

Waveplates for 10.6μm, 5.3μm, and Other IR Wavelengths

**Series WPM
Multiple-Order
Waveplates**
**Series WPZ
Zero-Order
Waveplates**
For:

- Altering beam polarization character
- Converting linear to circular polarization ($\lambda/4$ plates)
- Rotating plane of polarization ($\lambda/2$ plates)

Providing:

- Operating with CO₂, CO, or HF-DF and other IR lasers
- Apertures up to 1.0"
- Low insertion loss
- Visible transparency for ease of alignment
- Convenient rotating mounts for optical bench mounting

**Series WPM
Multiple-Order Waveplates**

When a plane-polarized beam is incident on a birefringent plate whose optic axis lies in the plane of the plate, the beam is resolved into two components. These components propagate through the plate with different velocities and recombine upon exiting with a new polarization. The character of the polarization depends upon the orientation of the optic axis and the net difference in optical path length for the two components. This difference, d , is given by

$$d = (\Delta\eta)t$$

where $\Delta\eta$ is the birefringence and t the plate thickness.

When d is equal to one quarter of the wavelength and the optic axis is at 45° to the incoming polarization, the outgoing polarization is circular. When it is equal to one-half of the wavelength being used, the output polarization is linear but rotated with respect to the input polarization by twice the angle between the incoming polarization and the optic axis.

The calculated thickness for a quarter waveplate of CdS at 10.6μm is approximately 0.01 inch, which is too thin for manufacturing. Therefore, plates are made at odd multiples of the quarter-wave thickness, i.e., 5 $\lambda/4$, 7 $\lambda/4$, or 9 $\lambda/4$. The net

effect at that the design wavelength is basically the same, but the devices are far less fragile. Half-wave plates are made at 3 $\lambda/2$ rather than $\lambda/2$, again for reliability. All plates are polished flat to better than $\lambda/40$ at 10.6μm and parallel to less than 5 arc seconds. They are supplied anti-reflection coated at the design wavelength.

Waveplates are available as unmounted elements or mounted elements in rotators with optical bench mounts.

Specifications

Plate Diameter	0.4, 0.6, 0.8, and 1.0"
Clear Aperture (when mounted)	Plate diameter minus 0.05"
Retardation Accuracy	±2° @ 10.6μm; ±4° @ 5.3μm
Bandwidth (for 6° error)	±0.1μm @ 10.6μm
Retardation Range	0 to 360°
Transmission	>98.5% @ 10.6μm

**Series WPZ
Zero-Order Waveplates**

Because of their multiple order and thickness, Series WPM waveplates have limitations on their bandwidth (tolerance to laser wavelength shift), acceptance angle, and temperature of operation. To attain greater tolerance in these areas, zero-order waveplates are employed. These waveplates are made from two pieces

of CdS whose thickness differs by the desired amount calculated from the equation above. Both plates are made thick enough to ensure stability and are mounted in a holder with a 90° rotation between their optic axes so that the net optical path difference is $\lambda/4$, $\lambda/2$, or some other specified amount. The bandwidth of such

plates is improved with respect to WPM units. In other words, the WPZ model, with two plates mounted in a metal cell, can work over a broader wavelength range than WPM units.

Specifications

Plate Diameter	0.4, 0.6, 0.8, and 1.0"
Clear Aperture (when mounted)	Plate diameter minus 0.10"
Retardation Accuracy	$\pm 2^\circ$ @ 10.6 μm ; $\pm 4^\circ$ @ 5.3 μm
Bandwidth (for 6° error)	$\pm 0.55\mu\text{m}$ @ 10.6 μm
Retardation Range	0 to 360°
Transmission	>98% @ 10.6 μm

How to Order

Use of the full Model No. WPA-BB.B-CC-DDD-E completely specifies waveplate units, where the A denotes the order of the plate, BB.B the wavelength for operation in microns, .CC the clear aperture in inches, DDD the desired relative phase retardation in degrees (90° is $\lambda/4$, 180° is $\lambda/2$, etc.), and E denotes mounted or unmounted.



WPM model



WPZ cell

Example

Model No.	Order	Wavelength	Clear Aperture (in inches)	Phase Retardation	Mounting
WPM-10.6-.55-180-U	WPM	10.6	0.55	180°	U=Unmounted
WPM-10.6-.55-180-R	WPM	10.6	0.55	180°	R=Rotating Mount