

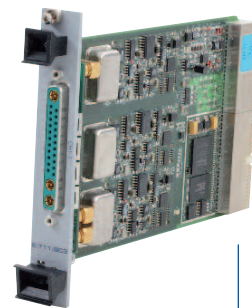
E-712 Modular Digital Piezo Controller

Ultra-High Performance & Flexibility for any High-End Application

ULTRA HIGH PERFORMANCE



FLEXIBLE



MODULAR

E-712 Ultra-High Performance Digital Nanopositioning Controller

Modular Platform for Precision Piezo Systems and NEXLINE® Drives



Example for the modular use of an E-712 for the vertical and tilt system with three mixed, hybrid drives. They consist of NEXLINE® linear actuators with additional PICMA® actuators for an increased fine adjustment range.

The E-712 digital piezo controller is ideal when it comes to meeting the most demanding accuracy and dynamic-performance requirements of multi-axis nanopositioning systems. The high-performance, real-time operating system makes possible coordinated servo-control of multiple axes (also in parallel-kinematics systems) and thus ensures excellent trajectory control even during complex motion. The modular design allows flexible configuration of systems supporting the number of axes and channels required for the application. Flexibility in meeting customers' needs is also behind the interface design: The optional analog inputs and outputs support processing external sensor or control signals as well as driving external amplifiers.

Digital Linearization and Control Algorithms for Highest Accuracy

Linearization algorithms based on higher-order polynomials improve the positioning accuracy to better than 0.01% for capacitive sensors, typically

10 times better than achievable with conventional controllers.

More than just a Controller—Trajectory Control and Data Recording

During fast periodic motion, as typical for scanning applications, the tracking accuracy can be further improved with Dynamic Digital Linearization (DDL, E-710.SCN). This optionally available control algorithm reduces the tracking error by a factor of up to 1000 and enables the spatial and temporal tracking during a dynamic scan. The integrated wave generator can output periodic motion profiles. In addition to sine and triangle waves, arbitrary, user-defined motion profiles can be created and stored. The flexibly configurable data recorder enables simultaneous recording and read-out of the corresponding data.

Flexible Analog Inputs and Real-time PIO

Each of the four optionally available analog inputs can be configured in two ways. When used as a control input, the applied voltage is linked to one of

the axes, for target value settings, for example. When configured as an external sensor input, additional sensor signals e.g. for auto-focusing, can be read in. Alternatively, the system can be equipped with a fast 32-bit PIO (Parallel I/O) for placing commands. The PIO supports a restricted command set required for the motion with 100,000 read and write commands per second.

Simple System Integration

All parameters can be checked and reset via software. System setup and configuration is done with the included NanoCapture™ and PIMikroMove™ user-interface software. Interfacing to custom software is facilitated with included LabVIEW drivers and DLLs. System programming is the same with all PI controllers, so controlling a system with a variety of different controllers is possible without difficulty.

Ordering Information

E-712.3CD
Modular Digital Multi-Channel Piezo Controller, 3 Channels, Capacitive Sensors

E-712.3CDA
Modular Digital Multi-Channel Piezo Controller, 3 Channels, Capacitive Sensors, Analog INs and OUTs

E-712.6CD
Modular Digital Multi-Channel Piezo Controller, 6 Channels, Capacitive Sensors

E-712.6CDA
Modular Digital Multi-Channel Piezo Controller, 6 Channels, Capacitive Sensors, Analog INs and OUTs

These models have RS-232, USB and TCP/IP Interfaces.

