

Optics Cookbook No. 6

New Additions

3" and 4" Super Large
Zero Order Waveplates
4" to 6" Beam Expander
6" Transmission Flat

Waveplates
Achromatic Waveplates
Optical Assemblies
Micro Optics
Mini Lenses
Lenses
Windows
Hot and Cold Mirrors
Filters and Coatings
Polarizers
Beamsplitters
Prisms
Optical Flats
Transmission Flats
Custom Optics
Beam Expander





Welcome to Tower Optical



Dear Customer:

I am pleased to present the sixth edition of our Optics Cookbook. We have expanded our line of waveplates and added filter and polarization optics.

Much of our business is custom build-to-print optics and filling OEM requests. Please feel free to contact us for a quotation regarding any requirement for precision optics you may have. We take pride in being able to offer you both a quick response to your request for quotations and, of course, a quality product.

Whether you are a returning customer or new to Tower Optical, we thank you for your interest in our company. We are committed to making you a customer for life!

Mel Kantor, *President / CEO*

Products You Can Trust

***Waveplates • Achromatic Waveplates • Lenses • Micro Lenses
Prisms • Micro Prisms • Mirrors • Windows • Wedges • Polarizers
Beamsplitters • Filters • Multiple Element Assemblies • Optical Flats***



Waveplates

Standard waveplates are available in wavelengths from 248 nm to 2020 nm in 1/4 and 1/2 wave with 10 mm, 17.5 mm, 25.4 mm, 38.1 mm, and 50.8 mm diameters which include AR coatings and optional mounting rings. Also available: square, rectangular and dual wavelength in sizes from 1 mm to 50 mm.

Achromatic waveplates in stock.

Thousands in stock for immediate delivery

Custom Product and OEM Manufacturing

Tower Optical manufactures products and components that have been designed by its customers. We offer short lead time and low prices and custom optics.

Micro Optics

Waveplates from 0.5 mm x 0.5 mm x 90 μ

Prisms from 0.5 mm x 0.5 mm x 0.5 mm

Lenses from 1 mm

Quality Control

Tower Optical technicians have the experience and equipment to produce optics to the most demanding specifications. Extensive testing ensures that all our products comply with exacting specifications and precise tolerances. We are ISO 9001:2008 certified and SAE 9100 Rev. B compliant.

Optical Coating Capabilities

V Coat AR coatings, Broad Band (BBAR) coatings for UV, visible, and IR coatings based on your custom requirements.

We produce components for:

OEM manufacturers • Major catalog distributors
Research facilities • Colleges and universities
Government contractors • National laboratories

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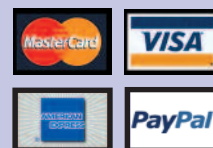


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About Us / Table of Contents



Tower Optical Corporation is a premier manufacturer and producer of high quality precision optics and assemblies. Its stock and "build to spec" custom products are used in leading-edge photonics technology, electro-optics, lasers, telecommunications, medical instruments, optical imaging and optical computing. Products include, but are not limited to, crystal quartz waveplates and achromatic waveplates (retarders), lenses, filters, polarizers, prisms, beamsplitters, windows, mirrors and transmission flats.

Tower is also the publisher of **PhotonicsConnection.com**, the premier information portal of the photonics industry.

Founded in 1978, **Tower** has operated under its present ownership since 1997. Its customers represent a broad variety of national and international companies and industries including military, aircraft, aerospace, medical, process measurement and control, university researchers and key U.S. Department of Defense contractors. **Tower** is registered with the U.S. State Department to obtain export licenses as required.

Tower is ISO certified for ISO 9001:2015.

Tower prides itself on its short lead times, quality products and competitive pricing.

Our Team...



Vision — To be the supplier of choice for the most demanding and innovative organizations who are focused on improving man's quality of life through the use of light based technologies.

Mission — To find cost effective solutions and provide customers with quality optical products and services in a timely manner.

Quality — Tower technicians have the experience, skill and equipment to design and manufacture products to the most demanding specifications. The company's extensive testing equipment ensures that all products are shipped to exacting specifications.

Service — In addition to the large inventory of products for immediate shipment, Tower welcomes custom orders and working with customer's engineers to develop prototypes and OEM manufactured products that will meet special needs.

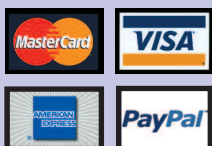
Pricing — Tower's manufacturing techniques coupled with a constant focus to contain overhead enables us to offer prices that are the most competitive in the industry. Discounts are offered for larger quantity orders.

Tower Optical is a Service Disabled, Veteran Owned, Small Business SDVOSB—Cage Code 1N2U3.

Call, fax or e-mail your requirements for special price consideration.

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Zero Order Waveplates–10 mm



- 8 mm clear aperture
- 10 mm unmounted diameter
- 12.7 or 25.4 mm mounted diameter
- Wide range of wavelengths
- ½ and ¼ wave retardation
- Waveplates are AR coated
- Very high laser quality
- High performance specifications

Tower's 10 mm zero order waveplates provide users with a high performance crystal quartz retarder with a clear aperture of 8 mm. These waveplates are air spaced, having a stainless steel spacer between two crystal quartz plates that form the zero order capability. Zero order waveplates are far less sensitive to temperature variations than multiple orders. Air spaced waveplates have higher thermal stability and power handling capability than contacted or cemented. There are no failures as occur with contacted waveplates coming apart. Angular alignment of the waveplates is also more accurate.

Tower Optical standard 10 mm waveplates are made from laser quality crystal quartz and are AR coated. Each plate is AR

coated on both sides. Standard retardations are ½ or ¼ wave. The waveplates are offered either unmounted with a diameter of 10 mm or mounted in a 12.7 mm or 25.4 mm, anodized aluminum mounting ring with an 8mm clear aperture.

The standard wavelengths available are shown in the chart below. As a special feature, Tower offers the ability to supply the 10 mm zero order waveplates at wavelengths within a range of 10–20 nm from any of those listed on the chart. Other wavelengths are available on a custom order basis.

Waveplate Specifications

Material: crystal quartz – laser quality

Waveplate thickness range: 0.3 to 1.3 mm

Wavefront distortion: $\lambda/10$ @ 632.8 nm

Surface quality: 10-5 Scratch-Dig

Parallelism (wedge): 0.5 arc seconds

Wavelength range: per table to the right

Retardation tolerance: ± 0.005 waves @ 632.8 nm

Coating: anti reflective, $R < 0.25\%$ per surface

Damage threshold: 1 kW/cm² – CW, 3.5 J/cm² @ 10 ns

Diameter: 10 mm, +0.0/-0.25 mm unmounted; 12.7 or 25.4 mm, +0.00/-0.25 mm mounted

Mounted thickness: 6.4 (12.7 mm) or 7.8 (25.4 mm)

Standard Wavelengths for 8 mm clear apertures

248	266	308	325	355	399	408
413	423	442	458	488	514.5	527
532	556	589	632.8	647	650	660
670	676	694	710	755	767	780
790	795	800	808	810	825	830
850	905	940	980	1047	1053	1064
1112	1310	1319	1550	1570	1980	2020

See Page 10 for Any Wavelength Program

Ordering Information

Unmounted

Z-10-A-R-N-WL\$316

Mounted in a 12.7 mm ring

Z-10-A-R-A-WL\$351

Mounted in a 25.4 mm ring

Z-10-A-R-B-WL\$362

R = Retardation: .500 or .250, WL = Wavelength

See Page 15 for Waveplate Ordering Information

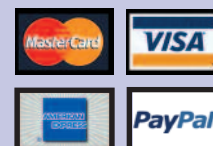


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Zero Order Waveplates–17.5 mm



- 15 mm clear aperture
- 17.5 mm unmounted diameter
- 1" (25.4 mm) mounted diameter
- Wide range of wavelengths
- ½ and ¼ wave retardation
- Waveplates are AR coated
- Very high laser quality
- High performance specifications

Tower's 17.5 mm zero order waveplates provide users with a high performance crystal quartz retarder with a clear aperture of 15 mm. These waveplates are air spaced, having a stainless steel spacer between two crystal quartz plates that form the zero order capability. Zero order waveplates are far less sensitive to temperature variations than multiple orders. Air spaced waveplates have higher thermal stability and power handling capability than contacted or cemented. There are no failures as occur with contacted waveplates coming apart. Angular alignment of the waveplates is also more accurate.

Tower Optical waveplates are made from laser quality crystal quartz. Each plate is AR coated on both sides. Standard

retardations are ½ or ¼ wave. The waveplates are offered either unmounted with a diameter of 17.5 mm or mounted in a 25.4 mm anodized aluminum mounting ring with a 15 mm clear aperture.

The standard wavelengths available are shown in the chart below. As a special feature, Tower offers the ability to supply these zero order waveplates at wavelengths within a range of 10–20 nm from any of those listed on the chart. Other wavelengths are available on a custom order basis.

Waveplate Specifications

Material: crystal quartz – laser quality
Waveplate thickness range: 0.3 to 1.3 mm
Wavefront distortion: $\lambda/10$ @ 632.8 nm
Surface quality: 10-5 Scratch-Dig
Parallelism (wedge): 0.5 arc seconds
Wavelength range: per table to the right
Retardation tolerance: ± 0.005 waves @ 632.8 nm
Coating: anti reflective, $R < 0.25\%$ per surface
Damage threshold: 1 kW/cm² – CW, 3.5 J/cm² @ 10 ns
Diameter: 17.5 mm, +0.0/-0.25 mm unmounted;
25.4 mm, +0.00/-0.25 mm mounted
Mounted thickness: 7.8, +0.00/-0.25 mm

See Page 15 for Waveplate Ordering Information

Standard Wavelengths for 15 mm clear apertures

248	266	308	325	355	399	408
413	423	442	458	488	514.5	527
532	556	589	632.8	647	650	660
670	676	694	710	755	767	780
790	795	800	808	810	825	830
850	905	940	980	1047	1053	1064
1112	1310	1319	1550	1570	1980	2020

See Page 10 for Any Wavelength Program

Ordering Information

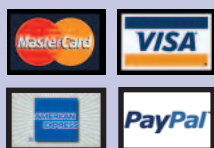
Unmounted

Z-17.5-A-R-N-WL\$335

Mounted in a 25.4 mm ring

Z-17.5-A-R-B-WL\$365

R = Retardation: .500 or .250, WL = Wavelength



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Zero Order Waveplates–1" (25.4 mm)



- 23 mm clear aperture
- 25.4 mm unmounted diameter
- 30 mm mounted diameter
- Wide range of wavelengths
- ½ and ¼ wave retardation
- Waveplates are AR coated
- Very high laser quality
- High performance specifications

Tower's 1" zero order waveplates provide users with a high performance crystal quartz retarder with a clear aperture of 23 mm. These waveplates are air spaced, having a stainless steel spacer between two crystal quartz plates that form the zero order capability. Zero order waveplates are far less sensitive to temperature variations than multiple orders. Air spaced waveplates have higher thermal stability and power handling capability than contacted or cemented. There are no failures as occur with contacted waveplates coming apart. Angular alignment of the waveplates is also more accurate.

Tower Optical standard 1" waveplates are made from laser quality crystal quartz and are AR coated. Each plate is AR

coated on both sides. Standard retardations are ½ or ¼ wave. The waveplates are offered either unmounted with a diameter of 25.4 mm or mounted in a 30 mm anodized aluminum mounting ring with a 23 mm clear aperture.

The standard wavelengths available are shown in the chart below. As a special feature, Tower offers the ability to supply the 1" zero order waveplates at wavelengths within a range of 10–20 nm from any of those listed on the chart. Other wavelengths are available on a custom order basis.

Waveplate Specifications

Material: crystal quartz – laser quality

Waveplate thickness range: 0.3 to 1.3 mm

Wavefront distortion: $\lambda/10$ @ 632.8 nm

Surface quality: 10-5 Scratch-Dig

Parallelism (wedge): 0.5 arc seconds

Wavelength range: Per table to the right

Retardation tolerance: ± 0.005 waves @ 632.8 nm

Coating: Anti Reflective, $R < 0.25\%$ per surface

Damage threshold: 1 kW/cm² – CW, 3.5 J/cm² @ 10 ns

Diameter: 25.4 mm, +0.0/-0.25 mm unmounted;
30 mm, +0.00/-0.25 mm mounted

Mounted thickness: 6.0, +0.00/-0.25 mm

Standard Wavelengths for 23 mm clear apertures

266	355	408	423
488	514.5	532	632.8
650	670	780	800
830	980	1064	1550

See Page 10 for Any Wavelength Program

Ordering Information

Unmounted

Z-25.4-A-R-N-WL\$485

Mounted in a 30 mm ring

Z-25.4-A-R-C-WL\$515

R = Retardation: .500 or .250, WL = Wavelength

See Page 15 for Waveplate Ordering Information

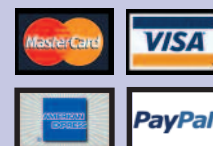


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Large Zero Order Waveplates – 38.1 & 50.8 mm



- Laser quality crystal quartz
- Air spaced for high power
- Clear apertures of 34 & 46 mm
- Mounted or unmounted
- Retardations of $\frac{1}{2}$ and $\frac{1}{4}$ wave
- Waveplates are AR coated
- High performance specifications

Tower's large aperture zero order waveplates provide users with the capability of handling new applications where beam size and/or beam position moves over larger distances. The waveplates described here are air spaced, having a stainless steel spacer between two crystal quartz plates that form the zero order capability. Zero order waveplates are far less sensitive to temperature variations than multiple orders. Air spaced waveplates have higher thermal stability and power handling capability than contacted or cemented.

