PI

PZ160E User Manual

E-621.CR LVPZT Controller/Amplifier Module

Release: 2.3.0　　　Date: 2010-08-13

This document describes the following product(s)*:

■ **E-621.CR**
LVPZT Controller/Amplifier, Single Channel, for Capacitive Sensors

With servo-control and computer interface and command interpreter submodules as standard

Strain gauge and LVDT sensor E-621 versions are described in a separate manual, PZ115E.

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Declaration of Conformity

according to DIN EN ISO/IEC 17050:2005-01

Manufacturer:	Physik Instrumente (PI) GmbH & Co. KG	
Manufacturer´s Address:	Auf der Römerstrasse 1 D-76228 Karlsruhe, Germany	CE

The manufacturer hereby declares that the product

Product Name: **LVPZT Controller/Amplifier Module**

Model Numbers: **E-621**

Product Options: **all**

complies—if installed in compatible chassis from PI (E-500.621 or E-501.621)— with the following European directives:

2006/95/EC, Low voltage directive (LVD)

2004/108/EC, EMC-Directive

The applied standards certifying the conformity are listed below.

Electromagnetic Emission: EN 61000-6-3, EN 55011

Electromagnetic Immunity: EN 61000-6-1

Safety (Low Voltage Directive):   EN 61010-1

April 09, 2009
Karlsruhe, Germany

Dr. Karl Spanner
President

About This Document

Users of This Manual

This manual is designed to help the reader to install and operate the E-621.CR LVPZT Controller/Amplifier Module. It assumes that the reader has a fundamental understanding of basic servo systems, as well as motion control concepts and applicable safety procedures. The manual describes the physical specifications and dimensions of the E-621.CR LVPZT Controller/Amplifier Module as well as the hardware installation procedures which are required to put the associated motion system into operation.

This document is available as PDF file on the product CD. Updated releases are available for download from www.pi.ws or via email: contact your Physik Instrumente Sales Engineer or write info@pi.ws.

Conventions

The notes and symbols used in this manual have the following meanings:

WARNING

Calls attention to a procedure, practice or condition which, if not correctly performed or adhered to, could result in injury or death.

DANGER

Indicates the presence of high voltage (> 50 V). Calls attention to a procedure, practice or condition which, if not correctly performed or adhered to, could result in injury or death.

CAUTION

Calls attention to a procedure, practice, or condition which, if not correctly performed or adhered to, could result in damage to equipment.

NOTE

Provides additional information or application hints.

Related Documents

The hardware components and the software tools which might be delivered with E-621.CR LVPZT Controller/Amplifier Modules are described in their own manuals. All documents are available as PDF files on the product CD. Updated releases are available for download from www.pi.ws or via email: contact your Physik Instrumente Sales Engineer or write info@pi.ws..

E-802 User Manual, PZ150E
E-816 User Manual, PZ116E
E-816 DLL Software Manual, PZ120E
E-816 LabVIEW Software Manual, PZ121E
Analog Controller LabView Driver Library Software Manual, PZ181E
PIMikroMove™Software Manual, SM148E

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1 Introduction

1.1 Hardware Overview

The E-621.CR amplifier/controller is designed as a EURO board plug-in module which can be mounted in a 9.5" desktop chassis (E-501.621) or a 19" rack chassis (E-500.621).

The E-621.CR amplifier/controller is designed to drive and control the displacement of a low-voltage piezoelectric stage or actuator (LVPZT) in a system with capacitive sensor position feedback.

It comes with an E-802 Servo-Controller and an E-816 Computer Interface and Command Interpreter installed as standard.

Networking of E-621.CR's with each other allows controlling up to 12 devices over a single RS-232 or USB computer interface. The modules to be networked must be installed in the same chassis (if an E-50x.621 chassis is used, it must have been manufactured after August 2006).

Fig. 1: E-621s installed in compatible PI chassis (E-500.621 in this example) are automatically networked

E-621s for use with SGS or LVDT sensors are described in detail in their own manual, PZ115E.

1.2   Prescribed Use

The E-621.CR LVPZT Controller/Amplifier Module is designed for installation in a suitable chassis, e.g. the E-500.621 or E-501.621 provided by PI.

Based on its design and realization, the E-621.CR LVPZT Controller/Amplifier Module is intended to drive capacitive loads, in the present case, piezoceramic actuators. The E-621.CR must not be used for applications other than stated in this manual, especially not for driving ohmic (resistive) or inductive loads.

E-625s can be used for both static and dynamic applications.

E-621.CRs can be operated in closed-loop mode using capacitive position sensors. Appropriate sensors are provided by PI and integrated in the mechanics according to the mechanics product specifications. Other sensors may be used as position sensors only with permission of PI.

Observe the safety precautions given in this User Manual.

E-621.CRs meet the following minimum specifications for operation[*]:

- Indoor use only

- Altitude up to 2000 m

- Ambient temperature from 5°C to 40°C

- Relative humidity up to 80% for temperatures up to 31°C, decreasing linearly to 50% relative humidity at 40°C

- Line voltage fluctuations of up to ±10% of the line voltage

- Transient overvoltages as typical for public power supply
  Note: The nominal level of the transient overvoltage is the standing surge voltage according to the overvoltage category II (IEC 60364-4-443).

- Degree of pollution: 2

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[*] Any more stringent specifications in the Technical Data table are, of course, also met.

1.3   Safety Precautions

DANGER

High Voltage: Read This Before Operation:

E-621.CR LVPZT Controller/Amplifier Modules generate voltages up to 130 V for driving LVPZTs. The output power may cause serious injury.

When working with these devices or using PZT products from other manufacturers we strongly advise you to follow general accident prevention regulations.

All work done with and on the equipment described here requires adequate knowledge and training in handling High Voltages. Any cabling or connectors used with the system must meet the local safety requirements for the voltages and currents carried.

Procedures which require removing the E-621 module from the chassis should be carried out by authorized, qualified personnel only.

Disconnect the chassis from power when removing modules, and when resetting internal switches or jumpers.

When a module removed from the chassis must be operated, use a 32-pin extension connector (P-895.00, not included). Voltages of up to 130 V can be exposed. Do not touch internal conductors.

Be sure to connect pin 14a and 14c to a Protective Ground!

WARNING

Connect the AC power cord of the E-500.621 or E-501.621 chassis in which the E-621 is installed to the wall socket (100 to 240 VAC).

To disconnect the system from the supply voltage completely, remove the power plug from the wall socket, or remove the power cord from the chassis.

Install the system near the AC outlet and such that the AC power plug can be reached easily.

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CAUTION

!

Place the chassis with the E-621(s) in a location with adequate ventilation to prevent internal heat build-up. Allow at least 10 cm (4 inches) clearance from the top and the rear of the unit and 5 cm (2 inches) from each side.

Never cover the ventilation slots of the chassis as this will impede ventilation.

CAUTION

!

E-621 modules are ESD-sensitive (electrostatic discharge sensitive) devices. Observe all precautions against static charge buildup before handling these devices. Avoid touching circuit components, pins and PCB traces. Discharge any static electricity you may have on your body by briefly touching a conductive, grounded object before you touch any electronic assembly. Pose PCBs only on conductive surfaces, such as ESD-safe transport containers (envelopes, foam). Electronic subassemblies must always be kept and transported/shipped in conductive packaging.

Make sure that no conductive particles of any kind (metallic dust or shavings, broken pencil leads, loose screws) contact the device circuitry.

CAUTION

!

The E-621 main connector pinout is not compatible with the PI EURO board modules of the E-500 series (e.g. E-509 servo-controller or E-50x amplifier).

CAUTION

!

For successful operation of two or more E-621.CRs, their E-500.621 or E-501.621 chassis must have been manufactured after August 2006. Contact PI if you are not sure about the manufacturing date of your chassis.

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!

CAUTION

Calibration should only be done after consultation with PI, otherwise the internal configuration data may be destroyed by erroneous operation.

!

CAUTION

Thermally stable systems have the best performance. For a thermally stable system, switch on the E-621 at least one hour before you start working with it.

!

CAUTION

If the piezo stage starts oscillating (humming noise):

In closed-loop operation, switch off the servo immediately. The load and / or the dynamics of operation probably differ too much from the setup for which the system was calibrated.

In open-loop operation, stop the motion immediately. Do not operate the piezo stage at its resonant frequency even though the notch filter by default is also active in open-loop operation.

Otherwise the piezo stage could be irreparable damaged.

1.4 Unpacking

According to your order, the E-621.CR LVPZT
Controller/Amplifier Module comes separately or installed in an
E-500.621 or E-501.621 chassis. Unpack the system with care.
Compare the contents against the items covered by the
contract and against the packing list. The following items should
be included with an E-621 unit:

- RS-232 null-modem cable for PC connection (C-815.34)

- USB cable (USB-A (m)/USB Mini-B (m)) for PC
  connection (000014651)

- SMB/BNC adapter cables (E-692.SMB) 1.5 m, two units

- 32-pin multipoint socket connector (DIN 416123) for
  installing the E-621 module in custom electronics (588)

- User Manual for E-621.CR (PZ160E), this document

- User Manual for E-816 Computer Interface and
  Command Interpreter Submodule (PZ116E)

- User Manual for E-802 Servo-Control Submodule
  (PZ150E)

- CD for E-816-interface devices with software and
  documentation (E-816.CD)

Inspect the contents for signs of damage. If parts are missing or
you notice signs of damage contact PI immediately.

Save all packing materials in the event the product needs to be
shipped elsewhere.

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2 Quick Start

2.1 Line Power and Fuses

This section is only relevant if the E-621 comes installed in an E-500.621 or E-501.621 chassis provided by PI.

The power connection and the line fuses are located on the rear panel of the E-500.621 or E-501.621 chassis. The chassis is equipped with a wide-range power supply and with fuses that are admissible for both 115 V and 230 V operation. No settings need be changed when connecting the system to a different supply voltage. The orientation of the fuse carrier is irrelevant.

