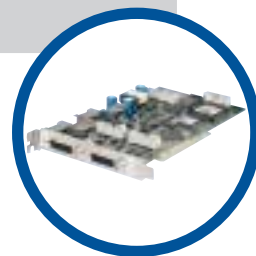


# Motion Controllers for Micropositioning: Servos, Ultrasonic Motors, Steppers

Updated 10/2006



# Contents

## Motion Controllers for Micropositioning Stages

**See p. 9-5a - 9-5d** Contents ..... 9-2  
**for 2006 NEWS**

<b>Motion Controllers for Micropositioning</b>	
Overview / Experience .....	9-3
<b>Selection Guide Motion Controllers</b> .....	9-5
<b>Servo-Motor Controllers (DC-Motors)</b>	
C-862 Mercury™ II DC-Motor Controller/Driver .....	9-6
C-843 Servo Motion Controller/Driver PCI Board for 2/4 Axes .....	9-8
C-848 DC-Motor Controller for 2/4 Axes .....	9-10
<b>PILine® Ultrasonic Piezo Motor Controllers/Drivers</b>	
C-865 High-Speed, Closed-Loop Controller/Driver for PILine® Piezo Linear Motors .....	9-12
C-170 RedStone Open-Loop Controller/Driver for PILine® Piezo Linear Motors . . . .	9-14
C-180 Analog and Pulsed Drivers for PILine® Piezo Linear Motors .....	9-16
<b>Automation Platform</b>	
C-880 Automation Platform .....	9-18
<b>Stepper Motor Controllers</b>	
C-630 Apollo Motion Controller/Driver for Stepper Motors .....	9-22
C-600 Precision Motion Controller/Driver for Stepper Motors .....	9-24
<b>Servo-Amplifiers, PIMotion&amp;Vision™ System</b>	
C-809.40 4-Channel Servo-Amplifier / Motion I/O Interface for NI Motor Controllers .....	9-26
F-311 PIMotion&Vision™—Integration of Vision System and Micro-/Nanopositioning .....	8-16
<b>Accessories</b> .....	9-27
<b>General Command Set (GCS)</b> .....	9-28

For more information on PI products, visit <http://www.pi.ws/news>

# Motion Controllers for Micropositioning

## Overview / Experience

PI offers a large variety of innovative motion control solutions for precision positioners. Included products range from compact, single-axis controllers for DC servomotors, piezomotors and voice coil scanners, to control systems for complex, parallel kinematics, 6-DOF Hexapods. Custom systems have been built capable of coordinating up to 273 axes.

### Positioning and Sequencing: Automation System Solutions from PI

The motion controllers shown here were specially designed for PI micropositioning systems. With PI mechanics, the comprehensive palette of software, and all necessary cables included, plug-and-play operation is the rule. With some controllers, it is possible to network up to 27 or more axes for simple system scalability. In addition to standard systems, custom systems can be assembled with control for several hundred axes.

### Integrated Drivers

All PI motor controllers are equipped with integrated servo-amplifiers and/or drivers in order to simplify system design and reduce costs. In addition, the DC-motor controllers offer PWM outputs for use with external amplifiers or with the integrated amplifiers in PI's direct-drive, ActiveDrive™ stages, such as the M-511.PD.

### Integrated Controllers

PI also offers micropositioning stages complete with integrated motor controllers and amplifiers which can be connected directly to the host computer.

### Image Processing and Automation

The PIMotion&Vision™ system was developed for automation applications; it features a large number of drivers for real-time image processing. Up to 80 axes,



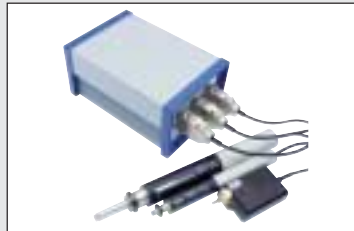
Custom 8-axis motor control card (right) and miniature single-axis controller (left).



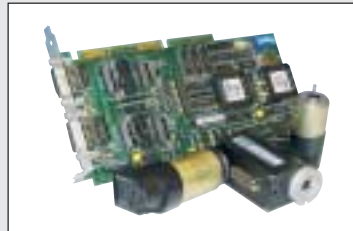
Automation platform for up to 18 axes for servo motors, piezo drives and voice coils with optional integrated photometer.



Stepper motor controller with multi-axis interpolation and trajectory control capability.



Compact, multi-axis, stepper motor controller with linear actuators.



Multi-axis controller for DC motors.



Compact, networkable single-channel, servo-motor controller with micropositioning stage.



Custom voice coil scanner controller.



Custom stepper motor with integrated, networkable controller/driver.



Multi-channel controller card for DC motors.

Piezo Actuators

Nanopositioning & Scanning Systems

Active Optics / Steering Mirrors

Tutorial: Piezo-electrics in Positioning

Capacitive Position Sensors

Piezo Drivers & Nanopositioning Controllers

Hexapods / Micropositioning

Photonics Alignment Solutions

**Motion Controllers**

Ceramic Linear Motors & Stages

Index

# Motion Controllers for Micropositioning

## Overview / Experience

switching functions and photometer signals can be included in the processing algorithms. The software supports functions ranging from autofocus, edge alignment and displacement measurement with micron accuracy, as well as complex alignment routines in six degrees of freedom.

### Typical Applications for PI Motion Controllers

- Micromachining
- Micro-Assembly
- Medical Technology
- Semiconductor Technology
- Data Storage Device Testing
- Lasers and Electro-Optics
- Photonics Packaging
- Biotechnology

### Reasons for Choosing PI

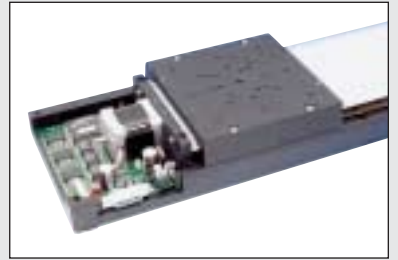
- 35 Years Experience with Micro- and Nanopositioning Systems
- Choice of Different Control Strategies
- Stepper Motor Controllers
- DC-Motor Controllers
- Voice-Coil Controllers
- Controllers for Ceramic Servo-Drives
- Six Degree-of-Freedom Hexapod Controllers
- Automation Platform
- PIIntelliStage™ Translation Stages with Integrated Controller
- Custom Controllers with up to 273 Channels



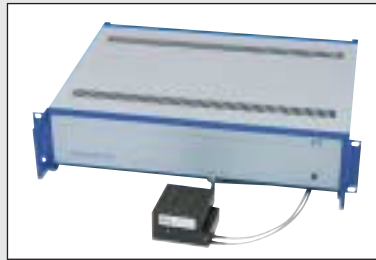
PIMotion&Vision™ system can control up to 80 axes.



Two-axis controller card for voice coil drives.



Networkable stepper motor controller, integrated in precision linear stage (with cover removed).



Multi-axis digital controller for voice coil scanners.



Custom rotary piezomotor with OEM driver electronics.



Complex 6D controller with automatic coordinate transformation, shown with parallel kinematics F-206 Hexapod micropositioning system.



Piezomotor controller with microstage.

# Selection Guide

## Motion Controllers

### Servo-Motor Controllers (DC-Motors)

Models*	Description	Channels	Outputs for Motor Types	PC Interfaces	Page
C-862	Mercury™ single-axis servo-controller / amplifier. Compact, excellent value, networkable, integrated Amplifier + PWM outputs, stand-alone	1 – 6**	DC-servo	RS-232	9-6
C-843	PCI bus controller card Integrated linear amplifier and PWM outputs	2, 4	DC-servo	PCI bus	9-8
C-848	Servo-motor controller 19"-Package, integrated Linear amplifier and PWM outputs	2, 4	DC-servo	RS-232, IEEE 488	9-10
Hexapod Controller	See Hexapod systems: M-840, M-850, F-206	6 + 2	DC-servo	RS-232, IEEE 488, special	7-18 ff.

### PILine® Ultrasonic Piezo Motor Controllers/Drivers

Models*	Description	Channels	Outputs for Motor Types	PC Interfaces	Page
C-865	High-speed, closed-loop controller/driver for closed-loop PILine® piezomotors	1	PILine® piezomotor	USB, RS-232	9-12
C-170	Redstone open-loop controller/driver for PILine® ultrasonic piezo linear motors	1, 2	PILine® piezomotor		9-14
C-180 - C-185	Analog / pulsed drivers for PILine® ultrasonic piezo linear motors	1	PILine® piezomotor	TTL / analog	9-16

### Stepper Motor Controllers

Models*	Description	Channels	Outputs for Motor Types	PC Interfaces	Page
C-630	Apollo stepper motor controller, microstep operation compact, networkable	3**	2-phase-stepper motor	RS-232	9-22
C-600	High-performance stepper-motor controller, microstep operation, linear and circular interpolation, stand-alone.	4	2-phase-stepper motor	RS-232	9-24
M-511.ix	PIIntelliStage™ precision stage with integrated 5-phase-stepper motor controller, networkable	1 – 27**	–	RS-232	7-50

### Servo-Amplifiers, Automation Platforms, PIMotion&Vision™ System

Models*	Description	Channels	Outputs for Motor Types	PC Interfaces	Page
C-809.40	4-channel servo-amplifier / interface for National Instruments controllers	4	DC-servo	–	9-26
C-880	Automation platform, very flexible, optional photometer and photonics alignment routines	4 – 18	DC-servo, piezo, voice coil	RS-232, IEEE 488	9-18
F-311	PIMotion&Vision™ system for micro- and nan positioning.	to 80 channels			8-16

### Nanopositioning Controllers see p. 6-2 ff.

\*\* Ask about custom designs.

\*\* Networkable (daisy-chain)

**See p. 9-5a - 9-5d  
for 2006 NEWS**

Piezo Actuators

Nanopositioning & Scanning Systems

Active Optics / Steering Mirrors

Tutorial: Piezo-electrics in Positioning

Capacitive Position Sensors

Piezo Drivers & Nanopositioning Controllers

Hexapods / Micropositioning

Photonics Alignment Solutions

**Motion Controllers**

Ceramic Linear Motors & Stages

Index

## C-663

## Mercury™ Step Compact Networkable Stepper Motor Controller



C-663 Mercury™ Step stepper motor controller for cost-sensitive micropositioning tasks

- High Performance at Low Cost
- Stand-Alone Functionality
- Network Capability for Multi-Axis Applications
- Compatible and Networkable with C-862 Mercury™ DC-Motor Controllers
- Joystick Port for Manual Control
- Non-Volatile Macro Memory
- Parameters Changeable On-the-Fly

The Mercury™ Step stepper motor controller is the perfect solution for cost-effective and flexible motion control applications where a precision positioner is to be controlled by a PC or PLC (programmable logic controller). The C-663 supplements the successful C-862 Mercury™ servo motor controller.

Microstepping of 1/16 full step (up to 6400 steps/rev. with PI

stepper motors) provides for ultra-smooth, high-resolution motion.

#### Multi-Axis Control, Combination of DC & Stepper Motors

The networking feature allows the user to start out with one Mercury™ controller and add more units later for multiaxis setups.

The Mercury™ Step stepper motor controller shares its programming language with the well-established Mercury™ DC-motor controller. Up to 16 Mercury™ controllers (DC and stepper) can be daisy chained and operated from one computer.

#### Flexible Automation

The C-663 offers a number of features to achieve automation

and handling tasks in research and industry in a very cost-effective way. Programming is facilitated by the high-level mnemonic command language with macro and compound-command functionality. Macros can be stored in the non-volatile memory for later recall.

For easy synchronization of motion with internal or external trigger signals four input and four output lines are provided. A joystick can also be connected for manual control.

Stand-alone capability is provided by a user-programmable autostart macro to run automation tasks at power up (no runtime computer communication required!).

#### User-Friendly: Comprehensive Software Package and Two Interface Options

Easy data interchange with laptop or PC is possible via the USB interface. To facilitate industrial applications, an RS-232 interface is also standard.

The included software supports networking of multiple controller devices. LabVIEW™ drivers and Windows DLLs allow for easy programming and integration into your system. Mercury™ Step controllers can also be operated using the PI General Command Set (GCS) via a DLL. PI-GCS allows networking of different PI-controllers such as piezo drivers and multi-axis servo controllers with minimal programming effort.

#### Contents of Delivery

Each Mercury™ Step comes with a wide-range power supply, RS-232 communications cables, a USB cable and a comprehensive software package.

