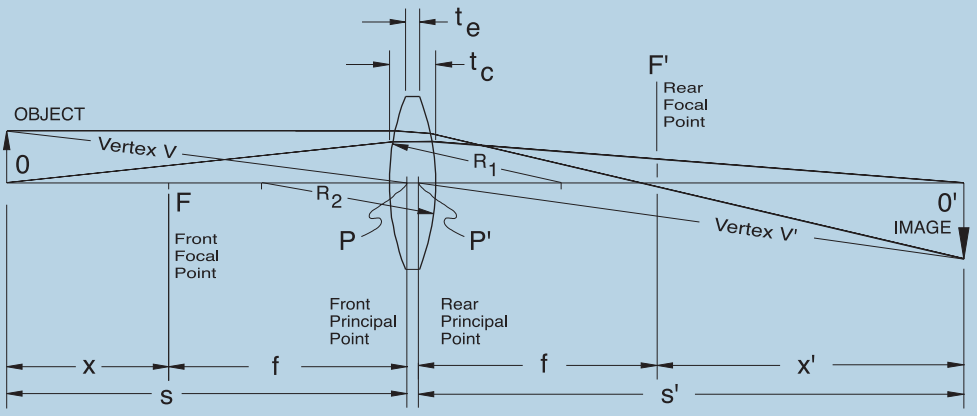
Spherical Lens Parameters



Ø = Lens Diameter

$M = \frac{S'}{S}$ Magnification or Conjugate Ratio

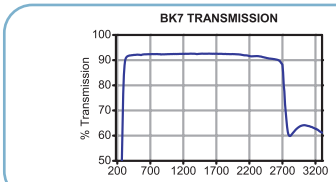
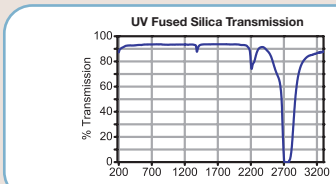
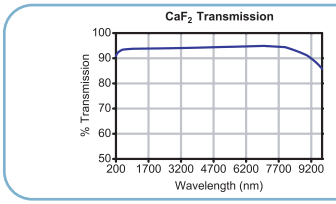
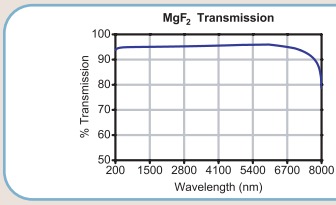
f = EFL (Effective Focal Length)

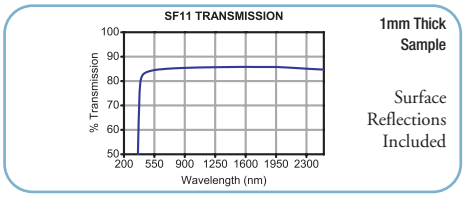
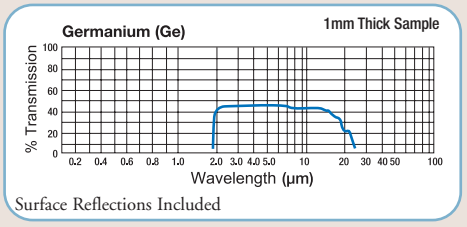
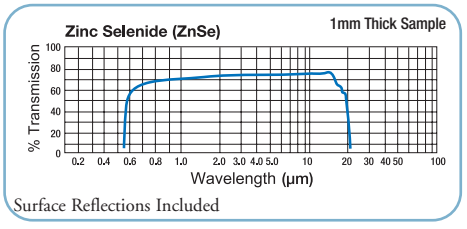
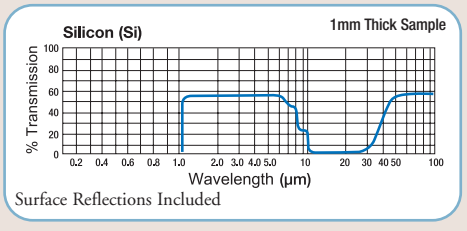
$\frac{1}{f} = \frac{1}{S} + \frac{1}{S'}$ Paraxial Lens Formula (assumes $\sin\theta \approx \theta$)

S = Object Distance, positive for objects to the left of the front principal point P.

