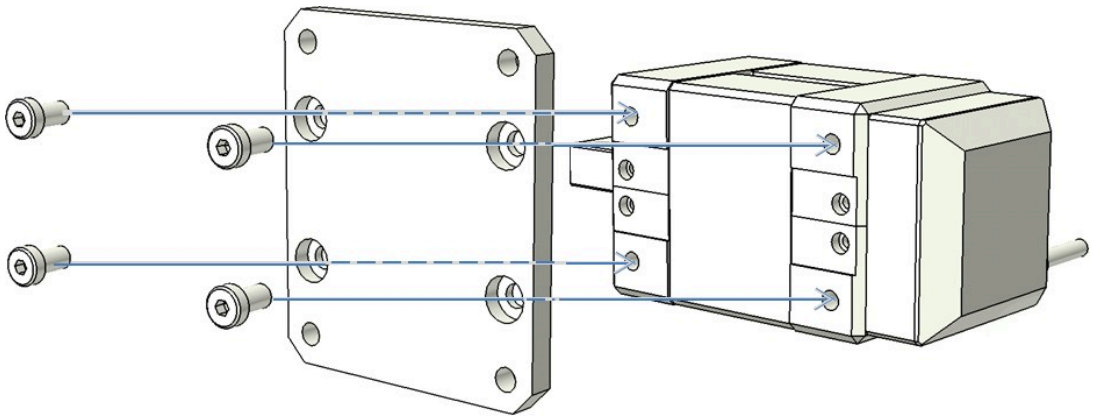


Fig. 11: Mounting of mounting flange A (exploded view)

Requirements

– The linear actuator is not connected to the electronics.

Tools and accessories

– Mounting flange A (p. 16), N216E0006
– 4 socket head screws, M5x10 (p. 16), DIN 7984
– AF4 hex key (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 in the mounting flange must be visible (i.e., aligned facing up). For details on correct alignment, refer to the mounting hole overview and the 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 backlash-free.

7.2.3 Fixing the mounting flange B to the actuator

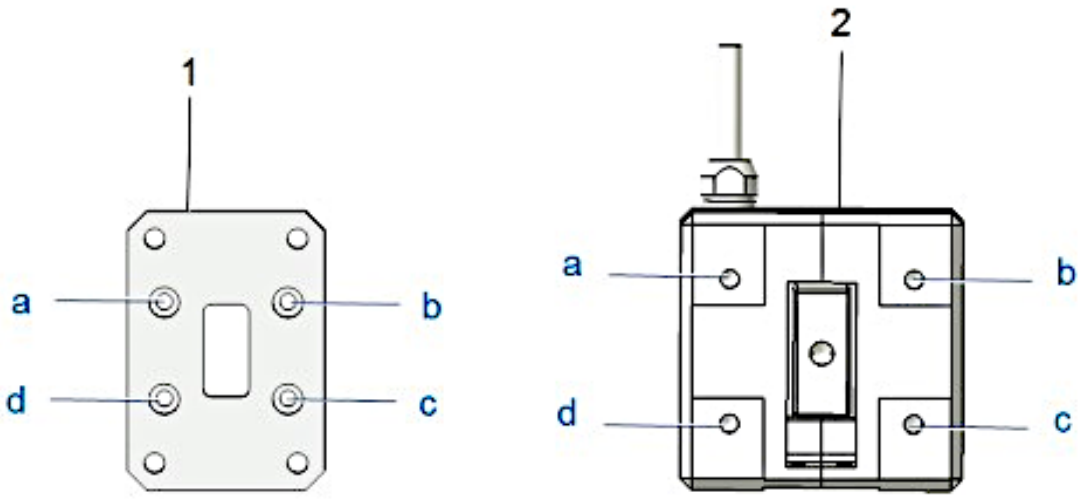


Fig. 12: Overview of the mounting holes for mounting flange B
Holes that cover each other during mounting are indicated by the same letter.