#### Ordering Information

**C-663.10**  
Mercury™ Step Stepper Motor Controller with Wide-Range Power Supply

**C-663.PS**  
Wide-Range Power Supply for Mercury™ Step, 24 V

#### Application Examples

- Flexible automation
- Handling
- Quality control
- Testing equipment
- Photonics applications
- Fiber positioning



## Technical Data

<b>Models</b>	<b>C-663</b>
Function	Stepper motor controller, stand-alone capability
Drive type	2-phase stepper motor
Channels	1
<b>Motion and control</b>	
Trajectory profile modes	Trapezoidal, point-to-point
Microstep resolution	1/16 full step
Limit switches	2 x TTL, programmable
Reference switches	1 x TTL, programmable
Motor brake	1 x TTL, programmable
<b>Electrical properties</b>	
Operating voltage	15 to 30 V
Current limitation per motor phase	1000 mA
<b>Interface and operation</b>	
Interface/Communication	USB, RS-232 (bus architecture)
Motor connector	Sub-D 15 (f)
Controller network	Up to 16 units* on single interface
I/O ports	4 analog/digital in, 4 digital out
Command set	Mercury™ native command set, GCS
User software	MMCRUN, PIMikroMove®
Software drivers	GCS (PI General Command Set)-DLL, LabVIEW™ drivers, native Mercury™ DLL
Supported functionality	Start-up macro
Manual control	Joystick, Y-cable for 2D motion, pushbutton box
<b>Miscellaneous</b>	
Operating temperature range	0 to 50 °C
Mass	0.3 kg
Dimensions	130 x 76 x 40 mm <sup>3</sup>

\*16 with USB; 6 with RS-232 (depending on RS-232 output driver of PC)

Piezo Actuators

Nanopositioning &amp; Scanning Systems

Active Optics / Steering Mirrors

Tutorial: Piezo-electrics in Positioning

Capacitive Position Sensors

Piezo Drivers &amp; Nanopositioning Controllers

Hexapods / Micropositioning

Photonics Alignment Solutions

**Motion Controllers**

Ceramic Linear Motors &amp; Stages

Index

## E-755

## Digital Controller for NEXLINE® Nanopositioning Linear Drives



- Special Control Algorithms for NEXLINE® Nanopositioning Linear Drives
- 32-Bit Digital Filters
- 24-Bit DAC Resolution
- Fully Programmable Low-Pass and Notch Filters
- Non-Volatile User Settings and Last-Position Data
- PI General Command Set Compatible

E-755 digital nanopositioning controllers are designed to drive the novel, 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.

#### Application Examples

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

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: a high-resolution, high dynamics direct piezo mode, with basically unlimited resolution, and a long-range mode with theoretically unlimited travel range.

#### High-Resolution Closed-Loop 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 an output range of  $\pm 250$  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 use without referencing next time it is powered up.

#### Zero-Voltage Control Mode Promotes Extreme Actuator Lifetime

NEXLINE® nanopositioning actuators can often be found in inaccessible locations deep inside complex equipment, where nanometer-precise alignment and vibration cancellation are required. This makes the long lifetime of NEXLINE® drives especially advantageous. The E-755 firmware incorporates a special procedure to bring the NEXLINE® actuator to a full-holding-force zero-drive-voltage condition, no matter where it is along its travel range. This eliminates long-term offset voltages, which can limit the lifetime of conventional piezo drives.

#### Ordering Information

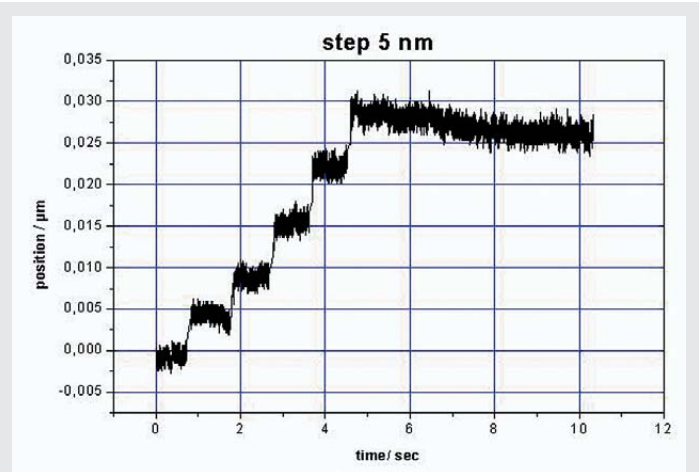
**E-755.1A1**  
Digital Controller for Closed-Loop NEXLINE® Nanopositioning Linear Drives with Incremental Encoder

**E-755.101**  
Digital Controller for Open-Loop NEXLINE® Nanopositioning Linear Drives

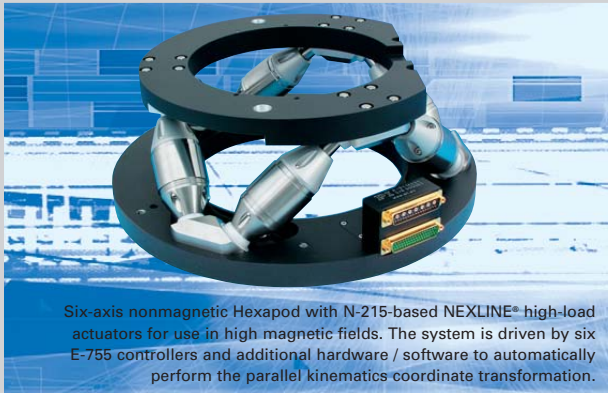
#### Linearization

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.

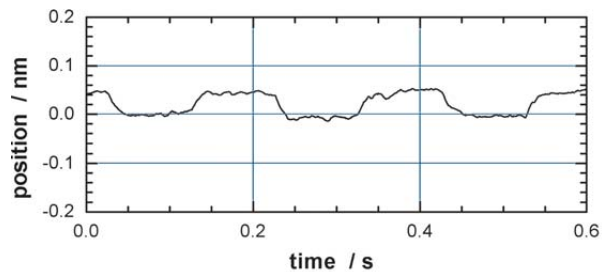
The products described in this datasheet are in part protected by the following patents: US-patent No. 6,800,984 German patent No. 10148267



5 nm steps performed by a system consisting of the N-214 NEXLINE® nanopositioner and the E-755.1A1 controller, measured by a Zygo ZMI 2000 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.



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 / software to automatically perform the parallel kinematics coordinate transformation.



50 picometer steps with a NEXLINE® drive in open-loop mode. Measured with external, ultra-high-resolution, capacitive sensor.

## Technical Data

Models	E-755.1A1	E-755.101
Function	Digital controller for NEXLINE® linear drives, incremental encoder	Digital controller for NEXLINE® linear drives, open-loop
Sensor channels	1 incremental sensor	-
Logical axes	1	1
Piezo linear amplifier channels	4	4
Processor	DSP 32-bit floating point, 50 MHz	DSP 32-bit floating point, 50 MHz
Sensor sampling time	0.1 ms	-
Servo update time	0.2 ms	-
Dynamic cycle time	0.2 ms	0.1 ms
Effective DAC Resolution	24-bit	24-bit
Maximum output power	15 W / channel	15 W / channel
Average output power	3 W / channel, limited by temperature sensor	3 W / channel, limited by temperature sensor
Peak output current (20 ms)	60 mA / channel	60 mA / channel
Average output current	25 mA / channel, limited by temperature sensor	25 mA / channel, limited by temperature sensor
Current limitation	Short-circuit proof	Short-circuit proof
Temperature sensor	max. 70 °C, high voltage output is automatically deactivated if temperature out of range	max. 70 °C, high voltage output is automatically deactivated if temperature out of range
Output voltage	-250 to +250 V	-250 to +250 V
PZT voltage output socket	Sub-D special	Sub-D special
Sensor socket	Sub-D 15 (m)	-
Interfaces	RS-232	RS-232
Dimensions	264 x 260 x 47 mm	264 x 260 x 47 mm
Weight	2.3 kg	2.3 kg
Operating voltage	24 V (E-750.PS power supply 20 to 30 V DC, 1.25 A, 5 A / 0.1 ms)	24 V (E-750.PS power supply 20 to 30 V DC, 1.25 A, 5 A / 0.1 ms)

Piezo Actuators

Nanopositioning &amp; Scanning Systems

Active Optics / Steering Mirrors

Tutorial: Piezo-electrics in Positioning

Capacitive Position Sensors

Piezo Drivers &amp; Nanopositioning Controllers

Hexapods / Micropositioning

Photonics Alignment Solutions

Motion Controllers

**Ceramic Linear Motors & Stages**

Index

Piezo Actuators

Nanopositioning & Scanning Systems

Active Optics / Steering Mirrors

Tutorial: Piezo-electrics in Positioning

Capacitive Position Sensors

Piezo Drivers & Nanopositioning Controllers

Hexapods / Micropositioning

Photonics Alignment Solutions

**Motion Controllers**

Ceramic Linear Motors & Stages

# C-862

## Mercury™ II DC-Motor Controller/Driver



Mercury™ II Palm-Top Controller front and back view. Euro and dollar coins for size comparison.

- High Performance at Low Cost
- Integrated Driver, no External Amplifier Required
- Stand-Alone Functionality
- Daisy-Chain Network for Multi-Axis Applications
- Easy Address Setting
- Macro Command Language
- Non-Volatile EEPROM for Macros and Parameters
- Parameters can Be Changed On-the-Fly
- TTL Inputs for Limit & Origin Switches
- Motor-Brake Control
- Additional TTL I/O Lines

The Mercury™ Palm-Top DC-Motor Controller is the perfect solution for motion control applications where a precision positioner is to be controlled by a PC or PLC (programmable logic controller).

### Integrated Amplifier and PWM Outputs

The unique Mercury™ concept combines a high-performance motion controller and an inte-

grated power amplifier in a small package. Additional PWM control outputs allow the direct operation of any DC-motor-driven PI micro-positioning system—even high-speed stages such as the M-500 ActiveDrive™ Translation Stages—reducing costs, increasing reliability and simplifying the setup.

### Dual Processor Architecture

The Mercury™ II controller employs a highly specialized processor providing high-performance PID motion control with many options for trajectory generation and filter settings. Position, velocity and other motion parameters can be changed on-the-fly. For increased system safety and performance, all communica-

tion and command parsing activity is handled by a second, independent processor. Any quadrature TTL incremental encoder can be used for position feedback (linear scales, rotary encoders, interferometers).

Limit and origin switch inputs and a motor-brake output are also standard.

### Macro Command Language

The Mercury™ II controller offers a high-level mnemonic command language with macro and compound command functionality. Macros can be stored in the non-volatile EEPROM for later recall. An autostart macro is available to run automation tasks at power up (no run-time computer communication required!).

### Network Capability

Up to 6 Mercury™ II controllers can be daisy-chained for multi-axis motion control applications.



Combination of 6 networked Mercury® Controllers

### Ordering Information

- C-862.00**  
Mercury™ II Palm-Top DC-Motor Controller Set, Including Power Supply
- C-890.PS**  
Wide-Range Power Supply for Mercury Controller
- C-862.CN**  
Additional Network Connecting Cable
- C-862.IO**  
I/O Connecting Cable with Open End for C-862 Mercury™ Controller
- C-862.PB3**  
Pushbutton Box for C-862
- C-663.00**  
Mercury™-Step Stepper Motor Controller, Including Power Supply

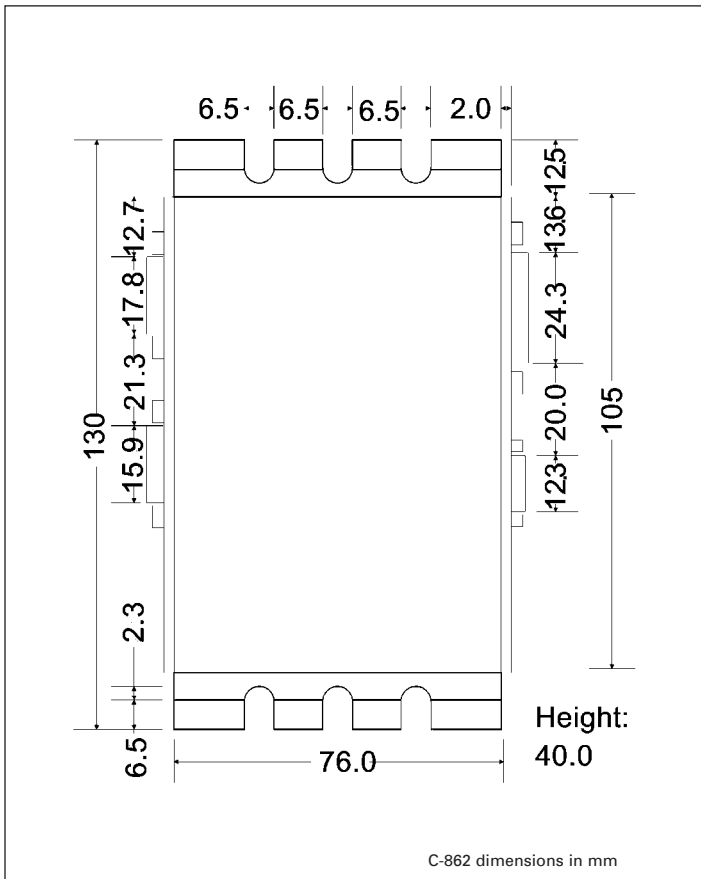
Each controller includes software, an RS-232 communications cable and a network cable. The C-862.00 set also includes the C-890.PS wide-range power supply, network-cable and a null modem cable for PC connection.

