User Manual

PZ271E, valid for N-331

KSch, 11/24/2023

N-331

PICMAWalk Drive

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Subject to change without notice. This manual is superseded by any new release. The latest release is available for download on our website (p. 6).

Contents

About this Document

This document contains the information needed for the intended use of the N-331 (hereinafter also referred to as “drive”).

Basic knowledge of servo systems, drive technologies and suitable safety measures is assumed.

Symbols and Typographic Conventions

CAUTION

Dangerous situation

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

➢ Actions to take to avoid the situation.

NOTICE

Dangerous situation

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

➢ Actions to take to avoid the situation.

INFORMATION

Information for easier handling, tricks, tips, etc.

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.

Other Applicable Documents

Product	Document
E-712.xAN digital controller	▪ PZ195E user manual ▪ PZ233E commands manual

Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

➢ Contact our customer service department (p. 24).

1. Open the website www.pi.ws.
2. Search the website for the product number (e.g., E-712).
3. Click the corresponding product to open the product detail page.
4. Click ***Downloads*** tab.

   The manuals are shown under ***Documentation***. Software manuals are shown under ***General Software Documentation***.
5. Click the ***ADD TO LIST*** button for the desired manual and then click ***REQUEST***.
6. Fill out the request form and click ***SEND REQUEST***.

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

Safety

Intended Use

The N-331 PICMAWalk drive 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.

Based on its design and realization the N-331 is intended for positioning, adjusting and shifting loads on one axis at various velocities.

The N-331 is a drive for applications in automation or handling technology. The drive is **not** intended for applications in areas in which a failure would present severe risks to human beings or the environment. The drive is not intended for continuous operation.

Some models of the drive are equipped with optical, incremental sensors. Some models are compatible for vacuum applications to 10^{-9} hPa.

The intended use of the drive is only possible when installed and in conjunction with a suitable electronics (p. 13). The electronics is not included in the scope of delivery of the drive.

The electronics must provide the required operating voltages. To ensure proper performance of the servo-control system, the electronics must also be able to read out and process the signals from the sensors.

Safety Precautions

CAUTION

Dangerous voltage and residual charge on piezo actuators!

The drive contains piezo actuators. Temperature changes and compressive stresses can induce charges in piezo actuators. After being disconnected from the electronics, piezo actuators can also stay charged for several hours. Touching or short-circuiting the contacts in the drive's connector or of the connected vacuum feedthrough can lead to minor injury. In addition, the piezo actuators can be destroyed by an abrupt contraction.

- Do **not** open the drive.
- Discharge the piezo actuators of the drive before installation:
  Connect the drive to the switched-off PI electronics, which is equipped with an internal discharge resistor.
- Do **not** pull out the connector from the electronics during operation.

Touching the contacts in the connector can lead to an electric shock (max. 130 V DC) and minor injuries.

- Do **not** touch the contacts in the connector or the connected vacuum feedthrough.
- Secure the connector of the drive or of the adapter cable on the air side with screws against being pulled out of the electronics.

CAUTION

Risk of crushing by moving parts!

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

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

NOTICE

Destruction of the PICMAWalk drive by electric flashovers!

The drive contains piezo actuators. The use of the drive in environments that increase the electrical conductivity can lead to the destruction of the piezo actuators by electric flashovers. Electric flashovers can be caused by moisture, high humidity, liquids and conductive materials such as metal dust. In addition, electric flashovers can also occur in certain air pressure ranges due to the increased conductivity of the air.

- Avoid operating the drive in environments that can increase the electric conductivity.
- Only operate the drive within the permissible ambient conditions and classifications (see p. 28).
- For operation in vacuum below 0.1 hPa:
  Do not operate the drive during evacuation and aeration.

Measures for Handling Vacuum-Compatible Products

When handling the vacuum versions of the drive, attention must be paid to appropriate cleanliness. At PI, all parts are cleaned before assembly. During assembly and measurement, powder-free gloves are worn. Afterwards, the drive is cleaned once again by wiping and shrink-wrapped twice in vacuum-compatible film.

- Only touch the drive with powder-free gloves.
- If necessary, wipe the drive clean after unpacking.

Product Description

Model Overview

Model	Description
N-331.10	Piezoelectric walking drive PICMAWalk, 25 mm travel range, open loop, 50 N drive force
N-331.13	Piezoelectric walking drive PICMAWalk, 25 mm travel range, incremental sensor, 50 N drive force
N-331.20	Piezoelectric walking drive PICMAWalk, 50 mm travel range, open loop, 50 N drive force
N-331.23	Piezoelectric walking drive PICMAWalk, 50 mm travel range, incremental sensor, 50 N drive force
N-331.40	Piezoelectric walking drive PICMAWalk, 100 mm travel range, open loop, 50 N drive force
N-331.43	Piezoelectric walking drive PICMAWalk, 100 mm travel range, incremental sensor, 50 N drive force
N-331.20U	Piezoelectric walking drive PICMAWalk, 50 mm travel range, open loop, 50 N drive force, vacuum compatible to 10^{-9} hPa
N-331.24U	Piezoelectric walking drive PICMAWalk, 50 mm travel range, incremental sensor, 50 N drive force, vacuum compatible to 10^{-9} hPa

Product View

N-331

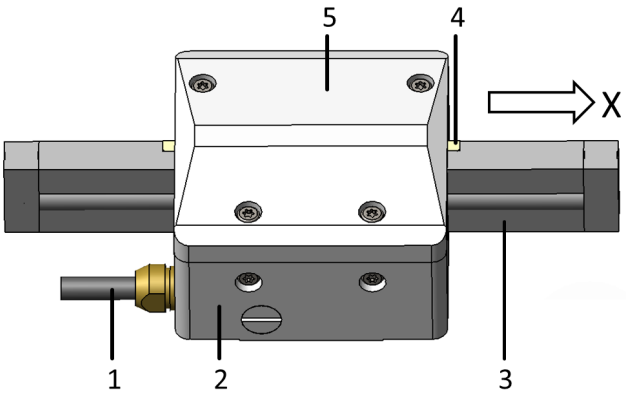

Figure 1: Example view of a drive without sensor (N-331.x0)

1 Cable exit
2 Base body
3 Runner
4 Ceramic rail (side view)
5 Cover

X: The arrow indicates the positive direction of motion.