WARNING

Connect the AC power cord of the E-500.621 or E-501.621 chassis in which the E-621 is installed to the wall socket (100 to 240 VAC).

To disconnect the system from the supply voltage completely, remove the power plug from the wall socket, or remove the power cord from the chassis.

Install the system near the AC outlet and such that the AC power plug can be reached easily.

WARNING

Before you open the door of the fuse carrier, remove the power plug from the wall socket to disconnect the system from the power supply completely.

CAUTION

Both fuses are active and have to be replaced if there is a fault.

To access the line power fuses, proceed as follows:

1 Switch the system off and remove the power cord.

2 Wait one minute to be sure that all electric circuits are discharged completely.

3   Pry open the door that covers the fuse carrier (see Fig. *2*) and pry out the fuse carrier.

4   Be sure to replace **both** fuses with:
IEC 4 AT (slow blow)
Note that IEC-standard fuses are designed to carry the nominal current indefinitely. Other fuse rating standards differ.

5   Reinstall the carrier and close the door.
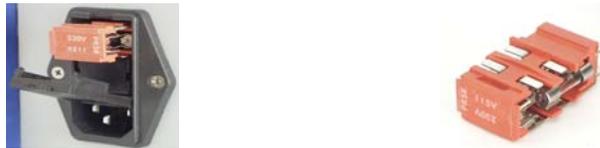
Fig. 2: Fuse location on the rear panel and in the carrier (1 of 2 fuses visible)

2.2   Installation

This section is only relevant if the E-621 modules come without chassis.

CAUTION   **!**

E-621 modules are ESD-sensitive (electrostatic discharge sensitive) devices. Observe all precautions against static charge buildup before handling these devices. Avoid touching circuit components, pins and PCB traces. Discharge any static electricity you may have on your body by briefly touching a conductive, grounded object before you touch any electronic assembly. Pose PCBs only on conductive surfaces, such as ESD-safe transport containers (envelopes, foam). Electronic subassemblies must always be kept and transported/shipped in conductive packaging.

Make sure that no conductive particles of any kind (metallic dust or shavings, broken pencil leads, loose screws) contact the device circuitry.

Before operation is possible, the E-621 must be installed in a suitable chassis. Required input and output lines must be connected via the 32-pin main connector. To do this, you can use the included multipoint socket connector (588). For pinout see "32-Pin Main Connector" on p. 50.

!

CAUTION

E-621 is only compatible with E-50x.621 chassis but incompatible with other chassis of PI's E-500-series. For sensor synchronization of multiple E-621.CRs, the E-50x.621 must have been manufactured after August 2006.

NOTE

All front-panel connections except of the USB lines are duplicated on the 32-pin main connector.

For a custom or OEM installation, consider the following:

- Networked units must have the I^{2}C networking lines connected to each E-621 in parallel (pins 32a and 32c). The network bus lines are limited to a maximum length of 1 m and a maximum capacitance of 400 pF. See "Networking on I^{2}C Bus" on p. 22 for details.

- If the network includes more than one capacitive sensor unit, one must be set to "sensor master" and the rest to "sensor slave" and they must have their synchronization lines (E-621.CR 32-pin main connector pins 20a and 24a) bused together. See "Sensor Synchronization" on p. 23 for details.

- Each unit requires sufficient power. A DC-DC converter is installed on the main board of the E-621 module with an input voltage range of 12 to 30 VDC (recommended supply 15 V). This converter generates -25 and +125 V for the power amplifier and +/-15 V for the sensor and servo-controller. When powering up the module, the DC-DC converter needs a peak current of about 1.5 A to start oscillating. The power supply should have a buffer capacitor, or should be able to supply the 1.5 A per E-621 for at least 1 second. The inputs and outputs of the DC-DC converter are not connected internally. Using a unipolar power supply, we recommend connecting the negative supply at pin 18a and 18c with the Test GND at pin 14a and 14c. This provides a defined GND level and helps to minimize noise. Be sure to connect pin 14a and 14c to a protective ground!

- If a DC-offset potentiometer is to be used (not included), connect the wiper to pin 12c, the zero-offset contact (presumably CCW) to pin 22c, 14a or 14c (GND) and the other contact (CW) to pin 12a. Make sure the external pot is activated with X8 in position 1-2.

■ By connecting pin 28a on the main connector to pin 14a or 14c (GND), the E-621 is set to closed-loop operation (servo ON). In this case, switching to open-loop operation (servo OFF) is neither possible with DIP switch 3 on the front panel nor with the SVO command via the E-816 computer interface submodule.

2.3   First Steps

CAUTION   **!**

Thermally stable systems have the best performance. For a thermally stable system, switch on the E-621 at least one hour before you start working with it.

CAUTION   **!**

If the piezo stage starts oscillating (humming noise):

In closed-loop operation, switch off the servo immediately. The load and / or the dynamics of operation probably differ too much from the setup for which the system was calibrated.

In open-loop operation, stop the motion immediately. Do not operate the piezo stage at its resonant frequency even though the notch filter by default is also active in open-loop operation.

Otherwise the piezo stage could be irreparable damaged.

1   Connect the E-621 to the supply power. Depending on your system configuration, consider the information in "Line Power and Fuses" on p. 9 or " Installation" on p. 10.

2   Make sure the E-621 is switched off.

3   Make the DIP switch settings required for the control
     mode (analog or computer-controlled) and the servo
     mode (ON or OFF) you wish to use. See "Front Panel
     Elements" on p. 15 and "Modes of Operation" on p. 18
     for details.

     Notes:

     The servo must be ON in analog mode, when you want
     to work with a computer-generated signal (e.g. from a
     DAQ board) and the analog LabVIEW driver set from
     PI (see step 5 below).

     To give the E-816 computer interface submodule
     complete control over the servo mode selection, DIP
     switch 3 on the E-621 front panel must be set to open-
     loop operation (= right). When installing the E-621 in a
     custom chassis, for servo mode selection via the E-816
     furthermore make sure that pin 28a on the main
     connector is not grounded (i.e. not connected to pin
     14a or 14c).

4   Connect the piezo stages/actuators to the proper E-
     621.CR units. If your system was calibrated by PI, the
     controllers and stages are not interchangeable.
     Respect the assignment given by the serial numbers
     marked on the calibration label of the controller.

5   Connect a suitable signal source to the "ANALOG
     INPUT" SMB socket. Depending on the control-mode
     selection, this input signal is either used as control
     input (in analog mode), or as trigger signal for wave
     table output and triggered motion (in computer-
     controlled mode). See "Front Panel Elements" on p. 15
     for signal details.

     In analog mode, the control input voltage can also be a
     computer-generated analog signal (e.g. from a DAQ
     board). You can use the PI LabVIEW Analog Driver set
     provided on the included E-816 CD to generate that
     analog signal. Install that driver set by running Setup
     on the E-816 CD. See the driver documentation on the
     E-816 CD for operation.

6   Optional: Connect a suitable measurement device to
     the "SENSOR MONITOR" SMB socket. This socket
     carries the filtered and processed sensor output value,
     with 0 to 10 V representing nominal travel range. See
     "User Electronics and Sensor Monitor Signal" on p. 23
     for further specifications.

7   Switch on the E-621.

8   Command motion of the connected piezo
     stage/actuator:

     Analog mode: Change the control input signal on
     "ANALOG INPUT" in the range of 0 to 10 V.

     Computer-controlled mode: Follow the instructions in
     "First Steps" in the E-816 Computer Interface
     Submodule User Manual.

If at the yellow "Overflow" LED glows in closed-loop operation
(servo ON), then a zero-point adjustment is necessary. Follow
the instructions for zero-point adjustment given in Section 4.1.1
on p. 27. To avoid an overflow of the amplifier in open-loop
operation, do not exceed the allowable control input range.

3 Operation

3.1 Front Panel Elements

NOTE

All front-panel connections except of the USB lines are duplicated on the 32-pin main connector.

Fig. 3: E-621.CR Front Panel

Power LED, green

Permanent glow indicates that the E-621 is powered on.

Overflow LED, yellow

Overflow signal, indicates power amplifier is so near the end of its range that it is no longer able to follow input changes properly (piezo voltage output outside of -30 V to 130 V range). If this LED glows in closed-loop operation (servo ON), a zero-point adjustment is necessary. Follow the instructions for zero-point adjustment given in Section 4.1.1 on p. 27. To avoid an overflow of the amplifier in open-loop operation, do not exceed the allowable control input range (see "ANALOG INPUT").

On Target LED, green

On target signal from E-802 servo-control submodule, indicates distance from target less than ±0.19% of range

ANALOG INPUT

SMB coaxial, GND on outer line. Usage of this input line depends on the mode settings made with the "Settings" DIP switches (see below):

- Analog mode: ANALOG INPUT is used as control input voltage which gives the target (either as voltage or position, depending on the servo mode; see below). The input signal should always be in the range of -2 to 12 V. Note that excursions to -3 or +13 V are possible but may cause overflow, especially with servo on, and reduce actuator lifetime, see "Lifetime of PICMA® Actuators" on p. 52 for details.
  The control input voltage can also be a computer-generated analog signal (e.g. from a DAQ board). You can use the PI LabVIEW Analog Driver set provided on the E-816 CD to generate that analog signal. See "Control Modes" on p. 18 for details

- Computer-controlled mode: ANALOG INPUT is used as trigger input signal for wave table operation and triggered motion (Active HIGH; LOW: 0 to 0.5 V, HIGH: 3.0 to 5.0 V, maximum 10 V; max. freq. 400 Hz; min. width: 5 μs). See the User Manual for E-816 Computer Interface and Command Interpreter Submodule (PZ116E) for more information

SENSOR MONITOR

SMB coaxial, GND on outer line, 0 to 10 V on inner line
Filtered and processed sensor output value, 0 to 10 V representing nominal travel range.