### Stepper Motors

A stepper motor version of the C-862 is available as part number C-663.

### Application Examples

- Flexible automation
- Quality control
- Test equipment
- Photonics packaging
- Fiber alignment



Mercury™ software, showing the terminal window and selection of controllers 1 through 4.

## Technical Data

<b>Models</b>	<b>C-862</b>
Function	Stand-alone DC-servo-motor controller
Servo characteristics	31-bit velocity, acceleration & position registers, 16-bit programmable PID, 256 $\mu$ s, parameter changes on-the-fly
Output power	15-watt PWM on-board, additional output for PWM drivers
Encoder input	A/B (quadrature) TTL signals (single-ended or RS-422 differential mode), max. $10^6$ counts / sec
Stall detection	Motor stop, servo off, triggered by programmable position error
Limit switches	2 TTL (pull-up/pull-down, programmable)
Origin switches	1 TTL (pull-up/pull-down, programmable), real-time position capture
Motor brake output	5 V TTL, software controllable
Additional I/O Lines	5 V TTL
Interface / Communication	RS-232, 9-pin (m) sub-D (cable included)
Command Set:	40 high-level mnemonic commands, ASCII format, compound & macro command capability (non-volatile EEPROM)
Motor connector	15-pin (f) sub-D
Internal safety features	Watchdog timer
Operating voltage	12 - 15 V, 1 - 2 A
Weight	0.3 kg

Piezo Actuators

Nanopositioning &amp; Scanning Systems

Active Optics / Steering Mirrors

Tutorial: Piezo-electrics in Positioning

Capacitive Position Sensors

Piezo Drivers &amp; Nanopositioning Controllers

Hexapods / Micropositioning

Photonics Alignment Solutions

**Motion Controllers**

Ceramic Linear Motors &amp; Stages

Index

# C-843

## Servo Motion Controller/Driver PCI Board for 2 / 4 Axes



C-843.41 DC-motor controller board with M-110.DG linear stage, M-235.5DG heavy duty linear actuator, M-511.DD direct drive translation stage and M-501.1DG vertical stage. No external amplifier is required to drive any of these or other PI stages. Small motors are driven through the C-843's onboard linear amplifiers, direct-drive PI stages (e.g. M-511.DD) employ ActiveDrive™ controlled off the C-843's PWM outputs.

- **Two and Four Axis Version**
- **Very Cost-Effective: Servo Amplifiers On-Board**
- **Additional PWM Outputs for High-Power Motors**
- **Trapezoidal Curve, S-Curve and Velocity Profile**
- **32 kSamples RAM for High-Speed Buffer Operations**
- **16 I/O Lines for Flexible Automation**
- **Fast PCI communication, 120 μs for position read**
- **Motor-Brake Control Output**
- **Extensive Software Support**
- **General Command Set (GCS) Compatible (see p. 9-28)**

The C-843 PCI motion controller card drives up to 4 axes of micropositioning equipment. Because there is no need for external servo-amplifiers, this new card is a very cost-effective, easy-to-set-up solution.

### On-Board Servo-Amplifiers

Unlike other PCI controller cards, the new C-843 comes with on-board, low-noise linear amplifiers for the small DC motors used in most compact micropositioning stages and actuators.

In addition, PWM outputs are available to drive more powerful equipment (all direct-drive

translation and rotation stages from PI feature the integrated ActiveDrive™ PWM amplifiers, and also connect to the C-843 with no external power amplifiers).

The PWM mode and linear amplifier mode can be programmed individually for each of the 4 (or 2) channels.

### High-Performance PID Control

The C-843 employs a fast DSP (digital signal processor) providing high-performance PID motion control with many options for trajectory generation and filter settings for superior positioning and tracking

accuracy. Position, velocity, acceleration and several other motion parameters can be programmed individually for each axis on-the-fly. High-bandwidth counters (5 MHz) support differential encoder feedback (incremental rotary encoders or linear scales) for fast and accurate positioning.

### I/O for Flexible Automation

In addition to 3 TTL inputs per channel for limit and reference signals, 16 more I/O lines are available for flexible automation tasks (trigger functions, etc.). The C-843 also features motor-brake output lines (e.g. for M-531.DDB stages).

### High-Speed Buffering

The integrated 32 k-sample trace memory allows online buffering (read and write) at integer multiples of the servo-loop time of up to four independent system variables (positions, velocities, internal register contents, etc.) This allows the observation of the motion system and also performing customized trajectory profiles.

### Easy-to-Use Software / General Command Set (GCS)

For ease of operation, the C-843 is compatible with the PI General Command Set, designed to allow flexible combinations with other PI motion controllers (fiber aligners, stepper-motor controllers and piezo controllers for ultra-fast, sub-nanometer motion control). For more information on GCS, see p. 9-28.

Communications to/from the board consist of packet-based messages passed via memory access. An interrupt line is provided so that the chipset can signal the PC when special conditions arise, such as recep-

### Ordering Information

- C-843.21**  
DC-Motor Controller PCI PC Board, 2-Axis
- C-843.41**  
DC-Motor Controller PCI PC Board, 4-Axis
- C-843.JS**  
Joystick and PCI Interface Board for C-843 Motor Controller

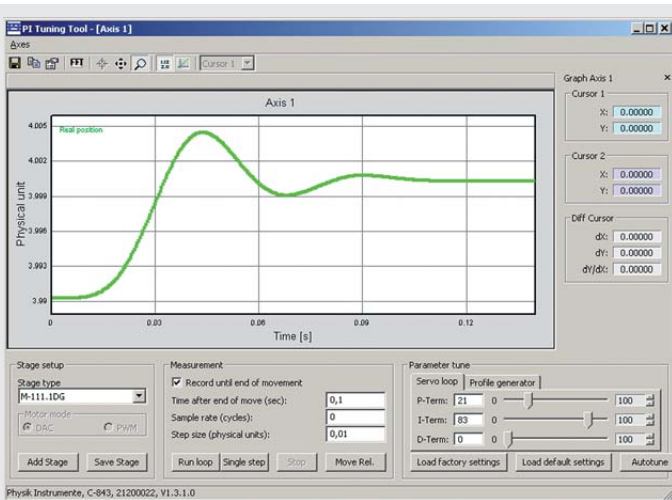
tion of an encoder index pulse. For system programmers the C-843 offers direct access to the DSP.

In addition to an ample array of software tools, such as LabView™ drivers and DLL libraries, the C-843 comes with the PIMikroMove® operating software, which provides a convenient interface for stage operation including tuning tool, joystick operation, terminal and macro editor.

To facilitate setup, any supported PI micropositioning system just needs to be selected from a PIMikroMove® menu and all default control parameters will be set.

Stage	K	Target	Step size	Position	HALT	State	Velocity	Servo
1	M-235.5DD	0.000000	0.100000	0.000000	HALT	on target	15.000000	✓
2	M-805.2DD	100.0000	0.1000	100.0000	HALT	unreferenced	25.000000	✓
3	M-511.PD	56.0000	1.0000	56.0000	HALT	on target	62.500000	✓
4	M-110.1DG	0.000000	0.010000	0.000000	HALT	on target	1.000000	✓

PIMikroMove® tabular presentation of four connected axes with display of absolute and relative positioning input, current position, halt axis button, state and velocity setting.



The Tuning Tool which is integrated in PIMikroMove® demonstrates acquiring and displaying step and settle data of micropositioning systems. Controls allow adjustment of the PID parameters for best performance.

## Technical Data

Models	C-843
Function	PC plug-in DC-servo-motor controller board, 32-bit plug-and-play PCI-bus interface, supported by main boards with 3.3 V and 5 V PCI bus connectors (universal card)
Axes	2 (C-843.21); 4 (C-843.41)
Servo characteristics	Programmable PID V-ff filter, parameter changes on-the-fly
Profile modes	Trapezoidal, S-curve, velocity profile
Output power / resolution	Analog 6 watts/channel (drawn directly from PC power supply), 12-bit D/A converters, PWM 10-bit, 24.5 kHz
Current limitation	500 mA per channel (short-circuit-proof)
Encoder input	AB (quadrature) differential TTL signals, $5 \times 10^6$ counts/s
Stall detection	Servo off, triggered by programmable position error
Limit switches	2 TTL / axis (active high/low, programmable)
Reference switches	1 TTL / axis (active high/low, programmable)
I/O ports	8 TTL inputs, 8 TTL outputs
Motor connectors	15-pin (f) sub-D per channel (2 on board + 2 on bracket for C-843.41)
Interface/communication	PC PCI bus
Command set	PI General Command Set (see p. 9-28)

Piezo Actuators

Nanopositioning &amp; Scanning Systems

Active Optics / Steering Mirrors

Tutorial: Piezo-electrics in Positioning

Capacitive Position Sensors

Piezo Drivers &amp; Nanopositioning Controllers

Hexapods / Micropositioning

Photonics Alignment Solutions

## Motion Controllers

Ceramic Linear Motors &amp; Stages

Index

# C-848

## DC-Motor Controller for 2 / 4 Axes



- **Integrated Linear Power Amplifiers and PWM Outputs**
- **Simultaneous Control of up to 4 DC Servo-Motors**
- **Powerful Macro Command Language**
- **Programmable Torque Limit**
- **Fast 32-bit Digital PID V-ff Servo Loop**
- **16 I/O Lines for Flexible Automation**
- **Electronic Gearing**
- **Motor-Brake Control Output**
- **Extensive Software Support**
- **RS-232 and Optional IEEE-488.2 Interfaces**
- **General Command Set (GCS) Compatible**

The C-848 is a flexible, multi-purpose, rackmount positioning and motion controller for DC servo-motors. It is designed for general positioning and automation tasks in research and industry.

### Flexibility, Multi-Processor Architecture

Based on a rugged, high-performance industrial PC, the C-848 offers the flexibility required in today's demanding and rapidly changing automation, prototyping and production processes. In addition to the general processor handling communication and macro command execution, a fast DSP motion-control chip set is dedicated to trajectory generation and servo-control. In addition

to 3 inputs per channel for limit switches and home position, eight TTL inputs and eight TTL outputs are available for flexible automation.

The C-848 provides flexible and fast high-level-command handling and has advanced features such as stackable macros. The command language complies with the PI General Command Set, which is a user-friendly, well structured language reflecting the device's functionality. The C-848 also offers advanced features such as linear interpolation, electronic gearing, real-time origin position capture and fast 32-bit PID +V-ff servo-control parameters (can be changed on-the-fly).

### Integrated Servo Amplifiers / PWM Output

Integrated, low-noise, 5-watt linear power amplifiers allow operation of any PI micropositioning system without additional external amplifiers, reducing costs and simplifying the setup. In addition to the linear motor drivers, PWM (pulse width modulation) output signals are available to drive PI micropositioning stages equipped with ActiveDrive™ motors (e.g. M-511.DD, M-126.PD) or external PWM power amplifiers from other manufacturers.

### Easy-to-Use Software / General Command Set (GCS)

For ease of operation, the C-848 is compatible with the PI General Command Set, designed to allow flexible combinations with other PI motion controllers (fiber aligners, stepper-motor controllers and piezo controllers for ultra-fast, sub-nanometer motion control). This intuitive command set saves valuable programming time by its convenient and easy-to-remember structure. For more information on GCS, see p. 9-28.

Control of the C-848 is provided through the RS-232 or an optional IEEE-488 interface. For manual control, the unit can be operated with a C-819.10 joystick.

In addition to an ample array of software tools such as LabView™ drivers and DLL libraries, the C-848 comes with the operating software C-848 Control, providing all functions for single command execution as well as macro command facilities.

