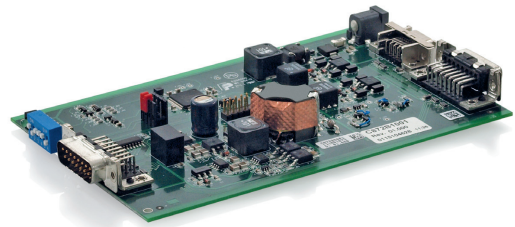


Piezo-Motor Controllers: PiezoWalk and Ultrasonic



E-862 NEXACT® PiezoWalk® Piezo Motor Controller, OEM

Low-Cost Drive Electronics for NEXACT® Piezo Stepping Drives



Cost-effective E-862 OEM drive electronics

- For NEXACT® PiezoWalk® Drives & Stages
- Combined Step Generator and Power Amplifier
- Cost-Effective Design
- Interface for Automation, Joystick for Manual Operation

The E-862 drive electronics is designed to put open-loop NEXACT® linear drives and stages into operation. E-862 supports the nanostepping mode of NEXACT® piezo stepping drives, which is ideal to cover a certain distance in the fastest possible way. The final position is stable without further current consumption.

Simple Control – High Resolution

The driver uses a ± 10 V signal that controls the velocity of the NEXACT® drive. The motion is resolved down to nanometers, depending on the drive and its mechanical integration.

Joystick Operation and Interface for Automation

Stand-alone operation is possible by connecting a joystick. As an alternative, the required

± 10 V signals can be sent over an analog interface.

PiezoWalk® Working Principle for Application Flexibility

NEXACT® piezo stepping drives combine high forces and a basically unlimited travel range in a compact package. In operation, piezoceramic bending elements act on the runner, which is connected to the moving part of the application. The length of the runner can be chosen freely and determines the stroke. Force capacity, resolution and velocity are determined by the piezo geometry and drive electronics. The drive design allows lower operating voltages of maximum 45 V. Furthermore, NEXACT® actuators have the high stiffness and resolution characteristic of piezo actuators of far below one nanometer.

Ordering Information

E-862.100
NEXACT® Driver, 1 Channel,
OEM Board, DSP based

Accessories:
C-819.20
Analog Joystick for 2 Axes

C-819.20Y
Y-Cable for Connecting
2 Controllers to C-819.20

For closed-loop systems the
E-861.1A1 controller (s. p. 1-20)
is available:

E-861.1A1
NEXACT® Controller, 1 Channel,
Linear Encoder

Ask about custom designs!

Closed-Loop Systems for Repeatable Positioning

The step size of piezo stepping drives depends on the applied load and a direct conversion of step count to travel is not possible. Therefore, for positioning tasks a closed-loop system is recommended.

Advantages of PiezoWalk® Piezo Stepping Drives

NEXLINE® and NEXACT® drives offer several advantages over drives with traditional technologies:

- Resolution in the picometer range
- Compact dimensions
- High drive forces to 10 N (NEXACT®) and up to several 100 N (NEXLINE®)
- High dynamic performance with sub-millisecond response
- Self-locking when powered down; no holding current
- Zero backlash, no wear or maintenance, no mechanical components like gears or leadscrews.
- Non-magnetic and vacuum compatible operating principle

Technical Data

Model	E-862.100
Function	Drive electronics for NEXACT® drives / stages
Drive type	NEXACT® drive
Channels	1
Motion resolution	12 bit
Input limit switch	2 x TTL (active high, to be activated)
Electrical properties	
Output power	max. 40 W
Output voltage range	0 to +45 V
Current	max. 1.6 A
Interfaces and operation	
Control	± 10 V analog velocity control (Mini-DIN, 9-pin)
Motor connector	HD Sub-D 15-pin. (f)
Manual control (optional)	Joystick, Y-cable for control of 2 axes with joystick
Miscellaneous	
Operating voltage	24 V
	External power supply (24 V, 2 A), not included
Operating temperature	0 to +50 °C
Mass	0.64 kg
Dimensions	166 x 100 x 46 mm

Note: All specifications for NEXACT® drives refer to use with E-861 controller. Compared to that, the drive electronics provides only a unipolar output voltage. Therefore, push force and velocity achievable with E-862 are derated by 20%.

