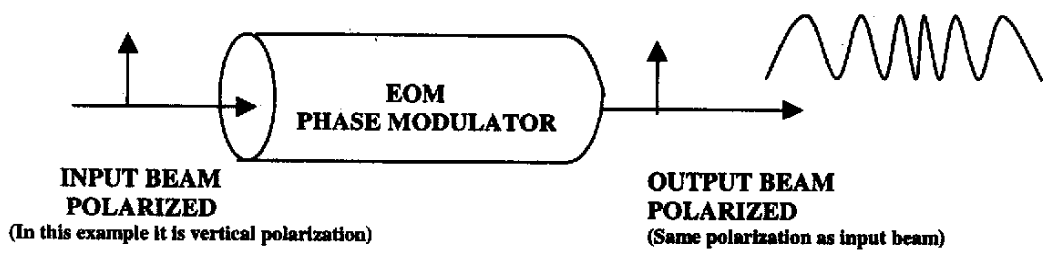
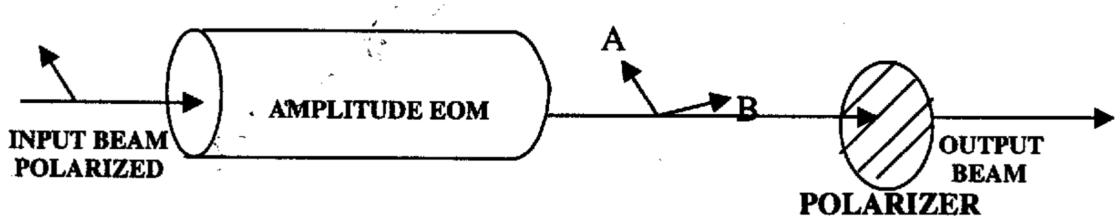
QUANTUM TECHNOLOGY

A comparison of PHASE, AMPLITUDE EOM and EO POLATIZATION ROTATORS



PHASE MODULATION

In PHASE MODULATION, the output amplitude and polarization remain unchanged, but the phase of the wave is altered by the external modulation signal to the EOM.



AMPLITUDE MODULATION

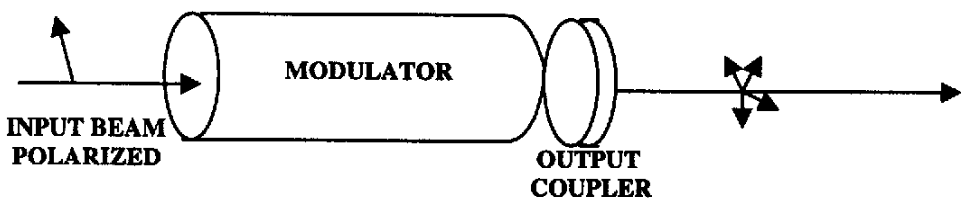
Point A (Linear Polarization state) at the output of the Amplitude EOM modulator occurs when the voltage on the modulator is zero volts.

Point B at the output of the Amplitude EOM modulator occurs when the voltage on the modulator is Vλ/2, or the halfwave voltage at some wavelength λ.

Note: At the halfwave voltage the vector represented by point A is rotated through 90 degrees to point B.

The addition of a BIAS voltage is required to reach the output linear polarization ~~linear~~ state A (point A above). With the correct DC step or an AC pulse equal to Vλ/2 (the halfwave voltage), the output polarization is linear in state B (point B above). However, going from point A to point B, the output polarization changes from linear along A to elliptical along A to circular at Vλ/4 (quarterwave voltage), or 45 degrees rotation. Then it becomes elliptical along B to linear along B (point B on page 1).

The light through the polarizer located as shown on page 1, would be observed by a detector as amplitude intensity changes. The polarizer assembly is usually mounted to the output end of the amplitude EOM, and is included as part of the amplitude modulation unit.



E-O POLARIZATION ROTATOR

The output polarization is always linear, and rotates as a linear function of the applied voltage to the E-O POLARIZATION ROTATOR. The halfwave voltage, Vλ/2, rotates the input polarized vector by 90 degrees; whereas, a quarterwave voltage, Vλ/4, rotates the input polarized vector by 45 degrees. The output light intensity is unchanged. The output coupler assembly is mounted as shown in the above diagram. This coupler can be removed to convert the modulator to a phase EOM, or when removed to convert this system to amplitude modulator by adding a polarizer.

A phase EOM may be used as an Amplitude or Polarization Rotator EOM by adding the appropriate external component. However, thermal stability is sacrificed. An Amplitude EOM or a Polarization Rotator may be used as a Phase EOM by removing the appropriate component as shown in the diagrams, that is, either the polarizer or the output coupler. But be aware, that the phase sensitivity is only half of that of a correctly built phase EOM. This is due to the fact that the set of crystals within the phase EOM are not rotated by 90 degrees as they would be in the other two cases. The rotation of these crystals by 90 degrees with the Amplitude and Polarization Rotational EOMs provides for thermal compensation between the **e** (extraordinary) and the **o** (ordinary) polarization vectors.

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MODULATION DEPTH
RISETIME and SIDE BANDS

The modulation depth can be calculated from the formulas below. In general, we are lookiing the sine squared function of the voltage.

MODULATION DEPTH: (Center Bias):

DEPTH of MODULATION (CTRBIAS)

$$= 2 \sin(\pi V_{pp} / 4 [V\lambda/2] + \pi/4)^2 - 1$$

$$= \sin(\pi V_{pp} / 2 [V\lambda/2])$$

MODULATION DEPTH: (Zero Bias):

DEPTH of MODULATION (ZBIAS) $= 2 \sin(\pi V_{pp} / 2 [V\lambda/2])^2$

***RISETIME SPEEDUP*:** t (*rise optical*) = 0.75 t (*rise electrical*)

***FIRST ORDER SIDE BAND POWER*:** $[J_1 (KmRad/V \times V_p)]^2$