Digital Piezo Nanopositioning Controllers

Digital Servo, Digital & Analog Interface Options

FAST

PRECISE

INDIVIDUAL

Single Axis Controllers with Digital Servo

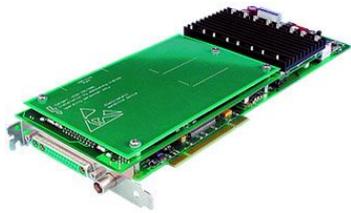E-609 low-cost digital controller board for OEMs

E-709 low-cost, high-performance digital piezo controller

E-753 ultra-high performance digital piezo controller

Multi-Axis Controllers with Digital Servo

E-761 Digital Piezo Controller Board, 3 Channels

E-725 High-Performance Digital Piezo Controller, 3 Channels

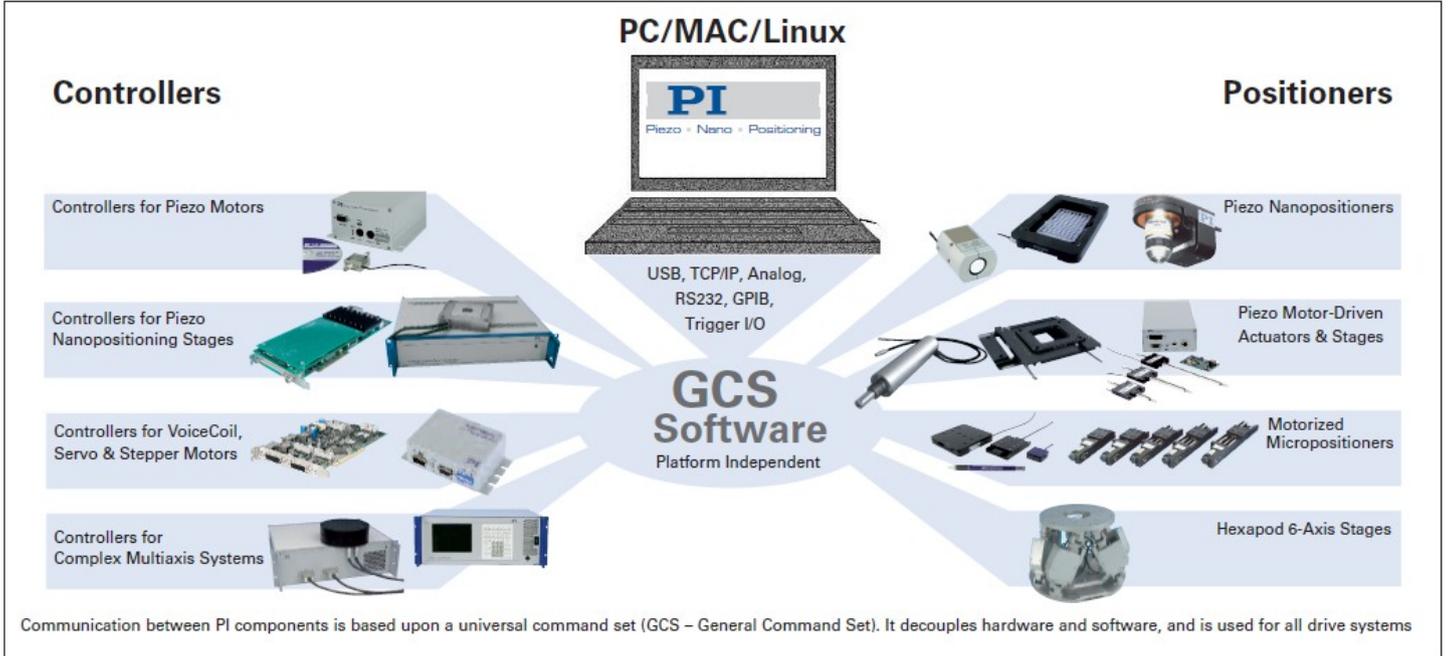E-712 Ultra-High Performance Modular Digital Piezo Controller, up to 6 Channels

E-710 Digital Piezo Controller. 3, 4 and 6 Axis Models

Software Tools

For LabView, C++, VB, Matlab, Image Acquisitiong Packages, NI DAC Cards, ...

PI provides high-level, robust, easy-to-use software tools for fast, seamless integration of motion systems into application control software

Communication between PI components is based upon a universal command set (GCS – General Command Set). It decouples hardware and software, and is used for all drive systems

The high quality of positioning systems is made apparent in daily operation by PI software. Starting with simple commissioning, through convenient operation with a graphical interface, to quick and simple integration in customized programs with high performance, PI software covers all aspects important to an application.

