PI

PZ166E
E-625 Piezo Servo Controller
User Manual

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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

MOTION | POSITIONING

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Subject to change. This manual is superseded by any new release. The latest respective release is available for download (p. 3) on our website.

PI

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1 About this Document

1.1 Objective and Target Audience of this User Manual

This user manual contains the information required for using the E-625 as intended.

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 on our website (p. 3).

1.2 Symbols and Typographic Conventions

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

DANGER
Immediate threat of danger Failure to comply could result in death or serious injuries. ➢ Precautions to avoid the risk.

NOTICE
Dangerous situation Failure to comply could result in damage to the equipment. ➢ Precautions to avoid the risk.

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

Symbol/ Label	Meaning
1. 2.	Action consisting of several steps with strict sequential order
➢	Action consisting of one or more steps without relevant sequential order.
▪	Bullet point

Symbol/ Label	Meaning
p. 5	Cross-reference to page 5
RS-232	Label on the product indicating an operating element (example: RS-232 interface socket)
⚠ ⚡	Warning signs on the product that refer to detailed information in this manual.

1.3 Figures

For better understandability, the colors, proportions, and degree of detail in illustrations can deviate from the actual circumstances. Photographic illustrations may also differ and must not be seen as guaranteed properties.

1.4 Other Applicable Documents

The devices and software tools from PI mentioned in this documentation are described in separate manuals.

You can download all manuals mentioned hereafter in a zip file from our website. To download the manuals, use the "E-816" and "PI software" links in the "A000T0081-Downloading Manuals from PI.pdf" file which you can find in the *Manuals* folder on the data storage device with the PI Software Suite.

All manuals are available on our website and can also be downloaded (p. 3) individually.

Component	Document
E-802 servo controller submodule	PZ150E User Manual
E-816 computer interface submodule	PZ116E User Manual PZ120 DLL Software Manual
PI GCS driver library for use with NI LabVIEW software	SM158E 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).

1.5 Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:
➢ Contact our customer service department (p. 61).

Downloading manuals

1. Open the website **www.pi.ws**.

2. Search the website for the product number (e.g., E-625).

3. In the search results, select the product to open the product detail page.

4. Select *Downloads*.

   The manuals are shown under *Documentation*. Software manuals are shown under *General Software Documentation*.

5. For the desired manual, select *ADD TO LIST* and then *REQUEST*.

6. Fill out the request form and select *SEND REQUEST*.

   The download link will be sent to the email address entered in the form.

2 Safety

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 positioners 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 of the E-625 may result in personal injury and/or damage to the E-625.

> ➢ Use the E-625 for its intended purpose only, and only when it is in perfect condition.
> ➢ Read the user manual.
> ➢ Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for installing and operating the E-625 correctly.

> ➢ 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, power cord) 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 the protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the E-625 in the event of a malfunction or failure of the system. If there are touch voltages, touching the E-625 can result in serious injury or death from electric shock.

▷ Connect the E-625 to a protective earth conductor (p. 15) before starting.

▷ 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 restarting.

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

▷ Only open the E-625 housing when you are authorized and have the corresponding qualifications.

▷ Before opening the housing, disconnect the E-625 from the power source by removing the power plug.

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

2.3 Organizational Measures

User Manual

▷ Always keep this user manual together with the E-625.
The latest versions of the user manuals are available for download on our website (p. 3).

▷ Add all information from the manufacturer to the user manual, for example, supplements or technical notes.

▷ If you give the E-625 to a third party, include this user manual as well as other relevant information provided by the manufacturer.

▷ Do the work only if the user manual is complete. Missing information due to an incomplete user manual can lead to serious or fatal injuries as well as damage to the equipment.

▷ Install and operate the E-625 only after you have read and understood this user manual.

Personnel Qualification

The E-625 may only be installed, started, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

3 Product Description

3.1 Features and Applications

The E-625 piezo servo controller is a benchtop device that provides closed-loop and open-loop control of the displacement of the positioner. The models E-625.CR and E-625.C0 work with capacitive sensors that measure the position directly and without contact.

The integrated E-802 servo controller submodule has 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 resonant 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 regard 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
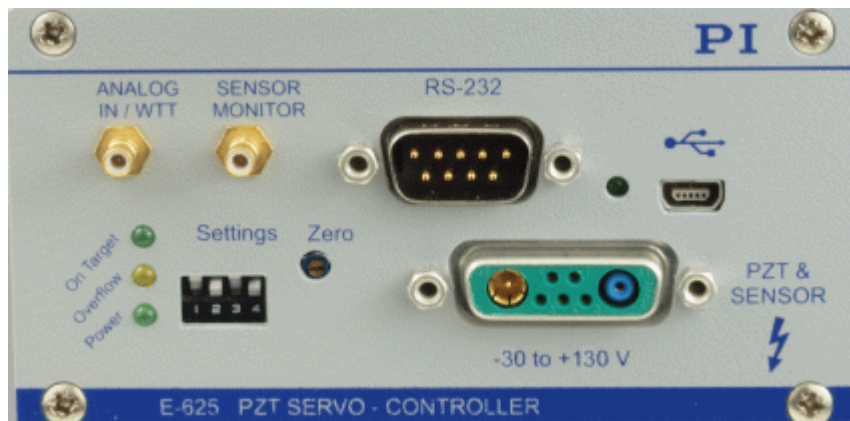
Figure 1: E-625.CR front panel

ANALOG IN/WTT

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

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

Control	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 reduce (p. 73) the lifetime of the piezo actuator in the positioner and cause 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 generate this analog signal with the NI LabVIEW driver from PI that is included in the PI Software Suite. Note: After installing the driver, it is necessary to activate the analog functionality (see the *Analog_Readme.txt* file in the installation directory of the PI Software).
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: 200 µs). Refer to the user manual for the E-816 computer interface submodule.

SENSOR MONITOR

SMB socket, coaxial output line with grounded line 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)

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

On Target LED, green

On-target signal from E-802 servo controller 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* D-sub socket on the rear panel of the E-625 (p. 69).

Overflow LED, yellow

When the *Overflow* LED comes on, the amplifier is near to its range limit (piezo voltage outside the range of –30 V to +130 V).

When the *Overflow* LED comes on in closed-loop operation (servo mode ON), a zero-point adjustment (p. 27) can be necessary.

Power LED, green

When the *Power* LED lights up continuously, 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) E-625.CR only: On the E-816 computer interface

Switch	Position	Function
		submodule, the servo mode can be switched on 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 ⚠

D-sub Mix 7W2 socket for connecting the positioner (p. 69):

- Voltage output for the piezo actuator in the positioner. The piezo voltage is between –30 and +130 V.

- Input for the sensor signal from the positioner

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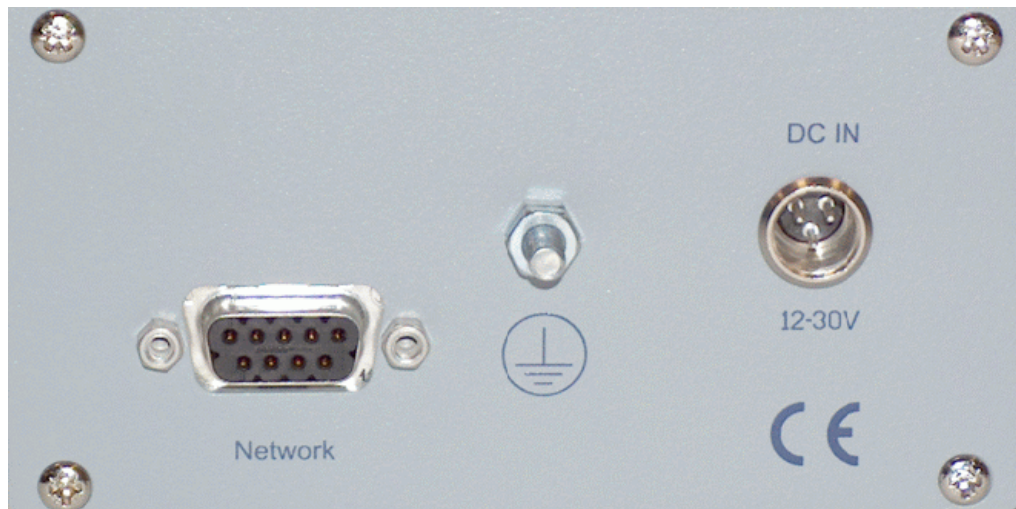
3.3.2   Rear Panel

Figure 2: E-625 rear panel

Network

D-sub socket, 9-pole, female (p. 69) for the network connection (only E-625.CR; I^{2}C-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 connector

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

DC IN 12–30 V

Panel plug for power adapter connector (p. 70). The C-501.15050H wide input range power supply must be connected by using an adapter from barrel to Switchcraft (p. 16).

3.4 Scope of Delivery

Order number	Description
E-625.CR **or** **E-625.C0**	Piezo servo controller according to order
C-501.15050H	Separate 15 V wide input range 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 adapter connector
3763	Power cord
E-692.SMB	SMB/BNC adapter cable, 1.5 m (2 pcs.)
PZ300EK	Short Instructions for Housed Analog Piezo Electronics
Only with E-625.CR:	
C-815.34	Null modem cable for the connection to the PC
000036360	USB cable (USB-A(m)/USB-Mini-B(m)) for the connection to the PC
C-990.CD1	Data storage device with PI Software Suite for digital electronics
Only with E-625.C0:	
E500T0011	Technical Note for analog control with the NI LabVIEW driver from PI

3.5 Optional Accessories

Order number	Description
E-625.CN	Network cable, 0.3 m, for interlinking two E-625 piezo servo controllers (I²C-bus, sensor synchronization; for details see the pin assignment of the cable (p. 70))

To order, contact our customer service department (p. 61).

