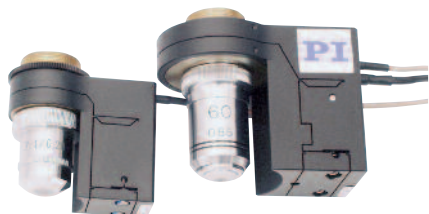


P-720 PIFOC® Piezo Nanofocusing Systems

Compact High-Dynamics Scanner for Small Objectives



The P-720 objective nanofocusing / scanning drive (objective not included) was designed for small objectives. Similar PIFOC® systems are available for large objectives and with position sensors

- Travel Range 100 μm
- Rapid Response & Settling Behavior
- Scans and Positions Objectives with Sub-nm Resolution
- Frictionless, High-Precision Flexure Guiding System
- Outstanding Lifetime Due to PICMA® Piezo Actuators

Model	Max. objective diameter	Travel	Open-loop, resolution	Stiffness	Push/pull force capacity	Rotation around θ_x, θ_y
P-720.00	25 mm	100 μm	0.5 nm	0.2 N/ μm	100 / 20 N	13 μrad

P-721K PIFOC® Nosepiece Nanopositioner

Compact Design, Sub-Nanometer Resolution



P-721KTPZ Compact Nosepiece Nanopositioner

- Positioning and Scanning of Microscope Turrets
- Direct-Metrology Capacitive Sensors for Highest Linearity, Stability and Control Dynamics
- Frictionless, High-Precision Flexure Guiding System for Better Focus Stability
- Outstanding Lifetime Due to PICMA® Piezo Actuators

Model	Travel	Closed-loop/ open-loop resolution	Resonant frequency (fully loaded)	Dimensions
P-721KTPZ Turret-PIFOC®	80 μm	10 / 0.5 nm	215 Hz	44.5 x 42 x 53 mm (W x L x H)

P-721K Power-PIFOC® Nosepiece Nanopositioner

For High-Resolution Microscopy. High-Load Capacity, Capacitive Feedback



The P-721KTPZ high-load PIFOC® allows precision positioning of a complete microscope turret

- Scans and Positions Objectives with Sub-nm Resolution
- Travel Ranges to 150 μm , Millisecond Settling Time
- Parallel Flexure Guiding for Minimized Objective Offset
- Direct Metrology with Capacitive Sensors for Highest Linearity
- Outstanding Lifetime Due to PICMA® Piezo Actuators

Model	Load capacity	Closed-loop travel	Resonant frequency	Mass
P-721KTPZ	20 N	to 150 μm	410 Hz (no load)	1.5 kg

Linear Actuators & Motors

Nanopositioning / Piezoelectrics

Piezo Flexure Stages / High-Speed Scanning Systems

Linear

Vertical & Tip/Tilt

2- and 3-Axis

6-Axis

Fast Steering Mirrors / Active Optics

Piezo Drivers / Servo Controllers

Single-Channel

Multi-Channel

Modular

Accessories

Piezoelectrics in Positioning

Nanometrology

Micropositioning

Index

P-720

PIFOC® High-Speed Microscope Objective Nanofocusing/Scanning Z-Drives



P-720 objective nanofocusing / scanning drive (objective not included)

- Scans and Positions Objectives with Sub-nm Resolution
- Low Inertia for Fast Settling
- Frictionless Precision Flexure Guiding System
- Travel to 100 μm
- Straightness of Travel $\leq 13 \mu\text{m}$
- PICMA® High-Performance Piezo Drives

P-720 PIFOCs® are high-speed, piezo-driven microscope objective nanofocusing/scanning devices which can be mounted on most microscopes. The frictionless, flexure guiding system combines high guiding precision for superior focus stability with fast response for rapid settling and scanning. The units are screwed between

the turret and the objective, providing a positioning and scanning range of up to 100 μm with sub-nanometer resolution, while extending the optical path by only 13 mm (infinity-corrected microscope required; extension tubes are available to adjust path lengths of other objectives on the turret). The standard thread is W0.8 x 1/36", for alternate threads see the P-721.CLQ. For larger positioning ranges, to 460 μm , see the P-725, page 2-22.