Universal Command Set Simplifies Commissioning and Programming

For uniform operation of nano and micropositioning systems, the universal PI General Command Set (GCS) is used. GCS operation is independent of the controller or drive principle used, so that several positioning systems can be controlled together, or new systems can be introduced with a minimum of programming effort. With GCS the development of custom application programs is simplified and less prone to errors, because the commands for all supported devices are identical in syntax and function. Through the use of the GCS command set with its convenient functions, the orientation phase and application development process is significantly accelerated. The GCS commands are available at the controller terminal, in macros and in the form of a universal driver set for LabVIEW (VIs), Windows dynamic link libraries (DLL) and Linux libraries. This facilitates the development of custom macros, as well as integration with programming languages like LabVIEW, C++ or MATLAB.
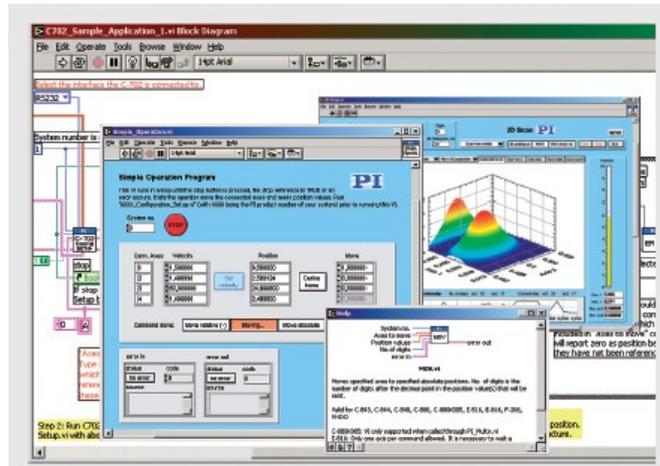
Easy integration in LabView. Quick access to the full functionality
Contact PI for our extensive library of software examples!

PI piezo stages & controllers are compatible with all major image acquisition software packages such as, Metamorph™, µManager™, Slidebook™, Simple PCI™, NIS Elements™, ImagePro™.

For more information on PI software support, go online or request the PI software brochure

Software and manuals can be downloaded, from the PI Support server

Software Updates Online

PI supports users with free updates, detailed online help and well structured manuals which ease initiation of the inexperienced but still answer the detailed questions of the professional.

Supported Operating Systems

Microsoft Windows Vista

Microsoft Windows XP

Microsoft Windows 2000

Linux

E-709 Compact, Low-Cost Digital Controllers for Cap & SGS
Increased Performance now Also availbable for Piezo Systems with Strain Sensors

Compact, low-cost E-709 digital controller (preliminary case design) with P-712 piezo-scanner

- ■ **Choice: Cap Sensors: Higher Performance; PRS: Lower Cost**
- ■ **Fast Digital Controller, Software Configurable Servo Parameters**
- ■ **Linearity of SGS and Piezoresistive Sensors Improved by up to 0.02 %**
- ■ **USB and RS-232 Interfaces**
- ■ **Fast 25 Mbit/s Serial Interface**
- ■ **Comprehensive I/O Functions**
- ■ **Additional High-Bandwidth Analog Control Input / Sensor Input**
- ■ **Analog Output, e. g. for External Amplifiers**
- ■ **Low-Cost OEM Versions Available**
- ■ **Comprehensive Software Package**

The E-709 opens up the possibilities of digital control for piezo-driven nanopositioning systems for the same price as analog controllers. It is available for capacitive sensors and nanopositioning stages which are equipped with cost effective measuring systems such as strain gauges or piezoresistive sensors. The advantage: higher precision, more control options and very simple operation. In addition, PI provides the full functionality of its comprehensive software packages free of charge! The E-709 can also be used for applications providing analog control signals. In addition to a variety of digital interfaces an analog input and output are also included. A software command allows the analog input to be interpreted as position control signal or as a sensor value. The analog output can be configured for the control of external amplifiers or for the output of position values.

Digital Linearization Now also for Strain Sensors: 10X More Precise!
For the first time, the E-709 nanopositioning controller opens up the advantages of digital control to compact systems with strain sensors. These sensors are based on the strain of metal foils or semiconductor films (piezoresistive sensors) and are used when space limitations prevent the use of the more advanced capacitive sensors, or where the requirements in terms of resolution or temperature stability are not as critical.
The limited linearity of these strain sensors can be improved by digital controllers, which use additional linearization algorithms to minimize the deviation between target and actual position. This improves the accuracy by up to one order of magnitude and achieves linearity values of up to 0.02 %.

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 immediately 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 potentiometers no longer have to be set manually, system integration becomes much more straight forward.

OEM Versions at an Even Lower Price

E-709 controllers are also offered without case. A lower cost version sold as the E-609 is available for purely analog control signals, maintaining the advantages of digital signal processing and parameter setting.

The target position is controlled via an analog signal, allowing system components with analog output (e.g. autofocus) to be integrated easily.

E-709 low-cost digital controller for capacitive sensros

Ordering Information

Cap/ Digital & Analog Input

E-709.CR
Digital Piezo Controller, 1 Channel, OEM Module, -30 to 130 V, Capacitive Sensor

E-709.CRG
Digital Piezo Controller, 1 Channel, -30 to 130 V, Capacitive Sensor, Bench-Top

Accessories:

E-709.01
Adapter HD-Sub-D 26-pin to Sub-D 9-pin with I/O Lines, 0.5 m

E-709.02
Adapter Cable HD-Sub-D 26-pin to Open Leads, 1 m

Strain/ Digital & Analog Input

E-709.PRG
Digital Piezo Controller, 1 Channel, -30 to 130 V, Piezoresistive Sensors, Bench-Top

E-709.SRG
Digital Piezo Controller, 1 Channel, -30 to 130 V, SGS-Sensor, Bench-Top

E-709.PR
Digital Piezo Controller, 1 Channel, OEM Module, -30 to 130 V, Piezoresistive Sensors

E-709.SR
Digital Piezo Controller, 1 Channel, OEM Module, -30 to 130 V, SGS-Sensor
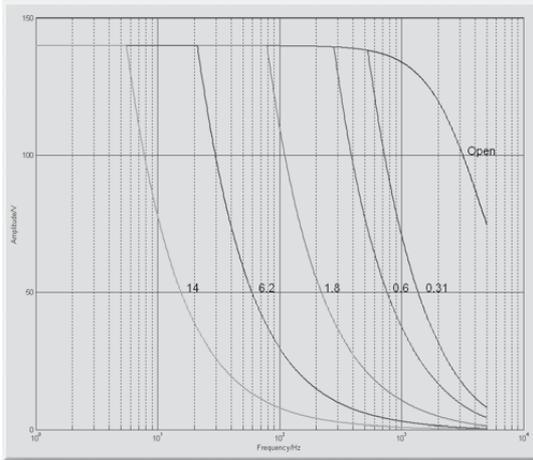
OEM Analog Input Only