1 Mounting flange B with holes a to d

2 Actuator with threaded holes a to d

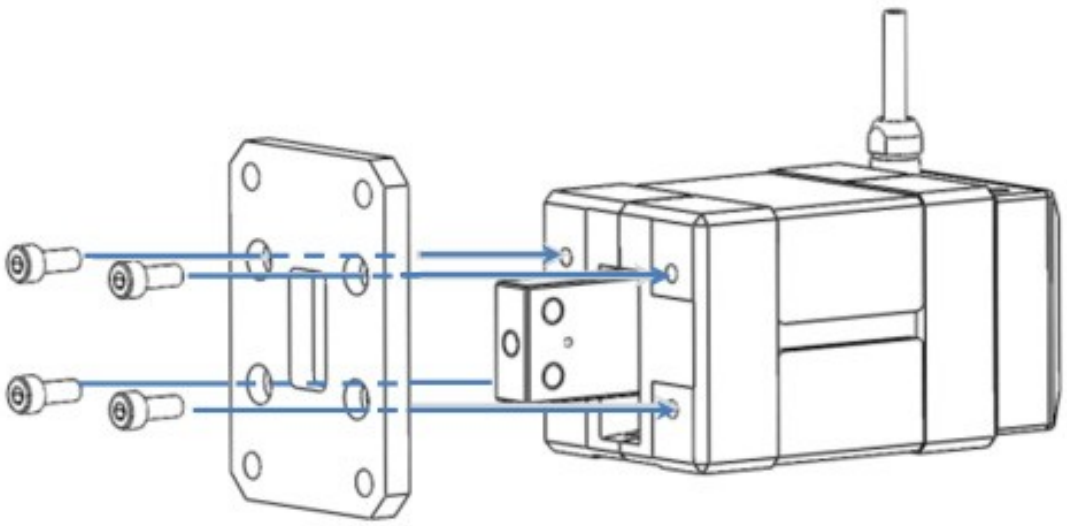


Fig. 13: Mounting of mounting flange B (exploded view)

Requirements

– The linear actuator is not connected to the electronics.

Tools and accessories

- Mounting flange B (p. 16), N216E0008
- 4 socket head screws, M4x8 (p. 16), ISO 4762
- AF3 hex key (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 in the mounting flange must be visible (i.e., aligned facing up). For details on correct alignment, refer to the mounting hole overview and the 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 backlash-free.

7.2.4 Mounting the product

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

Direct mounting

Use **either** the holes marked by white arrows **or** those marked with black arrows.

