

PZ250E E-836.1G Piezo Amplifier User Manual

Version: 1.1.0

Date: 7/12/2023



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. This manual is superseded by any new release. The latest respective release is available for download (p. 2) on our website.

Contents

1	About this Document	1
1.1	Objective and Target Group of this User Manual	1
1.2	Symbols and Typographic Conventions.....	1
1.3	Other Applicable Documents	2
1.4	Downloading Manuals.....	2
2	Safety	3
2.1	Intended Use	3
2.2	General Safety Instructions	3
2.3	Organizational Measures.....	4
3	Product Description	5
3.1	Product View	5
3.1.1	Front Panel	5
3.1.2	Rear Panel.....	6
3.2	Scope of Delivery.....	7
4	Unpacking	9
5	Installing	11
5.1	General Notes on Installation.....	11
5.2	Connecting the E-836.1G to the Protective Earth Conductor	11
5.3	Connecting the Power Supply to the E-836.1G	12
5.4	Connecting the Positioner	12
5.5	Connecting the Control Input Voltage.....	13
6	Startup	15
6.1	General Notes on Startup.....	15
6.2	Switching the E-836.1G On.....	16
6.3	Starting Motion	16
7	Maintenance	19
7.1	General Notes on Maintenance	19
7.2	Cleaning the E-836.1G	19

8	Troubleshooting	21
<hr/>		
9	Customer Service Department	23
<hr/>		
10	Technical Data	25
<hr/>		
10.1	Specifications.....	25
10.1.1	Data Table.....	25
10.1.2	Maximum Ratings.....	26
10.1.3	Ambient Conditions and Classifications	26
10.2	Operating Limits	27
10.3	Dimensions	28
10.4	Block Diagrams	29
10.5	Pin Assignment	29
10.5.1	PZT Socket.....	29
10.5.2	24 VDC Power Supply Connection.....	29
11	Old Equipment Disposal	31
<hr/>		
12	Appendix	33
<hr/>		
12.1	Lifetime of PICMA® Actuators	33
12.2	European Declarations of Conformity.....	35

1 About this Document

1.1 Objective and Target Group of this User Manual

This user manual contains the information necessary for using the E-836.1G as intended.

We assume that the user has basic knowledge of closed-loop systems, motion control concepts, and applicable safety measures.

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 lead to death or serious injury.

- Precautionary measures for avoiding the risk.

NOTICE



Dangerous situation

Failure to comply could cause damage to equipment.

- Precautionary measures to avoid the risk.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/ Label

Meaning

- | | |
|------|---|
| 1. | Action consisting of several steps with strict sequential order |
| 2. | |
| ➤ | Action consisting of one or more steps without relevant sequential order. |
| ▪ | Bullet point |
| p. 5 | Cross-reference to page 5 |

Symbol/ Label	Meaning
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 Other Applicable Documents

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

The latest versions of the user manuals are available on our website for download (p. 2).

Component	Document
Analog Controller Driver Library for Use with NI LabVIEW software	PZ181E Software Manual

1.4 Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

- Contact our customer service department (p. 23).

Downloading manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., E-836.1G).
3. Click the corresponding product to open the product detail page.
4. Click the **Downloads** tab.

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

5. Click the **ADD TO LIST** button for the desired manual and then click **REQUEST**.
6. Fill out the request form and click **SEND REQUEST**.

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

2 Safety

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 of the E-836.1G may result in personal injury and/or damage to the E-836.1G.

- Use the E-836.1G 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-836.1G correctly.

- 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, 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 the protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the E-836.1G in the event of a malfunction or failure of the system. If there are touch voltages, 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. 11) 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-836.1G to the protective earth conductor before restarting.

2.3 Organizational Measures

User Manual

- Always keep this user manual together with the E-836.1G. The latest versions of the user manuals are available for download on our website (p. 2).
- Add all information from the manufacturer to the user manual, for example, supplements or technical notes.
- If you give the E-836.1G 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-836.1G only after you have read and understood this user manual.

