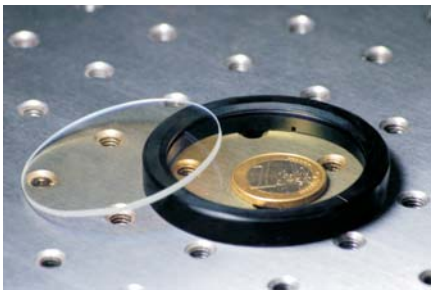
Waveplate

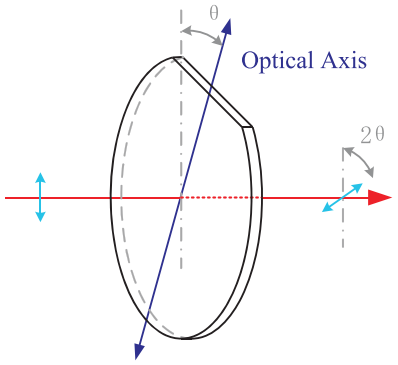
Waveplate Overview

Waveplates (retarders) are made from birefringent materials which introduce a phase difference between the fast and slow principal axis of the waveplate. The optical axis of waveplate is parallel to the face. Light incident normal to the surface will be split to components polarized parallel and perpendicular to the optical axis with different refractive index and velocity in this device. The difference in velocities gives rise to a phase shift which is called retardance. At any specific wavelength the phase retardance is governed by the thickness of Waveplates. The standard waveplates we provided include half waveplates and quarter waveplates, other custom waveplates can also be provided upon request.



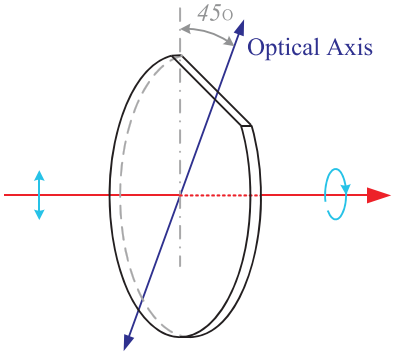
Half Waveplate

When applying a linearly polarized beam to a half waveplate, it emerges as a linearly polarized beam but its polarization plane is rotated with respect to the polarization plane of the input beam. The rotation of the polarization plane is such that the angle between the input polarization and the output polarization is twice the angle between the input polarization and the waveplate's axis. When applying a circularly polarized beam, a clockwise circular polarization will transform into a counter-clockwise circular polarization and vice versa. Half waveplates are often used as continuously adjustable polarization rotators and as a variable ratio beamsplitter when used in conjunction with a polarization beamsplitter cube.



Quarter Waveplate

When applying a linearly polarized beam with the polarization plane aligned at 45deg to the waveplate's principal plane, the output beam will be circularly polarized. Similarly when applying a circularly polarized beam to a λ/4 waveplate the output beam will be linearly polarized. When a quarter waveplate is double passed, i.e. by mirror reflection, it acts as a half waveplate and rotates the plane of polarization to a certain angle. Quarter waveplates are widely used in creating circular polarization from linear or linear polarization from circular, ellipsometry, optical pumping, suppressing unwanted reflection, optical isolation and etc.



Types of Waveplate

Types		Feature
Zero Order	Cemented	● Cemented by glue ● Better temperature bandwidth ● Wide wavelength bandwidth ● Moderate damage threshold
	Optically Contacted	● No glue ● Better temperature bandwidth ● Wide wavelength bandwidth ● Better damage threshold
	Air Spaced	● No glue, mounted ● Better temperature bandwidth ● Wide wavelength bandwidth ● High damage threshold ● Good Wavefront
True Zero Order	Cemented	● Cemented by glue ● Better temperature bandwidth ● Wide wavelength bandwidth ● Moderate damage threshold ● Good wavefront and parallelism
Telecom Waveplate Single Plate High Power Waveplate		● Single plate ● Better temperature bandwidth ● Wide wavelength bandwidth ● High damage threshold ● Good wavefront and parallelism ● Wide acceptance angle
Multi Order		● Low temperature bandwidth ● Low wavelength bandwidth ● High damage threshold ● Good wavefront and parallelism ● Low cost
Dual Wavelength		● Provide specific retardation at two different wavelengths
Middle Infrared Zero Order Waveplate		● Ideal for Applications in the 2.5-6.0μm Range ● Better Temperature Bandwidth ● Wide Wavelength Bandwidth ● High damage threshold
Achromatic		● Better temperature bandwidth ● Very broad wavelength bandwidth ● Cemented and air spaced available
Wedge Waveplate		● Eliminate Etalon effect ● Eliminate return light