Tower Optical large waveplates are made from laser quality crystal quartz. Each plate is AR coated on both sides. Retardations are $\frac{1}{2}$ or $\frac{1}{4}$ wave. The waveplates are offered either unmounted or mounted in anodized aluminum mounting rings.

Waveplate Specifications

Material: crystal quartz – laser quality
Waveplate thickness range: 3 to 4 mm
Wavefront distortion: $\lambda/10$ @ 632.8 nm
Surface quality: 40-20 Scratch-Dig
Parallelism (wedge): 0.5 arc seconds
Wavelength range: Per table to the right
Retardation tolerance: ± 0.005 waves @ 632.8 nm
Coating: Anti Reflective, $R < 0.25\%$ per surface
Damage threshold: 1 kW/cm² – CW, 3.5 J/cm² @ 10 ns
Diameter: 38.1 mm, +0.0/-0.25 mm unmounted;
 50.8 mm, +0.0/-0.25 mm mounted, or,
 50.8 mm, +0.0/-0.25 mm unmounted,
 76.2 mm +0.0/-0.25 mm mounted
Mounted thickness: 9.0, +0.00/-0.25 mm

See Page 15 for Waveplate Ordering Information

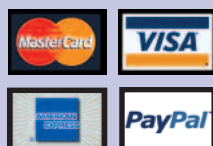
Standard Wavelengths (nm)

355	532	632.8	800	1064
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Ordering Information

38.1 mm WP Unmounted
 Z-38.1-A-R-N-WL\$1,395
38.1 mm WP Mounted in a 50.8 mm ring
 Z-38.1-A-R-E-WL\$1,450
50.8 mm WP Unmounted
 Z-50.8-A-R-N-WL.....\$2,040
50.8 mm WP Mounted in 76.2 mm ring
 Z-50.8-A-R-G-WL.....\$2,095

R = Retardation: .500 or .250,
WL = Wavelength



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Super Large Zero Order Waveplates – 76.2mm



A new standard in zero order waveplates has been established by Tower Optical – a 3" zero order waveplate from stock. This super large zero order waveplate provides users with the ability to perform new techniques with large beam lasers. In addition, these waveplates are air spaced thus providing operation at higher power levels than contacted or cemented waveplates. Standard retardations of 1/4 and 1/2 wave are provided for each wavelength offered. In stock wavelengths are 405, 532, 632.8, 800 and 1064nm. For custom orders the wavelength is selectable from 355nm to 2021nm.

The mounting ring for the three inch zero order waveplate is heavy duty Aluminum, 4 inch diameter and 7/8 inch thick to protect the dual plate Crystal Quartz waveplate. The crystal axis is shown as a scribe mark on the face of the ring. The waveplate is held in place with a retaining ring.

Super Large Zero Order Waveplates – 76.2mm

- Laser Quality Crystal Quartz
- Air Spaced for High Power
- Clear Aperture of 73mm
- Mounted or Unmounted
- Retardations of 1/2 and 1/4 Wave
- Waveplates are AR Coated
- Standard Wavelengths
- Custom Wavelengths available
- Rugged 4" Mounting Ring

Waveplate Specifications

Material: Crystal Quartz – Laser quality

Waveplate Thickness Range: 4.0 to 10mm

Wavefront Distortion: $\lambda / 10$ @ 632.8nm

Surface Quality: 20-10 Scratch/Dig

Parallelism (Wedge): 0.5 arc seconds

Wavelengths: Specify from 355nm to 2021nm

Retardation Tolerance: ± 0.005 waves @ 632.8nm

Coating: Anti Reflective, $R < 0.25\%$ per surface

Damage Threshold: 1kW/cm² – CW 3.5 J/cm² @10ns

Diameter: 76.2, +0.0/-0.25mm unmounted;
101.6, +0.00/-0.25mm mounted

Mounted Thickness: 24mm

Ordering Information

Unmounted

Z-76.2-A-R-N-WL\$2,845

Mounted in a 4 inch ring

Z-76.2-A-R-H-WL\$3,045

R=Retardation: 250 or .500, WL=Wavelength

Custom wavelengths are available for \$3400 in an unmounted version and \$3496 mounted



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Super Large 4" Zero Order Waveplates – 101.6mm



Tower Optical is now offering super large zero order waveplates that are 101.6mm in diameter. In addition, these Waveplates are air spaced, thus providing operation at higher power levels than contacted or cemented Waveplates.

These large Waveplates are available with 1/4 and 1/2 wave retardation. You can custom order the wavelength you desire from 355nm to 2021nm.

The mounting ring for the 4" Zero Order Waveplate is made of heavy duty Aluminum, 4.5" diameter and 7/8" thick to protect the dual plate Crystal Quartz Waveplate assembly. The optical axis is shown by a scribe mark on the face of the ring. The Waveplate is held in place with a retaining ring. Custom designed rings are also available, or the 4" Waveplate can be supplied unmounted.

Super Large Zero Order Waveplates – 101.6mm

- Laser Quality Crystal Quartz
- Air Spaced for High Power
- Clear Aperture of 96mm
- Mounted or Unmounted
- Retardations of 1/2 and 1/4 Wave
- AR Coated
- All Wavelengths Custom
- Rugged 4.5" Mounting Ring

Waveplate Specifications

Material: Crystal Quartz – Laser quality

Waveplate Thickness Range: 4.0 to 10mm

Wavefront Distortion: $\lambda / 10$ @ 632.8nm

Surface Quality: 20-10 Scratch/Dig

Parallelism (Wedge): 0.5 arc seconds

Wavelengths: Specify from 355nm to 2021nm

Retardation Tolerance: ± 0.005 waves @ 632.8nm

Coating: Anti Reflective, $R < 0.25\%$ per surface
IBS Lo R, Hi Pwr, optional

Damage Threshold: 1 kW/cm^2 – CW 3.5 J/cm^2 @ 10ns

Diameter: 101.6, $+0.0/-0.25 \text{ mm}$ unmounted;
114.3, $+0.00/-0.25 \text{ mm}$ mounted

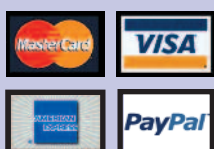
Mounted Thickness: 24mm

Ordering Information

Z-101.6-A-Ret-J/U-Wavelength (3 or 5 digits nm)

Ret=.250 or .500; J=4.5" mount, U=unmounted

Call for pricing



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Zero Order Waveplates – Any Wavelength



- Any wavelength waveplates
- Laser quality
- $\frac{1}{2}$ and $\frac{1}{4}$ wave retardation
- Optical axis marked on mounted and unmounted waveplates
- All waveplates are AR coated
- Custom sizes and shapes available
- Simple ordering selection

Any Wavelength Waveplate Program

Virtually any wavelength waveplate is now available in a matter of days compared to making a custom production run, which takes 8 weeks. Until now the waveplates were offered in 49 different wavelengths between 248 nm and 2021 nm. The waveplates can now be ordered at any wavelength between 248 nm and 2020 nm. This range represents 95% of current requests. This new approach optimizes a customer's system performance since he/she is not concerned with retardation errors from the use of an off the shelf near wavelength waveplate.

This new technique is available to our Zero Order product line at either $\frac{1}{2}$ wave or $\frac{1}{4}$ wave retardation. All four surfaces are AR (Anti-Reflection) coated, and the assembly offered mounted or unmounted.

All of these waveplates sell for the same low prices as our standard items. Any-Wavelength Waveplates are normally available within 3-5 business days.

Use our Standard Part Number (see page 15) and merely insert your desired wavelength.

General Product Description

Zero order waveplates are constructed of two crystal quartz plates that are oriented so that the optical axes are orthogonal. Our standard waveplates are air spaced; cemented and contacted versions are also available. Zero order waveplates are far less sensitive to temperature changes than multiple orders.

Tower Optical standard waveplates are laser quality crystal quartz which are AR coated. **Other wavelengths and custom dimensions are available on a special order basis.**

Our standard waveplates are available in 10 mm, 17.5 mm, 25.4 mm, 38.1 mm and 50.8 mm diameter in a variety of different mounts or unmounted.

Call for pricing.

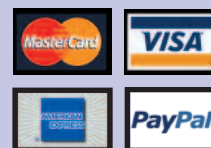


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Multiple Order Waveplates – All Sizes



- Laser quality crystal quartz
- Clear apertures of 8, 10, 15, 23, 34 & 46 mm
- Mounted or unmounted
- Retardations of $\frac{1}{2}$ and $\frac{1}{4}$ wave
- Waveplates are AR coated
- High performance specifications

Tower's multiple order waveplates comprise a single piece of laser quality crystal quartz. Because their retardation is the desired fraction ($\lambda/4$, $\lambda/2$) plus some integer number of waves, they are many times more sensitive to temperature and wavelength than zero order waveplates. Therefore they perform well only in laboratory environments and in monochromatic light.

Tower Optical multiple order waveplates are AR coated on both sides. Standard retardations are $\lambda/4$ and $\lambda/2$; other values are available upon request. They are offered either unmounted or mounted in an anodized aluminum ring.

Waveplate Specifications

Material: crystal quartz – laser quality
Waveplate thickness range: 0.3 to 2 mm
Wavefront distortion: $\lambda/10$ @ 632.8 nm
Surface quality: 10-5 Scratch-Dig
Parallelism (wedge): 0.5 arc seconds
Wavelength range: Per table to the right
Retardation tolerance: ± 0.005 waves @ 632.8 nm
Coating: Anti Reflective, $R < 0.25\%$ per surface
Damage threshold: 1 kW/cm² – CW, 3.5 J/cm² @ 10 ns
Diameter: 10, 12.5, 17.5, 25.4, 38.1 and 50.8 mm, $\pm 0.0/-0.25$ mm unmounted; or mounted in appropriate sized mounting rings
Mounted thickness: Depends on mount diameter

Wavelengths Available

248	266	308	325	355	399	408
413	423	442	458	488	514.5	527
532	556	589	632.8	647	650	660
670	676	694	710	755	767	780
790	795	800	808	810	825	830
850	905	940	980	1047	1053	1064
1112	1310	1319	1550	1570	1980	2020

Ordering Information

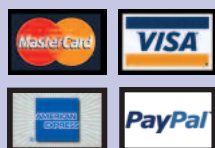
WP Unmounted example for 17.5 mm Dia
M-17.5-D-R-N-WL\$235
WP Mounted in a 25.4 mm ring
M-17.5-D-R-B-WL\$250

WP Unmounted example for 25.4 mm Dia
M-25.4-D-R-N-WL.....\$330
WP Mounted in a 30 mm ring
M-25.4-D-R-C-WL.....\$360

R = Retardation: .500 or .250, WL = Wavelength

Dual Wavelength Waveplates Available

See Page 15 for Waveplate Ordering Information



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Achromatic Waveplates – Cemented



- Low retardation variations
- Four broad spectral ranges
- Cemented construction
- Clear aperture of 23 mm
- Unmounted diameter of 25.4 mm
- Mounted in a 30 mm ring
- Retardations of $\frac{1}{2}$ and $\frac{1}{4}$ wave

Tower Optical offers this second series of Achromatic Waveplates (AWP's) which are built using 25.4 mm substrates of crystal quartz and magnesium fluoride. These substrates are cemented together. This technique helps to control costs by reducing the number of surfaces requiring AR coating while increasing the physical size thus accommodating larger beam diameters. As with the original series of AWP's these AWP's are available in the following ranges:

VIS	465 to 610 nm
VIS/NIR	610 to 850 nm
NIR	700 to 1000 nm
IR	1200 to 1650 nm

Each is broadband AR coated for its respective range. The retardation performance is shown graphically on the page "Achromatic Waveplates - Retardation Curves".