4 Unpacking

1. Unpack the E-625 with care.

2. Compare the contents with the scope of delivery according to the contract and the delivery note.

3. Inspect the contents for signs of damage. If any parts are damaged or missing, contact our customer service department immediately (p. 61).

4. Keep all packaging materials in case the product needs to be returned.

5 Installing

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 connectors 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

The E-625 must be connected to a protective earth conductor because it is not grounded via the power adapter connection.

INFORMATION
➢ Pay attention to the applicable standards for connecting the protective earth conductor.

Requirements

✓ You have read and understood the General Notes on Installation (p. 15).

✓ The E-625 is not connected to the power supply.

Tools and Accessories

▪ Suitable protective earth conductor:

– Cable cross section ≥ 0.75 mm^2

– Contact resistance < 0.1 ohm at 25 A at all points relevant for attaching the protective earth conductor

▪ Mounting hardware for the protective earth conductor, sits on the protective earth connector (threaded bolt) in the following order on delivery of the E-625, starting from the housing:

- Lock washer

- Nut

- Flat washer

- Lock washer

- Nut

▪ Suitable wrench

Connecting the E-625 to the Protective Earth Conductor

1. If necessary, attach 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 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 attached to the protective earth conductor is wedged between the lock washer and the nut.

   c) Tighten the nut with at least three turns and a torque of 1.2 Nm to 1.5 Nm.

5.4 Connecting the Power Supply to the E-625

Requirements

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

Tools and Accessories

▪ 15 V wide-range-input power supply included (for line voltages between 100 and 240 volts alternating current voltage at 50 or 60 Hz)

▪ Alternative: Sufficiently rated power adapter

▪ Barrel-to-Switchcraft adapter for the power supply (K050B0002, included in the scope of delivery)

▪ Alternative: Sufficiently sized adapter

▪ Power cord included

▪ Alternative: Sufficiently sized power cord

Connecting the Power Supply to the E-625

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

2. Connect the adapter's barrel connector to the power supply's barrel connector socket.

3. Connect the power cord to the power supply.

5.5 Connecting a Positioner to the E-625

Requirements

✓ 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 positioner with which the E-625 was calibrated

Connecting the Positioner

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

If your system was calibrated by PI, the piezo servo controller and the positioner 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 Connecting a Signal Source to the E-625

Requirement

✓ 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 DAQ board). You can generate this analog signal with the NI LabVIEW driver from PI that is included in the PI Software Suite.

− 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: 200 µs

▪ SMB/BNC adapter cable (included in the scope of delivery)

Connecting a Signal Source

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

5.7 Connecting a Measuring Device to 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 positioner.

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 measuring 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 measuring device input must be provided with a 4.7 nF capacitor (NP0 or COC ceramic capacitor).
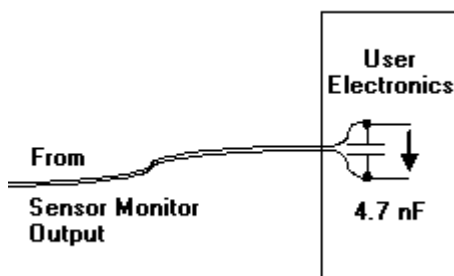
Figure 3: Electronic connection of the measuring device with the necessary input capacitance.

▪ SMB/BNC adapter cable (included in the scope of delivery)

Connecting a Measuring Device

➢ Use the adapter cable to connect a measuring device to the ***SENSOR MONITOR*** SMB socket of the E-625.

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

INFORMATION

In the computer-controlled mode (p. 31), 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.CSR.

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 controllers can also be connected to this network.

5.8.1 Connecting the E-625.CR to a PC

Requirements

- ✓ You have read and understood the user manual for the E-816 computer interface submodule.
- ✓ The required software has been installed from the data storage device with the PI Software Suite (included in the scope of delivery) on the PC.

Tools and accessories

- ▪ PC with a Windows or Linux operating system (For information on the compatibility of the software with PC operating systems see the C-990.CD1 Release News in the root directory of the data storage device.)
- ▪ Null modem cable or USB cable (USB-A(m)/USB-mini B(m)) for the connection to the PC (cable included 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 I²C-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. 70).

INFORMATION

The capacity of the I²C 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 controller modules from PI.
    Up to 12 of these modules can be installed in one housing where they are interlinked over the backplane of the housing.

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.

Requirements

✓ All devices to be interlinked are switched off, i.e., for all E-625, the wide input range 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. 40) 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. 12)

▪ Alternatively: Suitable connection cables with the same pin assignment as the E-625.CN (p. 70)

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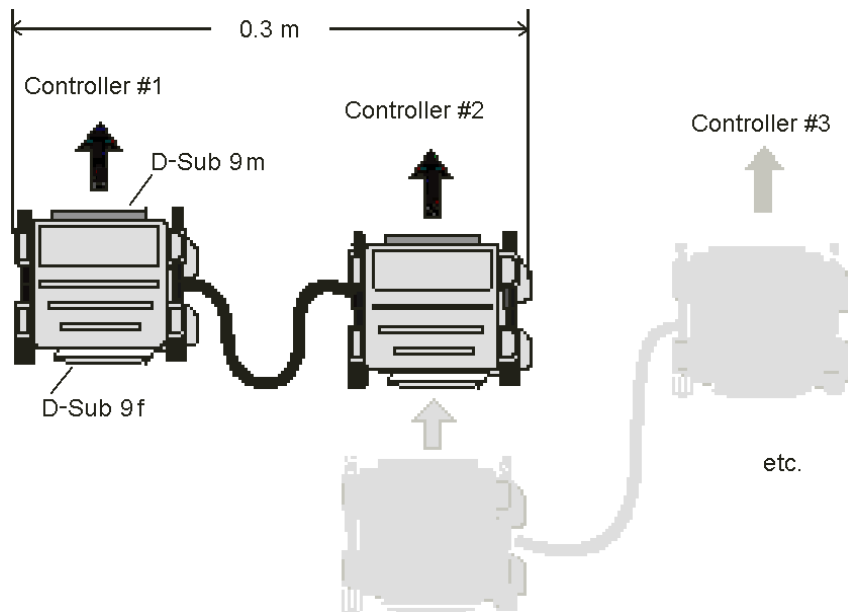
Figure 4: Interlinking via E-625.CN network cable

> ➢ Connect the **Network** sockets on the rear panels of the housing using the E-625.CN cables (see figure) or other suitable connection cables.

Networking can be done in a series or as a star. The E-625.CN cables have D-sub 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 network operation (e.g., for setting the channel names) are in the user manual for the E-816 computer interface submodule.

6 Startup

6.1 General Notes on Startup

<div style="background:red">**DANGER**</div>

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

➢ Connect the E-625 to a protective earth conductor (p. 15) before starting.
➢ 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 restarting.

<div style="background:blue">**NOTICE**</div>

Damage of the positioner from oscillations!
Oscillation of the positioner is indicated by humming and this is caused by incorrect adjustment of the notch filter and/or the P-I controller.

➢ At the first startup, 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 positioner immediately.

<div style="background:gray">**INFORMATION**</div>

Thermal instabilities can reduce the performance of the E-625 directly after it is switched on.
➢ Switch on the E-625 at least one hour before starting work.
➢ If the device is not in use, but should remain switched on to ensure the temperature stability:
Make sure that 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   Performing a System Test

➢ During the first startup, perform a system test under conditions typical to your application. This ensures that the E-625 and the positioner 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 positioner), and read out the position and output voltage via query commands.

For more information, refer to the user manual for the E-816 computer interface submodule.

Requirements

✓ You have read and understood the General Notes on Startup (p. 23).

✓ The E-625 has been installed properly (p. 15).

✓ You have installed the positioner in the same way as it will be used in your application (corresponding load and orientation).

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

✓ You have the user manual of the E-802 servo controller submodule within reach.

Tools and Accessories

▪ Oscilloscope; recommended: Digital storage oscilloscope (p. 18)

▪ Function generator for the output of a 1-V square-wave signal with 2 to 5 Hz

▪ Voltmeter

▪ 2 SMB/BNC adapter cables (included in the scope of delivery)

▪ Only if the housing needs to be opened for the adjustment of internal settings:

– Phillips-head screwdriver, size PH1

– Trimmer adjustment 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 input range power supply to the power socket.

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

3. Determine the resonant frequency of the positioner:

   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 function generator.

   d) On the oscilloscope (Y-t or FFT diagram), read the resonant frequency of the positioner.

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

   e) Open the E-625 (p. 36).

   f) Adjust (p. 41) the notch filter accordingly on the E-802 servo controller submodule.

4. Determine the position of the positioner 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 function 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 of the positioner 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) Adjust (p. 27) the zero point 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 (positioner's humming) can be heard after switching on the servo mode:

   a) Switch the servo mode off immediately.

   b) Open the E-625 (p. 36).

   c) Adjust the P term for the P-I controller by turning the P2 potentiometer on the E-802.55 servo controller submodule (p. 37) 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.

PI

e) Switch the servo mode on again.

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

   a) Measure again the resonant frequency of the positioner (see step 3).

   b) If necessary, improve the setting of the notch filter on the E-802.55 servo controller submodule (p. 41).

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

   a) Make sure that 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) On the oscilloscope, monitor the step response of the positioner (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. 36).

   e) Adjust the P term and the I term of the controller with the corresponding adjustment elements (p. 41) until the positioner shows the optimal settling behavior for your application.

