

User Manual

PZ271E, valid for N-331

KSch, 3/22/2017

PI

N-331

PICMAWalk Drive



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About this Document

This document contains the information needed for the intended use of the N-331.

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. 18).

INFORMATION

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

The password is included on the CD of the product.

For products with CD: Identify the password

1. Insert the product CD into the PC drive.
2. Switch to the Manuals directory on the CD.
3. In the Manuals directory, open the Release News (file including *releasenews* in the file name).
4. Find the user name and the password in the section "User login for software download" in the Release News.

Downloading manuals

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

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

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 which 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 and with defined forces.

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

Some models of the N-331 are equipped with optical, incremental sensors.

The intended use of the N-331 is only possible when installed and in conjunction with a suitable controller (p. 10). The controller is not included in the scope of delivery of the N-331.

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 N-331 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 connector of the N-331 can lead to minor injuries. In addition, the piezo actuators can be destroyed by an abrupt contraction.

- Do **not** open the N-331.
- Discharge the piezo actuators of the drive before installation:
Connect the drive to the switched-off PI controller, 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.
- Secure the connector of the drive with screws against being pulled out of the controller.

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 N-331 and a stationary part or obstacle.

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

Product Description

Model Overview

Model	Description
N-331.10	Piezoelectric walking drive PICMAWalk, 25 mm travel range, open loop, 50 N push/pull force
N-331.13	Piezoelectric walking drive PICMAWalk, 25 mm travel range, incremental sensor, 50 N push/pull force
N-331.20	Piezoelectric walking drive PICMAWalk, 50 mm travel range, open loop, 50 N push/pull force
N-331.23	Piezoelectric walking drive PICMAWalk, 50 mm travel range, incremental sensor, 50 N push/pull force
N-331.40	Piezoelectric walking drive PICMAWalk, 100 mm travel range, open loop, 50 N push/pull force
N-331.43	Piezoelectric walking drive PICMAWalk, 100 mm travel range, incremental sensor, 50 N push/pull force

Product View

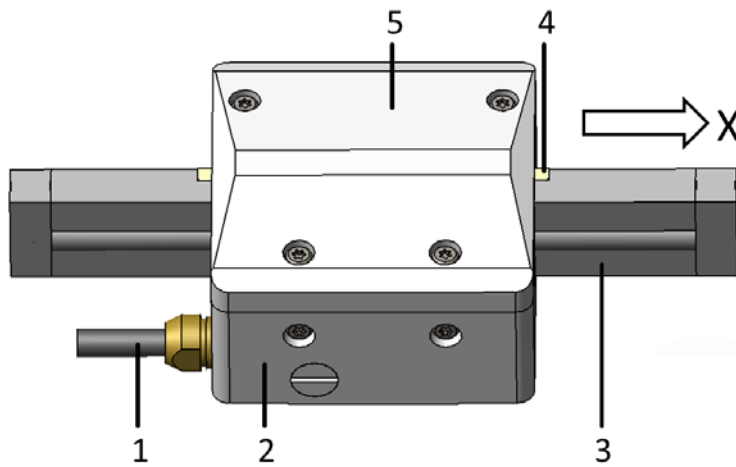


Figure 1: Example view of an N-331 without sensor (N-331.x0)

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

X: The arrow indicates the positive direction of motion.

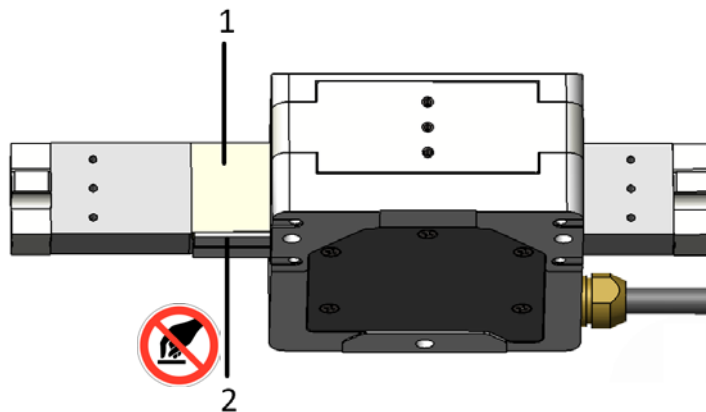


Figure 2: Example view of an N-331 with integrated sensor (N-331.x3)