Personnel Qualification

The E-836.1G may only be installed, started, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

3 Product Description

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. 11) 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
PZT -30 to 130 V 	LEMO socket EPK.00.250.NTN	Connection of the positioner <ul style="list-style-type: none"> Output of the piezo voltage for the piezo actuator in the positioner
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

Labeling	Type	Function
PI	-	Manufacturer's logo
E-836 Piezo Driver	-	Product Description
CE	-	CE conformity mark

3.1.2 Rear Panel

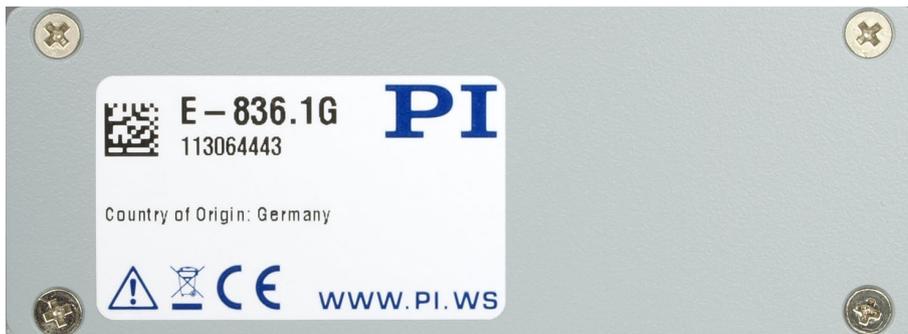


Figure 2: E-836.1G piezo amplifier, rear view

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 each position (from the left): 1 = internal information, 2 and 3 = year of manufacture, 4 to 9 = consecutive number
Country of origin: Germany	Country of origin
	Warning sign "Pay attention to the manual!"
	Old equipment disposal (p. 31)
CE	CE conformity mark
WWW.PI.WS	Manufacturer's address (website)

3.2 Scope of Delivery

Item ID	Component
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 PI analog drivers for use with NI LabVIEW software

4 Unpacking

1. Unpack the E-836.1G 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. 23).
4. Keep all packaging materials in case the product needs to be returned.

5 Installing

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 connectors that meet local safety regulations.

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

The E-836.1G 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. 11).
- ✓ The E-836.1G is not connected to the power supply.

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 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-836.1G, starting from the housing:
 - Lock washer
 - Nut
 - Flat washer
 - Lock washer
 - Nut
- Suitable wrench

Connecting the E-836.1G 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 front panel of the E-836.1G (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.

5.3 Connecting the Power Supply to the E-836.1G

Requirements

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

Tools and accessories

- 24 V wide input range power supply included (for line voltages between 100 and 240 VAC at 50 or 60 Hz)
- Alternative: Sufficiently rated power supply
- Power cord included
- Alternative: Sufficiently sized power cord

Connecting the power supply to the E-836.1G

- Connect the power supply to the E-836.1G's **24 VDC** connector.

5.4 Connecting the Positioner

Prerequisites

- ✓ 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

- Positioner with the following characteristics:
 - Drive: Piezo actuator(s)

- Operating voltage range: -30 to 130 V
- Voltage connection: Via LEMO connector

Connecting the positioner

- Connect the voltage connection of the positioner 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 positioner (p. 33).

Prerequisites

- ✓ 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 Startup

6.1 General Notes on Startup

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-836.1G in the event of a malfunction or failure of the system. If there are touch voltages, 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. 11) 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-836.1G to the protective earth conductor before restarting.

NOTICE



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

Applying a high static voltage to piezo actuators continuously reduces the lifetime of the piezo ceramic.

If the E-836.1G is not being used but should 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 positioner, 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 positioner.

- Measure the motion of the positioner 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 positioner will execute a corresponding motion, which can be noticeable as a clicking sound. This behavior is unproblematic and does **not** affect the positioner.

6.2 Switching the E-836.1G On

Prerequisites

- ✓ You have read and understood the general notes on startup (p. 15).
- ✓ You have connected the power supply to the E-836.1G (p. 12).
- ✓ 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 Starting Motion

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 positioner (p. 33).

Prerequisites

- ✓ You have read and understood the user manual for the positioner.
- ✓ You have mounted the positioner according to the description in the corresponding user manual.
- ✓ You have connected the positioner to the E-836.1G (p. 12).
- ✓ When the positioner is operated via a control input voltage: You have connected a signal source to the E-836.1G (p. 13).
- ✓ You have switched the E-836.1G (p. 16) on.

Starting motion

- 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 positioner generates corresponding motion.

7 Maintenance

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-circuiting or flashovers when cleaning fluids penetrate the housing.

- Before cleaning, disconnect the E-836.1G from the power source by removing the mains plug.
 - Prevent cleaning fluid from penetrating the housing.
-
- When necessary, clean the surfaces of the E-836.1G's housing using a cloth dampened with a mild cleanser or disinfectant.

