PI

PZ166E

E-625 Piezo Servo Controller

User Manual

Version: 1.7.0 Date: 20.06.2013

This document describes the following products:

- **E-625.CR**
  Piezo servo controller, single channel, for capacitive sensors
- **E-625.C0**
  Piezo servo controller, single channel, for capacitive sensors, only analog control

Physik Instrumente (PI) GmbH & Co. KG · Auf der Römerstr. 1 76228 Karlsruhe, Germany
Telephon +49 721 4846-0 · Telefax +49 721 4846-1019 · E-Mail info@pi.ws

Physik Instrumente (PI) GmbH & Co. KG is the owner of the following trademarks: PI®, PIC®, PICMA®, Picoactuator®, PIFOC®, PILine®, PInano®, PiezoWalk®, NEXACT®, NEXLINE®, NanoCube®, NanoAutomation®

Original instructions
First printing: 20.06.2013
Document number: PZ166E, BRo, version 1.7.0

Subject to change without notice. This manual is superseded by any new release. The latest release is available for download (p. 3) on our website.

Contents

1 About this Document

In this Chapter

1.1 Goal and Target Audience of this User Manual

This manual contains information on the intended use of the E-625.

It assumes that the reader has a fundamental understanding of basic servo systems as well as motion control concepts and applicable safety procedures.

The latest versions of the user manuals are available for download (p. 3) on our website.

1.2 Symbols and Typographic Conventions

The following symbols and typographic conventions are used in this user manual:

DANGER

Imminently hazardous situation

If not avoided, the hazardous situation will result in death or serious injury.

➢ Actions to take to avoid the situation.

NOTICE

Dangerous situation

If not avoided, the dangerous situation will result in damage to the equipment.

➢ Actions to take to avoid the situation.

INFORMATION
Information for easier handling, tricks, tips, etc.

Symbol/ Label	**Meaning**
1. 2.	Action consisting of several steps whose sequential order must be observed
➢	Action consisting of one or several steps whose sequential order is irrelevant
▪	List item
p. 5	Cross-reference to page 5
RS-232	Labeling of an operating element on the product (example: socket of the RS-232 interface)
	Warning signs affixed to the product that refer to detailed information in this manual.

1.3 Other Applicable Documents

The devices and software tools which are mentioned in this documentation are described in their own manuals. The latest versions of the user manuals are available for download (p. 3) on our website.

Component	**Document**
E-802 Servo-Control Submodule	PZ150E User Manual
Analog Controller LabView Driver Library	PZ181E Software Manual
Only with E-625.CR:	
E-816 Computer Interface Submodule	PZ116E User Manual
	PZ120E DLL Software Manual
	PZ121E LabVIEW Software Manual
PIMikroMove	SM148E Software Manual

INFORMATION
The E-625.S0 and E-625.SR models for operation with strain gauge sensors are described in a separate manual (PZ167E).

1.4 Downloading Manuals

INFORMATION

If a manual is missing on our website or if there are problems in downloading:

- Contact our customer service department (p. 75).

The current versions of the manuals are found on our website. To download a manual, proceed as follows:

1. Open the website **http://www.pi-portal.ws**.
2. Click ***Downloads***.
3. Click the corresponding category (e. g. ***E Piezo Drivers & Nanopositioning Controllers***).
4. Click the corresponding product code (e. g. ***E-625***).

   An overview of the available file types is shown for the selected product.
5. If ***(0 Files)*** is shown in the ***Documents*** line, log in as follows to display and download the documents:
   a) Insert the product CD in the corresponding PC drive.
   b) Open the ***Manuals*** directory.
   c) Open the Release News (e. g. ***E-816_Releasenews_x_x_x.pdf***) on the CD of the product.
   d) Find the user name and password in the **User login for software download** section in the Release News.
   e) In the ***User login*** area on the left margin in the website, enter the user name and the password in the corresponding fields.
   f) Click ***Login***.

   If ***Documents (0 Files)*** is still being displayed, no manuals are available:

   – Contact our customer service department (p. 75).
6. Click ***Documents***.
7. Click the desired manual and save it on the hard disk of your PC or on a data storage medium.

2 Safety

In this Chapter

2.1 Intended Use

The E-625 is a laboratory device according to DIN EN 61010. It is intended to be used in interior spaces and in an environment which is free of dirt, oil and lubricants.

Corresponding to its design, the E-625 is intended for driving capacitive loads (e. g. piezo ceramic actuators).

The E-625 must not be used for purposes other than those named in this user manual. In particular, the E-625 must not be used to drive ohmic or inductive loads.

The E-625 can be used for static as well as dynamic applications.

Capacitive sensors must be used for closed-loop operation. PI stages intended for closed-loop operation already have the corresponding sensors. Other sensors can only be used with PI approval.

2.2 General Safety Instructions

The E-625 is built according to state-of-the-art technology and recognized safety standards. Improper use can result in personal injury and/or damage to the E-625.

- ➢ Only use the E-625 for its intended purpose, and only use it if it is in a good working order.
- ➢ Read the user manual.
- ➢ Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for the correct installation and operation of the E-625.

- Install the E-625 near the power source so that the power plug can be quickly and easily disconnected from the mains.
- Use the supplied components (power supply, adapter and power cord (p. 15)) to connect the E-625 to the power source.
- If one of the supplied components for connecting to the power source has to be replaced, use a sufficiently dimensioned component.

If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the E-625 in the case of malfunction or failure of the system. If touch voltages exist, touching the E-625 can result in serious injury or death from electric shock.

- Connect the E-625 to a protective earth conductor before start-up (p. 20).
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e. g. in the case of modifications), reconnect the E-625 to the protective earth conductor before starting it up again.

If the E-625 is operated with an open case, live parts are accessible. Touching the live parts can result in serious injury or death from electric shock.

- Only open the E-625 case when you are authorized and have the corresponding qualifications.
- Before opening the case, remove the E-625 from the power source by pulling the power plug.
- When operating with an open case, do not touch any components in the case aside from the adjustment elements described in this user manual.

2.3 Organizational Measures

User manual

- Always keep this user manual available by the E-625.
  The latest versions of the user manuals are available for download (p. 3) on our website.
- Add all information given by the manufacturer to the user manual, for example supplements or Technical Notes.
- If you pass the E-625 on to other users, also turn over this user manual as well as all other relevant information provided by the manufacturer.
- Only use the device on the basis of the complete user manual. If your user manual is incomplete and is therefore missing important information, serious or fatal injury as well as property damage can result.
- Only install and operate the E-625 after having read and understood this user manual.

Personnel qualification

Only authorized and qualified personnel must install, operate, maintain and clean the E-625.

3 Product Description

In this Chapter

3.1 Features and Applications

The E-625 piezo servo controller is a bench-top device that provides closed-loop and open-loop control of the stage displacement. The models E-625.CR and E-625.C0 work with capacitive sensors that measure the stage position directly and without contact (direct metrology).

The integrated E-802 servo-control submodule contains the the slew rate limiter, the notch filter and the servo loop.

The notch filter improves the stability and enables a wider broad-band operation closer to the mechanical resonance frequency of the piezo system.

The E-625.CR module is equipped with an E-816 computer interface submodule. This enables it to offer the following additional functions:

- Multi-axis network:
  Several E-625.CR can be controlled from one single interface. A special network cable sets up the communication between the individual controllers.
- Waveform memory:
  The user can save any function values in an internal table and output these with a trigger. This makes it possible to reliably repeat and simply control motion profiles.
- General Command Set (GCS):
  For uniform control of nano and micropositioning systems, the universal command set from PI is used. With GCS, control is independent of the hardware used so that various positioning systems can be controlled together or new systems can be used with minimum programming effort.

3.2 Model Overview

There are 2 standard versions of the E-625. They differ in regards to the available control modes and the possibilities for use in network operation.

Model	Description
E-625.CR	Piezo servo controller, single channel, for capacitive sensors; analog mode and computer-controlled mode; network operation of several devices
E-625.C0	Piezo servo controller, single channel, for capacitive sensors; only analog mode; no network operation

3.3 Product View

3.3.1 Front Panel

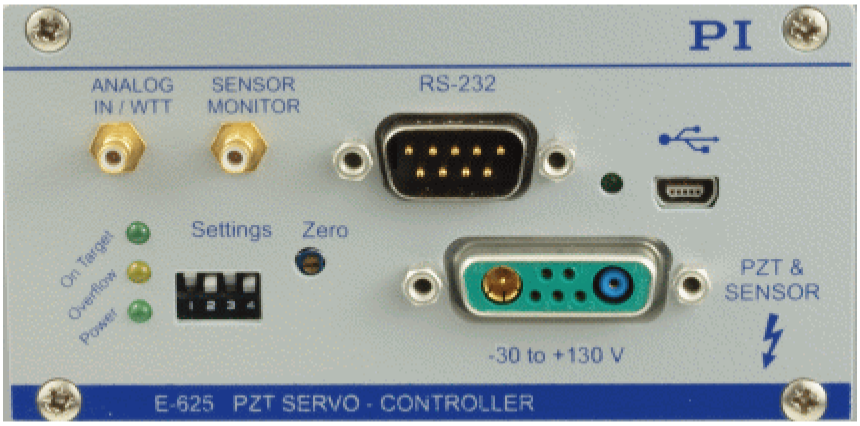


Figure 1: E-625.CR front panel

ANALOG IN/WTT

SMB socket, coaxial input line grounded on the outer conductor.

The use depends on the control mode which is set up with the ***Settings*** DIP switch block (see below):

Control Mode	Function
Analog mode	***ANALOG IN/WTT*** is used as the input voltage for the target value (depending on the servo mode interpreted as voltage or as position, see below) The input voltage should always be in the range of –2 to +12 V. The range can be expanded to –3 to +13 V. However, this can shorten (p. 89) the lifetime of the piezo actuator in the stage and causes the overflow LED to light up. The input voltage can also be a computer-generated analog signal (e.g. from a data acquisition board). You can use the PI LabVIEW analog driver from the E-816 CD to generate the analog signal (see the driver documentation on the E-816 CD).
Computer-controlled mode (only E-625.CR)	***ANALOG IN/WTT*** is used as the trigger input signal for the wave table output and triggered motion (active HIGH; LOW: 0 to 0.5 V, HIGH: 3.0 to 5.0 V, maximum 10 V; max. frequency 400 Hz; min. pulse width: 5 µs). See the user manual for the E-816 computer interface submodule.

SENSOR MONITOR

SMB socket, coaxial output line with grounded outer conductor and 0 to 10 V on the inner conductor. Filtered and converted sensor output value with 0 to 10 V for the nominal travel range. The output impedance is 10 kΩ.

RS-232 (only E-625.CR)

Sub-D panel plug, (9-pin, male) for the serial connection to the PC. See the user manual for the E-816 computer interface submodule.

USB Socket (only E-625.CR)

Universal serial bus interface (USB-mini-B(m) socket) for the serial connection to the PC. See the user manual for the E-816 computer interface submodule.

On Target LED, Green

On-target signal from E-802 servo-control submodule. When the ***On Target*** LED comes on, the distance from the target position is less than ±0.19 % of the travel range.

The signal (TTL, active low) is also applied to pin 6 of the ***Network*** sub-D socket on the rear panel of the E-625 (p. 84).

Overflow LED, Yellow

When the ***Overflow*** LED comes on, the amplifier is near its range limit (piezo voltage outside the range of –20 V to +120 V).

When the ***Overflow*** LED comes on in closed-loop operation (servo mode ON), a zero-point adjustment (p. 32) can be necessary.

Power LED, Green

When the ***Power*** LED is lit permanently, the E-625 has been switched on.

Settings DIP Switch Block

Switch	Position	Function
1 (left)	ON (down)	Signal on ***ANALOG IN/WTT*** used as the analog input voltage for specifying the target value
	OFF (up)	Signal on ***ANALOG IN/WTT*** not used as the analog input voltage for specifying the target value
2	ON (down)	Target value specified by the E-816 computer interface submodule
	OFF (up)	Target value not specified by the E-816 computer interface submodule
3	ON (down)	Servo mode switched on (closed-loop operation)
	OFF (up)	Servo mode switched off (open-loop operation) Only E-625.CR: The servo mode can be switched on on the E-816 computer interface submodule with the SVO command.
4	ON (down)	Signal on ***ANALOG IN/WTT*** used as the trigger for the wave table output or triggered motion
	OFF (up)	Signal on ***ANALOG IN/WTT*** not used as the trigger for the wave table output or triggered motion

The switches 1, 2 and 4 determine the control mode for the E-625 and consequently the usable control sources.

Switch	Analog Mode	Computer-Controlled Mode (only E-625.CR)
1	ON	OFF
2	OFF	ON
4	OFF	ON

Setting the switches 1, 2 and 4 in an incompatible manner can result in unpredictable behavior.

Zero Potentiometer

A trimmer adjustment tool can be used on the Zero potentiometer for a zero-point adjustment of the sensor. A zero-point adjustment can be necessary after longer operation (changes in temperature) or if the load is changed.

PZT & SENSOR

Sub-D Mix 7W2 socket for connecting the stage (p. 84):

- Voltage output for the piezo actuator in the stage. The piezo voltage is between –30 and +130 V.
- Input for the sensor signal from the stage

3.3.2 Rear Panel

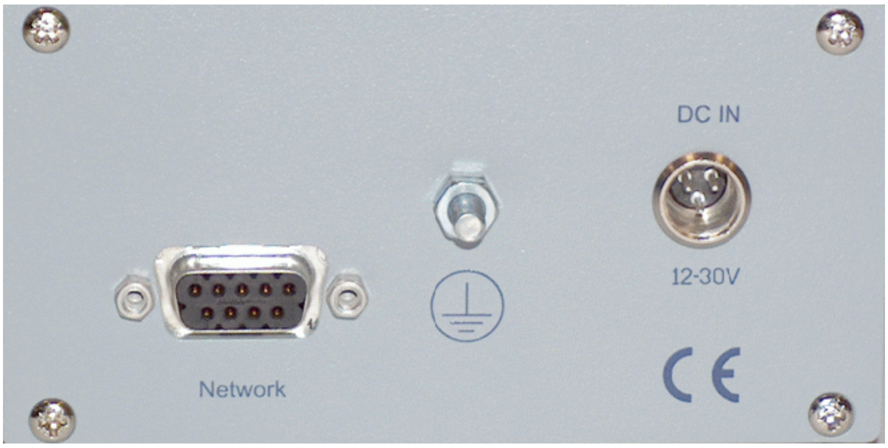


Figure 2: E-625 rear panel

Network

Sub-D socket, 9-pin, female (p. 84) for the network connection (only E-625.CR; I^2C-bus), the synchronization of the sensor and the on-target signal from the E-802 servo-controller submodule.

