

PZ250E E-836.1G Piezo Amplifier User Manual

Version: 1.0.1

Date: 10.03.2014



This document describes the following product:

- **E-836.1G**
Piezo Amplifier, 1 Channel, Bench-Top, -30 to 130 V



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 This manual is superseded by any new release.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



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1 About this Document

In this Chapter

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Other Applicable Documents	2
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1.1 Goal and Target Audience of this User Manual

This manual contains information on the intended use of the E-836.1G.

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

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

1.2 Symbols and Typographic Conventions

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

DANGER



Imminently hazardous situation

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

- Actions to take to avoid the situation.

NOTICE




Dangerous situation

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

- Actions to take to avoid the situation.

INFORMATION

Information for easier handling, tricks, tips, etc.

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

1.3 Other Applicable Documents

The devices and software tools which are mentioned in this documentation are described in their own manuals.

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

Component	Document
Analog Controller LabView Driver Library	PZ181E Software Manual

1.4 Downloading Manuals

INFORMATION

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

- Contact our customer service department (p. 25).

The current versions of the manuals are found on our website. For some products (e.g. Hexapod systems and electronics that are delivered with a CD), access to the manuals is password-protected. The password is stored on the CD.

Download freely accessible manuals

1. Open the website <http://www.pi-portal.ws>.
2. Click **Downloads**.
3. Click the corresponding category (e.g. **E Piezo Drivers & Nanopositioning Controllers**).
4. Click the corresponding product code (e.g. **E-836**).
5. Click **Documents**.

The available manuals are displayed.

6. Click the desired manual and save it on the hard disk of your PC or on a data storage medium.

Download password-protected manuals

1. Carry out steps 1 to 5 of the download process for freely accessible manuals.
2. Insert the product CD in the PC drive.
3. Switch to the **Manuals** directory on the CD.
4. In the **Manuals** directory, open the Release News (file including **releasenews** in the file name).
5. Find the user name and password in the **User login for software download** section in the Release News.
6. In the **User login** area on the left margin in the website, enter the user name and the password in the corresponding fields.
7. Click **Login**.

The available manuals are displayed.

8. Click the desired manual and save it on the hard disk of your PC or on a data storage medium.

2 Safety

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2.1 Intended Use

The E-836.1G is a laboratory device as defined by DIN EN 61010-1. 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-836.1G is intended for driving capacitive loads (e. g. piezo ceramic actuators).

The E-836.1G must not be used for purposes other than those named in this user manual. In particular, the E-836.1G must not be used to drive ohmic or inductive loads.

The E-836.1G can be used for static as well as dynamic applications.

2.2 General Safety Instructions

The E-836.1G is built according to state-of-the-art technology and recognized safety standards. Improper use can result in personal injury and/or damage to the E-836.1G.

- Only use the E-836.1G for its intended purpose, and only use it if it is in a good working order.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for the correct installation and operation of the E-836.1G.

- Install the E-836.1G near the power source so that the power plug can be quickly and easily disconnected from the mains.
- Use the supplied components (power supply, adapter and power cord) to connect the E-836.1G to the power source.
- If one of the supplied components for connecting to the power source has to be replaced, use a sufficiently dimensioned component.

If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the E-836.1G in the case of malfunction or failure of the system. If touch voltages exist, touching the E-836.1G can result in serious injury or death from electric shock.

- Connect the E-836.1G to a protective earth conductor (p. 13) before start-up.
- 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-836.1G to the protective earth conductor before starting it up again.

2.3 Organizational Measures

User manual

- Always keep this user manual available by the E-836.1G.
The latest versions of the user manuals are available for download (p. 3) on our website.
- Add all information given by the manufacturer to the user manual, for example supplements or Technical Notes.
- If you pass the E-836.1G on to other users, also turn over this user manual as well as all other relevant information provided by the manufacturer.
- Only use the device on the basis of the complete user manual. If your user manual is incomplete and is therefore missing important information, serious or fatal injury as well as property damage can result.
- Only install and operate the E-836.1G after having read and understood this user manual.

Personnel qualification

Only authorized and qualified personnel must install, operate, maintain and clean the E-836.1G.