8 Troubleshooting

Problem	Possible Causes	Solution
Positioner does not move	Cable is not connected correctly	➤ Check the cable connections.
	Positioner or cable is defective	➤ Replace the defective positioner with a suitable positioner and test the new combination.
	Control signal exceeds the permissible range	➤ Check the control input voltage. If you generate the control input voltage with a data acquisition board using the analog drivers for NI LabVIEW software: ➤ Check whether 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 positioner 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. 23).

9 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. 2).

10 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>).

10.1 Specifications

10.1.1 Data Table

	E-836.03	E-836.1G
Function	Piezo amplifier, OEM module	Piezo amplifier, benchtop device
Channels	1	1
Amplifier	E-836.03	E-836.1G
Input voltage range	-2 to 12 V	-2 to 12 V
Output voltage	-30 to 130 V	-30 to 130 V
Peak current (<8 ms)	100 mA	100 mA
Average output current	50 mA	50 mA
Current limitation	Short-circuit proof	Short-circuit proof
Voltage gain	10 ±0.1	10 ±0.1
Ripple, noise, 0 to 100 kHz	0.8 mV _{rms}	0.8 mV _{rms}
Capacitive base load (internal)	10 nF	10 nF
Output impedance	5 Ω	5 Ω
Input impedance	0.5 MΩ	1 MΩ
Miscellaneous	E-836.03	E-836.1G
Connectors	Soldering pins, Ø 0.7 mm	BNC, LEMO Barrel connector (power adapter) 1-turn potentiometer, adds 0 to 10 V to the input voltage
Operating temperature range	5 to 50 °C	5 to 50 °C
Overtemperature protection	Deactivation at 85 °C	Deactivation at 85 °C
Operating voltage	24 V DC ±10 %	24 V DC ±10 %, in the scope of delivery: External power adapter

Miscellaneous	E-836.03	E-836.1G with 24V / 2.0 A
Power consumption (max.)	10 W	16 W
Current consumption (max.)	0.5 A	0.65 A

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 for the E-836.1G 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