To facilitate setup, any supported PI micropositioning stage just needs to be selected from a menu and all default control

### Ordering Information

**C-848.40**  
DC-Motor Controller, 4 Axes,  
19" Rack Mount, RS-232

**C-848.40i**  
DC-Motor Controller, 4 Axes,  
19" Rack Mount, RS-232 and  
IEEE488

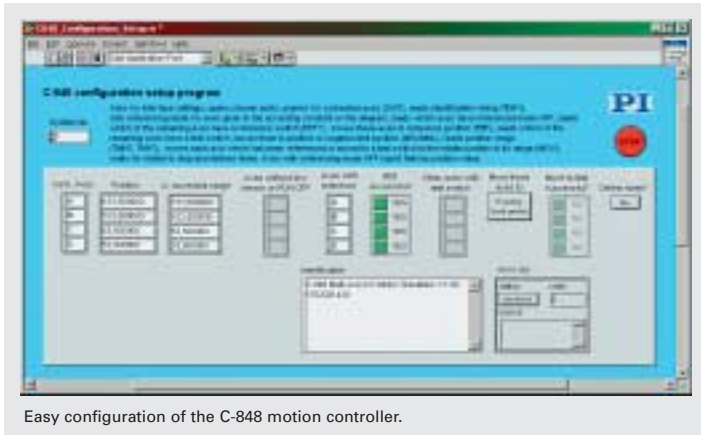
**C-848.20**  
DC-Motor Controller, 2 Axes,  
19" Rack Mount, RS-232

**C-848.20i**  
DC-Motor Controller, 2 Axes,  
19" Rack Mount, RS-232 and  
IEEE488

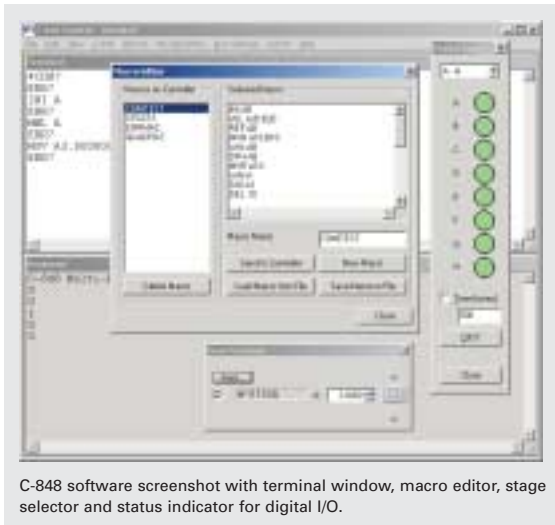
### Accessories

**C-819.10**  
Analog Joystick

parameters will be set. The C-848 can also run in stand-alone mode, and a standard computer keyboard and monitor can be plugged for direct programming.



Easy configuration of the C-848 motion controller.



C-848 software screenshot with terminal window, macro editor, stage selector and status indicator for digital I/O.

Piezo Actuators

Nanopositioning &amp; Scanning Systems

Active Optics / Steering Mirrors

Tutorial: Piezo-electrics in Positioning

Capacitive Position Sensors

Piezo Drivers &amp; Nanopositioning Controllers

Hexapods / Micropositioning

Photonics Alignment Solutions

**Motion Controllers**

Ceramic Linear Motors &amp; Stages

Index

## Technical Data

Models	C-848
Function	Rack-mountable DC-servo-motor controller
Channels	4 (C-848.40), 2 (C-848.20)
Servo characteristics	32-bit programmable PID V-ff filter, 100 $\mu$ s/ enabled axis; parameter changes on-the-fly
Profile modes	Trapezoidal, electronic gearing
Output power / resolution	Analog H-bridge $\pm$ 12 V, 5 watts/channel, 12-bit D/A converters, optional output for PWM drivers (10 bit, 24 kHz)
Current limitation	1 A peak (short-circuit proof)
Encoder input	AB (quadrature) TTL signals (single-ended or RS-422 differential mode), max. 10 <sup>6</sup> counts / sec
Stall detection	Motor stop, triggered by programmable position error
Limit switches (per axis)	2 TTL programmable soft limits
Origin switches (per axis)	1 TTL real-time position capture
I/O ports	8 TTL inputs, 8 TTL outputs (pull-up)
Motor brake output	12 V, software controllable
Interface / Communication	RS-232 (cable included), (IEEE 488.2 optional)
Command Set	>100 high-level commands, PI General Command Set compatible (see p. 9-28)
Host software & programming Tools	C-848 Control operating program, LabView™ drivers, DLL + COM for C, Pascal, BASIC for Windows™
Motor connectors (per axis)	15-pin (f) sub-D
Operating voltage	90 to 264 VAC, 50 to 60 Hz, wide range P/S
Dimensions	447 x 450 x 90 mm (19" rack mountable)
Weight	8.4 kg

# C-865

## High-Speed, Closed-Loop Controller/Driver for PLine® Ultrasonic Piezo Linear Motors



C-865 with a PLine® M-663 miniature translation stage.

- **Optimized for PLine® Piezo Linear Motors**
- **High-Speed Encoder Input: 35 MHz**
- **PID Servo Algorithm with Dynamic Parameter Switching**
- **Integrated Piezomotor Drive Electronics**
- **S-Curve Profile Generator**
- **Limit Switch Control**
- **3 TTL Inputs, 3 TTL Outputs**
- **Analog Input**
- **Comprehensive High-Level Language Command Set**
- **Extensive Software Support, GCS Compatible (see p. 9-28)**
- **1 Mbit RAM for Real-Time Tracing**

The C-865 controller was specially designed for the newest generation of PLine® piezo linear motors and stages. This compact unit contains not only servo-control and communications circuitry, but also the drive electronics for the piezoceramic motors.

### Application Examples

- Flexible automation
- Quality control
- Test equipment
- Biotechnology
- Photonics
- Fiber alignment

### Specialized PID Servo-Controller

The C-865 uses a highly specialized DSP (Digital Signal Processor) to handle the PID servo-control algorithm, which has a wide range of options for controlling and programming acceleration, velocity or settling as well as other system functions.

Because of the static friction which is typical for piezomotors, the controller has a number of special features, including dynamic parameter switching for an optimized high-speed motion and settling behavior. The high-bandwidth encoder input with a limit fre-

quency of 35 MHz has ample reserves for the high speeds characteristic of piezo linear motors.

### Integrated Drive Electronics, Optimized for PLine® Stages and Motors

To assure the best possible system performance, the integrated drive electronics is fine-tuned to the connected stage at the factory. M-663 miniature-stages can then, for example, achieve speeds up to 500 mm/s and more with a resolution of 0.1 µm and settling times of less than 10 ms.

### Easy-to-Use Software / General Command Set (GCS)

For ease of operation, the C-865 is compatible with the PI General Command Set, designed to allow flexible combinations with other PI motion controllers (fiber aligners, stepper-motor controllers and piezo controllers for ultra-fast, sub-nanometer motion control). For more information on GCS, see p. 9-28.

### Communication/Programming

Programming the C-865 is simplified by comprehensive software support, including LabView™ drivers and DLLs. All units are equipped with both USB and RS-232 Interfaces for communication with the host PC. In addition to the easy programming with GCS commands, direct DSP register access with low-level commands is also possible.

### Advantages of PLine® Micropositioning Systems

The piezoceramic drives used in PLine® devices have a number of advantages over classical drives:

- Higher Accelerations, up to 20 g

### Ordering Information

- C-865.161**  
Piezomotor Controller with Drive Electronics, 1 Channel, for PLine® Systems with P-661 Motors
- C-865.165**  
Piezomotor Controller with Drive Electronics, 1 Channel, for PLine® M-665 Translation Stages

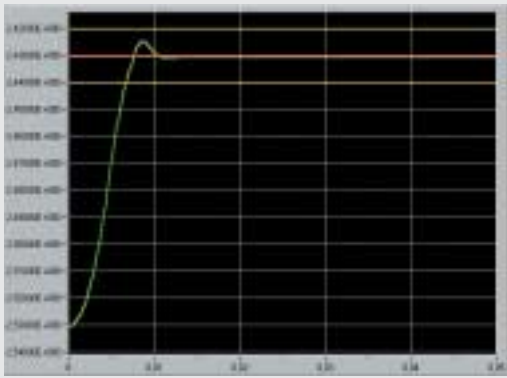
- Speeds to 500 mm/s and more
- Small Form Factor
- Self-Locking at Rest
- No Shafts, Gears or Other Rotating Parts

### Notes

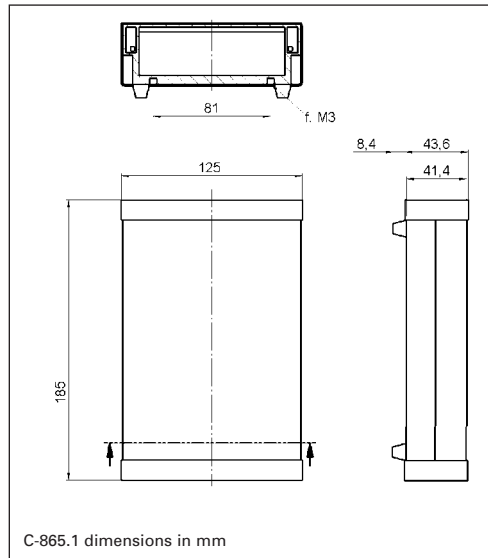
To reduce the number of components in the system, the piezomotor drive electronics has been integrated in the C-865 controller. Models C-865.161 and C-865.165 are optimized for positioners with P-661 motors and M-665 stages, respectively.



The C-865 operating software facilitates optimization and convenient operation of PLine® positioning systems. The results of the parameter setting can immediately be seen in the display as shown in the next graphics.



Settling behavior of a PI Line® M-663 linear stage with 100 g load after a 0.1 mm step. With dynamic parameter switching and the high servo rate, the C-865 can reach a stable position to within 0.1  $\mu\text{m}$  (1 encoder count) in only 10 ms. Vertical axis displays motion in mm, horizontal axis time in seconds.



## Technical Data

Models	C-865.1xx
Function	Controller / Driver for PI Line® Piezomotor Systems
Axes	1
Controller characteristics	Programmable PID, V-ff filter, on-the-fly parameter change
Trajectory profile	S-Curve
Resolution / output voltage	16-bit DAC, 0 to 60 Vrms (C-865.x61) or 0 to 170 Vrms (C-865.x65), at piezomotor MDR14 connector
Encoder input	A/B differential signal, 35 x 10 <sup>6</sup> Impulse/s, 4 x interpolated
Stall detection	Stop motor, deactivate servo, when position error exceeds programmable threshold.
Limit switch control	2 programmable TTL lines (active high/low)
Reference switch	1 programmable TTL line (active high/low)
Operating voltage	12 V DC, external power supply (included)
Operating current	190 mA (w/o piezomotor), current limit 1 A
Interfaces / communication	USB 1.1; RS-232, max. 115,200 Baud
Analog and digital I/O connections	DB9 Connector
Command set	PI General Command Set (GCS), see p. 9-28
Weight	565 g
Dimensions	185 x 125 x 44 mm

Piezo Actuators

Nanopositioning &amp; Scanning Systems

Active Optics / Steering Mirrors

Tutorial: Piezo-electrics in Positioning

Capacitive Position Sensors

Piezo Drivers &amp; Nanopositioning Controllers

Hexapods / Micropositioning

Photonics Alignment Solutions

**Motion Controllers**

Ceramic Linear Motors &amp; Stages

Index

# C-170

## RedStone Open-Loop Controller/Driver for PLine® Ultrasonic Piezo Linear Motors



C-170 RedStone controller with two M-662.470 micro positioning stages.

- Drives 2 PLine® Open-Loop Piezo Linear Motor Stages
- Integrated Programmable Motion Sequencer and Ultrasonic Driver for 2 Axes (No External Driver Required)
- Single 12 VDC Operation
- Stand-Alone Functionality
- Analog Joystick Option
- Network Option for Multi-Axis Applications
- Flash Memory for Motion Sequences and Parameters
- 8 Programmable TTL Input/Output Lines
- 4 Analog Inputs

C-170 RedStone controllers are compact and cost-effective units for the operation of open-

loop PLine® piezo linear motors and stages.

They incorporate programmable microsecond timers and ultrasonic drivers to operate one or two motors and/or micropositioning stages under computer control or in an autonomous stand-alone mode.

### Integrated Drive Electronics, Optimized for PLine® Stages and Motors

To assure the best possible system performance, the integrated drive electronics is fine-tuned to the connected stage at the factory. Micropositioning systems such as the M-661/M-662 miniature-stages can then achieve speeds of

500 mm/s and more with minimum incremental motion of 50 nm.

