BPA100
Benchtop Piezo Amplifier

User Guide

Original Instructions

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Chapter 1 Overview

1.1 Introduction

The BPA100 is a standalone high voltage (150 V), high current (10 A peak), high frequency amplifier, that allows piezo devices to be driven from a low voltage external source. It is designed to drive higher capacitive (low impedance) loads at moderate frequencies or lower capacitive loads at high frequencies. Examples include low voltage stacks and ultrasonic devices, respectively.

The input control (via analog signal to the BNC input connector) accepts -2 V to +10 V signal waveforms from external signal generators, computer controllers, or feedback networks - see Fig. 4.2 for frequency response data.

A built in protection circuit guards against short circuit or overload and a temperature sensing circuit protects against overheating of the unit.

With a maximum output voltage of 150 V, the BPA100 amplifier is suitable for use with many of our Thorlabs piezo actuators, chips, and stacks. It was designed for use in liquid dispensing applications, which require the piezo stacks to work at frequencies above 100Hz with a sinusoidal or square wave signal. However it is also suitable for use in a wide range of applications, including but not limited to: high dynamics placement, vibration control/damping, nozzle dithering during drilling or laser cutting, grinding, valve control, high dynamics tip/tilt mirror applications and ultrasonic applications, electro-optics, nanopositioning, and piezoelectric motors.

Chapter 2 Safety

2.1 Safety Information

For the continuing safety of the operators of this equipment, and the protection of the equipment itself, the operator should take note of the **Warnings, Cautions** and **Notes** throughout this handbook and, where visible, on the product itself.

The following safety symbols may be used throughout the handbook and on the equipment itself.

Warning: Risk of Electrical Shock

Given when there is a risk of injury from electrical shock.

Warning

Given when there is a risk of injury to users.

Caution

Given when there is a risk of damage to the product.

Note

Clarification of an instruction or additional information.

2.2 General Warnings

Warning

The BPA100 amplifier is specifically designed to drive the type of capacitive loads that characterize piezo actuators and provide high peak currents for the rapid charge and discharge of the piezo capacitance. It must not be used for applications other than stated in this manual, especially not for driving ohmic (resistive) or inductive loads.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. In particular, excessive moisture may impair operation.

Spillage of fluid, such as sample solutions, should be avoided. If spillage does occur, clean up immediately using absorbent tissue. Do not allow spilled fluid to enter the internal mechanism.

The equipment is for indoor use only.

The equipment is not designed for use in an explosive atmosphere.

Where the Warning symbol appears on the product, users must consult the manual to ascertain the nature of the potential hazard and the means of avoiding them.

Caution

High electrical currents require suitable connectors and cabling. The unit is fitted with SHV connectors which offer a high degree of safety and protection. A suitable cable (CA3262) is available separately from www.thorlabs.com. A suitable mating connector (T4004, T4005 or T4006) is available separately for use in connecting the piezo device being driven. It is not recommended to use any other type of connector or adapter.

In any case, the level of insulation provided by the connection must be doubled/reinforced insulation for 150 V peak minimum.

Chapter 3 Getting Started

3.1 Siting

The unit is designed to be used free standing on a shelf, benchtop or similar surface.

Caution

Ensure that proper airflow is maintained to the side and rear of the unit. Insufficient air flow will cause overheating and premature failure.

Do not cover the ventilation slots/fans on the side and rear of the unit. Place the amplifier in a location with adequate ventilation to prevent internal heat build-up. The device needs to be installed horizontally with 3 cm air circulation area. Vertical mounting prevents internal convection.

When siting the unit, it should be positioned so as not to impede the operation of the rear panel power supply switch.

3.2 Environmental Conditions

Warning

Operation outside the following environmental limits may adversely affect operator safety.

Location	Indoor use only
Maximum altitude	2000 m
Temperature range	5 °C to 40 °C
Maximum Humidity	Less than 80% RH (non-condensing) at 31°C
Line voltage fluctuations	Less than ±10% of the line voltage

To ensure reliable operation the unit should not be exposed to corrosive agents or excessive moisture, heat or dust.

If the unit has been stored at a low temperature or in an environment of high humidity, it must be allowed to reach ambient conditions before being powered up.

Caution

In applications requiring the highest level of accuracy and repeatability, it is recommended that the amplifier unit is powered up approximately 30 minutes before use, in order to allow the internal temperature to stabilize.

3.3 Electrical Installation

3.3.1 Connecting To The Supply

Warning: Risk of Electrical Shock

The unit must be connected only to an earthed fused supply of 85 V to 264 V.

The unit is shipped with appropriate power cables for use in the UK, Europe and the USA. When shipped to other territories the appropriate power plug must be fitted by the user. Cable identification is as follows:

Brown: Live

Blue: Neutral

Green/Yellow: Earth/Ground

Caution

High electrical currents require suitable connectors and cabling. The unit is fitted with SHV connectors which offer a high degree of safety and protection. A suitable cable (CA3262) is available separately from www.thorlabs.com. A suitable mating connector (T4004, T4005 or T4006) is available separately for use in connecting the piezo device being driven. It is not recommended to use any other type of connector or adapter.