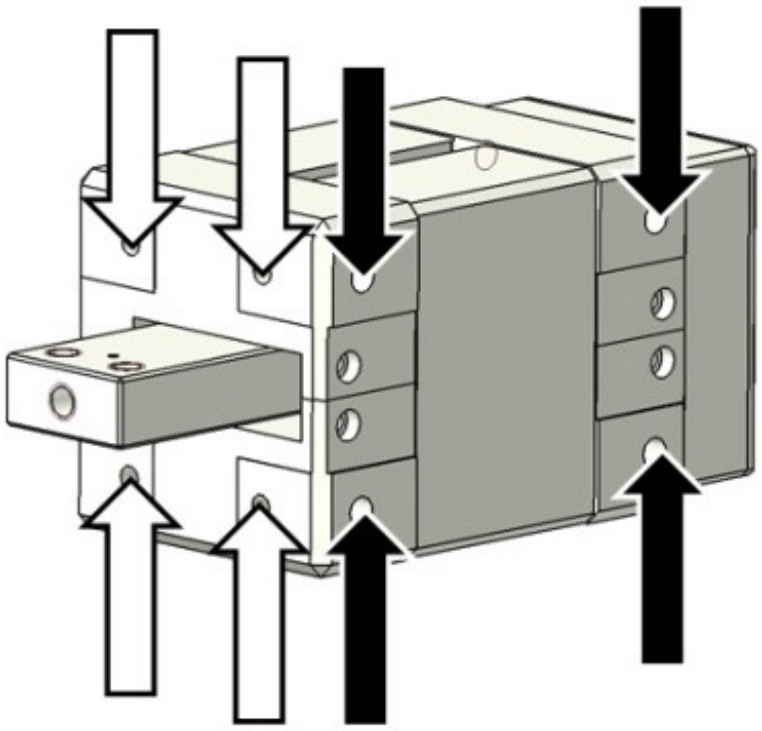


Fig. 14: Direct mounting: Position of the mounting holes used

Mounting using mounting flange A

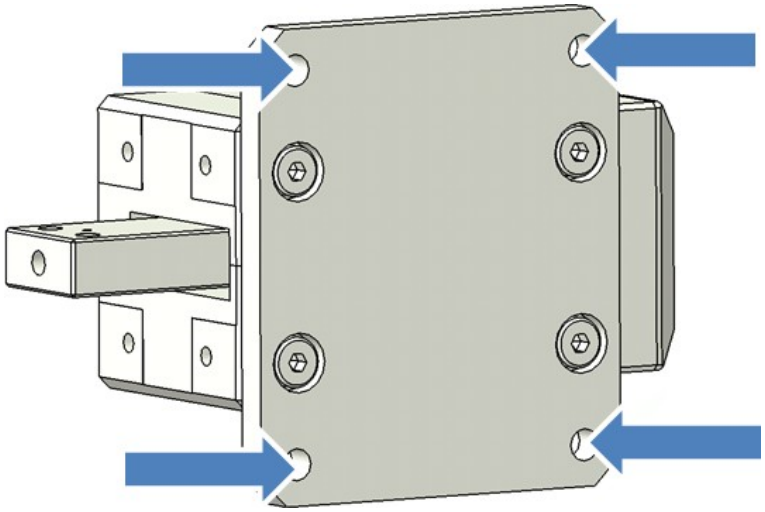


Fig. 15: Mounting flange A: Position of the mounting holes used

Mounting using mounting flange B

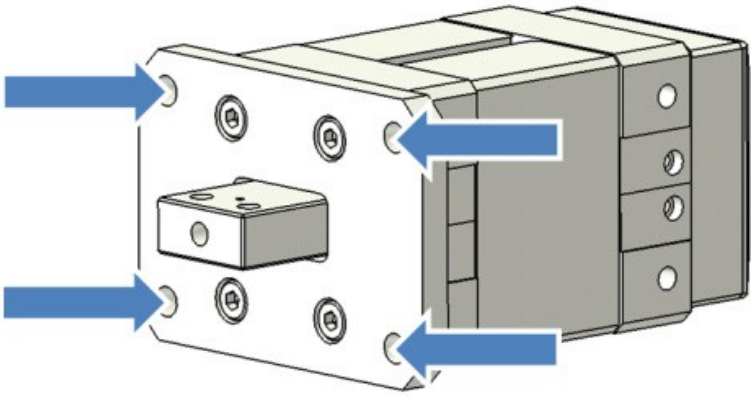


Fig. 16: Mounting flange B: Position of the mounting holes used

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 mounting holes where the spaces match the spaces between the corresponding holes in the mounting flange used or in the N-216 (depends on the mounting option selected; see Dimensions (p. 42)).
- The linear actuator is not connected to the electronics.

Tools and accessories

– 4 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 in the mounting flange for the actuator according to the mounting options 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.

7.3 Fixing the load

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. 36).

Information

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

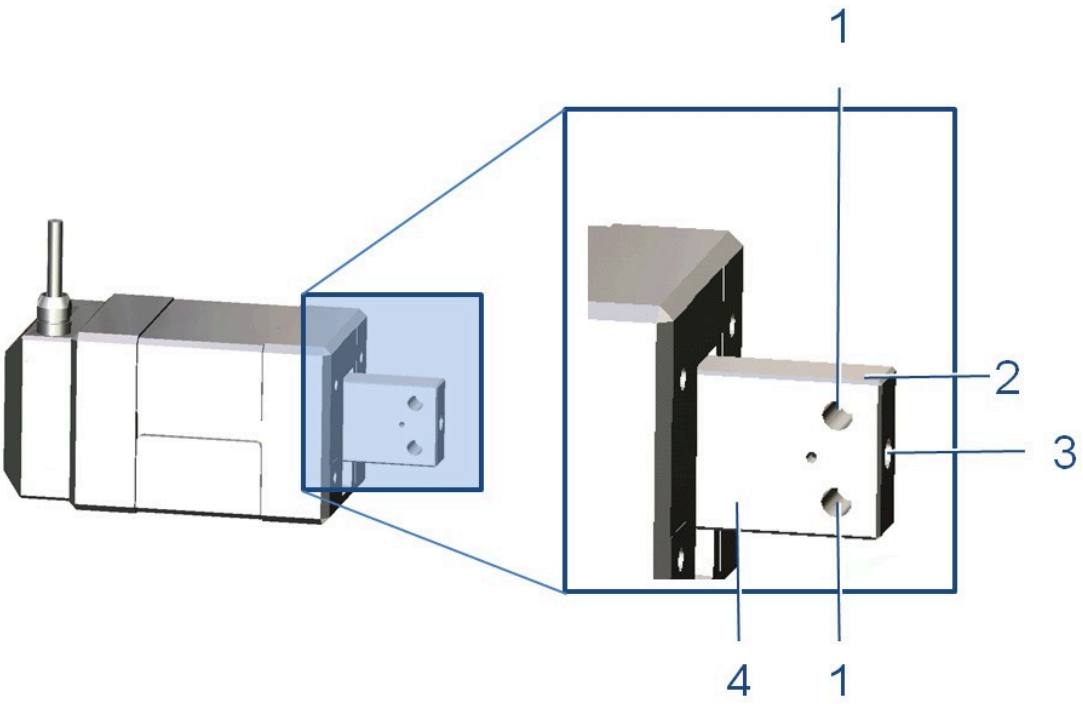


Fig. 17: Relevant runner components for fixing the load
Narrow / wide surface area of the runner: There is a corresponding (parallel) surface area, but it is not shown in the view.