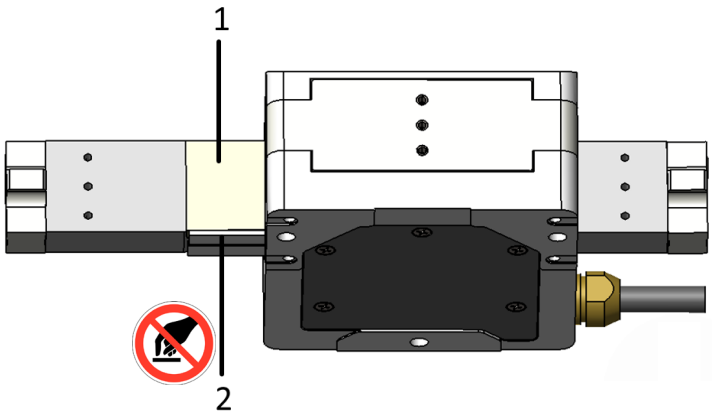

Figure 2: Example view of a drive with integrated sensor (N-331.x3)

1 Ceramic rail (top view)
2 Ruler of linear encoder (do **not** touch)

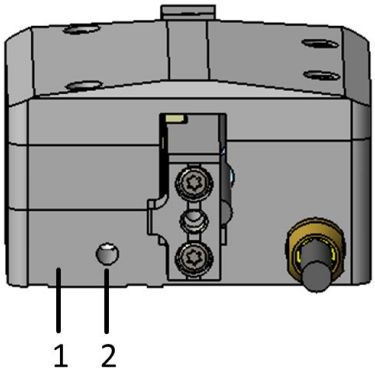

Figure 3: Position of the protective earth connection

1 Position of symbol for the protective earth conductor
2 M4 mounting hole

N-331.1LU Vacuum Feedthrough

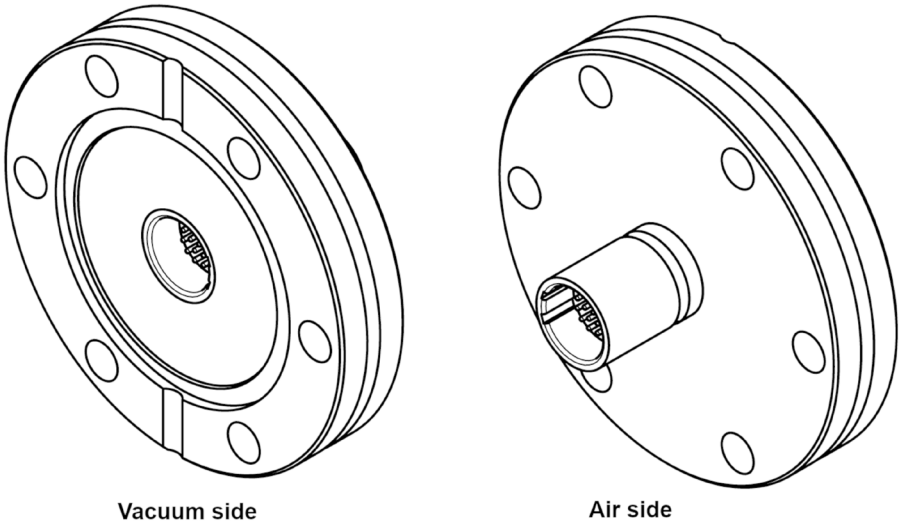

Figure 4: N-331.1LU vacuum feedthrough

N-331.0x Air-Side Adapter Cable

Figure 5: Here, the N-331.02 air-side adapter cable is shown

Product Labeling

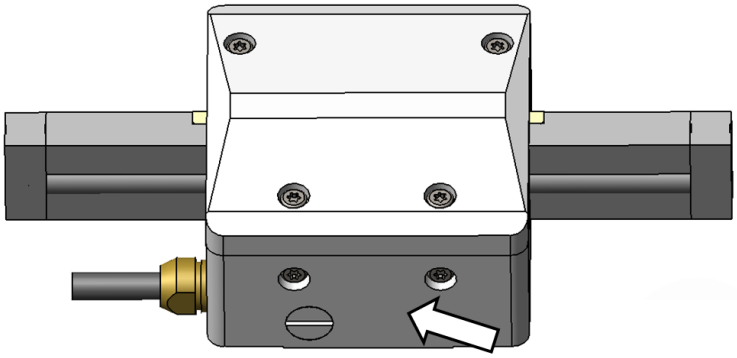

Figure 6: Position of the product labeling on the drive

Labeling	Description
N-331.20	Product name (example), the characters following the period refer to the model
116010244	Serial number (example), individual for each drive Meaning of the places (counting from left): 1 = internal information 2 and 3 = year of manufacture 4 to 9 = consecutive numbers
PICMAWalk	Brand name
PI	Manufacturer's logo
Country of origin: Germany	Country of origin
⚠	Warning sign "Observe manual!"
	Old equipment disposal (p. 36)
CE	CE conformity mark
WWW.PI.WS	Manufacturer's address (website)
⏚	Symbol for the protective earth conductor, marks the drive's protective earth connection (p. 15)

Labeling of the Sub-D 37 (m) connector

Figure 7: Sub-D 37 (m) connector of the N-331.xx models or of the N-331.0x adapter cable on the air side (with x = 2 or 5)

Warning sign "Residual Voltage": Notice of risk of electric shock (p. 7)

Scope of Delivery

Item ID	Components
N-331	PICMAWalk drive according to order (p. 8)
000036450	M4 screw set for protective earth, consisting of: ▪ 1 M4x8 flat-head screw with cross recess, ISO 7045 ▪ 2 safety washers ▪ 2 flat washers
PZ271E	User manual (this document) in printed form

Accessories

Only for N-331.xxU model (suitable for use in a vacuum to 10^{-9} hPa)

Item ID	Components
N-331.02	Adapter cable, LEMO 19-pin (f) to D-Sub 37 (m), 2 m
N-331.05	Adapter cable, LEMO 19-pin (f) to D-Sub 37 (m), 5 m
N-331.1LU	Vacuum feedthrough (drive and sensor signals), LEMO 19-pin (m/m), DN40CF

Suitable Electronics

Electronics	Description
E-712.1AN	Digital controller for PICMAWalk walking drive, 1 channel
E-712.2AN	Digital controller for PICMAWalk walking drive, 2 channels
E-712.3AN	Digital controller for PICMAWalk walking drive, 3 channels

PC software is included in the scope of delivery of the electronics from PI. The operation of the electronics is described in the corresponding user manuals.

Unpacking

INFORMATION

When handling the vacuum version of the drive, attention must be paid to appropriate cleanliness. At PI, all parts are cleaned before assembly. Powder-free gloves are worn during assembly and measuring. In addition, the drive is wipe cleaned afterwards and then shrink-wrapped twice in vacuum-compatible film.

- ➢ Touch the drive only with powder-free gloves.
- ➢ If necessary, wipe the drive clean after unpacking.

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

Installation

General Notes on Installation

NOTICE

Damage due to mechanical actions!

The encoder scale is scratch-sensitive and can be damaged by mechanical actions, e.g. from pointed objects.

- Handle the encoder scale with great care.
- Do not touch the encoder scale and the ceramic rail.
- Protect the encoder scale and the ceramic rail from dirt and lubricants.