Settings DIP switch block
The ON position is on the left.

Switch	Function
1	Usage of ANALOG INPUT socket as control input
2	Control input given by the E-816 computer interface submodule installed in E-621
3	Servo mode selection: OFF (right) = servo off (open-loop operation)* ON (left) = servo on (closed-loop operation)
4	Usage of ANALOG INPUT socket as trigger input

*To give the E-816 computer interface submodule complete control over the servo mode selection, DIP switch 3 must be set to open-loop operation (= right). When installing the E-621 in a custom chassis, for servo mode selection via the E-816 furthermore make sure that pin 28a on the main connector is not grounded (i.e. not connected to pin 14a or 14c).

Switches 1, 2 and 4 determine the control mode (computer-controlled or analog) of the E-621 and hence the applicable control sources. See "Control Modes" on p. 18 for details

Switch	Computer-Controlled Mode	Analog Mode
1	OFF	ON
2	ON	OFF
4	ON	OFF

Unpredictable behavior may result if sw 1, 2 and 4 are set incompatibly.

Zero potentiometer
Trim pot accessible with small screwdriver for sensor zero-point adjustment. Readjustment may become necessary with time or if the load is changed. Do the adjustment with Servo OFF! See Section "Open-Loop Zero-Point Adjustment" on p. 27 for more details.

PZT & SENSOR
Sensor input and piezo actuator drive voltage together on a combi-sub-D socket. The drive voltage output is in the range of -30 to 130 V. For pinout see p. 51.

RS-232
Serial connection to host PC. Sub-D 9 male, industry-standard RS-232. See the User Manual for E-816 Computer Interface

and Command Interpreter Submodule (PZ116E) for more information.

USB socket

Universal Serial Bus (USB Mini-B (m) socket) for connection to host PC. See the User Manual for E-816 Computer Interface and Command Interpreter Submodule (PZ116E) for more information.

3.2 Modes of Operation

Control modes: The E-621 can be operated in either analog mode or computer-controlled mode. The active mode determines the applicable control sources for the output voltage. See "Control Modes" below for more information.

Servo modes: The current servo mode determines if the motion axis is driven in open-loop (servo OFF) or closed-loop (servo ON) operation. In closed-loop operation a servo loop participates in the generation of the control value for the output voltage. The servo loop thus maintains the current axis position, based on a given target position and the position feedback of the corresponding sensor. See "Servo Modes (ON / OFF)" below for more information.

The individual control and servo modes can be combined arbitrarily.

3.2.1 Control Modes

The current control mode of the E-621 determines the applicable control sources for the output voltage and hence for the axis motion. It is selected with the "Settings" DIP switches on the E-621 front panel.

▪ **Analog mode:**

Activated with the following settings (ON position is on the left):
1 = ON, 2 = OFF, 4 = OFF

The output voltage depends on the input voltage applied to the "ANALOG INPUT" SMB socket of the E-621.
Control input from the E-816 computer interface submodule is ignored (i.e. move commands received via computer interface or from a running macro, trigger input or wave table output).
The input signal should always be in the range of -2 to 12 V. Note that excursions to -3 or +13 V are possible but may cause overflow, especially with servo on, and reduce actuator lifetime, see "Lifetime of PICMA® Actuators" on p. 52 for details.

The analog control input can be a computer-generated analog signal (e.g. from a DAQ board). You can use the PI LabVIEW Analog Driver set provided on the E-816 CD to generate that analog signal. This driver set also includes the Hyperbit drivers which make possible position resolution higher than that of the DAQ board used. New releases of the LabVIEW Analog Driver set are available from the download area at www.pi.ws. See the E500T0011 Technical Note and the manual of the LabVIEW Analog Driver set provided on the E-816 CD for instructions. For the Hyperbit extension, contact your PI Sales Engineer.

▪ **Computer-controlled mode:**

Activated with the following settings (ON position is on the left):
1 = OFF, 2 = ON, 4 = ON

The E-816 computer interface module installed in the E-621 controls the generation of the output voltage. Target values for the axis motion can be given by move commands (received via computer interface or from a running macro), trigger input or wave table output. The analog control input voltage on the "ANALOG INPUT" socket is ignored.

Note

In analog mode, the E-816 accepts all commands just as in computer-controlled mode. The only difference between the modes is the control source selection.

3.2.2 Servo Modes (ON / OFF)

The current servo mode determines if a motion axis is driven in open-loop (servo OFF) or closed-loop (servo ON) operation.

The servo mode can be set as follows:

- Using DIP switch 3 on the E-621 front panel:
  OFF (right) = servo off (open-loop operation)
  ON (left) = servo on (closed-loop operation)

- Using pin 28a on the 32-pin main connector:
  Servo is on if pin 28a is grounded (i.e. connected to pin 14a or 14c (GND)). In this case, switching to open-loop operation (servo OFF) is neither possible with DIP switch 3 on the front panel nor with the SVO command via the E-816 computer interface submodule.
  By default and when installed in an E-50x.621 chassis from PI, pin 28a is not connected to pin 14a or 14c and hence set to servo off (open-loop operation)

- Via SVO command sent over the communications interface or received from a macro running on the E-816.
  To give the E-816 complete control over the servo mode selection, DIP switch 3 on the E-621 front panel must be set to open-loop operation (= right). Furthermore make sure that pin 28a on the main connector is not grounded (i.e. not connected to pin 14a or 14c; the signal on pin 28a must not be LOW (0 V)).
  Using the SVO? command, you can check the last sent SVO setting. SVO? does not report the setting of DIP switch 3 and pin 28a.
  See E-816 User Manual for command descriptions

Notes

Servo-control is implemented on a small PCB submodule (E-802.55). This submodule is included with the E-621 and comes already installed. The block diagram on p. 35 answers most questions about how the various elements interact with each other.

The usage of the E-802 submodule depends on an on-board jumper, X4: With X4 in position 1-2 the E-802 is connected (factory default), and the servo mode can then be controlled by DIP switch 3, by pin 28a of the 32-pin main connector or by the E-816. If jumper X4 is in position 2-3 the E-802 submodule is completely bypassed no matter what the other settings.

Slew-rate limitation and notch filtering remain on even when servo mode is switched off. They will only be deactivated if the E-802 servo-controller submodule is bypassed with X4 in position 2-3.

Normally, you do not need to change jumper X4. Access to X4 requires removing the E-621 module from the chassis. See "Components and Adjustment Elements" on p. 36 for more information.

- **Closed-loop operation**:

  Any control input (control voltage on "ANALOG INPUT", E-816 input like move commands and wave table output) is interpreted as target position. Based on this target position and on the position feedback of the corresponding sensor channel, the servo loop on the E-802 submodule generates the control value for the piezo output voltage. The servo loop thus maintains the axis position.
  Closed-loop operation offers both drift-free and hysteresis-free positioning as well as immunity to load variations.

  PI's standard calibration procedure assures that the piezo actuator reaches its nominal expansion when that position is commanded.

- **Open-loop operation**:

  Any control input is interpreted as piezo voltage target. Open-loop operation omits the servo loop on the E-802 submodule, and the control input directly controls the piezo output voltage. The slew rate limitation and notch filter remain active (unless, of course, jumper X4 is in position 2-3).
  When servo-mode is OFF, the system works like a linear amplifier with the piezo operating voltage proportional to the control signal input. (The sensor electronics works independently, and outputs the current piezo position even in open-loop mode, provided a sensor is properly connected. Since there is some variation among different piezos of the same model, the voltage required to bring the piezo to its nominal expansion will differ.)

Note

Closed-loop operation can be activated using a start-up macro. See the E-816 User Manual for more information.

3.3   Networking on I²C Bus

It is possible to command up to twelve E-621.CRs over a single RS-232 or USB interface from a single host PC. The E-621.CR connected to the RS-232 or USB link (the master) relays commands to the other units (slaves) on the network. Responses from the slaves are then relayed by the master back to the PC.

The modules to be networked must be installed in the same chassis since networked units must have the I²C networking lines connected to each E-621 in parallel (pins 32a and 32c of the 32-pin main connector). The network bus lines are limited to a maximum length of 1 m and a maximum capacitance of 400 pF. With multiple E-621.CRs networking requires also sensor synchronization via pins 20a and 24a of the 32-pin main connector (see "Sensor Synchronization" below for details).

It may be necessary to power-cycle the system for proper detection of the master unit (i.e. the E-621 directly connected to the host PC).

For details regarding networking (e.g. channel name settings) see the User Manual of the E-816 computer interface module.

3.4   Sensor Synchronization

On systems with multiple E-621.CRs, synchronization of their capacitive sensor units is required. The sensor excitation frequency can be provided internally (S2 master setting) or externally (slave). Set one unit to the sensor excitation master, the rest to slave and make sure all pins 20a and all pins 24a of the 32-pin main connectors are respectively connected together (see p. 50 for pinout).

Sensor master/slave settings require removing the E-621 modules from the chassis. See Fig. 9 on p. 39 for the location of the S2 Sensor Master/Slave switch.

DANGER

Procedures which require removing the E-621 module from the chassis should be carried out by authorized, qualified personnel only.

Disconnect the chassis from power when removing modules, and when resetting internal switches or jumpers.

E-621.CR units delivered in an E-500.621 or E-501.621 chassis manufactured after August 2006 come synchronized. One unit is set to the sensor master, and all other units are set to slave.

3.5   User Electronics and Sensor Monitor Signal

If you are connecting your own electronics to the sensor monitor signal, make sure it has sufficient input capacitance to eliminate high-frequency interference.

It may be necessary to add a 4.7 nF (ceramic NP0 or COC type) to the input connector. Use shielded cable if possible, otherwise make sure the lead pair is tightly twisted.