The on-target signal shows that the distance from the target position is less than ±0.19 % of the travel range. The signal (TTL, active low) is also applied to the ***On Target*** LED on the front panel of the E-625.

Protective Earth Connection

The protective earth connection (threaded bolt marked with the symbol for the protective earth conductor) has to be connected to a protective earth conductor, since the E-625 is not grounded via the power supply connector.

DC IN 12–30 V

Panel plug for power supply connector (p. 85). The C-890.PS wide-range-input power supply must be connected via a barrel-to-Switchcraft adapter (p. 21).

3.4 Scope of Delivery

Order Number	Items
E-625.CR or E-625.C0	Piezo servo controller according to order
C-890.PS	Separate 15 V wide-range-input power supply for use with line voltages from 100 to 240 V AC and voltage frequencies of 50 or 60 Hz, with barrel connector.
K050B0002	Barrel-to-Switchcraft adapter for the power supply connector
3763	Power cord
E-692.SMB	SMB/BNC adapter cable, 1.5 m (2 pcs.)
PZ166E	User manual for the E-625.CR and the E-625.C0 (this document)
PZ150E	User manual for the E-802 servo-controller submodule
Only with E-625.CR:	
C-815.34	Null-modem cable for the connection to the PC
000014651	USB cable (USB-A(m)/USB-Mini-B(m)) for the connection to the PC.
PZ116E	User manual for the E-816 computer interface submodule
E-816.CD	CD with software and documentation
Only with E-625.C0:	
E500T0011	Technical note for the LabVIEW analog driver

3.5 Accessories

Order Number	Description
E-625.CN	Network cable, 0.3 m, for interlinking two E-625 piezo servo controllers (I^2C-bus, sensor synchronization; for details see the pin assignment of the cable (p. 85))

- To order, contact our customer service department (p. 75).

4 Unpacking

1. Unpack the E-625 with care.
2. Compare the contents against the items covered by the contract and against the packing list.
3. Inspect the contents for signs of damage. If parts are missing or you notice signs of damage, contact PI immediately.
4. Keep all packaging materials in case the product needs to be returned.

5 Installation

In this Chapter

5.1 General Notes on Installation

- Install the E-625 near the power source so that the power plug can be quickly and easily disconnected from the mains.
- Only use cables and connections that meet local safety regulations.

5.2 Ensuring Ventilation

High temperatures can overheat the E-625.

- Set up the E-625 with a distance of at least 10 cm to the top and rear sides and at least 5 cm to the sides. If this is not possible, make sure that the area is cooled sufficiently.
- Ensure sufficient ventilation at the place of installation.
- Keep the ambient temperature to a non-critical level (<50° C).

5.3 Connecting the E-625 to the Protective Earth Conductor

INFORMATION

➢ Observe the applicable standards for mounting the protective earth conductor.

Prerequisite

✓ You have read and understood the General Notes on Installation (p. 19).

✓ The E-625 is switched off, i. e. the power supply is **not** connected to the power socket via the power cord.

Tools and Accessories

- Suitable protective earth conductor:
  - Cable cross-section ≥0.75 mm^2
  - Contact resistance < 0.1 ohm at 25 A at all connection points relevant for mounting the protective earth conductor
- Fastening material for the protective earth conductor, sits on the protective earth connector (threaded bolt) in the following order upon delivery of the E-625, starting from the case:
  - Safety washer
  - Nut
  - Flat washer
  - Toothed washer
  - Nut
- Suitable wrench

Connecting the E-625 to the Protective Earth Conductor

1. If necessary, fasten a suitable cable lug to the protective earth conductor.
2. Remove the outer nut from the protective earth connector on the rear panel of the E-625 (threaded bolt (p. 10) marked with ⏚).

3. Connect the protective earth conductor:
   a) Push the cable lug of the protective earth conductor onto the threaded bolt.
   b) Screw the nut onto the threaded bolt. In this way, the cable lug of the protective earth conductor is wedged between the toothed washer and the nut.
   c) Tighten the nut with at least three rotations and a torque of 1.2 Nm to 1.5 Nm.

5.4 Connecting the Power Supply to the E-625

Prerequisites

✓ The power cord is **not** connected to the power socket.

Tools and Accessories

- The included 15 V wide-range-input power supply (for line voltages between 100 and 240 volts alternating current voltage at 50 or 60 Hz)
- Alternatively: Sufficiently dimensioned power supply
- Barrel-to-Switchcraft adapter for the power supply (K050B0002, in scope of delivery)

- Alternatively: Sufficiently dimensioned adapter
- Included power cord
- Alternatively: Sufficiently dimensioned power cord

Connecting the Power Supply to the E-625

1. Connect the Switchcraft connector (f) of the adapter to the ***DC IN 12–30 V*** Switchcraft panel plug (m) of the E-625.

2. Connect the barrel connector of the adapter to the barrel connector socket of the power supply.

3. Connect the power cord to the power supply.

5.5 Connect a Stage to the E-625

Prerequisites

✓ The E-625 is switched off, i.e. the wide-range-input power supply is **not** connected to the power socket over the power cord.

Tools and Accessories

- The stage with which the E-625 was calibrated

Connecting the Stage

➢ Connect the stage to the ***PZT & SENSOR*** socket.

If your system was calibrated by PI, the piezo servo controller and the stage must not be replaced. Take note of the assignment indicated by the serial numbers on the calibration label on the piezo servo controller.

5.6 Connect a Signal Source to the E-625

Prerequisites

✓ The signal source is switched off or the output is 0 V.

Tools and Accessories

- Suitable signal source:
  - For use as the input voltage for specifying the target value in analog mode:
    The analog signal must always be in the range of –2 to +12 V. The input voltage can also be a computer-generated analog signal (e.g. from a data acquisition board). You can use the PI LabVIEW analog driver on the E-816 CD to generate this analog signal. See the driver documentation on the E-816 CD.
  - For the use as trigger input signal for wave table output and triggered motion in the computer-controlled mode:
    Active HIGH; LOW: 0 to 0.5 V, HIGH: 3.0 to 5.0 V, maximum 10 V; max. frequency 400 Hz; min. pulse width: 5 µs
- SMB/BNC adapter cable (in scope of delivery)

Connecting the Signal Source

➢ Use the adapter cable to connect a suitable signal source to the ***ANALOG IN/WTT*** SMB socket.

5.7 Connect a Measurement Device to the E-625

INFORMATION

The filtered and converted sensor output value with 0 to 10 V for the nominal travel range is on the ***SENSOR MONITOR*** SMB socket. The signal is directly proportional to the expansion of the piezo actuator in the stage.

Tools and Accessories

- Suitable device for measuring the sensor monitor signal:
  - The output impedance of the ***SENSOR MONITOR*** SMB socket is 10 kΩ. This is why the input resistance of the measurement device must be at least 1 MΩ for reliable measurement results.
  - The input capacitance of the electronics must be sufficiently high to suppress high-frequency interferences. If necessary, the measurement device input must be provided with a 4.7 nF capacitor (NP0 or COC ceramic capacitor).

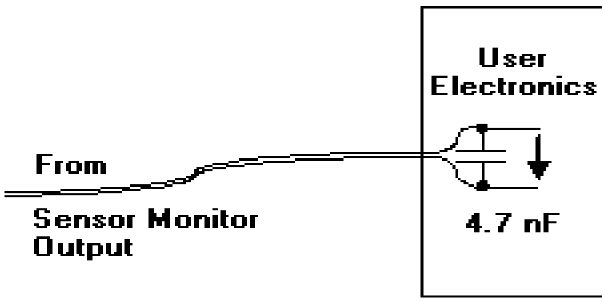


Figure 3: Electronic connection of the measurement device with the necessary input capacitance.

- SMB/BNC adapter cable (in scope of delivery)

Connecting the Measurement Device

➢ Use the adapter cable to connect the measurement device to the ***SENSOR MONITOR*** SMB socket on the E-625.

5.8 Connect a PC for the Computer-Controlled Mode (only E-625.CR)

INFORMATION

In the computer-controlled mode (p. 38), the target value is given among other things, by motion commands sent from the PC to the E-625.CR via the RS-232 or USB interface. These commands are processed by the E-816 computer interface submodule on the E-625.CR.

INFORMATION

Several devices can be interconnected and commanded from one single RS-232 or USB interface on the PC. E-625.SR or E-665 piezo servo controllers can also be connected to this network.

5.8.1 Connect the E-625.CR to the PC

Prerequisites

✓ You have read and understood the user manual for the E-816 computer interface submodule.

✓ The required software has been installed on the PC from the E-816 CD.

Tools and Accessories

- PC with a Windows or Linux operating system
- Null-modem cable or USB cable (USB-A(m)/USB-mini-B(m)) for the connection to the PC (cable in the scope of delivery).

Connecting the E-625.CR to the PC

➢ Connect the ***RS-232*** socket using the null modem cable or the USB socket using the USB cable to the PC.

5.8.2 Interlinking the Controllers

INFORMATION

The individual devices are interlinked using an I^2C-bus. This connects lines 3 and 4 on the ***Network*** socket and a ground wire (1, 2 or 5) to the corresponding wire. Furthermore, for all interlinked E-625.CRs, the sensors must be synchronized over the lines 7 and 8 on the ***Network*** socket. Using E-625.CN network cables from PI ensures that all stated connections exist, for details see the pin assignment of the cable (p. 85).

INFORMATION

The capacity of the I^2C bus is 400 pF. The larger the number of devices to be interlinked, the shorter the lines between the devices have to be. The maximum length of the bus must not exceed 1 m.

- ➢ When you use E-625.CN network cables, you can interlink a maximum of 4 devices.
- ➢ If you need to interlink more than 4 devices, use the E-621.piezo servo-control modules from PI.
  Up to 12 of these modules can be installed in one case where they are interlinked over the backplane of the case.

INFORMATION

The E-625, which is connected to the PC over the RS-232 or USB connection (communication master), forwards the commands to the other E-625 (communication slaves) in the network. The responses from the communication slaves are returned to the PC via the communication master.

Prerequisites

- ✓ All devices to be interlinked are switched off, i.e. for all E-625, the wide-range-input power supply is **not** connected to the power socket over the power cord.
- ✓ The piezo servo controller that serves as the communication master is connected to the PC over the RS-232 or USB connection.
- ✓ For the E-625.CR to be interlinked and all other piezo server controllers for capacitive sensors to be added to the network (e.g. E-665.CR), the master/slave setting has been made for the sensor synchronization, see "Synchronizing the Sensors" (p. 50) or the E-665 user manual.

Tools and Accessories

- One E-625.CN network cable for each device to be connected to the network, available as an optional accessory (p. 15)
- Alternatively: Suitable connection cables with the same pin assignment as the E-625.CN (p. 85)

Interlinking the Controllers

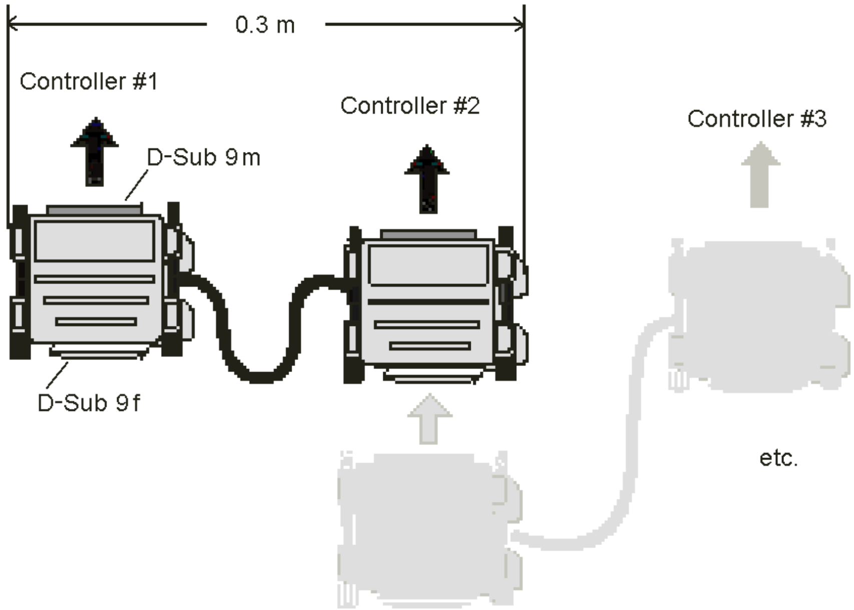


Figure 4: Interlinking via E-625.CN network cable

➢ Interlink the ***Network*** sockets on the rear panels of the cases using the E-625.CN cables (see figure) or other suitable connection cables.
The interlinking can be in a series or as a star. The E-625.CN cables have Sub-D special connectors with which several E-625.CN cables can be plugged into one E-625. The communication master can be selected as desired.

Details on the network operation (e.g. for setting the channel names) are located in the user manual for the E-816 computer interface submodule.

6 Start-Up

In this Chapter

6.1 General Notes on Start-Up

DANGER

Risk of electric shock if the protective earth conductor is not connected!

If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the E-625 in the case of malfunction or failure of the system. If touch voltages exist, touching the E-625 can result in serious injury or death from electric shock.

- Connect the E-625 to a protective earth conductor before start-up (p. 20).
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e. g. in the case of modifications), reconnect the E-625 to the protective earth conductor before starting it up again.

NOTICE

Stage damage from oscillations!

Oscillations can be detected by a humming of the stage and indicate incorrect adjustment of the notch filter and/or the P-I controller.

- At the first start-up, run a system test and, if necessary, correct the notch filter frequency and the P-I controller settings in the E-625.
- If oscillations occur during closed-loop operation, switch the servo mode off immediately.
- If oscillations occur during open-loop operation, stop the stage immediately.

INFORMATION

The E-625 performance can be reduced directly after power on due to thermal instability.

➢ Switch the E-625 on at least one hour before starting work.
➢ If the device is not used, but should remain switched on to ensure the temperature stability:
  Make sure that the servo mode is switched off (open-loop operation) and the piezo output voltage is set to 0 V:
  – Analog mode: The input voltage for the target value is 0 V
  – Computer-controlled mode: Corresponding commanding

6.2 Perform System Test

➢ During the first start up, perform a system test under conditions typical to your application. This ensures that the E-625 and the stage are optimally adapted to your conditions of use.

INFORMATION

If you perform the system test in the computer-controlled mode, you will not require a function generator or a voltmeter. You can then use the wave table output to generate a square-wave signal (to determine the resonant frequency and the settling behavior of the stage), and read out the position and output voltage via query commands.

➢ For more information, see the user manual for the E-816 computer interface submodule.

