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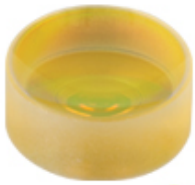
LD5451-E - December 20, 2024

Item # LD5451-E was discontinued on December 20, 2024. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

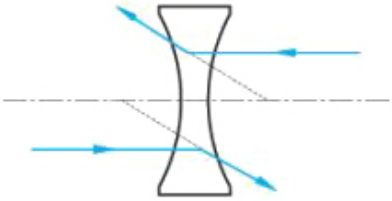
CALCIUM FLUORIDE BI-CONCAVE LENSES

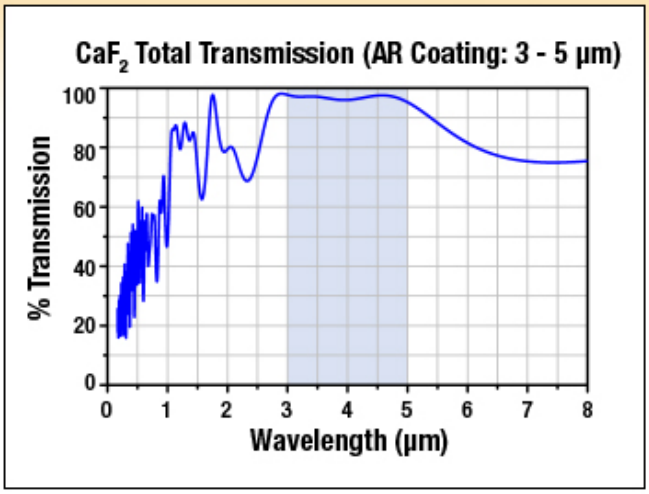
- **Lenses Offered Uncoated or with an AR Coating Optimized for the 3 - 5 µm Range**
- **Choose from Ø1/2" or Ø1"**
- **Ideal for use with Excimer Lasers**

LD5138
(Ø1")



LD5451-E
(Ø1/2")





OVERVIEW

Features

- Vacuum-Grade Calcium Fluoride Substrate
- Ø1/2" and Ø1" Versions Available
- Available Uncoated or with a Broadband AR Coating for the 3 - 5 µm Range*
- Focal Lengths from -15.0 mm to -50.0 mm

Thorlabs' Ø1/2" and Ø1" Calcium Fluoride (CaF_2) Bi-Concave Lenses, which offer high transmission from 0.18 µm to 8.0 µm, are available uncoated or with a broadband AR coating optimized for the 3 µm to 5 µm* spectral range deposited on both surfaces. This coating greatly reduces the surface reflectance of the substrate, yielding an average transmission in excess of 96.8% over the entire AR coating range. See the *Graphs* tab for detailed information.

CaF_2 is commonly used for applications requiring high transmission in the infrared and ultraviolet spectral ranges. Its extremely high laser damage threshold makes it useful for use with excimer lasers. The material exhibits a low refractive index, varying from 1.35 to 1.51 within its usage range of 180 nm to 8.0 µm. Calcium fluoride is also fairly chemically inert and offers superior hardness compared to its barium fluoride, magnesium fluoride, and lithium fluoride cousins.

Common Specifications	
Substrate Material	Vacuum-Grade Calcium Fluoride[a]
Wavelength Range	0.18 - 8.0 µm
Diameters Available	1/2" or 1"
Diameter Tolerance	+0.00/-0.10 mm
Thickness Tolerance	±0.1 mm
Focal Length Tolerance	±1%
Surface Quality	40-20 (Scratch-Dig)
Spherical Surface Power[b]	3λ/2
Spherical Surface Irregularity (Peak to Valley)	λ/2
Centration	≤3 arcmin
Clear Aperture	>90% of Diameter
Design Wavelength	588 nm

a. Click Link for Detailed Specifications on the Substrate
b. Much like surface flatness for flat optics, spherical surface power is a measure of the deviation between the surface of the curved optic and a calibrated reference gauge, typically for a 633 nm source, unless

otherwise stated. This specification is also commonly referred to as surface fit.

Bi-concave lenses have negative focal lengths, making them useful for a wide range of applications.They are often used to increase the divergance of a converging beam. In optical systems, it is common for researchers to choose their optics carefully so that the aberrations introduced by the positive- and negative-focal-length lenses approximately cancel. Others use these lenses in pairs to increase the effective focal length of a converging lens.