8. When the housing is open:

   a) Disconnect the E-625 from the power source by removing the power cord of the wide input range 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 positioner. 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 positioner was replaced. In this case, the displacement of the axis must first be recalibrated (p. 50).

INFORMATION

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

INFORMATION

When the yellow overflow LED comes on, the amplifier is near to its range limit (piezo voltage outside the range of –30 V to +130 V).

➢ In open-loop analog mode, do **not** exceed the recommended input voltage range of –2 to +12 V.

➢ Adjust the zero point of the sensor when the overflow LED comes on in closed-loop operation (servo mode ON) (p. 27).

6.3   Adjusting the Sensor Zero Point

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

Objectives 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 displacement of the positioner 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 and this lengthens the lifetime of the piezo actuator in the positioner without reducing the nominal travel range.

INFORMATION

The zero-point adjustment of the sensor changes the physical zero position of the positioner in closed-loop operation.

Requirements

- ✓ You have read and understood the General Notes on Startup (p. 23).
- ✓ For computer-controlled mode only:
  - − You have read and understood the user manual for the E-816 computer interface submodule.
  - − The required PI software has been installed on the PC.
- ✓ You have installed the positioner in the same way as it will be used in your application (corresponding load and orientation).
- ✓ The E-625 has been installed properly (p. 15).
- ✓ The E-625 is switched off, i.e., the wide input range power supply is **not** connected to the power socket with the power cord.

Tools and accessories

- In analog mode only:
  - − Suitable analog signal source (p. 17).
  - − SMB/BNC adapter cable (included in the scope of delivery)
- Only in computer-controlled mode:
  PC with RS-232 or USB-interface and installed PI software.
- Appropriate voltmeter (p. 18):
  - − 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 (included in the 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 the adapter cable.

3. Connect the voltmeter to the **SENSOR MONITOR** SMB socket using the adapter cable.

4. Connect the power cord on the wide input range 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 positioner 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 by 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 **SENSOR MONITOR** SMB socket using the adapter cable.

3. Connect the power cord on the wide input range 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 PIMikroMove.

5. Send the `SVO A 0` command (`A` indicates the axis) to ensure that 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 positioner 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 by 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 despite 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

7.1 General Notes on Operation

DANGER

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

➢ Connect the E-625 to a protective earth conductor (p. 15) before starting.
➢ 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 restarting.

NOTICE

Damage to the piezo ceramic!
The constant application of high voltage to the piezo actuators in the positioner could lead to leakage currents and flashovers that destroy the ceramic.

If the device is not in use, 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. 32) 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 expanded to –3 to +13 V. However, this can reduce (p. 73) the lifetime of the piezo actuator in the positioner and cause 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 generate this analog signal with the NI LabVIEW driver from PI that is included in the PI Software Suite. Note: After installing the driver, it is necessary to activate the analog functionality (see the *Analog_Readme.txt* file in the installation directory of the PI Software).

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 positioner 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 controllers 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 reduce (p. 73) the lifetime of the piezo actuator in the positioner and cause 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 controller submodule determines the piezo voltage on the basis of the target position and the feedback from the position sensor in the positioner. This is how the servo loop regulates the position of the positioner.

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 controller submodule is not considered.

When the jumpers are set accordingly, the slew rate limiter and the notch filter remain active (p. 37).

The sensor electronics work independently of the servo mode and report the current position of the positioner when a sensor is connected, even in open-loop operation. Since even positioners 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 operation uses the E-802.55 servo controller submodule that is installed in the E-625. The use of the E-802 servo controller submodule is set (p. 37) with an on-board jumper. In the default position, the E-802 servo controller submodule is active and the servo mode can be set as follows:

Settings of the 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 (E-625.CR only)

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 startup macro (refer to the user manual for the E-816 computer interface submodule).

8 Adjustment of Internal Settings

8.1 General Notes on the Adjustment of Settings

DANGER

Risk of electric shock during operation with open housing!
If the E-625 is operated with an open housing, live parts are accessible. Touching the live parts can result in serious injury or death from electric shock.

➢ Only open the E-625 housing when you are authorized and have the corresponding qualifications.
➢ Before opening the housing, disconnect the E-625 from the power source by removing the power plug.
➢ When operating with an open housing, do not touch any components in the housing 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 lead to oscillation of the positioner, deteriorated settling behavior, and reduced positioning accuracy.

➢ Change the internal system settings of the E-625 only if it is necessary.
➢ Contact our customer service department (p. 61) 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 housing.

▪ Notch filter and P-I controller for optimal settling behavior (p. 41)

- Sensor settings for the highest positioning accuracy after the replacement of the positioner or the controller (p. 46)

- Master/slave setting for the sensor synchronization (p. 40)

8.2 Opening the Housing

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 housing.

Requirements

✓ You have read and understood the General Notes on the Adjustment of Settings (p. 35).

✓ 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 Housing

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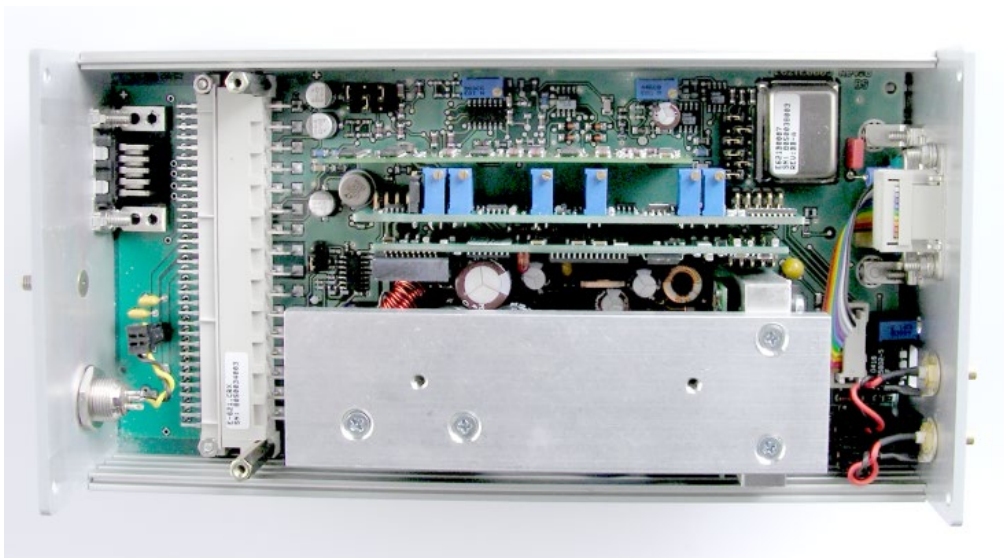
2. Lift off the top of the housing.

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

8.3   Adjustment Elements Inside the Housing

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 controller submodule. The servo controller submodule is inserted vertically on the main board.

The components of the E-625.C0 are identical except for the E-816 computer interface submodule.

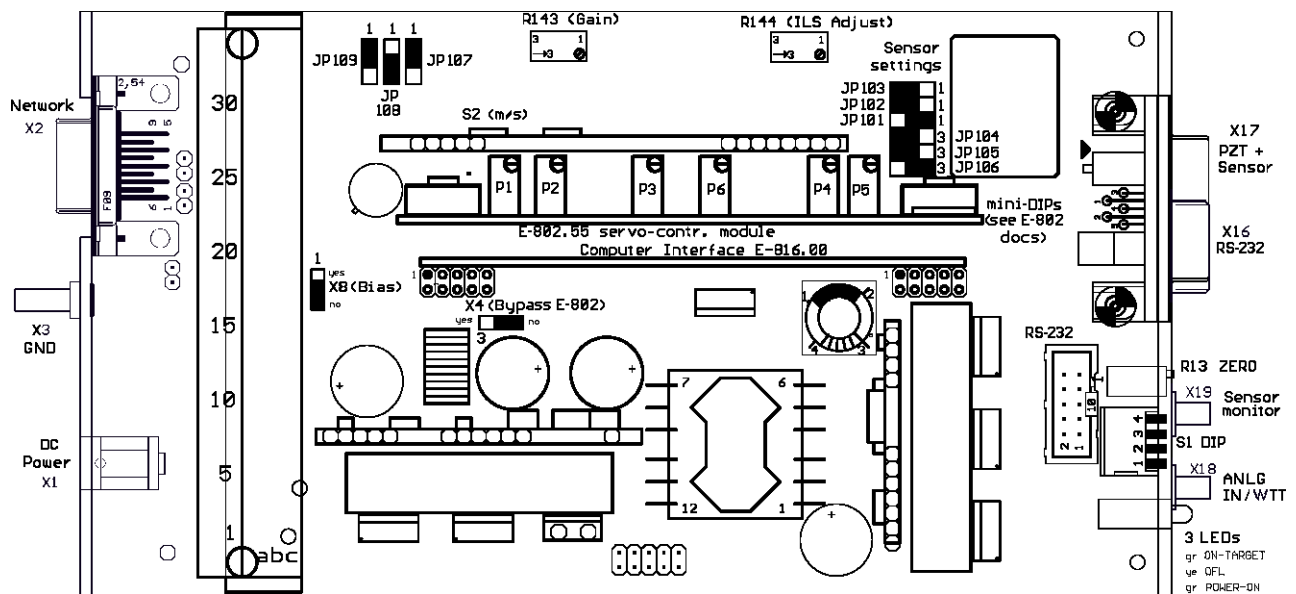The adjustment elements are shown in the default position.

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

8.3.1   Jumpers

Jumper X4

The *X4* jumper is located on the main board (p. 37).

Position	Function
1-2	The E-802 servo controller 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 remains active even when servo mode is switched off.
2-3	The E-802 servo controller submodule is bypassed, independent of all other settings.
	The slew rate limiter for the piezo voltage and the notch filter is inactive.