3 Product Description

In this Chapter



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3.1 Product View

3.1.1 Front Panel



Figure 1: E-836.1G piezo amplifier, front view




Labeling	Type	Function
24 VDC 	Barrel connector socket (input)	Connection for the supply voltage
	Threaded bolt with fastening material for protective earth conductor	Protective earth connection (p. 13) The threaded bolt must be connected to a protective earth conductor, since the E-836.1G is not grounded via the power supply connector.
Control In	BNC socket	Connection of a signal source <ul style="list-style-type: none"> Input for the control input voltage of the E-836.1G

Labeling	Type	Function
PZT -30 to 130 V  	LEMO socket EPK.00.250.NTN	Connection of the stage <ul style="list-style-type: none"> Output of the piezo voltage for the piezo actuator in the stage
DC Offset	Rotary knob	1-turn potentiometer, adds 0 to 10 V to control input voltage
Power	LED green/off	Display of the ready state: <ul style="list-style-type: none"> Green: E-836.1G is ready for operation Off: E-836.1G is not ready for operation
PI	-	Manufacturer's logo
E-836 Piezo Driver	-	Product Description
CE	-	CE conformity mark

3.1.2 Rear Panel



Figure 2: E-836.1G piezo amplifier, rear view

Labeling	Function
	Data matrix code (example; contains the serial number)
E-836.1G	Product name
PI	Manufacturer's logo
113064443	Serial number (example), individual for each E-836.1G Meaning of the places (counting from left): 1 = internal information, 2 and 3 = manufacturing year, 4 to 9 = consecutive numbers
Country of origin: Germany	Country of origin
	Warning sign "Observe manual!"
	Old equipment disposal (p. 33)
CE	CE conformity mark
WWW.PI.WS	Manufacturer's address (website)

3.2 Scope of Delivery

Item ID	Components
E-836.1G	Piezo amplifier
C-663.PS	Separate 24 V wide-range-input power supply for use with line voltages from 100 to 240 VAC and voltage frequencies of 50 or 60 Hz, with barrel connector
3763	Power cord
PZ250E	User manual for E-836.1G (this document)
E500T0011	Technical note for the LabVIEW analog driver

4 Unpacking

1. Unpack the E-836.1G with care.
2. Compare the contents against the items covered by the contract and against the packing list.
3. Inspect the contents for signs of damage. If parts are missing or you notice signs of damage, contact PI immediately.
4. Keep all packaging materials in case the product needs to be returned.

5 Installation

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Connecting the Power Supply to the E-836.1G.....	14
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5.1 General Notes on Installation

- Install the E-836.1G near the power source so that the power plug can be quickly and easily disconnected from the mains.
- Only use cables and connections that meet local safety regulations.

5.2 Connecting the E-836.1G to the Protective Earth Conductor

INFORMATION

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

Prerequisite

- ✓ You have read and understood the general notes on installation (p. 13).
- ✓ The E-836.1G is switched off, i. e. the power supply is **not** connected to the power socket via the power cord.

Tools and accessories

- Suitable protective earth conductor:
 - Cable cross-section $\geq 0.75 \text{ mm}^2$
 - Contact resistance $< 0.1 \text{ ohm}$ at 25 A at all connection points relevant for mounting the protective earth conductor

- Fastening material for the protective earth conductor, sits on the protective earth connector (threaded bolt) in the following order upon delivery of the E-836.1G, starting from the case:
 - Safety washer
 - Nut
 - Flat washer
 - Toothed washer
 - Nut
- Suitable wrench

Connecting the E-836.1G to the protective earth conductor

1. If necessary, fasten a suitable cable lug to the protective earth conductor.
2. Remove the outer nut from the protective earth connection on the front panel of the E-836.1G (threaded bolt (p. 7) marked with ⚡).
3. Connect the protective earth conductor:
 - a) Push the cable lug of the protective earth conductor onto the threaded bolt.
 - b) Screw the nut onto the threaded bolt. In this way, the cable lug of the protective earth conductor is wedged between the toothed washer and the nut.
 - c) Tighten the nut with at least three rotations and a torque of 1.2 Nm to 1.5 Nm.