Further Interfaces are available:

E-711.IA4
Analog Interface Module, 4 I/O for E-712 modular, digital, Controller System

E-711.IP
PIO Interface Module for E-712 modular, digital, Controller System

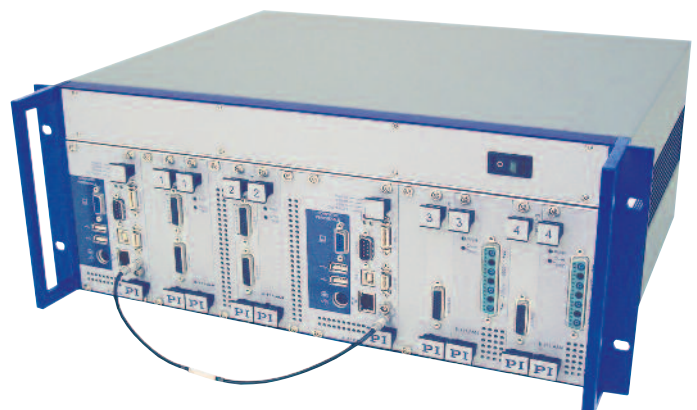
Ask about custom designs!

Options and Accessories:

E-710.SCN
DDL (Dynamic Digital Linearization) Firmware Upgrade

E-711.i1B
Analog Cable for Analog I/O, BNC Connector, 1.5 m

E-711.i10
Analog Cable for Analog I/O, Solderable End, 1.5 m



Examples of the modular use of one E-712 for a mixed operation of low voltage and medium voltage actuators (120 V or ±250 V). The positioning system has two separate axis systems for the adjusting and actual measurement process in an inspection system.

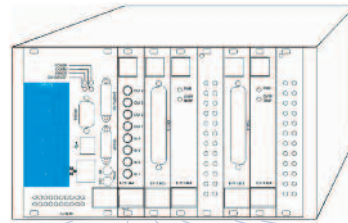
E-712 Digital Nanopositioning Controller: Options

Modular Platform for Precision Piezo Systems and NEXLINE® Drives



E-712 digital controller for nanopositioning systems with up to 6 axes

- Digital Controller of the Newest Generation: 600MHz Tact Rate; up to 50kHz Servo Update Rate; Highly Stable 20-bit D/A Converter
- Real-Time Operating System for Excellent Trajectory Control
- Modular Design for Greatest Flexibility in Meeting Custom Requirements
- Auto-Loading of Calibration Data from Stage ID-Chip for Interchangeability of Controller and Mechanics
- Versatile Interfaces: Ethernet, USB, RS-232
- Optional High-Bandwidth Analog Inputs and Outputs
- Extensive Software Support



	Preconfigured system	Digital controller unit	Case unit	Interface modul	Sensor modul	Amplifier modul	Sensor modul	Amplifier modul
Nanopositioning systems with voltage requirement of up to +120 V with 3 axes and capacitive sensors	E-712.3CD	E-712.M1*	E-712.R1*	-	E-711.SC3H*	E-711.AL4P*	-	-
Nanopositioning systems with voltage requirement of up to +120 V with up to 6 axes and capacitive sensors	E-712.6CD	E-712.M1*	E-712.R1*	-	E-711.SC3H*	E-711.AL4P*	E-711.SC3H*	E-711.AL4P*
Nanopositioning systems with voltage requirement of up to +120 V with three (six) axes and capacitive sensors; 4 analog inputs and outputs for direct issuing of commands and sensor/position evaluation	E-712.3CD (E-712.6CD)	E-712.M1*	E-712.R1*	E-711.IA4	E-711.SC3H*	E-711.AL4P*	(E-711.SC3H)*	(E-711.AL4P)*
Nanopositioning systems with voltage requirement of up to +120 V with 3 (six) axes and capacitive sensors; Parallel I/O interface for fast, digital commands PIO	E-712.3CD (E-712.6CD)	E-712.M1*	E-712.R1*	E-711.IP	E-711.SC3H*	E-711.AL4P*	(E-711.SC3H)*	(E-711.AL4P)*
Nanopositioning systems with voltage requirement of up to +120 V with 3 (six) axes and capacitive sensors and long distance between positioner and controller.		E-712.M1	E-712.R1	E-711.IA4 or E-711.IP optional	E-711.OCT	E-711.AL4P	(E-711.OCT)	(E-711.AL4P)
Nanopositioning systems with voltage requiremen ±250 V (PICOCUBE®) with up to 3 axes and capacitive sensors	E-712.3CM	E-712.M1*	E-712.R4*	E-711.IA4 or E-711.IP optional	E-711.SC3H*	E-711.AM4*	-	-
Nanopositioning systems with voltage requirement of up to +120 V with three (six) axes and incremental sensors		E-712.M1	E-712.R1	E-711.IA4 or E-711.IP optional	E-711.SA3 (E-711.SA6)	E-711.AL4P	-	(E-711.AL4P)
NEXLINE® positioning system with single-axis, incremental sensors and analog interfaces or PIO (optional)		E-712.N1**	E-712.R4	E-711.IA4 or E-711.IP optional	E-711.SA3	E-711.AM4	-	-
NEXLINE® positioning system with 3 axes (combined stepping drive), inkremental sensors and analog interfaces or PIO (optional)		E-712.N1**	E-712.R4	E-711.IA4 or E-711.IP optional	E-711.SA3	E-711.AM4	-	-
NEXLINE® positioning system with 3 axes (combined stepping drive), capacitive sensors and analog interfaces or PIO (optional)		E-712.N1**	E-712.R4	E-711.IA4 or E-711.IP optional	E-711.SC3	E-711.AM4	-	-