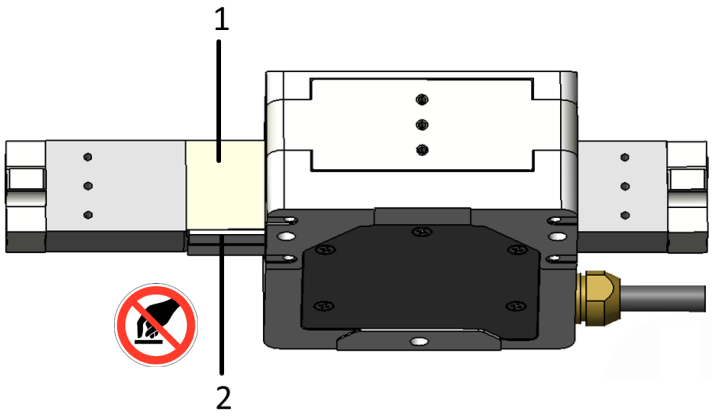

Figure 8: Ruler (1) of the linear encoder and ceramic rail (2) of the drive. The ruler is accessible when the runner is extended.

NOTICE

Malfunction due to soiling!

Any type of soiling, e.g. dust, oil, grease or condensation, will render the drive inoperable.

- Keep the drive free from lubricants, dirt and condensation.
- Avoid touching the ceramic rail of the drive and the ruler of the linear encoder.

NOTICE

Heating up of the drive during operation!

The heat produced during operation of the drive can affect your application.

- Install the drive so that the application is not affected by the dissipated heat.
- Ensure sufficient ventilation at the place of installation.
- Make sure that the complete drive is underneath in contact with the surface on which the drive is fixed.

NOTICE

Damage due to collisions!

Collisions can damage the drive, the load to be moved, and the surroundings.

- Make sure that no collisions are possible between the drive, the load to be moved, and the surroundings in the motion range of the drive.
- Do **not** place any objects in areas where they can be caught by moving parts.

INFORMATION

For the positive direction of motion of the runner, see "Product View" (p. 9).

Connecting the N-331 to a Protective Earth Conductor

INFORMATION

Pay attention to the applicable standards for mounting 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 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.

The drive features a separate protective earth connection, see “Dimensions” on p. 29.

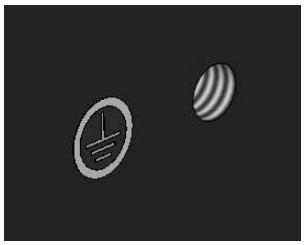

Figure 9: Example of a protective earth connection

Tools and accessories

- Suitable protective earth conductor: Cross-sectional area of the cable ≥0.75 mm^2
- Suitable screwdriver
- M4 screw for connecting the protective earth conductor

Connecting the protective earth conductor to the separate protective earth connection

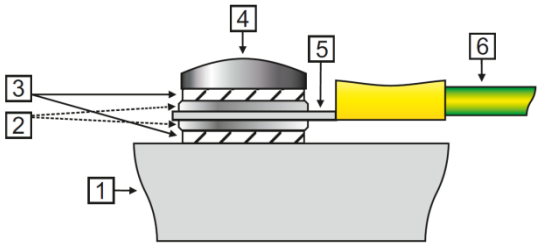

Figure 10: Recommended mounting of the protective earth conductor (profile view)

1 Base body of the drive
2 Flat washer
3 Safety washer
4 Screw
5 Cable lug
6 Protective earth conductor

1. If necessary, attach a suitable cable lug to the protective earth conductor.
2. Use the M4 screw (together with the washers and self-locking washers) to affix the cable lug of the protective earth conductor to the protective earth connection of the drive as shown in the profile 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 connection points relevant for connecting the protective earth conductor is <0.1 Ω at 25 A.

Integrating the N-331

The mounting holes in the underneath of the base body and at both ends of the runner make it possible to integrate the drive into an assembly.

Fixing the N-331 by Its Base Body

NOTICE

Warping of the drive due to mounting on uneven surfaces and lateral forces!

Mounting the drive onto an uneven surface can warp the drive. Lateral forces on the runner can warp the runner. Warping reduces the specifications of the drive.

- Mount the drive onto an even surface. The recommended evenness of the surface is ≤20 µm.
- For applications with large temperature changes:
  Only mount the drive onto surfaces that have the same or similar thermal expansion properties as the drive.
- Runner and movable part of the assembly, where the drive is to be integrated in, have to be parallel.

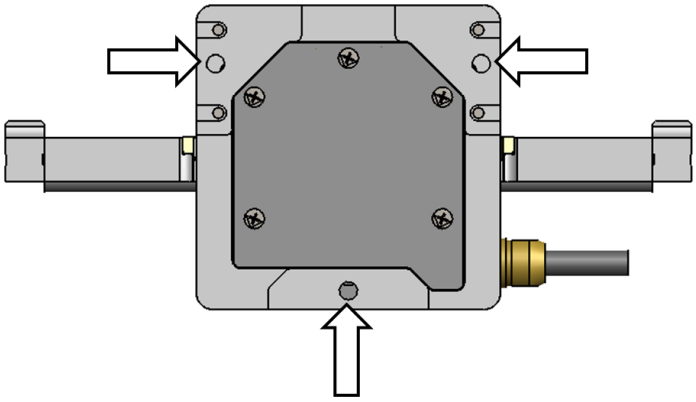

Figure 11: Mounting holes on the bottom of the drive.

See "Dimensions" (p. 29) for the exact location of the mounting holes.

Requirements

- ✓ You have read and understood the safety precautions (p. 7) and the general notes on installation (p. 14).
- ✓ The drive is not connected to the electronics.
- ✓ You have provided a suitable surface:
  - Three M4 holes are present.
  - The evenness of the surface is ≤20 µm.
  - For applications with large temperature changes: The surface should have the same thermal expansion properties as the drive.
- ✓ You have accounted for the space required to route cables without bending and according to regulations.

Tools and accessories

- 3 M4 screws of suitable length (p. 29)

Fixing the N-331 by its base body

1. Align the drive on the surface so that the M4 holes in the base body and the surface overlap.
2. Insert the three screws through the holes in the surface into the drive's base body from below.
3. Tighten the three screws.
   - Maximum screw-in depth: 7 mm
   - Maximum torque: 2.6 Nm
4. Check that the drive fits without backlash.

Fixing the N-331 by Its Runner

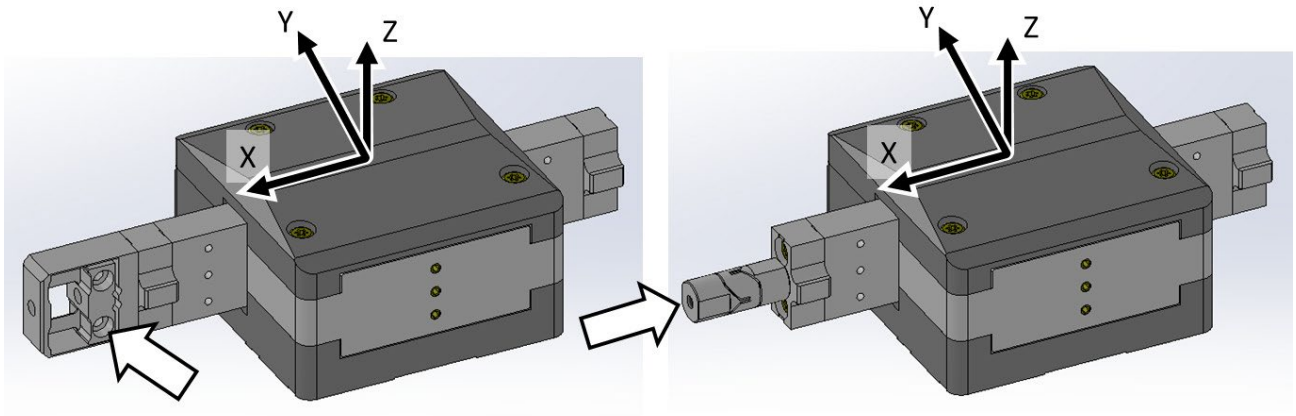

Figure 12: Examples for decoupling elements; Left: For lateral fixing, right: For axial fixing

NOTICE

Mechanical overload due to high torques and high forces!