5.3 Connecting the Power Supply to the E-836.1G

Prerequisites

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

Tools and accessories

- Included 24 V wide-range-input power supply (for line voltages between 100 and 240 VAC at 50 or 60 Hz)
- Alternatively: Sufficiently dimensioned power supply
- Included power cord
- Alternatively: Sufficiently dimensioned power cord

Connecting the power supply to the E-836.1G

- Connect the power supply to the **24 VDC** connection of the E-836.1G.

5.4 Connecting the Stage

Prerequisite

- ✓ When a signal source is connected to the **Control In** BNC socket: The signal source is switched off or its output is 0 V.
- ✓ The **DC Offset** potentiometer is turned fully counterclockwise.

Tools and accessories

- Stage with the following characteristics:
 - Drive: Piezo actuator(s)
 - Operating voltage range: -30 to 130 V
 - Voltage connection: Via LEMO connector

Connecting the stage

- Connect the voltage connection of the stage to the **PZT -30 to 130 V** LEMO socket of the E-836.1G.

5.5 Connecting the Control Input Voltage

INFORMATION

The control signal for the output piezo voltage is the sum of the following signals:

- Control input voltage at the **Control In** BNC socket
- Offset that is set with the **DC Offset** potentiometer

The control signal should always be within the range of -2 to +12 V. The range can be expanded to -3 to +13 V. However, this can shorten the lifetime of the piezo actuator in the stage (p. 35).

Prerequisite

- ✓ The signal source for the control input voltage is switched off or its output is 0 V.
- ✓ The **DC Offset** potentiometer is turned fully counterclockwise.

Tools and accessories

- Signal source for the control input voltage. The control input voltage can also be a computer-generated analog signal (e. g. from a data acquisition board). You can use the PI LabVIEW analog drivers to generate the analog signal (see E500T0011 Technical Note and the PZ181E manual).

Connecting the control input voltage

- Connect the signal source to the **Control In** BNC socket.

6 Start-Up

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General Notes on Start-Up	17
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6.1 General Notes on Start-Up

DANGER



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

If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the E-836.1G in the case of malfunction or failure of the system. If touch voltages exist, touching the E-836.1G can result in serious injury or death from electric shock.

- Connect the E-836.1G to a protective earth conductor (p. 13) before start-up.
- 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-836.1G to the protective earth conductor before starting it up again.

NOTICE



Reduced lifetime of the piezo ceramic due to permanently high voltage!

The permanent application of a high static voltage to the piezo actuators in the stage reduces the lifetime of the piezo ceramic.

If the E-836.1G is not used, but is to remain switched on:

- Set the control signal (sum of Control In and DC Offset) to 0 V.

INFORMATION

The output piezo voltage contains the switching frequency of the internal DC/DC transducer of the E-836.1G (600 kHz). This frequency has no effect on the motion of the stage, however. For this reason, the measurement of the piezo voltage (e.g. with a digital oscilloscope) is **not** suitable for determining the motion resolution of the stage.

- Measure the motion of the stage directly, e.g. with optical methods or high-resolution sensors.

INFORMATION

When it is switched off, the E-836.1G generates a voltage spike at the output for the piezo voltage. A connected stage will execute a corresponding motion, which can be noticeable as a clicking sound. This behavior is unproblematic and does **not** affect the stage.

6.2 Switching on the E-836.1G

Prerequisite

- ✓ You have read and understood the general notes on start-up (p. 17).
- ✓ You have connected the power supply to the E-836.1G (p. 14).
- ✓ When a signal source is connected to the **Control In** BNC socket: The signal source is switched off or its output is 0 V.
- ✓ The **DC Offset** potentiometer is turned fully counterclockwise.

Switching on the E-836.1G

- Connect the power cord of the power supply with the power socket.

The **Power** LED on the front panel shows the ready state of the E-836.1G:

- Green: E-836.1G is ready for operation
- Off: E-836.1G is not ready for operation

6.3 Executing Motions

INFORMATION

The control signal for the output piezo voltage is the sum of the following signals:

- Control input voltage at the **Control In** BNC socket
- Offset that is set with the **DC Offset** potentiometer

The control signal should always be within the range of -2 to $+12$ V. The range can be expanded to -3 to $+13$ V. However, this can shorten the lifetime of the piezo actuator in the stage (p. 35).