E-609.C0
Piezo Driver with Digital Servo, Analog Control Input, 1 Channel, OEM Module, -30 to 130 V, Capacitive Sensor

E-609.P0
Piezo Driver with Digital Servo, Analog Control Input, 1 Channel, OEM Module, -30 to 130 V, Piezoresistive Sensor

E-609.S0
Piezo Driver with Digital Servo, Analog Control Input, 1 Channel, OEM Module, -30 to 130 V, SGS-Sensor

OEM Version Board

E-709: operating limits with various PZT loads (open-loop), capacitance is measured in µF

Comparison of the linearity of a strain gauge sensor with analog controller (top) and the E-709 digital controller (bottom), which improves the linearity by up to one order of magnitude

Technical Data

| Model	E-709.SR E-709.SRG E-709.PR E-709.PRG	E-709.CR / E-709.CRG
Function	Digital controller for single-axis piezo nanopositioning systems (.SR, .PR: OEM board)	Digital controller for single-axis piezo nanopositioning systems (.CR: OEM board)
Channels	1	1
Processor	DSP 32-bit floating point, 150 MHz	DSP 32-bit floating point, 150 MHz
Servo characteristics	P-I, two notch filters, sensor linearization	P-I, 2 notch filter, sensor linearization
Sampling rate, servo control	10 kHz	10 kHz
Sampling rate, sensor	10 kHz	10 kHz
Sensor		
Sensor type	Metal foil strain gauge sensors (.SR, .SRG), Piezoresistive sensors (.PR, .PRG)	Capacitive sensors
Linearization	5th order polynomials	5th order polynomials
Sensor bandwidth	5 kHz	5 kHz
Sensor resolution	16 bit	16 bit
Ext. synchronization	No	No
Amplifier		
Output voltage	-30 V to +130 V	-30 V to +130 V
Peak output power	10 W (<5 ms)	10 W (< 5 ms)
Average output power	5 W (>5 ms)	5 W (> 5 ms)
Peak current	100 mA (<5 ms)	100 mA (< 5 ms)
Average current	50 mA (>5 ms)	50 mA (> 5 ms)
Current limitation	Short-circuit-proof	Short-circuit-proof
Resolution DAC	17 bit	17 bit
Interfaces and operation		
Communication interfaces	USB, RS-232, SPI	USB, RS-232, SPI
Piezo / sensor connector	Sub-D 9-pin	Sub-D-Special connector
I/O connector	HD-Sub-D 26-pin, 1 analog control input 0 to 10 V, 1 sensor monitor 0 to 10 V, 1 digital input (LVTTL, programmable), 1 analog output, 5 digital outputs (LVTTL, 3 predefined, 2 programmable)	HD-Sub-D 26-pin, 1 analog input 0 to 10 V, 1 sensor monitor 0 to 10 V, 1 digital input (LVTTL, programmable), 1 analog output, 5 digital outputs (LVTTL, 3 predefined, 2 programmable)
Command set	PI General Command Set (GCS)	PI General Command Set (GCS)
User software	PIMikroMove, NanoCapture	PIMikroMove, NanoCapture
Software drivers	LabVIEW drivers, DLLs	LabVIEW drivers, DLLs
Supported functionality	Wave generator, data recorder, auto zero, trigger I/O	Wave generator, data recorder, auto zero, trigger I/O
Display	Status LED, overflow LED	Status LED, overflow LED
Miscellaneous		
Operating temperature range	8 to 50 °C (over 40 °C, max. power av. power derated)	12 to 50 °C (over 40 °C, max. av. power derated)
Dimensions	160 x 96 x 33 mm	160 x 96 x 33 mm
Mass	260 g (.SR / .PR), 470 g (.SRG / .PRG)	260 g / 470 g
Operating voltage	24 VDC	24 VDC
Power consumption	24 W max.	24 W
		Target ground connector - / yes
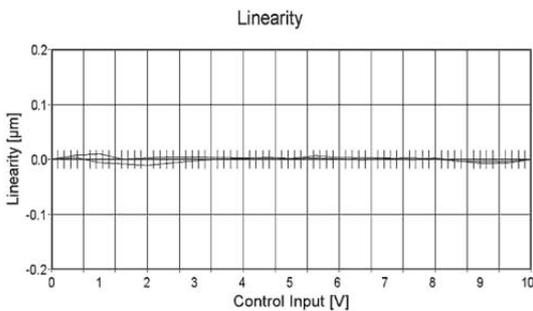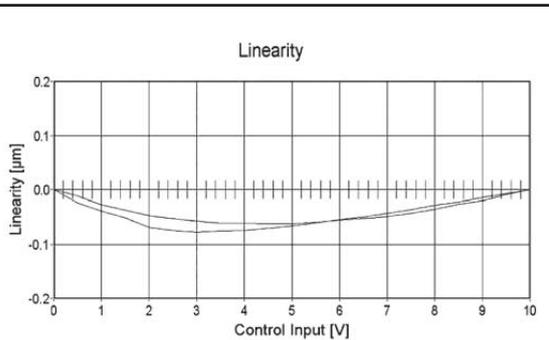
E-753 Ultra-High Performance Digital Piezo Controller, 1 Axis