See Retardation Curves on Page 14

Ordering Information

Unmounted version

A-25.4-B-R-N X.....\$810

Mounted version

A-25.4-B-R-C-X.....\$845

R = Retardation, .250 or .500

X = Wavelength range, 1, 2, 3 or 4

Waveplate Specifications

Substrate material: crystal quartz & MgF₂

Retardance: $\lambda/4$ and $\lambda/2$

Retardation tolerance: $\lambda/100$ over wavelength range

Clear aperture: 23 mm

Temp coefficient of retardation: $< \lambda/500$ per °C

Wavelength ranges: 1 = 465-610 nm, 4 = 610-850 nm, 2 = 700-1000 nm, 3 = 1200-1650 nm

Transmitted wavefront distortion: $\lambda/4@633$ nm

Surface quality: 20-10 Scratch-Dig

Beam deviation: < 1 arc minute

Parallelism: < 1 arc minute

AOI range for $< 1\%$ change in retardance: $\pm 3^\circ$

Optical axis: Marked on the mounting ring

Temperature storage range: -40°C to $+75^\circ\text{C}$

Damage threshold: 2J/cm² (8 ns pulse @ 1064 nm); 500 kW/cm², CW

Diameter mounted: 30 mm

Ring thickness: 6 mm

Coating: Ravg $<1\%$ at 465-610 nm per surface
Ravg $<0.7\%$ at 610-850 nm per surface
Ravg $<0.6\%$ at 700-1000 nm per surface
Ravg $<0.5\%$ at 1200-1650 nm per surface

See Page 15 for Waveplate Ordering Information



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Achromatic Waveplates – Air Spaced



- Low retardation variations
- Four broad spectral ranges
- Air spaced for high power
- Clear aperture of 12 mm
- Mounted in a 25.4 mm ring
- Retardations of $\frac{1}{2}$ and $\frac{1}{4}$ wave

Tower's achromatic waveplate (AWP) is similar to a zero-order waveplate, which is made from two pieces of crystal quartz except that the AWP is composed of one piece of crystal quartz and one piece of magnesium fluoride, MgF₂. Both of these materials are birefringent, however, by proper matching of the birefringent changes of the two materials, retardation changes are minimized as the wavelength changes. This phenomenon produces a waveplate whose change in retardation is extremely small for large variations in wavelength.

For tunable sources or lasers with large spectral widths, you'll want an AWP – one whose performance is nearly independent of wavelength.

Tower's AWP's are designed to effectively eliminate the wavelength dependence over a wide spectral range, typically several hundred nanometers. The AWP's are available for four wavelength ranges: 465-610 nm (VIS), 610-850 nm (VIS/NIR), 700-1000 nm (NIR), and 1200-1650 nm (IR.) These AWP's operate beyond these ranges; however the retardation change exceeds the specification. The standard versions are air-spaced. Custom AWP's are available to meet your specific requirements. Send us your drawing for a quote on a custom AWP.

Ordering Information

A-12.7-A-R-B-X\$735

R = Retardation, .250 or .500

X = Wavelength range, 1, 2, 3 or 4

Waveplate Specifications

Substrate material: crystal quartz & MgF₂

Retardance: $\lambda/4$ and $\lambda/2$

Retardation tolerance: $\lambda/100$ over wavelength range

Clear aperture: 12 mm

Temp coefficient of retardation: $< \lambda/500$ per °C

Wavelength ranges: 1 = 465-610 nm, 4 = 610-850 nm, 2 = 700-1000 nm, 3 = 1200-1650 nm

Transmitted wavefront distortion: $\lambda/4@633$ nm

Surface quality: 20/10 scratch dig

Beam deviation: 0.5"

Parallelism: < 1 arc minute

AOI range for $< 1\%$ change in retardance: $\pm 3^\circ$

Optical axis: Marked on the mounting ring

Temperature storage range: -40°C to $+75^\circ\text{C}$

Damage threshold: 2J/cm² (8 ns pulse @ 1064 nm);
500 kW/cm², CW

Diameter mounted: 25.4 mm

Ring thickness: 8 and 9 mm

Coating: Ravg $<1\%$ at 465-610 nm per surface
Ravg $<0.7\%$ at 610-850 nm per surface
Ravg $<0.6\%$ at 700-1000 nm per surface
Ravg $<0.5\%$ at 1200-1650 nm per surface

See Retardation Curves on Page 14

See Page 15 for Waveplate Ordering Information



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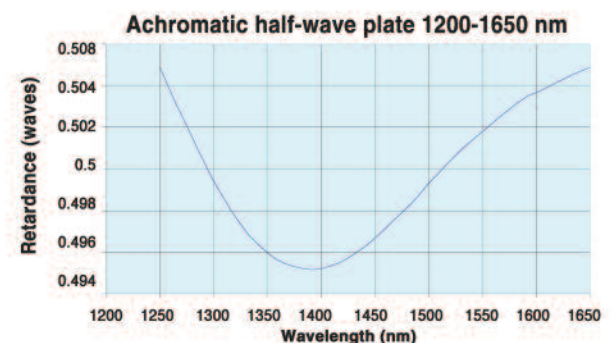
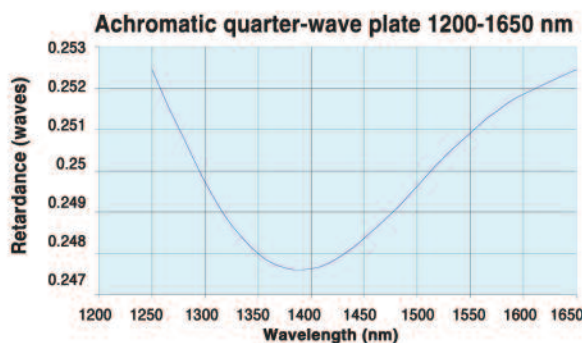
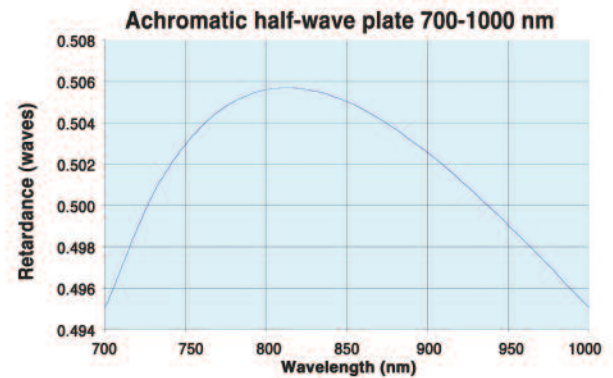
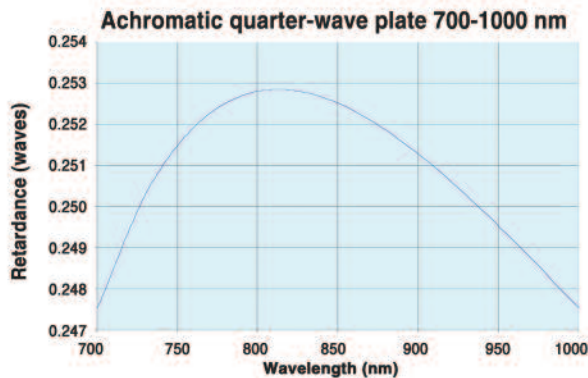
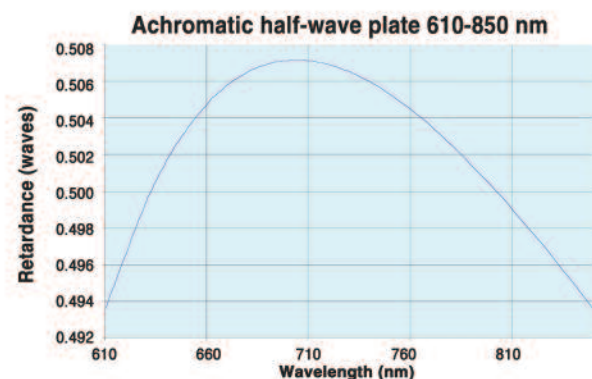
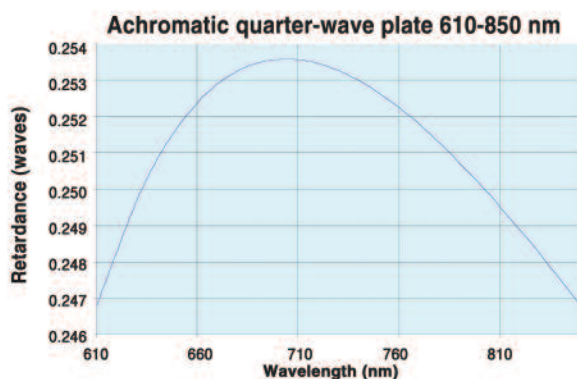
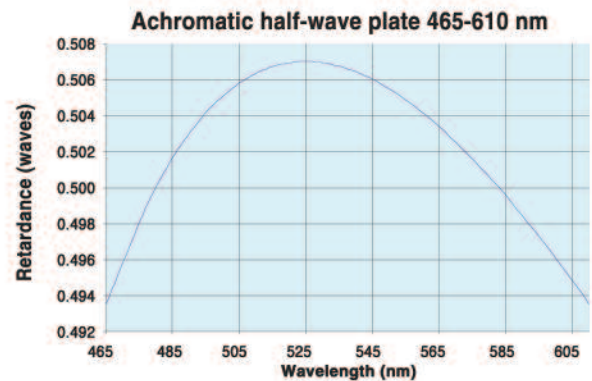
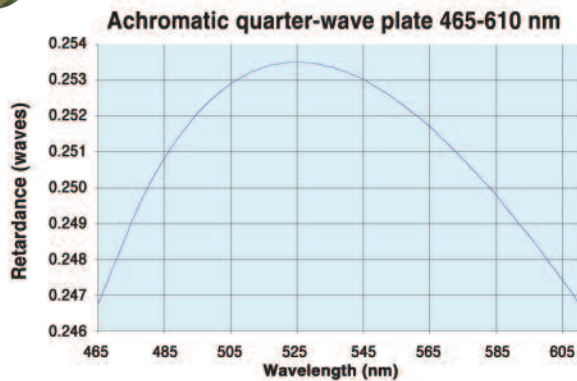
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Achromatic Waveplates – Retardation Curves

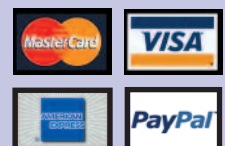


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Waveplate Ordering Information

The following is an explanation of the part numbering system used for Tower Optical Waveplates. Your familiarity will make it extremely easy to order any combination of parameters required.

Waveplate Part Numbers

Type (Order)	Unmounted Diameter	Construction	Retardation	Mounting Ring Diameter	Wavelength
Z-Zero	10 mm	A-Air Gap	.500	A-12.7 mm	
M-Multi	12.7 mm	B-Cemented	.250	B-25.4 mm	
T-True Zero	17.5 mm	C-Contacted	Other	C-30 mm	
D-Dual Wave	25.4 mm	D- Single Plate		D-38.1 mm	
A-Achromatic	38.1 mm			E-50.8 mm	
	43 mm			F-63.5 mm	
	50.8 mm			G-76.2 mm	
	76.2mm			H-101.6	
	101.6mm			J-114.3	
				N-None	

For achromatic WP's select wavelengths as follows:

1 = 465-610 nm
2 = 700-1000 nm
3 = 1200-1650 nm
4 = 610-850 nm

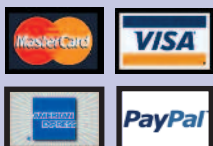
248	266	308	325	355	399	408
413	423	442	458	488	514.5	527
532	556	589	632.8	647	650	660
670	676	694	710	755	767	780
790	795	800	808	810	825	830
850	905	940	980	1047	1053	1064
1112	1310	1319	1550	1570	1980	2020

Example: Z-17.5-A-.250-B-1064

Part Number Creation

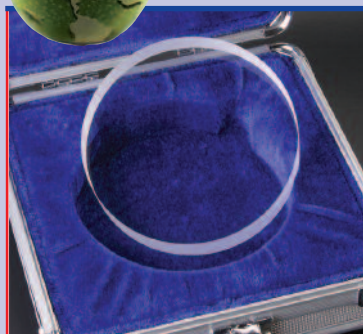
The part number matrix is shown above. A part number is created by selecting the variables as shown above in the top line of parameter boxes starting with the type of waveplate. For a zero order waveplate select Z from the pull-down choices. The assembly of a part number is shown in the example in the middle of the matrix. This is followed by selecting the next variable which is the diameter of the unmounted waveplate, which in the

example is 17.5 mm. The construction of the waveplate is next and in this case is A for air gap. The next parameter is the retardation which is .250 representing $\frac{1}{4}$ wave. The mounting option is next and if no mounting is required you would select N but in the case of the example a 25.4 mm mounting ring is selected. It should be mentioned here that some ring sizes are not available. In the example, an A ring would not work and you would not use any ring larger than a B.





Precision Optical Flats



Precision optical flats are fused silica optical components that are used as a reference against which the flatness of an unknown surface can be determined. For less demanding jobs Tower offers them made from BK7 with a flatness specified as $\lambda/4$ or better. These optical flats may also be used as windows.