Prerequisite

- ✓ You have read and understood the user manual of the stage.
- ✓ You have mounted the stage according to the description in the corresponding user manual.
- ✓ You have connected the stage to the E-836.1G (p. 15).
- ✓ When the stage is operated via a control input voltage: You have connected a signal source to the E-836.1G (p. 15).
- ✓ You have switched on the E-836.1G (p. 18).

Executing motions

- Change the control signal within the range of -2 V to $+12$ V:
 - Change the control input voltage at the **Control In** BNC socket.
 - Turn the **DC Offset** potentiometer.

The stage generates corresponding motions.

7 Maintenance

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7.1 General Notes on Maintenance

The E-836.1G is maintenance-free.

7.2 Cleaning the E-836.1G

NOTICE



Short circuits or flashovers!

The E-836.1G contains electrostatic sensitive devices that can be damaged by short circuits or flashovers when cleaning fluids enter the case.

- Before cleaning, remove the E-836.1G from the power source by pulling the power plug.
- Prevent cleaning fluid from entering the case.

- When necessary, clean the surfaces of the E-836.1G case with a cloth that has been lightly dampened with a mild cleanser or disinfectant.
- Do **not** use any organic solvents.

8 Troubleshooting

Problem	Possible Causes	Solution
Stage does not move	Cable is not connected correctly	➤ Check the cable connections.
	Stage or stage cable is defective	➤ Replace the defective stage with a suitable stage and test the new combination.
	Control signal exceeds the permissible range	➤ Check the control input voltage (Control In BNC socket) and the setting of the DC Offset potentiometer. If you generate the control input voltage with a data acquisition board using the LabVIEW analog drivers: ➤ Check that the analog drivers and the data acquisition board are working correctly.
	E-836.1G voltage output is deactivated	When the internal temperature reaches $\geq 85^{\circ}\text{C}$ the E-836.1G voltage output is deactivated and the stage stops moving. When the internal temperature then drops to 75°C , the voltage output is switched on again automatically. ➤ Ensure sufficient ventilation at the place of installation. ➤ Reduce the frequency and/or the amplitude and/or the output duration of the control input voltage (Control In BNC socket).

If the problem that occurred with your system is not listed in the table above or cannot be solved as described, contact our customer service department (p. 25).

9 Customer Service

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

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

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

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

10 Technical Data

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10.1 Specifications




10.1.1 Data Table

	E-836.1G	Unit
Function	Piezo amplifier, 1 channel Bench-top device	
Control input voltage	-2 to 12	V
Output voltage	-30 to 130	V
Peak current (<8 ms)	100	mA
Average current	50	mA
Current limitation	Short-circuit-proof	
Voltage gain	10 ±0.1	
Ripple, noise, 0 to 100 kHz	0.8	mV _{rms}
Capacitive base load (internal)	10	nF
Output impedance	5	Ω
Input impedance	1	MΩ
Connectors	BNC, LEMO Barrel connector (power supply) 1-turn pot., adds 0 to 10 V to Control input	
Operating temperature range	5 to 50	°C
Overtemp protection	Deactivation at 85 °C	°C
Operating voltage	24 ±10 %, included: external power supply, 24 V / 2.0 A	VDC
Power consumption (max.)	16	W
Current consumption (max.)	0.65	A

Ask about custom designs!

10.1.2 Maximum Ratings

The E-836.1G is designed for the following operating data:

Input on:	Maximum Operating Voltage	Operating Frequency	Fused Current Consumption
			
Barrel connector socket	24 V	— — —	2 A

10.1.3 Ambient Conditions and Classifications

The following ambient conditions and classifications must be observed for the E-836.1G:

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

10.2 Operating Limits

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

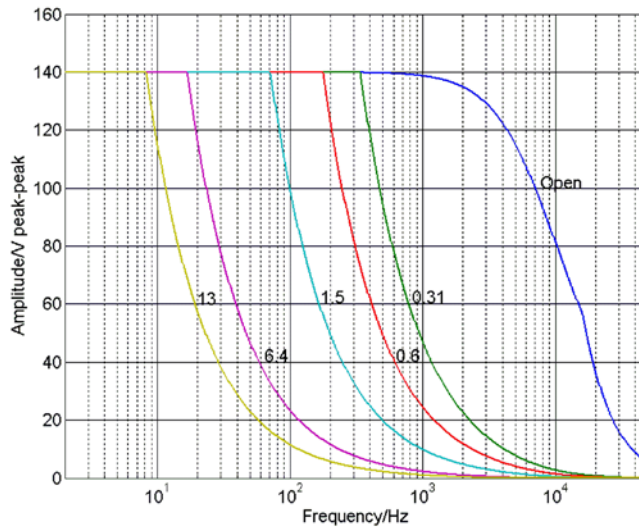


Figure 3: Operating limits

10.3 Dimensions

Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

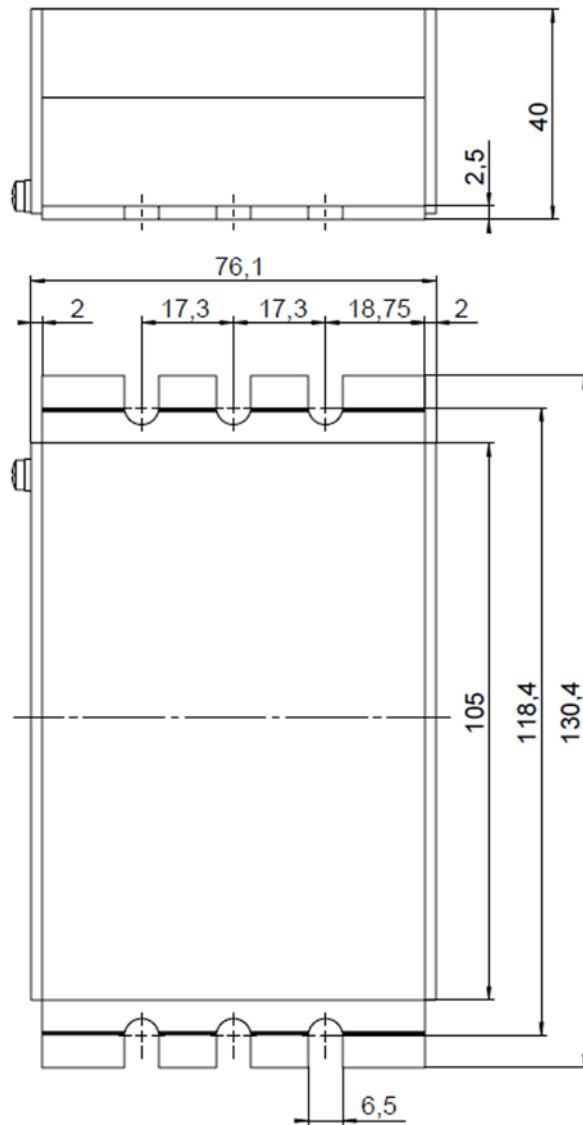


Figure 4: E-836.1G, dimensions in mm

10.4 Block Diagrams

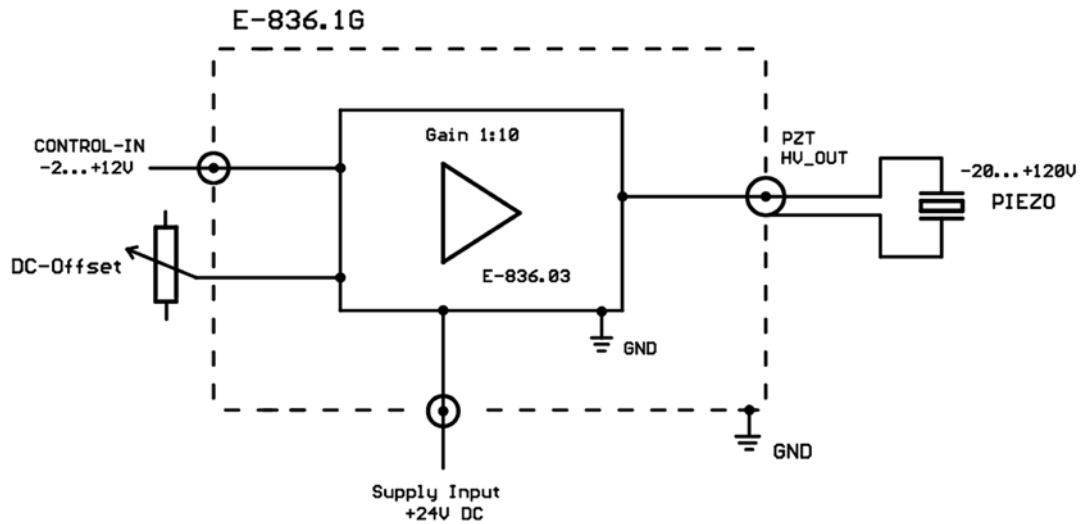


Figure 5: E-836.1G block diagram

10.5 Pin Assignment

10.5.1 PZT Socket

LEMO socket EPK.00.250.NTN, 2-pin, for transmission of the piezo voltage:

