

PZ178E User Manual

E-421 · E-470 · E-471 · E-472 HVPZT

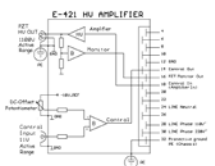
Piezo Power Amplifier / Controller

Release: 1.1.0 Date: 23.10.2012



This document describes the following product(s):

- E-421.00
HVPZT Piezo Power Amplifiermodule, 1 Channel
- E-470.20
HVPZT Piezo Power Amplifier/Controller, 1 Channel, Benchtop
- E-471.20
HVPZT Piezo Power Amplifier/Controller, 1 Channel, 19"
- E-472.20
HVPZT Piezo Power Amplifier/Controller, 2 Channels



Declaration of Conformity

according to ISO / IEC Guide 22 and EN 45014

Manufacturer:	Physik Instrumente (PI) GmbH & Co. KG	
Manufacturer's Address:	Auf der Römerstrasse 1 D-76228 Karlsruhe, Germany	

The manufacturer hereby declares that the product

Product Name: **Power Amplifier for HVPZT**

Model Numbers: **E-470, E-471, E-472, E-421**

Product Options: **all**

complies with the following European directives:

73/23/EEC, Low voltage directive

89/336/EEC, EMC-Directive


The applied standards certifying the conformity are listed below.

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

Electromagnetic Immunity: EN 61000-6-1

Safety (Low Voltage Directive): EN 61010-1

February 19, 2007
Karlsruhe, Germany



Dr. Karl
Spanner
President

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About this Document

Users of this Manual

This manual is designed to help the reader to install and operate the E-47x HVPZT Piezo Power Amplifier. It assumes that the reader has a fundamental understanding of basic servo systems, as well as motion control concepts and applicable safety procedures.

The manual describes the physical specifications and dimensions of the E-47x HVPZT Piezo Power Amplifier as well as the installation procedures which are required to put the system into operation.

Conventions

The notes and symbols used in this manual have the following meanings:

WARNING

Calls attention to a procedure, practice or condition which, if not correctly performed or adhered to, could result in injury or death.



DANGER

Indicates the presence of high voltage (> 50 V). Calls attention to a procedure, practice or condition which, if not correctly performed or adhered to, could result in injury or death.



CAUTION

Calls attention to a procedure, practice, or condition which, if not correctly performed or adhered to, could result in damage to equipment.



NOTE

Provides additional information or application hints.

Any optional elements which might be mentioned in this documentation are described in their own manuals. Current releases can be downloaded from the PI Website as PDF files (<http://www.pi.ws>), obtained from your Physik Instrumente sales engineer or from info@pi.ws (<mailto:info@pi.ws>).

Contents

1	Introduction	3
1.1	Overview	3
1.2	Prescribed Use	4
1.3	Safety Precautions.....	4
1.4	Model Survey and Upgrades	6
1.5	Unpacking	8
2	Operation	9
2.1	Calibrated System	9
2.2	Setup.....	9
2.3	Front and Rear Panel Elements.....	10
2.4	Line Voltage Connection.....	11
2.5	Output Voltage Range	11
2.6	Piezo Actuator Connection	14
2.6.1	Bipolar Piezo Actuators	15
2.6.2	Unipolar Piezo Actuators	15
2.6.3	Wiring Example.....	15
2.7	Modes of Operation	16
2.7.1	Open-Loop and Closed-Loop Operation	16
2.7.2	Analog Operation.....	16
2.7.3	Remote Control via Computer Interface.....	17
2.8	Analog Control Signal	17
2.9	First Operation.....	17
2.10	Zero-Point Adjustment in Closed-Loop Operation with E-509	18
3	Maintenance	21
3.1	AC Power and Line Power Fuses	21
3.1.1	Line Cord	21
3.1.2	Line Power Fuses	21
3.2	Cleaning	22
4	Troubleshooting	23
5	Technical Data	24
5.1	Specifications	24
5.2	Frequency Response Diagram	25

5.3	Block Diagram	26
5.4	Signal Path with Servocontroller and PC-Interface Module	26
5.5	Pin Assignments.....	28
5.5.1	2-Pin High-Voltage Connector.....	28
5.5.2	Internal Backplane Connector of E-47x Chassis.....	29
5.5.3	E-421 Main Connector.....	29

1 Introduction

1.1 Overview



Figure 1: E-471 Configuration example: E-471.20 HVPZT amplifier, with optional E-509 PZT servo-controller and E-516 interface/display module (predecessor of the current E-517 interface and display module)

The E-470 series high-power piezo amplifiers/controllers are specifically designed to drive high-capacitance PICA piezo actuators. They are based on the E-421 four-quadrant amplifier module, which can output and sink a peak current of 500 mA and an average current of 100 mA in a voltage range of 3 to 1100 V (jumper selectable bipolar range also provided). Three standard configurations are available:

- E-470.20 is a bench-top amplifier in a 9.5" chassis for open-loop operation (1 channel)
- E-471.20 is the amplifier module in a 19" rackmount chassis that can hold additional servo-control, interface and display modules
- E-472.20 is a 2-channel version in a 19" rackmount chassis for dynamic open-loop operation

These amplifiers can be used to drive open and closed-loop piezo positioning systems.

Open-Loop Piezo Operation

For open-loop piezo operation the amplifier output voltage is determined by the analog signal at the Control Input combined with the DC-offset potentiometer setting. Open-loop operation is ideal for applications where the fastest response and the highest bandwidth are essential. Here, commanding and reading the target position in absolute values is either not important or carried out by an external feedback loop.