The integrated piezomotor driver electronics is also available as a separate product for use with external pulse generators (ordering number C-181).

### Driving PLine® Motors in Open-Loop

The distance and velocity traveled corresponds to the width, frequency and number of motor-on pulses. By varying the pulse width, the step length and thus the motor velocity can be controlled. As the mechanical environment also influences the motion, the size of single steps is not highly repeatable. For precise position control, a system with a position feedback device is recommended (closed-loop operation).

In addition to the single step and step sequence operating modes, RedStone controllers provide a high-speed CW mode with acceleration to 20 g and velocities to 500 mm/s and more. The CW mode is practical for applications where fast end-to-end motion is required, such as shutter or switching applications.

### Complete Software Package and Macro Command Language

RedStone controllers come with a complete software package, consisting of DLL and LabView™ drivers and turnkey operating software for all Windows™ systems.

The RedStone high-level command language was derived from the successful C-862 Mercury DC-Motor controller. Motion sequences can be stored in non-volatile memory for execution on demand by software commands or external

### Ordering Information

- C-170.161**  
RedStone Open-Loop Piezomotor Controller/Driver, 1 Channel, for PLine® Systems with P-661 Motors
- C-170.261**  
RedStone Open-Loop Piezomotor Controller/Driver, 2 Channels, for PLine® Systems with P-661 Motors
- C-890.PS**  
Wide-Range Power Supply
- C-862.CN**  
Network Connecting Cable
- C-862.PB3**  
Software-Accessible Push Button Box
- C-819.20**  
Analog Joystick

TTL-trigger signals. An auto-start macro can be defined to call macro commands at power-up without the need for computer communications.

### Advantages of PLine® Micropositioning Systems

The piezoceramic drives used in PLine® devices have a number of advantages over classical drives:

- Higher accelerations, up to 20 g
- Velocities up to 500 mm/s and more
- Small form factor
- Self-locking when at rest
- No shafts, gears or other rotating parts

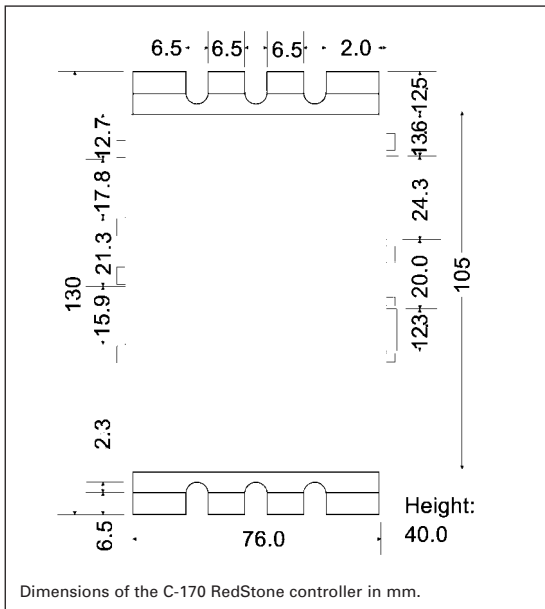
### Notes

To reduce the number of components in the system, the piezomotor drive electronics has been integrated in the C-170 controller. The model C-170.161 is optimized for positioners with piezomotors P-661.

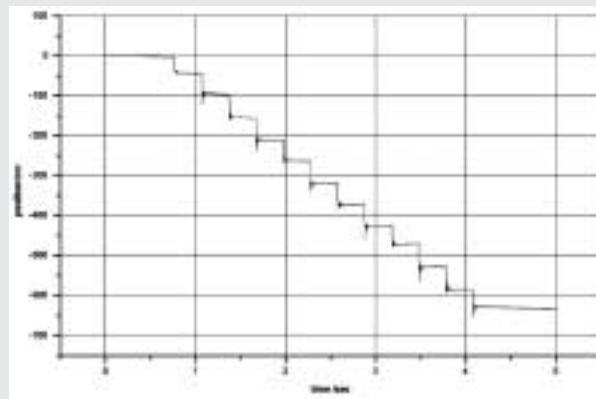
The products described in this document are in part protected by the following patents: US-Patent No. 6,765,335

### Application Examples

- Test equipment
- Micromachining
- Scanning applications
- Life sciences
- Metrology
- Quality control
- Switches, shutters, sorters
- R&D
- Photonics packaging automation
- Fiber optic instrumentation



RedStone operating software allows easy setting of the open-loop motion parameters step size, frequency and number of steps within a move (burst).



50 nm steps created with a system consisting of C-170.161 RedStone and PILine® M-662.470 open-loop piezo linear motor stage.

## Technical Data

Models	C-170.1xx; C-170.2xx RedStone
Function	Controller/driver for open-loop PILine® piezo linear motors / stages
Axes	1 (C-170.1xx); 2 (C-170.2xx)
Supply voltage	12 V DC from external power supply (included in delivery)
Power	0.6 W idle, 6 W per channel max.
Interface/communication	RS-232, 9600 baud
Network	Daisy-chain up to 8 units, address setting via dip switch
Analog & digital I/O connector	9-pin socket
Command set	40 high-level ASCII commands; 32 macro commands; 1 autostart macro
Weight	310 g
Size	130 x 76 x 40 mm
Firmware	EEPROM resident
Firmware update	via serial port

Piezo Actuators

Nanopositioning &amp; Scanning Systems

Active Optics / Steering Mirrors

Tutorial: Piezo-electrics in Positioning

Capacitive Position Sensors

Piezo Drivers &amp; Nanopositioning Controllers

Hexapods / Micropositioning

Photonics Alignment Solutions

**Motion Controllers**

Ceramic Linear Motors &amp; Stages

Index

# C-180 · C-181 · C-184 · C-185

## Analog and Pulsed Drivers for PLine® Ultrasonic Piezo Linear Motors



C-181.161 drive electronics with M-662.470 PLine® stage (20 mm, open-loop)

- For PLine® Ultrasonic OEM Motors and Stages
- Pulsed or Analog Drive
- OEM Board or Interface Box
- Ideal also with Third Party Controllers

C-180 to C-185 are single-channel drive electronics for PLine® ultrasonic piezomotors and stages. They were developed for customers who do not want to use the fully integrated C-170 and C-865 PLine® controllers/drivers. Drive electronics for piezomotors convert an analog or PWM input signal into a high-frequency drive signal which excites the required oscillations in the piezomotor and cause it to move.

### OEM or Packaged 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, independent of control signal type, 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.

### C-180, C-181 – Pulsed-Mode Operation

Pulsed operation with C-180 (OEM-Board) or C-181 (box with interface connectors) is especially suited for applications requiring small steps or rapid end-to-end motion, as in microscopy, automation or similar applications. The motor can be controlled with 5 V TTL pulses connected to the signal input on the driver electronics. The width of the pulses will determine the approximate length of the steps the motor makes. The smallest possible step is about 50 nm, requiring a pulse of about 10 µs in duration. The pulse rate and width can be used to influence the step size and rate, thus determining the velocity.

In addition to the single-step and step-sequence operating

modes, PLine® motors and stages can be operated in a high-speed CW mode with acceleration up to 20 g and velocities up to 500 mm/s and more. The CW mode is practical for applications where fast end-to-end motion is required, such as shutter or switching applications.

A flexible, programmable pulse generator with integrated C-180 driver is available as C-170.161.

### C-184, C-185 Analog Driver

The C-185 analog driver controls the motor speed as a function of a 10 V differential analog input. With an external position sensor and a controller, it is thus possible to set up a very fast, closed-loop system. The M-663 stage (see p. 10-18) with integrated linear encoder can also be run with this driver.

For closed-loop systems, PI also provides the C-865 controller (see p. 9-12), which already contains the analog drive electronics.

### Ordering Information

**C-180.161**  
Pulse-Mode OEM Drive Electronics for PLine® P-661 Piezo Linear Motors

**C-181.161**  
Pulse-Mode Drive Electronics for PLine® P-661 Piezo Linear Motors or Translation Stages with P-661 Motors; with Power Supply

**C-184.161**  
Analog OEM Drive Electronics for PLine® P-661 Piezo Linear Motors

**C-184.165**  
Analog OEM Drive Electronics for PLine® M-665 Translation Stages

**C-185.161**  
Analog Drive Electronics for PLine® P-661 Piezo Linear Motors or Translation Stages with P-661 Motors; with Power Supply

**C-185.165**  
Analog Drive Electronics for PLine® M-665 Translation Stages; with Power Supply

### Notes

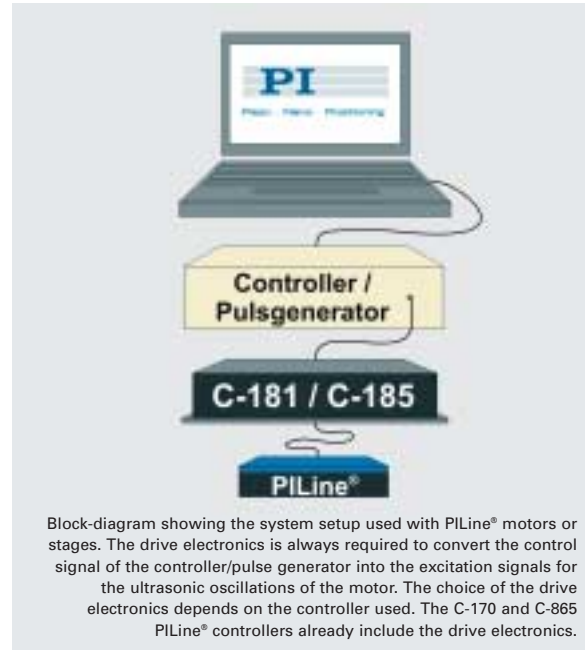
The products described in this document are in part protected by the following patents: US-Patent No. 6,765,335.



C-180 OEM driver board with P-661 PLine® OEM piezomotor.



C-185.161 drive electronics with M-663.485 P-Line® stage (20 mm travel range, closed-loop)



Block-diagram showing the system setup used with P-Line® motors or stages. The drive electronics is always required to convert the control signal of the controller/pulse generator into the excitation signals for the ultrasonic oscillations of the motor. The choice of the drive electronics depends on the controller used. The C-170 and C-865 P-Line® controllers already include the drive electronics.

Piezo Actuators

Nanopositioning &amp; Scanning Systems

Active Optics / Steering Mirrors

Tutorial: Piezo-electrics in Positioning

Capacitive Position Sensors

Piezo Drivers &amp; Nanopositioning Controllers

Hexapods / Micropositioning

Photonics Alignment Solutions

**Motion Controllers**

Ceramic Linear Motors &amp; Stages

Index

## Technical Data

Models	C-180.161	C-181.161	C-184.161	C-185.161	C-184.165	C-185.165
Function	Single-channel OEM drive electronics board, pulsed mode	Single-channel driver box, pulsed mode	Single-channel OEM drive electronics board, analog mode	Single-channel driver box, analog mode	Single-channel OEM drive electronics board, analog mode	Single-channel driver box, analog mode
Motor / stage type	P-661 P-Line® OEM piezo linear motor	P-661 piezo linear motors	P-661 piezo linear motors	P-661 piezo linear motors	M-665 translation stages	M-665 translation stages
Channels	1	1	1	1	1	1
Power supply	12 V ±10%, typ. 0.5 A	12 V, 15 W (included)	12 V, ±10%, typ. 0.5 A	12 V, 15 W (included)	12 V, ±10%, typ. 1 A	12 V, 15 W (included)
Control signal (input)	ENA (enable) and DIR (direction), TTL (but high up to 12 V allowed), Active high	ENA (enable) and DIR (direction), TTL (but high up to 12 V allowed), Active high	Differential, magnitude (max. 10 V) controls speed, polarity controls direction*	Differential, magnitude (max. 10 V) controls speed, polarity controls direction*	Differential, magnitude (max. 10 V) controls speed, polarity controls direction*	Differential, magnitude (max. 10 V) controls speed, polarity controls direction*
Output voltage to motor	3 x 60 V, 210 kHz	3 x 60 V, 210 kHz	3 x 60 V, 210 kHz	3 x 60 V, 210 kHz	3 x 170 V, 43 kHz	3 x 170 V, 43 kHz
Output power to motor	3 W	3 W	3 W	3 W	5 W	5 W
Controller connector	Soldering points	Sub-D 9	Soldering points	Sub-D 15	Soldering points	Sub-D 15
Stage/motor connector	Soldering points	LEMO EPL.0S.303.HLN	Soldering points	MDR 14 and LEMO EPL.0S.303.HLN	Soldering points	MDR 14 and LEMO EPL.0S.303.HLN
Operating temperature	+10 °C to +50 °C	+10 °C to +50 °C	+10 °C to +50 °C	+10 °C to +50 °C	+10 °C to +50 °C	+10 °C to +50 °C
Dimensions	35 x 18 mm <sup>2</sup>	108 x 34 x 56 mm <sup>3</sup>	65 x 38 mm <sup>2</sup>	108 x 34 x 76 mm <sup>3</sup>	65 x 38 mm <sup>2</sup>	108 x 34 x 76 mm <sup>3</sup>

\*Neither side of differential input may be more than 10 V from GND

# C-880

## Automation Platform



Fiber alignment configuration example. Top: C-880.00D equipped with F-206.IRU IR-photometer card, 2 x C-842.40 servo-motor control cards and E-760.3S0 piezo controller card. Bottom left: M-511.DD precision translation stage with 0.1 µm linear encoder for rapid loading/unloading; F-131.3SD hybrid fiber alignment system with 15 mm travel range in XYZ and 1 nm resolution. Bottom right: M-501.1PD precision vertical stage with 0.008 µm encoder resolution; M-061.PD rotation stage and the discontinued F-210 fiber rotator.

