

P-620.Z – P-622.Z PIHera® Precision Z-Stage Nanopositioning System Family with Direct Metrology and Long Travel Ranges



P-620.ZCL, P-621.ZCL and P-622.ZCL (from left) PIHera® piezo nano-elevation stages, 50 to 400 µm (CD for size comparison)

- Vertical Travel Range 50 to 400 µm
- High-Precision, Cost-Efficient
- Resolution to 0.1 nm
- Direct Metrology with Capacitive Sensors
- 0,02 % Positioning Accuracy
- Frictionless, High-Precision Flexure Guiding System
- Outstanding Lifetime Due to PICMA® Piezo Actuators
- X-, XY-, Z- XYZ-Versionen
- Vacuum-Compatible Versions Available

Z-axis PIHera® systems are cost-efficient piezo nanopositioning stages featuring travel ranges up to 400 µm and provide sub-nanometer resolution. Despite the increased travel ranges, the units are extremely compact and provide sub-nanometer resolution. The long

travel range is achieved with a friction-free and extremely stiff flexure system, which also offers rapid response and excellent guiding accuracy.

PIHera® piezo nanopositioning stages are also available as X- and XY-stages (see p. 2-22 and p. 2-54).

Application Examples

- Interferometry
- Microscopy
- Nanopositioning
- Biotechnology
- Quality assurance testing
- Semiconductor technology

Nanometer Precision in Milliseconds

One of the advantages of PIHera® stages over motor-driven positioning stages is the rapid response to input changes and the fast and precise settling behavior. The P-622.1CD, for example, can settle to an accuracy of 10 nm in only 30 msec (other

PI stages provide even faster response)!

Superior Accuracy With Direct-Metrology Capacitive Sensors

A choice of tasks such as optical path adjustment in interferometry, sample positioning in microscopy, precision alignment or optical tracking require the relatively long scanning ranges and nanometer precision offered by PIHera® nanopositioning stages.

PI's proprietary capacitive sensors measure position directly and without physical contact. They are free of friction and hysteresis, a fact which, in combination with the positioning resolution of well under 1 nm, makes it possible to achieve very high levels of linearity. A further advantage of direct metrology with capacitive sensors is the high phase fidelity and the high bandwidth of up to 10 kHz.

Designed for Precision

High stiffness is achieved with the FEA-optimized design of the frictionless flexure elements, which assure excellent guiding

Ordering Information

P-620.ZCD

PIHera® Precision Vertical Nanopositioning Stage, 50 µm, Capacitive Sensor, Sub-D Connector

P-620.ZCL

PIHera® Precision Vertical Nanopositioning Stage, 50 µm, Capacitive Sensor, LEMO Connector

P-621.ZCD

PIHera® Precision Vertical Nanopositioning Stage, 100 µm, Capacitive Sensor, Sub-D Connector

P-621.ZCL

PIHera® Precision Vertical Nanopositioning Stage, 100 µm, Capacitive Sensor, LEMO Connector

P-622.ZCD

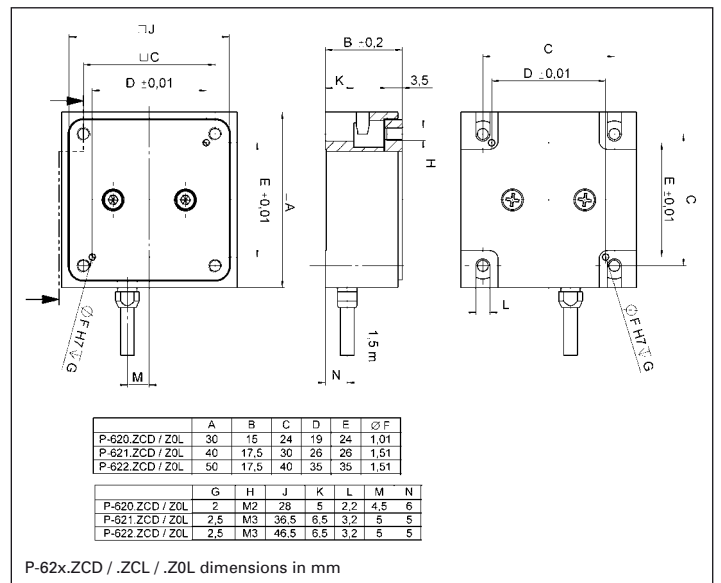
PIHera® Precision Vertical Nanopositioning Stage, 250 µm, Capacitive Sensor, Sub-D Connector