When deciding between a plano-concave lens and a bi-concave lens, both of which cause the incident light to diverge, it is usually preferrable to choose a bi-concave lens if the absolute conjugate ratio (object distance divided by image distance) is close to 1. When the desired absolute magnification is either less than 0.2 or greater than 5, the tendency is to choose a plano-concave lens instead.

*The LD5451-E lens features an enhanced AR coating for the 2 µm to 5 µm range. See the tables below for individual lens specifications.

Zemax Files

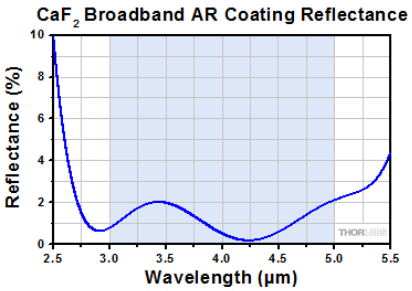
Click on the red Document icon next to the item numbers below to access the Zemax file download. Our entire Zemax Catalog is also available.

Selection Guide

Calcium Fluoride Lenses	Other MIR Lenses	Other Spherical Singlets
More [+]	More [+]	More [+]

GRAPHS

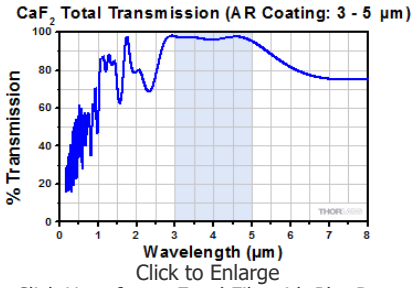
3 - 5 µm AR Coating Graphs



Click to Enlarge

Click Here for an Excel File with Plot Data

Shown above is a graph of the measured percent reflectance of the AR coating as a function of wavelength. The average reflectance in the 3 - 5 µm range is <2.0%. The blue shading indicates the region for which the AR coating is optimized. Performance outside of the specified range is not guaranteed and varies from lot to lot.

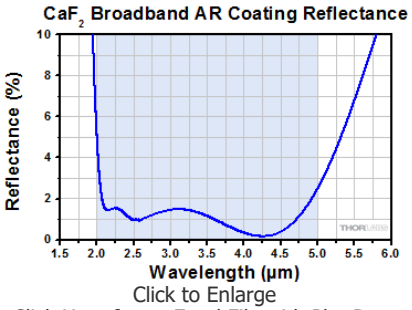


Click to Enlarge

Click Here for an Excel File with Plot Data

Shown above is a graph of the theoretical transmission of an AR-coated calcium fluoride plano-convex lens. The blue shaded region denotes the 3 - 5 µm spectral range where the AR coating is optimized. For this wavelength range, the measured transmission is in excess of 95%. Performance outside of the specified range is not guaranteed and varies from lot to lot.

Enhanced AR Coating for 2 - 5 µm

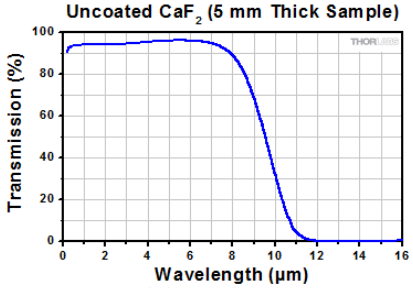


Click to Enlarge

Click Here for an Excel File with Plot Data

Shown above is a graph of the measured percent reflectance of the enhanced AR coating as a function of wavelength. The average reflectance in the 2 - 5 µm range is <1.25%. The blue shading indicates the region for which the AR coating is optmized. Performance outside of the specified range is not guaranteed and varies from lot to lot. The excel file above provides the

CaF_2 Transmission



Click to Enlarge

Click Here for an Excel File with Plot Data

Shown above is a graph of the measured transmission of an uncoated, 5 mm thick sample of CaF_2.

coating curve data over an extended wavelength range.

Total Transmission of Optic (CaF_2 Substrate, Uncoated)

The table below gives the approximate theoretical transmission of these uncoated optics for a few select wavelengths in the 0.18 - 8.0 µm range. To see an excel file that lists all measured transmission values for this wavelength range, please click here.