- Seamless Control of up to 18 Axes with Piezo Actuators, Servo-Motors, Voice Coil Drives
- Integrated High-Level Command Set Performs Scans, Alignments, etc.
- Plug-and-Play Configuration
- Integrated Amplifiers
- Large Variety of Accessories: I/O Cards, Photometers, Manual Control Pad
- Optional IEEE 488 Interface
- Software Libraries and High-Level Drivers
- Powerful Macro Command Language

**Flexibility from the Ground up**  
 The C-880 Automation Platform is a modular and highly versatile system for complex multi-axis positioning and automation tasks. It was conceived for applications ranging from photonics alignment and packaging to biotechnology.

Based on a rugged, industrial PC, it offers the flexibility expected in today's demanding prototyping and high-precision production environment.

Several basic versions and upgrades are available to coordinate combinations of up to 18 micro- and nanopositioning channels. Servo-motors, voice coil-drives and piezo actuators/stages can be controlled in almost any combination. Available options include photometer cards for fully automated fiber alignment, a relay board for flexible automation, an integrated screen and keyboard for stand-alone operation, and a manual control pad.

### Up to 273 Channels

A special version of the C-880 Controller was developed for

the SALT telescope in South Africa ([www.salt.ac.za](http://www.salt.ac.za)). This telescope, the largest in the southern hemisphere, is controlled by 9 modified and networked C-880 controllers which in turn control 273 precision linear actuators based on the M-235 DC-Mike (see p. 7-82).

### Ease of Operation, System Integration and Upgrade

All C-880s are delivered fully configured to your requirements and with all installed options tested and ready to run your positioning equipment. The sophisticated configuration engine allows you to upgrade the system at any time, change the assignment of the individual axes and replace or add controller cards easily.

Operating the system, alone or as part of a larger complex, is

### Technical Data

Models	C-880.00, C-880.00D
Axes	Up to 18 axes with (servo-motors, voice coil drives), or piezo actuators (max. 6 piezo axes)
Processor	32-bit AMD
Interfaces	RS-232, IEEE 488/GPIB, optional
Command set	PI General Command Set, ASCII communications
Dimensions	19-inch case, 450 mm x 460 mm x 180 mm
Operating voltage	100 to 250 VAC, 50 / 60 Hz

### Ordering Information

**C-880.00**  
 Automation Platform, Chassis with Power Supply, RS-232 Interface

**C-880.00D**  
 Automation Platform, Chassis with Power Supply, RS-232 Interface, Front-Panel Keypad and LCD Monitor

#### Options

**C-842.20**  
 DC-Motor Controller Card, 2 Channels

**C-842.40**  
 DC-Motor Controller Card, 4 Channels

**V-820.20**  
 Voice Coil Controller, 2 Channels

**E-760.3S0**  
 Piezo Controller for NanoCube®

#### Options and Accessories

**F-206.iRU**  
 Photometer Card, IR Range

**F-206.00U**  
 Photometer Card, Visible Range

**F-206.i3E**  
 GPIB/IEEE 488 Interface Card

**F-206.MC6**  
 Manual Control Pad

**C-880.R8**  
 Relay Board with 8 Relays

**Additional Options:**  
**See Description!**

facilitated by the C-880's open software architecture. A powerful and comprehensive high-level-language command set, including complete scan and alignment routines, reduces both the programming effort and the communications bandwidth usage.

### Application Examples

- Photonics
- Fiber alignment
- Micro-assembly
- Flexible automation
- Quality control
- Semiconductor test equipment
- Biotechnology

## Integration of Nano- and Micropositioning Drives



The F-130.3SD Hybrid Fiber Alignment System permits rapid XYZ alignment of optical fibers and other optical components with nanometer precision. Two F-130 systems can be controlled in parallel with other devices by a single C-880 controller.

The C-880 controller can be equipped with servo-controllers and power amplifiers for the following drive types:

### Fast Piezo Nanopositioning Stages

Frictionless, stictionless piezo-nanopositioning systems provide sub-nanometer accuracy combined with very short settling times. The high acceleration of piezo drives makes possible precision scans like those

used in scanning microscopy or for characterizing fiber optic devices in significantly shorter times than with motor-driven stages.

The C-880 can accommodate up to two P-611 NanoCube® XYZ piezo nanopositioners.

### Micropositioning Stages and Actuators

The C-880 can control all DC-motor-drive translation, rotation, tip/tilt stages and linear

actuators offered by PI, without the need for external amplifiers. Examples are the highly compact M-110 / M-111 / M-112 translation stages with 50 nanometer minimum incremental motion, the high-load M-235 series and the high-precision M-605 translation stages with integrated linear encoder.

### Voice Coil Drives: Fast Linear Drives for Scanning Applications

Voice coil drives offer high scanning rates with travel ranges in the centimeter range in a very small package. Standard systems like the V-106 can be controlled directly from the C-880.

### Photonics Applications

The C-880 has its roots in the F-206 HexAlign Hexapod photonics alignment systems (see p. 8-8) and has integrated routines like fast scans conceived for aligning or scanning fiber optic components.

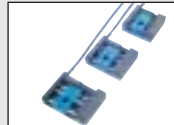
### C-880 Drive Examples



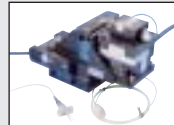
P-611 NanoCube PZT NanoPositioning System. High-speed scanning, nanometer-level precision



M-230 through M-235 Linear actuators. 50 nm min. incremental motion



M-110 series miniature translation stages. 60 x 62 mm foot print, 50 nm min. incremental motion



F-130 low-inertia hybrid photonics alignment system. PZT drives / servo motors



M-501 elevator stage. 12.5 mm vertical travel, < 0.1 µm min. inc. motion



V-106 Voice-Coil-driven XY scanner. 6 mm travel, up to 5 Hz scanning rate. Direct output metrology



M-500 series translation stages, 100 to 300 mm travel. High load, high resolution



M-605 compact translation stage. 50 mm travel, direct output metrology



M-060 to M-062 series rotation stages. Compact, high resolution



Pneumatic grabber

The high flexibility of the C-880 makes it the solution of choice for many automation and precision-positioning tasks. Here only a few examples can be given. Contact a PI Applications Engineer about your application.

Piezo Actuators

Nanopositioning &amp; Scanning Systems

Active Optics / Steering Mirrors

Tutorial: Piezo-electrics in Positioning

Capacitive Position Sensors

Piezo Drivers &amp; Nanopositioning Controllers

Hexapods / Micropositioning

Photonics Alignment Solutions

Motion Controllers

Ceramic Linear Motors &amp; Stages

Index

# C-880

## Options and Accessories



Pneumatic grabber gripper on an XZ micro-positioning combination for high precision pick-and-place applications. The C-880 controls both the stages (M-505.4PD, 100 mm horizontal travel and M-605.2DD, 50 mm vertical travel) and the gripper with the C-880.R8 power-switch card.

### Accessories for Flexible Automation

To live up to its name of "Automation Controller," a variety of options and high-level drivers are available for the C-880.

#### ■ F-206.I3E

IEEE 488 interface card for operation of one or more C-880s from a single PC.

#### ■ C-880.R8

Relay Board which can switch power on up to 8 channels. The high-power capacity (24 V, 1 A) can be used to directly drive loads like pneumatic valves, magnets, relays, etc.

#### ■ F-206.MC6

Interactive manual control pad. This option allows easy manual control of any 6 motorized axes in the system using control knobs with programmable step-sizes.

#### ■ F-206.iRU / F-206.00U

Photometer and A/D Cards. These cards are equipped with fiber-optic connectors, infrared or visible-light photodiodes and amplifiers. Both have integrated 12-bit A/D converters with inputs accessible via a BNC socket on the card bracket.

### Technical Data C-880.R8 Power- Switch Card

Models	C-880.R8
Function	Power-switch card
Channels	8
Output power	60 W
Voltage per channel	24 V
Current per channel	1 A

### Technical Data C-842 Servo Motion Controller Card

Models	C-842.20 / C-842.40
Function	DC servo-motor controller
Channels	2 / 4
Output power	Analog H-bridge +/-12 V, 5 W per channel, 12-bit PWM output, 10 bit, 24.5 kHz for external amplifiers (ActiveDrive™)
Encoder input	Quadrature encoder signals (single-ended or differential mode), max. 10° cts/s
I/O Ports	Limit and origin switches
Servo characteristics	32-bit programmable PID-ff filter
Connectors	2 x 15-pin D-sub on board 2 x 15-pin D-sub on bracket holder (C-842.40)
Dimensions	PC card (ISA)

### Technical Data E-760 Piezo-Controller Card

Models	E-760
Function	Power amplifier & sensor/position servo-control of P-611 NanoCube® systems
Channels	3 LVPZT
Max. output power	9 W
Average output power	3 W
Peak output current	90 mA
Average output current	30 mA
Output voltage	-20 to +120 V
Sensor type	Strain gauge
Servo characteristics	P-I (analog), notch filter
Connector	25-pin sub-D
Dimensions	PC card (ISA)

# C-880

## Software Tools

### PI General Command Set (GCS)

The C-880 comprehensive command structure is based on the PI General Command Set (GCS). The GCS was developed by PI to facilitate coordinated operation of a variety of devices with a minimum of programming effort. Most PI piezo controllers and servomotor controllers can be commanded with GCS.

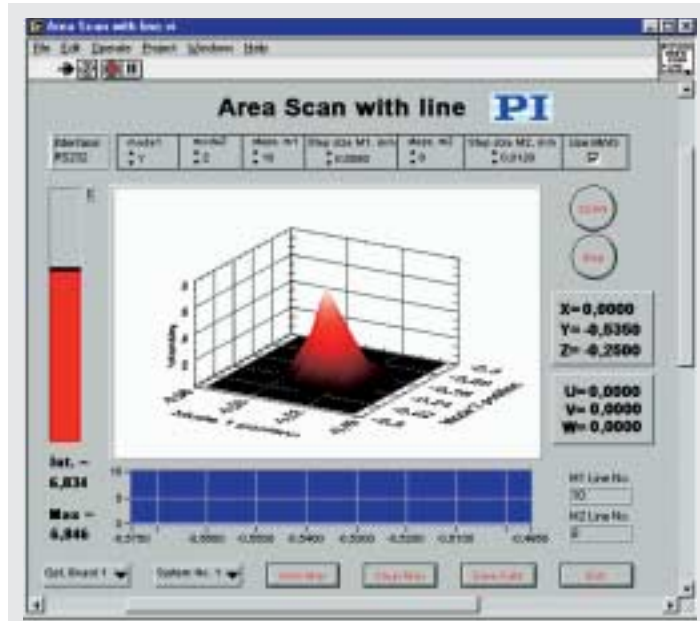
For more information on GCS, see p. 9-28.

### Software

All C-880 controllers are delivered preconfigured for the intended application. All you need to do is connect the system components together and install and start the operating software. Later system changes or upgrades can be incorporated easily using the included configuration software.

### DLL, COM and LabView™ Drivers for Custom Programming

A number of driver libraries are provided to make the full power of the C-880 available to the programmer. Custom programs have access to all features of the C-880, including internal routines like those designed for automated fiber alignment.