E-861 PiezoWalk® Piezo Motor Controller for NEXACT® Drives

Networkable Controller for NEXACT® Linear Drives and Positioners



PiezoWalk® System: E-861.1A1 NEXACT® Controller with open-loop N-310.01 NEXACT® linear drive; suitable for installation in stage with linear encoder

- For NEXACT® Drives and Positioning Systems
- Complete System with Controller, Integrated Power Amplifiers and Software
- Open-Loop Operation, or Closed-Loop with Linear Encoder
- High Performance at Low Cost
- Daisy-Chain Networking for Multi-Axis Operation
- Non-Volatile Macro Storage for Stand-Alone Functionality with Autostart Macro
- I/O for Automation, Joystick for Manual Operation
- Parameter Changes On-the-Fly

The new, compact E-861 controller is designed to operate NEXACT® linear drives and closed-loop positioning systems using them, simply and precisely. In perfect harmony with the mechanics, the E-861 supports both motion modes of the PiezoWalk® stepping drive: for longer moves, the stepping mode, and for moves shorter than typically 7 µm, the analog mode, which provides high-dynamics positioning with resolutions of less than 1 nm. The NEXACT® drive design minimizes piezo operating voltages to 45 V and below.

Flexible Automation

E-861 controllers offer a number of features to support automation and handling. For example, macros can be stored in non-volatile memory. A programmable autostart macro allows stand-alone operation without external

communication. Upon power-up, the macro with its internal command sequence is executed automatically.

For easy synchronization of motion with internal or external trigger signals, four input and four output lines are provided.

Multi-Axis Operation

Up to 16 E-861 controllers can be networked and controlled over a single PC interface.

Such daisy chain networks are flexible, can be extended at any time and are compatible with other PI controllers (e.g. DC servo-motor and stepper motor controllers).

Ordering Information

E-861.1A1
NEXACT® Controller, 1 Channel,
Linear Encoder

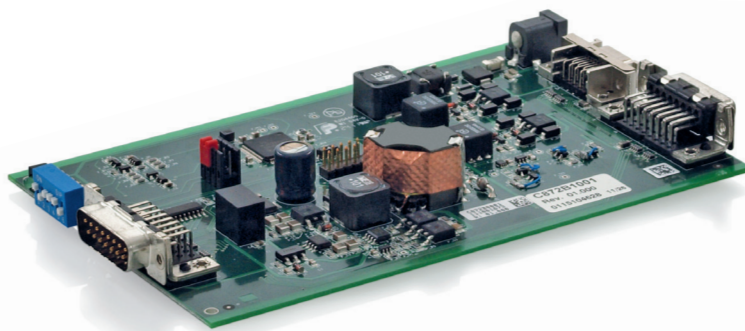
Easy System Setup, Comprehensive Software

All parameters can be set and checked by software. System setup and configuration is done with the included PIMikro-Move user-interface software. Interfacing to custom software is facilitated with included Lab-View drivers and DLLs. With the PI General Command Set (GCS), system programming is the same with all PI controllers, so controlling a system with a variety of different controllers is possible without difficulty.

Model	E-861.1A1
Function	Controller for NEXACT® drives / systems 1 Channels
Drive type	NEXACT® linear drive
Servo characteristics	P-I-D servo control, parameter change on-the-fly
Trajectory profile modes	Trapezoidal
Encoder input	Analog encoder input sine-cosine, interpolation circuit preset for differential transmission, 1 V _{pp} amplitude and 2.5 V offset of the encoder signal
Stall detection	Servo off, triggered by programmable position error
Input limit switch	2 x TTL (pull-up/pull-down, programmable)
Input reference switch	1 x TTL
Output power	max. 40 W
Output voltage	-10 to +45 V
Current consumption	0.8 A
Current consumption interfaces	USB 2.0, RS-232 (9-pin (m) Sub-D)
Motor connector	Sub-D 15-pin (f) High Density
Sensor connector	Sub-D 15-pin (m) High Density
Controller network	Up to 16 units on single interface
I/O ports	4 analog/digital in, 4 digital out (TTL)
Command set	PI General Command Set (GCS)
User software	PIMikroMove, PI Terminal
Software drivers	GCS-DLL, LabVIEW drivers
Supported functionality	Start-up macro; data recorder for categories like current position or velocity; internal safety circuitry: watchdog timer
Manual control (optional)	Joystick, Y-cable for 2D motion, pushbutton box
Operating voltage	24 V included: external power supply, 24 V, 2.0 A
Operating temperature range	0 to +50 °C
Mass	1.1 kg
Dimensions	206 x 130 x 66 mm (with mounting rails)

Driver for PLine® Ultrasonic Piezomotors

HIGHLY EFFICIENT PIEZOMOTOR AMPLIFIER



C-872

- For all PLine® motors
- Analog control input
- Automatic frequency control
- Minimum heat generation

All-purpose driver for all PLine® single and dual drives
 OEM board with analog control input. Suitable for PLine® ultrasonic piezomotors P-661, U-161, U-164 and PLine® RodDrive U-264

PLine® ultrasonic piezomotors and drives
 High velocity. Self-locking, no heat generation at rest. Excellent start/stop dynamics

Resonance tracking
 Automatically adjusts the driving frequency for maximum motor performance and efficiency (can be switched off)



RodDrive Piezomotor Direct Drive

Related products

- U-264 RodDrive Piezomotor Direct Drive
- M-272 Ceramic Linear Drive for Automation
- C-867.OE Controller Board PLine®

