User Manual

PZ288, valid for E-619

Bro, ibs_CHe, 2/4/2025

E-619

Modular High-Power Piezo Amplifier

Original instructions
First printing: 2/4/2025

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Contents

1 Introduction

1.1 About this document

1.1.1 Objective and target group of this user manual

This user manual contains the information necessary for using the E-619 as intended.

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

1.1.2 Symbols and typographic conventions

The following symbols and typographic conventions are used in the user manuals of PI:

DANGER

Imminently hazardous situation

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

➢ Actions to take to avoid the situation

WARNING

Possibly hazardous situation

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

➢ Actions to take to avoid the situation.

CAUTION

Dangerous situation

If not avoided, the dangerous situation will result in minor 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
RS-232	Label on the product indicating an operating element (example: RS-232 interface socket)
	Warning sign on the product referring to detailed information in this manual.

1.1.3 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.

1.1.4 Other applicable documents

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

Product	Document
Housed Analog Piezo Electronics	PZ300EK Short Instructions
Analog Drivers	E500T0011 Technical Note
E-518.I3 Interface Module	E518T0001 User Manual
E-509 Position Servo-Control Module	PZ77E User Manual

1.1.5 Downloading manuals

INFORMATION

If a manual is missing or problems occur with downloading:

➢ Contact our customer service department (p. 6).

Downloading manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e. g., E-619).
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 e-mail address entered in the form.

1.2 European declarations of conformity

For the E-619, 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

1.3 Customer service

For inquiries and orders, contact your PI representative or send us an e-mail: service@pi.de

If you have any 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)
- Operating system on the PC (if applicable)

If possible: Take photographs or make videos of your system that can be sent to our customer service department if requested.

2 Safety

2.1 Intended use

E-619 is a laboratory device as defined by DIN EN 61010-1. E-619 is intended for indoor use and in an environment free from corrosive and/or electrically conductive acids, alkalines, oils, vapors, and dust.

In accordance with their design, E-619 amplifier modules are intended to drive capacitive loads, in the present case, piezoceramic actuators with high-current termination electrodes. E-619 amplifier modules must not be used for applications other than stated in this manual, especially not for driving ohmic (resistive) or inductive loads.

It is only possible to use E-619 as intended when it is installed and connected properly, and when all measures described herein are adhered to.

2.2 General safety instructions

E-619 is built according to state-of-the-art technology and recognized safety standards. Improper use of the E-619 may result in personal injury and/or damage to the E-619.

- Use E-619 only for its intended purpose and when it is in perfect condition.
- Read the user manual.
- Eliminate any malfunctions that may affect safety immediately.

The operator is responsible for installing and operating the E-619 correctly

- Install the E-619 system near the AC outlet and such that the AC power plug can be reached easily.
- Only use the supplied power cord or a sufficiently dimensioned power cord to connect the E-619 to the power source.
- Both fuses are active and have to be replaced or checked if there is a fault. See "Replacing fuses" (p. 23) for how to replace the line power fuses.
- To disconnect the E-619 system from the power supply completely, remove the power plug from the wall socket, or remove the power cord from the E-619 system.

DANGER

Danger of death due to high voltage.

E-619 power amplifiers output very high voltages and high currents which can cause death or serious injury.

- Do not touch the pins of the LEMO connector which carries the piezo output voltage. The high voltage output may be active whenever the device is turned on. Voltages between -30 V and +130 V can be present on the LEMO connector.
- Make sure that only adequately trained and educated personnel operates these devices.
- Allow operation of an E-619 system only if all components are installed properly.
- E-619 amplifier modules and offset voltage modules do not contain any user-serviceable parts. Never disassemble the device. Hazardous voltage can be present on the internal components.

NOTICE

Air Circulation

Vertical mounting prevents internal convection. Insufficient air flow will cause overheating and premature failure.

- Do not cover the ventilation slots on the top side of the E-619.
- Place the E-619 system in a location with adequate ventilation to prevent internal heat build-up.
- Install the device horizontally with 3 cm air circulation area.

NOTICE

Dynamic applications or continuous operation

If not avoided, the heat generation will result in damage to the equipment.

- The use of a temperature sensor (PT1000) on the piezo actuator is recommended. See p. 18 for details.

INFORMATION

Use only PICMA® piezo actuators with high-current termination electrodes. Standard piezo systems and actuators have to be adapted before they can be used with an E-619 system.

2.3 Organizational measures

User manual

- Always keep this user manual available with the E-619.
- Add all information from the manufacturer such as supplements or technical notes to the user manual.
- If you give E-619 to a third party, also include this user manual as well as other relevant information provided by the manufacturer.
- Only use the device on the basis of the complete user manual. Missing information due to an incomplete user manual can result in minor injury and damage to equipment.
- Only install and operate E-619 after you have read and understood this user manual.

General personnel qualification

E-619 may only be installed, started up, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

3 Product description

3.1 Model overview

The following components are available for the E-619 system:

E-619.H	High-Power Piezo Amplifier Module, 1 Channel, 20 kHz Bandwidth, 1200 W Peak Power, -30 V to 130 V
E-619.00	High-Power Piezo Amplifier Module, 1 Channel, 3 kHz Bandwidth, 1200 W Peak Power, -30 V to 130 V
E-619.S	Offset-Voltage-Source Module for Tip/Tilt Platforms, 1 Channel, 1200 W Peak Power, 100 V Fixed Voltage
E-619.R1	9.5" Housing for E-619 Amplifier Modules, 1 Slot For one E-619 amplifier module. With E-596.XX monitor module for the piezo output voltage*.
E-619.R3	19" Housing for E-619 Amplifier Modules, 3 Slots For up to three E-619 amplifier modules. With E-596.XX monitor module for the piezo output voltage*.

* Basic configuration. If an E-518 interface module has been ordered as optional upgrade (p. 10), it replaces the monitor module.

3.2 Controller and interface upgrades

Upgrade options for the E-619 system:

- E-509 servo-control module
- E-518 computer interface module

All modules ordered come installed directly in the E-619 housing. If the servo-control module and a piezo actuator are ordered with the system, your E-619 system will be fully calibrated before being shipped.

Contact our customer service department (p. 6), if you want to upgrade your E-619 system. Any additional modules are described in their own separate manuals.

The following modules are available:

E-509.C1A / .C2A / .C3A, E-509.E03 / .E3, E-509.S1 / .S3	Sensor / Servo-Controller Module for capacitive or SGS position sensors respectively, 1 / 2 / 3 channel/s to eliminate drift and hysteresis from positioning operations.
E 518.i3	Interface Module, 3 Channels, TCP/IP, USB, RS-232 and SPI Interfaces. Communicates with a host PC for remote control of the E-619 system. DLL, drivers for NI LabVIEW software and convenient interactive user interface software are provided.

3.3 Available accessories

Contact our customer service (p. 6), if you need one of the additional components listed below.

Extension cables for the piezo stages:

E-618.X11	Piezo cable, 1 m, Lemo 2-pin/open end for soldering piezo actuators
E-618.X03	Extension cable, Lemo 2-pin m/f, 3 m
E-692.SMB	SMB/BNC adapter cable, 1.5 m

3.4 Front panel elements

The following subsections describe the front panel elements of the E-619 amplifier modules and the E-596.XX monitor module.