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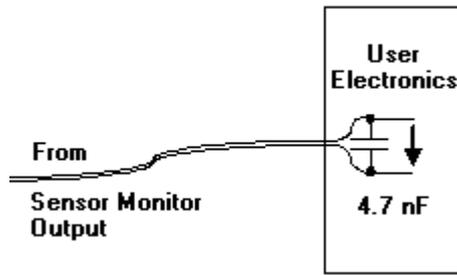
Fig. 4: Electronics on Sensor Monitor line with required input capacitance

4   Calibration

If PI had sufficient knowledge of your application and you ordered your system components together, they will be preinstalled and preconfigured. Do not adjust potentiometers unnecessarily, and be aware that many adjustment points are interdependent and effect both computer-controlled and analog operating modes. Reference to the block diagram (p. 35) can aid in understanding the scope of the various control elements.

!

CAUTION

E-621 modules are ESD-sensitive (electrostatic discharge sensitive) devices. Observe all precautions against static charge buildup before handling these devices. Avoid touching circuit components, pins and PCB traces. Discharge any static electricity you may have on your body by briefly touching a conductive, grounded object before you touch any electronic assembly. Pose PCBs only on conductive surfaces, such as ESD-safe transport containers (envelopes, foam). Electronic subassemblies must always be kept and transported/shipped in conductive packaging.

Make sure that no conductive particles of any kind (metallic dust or shavings, broken pencil leads, loose screws) contact the device circuitry.

Only the DIP switch block (S1) and the Zero potentiometer are accessible without removing the E-621 from the chassis.

NOTE

All front-panel connections except of the USB lines are duplicated on the 32-pin main connector. So you can use that pins instead of the front panel connections. See pinout on p. 50 for details.

4.1   Sensor Connection and Adjustment

If you inform PI about your application, your E-621.CRs will be fully calibrated before being shipped. It is usually not necessary for you to do anything more than adjust the zero point before operating the system.

CAUTION

!

Calibration should only be done after consultation with PI, otherwise the internal configuration data may be destroyed by erroneous operation.

Capacitive position sensors are connected to the "PZT & Sensor" front panel connector (pinout on p. 51). If you wire your own connector and interchange Target and Probe lines, the system will still operate but may not attain the specified accuracy.

The output from the sensor-processing circuitry is an analog signal that is directly proportional to the piezo's expansion and is available at "SENSOR MONITOR" on the front panel and on pin 22a of the 32-pin main connector. See the "Sensor Synchronization" section, starting on p. 23 and the Capacitive Sensor User Manual for more details.

As seen in the block diagram (p, 35), the sensor signal goes through the sensor range settings (JP101-JP106), ILS linearization (R144), gain (R143) and zero-adjust (R13), and then branches to the "SENSOR MONITOR" output, the computer-interface submodule and the servo-control submodule. The voltage range setting (JP108, JP109) must remain as set at the factory.

Since the servo-control and computer interface submodules see "copies" of the sensor signal, it is important that the zero point and gain in the sensor circuitry be properly adjusted. The zero point is especially likely to need correction.

In addition to the adjustments on the analog side, there are digital offset and range corrections on the E-816 computer interface submodule. The A/D converter on the E-816 is always precalibrated and its offset and gain values stored in EPROM are not customer modifiable. If the hardware adjustments are exact, then the Osen (sensor offset) digital correction factor should be set to 0 and Ksen, the sensor coefficient, should be set to a value equal to the travel range (in μm) divided by 10 volts (the nominal sensor readout electronics output range). See the E-816 User Manual for details.

4.1.1 Open-Loop Zero-Point Adjustment

Zero-point calibration has the following goals:

- Make the full travel range available: If the electrical zero point is adjusted properly, the full output voltage range of the amplifier can be used. This prevents overflow conditions from occurring

- Preserve the piezo actuators in the mechanics: The point of zero sensor readout should correspond to zero or a (small) negative output voltage. This technique can reduce the average applied voltage without loss of displacement and thereby increase piezo lifetime

There might be some small deviation of the electrical zero-point caused by thermal drift or changes in mechanical loading. Let the system warm up for several minutes before setting the zero point.

This procedure can be carried out either in computer-controlled or in analog mode. If you use analog mode, you will need a voltmeter. In computer-controlled mode the voltmeter is helpful but not required. Before starting, install the positioner(s) with the same loads and in the same positions as they will have in your application.

OPEN-LOOP SENSOR ZERO POINT	Computer-Controlled Mode	Analog Mode
1. Set DIP switches on the front panel for operating mode	sw1 OFF, sw2 ON, sw4 ON; connect RS-232 or USB cable to this unit	sw1 ON, sw2 OFF, sw4 OFF
2. Power up	After power-on, establish communications, e.g. with PITerminal	
3. Set up for servo-off operation	Send SVO *A* 0 where *A* is the axis identifier. Make sure that servo is not set on with DIP switch 3 or pin 28a..	Set DIP switch 3 OFF. Make sure that servo is not set on with pin 28a or SVO command.
4. Exercise the piezo over the nominal expansion range	Command voltages from 0 to 100 V, e.g. with SVA command	Apply an analog signal in the range of 0-10 V to "ANALOG INPUT" (DC offset must be 0 or OFF (X8 2-3))
5. Command 0 V	Command a voltage of 0 volts by sending SVA *A* 0 where *A* is the axis identifier	Put 0 V on "ANALOG INPUT"

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6. Read sensor	Send POS? *A* where *A* is the axis identifier, or read the value at the "SENSOR MONITOR" SMB socket on the front panel with a voltmeter	Read the value at the "SENSOR MONITOR" SMB socket on the front panel with a voltmeter
7. Correct zero	Adjust the Zero potentiometer on the front panel so that the sensor-monitor signal is +1 V	

After successful zero point adjustment, the "Overflow" LED should no longer glow in closed-loop operation. Permanent glow of this LED in spite of zero point adjustment may indicate hardware failure. To avoid an overflow of the amplifier in open-loop operation, do not exceed the allowable control input range.

4.1.2 Open-Loop Sensor Range Adjustment

The object of open-loop sensor range calibration is to assure that when the piezo is at nominal expansion the sensor will report the nominal-expansion position. (Note that the voltage required to cause the piezo to expand to its nominal value will not be exactly 100 V, but somewhere in the 85-105 V range.)

All piezo positioning systems ordered together with a piezo translator are delivered with performance test documents to verify the system performance.

The system ordered is calibrated in our labs prior to shipment. Normally there is no need for the customer to perform a full calibration. Only if the piezo, the sensor, extension cable or the mechanical setup is changed, may new calibration be necessary.

Open-loop sensor range adjustment requires an external measuring device with 0.1 µm resolution and a 32-pin extension connector (P-895.00, not included).

DANGER

Procedures which require removing the E-621 module from the chassis should be carried out by authorized, qualified personnel only.

Disconnect the chassis from power when removing modules, and when resetting internal switches or jumpers.

When a module removed from the chassis must be operated, use a 32-pin extension connector (P-895.00, not

included). Voltages of up to 130 V can be exposed. Do not touch internal conductors.

OPEN-LOOP SENSOR RANGE	Computer-Controlled Mode	Analog Mode
1. Make adjustment elements accessible	Remove E-621 from the chassis and connect via P-895.00 extension connector (qualified, authorized personal only)	Remove E-621 from the chassis and connect via P-895.00 extension connector (qualified, authorized personal only)
2. Set DIP switches on the front panel for operating mode	sw1 OFF, sw2 ON, sw4 ON, connect RS-232 or USB cable to this unit	sw1 ON, sw2 OFF, sw 4 OFF
3. Power up	After power-on, establish communications, e.g. with PITerminal	
4. Set up for servo-off operation	Send SVO *A* 0 where *A* is the axis identifier. Make sure that servo is not set on with DIP switch 3 or pin 28a..	Set DIP switch 3 OFF. Make sure that servo is not set on with pin 28a or SVO command.
5. Exercise the piezo over the nominal expansion range	Command voltages from 0 to 100 V, e.g. with SVA command	Apply an analog signal in the range of 0-10 V to "ANALOG INPUT" (DC offset must be 0 or OFF (X8 2-3))
6. Command 0 V	Command a voltage of 0 volts by sending SVA *A* 0 where *A* is the axis identifier	Put 0 V on "ANALOG INPUT"
7. Check/adjust zero-point	Send POS? *A* where *A* is the axis identifier, or read the value at the "SENSOR MONITOR" SMB socket on the front panel with a voltmeter. If necessary, adjust the zero point as described in Section 4.1.1.	Read the value at the "SENSOR MONITOR" SMB socket on the front panel with a voltmeter. If necessary, adjust the zero point as described in Section 4.1.1
8. Expand the piezo to its nominal expansion as indicated by external gauge	Use a series of commands like SVA *A* 90 followed by repeated SVR *A* 1 (*A* is the axis identifier)	Increase analog input voltage slowly
9. Adjust sensor gain	Adjust the sensor gain potentiometer on the main board (see Section 5.2 p. 36 for component location) so that the value at the "SENSOR MONITOR" SMB socket on the front panel is 10 V.	

10. Recheck	It may be necessary to repeat the last steps until stable readings are obtained.

4.1.3 Servo-Control Static Gain Calibration

The object of servo-control static gain adjustment is to assure that the piezo moves to the nominal travel range end position when that position is commanded in servo-on mode (in analog mode, 10 V control input).

You will need an external measuring device and a 32-pin extension adapter to access the potentiometers mentioned while the unit is in operation (P-895.00, not included).

Since the servo-controller uses the sensor signal as a basis, the analog sensor zero point and open-loop range should be adjusted before the static servo-gain is set.

This procedure can be carried out with the unit in either computer-controlled or analog mode. If done in analog mode, you will also need a highly accurate voltage source and meter.