P-622.ZCL

PIHera® Precision Vertical Nanopositioning Stage, 250 µm, Capacitive Sensor, LEMO Connector

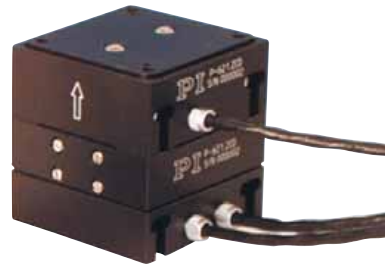
Open-loop versions are available as P-62x.Z0L

accuracy and dynamics. A straightness and flatness in the nanometer range is achieved.



System properties

System configuration	P-621.ZCD with E-753 digital controller and 30 g load
Amplifier bandwidth, small signal	25 Hz
Amplifier bandwidth, large signal	25 Hz
Settling time (full travel)	15 ms



PIHera® XYZ combination

Technical Data

Model	P-620.ZCD P-620.ZCL	P-621.ZCD P-621.ZCL	P-622.ZCD P-622.ZCL	P-62x.Z0L Open-loop versions	Units	Tolerance
Active axes	Z	Z	Z	Z		
Motion and positioning						
Integrated sensor	Capacitive	Capacitive	Capacitive	–		
Open-loop travel, -20 to +120 V	65	140	400	as P-62x.ZCD	µm	min. (+20 %/-0 %)
Closed-loop travel	50	100	250	–	µm	
Open-loop resolution	0.1	0.2	0.5	as P-62x.ZCD	nm	typ.
Closed-loop resolution	0.2	0.3	1	–	nm	typ.
Linearity	0.02	0.02	0.02	–	%	typ.
Repeatability	±1	±1	±1	–	nm	typ.
Runout θ_x, θ_y)	<20	<20	<80	as P-62x.ZCD	µrad	typ.
Mechanical properties						
Stiffness	0.5	0.6	0.24	as P-62x.ZCD	N/µm	±20 %
Unloaded resonant frequency	1000	790	360	as P-62x.ZCD	Hz	±20 %
Resonant frequency @ 30 g	690	500	270	as P-62x.ZCD	Hz	±20 %
Push/pull force capacity	10 / 5	10 / 8	10 / 8	as P-62x.ZCD	N	Max.
Load capacity	10	10	10	as P-62x.ZCD	N	Max.
Lateral Force	10	10	10	as P-62x.ZCD	N	Max.
Drive properties						
Ceramic type	PICMA® P-883	PICMA® P-885	PICMA® P-885	as P-62x.ZCD		
Electrical capacitance	0.7	3	6.2	as P-62x.ZCD	µF	±20 %
Dynamic operating current coefficient	1.8	3.8	3.1	as P-62x.ZCD	µA/(Hz • µm)	±20 %
Miscellaneous						
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	-20 to 150	°C	
Material	Aluminum	Aluminum	Aluminum	Aluminum		
Mass	0.12	0.17	0.24	as P-62x.ZCD	kg	±5 %
Cable length	1.5	1.5	1.5	as P-62x.ZCD	m	±10 mm
Sensor / voltage connection	Sub-D special (CD-version) CL-version: LEMO	Sub-D special (CD-version) CL-version: LEMO	Sub-D special (CD-version) CL-version: LEMO	LEMO (no sensor)		

Recommended controller

CD-Versions:

E-610 servo controller / amplifier (p. 2-110), E-625 servo controller, bench-top (p. 2-114), E-665 powerful servo controller, bench-top (p. 2-116)

Single-channel digital controller: E-753 (bench-top) (p. 2-108)

CL-Versions:

Modular piezo controller system E-500 (p. 2-142) with amplifier module E-505 (high performance) (p. 2-147) and E-509 controller (p. 2-152)

Open-loop versions: modular piezo controller system E-500 (p. 2-142) with amplifier module E-505 (high performance) (p. 2-147)