Wavelength (µm)	Total Transmission	Wavelength (µm)	Total Transmission	Wavelength (µm)	Total Transmission	Wavelength (µm)	Total Transmission
0.2	0.910	2.2	0.939	4.2	0.943	6.2	0.947
0.4	0.929	2.4	0.939	4.4	0.943	6.4	0.947
0.6	0.935	2.6	0.940	4.6	0.943	6.6	0.948
0.8	0.937	2.8	0.940	4.8	0.944	6.8	0.949
1.0	0.938	3.0	0.940	5.0	0.945	7.0	0.949
1.2	0.938	3.2	0.941	5.2	0.945	7.2	0.948
1.4	0.938	3.4	0.941	5.4	0.945	7.4	0.947
1.6	0.938	3.6	0.941	5.6	0.946	7.6	0.946
1.8	0.939	3.8	0.942	5.8	0.946	7.8	0.945
2.0	0.939	4.0	0.942	6.0	0.947	8.0	0.944

Total Transmission of Optic (CaF_2 Substrate + AR Coating for 3 - 5 µm)

The table below gives the approximate theoretical transmission of these AR-Coated optics for a few select wavelengths in the 0.18 - 8.0 µm range. To see an excel file that lists all measured transmission values for this wavelength range, please click here. Please note that the transmission values stated for wavelengths outside of the AR coating range are approximate and can vary significantly by coating lot.

Wavelength (µm)	Total Transmission	Wavelength (µm)	Total Transmission	Wavelength (µm)	Total Transmission	Wavelength (µm)	Total Transmission
0.2	0.210	2.2	0.733	4.2	0.965	6.2	0.795
0.4	0.361	2.4	0.704	4.4	0.972	6.4	0.779
0.6	0.284	2.6	0.858	4.6	0.975	6.6	0.767
0.8	0.453	2.8	0.972	4.8	0.969	6.8	0.759
1.0	0.481	3.0	0.977	5.0	0.952	7.0	0.753
1.2	0.799	3.2	0.971	5.2	0.927	7.2	0.750
1.4	0.838	3.4	0.972	5.4	0.898	7.4	0.749
1.6	0.641	3.6	0.968	5.6	0.868	7.6	0.750
1.8	0.932	3.8	0.962	5.8	0.839	7.8	0.751
2.0	0.794	4.0	0.960	6.0	0.815	8.0	0.754

FOCAL LENGTH SHIFT

Wavelength-Dependent Focal Length Shift

The paraxial focal length of a lens is wavelength dependent. The focal length listed below for a given lens corresponds to the value at the design wavelength (i.e., the focal length at 588 nm). Since CaF_2 offers high transmission from 0.18 - 8.0 µm, users may wish to use these lenses at other popular wavelengths. Click on the icons below to view theoretically-calculated focal length shifts for wavelengths within the 0.18 - 8.0 µm range.

The blue shading indicates the region for which the AR coating is optimized. Please see the *Graphs* tab for more information.

Ø1/2" Bi-Concave Lenses

Item #	LD5451	LD5788
Focal Length @ 588 nm	-15.0 mm	-25.0 mm

Focal Length Shift (Click for Details)		
Raw Data (Click to Download)	Data	Data

Ø1" Bi-Concave Lenses

Item #	LD5138	LD5313
Focal Length @ 588 nm	-30.0 mm	-50.0 mm
Focal Length Shift (Click for Details)		
Raw Data (Click to Download)	Data	Data

Item #	LD5451-E	LD5788-E
Focal Length @ 588 nm	-15.0 mm	-25.0 mm
Focal Length Shift (Click for Details)		
Raw Data (Click to Download)	Data	Data

Item #	LD5138-E	LD5313-E
Focal Length @ 588 nm	-30.0 mm	-50.0 mm
Focal Length Shift (Click for Details)		
Raw Data (Click to Download)	Data	Data

MOUNTING OPTIONS

Click to Enlarge
LMR1 Fixed Mount with
Ø1" Lens

Click to Enlarge
CXY1A Translation Mount
and
SM1 Lens Tube Mounted
in a
30 mm Cage System

