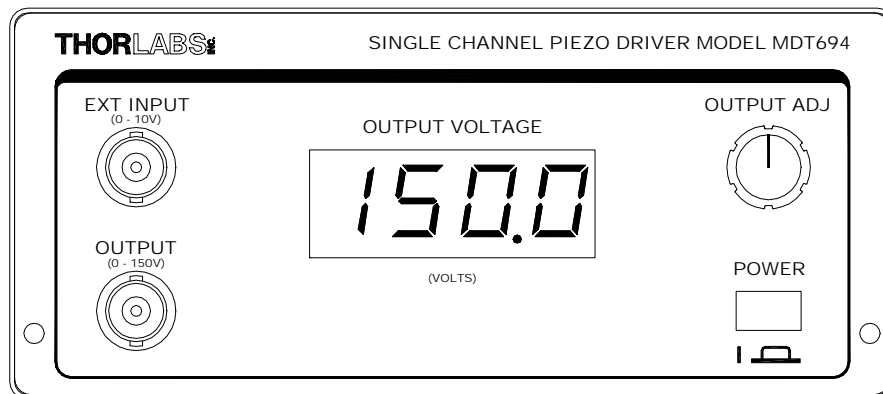

MDT694

Single Channel Piezo Driver

Operating Manual



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Section 1.0 Specifications

Physical Features:

Dimensions:	5 1/2" x 2 1/2" x 12"
External Input Connector:	BNC
Output Connector:	BNC
Manual Control:	10-Turn Potentiometer
RS-232 Interface:	Female DB9
Number of Channels:	1
Display Type:	3 1/2 Digit LED
Display Color:	Orange
Power Supply:	Switch Selectable between 115 / 230 VAC
Input Power:	115 / 230 VAC, 50-60 Hz
Computer Interface:	RS-232 Interface (Optional)

Max Ratings:

Max Output Current:	60mA
Max Ext. Input Voltage:	10V
Fuse Rating:	500mA @115VAC 250mA @ 230V

Electrical Characteristics:

Ext. Input Voltage Range:	0 to 10V
Ext. Input Resistance:	10K Ω
Output Impedance:	50 Ω
Output Voltage Range:	0 to 150V
External Input Gain:	15 V/V +/- 5%
Noise ¹ :	<1.5 mV _{RMS}
-3dB Bandwidth ² :	40kHz
Stability:	<0.1% over 16 hours
Operating Temp:	0 to 40 °C
Storage Temp:	0 to 40 °C

- 1 The noise was measured with the output set to 150V and an output capacitance of 0.1 μ F. The noise will decrease with higher output capacitance and increase with no output capacitance.
- 2 The Bandwidth was measured at 150V output with no load.



DANGER
High Voltage

! IMPORTANT SAFETY NOTES

The MDT694 can produce hazardous voltages and currents. Use CAUTION when operating the MDT694 and handling the piezo actuators!

The piezo elements are electrical capacitors capable of storing electrical energy over long periods of time. Besides storing charge from the MDT694, the piezo can accumulate static charge over time due to varying storage temperature and/or mechanical loads.

To safely discharge a piezo, connect it to the MDT694 and set the output voltage to 0 volts

The MDT694 has no user serviceable parts. Service should be performed by trained service personnel only!

Section 2.0 Overview

The MDT694 is a precision, low-noise, low-drift, high voltage controller for piezo actuators. The MDT694 provides both manual and external control of the piezo drive voltages. The MDT694 is an ideal driver for use with Thorlabs Piezo Actuators including the PE4 and the AE-series piezo elements. Typical applications include remote alignment of single-mode fiber couplers, remote positioning, Fabry-Perot etalons, etc.

The piezo drive voltage can be controlled manually as well as with an external modulating voltage. A precision 10-turn potentiometer is provided for manual adjustment of the drive voltage over the full operating range. This allows a hands-off control of the piezo to take full advantage of the inherently high resolution of the piezo element.

The drive voltage can also be controlled externally by applying an analog voltage (from 0 to 10V) to the front panel BNC input. This voltage is multiplied by a gain of 15 V/V and summed with the manual control voltage. The external control voltage can be supplied by any stable voltage source including function generators, DAC outputs, or DC supplies. Also, the external voltage can be used as part of a feedback loop for automated alignment systems. Since both the manual control and the external input voltage are summed, the manual control can be used for offset adjustments without having to readjust the external voltage source.

The MDT694 has a front-panel mounted LED digital readout for monitoring the high-voltage output.