Preliminary Data	C-872.160	Unit	Tolerance
Function	Driver for PLine® ultrasonic piezomotors / single and dual drives with P-661, U-161, U-164 and U-264		
Channels	1		
Control In	±10 V defines the velocity, polarity defines the direction of motion, 12-bit A/D converter		
Electrical properties			
Output power	50	W	max.
Output voltage	240 (AC voltage, amplitude and frequency depending on motor selection)	V _{pp}	max.
Current limitation	2.5 (short-circuit-proof)	A	max.
Interface and operation			
DIP switches	Motor selection, frequency control activated/deactivated		
Motor connector	MDR14 and sub-D 15 (f)		
I/O ports	Sub-D 15 (m) 1x frequency control activated/deactivated Looped through: 3x signals for limit and reference point switches (TTL), 4x encoder signal (A/B, differential)		
Miscellaneous			
Operating voltage	24 VDC, 50 W, from external power supply (not included)		
Current consumption	2.5	A	max.
Operating temperature range	5 to 40	°C	
Mass	0.125	kg	
Dimensions	172 × 100 × 20 (incl. connector)		

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C-184 · C-185 PLine® Piezo Motor Drivers, Ultrasonic Motors OEM Boards and Stand-Alone Units for Ultrasonic Piezomotors



C-185.D64 single-channel bench-top driver electronics with PLine® M-674 RodDrive featuring travel ranges up to 150 mm and 7 N drive force at 450 mm/s

- For PLine® Ultrasonic OEM Motors and Positioners
- Accepts Analog Drive Signal from Standard Controller
- Available as Cost-Effective OEM board and Plug-and-Play Desktop Unit

sitioners have a number of advantages over classical drives:

- Higher Accelerations, up to 5 g
- Speeds up to 500 mm/s
- Small Form Factor
- Self-Locking When Powered Down
- No Shafts, Gears or Other Rotating Parts
- Non-Magnetic and Vacuum-Compatible Drive Principle

Note

The products described in this document are in part protected by the following patents:
US Pat. No. 6,765,335
German Patent No. 10154526

Ordering Information

- C-184.161**
Analog OEM Driver Board for PLine® P-661 Motors
- C-185.161**
Analog Stand-Alone Drive Electronics with Power Supply for PLine® P-661 Motors
- C-184.164**
Analog OEM Driver Board for PLine® P-664 Motors
- C-185.164**
Analog Stand-Alone Drive Electronics with Power Supply for PLine® P-664 Motors
- C-184.D64**
Analog OEM Driver Board for PLine® RodDrive M-674
- C-185.D64**
Analog Stand-Alone Drive Electronics with Power Supply for PLine® RodDrive M-674

The C-184 OEM-board and the C-185 stand-alone unit are single-channel drive electronics for PLine® ultrasonic piezomotors and PLine® stages. Piezo-motor drive electronics convert analog input signals into the high-frequency drive signals necessary to excite the required oscillations in the piezomotor stator which cause the motion. Both the C-184 and C-185 are available in three versions, for use with different motors and translation stages.

OEM and Integrated Electronics

The philosophy behind the design of PLine® ultrasonic drives dictates that they be easily adaptable to customer requirements. This includes making the drive electronics both independent of control signal type and available either as an OEM board or as a stand-alone unit in its own case.

While the OEM boards are the most economic solution for large quantities, the stand-alone units make it possible to plug a system with PLine® stages together and put it into operation quickly and easily, for example for system evaluation purposes.

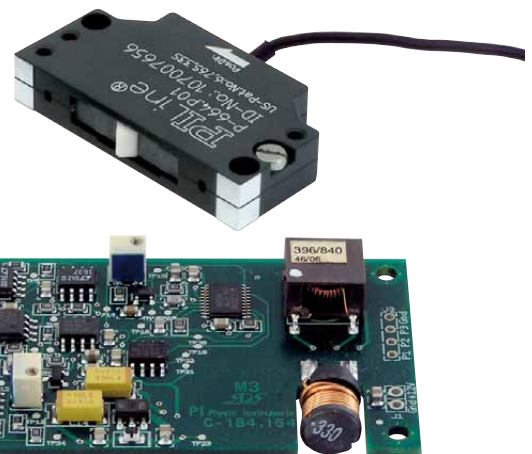
Analog Control

Both drivers control the motor speed based on an analog signal from 0 to 10 V. With an external position sensor and a servo controller, it is possible to set up a very fast, closed-loop system.