10.2 Operating Limits

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

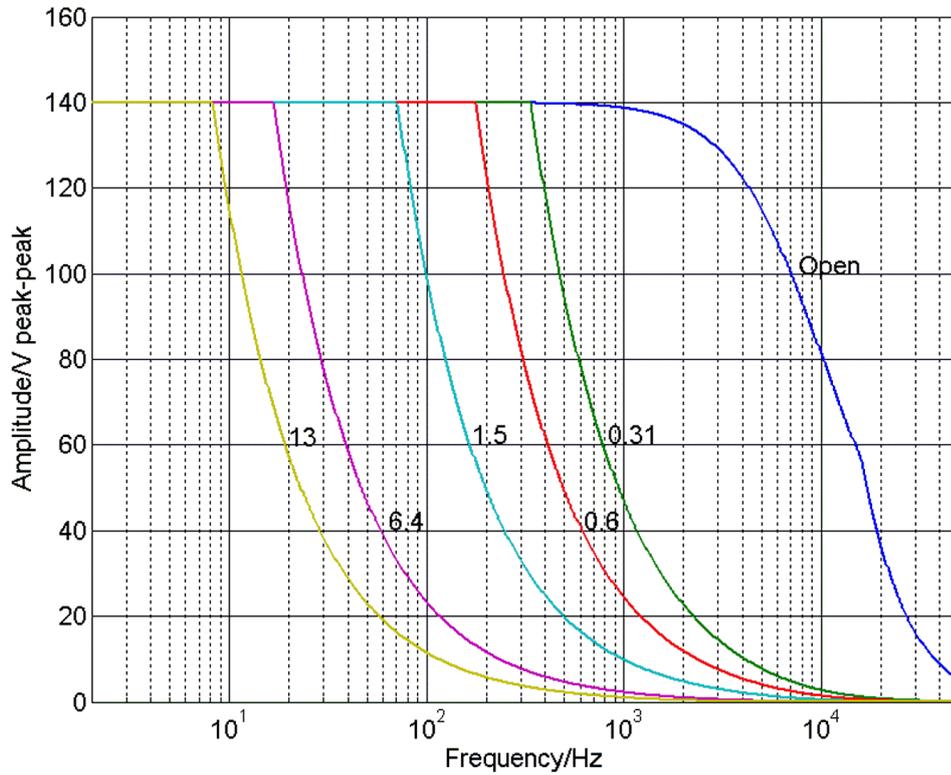


Figure 3: Operating limits

10.3 Dimensions

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

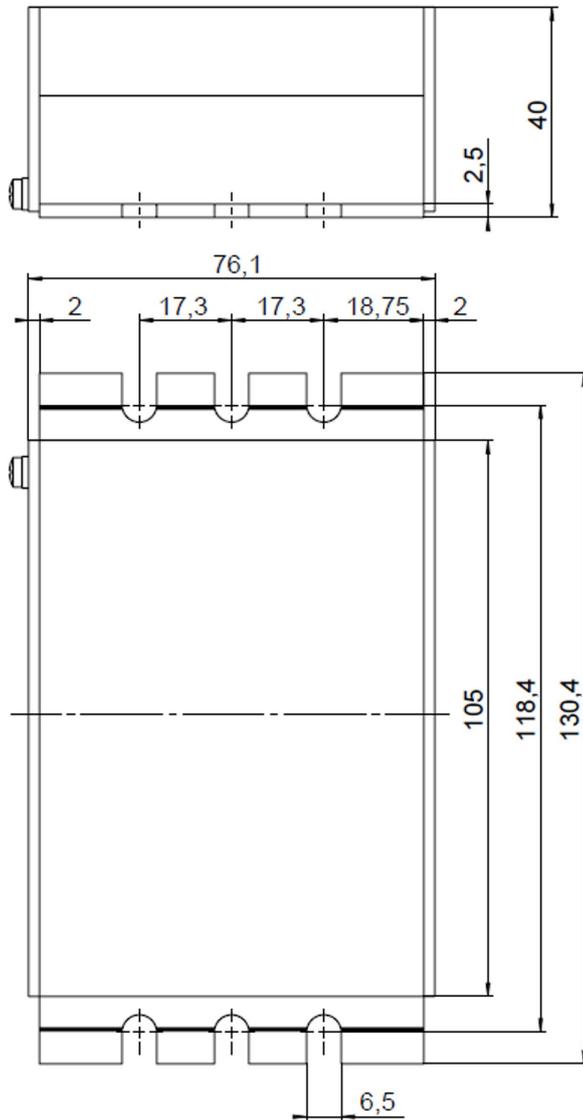


Figure 4: E-836.1G, dimensions in mm

10.4 Block Diagrams

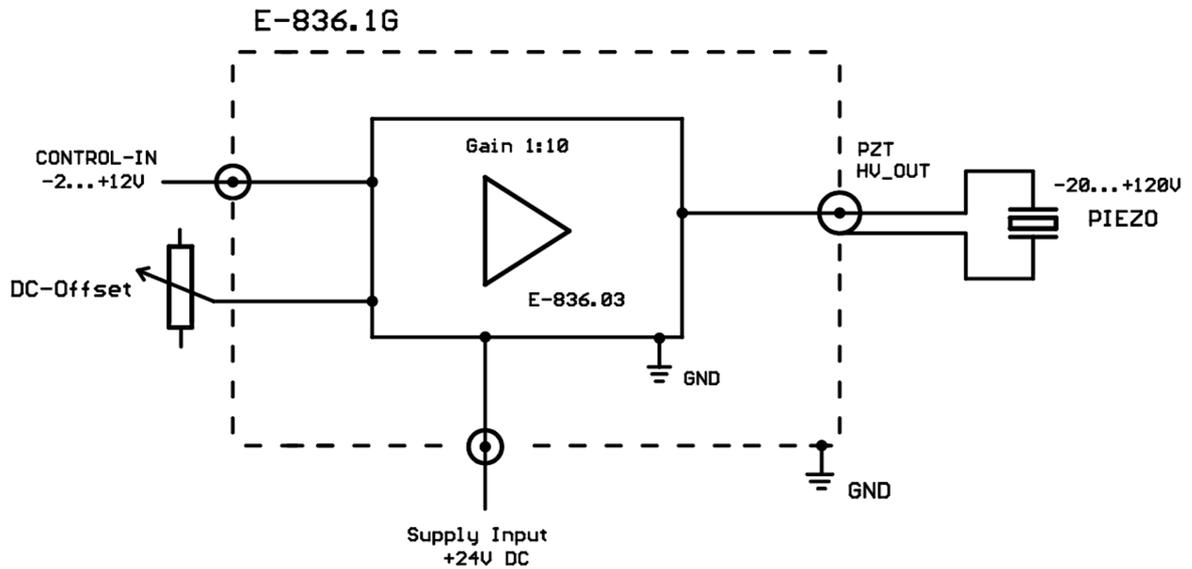


Figure 5: E-836.1G block diagram

10.5 Pin Assignment

10.5.1 PZT Socket

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

- Outer contact: PZT ground (connected with the housing)
- 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 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



12 Appendix

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.