- Outer contact: PZT ground (connected with the case)
- Inner contact: PZT+ (-30 to +130 V)

10.5.2 24 VDC Power Supply Connection

Barrel connector socket



Pin	Function
Center pin	Input: 24 V DC
Outer conductor	GND (power)

11 Old Equipment Disposal

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

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

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

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

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



12 Appendix

In this Chapter

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12.1 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.

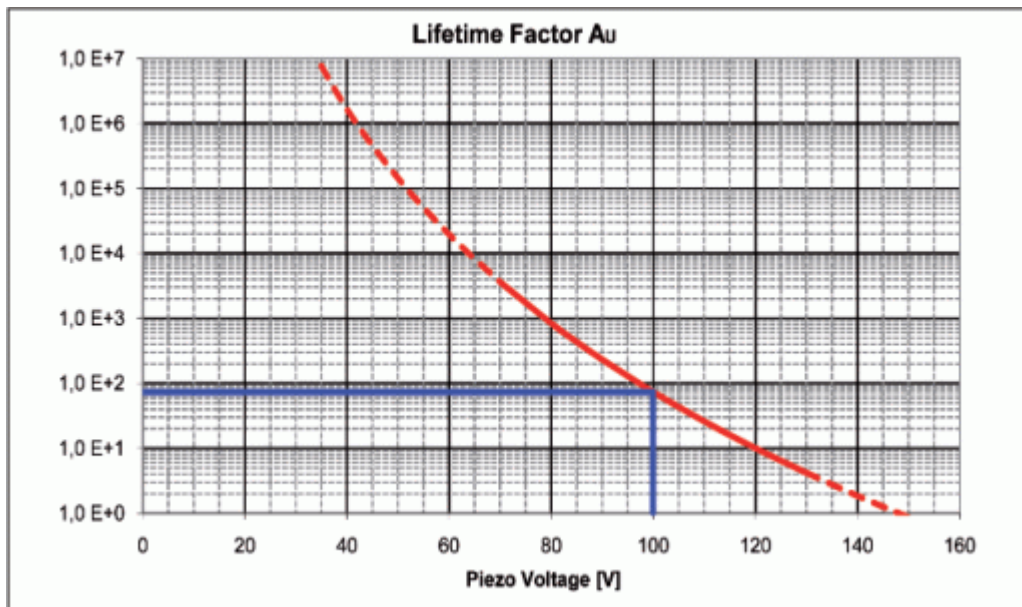


Figure 6: Dependency of the mean time between failure (MTTF) of a PICMA® actuator on the applied voltage