The E-619 system may be equipped with optional modules for servo control (E-509) and PC interface (E-518). The controls of these modules are described in their own separate manuals.

Note that if an E-518 interface module has been ordered as optional upgrade, it replaces the E-596.XX monitor module and enables you to query the current piezo output voltage via a computer interface (p. 14).

3.4.1 E-619 amplifier modules

Figure 1: Front panel of E-619.H and E-619.00 amplifier modules

Name	E-619.H, E-619.00	E-619.S	Function
POWER	☑	☑	LED green / off. Green light indicates that the device is powered on.
OVERTEMP	☑	-	LED red / off. Red light indicates that the temperature on the connected temperature sensor exceeds 150 °C. The output voltage for the piezo actuator is then deactivated (p. 19).
CONTROL INPUT -2 V to +12 V ⚠	☑	-	SMB connector for control input voltage. -2 V to 12 V is the recommended control input range, resulting in -20 V to 120 V piezo output voltage (without DC-offset potentiometer usage). -3 V to 13 V control input are possible and will result in -30 V to 130 V output voltage (without DC-offset potentiometer usage), but working with increased output voltage will decrease actuator lifetime. See "Lifetime of PICMA® Actuators" on p. 34 for details.
DC-OFFSET	☑	-	10-turn potentiometer for DC offset
TEMP SENSOR IN max. 4 V ⚠	☑	-	Lemo socket for connection of a PT1000 temperature sensor (p. 18). When the piezo actuator connected to the E-619 amplifier module does not feature a temperature sensor, the included dummy plug must be used.
PZT OUT -30 V to +130 V ⚠ ⚡	☑	-	Lemo socket that carries the output voltage for the piezo actuator (-30 V to 130 V); with security cover
PZT OUT 100 V ⚠ ⚡	-	☑	Lemo socket that carries the offset voltage (100 V) for the piezo actuators of a tip/tilt platform; with security cover

3.4.2 E-596.XX monitor module

The E-596.XX monitor module described here is available with the basic configuration of the E-619 system.

Figure 2: E-596.XX monitor module of E-619.R1 and E-619.R3 housings

Name	Function
PZT Monitor 1 ***PZT Monitor 2*** ***PZT Monitor 3*** max. +/- 15 V ⚠	SMB connectors for monitor channels 1 to 3 1 V monitor voltage corresponds to 10 V piezo output voltage. With E-619.R3 housings, the monitor channels are assigned to the amplifier modules as follows when viewed from the front: ▪ Monitor 1 belongs to the amplifier module on the far left ▪ Monitor 2 belongs to the middle amplifier module ▪ Monitor 3 belongs to the amplifier module on the far right With E-619.R1 housings, use only monitor channel 1.

3.5 Control signal connection

3.5.1 Analog operation

E-619.H and E-619.00 amplifier modules can be operated by an analog control signal. The output voltage (if in open-loop operation) or the actuator position (closed-loop operation) is directly proportional to this analog control signal. The analog control signal consists of two components:

Analog control signal = ***CONTROL INPUT*** + ***DC OFFSET***

where

CONTROL INPUT is the voltage connected to the corresponding SMB connector on the front panel

DC OFFSET is the DC offset voltage set via the corresponding potentiometer on the front panel (0 V to 10 V)

-2 V to 12 V is the recommended range for the analog control signal, resulting in -20 V to 120 V piezo output voltage. A range of -3 V to 13 V is possible and will result in -30 V to 130 V output voltage, but working with increased output voltage will decrease actuator lifetime. See "Lifetime of PICMA® actuators" on p. 34 for details.

The signal applied to the ***CONTROL INPUT*** SMB connector can be generated using a D/A board in a PC. PI offers a driver set for use with NI LabVIEW software and certain D/A boards. The "GCS driver library for use with NI LabVIEW software" is part of the PI Software Suite which is provided on a data storage device (C-990.CD1).

3.5.2 Remote control via computer interface

E-619 systems equipped with an E-518 computer interface module can be controlled from a host computer via the TCP/IP, USB, or RS-232 PC interface. See the E518T0001 User Manual for details.

3.6 Modes of operation

3.6.1 Open-loop operation

E-619.H and E-619.00 amplifier modules can be operated in open-loop mode. Open-loop operation means that any control input provided by the user determines the output voltage directly.

3.6.2 Closed-loop operation

Closed-loop operation requires a position sensor in the mechanics and a servo-control module, e.g., E-509, in the E-619 system.

Closed-loop operation means that the user commands the piezo excursion. The output voltage required to reach this target position is calculated internally by the servo-loop, based on the given target and the feedback of the position sensor (see E-509 User Manual PZ77E).

Note: In closed-loop operation up to 10% of the amplifier output range may be required for compensating nonlinearity and drift.

3.7 Functional principles

The low-noise high-power amplifiers of the E-619 modular system are specifically designed for dynamic continuous operation of piezo actuators. They provide peak output currents up to 10 A and a peak power of 1200 W in a voltage range of -30 V to 130 V.

3.7.1 Working principle

E-619 modules are switching amplifiers with pulse width modulation (PWM) of the piezo output voltage. When the piezo actuator is discharged, a patented circuitry for energy recovery stores parts of the returning energy in a capacitor and makes it reusable for the next charging cycle. The amplifier runs cooler and provides better stability. Compared to the available output power, the power consumption of switching amplifiers is very low.

3.7.2 Piezo overtemperature protection

To protect the mechanics especially in high-dynamics applications, the E-619 system features a temperature sensor input and controller circuit that shuts down the amplifier if the piezo actuator exceeds the maximum temperature threshold.

3.7.3 Piezo operation

The motion of the piezo actuator is controlled via an analog signal at the control input combined with the DC-offset potentiometer setting. The control signal directly determines the output voltage for the piezo actuator.

Closed-loop operation is possible via the E-509 sensor/servo-controller module which is available as an upgrade option. In closed-loop operation, the control signal gives the target position.

For remote control by a PC, the E-518 computer interface module is available as an upgrade option.

3.7.4 Special piezo connector required

The high electrical currents require adequate connectors and cabling. Therefore, standard piezo systems and actuators have to be adapted.

4 Unpacking

4.1 E-619 unpacking

1. Unpack the E-619 carefully.
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 there is any sign of damage or missing parts, contact PI immediately.
4. Keep all packaging materials in case the product needs to be returned.

4.2 Scope of delivery

Product number	Description
PZ300EK	Short instructions for housed analog piezo electronics
000016103	Dummy plug for the temperature sensor socket. One plug per E-619.H and E-619.00 amplifier module. Must be used when the piezo actuator connected to the E-619 amplifier module does not feature a temperature sensor.
E-692.SMB	SMB/BNC adapter cable, 1.5 m. One cable per E-619.H and E-619.00 amplifier module.
E500T0011	Technical Note for GCS LabVIEW driver set
3763	Power cord

5 Installation

If an E-509 servo-control module is ordered together with the E-619 system and a piezo actuator, the system will be fully calibrated at PI according to your specifications before being shipped and will come with a calibration information sheet.

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

It is usually not necessary for you to do anything more than adjust the zero point before operating the system.

Do not interchange the E-619 system (whole device or individual modules) and/or piezo stages if they are matched and calibrated together. Respect the assignment of the piezo actuators to the individual channels, as indicated by the serial numbers on the labels affixed to the devices. With multi-axis stages respect the channel/axis assignments indicated by the cable labeling.