Jumper X8

The *X8* jumper is located on the main board (p. 37).

Position	Function
1-2	DC-offset potentiometer is activated. **Only activate when a DC-offset potentiometer (not included in the 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. 37).

Figure 7: Settings for the sensor range jumpers

The extension factors are set according to the connected positioners. If the positioner is not known to PI, the extension factor of 1.0 is set.

Jumper JP107 to 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 controller submodule (positive polarity, 0 to 10 V) (default settings).
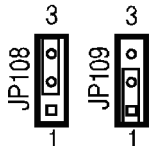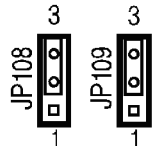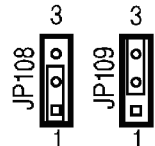
Typical Application	Using with PI's position control electronics	Using as a position detector	Special application
Position of Jumpers JP108 and JP109			
Voltage range of output	0V ~ 10V	-5V ~ +5V	-10V ~ 0V

Figure 8: Settings for the sensor evaluation range

8.3.2   Switches

Switches of the E-802.55 Servo Controller Submodule

The mini DIP switches and the S1 switch for the notch filter setting of the E-802.55 servo controller submodule are described in the E-802 servo controller 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).
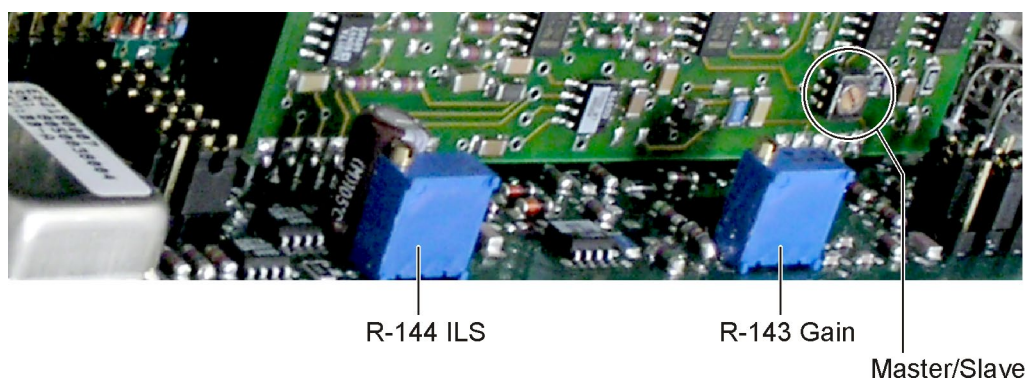
Figure 9: Master/slave switch in default setting (master)

8.3.3　Potentiometers

Potentiometers to adapt settings are located in the following places (p. 37):

- 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 controller submodule (refer to the user manual for the servo controller submodule)

8.3.4　E-802 Servo Controller Submodule

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

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

The E-802 servo controller 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. 39) 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 single 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. 70).

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).

Requirements

✓ You have read and understood the general notes on the adjustment of settings (p. 35).

✓ All E-625s to be synchronized are disconnected from the power source, i.e., the wide input range power supplies are **not** connected to power sockets over the power cords.

✓ You have opened the housing for the E-625 to be synchronized (p. 36).

Tools and Accessories

▪ Trimmer adjustment tool, or alternatively a narrow slot screwdriver
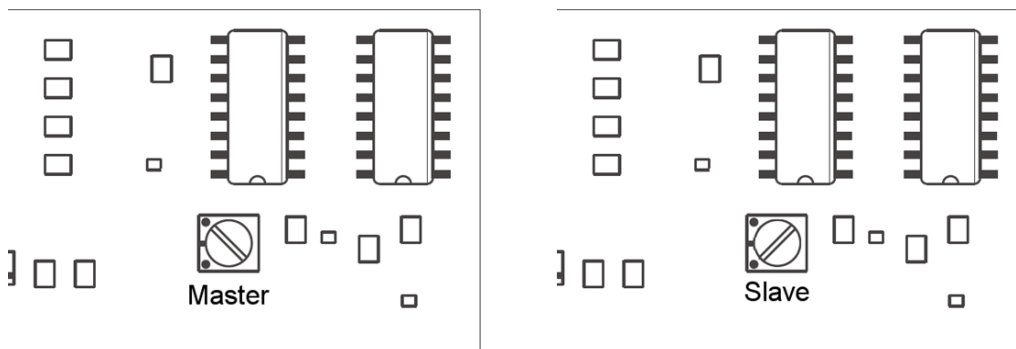
Synchronizing the Sensors

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 housings.

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. 70)).

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 resonant frequency can be suppressed in dynamic operation.

Adjusting the P-I controller optimizes the system's dynamic properties (overshoot and settling time). The objective is a compromise between the best stability (avoid oscillation of the positioner) and the highest speed. The optimal P-I controller settings depends on your application and your requirements.

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

1. Adjust (p. 41) the notch filter.

2. Improve the settings of the P-I controller (p. 45).

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

INFORMATION

If the **X4** jumper on the main board is in the default setting (p. 37), the notch filter and the slew rate limiter for the piezo voltage will be active when servo mode is switched off. Readjusting the notch filter frequency in open-loop operation could lead to a change in the piezo voltage 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, refer to the user manual for the E-816 computer interface submodule.

8.5.1   Adjusting the Notch Filter

Requirements

> ✓ You have read and understood the general notes on the adjustment of settings (p. 35).

> ✓ You have the user manual of the E-802 servo controller submodule within reach.

> ✓ The E-625 has been disconnected from the power source, i.e., the wide input range power supply is **not** connected to the power socket using the power cord.

> ✓ The E-625 has been installed properly (p. 15).

> ✓ You have installed the positioner in the same way as it will be used in your application (corresponding load and orientation).

> ✓ You have opened the E-625 (p. 36).

Tools and Accessories

- Oscilloscope; recommended: Digital storage oscilloscope (p. 18)
- 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 (included in the 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 input range 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 positioner, 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 controller 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 resonant frequency of the positioner by using the DIP switch block on the E-802.55 servo controller submodule.

7. Adjust the notch filter damping. To do this, turn the S1 switch on the E-802.55 servo controller submodule using the trimmer adjustment tool.
   Possible damping settings of the notch filter: −20 dB or −25 dB

   - If the resonant frequency level is between 15 and 20 dB:
     Set damping to −25 dB.

   - If the resonant 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 resonant frequency on the oscilloscope (Y-t or FFT display).

10. Turn the P4 potentiometer on the E-802.55 servo controller submodule by using the trimmer adjustment tool to optimally adapt the notch filter frequency to the resonant frequency of the positioner.

11. Repeat the last steps until the resonant frequency of the positioner has the best damping.

12. Improve the settings of the P-I controller (p. 45).

In the two figures below, you can find examples for resonant 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.
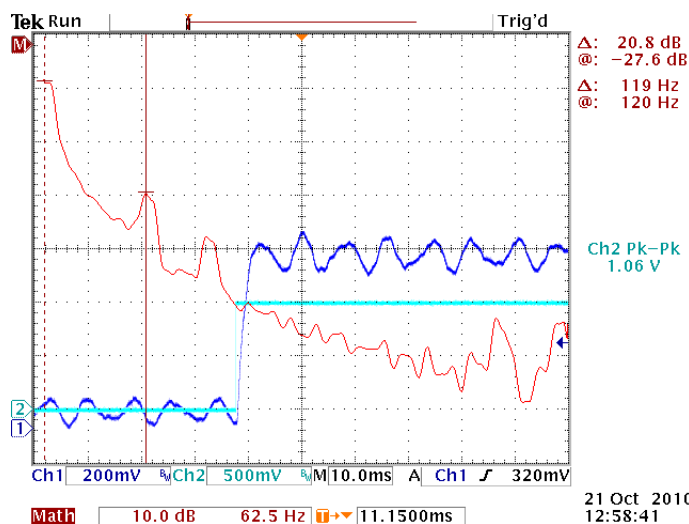

Figure 11: Open-loop operation, notch filter not adjusted, first resonant frequency at 119 Hz
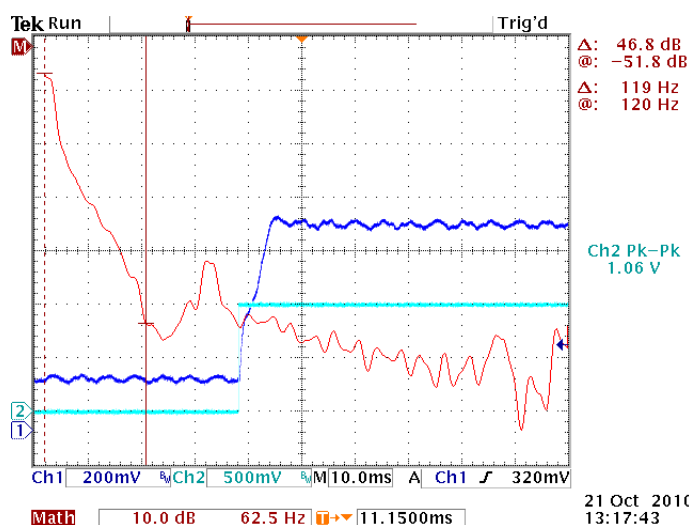

Figure 12: Open-loop operation, first resonant frequency damped by the notch filter

8.5.2   Setting the P-I Controller in Analog Mode

Requirements

- ✓ You have correctly adjusted the notch filter (p. 41).
- ✓ You have not changed anything on the system setup 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. 41)

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 (positioner's 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 controller submodule with the trimmer adjustment tool fully counterclockwise.
   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. On the oscilloscope, monitor the step response of the positioner (sensor monitor signal over time).