High-Speed, Single-Axis Controller

E-753 Single-channel digital controller together with the PIHera® P-629.1CD nanopositioning stage with 1500 µm travel

- **Next Generation Digital Controller Provides Higher Flexibility, Accuracy and Speed**
- **100 kHz Sensor Sampling; 32-bit Floating Point DSP; 24-bit Low-Noise D/A Converters**
- **Ethernet (TCP/IP) Interface for Remote Control Capability, RS-232**
- **Auto-Loading of Calibration Data from Stage ID-Chip for Interchangeability of Controller and Mechanics**
- **Additional High-Bandwidth Analog Control Input / Sensor Input**
- **Digital I/O Lines for Task Triggering**
- **Extensive Software Support**
- **For Nanopositioning Systems with Capacitive Sensors**

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.

Higher Velocity and Bandwidth for Dynamic Applications

The controller is perfectly suited for high-dynamics operation thanks to its high-resolution DA-converter and high-performance voltage amplifier. The high-speed processor with a sensor sampling rate of 100 kHz assures settling times in the millisecond range and below.

Flexibility for a Variety of Applications

PI nanopositioning systems which are equipped with an ID-chip and calibrated with a digital controller have the mechanics-related calibration and servo-control parameters stored in the chip. The controller automatically adapts to the connected mechanics by the appropriate use of this data, so that recalibration is not necessary when system components are replaced.

The integrated wave generator can save and output periodic motion profiles. In addition to sine and triangle waves, arbitrary, user-defined profiles can be created.

Simple System Integration

All parameters can be checked and reset via software. System setup and configuration is done with the included Nano Capture™ 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.

The E-753 next-generation digital piezo controller is the result of PI's 30+ years of experience with piezo motion control systems. It is ideal when it comes to meeting the most demanding accuracy and dynamic-performance requirements of nanopositioning systems of the highest precision class. The E-753 replaces the E-750 controller.

Digital Linearization and Control Algorithms for Highest Accuracy

Linearization algorithms based on higher-order polynomials improve the positioning accuracy to 0.001 % of the travel range. During fast periodic motion, as typical for scanning applications, the tracking accuracy can be further improved with

P-725 PIFOC® objective Z-positioner and E-753 controller constitute an optimal system for high-speed, high-resolution positioning and scanning.

Technical Data

Model	E-753.1CD
Function	Digital controller for single-axis piezo nanopositioning systems with capacitive sensors
Axes	1
Processor	DSP 32-bit floating point, 60 MHz
Sampling rate, servo-control	25 kHz
Sampling rate, sensor	100 kHz
Sensor	
Servo characteristics	P-I, two notch filters
Sensor type	Capacitive
Sensor channels	1
Sensor bandwidth	5.6 kHz
Sensor resolution	17-bit
Ext. synchronization	Yes
Amplifier	
Output voltage	-30 V to 135 V
Amplifier channels	1
Peak output power <5 ms	15 W
Average output power >5 ms	5 W
Peak current <5 ms	110 mA
Average current >5 ms	40 mA
Current limitation	Short-circuit-proof
Resolution DAC	24-bit
Interfaces and operation	
Communication interfaces	Ethernet, RS-232
Piezo connector	Sub-D special connector
Sensor connection	Sub-D special connector
Analog input	LEMO, ±10 V, 18 bit
Digital input	2 x LEMO, TTL
Digital output	2 x LEMO, TTL
Command set	GCS
User software	NanoCapture™, PIMikroMove™
Software drivers	LabVIEW drivers, DLLs
Supported functionality	Wave generator, trigger I/O, data recorder
Display	Status LEDs
Linearization	4th order polynomials, DDL (optional)
Separate protective ground connector	Yes
Miscellaneous	
Operating temperature range	5 to 50 °C
Overtemp protection	Deactivation of the piezo voltage output at 85 °C
Mass	0.9 kg (controller)
Dimensions	Controller: 264 x 125 x 48 mm (with rubber feet) Power supply: 174 x 95 x 58 mm (with rubber feet)
Power consumption	10 W max.
Operating Voltage	24 VDC from external power supply (included)
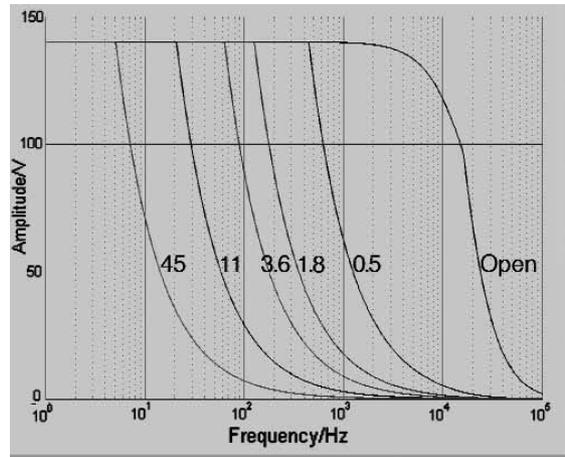
E-753 open-loop operating limits with various PZT loads. Graphs reflect the large signal-current limitation of the amplifier circuit, not the actual bandwidth.