High torques when fixing the runner to an assembly can overload the drive's runner. Mechanical overload can damage the drive.

- ➢ Hold the runner firmly to prevent it from moving when tightening the screws.
- ➢ Pay attention to the maximum permissible forces according to the maximum values for torque and forces (p. 29).
- ➢ Avoid tilting torques on the runner.
- ➢ The coupling between runner and assembly must be very stiff in the runner's motion direction, here along X axis, but flexible in Y and Z axes.
  See Figure 12 for a drive with two examples for decoupling elements: these allow a stiff coupling and prevent force or torque on the runner when the runner is fixed to the assembly.
- ➢ Make sure that displacement of the runner in Y and Z directions does not occur.

The runner can be fixed to an assembly on both sides of the runner.

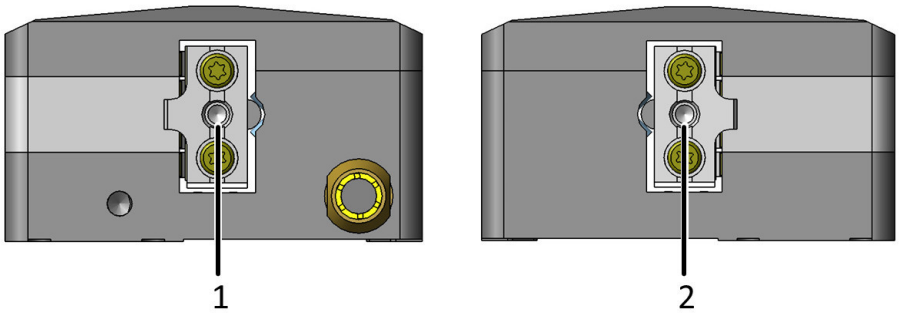

Figure 13: Lateral views of drive: Fixing the runner with M4 screws

1 M4 inner thread in the runner, at side with cable exit
2 M4 inner thread in the runner, at the opposite side

Tools and accessories

Optional:

- Suitable decoupling element
- Suitable screws to fix the decoupling element to the assembly
- Suitable screwdriver

- M4 screw of suitable length (p. 30)
- Screwdriver for M4 screw

Requirements

- ✓ You have read and understood the safety precautions (p. 7) and the general notes on installation (p. 14).
- ✓ The drive is not connected to the electronics.
- ✓ You have fixed the drive properly.
- ✓ The distance between the center of gravity of the load and the center of the hole in the runner is as small as possible in all directions.

Fixing the N-331 by its runner

1. Choose one side of the runner where to fix it to the assembly.
2. Optional: Fix a suitable decoupling element to the runner holding the runner firmly to avoid torque on it and to hold it in place.

   Pay attention to a maximum torque, see p. 29 and Figure 15 on p. 29.

3. Optional: Fix the decoupling element to the assembly with suitable screws.

   Pay attention to a maximum torque, see p. 29 and Figure 15 on p. 29.

4. If the runner is to be fixed to the assembly directly use the M4 screw. Hold the runner firmly to avoid torque on it.

   Pay attention to a **maximum torque of 0.2 Nm**.

5. Optional: Fix the other side of the runner to the assembly repeating steps 2 to 4.

Connecting the N-331 to the Electronics

Requirements

- ✓ You have read and understood the safety precautions (p. 7) and the general notes on installation (p. 14).
- ✓ You have installed the electronics (p. 13).
- ✓ You have read and understood the user manual of the electronics.
- ✓ The electronics are switched off.

Tools and accessories

- For N-331.xxU, i.e. for operation in a vacuum:
  - N-331.1LU vacuum feedthrough (suitable for use in a vacuum to 10^{-9} hPa), available as optional accessory (p. 13)
  - N-331.02 or N-331.05 air-side cable, available as optional accessory (p. 13)
  - Suitable tools for installing the vacuum feedthrough

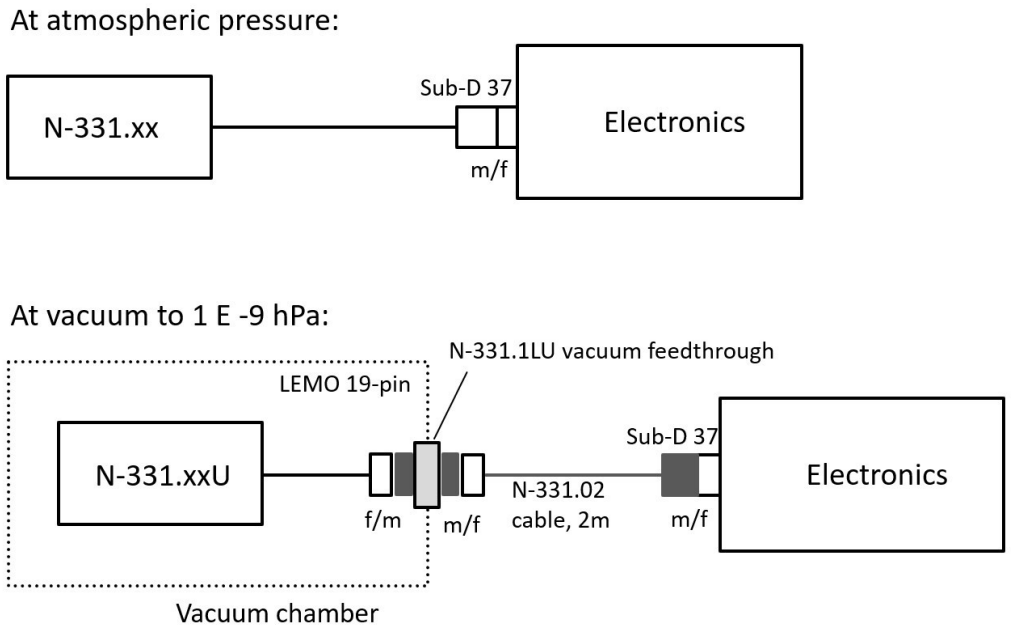

Figure 14: Connection diagrams: Top: for N-331.xx at atmospheric pressure, bottom: example for N-331.xxU at vacuum to 10^{-9} hPa, here with N-331.02 cable

1. For N-331.xxU: Install the vacuum feedthrough:
   a) Obtain the dimensions from the corresponding dimensional drawing (p. 31).
   b) Make sure that the vacuum feedthrough is oriented correctly, see p. 10.
   c) Make a suitable opening in the vacuum chamber.
   d) Install the vacuum feedthrough.