* The modul is already included.

** The single- or 3-channel NEXLINE® operation is adjustable via software commands.

E-712 Ultra-High Performance Modular Digital Piezo Controller

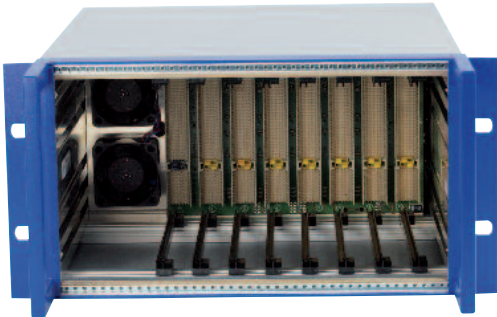
Modular System for up to 6 Axes with Highest Precision

Technical Data

Model	E 712.3CD	E 712.6CD	E-712.3CM
Function	Modular digital controller for multi-axis piezo nan positioning systems with capacitive sensors	Modular digital controller for multi-axis piezo nan positioning systems with capacitive sensors	Modular digital controller for PicoCube® nan positioning systems with capacitive sensors
Axes	3	6	3
Processor	PC-based, 600 MHz, real-time operating system	PC-based, 600 MHz, real-time operating system	PC-based, 600 MHz, real-time operating system
Sampling rate, servo-control	50 kHz	20 kHz	50 kHz
Sampling rate, sensor	50 kHz	20 kHz	50 kHz
Sensor			
Servo characteristics	P-I, two notch filters	P-I, two notch filters	P-I, two notch filters
Sensor type	Capacitive	Capacitive	Capacitive
Sensor channels	3	6	3
Sensor bandwidth (-3 dB)	10 kHz	10 kHz	10 kHz
Sensor resolution	18 Bit	18 Bit	18 Bit
Ext. synchronization	Yes	Yes	Yes
Amplifier			
Output voltage	-30 V to +135 V	-30 V to +135 V	-250 V to +250 V
Amplifier channels	4	8	4
Peak output power per channel	25 W	25 W	45 W
Average output power per channel	8 W	8 W	15 W
Peak current	250 mA	250 mA	180 mA
Average current per channel	100 mA	100 mA	60 mA
Current limitation	Short-circuit-proof	Short-circuit-proof	Short-circuit-proof
Resolution DAC	20-bit	20-bit	20-bit
Interfaces and operation			
Communication interfaces	Ethernet, USB, RS-232	Ethernet, USB, RS-232	Ethernet, USB, RS-232
Piezo / sensor connector	Sub-D special connector	Sub-D special connector	Sub-D special connector
Analog in/out	optional je 4 x LEMO, ±10 V (E-711.IA4)	optional je 4 x LEMO, ±10 V (E-711.IA4)	optional je 4 x LEMO, ±10 V (E-711.IA4)
Digital in/out	MDR20; 2 x IN, 8 x OUT; TTL	MDR20; 2 x IN, 8 x OUT; TTL	MDR20; 2 x IN, 8 x OUT; TTL
Command set	PI General Command Set (GCS)	PI General Command Set (GCS)	PI General Command Set (GCS)
User software	NanoCapture™, PIMikroMove®	NanoCapture™, PIMikroMove®	NanoCapture™, PIMikroMove®
Software drivers	LabVIEW Drivers, DLLs	LabVIEW Drivers, DLLs	LabVIEW Drivers, DLLs
Supported functionality	Wave gen, trigger I/O	Wave gen, trigger I/O	Wave gen, trigger I/O
Display	LEDs for OnTarget, Err, Power	LEDs for OnTarget, Err, Power	LEDs for OnTarget, Err, Power
Linearization	4th order polynomials, DDL-Option (Dynamic Digital Linearization)	4th order polynomials, DDL-Option (Dynamic Digital Linearization)	4th order polynomials, DDL-Option (Dynamic Digital Linearization)
Miscellaneous			
Operating temperature range	5 to 50 °C	5 to 50 °C	5 to 50 °C
Overtemp protection	Max. 75°C, of the piezo voltage output	Max. 75°C, deactivation of the piezo voltage output	Max. 75°C, deactivation of the piezo voltage output
Mass	5.35 kg	5.78 kg	5.43 kg
Dimensions	9,5" chassis, 236 x 132 x 296 mm + handles (47 mm length)	9,5" chassis, 236 x 132 x 296 mm + handles (47 mm length)	9,5" chassis, 236 x 132 x 296 mm + handles (47 mm length)
Power consumption	100 W max.	100 W max.	100 W max.
Operating voltage	90 to 240 VAC, 50–60 Hz	90 to 240 VAC, 50–60 Hz	90 to 240 VAC, 50–60 Hz