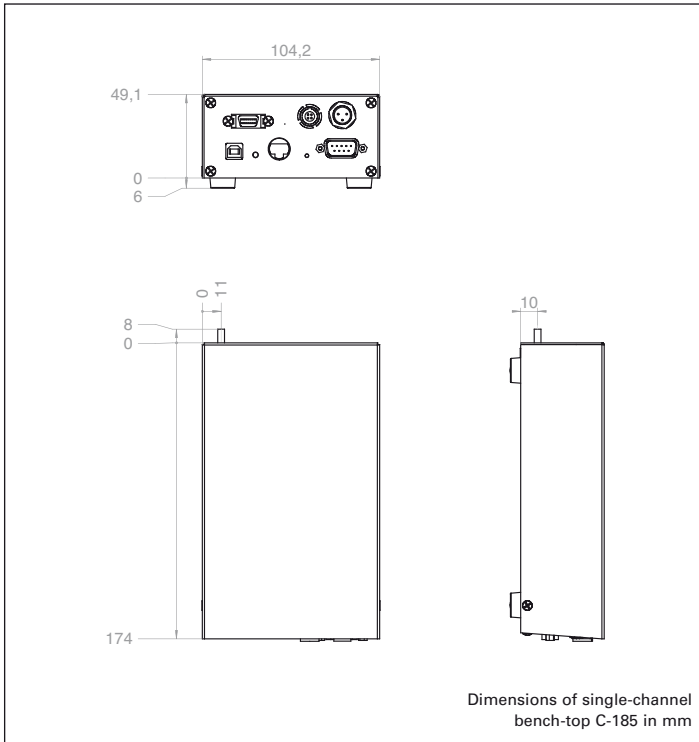
For optimum closed-loop system performance, the C-867 (see p. 4-116) piezo servo-controller is recommended.

Advantages of PLine® Micropositioning Systems

The ultrasonic piezoceramic drives used in PLine® micropo-



C-184.164 OEM driver board with PLine® P-664 OEM motor



Technical Data

Model	C-184	C-185
Function	Analog drive electronics (OEM board) for PLine® C-184.161: P-661 Motors & Positioners C-184.164: P-664 Motors & Positioners C-184.D64: M-674 RodDrive	Analog single-channel driver box for PLine® C-185.161: P-661 Motors & Positioners C-185.164: P-664 Motors & Positioners C-185.D64: M-674 RodDrive
Channels	1	1
Electrical properties		
Control in	Differential, -10 V up to +10 V, polarity controls direction	Differential, -10 V up to +10 V, polarity controls direction
Operating voltage	12 V, ±10 %	12 VDC external power supply (included)
Output power / channel	Model dependent: C-184.161: 5 W C-184.164: 10 W C-184.D64: 15 W	Model dependent: C-185.161: 5 W C-185.164: 10 W C-185.D64: 15 W
Output voltage / channel	Model dependent: C-184.161: 120 V _{PP} / 42 V _{RMS} , 210 kHz C-184.164: 168 V _{PP} / 60 V _{RMS} , 155 kHz C-184.D64: 190 V _{PP} / 67 V _{RMS} , 155 kHz	Model dependent: C-185.161: 120 V _{PP} / 42 V _{RMS} , 210 kHz C-185.164: 168 V _{PP} / 60 V _{RMS} , 155 kHz C-185.D64: 190 V _{PP} / 67 V _{RMS} , 155 kHz
Interfaces and operation		
Motor connector	Solder pads	LEMO connector or MDR connector, 14-pin
I/O ports	Solder pads	Sub-D connector, 15-pin
Miscellaneous		
Operating temperature range	+5 to +40 °C	+5 to +40 °C
Mass	C-184.161, C-184.164: 15 g C-184.D64: 24 g	690 g
Dimensions	65 x 38 mm	174 x 104 x 49 mm (without ground connection, pads and fitting panel) 182 x 104 x 49 mm (with ground connection)

C-867 Piezo Motor Controller for Ultrasonic Motors

Servo-Controller with Integrated Driver for High-Speed Ultrasonic Piezo Motors



The two-channel C-867.260 controller operates XY scanning stages, here: a customized M-686 stage for microscopy

- Optimized for PLine® Ultrasonic Piezo Linear Motors
- High-Bandwidth Encoder Inputs Allow High Speed and Resolution
- PID Servo-Control with Dynamic Parameter Switching
- Integrated Piezo Motor Power Driver
- USB, RS-232 and Analog Interfaces (e. g. for Joystick)
- 4 + 4 Programmable TTL-I/Os for Flexible Automation
- Data Recorder
- Daisy-Chain Networking for up to 16 Axes
- Powerful Macro Programming Language, e. g. for Stand-Alone Operation
- Extensive Software Support, LabVIEW, DLL ...

The C-867 controller is especially designed for closed-loop positioning systems equipped with PLine® piezo linear motor drives. A compact case contains both drive electronics for the piezo ceramic motors and components for controlling and communication.