Optional Servo-Controller Upgrade

The E-471.20 version allows easy installation of an optional E-509 sensor- / servo-controller module for closed-loop piezo position control. In this mode the amplifier is slaved to the E-509 servo controller. Depending on the attached piezo mechanics and feedback sensor, positioning accuracy and repeatability in the nanometer range and below are feasible.

Computer Control

The E-517 computer interface/display module can also be installed in the E-471 / E-472.

Optionally digital control via a D/A converter is possible. For several D/A boards from National Instruments PI offers a corresponding LabVIEW driver set which is compatible with the PI General Command Set (GCS), the command set used by all PI controllers. A further option includes the patented Hyperbit technology providing enhanced system resolution.

1.2 Prescribed Use

Based on their design and realization, E-47x HVPZT Piezo Power Amplifiers are intended to drive capacitive loads, in the present case, piezoceramic actuators. E-47xs must not be used for applications other than stated in this manual, especially not for driving ohmic (resistive) or inductive loads. Observe the safety precautions given in this User Manual.

The E-47x meets the specifications as defined by DIN EN 61010 for safe operation under normal ambient conditions. See the specifications table for details. (p. 24)

1.3 Safety Precautions

Carefully read also the user manuals and/or technical notes of all other components involved, such as controllers or software. Failure to heed warnings in this manual can result in bodily injury or material damage or loss of warranty.



DANGER—HIGH VOLTAGE

E-47x Power Amplifiers output VERY HIGH VOLTAGES and HIGH CURRENTS which can cause death or injury!

Take special care if connecting products from other manufactures. Follow general accident prevention rules!

Working with these devices requires adequately trained and educated operating personnel.

During operation, do NOT touch any part which might be connected to the HV output!



WARNING

Piezo Actuators Sensitive to Overvoltage or Reverse Polarity

Exposing some piezo actuators to voltages too far outside their operating range will destroy the active element in the actuator. Make sure that both the polarity and the voltage as seen by the piezo actuator are within the allowable range.

Be especially vigilant regarding polarity when using older actuators, adapter cables and controllers set up for non-standard voltage ranges.



CAUTION

Read this before operating the equipment covered in this manual. Always keep the User Manual safe and close to the described device. In case of loss or damage to the instructions, please order a new copy from your PI distributor or download one from www.pi.ws (<http://www.pi.ws>). Also keep and add all further information (e.g. extended instructions or Technical Notes) to the User Manual.



CAUTION—AIR CIRCULATION

Do not cover the ventilation slots on the top side of the E-47x. The device needs to be installed horizontally with 3 cm air circulation area. Vertical mounting prevents internal convection. Insufficient air flow will cause overheating and premature failure.

1.4 Model Survey and Upgrades

The following standard configurations of E-47x series piezo amplifiers are available:

E-470.20	HVPZT Piezo Amplifier, 1 channel, 550 W, 1100 V, Bench-Top, includes one E-421 piezo amplifier module with power supply in a 9.5" chassis
E-471.20	HVPZT Piezo Amplifier, 1 channel, 550 W, 1100 V, Bench-Top, includes one E-421 piezo amplifier module and power supply, upgrade with servo-controller and interface / display module possible, 19" ' chassis for rackmounting
E-472.20	HVPZT Piezo Amplifier, 2 channels, 550 W, 1100 V, Bench-Top, includes two E-421 piezo amplifier modules and power supply (is equivalent to E-471.20 with E-421 upgrade), 19" -chassis for rackmounting

NOTE

The content of this user manual applies only to the models listed above. The predecessors—E-47x.00 and E-420—are no longer in production, and this user manual is not valid for them.

The E-471.20 amplifier is upgradable with a servo-control module (E-509), and/or a computer interface and display module (E-517, E-515 for display only). These modules come installed directly in the chassis. If the servo module and a piezo actuator are ordered with the system, your E-471.20 will be fully calibrated before being shipped.

Contact your PI sales engineer or write info@pi.ws, if you want to upgrade your amplifier. Any additional modules are described in their own separate manuals.

The following modules are available:

E-509.C1A, E-509.L1, E-509.S1	Sensor / Servo-Controller Module for capacitive, LVDT or SGS position sensors respectively, 1 channel to eliminate drift and hysteresis from positioning operations.
-------------------------------------	--

- E-517.i1/.i10 Interface- / Display Module, 24 Bit D/A, TCP/IP, USB, RS-232, .i10 only: IEEE 488; 1 Channel; displays the current voltage and, if servo-module also present, the position of the piezo actuator, and can also communicate with a host PC. Dynamic link library, LabVIEW driver set and convenient interactive user interface software are provided.
- E-515.01 Display Module for Piezo Voltage and Position, 1 channel
- E-500.ACD CD with Driver Set for Analog Controllers, available free of charge upon request
Computer control can be implemented using a DAC-board in a PC to generate the analog input signal. PI offers a LabVIEW driver set which can be used with certain D/A boards. This driver set is compatible with the PI General Command Set (GCS) LabVIEW driver set available for all newer controllers from PI.
The PI Analog Controller drivers support all D/A converter boards from National Instruments that are compatible with DAQmx8.3. LabVIEW compatibility is given from version 7.1 upwards. Connection of a sensor monitor signal from a sensor- or servo-module (e.g. E-509) is required.
The driver set is also available for download from the PI website.
- E-500.HCD Hyperbit Functionality for Enhanced System Resolution access
PI's patented Hyperbit technology for providing position resolution higher than that of the D/A board is in the E-500.ACD driver set. Activating Hyperbit requires purchase of the password, which can be obtained from PI under Order No. E-500.HCD.