1 M5 through-hole for fixing the load
2 Narrow surface of the runner
3 M5 blind hole (8 mm depth) for fixing the load
4 Wide surface area of the runner

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. 42))
- If necessary: M5 spring washer(s) or M5 flat washer(s)
- Open-end wrench AF 10 or AF 22, as necessary
- Suitable screwdriver, hex key, or open-end wrench for the mounting screw(s)

Fixing the load to the N-216

1. Use an open-end wrench 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. Use the mounting screws to fix the load at the threaded holes in the runner of the linear actuator.
   - If necessary, use spacers, lock washers, or spring washers in addition.
   Screw in 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 backlash-free all times.

7.4 Connecting the product to the electronics

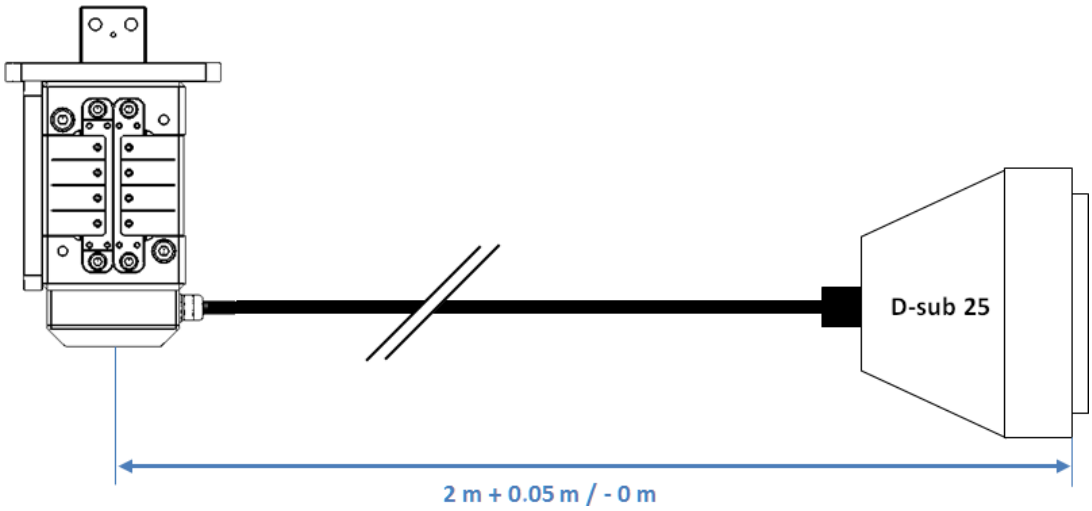


Fig. 18: Cable diagram

Requirements

– You have mounted the linear actuator properly (p. 17) and have connected the protective earth conductor (p. 17).
– You have installed suitable electronics (p. 15).
– You have read and understood the user manual for the electronics.

Connecting the N-216 to the electronics

1. Insert the plug connector on 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.

8 Starting and operating

8.1 General notes on starting and operating

DANGER

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

If the protective earth conductor is not connected or is not connected properly, hazardous touch voltages can occur on the N-216 during system malfunction or failure. If there are touch voltages, touching the N-216 can lead to serious injury or death by electric shock.

- Connect the N-216 to a protective earth conductor (p. 17) before startup.
- Do not remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e.g., for modifications), re-connect 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 plug 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 plug connector on the N-216.
- Use screws to secure the N-216's plug connectors against being disconnected from the electronics.
- Do not disconnect the connector from the electronics during operation.
- Discharge (p. 32) the N-216 before disconnecting the connector.
- If possible: Switch the electronics off before disconnecting the plug connector and wait at least 10 seconds.

NOTICE

Destruction of the drive at the end position in the event of 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.
- Afterward, 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 while operating the N-216 can affect your application.

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

NOTICE

Uncontrolled oscillation!

Your application and the N-216 can be damaged by uncontrolled oscillations. Uncontrolled oscillations can be identified by the fact that the linear actuator approaches the target position too slowly or too fast, or does not maintain a stable position (servo jitter).

If uncontrolled oscillations occur during the operation of the N-216:

- Immediately switch off the servo control system of the affected axis.
- 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

For commanding the linear actuator, the outward motion of the runner is defined as positive direction of motion.

Information

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

Information

The repeatability of the positioning is only ensured if the reference switch is always approached from the same side. Recommended controllers from PI fulfill this requirement due to the automatic direction sensing for referencing moves to the reference switch.

8.2 Starting and operating the product

Requirements

- You have read and understood the general notes on starting and operating (p. 30).
- 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 the N-216 properly (p. 17), connected the protective earth conductor (p. 17), and fixed the load (p. 26).
- The electronics and the required PC software have been installed. All connections to the electronics have been made (refer to the user manual for the electronics).