5.1 Connecting the E-619 to the power supply

Unless you request otherwise, upon delivery the E-619 will be set up for the voltage predominant in your country, either

AC: 115 V / 50 Hz to 60 Hz

or

AC: 230 V / 50 Hz to 60 Hz

To adapt the E-619 to a different line voltage, the line power fuses must be replaced. See "Replacing fuses" (p. 23) for instructions and for the required fuse types.

Connecting the voltage

- ➢ Connect the included power cord from the E-619 housing's rear panel to a grounded wall socket (220 V to 240 V AC or 100 V to 120 V AC).

5.2 Connecting the actuator to the E-619

Requirements

- ✓ You have read and understood the general safety instructions (p. 7).

Connecting the actuator

- ➢ Connect the piezo system or actuator to the E-619 amplifier module via the ***PZT OUT*** Lemo socket on the front panel. Note that with the basic configuration of the E-619 system, you can connect one monitor output per amplifier channel via the corresponding ***PZT Monitor SMB*** connector on the E-596.XX monitor module (p. 13). If an E-518 interface module has been ordered as optional upgrade, you can query the current piezo output voltage via a computer interface (p. 14).

If your PICMA® piezo actuator with high-current termination electrodes is not equipped with a connector, you have to attach a suitable connector according to the type and pinout of the ***PZT***

OUT socket shown below. A connecting cable with open end for soldering piezo actuators can be ordered separately, order No. E-618.X11.

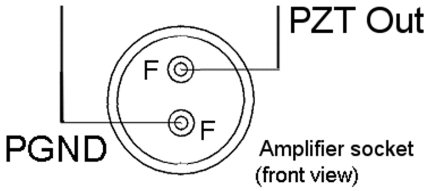
***PZT OUT* socket on E-619:**

Type: LEMO

EGG.1B.302.CLL with 2 conductors and a shield

Pin Assignments:

PZT Out:	Piezo output, -30 to 130 V (E-619.H, .00) or 100 V (E-619.S)
PGND:	Power ground
Housing:	Cable shield, for protective ground



5.3 Connecting the temperature sensor to the E-619

E-619.H and E-619.00 amplifier modules are equipped with a temperature monitoring circuit to avoid overheating of the connected mechanics. It can be used with PT1000 temperature sensors.

Connecting the temperature sensor

- Connect the PT1000 to the ***TEMP SENSOR IN*** Lemo socket on the front panel of the E-619 amplifier module. When the mechanics connected to the E-619 amplifier module does not feature a temperature sensor, the included dummy plug (order No. 000016103) must be used.
- When a temperature of 150 °C is detected on the mechanics, the E-619 temperature monitoring circuit deactivates the output of the amplifier (***PZT OUT*** socket), and the red ***OVERTEMP*** LED on the front panel of the module lights up. See p. 19 for how to proceed in this case.
- To avoid overheating, you can reduce the maximum operating frequency and output voltage. The maximum operating frequency and output voltage (travel) depend on operating conditions such as thermal coupling (single- or double-ended, with or without air cooling) length-to-diameter ratio and, of course, on the driving waveform.
- The maximum possible frequency for a particular system should be determined after the system is set up with the defined operating conditions by slowly running the system up to the point where the amplifier performs a thermal shutdown. It is important to take proper account of the temperature sensor time constant, the mechanical characteristics of the system, and the amplifier parameters.

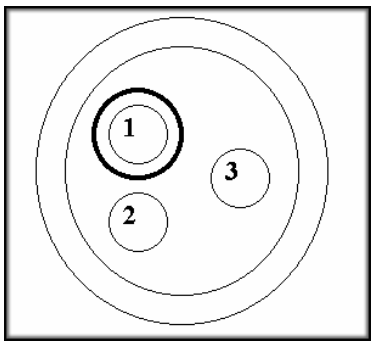


Figure 3: Temperature sensor connector of the E-619 amplifier, view from solder side

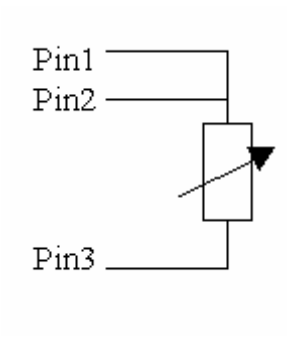


Figure 4: Temperature sensor diagram

Pin assignment:

Pin 1:	Temp_SA
Pin 2:	Temp_S
Pin 3:	GND/PE
Housing:	Shield/GND/PE

Protection against overheating

To protect the system against overheating, the piezo voltage output on the ***PZT OUT*** socket is deactivated automatically in the following case:

- A PT1000 temperature sensor connected to the E-619.H or E-619.00 amplifier module detects a temperature of 150 °C on the piezo actuator. In this case, the red ***OVERTEMP*** LED on the front panel of the module lights up.

If the piezo voltage output has been deactivated, the piezo actuator will no longer move. Proceed as follows:

1. Turn off the E-619 system for a cooling phase.
2. Wait until the temperature has dropped on the mechanics.
3. Power up the E-619 system again.

Permanent deactivation of the piezo output voltage due to overheating may indicate hardware failure.

6 Operation

6.1 First steps

INFORMATION

If an E-619 amplifier module is turned on while no piezo actuator is connected, the output voltage on the ***PZT OUT*** socket will oscillate with its natural frequency.

The following instructions refer to analog operation (p. 14) of the system. If your E-619 system is equipped with an E-518 computer interface module and you want to control the system via the computer interface, only perform steps 1 to 4 of the instructions below and then operate the system as described in the E518T0001 User Manual.

The following instruction assumes that the E-619 system contains a single E-619.H or E-619.00 amplifier module. If more than one E-619 amplifier module is present in your system, perform the respective steps for all amplifier modules. With E-619.S offset voltage modules, simply perform steps 1 and 2 before you turn on the E-619 system.

INFORMATION

Do not interchange the E-619 system (whole device or individual modules) and/or piezo stages if they are matched and calibrated together. Respect the assignment of the piezo actuators to the individual channels, as indicated by the serial numbers on the labels affixed to the devices. With multi-axis stages respect the channel/axis assignments indicated by the cable labeling.

1. Make sure the E-619 system is connected to line voltage but powered down. See "Connecting the E-619 to the power supply" (p. 17) for details.
2. Connect the piezo actuator to the ***PZT OUT*** socket of the E-619 amplifier module.
3. Connect the PT1000 temperature sensor of the piezo actuator to the ***TEMP SENSOR IN*** socket of the E-619 amplifier module. If the temperature sensor is not to be connected, the included dummy plug (order No. 000016103) must be connected to this socket.
4. For closed-loop systems only (E-619 system with E-509 servo-control module; see also the E-509 User Manual):
   a) Connect the sensor cable to the corresponding socket.
   b) If you are using the sensor monitor signal, connect your appropriate electronics to the SENSOR MONITOR socket.
   c) Set the SERVO toggle switch on the servo module to "OFF".
5. If you are using the piezo voltage monitor signal, connect your appropriate electronics the corresponding ***PZT Monitor SMB*** connector on the E-596.XX monitor module.
6. Turn the ***DC-OFFSET*** potentiometer of the E-619 amplifier module fully counterclockwise (CCW).
7. If desired, connect a suitable signal source to the ***CONTROL INPUT*** SMB connector. See "Control signal connection" (p. 14) for details on the analog control signal that results from ***DC-OFFSET*** and ***CONTROL INPUT***.

