

# Electro-Optic Modulators



EO-PM-NR-C1

EO-AM-NR-C2  
With EO-GTH5M



EO-HVA

Thorlabs’ free-space electro-optic (EO) amplitude and phase lithium niobate modulators combine crystal growth and electro-optic materials. Our standard modulators use undoped lithium niobate. For higher-power operation, we offer MgO-doped lithium niobate. The standard EO modulators are broadband DC-coupled, and a high Q resonant model option is available.

Our standard DC-coupled broadband EO modulators consist of an EO crystal packaged in a housing optimized for maximum RF performance. The RF drive signal is connected directly to the EO crystal via the SMA RF input. An external RF driver supplies the drive voltage for the desired modulation. The crystal may be modulated from DC up to the frequency limits of the external RF driver.

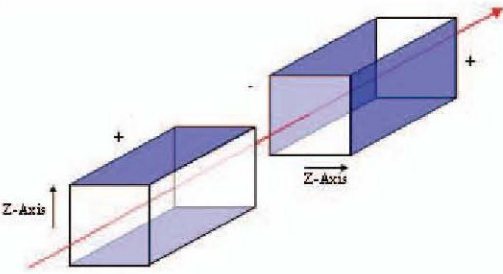
For flexibility, Thorlabs also offers a second modulator option. Resonant frequency modulators simplify the driver requirements for many applications where the modulator is operated at a single frequency. A high Q resonant tank circuit located inside the modulator boosts the low-level RF input voltage from a standard function generator to the high voltage needed to get full depth of modulation. Call our tech support team for details on the specific resonant frequencies available.

## EO Amplitude Modulator

The electro-optic amplitude modulator (EO-AM) is a Pockels cell type modulator consisting of two matched lithium niobate crystals packaged in a compact housing with an RF input connector. Applying an electric field to the crystal induces a change in the indices of refraction (both ordinary and extraordinary), giving rise to an electric field-dependent birefringence, which leads to a change in the polarization state of the optical beam. The EO crystal acts as a variable wave plate with retardance linearly dependent on the applied electric field. By placing a linear polarizer at the exit, the beam intensity through the polarizer varies sinusoidally with linear change in applied voltage.

## Features

- High Performance in a Compact Package
- Broadband DC Coupled and High Q Resonant Models for Low RF Drive
- Standard Broadband AR and Custom Coatings
- Ø2mm Clear Aperture
- SMA Female Modulation Input Connector
- MgO-Doped Versions for High Power
- DC to 100MHz
- Custom OEM Versions Available

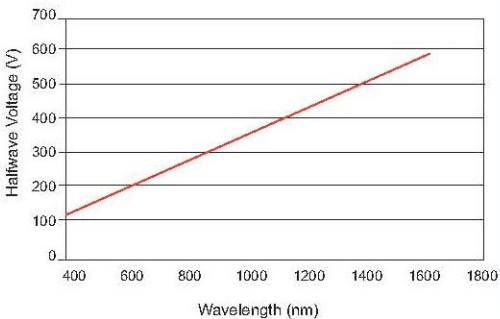


EO Amplitude Modulator Crystal Configuration

## EO-Amplitude Modular Specifications

Specification	Description
Modulator Crystal	Lithium Niobate (LiNbO <sub>3</sub> )
Wavelength Range	
C1	600-900nm
C2	900-1250nm
C3	1250-1650nm
C4	400-600nm
Clear Aperture	Ø2mm
Input Connector	SMA Female
Max Optical Power Density	2W/mm <sup>2</sup> @ 532nm, 4W/mm <sup>2</sup> @ 1064nm
Capacitance	14pF (typical)

## EO-AM Half-Wave Voltage Vs Wavelength



# Electro-Optic Modulators (cont.)

## EO Phase Modulator

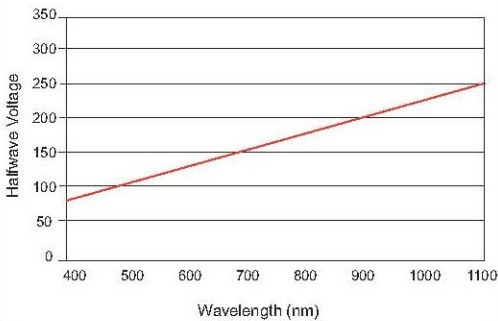
Our Electro-Optic phase modulators (EO-PM) provide a variable phase shift on a linearly polarized input beam. The input beam is linearly polarized along the vertical direction, which is the Z-axis of the crystal. A voltage at the RF input is applied across the Z-axis electrodes inducing a change in the crystal's extraordinary index of refraction and thereby causing a phase shift in the optical signal.