4. Alternatingly turn P2 and P3 (I term) potentiometers on the E-802.55 servo controller submodule by 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 input range 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.
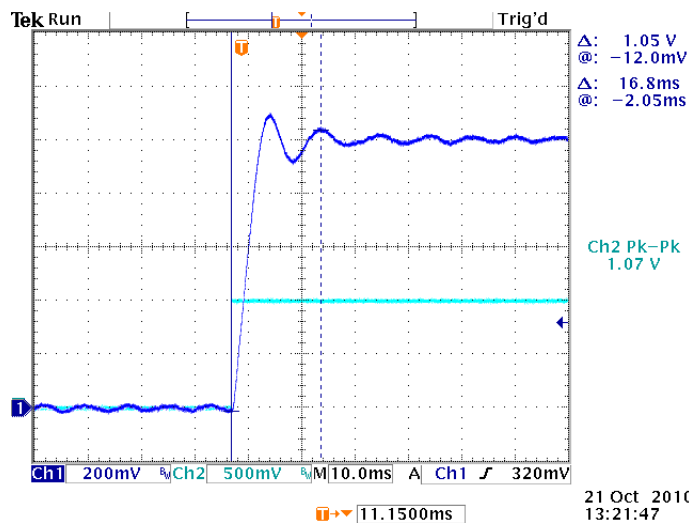
Figure 13: Closed-loop operation, P-term set too large (strong overshoot)
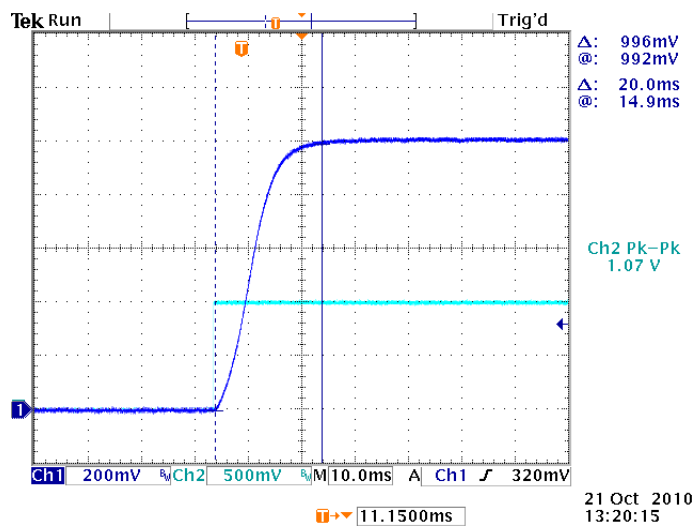
Figure 14: Closed-loop operation, conservative setting of P-term and I-term, stable system with relatively long settling time

8.6 Calibrating the Displacement of the Positioner

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

NOTICE

Damage of the positioner from oscillations!
Oscillation of the positioner is indicated by humming and this is caused by 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. 41).

Calibrating the displacement of the positioner includes the following steps:

- Adjust the sensor range (open-loop operation), (p. 47).
- Adjust the static sensor gain (closed-loop operation), (p. 50).
- Adjust the sensor linearization (closed-loop operation), (p. 52).

➢ Perform these steps immediately in sequence.

INFORMATION

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

INFORMATION

The calibration of the displacement of the positioner 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 does 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 positioner has reached the nominal displacement. The adjustment is made in open-loop operation (servo mode OFF).

INFORMATION

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

Requirements

✓ You have read and understood the General Notes on Startup (p. 23).

✓ For computer-controlled mode only:

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

    − The required PI software has been installed on the PC.

✓ The E-625 has been installed properly (p. 15).

✓ You have installed the positioner in the same way as it will be used in your application (corresponding load and orientation).

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

✓ You have opened the E-625 (p. 36).

Tools and accessories

▪ In analog mode only:

    − High-precision analog signal source (p. 17).

    − SMB/BNC adapter cable (included in the scope of delivery)

▪ Only in computer-controlled mode:
PC with RS-232 or USB-interface and installed PI software.

▪ High-precision voltmeter (p. 18):

    − 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 (included in the scope of delivery).

▪ High-precision, external measuring device (e.g., interferometer) to measure the displacement of the positioner

▪ 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 the adapter cable.

3. Connect the voltmeter to the **SENSOR MONITOR** SMB socket using the adapter cable.

4. Install the external measuring device so that it can measure the displacement of the positioner. If the measuring 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 input range 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 positioner 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. 27) 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 measuring device shows the nominal displacement of the positioner (upper travel range limit).

11. Adjust the sensor gain potentiometer R143 on the main board (p. 37) with the trimmer adjustment tool 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 measuring 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. 50) the static static gain factor.

➢ If not: Disconnect the E-625 from the power supply by removing the power cord of the wide input range 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 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 **SENSOR MONITOR** SMB socket using the adapter cable.

3. Install the external measuring device so that it can measure the displacement of the positioner. If the measuring 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 input range power supply to the power socket.

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

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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 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 positioner is reached approximately.

8. Send the `SVA A 0` command to set the piezo voltage to 0 V.

9. Read the 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. 27) 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 A 1` to slowly increase the piezo voltage until the external measuring device shows the nominal displacement of the positioner (upper travel range limit).

13. Adjust the sensor gain potentiometer R143 on the main board (p. 37) 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 measuring 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. 50) the static static gain factor.

➢ If not: Disconnect the E-625 from the power supply by removing the power cord of the wide input range 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 positioner moves precisely to the upper travel range limit when this position is commanded. The setting is made in closed-loop operation (servo mode ON).

Requirements

✓ You have correctly adjusted the sensor range (p. 47).

✓ You have not changed anything on the system setup that was used for the adjustment of the sensor range. All devices are still ready for operation.

✓ You have the user manual of the E-802 servo controller submodule within reach.

Tools and Accessories

- As for the adjustment of the sensor range (p. 47)

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 (positioner's humming) can be heard after switching on the servo mode:

   a) Switch the servo mode off immediately.

   b) Optimize the notch filter frequency and the P-I controller settings in the E-625 (p. 41).

   c) Make sure that servo mode is switched on.

2. Apply 0.0000 V input voltage to the *ANALOG IN/WTT* SMB socket.

3. Adjust the external measuring device so that it shows the zero position exactly.

4. Apply exactly +10.0000 V input voltage to the *ANALOG IN/WTT* SMB socket.

5. Check the position of the positioner:

   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 measuring 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 controller submodule by using the trimmer adjustment tool until the sensor signal is exactly +10.0000 V (refer to the E-802 user manual).

7. If the measurement value on the external measuring device deviates from the upper travel range limit:
   Adjust the sensor gain potentiometer R143 on the main board (p. 37) by using the trimmer adjustment tool until the external measuring device shows exactly the upper travel range limit (the displacement of the positioner changes).

8. If necessary, repeat the last steps until stable values are displayed on the measuring devices.

Is the nonlinearity of the sensor signal more than 0.05 % of the nominal travel range?

- ➢ If so: Linearize the sensor signal (p. 52).

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

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

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

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

   a) Switch the servo mode off immediately.

b) Optimize the notch filter frequency and the P-I controller settings in the E-625 (p. 41).

c) Make sure that servo mode is switched on.

2. Send the `MOV A 0` command.

3. Adjust the external measuring 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 position of the positioner 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 controller submodule by using the trimmer adjustment tool until the sensor signal corresponds exactly to the upper travel range limit (refer to the E-802 user manual).

7. Read the measured value on the external measuring device.

   The value must correspond exactly to the upper travel range limit.

8. If the measurement value on the external measuring device deviates from the upper travel range limit:
   Adjust the sensor gain potentiometer R143 on the main board (p. 37) by using the trimmer adjustment tool until the external measuring device shows exactly the upper travel range limit (the displacement of the positioner changes).

9. If necessary, repeat the last steps until stable values are displayed on the measuring devices.

Is the nonlinearity of the sensor signal more than 0.05 % of the nominal travel range?

➢ If so: Linearize the sensor signal (p. 52).

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

8.6.3   Adjusting the Sensor Linearization

The sensor linearization should minimize the nonlinear second order contributions 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.

Requirements

- ✓ You have correctly adjusted the sensor range (p. 47).
- ✓ You have correctly adjusted the static sensor gain for closed-loop operation (p. 50).
- ✓ You have not changed anything on the system setup 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. 47)

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 position of the positioner from the external measuring device.
   For the linearization of the negative direction of motion: Reduce the input voltage stepwise from 10 V to 0 V.

2. Using the trimmer adjustment tool, adjust the R144 (p. 37) ILS adjust potentiometer on the main board until the position of the positioner 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 the closed-loop operation (p. 50).

4. Disconnect the E-625 from the power source by removing the power cord of the wide input range 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 positioner while reading the position of the positioner on the external measuring device.

For the linearization of the negative direction of motion: Reduce the target position using the MOV command stepwise from the upper travel range limit to 0 µm.

2. Using the trimmer adjustment tool, adjust the R144 (p. 37) ILS adjust potentiometer on the main board until the position of the positioner 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. 50).

4. Disconnect the E-625 from the power source by removing the power cord of the wide input range 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 position changes by Ks µm.
Sensor offset Os	µm	When the sensor signal is 0 V, the 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 positioner and/or have recalibrated the displacement of the positioner as described in this user manual.

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

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9 Maintenance

9.1 Cleaning the E-625

NOTICE

Short circuits or flashovers!
The E-625 contains electrostatic-sensitive devices that can be damaged by short-circuiting or flashovers when cleaning fluids penetrate the housing.