DANGER

Procedures which require removing the E-621 module from the chassis should be carried out by authorized, qualified personnel only.

Disconnect the chassis from power when removing modules, and when resetting internal switches or jumpers.

When a module removed from the chassis must be operated, use a 32-pin extension connector (P-895.00, not included). Voltages of up to 130 V can be exposed. Do not touch internal conductors.

CLOSED-LOOP SERVO STATIC GAIN	Computer-Controlled Mode	Analog Mode
1. Make adjustment elements accessible	Remove E-621 from the chassis and connect via P-895.00 extension connector (qualified, authorized personal only)	Remove E-621 from the chassis and connect via P-895.00 extension connector (qualified, authorized personal only)
2. Set DIP switches on the front panel for operating mode	sw1 OFF, sw2 ON, sw 4 ON, connect RS-232 or USB cable to this unit	sw1 ON, sw2 OFF, sw4 OFF
3. Power up	After power-on, establish communications, e.g. with PITerminal	
4. Set servo ON	Send SVO *A* 1 where *A* is the axis identifier	Set DIP switch 3 ON or connect pin 28a to pin 14a or 14c
5. Check for oscillation	If the piezo goes into oscillation, you will have to perform the dynamic adjustments (especially notch filter) first.	
6. Set external gauge to 0	Send MOV *A* 0 where *A* is the axis identifier, and set external gauge to 0	Put 0 V analog input on the "ANALOG INPUT" SMB socket (DC offset must be to 0 or OFF (X8 2-3)) and set external gauge to 0.
7. Command a position equal to the end of the nominal travel range	e.g. send MOV *A* 100 where *A* is the axis identifier The piezo should expand to the nominal expansion, and the output on the "SENSOR MONITOR" SMB socket should be exactly 10 V. Verify this with the external gauge and meter	Using an appropriately accurate source apply +10.0000 V to the analog input. The piezo should expand to the nominal expansion, and the output on the "SENSOR MONITOR" SMB socket should be exactly 10 V. Verify this with the external gauge and meter
8. Adjust sensor monitor output	To adjust the "SENSOR MONITOR" output to exactly 10.000 V use the GAIN Fine Adjust potentiometer on the servo submodule, E-802.55	
9. Adjust piezo expansion	To adjust the expansion without changing the "SENSOR MONITOR" output (servo-control is on!) use the gain adjustment potentiometer R143 on the main board (see Section 5.2 p. 36 for component location)	
10. Repeat the last steps several times until stable results are obtained		

This adjustment can only be done accurately for one control mode (analog mode or computer-controlled mode). If you use the unadjusted mode, 1% error in the sensor monitor output voltage can be expected.

4.1.4 Second Order Polynomial Linearization (ILS)

> ### DANGER
>
> Procedures which require removing the E-621 module from the chassis should be carried out by authorized, qualified personnel only.
>
> Disconnect the chassis from power when removing modules, and when resetting internal switches or jumpers.
>
> When a module removed from the chassis must be operated, use a 32-pin extension connector (P-895.00, not included). Voltages of up to 130 V can be exposed. Do not touch internal conductors.

The capacitive sensor electronics on the E-621.CR main board includes a trim pot (ILS) for minimizing second-order polynomial non-linearity. To adjust the ILS proceed as follows:

1 Set DIP switches on the front panel for analog operating mode:
sw1 ON, sw2 OFF, sw4 OFF

2 Make sure the piezo actuator is mounted in the same way and with the same load as during normal operations in the application. In multi-axis systems, make sure the piezos are always connected to the same controller units.

3 Mount an external gauge to measure the piezo displacement. Only if the external measurement system offers higher precision than the capacitive sensor can the maximum performance be achieved. With E-621 powered down, the external gauge should read 0; if it does not, note the offset and subtract it from subsequent readings.

4 Remove the E-621 from the chassis and reconnect through a P-895.00 extension bracket (not included). To remove the module, proceed as follows:

Loosen the two Phillips screws on the front panel.

Using the grip at the bottom of the front panel, pull the module out of the chassis.

5 Power up the E-621

6   Scan the voltage at "ANALOG INPUT" from 0 V to +10 V and read the piezo displacement using the external gauge.

7   Adjust the Integrated Linearization System (ILS) by turning the ILS potentiometer (see p. 36) and maximize the linearity of the piezo displacement.

4.2   Servo-Control Dynamic Characteristics

The object of servo-control dynamic calibration is to regulate behavior such as overshoot, ringing and settling time. The servo-control submodule also has a notch filter which makes it possible to eliminate vibration at the mechanical resonant frequency of the system.

Dynamic calibration procedures require an oscilloscope (a digital storage oscilloscope is recommended), frequency generator to output square and sine functions from 1Hz to 1 kHz and an ohmmeter with a range from 0.1 to 100 kΩ and, depending on the installation, a 32-pin extension adapter to allow access to the trim potentiometers while the board is in operation.

DANGER

Procedures which require removing the E-621 module from the chassis should be carried out by authorized, qualified personnel only.

Disconnect the chassis from power when removing modules, and when resetting internal switches or jumpers.

When a module removed from the chassis must be operated, use a 32-pin extension connector (P-895.00, not included). Voltages of up to 130 V can be exposed. Do not touch internal conductors.

The dynamic calibration procedures are described in the User Manual for the E-802.55 servo-control submodule (execution in analog mode). Using the wave table of the E-816 computer interface module it should also be possible to perform them in computer-controlled mode without an external frequency generator.

Note that the notch filter and slew rate limiter are not deactivated by the servo-off line. Resetting the notch filter

frequency in this mode (open-loop via servo-off signal) can cause the piezo output voltage to change by as much as 5%. To deactivate the notch filter and slew rate limiter, use jumper X4 in position 2-3 to remove the E-802 from the circuit entirely (see block diagram below).

5   Electronics Details

5.1   E-621.CR Block Diagram
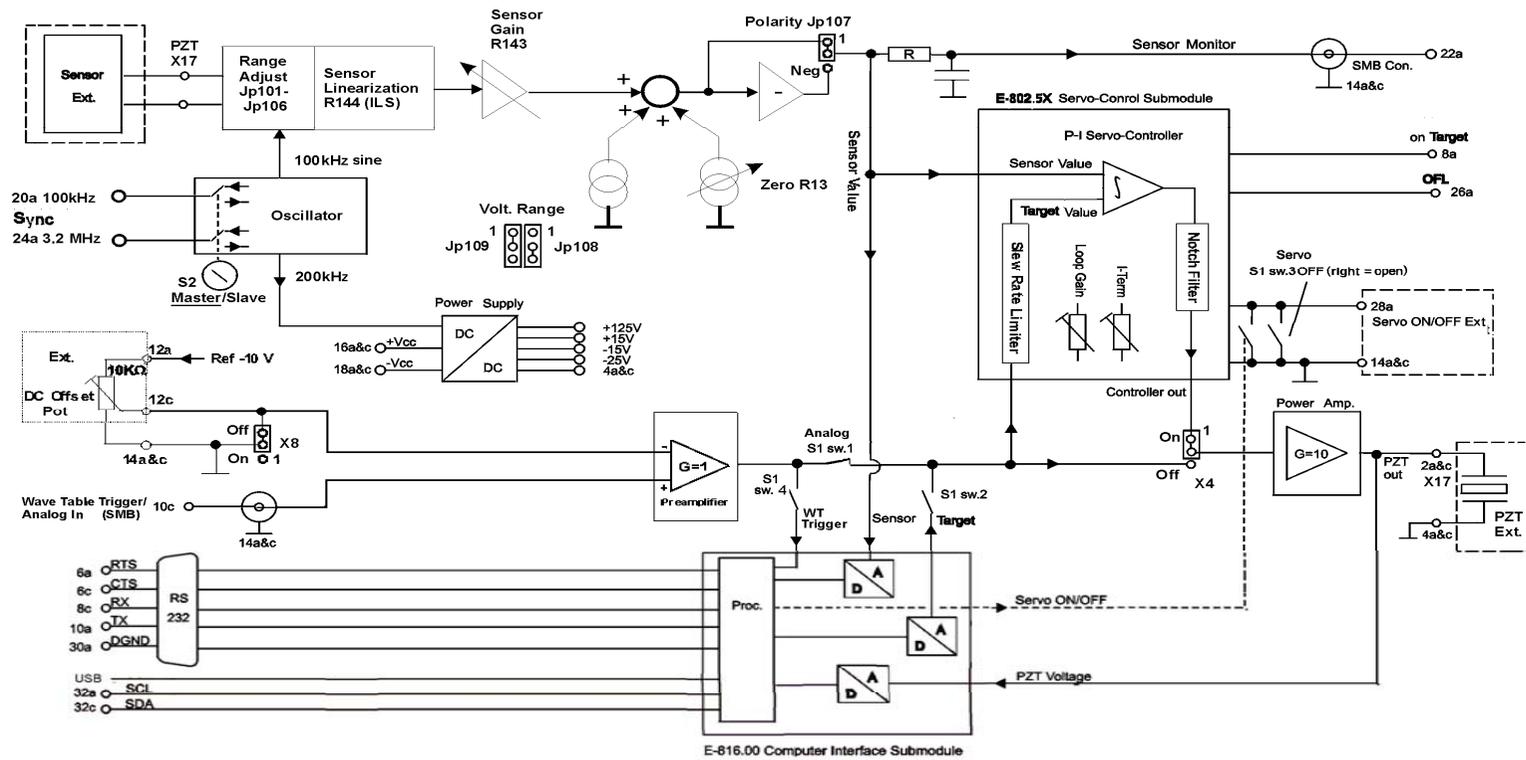
Fig. 5:
E-621.CR
Block
Diagram

NOTE:
Input signals on the analog input line (front panel SMB connector and main connector pin 10c) and the position of the external DC-offset potentiometer (if activated) are combined in the preamplifier stage. Depending on the DIP switch settings, the resultant signal will be used either as control input, or as digital input for triggering. **If the signal on the SMB socket is to be used as trigger, DC offset must be deactivated or set to 0.**