E-725 High-Performance 3-Channel Digital Piezo Controller

For 3-Axis High-Speed Precision Positioning Systems

E-725 Digital 3-channel controller
with P-528 Z/tip/tilt
nanopositioning system

- **For Nanopositioning Systems with Capacitive Sensors**
- **3-Channel Version**
- **Powerful Digital Controller: DSP 32-bit Floating Point, 225 MHz; 20 kHz Sampling Rate; 24-bit DAC**
- **Communication via Ethernet, USB, RS-232**
- **4th Order Polynomial Linearization for Mechanics & Electronics**
- **Dynamic Digital Linearization (DDL) Option for Improved Path Accuracy**
- **Auto-Loading of Calibration Data from Stage ID-Chip for Interchangeability of Controller and Mechanics**
- **Additional High-Bandwidth Analog Control Input / Sensor Input**
- **Optional High-Speed Parallel I/O Interface**
- **Flexible Wave Generators**
- **Digital I/O Lines for Task Triggering**
- **Extensive Software Support**

The E-725 digital piezo controller is a compact, high-performance drive electronics for nanopositioning systems with up to three axes. High-power amplifiers permit dynamic scans even for piezo systems with large range or direct drive. State-of-the-art processor technology optimizes the operating parameters for improved linearity and tracking accuracy. High-resolution D/A converters provide for nanopositioning that deserves this name.

With the E-725.3CM, PI for the first time offers a digital controller for the P-363 PicoCube™ (see p. 2-66), a fast precision scanner for atomic force microscopy.

Optional interfaces and analog in- and outputs make it possible to process external sensor or control values.

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.

This control algorithm 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.

Extensive Software Support

The controllers are delivered with Windows operating software. Comprehensive DLLs and LabVIEW drivers are available for automated control.

Automatic Configuration

PI digital piezo controllers and nanopositioning stages with ID-Chip can be operated in any combination, supported by the AutoCalibration function of the controller. Individual stage data and optimized servo-control parameters are stored in the ID-Chip and are read out automatically by the digital controllers.

Technical Data

Model	E-725.3CD	E-725.3CM	Tolerance
Function	Digital Controller for Multi-Axis Piezo Nanopositioning Systems with Capacitive Sensors	Digital Controller for Multi-Axis Piezo Nanopositioning Systems with Capacitive Sensors	
Axes	3	3	
Processor	DSP 32-bit floating point, 225 MHz	DSP 32-bit floating point, 225 MHz	
Sampling rate, servo-control	20 kHz	20 kHz	
Sampling rate, sensor	20 kHz	20 kHz	
Sensor			
Servo characteristics	P-I, two notch filters	P-I, two notch filters	
Sensor type	Capacitive	Capacitive	
Sensor channels	3	3	
Sensor bandwidth (-3 dB)	5.6 kHz	5.6 kHz	max.
Sensor resolution	18 bit	18 bit	
Ext. synchronization	Yes	Yes	
Amplifier			
Output voltage	-30 to 135 V	-250 to 250 V	±3 V
Amplifier channels	4	4	
Peak output power per channel	25 W	47 W	max.
Average output power per channel*	10 W	10 W	max.
Peak output current per channel	190 mA	190 mA	max.
Average output current per channel*	120 mA	60 mA	max.
Current limitation	Short-circuit proof	Short-circuit proof	
Resolution DAC	24 bit	24 bit	
Interfaces and operation			
Communication interfaces	Ethernet, USB, RS-232	Ethernet, USB, RS-232	
Piezo / sensor connector	Sub-D special connector	Sub-D special connector	
Analog input	1 x Lemo, ±10 V, 18 bit	1 x Lemo, ±10 V, 18 bit	
Digital input / output	MDR20; 2 x IN, 8 x OUT	MDR20; 2 x IN, 8 x OUT	
Command set	PI General Command Set (GCS)	PI General Command Set (GCS)	
User software	NanoCapture™, PIMikroMove™	NanoCapture™, PIMikroMove™	
Software drivers	LabVIEW driver, DLLs	LabVIEW driver, DLLs	
Supported functionality	Wave-Gen, Trigger I/O	Wave-Gen, Trigger I/O	
Display	LEDs for Power, On Target, Error, Cmd	LEDs for Power, On Target, Error, Cmd	
Linearization	4th order polynomial, DDL (Dynamic Digital Linearization)	4th order polynomial, DDL (Dynamic Digital Linearization)	
Separate protective ground connector	Yes	Yes	
Miscellaneous			
Operating temperature range	5 to 50 °C	5 to 50 °C	
Overheat protection	Max. 71 °C, deactivation of the piezo voltage output	Max. 71 °C, deactivation of the piezo voltage output	
Mass	3.5 kg	3.6 kg	
Dimensions	263 x 89 x 302 mm (with handles)	263 x 89 x 302 mm (with handles)	
Power consumption	70 W	70 W	max.
Operating voltage	24 VDC from external power supply (included)	24 VDC from external power supply (included)	

* The total output power of all 4 amplifier channels should not exceed 34.5 W to avoid overcurrent (E-725 is equipped with a 3. 15 AM fuse).

E-761 Digital Piezo Nanopositioning Controller Card, 3 Channels

Cost-Efficient PCI Board for Piezo Stages with up to 3 Axes

E-761 Digital Piezo Controller in PCI-Board Format

- ■ **For Piezo Stages with Capacitive Sensors**
- ■ **High-Speed PCI Interface**
- ■ **3 Logical Axes, 4 Piezo Amplifiers**
- ■ **Additional High-Bandwidth Analog Interface**
- ■ **32-Bit Digital Filters**
- ■ **Notch Filter for Higher Bandwidth**
- ■ **24-Bit Ultra-Low-Noise DAC Converters**
- ■ **Auto-Loading of Calibration Data from Stage ID-Chip for Interchangeability of Controller and Mechanics**
- ■ **Coordinate Transformation for Parallel-Kinematics / Parallel-Metrology Systems**
- ■ **Extensive Software Support**

E-761 digital piezo controllers offer advanced control technology in a cost-effective PCI-board format. They were designed to run piezo stages with up to three logical axes. The E-761 incorporates four instrumentation-class, 24-bit digital-analog converters (DAC) behind ultra-low-noise power amplifiers, and is based on a specialized 32-bit digital signal processor (DSP) with proprietary firmware.