8. Make sure that the voltage at ***CONTROL INPUT*** is set to 0 V.
9. Turn on the E-619 system. The green ***POWER*** LED of the amplifier module will light up.
10. Command the first motion of the piezo actuator by turning the offset potentiometer fully clockwise (CW) to run the actuator over the nominal travel range, then turn the potentiometer back fully CCW.

    The PZT Monitor signal will show one tenth of the piezo output voltage.

    If an E-509 servo-control module is installed, the SENSOR MONITOR signal will show a voltage from about 0 V up to 10 V and then 0 V again, proportional to the piezo extension.
    Example: A piezo actuator with a nominal travel of 100 µm shows a sensor monitor signal of 1.5 V at 15 µm. For an actuator with 30 µm nominal travel, 1.5 V at sensor monitor would correspond to 4.5 µm (15% of 30 µm)
11. Command further motion by adjusting the ***DC-OFFSET*** potentiometer and / or the ***CONTROL INPUT*** signal.

E-619 systems equipped with E-509 servo-control modules:

If you switch to closed-loop operation (servo ON), the yellow OFL overflow LED on the E-509 module may light up. In this case, a zero-point adjustment is necessary. Follow the instructions for zero-point adjustment given below. To avoid an overflow of the amplifier in open-loop operation, do not exceed the allowable control input range (-3 V to +13 V).

6.2 Zero-point adjustment with E-509

Zero-point adjustment on the E-509 sensor and servo-control module has the following goals:

- Making the full travel range available: If the electrical zero point is adjusted properly, the full output voltage range of the amplifier can be used in closed-loop operation. This prevents overflow conditions from occurring.
- Preserving the piezo actuators in the mechanics: The point of zero sensor readout should correspond to zero or a (small) negative output voltage. This technique can reduce the average applied voltage without loss of displacement and thereby increase piezo lifetime.

There might be some small deviation of the electrical zero-point caused by thermal drift or changes in mechanical loading. Let the system warm up for several minutes before setting the zero point. See also the E-509 User Manual, PZ77E.

How to perform zero-point adjustment in analog operation:

1. Make sure the piezo actuator is mounted in the same way and with the same load as during normal operation in the application.
2. Make sure that the analog signal on ***CONTROL INPUT*** is 0 V and turn the ***DC-OFFSET*** potentiometer fully CCW.
3. Optional and only if your E-619 system has an E-596.XX monitor module: You can connect a precision voltmeter to the ***PZT Monitor SMB*** connector on the monitor module.
4. Connect a precision voltmeter to the SENSOR MONITOR socket on the E-509 front panel.

5. Power up the system.
6. Set the SERVO toggle switch on the E-509 front panel to OFF (open-loop operation).
7. Turn the ***DC-OFFSET*** potentiometer fully clockwise (10 V) and then back fully counterclockwise (0 V) to deflect the piezo actuator.
   If available, you can use the PZT Monitor signal to check whether the piezo output voltage is actually zero volts again after the actuator has finished deflecting.
8. Adjust the ZERO potentiometer on the E-509 until a sensor-monitor signal of +1 V is measured by the precision voltmeter on the SENSOR MONITOR socket.

After successful zero-point adjustment, the "OFL" overflow LED on the E-509 module should no longer glow in closed-loop operation. Permanent glow of this LED in spite of zero-point adjustment may indicate hardware failure. To avoid an overflow of the amplifier in open-loop operation, do not exceed the allowable control input range (-3 V to +13 V).

7 Maintenance

7.1 General maintenance instructions

- Switch E-619off and disconnect it from the power supply, before you perform the following work:
  - Opening the housing
  - Replacing the fuses
  - Cleaning the E-619

7.2 Replacing fuses

Unless otherwise requested, the unit will be set up for the power predominant in your country. New line-power fuses are required when changing the supply voltage.

DANGER

Risk of electric shock

An E-619 system requires a supply voltage of 100 V to 120 V AC or 220 V to 240 V AC (line voltage). Touching the line voltage can result in serious or even lethal injury due to electric shock.

- Remove the power cord from the E-619 housing before you change the line fuses.

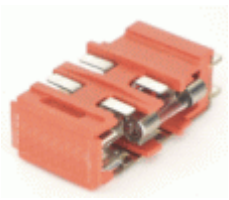
CAUTION

Dangerous situation

If not avoided, the dangerous situation will result in minor injury.

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



Replacing the fuses

The power connection and line fuses are located on the rear panel of the housing. To access the line fuses, proceed as follows:

1. Switch off the E-619 system and remove the power cord.
2. Wait a minute to be sure that any residual voltage has dissipated.
3. Pry open the door that covers the fuse carrier and pry out the fuse carrier.
4. Be sure to replace both fuses with fuses of the suitable type:
   - E-619.R1 9.5" housing: 100 V to 240 V~ -> 2 x IEC T2AH, 250 V
   - E-619.R3 19" housing: 100 V to 240 V~ -> 2 x IEC T4AH, 250 V

   Note: IEC-standard fuses are designed to carry the nominal current indefinitely. Other fuse rating standards differ.
5. Reinstall the carrier and close the door.

7.3 Cleaning

The outside surface of the case can be cleaned using mild detergents or disinfectant solutions. Organic solvents must not be used.

8 Troubleshooting

Fault: Positioner does not move	
Possible causes	**Remedial measures**
Cable not connected correctly or defect	➢ Check the connecting cables. ➢ Check the analog control signal ***CONTROL INPUT*** and ***DC-OFFSET*** (p. 14) ➢ Check the piezo output voltage, either via the PZT Monitor signal or, if available, via the E-518 interface module. The piezo voltage output (***PZT OUT*** socket) may be deactivated due to overheating of the mechanics. (p. 19)
The ***OVERTEMP*** LED Lights	➢ The connected temperature sensor is reporting 150 °C and the piezo voltage output has thus been shut off. Turn off the E-619 system. Wait until the temperature at the mechanics has dropped before powering the E-619 system up again.

9 Technical data

9.1 Specifications

9.1.1 E-619 amplifier modules

	E-619.H, E-619.00	E-619.S
Function	High-power amplifier module for PICMA® piezo actuators with special electrodes	Offset voltage source for tip/tilt platforms with PICMA® piezo actuators and special electrodes
Channels	1	1
Amplifier		
Input voltage range	-2 V to 12 V	-
Output voltage	-30 V to 130 V	100 V
Peak output power (<5 ms)	1200 W	1200 W
Average output power (>5 ms)	Equivalent to 800 VA reactive power	Equivalent to 800 VA reactive power
Peak current (<5 ms)	10 A	10 A
Average output current (>5 ms)	>5 A	>5 A
Current limitation	Short-circuit proof	Short-circuit proof
Voltage gain	10 ±0.1	-
Amplifier bandwidth, small signal	20 kHz / 3 kHz	-
Ripple, noise, 0 kHz to 10 kHz	<2 mVrms <20 mVpp	<2 mVrms <20 mVpp
Capacitive base load (internal)	2 µF / 1 µF	2 µF
Recommended piezo load	>1 µF	>1 µF
Output impedance	0.1 Ω; 53 µH; 2 µF / 0.1 Ω; 1 mH; 1 µF	0.1 Ω; 53 µH; 2 µF
Amplifier resolution	<2 mV	<2 mV
Amplifier classification	Class D, switched 400 kHz / 100 kHz	Class D, switched 400 kHz
Input impedance	100 kΩ	-
Interfaces and operation		
Piezo connection	LEMO EGG.1B.302.CLL, with safety cover	LEMO EGG.1B.302.CLL, with safety cover
Analog input	SMB	-

