Visible Achromatic Doublets – Page 1 of 2

Most visible achromatic doublets use the helium "D" line (587.6nm, yellow), hydrogen "F" (486.1nm, blue/green), and "C" (656.3nm, red) lines to represent the visible spectrum and define the Abbe V number of a material.

These cemented doublets are computer optimized to provide excellent performance in the visible region. When chromatic aberration must be controlled, a doublet is typically employed. Frequently, a diffraction-limited spot may be achieved when using a monochromatic source such as a laser.
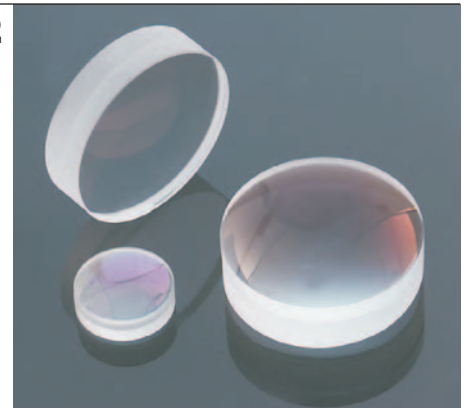
Specifications

- **Design Wavelengths for A1 Coating:** 486.1, 587.6, and 656.3nm
- **Dia. Tolerance:** +0.00/-0.10mm
- **Focal Length Tolerance:** ±1%
- **Scratch/Dig:** 40/20

- **Centration:** ≤3arcmin
- **Clear Aperture:** >90% of Dia.
- **Coating:** R_{avg} < 0.5% From 400-700nm (A1 coating range)
- **Operating Temperature:** -40°C to +85°C
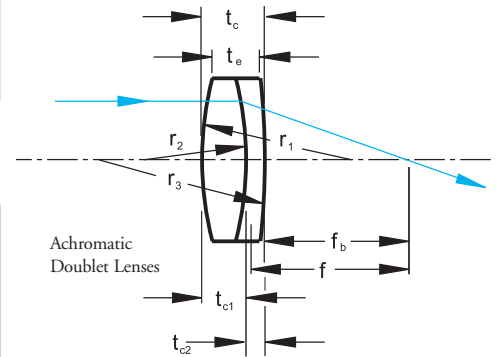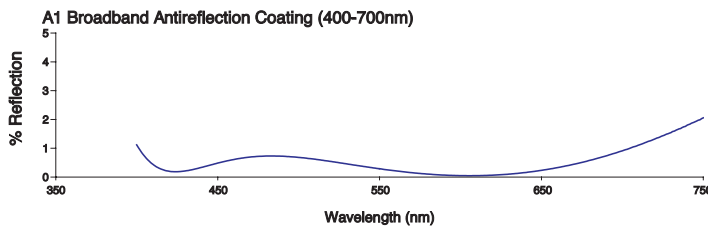
A1 Broadband Antireflection Coating (400-700nm)