Single Sided and Double Sided Optical Flats

- Fused silica
- Flatness of $\lambda/10$ or $\lambda/20$
- Single and double sided
- Easy to use
- From 25 mm to 200 mm
- Precision ground and polished
- BK7 available at lower cost

Specifications

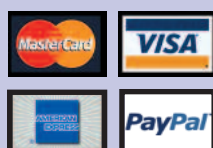
for single and dual surface optical flats

Material:	BK7	fused silica
Exp. coefficient:	$7.1 \times 10^{-6}/^{\circ}\text{C}$	$0.55 \times 10^{-6}/^{\circ}\text{C}$
Surface quality:	60/40	
Parallelism:	<1 arc minute	
Back surface (single):	1-2 λ @633nm	
Diameter tolerance:	± 1 mm	
Thickness tolerance:	± 1.5 mm	

Custom versions also available

Diameter (mm)	Thickness (mm)	Material	Single or Dual Surface	Lambda/10		Lambda/20	
				Catalog No.	Price	Catalog No.	Price
25	12.5	Fused Silica	Single	4542-0002	\$140.00	4542-0022	call for price
25	12.5	Fused Silica	Dual	4542-0004	\$240.00		
50	15	Fused Silica	Single	4542-0006	\$400.00	4542-0024	call for price
50	15	Fused Silica	Dual	4542-0008	\$520.00		
100	20	Fused Silica	Single	4542-0010	\$680.00	4542-0026	call for price
100	20	Fused Silica	Dual	4542-0012	\$860.00		
150	25	Fused Silica	Single	4542-0014	\$1,447.00		
150	25	Fused Silica	Dual	4542-0016	\$1,630.00		
200	38	Fused Silica	Single	4542-0018	\$2,872.00		
200	38	Fused Silica	Dual	4542-0020	\$3,052.00		
				Lambda/4 or better			
25	12.5	BK7	Single	4542-0001	\$75.00		
25	12.5	BK7	Dual	4542-0003	\$83.00		
50	15	BK7	Single	4542-0005	\$75.00		
50	15	BK7	Dual	4542-0007	\$100.00		
100	20	BK7	Single	4542-0009	\$215.00		
100	20	BK7	Dual	4542-0011	\$300.00		
150	25	BK7	Single	4542-0013	\$450.00		
150	25	BK7	Dual	4542-0015	\$580.00		
200	38	BK7	Single	4542-0017	\$800.00		
200	38	BK7	Dual	4542-0019	\$1,200.00		

If a carrying case is required order 1405-0008 for up to 100 mm for \$50, and 1405-0009 for 150 & 200 mm for \$75.



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Transmission Flats 4" and 6"



Model TX Flat 4" and 6"

- Fused silica
- Surface accuracy of $\lambda/20$
- Wedge of 15 arc minutes
- Clear aperture: 4" TX Flat = 100 mm
6" TX Flat = 153 mm
- Compatible with bayonet-style mount
- Custom storage case included
- Low cost

The surface flatness of plano elements such as mirrors, prisms and windows can be verified by the use of an interferometer in conjunction with a transmission flat.

Transmission flats are used when measuring the surface flatness or transmitted wavefront of flat surfaces or optics. The Tower 4" TX Flat provides a clear aperture of 100mm, while the Tower 6" TX Flat provides a clear aperture of 153mm. The TX Flat is an assembly of a precision optical window mounted in an anodized aluminum ring that provides mounting compatibility with most bayonet-style housings. The transmission flat assembly is supplied in an aluminum shipping/storage case.

The TX Flat is supplied with one surface AR coated with $R \leq 0.25\%$ @ 633 nm. The uncoated side has a reflectivity of about 4%. It is accompanied by a documented interferogram and Certificate of Compliance.

Ordering Information

	<u>4" TX Flat</u>	<u>6" TX Flat</u>
Catalog number:	0535-0005	0535-0011
Price:	\$2,750	\$4,250

Specifications

Window

Material: fused silica

Transmitted wavefront distortion: $\lambda/20$

	<u>4"TX Flat</u>	<u>6" TX Flat</u>
Diameter:	114.2 mm	161.5 mm
Thickness:	19.0 mm	28.2 mm

Surface quality: 20/10, both sides

Wedge: 15 ± 1 arc minutes

Protective bevel: 1.0 mm x 45°

Anti reflective coating: one side, $R \leq 0.25\%$
@ 633 nm

Housing

Material: aluminum, 6061-T6

	<u>4"TX Flat</u>	<u>6" TX Flat</u>
Diameter:	127.0 mm	181.1 mm
Height:	28.1 mm	36.8 mm

Finish: black anodize

Case

Material: wood and foam insert

Size: 4" TX Flat ~170 x 170 x 50 mm
6" TX Flat ~220 x 220 x 70 mm



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Beam Expander, 4" to 6"



Beam Expander, 4" to 6"

- Precision Optics
- Quality Mechanics
- User Friendly
- Simple Setup
- Low cost

Tower's new BeamEx1000 provides a low cost solution to expanding the capability of a standard 4" Fizeau Interferometer to measure up to 6" optics. The BeamEx 1000 mounts to the front of a standard interferometer using the industry standard bayonet mount.

The combination of the BeamEx1000 and the interferometer provides for testing of very precise optical surfaces.

The BeamEx1000 also provides an adjustable tip and tilt capability incorporated with a 6" bayonet mounting to accommodate a suitable transmission flat, a reference flat or a transmission sphere.

Tower offers as an option a 6" Transmission Flat which snaps into the Beam Ex 1000.

The 6" flat has a surface error of $\lambda/20$ and is AR coated for 632.8nm.

Specifications

Mechanical Interfaces

Input: 4" industry standard bayonet mount

Output: 6" industry standard bayonet mount

Adjustment: 2 Axis Tip and Tilt of optional 6" Transmission Flat optic

Input Wavelength: 632.8nm

AR Coating for internal optics: $R < 0.25\%$ @ 633nm, per surface

Wavefront Deformation: Single pass @ 23°C, $< \lambda/3$

Input Diameter: 104mm

Output Diameter: 155mm

Overall Length: 210mm

Overall Width: 204mm

Overall Height: 204mm

Weight: 11.7 Lbs no Tx Flat

15.4 Lbs with Tx Flat



BeamEx 1000 with 6" Transmission Flat installed.

Ordering Information

	Catalog No.	Price
BeamEx1000	0535-0018	\$9995.00
Tranmission Flat 6"	0535-0011	\$4250.00



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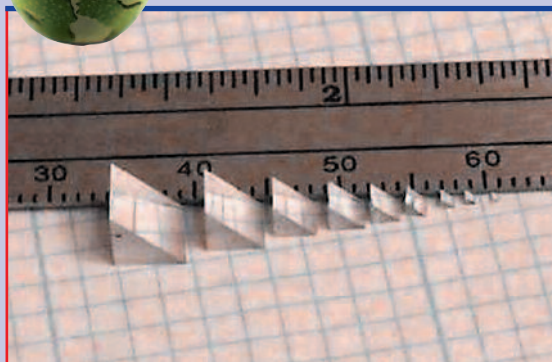
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Micro Prisms – Coated and Uncoated



- Nine standard sizes available: 0.5, 0.7, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0 and 5.0 mm
- 45° - 90° - 45°
- Uncoated or enhanced aluminum on hypotenuse
- Use for concept testing or production
- Low cost

Specifications

Material: NBK-7 or H-K9L

Sizes: nine as follows: 0.5 mm, 0.7 mm, 1.0 mm, 1.5 mm, 2.0 mm, 2.5 mm, 3.0 mm, 4.0 mm and 5.0 mm

Dimensional tolerance:

For 0.5 and 0.7 mm: ± 0.05 mm

For balance: $\pm 0.0, -0.2$ mm

Angular tolerance: ± 3 arc minutes

Surface quality: 40-20 Scratch-Dig

Corner chips: none allowed

Coating: MPCH Series = enhanced aluminum, MPU Series = none

Clear aperture: $>80\%$

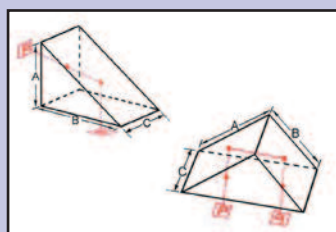
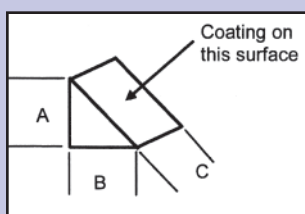
Flatness: $\lambda/2$ @ 632.8 nm

Bevel: allowed up to 0.1 mm

Tower has expanded its line of precision optics to include standard micro prisms, coated and uncoated, for use with laser sources and imaging applications. The micro prisms are right angle, 45°-90°-45° prisms, whose sizes range from 0.5 mm to 5.0 mm with a format of A=B=C.

These right angle prisms are used to deflect a light beam 90° or 180° as shown to the left. Depending on prism orientation, images will be inverted, but correct left to right. If the prism is rotated 90°, images viewed through it will be erect, but reversed left to right.

Coated prisms can also be used as mirror reflectors with respect to incoming light. Uncoated prisms act as mirrors for light incident on one of the short sides since incident light is totally internally reflected at the hypotenuse.



Pricing and Ordering Information

Micro Prism Size A=B=C	Uncoated			Coated		
	Catalog #	Model	Price 1-9	Catalog#	Model	Price 1-9
0.5 mm	4531-0001	MPU-0.5	\$53	4531-0020	MPCH-0.5	\$69
0.7 mm	4531-0002	MPU-0.7	\$39	4531-0021	MPCH-0.7	\$69
1.0 mm	4531-0003	MPU-1.0	\$36	4531-0022	MPCH-1.0	\$63
1.5 mm	4531-0004	MPU-1.5	\$36	4531-0023	MPCH-1.5	\$63
2.0 mm	4531-0005	MPU-2.0	\$33	4531-0024	MPCH-2.0	\$63
2.5 mm	4531-0006	MPU-2.5	\$33	4531-0025	MPCH-2.5	\$63
3.0 mm	4531-0007	MPU-3.0	\$30	4531-0026	MPCH-3.0	\$60
4.0 mm	4531-0008	MPU-4.0	\$30	4531-0028	MPCH-4.0	\$60
5.0 mm	4531-0009	MPU-5.0	\$19	4531-0029	MPCH-5.0	\$60

Contact factory for quantity pricing or special coatings

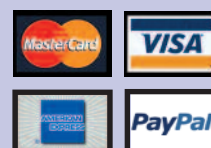


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Large Right Angle Prisms

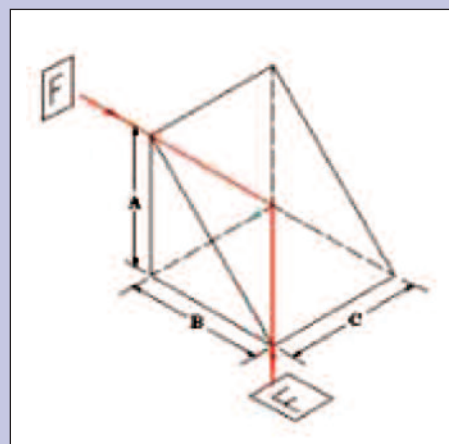


50, 25, 20, 15 and 12.5 mm Prisms

Tower Optical offers large format, high quality, right angle prisms for experimentation, research and education. These prisms are stock products for immediate shipment. Prisms are available in BK7 or fused silica type glass.

Series LPU – Large Prisms Uncoated

- 12.5 mm to 50 mm
- BK7 or UV fused silica
- High quality
- Uncoated
- Coated on special order
- Custom variations



Specifications

Material: BK7 (or equiv) or UV fused silica

Dimensional tolerance: ± 0.1 mm

Flatness: $\lambda/4$ @ 632.8 nm

Surface quality: 40-20 Scratch-Dig

Angle tolerance: ± 30 arc seconds

Pyramid error: Less than 10 arc minutes

Bevel: 0.2-0.5 mm x 45°

Coating: Not coated

Pricing and Ordering Information

Catalog Number	Model No.	Glass	Size mm A=B=C	Price Each \$
4531-0010	LPU-112	BK7	12.5	25
4531-0011	LPU-115	BK7	15.0	28
4531-0012	LPU-120	BK7	20.0	41
4531-0013	LPU-125	BK7	25.0	49
4531-0014	LPU-150	BK7	50.0	120
4531-0015	LPU-212	FS	12.5	98
4531-0016	LPU-215	FS	15.0	108
4531-0017	LPU-220	FS	20.0	130
4531-0018	LPU-225	FS	25.0	246
4531-0019	LPU-250	FS	50.0	480

For sizes larger than 50 mm or variations in the dimensions, or coatings on the prism surfaces contact Sales@TowerOptical.com

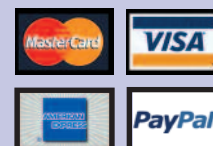


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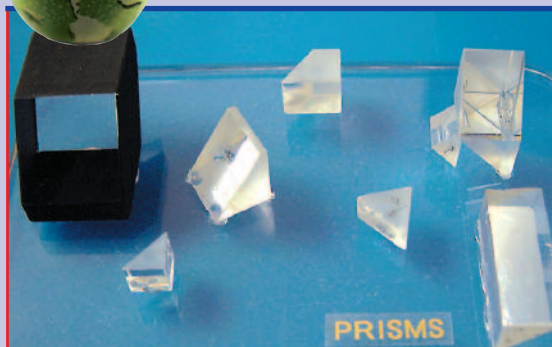
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Custom and Standard Prisms



Prisms are transparent optical blocks having at least two flat polished sides inclined relative to each other, at precisely controlled angles, so as to deflect, deviate, and rotate beams of light as well as dispersing their wavelengths. There are many types of prisms, each having a particular shape to achieve the necessary reflections to perform a specific optical task.