Starting up and operating the N-216

➢ Follow the instructions on starting and operating the N-216 in the user manual for the electronics used (p. 15).

8.3 Discharging the product

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 disconnecting the plug connector (e.g., before cleaning and transporting 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

9 Maintenance

9.1 General notes on maintenance

NOTICE

Damage due to incorrect maintenance!

The linear actuator can become misaligned by incorrect maintenance. The specifications (p. 36) can change as a result.

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

NOTICE

Damage from ultrasonic cleaning!

Ultrasonic cleaning can damage the N-216.

➢ Do not perform any ultrasonic cleaning.

9.2 Cleaning the product

Requirements

– You have discharged (p. 32) the piezo actuators of the N-216.

– You have disconnected the N-216 from the electronics.

Cleaning the N-216

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

10 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-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	– Excessive load – Excessive counterforces in the direction of motion	➢ Reduce the load (see Mechanical load capacity (p. 38)). ➢ When mounted vertically: Ensure gravity compensation so that the maximum load (p. 38) 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 (p. 45).

11 Specifications

11.1 Technical data

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

Motion	Unit	Tolerance	N-216.1A1	N-216.2A1
Active axes			X	X
Travel range in X	mm		20	20
Travel range in X (analog mode)	µm		±3	±3
Velocity (10 % duty cycle, full-step mode)	mm/s	Max.	1	1
Velocity (100 % duty cycle, full-step mode)	mm/s	Max.	0.6	0.6
Velocity (100 % duty cycle, nanostepping mode)	mm/s	Max.	0.4	0.4

Positioning	Unit	Tolerance	N-216.1A1	N-216.2A1
Reference switch			Optical, direction sensing (reference edge track), 5 V, TTL	Optical, direction sensing (reference edge track), 5 V, TTL
Resolution in X, open loop	nm	Typ.	0.03	0.03
Integrated sensor			Incremental linear encoder	Incremental linear encoder
System resolution in X	nm		5	5

Drive Properties	Unit	Tolerance	N-216.1A1	N-216.2A1
Drive type			NEXLINE® piezo walking drive	NEXLINE® piezo walking drive
Operating voltage	V		-250 to +250	-250 to +250
Drive force in X	N	Max.	300	600

Mechanical Properties	Unit	Tolerance	N-216.1A1	N-216.2A1
Holding force in X, passive	N	Min.	400	800
Overall mass	g		1150	1250
Material			Aluminum, stainless steel	Aluminum, stainless steel

Miscellaneous	Unit	Tolerance	N-216.1A1	N-216.2A1
Operating temperature range	°C		0 to 55	0 to 55
Connector			D-sub 25 (m)	D-sub 25 (m)
Cable length	m	+50 mm / -0 mm	2	2
Recommended controllers/ drivers			E-712.1AM	E-712.1AM

Velocity in full-step mode: Depending on drive electronics.
Velocity in nanostepping mode: 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.
Drive force: Data refer to full step mode operation.

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

11.2 Ambient conditions and classifications

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

Area of application	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(acc. to IEC 60529)	IP20

11.3 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-216.1A1	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-216.1A1	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

11.4 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	
	N-216.1A1	N-216.2A1
Passive force (holding force, no current to linear actuator) 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.

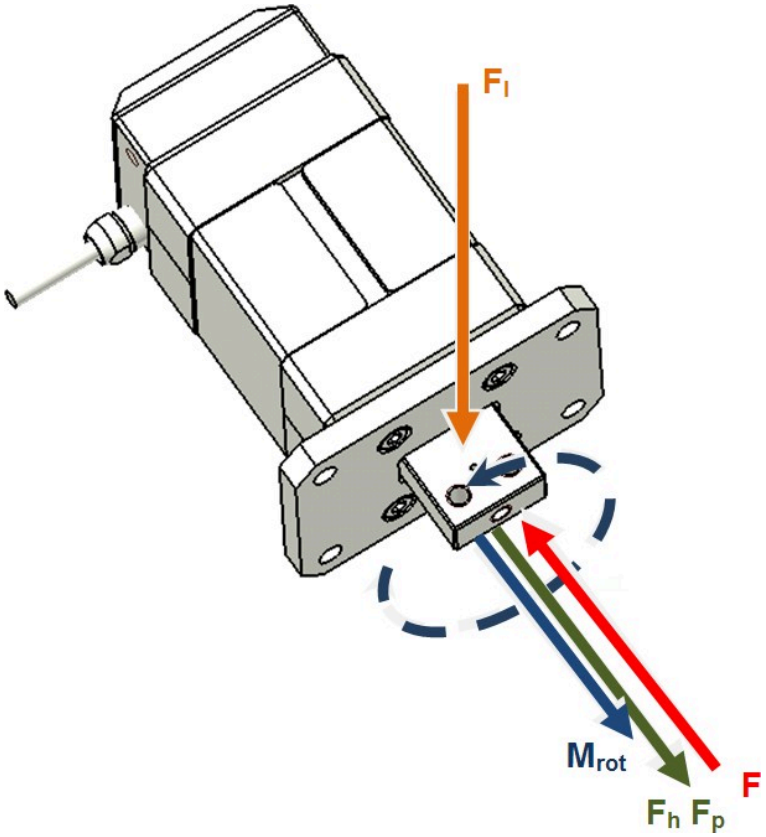


Fig. 19: Forces and torques potentially affecting the runner (schematic)

