

# Waveplates

Optics

Lenses

Mirrors & Beamsplitters

Prisms & Polarizers

Filters

Pinholes

- Quarter and half waveplates
- Zero or multiple order available



Opto-mechanics

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Mounting Hardware

Mirror & Component Mounts

Manual Micro Positioners

Motorized Positioners

Applications for Half Waveplates include rotating the plane of polarization (e.g. in a laser), electro-optic modulation and as a variable ratio beamsplitter (when used in conjunction with a polarizing cube).

Waveplates are made from materials which exhibit birefringence. The velocities of the extraordinary and ordinary rays through the birefringent material vary inversely with their refractive indices. For the case of crystal quartz the extraordinary beam has a higher refractive index and therefore a slower velocity. For this reason its direction is known as the 'slow' axis. Likewise, the direction of the ordinary beam is known as the 'fast' axis and is indicated by the marked lines on the mount.

The difference in velocities gives rise to a phase difference when the two beams recombine. In the case of an incident linearly polarized beam this is given by

$$\theta = \pm \frac{2\pi d (n_e - n_o)}{\lambda}$$

where:

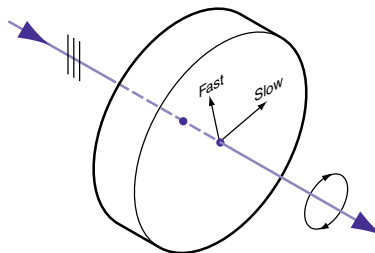
$\theta$  = phase difference

$d$  = thickness of waveplate in mm

$n_e, n_o$  = refractive indices of extraordinary and ordinary rays respectively

$\lambda$  = wavelength in nm

At any specific wavelength the phase difference is governed by the thickness of the retarder. Quarter and Half Waveplates are two specific cases of this.



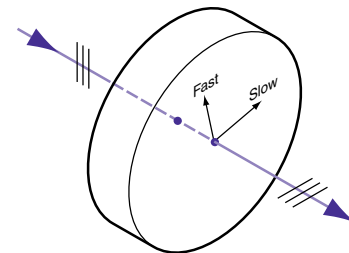
## Quarter Waveplate

A Quarter Waveplate is used to convert linearly polarized beams into circularly polarized beams (and vice versa).

The construction of a Quarter Waveplate is such that the fast axis, indicated by the marked line, lies in the surface at 45° to the input polarization. The input beam is resolved into two

components of equal amplitude, but each with a different velocity.

Applications for Quarter Waveplates include creating circular polarization from linear or linear polarization from circular, ellipsometry, optical pumping, suppressing unwanted reflections (when used in conjunction with a polarizer) and optical isolation (when used with a Polarizing Beamsplitter Cube.)



## Half Waveplates

The thickness of a Half Waveplate is such that the phase difference is  $\pi$  (zero order) or  $3\pi$ ,  $5\pi$ ,  $7\pi$ , etc (multiple orders). A linearly polarized beam incident on a Half Waveplate emerges as a linearly polarized beam but rotated such that its angle to the optic axis is twice that of the incident beam. It is usual to have the fast axis lying in the surface of the retarder at 45° to the input polarization. The Half Waveplate therefore introduces a 90° rotation of the plane of polarization.

# Zero Order Waveplates

Ealing Zero Order Waveplates are the preferred type of waveplate. They are not as sensitive to changes in temperature, wavelength, angle of incidence, or collimation. A wavelength shift of 15 nm will result in approximately a 1% retardation change. They are supplied in a 25.4 mm mount.