Tower Optical's prism capability includes penta prisms, right angle prisms, Dove prisms, roof prisms, Amici prisms, corner cube reflectors, anamorphic prisms, wedge prisms and polarizers including Glan-Taylor prisms, Wollaston prisms and Rochon prisms.

For right angle prisms, Tower Optical offers three different quality standards: Standard Grade, High Grade and Laser Grade.

The basic specifications are shown below.

Specification	Standard Grade	High Grade	Laser Grade
Material	BK7 grade A glass	BK7 grade A glass	BK7 grade A glass
Dimensional tolerance	±0.2 mm	±0.1 mm	±0.1 mm
Flatness	$\lambda/2$ @ 632.8 nm	$\lambda/4$ @ 632.8 nm	$\lambda/10$ @ 632.8 nm
Surface quality	60-40 Scratch-Dig	40-20 Scratch-Dig	20-10 Scratch-Dig
Angle tolerance	±3 arc minutes	±30 arc seconds	±30 arc seconds
Pyramid Error	< 10 arc minutes	< 10 arc minutes	< 5 arc minutes
Bevel	0.2-0.5 mm x 45°	0.2-0.5 mm x 45°	0.25 mm x 45°

These prisms are also available in UV grade Fused Silica as well as other material. Optical coatings are also available for AR, mirror or beamsplitter applications.

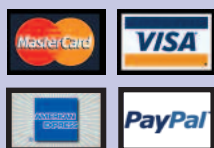
Tower Optical
manufactures custom prisms.

*If you have a design simply email it to
Sales@TowerOptical.com
and indicate the quantity required.*

*We will respond with a quotation
ASAP.*

Custom Prism Capabilities

Sizes	0.5 - 100 mm
Angle tolerance to	1 arc second
Dimensional tolerance	+0.10 mm
Surface quality (Scratch/ Dig)	10/5
Flatness	$\lambda/10$ @ 632.8nm



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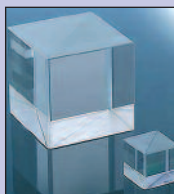
Beamsplitters

Beamsplitters are used to split or combine beams of light. Tower Optical provides some standard beamsplitters, but most are custom per drawings submitted by a customer. Some standard cubes and plate beamsplitters are shown below.

Plates are used for most laser applications as they exhibit low absorption. Cubes are a convenient, protected form for low power applications. The performance of the beamsplitters is a function of the beamsplitter coating.

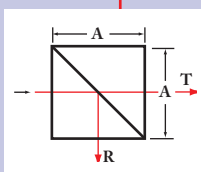
Polarization Beamsplitter Cubes

These beamsplitters are based upon using two complementary prisms. The output beam that is parallel to the input beam is **p-polarized**, while the orthogonal output beam is **s-polarized**. Non-polarized beamsplitter cubes can be provided.



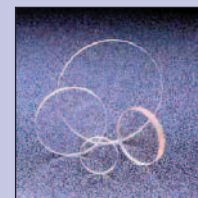
Specifications

Material: BK-7 grade A optical glass
Dimension range: 3.2 mm to 50.8 mm
Dimensional tolerance: ± 0.2 mm
Angular tolerance: ± 3 arc minutes
Surface quality: 60-40 Scratch-Dig
Beam deviation: 3 arc minutes
Extinction ratio: $>100:1$
Principal transmittance: $T_p > 95\%$ and $T_s < 1\%$
Principal reflectance: $R_s > 99\%$ and $R_p < 5\%$
Wavelength range: 226 nm to 2300 nm
Polarization beamsplitter coating: on hypotenuse
AR coating: $R < 0.25\%$ per face for 4 faces



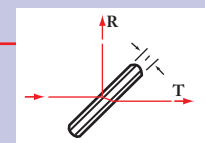
Beamsplitter Plates

Beamsplitter plates are primarily used to split or recombine a beam of light, especially in high power lasers. When using beamsplitter plates the two partial beams travel different optical paths. The optical paths depend on the incident angle and the thickness of the plates. The beam can be shifted.



Specifications

Material: BK-7 grade A optical glass
Diameter range: 10 mm to 50.8 mm
Dimensional tolerance: ± 0.2 mm
Thickness tolerance: ± 0.2 mm
Flatness: $\lambda/4 @ 632.8$ nm per 25 mm
Surface quality: 60-40 Scratch-Dig
Parallelism: 1 arc minute
T/R: $50/50 \pm 5\%$ for random polarization
 $T = (T_s + T_p)$, $R = (R_s + R_p)/2$
Coatings: 45° incidence
S1: Single wavelength partial reflectance
S2: "V" AR-coatings



Pricing and Ordering Information

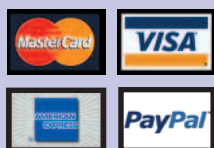
Model	Narrow or Broad	Size mm	Price \$
BSPN1-5-X	N	5 x 5 x 5	148
BSPN1-10-X	N	10 x 10 x 10	148
BSPN1-15-X	N	15 x 15 x 15	185
BSPN1-20-X	N	20 x 20 x 20	209
BSPB1-10-Y	B	10 x 10 x 10	160
BSPB1-15-Y	B	15 x 15 x 15	190
BSPB1-20-Y	B	20 x 20 x 20	203

Model	Narrow or Broad	Size mm	Shape RND SQ	Price \$
BSNN1-12.7S-X	N	12.7 x 12.7 x 3	SQ	56
BSNN1-25.4S-X	N	25.4 x 25.4 x 3	SQ	78
BSNN1-25.4R-X	N	25.4 x 3	RND	78
BSNN1-50.8S-X	N	50.8 x 50.8 x 3	SQ	129
BSNB1-12.7S-Y	B	12.7 x 12.7 x 3	SQ	67
BSNB1-25.4S-Y	B	25.4 x 25.4 x 3	SQ	83
BSNB1-25.4R-Y	B	25.4 x 3	RND	83
BSNB1-50.8S-Y	B	50.8 x 50.8 x 3	SQ	133

X = Narrow band wavelengths: 488, 514, 633, 780, 850, 1064, 1300, 1550 nm,

Y = Broad band ranges (nm): 1 = 450 - 680, 2 = 650 - 850, 3 = 900 - 1200, 4 = 1200 - 1550

The Beamsplitter specifications are general - We are happy to quote other specifications.



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Optical Filters and Coatings



Custom Filters

Tower custom filters cover applications for biomedical bandpass, narrow bandpass, broad bandpass or long pass. Using ion-beam sputtering together with volume manufacturing methods, Tower is able to offer cost-effective solutions.

Biomedical Filters

From: 340 nm to 766 nm
Size: as required
CWL tolerance: ± 2 nm
FWHM: 8-10 nm, typical
FWHM tolerance: ± 1 nm
Transmission: $>50\%$
Blocking: 300 nm – 1200 nm
Rejection: OD=4, 0.01% or 10^{-4}

Narrow Bandpass

From: 340 nm to 1570 nm
Size: as required
CWL tolerance: 0.4 nm – 2 nm
FWHM: 2 nm – 50 nm
Transmission: $>90\%$
Blocking: 300 nm – 1200 nm
300 nm – 1800 nm
Rejection: OD >4 , OD >6

Broad Bandpass

From: 340 nm to 1570 nm
Size: as required
CWL tolerance: >10 nm
FWHM: >50 nm
Transmission: $>70\%*$
Blocking: 300 nm – 1200 nm
300 nm – 1800 nm
Rejection: OD >3 , OD >4
* Specify desired level

Coatings

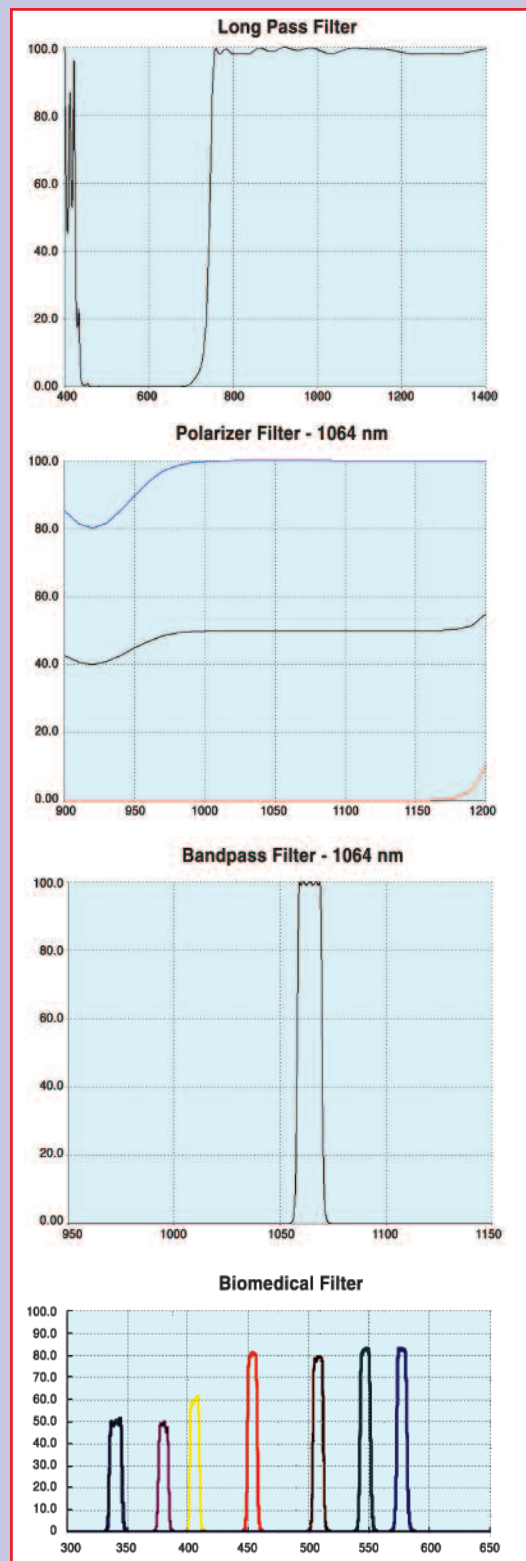
- Highpower laser coatings:
anti-reflection, reflective,
partial reflectors, beamsplitters and polarizers
- Metallic coatings
Aluminum – UV and protected
Silver – protected
Reflectance $>98\%$ 800 nm to IR
Gold – protected and unprotected
- Broadband dichroic beamsplitter coatings
- Polarizing beamsplitter coatings
- Multi-wavelength and extended coatings
- Anti-reflective coatings from UV to IR
- Dielectric high reflective coatings high power
- Filters short pass, long pass and bandpass filters

The above coatings are available for wavelengths ranging from UV, VIS, and near IR, including laser wavelengths from 193 nm to 3 microns.

Custom and specialized coatings available upon request.

IBS Ion beam sputtered thin films for the most complex optical image.

We can provide computer design of optical systems and thin film coatings.



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Hot and Cold Mirrors

Hot Mirrors are used in applications when there is the requirement to separate visible light from heat. The hot mirror accomplishes this by reflecting the heat. The use of borosilicate type glass allows operation in high temperatures. Operation at an AOI of 0° is preferred. The most common wavelength range for an average transmission of 85% through the hot mirror is 420 – 700 nm. The reflective range for the hot mirror for R>95% is 800–1000 nm. Additionally, R>50% from 735 – 1080 nm.

Cold Mirrors are used where the requirements are to reflect visible light and remove the heat by transmission. Operation at an AOI of 45° is preferred. The most common wavelength range for transmission through the cold mirror is 800–1200 nm. The average-transmission range is T>85%. Additionally, R>95% for 400 - 700 nm.