Frequently Used Wavelength(nm)

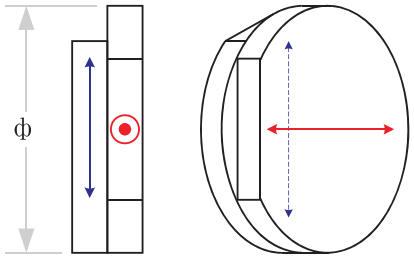
213	248	257	266	308	355	405	488	515	532	546	632.8
670	780	808	850	980	1030	1047	1053	1064	1310	1550	2020

Order Information

WPZ4225 — 1064 — 30 ➲ Part No.-Wavelength-Mount Diameter

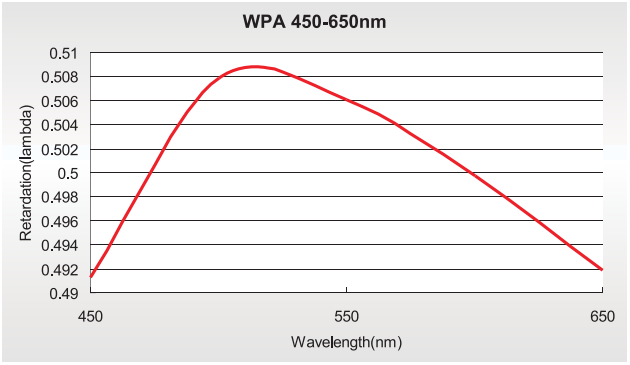
Achromatic Waveplate

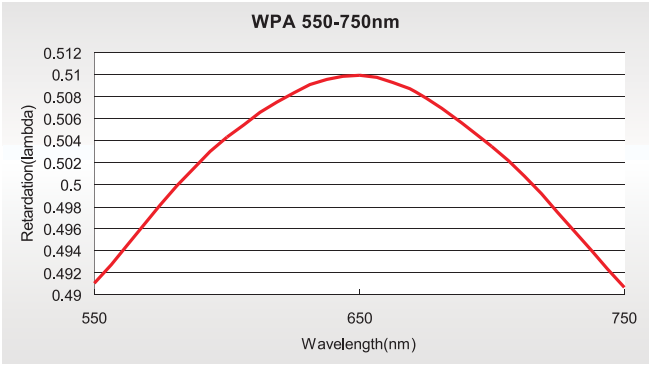
Achromatic waveplate is similar to zero order waveplate except that the two plates are made from different birefringent crystals. Since the dispersion of the birefringence of two materials is different, it is possible to specify the retardation values at a broad wavelength range. So, the retardation will be less sensitive to wavelength change. In other words, it can be used at a broadband wavelength range.