5.2 Components and Adjustment Elements

See also the E-801 and E-802 User Manuals for adjustment elements on those submodules which are not described here.
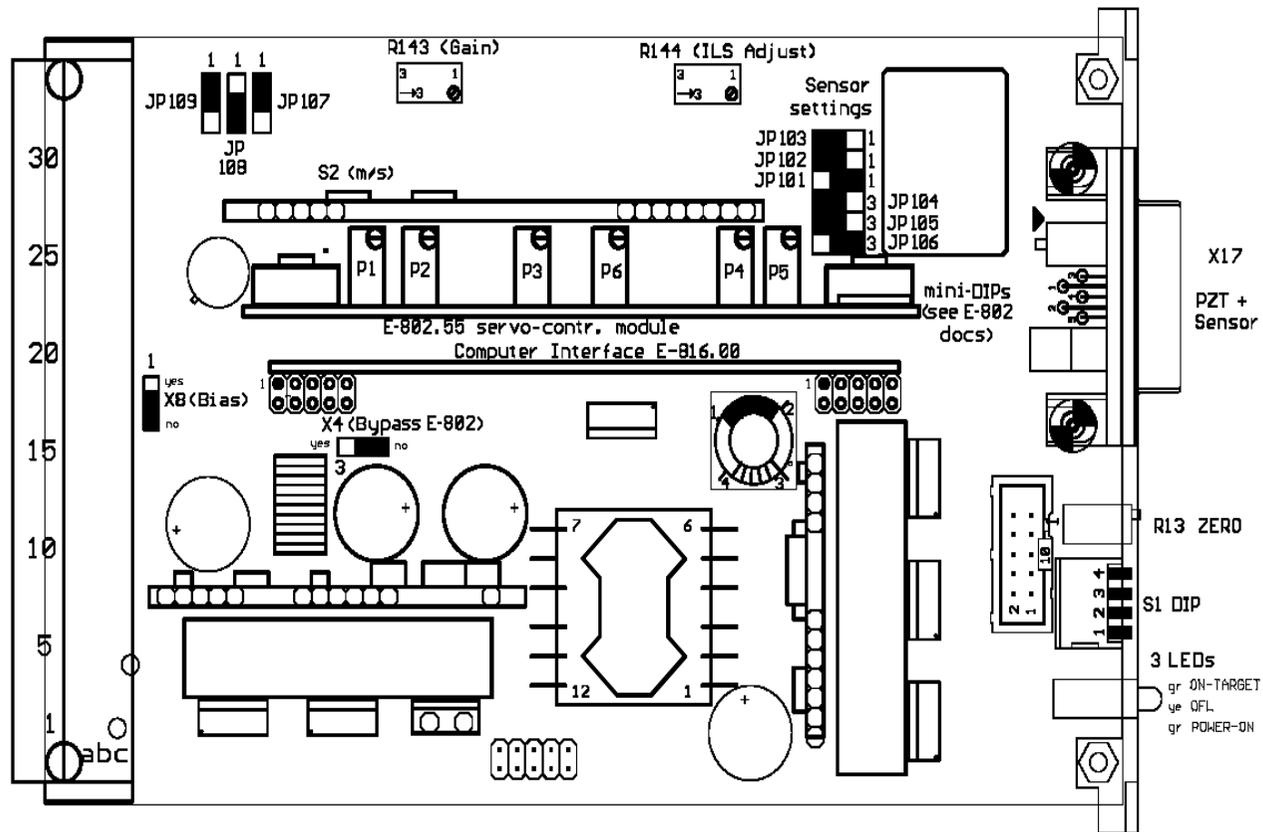
Fig. 6: E-621.CR (viewed from component side, with bottom edge on top) component locations; adjustment elements shown in default settings, all except X4 (E-802 bypass) are accessible without removing cover plate (not shown)

5.2.1 Jumpers

Jumpers are also shown on the block diagram on p. 35.

<u>X4</u> Servo mode, notch filter and slew rate bypass

1-2: Factory setting: the servo-control mode depends on the setting of DIP switch 3 on the E-621 front panel, on pin 28a of the 32-pin main connector or on the SVO command settings. The slew rate limitation and notch filter are always ON.

2-3: E-802.55 submodule with servo-control, slew rate limitation and notch filter is completely bypassed. No other combination of settings or commands can activate it.

X8 External DC offset potentiometer (not included):
1-2   activated (do not activate without wiring to the 32-pin main connector, p. 50)
2-3   deactivated

<u>JP101-JP106</u> Sensor Measurement Range

measurement range extension factor		no measurement	0.56	0.68	0.75	1.0	1.25	2.13	3
Jumper Position	JP103 JP102 JP101 JP104 JP105 JP106								

Fig. 7: E-621.CR sensor range jumper settings

The jumper group is shown as arranged on the main board (see component map, p. 36). Units are delivered set as required for the attached stages. With no information on the stage, PI usually sets units to 1.0.

JP107 - JP109 shift the voltage range of the sensor processing circuitry. They must remain as set at the factory, i.e. for use with an E-802 Servo-Control submodule (positive polarity, 0-10 V)

Position of the Jumper JP107		
Polarity of Output	Positive	Negative

Typical Application	Using with PI's position control electronics	Using as a position detector	Special application
Position of Jumpers JP108 and JP109			
Voltage range of output	0V ~ 10V	-5V ~ +5V	-10V ~ 0V

Fig. 8: E-621.CR sensor processing output settings

5.2.2 Switches

DIP switch block S1 is accessible through the front panel. (Do not confuse with the S1 damping control on the E-802 submodule, described in the E-802 User Manual).

sw1 (left switch)	ON (down)	Signal on "ANALOG IN/WTT" line used as analog input
	OFF (up)	Signal on "ANALOG INPUT" line not used as analog input
sw2	ON (down)	Control input from E-816 computer interface submodule used
	OFF (up)	Control input from E-816 computer interface submodule not used
sw3	ON (down)	Servo on
	OFF (up)	Servo off; can be switched on by E-816 via SVO command or by grounding pin 28a of the 32-pin main connector
sw4	ON (down)	Signal on "ANALOG INPUT" line used as trigger for wave table output or triggered motion
	OFF (up)	Signal on "ANALOG INPUT" line not used as trigger for wave table output or triggered motion

Unpredictable behavior may result if sw 1, 2 and 4 are set incompatibly. For admissible combinations, see "Front Panel Elements" on p. 15.

Switch S2 (master/slave) for capacitive sensor excitation synchronization (do not confuse with the S2 mini DIP block on the E-802 submodule, described in the E-802 User Manual) in systems with multiple capacitive sensor units. One system remains as sensor master, the others must be set as slaves, and the sync. lines of all must be bused together. Fig. 9 shows switch S2 in the Master position (default). For the Slave position, turn the switch through 90° using a screwdriver.

Mini-DIPs on E-802   Slit for accessing P1-P6 on E-802 Submodule
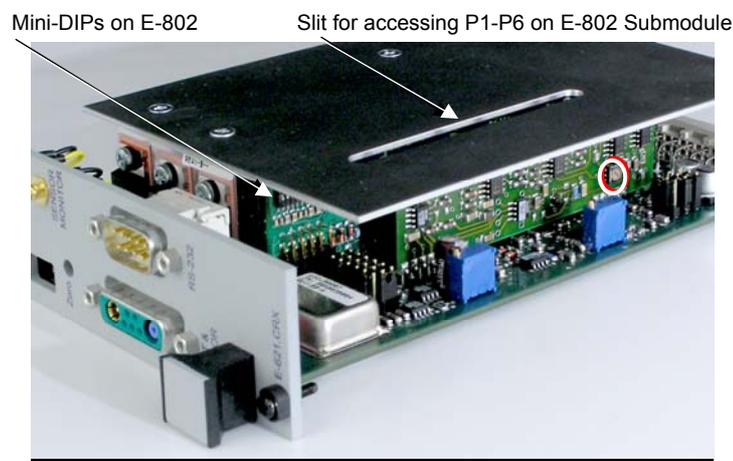
Fig. 9: Master/Slave switch S2 (circled) on PCB soldered perpendicular to main board, shown in default Master position.

Mini-DIP switches on the E-802.55 Servo-Control submodule: see the E-802 manual for description.

5.2.3 Potentiometers

The calibration procedures involve setting a number of trim pots. The R13 Zero potentiometer is accessible through a hole in the front panel. It is necessary to remove the E-621.CR from the chassis to adjust others, like R143 Sensor Gain and R144 ILS adjust, which are located on the main board, and the servo-control adjustments, which are on the E-802 submodule.

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5.3   E-802 Position Servo-Control Board

The E-802 is a small plug-in PCB that processes the control signal for the amplifier driving the piezoelectric translators. Slew rate limitation, notch filter and servo-control loop are all implemented on the E-802.