In any case, the level of insulation provided by the connection must be double/reinforced insulation at 150 V peak minimum.

3.3.2 Fuses

Two type T 3.15 A H 250 V AC antisurge ceramic fuses are located on the back panel, one for the live feed and one for the neutral.

When replacing fuses:

1) Switch off the power and disconnect the power cord before removing the fuse cover.
2) Always replace broken fuses with a fuse of the same rating and type.

3.3.3 Rear Panel Description

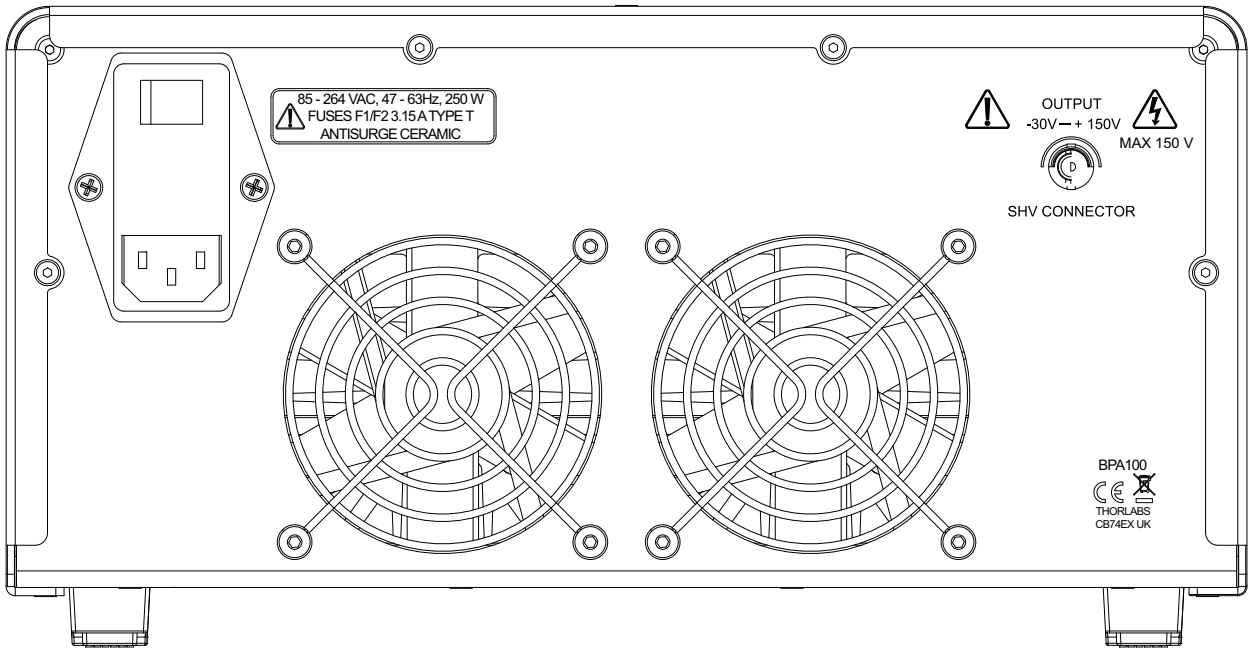


Fig. 3.1 Rear panel connections

OUTPUT - Female SHV connector. Provides connection to the actuator. A suitable cable (CA3262) for connecting the piezo actuator to the unit is available separately from www.thorlabs.com. Use only this cable when connecting the actuator. Replacement cables are available from www.thorlabs.com

Power - Standard IEC type connector. A region specific cable is shipped with the unit.

3.3.4 Connecting the Piezo Actuator

Warning: Risk of Electrical Shock

Piezo actuators are driven by high voltages. Voltages up to 150 V may be present at the SHV connector. This is hazardous and can cause serious injury. Appropriate care should be taken when using this device.

Do not touch the pins of the SHV connector which carries the piezo output voltage. A high voltage output may be active whenever the device is turned on. The output value depends on the control input.

Persons using the device must understand the hazards associated with using high voltages and the steps necessary to avoid risk of electrical shock.

The piezo amplifier must be switched OFF before the piezo actuator is plugged in or unplugged. Failure to switch the amplifier off may result in damage to either the amplifier, the stage or both.

Caution

A suitable mating connector (T4004, T4005 or T4006) is available separately for use in wiring the piezo device being driven. It is not recommended to use any other type of cable or adapter. Connectors and replacement or additional cables (CA3262) are available from www.thorlabs.com.

1) Ensure the power to the unit is switched OFF.
2) Connect the piezo actuator being driven to the OUTPUT connector.

3) Switch power ON.