P-620.1 – P-629.1 PIHera® Piezo Linear Stage

Compact Nanopositioning System Family with Long Travel Ranges



PIHera® piezo nanopositioning systems feature travel ranges from 50 to 1800 μm

- Travel Ranges 50 to 1800 μm
- High-Precision, Cost-Efficient
- Resolution to 0.1 nm
- Direct Metrology with Capacitive Sensors
- 0.02 % Positioning Accuracy
- Frictionless, High-Precision Flexure Guiding System
- Outstanding Lifetime Due to PICMA® Piezo Actuators
- X-, XY-, Z-, XYZ Versions
- Vacuum-Compatible Versions Available

Single-axis PIHera® systems are piezo-nanopositioning stages featuring travel ranges from 50 to 1800 μm . Despite the increased travel ranges, the units are extremely compact and provide rapid response and high guiding precision. This and the long travel range is achieved with a friction-free and extremely stiff flexure system.

The PIHera® piezo nanopositioning series also includes Z- and XY-stages (see p. 2-40, p. 2-54).

Nanometer Precision in Milliseconds

One of the advantages of PIHera® stages over motor-driven positioning stages is the rapid response to input changes and the fast and precise settling behavior. The P-622.1CD, for example, can settle to an accuracy of 10 nm in only 30 msec (other PI stages provide even faster response)!

Superior Accuracy With Direct-Metrology Capacitive Sensors

A choice of tasks such as optical path adjustment in interferometry, sample positioning in microscopy, precision alignment or optical tracking require

the relatively long scanning ranges and nanometer precision offered by PIHera® nanopositioning stages.

PI's proprietary capacitive sensors measure position directly and without physical contact. They are free of friction and hysteresis, a fact which, in combination with the positioning resolution of well under 1 nm, makes it possible to achieve very high levels of linearity. A further advantage of direct metrology with capacitive sensors is the high phase fidelity and the high bandwidth of up to 10 kHz.

Designed for Precision

High stiffness is achieved with the FEA-optimized design of the frictionless flexure elements, which assure excellent guiding accuracy and dynamics. A straightness and flatness in the nanometer range is achieved.

Ordering Information

P-620.1CD* / P-620.1CL*
PIHera® Precision Piezo Linear Nanopositioning System, 50 μm , Direct Metrology, Capacitive Sensor

P-621.1CD* / P-621.1CL*
PIHera® Precision Piezo Linear Nanopositioning System, 100 μm , Direct Metrology, Capacitive Sensor

P-622.1CD* / P-622.1CL*
PIHera® Precision Piezo Linear Nanopositioning System, 250 μm , Direct Metrology, Capacitive Sensor

P-625.1CD* / P-625.1CL*
PIHera® Precision Piezo Linear Nanopositioning System, 500 μm , Direct Metrology, Capacitive Sensor

P-628.1CD* / P-628.1CL*
PIHera® Precision Piezo Linear Nanopositioning System, 800 μm , Direct Metrology, Capacitive Sensor

P-629.1CD* / P-629.1CL*
PIHera® Precision Piezo Linear Nanopositioning System, 1500 μm , Direct Metrology, Capacitive Sensor

*.1CD with Sub-D Connector

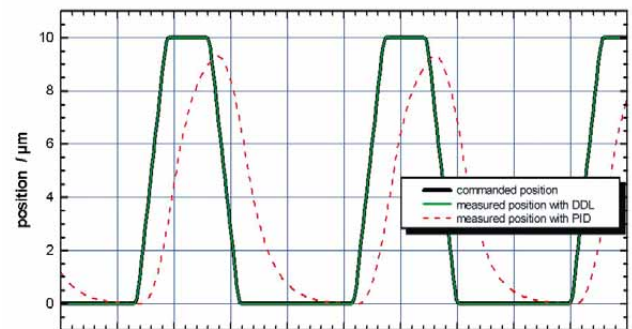
*.1CL with LEMO Connector

Open-loop versions are available as P-62x.10L.

Vacuum versions to 10^{-9} hPa are available as P-62x.1UD.

