

PresencePLUS®

lens selection guide



WARNING . . . Not To Be Used for Personnel Protection

Never use these products as sensing devices for personnel protection. Doing so could lead to serious injury or death.

These sensors do NOT include the self-checking redundant circuitry necessary to allow their use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition. Consult your current Banner Safety Products catalog for safety products which meet OSHA, ANSI and IEC standards for personnel protection.



more sensors, more solutions

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General Lens Considerations

There are many lens options to consider, such as focal length, mounting style, and focus locking. The two most critical lens considerations are mounting style and focal length. Banner products use C-Mount lenses only. Before selecting the appropriate focal length, Field of View (FOV) and working distance must be determined.

Banner offers C-Mount lenses of the following focal lengths (in millimeters): 4, 8, 12, 16, 25, 50, and 75. Other manufacturers' C-Mount lenses may also be used.

The following sections provide a tour through the process of determining the Field of View, working distance, and focal length:

[Determining Field of View](#) page 2

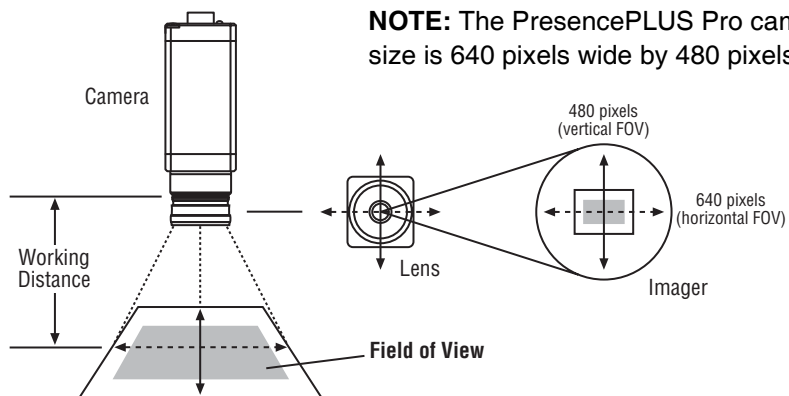
[Determining Working Distance](#) page 3

[Determining Focal Length](#) page 4

For additional help, support is available from your local Banner representative or a Banner Application Engineer. Application Engineers are available from 8:00 A.M. to 5:30 P.M. Central Time, Monday through Friday, excluding holidays.

Field of View

Field of view (FOV) is the area of the inspection captured on the camera's imager. The size of the FOV and the size of the camera's imager directly affect the image resolution (one determining factor in accuracy). See the illustration below.



Determining Field of View

To determine FOV size: Measure the size of the inspection area (inches or millimeters), and allow extra area to accommodate any anticipated movement of the target object.

To verify that the FOV is sufficient for the required resolution:

1. Estimate the required resolution or minimum detection size; for example, will the inspection measure to a tolerance of 0.1 mm? 1 inch? 10 feet?
2. Use the FOV Formula below to determine the maximum horizontal and vertical FOV that will maintain the required resolution.
3. Verify that the calculated FOV is larger than the inspection area.

FOV Formula

Required Resolution x 640 pixels = Maximum Horizontal FOV

Required Resolution x 480 pixels = Maximum Vertical FOV

Calculated FOV Example

Approximate area of inspection is 3.0" by 3.5". Required resolution is 0.01".

For the required resolution, is the area of inspection an acceptable FOV?

Required Resolution x 640 pixels = Maximum Horizontal FOV.

0.01" x 640 = 6.4" Maximum Horizontal FOV.

Required Resolution x 480 pixels = Maximum Vertical FOV.

0.01" x 480 = 4.8" Maximum Vertical FOV.

