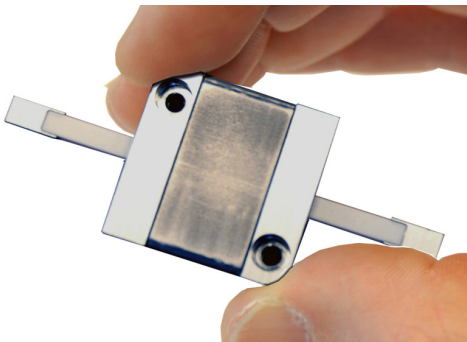
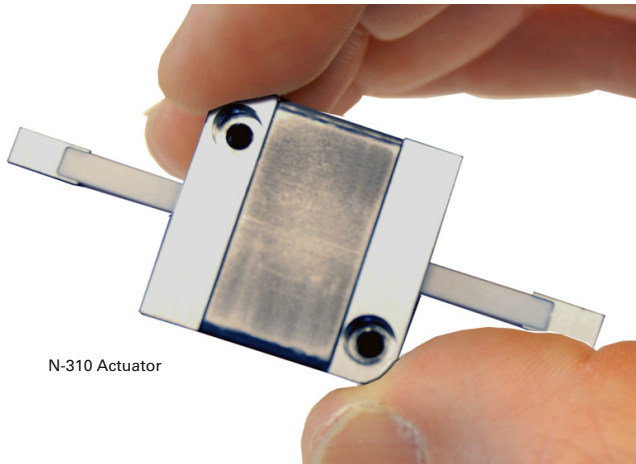


Small PiezoWalk Linear Motors & Actuators, Slides



NEXACT® Piezo Linear Motor & Actuator, 20 to 125 mm

Compact, High-Speed PiezoWalk® Drive



N-310 Actuator

- 20 to 125 mm Standard Travel Range
- Compact and Cost-Effective Design
- 0.03 nm Resolution**
- To 10 N Push/Pull Force
- Low Operating Voltage
- Self Locking at Rest, No Heat Generation, nm Stability
- Non-Magnetic and Vacuum-Compatible Working Principle

N-310 NEXACT® PiezoWalk® linear drives feature travel ranges of up to 125 mm and push/pull force capacities to 10 N in a compact package of only 25 x 25 x 12 mm. With their high resolution, NEXACT® drives, are ideal for high-precision positioning over long travel ranges. The N-310 can be operated in open-loop and closed-loop mode (with the addition of an external position sensor). A variety of NEXACT® controllers facilitates the integration into micro- or nanopositioning applications.

Working Principle for Application Flexibility

NEXACT® PiezoWalk® technology overcomes the limitations of conventional nanopositioning drives and combines virtually unlimited travel ranges with high stiffness in a very small package. Furthermore, NEXACT® actuators provide piezo-class resolution (far below one nanometer) and millisecond responsiveness. The special drive design reduces the operating voltage to 45 V and below.

In operation, piezoceramic bending elements act on the runner, which is connected to the moving part of the application. The length of the runner determines the travel range. Force capacity, resolution and velocity are determined by the piezo geometry and drive electronics and are scalable. To move the runner over longer distances the stepping mode is used, whereas for distances smaller than one step, the linear (analog) mode enables high-dynamics positioning with resolutions far below one nanometer.

Wear- and Maintenance-Free

In contrast to ordinary DC or stepper motor drives, the PiezoWalk® drives effect linear motion directly, without the need to transform rotation with mechanical elements such as gears, leadscrews and nuts. Therefore, mechanical limitations such as backlash and wear are eliminated and the drive is maintenance-free.

Self-Locking PiezoWalk® Piezo Stepping Drive

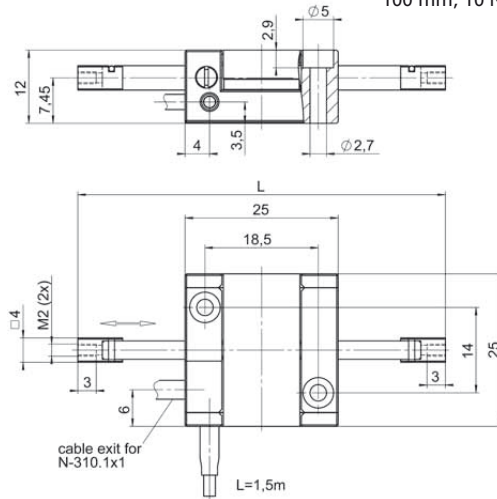
NEXLINE® and NEXACT® exhibit high stiffness and are self-locking even when powered down due to the clamping action of the piezo actuators in the mechanics. This entails nanometer position stability at rest, with no heat generation or servo-dither.

N-310.16
NEXACT® OEM Linear Drive,
125 mm, 10 N

Ask about custom designs!