E-712 Basic Modules

Powerful Processor, Fast Digital Interfaces and Cases



The basic configuration of an E-712 system always includes a chassis (picture) and a rack- or rather an interface module



E-712 module with fast standard interfaces USB, Ethernet and RS-232

- Digital Controller of the Newest Generation: 600MHz Processor; up to 50kHz Servo Update Rate
- Versions for Conventional Nanopositioning and NEXLINE® Piezo Linear Drives
- Real-Time Operating System for Excellent Trajectory Control
- Flexible Interfaces: Ethernet, USB, RS-232

The modular E-712 digital controller is the platform for the most demanding nanopositioning applications. The basic elements of the modular concept are the casing (E-712.R1 or E-712.R4) and the CPU (E-712.M1 or E-712.N1). Further components are available such as different amplifiers, signal conditioners and additional interfaces from the E-711 range.

How many axes would you like?

For special applications, up to 13 channels can be operated in a 19" chassis (482 mm). Conventional applications with up to 6 axes can be fitted into compact 9.5" (241 mm) casings. The casings are equipped with power supplies to suit the type of drive: The E-712.R1 is designed for conventional nanopositioning with low-voltage actuators with up to 6 axes. The E-712.R4 is designed for up to 3 NEXLINE® drives or PicoCube® AFM scanners.

Adjusting the stepping motion of a drive allows operating

modes from fast stepping or a constant speed mode to the purely analog shear operation. As an alternative to operating one individual drive, the same E-712 controller can also operate nanopositioning systems with three NEXLINE® drives in coordination.

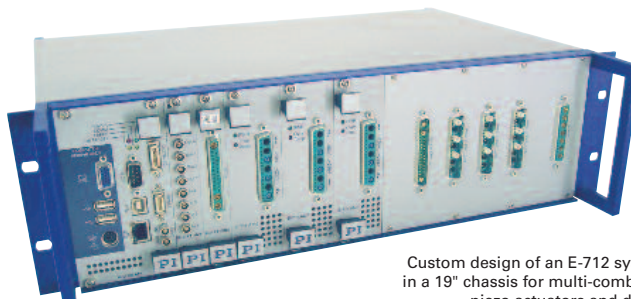
The Hard Core

The E-712 is PC based. Its computing power is designed for processing times by having a servo update rate of up to 50 kHz, for example. In addition, algorithms for linearization, control, to transform coordinates or store trajectory information are carried out in real

time. Even for dynamic applications, the position can thus be achieved with an accuracy of a few nanometers, for example. The varying requirements placed on the motions mean there is a different computer module for nanopositioning applications with conventional ceramic actuators and NEXLINE® Walk Drives.