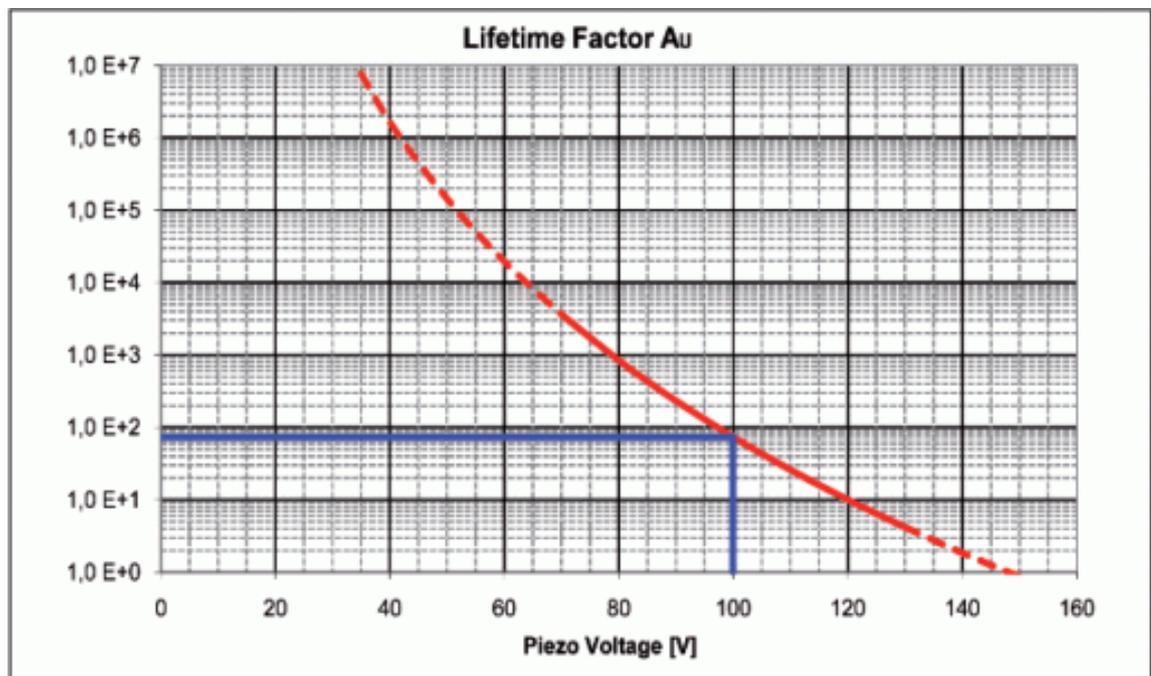


Figure 6: Dependency of the mean time between failure (MTTF) of a PICMA® actuator on the applied voltage