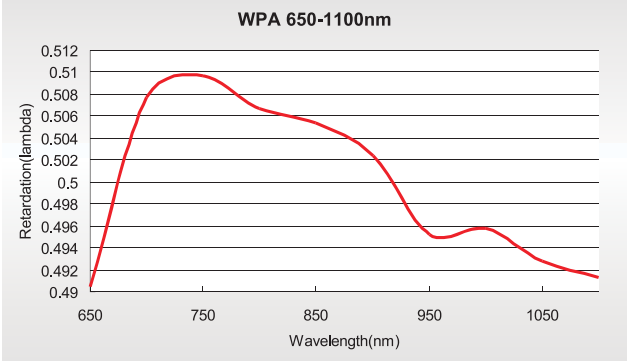


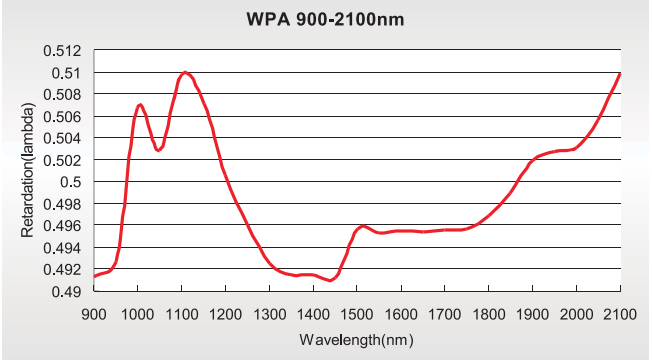
- Epoxy Cemented or Air Spaced available
- Very Broad Bandwidth
- Custom size available
- RoHS Compliant

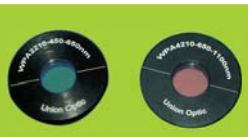
Retardation Curve











Specifications

Material	Crystal Quartz+MgF_2
Dimension Tolerance	+0.0/-0.2mm
Wavefront Distortion	λ/4@632.8nm (for air spaced type)
Retardation Tolerance	λ/100
Parallelism	<10 arc seconds (for single plate)
Surface Quality	40/20 scratch and dig
Clear Aperture	>90% central area
Standard Wave	quarter-wave(λ/4), half-wave(λ/2)
Standard Wavelength	450-650nm 550-750nm 650-1100nm 900-2100nm
Coating	Both sides AR coated, R<1% per face
Damage Threshold	Cemented: >500mJ/cm^2, 20ns, 20Hz @1064nm Air spaced: >5J/cm^2, 20ns, 20Hz @1064nm

Standard Products-Cemented Type

λ/2 Part No.	λ/4 Part No.	Diameter(mm)	Type
WPA2210	WPA4210	10.0	Cemented
WPA2215	WPA4215	15.0	Cemented
WPA2220	WPA4220	20.0	Cemented
WPA2225	WPA4225	25.4	Cemented

Standard Products-Air Spaced Type

λ/2 Part No.	λ/4 Part No.	Mount Diameter (mm)	Mount Thickness (mm)	Clear Aperture (mm)	Type
WPA2410	WPA4410	25.4	6.0	9.0	Air Spaced
WPA2415	WPA4415	25.4	6.0	13.5	Air Spaced
WPA2420	WPA4420	25.4	6.0	18.0	Air Spaced
WPA2425	WPA4425	30.0	6.0	22.9	Air Spaced

Order Information

WPA2220 — 650-1100 — 25.4 ➲ Part No.-Wavelength-Mount Diameter

Standard Wavelength: 450-650nm, 550-750nm, 650-1100nm, 900-2100nm

Zero Order Waveplate

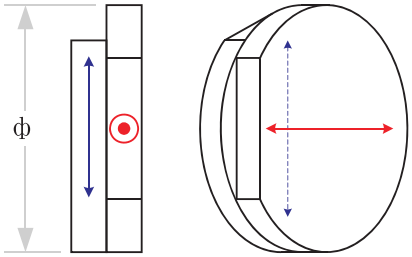
Zero order waveplate is constructed by two quartz plates with their fast axis crossed. The difference in thickness between the two plates determines the retardance. Zero order waveplates offer a substantially lower dependence on temperature and wavelength change than multi-order waveplates.