Modern Interfaces

The computer module offers USB, RS-232 and a fast Ethernet interface as standard. The system can further be supplemented with an analog interface module or a very fast 32-bit PIO.



Custom design of an E-712 system in a 19" chassis for multi-combined piezo actuators and drives

Ordering Information

For conventional nanopositioning systems with PICMA® low voltage piezo actuating or for PicoCube™

E-712M1
Digital Computer and Interface Module E-712 with Ethernet Interface, USB, RS-232

E-712R1
Digital Modular Piezo Controller System, 3 to 6 Channels, 9.5" Chassis with P/S

E-712QSCN
DDL (Dynamic Digital Linearization) Firmware Upgrade

E-712U1
Advanced Piezo Control Option

E-712U2
Firmware Upgrade PicoPlane™: Option for Nanometer Precision (convenient hardware required)

E-712U3
Real-Time System Upgrade for Host PC

For NEXLINE® linear drives:

E-712N1
Digital NEXLINE® Processor and Interface Module E-712 with Ethernet Interface, USB, RS-232

E-712R4
Digital Modular Piezo Controller System, 3 to 6 Channels, 9.5" Chassis with Power Supply for ±250 V Piezo Voltage

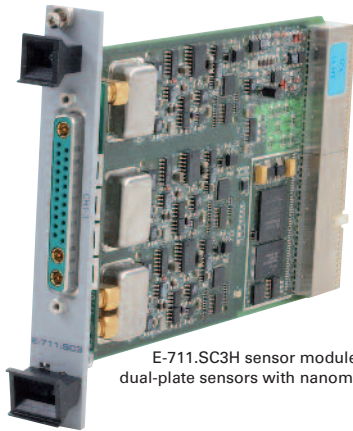
Ask about custom designs!

Technical Data

Model	E-712M1	E-712N1
Function	Digital NanoAutomation processor- and interface module with Ethernet Interface, USB Interface, RS-232	Digital NEXLINE® processor- and interface module with Ethernet Interface, USB Interface, RS-232
Processor	PC based, 600 MHz, real-time operating system	PC based, 600 MHz, real-time operating system
Sample rate control (max.)	50 kHz	50 kHz
Sample rate sensor (max.)	50 kHz	50 kHz
Sensor characteristics	P-I, two notch filters or advanced piezo control, optional	P-I, two notch filters
Temperature sensor	Yes	Yes
Interfaces and operation		
Communication interfaces	RS-232, USB, Ethernet (FTP, UDP, HTTP, TCP/IP)	RS-232, USB, Ethernet (FTP, UDP, HTTP, TCP/IP)
Digital Input	MDR 20, 2 x IN, TTL	MDR 20, 2 x IN, TTL
Digital Output	MDR 20, 8 x OUT, TTL	MDR 20,8 x OUT, TTL
Command set	PI General Command Set (GCS)	PI General Command Set (GCS)
User software	PI MikroMove™, NanoCapture™	PI MikroMove™, NanoCapture™
Software drivers	LabVIEW Driver, DLLs	LabVIEW Driver, DLLs
Supported functionality	Wave generator, data recorder, trigger I/O	data recorder, trigger I/O
Display	LEDs for OnTarget, Error, Power	LEDs for OnTarget, Error, Power
Linearization	4th order polynomials, DDL Option (Dynamic Digital Linearization)	4th order polynomials; linearization stepping drive
Miscellaneous		
Operating temperature range	5 to 50 °C	5 to 50 °C
Overtemp protection	max. 75 °C, deactivation of the piezo voltage output	max. 75 °C, deactivation of the piezo voltage output
Dimensions	12 TE 3 HE	12 TE 3HE
Mass	0.52 kg	0.52 kg
Operating voltage	90 to 240 VAC; 50–60 Hz	90 to 240 VAC; 50–60 Hz