Click to Enlarge
LM2XY Translating Mount
with Ø2" Lens

Click to Enlarge

Ø1" Optic Mounted in a ST1XY-S XY Translator

Recommended Mounting Options for Thorlabs Lenses		
Item #		**Mounts for Ø2 mm to Ø10 mm Optics**
Imperial	**Metric**	
(Various)		Fixed Lens Mounts and Mini-Series Fixed Lens Mounts for Small Optics, Ø5 mm to Ø10 mm
(Various)		Small Optic Adapters for Use with Standard Fixed Lens Mounts, Ø2 mm to Ø10 mm
Item #		**Mounts for Ø1/2" (Ø12.7 mm) Optics**
Imperial	**Metric**	
LMR05	LMR05/M	Fixed Lens Mount for Ø1/2" Optics
MLH05	MLH05/M	Mini-Series Fixed Lens Mount for Ø1/2" Optics
LM05XY	LM05XY/M	Translating Lens Mount for Ø1/2" Optics
SCP05		16 mm Cage System, XY Translation Mount for Ø1/2" Optics
(Various)		Ø1/2" Lens Tubes, Optional SM05RRC Retaining Ring for High-Curvature Lenses (See Below)
Item #		**Mounts for Ø1" (Ø25.4 mm) Optics**
Imperial	**Metric**	
LMR1	LMR1/M	Fixed Lens Mount for Ø1" Optics
LM1XY	LM1XY/M	Translating Lens Mount for Ø1" Optics
ST1XY-S	ST1XY-S/M	Translating Lens Mount with Micrometer Drives (Other Drives Available)
CXY1A		30 mm Cage System, XY Translation Mount for Ø1" Optics
(Various)		Ø1" Lens Tubes, Optional SM1RRC Retaining Ring for High-Curvature Lenses (See Below)
Item #		**Mount for Ø1.5" Optics**
Imperial	**Metric**	
LMR1.5	LMR1.5/M	Fixed Lens Mount for Ø1.5" Optics
(Various)		Ø1.5" Lens Tubes, Optional SM1.5RR Retaining Ring for Ø1.5" Lens Tubes and Mounts
Item #		**Mounts for Ø2" (Ø50.8 mm) Optics**
Imperial	**Metric**	
LMR2	LMR2/M	Fixed Lens Mount for Ø2" Optics
LM2XY	LM2XY/M	Translating Lens Mount for Ø2" Optics
CXY2		60 mm Cage System, XY Translation Mount for Ø2" Optics
(Various)		Ø2" Lens Tubes, Optional SM2RRC Retaining Ring for High-Curvature Lenses (See Below)
Item #		**Adjustable Optic Mounts**
Imperial	**Metric**	
LH1	LH1/M	Adjustable Mount for Ø0.28" (Ø7.1 mm) to Ø1.80" (Ø45.7 mm) Optics
LH2	LH2/M	Adjustable Mount for Ø0.77" (Ø19.6 mm) to Ø2.28" (Ø57.9 mm) Optics
VG100	VG100/M	Adjustable Clamp for Ø0.5" (Ø13 mm) to Ø3.5" (Ø89 mm) Optics
SCL03	SCL03/M	Self-Centering Mount for Ø0.15" (Ø3.8 mm) to Ø1.77" (Ø45.0 mm) Optics
SCL04	SCL04/M	Self-Centering Mount for Ø0.15" (Ø3.8 mm) to Ø3.00" (Ø76.2 mm) Optics
LH160C	LH160C/M	Adjustable Mount for 60 mm Cage Systems, Ø0.50" (Ø13 mm) to Ø2.00" (Ø50.8 mm) Optics
SCL60CA	SCL60C/M	Self-Centering Mount for 60 mm Cage Systems, Ø0.15" (Ø3.8 mm) to Ø1.77" (Ø45.0 mm) Optics

Mounting High-Curvature Optics

Thorlabs' retaining rings are used to secure unmounted optics within lens tubes or optic mounts. These rings are secured in position using a compatible spanner wrench. For flat or low-curvature optics, standard retaining rings manufactured from anodized aluminum are available from Ø5 mm to Ø4". For high-curvature optics,

extra-thick retaining rings are available in Ø1/2", Ø1", and Ø2" sizes.

Extra-thick retaining rings offer several features that aid in mounting high-curvature optics such as aspheric lenses, short-focal-length plano-convex lenses, and condenser lenses. As shown in the animation to the right, the guide flange of the spanner wrench will collide with the surface of high-curvature lenses when using a standard retaining ring, potentially scratching the optic. This contact also creates a gap between the spanner wrench and retaining ring, preventing the ring from tightening correctly. Extra-thick retaining rings provide the necessary clearance for the spanner wrench to secure the lens without coming into contact with the optic surface.

Ø1/2" CaF_2 Bi-Concave Lenses, Uncoated

Item #	Diameter	Focal Length	Diopter[a]	Radius of Curvature	Center Thickness	Edge Thickness[b]	Back Focal Length[c]	Reference Drawing
LD5451[d]	1/2" (12.7 mm)	-15.0 mm	-66.6	-13.4 mm	2.5 mm	5.7 mm	-15.8 mm	
LD5788[e]	1/2" (12.7 mm)	-25.0 mm	-40.0	-22.1 mm	3.0 mm	4.9 mm	-26.0 mm	

a. Reciprocal of the Focal Length in Meters
b. Edge Thickness Given Before 0.2 mm at 45° Typical Chamfer
c. Measured at the Design Wavelength, 588 nm
d. Suggested Fixed Lens Mounts: LMR05(/M) & SM05L03
e. Suggested Fixed Lens Mount: LMR05(/M)