1.5 Unpacking

Unpack the E-47x HVPZT Piezo Power Amplifier with care. Compare the contents against the items covered by the contract and against the packing list.

The following components are included:

PZ178 User manual for E-421/E-47x.20

3763 Line cord

Inspect the contents for signs of damage. If parts are missing or you notice signs of damage, contact PI immediately.

Save all packing materials in case the product need be shipped again.

2 Operation

2.1 Calibrated System

If a controller with an included servo module is ordered together with 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.



CAUTION—CALIBRATION

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

If you inform PI about your application, your E-47xs will be fully calibrated before being shipped. It is usually not necessary for you to do anything more than adjust the zero point before operating the system.

Do not interchange controller (whole devices or individual modules) and/or piezo stages if they are matched and calibrated together. Respect the assignment of the piezo actuators to the individual controller 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

2.2 Setup



CAUTION—AIR CIRCULATION

Do not cover the ventilation slots on the top side of the E-47x. The device needs to be installed horizontally with 3 cm air circulation area. Vertical mounting prevents internal convection. Insufficient air flow will cause overheating and premature failure.

The E-471.20 and E-472.20 amplifiers are suitable for mounting in a 19" rack. The device must be installed horizontally with 3 cm clearance for air circulation. Do not cover the ventilation slots.

2.3 Front and Rear Panel Elements



DC Offset turning knob	10-turn potentiometer for DC Offset (see "Analog Control Signal" p. 17)
"CONTROL INPUT" BNC socket	Connection of control signal (see "Analog Control Signal" p. 17)
"PZT HIGH VOLTAGE" LEMO socket	High-voltage output for piezo actuator
"Power" LED	Steady green during operation

The controls of the optional servo-control (E-509) and PC interface/display (E-517, E-515) modules are described in their own separate manuals. The on/off switch, line voltage connection and fuses are located on the rear panel of the device (p. 21).

2.4 Line Voltage Connection

Unless you request otherwise, upon delivery the E-47x will be set up for the voltage predominant in your country, either

115 V ~ / 50-60 Hz
or
230 V ~ / 50-60 Hz

The preset voltage can be identified on the rear panel of the device (p. 21).

To adapt the E-47x to a different line voltage, the line power fuses must be replaced. See “AC Power and Line Power Fuses” (p. 21) for instructions and for the required fuse types.

Connect the line voltage connection on the rear panel of the device to an appropriate power outlet via the included line cord.

2.5 Output Voltage Range

The maximum voltage swing of E-47x is 1100 V. In closed-loop operation, 10% of this maximum output is reserved for the control loop. The default setting for the output range is 0 to +1100 V (1000 V). This setting can be changed by moving an internal pin accessible at the rear of the E-421 piezo amplifier module.



DANGER—HIGH VOLTAGE

Disconnect from line voltage before changing the output voltage range!

NOTE

With a closed-loop system, changing the output voltage requires a new calibration. Contact your PI representative.

To change the output voltage range, proceed as follows:

- Disconnect the piezo amplifier from line voltage and wait a minute to be sure that any residual voltage has dissipated
- Remove the rear panel of the case

- Select the desired output voltage range by re-plugging the pin (see figure below)
For E-472: output voltage ranges of both channels can be set independently from each other
- Remount the rear panel

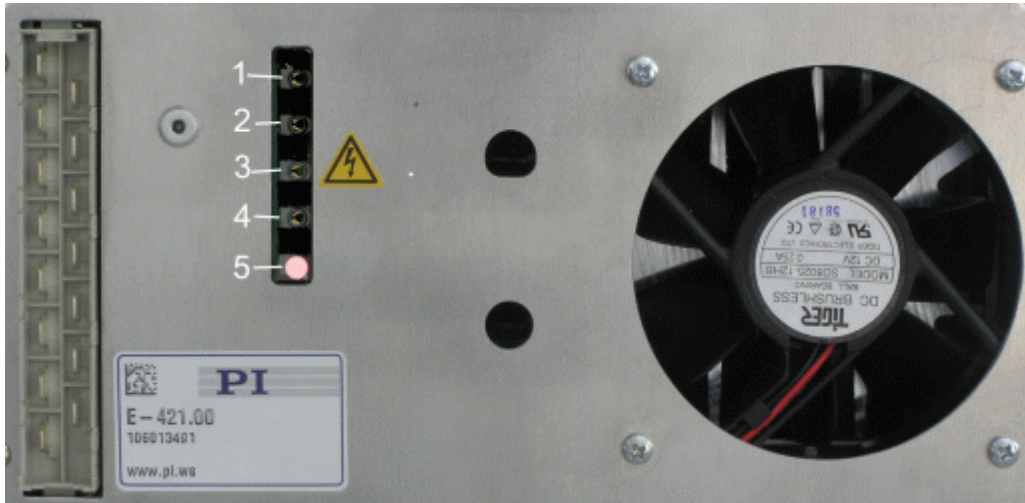


Figure 2: Output voltage range selection; the red pin is at the lowest (default) position

Pin position	Output voltage
(5) Lowest Position (default)	+3 to +1100 V
(4)	-260 to +780 V
(3)	-550 to +550 V
(2)	+260 to -780 V
(1) Upper Position	-3 to -1100 V

Gain Selection

For each amplifier channel the gain is set to +100 by default. Alternatively the gain can be set to -100.