Having PCI-board format, the E-761 digital controller can be easily installed in any commercial or industrial PC, allowing for easy integration with other devices such as frame grabbers. The PCI interface with its high bandwidth makes possible a very fast communication between software and

controller. This is a definite plus in time-critical applications or when controlling several axes.

Additionally, the E-761.3CT version offers three digital output lines for a variety of triggering tasks.

Improved Trajectory Accuracy Through Parallel Metrology

Digital controllers have a number of advantages over conventional analog piezo controllers. Sensor and actuator axes need not be parallel to each other, or to the ortho-gonal logical axes used to command the system. The flexible coordinate transformation algorithm permits operation of complex, multi-axis, parallel metrology stages (e. g. 3-axis Z-tip-tilt-stages).

With parallel motion metrology, the controller compensates the undesired off-axis motion of each actuator automatically using the others (active trajectory control). High-end nanopositioning systems with active trajectory control can attain motion accuracies in the sub-nanometer range.

Digital Linearization and Control Algorithms for Highest Accuracy

Linearization algorithms based on higher-order polynomials improve the positioning accuracy to 0.001 % of the travel range.

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.

The integrated wave generator can save and output periodic motion profiles. In addition to sine and triangle waves, arbitrary, user-defined profiles can be created.

Automatic Configuration

PI digital piezo controllers and nanopositioning stages with ID-chips can be operated in any combination, supported by the controller's AutoCalibration function. Individual stage data and optimized servo-control parameters are stored in the ID-Chips and are read out automatically by the digital controller.

Simple System Integration

All parameters can be set and checked by software. System setup and configuration is done with the included

NanoCapture™ and PZTControl™ user-interface software. Interfacing to custom software is facilitated with included LabVIEW drivers and DLLs. All PI controllers use the same command set, a significant advantage during application software development, system upgrade or when operating a variety of different controllers from one application.

Technical Data

Model	E-761.3CD	E-761.3CT
Function	Digital piezo controller and power amplifier, PCI board	Digital piezo controller and power amplifier, PCI board, trigger output
Axes	3	3
Processor	32-bit, floating-point DSP	32-bit, floating-point DSP
Sampling rate, servo-control	40 µs / 25 kHz (sensor-oversampling factor 4)	40 µs / 25 kHz (sensor-oversampling factor 4)
Sensor		
Servo characteristics	P-I, two notch filters	P-I, two notch filters
Sensor type	Capacitive	Capacitive
Sensor channels	3	3
Sensor resolution	16-bit	16-bit
Ext. synchronization	Yes	Yes
Amplifier		
Output voltage	-20 to 120 V	-20 to 120 V
Amplifier channels	4	4
Peak output power per channel,	5.3 W	5.3 W
Average output power per channel	1.7 W	1.7 W
Peak current per channel, <20 ms	50 mA	50 mA
Average current per channel, >20 ms	10 mA	10 mA
Current limitation	Short-circuit-proof	Short-circuit-proof
Resolution DAC	24-bit	24-bit
Interfaces and operation		
Interface / communication	PCI connector	PCI connector
Piezo / sensor connector	Sub-D special	Sub-D special
Control Input sockets	LEMO	LEMO
Digital output	-	3 x TTL
Command set	GCS	GCS
User software	NanoCapture™, PZTControl™	NanoCapture™, PZTControl™
Software drivers	LabVIEW drivers, Windows and Linux Libraries (DLL)	LabVIEW drivers, Windows and Linux Libraries (DLL)
Supported functionality	Wave generator	Wave generator, trigger output
Display	Status LED for piezo voltage	Status LED for piezo voltage
Linearization	4th order polynomial	4th order polynomial
Miscellaneous		
Operating temperature range	+5 to +50 °C (derated 10 % over 40 °C)	+5 to +50 °C (derated 10 % over 40 °C)
Overtemp protection	Deactivation at 60 °C	Deactivation at 60 °C
Dimensions	287 x 108 x 25 mm (2 slots)	287 x 108 x 25 mm + 122 x 45x 26 mm (3 slots)
Mass	0.56 kg	0.56 (PCI-board only)
Operating voltage	5 V	5 V
Power consumption	20 W, 4 A max.	20 W, 4 A max.
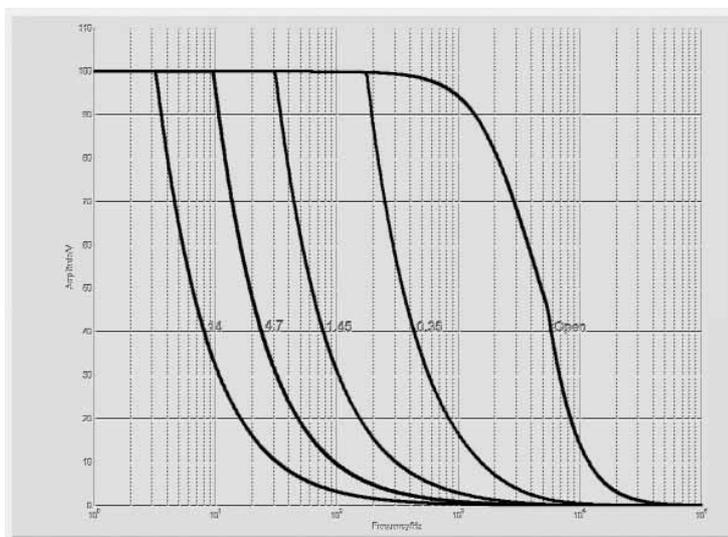
E-761: operating limits with various PZT loads (open-loop), capacitance is measured in µF