Operation

The P-720 open-loop PIFOC® is designed for fast, high-resolution positioning and scanning tasks where the absolute position is not important or where an external sensor is used. The vertical position of the objective is roughly proportional to

the drive voltage (see p. 4-15 ff. in the "Tutorial: Piezoelectrics in Positioning" section for behavior of open-loop piezos). If absolute position control, high linearity, or repeatability in the nanometer range is required, refer to the P-721 and P-725 closed-loop devices (see pages 2-20 and 2-22).

Working Principle / Reliability

PIFOCs® are equipped with the award winning PICMA® piezo drives, integrated into a sophisticated flexure guiding system. The wire-EDM-cut flexures are FEA modeled for zero stiction, zero friction and exceptional guiding precision. The ceramic-encapsulated PICMA® drives are more robust than conventional piezo actuators, featuring superior lifetime and performance in both dynamic and static applications.

Notes

See the "Selection Guide" on p. 2-14 ff. for comparison with other nanopositioning systems.

Ordering Information

P-720.00
PIFOC® Objective Positioner & Scanner, 100 μm , W0.8 x 1/36"

For PIFOC® Objective Positioners & Scanners with direct metrology and travel ranges to 400 μm see P-721 and P-725, p. 2-20 and p. 2-22

P-720.01
Objective extension tube, 13 mm

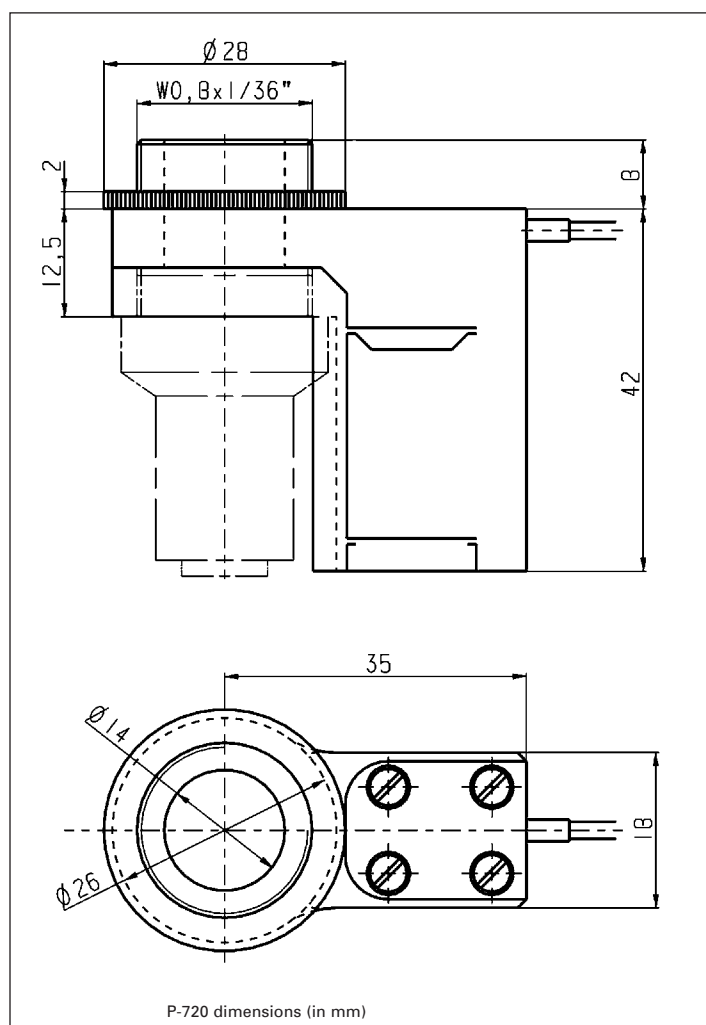
Ask about custom designs!



P-721 on a microscope turret

Application Examples

- Scanning interferometry
- Surface structure analysis
- Disk drive testing
- Autofocus systems
- Confocal microscopy
- Biotechnology
- Semiconductor test equipment



Custom PIFOC® nosepiece nanopositioner
for microscope turret.