Typical Specifications

Hot Mirrors

Material: borosilicate type glass

Size: 15 mm to 300 mm

Thickness: 3.3 mm

Mirror coating: dielectric multilayer

Transmission: Tave>85% for 425–700nm

Reflection: Rave>90% for 750–1050nm

Surface Finish: 80-50

Flatness: $\lambda/2$ @633 nm per inch

Protective Bevel: 0.3 mm x 45°

Cold Mirrors

Material: borosilicate type glass

Size: 15 mm to 300 mm

Thickness: 3.3 mm

Mirror coating: dielectric multilayer

Transmission: tave>85% for 750–1000 nm

Reflection: rave>90% for 400–700 nm

Surface Finish: 80-50

Flatness: $\lambda/2$ @633 nm per inch

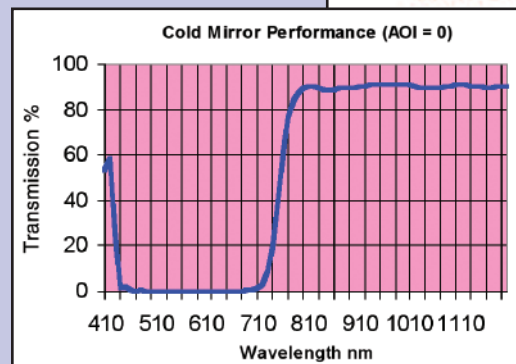
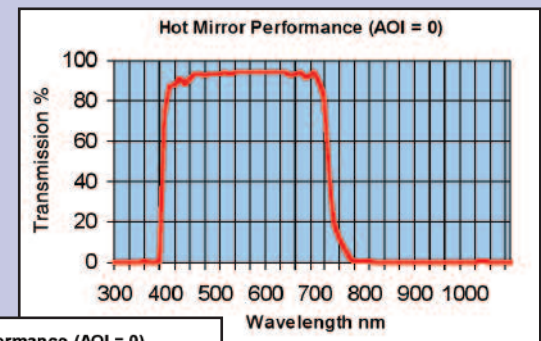
Protective Bevel: 0.3 mm x 45°

Features of Hot Mirrors

- High transmission for the visible range
- High reflection for infrared
- Removes heat
- Uses Borofloat® type glass
- Dielectric coating
- AOI's of 0° or 45°
- Custom mirrors to your configuration

Features of Cold Mirrors

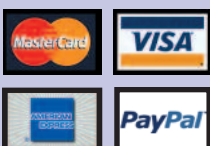
- High reflection for the visible range
- High transmission for infrared



Standard Cold/Hot Mirrors

Type	Model	AOI	Price
Cold	MC0-25.4	0	\$50
	MC0-50.8	0	\$61
	MC45-25.4	45	\$50
	MC45-50.8	45	\$61
Hot	MH0-25.4	0	\$53
	MH0-50.8	0	\$79
	MH45-25.4	45	\$54
	MH45-50.8	45	\$72

Custom Cold/Hot Mirrors available.



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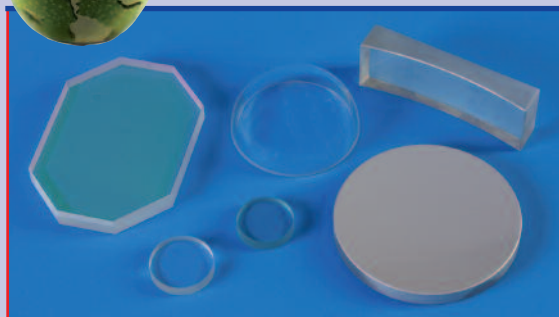
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Windows and Mirrors



Windows are used to isolate different physical environments while allowing light to pass. The selection of a window should consider the properties of the different optical materials, transmission, wavelength range, and resistance to the environment. Tower offers a wide range of materials and a variety of anti-reflecting coatings that can be deposited on the windows.

Tower Optical manufactures windows from BK7, UV grade fused silica and sapphire. Other materials are available on a custom basis. In addition, we offer three different quality standards as described below. Contact factory for info on sapphire windows.

Specifications	Standard Grade	High Grade	Laser Grade	High Grade
Material	BK7 grade A	BK7 grade A	UV fused silica	sapphire
Dimensional tolerance	+0.0/-0.1 mm	+0.0/-0.1 mm	+0.0/-0.1 mm	±0.1 mm
Flatness (TWF)	$\lambda/2$ @ 632.8 nm	$\lambda/10$ @ 632.8 nm	$\lambda/10$ @ 632.8 nm	$\lambda/4$ per 25.4 mm
Surface quality	40-20 Scratch-Dig	20-10 Scratch-Dig	20-10 Scratch-Dig	40-20 Scratch-Dig
Thickness tolerance	±0.2 mm	±0.2 mm	±0.2 mm	±0.1 mm
Parallelism	< 1 arc minute	< 10 arc seconds	< 10 arc seconds	<30 arc seconds
Bevel	0.2 mm x 45°	0.2 mm x 45°	0.2 mm x 45°	—

BK7 grade A optical glass, Standard WB11 and High WB12								UV grade fused silica, High WF22			
Model No.	Dia mm	Thick	4541	Model No.	Dia mm	Thick	4541	Model No.	Dia mm	Thick	4541
WB11-005	5.0	2.0	-0001	WB12-005	5.0	2.0	-0008	WF22-005	5.0	2.0	-0015
WB11-010	10.0	2.0	-0002	WB12-010	10.0	2.0	-0009	WF22-010	10.0	2.0	-0016
WB11-012	12.5	2.0	-0003	WB12-012	12.5	6.0	-0010	WF22-012	12.5	6.0	-0017
WB11-020	20.0	2.0	-0004	WB12-020	20.0	6.0	-0011	WF22-020	20.0	6.0	-0018
WB11-025	25.0	2.0	-0005	WB12-025	25.0	6.0	-0012	WF22-025	25.0	6.0	-0019
WB11-038	38.0	4.0	-0006	WB12-038	38.0	10.0	-0013	WF22-038	38.0	10.0	-0020
WB11-050	50.0	4.0	-0007	WB12-050	50.0	10.0	-0014	WF22-050	50.0	10.0	-0021

Mirrors have one surface with a highly reflective coating, usually aluminum or silver. Most mirrors for optical applications are called first surface types since the coating is on the front surface thereby eliminating the optical properties of the glass from affecting the incident or reflected light. The rear surface is usually fine ground. *All of the following mirrors have a protected aluminum coating applied to the front surface.*

Specifications	Standard grade	High grade
Material	BK7 grade A	BK7 grade A or fused silica
Dimensional tolerance	+0.0/-0.1 mm	+0.0/-0.1 mm
Flatness:	$\lambda/5$ @ 632.8 nm	$\lambda/10$ @ 632.8 nm
Surface quality	40-20 Scratch-Dig	10-5 Scratch-Dig
Thickness tolerance	±0.2 mm	±0.2 mm
Parallelism	< 3 arc minutes	< 3 arc minutes

BK7 grade A optical glass, Standard MB11 and High MB12								UV grade fused silica, High MF22			
Model No.	Dia mm	Thick	4526	Model No.	Dia mm	Thick	4526	Model No.	Dia mm	Thick	4526
MB11-010	10.0	2.0	-0001	MB12-010	10.0	2.0	-0007	MF22-010	10.0	2.0	-0013
MB11-012	12.5	2.0	-0002	MB12-012	12.5	6.0	-0008	MF22-012	12.5	6.0	-0014
MB11-020	20.0	2.0	-0003	MB12-020	20.0	6.0	-0009	MF22-020	20.0	6.0	-0015
MB11-025	25.0	2.0	-0004	MB12-025	25.0	6.0	-0010	MF22-025	25.0	6.0	-0016
MB11-038	38.0	4.0	-0005	MB12-038	38.0	10.0	-0011	MF22-038	38.0	10.0	-0017
MB11-050	50.0	4.0	-0006	MB12-050	50.0	10.0	-0012	MF22-050	50.0	10.0	-0018

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Lenses – Custom and Cylindrical



Custom Lenses

- Lenses and micro lenses
- Custom made to your specifications
- Singlets, doublets, triplets
- Multi-element assemblies
- Precision tolerances available
- Free consultation

General Lens Capabilities

Sizes: 1 mm to 350 mm
Diameter tolerance: ± 0.02 mm
Decentration (wedge): ± 10 second
Irregularity: 0.05 waves @ 632.8
Spherical error: 0.10 waves @ 632.8
Surface quality: 10-5 Scratch-Dig
Thickness tolerance: ± 0.01 mm

*Send us
your drawing*



Cylindrical Lenses

Plano Convex Cylindrical Lenses

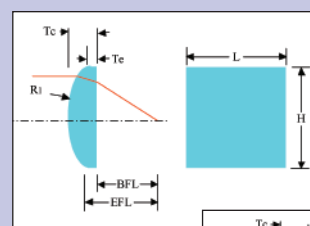
Model	H x L mm	EFL mm	BFL mm	R1 mm	Tc mm	Te mm	Price \$
CYX15-010-012	10 x 10	12.7	9.862	6.56	4.31	2.0	75
CYX15-010-020	10 x 10	20	17.835	10.33	3.29	2.0	70
CYX15-010-025	10 x 10	25	23.016	12.92	3.01	2.0	70
CYX15-020-012	10 x 20	12.7	9.862	6.56	4.31	2.0	81
CYX15-020-020	10 x 20	20	17.835	10.33	3.29	2.0	76
CYX15-020-025	10 x 20	25	23.016	12.92	3.01	2.0	76
CYX15-040-050	20 x 40	50	47.352	25.82	4.02	2.0	87
CYX15-040-075	20 x 40	75	72.822	38.73	3.31	2.0	81
CYX15-040-100	20 x 40	100	97.381	51.64	3.98	3.0	81
CYX15-040-150	20 x 40	150	147.6	77.46	3.65	3.0	81

Specifications

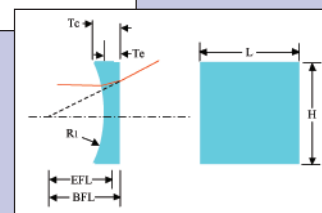
Material: BK7 or equivalent
Design wavelength: 587.6nm
Dimensional tolerance: ± 0.2 mm
Focal length tolerance: $\pm 2\%$
Centering tolerance: 5-15 arc minutes
Clear aperture: 90%
Surface quality: 60-40 Scratch-Dig
Bevel: 0.2 mm x 45°
Coating: none

Plano Concave Cylindrical Lenses

Model	H x L mm	EFL mm	BFL mm	R1 mm	Tc mm	Te mm	Price \$
CYV16-010-012	10 x 10	-12.7	-14.023	-6.56	2.0	4.31	75
CYV16-010-025	10 x 10	-25.0	-26.320	-12.91	2.0	3.01	70
CYV16-020-012	10 x 20	-12.7	-14.030	-6.56	2.0	4.31	81
CYV16-020-025	10 x 20	-25.0	-26.320	-12.91	2.0	3.01	76
CYV16-040-050	20 x 40	-50.0	-51.981	-25.82	2.0	4.02	87
CYV16-040-075	20 x 40	-75.0	-76.983	-38.73	3.0	4.31	81
CYV16-040-100	20 x 40	-100.0	-101.325	-51.64	3.0	3.98	81
CYV16-040-150	20 x 40	-150.0	-151.987	-77.46	3.0	3.65	81
CYV16-040-250	20 x 40	-250.0	-251.974	-129.09	3.0	3.39	81
CYV16-040-500	20 x 40	-500.0	-501.969	-258.18	3.0	3.19	81



Convex



Concave



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Ball and Drum Lenses



Ball Lenses are used for various tasks such as improving the coupling between optical fibers and the emitters or detectors they interface with. Standard size lenses range from 1.0 mm to 5.0 mm. Custom-made sizes or special materials are also available. All ball lenses can be ordered with full-surface anti-reflection (AR) coating.