	E-619.H, E-619.00	E-619.S
Temperature sensor (piezo actuator)	PT 1000; LEMO FFA.OS.303.CLAC32 Max. 150 °C, deactivation of the voltage output	-
Display and indicators	LEDs for Power, Temp Overflow	Power LED
DC offset setting	10-turn potentiometer, adds 0 V to 10 V to the input voltage	-
Miscellaneous		
Operating voltage	Supply via E-619 housing	Supply via E-619 housing
Max. power consumption, full load	<150 W	<150 W
Max. power consumption without load	20 W	20 W
Operating temperature range	5 °C to 40 °C	5 °C to 40 °C
Mass	3.5 kg	3.5 kg
Dimensions	21 HP/3 U	21 HP/3 U

9.1.2 E-619.Rx housings

	E-619.R1	E-619.R3
Function	9.5 " housing for E-619 amplifier modules	19 " housing for E-619 amplifier modules
Channels	1	3
Miscellaneous		
Operating voltage	100 V - 240 V~, 50 Hz - 60 Hz	100 V - 240 V~, 50 Hz - 60 Hz
Max. power consumption, full load	150 VA	360 VA
Max. power consumption without load	30 VA	80 VA
Operating temperature range	5 °C to 40 °C	5 °C to 40 °C
Mass	10 kg	18 kg
Dimensions	236 × 132 × 296 mm (without handles)	450 x 132 x 296 mm (without handles)

9.2 Ambient conditions and classifications

The following ambient conditions and classifications for the C-863.12 must be observed:

Area of application	For indoor use only
Maximum altitude	2000 m above msl
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
Supply voltage fluctuations	Max. ±10 % of the nominal voltage
Protection class	I
Degree of pollution	2
Degree of protection according to IEC 60529	IP20