$\mathbf{F}_p$	Active force (direction for forward motion of the runner)	$\mathbf{F}_h$	Holding force (when the runner is at rest)
F	Force generated by load (positioning or holding)	$\mathbf{F}_l$	Lateral force
$\mathbf{M}_{rot}$	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

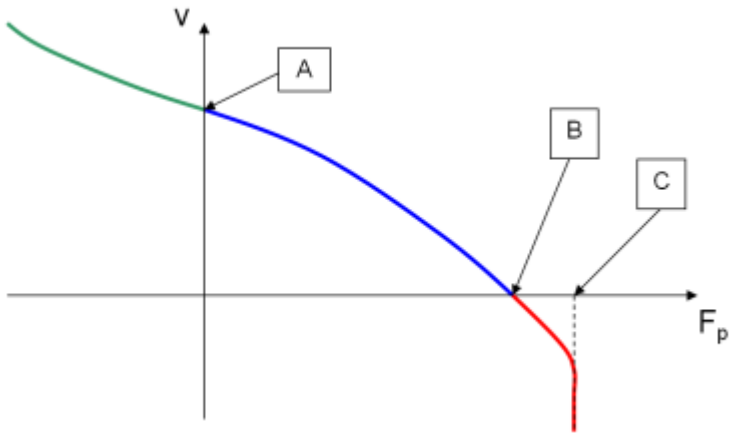


Fig. 20: Velocity v as a function of the active force F_p (qualitative)

$\mathbf{F}_p$	Active force
v	Velocity of the runner
Special conditions:	
A	Without load
B	At rest
C	Slippage

The achievable step size of the drive elements and therefore also the maximum velocity of the runner decreases as the load's mass increases (and therefore the active force to be applied); (refer to 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 no current is 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 impermissibly high load, the clamping effect of the piezo assemblies on the runner is lost (slippage, point C).

Analog conditions to those for velocity arise for the step sizes in normal operation (see graph, range to the left of B).

11.5 Pin assignment

N-216.1A1 / N-216.2A1

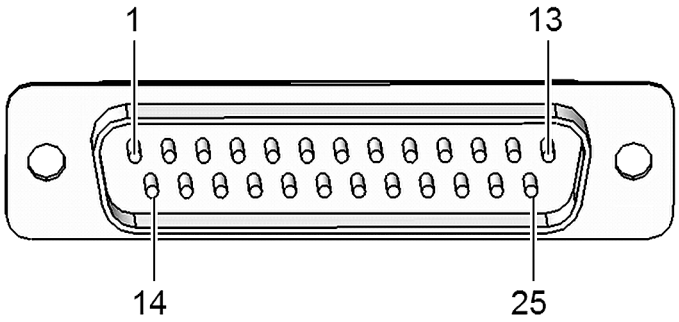


Fig. 21: D-sub 25 connector (m), front view

Pin	Signal*	Function	Direction
1	D1+	Supply voltage for shearing group 1 (-250 V to 250 V)	Input
2	+5 V (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)	Encoder ground	GND
9	GND (ref)	Ground, reference switch	GND
10	C2+	Supply voltage for clamping group 2 (-250 V to 250 V)	Input
11	-		

Pin	Signal*	Function	Direction
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.

11.6 Dimensions

11.6.1 N-216 actuator

Dimensions in mm.