The effective focal length of a ball lens is given by the following formula:

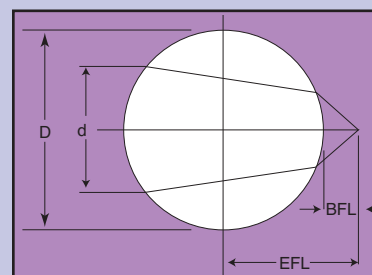
$$BFL = F - D/2 \text{ and } EFL = nD/4(n-1)$$

The Numerical Aperture (NA) of a ball lens is dependent on the focal length of the ball and on the input diameter, d.

$$NA = 2d(n-1)/nD$$

Pricing and ordering info

Ball Lens Diameter	Material	Model Number	Price
1.0 mm	BK7	LB1-001	\$22
2.0 mm	BK7	LB1-002	\$21
3.0 mm	BK7	LB1-003	\$20
4.0 mm	BK7	LB1-004	\$20
5.0 mm	BK7	LB1-005	\$22
1.0 mm	UV FS	LB2-001	\$34
2.0 mm	UV FS	LB2-002	\$28
3.0 mm	UV FS	LB2-003	\$28
4.0 mm	UV FS	LB2-004	\$28
5.0 mm	UV FS	LB2-005	\$30
6.0 mm	UV FS	LB2-006	\$41
8.0 mm	UV FS	LB2-008	\$43
10.0 mm	UV FS	LB2-010	\$58



Specifications

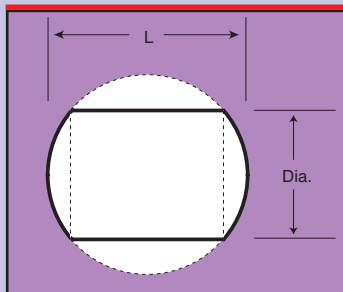
Material: BK7 grade A or equivalent or UV fused silica

Diameter tolerance: ± 0.01 mm

Sphericity: ± 0.003 mm

Surface quality: 40-20 Scratch-Dig

Coating: none



Drum Lenses

A drum lens is a variation of a ball lens where a portion of the ball is ground down to a smaller diameter. These lenses are used in similar applications to those of ball lenses. The drum lens adds the ability to handle and package it in a different way.

Specifications

Material: BK7 grade A optical glass

Diameter tolerance: $+0.0/-0.05$ mm

Length: ± 0.01 mm

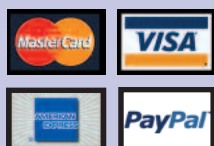
Surface quality: 40-20 Scratch-Dig

Coating: none

Pricing and ordering info

Model No.	Diameter	Length	Price
LD1-020-025	2.0 mm	2.5 mm	\$30
LD1-020-030	2.0 mm	3.0 mm	\$30
LD1-020-040	3.0 mm	4.0 mm	\$31
LD1-020-050	4.0 mm	5.0 mm	\$31

LD2-XXX-yyy is Fused Silica drum lenses. Contact factory for pricing.



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Plano Concave Lenses



Tower Optical's plano concave lenses have a negative focal length, diverge collimated incident light, and form only virtual images which are seen through the lens. They are often used to expand light beams or increase focal lengths in existing systems.

They are widely used in telescopes, collimators, optical transceivers, magnifiers, radiometers and condensers.

Specifications

Material: BK7, grade A, fine anneal, or K9 substitute

Design wavelength: 632.8 nm

Diameter tolerance: +0/-0.10 mm

Focal length tolerance: $\pm 1\%$

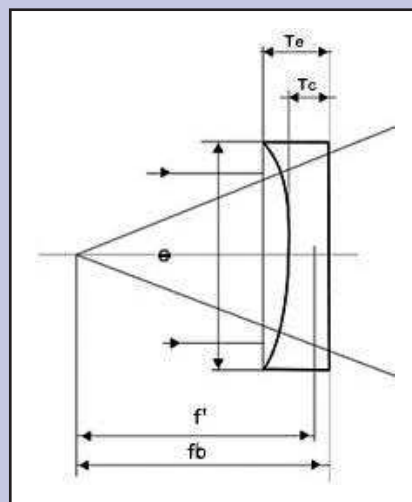
Centering: ± 3 arc minutes

Clear aperture: 90% of diameter

Surface quality: 60-40 Scratch-Dig

Bevel: 0.25 mm x 45°

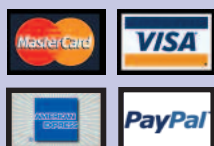
Coating: none



Part No. Number	Dia. (mm)	EFL (mm)	R1 (mm)	R2 (mm)	CT (mm)	ET (mm)	BFL (mm)	Price each
LNCV001	6	-18	-9.26	∞	2	2.5	-19.32	18
LNCV002	6	-24	-12.35	∞	2	2.37	-25.32	18
LNCV003	12.7	-25	-12.87	∞	3	4.68	-26.98	19
LNCV004	12.7	-30	-15.44	∞	3	4.37	-31.98	19
LNCV005	12.7	-50	-25.73	∞	3.5	4.3	-52.31	19
LNCV006	25.4	-50	-25.7	∞	3.5	6.9	-52.3	22
LNCV007	25.4	-75	-38.6	∞	3.5	5.65	-77.31	22
LNCV008	25.4	-100	-51.46	∞	4	5.59	-102.64	22
LNCV009	50.8	-75	-38.6	∞	3.5	13.04	-77.31	29
LNCV010	50.8	-100	-51.46	∞	4	10.71	-102.64	29
LNCV011	50.8	-150	-77.19	∞	4	8.3	-31.97	29

Please check with Tower for availability.

Call us for quantity pricing.



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Plano Convex Lenses



Tower Optical's plano convex lenses have positive focal lengths, converge incident light, and form both real images (as might be focused in a piece of paper), and virtual images (as are seen through the lenses when they are used as magnifiers.)

They are widely used in telescopes, collimators, optical transceivers, magnifiers, radiometers and condensers.

Plano Convex Lenses

Part No. Number	Diameter (mm)	EFL (mm)	R1 (mm)	CT (mm)	ET (mm)	BFL (mm)	Price each
LNCX001	6	10	5.15	2.46	1.5	8.37	18
LNCX002	6	12	6.18	2.28	1.5	10.5	16
LNCX003	6	15	7.73	2.11	1.5	13.61	16
LNCX004	6	30	15.54	1.79	1.5	28.82	18
LNCX005	12.7	15	7.73	5.12	1.8	11.62	23
LNCX006	12.7	20	10.3	3.99	1.8	17.37	21
LNCX007	12.7	25	12.88	3.47	1.8	22.71	21
LNCX008	12.7	30	15.45	3.17	1.8	27.91	21
LNCX009	12.7	40	20.6	2.8	1.8	38.15	21
LNCX010	12.7	50	25.75	2.6	1.8	48.29	21
LNCX011	12.7	100	51.51	2.19	1.8	98.55	23
LNCX012	25.4	25.4	13.08	11.74	1.8	17.65	29
LNCX013	25.4	30	15.45	8.65	2	24.29	25
LNCX014	25.4	35	18.03	7.23	2	30.23	24
LNCX015	25.4	40	20.6	6.38	2	25.79	24
LNCX016	25.4	50	25.75	5.35	2	46.47	24
LNCX017	25.4	60	30.9	4.73	2	56.88	24
LNCX018	25.4	75	38.63	4.15	2	72.26	24
LNCX019	25.4	100	51.51	3.59	2	97.63	24
LNCX020	25.4	125	64.39	3.26	2	122.85	24
LNCX021	25.4	150	77.26	3.05	2	147.99	24
LNCX022	25.4	175	90.14	2.9	2	173.09	24
LNCX023	25.4	200	103.02	2.79	2	198.16	24
LNCX024	25.4	250	128.77	2.63	2	248.27	24

(continued on next page)

Please check with Tower for availability.

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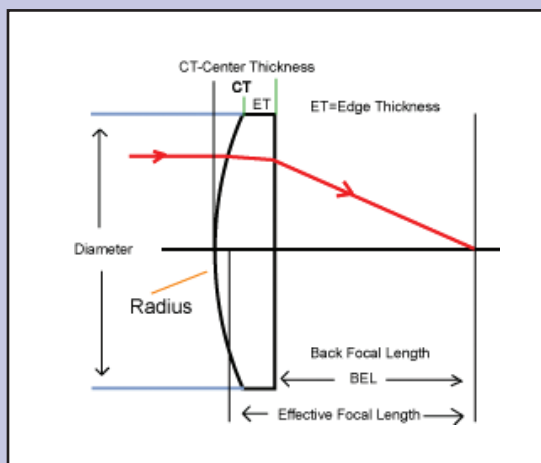
Plano Convex Lenses



Plano Convex Lenses (continued)

Part No. Number	Diameter (mm)	EFL (mm)	R1 (mm)	CT (mm)	ET (mm)	BFL (mm)	Price each
LNCX025	25.4	300	154.52	2.52	2	298.33	24
LNCX026	25.4	400	206.03	2.39	2	398.42	24
LNCX027	25.4	500	257.54	2.31	2	498.47	27
LNCX028	25.4	750	386.31	2.21	2	748.54	28
LNCX029	25.4	1000	515.08	2.16	2	998.58	29
LNCX030	50.8	60	30.9	16.3	3	49.24	42
LNCX031	50.8	75	38.63	12.52	3	66.73	41
LNCX032	50.8	100	51.51	9.7	3	93.6	40
LNCX033	50.8	125	64.39	8.22	3	119.57	40
LNCX034	50.8	150	77.26	7.29	3	145.19	40
LNCX035	50.8	175	90.14	6.65	3	170.61	40
LNCX036	50.8	200	103.02	6.18	3	195.92	40
LNCX037	50.8	250	128.77	5.53	3	246.35	40
LNCX038	50.8	300	154.52	5.1	3	296.63	40
LNCX039	50.8	400	206.03	4.57	3	396.98	40
LNCX040	50.8	500	257.54	4.26	3	497.19	41
LNCX041	50.8	750	386.31	3.84	3	747.47	42
LNCX042	50.8	1000	515.08	3.63	3	997.61	42
LNCX043	75	85	43.78	24.19	3	69.04	58
LNCX044	75	100	51.51	19.2	3	87.33	56
LNCX045	75	150	77.26	12.71	3	141.61	55
LNCX046	75	200	103.02	10.07	3	193.35	55

Please check with Tower for availability.



Specifications

Material: BK7, grade A, fine anneal, or K9

Design wavelength: 632.8 nm

Diameter tolerance: +0/-0.10 mm

Focal Length tolerance: $\pm 1\%$

Centering: ± 3 arc minutes

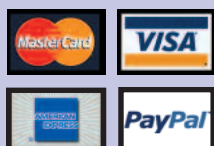
Clear aperture: 90% of diameter

Surface quality: 60-40 Scratch-Dig

Bevel: 0.25 mm x 45°

Coating: none

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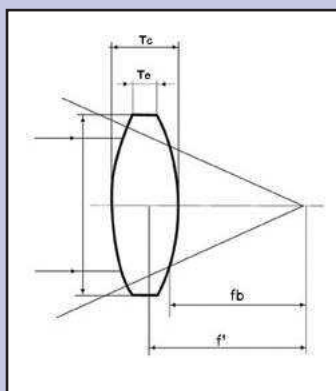
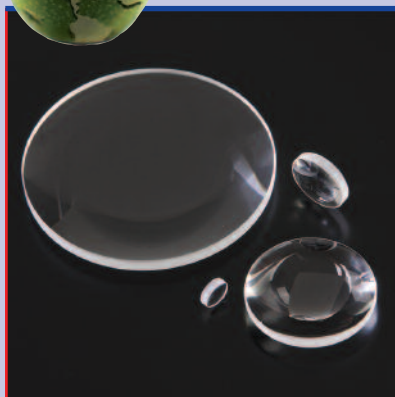
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Bi Convex Lenses