The gain of an amplifier should only be changed, if the analog Control In signal does not match the selected output voltage range (see Section "Analog Control Signal" (p. 17)).

To change the gain, proceed as follows:

- Disconnect the E-47x.20 from line voltage
- Unscrew the front panel of the respective E-421 piezo amplifier module. Pull the amplifier module out of the chassis
- Unscrew the rear panel of the E-421 amplifier module and remove the rear panel
- Reverse the switch (circled in figure below)

- Re-install the rear panel, put the E-421 amplifier module into the chassis and re-fasten the module's front panel screws

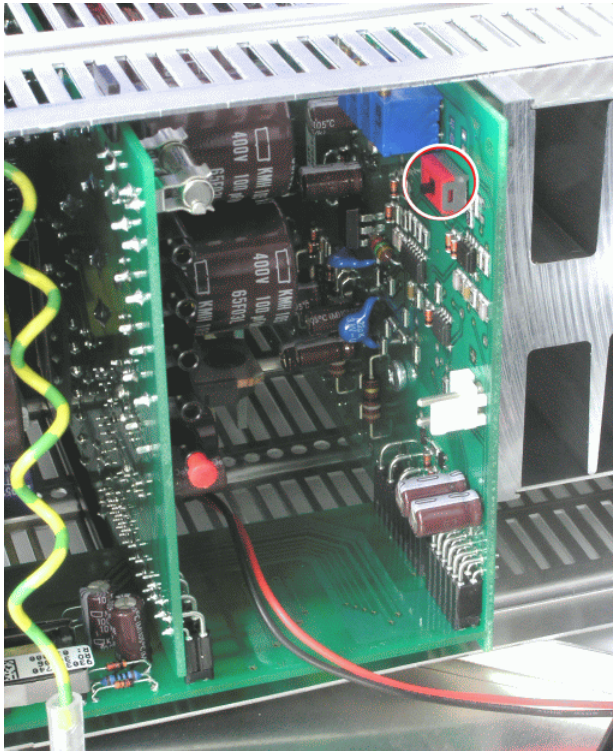


Figure 3: E-421 with rear panel removed: The gain switch is circled. Default gain setting +100

Example:

With gain set to +100 (default) and range #4 selected, an analog signal at Control In of +2.5 to -7.5 V leads to an output voltage range of +250 to -750 V.

2.6 Piezo Actuator Connection

DANGER—HIGH VOLTAGE

E-47x Power Amplifiers output VERY HIGH VOLTAGES and HIGH CURRENTS which can cause death or injury!

Take special care if connecting products from other manufactures. Follow general accident prevention rules!

Working with these devices requires adequately trained and educated operating personnel.

During operation, do NOT touch any part which might be connected to the HV output!



DANGER—IMPROPER WIRING CAN CAUSE DEATH, INJURY, DAMAGE AND VOID WARRANTY

Modification of HIGH VOLTAGE Connectors should only be carried out by the manufacturer. Any unauthorized modification may jeopardize operating personnel. Treat HIGH VOLTAGES and HIGH CURRENTS with respect.



Connect the piezo actuator to the “PZT Out” socket of the E-47x. If you are connecting other actuators or wiring your own connector, read the discussion of actuator type carefully and any documentation that came with the actuator.

WARNING

Piezo Actuators Sensitive to Overvoltage or Reverse Polarity

Exposing some piezo actuators to voltages too far outside their operating range will destroy the active element in the actuator. Make sure that both the polarity and the voltage as seen by the piezo actuator are within the allowable range.



Be especially vigilant regarding polarity when using older actuators, adapter cables and controllers set up for non-standard voltage ranges.

2.6.1 Bipolar Piezo Actuators

Here the output voltage swing is so chosen that the actuator sees both negative and positive high voltages. The output always has one lead at 0 V (PGND), and here the other is in a zero-crossing range, commonly $\pm 500\text{V}$.

2.6.2 Unipolar Piezo Actuators

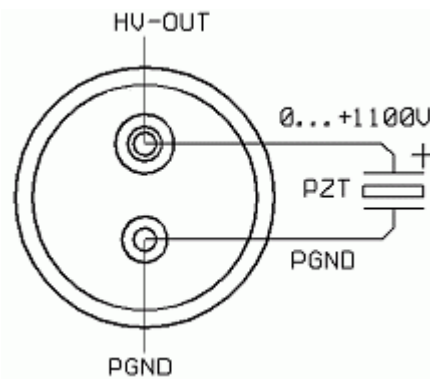
The notation of "positive" and "negative" polarity of piezo actuators does not refer to their direction of motion. Unipolar piezos of any polarity will elongate when a voltage is applied.

"Positive" and "negative" refers to the sign of the voltage applied to the piezo actuator.

For example, with an unipolar actuator with positive polarity, one terminal is at ground potential while the high voltage of up to +1100 V is applied to the other terminal (see "2-Pin High-Voltage Connector" S. 28).

2.6.3 Wiring Example

In the wiring example shown at right, a "positive" piezo is connected so as to have 0 to +1100 V applied. To achieve this, the positive terminal (possibly labeled "+1100 V") is connected to the variable HV-Out and the negative terminal to PGND.



Standard PI piezo actuators have positive polarity and are equipped with suitable LEMO connectors .

2.7 Modes of Operation

2.7.1 Open-Loop and Closed-Loop Operation

Open-Loop Operation

All E-47x versions can be operated in open-loop mode. Open-loop operation means that any control input provided by the user determines the output voltage directly.