➢ Before cleaning, disconnect the E-625 from the power source by removing the mains plug.
➢ Prevent cleaning fluid from penetrating the housing.

➢ When necessary, clean the surfaces of the E-625's housing using a cloth dampened with a mild cleanser or disinfectant.

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

Fault: Positioner does not move	
Possible causes	**Remedial measures**
Cable not connected correctly	➢ Check the cable connections.
Positioner or positioner cable is defective	➢ If available, replace the defective positioner with another positioner and test the new combination. Because the positioner and the E-625 must always be calibrated with each other, the system will probably be less exact with the new positioner than with the original positioner. If you wish to continue using the new positioner for your application, you must calibrate the system again.
Control mode for the piezo voltage is set incorrectly	➢ Select the control mode (analog or in computer-controlled mode) according to the control source used for the axis motion. E-625.CR only: 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 (refer to 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 DAQ board using the NI LabVIEW drivers from PI: ➢ Check that the driver and the DAQ board are working correctly.
Incorrect command or incorrect syntax	➢ Send the `ERR?` command and check the error code that is returned. 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.
Wrong axis commanded	➢ Make sure that the correct axis identifier is used and that the commanded axis belongs to the correct positioner. An axis identifier is even required on systems with only one axis.
Incorrect configuration	➢ Use the `SPA?` command to check the E-816 computer interface submodule parameter settings.

Fault: Positioner does not move	
Possible causes	**Remedial measures**
Voltage output of the E-625 is deactivated	When the internal temperature reaches ≥75° C, the voltage output of the E-625 is deactivated and the positioner 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. 15). ➢ When using the wave table output, reduce the frequency and/or the amplitude and/or the output duration.

Fault: Positioner is oscillating or positions inaccurately	
Possible causes	**Remedial measures**
The load was changed.	➢ Readjust the system according to the changed load.

Fault: Communication with the controller does not work	
Possible causes	**Remedial measures**
The wrong communication cable is used or it is defective	➢ Use a null modem cable for the RS-232 connection. ➢ If necessary, check whether the cable works on a fault-free system.

The communication interface is not configured correctly	**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:
	Once the E-625 has been switched on, a message will appear that new hardware has been detected.
	➢ Install the USB driver from the data storage device with the PI software. The installation files for the USB drivers can be found in the \SingleSetups folder on the data storage

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Fault: Communication with the controller does not work	
Possible causes	**Remedial measures**
	device.
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.
Another program is accessing the interface.	➢ Close the other program.
Problems with special software	➢ Check whether the system works with other software, such as a terminal program or a development environment. You can test communication by starting a terminal program (e.g., PITerminal) and entering `*IDN?`. ➢ Make sure that you end the commands with an LF (line feed). A command is only executed when LF has been received.

Fault: The customer software does not function with the PI drivers	
Possible causes	**Remedial measures**
Incorrect combination of driver routines/VIs	➢ Check whether the system functions with a terminal program (e.g., PITerminal). If so: ➢ Read the information in the corresponding software manual and compare your program code with the sample code on the data storage device with the PI Software Suite.

Fault: Unsatisfactory system performance	
Possible causes	**Remedial measures**
▪ The sensor values are unreliable and the entire system is instable. ▪ The system is not temperature stable	➢ Switch on the E-625 at least one hour before starting work. ➢ While the E-625 is not in use: Make sure that 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

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Fault: Overflow LED comes on	
Possible causes	**Remedial measures**
The amplifier output is near to its range limit threshold value	➢ Perform (p. 27) 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. 61) our customer service department.

If the problem that occurred with your system is not in the list above or cannot be solved as described, contact our customer service department (p. 61).

11   Customer Service Department

For inquiries and orders, contact your PI sales engineer or send us an email (mailto:service@pi.de).

> ➢ If you have questions concerning your system, provide the following information:
>
> − Product and serial numbers of all products in the system
>
> − Firmware version of the controller (if applicable)
>
> − Version of the driver or the software (if applicable)
>
> − PC operating system (if applicable)
>
> ➢ If possible: Take photographs or make videos of your system that can be sent to our customer service department if requested.

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

12   Technical Data

Subject to change. You can find the latest product specifications on the product web page at www.pi.ws (https://www.pi.ws).

12.1   Specifications

12.1.1   Data Table

	E-625.SR, E-625.S0 / E-625.CR, E-625.C0
Function	Piezo amplifier / servo controller
Channels	1

Sensor	**E-625.SR, E-625.S0 / E-625.CR, E-625.C0**
Controller type	P-I (analog), notch filter
Sensor type	SGS (.S) / capacitive (.C)

Amplifier	**E-625.SR, E-625.S0 / E-625.CR, E-625.C0**
Input voltage range	-2 to +12 V
Min. output voltage	-30 to +130 V
Peak current, < 50 ms	120 mA
Average output 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

Interfaces and operation	**E-625.SR, E-625.S0 / E-625.CR, E-625.C0**
Communication interfaces*	USB, RS-232 (D-sub 9 (m)), 24-bit A/D and 20-bit D/A
Piezo connection	LEMO ERA.00.250.CTL (.S) / D-sub special (.C)
Sensor connector	LEMO EPL.0S.304.HLN (.S) / D-sub special (.C)
Analog input socket	SMB
Sensor monitor socket	SMB
Controller network*	up to 12 channels

Interfaces and operation	E-625.SR, E-625.S0 / E-625.CR, E-625.C0
Command set*	PI General Command Set (GCS)
User software*	PIMikroMove
Software drivers*	NI LabVIEW driver, dynamic libraries for Windows (DLL) and Linux
Supported functions*	Wave table, 256 data points, external trigger, up to 16 macros

Miscellaneous	E-625.SR, E-625.S0 / E-625.CR, E-625.C0
Operating temperature range	5 to 50 °C
Overheat protection	Deactivation at 75 °C
Dimensions	205 mm × 105 mm × 60 mm
Mass	1.05 kg
Operating voltage	12 to 30 V DC, stabilized (included in the scope of delivery: external power adapter)
Current consumption	2 A

* E-625.S0 and E-625.C0 without digital interface

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-pole	30 V	⎓	2 A

12.1.3   Ambient Conditions and Classifications

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

Area of application	For indoor use only
Maximum altitude	2000 m
Air pressure	1100 hPa to 0.1 hPa
Relative humidity	Highest relative humidity 80 % for temperatures up to 31 °C Decreasing linearly to 50 % relative air 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
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.
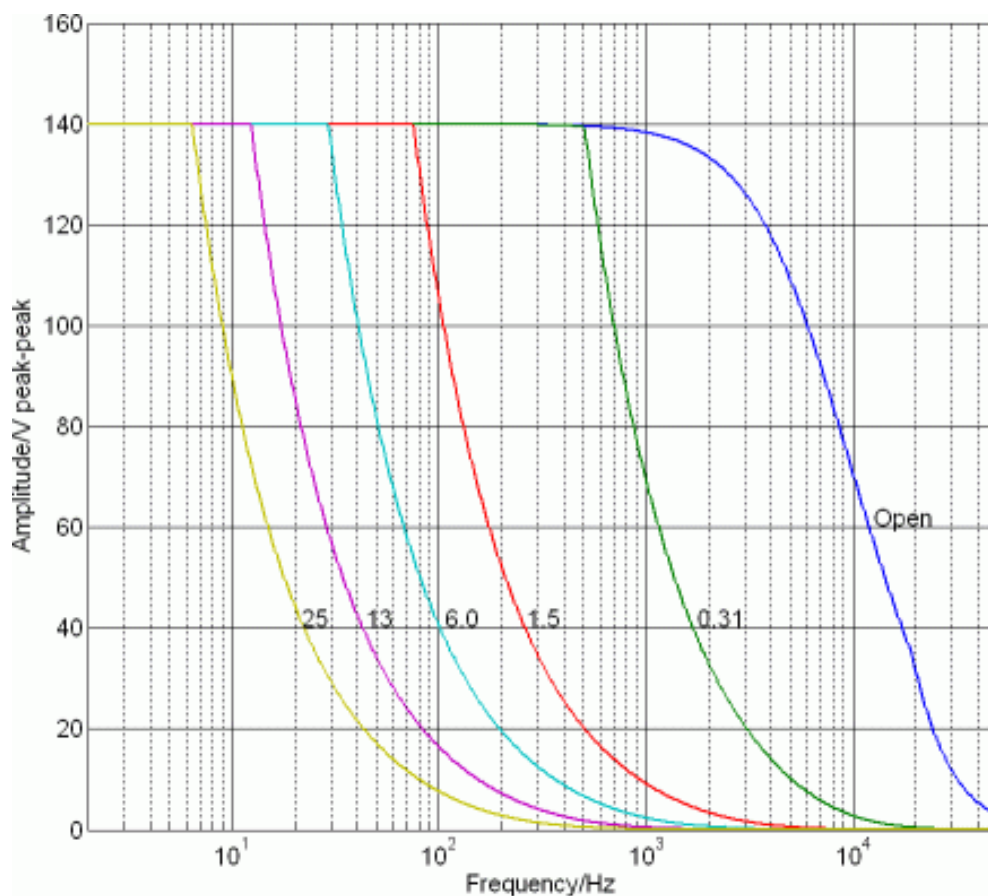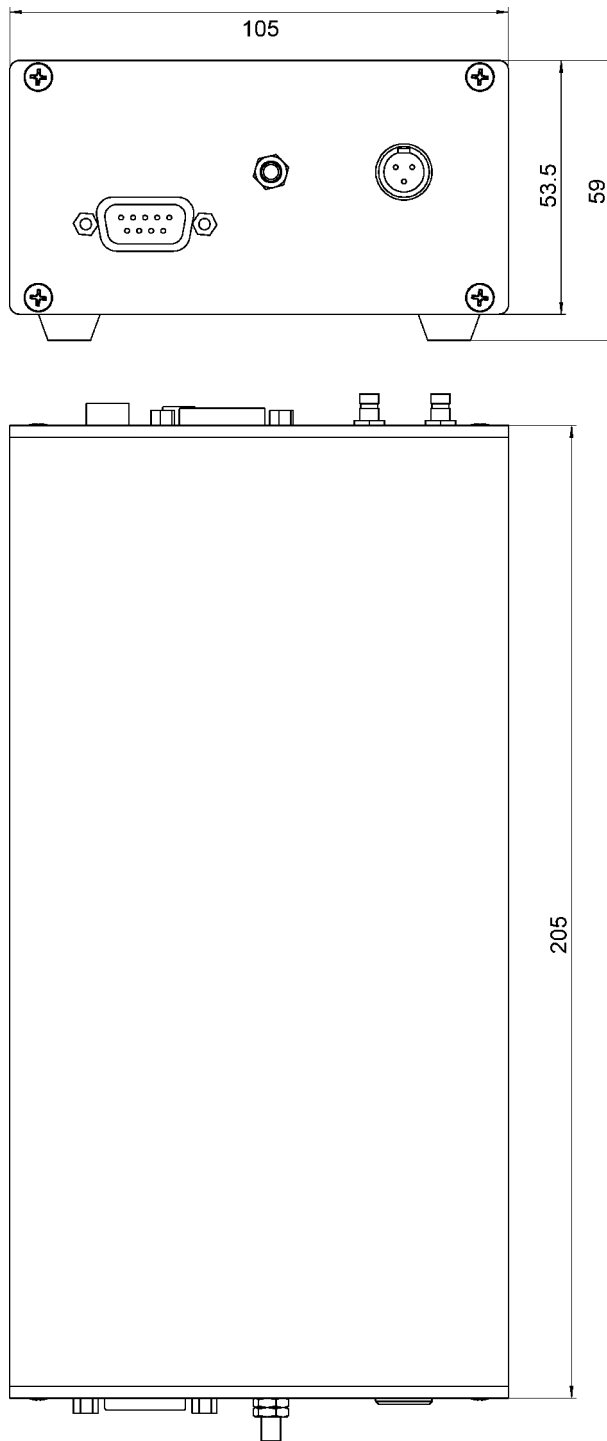