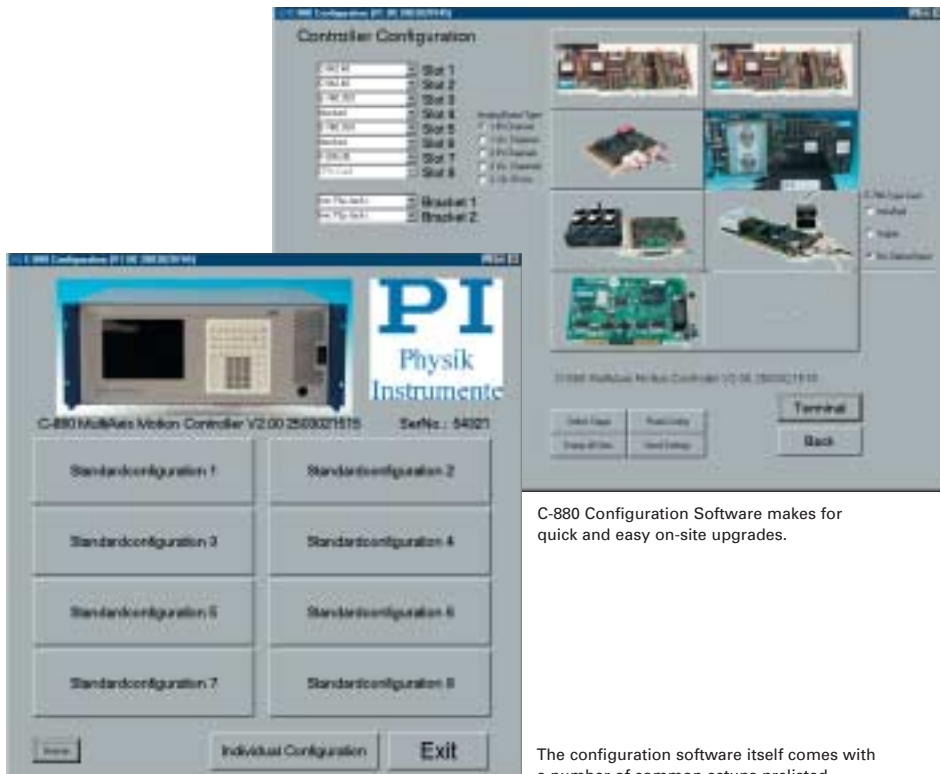


The versatile scan-and-align routines make the C-880 an ideal tool for photonics applications.

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

### Motion Controllers

- Ceramic Linear Motors & Stages
- Index



C-880 Configuration Software makes for quick and easy on-site upgrades.

The configuration software itself comes with a number of common setups prelisted.

# C-630

## Apollo Motion Controller/Driver for Stepper Motors



- 3-Axis, Compact Stepper-Motor Controller/Driver for 2-Phase Motors
- Up to 50 x Microstep Resolution for Smooth, High-Resolution Positioning
- Network Feature for Multi-Channel Applications
- PIIntelliStage™ Compatible

The C-630 Apollo controller combines a high-resolution motion controller and driver in an extremely small package. The Apollo is a very cost-effective solution for automation, precision measurements or general positioning tasks in research and industry.

### Integrated Drives for High-Resolution Motion

Apollo can drive up to three 2-phase stepper motors simultaneously, and feature microstep technology with up to 20,000 steps/rev. for ultra-smooth, high-resolution motion. Limit switch and refer-

ence switch inputs for each axis are provided to protect the mechanics and for easy operation.

### Network Capability for Flexible Automation

For control of more than three axes, the Appollo's network functionality comes in handy. Up to three controllers can be linked and controlled over a single interface.

The network may include up to three Apollo controllers or a combination of up to three PIIntelliStages™ (see p. 7-54) and two Apollos.

Each Apollo controller includes software, an RS-232 communications cable and a wide-range power supply for universal operation.

### Easy-To-Use Software and Drivers

Windows™ software is provided with Apollo controllers for

easy installation and operation. It is derived from the PIIntelliStage™ Software, and is able to run both Apollos and PIIntelliStages™ in the same window.

Window DLLs and LabView™ Drivers are also provided for advanced programming and integration into existing user program environments.

### Ordering Information

**C-630.32**  
Apollo Controller for 2-Phase Stepper Motors, 3 Axes, RS-232 Interface

**M-500.PS**  
Power Supply for Apollo Controller (Included in C-630.32)

**C-863.633**  
Interface Cable for Operation with PIIntelliStage™ Translation Stages (3 m)



### Technical Data

Models	C-630.32
Function	Stepper-motor controller and driver for 2-phase motors
Axes	3
Trajectories	Point-to-point, 3D linear interpolation
Motor resolution	Up to 50 x microstep resolution (up to 20,000 steps/rev) with PI stepper motors
Motor current	Up to 800 mA, 24 V, chopped
Limit switches / reference switches / I/O ports (per axis)	4 TTL, programmable
Interface / communication	RS-232 (cable included), 9.6 to 57 kbit/sec.
Daisy-chain function	Up to 3 units
Command set, programming	ASCII command set
Host Software LabView™ Drivers	Windows™ operating software and DLLs,
Motor connectors (per axis)	15-pin (f) sub-D
Operating voltage	24 V DC, provided by external wide-range P/S 85 to 240 VAC, 50 to 60 Hz
Dimensions	260 mm x 145 mm x 45 mm
Weight	1 kg

### Application Examples

- Flexible automation
- Quality control
- Test equipment
- Photonics packaging
- Fiber alignment



Configuration example of a combined PIIntelliStage™ Apollo network: 4-Axis of motion consisting of 2 PIIntelliStages™ for X and Y motion with an M-062.2S rotary stage for rotation around the vertical (Z) axis and a second smaller M-060.2S for rotation around X or Y. For setup and wiring see block diagram below on the next picture.



PIIntelliStage™ with the integrated controller exposed.



M-511.5iM PIIntelliStage™ with integrated motion controller. PIIntelliStages™ are available with travel ranges up to 306 mm.

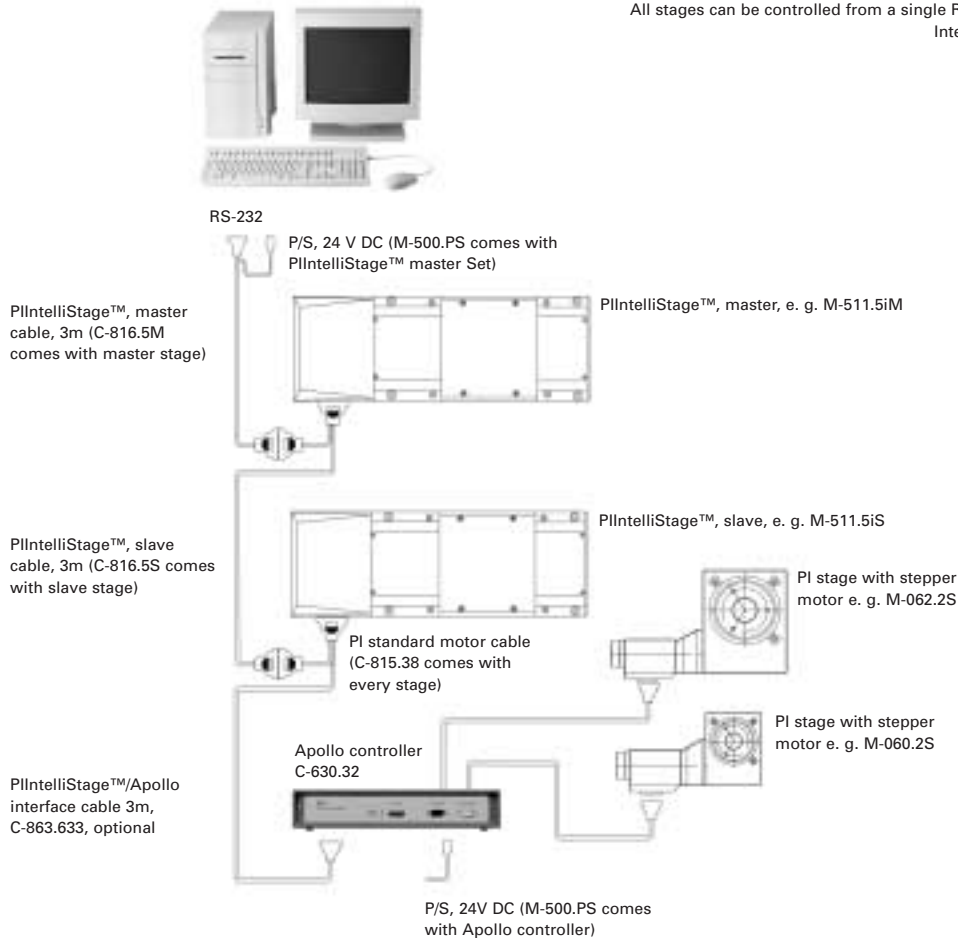
- Piezo Actuators
- Nanopositioning & Scanning Systems
- Active Optics / Steering Mirrors
- Tutorial: Piezo-electrics in Positioning
- Capacitive Position Sensors
- Piezo Drivers & Nanopositioning Controllers
- Hexapods / Micropositioning
- Photonics Alignment Solutions

**Motion Controllers**

Ceramic Linear Motors & Stages

Index

The same configuration example as block diagram. All stages can be controlled from a single RS-232 Interface.



# C-600

## Precision Motion Controller/Driver for Stepper Motors



C-600 Multi-axis stepper motor controller/driver

- **4-Axis Stepper-Motor Controller/Driver for Complex, High-Precision Motion Control**
- **20,000 Steps/Rev. Microstepping for Ultra-Smooth, High-Resolution Positioning**
- **Precision Circular/Linear Interpolation and Continuous Path Contouring for Complex Motion Profiling**
- **RS-232 Interface for Universal Connectivity**
- **Powerful MotionBASIC™ Programming Language for Online/Offline Programming**
- **Front Panel Keypad and LCD Display for User-Friendly Operation**
- **Non-Volatile Flash ROM for up to 8000 Lines of MotionBASIC™ User Program Code**

The C-600 is a highly advanced, easy-to-use, multi-axis motion controller for automation, precision measurements or general positioning tasks in research and industry.

The controller is based on a high-speed, 32-bit DSP processor for high-precision synchronized control and program/command handling. The integrated drivers for four stepper motors (2- or 4-phase, 1.5 A max.) simplify system setup and offer improved reliability.

### Circular & Linear Interpolation

The C-600 simultaneously operates up to 4 axes and supports complex 2D and 3D trajectories (synchronized circular and lin-

ear interpolation) and continuous path contouring—a must for high-precision measurement tasks and complex motion profiling. In addition, the controller features microstep technology with up to 20,000 steps/rev for ultra-smooth, high-resolution motion at step frequencies up to 100 kHz.

### Programming

Programming the C-600 is easy. The controller's unique MotionBASIC™ online and offline IDE (integrated development environment) is intuitive and allows powerful, complex programs to be written and downloaded to the controller with minimum effort. MotionBASIC™ is a combination of

the unsurpassed functionality of the modern general-purpose BASIC programming languages and the G-code language used in CNC machines. Communication is via a serial RS-232 interface for universal connectivity.

### Stand-Alone Operation

The C-600 provides non-volatile flash ROM to hold up to 8,000 lines of MotionBasic™ program code and data. User-defined motion libraries make the C-600 a versatile automation device with all the features of a traditional PLC (programmable logic controller).

Furthermore, the C-600 features a backlit LCD display and a user-friendly, front-panel-operated menu system for manual positioning, execution of complex motion programs, or system configuration. Four LEDs provide system status information.

### I/O Capabilities

Synchronizing motion with events internal and external to the controller (e.g. firing a laser) is easily achieved with one or more of the 12 digital I/O (TTL) lines. Four additional power outputs provide 200 mA current, such as for direct motor-brake control. The C-600 even supports analog data acquisition via 2 A/D input channels.

### Other Benefits

Since the controller's firmware resides in flash ROM, it can be updated by simple downloading, allowing users to benefit from newly added features without the need for factory return or even opening the case.

The integrated power supply permits a wide range of operat-

### Ordering Information

**C-600.42**  
Controller for 2- and 4-Phase Stepper Motors, 4-Axis, 19" Rackmount, RS-232 Interface

ing voltages (85-240 V) for universal usage—another decisive benefit for OEM customers.

This controller is compatible with all PI 2- and 4-phase stepper-motor-driven micropositioning systems.