System properties

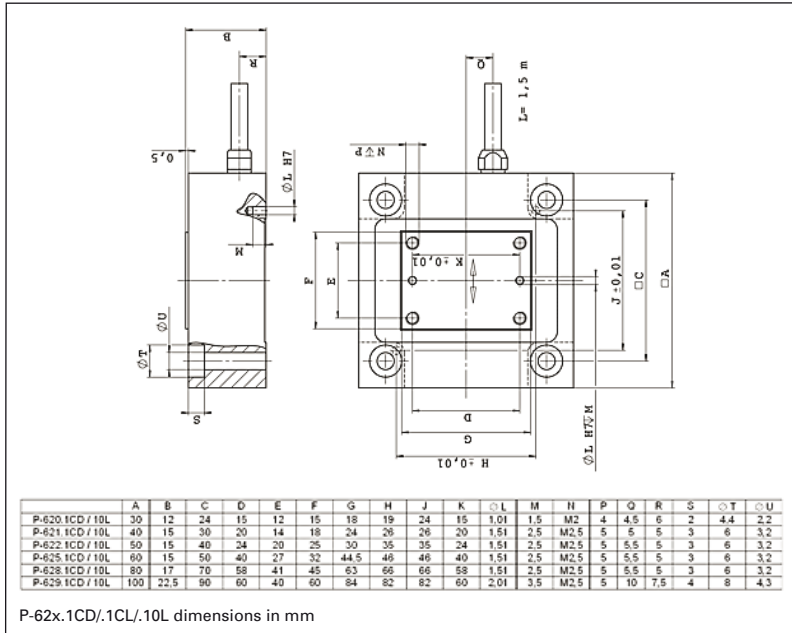
System configuration	P-625.1CD and E-500 modular piezo controller system with E-505.00F amplifier and E-509.C1A servo controller; 250 g load
Closed-loop amplifier bandwidth, large signal	30 Hz
Settling time (full travel)	31 ms



Rapid scanning motion of a P-621.1CD (commanded rise time 5 ms) with the E-710 controller ##600300 and Digital Dynamic Linearization (DDL) option. DDL virtually eliminates the tracking error (<20 nm) during the scan. The improvement over a classical PI controller is up to 3 orders of magnitude, and increases with the scanning frequency

Application Examples

- Interferometry
- Microscopy
- Nanopositioning
- Biotechnology
- Quality assurance testing
- Semiconductor technology



PIHera® XYZ combination,
P-62x.2 XY piezo stage (see
p. 2-54), P-62x.Z vertical
stage (see p. 2-40)

Technical Data

Model	P-620.1CD/ P-620.1CL	P-621.1CD/ P-621.1CL	P-622.1CD/ P-622.1CL	P-625.1CD/ P-625.1CL	P-628.1CD/ P-628.1CL	P-629.1CD/ P-629.1CL	P-62x.10L open-loop version	Units	Tolerance
Active axes	X	X	X	X	X	X	X		
Motion and positioning									
Integrated sensor	Capacitive	Capacitive	Capacitive	Capacitive	Capacitive	Capacitive	–		
Open-loop travel, -20 to +120 V	60	120	300	600	950	1800	as P-62x.1CD	µm	min. (+20%/0%)
Closed-loop travel	50	100	250	500	800	1500	–	µm	calibrated
Closed-loop / open-loop resolution	0.2 / 0.1	0.4 / 0.2	0.7 / 0.4	1.4 / 0.5	1.8 / 0.5	3 / 2	as P-62x.1CD	nm	typ.
Linearity, closed-loop	0.02	0.02	0.02	0.02	0.03*	0.03**	–	%	typ.
Repeatability	±1	±1	±1	±5	±10	±14	–	nm	typ.
Pitch / yaw	±3	±3	±3	±6	±6	±10	as P-62x.1CD	µrad	typ.
Mechanical properties									
Stiffness in motion direction	0.42	0.35	0.2	0.1	0.12	0.13	as P-62x.1CD	N/µm	±20%
Unloaded resonant frequency	1100	800	400	215	125	125	as P-62x.1CD	Hz	±20%
Resonant frequency @ 20 g	550	520	340	180	115	120	as P-62x.1CD	Hz	±20%
Resonant frequency @ 120 g	260	240	185	110	90	110	as P-62x.1CD	Hz	±20%
Push/pull force capacity in motion direction	10	10	10	10	10	10	as P-62x.1CD	N	Max.
Load capacity	10	10	10	10	10	10	as P-62x.1CD	N	Max.
Lateral Force	10	10	10	10	10	8	as P-62x.1CD	N	Max.
Drive properties									
Ceramic type	PICMA® P-883	PICMA® P-885	PICMA® P-885	PICMA® P-885	PICMA® P-887	PICMA® P-888	as P-62x.1CD		
Electrical capacitance	0.35	1.5	3.1	6.2	19	52	as P-62x.1CD	µF	±20%
Dynamic operating current coefficient	0.9	1.9	1.9	1.6	3	4.3	as P-62x.1CD	µA/(Hz • µm)	±20%
Miscellaneous									
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 150	°C	
Material	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum		
Dimensions	30 x 30 x 12	40 x 40 x 15	50 x 50 x 15	60 x 60 x 15	80 x 80 x 17	100 x 100 x 22.5	as P-62x.1CD	mm	
Mass	0.11	0.16	0.2	0.24	0.38	0.72	as P-62x.1CD	kg	±5%
Cable length	1.5	1.5	1.5	1.5	1.5	1.5	1.5 m		±10 mm
Sensor / voltage connection	CD version: Sub-D special CL version: LEMO	CD version: Sub-D special CL version: LEMO	CD version: Sub-D special CL version: LEMO	CD version: Sub-D special CL version: LEMO	CD version: Sub-D special CL version: LEMO	CD version: Sub-D special CL version: LEMO	LEMO (no sensor)		