Figure 15: Operating limits

12.3   Dimensions

Figure 16: E-625 dimensions in mm

12.4 Block Diagrams

12.4.1 E-625.CR Block Diagram
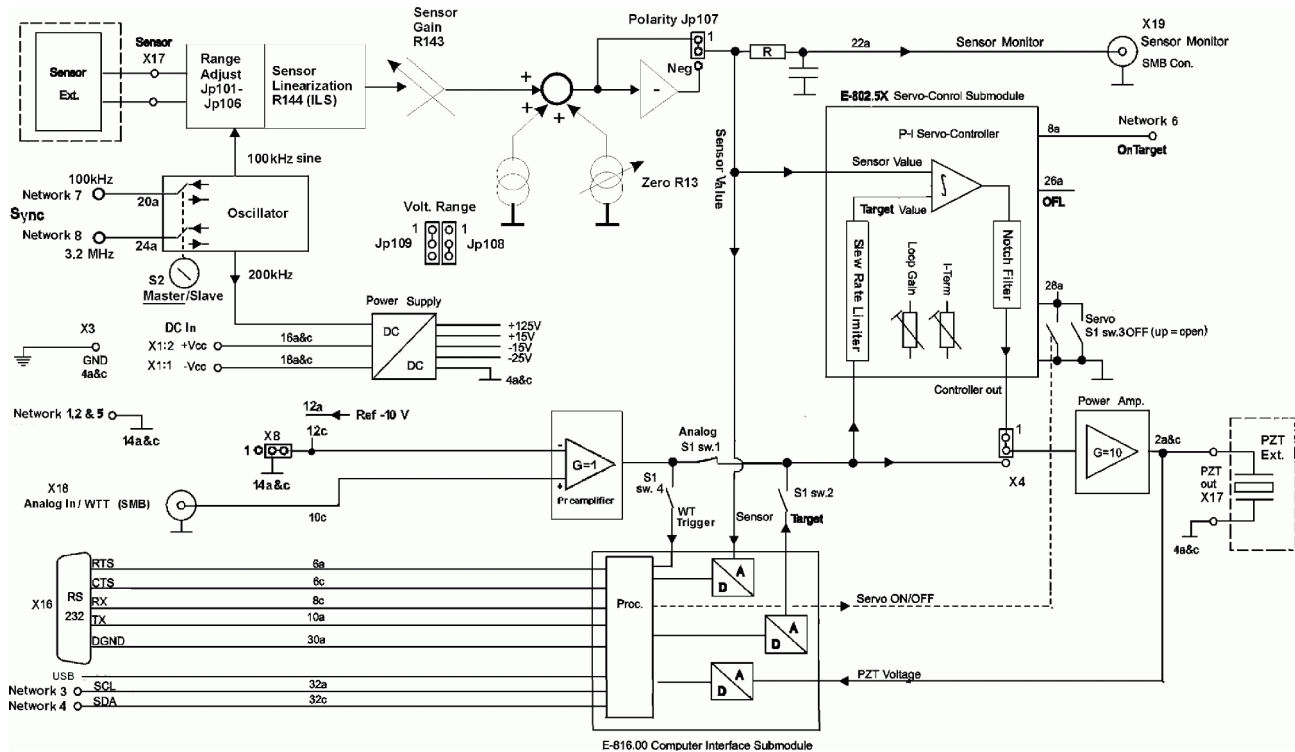
Figure 17: E-625.CR block diagram

"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.
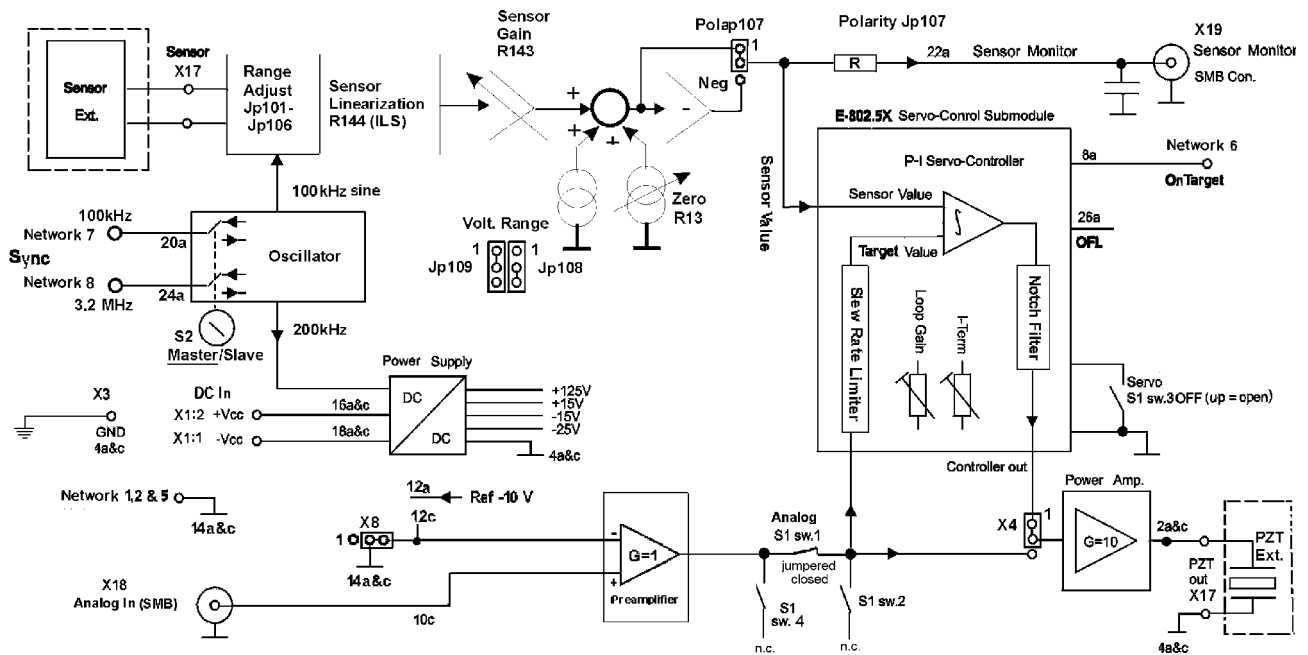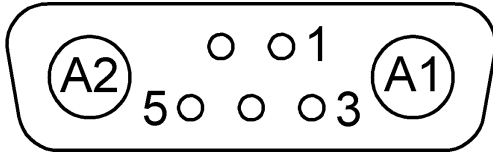
12.4.2 E-625.C0 Block Diagram

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 D-sub 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 housing)	
4	Not connected	
5	Sensor target	

12.5.2   Network

D-sub socket, 9-pole, female

Pin	Function
1	GND
2	GND
3	SCL (I²C network operation)*; not for E-625.C0
4	SDA (I²C 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. 70).