Ordering Information

- N-310.xx1: Shifted Cable Exit**
- N-310.11**
NEXACT® PiezoWalk®
OEM Linear Drive, 20 mm, 10 N
- N-310.12**
NEXACT® OEM Linear Drive,
30 mm, 10 N
- N-310.13**
NEXACT® OEM Linear Drive,
50 mm, 10 N
- N-310.14**
NEXACT® OEM Linear Drive,
75 mm, 10 N
- N-310.15**
NEXACT® OEM Linear Drive,
100 mm, 10 N



Model	N-310
Active axes	X
Motion and positioning	
Step size (in step mode)	5 nm to 5 µm
Travel range in analog operation	7 µm, max.
Open-loop resolution	0.03 nm** typ.
Step frequency	1.5 kHz* max.
Max. speed	10 mm/s*, max.
Mechanical properties	
Push/Pull force (active)	10 N, max.
Drive properties	
Drive type	NEXACT® linear drive
Operating voltage	-10 V to +45 V
Miscellaneous	
Operating temperature range	0 to 50 °C
Body material	Stainless steel, non-magnetic
Mass	50 g (20 mm travel), ±5%
Cable length	1.5 m ±10 mm
Connector	HD Sub-D connector 15 pin, single channel
Recommended controller/driver	E-862, E-861 (see p. 1-20)

* Depending on the control electronics.

** Depending on the drive electronics. 1 nm with E-861.

*The products described in this document are in part protected by the following patents:
German Patent No. P4408618.0

N-381 NEXACT® Linear Motor Actuator, Manipulator, Piezo Stepper High-Resolution PiezoWalk® Linear Actuator with Optional Position Sensor

N-381 piezo stepper linear actuator for sample positioning and manipulation provides long travel, high speed and very high resolution; shown with E-861 NEXACT® Controller



- Travel Range 30 mm
- Zero-Wear Piezo Stepping Drive, Ideal for Micro- and Nano-Manipulation
- Integrated Linear Encoder Option for Highest Accuracy with 20 nm Resolution
- Very High Acceleration, e.g. for Cell Penetration
- Two Operating Modes: Continuous Stepping Mode and Continuously Variable, High-Dynamics Analog Mode for 30 µm Resolution**
- Up to 10 N Force Generation
- Self Locking at Rest, no Heat Generation
- Smooth Motion, no Closed-Loop Jitter
- Vacuum-Compatible and Non-Magnetic Versions

The compact N-381 linear actuators are ideal drives and micro manipulators e.g. for biotechnology and nanotechnology applications. Rapid accelerations, velocities of 10 mm/s

and forces up to 10 N enable high-dynamics and throughput for automation tasks. The PiezoWalk® drive principle allows long travel ranges and fast oscillations of 7 µm amplitude with frequencies up to several 100 Hz. This “analog mode” can be used to provide rapid acceleration, e.g. in cell penetration applications, or smooth motion for dynamic laser tuning or even for active damping of oscillations. Two models are available: The N-381.3A model is equipped with a high-resolution position sensor, allowing sub-micrometer repeatability in closed-loop operation. The N-381.30 open-loop version is intended for high precision applications where the absolute position is

not important or is controlled by an external loop (video, laser, quadcell, etc.).

Piezo Stepping Drive – the Multi-Functional Piezo Linear Motor

A great advantage characteristic of the NEXACT® piezo stepping drive is its dual-mode operating principle combining the best features of other piezo motor designs, such as high resolution, high force and high speed into one compact unit. At the target position the drive requires no current and generates no heat while providing long-term, nanometer stability. This autolocking feature also completely eliminates servo-jitter as it occurs with other

Ordering Information

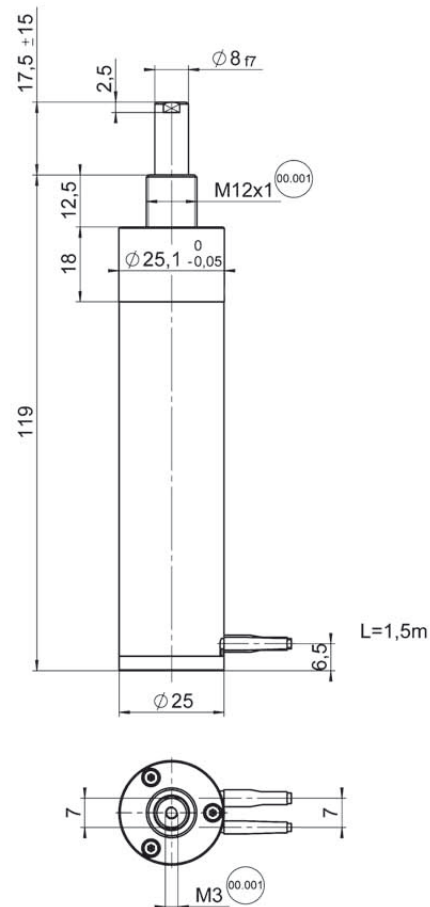
N-381.3A
NEXACTUATOR® Linear Actuator, 30 mm, 20 nm Encoder Resolution

N-381.30
NEXACTUATOR® Linear Actuator, 30 mm, Open-Loop

Available on request

Ask about custom designs!

closed-loop motors. Since motion is not based on dynamic friction as with piezo inertial drives (stick-slip-motors) but solely caused by the nanometer precise motion of clamped piezo actuators, there is no wear to limit the lifetime. When operated in closed-loop, excellent velocity control is achieved.



N-381 dimensions in mm

Application Examples

- Drive unit for scanning stage
- Cell manipulation, biohandling
- Micromanipulation
- Life science
- Photonics
- Laser tuning
- Motion in strong magnetic fields

Working Principle for Application Flexibility

NEXACT® PiezoWalk® technology overcomes the limitations of conventional nanopositioning drives and combines virtually unlimited travel ranges with high stiffness in a very small package. Furthermore, NEXACT® actuators provide piezo-class resolution (far below one nanometer) and millisecond responsiveness. The special drive design reduces the operating voltage to 45 V and below.