Closed-Loop Operation

Closed-loop operation requires a position sensor and a servo module (e.g. E-509). 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 sensors (see E-509 User Manual PZ77E).

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

2.7.2 Analog Operation

All E-47x versions can be operated by an analog control signal. Depending on the servo mode (open-loop or closed-loop), this signal determines either the output voltage or the position for the piezo actuator. The range of the analog signal is to be adapted to the selected output voltage range (see "Analog Control Signal" (p. 17)) The analog signal consists of the following components:

External Analog Signal

An external voltage can be applied to the "Control In" BNC socket. This signal can be anywhere in the range of -10 to +10 V, but may not have an active swing more than 11 V wide.

The signal can be generated using a DAC-board in a PC. PI offers a LabVIEW driver set which can be used with certain D/A boards from National Instruments. This driver set is compatible with the PI General Command Set (GCS). In addition, PI's patented Hyperbit technology for providing position resolution higher than that of the D/A board is in this driver set (see "Model Survey and Upgrades" p. 6).

DC Offset potentiometer

Depending on the position of the potentiometer, a DC voltage between 0 and 10 V is made available. If you require a constant DC-offset, make sure the knob stays at the required position.

2.7.3 Remote Control via Computer Interface

E-47x models equipped with an E-517 computer interface and display module can be controlled from a host computer via a PC interface (TCP/IP, USB, RS-232 or IEEE488). In this operating mode all analog input is ignored (signal at "Control In", setting of the DC-offset potentiometer). If servo-controller modules for closed-loop operation are present, all SERVO switched must be set to "OFF". This operating mode is also referred to as ONLINE mode, while analog operation is also referred to as OFFLINE mode. See the E-517 User Manual for details.

2.8 Analog Control Signal

The permissible range of the analog control voltage in open-loop operation is one-hundredth of the output voltage range. If the gain was inverted to -100, the range of the control signal is changed accordingly too (see "Output Voltage Range" p. 11).

The external analog signal at the "Control In" socket and the voltage generated by the DC offset potentiometer sum up internally to the actual analog control signal, so that the DC offset potentiometer can be used to shift the external analog signal into the suitable range. This can be necessary to make use of the full output voltage range.

The permissible range of the control voltage in closed-loop operation with the E-509 sensor/servo module is 0 to 10 V.

2.9 First Operation



CAUTION—AIR CIRCULATION

Do not cover the ventilation slots on the top side of the E-47x. The device needs to be installed horizontally with 3 cm air circulation area. Vertical mounting prevents internal convection. Insufficient air flow will cause overheating and premature failure.

The following instructions refer to Analog Operation (p. 16) of the system. If your E-47x is equipped with an E-517 computer interface and display module and you want to control the system via the computer interface, perform only steps 1 and 2 of the instructions below and then operate the system as described in the E-517 User Manual.

- 1 Connect the E-47x to the line voltage using the included line cord. The connection is on the rear panel of the chassis (see "Line Voltage Connection" p. 11)

- 2 Connect the piezo actuator to the E-47x HV output.
For closed-loop systems (see also the E-509 User Manual):
 - 2.1 Connect the sensor cable to the corresponding socket
 - 2.2 If you are using the sensor monitor signal, connect your appropriate electronics to the SENSOR MONITOR socket
 - 2.3 Set "SERVO" toggle switch on the servo module "OFF"
- 3 Turn the DC offset potentiometer full counterclockwise (CCW)
- 4 Make sure that voltage at "Control In" is set to 0 V
- 5 Turn on the line power. The green "POWER" LED will light up
- 6 Command the first motion of the piezo actuator by turning the offset potentiometer full clockwise (CW) to run the actuator over the nominal travel range, then turn the potentiometer back full CCW
If an E-517 interface and display module or an E-515 display module is installed, watch the voltage and, if an E-509 servo module is present, the position on the display to check whether the system is operating properly.
Make sure that the full voltage swing is attained
- 7 If an E-509 servo module is installed, the SENSOR MONITOR signal will show a voltage from about 0 to 10 V 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)
- 8 If you want to use an external analog signal for control, connect a suitable signal source to the "Control In" BNC socket. The permissible range of the analog control signal is 1/100 of the selected output voltage range (p. 11).

If you have a closed-loop system, follow up by performing a zero-point adjustment.

2.10 Zero-Point Adjustment in Closed-Loop Operation with E-509

The zero-point adjustment becomes necessary when the application conditions (particularly load, temperature) of the piezo actuator have changed. Proper zero-point adjustment ensures that the full output voltage

swing can be used without reaching the output voltage limits of the amplifier and causing an overflow condition (see E-509 user manual, PZ77E).

The adjustment can be performed in "Online" as well as in "Offline" mode (p. 17). However, "offline" and "online" modes must not be mixed during the adjustment.

In "Online" mode with the E-517 interface and display module, zero-point adjustment can be performed without additional equipment; see the E-517 user manual for how to proceed.

For zero-point adjustment in analog (offline) mode, the following additional equipment is required: an adjustable voltage source which is able to output 1/100 of the selected output voltage range, and a precision voltmeter.

How to perform zero-point adjustment in "offline" mode (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 external analog control signal at "Control In" is 0 V and turn the DC offset potentiometer full CCW
- 3 Set the SERVO toggle switch on the front panel to OFF
- 4 Connect a voltmeter to the SENSOR MONITOR socket
- 5 Power up the system
- 6 Turn the DC offset potentiometer full clockwise and than back full counterclockwise (0 V) to exercise the mechanics over its full travel range
- 7 Adjust the ZERO potentiometer on the E-509 module until a sensor-monitor signal of 0 V is measured by the voltmeter on the SENSOR MONITOR socket
- 8 Switch to closed-loop operation (SERVO ON)

CAUTION

If your piezo actuator starts oscillating (humming noise), turn off the SERVO immediately! The actuator can be irreparably damaged by resonant oscillation. Call your PI representative.