The control signal may be a DC or a time varying RF signal. When the control voltage is a time varying signal, the optical beam undergoes frequency modulation whereby some of the energy at the fundamental frequency is converted into sidebands separated from the fundamental frequency by the integer multiples of the modulating frequency. The amount of energy converted into sidebands is determined by the depth of modulation.

### EO-Phase Modulator Specifications

Specification	Description
Modulator Crystal	Lithium Niobate (LiNbO <sub>3</sub> )
Wavelength Range	
C1	600nm to 900nm
C2	900nm to 1250nm
C3	1250nm to 1650nm
C4	400nm to 600nm
Clear Aperture	Ø2mm
Input Connector	SMA Female
Half Wave Voltage, V <sub>π</sub>	240V@1064nm
Max Optical Power Density	2W/mm <sup>2</sup> @ 532nm, 4W/mm <sup>2</sup> @ 1064nm
Capacitance	14pF (typical)

EO-PM Half-Wave Voltage Vs Wavelength



## High Voltage Amplifier for EO Modulators

Our high-voltage amplifier is designed to directly drive the electro optic modulators. It features a large output span, pulsed output current, wide power bandwidth, and low noise. A voltage gain of 20x boosts the input up to the high voltages needed to drive our lithium niobate broadband modulators. The DC bias control consisting of a 10-turn potentiometer with a digital readout provides precise control and repeatability. The bias adjustment is used to shift the DC level of the output as needed. A voltage monitor output is provided to allow real-time monitoring of the high-voltage output.

### High Voltage Amplifier Specifications

- ±200V Bipolar Output
- 200mA Pulsed Output Current (100mA Continuous)
- 1MHz Bandwidth
- 600V/μs Slew Rate
- -20V/V Gain

## Swivel Polarizer Mount for EO Modulators

Our new EO-PMT Swivel Polarizer Mount provides an easy way to mount one or two of our 5mm calcite Glan-Thompson polarizers (GTH5M) directly onto the EO Modulator, eliminating the need for separate polarizer mounts.

The pivoting swivel mount is an exclusive feature of our polarizer mount that allows the polarizer to be rotated easily allowing full access to the modulator input and output apertures without having to remove the polarizer. This feature is handy for beam alignment and other diagnostic purposes.

The EO-GTH5M packages the Glan-Thompson polarizer (GTH5M) with the mounting adapter.

### Swivel Polarizer Mount Specifications

- 13mm Diameter Aperture for Use With GTH5M
- #2-56 Mounting Screw and Washer Included
- Rotates Out of Beam Path

ITEM#	DESCRIPTION
EO-AM-NR-C1	Electro-Optic Amplitude Modulator, 600-900nm
EO-AM-NR-C2	Electro-Optic Amplitude Modulator, 900-1250nm
EO-AM-NR-C3	Electro-Optic Amplitude Modulator, 1250-1650nm
EO-AM-NR-C4	Electro-Optic Amplitude Modulator, 400-600nm
EO-PM-NR-C1	Electro-Optic Phase Modulator, 600-900nm
EO-PM-NR-C2	Electro-Optic Phase Modulator, 900-1250nm
EO-PM-NR-C3	Electro-Optic Phase Modulator, 1250-1650nm
EO-PM-NR-C4	Electro-Optic Phase Modulator, 400-600nm
EO-HVA	Electro-Optic High-Voltage Amplifier
EO-PMT	Modulator Mounting Adapter
EO-GTH5M	Modulator Mounting Adapter With GTH5M