3.3.5 Front Panel Description

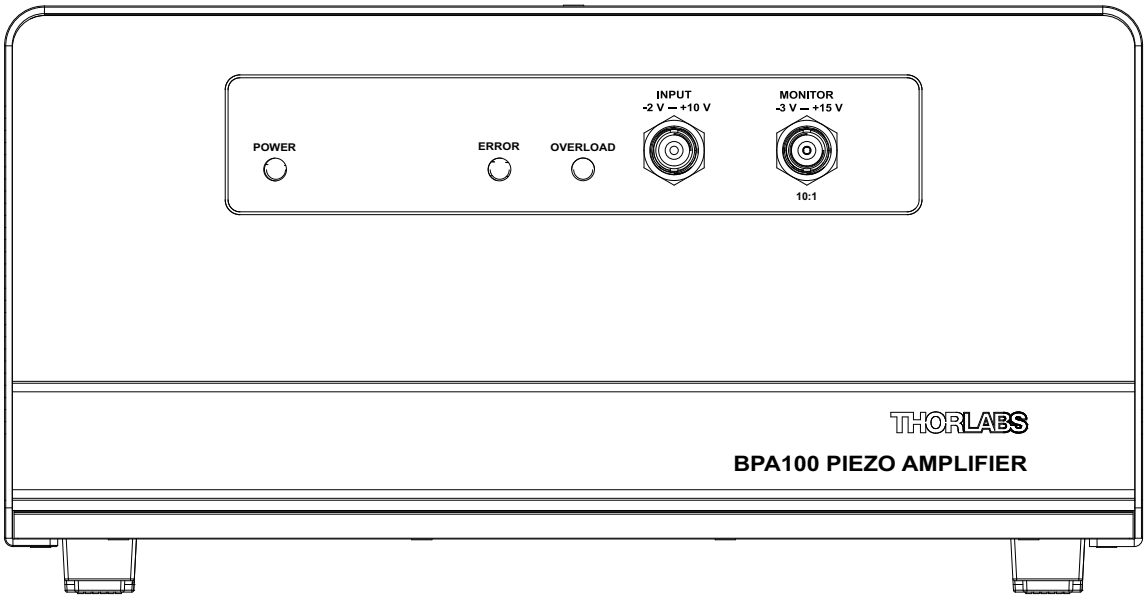


Fig. 3.2 Front panel

INPUT – BNC Connector. Provides connection to the controlling input source. This input allows a -2 V to +10 V signal to drive the output to its full scale -30 V to +150 V. This gives a gain of 15.

MONITOR – BNC Connector. Provides connection to a monitoring system (e.g. oscilloscope), in the range -3 V to +15 V.

POWER – Green LED. Lit when power is applied to the unit.

ERROR – Red LED. Lit when the power supply voltages are outside their tolerance bands. Under heavy load conditions when the current demand from the power supply exceeds its specified limit the power supply turns its output off to protect itself from damage. This results in one of the high voltage supply voltages dropping below their normal levels. This is indicated by the red ERROR LED.

After a number of seconds the power supply will attempt to switch on its output again. If the overload condition has cleared, the fault will clear automatically and the amplifier will return to its normal operating mode. If, however, the original load condition persists, the power supply will shut down again. This can result in cyclic shutdown behaviour.

As the power supply shutdown is caused by the extreme load condition, the fault can be cleared by reducing the load current, either by reducing the amplitude of the driving waveform or using a lighter load.

OVERLOAD – Red LED. Lit when that the operating conditions of the output power devices (their semiconductor junction temperatures) have reached their safe limits and, in order to prevent potential damage to them, the protection circuit has reduced the maximum output current. The reduction is gradual and changes dynamically as the load current and the junction temperature of the output devices changes. The OVERLOAD LED reflects this gradual reduction by the intensity of its illumination. Thus at the onset of current limiting, the LED is lit up dimly and the brightness is increased as the output devices are nearer their operating limits.

As the OVERLOAD condition is related to the semiconductor junction temperature of output devices, it can also occur under inadequate cooling conditions, for example if airflow to the fans is blocked, or the ambient temperature is too high.

Note

Although both red LEDs indicate a fault condition and normally turn on under excessive load conditions, the main difference between the ERROR LED and the OVERLOAD LED is that the former shows that the power supply protection has activated whilst the latter indicates the same for the amplifier. It is possible, for example, to draw excessive current from the power supply without excessive dissipation demanded from the output transistors (a typical case being high current drawn at a high voltage). Similarly, aggressive pulse load conditions or sustained high current demand at low voltages might result in excessive dissipation on the output transistors without exceeding the maximum current capability of the power supplies.

Neither of these fault conditions results in the output voltage being disabled. The amplifier will operate with a reduced rail voltage or limited output current and in general this will mean that the output waveform will be clipped or distorted. If the cause of the problem is removed (for example the amplitude of the input drive signal reduced) the amplifier will return to its normal operating mode. As the OVERLOAD condition is linked to high temperatures, the recovery might take several seconds, until the internal temperature had the time to cool down sufficiently.

Chapter 4 Operation

Warning: Risk of Electrical Shock

Piezo actuators are driven by high voltages. Voltages up to 150 V may be present at the SHV connector. This is hazardous and can cause serious injury. Appropriate care should be taken when using this device.

Do not touch the pins of the SHV connector which carry the piezo output voltage. A high voltage output may be active whenever the device is turned on. The output value depends on the control input.

Persons using the device must understand the hazards associated with using high voltages and the steps necessary to avoid risk of electrical shock.