If a display module is present, the position of the piezo will now jump to "0". Connect a voltmeter in parallel with the piezo to the "PZT Out" socket, or watch the output voltage on the display module, if present. Adjust the ZERO potentiometer on the E-509 module to obtain the following value for the output voltage at the sensor zero point:

Selected output voltage range	Output voltage value at sensor zero point
0 to 1000 V	50 V
-250 to +750 V	-200 V
-500 to +500 V	-450 V (positive piezo polarity) +450 V (negative piezo polarity)
+250 to -750 V	200 V
0 to -1000 V	-50 V

This is the output voltage value corresponding to the low end of the piezo actuator travel range.

Check the output voltage range at "PZT Out" using the voltmeter or a display module while you command the maximum extension with either a DC voltage of 0 to 10 V on "Control In" or by turning the DC offset potentiometer full clockwise.

If the full output voltage range is attainable, the zero-point adjustment is finished. If not, repeat the adjustment with a slightly different value for the zero point.

3 Maintenance



WARNING—LINE VOLTAGE

E-47xs need to be installed in such a way that they can quickly and easily be separated from the line voltage. Before cleaning the E-47x, changing the AC fuses and removing or installing modules, switch the device off and disconnect it from the line power.

3.1 AC Power and Line Power Fuses

3.1.1 Line Cord

Replace the included line cord only by a line cord with suitable rating.

3.1.2 Line Power 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.



CAUTION – DOUBLE POLE FUSE

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



Figure 4: Position of the line fuses and fuse carrier, only one of two fuses visible



Figure 5: Fuse carrier

To access the line power fuses, proceed as follows:

- 1 Switch off the E-47x and remove the line cord
- 2 Wait at least one 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 (see figures above)
- 4 Replace **both** fuses with fuses of the suitable type:
220 V AC to 240 V AC 2 x IEC* 1.25 A HT (slow blow)/250 V AC
100 V AC to 120 V AC 2 x IEC* 2.5 A HT (slow blow)/250 V AC
- 5 Rotate the fuse carrier so that the valid voltage setting (115 V or 230 V) will show through the window when the door is closed
- 6 Reinstall the carrier and close the door

NOTE

The E-472 piezo amplifier with two E-421 amplifier modules must be supplied with the following fuses:

- 220 V AC to 240 V AC 2 x IEC* 2.5 A HT (slow blow)/250 V AC
 - 100 V AC to 120 V AC 2 x IEC* 5 A HT (slow blow)/250 V AC
-

3.2 Cleaning

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

* IEC fuses are cited: other fuse standards may require higher nominal current rating

4 Troubleshooting

Positioner does not move.

Cables not connected properly:

- Check the connecting cables.

- Note the permissible voltage range for the analog control signal at "Control In".
The permissible range of the analog control voltage is one one-hundredth of the output voltage range (see "Analog Control Signal" p. 17)

Still having problems? Call your local distributor or write to info@pi.ws; please have the following information about your system ready:

- Product codes and serial numbers of all products in the system
- Current firmware version of the controller
- Software version of drivers and / or host software
- Operating system on host PC

5 Technical Data

5.1 Specifications

	E-470.20, E-471.20, E-472.20, E-421.00	Unit
Function	Power amplifier for PICA high-voltage piezo actuators (servo-controller and interface option for E-471)	
Amplifier		
Output voltage	3 to 1100 (default) (Selectable -260 to +780 -550 to +550 +260 to -780 -3 to -1100)	V
Amplifier channels	1 (E-472: 2)	
Average current	100	mA
Peak current, < 5ms	500	mA
Amplifier bandwidth, small signal	DC to 3 kHz, related to load capacitance, see operating limits graph	
Amplifier bandwidth, large signal	DC to 3 kHz, related to load capacitance, see operating limits graph	
Ripple, noise 0 to 100 kHz	<25 100 (200 nF)	mV _{RMS} mV _{P-P}
Current limitation	Short-circuit-proof	
Voltage gain	+100 ±1 (default), -100 ±1	
Control input voltage	Servo off: ±1/100 of selected output range Servo on: 0 to 10 V	
Input impedance	100	kΩ
Interfaces and operation		
Piezo voltage output	LEMO EGG.0B.701.CJL1173	
Control input	BNC	
DC Offset	10-turn pot., adds 0 to +10 V to Control IN	
Miscellaneous		
Operating voltage	100 - 120 or 220 - 240 V AC, selectable (fuse change required)	
Operating temperature range	+5 °C to +50 °C (above 40 °C, power derated)	°C
Overtemp protection	Max. 75 °C, deactivation of the piezo voltage output	
Mass	5.2 (E-470); 7.6 (E-471); 10.1 (E-472); 2.5 (E-421)	kg
Dimensions	236 x 132 x 296 + handles (E-470); 450 x 132 x 296 + handles (E-471, E-472); 215 x 123 x 185 (E-421)	mm