Specifications

Material: BK7, grade A, fine anneal, or K9 substitute

Design wavelength: 632.8 nm

Diameter tolerance: +0/-0.10 mm

Focal Length tolerance: $\pm 1\%$

Centering: ± 3 arc minutes

Clear aperture: 90% of diameter

Surface quality: 60-40 Scratch-Dig

Bevel: 0.25 mm x 45°

Coating: none

Part No. Number	Dia. (mm)	EFL (mm)	R1 (mm)	R2 (mm)	CT (mm)	ET (mm)	BFL (mm)	Price each
LNBX001	6	10	9.87	9.87	2.43	1.5	9.16	22
LNBX002	6	12	11.97	11.97	2.76	1.5	11.73	20
LNBX003	6	15	15.09	15.09	2.1	1.5	14.29	20
LNBX004	6	30	30.6	30.6	1.79	1.5	29.4	22
LNBX005	9	12	11.72	11.72	3.6	1.8	10.75	23
LNBX006	9	20	20.11	20.11	2.82	1.8	19.05	23
LNBX007	12.7	15	14.61	14.61	4.7	1.8	13.36	25
LNBX008	12.7	20	19.92	19.92	3.88	1.8	18.68	23
LNBX009	12.7	25	25.16	25.16	3.43	1.8	23.84	23
LNBX010	12.7	30	30.36	30.36	3.14	1.8	28.95	23
LNBX011	12.7	40	40.72	40.72	2.8	1.8	39.07	23
LNBX012	12.7	50	51.06	51.06	2.59	1.8	49.14	23
LNBX013	12.7	100	102.64	102.64	2.19	1.8	99.27	25
LNBX014	25.4	25.4	24.54	24.54	8.98	1.8	22.24	27
LNBX015	25.4	30	29.53	29.53	7.74	2	27.33	24
LNBX016	25.4	35	34.86	34.86	6.79	2	37.68	22
LNBX017	25.4	40	40.14	40.14	6.12	2	37.93	22
LNBX018	25.4	50	50.6	50.6	5.24	2	48.24	22
LNBX019	25.4	60	61.01	61.01	4.67	2	58.44	22
LNBX020	25.4	75	76.56	76.56	4.12	2	73.62	22
LNBX021	25.4	100	102.4	102.4	3.58	2	98.81	222
LNBX022	25.4	125	128.21	128.21	3.26	2	123.92	22
LNBX023	25.4	150	154	154	3.05	2	148.99	22
LNBX024	25.4	175	179.78	179.78	2.9	2	174.04	22
LNBX025	25.4	200	205.56	205.56	2.79	2	199.06	22
LNBX026	25.4	250	257.09	257.09	2.63	2	249.13	22
LNBX027	25.4	300	308.62	308.62	2.52	2	299.17	22
LNBX028	25.4	400	411.66	411.66	2.39	2	399.21	22
LNBX029	25.4	500	514.69	514.69	2.31	2	499.34	22
LNBX030	25.4	750	772.25	772.25	2.21	2	749.27	24
LNBX031	25.4	1000	1029.8	1029.8	2.16	2	999.29	26
LNBX032	50.8	60	59.25	59.25	14.44	3	55.03	35
LNBX033	50.8	75	75.19	75.19	11.84	3	70.99	33
LNBX034	50.8	100	101.38	101.38	9.47	3	96.82	32
LNBX035	50.8	125	127.38	127.38	8.12	3	122.29	32
LNBX036	50.8	150	153.28	153.28	7.24	3	147.59	32
LNBX037	50.8	175	139.15	139.15	6.62	3	172.8	32
LNBX038	50.8	200	204.98	204.98	6.16	3	197.96	32
LNBX039	50.8	250	256.6	256.6	5.52	3	248.17	32
LNBX040	50.8	300	308.16	308.16	5.1	3	298.31	32
LNBX041	50.8	400	411.29	411.29	4.57	3	398.49	32
LNBX042	50.8	500	514.36	514.36	4.26	3	498.59	32
LNBX043	50.8	750	771.97	771.97	3.84	3	748.73	32
LNBX044	50.8	1000	1029.55	1029.55	3.63	3	998.8	35

Please check with Tower for availability

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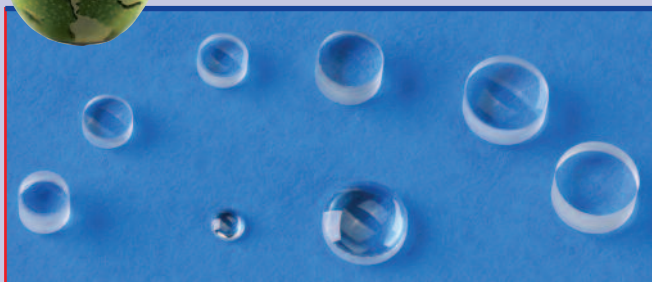
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Mini Lenses



Biconvex Mini Lenses

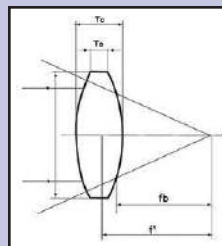
Part Number	Dia (mm)	FL (mm)	Material	Tc (mm)	Te (mm)	Price Each
LMBX001	3.0	4.5	BK7	2.0	1.5	\$26
LMBX002	3.0	6.0	BK7	1.8	1.4	\$26
LMBX003	3.0	9.0	BK7	1.6	1.4	\$26
LMBX004	5.0	4.5	BK7	3.0	1.3	\$26
LMBX005	5.0	7.0	BK7	3.0	2.0	\$26
LMBX006	5.0	10.0	BK7	2.6	2.0	\$26

Plano Convex Mini Lenses

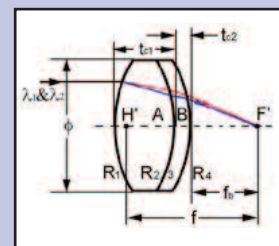
Part Number	Dia (mm)	FL (mm)	Material	Tc (mm)	Te (mm)	Price Each
LMPX001	1.0	0.6	LaSFN9	0.50	0.39	\$36
LMPX002	1.5	1.0	LaSFN9	0.80	0.30	\$36
LMPX003	1.5	1.5	LaSFN9	0.80	0.56	\$36
LMPX004	1.5	29.0	BK7	0.50	0.46	\$36
LMPX005	2.0	1.5	LaSFN9	0.80	0.32	\$35
LMPX006	2.0	2.0	LaSFN9	0.80	0.48	\$35
LMPX007	2.5	1.6	LaSFN9	0.99	0.17	\$34
LMPX008	2.5	2.0	LaSFN9	0.80	0.25	\$34
LMPX009	2.5	2.5	LaSFN9	0.80	0.39	\$34
LMPX010	2.5	3.0	LaSFN9	0.80	0.48	\$34
LMPX011	3.0	3.0	SF11	2.00	1.46	\$26
LMPX012	3.0	4.5	SF6	1.80	1.47	\$26
LMPX013	3.0	6.0	BK7	1.80	1.41	\$26
LMPX014	3.0	9.0	BK7	1.50	1.25	\$26
LMPX015	3.0	12.0	BK7	1.08	0.90	\$26
LMPX016	3.0	15.0	BK7	1.26	1.12	\$26
LMPX017	4.0	4.0	SF6	1.70	1.00	\$25
LMPX018	4.0	6.0	BK7	2.26	1.53	\$25
LMPX019	4.0	8.0	BaF10	1.39	1.00	\$25
LMPX020	4.0	10.0	BK7	1.64	1.24	\$25
LMPX021	4.0	12.0	BK7	1.52	1.19	\$25
LMPX022	5.0	5.0	SF6	1.87	1.00	\$25
LMPX023	5.0	10.0	BK7	1.64	1.00	\$25
LMPX024	5.0	12.0	BK7	1.77	1.25	\$25
LMPX025	5.0	15.0	BK7	1.60	1.19	\$25

Mini Achromatic Lenses (MgF2 coated)

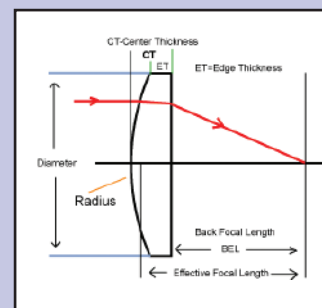
Part Number	Dia (mm)	FL (mm)	Tc (mm)	Te (mm)	Price Each
LMD001	3.0	9.0	2.50	2.19	\$60
LMD002	3.0	12.0	2.68	2.45	\$60
LMD003	4.0	8.0	2.53	2.09	\$60
LMD004	5.0	7.5	4.75	3.98	\$60
LMD005	5.0	10.0	2.75	2.22	\$60
LMD006	5.0	15.0	2.58	2.23	\$60
LMD007	5.0	20.0	2.64	2.37	\$60



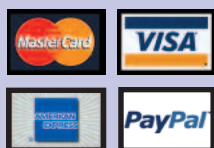
Biconvex Mini Lenses



Mini Achromatic Lenses



Convex Mini Lenses



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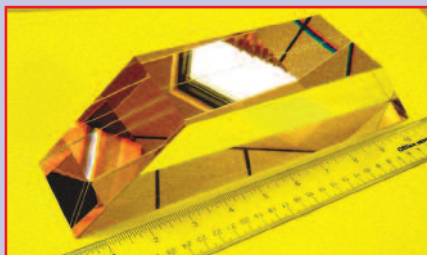


Large Optics

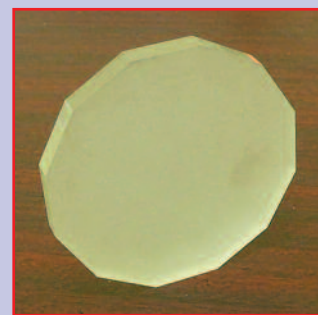


2" Beamsplitter

These are a sampling of **Tower's** capability in fabricating large, precision optics. *Send us your drawings so we can quote them and build one for you.*



10" custom Dove Prism

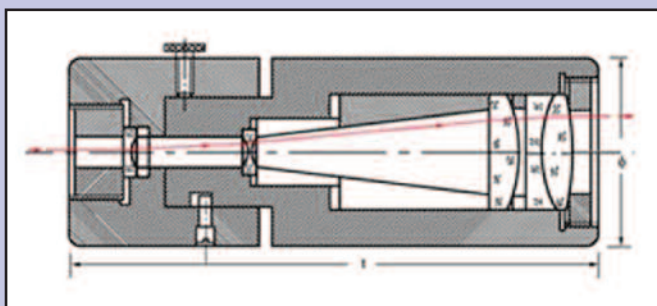


12 sided Optic Scanner Prism

Optical Assemblies



- **Multi-element assemblies**
- **Beam combiners**
- **Custom prism assemblies**
- **Window assemblies**
- **Cell null lens assembly**
- **Mirror mounts**
- **IR optics for military**
- **Reflector assemblies**
- **And more!**



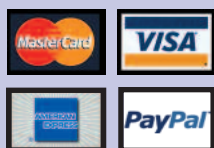
Take advantage of **Tower Optical's** knowledge and experience with precision assembly by allowing Tower Optical, and its worldwide network of optical partners, to provide you with optical assembly services for even the most challenging tasks and exacting specifications. Note, of course, that Tower can also manufacture the optical components required in your assembly thereby allowing you to achieve your end objective in fewer, more efficient, steps. Tower is dedicated to being a top-quality source for both optical components and assembly services.

Tower Optical will bring you the precision you want at lower prices that will make and keep you competitive.

Experienced Staff

Tower's in-house staff of optics professionals includes experienced technicians with a track record in a wide variety of assemblies. Our worldwide partner network adds to the in-house capability and allows the expansion of the force to accommodate large jobs as well as small ones.

Please submit your requirements to sales@toweroptical.com for a prompt quote.



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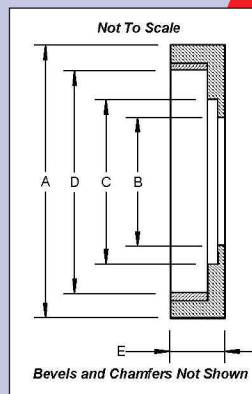
Waveplate and Similar Optics Mounting Rings



- Mounting ring includes retainer
- All retainers use fine threads
- High grade aluminum
- Hard coat black anodize
- Six sizes
- With or without axis mark

Tower Optical optics mounts are precision machined optical assemblies consisting of a housing and a retaining ring. The interface between the housing and ring is a fine metric thread. The retaining rings all have slots to simplify insertion and securing the internal optic being held. The mounts can be used for waveplates, mirrors, windows and lenses.

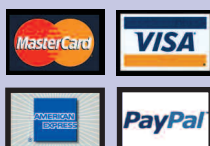
The mounts shown here are standard products, in stock, for immediate shipment. Tower welcomes requests for custom mounts that you may require. Simply email your drawings with quantities to quote to sales@TowerOptical.com. We will respond promptly.



*New
Offering*

Pricing and Odering Information

Mount P/N	A Diameter	B Clear Aperture	C Optics Diameter	D Internal Clearance	E Thickness	F Axis	Price
0515-0002	12.7	8	10	11	6.4	No	\$25
0515-0002-L	12.7	8	10	11	6.4	Yes	\$25
0515-0003	25.4	8	10	18	7.8	No	\$35
0515-0003-L	25.4	8	10	18	7.8	Yes	\$35
0515-0001	25.4	15	17.5	18	7.8	No	\$40
0515-0001-L	25.4	15	17.5	18	7.8	Yes	\$40
0515-0004	30	23	25.4	25.8	6	No	\$44
0515-0004-L	30	23	25.4	25.8	6	Yes	\$44
0515-0005	50.8	34	38.1	42.5	9	No	\$50
0515-0005-L	50.8	34	38.1	42.5	9	Yes	\$50
0515-0006	76.2	46.8	50.8	62	10	No	\$65
0515-0006-L	76.2	46.8	50.5	62	10	Yes	\$65



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www.asrworldwide.com
616-942-6273



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TOWER OPTICAL CORPORATION
3600 SOUTH CONGRESS AVE.
UNIT J
BOYNTON BEACH, FL 33426

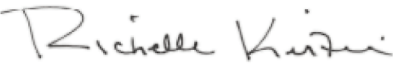
with a scope of:

***MANUFACTURE, SALES AND MARKETING OF
PRECISION OPTICS***

has established a quality management system that is in conformance with the International Quality System Standard

ISO 9001:2015

ASR Certificate Number: 6418
Date of Certification: February 27, 2018
Date of Certification Expiration: February 21, 2019
Date of Initial Registration: March 28, 2007
Revision:
Re-Issue Date:


President

CERTIFICATE OF REGISTRATION



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www.TowerOptical.com

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