The piezo amplifier must be switched OFF before the piezo actuator is plugged in or unplugged. Failure to switch the amplifier off may result in damage to either the amplifier, the stage or both.

Warning

The amplifier is capable of high peak current pulses, in excess of 10 Amps. This, in conjunction with the high output voltage, can result in a peak pulse power of over 1.5 kW. The amount of energy present in these pulses can cause a damaged or underrated piezo load to crack and potentially explode.

4.1 Using the Amplifier

1) Ensure the output is set to zero, then connect a -2 V to 10 V external source to the INPUT connector on the front panel.

Warning

The amplifier has an output voltage of -30 V to 150 V. If using a piezo rated at a voltage range lower than -30 V to 150 V, extreme care must be taken when adjusting the external source to ensure that the drive voltage does not exceed the piezo's rated values. Exceeding this voltage will damage the piezo.

2) Using the cable supplied, connect the piezo actuator to the OUTPUT connector on the rear panel.

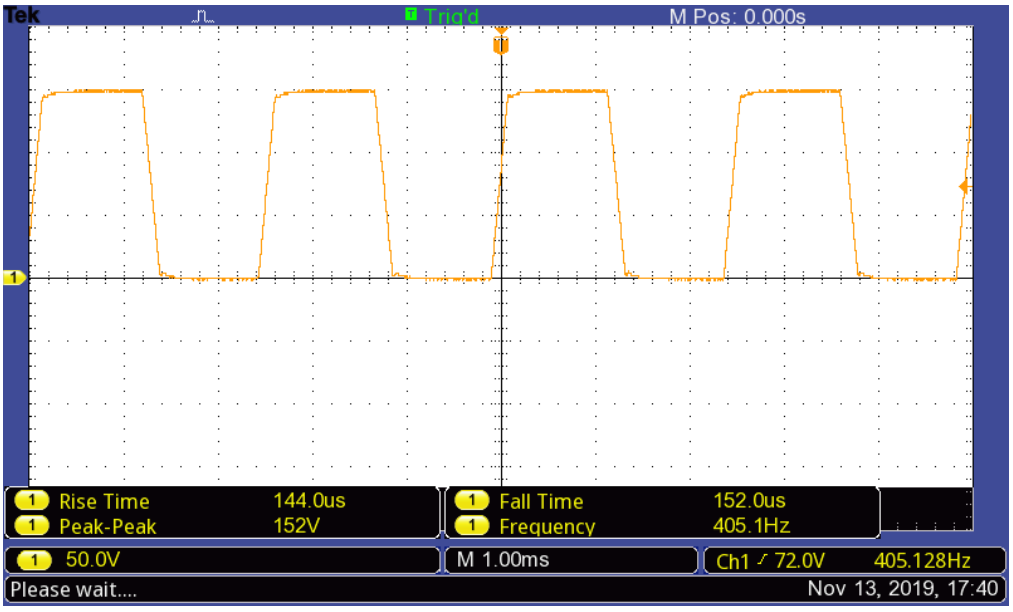
Any voltage on the front panel INPUT connector is now amplified by the unit and presented at the OUTPUT (piezo drive) connector and the position of the piezo actuator can be controlled by varying the -2 V to 10 V external source.

4.2 Typical Output Waveforms under Capacitive Load Conditions

The following waveforms illustrate the typical behavior of the output under load conditions.

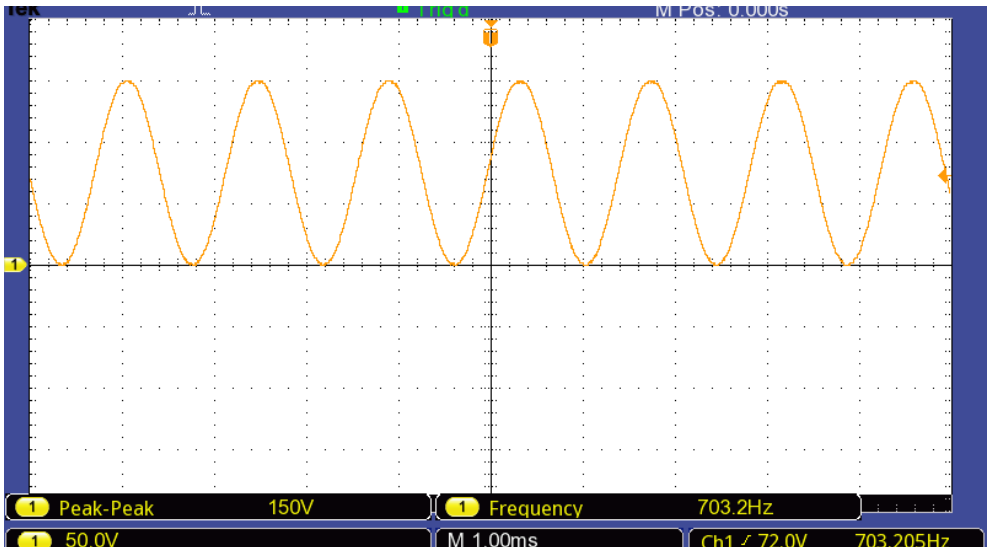
For consistency, measurements were carried out using high voltage polypropelene capacitors. Waveform plots were acquired using a Tektronix TBS1052B digital oscilloscope.