In operation, piezoceramic bending elements act on the runner, which is connected to the moving part of the application. The length of the runner determines the travel range

and can be chosen as required. To move the runner over longer distances the stepping mode is used, whereas for distances smaller than one step, the analog mode enables high-dynamics positioning with resolutions far below one nanometer.

Controllers and Drivers Optimized for the Application

NEXACT® actuators require special drive electronics to control the complex stepping sequences. The E-861 (see p.1-20) includes a complete NEXACT® servo-controller with low-noise drivers and a powerful DSP. It also comes with ample software for easy integration and highly effective computer control. For applications which do not require the highest reso-

lution, the E-862 (see p. 3-10) lower-priced drive electronics, can be ordered.

The products described in this document are in part protected by the following patents:

German Patent No. P4408618.0

Technical Data (Preliminary)

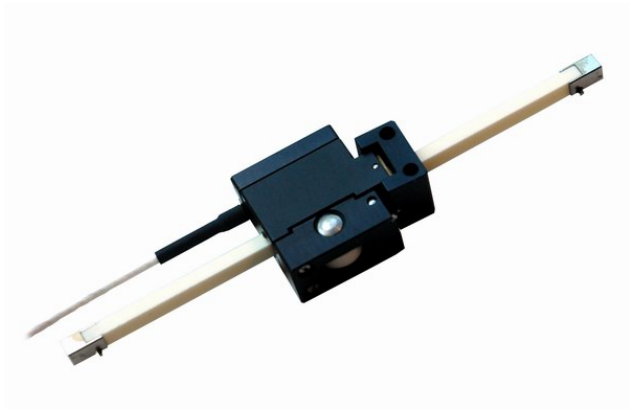
Model	N-381.30	N-381.3A
Active axes	X	X
Motion and positioning		
Travel range	30 mm	30 mm
Step size (in step mode)	0.1 to 15 µm	–
Integrated sensor	–	Incremental linear encoder
Sensor resolution	–	20 nm*
Travel range in analog mode	7 µm	7 µm
Open-loop resolution	0.03 nm**	0.03 nm**
Closed-loop resolution	–	20 nm*
Step frequency	0 to 800 Hz	–
Max. velocity	10 mm/s*	10 mm/s*
Mechanical properties		
Stiffness in motion direction	2.4 N/µm	2.4 N/µm
Max. push / pull force (active)	10 N	10 N
Max. holding force (passive)	15 N	15 N
Lateral force	10 N	10 N
Drive properties		
Drive type	NEXACT® linear drive	NEXACT® linear drive
Operating voltage	-10 V to +45 V	-10 V to +45 V
Miscellaneous		
Operating temperature range	0 to 50 °C	0 to 50 °C
Material	Stainless steel / CFRP	Stainless steel / CFRP
Mass	250 g	255 g
Cable length	1.5 m	1.5 m
Connector	15-pin HD-Sub-D connector, one channel	15-pin HD-Sub-D connector, one channel
Recommended controller/driver	E-860 series (see p. 1-20)	E-861.1A1 (see p. 1-20)

*With E-861. Depending on drive electronics.

**Depending on the drive electronics. 1 nm with E-861.

N-900C001 Nonmagnetic PiezoWalk[®] Motor Actuator

Long Travel, High Resolution, for Operation in Strong Magnetic Fields



The N-900C001 actuator is based on PI's patented NEXACT[®] piezo linear motor technology and is built exclusively from non-magnetic components.

Ordering Information

N-900C001
Nonmagnetic Piezo Motor Actuator

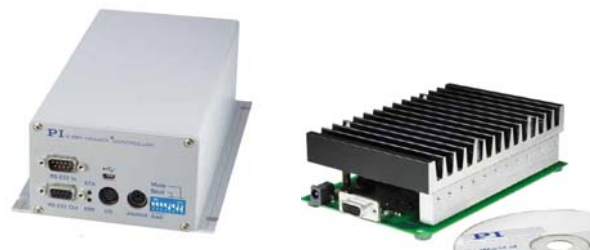
E-861
PiezoWalk[®] Motor Controller/Driver,
Desktop

E-862
PiezoWalk[®] Motor Controller/Driver,
OEM

Application Examples

- Medical Technology
- MRI
- High Energy Physics

- Non-Magnetic Working Principle
- For Operation in Strong Magnetic Fields, such as MRI
- Patented PiezoWalk[®] Motor
- Travel Range to 70 mm
- Self-Aligning Design
- Sub-Micrometer Step Size
- 5 N Force
- Self-Locking at Rest, No Heat Generation
- Custom Designs Available



Controllers for PiezoWalk[®] motors.
E-861 desktop version left and E-862 OEM version (right)

PiezoWalk[®] Working Principle

PiezoWalk[®] technology overcomes the limitations of conventional piezo drives and combines virtually unlimited travel ranges with high stiffness in a very small package. NEXACT[®] actuators provide piezo-class resolution and millisecond responsiveness. The special drive design reduces the operating voltage to 45 V and below.