Resolution of PI Piezo Nanopositioners is not limited by friction or stiction. The value given is noise equivalent motion with E-710 controller (p. 2-128).

*With digital controller. For analog controller 0.05%.

**With digital controller. For analog controller 0.07%.

Recommended controller / amplifier

CD version: E-610 servo controller / amplifier (p. 2-110), E-625 servo controller, bench-top (p. 2-114), E-665 powerful servo controller, bench-top (p. 2-116)

Single-channel digital controller: E-753 (bench-top) (p. 2-108)

CL version: E-500 modular piezo controller system (p. 2-142) with E-505 amplifier module (high power) p. 2-147 and E-509 controller (p. 2-152)

Open-loop version: E-500 modular piezo controller system (p. 2-142) with E-505 amplifier module (high power) (p. 2-147)

P-620.2 - P-629.2 PIHera® XY Piezo Stage

High-Precision Nanopositioner Family—Compact and Long Travel Ranges



PIHera® XY nanopositioning systems provide travel ranges from 50 x 50 µm to 1800 x 1800 µm

- Travel Ranges 50 to 1800 µm
- High-Precision, Cost-Efficient
- Resolution to 0.1 nm
- Frictionless, High-Precision Flexure Guiding System
- 0,02 % Positioning Accuracy
- Outstanding Lifetime Due to PICMA® Piezo Actuators
- X-, XY-, Z- and XYZ-Versions
- Vacuum-Compatible Versions Available

Two-axis (XY) PIHera® systems are piezo-nanopositioning stages featuring travel ranges from 50 to 1800 µm. Despite the increased travel ranges, the units are extremely compact and provide rapid response and high guiding precision. This, and the long travel range is achieved with a friction-free and extremely stiff flexure system nanometer resolution. The PI-

Hera® piezo nanopositioning series also includes Z and X stages (see p. 2-22 and p. 2-40).

Nanometer Precision in Milliseconds

One of the advantages of PIHera® stages over motor-driven positioning stages is the rapid response to input changes and the fast and precise settling behavior. The P-622.1CD, for example, can settle to an accuracy of 10 nm in only 30 msec (other PI stages provide even faster response)!

Superior Accuracy With Direct-Metrology Capacitive Sensors

A choice of tasks such as optical path adjustment in interferometry, sample positioning in microscopy, precision align-

ment or optical tracking require the relatively long scanning ranges and nanometer precision offered by PIHera® nanopositioning stages. PI's proprietary capacitive sensors measure position directly and without physical contact. They are free of friction and hysteresis, a fact which, in combination with the positioning resolution of well under 1 nm, makes it possible to achieve very high levels of linearity. A further advantage of direct metrology with capacitive sensors is the high phase fidelity and the high bandwidth of up to 10 kHz.