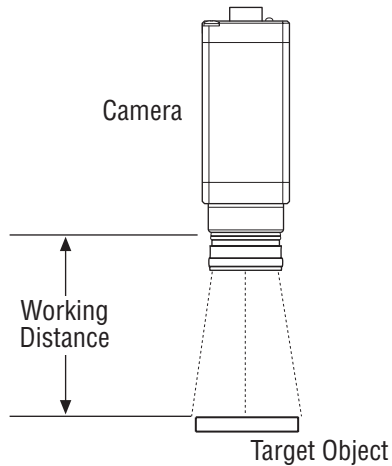
The Calculated FOV (6.4" x 4.8") is larger than the area of inspection; therefore, a 3.0" x 3.5" FOV is acceptable.

If the calculated FOV is smaller than the desired area of inspection, options are as follows:

- Use multiple cameras.
- Inspect a smaller portion of the area.
- Reduce the resolution requirement.

Determining Working Distance

Working distance is the distance between the back of the lens and the target object.

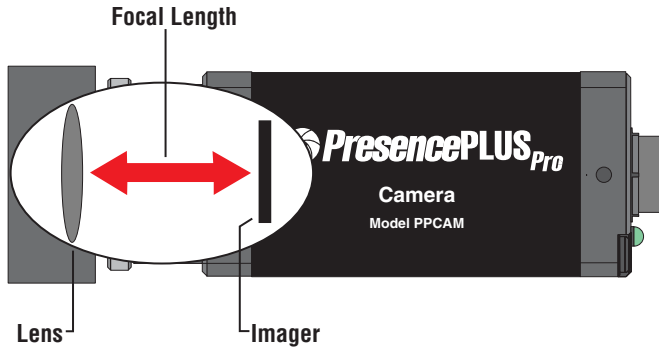


Some of the key factors that can restrict working distance are as follows:

- The minimum working distance of Banner's standard lenses is about 2.5 inches. Banner's high-performance lenses and most C-Mount lenses have a minimum working distance of 14 inches (spacers can be used to reduce that working distance).
- The lens may need to be close to the target object to avoid light fluctuations.
- There may be physical constraints that limit where the camera can be mounted.

Determining Focal Length

Focal length is the distance between the rear nodal point of the lens (the point where the light rays leave the rear of the lens) and the camera's imager and is specified in millimeters.



Focal Length Tools

To choose the best focal length for a specific application, use any of the following tools:

- [Focal Length and Lens Extension Tables](#) page 6
- [Working Distance vs. FOV Graphs](#) page 10
- [Focal Length Formula](#) page 16

Focal Length Considerations

If more than one focal length seems appropriate for the application, consider the following:

- **Cost:** A lens with a shorter focal length is less expensive.
- **Depth of focus capability:** Depth of focus (focus tolerance) is the area in front of and beyond the optimal point of focus in which the image quality remains acceptable. A longer focal length provides less depth of focus; a shorter focal length provides more depth of focus.
- **Distortion (see example below):** A larger focal length lens provides a less distorted image. Gauging and the pattern matching tools are sensitive to distortion.

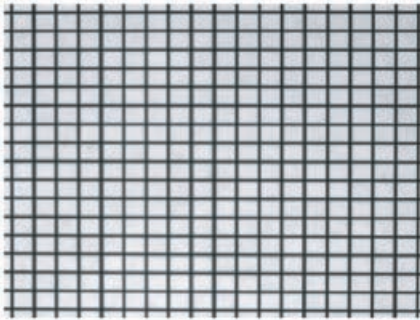


Image of Grid with 25 mm Lens

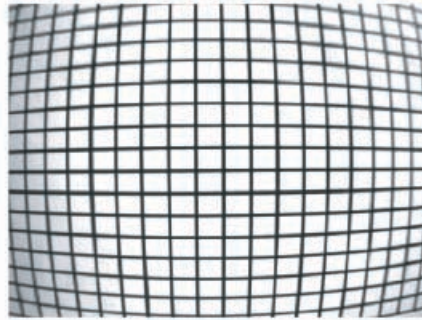


Image of Same Grid with 4 mm Lens

Focal Length and Lens Extension Tables

NOTE: Working distance and FOV must be known in order to use these tables. See [Field of View](#) on page 1 and [Determining Working Distance](#) on page 3.