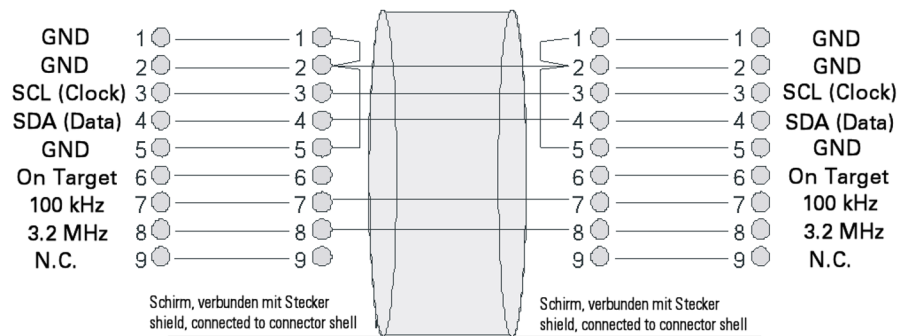**PI**

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 EU law, electrical and electronic equipment may not be disposed of in EU member states via the municipal residual waste.

Dispose of your old equipment according to international, national, and local rules and regulations.

To fulfill the responsibility as the product manufacturer, Physik Instrumente (PI) GmbH & Co. KG undertakes environmentally correct disposal of all old PI equipment made available on the market after 13 August 2005 without charge.

Any old PI equipment can be sent free of charge to the following address:

Physik Instrumente (PI) GmbH & Co. KG

Auf der Römerstraße 1

76228 Karlsruhe, Germany

PI

14 Appendix

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.
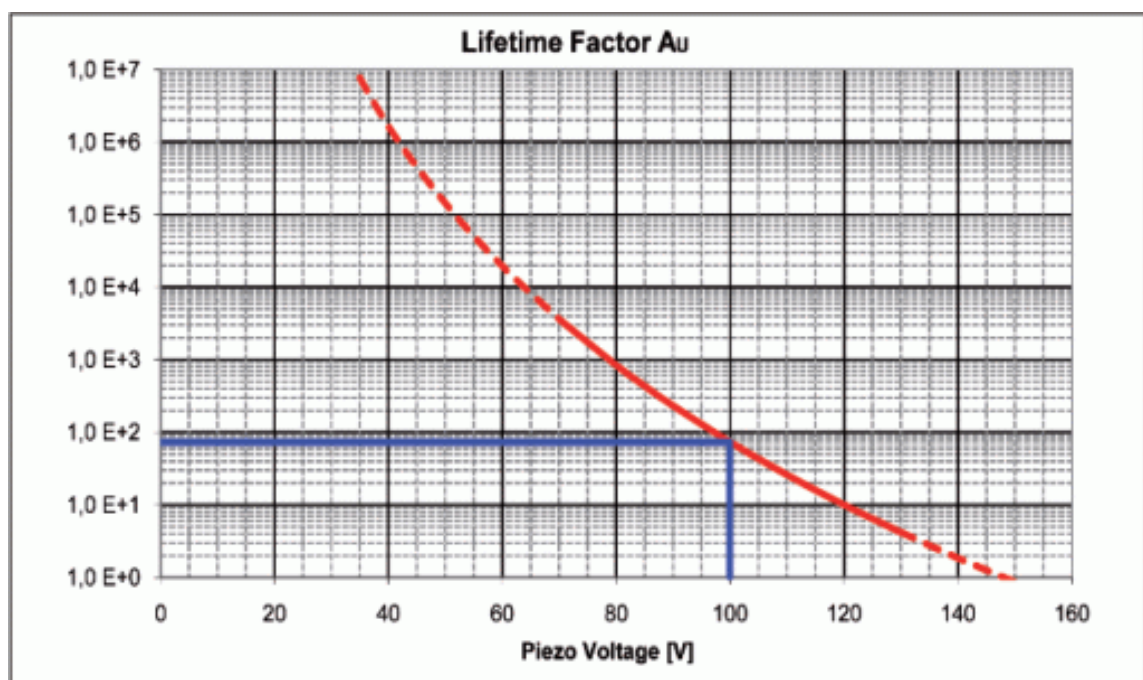

Figure 20: Dependency of the mean time between failure (MTTF) of a PICMA® actuator on the applied voltage
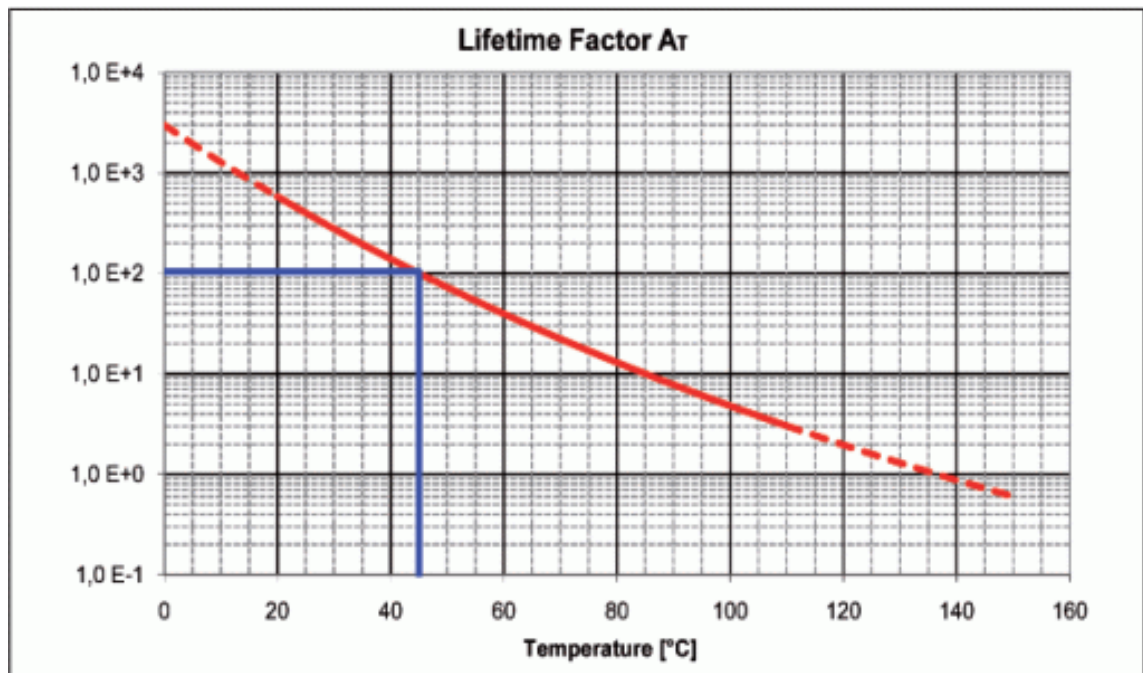
Figure 21: Dependency of the mean time between failure (MTTF) of a PICMA® actuator on the ambient temperature

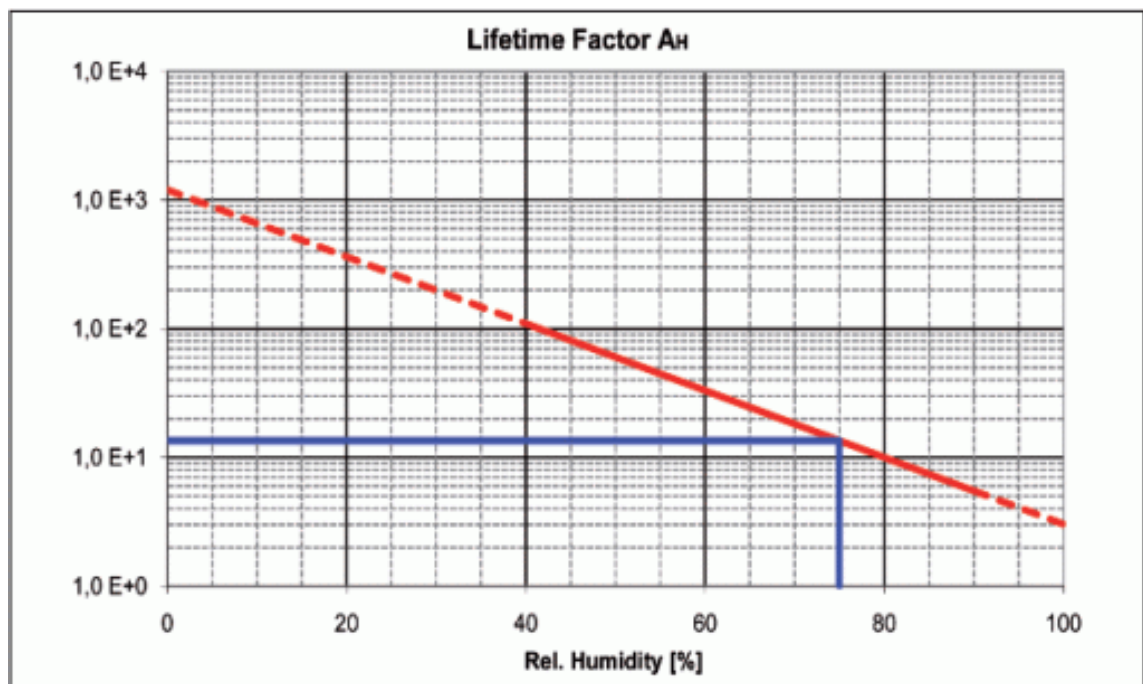

Figure 22: Dependency of the mean time between failure (MTTF) of a PICMA® actuator on the relative humidity

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	$\Rightarrow A_U = 100$
Relative humidity:	75 %	$\Rightarrow A_F = 14$

$MTTF = 14 \times 75 \times 100$ h = 105000 h (approx. 12 years)

14.2 European Declarations of Conformity

For the E-625, declarations of conformity were issued according to the following European statutory requirements:

Low Voltage Directive

EMC Directive

RoHS Directive

The standards applied for certifying conformity are listed below.

Safety (Low Voltage Directive): EN 61010-1

EMC: EN 61326-1

RoHS: EN IEC 63000