Prerequisites

✓ You have read and understood the General Notes on Start-Up (p. 27).

✓ The E-625 was installed (p. 19) properly.

✓ You have installed the stage in the same manner as it will be used in your application (corresponding load and alignment).

✓ The E-625 is switched off, i.e. the wide-range-input power supply is **not** connected to the power socket over the power cord.

✓ Have the user manual for the E-802 computer interface submodule within reach.

Tools and Accessories

- Oscilloscope; recommended: Digital storage oscilloscope (p. 23)
- Function generator for the output of a 1-V square-wave signal with 2 to 5 Hz
- Voltmeter
- 2 SMB/BNC adapter cables (in scope of delivery)
- Only if the case needs to be opened for the adjustment of internal settings:
  - Phillips-head screwdriver, size PH1
  - Timmer alignment tool

Performing a System Test in Analog Mode

1. Select analog mode and open-loop operation (servo mode OFF) using the ***Settings*** DIP switch block:
   - 1: ON (down)
   - 2: OFF (up)
   - 3: OFF (up)
   - 4: OFF (up)
2. Connect the power cord on the wide-range-input power supply to the power socket.

   The E-625 is ready for operation when the green ***Power*** LED comes on.
3. Determine the stage resonance frequency:

   a) Connect the function generator to the ***ANALOG IN/WTT*** SMB socket using an adapter cable.
   b) Connect the oscilloscope to the ***SENSOR MONITOR*** SMB socket using an adapter cable.
   c) Generate a 1-V square-wave signal (peak-peak) with 2 to 5 Hz using the funciton generator.
   d) Read the stage resonance frequency on the oscilloscope (Y-t or FFT diagram).

   If the resonance frequency is not dampened sufficiently (peak too high):

   e) Open the E-625 (p. 45).
   f) Adjust (p. 52) the notch filter accordingly on the E-802 servo-control submodule.
4. Determine the stage position at 0 V input voltage:

   a) Remove the oscilloscope from the ***SENSOR MONITOR*** SMB socket.

b) Connect the voltmeter to the ***SENSOR MONITOR*** SMB socket using the adapter cable.
c) Use the funtion generator (DC mode) to increase the input voltage on the ***ANALOG IN/WTT*** SMB socket in increments of 1 volt from 0 V up to the value where the upper travel range limit for the stage is reached approximately.
d) Reduce the input voltage on the ***ANALOG IN/WTT*** SMB socket to 0 V.
e) Read the sensor signal on the ***SENSOR MONITOR*** SMB socket using the voltmeter.

If, with 0 V input voltage, the sensor monitor signal is larger than +1 V (+1 V corresponds to 10 % of the travel range):

f) Perform (p. 32) a zero-point adjustment of the sensor.

When the system test in open-loop operation was successful or if you have adapted the notch filter and/or zero point:

5. Switch the servo mode on by moving switch 3 on the ***Settings*** DIP switch block to ON (down).

   If an oscillation (stage humming) can be heard after switching on:

   a) Switch the servo mode off immediately.
   b) Open the E-625 (p. 45).
   c) Adjust the P-term for the P-I controller by turning the P2 potentiometer on the E-802.55 servo-control submodule (p. 46) with the trimmer adjustment tool fully counterclockwise.
      Typically you will hear a click.
   d) Reconnect the power cord on the wide-range-input power supply to the power socket.
   e) Switch the servo mode on again.

6. Check the notch filter setting in closed-loop operation:

   a) Measure the stage resonance frequency again (see step 3).
   b) If necessary, improve the setting of the notch filter on the E-802.55 servo-control submodule (p. 52).

7. Determine the settling behavior of the stage in closed-loop operation:

   a) Make sure that the servo mode is switched on (switch 3 on the ***Settings*** DIP switch block to ON (down)).
   b) Generate a 1-V square-wave signal (peak-peak) with 2 to 5 Hz using the function generator.
   c) Observe the stage step response on the oscilloscope (sensor monitor signal over time).

If the sensor monitor signal shows an unsatisfactory adjustment of the P-I controller (for example overshoot or settling time too long):

d) Open the E-625 (p. 45).
e) Adjust the P-term and the I-term of the controller with the corresponding adjustment elements (p. 52) until the stage shows the optimal settling behavior for your application.

8. When the case is open:

   a) Disconnect the E-625 from the power source by removing the power cord of the wide-range-input power supply from the power socket.
   b) Close the E-625.

If the system test was successful, you can work with the E-625 and the connected stage. A renewed system test is only necessary in the following cases:

- The conditions of use have changed (load, installation, ambient temperature).
- The E-625 or the stage was replaced. In this case first the axis displacement must be recalibrated (p. 63).

INFORMATION

➢ In regular intervals check the position of the stage at 0 V input voltage and adjust the sensor zero point if necessary. This can extend the lifetime of the piezo actuator in the stage.

INFORMATION

When the yellow overflow LED comes on, the amplifier is near its range limit (piezo voltage outside the range of –20 V to +120 V).

➢ In open-loop analog mode, do **not** exceed the recommended input voltage range of –2 to +12 V.
➢ Perform a zero-point adjustment of the sensor when the overflow LED comes on in closed-loop operation (servo mode ON) (p. 32).

6.3 Adjust the Sensor Zero-Point

Changes in temperature or changes in the mechanical load can cause small deviations of the sensor zero point.

Goal of the zero-point adjustment:

- Make the entire travel range available:
  When the sensor zero-point is set correctly, the complete output voltage range of the amplifier can be used in closed-loop operation.
- Prevent the piezo actuators from damage:
  In open-loop operation, the stage displacement with 0 V piezo voltage should already be about 10 % of the travel range (sensor monitor signal is +1 V). Then the average applied voltage is reduced which lengthens the lifetime of the piezo actuator in the stage without reducing the nominal travel range.

INFORMATION

The physical zero-position of the stage in closed-loop operation is changed by the zero-point adjustment of the sensor.

Prerequisites

✓ You have read and understood the General Notes on Start-Up (p. 27).

✓ Only for the computer-controlled mode:

  – You have read and understood the user manual for the E-816 computer interface submodule.

  – The required software has been installed on the PC from the E-816 CD.

✓ You have installed the stage in the same manner as it will also be used in your application (corresponding load and alignment).

✓ The E-625 was installed (p. 19) properly.

✓ The E-625 is switched off, i.e. the wide-range-input power supply is **not** connected to the power socket over the power cord.

Tools and Accessories

- Only in analog mode:
  - Suitable analog signal source (p. 22).
  - SMB/BNC adapter cable (in scope of delivery)

- Only in computer-controlled mode:
  PC with RS-232 or USB-interface for commanding and installed software from the E-816 CD.
- Appropriate voltmeter (p. 23):
  - necessary in analog mode
  - not necessary, but helpful, in computer-controlled mode (only E-625.CR)

  If the voltmeter is used, an additional SMB/BNC adapter cable is necessary (in scope of delivery).
- Trimmer adjustment tool

Performing the Zero-Point Adjustment in Analog Mode

1. Select analog mode and open-loop operation (servo mode OFF) using the ***Settings*** DIP switch block:
   - 1: ON (down)
   - 2: OFF (up)
   - 3: OFF (up)
   - 4: OFF (up)
2. Connect the signal source to the ***ANALOG IN/WTT*** SMB socket using an adapter cable.
3. Connect the voltmeter to the ***SENSOR MONITOR*** SMB socket using the adaptor cable.
4. Connect the power cord on the wide-range-input power supply to the power socket.

   The E-625 is ready for operation when the green ***Power*** LED comes on.
5. Increase the input voltage on the ***ANALOG IN/WTT*** SMB socket in increments of 1 volt from 0 V up to the value where the upper travel range limit for the stage is reached approximately.
6. Reduce the input voltage on the ***ANALOG IN/WTT*** SMB socket to 0 V.
7. Read the sensor signal on the ***SENSOR MONITOR*** SMB socket using the voltmeter.
8. Adjust the ***Zero*** potentiometer using the trimmer adjustment tool until the sensor signal is +1 V.

Performing the Zero-Point Adjustment in Computer-Controlled Mode (only E-625.CR)

1. Select the computer-controlled mode and the open-loop operation (servo mode OFF) using the ***Settings*** DIP switch block:
   - 1: OFF (up)
   - 2: ON (down)
   - 3: OFF (up)
   - 4: ON (down)
2. Optional: Connect the voltmeter to the SMB socket ***SENSOR MONITOR*** using the adapter cable.
3. Connect the power cord on the wide-range-input power supply to the power socket.

   The E-625 is ready for operation when the green ***Power*** LED comes on.
4. Establish communication between the PC and the E-625 e.g. with the PIMikroMove.
5. Send the `SVO A 0` command (`A` indicates the axis) to ensure that the servo mode is switched off.
6. Increase the piezo voltage using the SVA command in increments of 10 volts from 0 V up to the value where the upper travel range limit for the stage is reached approximately.
7. Send the `SVA A 0` command to set the piezo voltage to 0 V (`A` indicates the axis).
8. Read the sensor signal.
   - Use the voltmeter on the ***SENSOR MONITOR*** SMB socket.
     or
   - Send the `POS? A` command (`A` indicates the axis).
9. Adjust the ***Zero*** potentiometer using the trimmer adjustment tool until the sensor shows 10 % of the travel range:
   - The voltmeter on the ***SENSOR MONITOR*** SMB socket shows +1 V.
     or
   - The response to the `POS? A` command is approx. 10 % of the travel range (in µm).

Was the Zero-Point Adjustment Successful?

After the successful zero-point adjustment, the overflow LED will no longer light up in closed-loop operation. When the overflow LED light is on constantly in spite of the zero-point adjustment, there can be a hardware error.

INFORMATION

To prevent an overflow in open-loop operation:

- Do **not** exceed the recommended input voltage range of –2 to +12 V (analog mode).
- Do not command any piezo voltage outside of the recommended range of –20 to +120 V (computer-controlled mode).

7 Operation

In this Chapter

7.1 General Notes on Operation

DANGER

Risk of electric shock if the protective earth conductor is not connected!

If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the E-625 in the case of malfunction or failure of the system. If touch voltages exist, touching the E-625 can result in serious injury or death from electric shock.

- Connect the E-625 to a protective earth conductor before start-up (p. 20).
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e. g. in the case of modifications), reconnect the E-625 to the protective earth conductor before starting it up again.

NOTICE

Damage to the piezo ceramic!

The constant application of high voltage to the piezo actuators in the stage can lead to leakage currents and flashovers that destroy the ceramic.

If the device is not used, but should remain switched on to ensure the temperature stability.

- Switch the servo mode off (open-loop operation)
- Set the piezo voltage to 0 V:
  - Analog mode: The input voltage for the target value is 0 V
  - Computer-controlled mode: Corresponding commanding

7.2 Operating Modes

7.2.1 Control Mode

The E-625.CR and the E-625.C0 can be run in analog mode. Alternatively, the E-625.CR can be run in computer-controlled mode. The active control mode determines the applicable control sources for the output voltage.

Analog Mode

The piezo voltage depends on the input voltage applied to the ***ANALOG IN/WTT*** SMB socket. Depending on the servo mode, the input voltage is interpreted (p. 39) as a direct specification for the piezo voltage or as a specification for the target position.

The recommended range for the input voltage is –2 to +12 V. The range can be extended to –3 to +13 V. However, this can shorten (p. 89) the lifetime of the piezo actuator in the stage and causes the overflow LED to light up.

The input voltage can also be a computer-generated analog signal (e.g. from a data acquisition board). You can use the PI LabVIEW analog drivers from the E-816 CD to generate the analog signal. These drivers also include the HyperBit drivers that enable a higher position resolution than that of the data acquisition board. The newest PI LabVIEW analog drivers can be downloaded from the PI website. Installation instructions are in the Technical Note E500T0011 and on the E-816 CD. For information on the Hyper Bit Upgrade, please contact our customer service department. (p. 75)

Computer-Controlled Mode (only E-625.CR)

The E-816 computer interface submodule that is integrated into the E-625.CR controls the generation of the piezo voltage. The target value (position or piezo voltage, depending on the servo mode) can be set by commands sent from the PC or from a running macro. Furthermore, the motion of the stage can also be triggered by wave table output or a trigger input on the ***ANALOG IN/WTT*** SMB socket.

INFORMATION

The E-816 computer interface submodule accepts all commands in analog mode as well as in computer-controlled mode. The only difference between the two control modes is in the selection of the control source for the piezo voltage.

INFORMATION

Several devices can be networked together and commanded from one single RS-232 or USB interface on the PC. E-625.SR or E-665 piezo servo controller can also be connected to this network.

Consult the user manual for the E-816 computer interface submodule for additional information.

The recommended range for the commanded piezo voltage is -20 to +120 V. The range can be extended to -30 to +130 V. However, this can shorten (p. 89) the lifetime of the piezo actuator in the stage and causes the overflow LED to light up.

7.2.2 Servo Mode

The servo mode determines whether the motion is performed in open-loop operation (servo mode OFF) or in closed-loop operation (servo mode ON).

The control and servo modes can be combined at will.

Closed-Loop Operation

Control input signals (input signal on ***ANALOG IN/WTT*** or E-816 inputs over commands and wave table output) are interpreted as the target position.

The servo loop of the E-802 servo-control submodule determines the piezo voltage on the basis of the target position and the feedback from the position sensor in the stage. This is how the servo loop regulates the stage position.

The positioning in closed-loop operation is free of drift and hysteresis and independent of changes in load.

Open-Loop Operation

Control input signals (input signal on ***ANALOG IN/WTT*** or E-816 inputs over commands and wave table output) are interpreted as a direct specification for the piezo voltage.

In open-loop operation, the servo loop for the E-802 servo-control submodule is not considered.

When the jumpers are set accordingly, the slew rate limiter and the notch filter remain active (p. 47).

The sensor electronics works independent of the servo mode and if a sensor is connected reports the current position of the stage even in open-loop operation. Since the stages even of the same model differ slightly, the voltage required to achieve nominal displacement differs.

7.3 Selecting the Operating Mode

7.3.1 Selecting the Control Mode

The control mode is set with the ***Settings*** DIP switch block on the front panel of the E-625.