Achromatic Doublet Lenses

Positive Visible Achromats: Infinite Conjugate Ratio

ITEM#	DIA (mm)	f (mm)	f_b (mm)	r_1 (mm)	r_2 (mm)	r_3 (mm)	t_{c1} (mm)	t_{c2} (mm)	t_e (mm)	MATERIALS	$	£	€	RMB
AC050-008-A1	5.0	7.5	5.2	5.25	-3.90	-17.06	2.8	1.7	3.7	BAFN10-SFL6	$ 46.30	£ 29.15	€ 43,10	¥ 442.20
AC050-010-A1	5.0	10.0	7.9	6.55	-4.25	-15.42	2.5	1.9	3.7	BAK4-SF5	$ 34.90	£ 22.00	€ 32,50	¥ 333.30
AC050-015-A1	5.0	15.0	13.6	12.54	-5.25	-12.05	2.7	2.1	4.3	BK7-SF2	$ 34.90	£ 22.00	€ 32,50	¥ 333.30
AC060-010-A1	6.0	10.0	7.9	6.17	-4.61	-19.63	2.5	1.5	3.0	BAK4-SF5	$ 34.90	£ 22.00	€ 32,50	¥ 333.30
AC064-013-A1	6.35	12.7	10.3	7.08	-5.94	-40.36	2.5	1.5	3.1	BAK4-SF5	$ 34.90	£ 22.00	€ 32,50	¥ 333.30
AC064-015-A1	6.35	15.0	13.0	8.79	-6.55	-21.68	2.5	1.5	3.2	BK7-SF2	$ 34.90	£ 22.00	€ 32,50	¥ 333.30
AC080-010-A1	8.0	10.0	6.7	7.08	-5.25	-22.66	4.5	2.0	4.9	BAFN10-SFL6	$ 34.90	£ 22.00	€ 32,50	¥ 333.30
AC080-016-A1	8.0	16.0	13.9	11.02	-9.20	-46.77	2.5	1.5	3.1	BAFN10-SFL6	$ 34.90	£ 22.00	€ 32,50	¥ 333.30
AC080-020-A1	8.0	20.0	17.8	11.08	-9.20	-34.83	2.5	1.5	3.0	BK7-SF2	$ 34.90	£ 22.00	€ 32,50	¥ 333.30
AC127-019-A1	12.7	19.0	15.7	12.94	-11.04	-59.26	4.5	1.5	4.0	BAFN10-SFL6	$ 52.60	£ 33.15	€ 48,90	¥ 502.30
AC127-025-A1	12.7	25.0	21.5	18.79	-10.59	-68.08	5.0	2.0	5.6	BAF10-SF10	$ 48.40	£ 30.50	€ 45,00	¥ 462.20
AC127-030-A1	12.7	30.0	27.5	17.86	-13.53	-44.17	3.5	1.5	3.4	BK7-SF2	$ 48.40	£ 30.50	€ 45,00	¥ 462.20
AC127-050-A1	12.7	50.0	47.2	27.36	-22.54	-91.83	3.5	1.5	4.0	BK7-SF2	$ 48.40	£ 30.50	€ 45,00	¥ 462.20
AC127-075-A1	12.7	75.0	72.9	41.30	-33.96	-137.09	2.5	1.5	3.4	BK7-SF2	$ 48.40	£ 30.50	€ 45,00	¥ 462.20
AC254-030-A1	25.4	30.0	22.9	20.89	-16.73	-79.80	12.0	2.0	8.8	BAFN10-SFL6	$ 76.95	£ 48.50	€ 71,60	¥ 734.90
AC254-035-A1	25.4	35.0	27.3	23.99	-19.10	-102.09	12.0	2.0	9.6	BAFN10-SFL6	$ 76.95	£ 48.50	€ 71,60	¥ 734.90
AC254-040-A1	25.4	40.0	33.4	23.66	-20.09	-57.68	10.0	2.5	7.4	BK7-SF5	$ 71.25	£ 44.90	€ 66,30	¥ 680.40
AC254-045-A1	25.4	45.0	40.2	31.24	-25.94	-130.62	7.0	2.0	5.7	BAFN10-SFL6	$ 76.95	£ 48.50	€ 71,60	¥ 734.90
AC254-050-A1	25.4	50.0	43.4	33.34	-22.28	-291.07	9.0	2.5	8.7	BAF10-SF10	$ 71.25	£ 44.90	€ 66,30	¥ 680.40
AC254-060-A1	25.4	60.0	54.3	41.69	-25.88	-230.70	8.0	2.5	8.2	BAF11-FD10	$ 71.25	£ 44.90	€ 66,30	¥ 680.40
AC254-075-A1	25.4	75.0	70.3	46.54	-33.91	-95.54	7.0	2.5	6.9	BK7-SF5	$ 71.25	£ 44.90	€ 66,30	¥ 680.40
AC254-100-A1	25.4	100.0	97.1	62.75	-45.71	-128.23	4.0	2.5	4.7	BK7-SF5	$ 71.25	£ 44.90	€ 66,30	¥ 680.40
AC254-150-A1	25.4	150.0	146.1	91.62	-66.68	-197.70	5.7	2.2	6.6	BK7-SF5	$ 71.25	£ 44.90	€ 66,30	¥ 680.40
AC254-200-A1	25.4	200.0	194.0	77.40	-87.57	291.07	4.0	2.5	5.7	SSKN5-LAFN7	$ 71.25	£ 44.90	€ 66,30	¥ 680.40
AC254-250-A1	25.4	250.0	246.7	137.09	-111.51	-459.20	4.0	2.0	5.2	BK7-SF2	$ 71.25	£ 44.90	€ 66,30	¥ 680.40
AC254-300-A1	25.4	300.0	297.0	165.20	-137.09	-557.40	4.0	2.0	5.4	BK7-SF2	$ 71.25	£ 44.90	€ 66,30	¥ 680.40
AC254-400-A1	25.4	400.0	396.0	219.80	-181.55	-738.50	4.0	2.0	5.5	BK7-SF2	$ 71.25	£ 44.90	€ 66,30	¥ 680.40
AC254-500-A1	25.4	500.0	499.9	337.30	-186.75	-557.40	4.0	2.0	5.6	BK7-SF2	$ 71.25	£ 44.90	€ 66,30	¥ 680.40
AC300-050-A1	30.0	50.0	44.3	34.04	-29.38	-161.50	8.5	2.0	6.3	BAFN10-SFL6	$ 80.75	£ 50.85	€ 75,10	¥ 771.20
AC300-080-A1	30.0	80.0	74.3	55.98	-44.17	-219.80	8.5	2.0	7.9	BAFN10-SFL6	$ 80.75	£ 50.85	€ 75,10	¥ 771.20