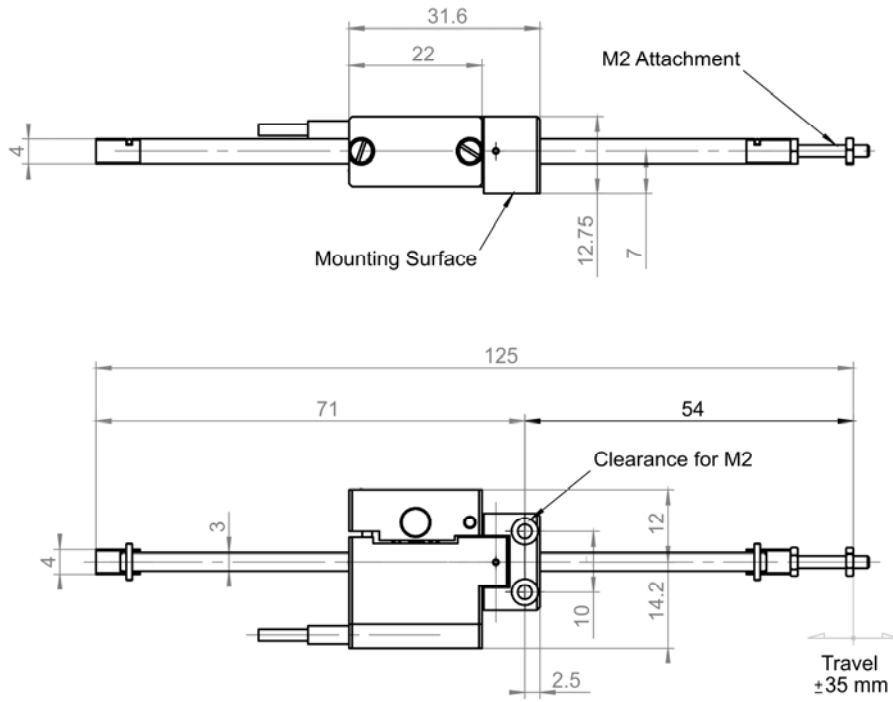
Non Magnetic Design

The N-900C001 is a customized PiezoWalk[®] linear actuator for applications in very strong magnetic fields, such as encountered in MRI systems. All components and materials employed in the actuator are non-magnetic and non-magnetizable.

Preliminary Data

Models	N-900C001	Units	Tolerance
Active axes	X		
Drive type	NEXACT [®] linear drive		
Travel Range	70	mm	
*Step size (in step mode)	10 nm to 5 μm		
Travel range in analog operation	7	μm	max.
Push/pull force	5 (E-861) 4 (E-862)	N	typ.
Step frequency	1.0	kHz*	max.
Recommended operating temperature	10 to 40 °C	°C	
Material	PZT, ceramic, AL, 300 series stainless steel		
Mass	30	g	±5%
Cable length	2	m	±0.1 m
Connector	HD Sub-D, 15 pin		

*Depends on drive electronics.



N-900C001, dimensions in mm

High-Resolution Translation Stage

NANOMETER STEP SIZES



N-664

- Travel range 30 mm
- Encoder resolution 0.5 nm
- Minimal incremental motion 2 nm
- Excellent guiding accuracy
- Max. velocity 10 mm/s

Reference-class translation stage with linear motor

Piezo motor-based direct drive

NEXACT® piezo stepping motor with subnanometer resolution. High load capacity and precision due to crossed roller bearings. Reference switch. Low operating voltage. Self-locking at rest, no heat generation

Direct measuring principle

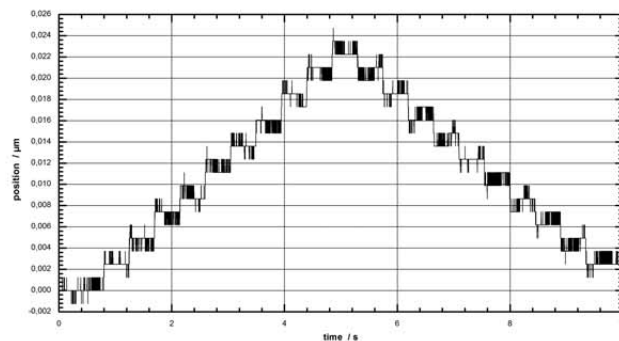
High-precision linear encoder PIONE with subnanometer resolution

Application fields

Research and industry. Option: vacuum version

Related Products

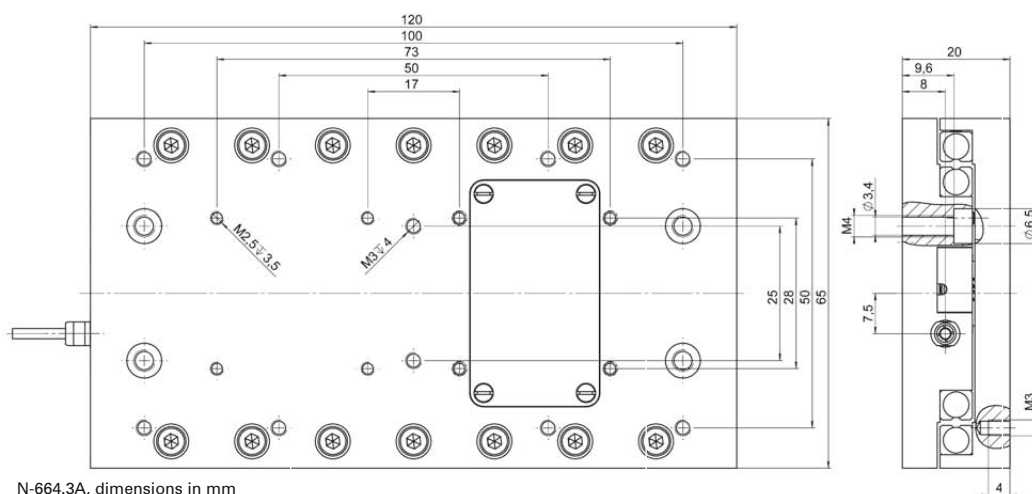
M-511.HD Nano-Precision Heavy-Duty Stage
N-661 Miniature Linear Stage with NEXACT® Drive