9.3 Dimensions

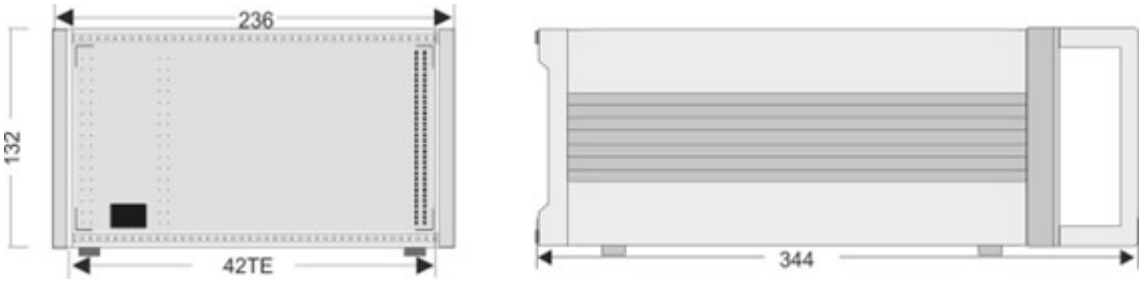


Figure 5: E-619.R1 housing

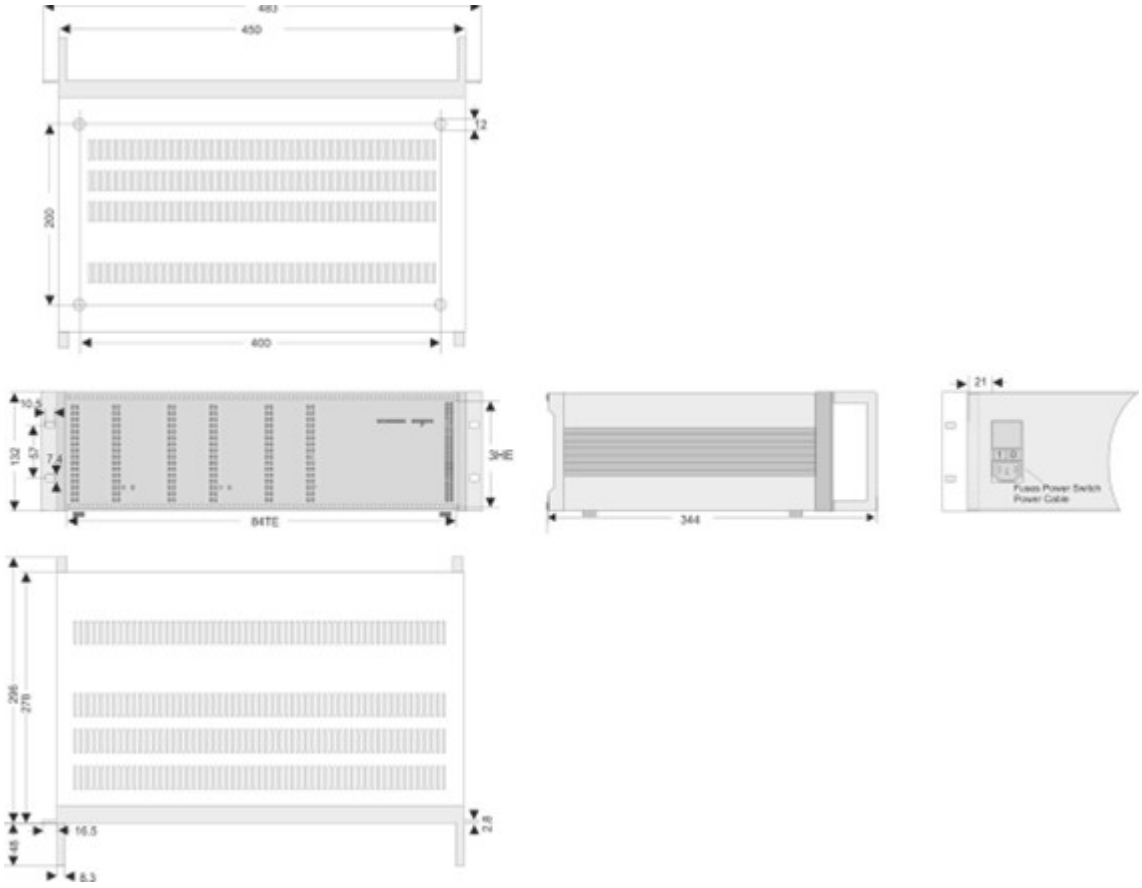


Figure 6: E-619.R3 housing

9.4 Frequency response diagrams

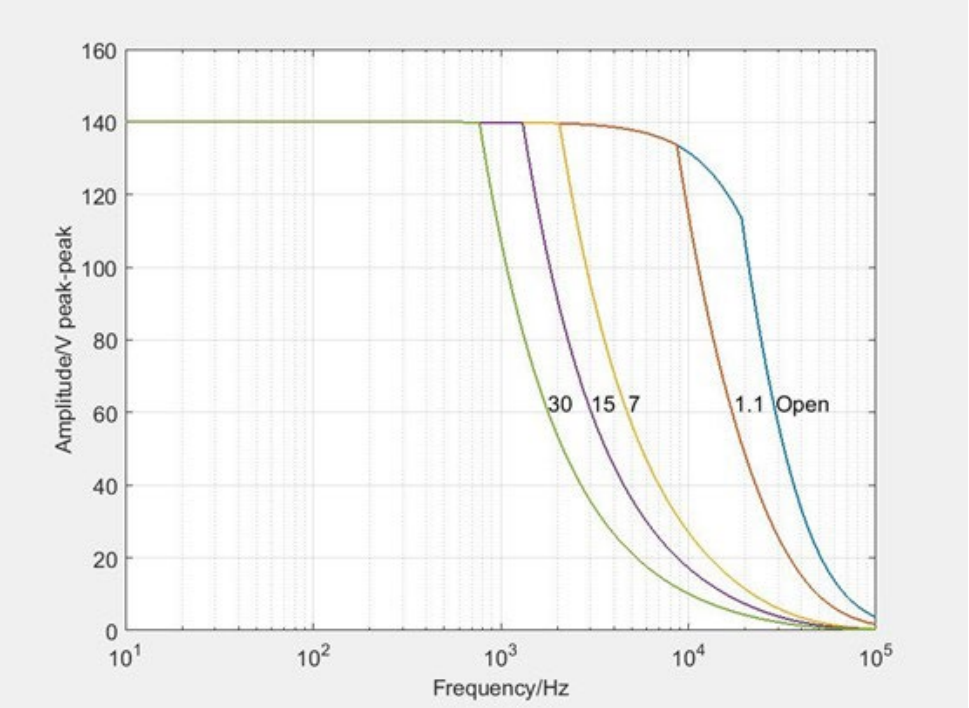


Figure 7: E-619.H: Operating limits (open loop) with various piezo loads, capacitance values in µF

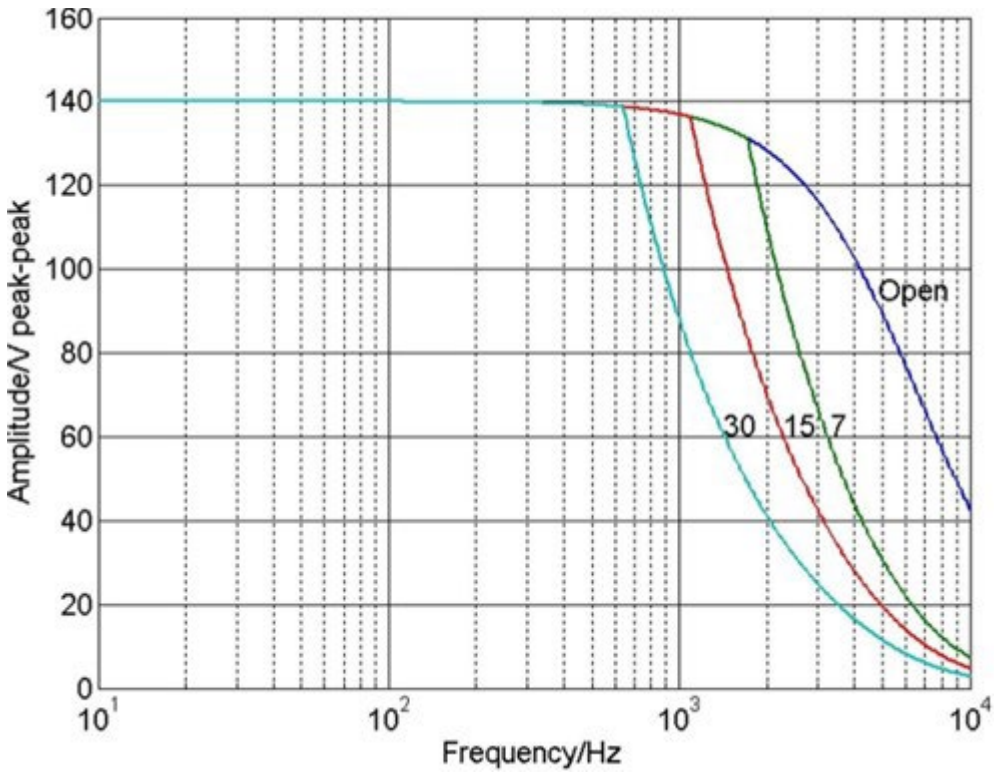


Figure 8: E-619.00: Operating limits (open loop) with various piezo loads, capacitance values in µF

9.5 Signal path

The block diagram below shows the signal path for the E-619 system with an E-509 servo-control module and an E-518 interface module.