Analog Mode

The analog mode is active when the DIP switch setting is as follows:

DIP Switch	Setting	Switch Setting
1	ON	down
2	OFF	up
4	OFF	up

Computer-Controlled Mode (only E-625.CR)

The computer-controlled mode is active when the DIP switch setting is as follows:

DIP Switch	Setting	Switch Setting
1	OFF	up
2	ON	down
4	ON	down

7.3.2 Selecting the Servo Mode

The closed-loop control uses the E-802.55 servo-control submodule that is installed in the E-625. The use of the E-802 servo-control submodule is set (p. 47) with an on-board jumper. In the default position, the E-802 servo-control submodule is active and the servo mode can be set as follows:

Settings DIP Switch Block (E-625.CR and E-625.C0)

➢ Move the DIP switch 3 on the front panel of the E-625 to the corresponding position:

Servo Mode	Setting	Switch Setting
Closed-loop operation	ON	down
Open-loop operation	OFF	up

SVO Command (only E-625.CR)

INFORMATION

To be able to set the servo mode over the E-816 computer interface submodule with the SVO command, the DIP switch 3 must be set to open-loop operation (up).

- ➢ Send the corresponding axis-specific SVO command via the communication interface or by using a macro running on the E-816 computer interface submodule.

The `SVO?` command can be used to get the last sent SVO settings for each axis. `SVO?` does **not** show the settings of the DIP switch 3 for the servo mode.

Closed-loop operation can also be activated by a start-up macro (see the user manual for the E-816 computer interface submodule).

8 Adjustment of Internal Settings

In this Chapter

8.1 General Notes on the Adjustment of Settings

DANGER

Risk of electric shock during operation with open case!

If the E-625 is operated with an open case, live parts are accessible. Touching the live parts can result in serious injury or death from electric shock.

➢ Only open the E-625 case when you are authorized and have the corresponding qualifications.

➢ Before opening the case, remove the E-625 from the power source by pulling the power plug.

➢ When operating with an open case, do not touch any components in the case aside from the adjustment elements described in this user manual.

NOTICE

Damage to the E-625 from electrostatics!

The E-625 contains electrostatic sensitive devices that can be damaged if handled improperly.

➢ Wear an antistatic wrist strap if you have to touch electrostatic components in the E-625.

➢ If there is no antistatic wrist strap available:
Before touching electronic components, quickly touch a conducting, grounded object.

➢ Make sure that no conductive parts (such as metallic dust, metal shavings, broken pencil leads, loose screws) have contact with the PCB tracks.

NOTICE

Loss of system settings when internal components are adjusted!

When the system settings are changed, the original settings will be lost. Unfavorable settings can cause stage oscillation, worse settling behavior and reduced positioning accuracy.

➢ Only change the internal system settings for the E-625 if necessary.

➢ Contact our customer service department (p. 75) if you are not sure whether a change to the system settings is necessary.

If necessary, you can adjust the following settings in the inside of the E-625 case.

- Notch filter and P-I controller for optimal settling behavior (p. 52)
- Sensor settings for the highest positioning accuracy after the replacement of the stage or the controller (p. 58)
- Master/slave setting for the sensor synchronization (p. 50)

8.2 Opening the Case

Only the ***Settings*** DIP switch block and the ***Zero*** potentiometer can be accessed from the outside. All other E-625 adjustment elements are located inside the case.

Prerequisite

- ✓ You have read and understood the General Notes on the Adjustment of Settings (p. 43).
- ✓ The E-625 is switched off, i.e. the wide-range-input power supply is **not** connected to the power socket using the power cord.

Tools and Accessories

- Phillips-head screwdriver, size PH1

Opening the Case

1. Remove the two upper cross-head screws on the front and rear panel.
2. Lift off the top of the case.

Figure 5: E-625 with top of the case removed

8.3 Adjustment Elements Inside the Case

The following figure shows the position of the components and adjustment elements (jumpers, switches) on the main board of the E-625.CR and on the E-802.55 servo-control submodule. The servo-control submodule is inserted vertically on the main board.

The E-625.C0 components are identical with the exception of the E-816 computer interface submodule.

The adjustment elements are shown in the default position.

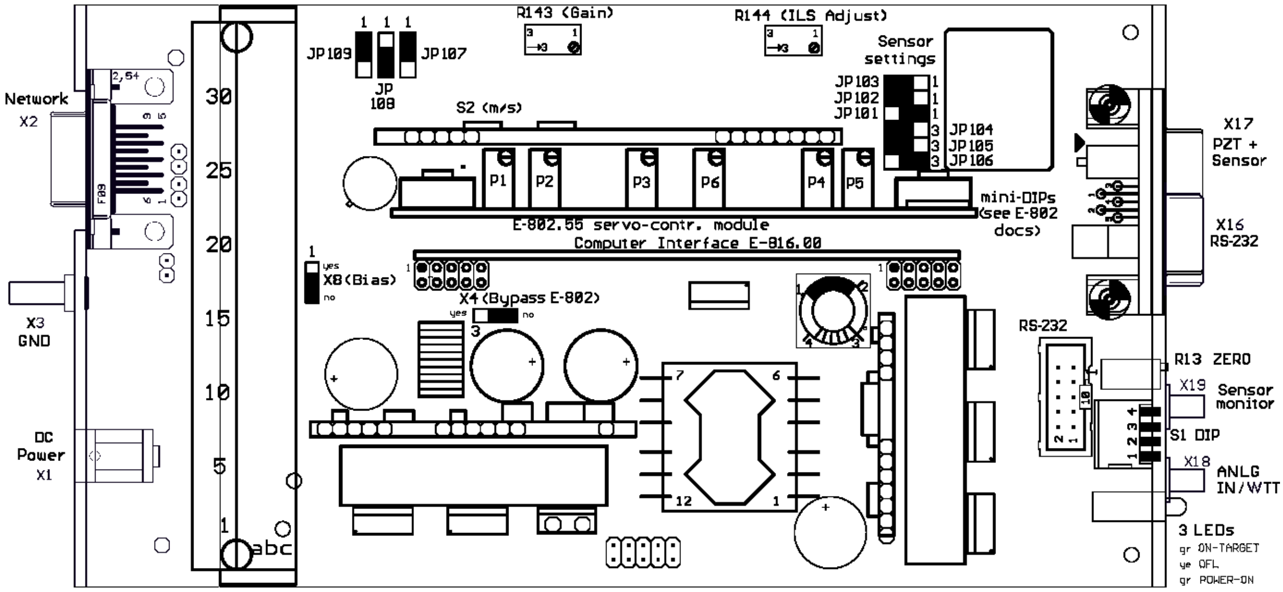


Figure 6: E-625.CR: Positions of the components and adjustment elements

8.3.1 Jumper

Jumper X4

The ***X4*** jumper is located on the main board (p. 46).

Position	Function
1-2	The E-802 servo-control submodule is activated (default settings). The servo mode can be controlled with switch 3 on the ***Settings*** DIP switch block and (only for E-625.CR) over the E-816 computer interface submodule. The slew rate limiter for the piezo voltage and the notch filter remain active even when the servo mode is switched off.
2-3	The E-802 servo-control submodule is bypassed, independent of all other settings. The slew rate limiter for the piezo voltage and the notch filter are inactive.

Jumper X8

The ***X8*** jumper is located on the main board (p. 46).

Position	Function
1-2	DC-offset potentiometer is activated. **Only activate when a DC-offset potentiometer (not in scope of delivery) is connected.**
2-3	DC-offset potentiometer is deactivated.

Jumper JP101 to JP106

The jumpers ***JP101*** to ***JP106*** are used to adjust the sensor range. The figure below shows the jumper layout on the main board (p. 46).

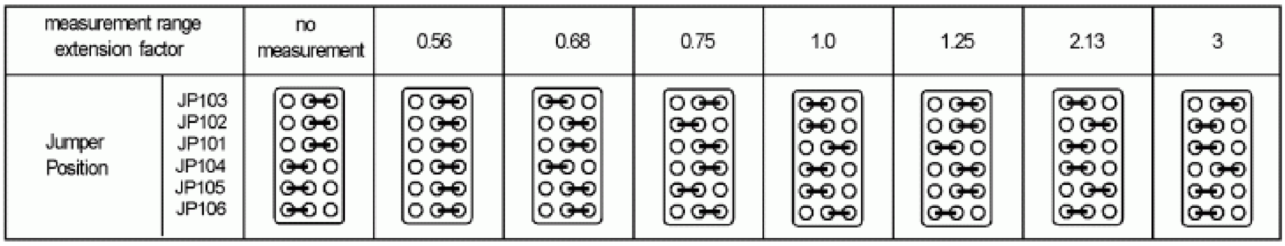
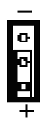
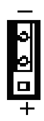


Figure 7: Settings for the sensor range jumpers

The extension factors are set according to in the connected stages. If the stage is not known to PI, the extension factor of 1.0 is set.

Jumper JP107-JP109

The jumpers ***JP107*** to ***JP109*** shift the voltage range on the sensor processing circuitry. These must remain set for the use with an E-802 servo-control submodule (positive polarity, 0 to 10 V) (default settings).

Position of the Jumper JP107		
Polarity of Output	Positive	Negative

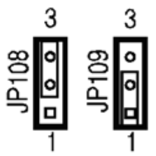
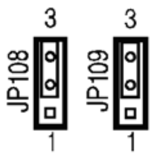
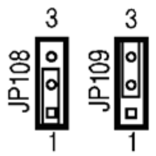
Typical Application	Using with PI's position control electronics	Using as a position detector	Special application
Position of Jumpers JP108 and JP109			
Voltage range of output	0V ~ 10V	-5V ~ +5V	-10V ~ 0V

Figure 8: Settings for the sensor evaluation range

8.3.2 Switches

Switches on the E-802.55 Servo-Control Submodule

The mini DIP switches and the S1 switch for the notch filter setting of the E-802.55 servo-control submodule are described in the E-802 servo-control submodule user manual.

Master/Slave Switch for the Sensor Synchronization

In systems with several capacitive sensors, the master/slave switch makes the master/slave settings.

The master/slave switch is located on the printed circuit board which is soldered vertically on the main board (see the circle in the following figure, near the R-143 gain potentiometer).

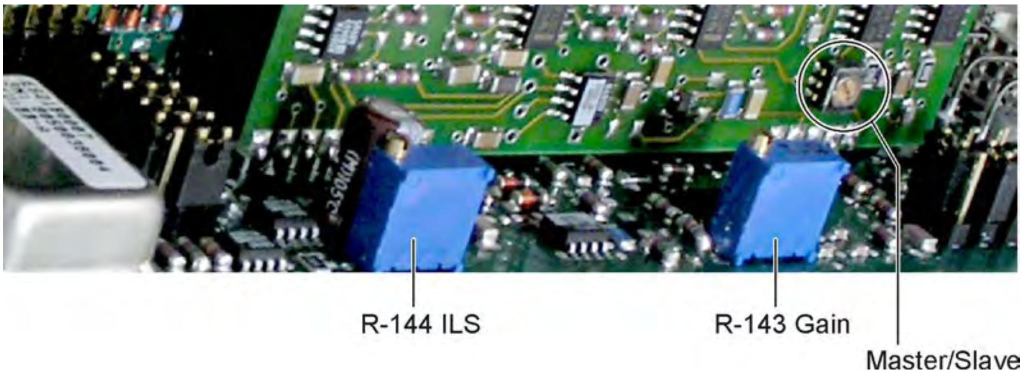


Figure 9: Master/slave switch in default setting (master)

8.3.3 Potentiometers

Potentiometers to adapt settings are located at the following places (p. 46):

- R143 for the sensor gain: Main board
- R144 for the linearization (ILS): Main board
- Potentiometers for setting the notch filter (P4) and the P-I controller (P2, P3): E-802 servo-control submodule (see the user manual for the servo-control submodule)

8.3.4 E-802 Servo-Control Submodule

The E-802 servo-control submodule contains the slew rate limiter, the notch filter and the servo loop.

In closed-loop operation, the servo loop of the E-802 servo-control submodule determines the piezo voltage on the basis of the target position and the feedback from the position sensor in the stage. This uses an analog proportional integral (P-I) algorithm.

The E-802 servo-control submodule is explained in detail in a separate user manual.

8.4 Synchronizing the Sensors

The sensors can be synchronized in systems with several capacitive sensors. For this, the master/slave switch configures one system as the sensor master. The other systems are set as slaves.

- Switch in master position (default settings): The excitation frequency of the sensors is provided internally.
- Switch in slave position: The excitation frequency of the sensors is provided externally.

The master/slave switch is located on the printed circuit board which is soldered (p. 48) vertically on the main board.

Furthermore, for all E-625.CR to be synchronized, wires 7 and 8 as well as a ground wire (1, 2 or 5) of the ***Network*** socket must be connected to the corresponding wire.

INFORMATION

Several E-625.CR can be networked together and commanded from one individual RS-232 or USB interface on the PC. In this case, all sensors must be synchronized. Using E-625.CN network cables from PI ensures the necessary connection of the wires 7, 8 and a ground wire, for details see the pin assignment of the cable (p. 85).

INFORMATION

If a E-625.CR is to be interlinked with at least one E-665.CR piezo servo controller for capacitive sensors:

1. Configure the E-625.CR as sensor master.
2. Configure all E-665.CR as sensor slaves (see E-665 user manual).

Prerequisite

- ✓ You have read and understood the General Notes on the Adjustment of Settings (p. 43).
- ✓ All E-625s to be synchronized are disconnected from the power source, i.e. the wide-range-input power supplies are **not** connected to power sockets over the power cords.
- ✓ You have opened the cases for the E-625 to be synchronized (p. 45).

Tools and Accessories

- Trimmer adjustment tool, or alternatively a thin-bladed screwdriver

Synchronizing the Sensors

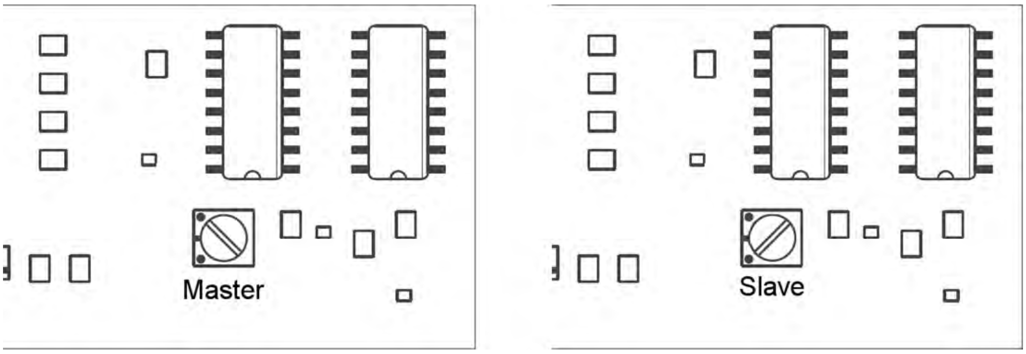


Figure 10: Settings for the master/slave switch

1. Select an E-625 as the sensor master and check the position of the master/slave switch. The master position (see top figure) is the default setting.
2. If the master/slave switch on the selected sensor master is not in the master position, use the trimmer adjustment tool to turn it to the master position.
3. Set all other E-625 to sensor slave. To do this, turn the master/slave switches to the slave position (see top figure) using the trimmer adjustment tool.
4. Close the cases.
5. Make sure that all devices have the synchronization lines (pin 7 and 8 on the ***Network*** socket) and at least one ground wire (pin 1, 2 or 5 on the ***Network*** socket) connected to the corresponding wire, (for details see pin assignment of the E-625.CN network cable (p. 85)).