E-710 Digital Piezo Nanopositioning Controller, Many Options

3 to 6 axes, extremely versatile

E-710.6CD 6-axis Digital Piezo Controller top model of the E-710 family , shown with custom Super-Invar 6-DOF piezo flexure nanopositioning stage

- **For Nanopositioning Systems with Capacitive Feedback**
- **All Control Parameters Software-Settable**
- **3-, 4- & 6-Channel Versions**
- **Firmware Linearization: Dynamic Digital Linearization (DDL) Option Improves Scanning Linearity**
- **Coordinate Transformation for Parallel-Kinematics / Parallel-Metrology Systems**
- **Auto-Loading of Calibration Data from Stage ID-Chip for Interchangeability of Controller and Mechanics**
- **Interface Options: High-Speed Parallel I/O Interface and Analog Inputs**
- **Notchfilter for Higher Bandwidth**
- **Extensive Software Support**
- **Option: Digital Sensor-Signal Transmission over 15 m and More**

E-710 digital piezo controllers offer sophisticated functionality in a variety of configurations. Based on powerful 32-bit DSPs (digital signal processor) they include integrated, low-noise power amplifiers for piezo actuators and excitation/read-out electronics for extremely high-resolution capacitive position sensors. E-710s provide up to 8 piezo driver channels, 7 sensor channels and the processing power for coordinated control of up to 6 logical axes, e. g. for parallel kinematics systems.

Digital Linearization and Control Algorithms for Highest Accuracy

Linearization algorithms based on higher -order polynomials improve the positioning accuracy to 0.001 % of the travel range. The high-speed processor with a sensor sampling rate of 25 kHz, assures settling times in the millisecond range and below. The controller is perfectly suited for high-dynamics operation, thanks to its high-resolution DA-converters and high-performance voltage amplifiers.

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 Dy - namic Digital Linearization (DDL, E-710.SCN). This optionally available control algorithm reduces the tracking error by a factor of up to 1000.
This control algorithm enables the spatial and temporal tracking during a dynamic scan. The integrated wave generator can save and output periodic motion profiles. In addition to sine and triangle waves, arbitrary, user-defined profiles can be created. The flexibly configurable data recorder enables simultaneous recording and read-out of the corresponding data.

Sensor-Signal Transmission up to 15 m

A remote sensor interface box is available for applications where the distance between the me - chanics and electronics is greater than 10 m. This DST option (digital sensor -signal transmission), includes a compatible E-710 controller . It is designed to reduce the interference that begins to degrade performance when the analog sensor excitation and readout signal paths exceed 10 m. The connection between the sensor box and the controller can be up to 15 m (longer distances on request), as the digital signals it carries are far more robust.

Simple System Integration

All parameters can be checked and reset via software. System setup and configuration is done with the included NanoCap - ture™ and PIMikroMove™ user-interface software. Interfacing to custom software is facilitated with included LabVIEW drivers and DLLs. System program-

ming is the same with all PI controllers, so controlling a system with a variety of different controllers is possible without difficulty.

PI

Ordering Information / Interface Options

Channels	Connector (piezomechanics)	Base Model	Parallel I/O Interface	Analog Input*	Analog Input* + Parallel I/O Interface	DST** + Analog Input*
3	1 x Special Sub-D, 3 ch.	E-710.3CD	E-710.P3D	E-710.A3D	E-710.APD	incl. Parallel I/O Interface E-710.APS
4	4 x LEMO	E-710.4CL	E-710.P4L	–	–	–
	4 x Special Sub-D, 1 ch.	E-710.4CD	E-710.P4D	–	–	–
	1 x Special Sub-D, 3 ch. + 1 x Special Sub-D, 1 ch.	E-710.C4D	E-710.4PD	–	–	–
6	2 x Special Sub-D, 3 ch.	E-710.6CD	–	Standard	–	Analog input on DST box E-710.6SD

*LEMO connector
**Digital Signal Transmission

The digital sensor-signal transmission (DST) allows a distance
up to 15 m between positioning unit and controller