1) 152 Volt peak-to-peak, 405 Hz square wave into 10.4 µF capacitive load.



The rise time of 144 µs and fall time of 152 µs show that the peak charge and discharge currents are in excess of 10 A.

2) 150 V peak-to-peak, 703 Hz sine wave into 10.4 µF capacitive load.

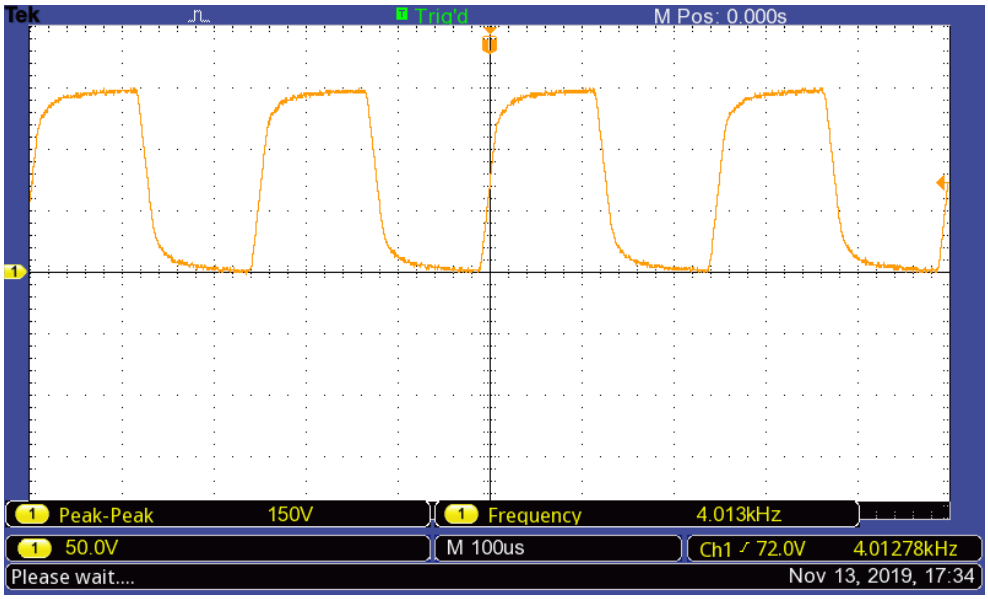


150 V peak to peak sine wave = 53 Volt RMS

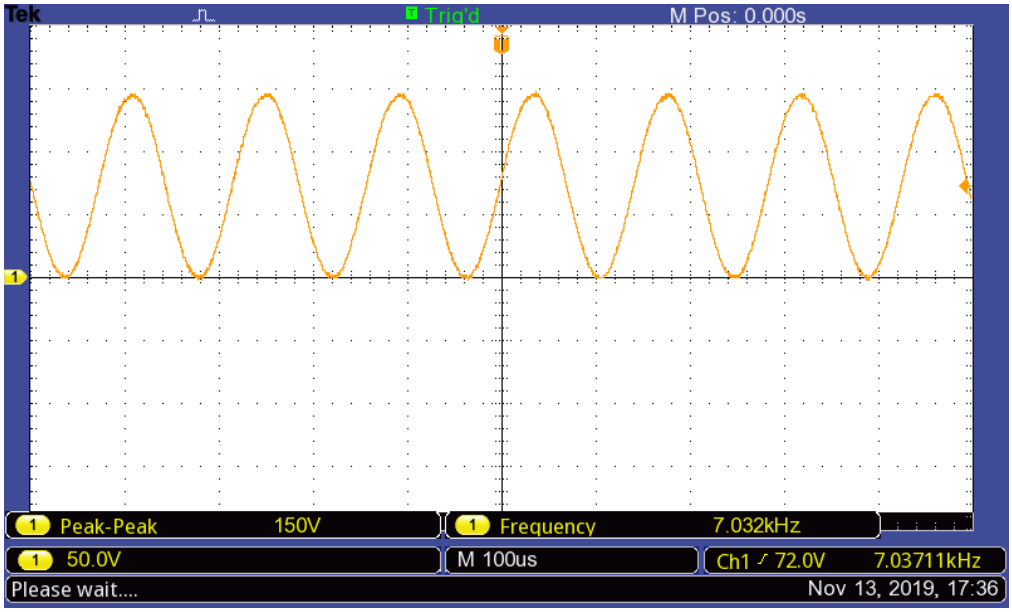
At 703 Hz, the impedance of the 10.4 µF capacitor is -21.8 Ω (theoretical)

Calculated RMS current: 2.43 A

3) 150 V peak to peak, 4 kHz square wave into 1.1 µF capacitive load.



4) 150 V peak to peak, 7 kHz sine wave into 1.1 µF capacitive load



4.3 Fans

The fan speed is regulated by the controller depending on the load and temperature conditions. Under idle or very light load conditions the fan speed is normally reduced to make operation quieter and reduce any potential accumulation of dust.