Application Examples

- Biotechnology
- Microscopy
- Fiber positioning
- Automation
- Photonics / integrated optics
- Quality assurance testing
- Testing equipment

The controller can be operated from a host PC either via a USB port or an RS-232 interface. Alternatively, a stand-alone operation is possible. Here, stored macro commands can be executed, or manual control by joystick or pushbutton box is possible.

Two models are available: C-867.160 is used to operate single-axis positioning systems, the two-channel C-867.260 is used with XY scanning stages.

Highly Specialized PID Servo-Controller

The C-867 is based on a highly specialized DSP (Digital Signal Processor) that handles the PID servo-control algorithm as well as other system functions.

Because of the motion properties typical for ultrasonic piezomotors, the controller has a number of advanced features, including dynamic control parameter adaption. By automatically switching between gainsets for dynamic and static operation an optimized settling behavior within a couple of 10 milliseconds is achieved. The broadband encoder input (50 MHz) allows high resolution encoders to be used with the outstandingly high accelerations and velocities that PLine® drives deliver.

Highest Stability by Frequency Control

The integrated piezomotor drive electronics support all PLine® ultrasonic piezomotors used for the M-66x to M-69x positioning stage series.

Drift in the mechanical frequency of the motor caused by temperature or load changes is automatically compensated by a frequency-control loop which adjusts the operating frequency of the driving voltage. This leads to the highest stability in pushing force, velocity and closed-loop control.

Software / Programming

In addition to the user software for setup, system optimization and operation, comprehensive LabVIEW and DLL libraries are provided.

The PIMikroMove™ user software provides the PITuningTool for optimizing system performance. Graphic displays show the system's behaviour and facilitate parameter setting.

Advantages of PLine® Micropositioning Systems

Positioning systems equipped with ceramic ultrasonic drives of the PLine® series provide

Ordering Information

C-867.160
Piezomotor Controller with Drive Electronics, Networkable, for PLine® Systems

C-867.260
Piezomotor Controller with Drive Electronics, 2 Channels, for PLine® Systems

Accessories:

C-819.20
Analog Joystick for 2 axes

C-819.20Y
Y-Cable for Connecting 2 Controllers to C-819.20

C-170.PB
Pushbutton Box, 4 Buttons and 4 LEDs

Ask about custom designs!

several advantages over positioners that apply classic drive technology:

- Smaller dimensions
- Higher holding force when powered down; no holding current
- Increased acceleration of up to 5 g
- Increased velocity of up to 500 mm/s or 720°/s
- No leadscrews, gears or other mechanical components, no wear or maintenance
- No lubricants
- Non-magnetic and vacuum-compatible operating principle



C-867 piezomotor controller together with an extremely low-profile M-692 positioner with integrated piezoceramic PLine® linear drive

Technical Data

Model	C-867.160	C-867.260
Function	Controller and drive electronics for PLine® piezomotors / systems	
Drive type	PLine® motors, single and dual drives with P-661, P-664, U-161 or U-164	
Channels	1	2
Motion and control		
Servo characteristics	Programmable PID V-ff filter, parameter changes on the fly	
Trajectory profile modes	Trapezoidal	
Encoder input	A/B differential signals, 50 x 10° impulses/s	
Stall detection	Servo off, triggered by programmable position error	
Limit switch	2 x TTL per channel (programmable)	
Reference switch	1 x TTL per channel (active high / low, programmable)	
Electrical properties		
Max. output power / channel	15 W	
Max. output voltage / channel	200 V _{pp}	
Interfaces and operation		
Communication interfaces	USB, RS-232	
Motor connector	MDR14	2 x MDR14
Controller network	Up to 16 units on single interface	
I/O ports	4 analog/digital in, 4 digital out (Mini-DIN, 9-pin) digital: TTL analog: 0 to 5 V	
Command set	PI General Command Set (GCS)	
User software	PIMikroMove	
Software drivers	GCS-DLL, LabVIEW drivers	
Supported functionality	Start-up macro; macro; data recorder for recording parameters as motor input voltage, velocity, position or position error	
Manual control	Pushbutton box, joystick, Y-cable for control of 2 axes with joystick	Pushbutton box, joystick
Miscellaneous		
Operating voltage	24 VDC from external power supply (included)	
Current consumption	300 mA + motor current (2 A max.)	600 mA + motor current (4 A max.)
Operating temperature range	+5 °C to +40 °C	
Mass	1.0 kg	2.4 kg
Dimensions	206 x 130 x 66 mm (including mounting rails)	320 x 150 x 80.5 mm (including mounting rails)

C-867.OE OEM Piezo Motor Controller for Ultrasonic Motors

Affordable OEM Piezo Motor Controller with CAN Interface



Cost-effective combination:
M-272 closed-loop linear pusher and C-867.OE controller card

- **Optimized for all PLine® Ultrasonic Piezo Linear Motors with Single or Double Drive**
- **PID Servo-Control with Dynamic Parameter Switching**
- **Integrated Piezo Motor Power Driver with Frequency Control**
- **CAN, RS-232, and Analog Interfaces (e.g. for Joystick)**
- **Data Recorder**
- **Powerful Macro Command Language, e.g. for Standalone Operation**
- **Extensive Software Support, LabVIEW, DLL, ...**

The C-867 OEM card is a cost-effective motion controller for closed-loop positioning systems equipped with PLine® ultrasonic piezo motors. The controller card integrates both

the servo controller / communication hardware and the driver electronics for the ultrasonic piezo motors.