The servo-loop logic compares the control voltage input and the sensor signal to generate the amplifier control signal using an analog proportional-integral (P-I) algorithm.
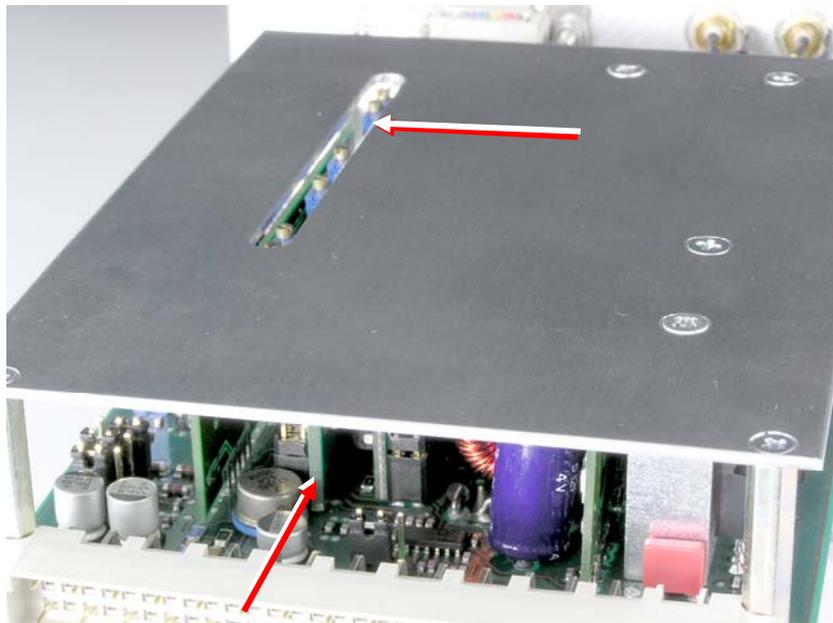
Fig. 10: E-802 servo-control submodule (lower arrow) trim pots accessible through slot (upper arrow) in shield plate

For calibration procedures, see "Servo-Control Static Gain Calibration", p. 30 and "Servo-Control Dynamic Characteristics", p. 33. The E-802 submodule is described in detail in a separate user manual.

6   Troubleshooting

Stage does not move

Cable not connected properly

→ Check the connecting cable(s)

Stage or stage cable is defective

→ If a working stage of the same type is available, exchange the defective stage to test a new combination of E-621.CR and stage. Since stage and E-621.CR always form a calibrated system, the performance with the new stage will probably be lower than with the original stage. If the new stage is to be used permanently and in normal operation, a new calibration is required. See "Calibration" on p. 25 for details.

Incorrect control mode of the piezo channel

→ The applicable control sources for the axis motion depend on the current control mode (analog or computer-controlled mode, see "Control Modes" on p. 18 for details).

In analog mode, move commands (received via interface or from a running macro), trigger input and wave table output are ignored and may provoke an error message.

In computer-controlled mode, the axis motion can be commanded by move commands received via interface or from a running macro, by trigger input and wave table output. Respect the prioritization of the individual sources (see the User Manual of the E-816 computer interface submodule for details).

Check the DIP switch setting on the front panel for the current control mode ("Front Panel Elements", p. 15).

No control signal applied or signal out of range

→ In analog mode, apply an analog control signal to the "ANALOG INPUT" SMB socket to command the axis motion. The signal should always be in the range of -2 to 12 V (excursions to -3 or +13 V may cause overflow, especially with servo on, and reduce actuator lifetime).

If you generate the analog signal with a DAQ board in a PC running LabVIEW and using PI's LabVIEW Analog Driver Set, check the driver and the DAQ board for proper operation.

Move commands or wave table commands may provoke errors and are ignored.

Wrong command or wrong syntax

→ Check the error code with the ERR? command. Note that the response to this command contains only the error code of the master unit. See the ERR? description in the User Manual of the E-816 computer interface submodule for the complete error reference.

Wrong axis commanded

→ Check if the correct axis identifier is used and if the commanded axis is that of the desired stage (axis identifier also required with single-axis systems!)

Incorrect configuration

→ Check the parameter settings on the E-816 computer interface module with the SPA? command.

The high voltage output of the E-621.CR is deactivated

→ If the internal temperature goes out of range (75 °C or higher), the high voltage output of the E-621.CR will be deactivated. In that case the mechanics will no longer move. When the internal temperature falls below 60 °C, the high voltage output is reactivated automatically.

How to avoid overheating:

Keep the ambient temperature at a noncritical value: Note that the difference between ambient temperature and internal temperature of the E-621.CR normally is about 20 Centigrade (36 Fahrenheit) degrees.
Place the system in a location with adequate ventilation. Allow at least 10 cm (4 inches) clearance from the top and the rear of the unit and 5 cm (2 inches) from each side. If this is not possible, keep the ambient temperature low.
When using the wave table output, it is recommended to reduce the frequency and/or the amplitude and/or the output duration to avoid overheating.

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Communication with controller does not work

Communication cable is wrong or defective

→ Check cable. Does it work properly with another device?

For RS-232, a null-modem cable must be used.

The interface is not configured correctly

→ With the RS-232 interface, check port and baud rate (set via BDR command). The serial port on the E-816 is preset to the following parameters: 115,200 baud, 8 data bits, 1 stop bit, no parity, RTS/CTS.
It is recommended that the host PC have a "genuine" RS-232 interface on board. If the host PC uses a USB-to-serial adapter instead, data loss could occur during communication, especially when transferring large amounts of data.

→ The first time you connect over the USB interface, be sure you are logged on the PC as a user having administrator rights. After the E-621.CR is powered on, a message will appear saying that new hardware has been detected. Follow the on-screen instructions and insert the E-816 CD. The required hardware driver is found in the \USB_Driver directory.

Controller was power-cycled or rebooted

→ With USB connections, communication can not be maintained after the E-621.CR is power-cycled or the E-816 digital operation module is reset. The connection must then be closed and reopened.

Another program is using the interface

→ Close the other program.

Specific software has problems

→ See if the system works with some other software, e.g. a terminal or development environment. You can, for example, test the communication by simply starting a terminal program, e.g. PI Terminal, and entering *IDN?. Note that multi-character commands are transferred as terminated by a LF (line feed) character and are executed only after the LF is received.

Unsatisfactory system performance

The sensor values are not reliable, and the whole system is instable.

→ Only thermally stable systems can have the best performance. For a thermally stable system, power on the E-621.CR at least one hour before you start working with it.

The stage starts to oscillate, or shows nonsatisfying settling behaviour.

→ Your system will be fully calibrated before being shipped. But due to load changes in the application, some calibration settings may no longer be suitable. See "Servo-Control Dynamic Characteristics" on p. 33 for details.

Overflow LED glows

The output of the amplifier is being clipped at one of its limits.

→ Try to adjust the sensor reading window as described in "Open-Loop Zero-Point Adjustment" on p. 27 (a small deviation of the electrical zero-point may be caused by thermal drift or changes in mechanical loading).

Adjustments to the zero point should not exceed ±10% of the stage travel.

After successful zero point adjustment, the "Overflow" LED should no longer glow in closed-loop operation. To avoid an overflow of the amplifier in open-loop operation, do not exceed the allowable control input range.

Permanent glow of the "Overflow" LED in spite of zero point adjustment may indicate hardware failure. Contact your Physik Instrumente Sales Engineer.

Custom software accessing PI drivers does not run.

Wrong combination of driver routines/Vis

→ Check if system runs with Terminal program. If yes read the software manual and compare sample code from the E-816 CD to check the necessary driver routines.

7 Customer Service

Call your PI representative or write to info@pi.ws; please have the following information about your system ready:

- Product codes and serial numbers of all products in the system

- Current firmware version of the controller (if present)

- Version of drivers and / or host software (if present)

- Operating system on host PC (if present)

8   Old Equipment Disposal

In accordance with EU directive 2002 / 96 / EC (WEEE), as of 13 August 2005, electrical and electronic equipment may not be disposed of in the member states of the EU mixed with other wastes.

To meet the manufacturer's product responsibility with regard to this product, Physik Instrumente (PI) GmbH & Co. KG will ensure environmentally correct disposal of old PI equipment that was first put into circulation after 13 August 2005, free of charge.

If you have such old equipment from PI, you can send it to the following address postage-free:

Physik Instrumente (PI) GmbH & Co. KG
Auf der Römerstr. 1
76228 Karlsruhe, Germany

9   Technical Data

9.1   Specifications

	E-621.CR
Function	Piezo Amplifier / Servo-Controller
Axes	1
Sensor	
Servo characteristics	P-I (analog), notch filter
Sensor type	capacitive
Sensor resolution	20-bit
Amplifier	
Control input voltage range	-2 to 12 V
Min. output voltage	-30 to 130 V
Peak output power, < 5 ms	12 W
Average output power	6 W
Peak current, < 5 ms	120 mA
Average current	60 mA
Current limitation	Short-circuit-proof
Noise, 0 to 100 kHz	0.8 mVrms
Ripple of Uout	20 mVpp at low frequencies, 40 mVpp (spikes) at 30 kHz
Voltage gain	10 ±0.1
Input impedance	100 kΩ

Interfaces and operation	
Interface / communication	USB, RS-232 (9-pin Sub-D connector, 9.6 - 115.2 kBaud), 24-bit A/D and 20-bit D/A resolution
Piezo connector	Sub-D special
Sensor connection	Sub-D special
Control input / trigger input socket	SMB
Sensor monitor socket	SMB
Sensor monitor output	0 to +10 V for nominal expansion
Controller network	up to 12 channels
Supported functionality	Wave table with 256 data points, external trigger, 16 macros
DC Offset	External potentiometer (not included), adds 0 to 10 V to the analog input
Miscellaneous	
Operating temperature range	+5 to +50 °C (10% derated over 40 °C)
Overheat protection	Deactivation at 75°C
Dimensions	7HP/3U
Mass	0.6 kg
Operating voltage	12 to 30 V DC, stabilized
Current consumption	2 A

Chassis Model	E-500.621	E-501.621
E-621 modules (max.)	12	4
Operating voltage	100 to 240 VAC, 50-60 Hz	100 to 240 VAC, 50-60 Hz
Dimensions	450 x 132 x 296 mm + handles	236 x 132 x 296 mm + handles