2. Connect the drive and the electronics to each other as shown in the connection diagram above.
3. Take suitable measures to secure the connections against accidental disconnection.

Startup and Operation

General Notes on Startup and Operation

CAUTION

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

If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur and there is a risk of electric shock. In the case of malfunction or failure of the system, touching the drive or the contacts of the connected vacuum feedthrough can result in minor injuries.

- Connect the drive to a protective earth conductor (p. 15) before start-up.
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be temporarily removed (e.g., for modifications), reconnect the drive to the protective earth conductor before starting it up again.

NOTICE

Destruction of the PICMAWalk drive by electric flashovers!

The drive contains piezo actuators. The use of the drive in environments that increase the electrical conductivity can lead to the destruction of the piezo actuators by electric flashovers. Electric flashovers can be caused by moisture, high humidity, liquids and conductive materials such as metal dust. In addition, electric flashovers can also occur in certain air pressure ranges due to the increased conductivity of the air.

- Avoid operating the drive in environments that can increase the electric conductivity.
- Only operate the drive within the permissible ambient conditions and classifications (see p. 28).
- For operation in vacuum below 0.1 hPa:
  Do not operate the drive during evacuation and aeration.

NOTICE

Destruction of the piezo actuator by continuously high voltage!

The constant application of high voltage to piezo actuators can lead to leakage currents and flashovers that destroy the ceramic.

If the drive is not used, but the electronics is to remain switched on to ensure temperature stability:

In closed-loop operation:

1. Switch the servo mode off on the electronics (open-loop operation).
2. Set the piezo voltage to 0 V on the electronics.

In open-loop operation:

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

NOTICE

Operating voltage too high or incorrectly connected!

Operating voltages that are too high or incorrectly connected can cause damage to the drive.

- Only operate the drive with a electronics from PI.
- Do **not** exceed the operating voltage range (p. 27) for which the drive is specified.
- Only operate the drive when the operating voltage is properly connected; see "Pin Assignment" (p. 32).

NOTICE

Uncontrolled oscillation!

Oscillations can cause irreparable damage to the drive. Oscillations are indicated by a humming and can result from the following causes:

- A change in the load and/or dynamics requires the servo-control parameters to be adjusted.
- The drive is operated near its resonant frequency.

If you notice oscillations:

- In closed-loop operation, immediately switch off the servo mode.
- In open-loop operation, immediately stop the drive.

NOTICE

Damage due to travel to the hard stop!

Repeated travel to the hard stop can cause damage and considerable wear to the mechanics.

- Stop the motion immediately if an electronics malfunction occurs.
- Set the control signal so that the moving part does not try to continue moving at the end of the travel range.

INFORMATION

In a vacuum, there is no heat dissipation via convection.

We recommend to operate the vacuum version of the drive with a maximum duty cycle of 30 % with a maximum duration of motion of 10 sec.

- ➢ Select an underlying surface for fixing the N-331.xxU that has high thermal conductivity.
- ➢ Make sure that the entire lower surface of the N-331.xxU contacts the underlying surface that it is fixed to.

Startup and Operation

Requirements

- ✓ You have read and understood the safety precautions (p. 7) and the general notes on startup and operation (p. 21).
- ✓ You have read and understood the user manual of the electronics.
- ✓ You have properly installed the drive (p. 14).
- ✓ The electronics and the required PC software have been installed. All connections with the electronics have been established (see user manual of the electronics).

Startup and operation

- ➢ For startup and operation of the drive, follow the instructions in the manual of the electronics used.

Discharging the N-331

The drive must be discharged in the following cases:

- Before installation
- If the drive is not used but the electronics remains switched on to ensure temperature stability
- Before demounting (e.g., before cleaning and transporting the drive and for modifications)

The drive is discharged through the internal discharge resistor of the electronics from PI.

Discharging an N-331 that is connected to the electronics

In closed-loop operation:

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

In open-loop operation:

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

Discharging an N-331 that is not connected to the electronics

- ➢ Connect the drive to the switched-off electronics from PI.

Maintenance

General Notes on Maintenance

NOTICE

Misalignment from loosening screws!

The drive is maintenance-free and achieves its positioning accuracy as a result of the optimum alignment of mechanical components and piezo actuators. Loosened screws cause a loss in positioning accuracy.

- ➢ Only loosen screws according to the instructions in this document.
- ➢ Do **not** open the drive.

Cleaning the N-331

Requirements

- ✓ You have discharged the piezo actuators of the drive (p. 27).
- ✓ You have disconnected the drive from the electronics.

Cleaning the N-331

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

Only when the drive is not used in vacuum:

- ➢ Clean the surfaces of the drive with a cloth that is slightly dampened with a mild cleanser or disinfectant (e.g. ethanol or isopropanol).

When the drive is used in a vacuum:

- ➢ Touch the drive only with powder-free gloves.
- ➢ If necessary, wipe the drive clean.

Customer Service

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

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

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

Technical Data

Specifications of N-331.xx, Not Vacuum Compatible

Motion	Unit	Tolerance	N-331.10	N-331.13	N-331.20	N-331.23	N-331.40	N-331.43
Active axes			X	X	X	X	X	X
Travel range in X	mm			25		50		100
Travel range in X, open loop	mm	±0.5 mm	30	30	55	55	105	105
Travel range in X (analog mode)	µm	Typ.	20	20	20	20	20	20
Operating frequency in full step mode	kHz		0.6	0.6	0.6	0.6	0.6	0.6
Velocity (100% duty cycle, full-step mode)	mm/s	Max.	12	12	12	12	12	12
Velocity (100% duty cycle, nanostepping mode)	mm/s	Max.	10	10	10	10	10	10

Positioning	Unit	Tolerance	N-331.10	N-331.13	N-331.20	N-331.23	N-331.40	N-331.43
Minimum incremental motion in X	µm	Typ.	0.01	0.01	0.01	0.01	0.01	0.01
Resolution in X, open loop	nm	Typ.	0.02	0.02	0.02	0.02	0.02	0.02
Integrated sensor				Incre-mental linear encoder		Incre-mental linear encoder		Incre-mental linear encoder
System resolution in X	nm			10		10		10

Drive Properties	Unit	Tolerance	N-331.10	N-331.13	N-331.20	N-331.23	N-331.40	N-331.43
Drive type			PICMA Walk	PICMA Walk	PICMA Walk	PICMA Walk	PICMA Walk	PICMA Walk
Operating voltage	V		-20 to 120	-20 to 120	-20 to 120	-20 to 120	-20 to 120	-20 to 120
Drive force in negative direction of motion in X	N	Max.	50	50	50	50	50	50
Drive force in positive direction of motion in X	N	Max.	50	50	50	50	50	50

Mechanical Properties	Unit	Tolerance	N-331.10	N-331.13	N-331.20	N-331.23	N-331.40	N-331.43
Holding force in X, passive	N	Min.	60	60	60	60	60	60
Moved mass in X, unloaded	g		110	110	140	140	190	190
Overall mass	g		580	580	610	610	660	660
Material			Aluminum, stainless steel					
Endurance at 1013 hPa, 2 kg payload, 70% duty cycle	km		> 30	> 30	> 30	> 30	> 30	> 30