8.5 Adjusting Notch Filter and P-I Controller

The E-625 is equipped with a notch filter with which the oscillations at the mechanical resonance frequency can be suppressed in dynamic operation.

Adjusting the P-I controller improves the dynamic properties of the system (overshoot and settling time). The goal is a compromise between the best stability (avoid stage oscillation) and the highest speed. The optimum P-I controller settings depends on your application and your requirements.

➢ If the load to be moved has changed or PI had no information about your system when shipped, perform the following steps immediately in sequence:

1. Adjust (p. 52) the notch filter.
2. Improve the settings of the P-I controller (p. 56).

All adjustment elements are located on the E-802.55 servo-control submodule.

INFORMATION

If the ***X4*** jumper on the main board is in the default setting (p. 47), the notch filter and the slew rate limiter for the piezo voltage will be active when the servo mode is switched off. Readjusting the notch filter frequency in open-loop operation can lead to a change in the piezo voltage of up to 5 %.

INFORMATION

If you make the settings in the computer-controlled mode, you will not require a function generator. You can then use the wave table output to generate a square wave signal.

➢ For more information, see the user manual for the E-816 computer interface submodule.

8.5.1 Adjusting the Notch Filter

Prerequisite

- ✓ You have read and understood the General Notes on the Adjustment of Settings (p. 43).
- ✓ You have read and understood the user manual for the E-802.55 servo-control submodule.
- ✓ The E-625 has been disconnected from the power source, i.e. the wide-range-input power supply is **not** connected to the power socket using the power cord.
- ✓ The E-625 has been installed properly (p. 19).
- ✓ You have installed the stage in the same manner as it will be used in your application (corresponding load and orientation).
- ✓ You have opened the E-625 (p. 45).

Tools and Accessories

- Oscilloscope; recommended: Digital storage oscilloscope (p. 23)
- Function generator for the output of square and sine wave functions in the range of 1 Hz to 1 kHz
- 2 SMB/BNC adapter cables (in scope of delivery)
- Trimmer adjustment tool

Adjusting the Notch Filter in Analog Mode

1. Select analog mode and open-loop operation (servo mode OFF) using the ***Settings*** DIP switch block:
   - 1: ON (down)
   - 2: OFF (up)
   - 3: OFF (up)
   - 4: OFF (up)
2. Connect the function generator to the ***ANALOG IN/WTT*** SMB socket using an adapter cable.
3. Connect the oscilloscope to the ***SENSOR MONITOR*** SMB socket using an adapter cable.
4. Connect the power cord on the wide-range-input power supply to the power socket.

   The E-625 is ready for operation when the green ***Power*** LED comes on.

5. If you do not know the resonant frequency for the stage, determine it as follows:
   a) Set the notch filter frequency range as high as possible using the DIP switch block on the E-802.55 servo-control submodule (all DIP switches to OFF).
   b) Generate a 1-V square wave signal (peak-peak) with 2 to 5 Hz using the function generator.
   c) Read the resonant frequency and its level on the oscilloscope (Y-t or FFT display).
6. Adapt the notch filter frequency range to the stage resonance frequency using the DIP switch block on the E-802.55 servo-control submodule.
7. Adjust the notch filter damping. To do this, turn the S1 switch on the E-802.55 servo-control submodule using the trimmer adjustment tool.
   Possible damping settings of the notch filter: –20 dB or –25 dB
   - If the resonance frequency level is between 15 and 20 dB:
     Set damping to –25 dB.
   - If the resonance frequency level is <15 dB:
     Set damping to –20 dB.
8. Generate a 1-V square wave signal (peak-peak) with 2 to 5 Hz using the function generator.
9. Read the resonance frequency on the oscilloscope (Y-t or FFT display).
10. Turn the P4 potentiometer on the E-802.55 servo-control submodule using the trimmer adjustment tool to optimally adapt the notch filter frequency to the stage resonance frequency.
11. Repeat the last steps until the stage resonance frequency has the best damping.
12. Improve the settings of the P-I controller (p. 56).

The two figures below have examples for resonance frequency measurements with a digital storage oscilloscope. They show the input voltage and the sensor signal as well as the FFT (Fast Fourier Transform) of the sensor signal.

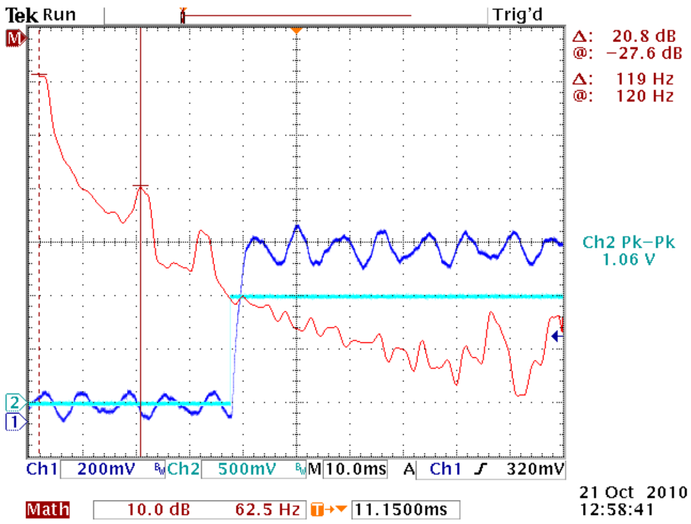


Figure 11: Open-loop operation, notch filter not adjusted, first resonant frequency at 119 Hz

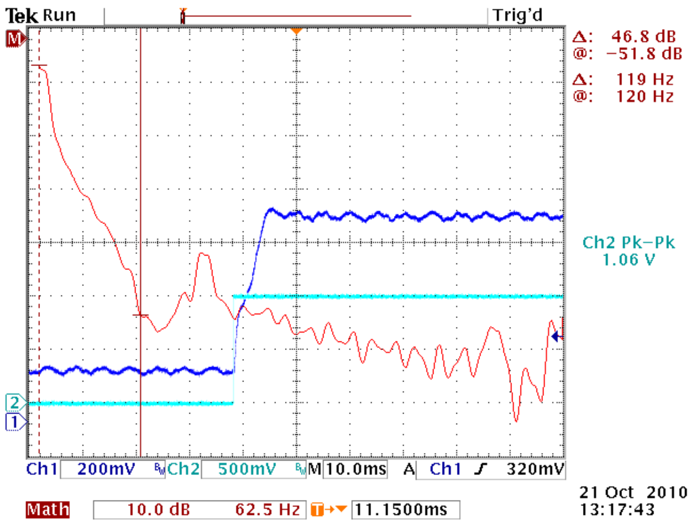


Figure 12: Open-loop operation, first resonant frequency damped by the notch filter

8.5.2 Setting the P-I Controller in Analog Mode

Prerequisites

✓ You have adjusted the notch filter correctly (p. 52).

✓ You have not changed anything on the system set-up that was used for the adjustment of the notch filter.

✓ All devices are still ready for operation.

Tools and Accessories

- As for the adjustment of the notch filter (p. 52)

Setting the P-I Controller

1. Switch the servo mode on by moving switch 3 on the ***Settings*** DIP switch block to ON (down).

   If an oscillation (stage humming) can be heard after switching on the servo mode:

   a) Switch the servo mode off immediately.
   b) Adjust the P-term for the P-I controller by turning the P2 potentiometer on the E-802.55 servo-control submodule with the trimmer adjustment tool fully counter-clockwise.
      Typically you will hear a click.
   c) Switch the servo mode on again.

2. Generate a 5-V square wave signal (peak-peak) with 5 to 10 Hz using the function generator.

3. Observe the stage step response on the oscilloscope (sensor monitor signal over time).

4. Alternatingly turn P2 and P3 (I-term) potentiometers on the E-802.55 servo-control submodule using the trimmer adjustment tool until the step response is optimal (minimal overshot, settling time not too long).

5. Disconnect the E-625 from the power source by removing the power cord of the wide-range-input power supply from the power socket.

6. Close the E-625.

The two figures below have examples for step response measurements with a digital storage oscilloscope for improvement of the P-I controller. The input voltage and the sensor signal are shown.

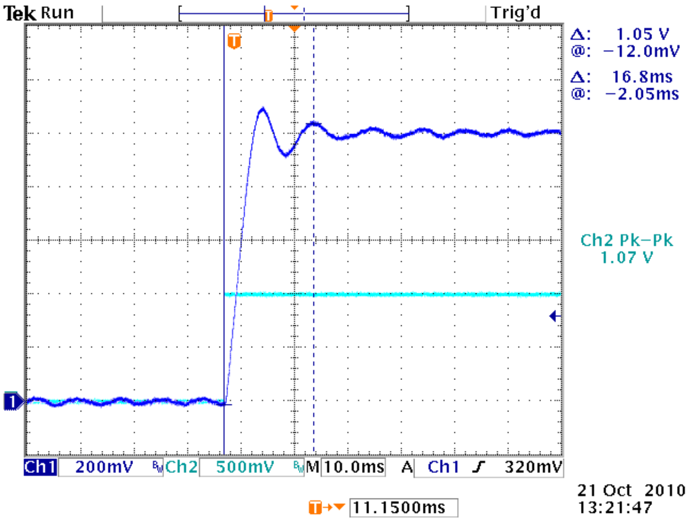


Figure 13: Closed-loop operation, P-term set too large (strong overshoot)

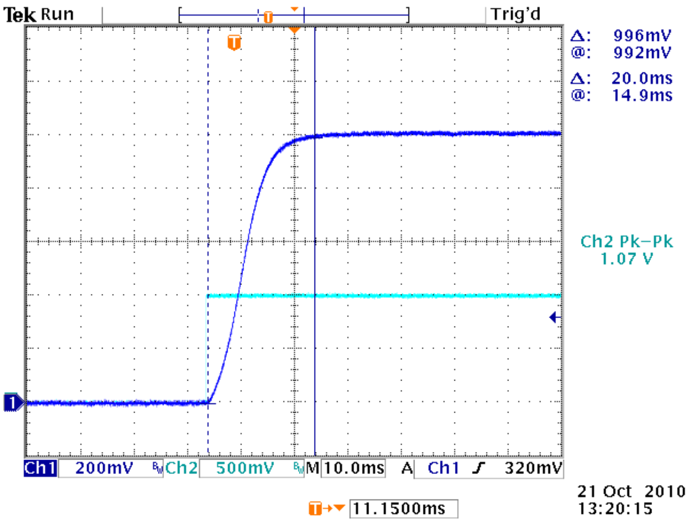


Figure 14: Closed-loop operation, conservative setting of P-term and I-term, stable system with relatively long settling time

8.6 Calibrating the Stage Displacement

A recalibration of the displacement is only necessary when the stage (or parts of it) or the E-625 was replaced in a calibrated system. A calibrated, external measurement device is used to re-calibrate the position sensor back to the accuracy specified in the original measurement protocol.

NOTICE

Stage damage from oscillations!

Oscillations can be detected by a humming of the stage and indicate incorrect adjustment of the notch filter and/or the P-I controller.

➢ Switch the servo mode off immediately and optimize the notch filter frequency and the P-I controller settings in the E-625 (p. 52).

The calibration of the stage displacement includes the following steps:

- Adjust the sensor range (open-loop operation), (p. 59).
- Adjust the static sensor gain (closed-loop operation), (p. 63).
- Adjust the sensor linearization (closed-loop operation), (p. 66).

➢ Perform these steps immediately in sequence.

INFORMATION

All stages ordered together with a E-625 are delivered with measurement protocols as evidence of the system performance.

INFORMATION

The calibration of the stage displacement applies only to the control mode (analog or computer-controlled mode) in which the settings were made. In the other control modes, you must expect a deviation of 1 %.

With E-625 models that can be operated computer-controlled (E-625.CR), PI performs the calibration in the computer-controlled mode by default.

8.6.1 Adjusting the Sensor Range

The sensor range adjustment ensures that the sensor reports the nominal displacement position (upper travel range limit) when the stage has reached the nominal displacement. The adjustment is made in open-loop operation (servo mode OFF).

INFORMATION

The piezo voltage required to deflect the stage to the upper travel range limit is not exactly 100 V but lies in the range of 85 to 105 V.

Prerequisites

- ✓ You have read and understood the General Notes on Start-Up (p. 27).
- ✓ Only for the computer-controlled mode:
  - You have read and understood the user manual for the E-816 computer interface submodule.
  - The required software has been installed on the PC from the E-816 CD.
- ✓ The E-625 was installed (p. 19) properly.
- ✓ You have installed the stage in the same manner as it will also be used in your application (corresponding load and alignment).
- ✓ The E-625 is switched off, i.e. the wide-range-input power supply is **not** connected to the power socket over the power cord.
- ✓ You have opened the E-625 (p. 45).

Tools and Accessories

- Only in analog mode:
  - High-precision analog signal source (p. 22).
  - SMB/BNC adapter cable (in scope of delivery)
- Only in computer-controlled mode:
  PC with RS-232 or USB-interface for commanding and installed software from the E-816 PC.

- High-precision voltmeter (p. 23):
  - necessary in analog mode
  - not necessary, but helpful, in computer-controlled mode (only E-625.CR)

  If the voltmeter is used, an additional SMB/BNC adapter cable is necessary (in scope of delivery).
- High-precision, external measurement device (e.g. interferometer) to measure the stage displacement
- Trimmer adjustment tool

Adjusting the Sensor Range in Analog Mode

1. Select analog mode and open-loop operation (servo mode OFF) using the ***Settings*** DIP switch block:
   - 1: ON (down)
   - 2: OFF (up)
   - 3: OFF (up)
   - 4: OFF (up)
2. Connect the signal source to the ***ANALOG IN/WTT*** SMB socket using an adapter cable.
3. Connect the voltmeter to the ***SENSOR MONITOR*** SMB socket using the adapter cable.
4. Install the external measurement device so that it can measure the stage displacement. If the measurement device shows a value other than zero, note the offset and subtract this from the values read in the following measurements.
5. Connect the power cord on the wide-range-input power supply to the power socket.