For seamless integration in industrial automation environments, the controller can be operated via RS-232 and CAN interfaces. In addition, an analog (joystick) interface and non-volatile macro command memory make stand-alone operation possible.

Highly Specialized PID Servo-Controller

The C-867 is based on a highly specialized DSP (Digital Signal Processor) that handles the PID servo-control algorithm as well as other system functions. Because of the motion properties

Application Examples

- **Biotechnology**
- **Microscopy**
- **Fiber positioning**
- **Automation**
- **Photonics / integrated optics**
- **Quality assurance testing**
- **Testing equipment**

Ordering Information

C-867.OE
OEM Driver / Controller Card
for PLine® Ultrasonic Motors,
1 Channel

Ask about custom designs!

typical for ultrasonic piezomotors, the controller has a number of advanced features, including dynamic control parameter adaption. By automatically switching between gainsets for dynamic and static operation an optimized settling behavior within a couple of 10 milliseconds is achieved. The broadband encoder input (50 MHz) allows high-resolution encoders to be used with the outstandingly high accelerations and velocities that PLine® drives deliver.

Highest Stability and Reliability with Automatic Frequency Control

The integrated piezomotor drive electronics supports all types of PLine® ultrasonic piezomotors currently available.

Variations in the resonant frequency of the motor caused by temperature or load changes are automatically compensated for by a frequency-control loop which adjusts the operating frequency of the driving voltage. This leads to higher stability of the motor output force and velocity and to higher position accuracy.

Software / Programming

In addition to the user software for setup, system optimization and operation, comprehensive LabVIEW and DLL libraries are provided.

The PIMikroMove user software provides the PI Tuning Tool for optimizing system performance. Graphic displays show the system's behaviour and facilitate parameter setting.

Technical Data

Model	C-867.OE
Function	Controller and drive electronics for PILine® piezomotors/systems
Drive type	PILine® motors, single and dual drives with P-661, P-664, U-161, U-164 and U-264
Channels	1
Motion and control	
Servo characteristics	Programmable PID V-ff filter, parameter changes on-the-fly
Trajectory profile modes	Trapezoidal
Encoder input	A/B differential signals, 50 MHz
Stall detection	Servo off, triggered by programmable position error
Limit switches	2 TTL (programmable)
Reference switches	1 TTL (active high / low, programmable)
Electrical properties	
Max. output power	15 W
Max. output voltage	200 V _{pp}
Interfaces and operation	
Communication interfaces	RS-232, CAN, input / output 32-pin (male) on rear panel (DIN 41612/D)
Motor connector	MDR14
Command set	PI General Command Set (GCS)
User software	PIMikroMove
Software drivers	GCS-DLL, LabVIEW drivers
Supported functionality	Start-up macro, macro, data recorder for recording parameters as motor input voltage, velocity, position or position error
Miscellaneous	
Operating voltage	24 VDC from external power supply (not included)
Current	150 mA + motor current (2 A max.)
Operating temperature range	+5 °C to +40 °C
Mass	420 g
Dimensions	175 x 100 x 38 mm (connectors included)

E-755 Digital NEXLINE® Piezo Motor Controller

Controller for Picometer-Precision PiezoWalk® Linear Actuators / Positioners



E-755 digital NEXLINE® controller with N-214 nanopositioner, 20 mm travel range.

- **Special Control Algorithms for NEXLINE® Nanopositioning Linear-Motor Actuators**
- **32-Bit Digital Filters**
- **24-Bit DAC Resolution**
- **Fully Programmable Low-Pass and Notch Filters**
- **Non-Volatile User Settings and Last-Position Data**
- **Daisy-Chain Networking for up to 16 Axes**
- **PI GCS (General Command Set) Compatible**

E-755 digital single-axis nanopositioning controllers are designed to drive the patented NEXLINE® nanopositioning linear drives. Combining advanced control technology and sensor signal processing with special drive algorithms, the E-755 can provide precision motion control over hundreds of millimeters with picometer-range resolution. Coordinated action of shearing and clamping piezo elements is what allows NEXLINE® to

break through the barriers of conventional nanopositioning actuators.

The E-755 offers two different control modes for the NEXLINE® walking drives: a high-resolution, high dynamics direct piezo mode, with basically unlimited resolution (analog mode), and a long-range stepping mode with theoretically unlimited travel range.