Focal Length Table, Working Distances in Inches

FOV in Inches (H x V)	Working Distances in Inches							
	4 mm Lens	8 mm Lens	12 mm Lens	16 mm Lens	25 mm Lens	50 mm Lens	75 mm Lens	
0.2 x 0.2						4.1*	5*	* Extensions may be added to these 25-, 50-, and 75-mm lenses as indicated by the given lengths (in mm) in the inch table .
0.3 x 0.2					1.6*	5.2*	7*	
0.4 x 0.3					2.1*	6.2*	8*	
0.5 x 0.4				1.7	2.6*	7.3*	9*	
1.0 x 0.8			2.5	3.3	5.2*	12.5*	17*	
1.5 x 1.1		2.5	3.8	5.0	7.8*	17.7*	26*	
2.0 x 1.5		3.3	5.0	6.7	10.4*	23*	34*	
2.5 x 1.9		4.2	6.3	8.3	13.0*	28*	40*	
3.0 x 2.3		5.0	7.5	10.0	15.6*	33	46	
3.5 x 2.6	2.9*	5.8	8.8	11.7	18.2*	39	54	
4.0 x 3.0	3.3*	6.7	10.0	13.3	21*	44	62	
4.5 x 3.4	3.8*	7.5	11.3	15.0	23	49	70	
5.0 x 3.8	4.2*	8.3	12.5	16.7	26	54	77	
5.5 x 4.1	4.6*	9.2	13.8	18.3	29	59	85	
6.0 x 4.5	5.0*	10.0	15.0	20	31	65	93	
6.5 x 4.9	5.4*	10.8	16.3	22	34	70	101	
7.0 x 5.3	5.8*	11.7	17.5	23	36	75	108	
7.5 x 5.6	6.3	12.5	18.8	25	39	80	116	
8.0 x 6.0	6.7	13.3	20	27	42	85	124	
8.5 x 6.4	7.1	14.2	21	28	44	91	121	
9.0 x 6.8	7.5	15.0	23	30	47	96	139	
9.5 x 7.1	7.9	15.8	24	32	49	101	147	
10.0 x 7.5	8.3	16.7	25	33	52	106	155	
10.5 x 7.9	8.8	17.5	26	35	55	111	162	
11.0 x 8.3	9.2	18.3	28	37	57	117	170	
11.5 x 8.6	9.6	19.2	29	38	60	122	178	
12.0 x 9.0	10.0	20	30	40	63	127	186	
12.5 x 9.4	10.4	21	31	42	65	132	193	
13.0 x 9.8	10.8	22	33	43	68	147	201	
13.5 x 10.1	11.3	23	34	45	70	143	209	
14.0 x 10.5	11.7	23	35	47	73	148	216	
14.5 x 10.9	12.1	24	36	48	76	153	224	
15.0 x 11.3	12.5	25	38	50	78	158	232	
15.5 x 11.6	12.9	26	39	52	81	164	240	
16.0 x 12.0	13.3	27	40	53	83	169	247	
16.5 x 12.4	13.8	28	41	55	86	174	255	
17.0 x 12.8	14.2	28	43	57	89	179	263	
17.5 x 13.1	14.6	29	44	58	91	184	271	
18.0 x 13.5	15.0	30	45	60	94	190	278	
18.5 x 13.9	15.4	31	46	62	96	195	286	
19.0 x 14.3	15.8	32	48	63	99	200	294	
19.5 x 14.6	16.3	33	49	65	102	205	302	
20.0 x 15.0	16.7	33	50	67	104	210	309	

Lens Extensions Table, Working Distances in Inches

These extensions, in lengths of 0.5, 1.0, 5.0, 10, and 20 millimeters, may be combined to achieve a desired focal length. Extension lengths are in parenthesis.