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

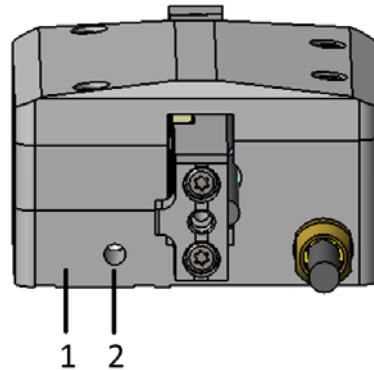


Figure 3: Position of the protective earth connection

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

Product Labeling

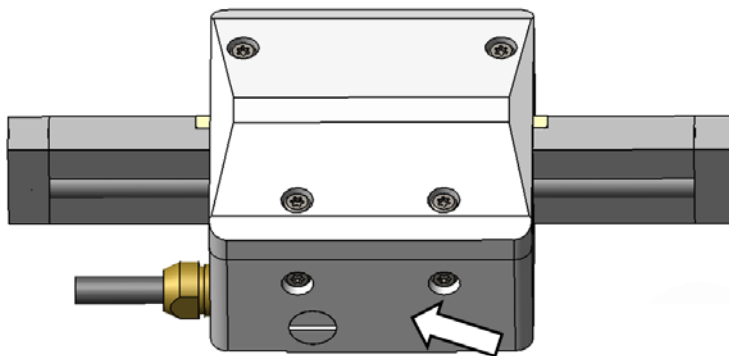







Figure 4: Position of the product labeling on the drive

Labeling	Description
N-331.20	Product name (example), the characters following the period refer to the model
116010244	Serial number (example), individual for each N-331 Meaning of the places (counting from left): 1 = internal information 2 and 3 = year of manufacture 4 to 9 = consecutive numbers
PICMAWalk	Brand name
	Manufacturer's logo
Country of origin: Germany	Country of origin
	Warning sign "Observe manual!"
	Old equipment disposal (p. 23)
	CE conformity mark
WWW.PI.WS	Manufacturer's address (website)
	Symbol for the protective earth conductor, marks the protective earth connection of the N-331 (p. 12)

Labeling of the Sub-D 37 (m) connector



Figure 5: Sub-D 37 (m) connector of the N-331



Warning sign "Residual Voltage": Notice of risk of electric shock (p. 5)

Scope of Delivery

Item ID	Components
N-331	PICMAWalk drive according to order (p. 6)
000036450	M4 screw set for protective earth, consisting of: <ul style="list-style-type: none">▪ 1 M4x8 flat-head screw with cross recess, ISO 7045▪ 2 safety washers▪ 2 flat washers
PZ271E	User manual (this document) in printed form

Suitable Electronics

Controller	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 controllers from PI. The operation of the controllers is described in the corresponding user manuals.

Installation

General Notes on Installation

NOTICE



Destruction of the piezo actuator by electric flashovers!

The use of the N-331 in environments that increase the electrical conductivity can lead to the destruction of the piezo actuator 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 N-331 in environments that can increase the electric conductivity.
- Only operate the N-331 within the permissible ambient conditions and classifications (p. 20).

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.

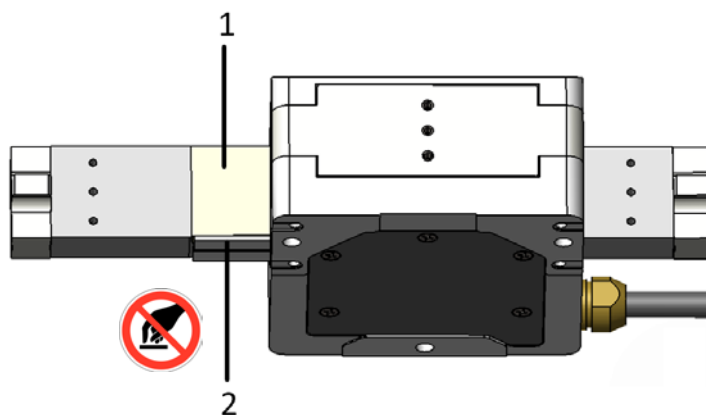


Figure 6: Ruler (1) of the linear encoder and ceramic rail (2) of the N-331. The ruler is accessible when the runner is extended.

NOTICE



Malfunction due to soiling!

Any type of soiling, e.g. dust, oil, grease or condensation, will render the N-331 inoperable.

- Keep the N-331 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 N-331 during operation!

The heat produced during operation of the N-331 can affect your application.