Technical Data

Model	E-710.3CD / E-710.P3D / E-710.A3D E-710.APD / E-710.APS	E-710.4CD / E-710.4CL / E-710.C4D E-710.4PD / E-710.P4D / E-710.P4L	E-710.6CD / E-710.6SD
Function	Digital piezo controller for multi-axis nanopositioning systems with capacitive sensors	Digital piezo controller for multi-axis nanopositioning systems with capacitive sensors	Digital piezo controller for multi-axis nanopositioning systems with capacitive sensors
Axes	3	4	6
Processor	32-bit, floating-point DSP	32-bit, floating-point DSP	2 x 32-bit, floating-point DSP
Sampling rate, servo-control	200 µs / 5 kHz	200 µs / 5 kHz	200 µs / 5 kHz
Sampling rate, sensor	50 µs / 20 kHz	50 µs / 20 kHz	40 µs / 25 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	4	6
Sensor resolution	16 bit	16 bit	16 bit
Ext. synchronization	Yes	Yes	Yes
Amplifier			
Output voltage	-20 to 110 V	-20 to 110 V	-20 to 110 V
Amplifier channels	4	4	8
Peak output power per channel,	25 W	25 W	25 W
Average output power per channel	6 W	6 W	6 W
Peak current per channel, <20 ms	200 mA	200 mA	200 mA
Average current per channel, >20 ms	60 mA	60 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 see separate table			
Communication interfaces	RS-232; IEEE 488 Parallel I/O (E-710.Pxx / .xPx only)	RS-232; IEEE 488 Parallel I/O (E-710.Pxx / .xPx only)	RS-232; IEEE 488
Command set	GCS	GCS	GCS
User software	PIMikroMove™, PZTControl™, NanoCapture™	PIMikroMove™, PZTControl™, NanoCapture™	PIMikroMove™, PZTControl™, NanoCapture™
Software drivers	LabVIEW drivers, DLLs	LabVIEW drivers, DLLs	LabVIEW drivers, DLLs
Supported functionality	Wave generator, data recorder	Wave generator, data recorder	Wave generator, data recorder
Display	Power LED	Power LED	Power LED
Linearization	4th order polynomials, DDL (optional)	4th order polynomials, DDL (optional)	4th order polynomials, DDL
Miscellaneous			
Operating temperature range	5 to 50 °C	5 to 50 °C	5 to 50 °C
Dimensions	450 x 88 x 343 mm + handles	450 x 88 x 343 mm + handles	450 x 88 x 343 mm + handles
Mass	7 kg	7 kg	7 kg
Operating voltage	90–120 or 220–264 VAC, 50–60 Hz	90–120 or 220–264 VAC, 50–60 Hz	90–120 or 220–264 VAC, 50–60 Hz
Max. power consumption	60 W	60 W	120 W

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 confection 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: 600 MHz Tact Rate; up to 50 kHz 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
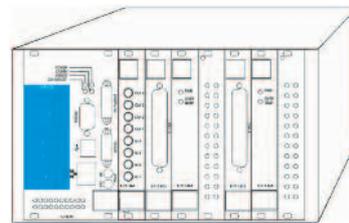
	Preconfigured system	Digital controller unit	Case unit	Interface modul	Sensor modul	Amplifier modul	Sensor modul	Amplifier modul
Nanopositioning systems with voltage requirement of up to +120 V with 3 axes and capacitive sensors	E-712.3CD	E-712.M1*	E-712.R1*	–	E-711.SC3H*	E-711.AL4P*	–	-
Nanopositioning 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-711.0CT	E-711.AL4P	(E-711.0CT)	(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) 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 nanopositioning systems with capacitive sensors	Modular digital controller for multi-axis piezo nanopositioning systems with capacitive sensors	Modular digital controller for PicoCube® nanopositioning 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
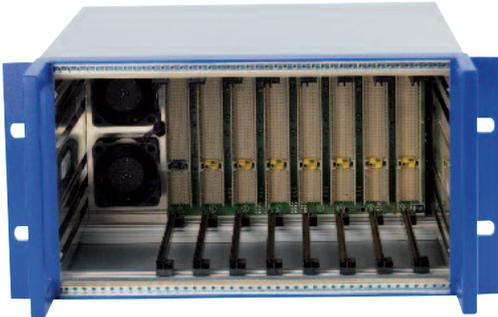
The basic configuration of an E-712 system always includes a chassis (picture) and a rack- or rather an interface module

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

- **Digital Controller of the Newest Generation:**
  600 MHz Processor; up to 50 kHz 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 Pico-Cube® 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-712.M1
Digital Computer and Interface Module E-712 with Ethernet Interface, USB, RS-232

E-712.R1
Digital Modular Piezo Controller System, 3 to 6 Channels, 9,5" Chassis with P/S

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

E-712.U1
Advanced Piezo Control Option

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

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

For NEXLINE® linear drives:

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

E-712.R4
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-712.M1	E-712.N1
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

- ■ **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**

E-711.SC3H sensor module for capacitive dual-plate sensors with nanometer resolution
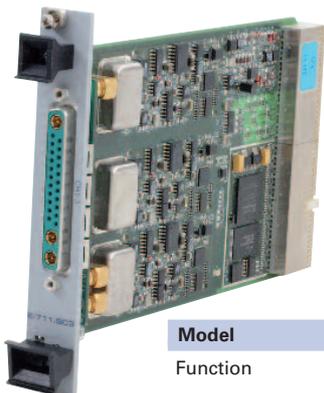
Model	E-711.SC3H	E-711.0CT	E-711.SE3	E-711.SA3
Function	Modul for capacitive sensors	Module for capacitive sensors with sensor analysis (DST)	Module for capacitive PISeca™ single-electrode sensors	Module for incremental sensors
Channels	3	3	3	3
Sensor type	capacitive	capacitive	Single-electrode, capacitive	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
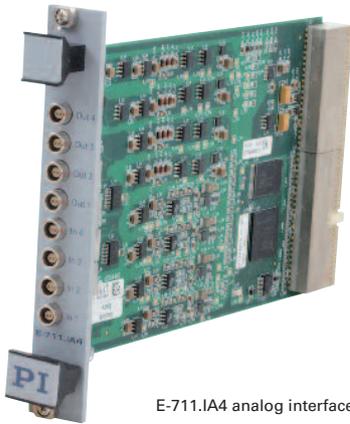
E-711.IA4 analog interface module

- **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, ±10V
Analog Output	4 LEMO, ±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 ±250 V output voltage forPicoCube™ and NEXLINE®

- **Flexible Opions 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

PI

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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