Piezo Actuators
Nanopositioning & Scanning Systems
Active Optics / Steering Mirrors
Tutorial: Piezo-electrics in Positioning
Capacitive Position Sensors
Piezo Drivers & Nanopositioning Controllers
Hexapods / Micropositioning
Photonics Alignment Solutions
Motion Controllers
Ceramic Linear Motors & Stages
Index

Technical Data

Models	P-720.00	Units	Notes see p. 2-84
Max. objective diameter	25	mm	
Open-loop travel @ 0 to 100 V	100	μm ±20%	A2
* Open-loop resolution	1	nm	C1
Stiffness	0.2	N/μm ±20%	D1
Push/pull force capacity (in operating direction)	100 / 20	N	D3
Tilt (θ _x , θ _y) (typ.)	13	μrad	E1
Lateral runout (Y) (typ.)	100	nm	E2
Electrical capacitance	3.0	μF ±20%	F1
** Dynamic operating current coefficient (DOCC)	3.8	μA/(Hz 3 μm)	F2
Unloaded resonant frequency	400	Hz ±20%	G2
Resonant frequency @ 120 g load	180	Hz ±20%	G3
Resonant frequency @ 200 g load	150	Hz ±20%	G3
Operating temperature range	-20 to 80	°C	H2
Voltage connection	VL		J1
Weight (with cables)	100	g ±5%	
Body material	Al		L
Recommended driver/controller (codes explained p. 2-17)	G, C, (A)		

- * For calibration information see p. 2-8.
Resolution of PI piezo nanopositioners is not limited by friction or stiction. The value given is noise equivalent motion with E-503 amplifier.
- ** Dynamic Operating Current Coefficient in μA per Hz and μm . Example:
Sinusoidal scan of 30 μm at 10 Hz requires approximately 1.2 mA drive current.

PIFOC® Objective Scanning System

High-Dynamics Sub-Nanometer Piezo Drive; Controller & Software



PIFOC® long range objective scanning system with QuickLock thread adapter and controller (objective not included)

- **Complete System with Controller: Fast Digital Controller, Software-Configurable Servo Parameters**
- **Travel Range 100 µm**
- **Scans and Positions Objectives with Sub-nm Resolution**
- **Frictionless, High-Precision Flexure Guiding System for Better Focus Stability**
- **Higher Linearity and Stability Through Digital Control and Direct Metrology with Capacitive Sensors**
- **Clear Aperture up to 29 mm Ø, QuickLock Adapter for Easy Attachment**
- **Interfaces: USB, RS-232 and analog**
- **Comprehensive Software Package, Compatible with MetaMorph Imaging Software**

The PIFOC® piezo objective scanner systems include a high precision piezo mechanism and a custom-tuned compact digital controller. This combination provides higher performance at reduced costs. The integrated, frictionless and stiff piezo flex-

ure drive ensures high stiffness and fast settling times, as well as an exceptional guiding accuracy and response. The settling time of less than 10 ms increases the throughput and allows rapid Z-stack acquisition.

Application Examples

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

Position Measurement with Highly Accurate Capacitive Sensors or Lower-Priced Strain Gauge Sensors

Capacitive sensors measure the position directly and without contact, they offer therefore a position resolution of far below one nanometer and excellent values in linearity. As an alternative, compact and lower-priced strain gauge sensors (SGS) with nanometer-

level resolution can be used which are applied to appropriate places on the drive train and thus measure the displacement of the moving part of the stage. The linearity is improved considerably with the digital controller provided.

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. For applications which require a particularly large optical aperture a version with a 29 mm diameter threaded inserts is available.

Digital Controller for Automated Scans

Included in the delivery is a digital controller which opens up the possibilities of digital control for piezo-driven nanopositioning systems for the same price as analog controllers. The advantage: higher linearity, simple operation and access to advanced features.