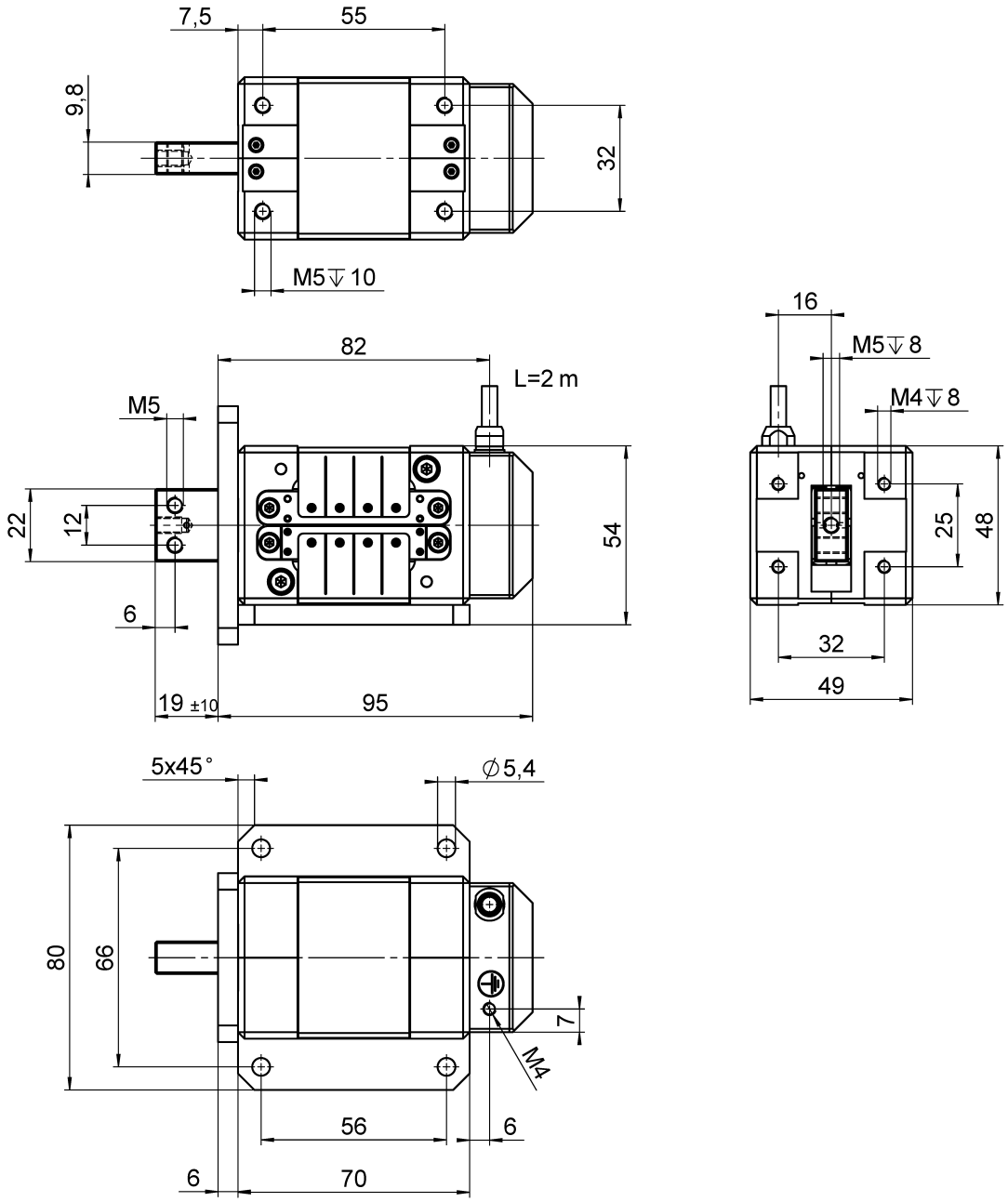


Fig. 22: N-216 dimensions (all models), runner at center position. In some cases, view with mounting flange.

11.6.2 Mounting flange A (N216E0006)

Dimensions in mm.

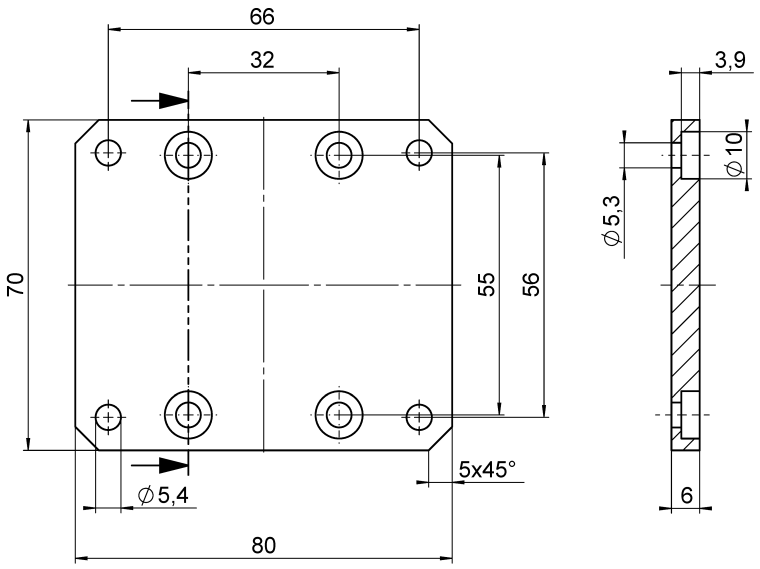


Fig. 23: Mounting flange A (N216E0006)

11.6.3 Mounting flange B (N216E0008)

Dimensions in mm.