www.thorlabs.com

THORLABS

Visible Achromatic Doublets – Page 2 of 2

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

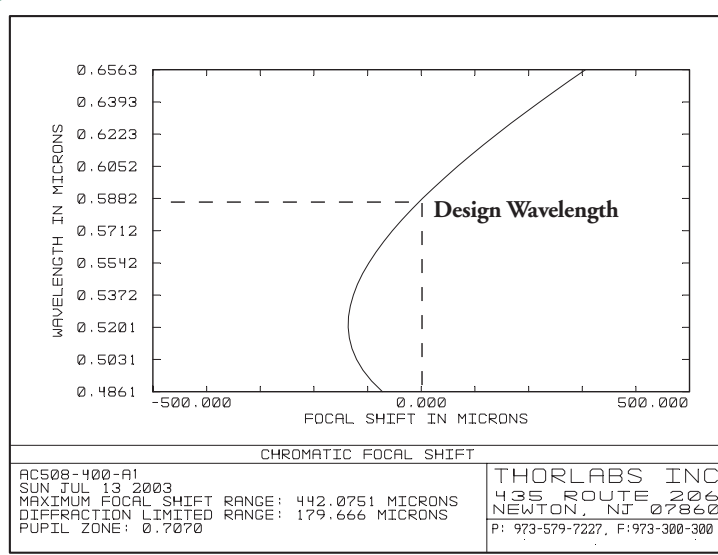Gas Cells

Focal Shift Versus Wavelength

Aside from the specifications already listed in the tables below, detailed information regarding each of the achromatic doublets can be found on our website at www.thorlabs.com.

For example, the graph to the right shows the relationship between the paraxial focal shift and the wavelength for the AC508-400-A1, which is a 400mm focal length, Ø50.8mm, visible achromatic doublet.

Information about the modulation transfer function (MTF), spot size, and wavefront error as well as a ray fan plot are all available on our website.


```
CHROMATIC FOCAL SHIFT
AC508-400-A1
SUN JUL 13 2003
MAXIMUM FOCAL SHIFT RANGE: 442.0751 MICRONS
DIFFRACTION LIMITED RANGE: 179.666 MICRONS
PUPIL ZONE: 0.7070

THORLABS INC
435 ROUTE 206
NEWTON, NJ 07860
P: 973-579-7227, F:973-300-300
```

For the LMRA Series of Small Optic Adapters, See Page 758

LMRA6

ACHROMATIC ESSENTIALS LENS KITS

This kit contains all of the positive and negative achromatic doublets at a savings of 20% when compared to the cost of buying the lenses separately.

See Page 720

ITEM #	$	£	€	RMB
ESK50-A1	$3,500.00	£2,205.00	€3.255,00	¥33,425.00.
ESK50-B	$4,460.00	£2,809.80	€4.147,80	¥42,593.00.

Positive Visible Achromats: Infinite Conjugate Ratio (continued)

