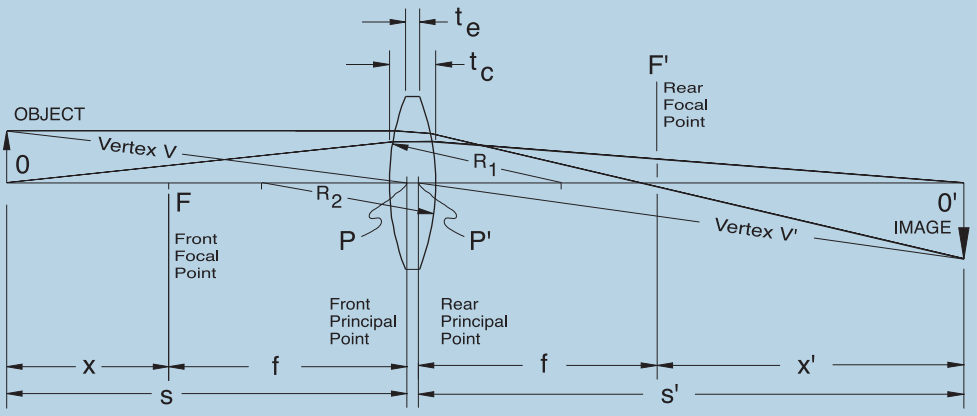
Spherical Lens Parameters



Ø = Lens Diameter

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

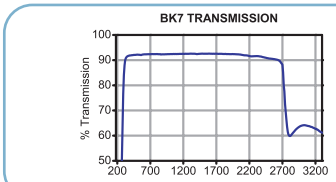
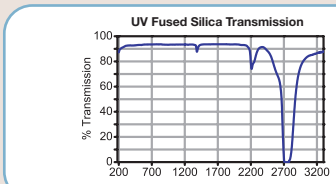
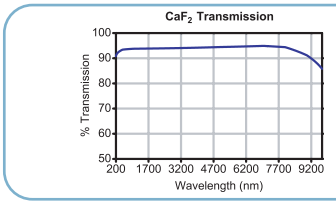
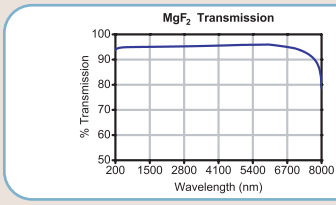
f = EFL (Effective Focal Length)

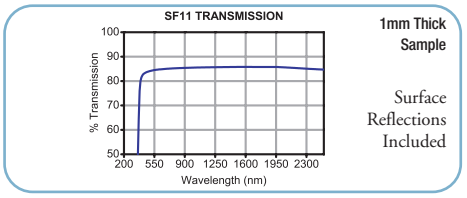
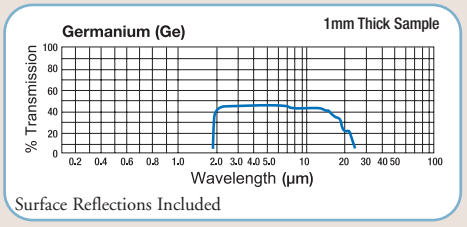
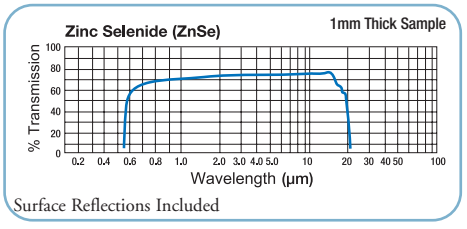
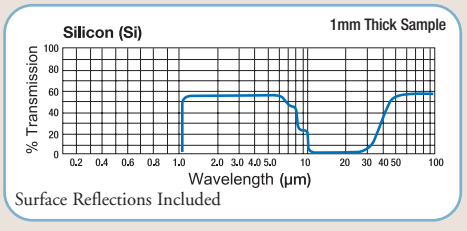
$\frac{1}{f} = \frac{1}{S} + \frac{1}{S'}$ Paraxial Lens Formula (assumes $\sin\theta \approx \theta$)