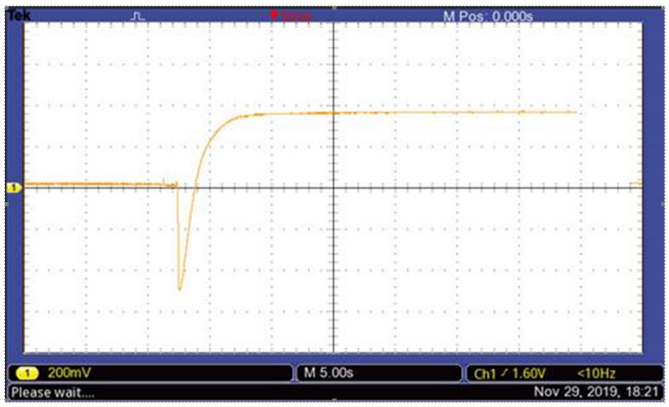
4.4 Powering Down The Unit

Warning

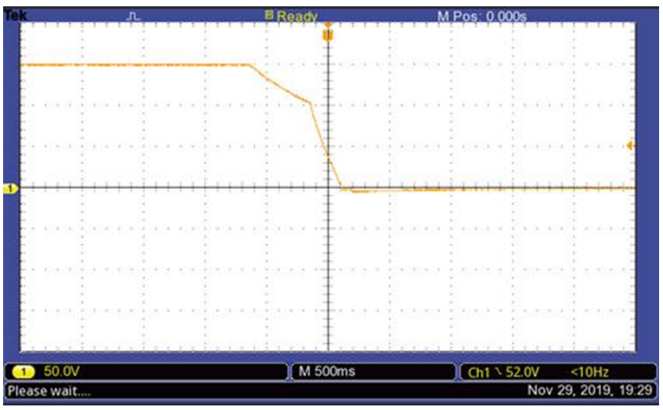
The amplifier may cause drive voltage spikes on power down. Ensure that the unit is powered down before making connections or disconnections.

As the power supply voltages collapse, the output voltage will show some transients as the amplifier powers down. Likewise, due to the large capacitance in the power supply lines, a small voltage can be present on the output for a while after the mains power is switched off. The oscilloscope waveform capture (A) below shows the typical behavior with 10 µF load capacitance connected and the output at 0 V. After the power is switched off, a small (approximately -0.5 V) spike is seen, the output voltage rises to about +0.4 Volt and then gradually decays. In most applications this behaviour can be ignored as the small residual voltages associated with it are negligible.

If the amplifier is switched off while outputting a high voltage, it will take a few seconds for the voltage to decay. The waveform capture (B) below shows the output voltage when the amplifier is turned off when outputting a constant +150 V.



A - Typical Shutdown Behavior



B - Shutdown with +150 V Output

Fig. 4.1 Power Down Behavior

4.5 Load Response

The load response of the BPA100 amplifier to a sinusoidal waveform at varying loads and frequencies is shown below.