Ordering Information

PD72Z1CAA

Fast PIFOC® Piezo Nanofocusing Z-Drive, 100 µm, Capacitive Sensor, M32 Large Aperture QuickLock Thread Adapters, Digital Controller with USB, RS-232

PD72Z1CAQ

Fast PIFOC® Piezo Nanofocusing Z-Drive, 100 µm, Capacitive Sensor, M25 QuickLock Thread Adapters, Digital Controller with USB, RS-232

PD72Z1SAA

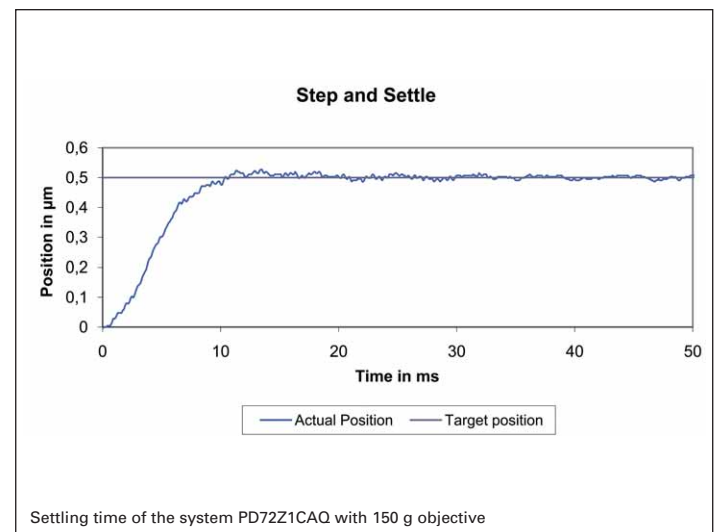
Fast PIFOC® Piezo Nanofocusing Z-Drive, 100 µm, SGS Sensor, M32 Large Aperture QuickLock Thread Adapters, Digital Controller with USB, RS-232

PD72Z1SAQ

Fast PIFOC® Piezo Nanofocusing Z-Drive, 100 µm, SGS Sensor, M25 QuickLock Thread Adapters, Digital Controller with USB, RS-232

Flexibility: Software Configurable Servo Parameters

All servo controllers require tuning and adjustment of servo parameters for optimum performance (e.g. as a result of changes to the load or the motion profile). With a digital controller, all adjustments are carried out by simple software commands and the resulting motion or transient characteristics can be viewed, analyzed and further optimized immedi-



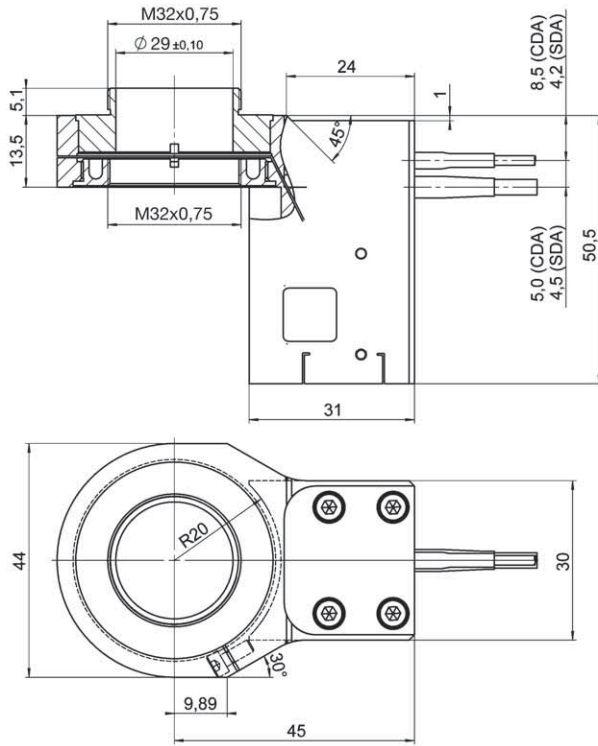
ately with the provided software. It is also possible to switch between previously found sets of parameters when the controller is in operation. Since jumpers and potentiome-

ters no longer have to be set manually, system integration becomes much more straightforward. System setup with the included user-interface software is fast