   The E-625 is ready for operation when the green ***Power*** LED comes on.
6. Increase the input voltage on the ***ANALOG IN/WTT*** SMB socket in increments of 1 volt from 0 V up to the value where the upper travel range limit for the stage is reached approximately.
7. Reduce the input voltage on the ***ANALOG IN/WTT*** SMB socket to 0 V.
8. Read the sensor signal on the ***SENSOR MONITOR*** SMB socket using the voltmeter.
9. If necessary, perform (p. 32) a zero-point adjustment of the sensor.

10. Increase the input voltage on the ***ANALOG IN/WTT*** SMB socket slowly up to the value where the external measurement device shows the nominal displacement of the stage (upper travel range limit).
11. Adjust the R143 on the main board (p. 46) sensor gain potentiometer on the main board with the trimmer adjustment tool until the until the voltage on the ***SENSOR MONITOR*** SMB socket is 10 V.
12. If necessary, repeat the last steps until stable values are displayed on the measurement devices.

Do you want to use your system in closed-loop operation?

- If so: For the highest positioning accuracy in closed-loop operation, adjust (p. 63) the static gain factor.
- If not: Disconnect the E-625 from the power source by pulling the power cord of the wide-range-input power supply from the power socket and close the E-625.

Adjusting the Sensor Range in Computer-Controlled Mode (only E-625.CR)

1. Select computer-controlled mode and open-loop operation (servo mode OFF) using the ***Settings*** DIP switch block:
   - 1: OFF (up)
   - 2: ON (down)
   - 3: OFF (up)
   - 4: ON (down)
2. Optional: Connect the voltmeter to the ***SENSOR MONITOR*** SMB socket using the adapter cable.
3. Install the external measurement device so that it can measure the stage displacement. If the measurement device shows a value other than zero, note the offset and subtract this from the values read in the following measurements.
4. Connect the power cord on the wide-range-input power supply to the power socket.

   The E-625 is ready for operation when the green ***Power*** LED comes on.
5. Establish communication between the PC and the E-625 e.g. with PIMikroMove.

6. Send the `SVO A 0` command (`A` indicates the axis) to ensure that the servo mode is switched off.
7. Increase the piezo voltage using the SVA command in increments of 10 volts from 0 V up to the value where the upper travel range limit for the stage is reached approximately.
8. Send the `SVA A 0` command to set the piezo voltage to 0 V.
9. Read the other sensor signal.
   – Use the voltmeter on the ***SENSOR MONITOR*** SMB socket.

   or

   – Send the `POS? A` command (`A` indicates the axis).
10. If necessary, perform (p. 32) a zero-point adjustment of the sensor.
11. Send the `SVA A 90` command to set the piezo voltage to 90 V.
12. Resent `SVR A1` to slowly increase the piezo voltage until the external measurement device shows the nominal displacement of the stage (upper travel range limit).
13. Adjust the R143 on the main board (p. 46) sensor gain potentiometer with the trimmer adjustment tool until the sensor shows the nominal displacement:
   – The voltmeter on the ***SENSOR MONITOR*** SMB socket shows +10 V.

   or

   – The response to the `POS? A` command shows the upper travel range limit in µm.
14. If necessary, repeat the last steps until stable values are displayed on the measurement devices.

Do you want to use your system in closed-loop operation?

➢ If so: For the highest positioning accuracy in closed-loop operation, adjust (p. 63) the static static gain factor.

➢ If not: Disconnect the E-625 from the power source by pulling the power cord of the wide-range-input power supply from the power socket and close the E-625.

8.6.2 Adjusting the Static Sensor Gain for Closed-Loop Operation

The adjustment of the static sensor gain ensures that in closed-loop operation the stage moves precisely to the upper travel range limit when this position is commanded. The setting is made in closed-loop operation (servo mode ON).

Prerequisites

- ✓ You have adjusted the sensor range correctly (p. 59).
- ✓ You have not changed anything on the system set-up that was used for the adjustment of the sensor range. All devices are still ready for operation.
- ✓ You have read and understood the user manual for the E-802.55 servo-control submodule.

Tools and Accessories

- As for the adjustment of the sensor range (p. 59)

Adjusting the Static Sensor Gain in Analog Mode

1. Switch the servo mode on by moving switch 3 on the ***Settings*** DIP switch block to ON (down).

   If an oscillation (stage humming) can be heard after switching on:

   a) Switch the servo mode off immediately.
   b) Optimize the notch filter frequency and the P-I controller settings in the E-625 (p. 52).
   c) Make sure that the servo mode is switched on.

2. Apply 0.0000 V input voltage to the ***ANALOG IN/WTT*** SMB socket.
3. Adjust the external measurement device so that it exactly shows the zero position.
4. Apply exactly +10.0000 V input voltage to the ***ANALOG IN/WTT*** SMB socket.
5. Check the stage position:

   a) Read the sensor signal on the ***SENSOR MONITOR*** SMB socket using the voltmeter. It must be exactly +10.0000 V.
   b) Read the measured value on the external measurement device. The value must correspond exactly to the upper travel range limit.

6. If the sensor signal on the ***SENSOR MONITOR*** SMB socket deviates from +10.0000 V:
   Adjust the GAIN fine adjust potentiometer (P6) on the E-802.55 servo-control submodule using the trimmer adjustment tool until the sensor signal is exactly +10.0000 V (see the E-802 user manual).

7. If the measurement value on the external measurement device deviates from the upper travel range limit:
   Adjust the R143 on the main board (p. 46) sensor gain potentiometer on the main board using the trimmer adjustment tool until the external measurement device shows exactly the upper travel range limit (the stage displacement changes).
8. If necessary, repeat the last steps until stable values are displayed on the measurement devices.

Is the non-linearity of the sensor signal more than 0.05 % of the nominal travel range?

- If so: Linearize the sensor signal (p. 66).
- If not: Disconnect the E-625 from the power source by pulling the power cord of the wide-range-input power supply from the power socket and close the E-625.

Adjusting the Static Sensor Gain in Computer-Controlled Mode (only E-625.CR)

1. Send the `SVO A 1` command (`A` indicates the axis) to switch on the servo mode.

   If an oscillation (stage humming) can be heard after switching on:

   a) Switch the servo mode off immediately.
   b) Optimize the notch filter frequency and the P-I controller settings in the E-625 (p. 52).
   c) Make sure that the servo mode is switched on.
2. Send the `MOV A 0` command.
3. Adjust the external measurement device so that it shows the zero position exactly.
4. Send the `MOV A pos` command whereby `pos` corresponds to the upper travel range limit in µm.
5. Check the stage position measured by the sensor:

   a) Send the `POS? A` command (`A` indicates the axis). The response must show the upper travel range in µm.

   or

   b) Read the sensor signal on the ***SENSOR MONITOR*** SMB socket using the voltmeter. It must be exactly +10.0000 V.

6. If the sensor signal deviates from the upper travel range limit (the response to the `POS? A` command does not correspond to the upper travel range limit or the sensor signal on the ***SENSOR MONITOR*** SMB socket is not +10.0000 V):
   Adjust the GAIN fine adjust potentiometer (P6) on the E-802.55 servo-control submodule using the trimmer adjustment tool until the sensor signal corresponds exactly to the upper travel range limit (see the E-802 user manual).
7. Read the measured value on the external measurement device.

   The value must correspond exactly to the upper travel range limit.
8. If the measurement value on the external measurement device deviates from the upper travel range limit:
   Adjust the R143 on the main board (p. 46) sensor gain potentiometer on the main board using the trimmer adjustment tool until the external measurement device shows exactly the upper travel range limit (the stage displacement changes).
9. If necessary, repeat the last steps until stable values are displayed on the measurement devices.

Is the non-linearity of the sensor signal more than 0.05 % of the nominal travel range?

- ➢ If so: Linearize the sensor signal (p. 66).
- ➢ If not: Disconnect the E-625 from the power source by pulling the power cord of the wide-range-input power supply from the power socket and close the E-625.

8.6.3 Adjusting the Sensor Linearization

The sensor linearization should minimize the non-linear contributions of the 2nd order to the sensor signal.

INFORMATION

The sensor linearization can only be optimized for one direction of motion. PI by default makes the optimization for the positive direction of motion, i.e. for the motion from the zero position to the upper travel range limit.

Prerequisites

- ✓ You have correctly adjusted the sensor range (p. 59).
- ✓ You have correctly adjusted the static sensor gain for the closed-loop operation (p. 63).
- ✓ You have not changed anything on the system set-up that was used for the adjustment of the sensor range and the static sensor gain. All devices are still ready for operation.
- ✓ The servo mode is switched on.

Tools and Accessories

- As for the adjustment of the sensor range (p. 59)

Adjusting the Sensor Linearization in Analog Mode

1. For the linearization of the positive direction of motion:
   Increase the input voltage on the ***ANALOG IN/WTT*** SMB socket in increments of 1 volt from 0 V to 10 V and read the stage position from the external measurement device.
   For the linearization of the negative direction of motion: Reduce the input voltage stepwise from 10 V to 0 V.
2. Adjust the R144 (p. 46) ILS adjust potentiometer on the main board using the trimmer adjustment tool so that the stage position changes as linearly as possible as a function of the input voltage.

   Adjusting the ILS adjust potentiometer also changes the sensor gain.
3. After setting the optimal linearity, repeat the adjustment of the static sensor gain for closed-loop operation (p. 63).
4. Disconnect the E-625 from the power source by removing the power cord of the wide-range-input power supply from the power socket.
5. Close the E-625.

Adjusting the Sensor Linearization in Computer-Controlled Mode

1. For the linearization of the positive direction of motion:
   Increase the target position using the MOV command stepwise from 0 µm to the upper travel range limit of the stage while reading the stage position on the external measurement device.
   For the linearization of the negative direction of motion: Reduce the target position using the MOV A command stepwise from the upper travel range limit to 0 µm.
2. Adjust the R144 (p. 46) ILS adjust potentiometer on the main board using the trimmer adjustment tool so that the stage position changes as linearly as possible as a function of the target position.

   Adjusting the ILS adjust potentiometer also changes the sensor gain.
3. After setting the optimal linearity, repeat the adjustment of the static sensor gain for the closed-loop operation (p. 63).
4. Disconnect the E-625 from the power source by removing the power cord of the wide-range-input power supply from the power socket.
5. Close the E-625.

8.6.4 Digital Corrections (only E-625.CR)

In addition to the adjustments described in this user manual, the E-816 computer interface submodule can be used to digitally correct the following values:

Value	Unit	Function
Sensor coefficient Ks	µm/V	When the sensor signal changes by 1 V, the stage position changes by Ks µm.
Sensor offset Os	µm	When the sensor signal is 0 V, the stage position is Os µm.
Coefficient of the piezo voltage amplifier Kpzt	V/V	When the DA converter output changes by 1 V, the piezo voltage on the amplifier changes by Kpzt V.
Offset of the piezo voltage amplifier Opzt	V	When the DA converter output is 0 V, the piezo voltage on the amplifier is Opzt V.

➢ Only make changes to these settings if you have replaced the stage and/or have recalibrated the stage displacement as described in this user manual.

For additional information, consult the "Calibration" section in the user manual for the E-816 computer interface submodule.

9 Maintenance

In this Chapter

9.1 Cleaning the E-625

NOTICE

Short circuits or flashovers!

The E-625 contains electrostatic sensitive devices that can be damaged by short circuits or flashovers when cleaning fluids enter the case.

- Before cleaning, remove the E-625 from the power source by pulling the power plug.
- Prevent cleaning fluid from entering the case.

- When necessary, clean the surfaces of the E-625 case with a towel that has been lightly dampened with a mild cleanser or disinfectant.
- Do **not** use any organic solvents.

9.2 Updating Firmware

The E-625.CR module is equipped with an E-816 computer interface submodule whose firmware can be updated.

- For updating the firmware of the E-816 computer interface submodule, follow the instructions in the E-816 user manual.

10 Troubleshooting

Problem	Possible Causes	Solution
The stage does not move	The cable is not connected correctly	➢ Check the cable connections.
	The stage or the stage cable is defective	➢ If available, replace the defective stage with a new stage of the same type and test the new combination. Since the stage and the E-625 must always be calibrated with each other, the system will probably be less exact with the new stage than with the original stage. If you want to continue using the new stage for your application, you must calibrate the system again (p. 43).
	Control mode for the piezo voltage is set incorrectly	➢ Select (p. 40) the control mode (analog or in computer-controlled mode) according to the control source used for the axis motion. Only E-625.CR: In the analog mode, motion commands from the computer interface or from running macros, trigger input and wave table output are ignored and can provoke an error message. ➢ Remember the priority of the individual control sources (see the user manual for the E-816 computer interface submodule).
	The input voltage is not present or exceeds the permissible range	➢ In the analog mode, connect an analog signal to the ***ANALOG IN/WTT*** SMB socket to command the axis motion. If you generate the analog signal with a data acquisition board using the LabVIEW analog drivers: ➢ Check that the analog drivers and the data acquisition board are working correctly.
	Incorrect command or incorrect syntax	➢ Send the ERR? command and check the error code this returns. Please note that only the error code for the communication master is displayed. The user manual for the E-816 computer interface submodule contains a detailed description of the ERR? command and the error codes.

<table>
<tr><th>Problem</th><th>Possible Causes</th><th>Solution</th></tr>
<tr><td rowspan="3"></td><td>Incorrect axis commanded</td><td>➢ Make sure that the correct axis identifier is used and that the commanded axis belongs to the correct stage.
An axis identifier is even required on systems with only one axis.</td></tr>
<tr><td>Incorrect configuration</td><td>➢ Use the SPA? command to check the E-816 computer interface submodule parameter settings.</td></tr>
<tr><td>The E-625 voltage output is deactivated</td><td>When the internal temperature reaches ≥75° C the E-625 voltage output is deactivated and the stage stops moving. When the internal temperature then drops to <60° C the voltage output is switched on again automatically.
➢ Ensure sufficient ventilation at the place of installation (p. 19).
➢ When using the wave table output, reduce the frequency and/or the amplitude and/or the output duration.</td></tr>
<tr><td rowspan="2">Communication with the controller fails</td><td>The wrong communication cable is used or it is defective</td><td>➢ Check the cable.
The RS-232 connection requires a null-modem cable.
➢ Check whether the cable works on a fault-free system.</td></tr>
<tr><td>The communication interface is not configured correctly</td><td>When using the RS-232 interface:
➢ Check the port settings and the baud rate (can be set with the BDR command). The serial port on the E-816 computer interface submodule is set as follows:
– 115200 baud
– 8 data bits
– 1 stop bit
– No parity
– RTS/CTS
➢ Use a PC with a "genuine" RS-232 interface.
Using an USB-to-RS-232 adapter can result in data loss during communication, especially when larger amounts of data are transmitted.
When using the USB interface:
➢ The first time the USB interface is used, make sure that you are logged onto the PC with administrator rights.
Once the E-625 has been switched on, a message will appear that new hardware has been detected.
➢ Follow the instructions on the screen and insert the E-816 CD.
The necessary hardware drivers are located in the \USB_Driver directory.</td></tr>
</table>

Problem	Possible Causes	Solution
	The controller was switched off and on again or was restarted	With USB connections, the communication cannot be maintained after the E-625 has been switched off and on again or once the E-816 computer interface submodule has been reset. ➢ Disconnect and then reconnect.
	A different program is accessing the interface	➢ Close the other program.
	Problems with special software	➢ Check whether the system works with different software, such as a terminal program or a development environment. You can test the communication by starting a terminal program (such as PI Terminal) and entering `*IDN?`. ➢ Make sure that you end the commands with an LF (line feed). A command is not executed until the LF has been received.
Unsatisfac-tory system performance	▪ The sensor values are unreliable and the entire system is instable. ▪ The system is not temperature stable	➢ Switch the E-625 on at least one hour before starting work. ➢ While the E-625 is not used: Make sure that the servo mode is switched off (open-loop operation) and the piezo voltage is set to 0 V: – Analog mode: The input voltage for the target value is 0 V – Computer-controlled mode: Corresponding commanding
The stage starts oscillating or positions inaccurately	The load was changed	➢ Readjust the system according to the changed load (p. 43).