Miscellaneous	Unit		N-331.10	N-331.13	N-331.20	N-331.23	N-331.40	N-331.43
Operating temperature range	°C		0 to 50	0 to 50	0 to 50	0 to 50	0 to 50	0 to 50
Connector			D-sub 37-pin (m)	D-sub 37-pin (m)	D-sub 37-pin (m)	D-sub 37-pin (m)	D-sub 37-pin (m)	D-sub 37-pin (m)
Cable length	m		2	2	2	2	2	2
Recommended controllers / drivers			E-712.1AN •E-712.2AN •E-712.3AN					

Travel range in X, open loop: From one mechanical hard stop of the runner to the other mechanical hard stop, only in open-loop operation
Velocity (100 % duty cycle, full-step mode): Depends on the controller, the load, and the servo control parameters; controller here: E-712.1AN. When using the linear stage for longer positioning tasks with this controller, a velocity of less than 3 mm/s is recommended.
Operating frequency in full-step mode: When operated with a digital controller with 25 W peak power output
All specifications based on room temperature (22 °C ±3 °C).

Specifications of N-331.xxU, Vacuum Compatible

Motion	Unit	Tolerance	N-331.20U	N-331.24U
Active axes			X	X
Travel range in X	mm			50
Travel range in X, open loop	mm	±0.5 mm	55	55
Travel range in X (analog mode)	µm	Typ.	20	20
Operating frequency in full step mode	kHz		0.6	0.6
Velocity (100% duty cycle, full-step mode)	mm/s	Max.	12	12
Velocity (100% dury cycle, nanostepping mode)	mm/s		10	10

Positioning	Unit	Tolerance	N-331.20U	N-331.24U
Minimum incremental motion in X	µm	Typ.	0.01	0.01
Resolution in X, open loop	nm	Typ.	0.02	0.02
Integrated sensor				Incremental linear encoder
System resolution in X	nm			4

Drive Properties	Unit	Tolerance	N-331.20U	N-331.24U
Drive type			PICMAWalk	PICMAWalk
Operating voltage	V		-20 to 120	-20 to 120
Drive force in positive direction of motion in X	N	Min.	50	50
Drive force in negative direction of motion in X	N	Min.	50	50

Mechanical Properties	Unit	Tolerance	N-331.20U	N-331.24U
Holding force in X, passive	N	Min.	60	60
Moved mass in X, unloaded	g		140	140
Overall mass	g		610	610
Material			Aluminum, stainless steel	Aluminum, stainless steel
Endurance at 10E-9 hPa, 15% duty cycle	km		>2	>2

Miscellaneous	Unit		N-331.20U	N-331.24U
Operating temperature range	°C		0 to 50	0 to 50
Vacuum class	hPa		10^{-9}	10^{-9}
Connector			LEMO FGJ.2B.319.CLLD52	LEMO FGJ.2B.319.CLLD52
Cable length	m		1	1
Recommended controllers / drivers			E-712.1AN • E-712.2AN • E-712.3AN	E-712.1AN • E-712.2AN • E-712.3AN

Travel range in X, open loop: From one mechanical hard stop of the runner to the other mechanical hard stop, only in open-loop operation
Velocity (100 % duty cycle, full-step mode): Depends on controller, load and servo-control parameters, here: E-712.xA**1**. For longer positioning tasks of the linear actuator using this controller is only recommended with a velocity below 3 mm/s.
Operating frequency in full-step mode: When operated with a digital controller with 25 W peak power output
All specifications based on room temperature (22 °C ±3 °C).

Maximum Ratings

The N-331 is designed for the following operating data:

Mode of operation	Maximum operating voltage ⚠	Maximum operating frequency (unloaded) [1] ⚠	Maximum power consumption [2] ⚠
Analog	-20 to 120 V	300 Hz	30 W
Nanostepping		12 mm/s [3]	9 W
Nanostepping		15 mm/s [3]	11 W

[1] To ensure stable operation, the maximum operating frequency is defined as approximately 1/3 of the mechanical resonant frequency.

[2] The heat generated by the piezo actuator during dynamic operation limits the value for maximum power consumption.
Details can be found online:

http://piceramic.com/piezo-technology/properties-piezo-actuators/electrical-operation.html

[3] Note that the N-331's maximum velocity depends on the controller. Refer to the specifications starting on p. 25 for an estimation of the maximum velocity with available PI controllers.

Ambient Conditions and Classifications

The following ambient conditions and classifications must be observed for the N-331 drives:

Area of application	For indoor use only
Maximum altitude	2000 m
Air pressure	N-331.xx: 1100 hPa to 0.1 hPa N-331.xxU: 1100 hPa to 10^{-9} hPa
Relative humidity	Highest relative humidity 80 % for temperatures up to 31 °C Decreasing linearly to 50 % relative humidity at 40 °C
Operating temperature	0 °C to 50 °C
Storage temperature	-20 °C to 80 °C
Transport temperature	-25 °C to 80 °C
Maximum bakeout temperature	N-331.xxU: 80 °C, for 12 hours, only in switched-off state Vacuum feedthrough: 150 °C
Overvoltage category	II
Protection class	I
Degree of pollution	1
Degree of protection according to IEC 60529	IP20

Mechanical Load Capacity

Maximum values for torque and forces

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

Parameter	Permissible values
Passive force (holding force, linear actuator currentless) F_h	- 60 N to 60 N
Active force (drive force) F_p	- 50 N to 50 N
Lateral force F_l	- 5 N to 5 N
Torque M_{rot} in the direction of the runner axis	- 0.2 Nm to 0.2 Nm
Torque M_l generated by lateral force (radial; not shown)	- 0.15 Nm to 0.15 Nm

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

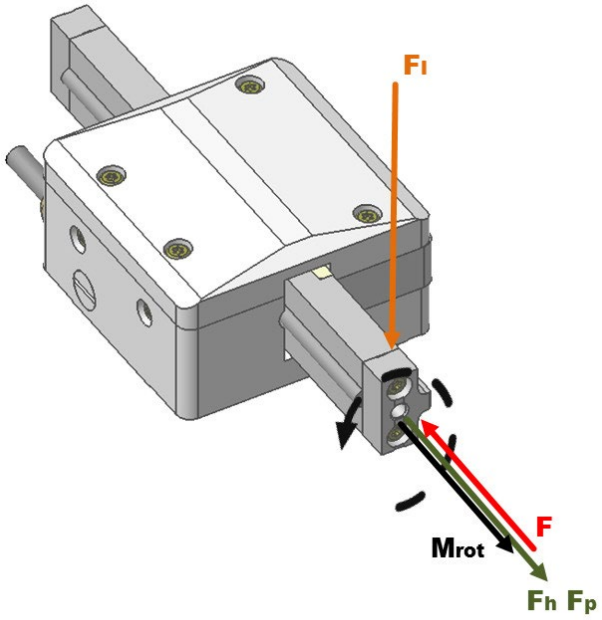

Figure 15: Forces and torques potentially affecting the runner (schematic)