S' = Image Distance, positive for images to the right of the rear rear principal point P'

Transmission of Various Materials

GLASS	DESCRIPTION	TRANSMISSION	
BK7	BK7 is a high-quality optical glass commonly used to make lenses intended for laboratory use. It has excellent mechanical and optical properties as well as good transmission in the visible and IR.	350nm to 2.0µm	 1mm Thick Sample Surface Reflections Included
UV Fused Silica	UV fused silica is an excellent material for the transmission of UV light. It is durable and has good mechanical properties $T_{external} \geq 80\%/cm$ @ 185nm $T_{internal} \geq 88\%/cm$ @ 185nm	185nm to 2.1µm	 1mm Thick Sample Surface Reflections Included
CaF_2	Calcium fluoride provides great transmission from the UV to the IR. Synthetic CaF_2 is used to improve deep UV transmission and to increase the damage threshold.	180nm to 8.0µm	 1mm Thick Sample Surface Reflections Included
MgF_2	Magnesium fluoride, an extremely rugged and durable material, is transparent over an extensive range of wavelengths from the UV to the IR.	200nm to 6.0µm	 1mm Thick Sample Surface Reflections Included

GLASS	DESCRIPTION	TRANSMISSION	
SF11	This glass provides excellent chemical resistance and has a high refractive index, which allows for the same amount of refraction with less curvature. It is useful for constructing optics that would be extremely difficult to make from BK7.	420nm to 2.3µm	
Ge	The transmission characteristics of germanium in the IR region of the spectrum make it an ideal choice for imaging 2.0 - 16µm light. Ge plano-convex lenses are particularly well suited for more biomedical and military imaging applications.	2.0µm to 16µm	
ZnSe	With a transmission range from 600nm - 16µm, zinc selenide plano-convex lenses are ideal for IR applications. Due to the low absorption coefficient, these lenses are also particularly well suited for high-power CO_2 laser applications. In contrast to Ge and Si, which also transmit in this spectral range, ZnSe transmits some visible light, thereby allowing for visual alignment of the optic.	600nm to 16µm	
Si	Silicon plano-convex lenses are an ideal choice for applications from 1.2 - 8µm and are particularly well suited for imaging, biomedical, and military applications.	1200nm to 8.0 µm	

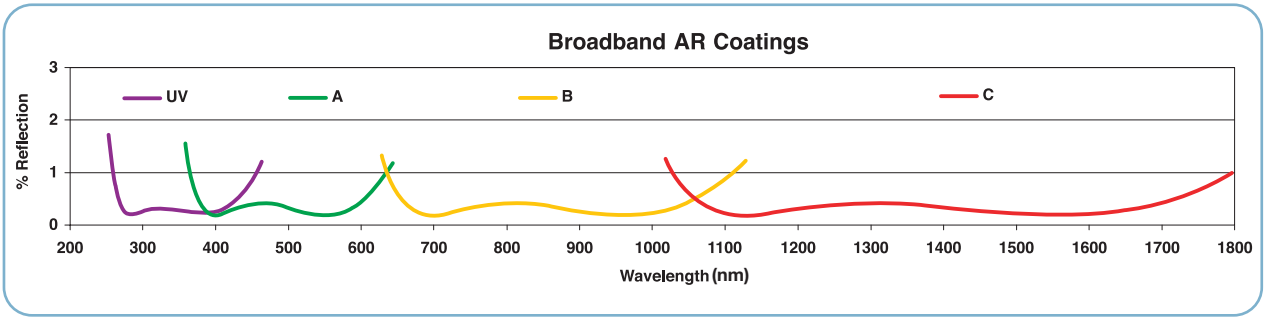
Spherical Singlet Anti-Reflection Coatings

Most of our standard optics are available with high-performance, multilayer AR coatings, which minimize surface reflections within the specified wavelength ranges. These coatings are designed for angles of incidence between 0° and 30° (0.5 NA). For optics intended to be used at large angles, consider using a custom coating optimized at a 45° of incidence; these coatings are effective from 25° to 52°. The plot shown below indicates the performance of the standard coatings in this family as a function of wavelength for a single surface. Broadband coatings have a typical absorption of 0.25% that is not shown in the reflectivity plots.

- R < 0.5% Average Over Band at 0° Incidence
- Less Angular Sensitivity within Angular Range
- Frequently Run Coatings are Listed Below

Normal Incidence Broadband Multilayer Anti-Reflective Coating

COATING CODE	WAVELENGTH RANGE	DESIGN ANGLE OF INCIDENCE	USEFUL ANGLE OF INCIDENCE
-UV	290-370nm	0°	0 to 30°
-A	350-650nm	0°	0 to 30°
-B	650-1050nm	0°	0 to 30°
-C	1050-1620nm	0°	0 to 30°