## Technical Data

<b>Models</b>	<b>C-600</b>
Function	Rack-mountable stepper-motor controller and driver for 2- or 4-phase motors, 32-bit DSP
Axes	4
Trajectories	Point-to-point, 2D and 3D trajectories (synchronized circular & linear interpolation), continuous path contouring
Motor resolution	100 x programmable microstep resolution (20,000 steps/rev) with most PI 2-phase stepper motors, up to 100 kHz output frequency
Motor current	Up to 1.5 A, 24 V, chopped
Limit switches (per axis)	2 TTL (pull-up / pull-down, programmable), programmable soft limits
Origin switches (per axis)	1 TTL (pull-up/pull-down, programmable), real-time position capture
I/O ports	12 TTL I/O (programmable), for synchronizing motion with internal/external events, 4 programmable power outputs (200 mA)
Analog input	2 channels
Interface / communication	RS-232 (cable included), 19.2 kbit/sec.
Manual operation	Front panel keypad and LCD display, joystick interface
Command set, programming	MotionBASIC™ command language, for online and offline programming
On-board memory	64 kB non-volatile flash ROM for up to 8000 lines of MotionBasic™ user program code and data
Motor connectors (per axis)	15-pin (f) sub-D
Operating voltage	85 to 240 VAC, 50 to 60 Hz, wide-range P/S
Dimensions	450 x 300 x 135 mm (19" rackmount)
Weight	6.6 kg

Piezo Actuators

Nanopositioning &amp; Scanning Systems

Active Optics / Steering Mirrors

Tutorial: Piezo-electrics in Positioning

Capacitive Position Sensors

Piezo Drivers &amp; Nanopositioning Controllers

Hexapods / Micropositioning

Photonics Alignment Solutions

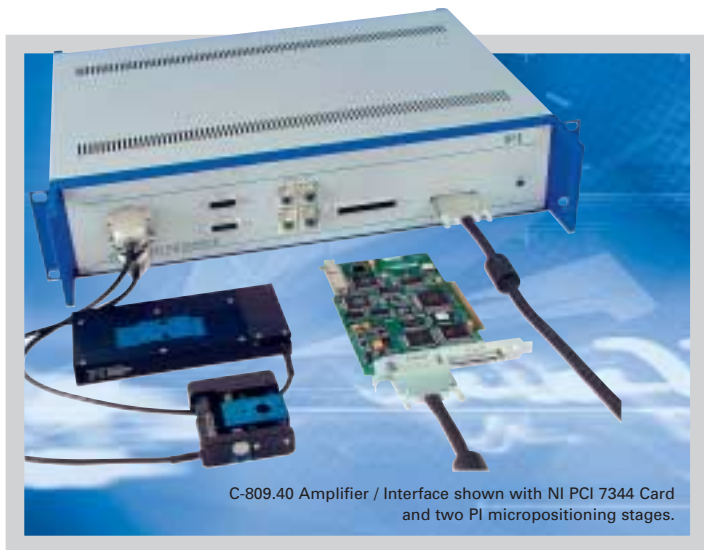
**Motion Controllers**

Ceramic Linear Motors &amp; Stages

Index

# C-809.40

## 4-Channel Servo-Amplifier / Motion I/O Interface for NI Motor Controllers



C-809.40 Amplifier / Interface shown with NI PCI 7344 Card and two PI micropositioning stages.

- Compatible with National Instruments Controllers
- Integrated Analog and PWM Amplifiers for 4 Channels
- Plug & Play Operation
- Uses Standard 68 Pin NI Connection Cable
- 37-Pin Interface for Auxiliary and I/O Lines



Many users of National Instruments (NI) motor controllers

use PI micropositioning systems. To simplify setup and operation of such systems, PI has developed the C-809.40 amplifier, which permits interconnection of up to four PI micropositioning systems and an NI controller such as the 7344.

### Ordering Information

**C-809.40**  
4-Channel Servo-Amplifier /  
Interface for NI Motor Controllers

In addition to linear amplifiers, the unit includes analog to PWM converters and circuitry to adapt PI's differential encoder signals to the single-ended signals required by NI controller.

The automatic analog to PWM conversion makes it possible to operate micropositioning systems with integrated PWM amplifiers. To facilitate neat and professional installation, all encoder, motor control, limit and reference switch signals are available on individual 15-conductor sockets on the front panel. Convenient fan-out of auxiliary and I/O lines from the NI 7344 is also provided via another front-panel sub-D connector.

### Technical Data

Models	C-809.40
Function	Amplifier / Interface for NI Motor Controllers
Channels	4
Output power	Analog 6 W/Channel, PWM **: Power for ActiveDrive™ motors is via separate power supplies or sockets on front panel***
Max. power	110-120 W / 24 V, for ActiveDrive™ motors
Current limits	1 A per channel for analog DC motors (short-circuit proof)
* Motor connections	Four 15-pin (f) sub-D sockets
I/O lines	37-pin (f) sub-D socket
Connections on NI controller	68-pin VHDCI motion I/O socket (SCSI-4 type) for NI cable SHC68-C68-S
Dimensions	450 x 105 x 390 mm
Power supply	Wide-range power supply, 90 to 240 VAC, 50 to 60 Hz

\* For standard PI linear and rotation stages with DB-15 connectors and DC motors. Motor brake signals are not supported.

Ask about compatibility with PILine® piezomotor stages.

\*\* The C-809 can be modified to accept PWM signals (instead of analog signals) from NI controllers.

\*\*\* The 24 VDC supply sockets can be used to supply PI micropositioning stages with integrated PWM amplifiers.

### Application Examples

- Quality control
- Test equipment
- Micromachining
- Biotechnology
- Micromanipulation
- Microscopy
- Photonics packaging
- Fiber alignment
- Metrology

# Accessories



## C-819.10 Joystick

The C-819.10 joystick can be used to operate the C-848 DC-motor-controllers via the PC game port.

## Notes

All PI micropositioners come with the appropriate motor cables. The cables shown here are available as replacements or can be used as extension cables.



## Ordering Information

### C-819.10

Analog Joystick

### C-815.38

Motor Cable, 3 m,  
sub-D 15-pin (f) / 15-pin (male)

### C-815.83

Motor Cable, 10 m,  
sub-D 15-pin (f) / 15-pin (male)

### C-815.34

RS-232 Cable, 3 m, Null Modem,  
9/9-pin with 25/9-pin Adapter

### C-815.62

Motor Cable, 3 m, 10-pin  
(Flat Ribbon)/15-pin (male)

### C-816.5M

Master Cable, 3 m, Included with  
PIIntelliStage™ "Master" Stages

### C-816.5S

Slave Cable, 3 m, Included with  
PIIntelliStage™ "Slave" Stages

### C-863.633

PIIntelliStage™ / Apollo Interface  
Cable, 3 m

Piezo Actuators

Nanopositioning &  
Scanning Systems

Active Optics /  
Steering Mirrors

Tutorial: Piezo-  
electrics in Positioning

Capacitive Position  
Sensors

Piezo Drivers & Nano-  
positioning Controllers

Hexapods /  
Micropositioning

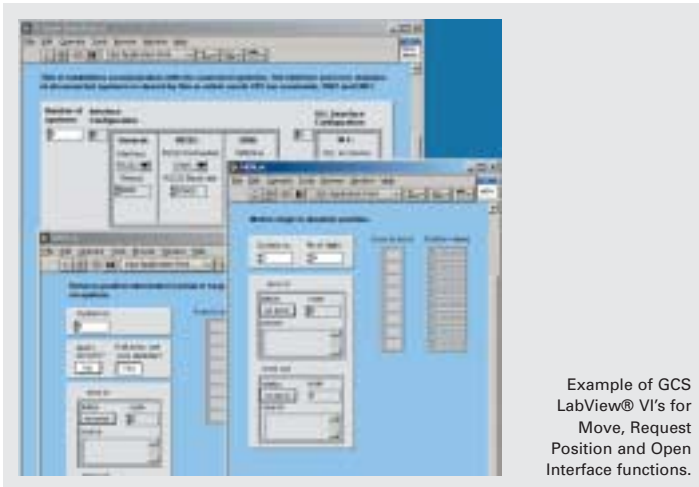
Photonics Alignment  
Solutions

## Motion Controllers

Ceramic Linear  
Motors & Stages

Index

# General Command Set (GCS)



Example of GCS LabView® VIs for Move, Request Position and Open Interface functions.

- **Accelerates Application Development and Increases Flexibility of Programmable PI Devices**
- **Allows use of Existing Software with Follow-up Systems**
- **Allows Addition of new Controllers into an Existing System or Exchange of Different Controllers without Need for Reprogramming**
- **Available as Universal PI-LabVIEW® VIs, DLL or COM-Object**

General Command Set (GCS) is PI's universal command set for uniform control of nano- and micropositioning systems. Almost all current PI piezo controllers and PI motor controllers including hexapods support the command set.

By GCS the control is independent of the used hardware, so that different devices can be controlled together or new devices can be used with minimum programming expenditure.

The production of own application programs becomes clearly simpler owing to GCS, since the commands for all supported devices are identical in syntax and function. Otherwise necessary training is void/can be omitted completely.

Application development is accelerated by the use of the GCS command set observably, since comfortable high-level

functions are used. This reduces at the same time the error probability.

The simple use of the GCS takes place in form of a universal PI-LabVIEW® driver set (VIs), a Windows® Dynamic Link Library (DLL), or a COM-Object.

### List of Supported Devices

Piezo controllers (nanopositioning systems): E-710, E-516, E-621, E-665.

Motor controllers / automation controllers: C-843, C-848, C-865, C-880, F-311.

Hexapod controllers: F-206, M-824, M-840, M-850.

## Headquarters

### Germany

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

**PI Ceramic GmbH**  
 Lindenstraße  
 07589 Lederhose  
 Tel. +49 36604 882-0  
 Fax +49 36604 882-25  
 info@piceramic.com  
<http://www.piceramic.com>

## Subsidiaries

### USA (East) & Canada (East)

**PI (Physik Instrumente) L.P.**  
 16 Albert Street  
 Auburn, MA 01501  
 Tel. +1 508 8323456  
 Fax +1 508 8320506  
 info@pi-usa.us  
<http://www.pi-usa.us>

### PI (West), Canada (West), Mexico

**PI (Physik Instrumente) L.P.**  
 5420 Trabuco Road, Suite 100  
 Irvine, CA 92620-5743  
 Tel. +1 (949) 679-9191  
 Fax +1 (949) 679-9292  
 info@pi-usa.us  
<http://www.pi-usa.us>

### JAPAN

**PI-Japan Co., Ltd.**  
 2-38-5 Akebono-cho  
 Tachikawa-shi  
 J-Tokyo 190-0012  
 Tel. +81 42 5267300  
 Fax +81 42 5267301  
 info@pi-japan.jp  
<http://www.pi-japan.jp>

**PI-Japan Co., Ltd.**  
 Hanahara Dai-ni-Building #703  
 4-11-27 Nishinakajima,  
 Yodogawa-ku, Osaka-shi  
 J-Osaka 532-0011  
 Tel. +81 6 63045605  
 Fax +81 6 63045606  
 info@pi-japan.jp  
<http://www.pi-japan.jp>

### CHINA

**Physik Instrumente (PI Shanghai) Co., Ltd.**  
 Building No. 7-306,  
 Longdong Avenue 3000  
 201203 Shanghai  
 Tel. +86 21 68790008  
 Fax +86 21 68790098  
 info@pi-china.cn  
<http://www.pi-china.cn>

### UK & Ireland

**Lambda Photometrics Ltd.**  
 Lambda House  
 Batford Mill  
 GB-Harpenden, Hertfordshire  
 AL5 5BZ  
 Tel. +44 1582 764334  
 Fax +44 1582 712084  
 info@lambdaphoto.co.uk  
<http://www.lambdaphoto.co.uk>

### France

**Polytec PI S.A.**  
 32 rue Delizy  
 F-93694 Pantin Cedex  
 Tel. +33 1 48103930  
 Fax +33 1 48100803  
 pi.phot@polytec-pi.fr  
<http://www.polytec-pi.fr>

### Italy

**Physik Instrumente (PI) S.r.l.**  
 Via G. Marconi, 28  
 I-20091 Bresso (MI)  
 Tel. +39 02 66501101  
 Fax +39 02 66501456  
 info@pionline.it  
<http://www.pionline.it>

## Request the 500 p. hardbound Nanopositioning & Micropositioning Catalog



Call or go to: <http://www.pi.ws>

### Program Overview

- Piezoelectric Actuators
- Piezo Nanopositioning Systems and Scanners
- Active Optics / Tip-Tilt Platforms
- Capacitive Sensors
- Piezo Electronics: Amplifiers and Controllers
- Hexapods
- Micropositioners
- Positioning Systems for Fiber Optics, Photonics and Telecommunications
- Motor Controllers
- Piezo Ceramic Linear Motors