2 nm steps of a N-664.3A with an E-861 Controller

	N-664.3A	Units	Tolerance
Active axes	X		
Motion and positioning			
Travel range	30	mm	
Min. incremental motion	2	nm	
Integrated sensor	PIOne linear nanometrology encoder		
Open-loop resolution	0.03	nm	typ.
Closed-loop resolution	0.5*	nm	
Max. step frequency, open-loop	0.8	kHz	max.
Max. velocity	10*	mm/s	max.
Linearity	< 0.002% (0,5 μm) along the entire travel range; 0.03% (5 nm) along 20 μm		
Bidirectional repeatability	< 10	nm	
Pitch	40	μrad	typ.
Yaw	40	μrad	typ.
Mechanical properties			
Stiffness in motion direction	2.5	N/μm	±20%
Max. load	20	N	
Max. push / pull force (active)	10	N	max.
Max. holding force (passive)	15	N	min.
Lateral force	50	N	max.
Drive properties			
Drive type	NEXACT® linear drive		
Operating voltage	-10 to +45	V	
Miscellaneous			
Operating temperature range	0 to 50	°C	
Material	Aluminum, nickel-plated		
Mass	530	g	±5%
Cable length	1.5	m	±10 mm
Connector	HD sub-D connector, 15-pin (motor) Sub-D 15 (f) 15-pin (sensor)		
Recommended controller	E-861 controller for NEXACT® linear drives and positioners		

* With E-861. Depending on drive electronics



N-664.3A, dimensions in mm

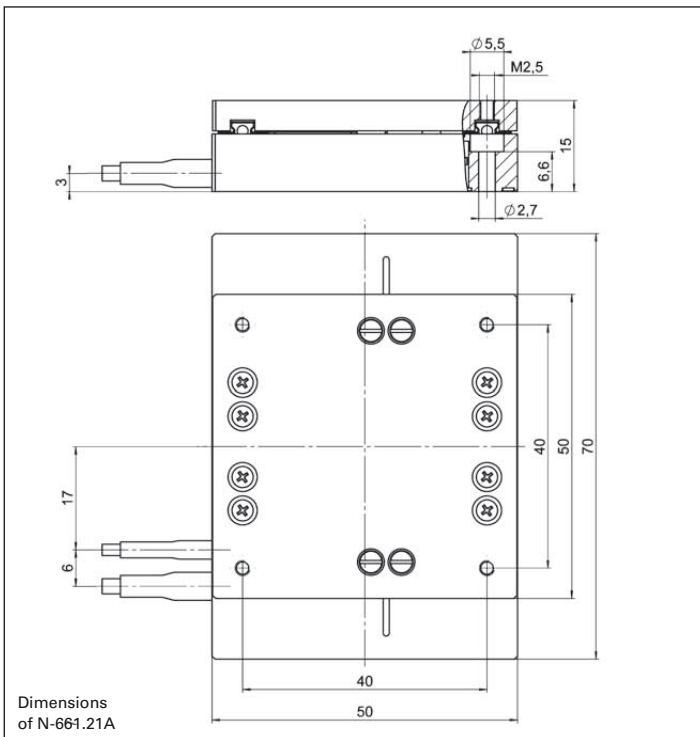
N-661 Miniature Slide with PiezoWalk® Linear Motor

PiezoWalk® Drive Provides Nanometer Precision, Smooth Motion and Rapid Response



The N-661 miniature linear stage integrates a PiezoWalk® NEXACT® linear motor combined with a high-resolution linear encoder. It provides 20 mm travel and resolution down to the nanometer range.

- **Travel Range 20 mm**
- **Self Locking at Rest, no Heat Generation, no Servo Dither**
- **Compact Design: 70 x 50 x 20 mm**
- **Zero-Wear Piezo Stepping Drive, Ideal for Micro- and Nano-Manipulation**
- **Integrated Linear Encoder Option for Highest Accuracy with 20 nm Resolution**
- **Two Operating Modes: Continuous Stepping Mode and Continuously Variable, High-Dynamics Analog Mode for 30 µm Resolution**
- **Up to 10 N Force Generation**



The compact N-661 nanopositioning stage is based on the NEXACT® PiezoWalk® drive. This dual-mode, high-performance piezo stepping linear motor can provide sub-nanometer resolution and high force, along with very rapid response. When run in its analog mode, fast oscillations with amplitudes up to 7 microns and resolutions down to 30 µm can be achieved. This mode is of great value in high-throughput applications as well as in dynamic laser tuning, cell penetration applications, or even for active vibration damping. The stage is equipped with a precision guiding system and an optical linear encoder to enable highly repeatable positioning.