5.2 Frequency Response Diagram

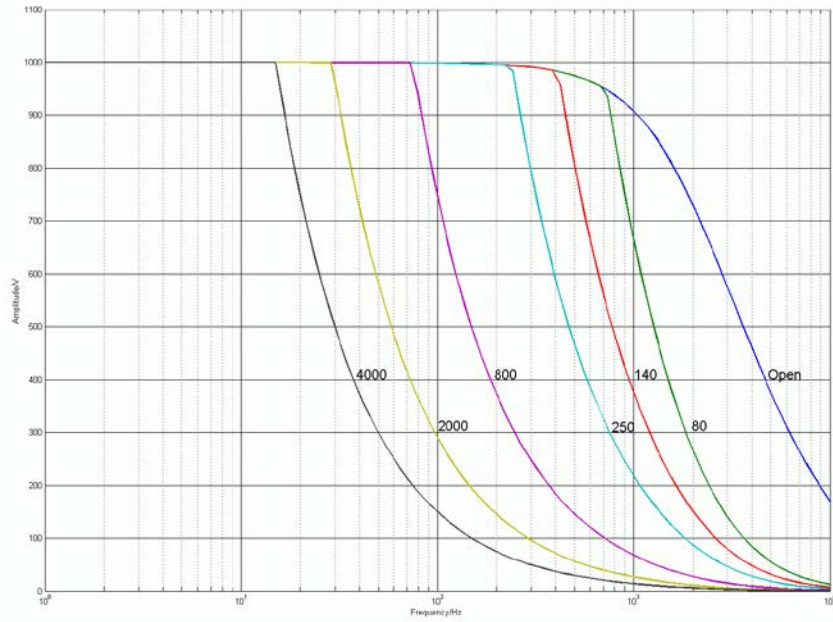


Figure 6: E-421.00, operating limits with various piezo loads. Values shown are capacitance in nanofarads

5.3 Block Diagram

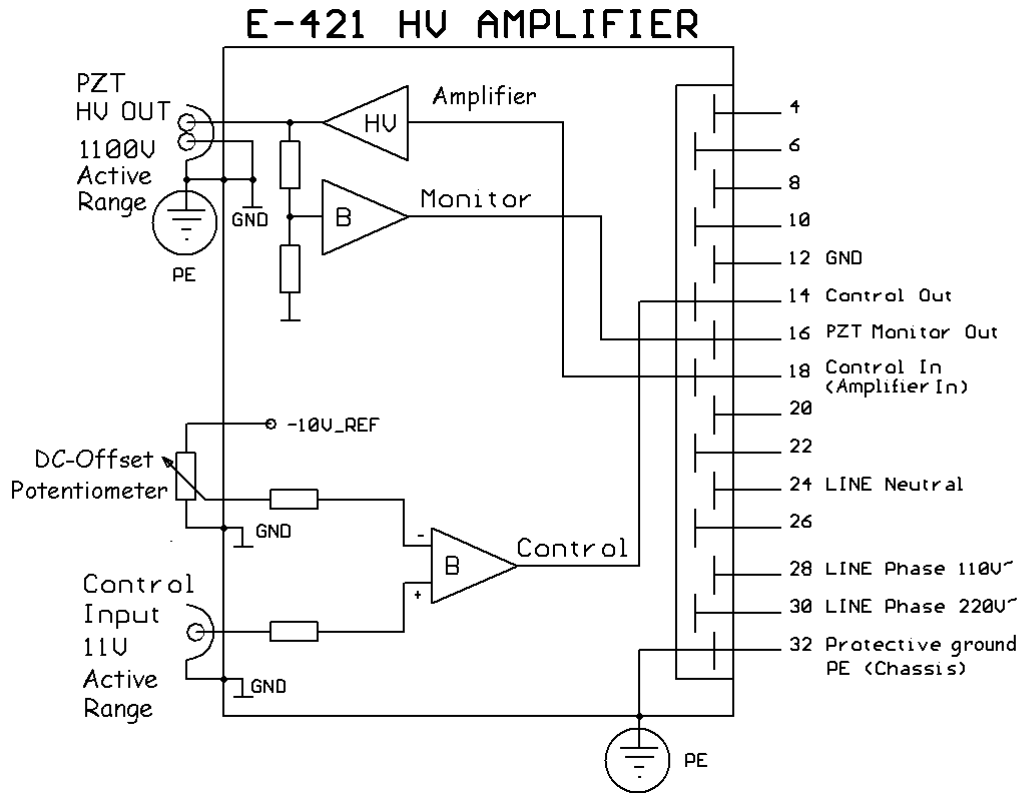


Figure 7: E-421 Blockschaltbild

5.4 Signal Path with Servocontroller and PC-Interface Module

The block diagram below shows the signal path for E-47x closed-loop versions upgraded with an E-517 interface and display module. The E-47x open-loop versions and models without E-517 module are equipped with dummy modules instead. The purpose of these dummies is to complete the internal circuitry and the front panel of the chassis.

CAUTION

If your E-47x contains dummy modules: Do not operate the E-47x when the dummy modules are removed. Without the dummy module(s), the system will malfunction because no Control In signal can be fed into the amplifier module due to the broken circuit.