Specifications

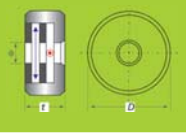
Material	Crystal Quartz
Dimension Tolerance	+0.0/-0.2mm
Wavefront Distortion	λ/8@632.8nm(not for cemented type)
Retardation Tolerance	λ/300
Parallelism (Single Quartz Plate)	<1 arc second
Surface Quality	20/10 scratch and dig
Clear Aperture	>90% central area
Standard Wave	quarter-wave(λ/4), half-wave(λ/2)
AR Coating	R<0.25%@central wavelength
Damage Threshold	Cemented: >500mJ/cm², 20ns, 20Hz @1064nm Optically Contacted: >5J/cm², 20ns, 20Hz @1064nm Air Spaced: >10J/cm², 20ns, 20Hz @1064nm

Cemented & Optically Contacted Zero Order

- Better Temperature Bandwidth
- Wide Wavelength Bandwidth
- AR Coated
- RoHS Compliant



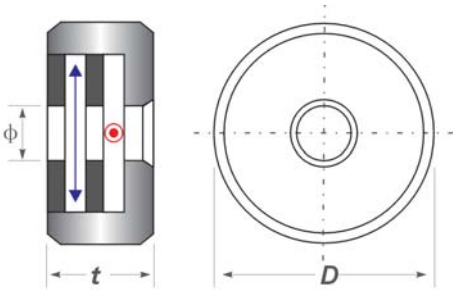
λ/2 Part No.	λ/4 Part No.	Diameter(mm)	Type
WPZ2310	WPZ4310	10.0	Optically Contacted Zero Order
WPZ2312	WPZ4312	12.7	
WPZ2315	WPZ4315	15.0	
WPZ2320	WPZ4320	20.0	
WPZ2325	WPZ4325	25.4	
WPZ2225	WPZ4225	25.4	Cemented Zero Order
WPZ2230	WPZ4230	30.0	
WPZ2238	WPZ4238	38.1	
WPZ2250	WPZ4250	50.8	



Air Spaced Zero Order Waveplate

Air spaced zero order waveplate is constructed by two quartz plates installed in a mount, to form a air gap between the two quartz plates. The difference in thickness between the two plates determines the retardance. Zero order waveplates offer a substantially lower dependence on temperature and wavelength change than multi-order waveplates.

- High Damage Threshold
- Better Temperature Bandwidth
- Wide Wavelength Bandwidth
- AR Coated and Mounted
- RoHS Compliant



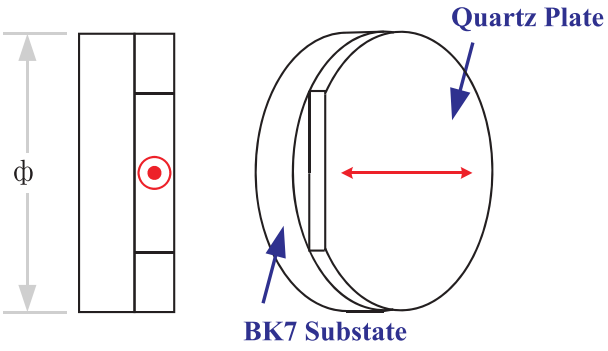
Standard Product

λ/2 Part No.	λ/4 Part No.	Mount Diameter (mm)	Clear Aperture (mm)	Mount Thickness (mm)
WPZ2410	WPZ4410	25.4	9.0	6.0
WPZ2412	WPZ4412	25.4	11.5	6.0
WPZ2415	WPZ4415	25.4	13.5	6.0
WPZ2420	WPZ4420	25.4	18.0	6.0
WPZ2425	WPZ4425	30.0	22.9	6.0

True Zero Order Waveplate

The thickness of a true zero order quartz plate is very thin, it is very easily damaged. In order to solve this problem, we can cement the thin quartz plate on a BK7 substrate to increase the strength.