ITEM#	DIA (mm)	f (mm)	f_b (mm)	r_1 (mm)	r_2 (mm)	r_3 (mm)	t_c1 (mm)	t_c2 (mm)	t_e (mm)	MATERIALS	$	£	€	RMB
AC300-100-A1†	30.0	100.0	96.4	70.00	-57.02	-284.40	5.0	2.0	5.0	BAFN10-SFL6	$ 80.75	£ 50.85	€ 75,10	¥ 771.20
AC508-075-A1†	50.8	75.0	61.7	50.80	-41.69	-247.70	20.0	3.0	14.9	BAF11-SF11	$ 128.25	£ 80.80	€ 119,30	¥ 1,224.80
AC508-080-A1†	50.8	80.0	69.9	54.90	-46.40	-247.20	16.0	2.0	10.5	BAFN10-SFL6	$ 113.05	£ 71.20	€ 105,10	¥ 1,079.60
AC508-100-A1†	50.8	100.0	89.0	71.12	-44.17	-363.10	16.0	4.0	14.4	BAF10-SF10	$ 97.85	£ 61.65	€ 91,00	¥ 934.50
AC508-150-A1†	50.8	150.0	141.0	83.18	-71.12	-247.70	12.0	3.0	9.7	BK7-SF5	$ 97.85	£ 61.65	€ 91,00	¥ 934.50
AC508-200-A1†	50.8	200.0	193.7	109.86	-93.11	-376.25	8.5	2.0	6.7	BK7-SF2	$ 97.85	£ 61.65	€ 91,00	¥ 934.50
AC508-250-A1†	50.8	250.0	244.6	137.09	-111.69	-459.20	7.5	2.0	6.4	BK7-SF2	$ 97.85	£ 61.65	€ 91,00	¥ 934.50
AC508-300-A1†	50.8	300.0	295.4	161.50	-134.00	-580.80	6.0	2.0	5.4	BK7-SF2	$ 97.85	£ 61.65	€ 91,00	¥ 934.50
AC508-400-A1†	50.8	400.0	396.1	219.80	-186.75	-760.00	5.0	2.0	5.1	BK7-SF2	$ 97.85	£ 61.65	€ 91,00	¥ 934.50
AC508-500-A1†	50.8	500.0	495.8	272.90	-234.27	-970.00	5.0	2.0	5.5	BK7-SF2	$ 97.85	£ 61.65	€ 91,00	¥ 934.50
AC508-750-A1†	50.8	750.0	746.5	417.80	-336.00	-1330.50	4.5	2.0	5.5	BK7-SF2	$ 97.85	£ 61.65	€ 91,00	¥ 934.50
AC508-1000-A1†	50.8	1000.0	994.6	738.50	-398.10	-1023.30	4.0	2.0	5.2	BK7-SF2	$ 97.85	£ 61.65	€ 91,00	¥ 934.50

† Popular Products @ More Popular Prices

Negative Visible Achromats: Infinite Conjugate Ratio

| ITEM#	DIA (mm)	f (mm)	f_b (mm)	r_1 (mm)	r_2 (mm)	r_3 (mm)	t_c1 (mm)	t_c2 (mm)	t_e (mm)	MATERIALS	$	£	€	RMB
ACN127-020-A1	12.7	-20.0	-22.3	-13.53	14.25	87.90	1.5	3.0	6.3	BAFN10-SFL6	$ 57.00	£ 35.90	€ 53,00	¥ 544.40
ACN127-025-A1	12.7	-25.0	-27.0	-16.94	16.48	97.72	1.5	2.5	5.4	BAFN10-SFL6	$ 56.00	£ 35.30	€ 52,10	¥ 534.80
ACN127-030-A1	12.7	-30.0	-32.2	-16.18	16.48	154.20	1.5	2.3	5.7	BAK4-SF5	$ 56.00	£ 35.30	€ 52,10	¥ 534.80
ACN127-050-A1	12.7	-50.0	-52.3	-25.55	25.55	372.70	1.5	2.2	4.6	BAK4-SF5	$ 56.00	£ 35.30	€ 52,10	¥ 534.80
ACN254-040-A1	25.4	-40.0	-43.6	-27.05	27.05	189.23	2.0	5.0	10.6	BAFN10-SF11	$ 104.00	£ 65.50	€ 96,70	¥ 993.20
ACN254-050-A1	25.4	-50.0	-53.2	-33.96	32.51	189.23	2.0	4.5	9.4	BAFN10-SFL6	$ 81.00	£ 51.05	€ 75,30	¥ 773.60
ACN254-075-A1	25.4	-75.0	-78.8	-39.02	39.17	489.80	2.0	4.3	8.6	BAK4-SF5	$ 81.00	£ 51.05	€ 75,30	¥ 773.60
ACN254-100-A1	25.4	-100.0	-103.6	-52.00	49.89	600.00	2.0	4.0	7.7	BAK4-SF5	$ 81.00	£ 51.05	€ 75,30	¥ 773.60