Part Number	Description	Price	Availability
LD5451	Ø1/2" CaF_2 Bi-Concave Lens, f = -15.0 mm, Uncoated	$155.62	Today
LD5788	Ø1/2" CaF_2 Bi-Concave Lens, f = -25.0 mm, Uncoated	$144.93	Today

Ø1/2" CaF_2 Bi-Concave Lenses, AR-Coated: 3 - 5 µm or 2 - 5 µm

Item #	Diameter	Focal Length	Diopter[a]	Radius of Curvature	Center Thickness	Edge Thickness[b]	Back Focal Length[c]	AR Coating	Reference Drawing
LD5451-E[d]	1/2" (12.7 mm)	-15.0 mm	-66.6	-13.4 mm	2.5 mm	5.7 mm	-15.8 mm	<1.25% R_{avg} from 2 - 5 µm	
LD5788-E[e]	1/2" (12.7 mm)	-25.0 mm	-40.0	-22.1 mm	3.0 mm	4.9 mm	-26.0 mm	<2.0% R_{avg} from 3 - 5 µm	

a. Reciprocal of the Focal Length in Meters
b. Edge Thickness Given Before 0.2 mm at 45° Typical Chamfer
c. Measured at the Design Wavelength, 588 nm
d. Suggested Fixed Lens Mounts: LMR05(/M) & SM05L03
e. Suggested Fixed Lens Mount: LMR05(/M)

Part Number	Description	Price	Availability
LD5451-E	Ø1/2" CaF_2 Bi-Concave Lens, f = -15.0 mm, AR-Coated: 2 - 5 µm	$192.44	Today
LD5788-E	Ø1/2" CaF_2 Bi-Concave Lens, f = -25.0 mm, AR-Coated: 3 - 5 µm	$180.56	Today

Ø1" CaF_2 Bi-Concave Lenses, Uncoated

Item #	Diameter	Focal Length	Diopter[a]	Radius of Curvature	Center Thickness	Edge Thickness[b]	Back Focal Length[c]	Reference Drawing
LD5138[d]	1" (25.4 mm)	-30.0 mm	-33.3	-26.4 mm	2.5 mm	9.0 mm	-30.9 mm	
LD5313[e]	1" (25.4 mm)	-50.0 mm	-20.0	-43.8 mm	3.0 mm	6.8 mm	-51.0 mm	

a. Reciprocal of the Focal Length in Meters
b. Edge Thickness Given Before 0.2 mm at 45° Typical Chamfer
c. Measured at the Design Wavelength, 588 nm
d. Suggested Fixed Lens Mounts: LMR1(/M) & SM1L05
e. Suggested Fixed Lens Mount: LMR1(/M)

Part Number	Description	Price	Availability
LD5138	Ø1" CaF_2 Bi-Concave Lens, f = -30.0 mm, Uncoated	$210.27	Today
LD5313	Ø1" CaF_2 Bi-Concave Lens, f = -50.0 mm, Uncoated	$199.58	Today

Ø1" CaF_2 Bi-Concave Lenses, AR-Coated: 3 - 5 µm

Item #	Diameter	Focal Length	Diopter[a]	Radius of Curvature	Center Thickness	Edge Thickness[b]	Back Focal Length[c]	AR Coating	Reference Drawing
LD5138-E[d]	1" (25.4 mm)	-30.0 mm	-33.3	-26.4 mm	2.5 mm	9.0 mm	-30.9 mm	<2.0% R_{avg} from 3 - 5 µm	
LD5313-E[e]	1" (25.4 mm)	-50.0 mm	-20.0	-43.8 mm	3.0 mm	6.8 mm	-51.0 mm		

a. Reciprocal of the Focal Length in Meters
b. Edge Thickness Given Before 0.2 mm at 45° Typical Chamfer
c. Measured at the Design Wavelength, 588 nm
d. Suggested Fixed Lens Mounts: LMR1(/M) & SM1L05
e. Suggested Fixed Lens Mount: LMR1(/M)

Part Number	Description	Price	Availability
LD5138-E	Ø1" CaF_2 Bi-Concave Lens, f = -30.0 mm, AR-Coated: 3 - 5 µm	$247.10	Today
LD5313-E	Ø1" CaF_2 Bi-Concave Lens, f = -50.0 mm, AR-Coated: 3 - 5 µm	$235.21	Today