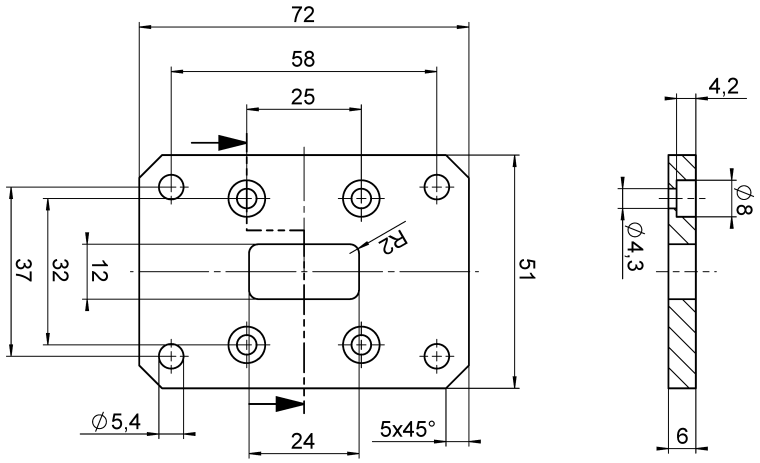


Fig. 24: Mounting flange B (N216E0008)

12 Old equipment disposal

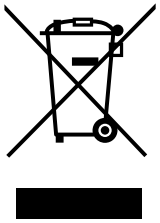
In accordance with EU law, electrical and electronic equipment may not be disposed of in EU member states via the municipal residual waste.

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

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

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

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



13 Customer service

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

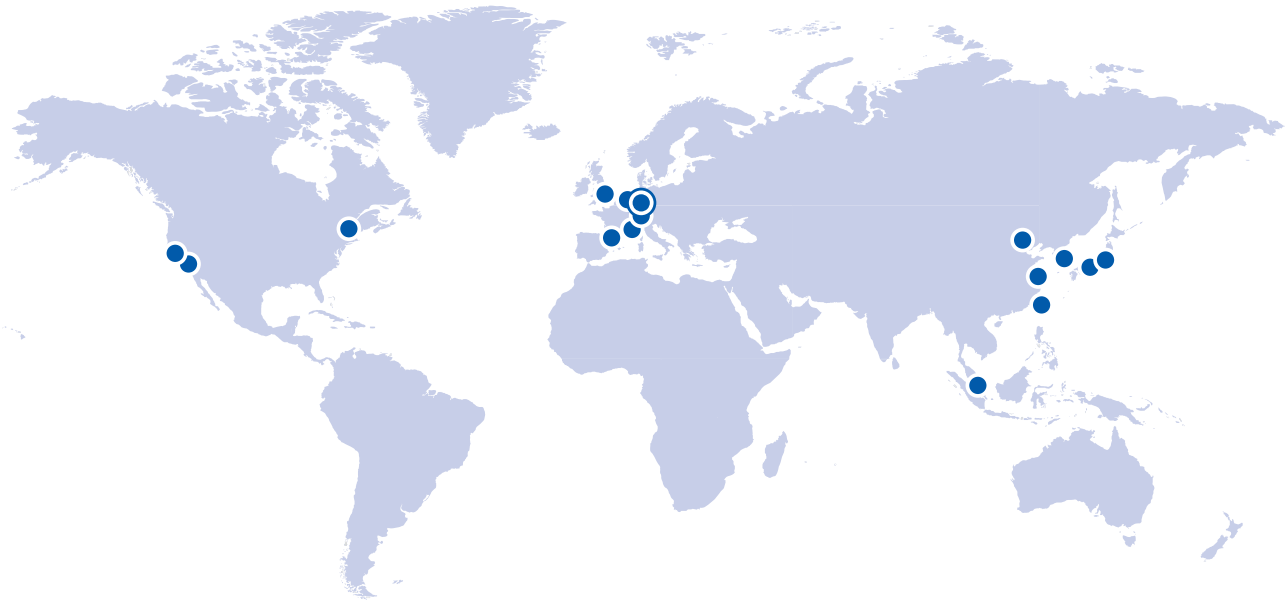
If you have questions regarding your system, provide us with the following information:

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

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

Customer service address:

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



Physik Instrumente (PI) SE & Co. KG
Auf der Römerstraße 1
76228 Karlsruhe
Germany

Phone: +49 712 4846-0
Fax: +49 712 4846-1019

info@pi.de
www.pi.de