THORLABS

Achromatic Doublet Lenses

Achieve a Tighter Focus

In comparison to singlet lenses, achromatic doublet lenses have far superior optical performance. For any application with demanding imaging requirements or laser beam manipulation needs, these doublets should be considered.
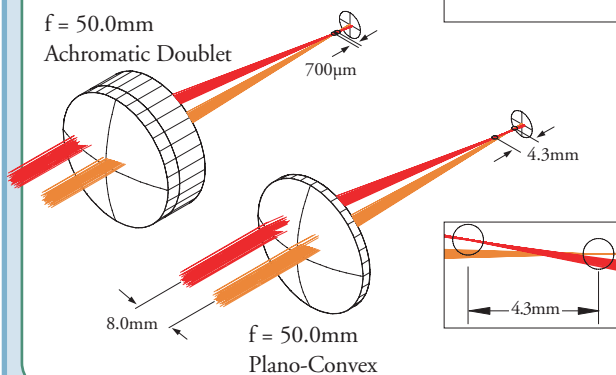
The figures to the right compare the focusing of a 633nm laser beam by a plano-convex singlet and an achromatic doublet. The figure shows that the spot size (circle of least confusion) from the doublet is 4.2 times smaller than that from the singlet.

633nm Monochromatic Light
Ø10mm Input Beam

f = 50.0mm
Achromatic Doublet

10μm

3.6μm Spot

Spot Diagrams

15μm Spot

10μm

f = 50.0mm
Plano-Convex
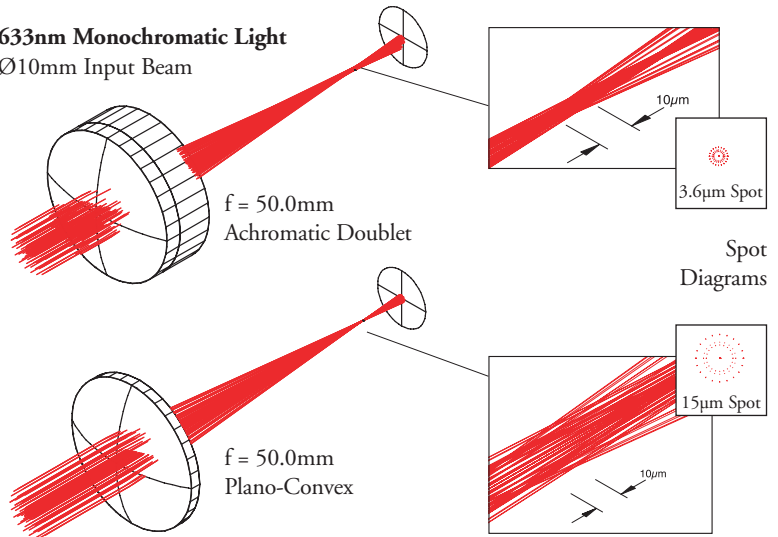
633nm Monochromatic Light
Ø3mm Input Beams
8mm Separation

f = 50.0mm
Achromatic Doublet

700μm

700μm

4.3mm

8.0mm

f = 50.0mm
Plano-Convex

4.3mm

Superior Off-Axis Performance

Achromatic Doublets have a much-reduced sensitivity to centration of the lenses on the beam axis. The figure to the left shows two 50.0mm focal length lenses, one of which is plano-convex and the other is an achromatic doublet. Both lenses are 25.4mm in diameter with one laser beam propagating along the optical axis and a second beam propagating parallel to the first but offset by 8.0mm. It can be seen that both lateral and transverse aberrations are greatly reduced by using an achromatic doublet.

Nearly Constant Focal Length Across a Wide Range of Wavelengths

When using a white light source with a singlet lens, the focal point and circle of least confusion are blurred by chromatic aberration. Chromatic aberration results from the variation of a material's refractive index with incident wavelength. In contrast, an achromatic doublet can partially compensate for chromatic aberration because it is comprised from two lenses, each of which has a different refractive index, thus leading to partial cancellation of this unwanted effect. The figure shows the effect on focal length for a number of different wavelengths of light, which are incident on an achromatic doublet and a plano-convex singlet. The figure also shows how the circle of least confusion for white light is reduced by using an achromatic doublet.

400-800nm White Light
Ø10mm Input Beam

f = 50.0mm
Achromatic Doublet

300μm screen

Enlarged 5X

17.0μm Spot

f = 50.0mm
Plano-Convex

300μm screen

147μm Spot

www.thorlabs.com

THORLABS