- Standard Thickness: 1.1±0.2mm
- Epoxy Cemented
- Moderate Damage Threshold
- Better Temperature Bandwidth
- Wide Wavelength Bandwidth
- Good Wavefront and Parallelism
- RoHS Compliant



Specifications

Material	Crystal Quartz
Dimension Tolerance	+0.0/-0.2mm
Wavefront Distortion	λ/8 @632.8nm
Retardation Tolerance	λ/300
Parallelism	<1 arc second
Surface Quality	20/10 scratch and dig
Clear Aperture	>90% central area
Standard Wave	quarter-wave(λ/4), half-wave(λ/2)
AR Coating	R<0.25%@central wavelength
Damage Threshold	>500mJ/cm², 20ns, 20Hz @1064nm

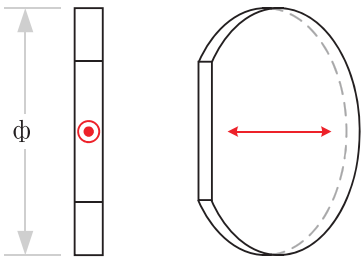
Standard Products

λ/2 Part No.	λ/4 Part No.	Diameter(mm)
WPF2210	WPF4210	10.0
WPF2212	WPF4212	12.7
WPF2215	WPF4215	15.0
WPF2220	WPF4220	20.0
WPF2225	WPF4225	25.4
WPF2230	WPF4230	30.0
WPF2238	WPF4238	38.1
WPF2250	WPF4250	50.8

Single Plate High Power Waveplate

Union Optic can offer single plate high power waveplate now, due to our unique technology, we can make thickness down to 20 microns. Thanks to her high damage threshold, single plate high power waveplate is normally used in high power application.

- High Damage Threshold
- Better Temperature Bandwidth
- Wide Wavelength Bandwidth
- Wide Acceptance Angle
- Thickness >=0.02mm
- Mounted in Ø25.4x6mm Black Anodized Ring Mount
- RoHS Compliant



Specifications

Material	Crystal Quartz
Dimension Tolerance	+0.0/-0.2mm
Wavefront Distortion	λ/8@632.8nm
Retardation Tolerance	λ/300
Acceptance Angle	10deg
Parallelism	<1 arc second
Surface Quality	20/10 scratch and dig
Clear Aperture	>90% central area
Standard Wave	quarter-wave(λ/4), half-wave(λ/2)
AR Coating	R<0.25%@central wavelength
Damage Threshold	>10J/cm^2, 20ns, 20Hz @1064nm

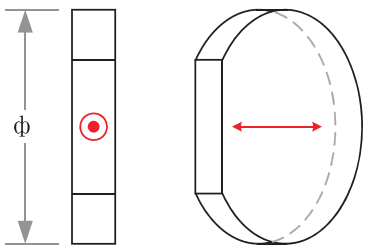
Standard Products

Part No.	Retardation	Mount(mm)	CA(mm)	Retardation Order	Waveplate Thickness(mm)	Wavelength(nm)
WPS2120-355	λ/2	Φ25.4x6	18	1	0.054	355
WPS2120-532	λ/2	Φ25.4x6	18	0	0.029	532
WPS2120-1030	λ/2	Φ25.4x6	18	0	0.059	1030
WPS2120-1064	λ/2	Φ25.4x6	18	0	0.061	1064
WPS4120-355	λ/4	Φ25.4x6	18	1	0.027	355
WPS4120-532	λ/4	Φ25.4x6	18	1	0.043	532
WPS4120-1030	λ/4	Φ25.4x6	18	0	0.029	1030
WPS4120-1064	λ/4	Φ25.4x6	18	0	0.03	1064

Multi Order Waveplate

Multiple order waveplate means the retardance of a light path will undergo a certain number of full wavelength shifts in addition to the fractional design retardance. The thickness of multi order waveplate is always around 0.5mm. Compared with zero order waveplate, multi order waveplate is more sensitive to wavelength and temperature changes. However, they are less expensive and widely used in many applications where the increased sensitivities are not critical.