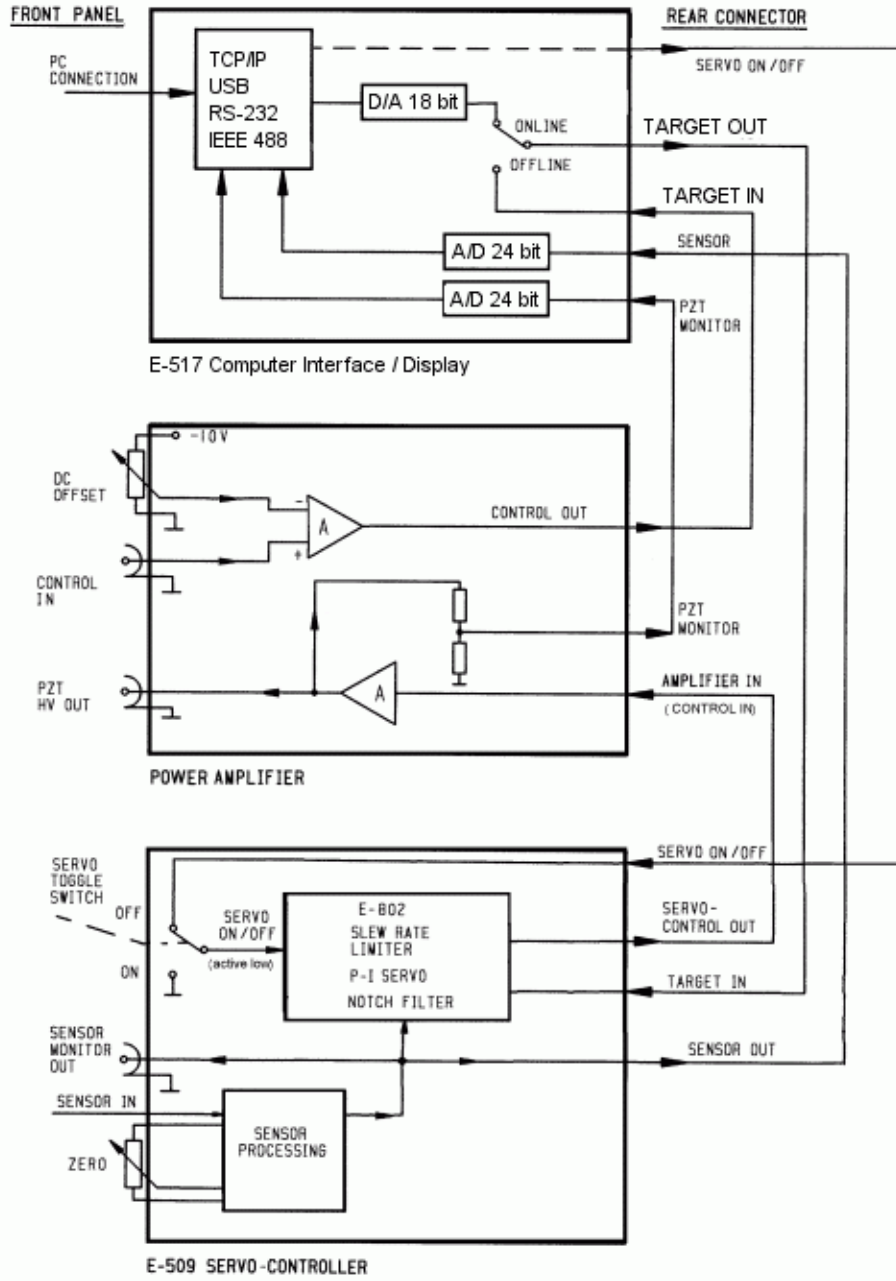


Figure 8: Interconnections between E-517 Interface, power amplifier (E-421) and E-509 Servo-Controller

5.5 Pin Assignments

5.5.1 2-Pin High-Voltage Connector

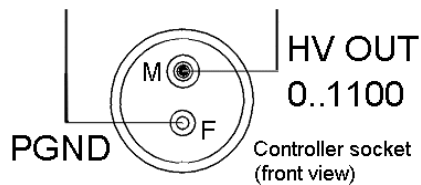
DANGER—IMPROPER WIRING CAN CAUSE DEATH, INJURY, DAMAGE AND VOID WARRANTY



Modification of HIGH VOLTAGE Connectors should only be carried out by the manufacturer. Any unauthorized modification may jeopardize operating personnel. Treat HIGH VOLTAGES and HIGH CURRENTS with respect.

Type: LEMO
EGG.0B.701.CJL.1173

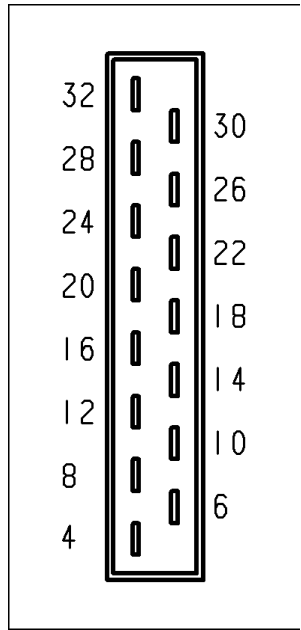
Pin Assignments:
HV OUT: HV output, up to 1100 V
PGND: Power ground
Housing: cable shield



5.5.2 Internal Backplane Connector of E-47x Chassis

The connector behind each module slot in the E-47x chassis (on the inside of the back panel) is for signal transmission and power supply of the module.

Pin	Function
4	GND (power)
6	+15 V output, 0.3 A
8	-15 V output, 0.3 A
10	+5 V output, 1.0 A
12	GND (measurement)
14	Control output
16	Piezo Monitor (0.1% of HV out)
18	Control input
20	Sync (-)
22	Sync (+)
24	Line power, 120/230 V AC common
26	n.c.
28	Line 120 V AC Phase
30	Line 230 V AC Phase
32	GND (chassis)



5.5.3 E-421 Main Connector

The rear connector on the E-421 amplifier module is compatible with the corresponding sockets in the E-47x chassis. Contact PI if you need more information for use in a different environment.