## Specifications

**Material:** Crystalline Quartz

**Retardation:**  $\pm 0.005\lambda$

**Wavefront Distortion:**  $\lambda/8$

**AR Coating:**  $<0.25\%R$  per surface

**Diameter:** 25.4 +0.0/-0.15 mm

**Aperture:** 15 mm

**Thickness:** 8 +0.0/-0.25 mm

**Laser Damage Threshold:** 500 MW/cm<sup>2</sup>

## Zero Order Waveplates

| Wavelength (nm) | Quarter Waveplate |          | Half Waveplate |          |
|-----------------|-------------------|----------|----------------|----------|
|                 | Catalog Number    | Price US | Catalog Number | Price US |
| 266             | 45-7572           | \$149.00 | 45-7796        | \$149.00 |
| 355             | 45-7598           | \$149.00 | 45-7812        | \$149.00 |
| 405             | 45-7661           | \$149.00 | 45-7811        | \$149.00 |
| 488             | 45-7606           | \$149.00 | 45-7820        | \$149.00 |
| 514             | 45-7614           | \$149.00 | 45-7838        | \$149.00 |
| 532             | 45-7622           | \$149.00 | 45-7846        | \$149.00 |
| 633             | 45-7648           | \$149.00 | 45-7861        | \$149.00 |
| 670             | 45-7663           | \$149.00 | 45-7887        | \$149.00 |
| 780             | 45-7697           | \$149.00 | 45-7911        | \$149.00 |
| 808             | 45-7705           | \$149.00 | 45-7929        | \$149.00 |
| 830             | 45-7721           | \$149.00 | 45-7945        | \$149.00 |
| 850             | 45-7739           | \$149.00 | 45-7952        | \$149.00 |
| 1064            | 45-7754           | \$149.00 | 45-7978        | \$149.00 |
| 1300            | 45-7762           | \$149.00 | 45-7986        | \$149.00 |
| 1550            | 45-7770           | \$149.00 | 45-7994        | \$149.00 |

# Multiple Order Waveplates

Ealing Multiple Order Waveplates are available in a range of laser-line wavelengths, mounted in a 25.4 mm diameter mount. Multiple Order Waveplates are sensitive to changes in temperature, angle of incidence, and degree of collimation. They are intended for use at the design wavelength only. If used at a different wavelength, a retardation change of 10% occurs for every 0.2 nm deviation.

## Specifications

**Material:** Crystalline Quartz

**Retardation:**  $\pm 0.005\lambda$

**Wavefront Distortion:**  $\lambda/8$

**AR Coating:**  $<0.25\%R$  per surface

**Diameter:** 25.4 +0.0/-0.15 mm

**Aperture:** 15 mm

**Thickness:** 8 +0.0/-0.25 mm

**Laser Damage Threshold:** 500 MW/cm<sup>2</sup>

## Multiple Order Waveplates

| Wavelength (nm) | Quarter Waveplate |          | Half Waveplate |          |
|-----------------|-------------------|----------|----------------|----------|
|                 | Catalog Number    | Price US | Catalog Number | Price US |
| 266             | 45-6855           | \$199.00 | 45-7069        | \$199.00 |
| 355             | 45-6871           | \$199.00 | 45-7085        | \$199.00 |
| 405             | 45-6881           | \$199.00 | 45-7081        | \$199.00 |
| 488             | 45-6889           | \$199.00 | 45-7093        | \$199.00 |
| 514             | 45-6897           | \$199.00 | 45-7101        | \$199.00 |
| 532             | 45-6905           | \$199.00 | 45-7119        | \$199.00 |
| 633             | 45-6921           | \$199.00 | 45-7135        | \$199.00 |
| 670             | 45-6947           | \$199.00 | 45-7150        | \$199.00 |
| 780             | 45-6970           | \$199.00 | 45-7184        | \$199.00 |
| 808             | 45-6988           | \$199.00 | 45-7192        | \$199.00 |
| 830             | 45-7010           | \$199.00 | 45-7226        | \$199.00 |
| 850             | 45-7016           | \$199.00 | 45-7234        | \$199.00 |
| 1064            | 45-7028           | \$199.00 | 45-7238        | \$199.00 |
| 1300            | 45-7036           | \$199.00 | 45-7242        | \$199.00 |
| 1550            | 45-7048           | \$199.00 | 45-7262        | \$199.00 |

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