- Thickness: 0.3-0.5mm
- High Damage Threshold
- Better Wavefront and Parallelism
- Low Cost
- RoHS Compliant



Specifications

Material	Crystal Quartz
Dimension Tolerance	+0.0/-0.2mm
Wavefront Distortion	λ/8 @632.8nm
Retardation Tolerance	λ/100
Parallelism	<1 arc second
Surface Quality	20/10 scratch and dig
Clear Aperture	>90% central area
Standard Wave	quarter-wave(λ/4), half-wave(λ/2)
AR Coating	R<0.25%@central wavelength
Damage Threshold	>10J/cm^2, 20ns, 20Hz @1064nm

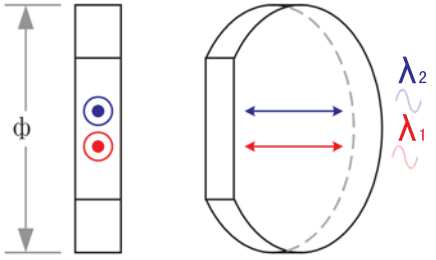
Standard Products

λ/2 Part No.	λ/4 Part No.	Diameter(mm)
WPM2110	WPM4110	10.0
WPM2112	WPM4112	12.7
WPM2115	WPM4115	15.0
WPM2120	WPM4120	20.0
WPM2125	WPM4125	25.4
WPM2130	WPM4130	30.0
WPM2138	WPM4138	38.1

Dual Wavelength Waveplate

This waveplate is a special kind of multi order waveplate. Dual wavelength waveplate is designed to be used in dual wavelength setups, for example, it can be operated as a quarter waveplate @1064nm and as a half waveplate @532nm at the same time. It's always used to manage the states of polarization of laser beams to obtain maximum conversion efficiency.

- Thickness: <2.0mm
- Optional wavelength available
- High damage threshold
- RoHS Compliant



Specifications

Material	Crystal Quartz
Dimension Tolerance	+0.0/-0.2mm
Wavefront Distortion	λ/8@632.8nm
Retardation Tolerance	λ/100
Parallelism	<1 arc second
Surface Quality	20/10 scratch and dig
Clear Aperture	>90% central area
Coating	R<0.5%@two wavelengths
Damage Threshold	>5J/cm^2, 20ns, 20Hz @1064nm

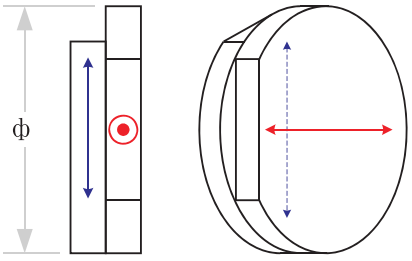
Standard Products

Part No.	Wavelength Combination	Diameter(mm)
WPD0120-1521	λ/2@1064nm+λ@532nm	20.0
WPD0125-1521	λ/2@1064nm+λ@532nm	25.4
WPD0120-1512	λ@1064nm+λ/2@532nm	20.0
WPD0125-1512	λ@1064nm+λ/2@532nm	25.4
WPD0120-1524	λ/2@1064nm+λ/4@532nm	20.0
WPD0125-1524	λ/2@1064nm+λ/4@532nm	25.4
WPD0120-1542	λ/4@1064nm+λ/2@532nm	20.0
WPD0125-1542	λ/4@1064nm+λ/2@532nm	25.4
WPD0120-1541	λ/4@1064nm+λ@532nm	20.0
WPD0125-1541	λ/4@1064nm+λ@532nm	25.4

Middle Infrared Zero Order Waveplate

Middle Infrared zero order waveplate is constructed by two Magnesium Fluoride (MgF2) plates with their fast axis crossed, the two plates are constructed by optically contacted method, the optical path is epoxy free. The difference in thickness between the two plates determines the retardance. Middle Infrared zero order waveplates is widely used in infrared applications, ideally for 2.5-6.0 micron range.