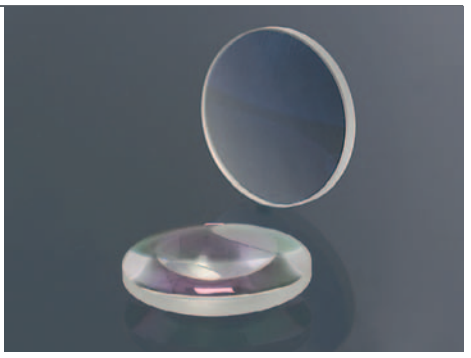


Optical Systems
Free Space Isolators
E-O Devices
Spherical Singlets
Multi-Element Lenses
Cylindrical Lenses
Aspheric Lenses
Mirrors
Diffusers & Lens Arrays
Windows
Prisms
Gratings
Polarization Optics
Beamsplitters
Filters & Attenuators
Gas Cells

BK7: Bi-Convex Lenses

Specifications

- **Material:** BK7
- **Wavelength Range:** 350nm-2.0µm
- **Design Wavelength:** 633nm (n = 1.515)
- **Dia. Tolerance:** +0.00/-0.10mm
- **Focal Length Tolerance:** ±1%
- **Scratch-Dig:** 40-20
- **Centration:** 3arcmin
- **Clear Aperture:** >90% of Dia.



Standard Broadband AR Coatings
To order the lens with a standard broadband AR Coating, add the coating code to the Item#, and add the coating cost to the lens price.

COATING	WAVELENGTH	$	£	€	RMB
-A	350-650nm	$ 9.20	£ 5.80	€ 8,60	¥ 87.90
-B	650-1050nm	$ 9.20	£ 5.80	€ 8,60	¥ 87.90
-C	1050-1620nm	$12.20	£ 7.70	€11,30	¥116.50

Example: LB1157 Coated with a 350-650nm Broadband AR Coating is LB1157-A and the cost is $20.10 + $9.20 = $29.30.

Bi-Convex lenses perfrom best when the object and image are on opposite sides of the lens and the ratio of the object to image distance (conjugate ratio) is between 0.2 to 5 or when used to create a virtual image from a real object.