Designed for Precision

High stiffness is achieved with the FEA-optimized design of the frictionless flexure elements, which assure excellent guiding accuracy and dynamics. A straightness and flatness in the nanometer range is achieved.

Ordering Information

P-620.2CD* / P-620.2CL*
PIHera® Precision XY Nanopositioning System,
50 x 50 µm, Direct Metrology, Capacitive Sensors

P-621.2CD* / P-621.2CL*
PIHera® Precision XY Nanopositioning System,
100 x 100 µm, Direct Metrology, Capacitive Sensors

P-622.2CD* / P-622.2CL*
PIHera® Precision XY Nanopositioning System,
250 x 250 µm, Direct Metrology, Capacitive Sensors

P-625.2CD* / P-625.2CL*
PIHera® Precision XY Nanopositioning System,
500 x 500 µm, Direct Metrology, Capacitive Sensors

P-628.2CD* / P-628.2CL*
PIHera® Precision XY Nanopositioning System,
800 x 800 µm, Direct Metrology, Capacitive Sensors

P-629.2CD* / P-629.2CL*
PIHera® Precision XY Nanopositioning System,
1500 x 1500 µm, Direct Metrology, Capacitive Sensors

*.2CD with Sub-D Connector
*.2CL with LEMO Connector

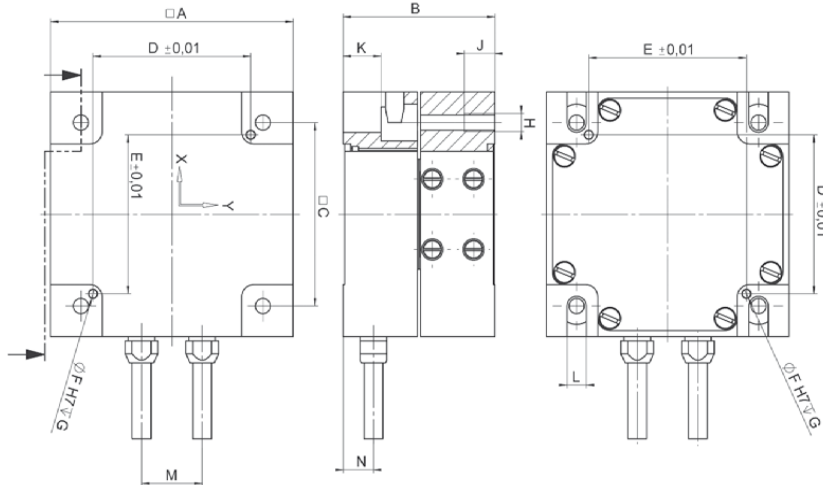
**Open-loop versions are available as P-62x.20L.
Vacuum versions to 10⁻³ hPa are available as P-62x.2UD.**



Single-axis PIHera® nanopositioning system with travel range to 1800 µm

Application Examples

- Interferometry
- Microscopy
- Nanopositioning
- Biotechnology
- Quality assurance testing
- Semiconductor technology



	A	B	C	D	E	∅F	G	H	J	K	L	M	N
P-620.2CD / 20L	30	21,5	24	24	19	1,01	1,5	M2	3,5	5,1	2,2	9	6
P-621.2CD / 20L	40	25	30	26	26	1,51	2,5	M3	5	6,25	3,2	10	5
P-622.2CD / 20L	50	25	40	35	35	1,51	2,5	M3	5	6,25	3,2	11	5
P-625.2CD / 20L	60	25	50	46	46	1,51	2,5	M3	6	6,25	3,2	11	5
P-628.2CD / 20L	80	30	70	66	66	1,51	2,5	M3	6	6,75	3,2	11	5
P-629.2CD / 20L	100	40	90	82	82	2,01	3,5	M4	7	9,75	4,3	16	7,5