Problem	Possible Causes	Solution
Overflow LED comes on	The amplifier output is near its range limit threshold value	➢ Perform (p. 32) a zero-point adjustment. Changes in temperature or changes in the mechanical load can cause small deviations of the sensor zero point. After the successful zero-point adjustment, the overflow LED will no longer light up during closed-loop operation. ➢ To prevent an overflow in open-loop operation, do not exceed the recommended control input voltage range of -2 to +12 V (analog mode) or do not command any piezo voltage outside of the recommended range of -20 to +120 V (computer-controlled mode). When the overflow LED is on constantly in closed-loop operation in spite of the zero-point adjustment, there can be a hardware error. ➢ In this case, contact (p. 75) our customer service department.
The customer software does not run with the PI drivers	Incorrect combination of driver routines/Vis	➢ Check whether the system works with a terminal program. If so: ➢ Read the information in the corresponding software manual and compare the sample codes on the E-816 CD with your program code.

If the problem that occurred with your system is not listed in the table above or cannot be solved as described, contact our customer service department (p. 75).

11 Customer Service

For inquiries and orders, contact your PI sales engineer or send us an e-mail (mailto:info@pi.ws).

If you have questions concerning your system, have the following information ready:

- Product codes and serial numbers of all products in the system
- Firmware version of the controller (if present)
- Version of the driver or the software (if present)
- Operating system on the PC (if present)

The latest versions of the user manuals are available for download (p. 3) on our website.

12 Technical Data

In this Chapter

12.1 Specifications

12.1.1 Data Table

	E-625.CR, E-625.C0
Function	Servo controller with integrated piezo amplifier
Channels	1
Sensor	
Servo characteristics	P-I (analog), notch filter
Sensor type	Capacitive
Amplifier	
Control input voltage	-2 to +12 V
Output voltage, min.	-30 to +130 V
Peak current, < 50 ms	120 mA
Average current	60 mA
Current limitation	Short-circuit-proof
Noise, 0 to 100 kHz	0.8 mV_{rms}
Voltage gain	10 ±0.1
Input impedance	100 kΩ

Interface 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 E-625.C0 without interface
Piezo connector	Sub-D special
Sensor connection	Sub-D special
Control Input socket	SMB
Sensor monitor socket	SMB
Controller network (E-625.CR only)	up to 12 channels
Command set (E-625.CR only)	PI General Command Set (GCS)
User software (E-625.CR only)	PIMikroMove
Software drivers (E-625.CR only)	LabVIEW drivers, dynamic libraries for Windows (DLL) and Linux
Supported functionality (E-625.CR only)	Wave table, 256 data points, external trigger, up to 16 macros
Miscellaneous	
Operating temperature range	+5 to +50°C
Overtemp protection	Deactivation at 75°C
Dimensions	205 mm × 105 mm × 60 mm
Mass	1.05 kg
Operating Voltage	12 to 30 V DC, stabilized
Current consumption	2 A

12.1.2 Maximum Ratings

The E-625 is designed for the following operating data:

Input on:	Maximum Operating Voltage ⚠	Operating Frequency ⚠	Maximum Current Consumption ⚠
Switchcraft panel plug, 3-pin	30 V	⎓	2 A

12.1.3 Ambient Conditions and Classifications

The following ambient conditions and classifications must be observed for the E-625:

Area of application	For indoor use only
Maximum altitude	2000 m
Relative humidity	Highest relative humidity 80% for temperatures up to 31°C Decreasing linearly to 50% relative humidity at 40°C
Storage temperature	0°C to 70°C
Transport temperature	–25°C to +85°C
Overvoltage category	II
Protection class	I
Degree of pollution	2
Measurement category	I
Degree of protection according to IEC 60529	IP20

12.2 Operating Limits

The following diagram shows the operating limits in open-loop operation for various piezo loads. The curve values are capacitance values in µF.

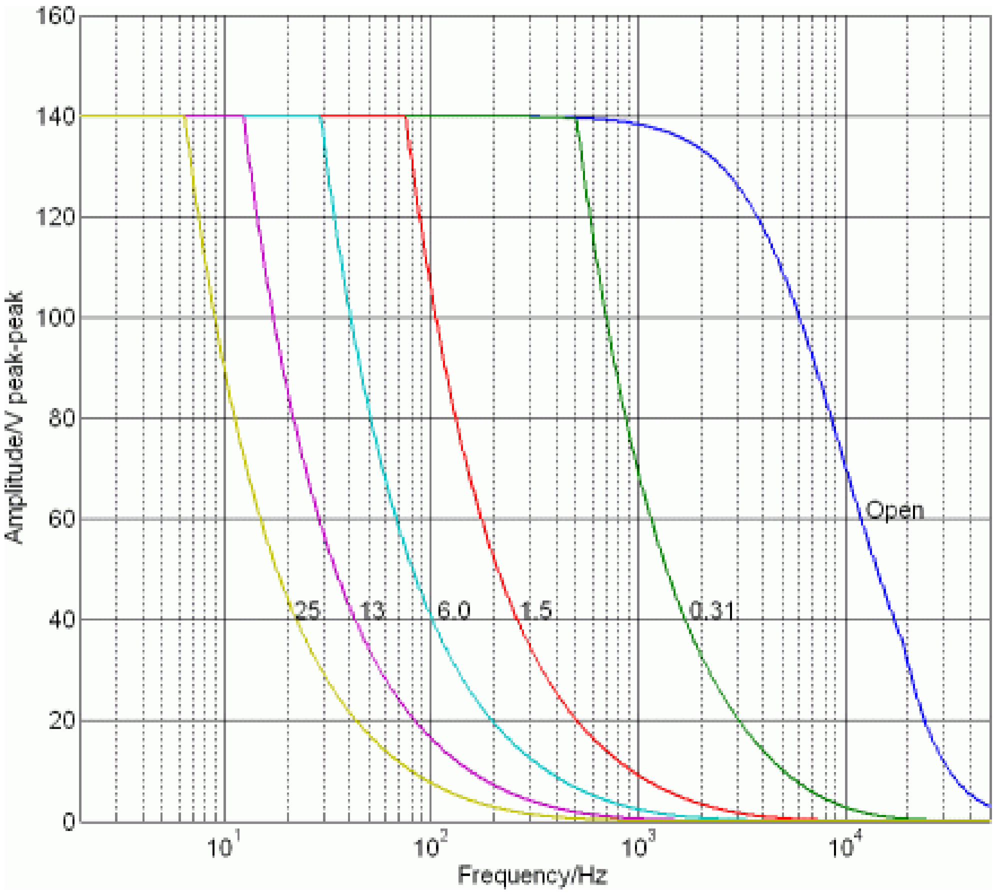


Figure 15: Operating limits

12.3 Dimensions

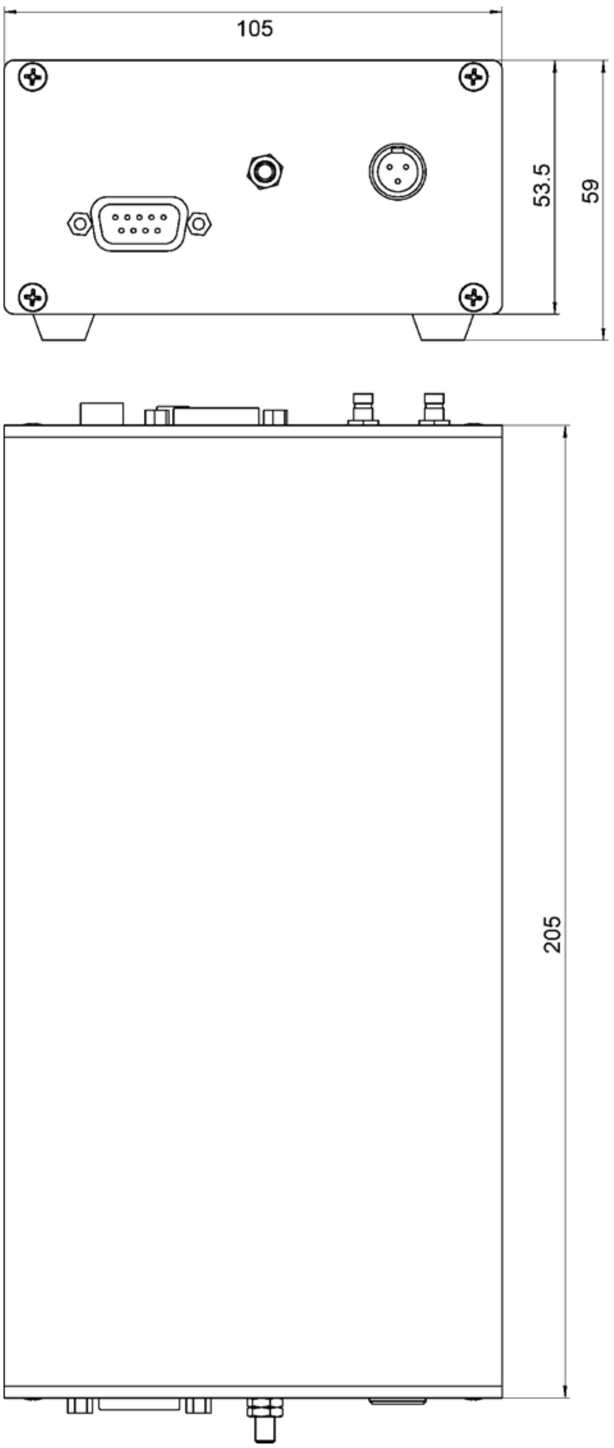


Figure 16: E-625 dimensions in mm

12.4 Block Diagrams

12.4.1 E-625.CR Block Diagram

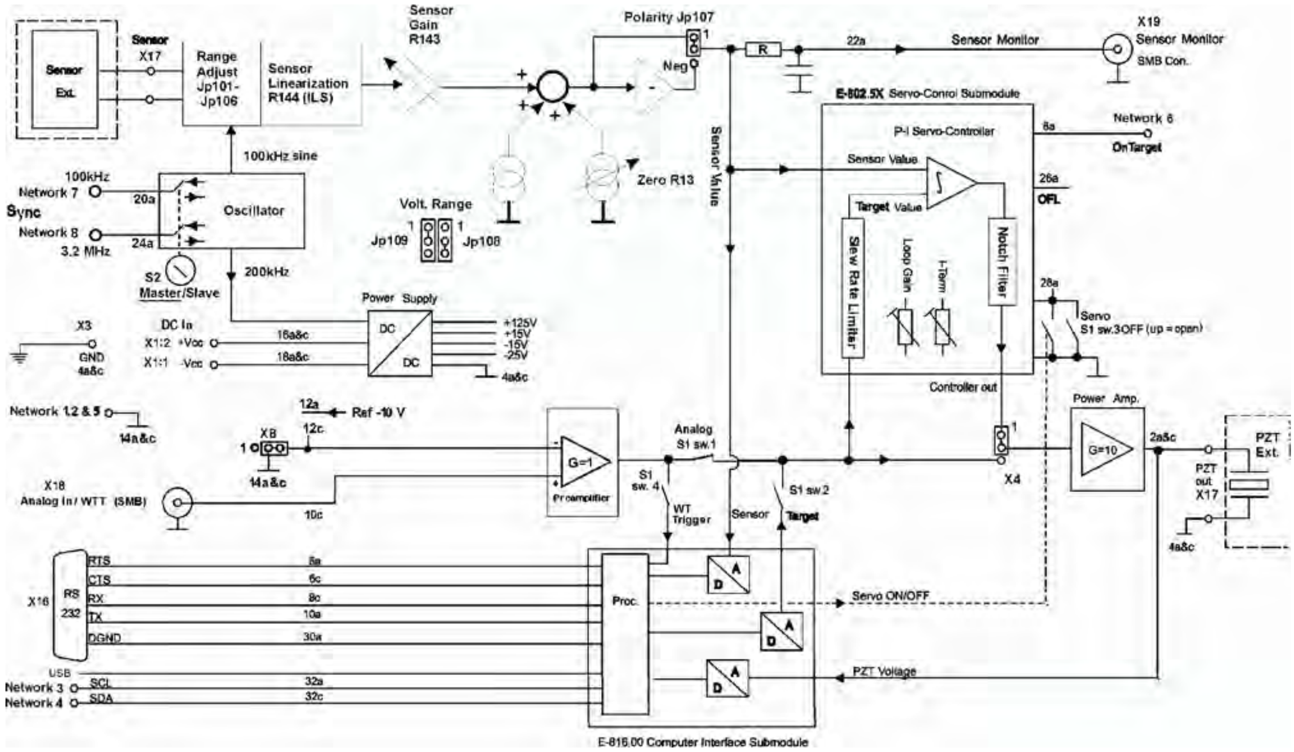


Figure 17: E-625.CR block diagram

"S1 sw. 4", "S1 sw. 1", "S1 sw. 2" and "S1 sw. 3" refer to the switches 4, 1, 2 and 3 on the ***Settings*** DIP switch block on the E-625 front panel.

The pin numbers 2a to 32c refer to an internal 32 pin connection and are only used for informational purposes.