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

Dimensions

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

N-331

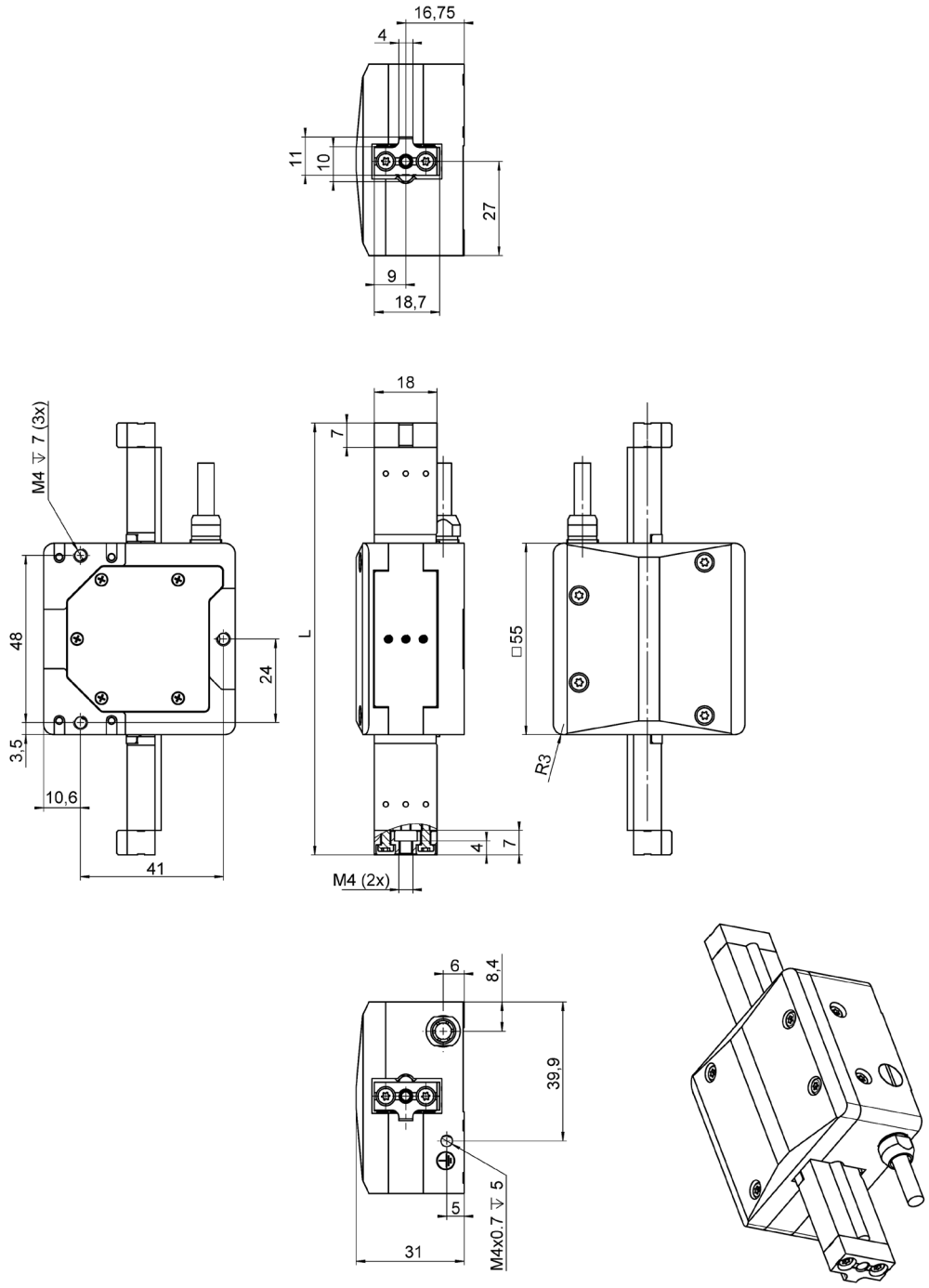

Figure 16: Dimensions of the N-331

L:	
N-331.1x:	99 mm
N-331.2x / N-331.2xU:	124 mm
N-331.4x:	174 mm

N-331.1LU Vacuum Feedthrough

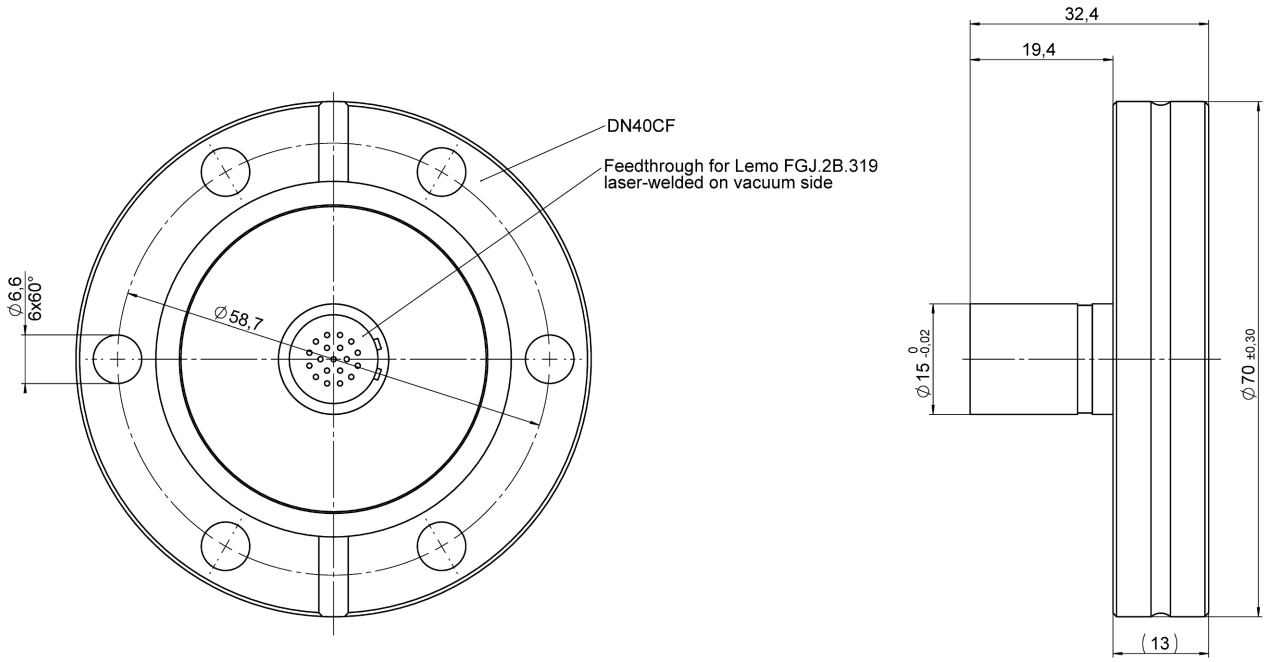

Figure 17: Dimensions of the N-331.1LU vacuum feedthrough

N-331.0x Air Side Adapter Cable

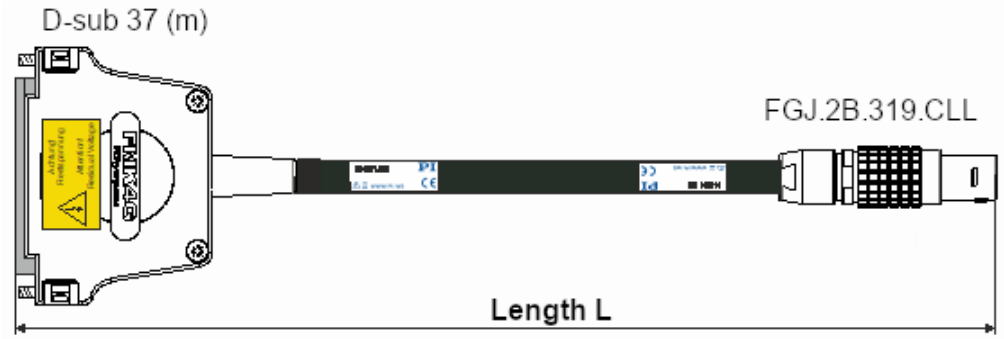

Figure 18: N-331.02: L is 2 m (-0 cm / + 10 cm), N-331.05: L is 5 m (-0 cm / + 15 cm)

Pin Assignment

N-331.xx

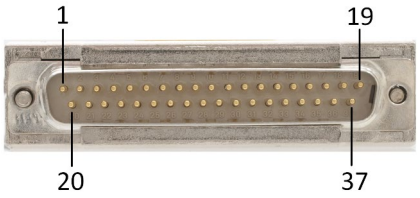

Figure 19: Sub-D 37 (m) piezo connector

Pin	Function*	Pin	Function*
1	-	20	-
2	GND	21	Internal use
3	-	22	-
4	-	23	-
5	-	24	-
6	-	25	-
7	-	26	-
8	-	27	-
9	-	28	-
10	-	29	-
11	-	30	-
12	Reference Ch1 (+)	31	Reference Ch1 (-)
13**	EncoderCOS (+)	32**	Encoder COS (-)
14**	Encoder SIN (+)	33**	Encoder SIN (-)
15**	Supply voltage for sensor, +5 V	34	PZT_N1
16	PZT_P1	35	PZT_N2
17	PZT_P2	36	PZT_N3
18	PZT_P3	37	PZT_N4
19	PZT_P4		

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

** Pin assignment for models with sensor. Not assigned with models without sensor

N-331.xxU (Vacuum Compatible for 10^{-9} hPa)

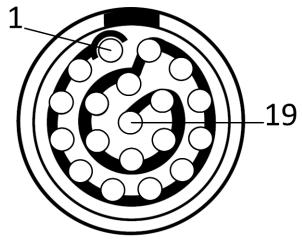

Figure 20: 19-pin (f) LEMO connector, FGJ.2B.319.CLLD52

Pin	Function
1	PZT_N1
2	Not connected
3	PZT_N2
4	GND
5	PZT_N3
6	PZT_N4
7*	Encoder COS (+)
8*	Encoder COS (-)
9	Reference (-)
10	Reference (+)
11*	Encoder SIN (+)
12*	Encoder SIN (-)
13	PZT_P1
14	PZT_P2
15	PZT_P3
16	PZT_P4
17	Internal use
18	Internal use
19*	Supply voltage for sensor, +5 V
Shell	Shield