Ordering Information

N-661.21A
Miniature NEXACT® Translation Stage, 20 mm, Linear Encoder, 20 nm Resolution

Ask about custom designs

Application Examples

- Life science
- Photonics
- Laser tuning
- Motion in strong magnetic fields

The products described in this document are in part protected by the following patents:
German Patent No. P4408618.0

Technical Data

Model	N-661.21A
Active axes	X
Motion and positioning	
Travel range	20 mm
Step size in stepping mode (open-loop)	To 5 µm
Integrated sensor	Linear encoder
Sensor resolution	20 nm *
Travel range in analog mode	7 µm
Open-loop resolution	0.03 nm
Closed-loop resolution	20 nm*
Bidirectional repeatability	200 nm
Pitch	500 µrad
Yaw	150 µrad
Max. Step frequency (open-loop)	0.8 kHz
Max. velocity	10 mm/s*
Mechanical properties	
Stiffness in motion direction	2.4 N/µm
Max. load capacity	20 N
Max. push / pull force (active)	10 N
Max. holding force (passive)	15 N
Lateral Force	20 N
Drive properties	
Drive type	NEXACT® linear drive
Operating Voltage	-10 V to +45 V
Miscellaneous	
Operating temperature range	0 to 50 °C
Material	Aluminum
Mass	150 g
Cable length	1.5 m
Connector	15-pin sub-HDD connector, one channel
Recommended controller/driver	E-861.1A1 Controller for NEXACT® (see p. 1-20)

*With E-861. Depending on drive electronics.

N-900C004 Mini XYZ Stage, Nonmagnetic, PiezoWalk® Motors

Vacuum Compatible, Self-locking, High Resolution, for SEM



Ordering Information

N-900C004
Miniature XYZ Positioning Stage,
Piezo-Motor-Driven, Non-Magnetic

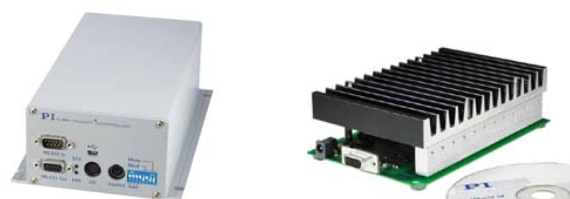
E-861
PiezoWalk® Motor Controller/Driver,
Desktop

E-862
PiezoWalk® Motor Controller/Driver,
OEM

Application Examples

- SEM
- Medical Technology
- MRI
- High Energy Physics

- Non-Magnetic & Vacuum Compatible Working Principle
- For Operation in Strong Magnetic Fields, such as MRI
- Patented PiezoWalk® Motor
- Travel Range to 10 mm
- Open-Loop with Sub-Micrometer Step Size:
Designed to Align Samples
- 5 N Force
- Self-Locking at Rest, No Heat Generation
- Custom Designs Available



Controllers for PiezoWalk® motors.
E-861 desktop version left and E-862 OEM version (right)

PiezoWalk® Working Principle

PiezoWalk® technology overcomes the limitations of conventional piezo drives and combines virtually unlimited travel ranges with high stiffness in a very small package. NEXACT® linear motors provide piezo-class resolution and millisecond responsiveness. The special drive design reduces the operating voltage to 45 V and below.