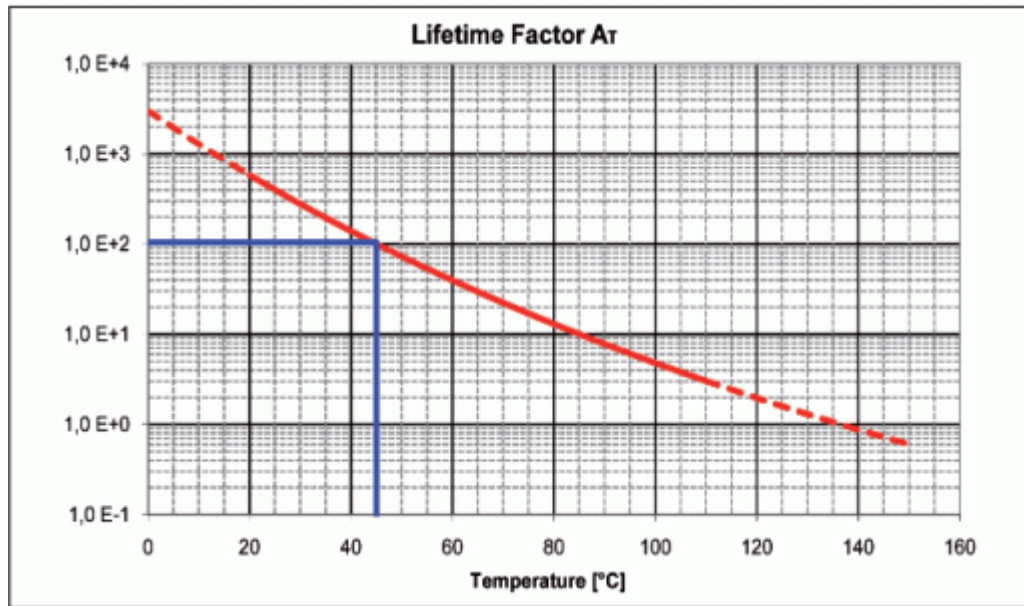


Figure 7: Dependency of the mean time between failure (MTTF) of a PICMA® actuator on the ambient temperature

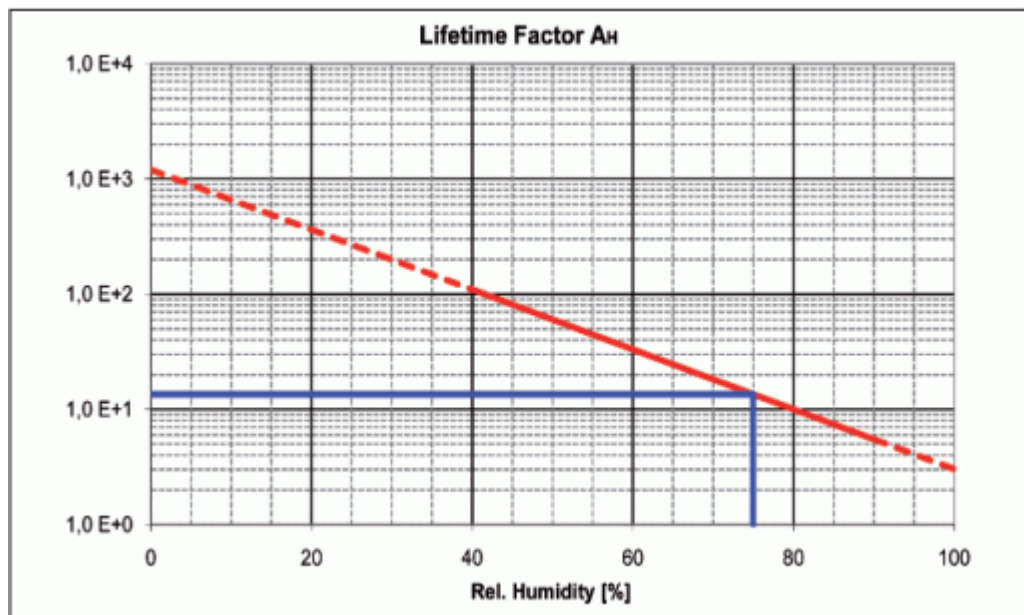


Figure 8: Dependency of the mean time between failure (MTTF) of a PICMA® actuator on the relative humidity

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

$$\text{MTTF} = A_U \times A_T \times A_F$$

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-836.1G is therefore -2 to $+12$ V. This results in a piezo voltage range of -20 to 120 V (in open-loop operation). The input voltage range can be expanded from -3 to $+13$ V (the piezo voltage is then in the range of -30 to $+130$ V), which however reduces the lifetime of the actuator.

Example (see markings in the diagrams)

Applied voltage: 100 V DC $\Rightarrow A_U = 75$

Ambient temperature: 45 °C $\Rightarrow A_T = 100$

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

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

You can find details in the PI catalog under "Reliability of PICMA® Multilayer Actuators".

12.2 EC Declaration of Conformity

For the E-836.1G, an EC Declaration of Conformity has been issued in accordance with the following European directives:

2006/95/EC, Low Voltage Directive

2004/108/EC, EMC Directive

2011/65/EU, RoHS Directive

The applied standards certifying the conformity are listed below.

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

EMC: EN 61326-1:2013

RoHS: EN 50581:2012