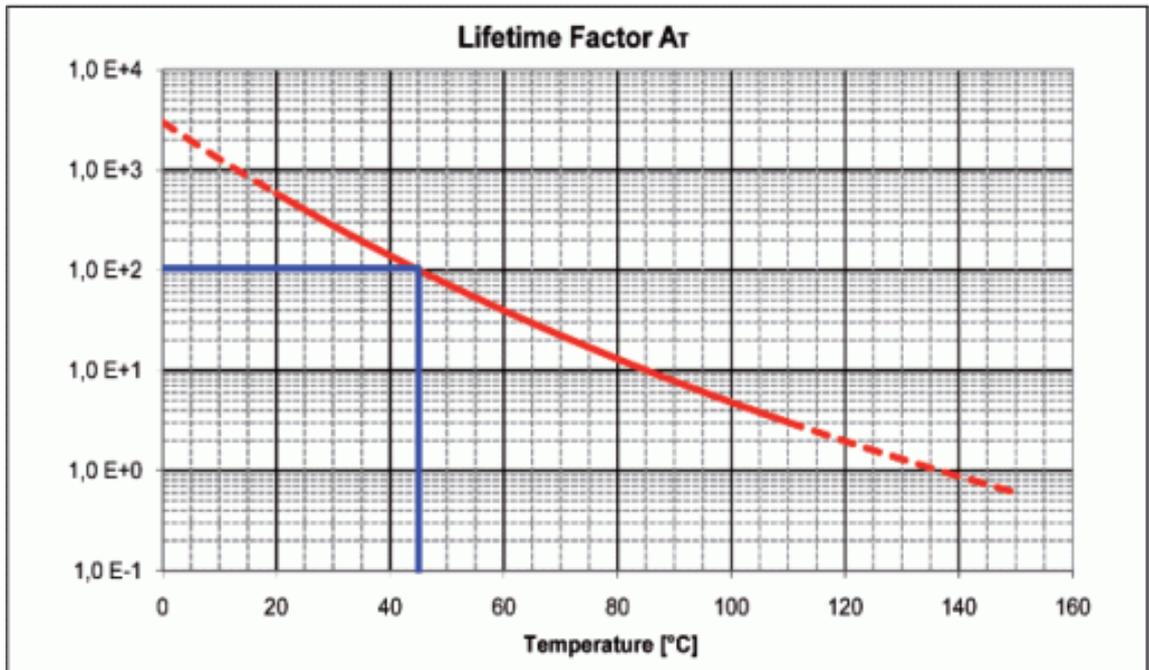


Figure 7: Dependency of the mean time between failure (MTTF) of a PICMA[®] actuator on the ambient temperature

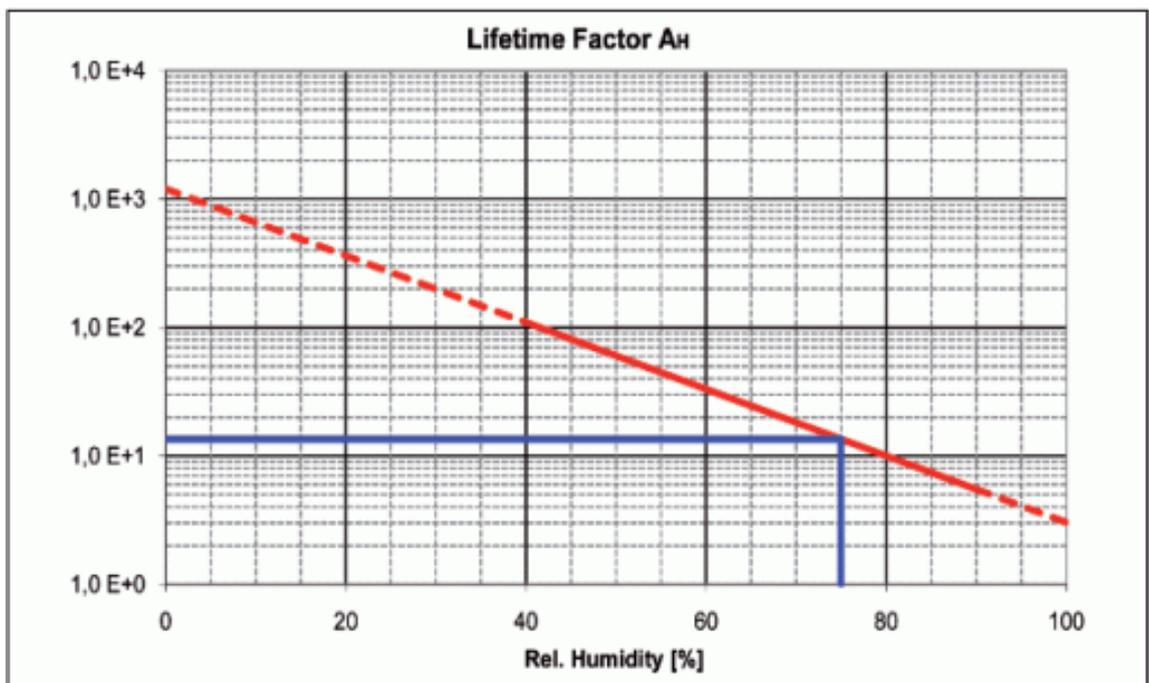


Figure 8: Dependency of the mean time between failure (MTTF) of a PICMA[®] actuator on the relative humidity

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

$$MTTF = A_U \times A_T \times A_F$$

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 % $\Rightarrow A_F = 14$

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

12.2 European Declarations of Conformity

For the E-836.1G, 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