- Install the N-331 so that the application is not affected by the dissipated heat.
- Ensure sufficient ventilation at the place of installation.
- Make sure that the complete bottom side of the N-331 is in contact with the surface on which the N-331 is mounted.

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. 7).

Connecting the N-331 to a Protective Earth Conductor

INFORMATION

Observe the applicable standards for mounting the protective earth conductor.

The N-331 features a separate protective earth connection, see "Dimensions" on p. 21.

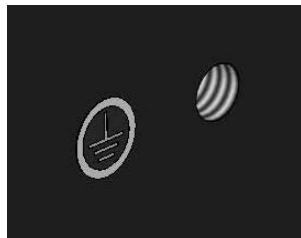


Figure 7: Example of a protective earth connection

Tools and accessories

- Suitable protective earth conductor: Cross-sectional area of the cable $\geq 0.75 \text{ mm}^2$
- Suitable screwdriver
- M4 screw for connecting the protective earth conductor

Connecting the protective earth conductor to the separate protective earth connection

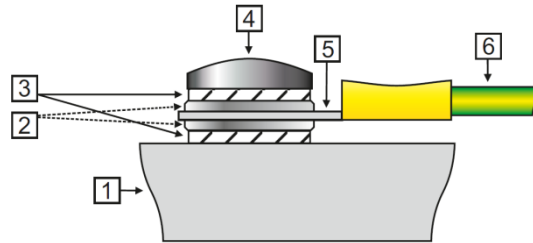


Figure 8: Recommended mounting of the protective earth conductor (profile view)

- 1 Base body of the N-331
- 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 N-331 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 $<0.1 \Omega$ at 25 A.

Mounting the N-331

NOTICE



Warping of the N-331 due to mounting on uneven surfaces!

Mounting the N-331 onto an uneven surface can warp the N-331. Warping reduces the accuracy.

- Mount the N-331 onto an even surface. The recommended evenness of the surface is $\leq 20 \mu\text{m}$.
- For applications with large temperature changes:
Only mount the N-331 onto surfaces that have the same or similar thermal expansion properties as the N-331.

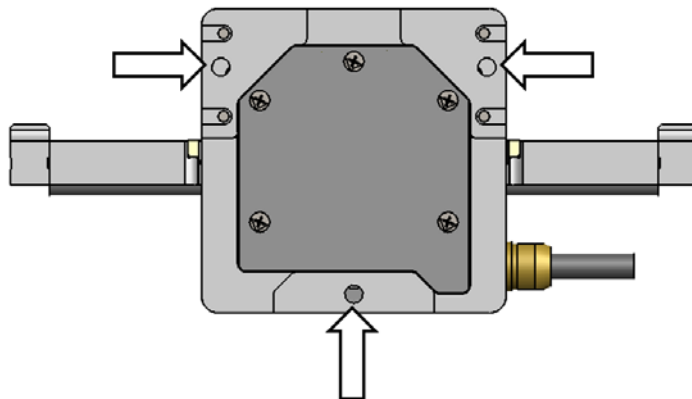


Figure 9: Mounting holes on the bottom side of the N-331.

See "Dimensions" (p. 21) for the exact location of the mounting holes.

Requirements

- ✓ You have read and understood the safety precautions (p. 5) and the general notes on installation (p. 10).
- ✓ The N-331 is **not** connected to the controller.
- ✓ You have provided a suitable surface:
 - Three M4 holes are present.
 - The evenness of the surface is $\leq 20 \mu\text{m}$.
 - For applications with large temperature changes: The surface should have the same thermal expansion properties as the N-331.
- ✓ 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. 21)

Mounting the N-331 on a surface

1. Align the N-331 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 base body of the N-331 from below.
3. Tighten the three screws.
 - Maximum screw-in depth: 7 mm
 - Maximum torque: 2.6 Nm
4. Check that the N-331 fits without backlash.

Start-Up and Operation

General Notes on Start-Up 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 N-331 can result in minor injuries.

- Connect the N-331 to a protective earth conductor (p. 12) 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 N-331 to the protective earth conductor before starting it up again.

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 N-331 is not used, but the controller is to remain switched on to ensure temperature stability:

In closed-loop operation:

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

In open-loop operation:

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

NOTICE



Operating voltage too high or incorrectly connected!

Operating voltages that are too high or incorrectly connected can cause damage to the N-331.

- Only operate the N-331 with a controller from PI.
- Do **not** exceed the operating voltage range (p. 20) for which the N-331 is specified.
- Only operate the N-331 when the operating voltage is properly connected; see "Pin Assignment" (p. 22).