9.2   Frequency Response Diagram
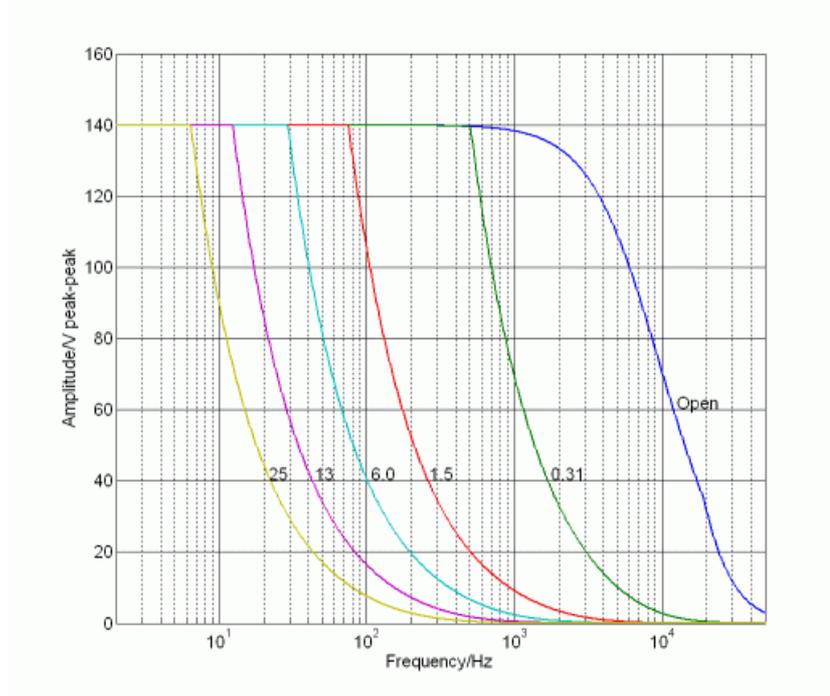
*Fig. 11: E-621 open-loop frequency response with various piezo
loads. Values shown are capacitance in µF*

9.3   Pin Assignments

9.3.1 32-Pin Main Connector

Because the DIN 41612 connector standard includes types with more pins, the 32 pins of the "D" version all carry even number designations and are in rows "a" and "c".

Pin	Function	Pin	Function
2a	PZT output	2c	PZT output
4a	PZT GND	4c	PZT GND
6a	RS-232/RTS	6c	RS-232/CTS
8a	On-Target (TTL, active low)****	8c	RS-232/RX
10a	RS-232/TX	10c	Analog input / trigger input (use depends on the settings of DIP switches 1 and 4)
12a	Pot 10 kOhm (-10 V)	12c	Pot wiper
14a	Pot 10 kOhm (GND)*****	14c	Pot 10 kOhm (GND), also Test GND*****
16a	+VCC supply	16c	+VCC supply
18a	-VCC supply	18c	-VCC supply
20a	100 kHz in/out***	20c	LVDT Sync.In (200 kHz)
22a	Monitor sensor	22c	GND for Sensor, Test, Analog In
24a	3.2 MHz in/out***	24c	Sensor excitation
26a	Overflow (TTL, active-low)	26c	Sensor inverting input
28a	Servo ON/OFF select*	28c	Sensor non-inverting input
30a	GND for RS-232	30c	GND for sensor excitation
32a	I^{2}C SCL-signal**	32c	I^{2}C SDA signal**

*0 V = LOW, 5 V = HIGH, Active LOW (LOW = servo ON; default is HIGH). Servo is on if pin 28a is connected to pin 14a or 14c (GND). In this case, switching to open-loop operation (servo OFF) is neither possible with DIP switch 3 on the front panel nor with the SVO command via the E-816 computer interface submodule.

**If E-621s are networked outside a single E-50x.621 chassis, the SCL and SDA bus lines are limited to a maximum length of 1 m and a maximum capacitance of 400 pF.

*** Sync lines are output if S2 set to Master, input if S2 set to Slave. The respective sync. lines of the (single) master and the slaves are tied together in newer E-50x.621 chassis (manufactured after August 2006).

**** On target signal from E-802 submodule, indicates distance from target less than ±0.19% of range, TTL active-low

*****Pins 14a and 14c should be connected to a protective ground

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9.3.2 PZT and Sensor Connector

Special sub-D (X17) carrying both piezo voltage and sensor lines.

A1   PZT out
A2   Sensor probe
1   ID-chip (not supported)
2   AGND target and ID GND
3   PZT GND (tied to case)
4   n.c.
5   Sensor target
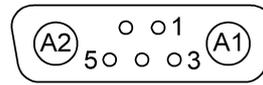
10 Appendix

10.1 Lifetime of PICMA® Actuators

The following factors can have an impact on the actuator lifetime and must be considered:

- Applied voltage
- Temperature
- Relative humidity

The effect of each individual factor on the lifetime can be read off the diagrams shown below. The lifetime calculated in hours simply results as the product of all three values read off the diagrams.

The impact of the applied voltage is particularly important. With decreasing voltage the lifetime increases exponentially. This must always be taken into consideration in an application. The recommended maximum range of the control input voltage for E-621 therefore is -2 to 12 V, resulting in a piezo voltage range of -20 to 120 V (in open-loop operation). A control input range of -3 to 13 V is possible (results in -30 to 130 V piezo voltage in open-loop operation), but will reduce the actuator lifetime accordingly.
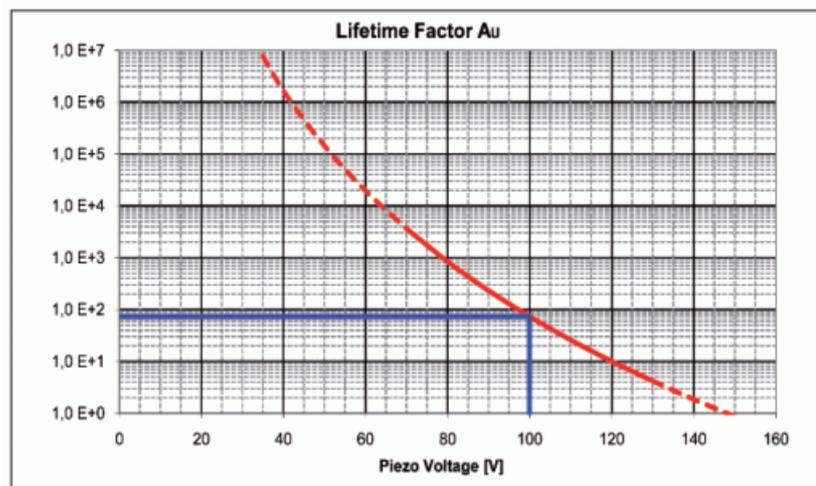
Fig. 12: Interdependency between the mean MTTF of a PICMA® actuator and the value of the voltage applied
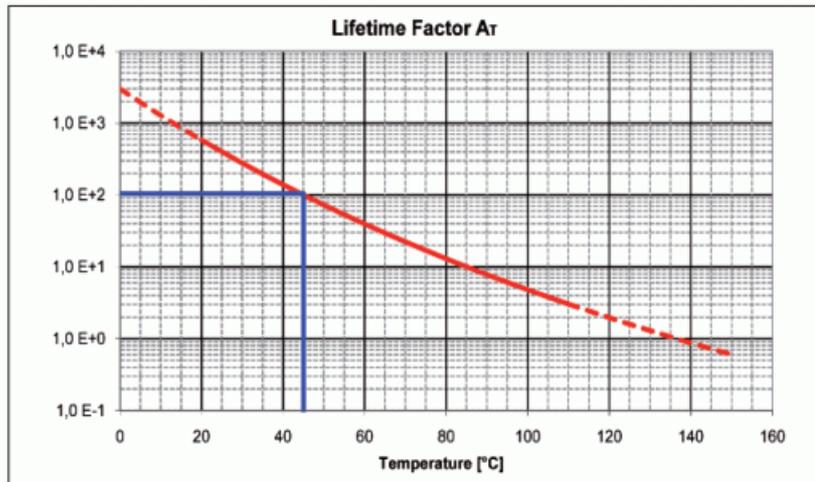
Fig. 13: Interdependency between the mean MTTF of a PICMA®
actuator and the ambient temperature
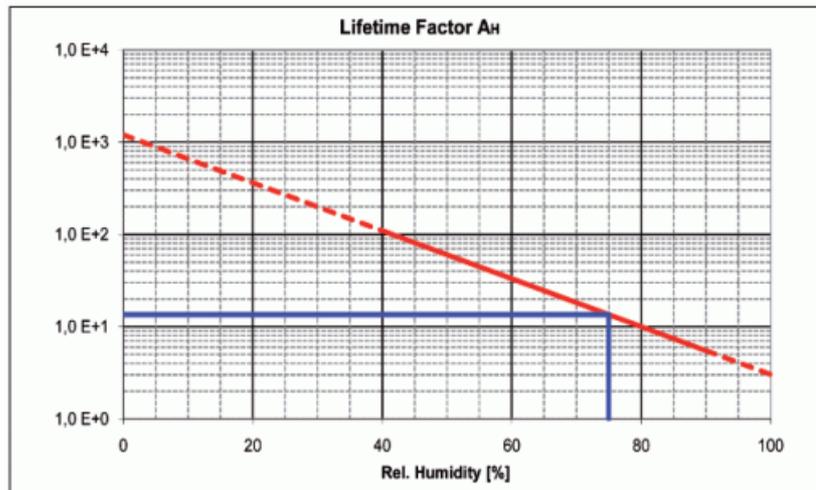
Fig. 14: Interdependency between the mean MTTF of a PICMA®
actuator and the relative humidity

Example

The simple formula MTTF = A_U * A_T * A_F provides a quick
estimate of the reliability in hours.

For example, the values for 75% RH (A_F=14), 100 VDC (A_U=75)
and 45 °C (A_T=100) result in an approximate MTTF of 105,000 h,
i.e. more than 11 years (see markings on the diagrams).

Read the "Tutorial: Piezoelectrics in Positioning" in the PI
Catalog for detailed information.