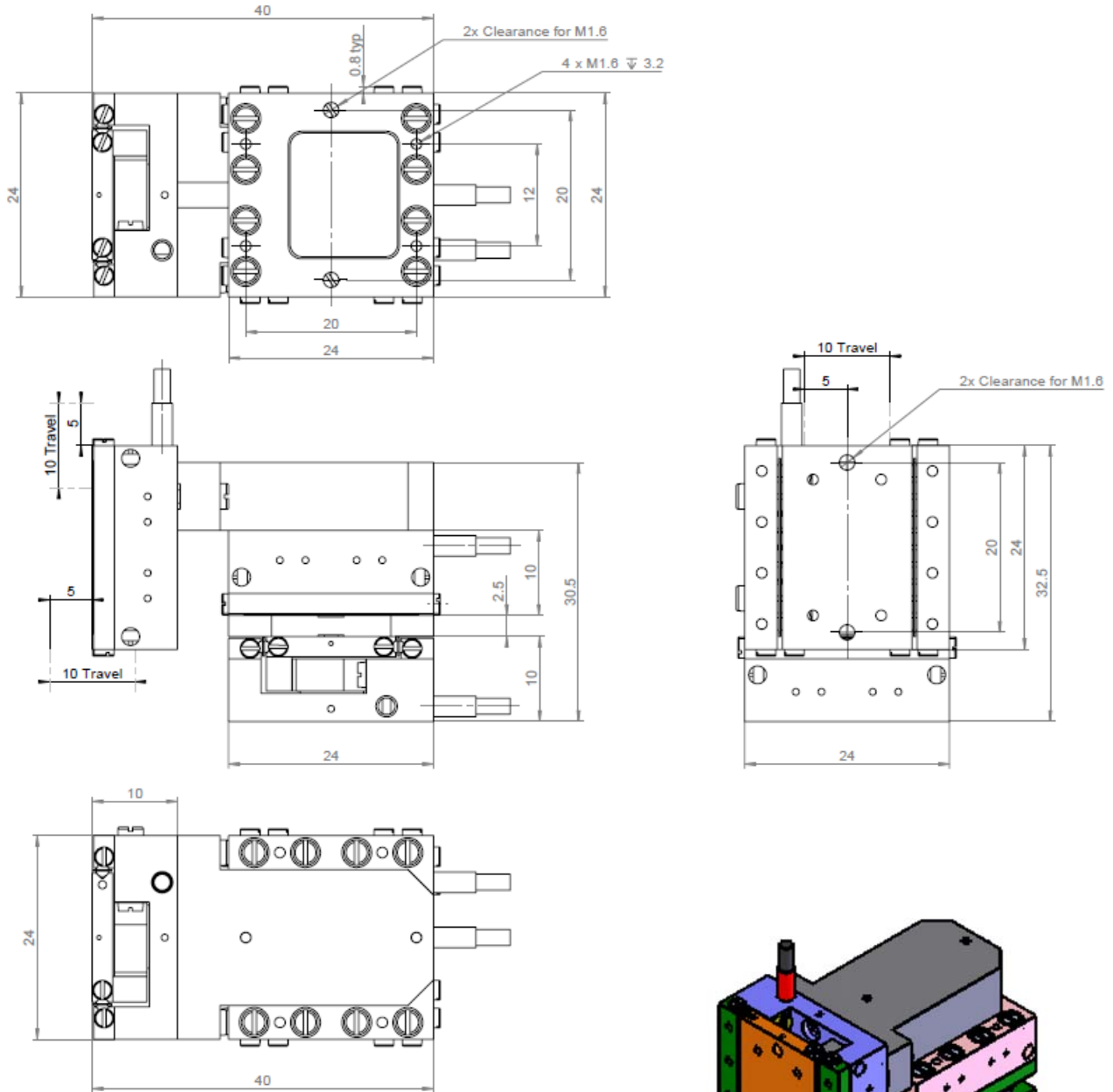
Non Magnetic Design

The N-900C004 is a customized PiezoWalk® linear motor-driven miniature XYZ stage for SEM or any other application where magnetic drive systems are not permissible. All components and materials employed in the stage and motor are non-magnetic and non-magnetizable.

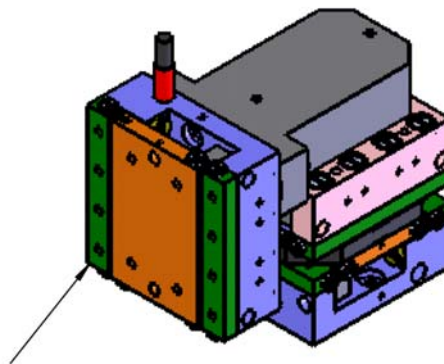
Preliminary Data

Models	N-900C001	Units	Tolerance
Active axes	XYZ		
Drive type	NEXACT® piezo motor		
Travel Range	10	mm	
*Open-Loop Step size (in step mode)	10 nm to 5 µm		
Travel range in analog operation	7 (E-861) 5 (E-862)	µm	max.
Push/pull force	5 (E-861) 4 (E-862)	N	typ.
Recommended operating temperature	10 to 40 °C	°C	
Mass	150	g	±5%
Connector	HD Sub-D, 15 pin		

*Depends on drive electronics.



N-900C004, dimensions in mm



Individual stage available as P/N N-900C003

N-725 PIFOC® High-Load Objective Scanner

1 mm Travel, Fast Response and Nanometer Precision



N-725 PIFOC® is the first piezo-objective drive with integrated NEXACT® Piezo Linear Motor, combining smooth motion, long travel ranges and fast response with extreme position stability

- High Force & High-Dynamics for Positioning and Scanning of Large Objectives up to 29 mm Ø
- 1 mm Travel for Applications with Large Penetration Depth
- Ideal for e. g. Two-Photon Microscopy
- Very Fast Response: 20 ms Step and Settle Time
- Self Locking at Rest, no Heat Generation, no Servojitter
- Drive Resolution < 1 nm, 20 nm Encoder Resolution
- Two Motion Modes: Continuous Nanostepping and High-Dynamics Analog Mode
- Compact Design: Ø 48 mm, 40.5 mm Height
- Frictionless, High-Precision Flexure Guiding System for Better Focus Stability
- QuickLock Thread Adapter for Simple Installation

The N-725 PIFOC® is the first piezo objective nanopositioner equipped with a PiezoWalk® linear motor. This drive combines smooth motion, long travel ranges and fast step and settle with extreme position stability. Its exceptional stroke of 1 mm renders stepper motor positioners -often used as range ex-

tenders for piezo drives- unnecessary. The focussing plane can be selected in an extended range without any change of the mechanics. Together with a step and settle time of less than 20 ms this allows for higher throughput.

The large travel range is a big advantage for applications that have large optical penetration depth like two-photon microscopy where it allows to make use of the full working range of the objective and quickly scan through z stacks of up to 1 mm.

Simple Installation with QuickLock Thread Options

The PIFOC® is mounted between the turret and the objective with the QuickLock thread adapter. After threading the

adapter into the turret, the QuickLock is affixed in the desired position. Because the PIFOC® body need not to be rotated, cable wind-up is not an issue.

PiezoWalk® – the Multi-Functional Piezo Linear Motor

A great advantage characteristic of the NEXACT® drive principle is its dual-mode operating principle combining the best features of piezo motor designs, such as high resolution, high force and high speed into one compact unit. At the target position the drive requires no current and generates no heat while providing long-term, nanometer stability. This autolocking feature also completely eliminates servo jitter as it occurs with other closed-loop motors. Since motion is solely caused by the nanometer precise motion of clamped piezo actuators, there is no wear to limit the lifetime. When operated in closed-loop, excellent velocity control is achieved.

See p. 1-12 for further information on NEXACT® PiezoWalk® technology.