Bi-Convex Lenses: Material BK7

ITEM #	DIA (mm)	f (mm)	PRICE UNCOATED (For Coated Lens Add Suffix) $	£	€	RMB	R (mm)	t_c (mm)	t_e[1] (mm)	f_b (mm)	SUGGESTED MOUNT[2]
LB1157	6.0	10.0	$ 20.10	£ 12.70	€ 18,70	¥ 192.00	9.9	2.4	1.5	9.2	
LB1406	6.0	12.0	$ 18.80	£ 11.80	€ 17,50	¥ 179.50	12.0	2.3	1.5	11.2	LMRA6 &
LB1987	6.0	15.0	$ 18.80	£ 11.80	€ 17,50	¥ 179.50	15.1	2.1	1.5	14.3	LMR05
LB1198	6.0	30.0	$ 18.50	£ 11.70	€ 17,20	¥ 176.70	30.6	1.8	1.5	29.4	
LB1494	9.0	12.0	$ 20.80	£ 13.10	€ 19,30	¥ 198.60	11.7	3.6	1.8	10.7	LMRA9 &
LB1212	9.0	20.0	$ 18.80	£ 11.80	€ 17,50	¥ 179.50	20.1	2.8	1.8	19.0	LMR05
LB1092	12.7	15.0	$ 20.80	£ 13.10	€ 19,30	¥ 198.60	14.6	4.7	1.8	13.4	
LB1450	12.7	20.0	$ 20.50	£ 12.90	€ 19,10	¥ 195.80	19.9	3.9	1.8	18.7	
LB1014	12.7	25.0	$ 19.10	£ 12.00	€ 17,80	¥ 182.40	25.2	3.4	1.8	23.8	
LB1258	12.7	30.0	$ 18.80	£ 11.80	€ 17,50	¥ 179.50	30.4	3.1	1.8	28.9	LMR05
LB1378	12.7	40.0	$ 18.40	£ 11.60	€ 17,10	¥ 175.70	40.7	2.8	1.8	39.1	
LB1844	12.7	50.0	$ 18.30	£ 11.50	€ 17,00	¥ 174.80	51.1	2.6	1.8	49.1	
LB1187	12.7	100.0	$ 18.30	£ 11.50	€ 17,00	¥ 174.80	102.6	2.2	1.8	99.3	
LB1761	25.4	25.4	$ 23.90	£ 15.10	€ 22,20	¥ 228.20	24.5	9.0	1.9	22.2	
LB1757	25.4	30.0	$ 23.30	£ 14.70	€ 21,70	¥ 222.50	29.5	7.7	2.0	27.3	
LB1811	25.4	35.0	$ 22.60	£ 14.20	€ 21,00	¥ 215.80	34.9	6.8	2.0	32.7	
LB1027	25.4	40.0	$ 22.30	£ 14.00	€ 20,70	¥ 213.00	40.1	6.1	2.0	37.9	
LB1471	25.4	50.0	$ 21.80	£ 13.70	€ 20,30	¥ 208.20	50.6	5.2	2.0	48.2	
LB1596	25.4	60.0	$ 21.50	£ 13.50	€ 20,00	¥ 205.30	61.0	4.7	2.0	58.4	
LB1901	25.4	75.0	$ 21.30	£ 13.40	€ 19,80	¥ 203.40	76.6	4.1	2.0	73.6	
LB1676	25.4	100.0	$ 20.70	£ 13.00	€ 19,30	¥ 197.70	102.4	3.6	2.0	98.8	
LB1904	25.4	125.0	$ 20.60	£ 13.00	€ 19,20	¥ 196.70	128.2	3.3	2.0	123.9	LMR1
LB1437	25.4	150.0	$ 20.10	£ 12.70	€ 18,70	¥ 192.00	154.0	3.1	2.0	149.0	
LB1294	25.4	175.0	$ 20.00	£ 12.60	€ 18,60	¥ 191.00	179.8	2.9	2.0	174.0	
LB1945	25.4	200.0	$ 19.90	£ 12.50	€ 18,50	¥ 190.00	205.6	2.8	2.0	199.1	
LB1056	25.4	250.0	$ 19.70	£ 12.40	€ 18,30	¥ 188.10	257.1	2.6	2.0	249.1	
LB1779	25.4	300.0	$ 19.60	£ 12.30	€ 18,20	¥ 187.20	308.6	2.5	2.0	299.2	
LB1391	25.4	400.0	$ 19.60	£ 12.30	€ 18,20	¥ 187.20	411.7	2.4	2.0	399.2	
LB1869	25.4	500.0	$ 19.60	£ 12.30	€ 18,20	¥ 187.20	514.7	2.3	2.0	499.2	
LB1475	25.4	750.0	$ 19.60	£ 12.30	€ 18,20	¥ 187.20	772.2	2.2	2.0	749.3	
LB1409	25.4	1000.0	$ 19.30	£ 12.20	€ 17,90	¥ 184.30	1029.8	2.2	2.0	999.3	
LB1723	50.8	60.0	$ 30.00	£ 18.90	€ 27,90	¥ 286.50	59.3	14.4	3.0	55.0	
LB1309	50.8	75.0	$ 29.90	£ 18.80	€ 27,80	¥ 285.50	75.2	11.8	3.0	71.0	
LB1630	50.8	100.0	$ 29.50	£ 18.60	€ 27,40	¥ 281.70	101.4	9.5	3.0	96.8	
LB1106	50.8	125.0	$ 29.40	£ 18.50	€ 27,30	¥ 280.80	127.4	8.1	3.0	122.3	
LB1374	50.8	150.0	$ 29.00	£ 18.30	€ 27,00	¥ 277.00	153.3	7.2	3.0	147.6	
LB1607	50.8	175.0	$ 29.00	£ 18.30	€ 27,00	¥ 277.00	179.1	6.6	3.0	172.8	
LB1199	50.8	200.0	$ 29.00	£ 18.30	€ 27,00	¥ 277.00	205.0	6.2	3.0	198.0	LMR2
LB1889	50.8	250.0	$ 29.00	£ 18.30	€ 27,00	¥ 277.00	256.6	5.5	3.0	248.2	
LB1917	50.8	300.0	$ 29.00	£ 18.30	€ 27,00	¥ 277.00	308.2	5.1	3.0	298.3	
LB1862	50.8	400.0	$ 29.00	£ 18.30	€ 27,00	¥ 277.00	411.3	4.6	3.0	398.5	
LB1909	50.8	500.0	$ 29.00	£ 18.30	€ 27,00	¥ 277.00	514.4	4.3	3.0	498.6	
LB1247	50.8	750.0	$ 29.00	£ 18.30	€ 27,00	¥ 277.00	772.0	3.8	3.0	748.7	
LB1859	50.8	1000.0	$ 29.00	£ 18.30	€ 27,00	¥ 277.00	1029.5	3.6	3.0	998.8	

1) Edge Thickness given before 0.2mm at 45° typical chamfer.
2) See the Lens Mount Section, Starting on Page 153.

AR Coating Plot on Page 699