High-Resolution Servo-Control

E-755 controllers are based on powerful 32-bit DSPs and come in open- and closed-loop versions. Both versions feature four high-resolution (24-bit) linear amplifiers with the output range of ± 250 V required to control a single-axis NEXLINE® drive. For the closed-loop models, high-resolution incremental position sensors are supported by special excitation and read-out electronics.

The sensors supported may provide better than nanometer resolution. A power-down routine in the E-755 firmware saves the current position, allowing a closed-loop system to be ready for operation without referencing next time it is powered up.

NEXLINE® Working Principle for Application Flexibility

NEXLINE® PiezoWalk® drives are ideal wherever high loads must be positioned very precisely over long distances and then perhaps subjected to small-amplitude dynamic adjustment, as for active vibration control. By varying the characteristics of the longitudinal and shear piezo elements, the step size, dynamic operating range (analog travel), clamping force, speed and stiffness can all be optimized for a particular application.

NEXLINE® PiezoWalk® piezoceramic clamping and shearing elements act directly on a moving runner that is coupled to the moved part in the application. While the runner can be removed large distances

Ordering Information

E-755.1A1
Digital Controller for NEXLINE® Nanopositioning Linear Drives, Incremental Sensors

E-755.101
Digital Controller for NEXLINE® Nanopositioning Linear Drives

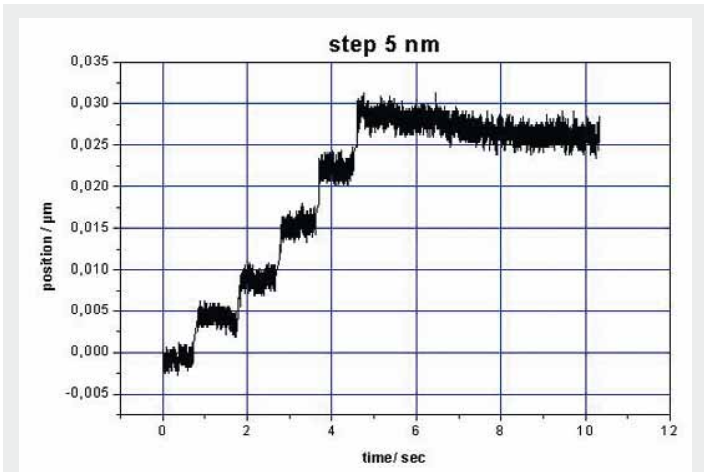
in step mode, high-dynamics positioning over distances of less than one step is possible with resolutions far below one nanometer in analog mode. The patented PiezoWalk® thus overcomes the limitations of conventional nanopositioning actuators and combines long travel ranges with high resolution and stiffness.

Extreme Actuator Lifetime

To eliminate long-term offset voltages, which limit the lifetime of conventional piezo drives, the E-755 controller uses a special procedure to bring the actuator to a full-holding-force, zero-voltage condition, no matter where it may be along its travel range. Due to the resulting long lifetime, NEXLINE® nanoposition-

Application Examples

- Semiconductor technology
- Quality assurance testing in semiconductor industry
- Astronomical telescopes
- Truss structures
- Active vibration control
- Alignment in high magnetic fields, as in particle physics, atomic fusion and superconductivity research



Steps of 5 nm performed by a system consisting of an N-214 NEXLINE® nanopositioner and an E-755.1A1 controller, measured by a high-resolution interferometer. Note the excellent system response to consecutive 5 nm step commands. In this case the closed-loop resolution is limited by the linear encoder in the N-214 (5 nm / increment); the E-755 can work with linear encoders with sub-nanometer resolution

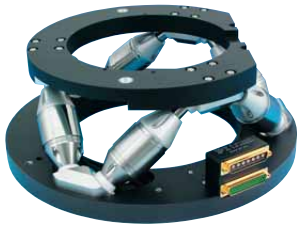
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ing actuators are ideal for installation in inaccessible locations deep inside complex equipment, where nanometer -precise alignment and vibration cancellation are required.

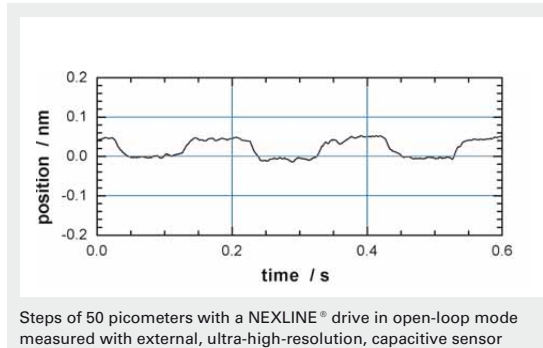
Linearization

E-755-controlled nanopositioning systems provide outstanding linearity, achieved by digital polynomial linearization. The linearization can improve linearity to