E-712 Sensor Modules

High-Resolution and Solid for Capacitive and Incremental Sensors



E-711.SC3H sensor module for capacitive dual-plate sensors with nanometer resolution

- Flexible Choice of Sensor Analysis, depend on Positioning Mechanic
- For capacitive 2 or 1 Plate Sensors or incremental Sensors
- Resolution to the Sub-Nano Region
- Up to 6 Channels

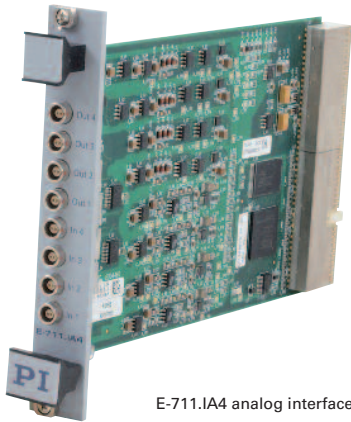
Ordering Information

- E-711.SC3H**
Module for Capacitive Sensors, 3 Channels, for E-712 modular, digital, Controller System
- E-711.OCT**
Digital Sensor Signal Transmission, 3 Channels, Capacitive Sensors, for E-712 Digital Controller
- E-711.SE3**
Module for PISeCa™ Capacitive Single-Electrode Sensors, 3 Channels, for E-712 modular, digital, Controller System
- E-711.SA3**
Module for incremental Sensors, 3 Channels, for E-712 modular, digital, Controller System
- E-711.SA6**
Module for incremental Sensors, 6 Channels, for E-712 modular, digital, Controller System
- Ask about custom designs!

Technical Data

Model	E-711.SC3H	E-711.OCT	E-711.SE3	E-711.SA3
Function	Modul for capacitive sensors	Module for capacitive sensors with sensor analysis (DST)	Module for capacitive PISeCa™ single-electrode sensors	Module for incremental sensors
Channels	3	3	3	3
Sensor type	capacitive	capacitive	Single-electrode, capacitive	incremental
Sensor bandwidth	10 kHz	10 kHz		
Sensor resolution	18-bit	18-bit	18-bit	16-bit
Sensor communication	Sub-D Special (multi-axis, capacitiv)	Sub-D Special (multi-axis, capacitiv), 10 m cable length between sensor analysis and controller	Sub-D Special (multi-axis, capacitiv)	Sub-D Special
Dimensions	4 TE 3 HE	4 TE 3 HE; Sensor analysis 198.5 x 102.9 x 38.3 mm	4 TE 3 HE	4 TE 3 HE
Mass	0.18 kg	Sensor analysis: 0.65 kg Interfacekarte: 0.15 kg	0.18 kg	0.15 kg

E-712 Analog Interface Module



E-711.IA4 analog interface module

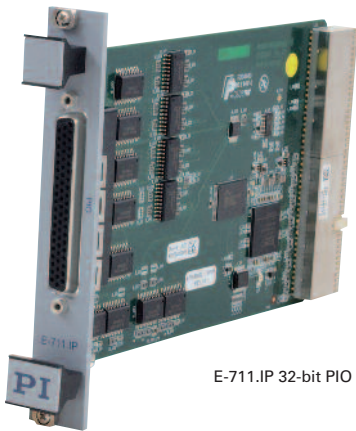
- 4 Analog Inputs
- 4 Analog Outputs
- 20-bit DA-Converter
- 18-bit AD-Converter
- Powerful FPGA
- Smallest Possible Latency
- Integrated Self-Testing

Technical Data

Model	E-711.IA4
Function	Analog Interface Module
Channels	4 In-, 4 Outputs
Resolution Input	18-bit
Resolution Output	16-bit, 20-bit effective
Analog Input	4 LEMO, $\pm 10V$
Analog Output	4 LEMO, $\pm 10V$
Dimensions	4 TE 3 HE
Mass	0.16 kg