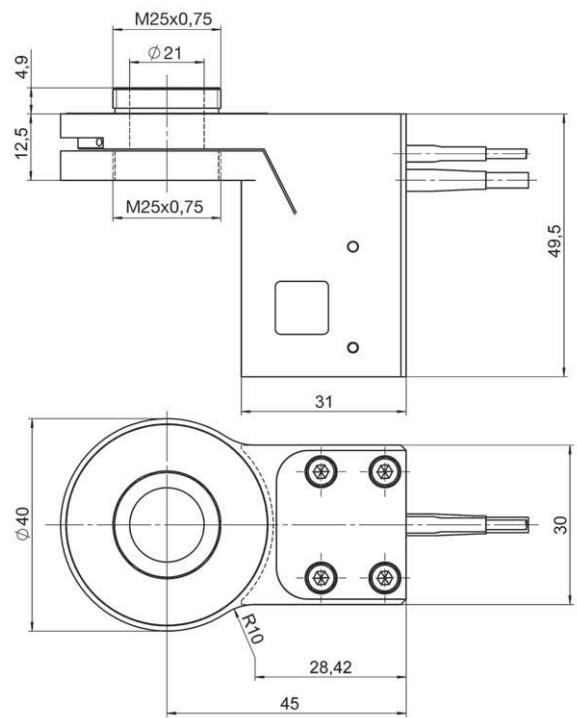
and easy, interfacing to the customers' software is facilitated with the included LabVIEW drivers and DLLs. Drivers for MetaMorph and μ Manager are available.

Technical Data

Model	PD72Z1SAA PD72Z1SAQ	PD72Z1CAA PD72Z1CAQ	Units	Tolerance
Active axes	Z	Z		
Motion and positioning				
Integrated sensor	SGS	Capacitive		
Closed-loop travel	100	100	μm	
Closed-loop resolution	5	1	nm	typ.
Closed-loop linearity	0.2	0.06	%	typ.
Repeatability	±10	±5	nm	typ.
Runout θX, θY	13	13	μrad	typ.
CrossTalk in X, Y	100	100	nm	typ.
Settling time (0.5 μm step with 5 % accuracy, 150 g)	10	10	ms	typ.
Mechanical properties				
Stiffness in motion direction	0.3	0.3	N/μm	±20%
Unloaded resonant frequency	580	580	Hz	±20%
Resonant frequency @ 120 g	235	235	Hz	±20%
Resonant frequency @ 200 g	180	180	Hz	±20%
Push/pull force capacity in motion direction	100 / 20	100 / 20	N	Max.
Drive properties				
Ceramic type	PICMA® P-885	PICMA® P-885		
Controller				
Function	Digital controller for single-axis piezo nanopositioning systems			
Processor	DSP 32-bit floating point, 150 MHz			
Communication interfaces	USB, RS-232			
Linearization	5th order polynomials			
Amplifier power	10 W (<5 ms); 5 W (>5 ms)			
I/O Connector	HD-Sub-D 26-pin, 1 Analog input 0 to 10 V, 1 Sensor monitor 0 to 10 V, 1 digital input (LVTTL, programmable), 5 digital outputs (LVTTL, 3 predefined, 2 programmable)			
User software	PIMikroMove, NanoCapture			
Software drivers	LabVIEW drivers, DLLs			
Supported functionality	Digital setting of the control parameters, wave generator, data recorder, auto zero, trigger I/O; compatible to MetaMorph, μManager			
Display	Status LED, overflow LED			
Miscellaneous				
Operating temperature range	10 to 50	10 to 50	°C	
Material scanner	Aluminum	Aluminum		
Weight	0.22 (scanner), 0.5 (controller)	0.24 (scanner), 0.5 (controller)	kg	±5%
Cable length to controller	1	1	m	
Dimensions controller	160 x 96 x 33	160 x 96 x 33	mm	



PD72Z1xAA with M32 QuickLock thread adapter
(large aperture version, 29 mm), dimensions in mm



PD72Z1xAQ with M25 QuickLock thread adapter, dimensions in mm