P-62x.2CD/.2CL/.20L dimensions in mm

Technical Data

Model	P-620.2CD/ P-620.2CL	P-621.2CD/ P-621.2CL	P-622.2CD/ P-622.2CL	P-625.2CD/ P-625.2CL	P-628.2CD/ P-628.2CL	P-629.2CD P-629.2CL	P-62x.20L open-loop versions	Units	Tolerance	
Active axes	X, Y	X, Y	X, Y	X, Y	X, Y	X, Y	X, Y			
Motion and positioning										
Integrated sensor	Capacitive	Capacitive	Capacitive	Capacitive	Capacitive	Capacitive	–			
Open-loop travel X, Y, -20 to +120 V	60	120	300	600	950	1800	as P-62x.2CD	µm	min. (+20%/-0%)	
Closed-loop travel	50	100	250	500	800	1500	–	µm		
Open-loop resolution	0.1	0.2	0.4	0.5	0.5	2	as P-62x.2CD	nm	typ.	
Closed-loop resolution	0.2	0.4	0.7	1.4	3.5	3.5	–	nm	typ.	
Linearity	0.02	0.02	0.02	0.03	0.03	0.03	–	%	typ.	
Repeatability	±2	±2	±2	±5	±10	±14	as P-62x.2CD	nm	typ.	
Pitch / yaw	±3	±3	±3	±3	±20	±30	as P-62x.2CD	µrad	typ.	
Mechanical properties										
Stiffness	0.22	0.25	0.2	0.1	0.05	0.1	as P-62x.2CD	N/µm	±20%	
Unloaded resonant frequency in X,	575	420	225	135	75	60	as P-62x.2CD	Hz	±20%	
Unloaded resonant frequency in Y	800	535	300	195	105	100	as P-62x.2CD	Hz	±20%	
Resonant frequency in X @ 50 g	270	285	180	120	60	55	as P-62x.2CD	Hz	±20%	
Resonant frequency in Y @ 50 g	395	365	215	150	85	85	as P-62x.2CD	Hz	±20%	
Resonant frequency in X @ 100 g	285	220	160	105	55	50	as P-62x.2CD	Hz	±20%	
Resonant frequency in Y @ 100 g	300	285	175	125	75	80	as P-62x.2CD	Hz	±20%	
Push/pull force capacity in motion direction	10 / 5	10 / 8	10 / 8	10 / 8	10 / 8	10 / 8	as P-62x.2CD	N	Max.	
Load capacity	10	10	10	10	10	10	as P-62x.2CD	N	Max.	
Lateral Force	10	10	10	10	10	10	as P-62x.2CD	N	Max.	
Drive properties										
Ceramic type	PICMA® P-883	PICMA® P-885	PICMA® P-885	PICMA® P-885	PICMA® P-887	PICMA® P-888	as P-62x.2CD			
Electrical Capacitance	0.35	1.5	3.1	6.2	19	52	as P-62x.2CD	µF	±20%	
Dynamic operating current coefficient	0.9	1.9	1.9	1.6	3	4.3	as P-62x.2CD	µA/(Hz·µm)	±20%	
Miscellaneous										
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 150	°C		
Material	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum			
Mass	0.195	0.295	0.348	0.43	0.7	1.37	as P-62x.2CD	kg	±5%	
Cable length	1.5	1.5	1.5	1.5	1.5	1.5	1.5	m	±10 mm	
Sensor / voltage connection	CD version: 2x Sub-D special CL version: LEMO	CD version: 2x Sub-D special CL version: LEMO	CD version: 2x Sub-D special CL version: LEMO	CD version: 2x Sub-D special CL version: LEMO	CD version: 2x Sub-D special CL version: LEMO	CD version: 2x Sub-D special CL version: LEMO	CD version: 2x Sub-D special CL version: LEMO	2x LEMO (no sensor)		

Lower axis: X; upper axis: Y.

Resolution of PI Piezo Nanopositioners is not limited by friction or stiction. The value given is noise equivalent motion with E-710 controller (p. 2-128)

Recommended controller

CD version: E-610 servo controller / amplifier (p. 2-110), E-625 servo controller, bench-top (p. 2-114), E-665 powerful servo controller, bench-top (p. 2-116)

Multi-channel digital controllers: E-710 bench-top (p. 2-128), E-712 modular (p. 2-140), E-725 high-power (p. 2-126), E-761 PCI board (p. 2-140)

CL version: E-500 modular piezo controller system (p. 2-142) with E-505 amplifier module (1 per axis, high power) (p. 2-147) and E-509 controller (p. 2-152)

Open-loop versions: E-500 modular piezo controller system (p. 2-142) with E-505 amplifier module (1 per axis, high power) (p. 2-147)