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 a controller malfunction occurs.
- Set the control signal so that the moving part does not try to continue moving at the end of the travel range.

Start-Up and Operation

Requirements

- ✓ You have read and understood the safety precautions (p. 5) and the general notes on start-up and operation (p. 15).
- ✓ You have read and understood the user manual of the controller.
- ✓ You have properly installed the N-331 (p. 10).
- ✓ The controller and the required PC software have been installed. All connections with the controller have been established (see user manual of the controller).

Start-up and operation

- For start-up and operation of the N-331, follow the instructions in the manual of the controller used.

Discharging the N-331

The N-331 must be discharged in the following cases:

- Before installation
- If the N-331 is not used but the controller remains switched on to ensure temperature stability
- Before demounting (e.g., before cleaning and transporting the N-331 and for modifications)

The N-331 is discharged through the internal discharge resistor of the controller from PI.

Discharging an N-331 that is connected to the controller

In closed-loop operation:

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

In open-loop operation:

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

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

- Connect the drive to the switched-off controller from PI.

Maintenance

General Notes on Maintenance

NOTICE



Misalignment from loosening screws!

The N-331 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 N-331.

Cleaning the N-331

Requirements

- ✓ You have discharged the piezo actuators of the N-331 (p. 27).
- ✓ You have disconnected the N-331 from the controller.

Cleaning the N-331

- Clean the surfaces of the N-331 with a cloth that is slightly dampened with a mild cleanser or disinfectant (e.g. ethanol or isopropanol).
- Do **not** do any ultrasonic cleaning.

Customer Service

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

- 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 controller (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. 4) on our website.

Technical Data

Data Table

	N-331.10 / N-331.13 N-331.20 / N-331.23 N-331.40 / N-331.43	Unit	Tolerance
Active axes	X		
Motion and positioning			
Integrated sensor	N-331.x0: Without sensor N-331.x3: With incremental sensor		
Travel range (step mode, open loop)*	N-331.1x: 30 N-331.2x: 55 N-331.4x: 105	mm	±0.5 mm
Travel range (step mode, closed loop)	N-331.1x: 25 N-331.2x: 50 N-331.4x: 100	mm	
Step size	10 nm to 25 µm		typ.
Step frequency**	600	Hz	max.
Velocity (step mode)**	15	mm/s	max.
Travel range (analog mode)	±10	µm	typ.




	N-331.10 / N-331.13 N-331.20 / N-331.23 N-331.40 / N-331.43	Unit	Tolerance
Resolution (open loop)	0.02	nm	typ.
Resolution (closed loop)	<10 (N-331.x3)	nm	typ.
Endurance (atmospherical operation)***	>30	km	
Mechanical properties			
Stiffness in motion direction	6	N/μm	±20 %
Push/pull force (active)	50	N	max.
Holding force (passive)	60	N	max.
Drive properties			
Drive type	PICMAWalk		
Operating voltage	-20 to 120	V	
Connectors			
Connector	Sub-D 37-pin (m)		
Miscellaneous			
Operating temperature range	-20 to 50	°C	
Material	Aluminum, stainless steel		
Mass with cable	N-331.1x: 580 N-331.2x: 610 N-331.4x: 660	g	±20 g
Moving mass	N-331.1x: 110 N-331.2x: 140 N-331.4x: 190	g	±10 g
Cable length	2.0	m	±10 mm
Recommended controllers / amplifiers	E-712.1AN E-712.2AN E-712.3AN		

* From one mechanical hard stop of the runner to the other mechanical hard stop, only in open-loop operation

** When operating with the E-712.xAN

*** At a load of 2 kg with max. 70 % duty cycle and external cooling of the E-712.1AN, at 20 °C and 1013 hPa

Maximum Ratings

Model	Mode of operation	Maximum operating voltage 	Maximum operating frequency (unloaded) ¹ 	Maximum power consumption ² 	
N-331.10	Analog	-20 to 120 V	300 Hz	30 W	
N-331.13					
N-331.20	Nanostepping		-20 to 120 V	12 mm/s	9 W
N-331.23					
N-331.40	Full step			-20 to 120 V	15 mm/s
N-331.43					

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>

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	1100 hPa to 0.1 hPa
Relative humidity	Highest relative humidity 80 % for temperatures up to 31 °C Decreasing linearly to 50 % relative humidity at 40 °C
Operating temperature	-20 °C to 50 °C
Storage temperature	-20 °C to 80 °C
Transport temperature	-25 °C to 80 °C
Overvoltage category	II
Protection class	I
Degree of pollution	1
Degree of protection according to IEC 60529	IP20