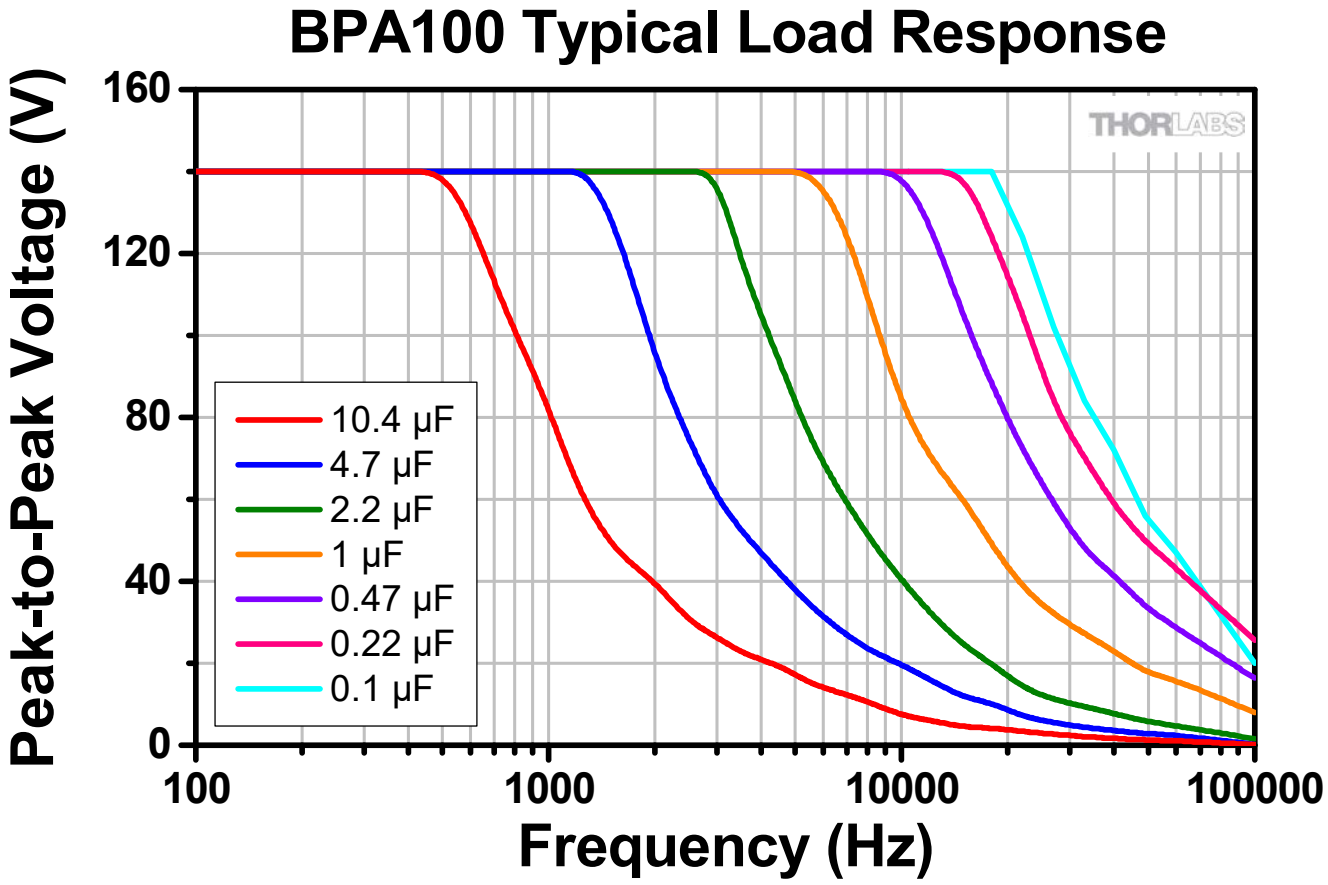


Fig. 4.2 Response of BPA100 Amplifier to Varying Loads and Frequencies

Appendix A Specifications

A.1 Specifications

Parameter	Value
Piezoelectric Output	
Voltage Output Range	-30 V to 150 V DC
Voltage Gain	15
Output Current	2.5 A Continuous (AC RMS), 10 A Peak
Voltage Stability	100 ppm over 24 hours (After 30 Minutes Warm-Up Time)
Noise	<0.5 mV RMS (Bandwidth 20 Hz to 100 kHz)
Typical Piezo Capacitance [a]	1 µF to 10 µF
Input	
Input Type	Single-Ended
Input Impedance	10 kΩ
Input Voltage Range	-2 V to 10 V DC
Input Voltage for Full Range	10 V DC ±2%
Monitor Output (BNC)	
Output Voltage Range	-3 V to 15 V
Output Impedance	220 Ω
Minimum Recommended Load Impedance	10 kΩ
Short Circuit/Overload Protection	Yes
Temperature Sensor	Yes
Scaling Factor (HV Monitor)	1/10 (15 V for a Piezo Voltage of 150 V)
Input Power Requirements (IEC Connector)	
Voltage	85 - 264 VAC
Supply Current	<2 A (Ignoring Power on Transient)
Protection	Internal Fuse, Qty 2, T3.15 A H 250 V Anti-surge Ceramic
General	
Dimensions	300.0 mm x 305.0 mm x 154.9 mm (11.81” x 12.01” x 6.1”)
Weight	6.0 kg (12.12 lbs)
Operating Temperature Range	5 °C to 40 °C

[a] The unit will drive loads with a capacitance outside the stated range - see Fig 4.2 for response data. Generally a lower capacitance will result in a flat response at higher frequency. For high capacitance loads, the response starts to fall off at lower frequencies.

Appendix B Preventive Maintenance

Warning

The equipment contains no user servicable parts.

Only personnel authorized by Thorlabs Ltd and trained in the maintenance of this equipment should remove its covers or attempt any repairs or adjustments.

Maintenance is limited to safety testing and cleaning as described in the following sections.

B.1 Cleaning

Warnings

Disconnect the power supply before cleaning the unit.

Never allow water to get inside the case.

Do not saturate the unit.

Do not use any type of abrasive pad, scouring powder or solvent, e.g. alcohol or benzene.

The fascia may be cleaned with a soft cloth, lightly dampened with water or a mild detergent.