E-712 Parallel-I/O Interface Modules

Fast, Digital Command in Real-Time



E-711.IP 32-bit PIO interface

- 32-bit Resolution
- Configured for up to 6 Axis
- 500 ns Read and 1200 ns Write
- Optional Real-Time System

Technical Data

Model	E-711.IP
Function	PIO Interface module
Resolution	32-bit
Communication interfaces	HD-Sub-D 62 connector
Speed of command	500 ns read / 1200 ns write
Supported functionality / software drivers	Optional Linux-based real-time system (E-712.U3)
Dimensions	4 TE 3 HE
Mass	0.15 kg

E-712 Amplifier Modules

High-Power and Low-Noise for Dynamic and Precision



E-711.AM4 amplifier module with $\pm 250 V$ output voltage for PicoCube™ and NEXLINE®

- Flexible Options for Nanopositioning, PicoCube™ and NEXLINE® Drives
- 4 Channels
- High-Voltage, 8 W per Channel
- Highest Stability, Low Noise
- 20-bit Effective
- Powerful FPGA

Technical Data

Model	E-711.AL4P
Function	High-Power amplifier module, 8 W, -30 bis +135 V
Channels	
Output Voltage min.	-30
Input Voltage max.	135
Peak output power per channel	25
Average output power per channel	8
Peak current per Channel	250
Average current per channel	100
Current limitation	Short-circuit-proof
Resolution DAC	20
Dimensions	8 TE 3 HE
Mass	0.48

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



USA (East) & CANADA

PI (Physik Instrumente) L.P.
16 Albert St.
Auburn, MA 01501
Tel: +1 (508) 832 3456
Fax: +1 (508) 832 0506
info@pi-usa.us
www.pi-usa.us

USA (West) & MEXICO

PI (Physik Instrumente) L.P.
5420 Trabuco Rd., Suite 100
Irvine, CA 92620
Tel: +1 (949) 679 9191
Fax: +1 (949) 679 9292
info@pi-usa.us
www.pi-usa.us

JAPAN

PI Japan Co., Ltd.
Akebono-cho 2-38-5
Tachikawa-shi
J-Tokyo 190
Tel: +81 (42) 526 7300
Fax: +81 (42) 526 7301
info@pi-japan.jp
www.pi-japan.jp

PI Japan Co., Ltd.
Hanahara Dai-ni Building, #703
4-11-27 Nishinakajima,
Yodogawa-ku, Osaka-shi
J-Osaka 532
Tel: +81 (6) 6304 5605
Fax: +81 (6) 6304 5606
info@pi-japan.jp
www.pi-japan.jp

CHINA

**Physik Instrumente
(PI Shanghai) Co., Ltd.**
Building No. 7-301
Longdong Avenue 3000
201203 Shanghai, China
Tel: +86 (21) 687 900 08
Fax: +86 (21) 687 900 98
info@pi-china.cn
www.pi-china.cn

UK & IRELAND

PI (Physik Instrumente) Ltd.
Trent House
University Way,
Cranfield Technology Park,
Cranfield,
Bedford MK43 0AN
Tel: +44 (1234) 756 360
Fax: +44 (1234) 756 369
uk@pi.ws
www.physikinstrumente.co.uk

FRANCE

PI France S.A.S
244 bis, avenue Max Dormoy
92120 Montrouge
Tel: +33 (1) 55 22 60 00
Fax: +33 (1) 41 48 56 62
info.france@pi.ws
www.pi-france.fr

ITALY

Physik Instrumente (PI) S.r.l.
Via G. Marconi, 28
I-20091 Bresso (MI)
Tel: +39 (02) 665 011 01
Fax: +39 (02) 873 859 16
info@pionline.it
www.pionline.it

GERMANY

**Physik Instrumente (PI)
GmbH & Co. KG**
Auf der Römerstr. 1
D-76228 Karlsruhe/Palmbach
Tel: +49 (721) 4846-0
Fax: +49 (721) 4846-100
info@pi.ws · www.pi.ws