Controller and Drive Electronics Optimized for the Application

NEXACT® actuators require special drive electronics to control the complex stepping sequences. The E-861 includes complete NEXACT® servo controller with low-noise drivers and a powerful DSP. It also comes with ample software for easy integration and highly effective computer control. For applications which do not require the highest resolution, the E-862 lower-priced drive electronics can be ordered.

The products described in this document are in part protected by the following patents: German Patent No. P4408618.0

Ordering Information

N-725.1A
PIFOC® Piezo Nanofocusing Z-Drive with NEXACT® Linear Motor, 1 mm, Linear Encoder, 20 nm Resolution, for QuickLock Thread Adapters

Accessories

QuickLock Thread Adapters: see figure

P-721.90Q
Extens. Tube, 12.5 mm, Thread W0.8 x 1/36"

P-721.91Q
Extens. Tube, 12.5 mm, Thread M25 x 0.75

P-721.92Q
Extens. Tube, 12.5 mm, Thread M26 x 0.75

P-721.93Q
Extens. Tube, 12.5 mm, Thread M27 x 0.75

P-721.94Q
Extens. Tube, 12.5 mm, Thread M28 x 0.75

P-721.95Q
Extens. Tube, 12.5 mm, Thread M32 x 0.75

P-721.96Q
Extens. Tube, 12.5 mm, Thread M26 x 1/36"

P-721.98Q
Extens. Tube, 12.5 mm, Thread M19 x 0.75

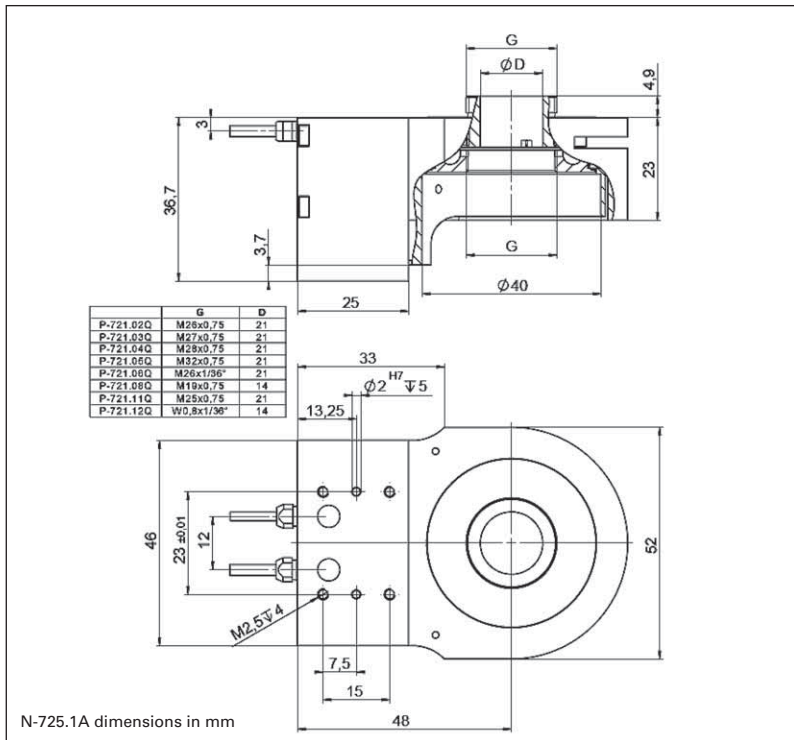
Ask about custom designs!

Scanner for Higher Resolution and Higher Loads

PI offers a range of related PIFOC® objective scanners with different specifications. The P-725 models e. g. (s. p. 2-28) offer resolutions of less than one nanometer. For larger loads and dynamic scanning applications the models P-726 (s. p. 2-32) and P-725.DD (s. p. 2-30) are also available with travel ranges of up to 100 µm.

Application Examples

- 3-D Imaging
- Screening
- Autofocus systems
- Microscopy
- Confocal microscopy
- Surface structure analysis
- Wafer inspection



Technical Data

Model	N-725.1A
Active axes	Z
Motion and positioning	
Travel range	1 mm
Integrated sensor	Linear encoder
Sensor resolution	20 nm *
Travel range in analog mode	7 µm
Closed-loop resolution	20 nm *
Linearity, closed-loop	0.1%
Bidirectional repeatability	50 nm
Rotation (X, Y) typ.	15 µrad / 100 µm
Step and Settle (200 nm), typ.	20 ms
Max. velocity	10 mm/s*
Mechanical properties	
Stiffness in motion direction	0.5 N/µm
Max. push / pull force (active)	10 N
Drive properties	
Drive type	NEXACT® linear drive
Operating voltage	-10 V to +45 V
Miscellaneous	
Operating temperature range	0 to 50°C
Material	Aluminium
Mass	440 g
Cable length	1.5 m
Connector	HD sub-D connector, 15-pin
Recommended controller	E-861.1A1 Controller for NEXACT® Linear Drives and Positioners

* With E-861. Depending on drive electronics.

Program Overview

- Piezo Ceramic Actuators & Motors
- Piezo Nanopositioning Systems and Scanners
- Active Optics / Tip-Tilt Platforms
- Capacitive Nanometrology Sensors
- Piezo Electronics: Amplifiers and Controllers
- Hexapod 6-Axis Positioners / Robots
- Micropositioning Stages & Actuators
- Photonics Alignment Systems, Solutions for Telecommunications
- Motor Controllers
- Ultrasonic Linear Motors

Request or download the complete PI Nanopositioning & Piezo Actuator Catalog



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