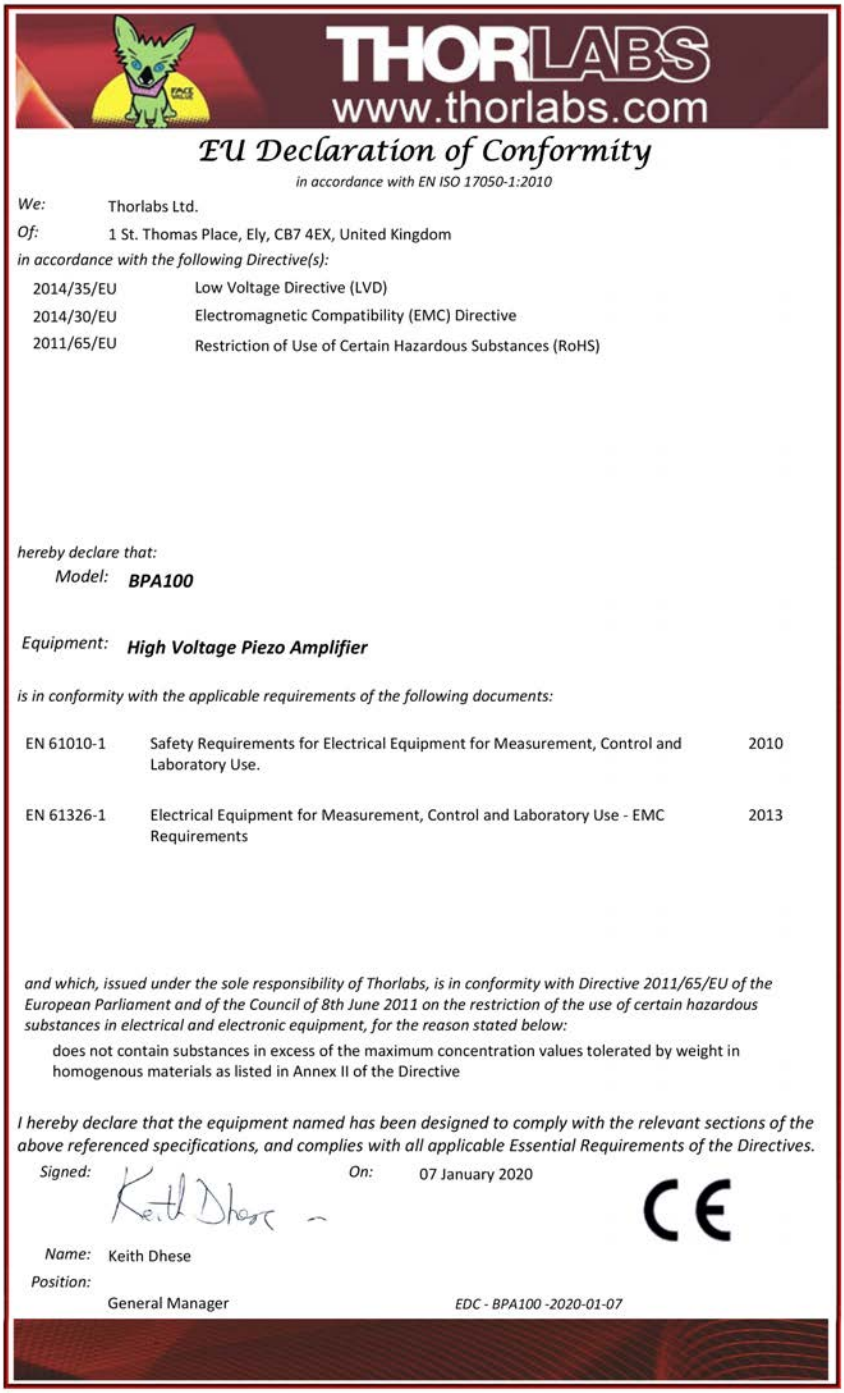
B.2 Testing

This product is designed to comply with EN 61010-1 and can be flash tested. It contains radio frequency interference suppressors and therefore, it is recommended that only a D.C. test is performed.

Appendix C Regulatory

C.1 Declarations Of Conformity

C.1.1 For Customers in Europe



THORLABS
www.thorlabs.com

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs Ltd.

Of: 1 St. Thomas Place, Ely, CB7 4EX, United Kingdom

in accordance with the following Directive(s):

2014/35/EU	Low Voltage Directive (LVD)
2014/30/EU	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)

hereby declare that:

Model: **BPA100**

Equipment: **High Voltage Piezo Amplifier**

is in conformity with the applicable requirements of the following documents:

EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.	2010
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013

and which, issued under the sole responsibility of Thorlabs, is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:

does not contain substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive

I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.

Signed: Keith Dhese On: 07 January 2020

CE

Name: Keith Dhese

Position: General Manager

EDC - BPA100 -2020-01-07

C.1.2 For Customers In The USA

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Changes or modifications not expressly approved by the company could void the user's authority to operate the equipment.

Appendix D Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.

USA, Canada, and South America
Thorlabs, Inc.
sales@thorlabs.com
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Thorlabs Ltd.
sales@uk.thorlabs.com
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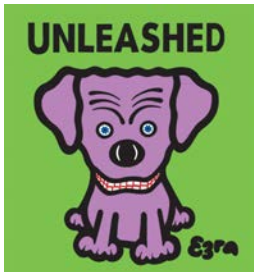
brasil@thorlabs.com

Japan
Thorlabs Japan Inc.
sales@thorlabs.jp

China
Thorlabs China
chinasales@thorlabs.com

Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return "end of life" Annex I category electrical and electronic equipment sold after August 13, 2005 to Thorlabs, without incurring disposal charges. Eligible units are marked with the crossed out "wheelie bin" logo (see right), were sold to and are currently owned by a company or institute within the EC, and are not dissembled or contaminated. Contact Thorlabs for more information. Waste treatment is your own responsibility. "End of life" units must be returned to Thorlabs or handed to a company specializing in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.



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