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	

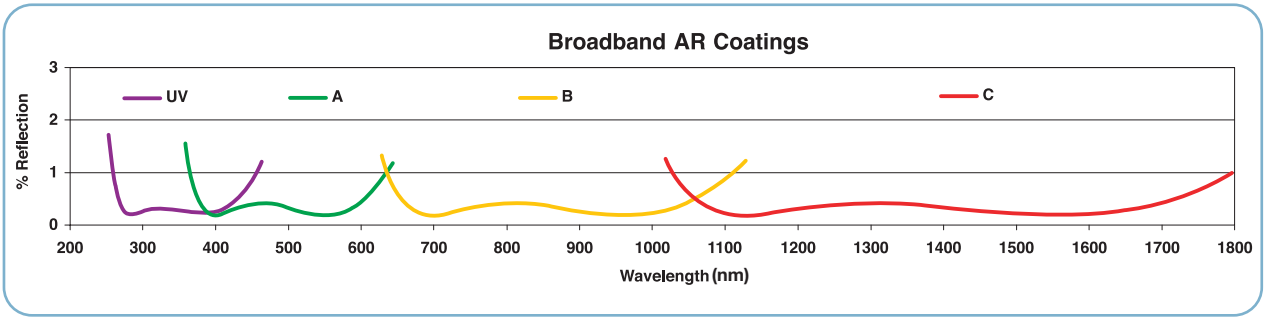
Spherical Singlet Anti-Reflection Coatings

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

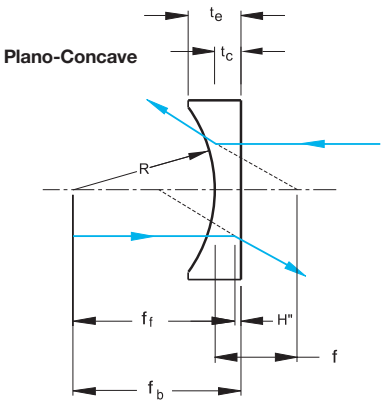
COATING CODE	WAVELENGTH RANGE	DESIGN ANGLE OF INCIDENCE	USEFUL ANGLE OF INCIDENCE
-UV	290-370nm	0°	0 to 30°
-A	350-650nm	0°	0 to 30°
-B	650-1050nm	0°	0 to 30°
-C	1050-1620nm	0°	0 to 30°



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

SF11 or BK7: Plano-Concave & Bi-Concave Lenses

Plano-Concave lenses have a negative focal length and are typically used to diverge collimated beams of light in instruments like Galilean type beam expanders or Telescopes. The spherical aberration introduced into the electromagnetic wavefront by a plano-concave lens is negative and, as a result, it can be used to balance the positive spherical aberration introduced by other lenses.



Specifications

- **Material:** BK7 or SF11
- **Wavelength Range:** BK7: 350nm-2.0µm SF11: 420nm-2.3µm
- **Design Wavelength:** 633nm
- **Dia. Tolerance:** +0.00/-0.10mm
- **Focal Length Tolerance:** ±1%
- **Scratch/Dig:** 40/20
- **Centration:** ≤3arcmin
- **Clear Aperture:** >90%

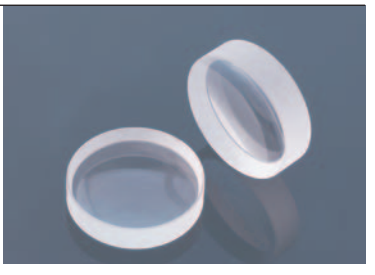
Plano-Concave Lenses: BK7 or SF11 Material