- Ideal for Applications in the 2.5-6.0μm Range
- High Damage Threshold
- Better Temperature Bandwidth
- Wide Wavelength Bandwidth
- Both Sides AR Coated
- RoHS Compliant



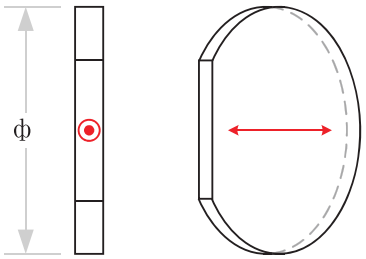
Specifications

Material	MgF2
Dimension Tolerance	+0.0/-0.2mm
Wavefront Distortion	<λ/4@632.8nm
Retardation Tolerance	<λ/100
Parallelism(single plate)	<5 arc seconds
Surface Quality	60/40 scratch and dig
Clear Aperture	>90% central area
Standard Wave	quarter-wave(λ/4), half-wave(λ/2)
Wavelength Range	2500-6000nm
AR Coating	R<1%@central wavelength
Damage Threshold	>1J/cm^2, 20ns, 20Hz @1064nm

Telecom Waveplate

Compared with cemented true zero order waveplate, telecom waveplate is only one quartz plate, it is mainly used in fiber communication. Telecom waveplates are thin & compact waveplates specifically designed to meet the demanding requirements of fiber communication component. The half-wave plate can be used for rotating the polarization state while the quarter-wave plate can be used to convert linearly polarized light into a circular polarization state and vice versa. The half waveplate is about 91μm thick, the quarter waveplate is always not 1/4 wave but 3/4 wave, about 137μm in thickness. These ultra thin waveplate ensures the best temperature bandwidth, angle bandwidth and wavelength bandwidth. The small size of these waveplates also makes them ideal for reducing the overall package size of your design. We can provide custom sizes per your request.

- High Damage Threshold
- Better Temperature Bandwidth
- Wide Wavelength Bandwidth
- Wide Acceptable Angle
- Thickness >0.04mm
- RoHS Compliant



Specifications

Material	Crystal Quartz
Dimension Tolerance	±0.1mm
Wavefront Distortion	λ/8@632.8nm
Retardation Tolerance	λ/300
Parallelism	<1 arc second
Surface Quality	20/10 scratch and dig
Clear Aperture	>90% central area
Standard Wave	quarter-wave(λ/4), half-wave(λ/2)
AR Coating	R<0.25%@central wavelength
Damage Threshold	>10J/cm^2, 20ns, 20Hz @1064nm

Ring Mount for Waveplate

- Material: Black Anodized Aluminum
- Outer Diameter(D) Tolerance: ±0.2mm
- Thickness Tolerance: ±0.2mm
- Clear Aperture Tolerance: ±0.2mm
- Custom size available

Standard Products

Part Number	Outside Diameter D(mm)	Waveplate Diameter Φ(mm)	Clear Aperture (mm)	Thickness (mm)
MSW9001	12.7	10.0	8.0	6.0
MSW9010	25.4	10.0	8.0	6.0
MSW9012	25.4	12.7	11.5	6.0
MSW9015	25.4	15.0	13.5	6.0
MSW9020	25.4	20.0	18.0	6.0
MSW9025	25.4	25.4	22.9	6.0

Rotator Mount for Waveplate

- Material: Black Anodized Aluminum
- Adjustment range: θx: ±360° θy: ±5° θz: ±5°
- Minimum reading: 2°

Standard Products

Part Number	Dimension(mm)	Center Height(mm)	Applied Optic Dimension (mm)	Clear Aperture (mm)
OMPO25.4-1	58.0*58.0*41.0	35.0	Φ25.4*6.0	22.9
OMPO30-1	66.0*66.0*41.0	39.0	Φ30.0*6.0	27.0

Selection Guide

Retardation. Half, quarter, or other special? Always, half waveplate is used to rotate the polarization plane, quarter waveplate is used to change circular polarization to plane polarization or vice vera.

Size and working wavelength. This is important for waveplate. The retardation is different at different wavelength. It depends on wavelength. Union Optic provides standard wavelength(nm) listed as below, and other wavelengths can be provided upon request.

Type, the diagram below show the comparison of different types.