* Pin assignment for models with sensor. Not assigned with models without sensor.

N-331.1LU Vacuum Feedthrough

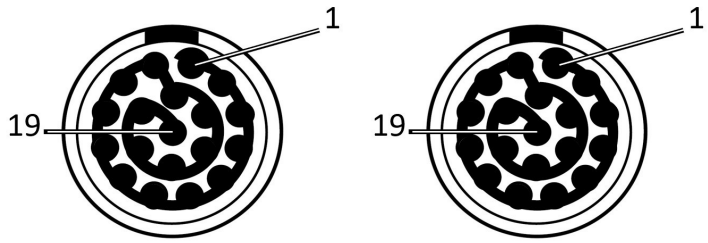

Figure 21: Left: Pin assignment on vacuum side; Right: Pin assignment on air side

The signals on the air side are **mirrored** compared with the signals on the vacuum side.

Pin / vacuum side	Signal	Pin / air side
1	PZT_N1	**12**
2	Not connected	**11**
3	PZT_N2	**10**
4	GND	**9**
5	PZT_N3	**8**
6	PZT_N4	**7**
7	Encoder COS (+)	**6**
8	Encoder COS (-)	**5**
9	Reference (-)	**4**
10	Reference (+)	**3**
11	Encoder SIN (+)	**2**
12	Encoder SIN (-)	**1**
13	PZT_P1	13
14	PZT_P2	**18**
15	PZT_P3	**17**
16	PZT_P4	16
17	Internal use	**15**
18	Internal use	**14**
19	Supply voltage for sensor, +5 V	19

N-331.0x Air-Side Adapter Cable, LEMO 19-Pin (f) to D-Sub 37-Pin (m)

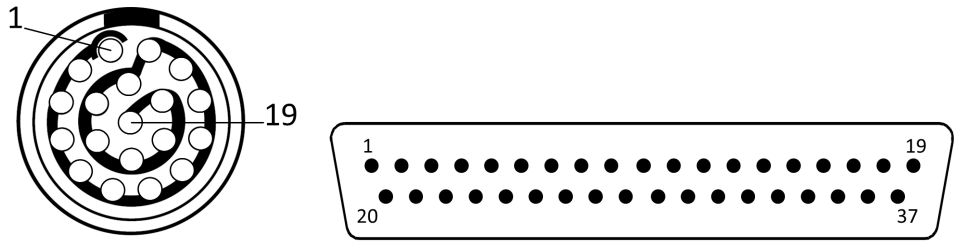

Figure 22: Left: 19-pin (f) LEMO connector, FGJ.2B.319.CLLD52; Right: D-sub 37-pin (m)

Pin / LEMO 19-pin (f) / Side of vacuum feedthrough	Signal	Pin / D-Sub 37 (m) / Electronics side
19	Supply voltage for sensor, +5 V	15
18	PZT_P2	17
17	PZT_P3	18
16	PZT_P4	19
15	Not connected	--
14	Not connected	--
13	PZT_P1	16
12	PZT_N1	34
11	Not connected	--
10	PZT_N2	35
9	GND	2
8	PZT_N3	36
7	PZT_N4	37
6	Encoder COS (+)	13
5	Encoder COS (-)	32
4	Reference (-)	31
3	Reference (+)	12
2	Encoder SIN (+)	14
1	Encoder SIN (-)	33
Housing	Shield	Shell

Old Equipment Disposal

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

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

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

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

Physik Instrumente (PI) GmbH & Co. KG

Auf der Roemerstr. 1

D-76228 Karlsruhe, Germany