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)	MATERIAL	SUGGESTED MOUNT*
LC2969	6.0	-6.0	$ 19.90	£ 12.50	€ 18,50	¥ 190.00	-4.7	1.5	2.6	-6.8	SF11	
LC2632	6.0	-12.0	$ 21.00	£ 13.20	€ 19,50	¥ 200.60	-9.3	2.0	2.5	-13.1	SF11	LMRA6 & LMR05
LC1035	6.0	-18.0	$ 13.60	£ 8.60	€ 12,60	¥ 129.90	-9.3	2.0	2.5	-19.3	BK7	
LC1975	6.0	-24.0	$ 13.60	£ 8.60	€ 12,60	¥ 129.90	-12.4	2.0	2.4	-25.3	BK7	
LC2067	9.0	-9.0	$ 24.80	£ 15.60	€ 23,10	¥ 236.80	-7.0	2.0	3.6	-10.1	SF11	
LC2873	9.0	-18.0	$ 19.60	£ 12.30	€ 18,20	¥ 187.20	-14.0	2.5	3.2	-19.4	SF11	LMRA9 & LMR05
LC1906	9.0	-27.0	$ 14.10	£ 8.90	€ 13,10	¥ 134.70	-13.9	2.0	2.7	-28.3	BK7	
LC2265	12.7	-15.0	$ 26.60	£ 16.80	€ 24,70	¥ 254.00	-11.7	3.0	4.9	-16.7	SF11	
LC1054	12.7	-25.0	$ 15.00	£ 9.50	€ 14,00	¥ 143.30	-12.9	3.0	4.7	-27.0	BK7	LMR05
LC1060	12.7	-30.0	$ 14.90	£ 9.40	€ 13,90	¥ 142.30	-15.4	3.0	4.4	-32.0	BK7	
LC1439	12.7	-50.0	$ 14.70	£ 9.30	€ 13,70	¥ 140.40	-25.7	3.5	4.3	-52.3	BK7	
LC2679	25.4	-30.0	$ 27.20	£ 17.10	€ 25,30	¥ 259.80	-23.4	3.5	7.3	-32.0	SF11	
LC1715	25.4	-50.0	$ 17.40	£ 11.00	€ 16,20	¥ 166.20	-25.7	3.5	6.9	-52.3	BK7	LMR1
LC1582	25.4	-75.0	$ 17.40	£ 11.00	€ 16,20	¥ 166.20	-38.6	3.5	5.6	-77.3	BK7	
LC1120	25.4	-100.0	$ 17.20	£ 10.80	€ 16,00	¥ 164.30	-51.5	4.0	5.6	-102.6	BK7	
LC1315	50.8	-75.0	$ 33.30	£ 21.00	€ 31,00	¥ 318.00	-38.6	3.5	13.0	-77.3	BK7	LH2
LC1093	50.8	-100.0	$ 28.20	£ 17.80	€ 26,20	¥ 269.30	-51.5	4.0	10.7	-102.6	BK7	
LC1611	50.8	-150.0	$ 27.00	£ 17.00	€ 25,10	¥ 257.90	-77.2	4.0	8.3	-152.6	BK7	LMR2

1 Edge Thickness given before 0.2mm @ 45° typ. Chamfer. 2) See the Lens Mount Section, Starting on Page 153.

AR Coating Plot on Page 699

Bi-Concave lenses have a negative focal length and are commonly used to increase the divergence of converging light.



Standard Broadband AR Coatings
To order a lens with a standard broadband AR Coating, add the coating code to the Item#, and then 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: LC2969 Coated with a 350-650nm Broadband AR Coating is LC2969-A, and the cost is $19.90 + $9.20 = $29.10

Bi-Concave Lenses: BK7 or SF11 Material

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)	MATERIAL	SUGGESTED MOUNT[2]
LD2746	6.0	-6.0	$ 23.40	£ 14.70	€ 21,80	¥ 223.50	-9.7	1.5	2.5	-6.4	SF11	LMRA6 &
LD2799	6.0	-12.0	$ 22.90	£ 14.40	€ 21,30	¥ 218.70	-19.1	2.0	2.5	-12.5	SF11	LMR05
LD2568	9.0	-9.0	$ 20.80	£ 13.10	€ 19,30	¥ 198.60	-14.4	2.0	3.4	-9.5	SF11	LMRA9 &
LD2181	9.0	-18.0	$ 20.70	£ 13.00	€ 19,30	¥ 197.70	-28.6	2.5	3.2	-18.7	SF11	LMR05
LD2060	12.7	-15.0	$ 26.10	£ 16.40	€ 24,30	¥ 249.30	-24.0	3.0	4.7	-15.8	SF11	
LD1569	12.7	-25.0	$ 14.40	£ 9.10	€ 13,40	¥ 137.50	-26.2	2.5	4.1	-25.8	BK7	LMR05
LD1903	12.7	-30.0	$ 14.30	£ 9.00	€ 13,30	¥ 136.60	-31.4	3.0	4.3	-31.0	BK7	
LD1357	12.7	-50.0	$ 14.10	£ 8.90	€ 13,10	¥ 134.70	-52.1	3.5	4.3	-51.1	BK7	
LD2297	25.4	-25.0	$ 31.20	£ 19.70	€ 29,00	¥ 298.00	-39.6	3.0	7.2	-25.8	SF11	
LD1464	25.4	-50.0	$ 18.90	£ 11.90	€ 17,60	¥ 180.50	-52.0	3.0	6.1	-51.0	BK7	LMR1
LD1170	25.4	-75.0	$ 18.20	£ 11.50	€ 16,90	¥ 173.80	-77.9	3.5	5.6	-76.1	BK7	
LD1613	25.4	-100.0	$ 16.70	£ 10.50	€ 15,50	¥ 159.50	-103.7	4.0	5.6	-101.3	BK7	

1 Edge Thickness given before 0.20mm @ 45° typ. Chamfer.
2) See the Lens Mount Section, Starting on Page 153.