0.001 % over the full travel range. The products described in this datasheet are in part protected by the following patents:
 German Patent No. 10148267
 US Patent No. 6,800,984



Six-axis nonmagnetic Hexapod with N-215-based NEXLINE® high-load actuators for use in high magnetic fields. The system is driven by six E-755 controllers and additional hardware/firmware to automatically perform the necessary parallel-kinematics coordinate transformation



Technical Data

Model	E-755.1A1	E-755.101
Funktion	Digital controller for NEXLINE® nanopositioning linear drives with incremental encoder	Digital controller for NEXLINE® nanopositioning linear drives
Axes	1	1
Processor	DSP 32-bit floating point, 50 MHz	DSP 32-bit floating point, 50 MHz
Sensor		
Sensor channels	1	-
Servo update time	0.2 ms	-
Sensor sampling time	0.1 ms	-
Dynamic cycle time	0.2 ms	0.1 ms
Servo characteristics	P-I, notch filter	-
Sensor type	Incremental sensor	-
Amplifier		
Amplifier channels	4	4
Output voltage	-250 to +250 V	-250 to +250 V
Peak output power per channel	5.5 W	5.5 W
Average output power per channel	3 W, limited by temperature sensor	3 W, limited by temperature sensor
Peak current	44 mA	44 mA
Average current per channel	25 mA, limited by temperature sensor	25 mA, limited by temperature sensor
Current limitation	Short-circuit-proof	Short-circuit-proof
Resolution DAC	24 bit	24 bit
Interfaces and operation		
Communication interfaces	RS-232	RS-232
Piezo connector	Sub-D Special	Sub-D Special
Sensor connector	15-pin sub-D connector	-
Controller network	Daisy-chain, up to 16 units	Daisy-chain, up to 16 units
Command set	GCS	GCS
User software	PIMikroMove™, NanoCapture™, PITerminal	PIMikroMove™, NanoCapture™, PITerminal
Software drivers	LabVIEW drivers, DLLs	LabVIEW drivers, DLLs
Supported functionality	NEXLINE® Control algorithms (closed-loop), data recorder, position storage	NEXLINE® Control algorithms (open-loop), data recorder
Display	Status LEDs	Status LEDs
Linearization	4th order polynomial	4th order polynomial
Miscellaneous		
Operating temperature range	5 to 50 °C	5 to 50 °C
Overtemp protection	Deactivation at 70 °C	Deactivation at 70 °C
Dimensions	264 x 260 x 47 mm	264 x 260 x 47 mm
Mass	2.3 kg	2.3 kg
Operating voltage	24 V (power supply included)	24 V (power supply included)
Power consumption	48 W, 2 A max.	48 W, 2 A max.

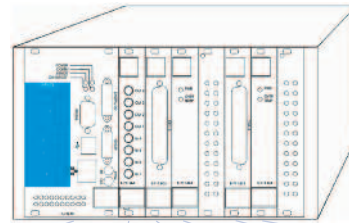
E-712 Digital Piezo Motor Controller

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



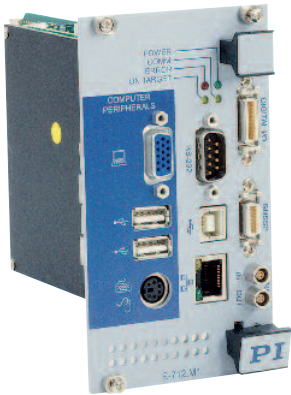
	Preconfigured system	Digital controller unit	Case unit	Interface modul	Sensor modul	Amplifier modul	Sensor modul	Amplifier modul
Nanopositioning systems with voltage requirement of up to +120 V with 3 axes and capacitive sensors	E-712.3CD	E-712.M1*	E-712.R1*	-	E-711.SC3H*	E-711.AL4P*	-	-
Nanopositioning 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.OCT	E-711.AL4P	(E-711.OCT)	(E-711.AL4P)
Nanopositioning systems with voltage requirement ±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), 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), 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.

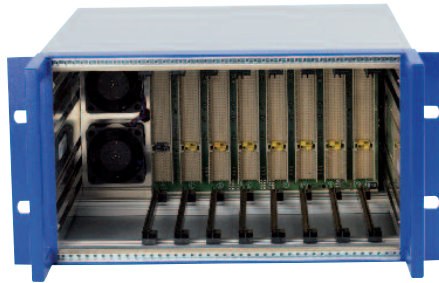
** The single- or 3-channel NEXLINE® operation is adjustable via software commands.

E-712 Basic Modules for Piezo Controller

Powerful Processor, Fast Digital Interfaces and Cases



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



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

Ordering Information

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

- **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

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 Amplifier Modules for Piezo Motors

High-Power and Low-Noise for Dynamic and Precision



E-711.AM4 amplifier module with ± 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

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

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

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

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

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

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

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

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