Section 3.0 Description

Front Panel Features

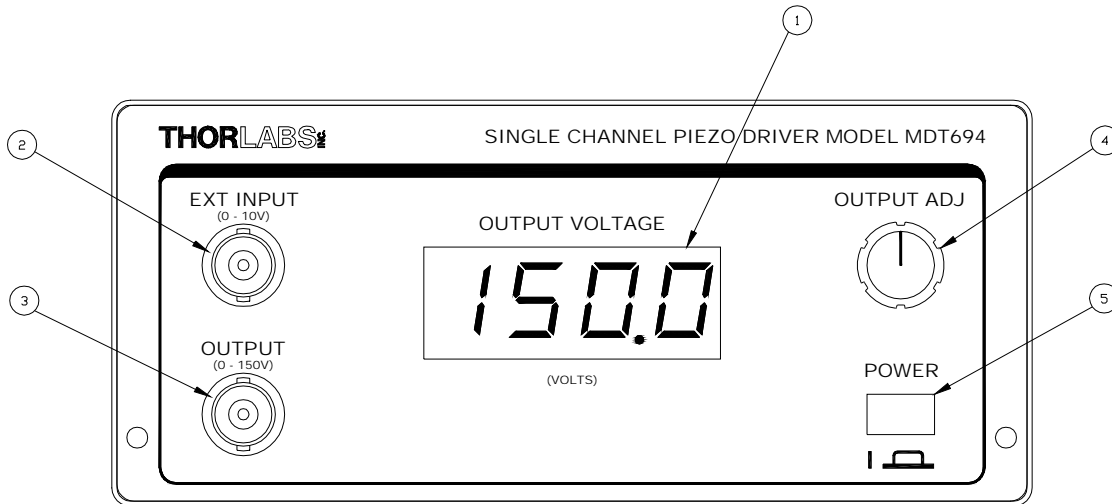


Figure 1. Front Panel

Feature	Description
1	3 ½ Digit LED Display (to display output voltage).
2	EXT INPUT BNC - This input is used to externally control the output. The input voltage range is 0 to 10V with a gain of 15 V/V.
3	OUTPUT BNC – The piezo element is connected to this BNC. It will output 0 to 150 volts at 60mA
4	OUTPUT ADJ Knob – This knob will adjust the output voltage from 0 to 150V DC. It can also be used as an offset for any external input, since it is summed with the EXT INPUT BNC.
5	POWER Button – Press in to turn the MDT694 on.

Controller Rear Panel Features

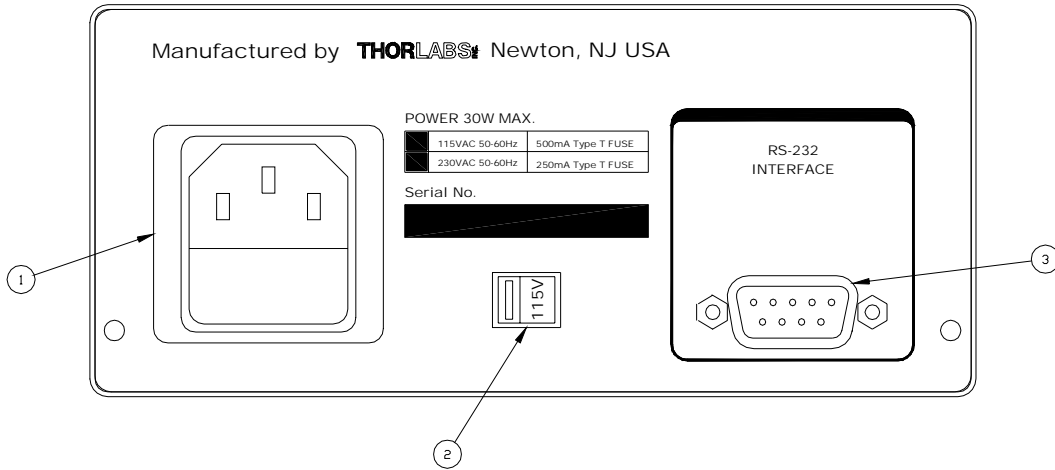


Figure 2. Rear Panel

Feature	Description
1	AC input and fuse receptacle
2	Line Voltage Selector Switch
3	RS-232 Serial Port Connector

Section 4.0 Operating Instructions



DANGER
High Voltage

The MDT694 can produce hazardous voltages and current. Use caution when operating this unit.

Using the OUTPUT ADJ knob

The OUTPUT ADJ knob is used to manually control the output voltage between 0 and 150 VDC. It can also be described as a DC offset voltage since it will be summed with the external input control and RS-232 control. Follow the procedure described below for operation in this mode.

1. Attach the piezo to the high voltage output connector on the MDT694 front panel.
Note: the BNC center conductor is positive and the shield is at ground potential. Be certain to match piezo polarity to the connector since most piezo elements will be permanently damaged if connected backwards.
2. Set the output voltage to 0V by turning the manual control knob counter-clockwise until the mechanical stop is reached.
3. Turn the power switch (located on the front panel) to the ON position. The digital display should begin displaying the output voltage.
4. Adjust the OUTPUT ADJ knob until the desired voltage is displayed or until the desired displacement is met.

Note: the maximum output voltage for the MDT694 is 150V. This may be too high for some piezo elements.