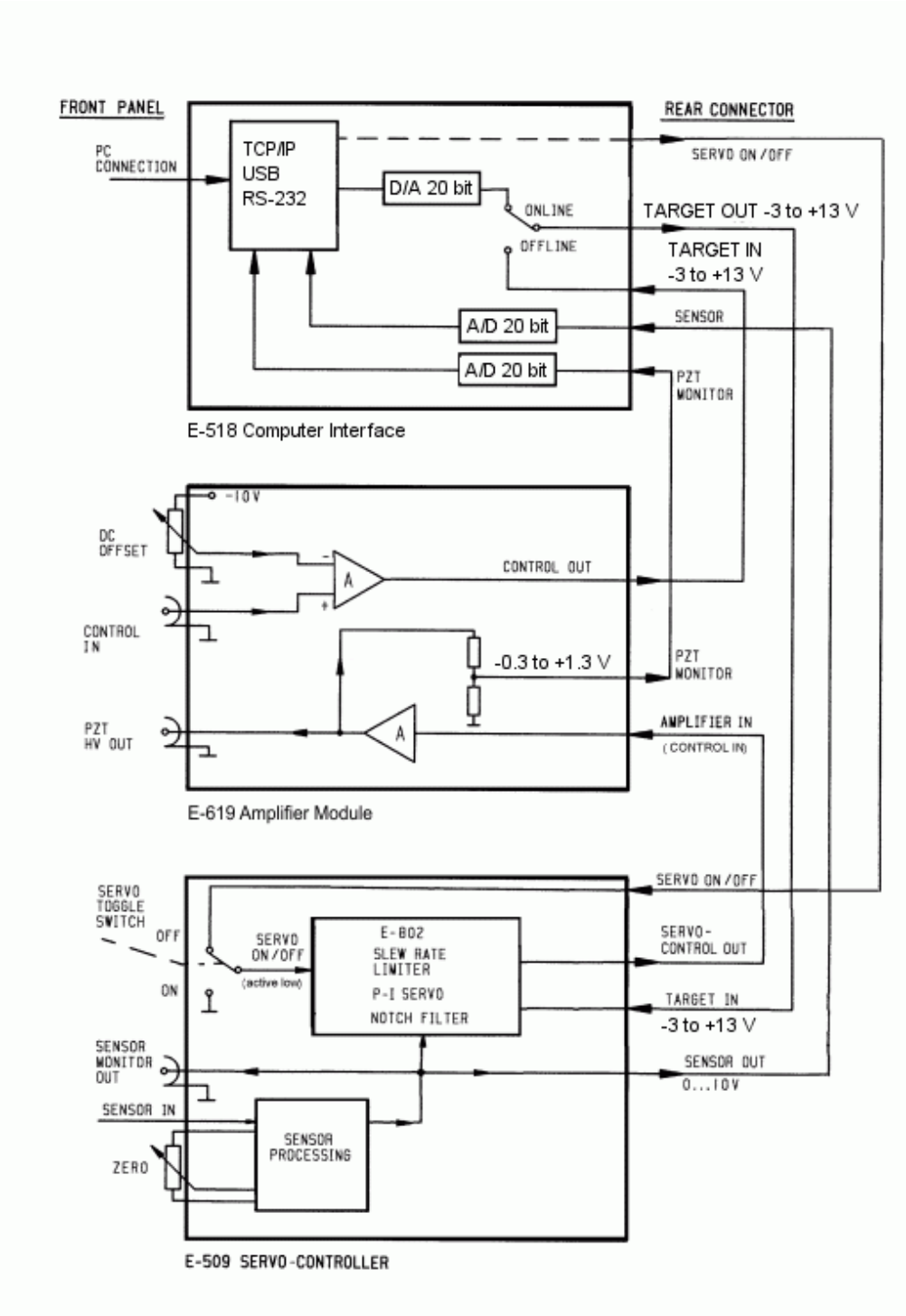


Figure 9: E-619 signal path with E-518 interface module

9.6 Pin assignment

32-pin main connector of the E-619 amplifier module

The pin assignment of E-619.H and E-619.00 amplifier modules is as follows:

Function				Function
PZT output	a	2	c	PZT output
PZT GND	a	4	c	PZT GND
Sync Input TTL Signal, E-619.H: 400 kHz / E-619.00: 100 kHz	a	6	c	Control Out, includes Offset Signal OUT
Monitor PZT out (100:1)	a	8	c	Amplifier In
OVN status signal (output)	a	10	c	Control In (also on SMB socket; use only one of the connections)
nc	a	12	c	nc
AGND	a	14	c	AGND
+VCC supply, +24 V	a	16	c	+VCC supply, +24 V
-VCC supply, 0 V	a	18	c	-VCC supply, 0 V (connect to 20c for minimum noise)
AGND	a	20	c	AGND
nc	a	22	c	AGND
nc	a	24	c	nc
nc	a	26	c	nc
nc	a	28	c	nc
nc	a	30	c	nc
Protective GND	a	32	c	Protective GND

nc = not connected

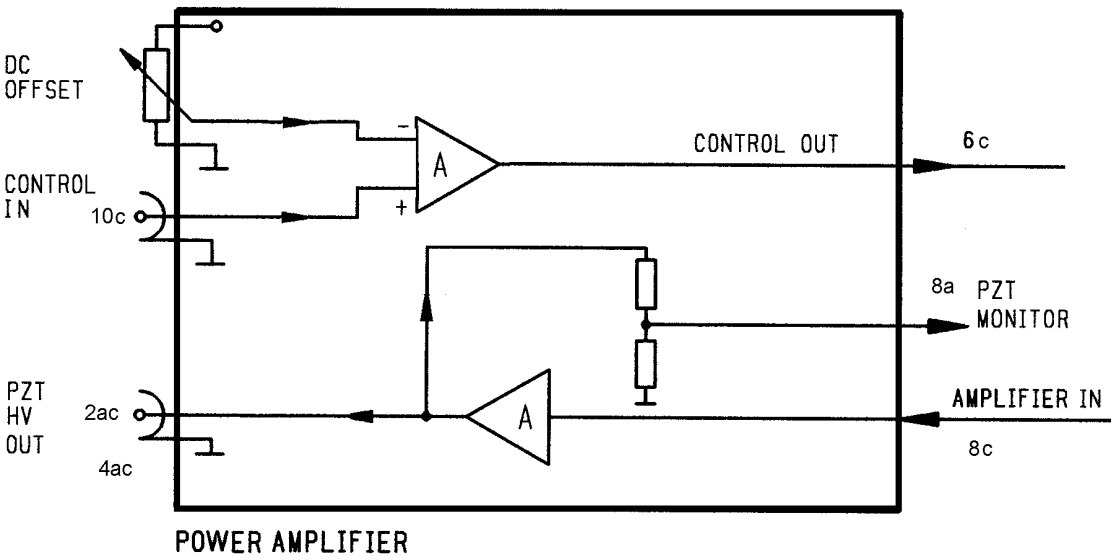


Figure 10: Signal path of the E-619 amplifier module with assignment of the corresponding main connector pins

10 Appendix

10.1 Lifetime of PICMA® actuators

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

- Applied voltage
- Temperature
- Relative humidity

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

The impact of the applied voltage is particularly important. With decreasing voltage the lifetime increases exponentially. This must always be taken into consideration in an application. The recommended maximum range of the control input voltage for the E-619 amplifier module therefore is -2 V to 12 V, resulting in a piezo voltage range of -20 V to 120 V. A control input range of -3 V to 13 V is possible (results in -30 V to 130 V piezo voltage), but will reduce the actuator lifetime accordingly.

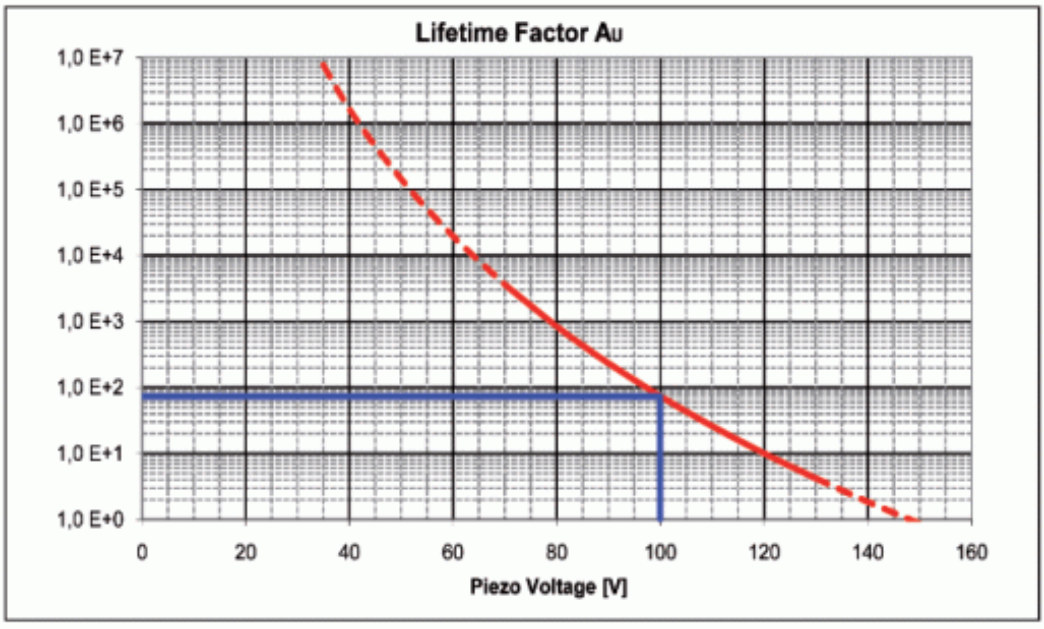


Figure 11: Interdependency between the mean MTTF of a PICMA® actuator and the value of the voltage applied