Dimensions

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

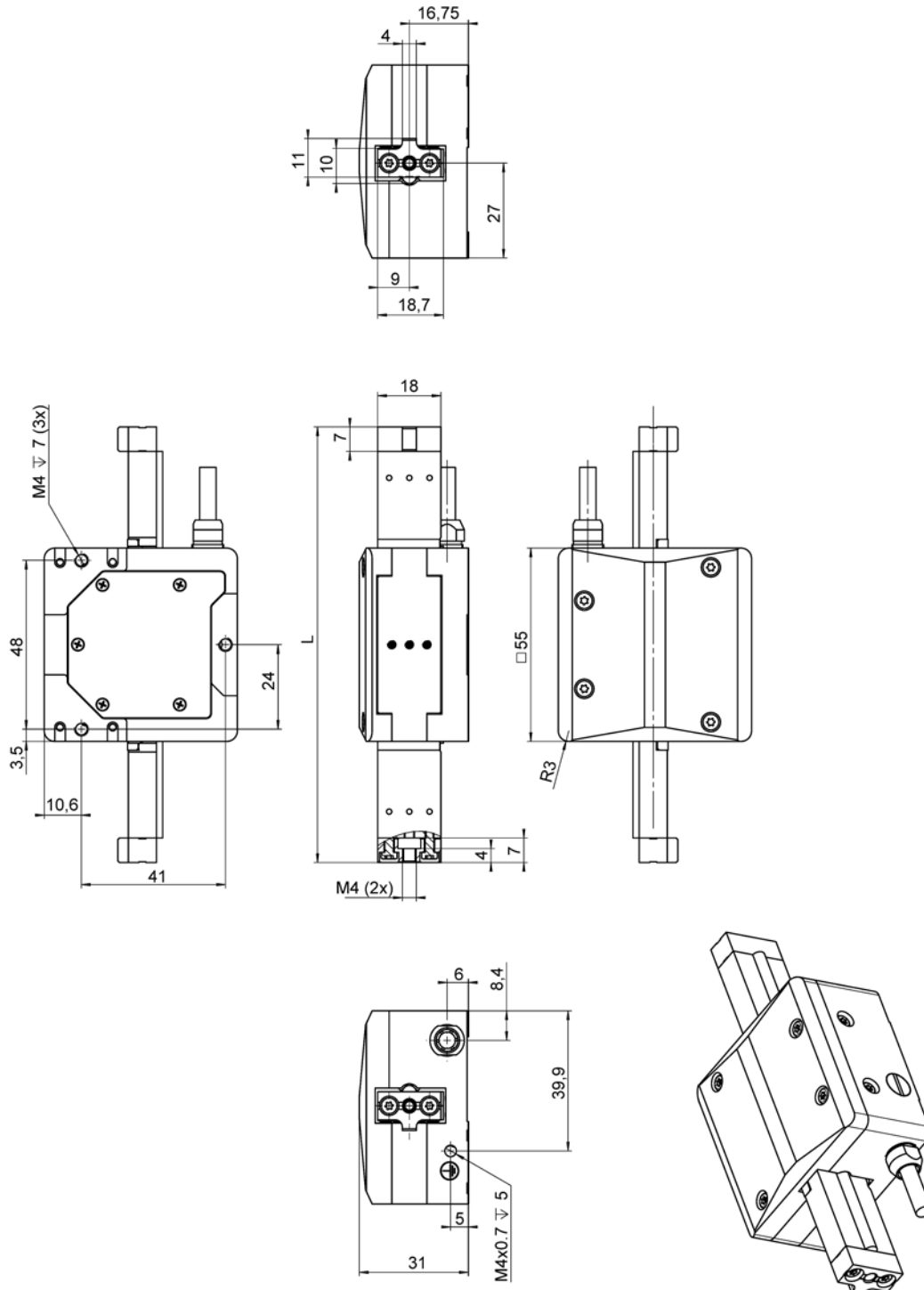


Figure 10: Dimensions of the N-331

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

Pin Assignment



Figure 11: Sub-D 37 (m) piezo connector

Pin	Function*	Pin	Function*
1	-	20	-
2	GND	21	IDChip1
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	Encoder B1 (+)	32	Encoder B1 (-)
14	Encoder A1 (+)	33	Encoder A1 (-)
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.

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