Using the EXT INPUT BNC

1. Attach the piezo to the high voltage output BNC connector, located on the front panel of the MDT694.
Note: the BNC center conductor is positive and the shield is at ground potential. Be certain to match piezo polarity to the connector since most piezo elements will be permanently damaged if connected backwards.
2. Set the output voltage to 0V by turning the manual control knob counter-clockwise until the mechanical stop is reached.
3. Turn the power switch on.
4. Connect an analog input signal (AC or DC), with a voltage between 0 and 10V, to the EXT INPUT BNC. The output will follow the EXT INPUT voltage with a gain of 15V/V.
Note: do not place a negative voltage on the EXT INPUT BNC that will cause the output to go below 0V. It is possible for the output voltage to go to a negative 15V. This has the potential of damaging a piezo element. A negative input voltage is possible if an offset voltage (set by the OUTPUT ADJ) is present. In this case the negative voltage must not allow the output to go below 0V.
5. For sinusoidal signals, calculate the output current and verify that it will not exceed the maximum current rating of 60mA. A piezo acts like a capacitor. The output current is a function of the change in voltage divided by the change in time (see Section 5 for details). The MDT694 has an output current limiting circuit to prevent damage to the unit, however the output sinusoid will be distorted.

Using the RS-232 Control (Optional)

See the instructions provided with the interface card.

Section 5.0 Applications Notes

Predicting Piezo Performance

The MDT694 is a precision, low-noise, low-drift voltage amplifier designed specifically to drive piezo actuators. Since piezo crystals can be modeled essentially as capacitors, it is easy to predict their dynamic performance using a basic set of equations:

$$i(t) = C \, dV/dt \quad \text{or} \quad I = C \, \Delta V/\Delta t \quad (\text{for a linear ramp})$$

Example 1

Q. How much current is needed to drive a Thorlabs piezo (p/n AE0505D16) a distance of 5 μ m in 10 ms?

For this piezo, we know the following:

$$C = 1.4\mu\text{F}$$

Displacement factor is 0.116 μ m / V

Therefore:

$$\Delta V = 5\mu\text{m} / (0.116\mu\text{m} / \text{V}) = 43\text{V}$$

$$I = 1.4\mu\text{F} * 43\text{V} / 10\text{ms} = 6\text{mA}$$

The MDT694 has an output current of 60mA, therefore it should have no difficulty driving this application.

Bandwidth

The output bandwidth will be affected in three ways. The maximum no load bandwidth is 40kHz at 150V. This is due to the open loop gain of the output amplifier. This maximum bandwidth will increase as the output signal amplitude decreases.

The bandwidth will also be limited by the maximum current rating. The ma current specified is 60mA. The output drive amplifier will limit the current automatically. For large capacitive loads the bandwidth will decrease. The formula can be seen in the previous section.

Lastly, the output bandwidth will be a function of the output impedance (50Ω) and the capacitance of the piezo as described below:

$$BW = 1 / (2 * \pi * 50\Omega * C_{PIEZO})$$

$$BW = .0032 / C_{PIEZO}$$

Hysteresis

Due to the inherent properties of the piezo crystal, all piezo actuators exhibit a certain amount of positional hysteresis that can affect repeatability and accuracy. Thorlabs piezo actuators have a typical hysteresis of about 5-10% at room temperature. One way to minimize the error due to hysteresis is to always approach a location from the same direction. A better approach would be to use an external encoder to give direct positional feedback.

Section 6.0 Serial Interface (Optional)

The MDT694 allows for an optional computer interface card to be installed. The rear panel DB9 connector will not be active unless the interface card is installed.

The RS-232 serial interface port will allow the user to remotely control and monitor the output voltage. The serial port can be connected to a PC running an ASCII terminal emulator program to remotely access the MDT694 features. The MDT694 has an interactive menu, which is accessible from the serial port. For experienced programmers, the serial interface may be incorporated into a user program developed on a serial port system.

Section 7.0 Maintenance & Troubleshooting

Setting the Line voltage

The MDT694 is shipped from the factory configured for 100-120VAC operation. The MDT694-EC is shipped from the factory configured for 220-240VAC operation. If the operating voltage needs to be changed, follow the procedure below:

1. Turn the MDT694 power switch OFF and remove the AC line cord.

2. Locate the voltage selector switch on the rear panel of the MDT694.
3. Slide the voltage selector switch, using a flat head screwdriver, to the desired line voltage. (i.e. The Line Voltage Selector Switch will display the set operating voltage, either 115V or 230V)
4. Replace the fuse for the proper line voltage. The fuse rating is located on the rear panel of the MDT694 and in the Specifications section of this manual.
5. Connect the AC Line cord and turn the power on.

Fuse Replacement

The main fuse is located inside the AC receptacle on the back cover. To replace the fuse, remove the AC line cord and pry the fuse holder out of the receptacle. Replace the fuse with the type fuse indicated on the rear panel.

Cleaning

The MDT694 should only be cleaned with a soft cloth and mild soap detergent or isopropyl alcohol. Do not use a solvent-based cleaner.

Technical Support

You may use any of the following methods to contact Thorlabs in case of difficulty or if you have questions regarding your MDT694.

www.thorlabs.com

Thorlabs web site will have up to date application notes and frequently asked questions regarding our products.

Techsupport@thorlabs.com

Send a detailed email message and one of our application engineers will respond promptly (within 1 business day).

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