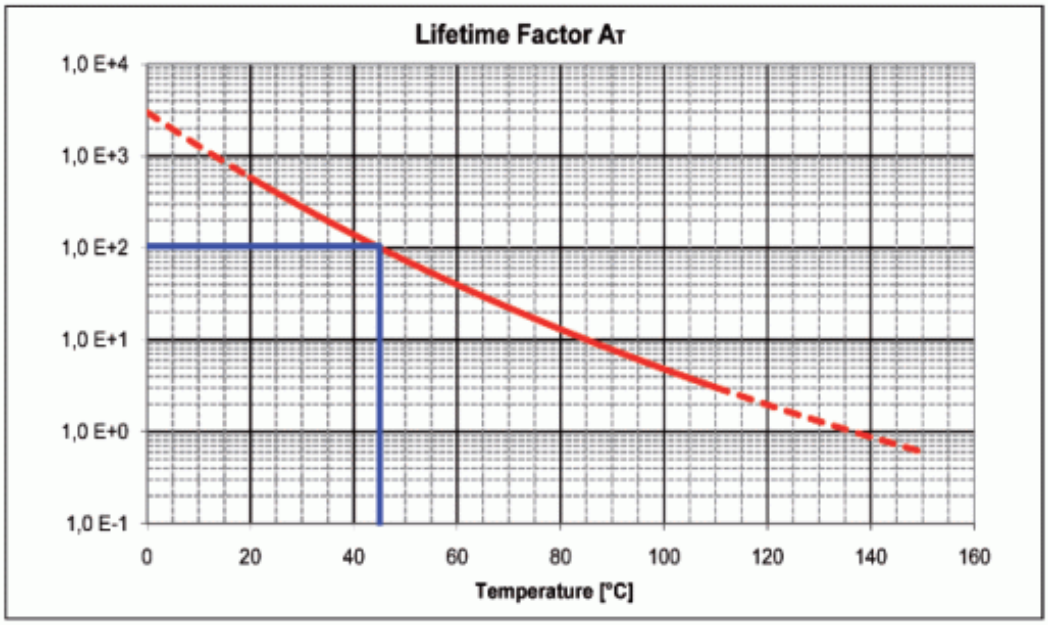


Figure 12: Interdependency between the mean MTTF of a PICMA® actuator and the ambient temperature

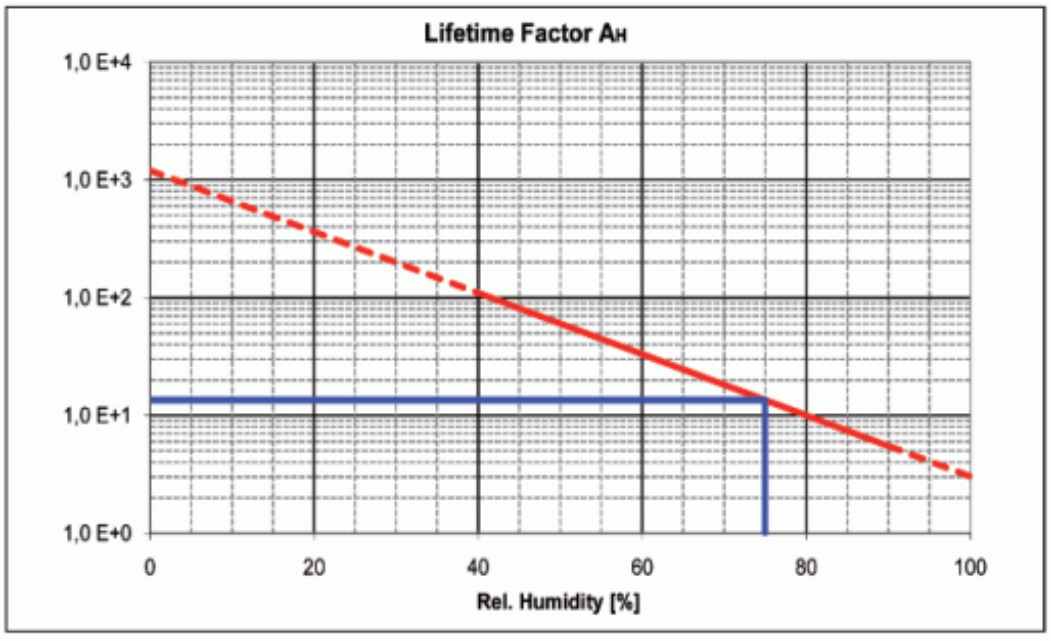


Figure 13: Interdependency between the mean MTTF of a PICMA® actuator and the relative humidity

Example:

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

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

10.2 How to measure the amplifier output

The innovative, efficient circuitry of the E-619 amplifier module reduces power consumption and heat dissipation, especially in dynamic applications. Working with an internal switching frequency of 100 kHz (with E-619.00; 400 kHz with E-619.H), charge is transferred to the piezo actuator using low-loss PWM techniques. The ripple of the amplifier output is <100 mV_{pp} at 100 kHz. But when measuring the amplifier output signal with low sampling rate and small bandwidth (e.g. with a digital oscilloscope), aliasing will occur and distort the measurement result. In digital signal processing, aliasing refers to an effect that the signal reconstructed from samples is different than the original continuous signal when the sampling rate is too low. With the E-619 amplifier output, this means that a low-frequency signal seems to be measured which is not present at all.

Example:

When a 91 Hz signal is sampled with 100 Hz sampling rate, the result seems to be a 9.1 Hz signal (see figure below).

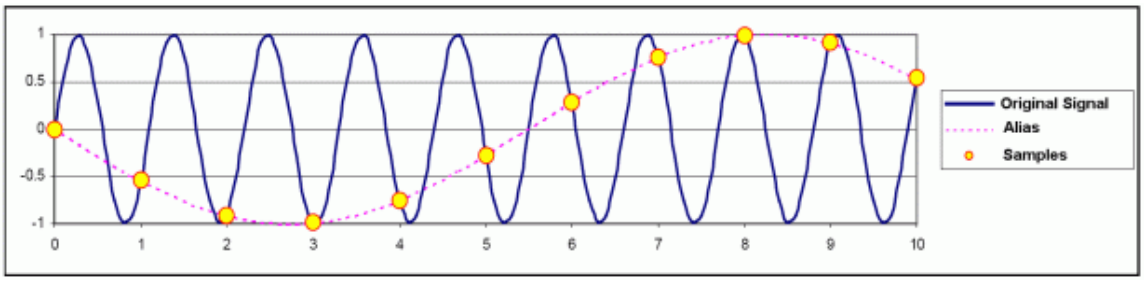


Figure 14: Signal digitization with too low sample rate (time in 1/100 s): Original signal = 91 Hz and sampling rate = 100 Hz; the result is mistaken as a 9.1 Hz signal ("Alias")

To avoid aliasing, the sampling rate must be at least twice as high as the highest frequency in the signal to be sampled (according to the Nyquist–Shannon sampling theorem). I.e. with an amplifier switching frequency of 100 kHz, the sampling rate must be 200 kHz or higher. If the sampling rate provided by your oscilloscope is not high enough, use a low-pass filter at the oscilloscope input to eliminate frequencies above 100 kHz. Alternatively, you can use an analog oscilloscope or perform high-resolution measurements in the lower frequency range.

With E-619.H, the switching frequency is 400 kHz which requires a sampling rate of about 800 kHz.

When following those instructions, you will obtain valid measurement results.

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.

In order to fulfil its responsibility as the product manufacturer, Physik Instrumente (PI) SE & 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) SE & Co. KG

Auf der Römerstr. 1

D-76228 Karlsruhe, Germany