12.4.2 E-625.C0 Block Diagram

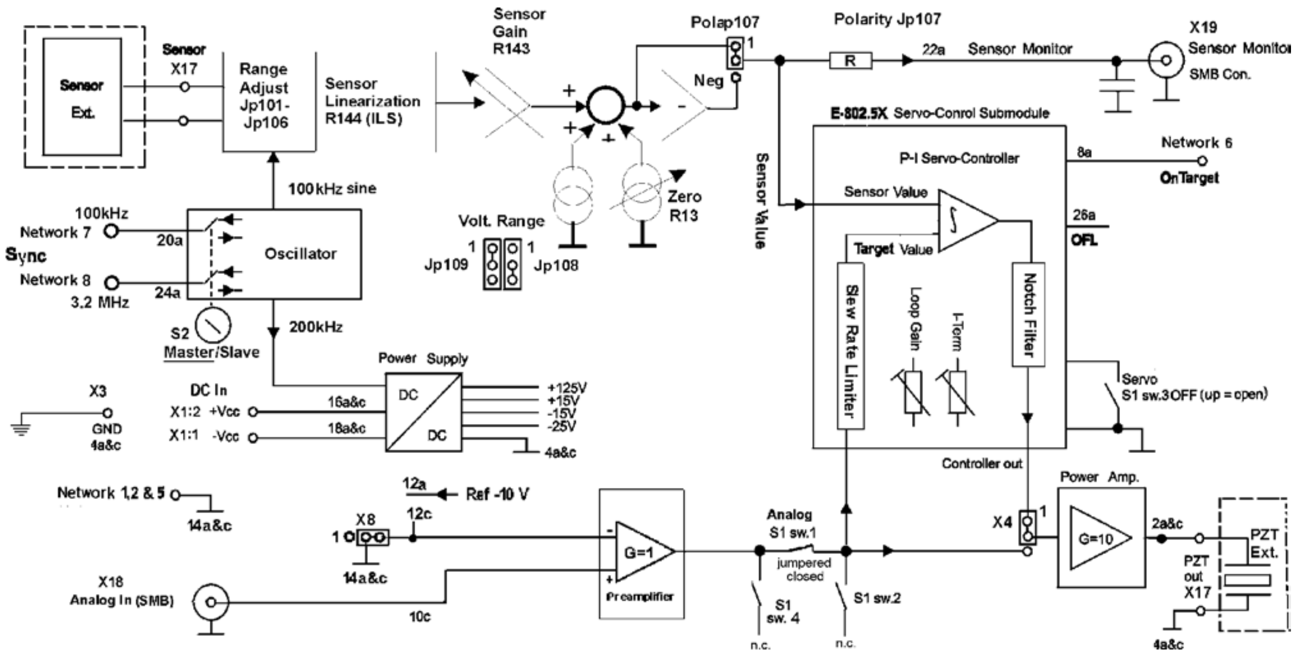


Figure 18: E-625.C0 block diagram

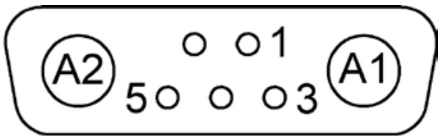
"S1 sw.4", "S1 sw. 1", "S1 sw. 2" and "S1 sw. 3" refer to the switches 4, 1, 2 and 3 on the ***Settings*** DIP switch block on the E-625 front panel.

The pin numbers 2a to 32c refer to an internal 32 pin connection and are only used for informational purposes.

12.5 Pin Assignment

12.5.1 PZT & SENSOR

Special Sub-D Mix 7W2 socket for the transmission of the piezo voltage and the sensor signals.

Pin	Function	
A1	PZT output (–30 to+130 V)	
A2	Sensor probe	
1	ID chip (not supported)	
2	AGND target and ID ground	
3	PZT ground (connected with case)	
4	Not connected	
5	Sensor target	

12.5.2 Network

Sub-D socket, 9-pin, female

Pin	Function
1	GND
2	GND
3	SCL (I^{2}C network operation)*; not for E-625.C0
4	SDA (I^{2}C network operation)*; not for E-625.C0
5	GND
6	On-target signal, TTL, active-low Shows that the distance from the target position is less than ±0.19 % of the travel range.
7	100 kHz (sensor synchronization)
8	3.2 MHz (sensor synchronization)
9	Not connected

* The SCL and SDA bus connections are limited to a maximum length of 1 m and a maximum capacitance of 400 pF.

The E-625.CN network cable is available for the operation of several E-625 in a network, for details see the pin assignment of the cable (p. 85).

12.5.3 E-625.CN Network Cable

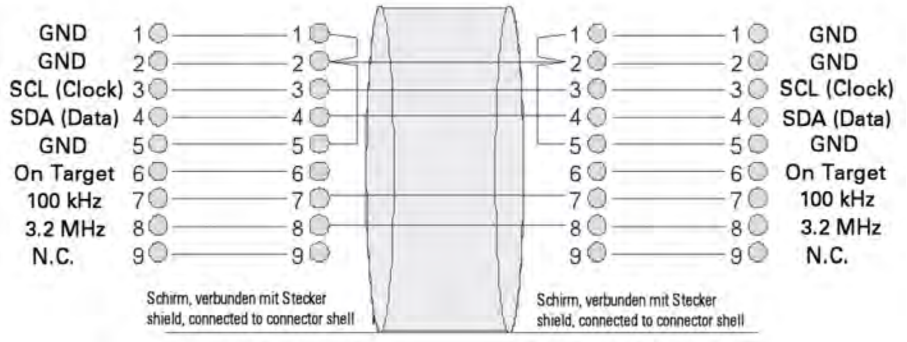


Figure 19: Pin assignment of E-625.CN network cable

12.5.4 Power Supply Connector

Switchcraft panel plug, 3-pin, male

Pin	Function	
1	GND	
2	12 to 30 VDC (15 V recommended), stabilized	
3	Not connected	

13 Old Equipment Disposal

In accordance with the applicable EU law, electrical and electronic equipment may not be disposed of with unsorted municipal wastes in the member states of the EU.

When disposing of your old equipment, observe the international, national and local rules and regulations.

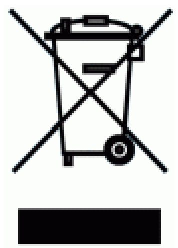
To meet the manufacturer's product responsibility with regard to this product, Physik Instrumente (PI) GmbH & Co. KG ensures environmentally correct disposal of old PI equipment that was first put into circulation after 13 August 2005, free of charge.

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

Physik Instrumente (PI) GmbH & Co. KG

Auf der Römerstr. 1

D-76228 Karlsruhe, Germany



14 Appendix

In this Chapter

14.1 Lifetime of PICMA® Actuators

The lifetime of a PICMA® piezo actuator can be influenced by the following factors:

- Applied voltage
- Temperature
- Relative humidity

The following diagrams show how the individual factors influence the lifetime of the actuator.

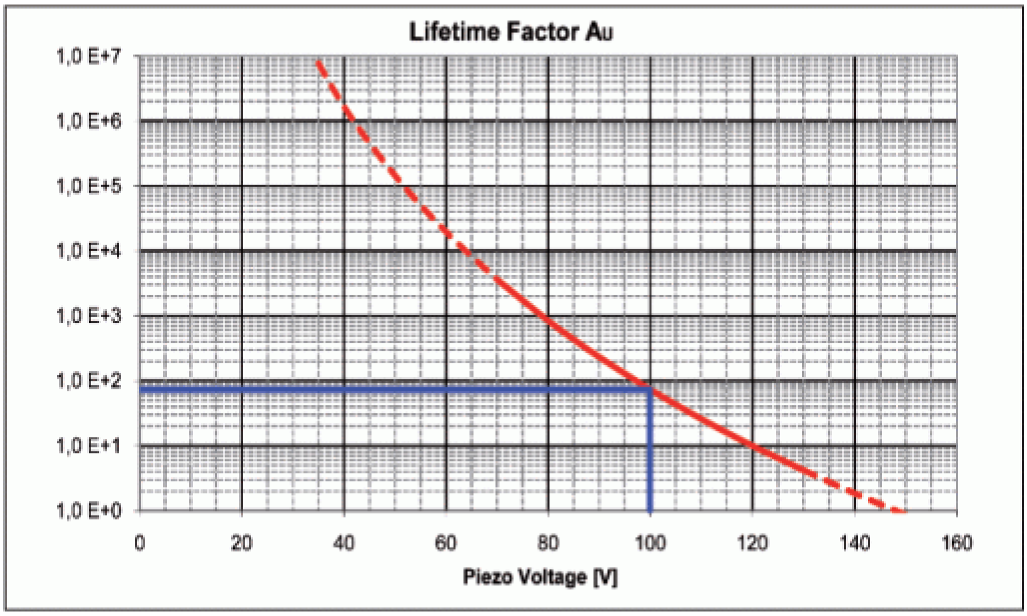


Figure 20: Dependency of the mean time between failure (MTTF) of a PICMA® actuator on the applied voltage

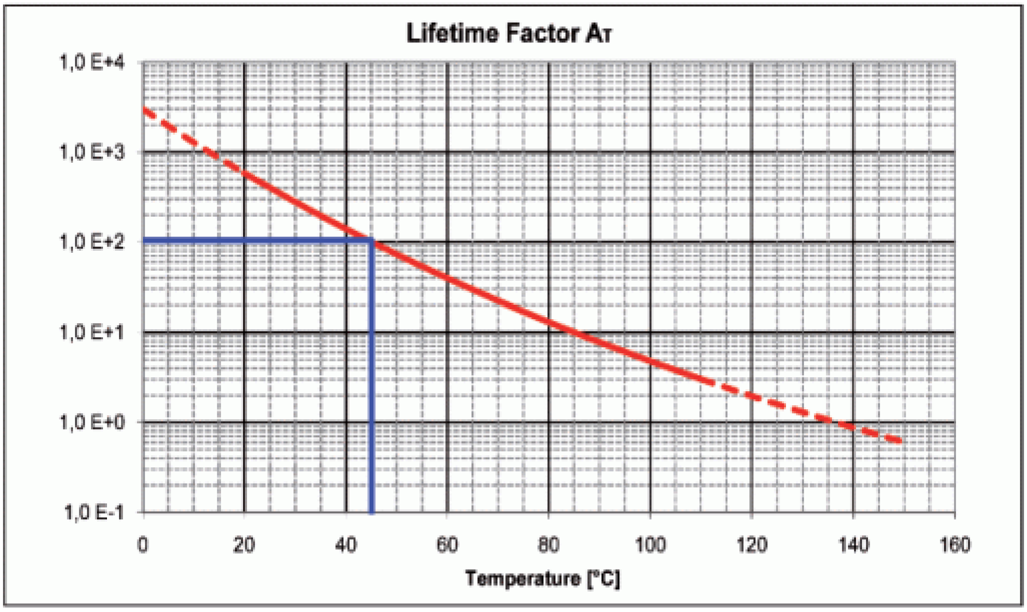


Figure 21: Dependency of the mean time between failure (MTTF) of a PICMA® actuator on the ambient temperature

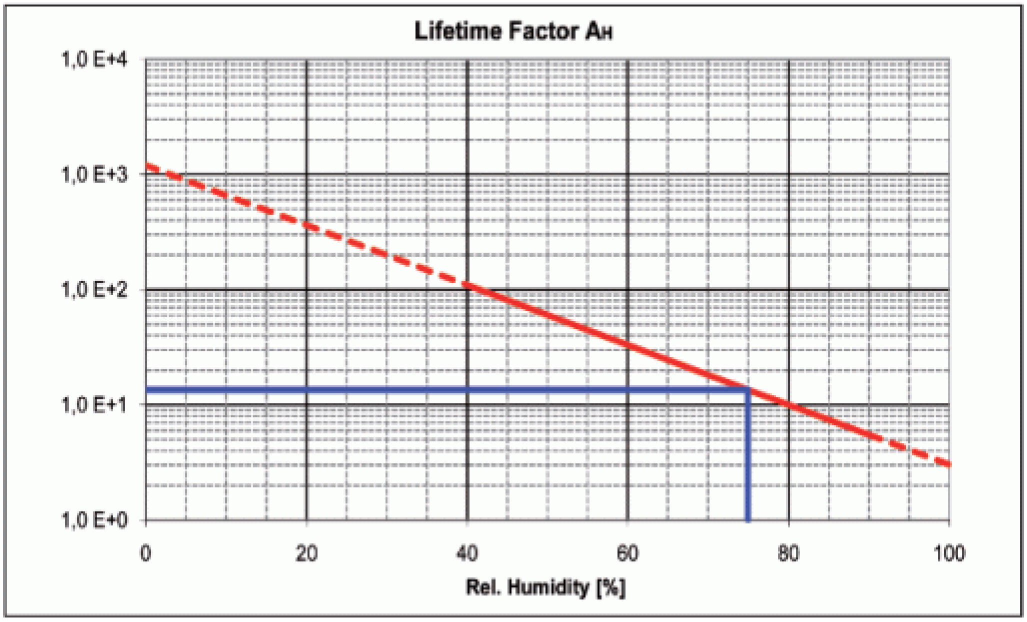


Figure 22: Dependency of the mean time between failure (MTTF) of a PICMA® actuator on the relative humidity

The calculated lifetime in hours results from the product of the values for the individual contributions:

MTTF = $A_U \times A_T \times A_F$

A_U: Contribution of the applied voltage

A_T: Contribution of the ambient temperature

A_F: Contribution of the relative humidity

The contribution of the applied voltage is especially important for applications. The lifetime increases exponentially with decreasing voltage. The recommended maximum range for the input voltage of the E-625 is therefore –2 to +12 V. This results in a piezo voltage range of –20 to 120 V (in open-loop operation). The input voltage range can be expanded from –3 to +13 V (the piezo voltage is then in the range of -30 to +130 V), which however reduces the lifetime of the actuator.

Example (see markings in the diagrams)

Applied voltage:	100 V DC	$\Rightarrow A_U = 75$
Ambient temperature:	45° C	$\Rightarrow A_T = 100$
Relative humidity:	75 %	$\Rightarrow A_F = 14$

MTTF = 14 × 75 × 100 h = 105000 h (approx. 12 years)

Details are located in the PI catalog under "Tutorials: Piezoelectrics in Positioning".

14.2 EC Declaration of Conformity

For the E-625, an EC Declaration of Conformity has been issued in accordance with the following European directives:

2006/95/EC, Low Voltage Directive

2004/108/EC, EMC Directive

2011/65/EU, RoHS Directive

The applied standards certifying the conformity are listed below.

Electromagnetic Emission: EN 61000-6-3:2007, EN 55011:2009

Electromagnetic Immunity: EN 61000-6-1:2007

Safety (Low Voltage Directive): EN 61010-1:2010