FOV in Inches (horizontal x vertical)	Working Distances in Inches			
	4 mm Lens	25 mm Lens	50 mm Lens	75 mm Lens
0.2 x 0.2			4.1 (40)	5 (40)
0.3 x 0.2		1.6 (10)	5.2 (30)	7 (30)
0.4 x 0.3		2.1 (10)	6.2 (20)	8 (20)
0.5 x 0.4		2.6 (7)	7.3 (15)	9 (15)
1.0 x 0.8		5.2 (5)	12.5 (10)	17 (10)
1.5 x 1.1		7.8 (1)	17.7 (5)	26 (10)
2.0 x 1.5		10.4 (1)	23 (1)	34 (5)
2.5 x 1.9		13.0 (1)	28 (1)	40 (5)
3.0 x 2.3		15.6 (1)		
3.5 x 2.6	2.9 (0.5)	18.2 (1)		
4.0 x 3.0	3.3 (0.5)	21 (1)		
4.5 x 3.4	3.8 (0.5)			
5.0 x 3.8	4.2 (0.5)			
5.5 x 4.1	4.6 (0.5)			
6.0 x 4.5	5.0 (0.5)			
6.5 x 4.9	5.4 (0.5)			
7.0 x 5.3	5.8 (0.5)			
7.5 x 5.6	6.3			
8.0 x 6.0	6.7			
8.5 x 6.4	7.1			
9.0 x 6.8	7.5			
9.5 x 7.1	7.9			
10.0 x 7.5	8.3			
10.5 x 7.9	8.8			
11.0 x 8.3	9.2			
11.5 x 8.6	9.6			
12.0 x 9.0	10.0			
12.5 x 9.4	10.4			
13.0 x 9.8	10.8			
13.5 x 10.1	11.3			
14.0 x 10.5	11.7			
14.5 x 10.9	12.1			
15.0 x 11.3	12.5			
15.5 x 11.6	12.9			
16.0 x 12.0	13.3			
16.5 x 12.4	13.8			
17.0 x 12.8	14.2			
17.5 x 13.1	14.6			
18.0 x 13.5	15.0			
18.5 x 13.9	15.4			
19.0 x 14.3	15.8			
19.5 x 14.6	16.3			
20.0 x 15.0	16.7			

Focal Length Table, Working Distances in Millimeters

FOV in Millimeters (H x V)	Working Distances in Millimeters							
	4 mm Lens	8 mm Lens	12 mm Lens	16 mm Lens	25 mm Lens	50 mm Lens	75 mm Lens	
5 x 4						104*	115*	* Extensions may be added to these 25-, 50-, and 75-mm lenses as indicated by the given lengths (in mm) in the mm table .
10 x 8						156*	230*	
15 x 11					78*	208*	285*	
20 x 15					104*	260*	370*	
25 x 19				83	130*	313*	425*	
30 x 23			75	100	156*	365*	510*	
35 x 26		58	88	117	182*	417*	595*	
40 x 30		67	100	133	208*	469*	640*	
45 x 34		75	113	150	234*	521	696	
50 x 38		83	125	167	260*	573	773	
60 x 45	50*	100	150	200	313*	677	928	
70 x 53	58*	117	175	233	365*	781	1082	
80 x 60	67*	133	200	267	417	885	1237	
90 x 68	75*	150	225	300	469	990	1392	
100 x 75	83*	167	250	333	521	1094	1546	
110 x 83	92*	183	275	367	573	1198	1701	
120 x 90	100*	200	300	400	625	1302	1856	
130 x 98	108	217	325	433	677	1406	2010	
140 x 105	117	233	350	467	729	1510	2165	
150 x 113	125	250	375	500	781	1615	2320	
160 x 120	133	267	400	533	833	1719	2474	
170 x 128	142	283	425	567	885	1823	2629	
180 x 135	150	300	450	600	938	1927	2783	
190 x 143	158	317	475	633	990	2031	2938	
200 x 150	167	333	500	667	1042	2135	3093	
225 x 169	188	375	563	750	1172	2396	3479	
250 x 188	208	417	625	833	1302	2656	3866	
275 x 206	229	458	688	917	1432	2917	4253	
300 x 225	250	500	750	1000	1563	3177	4639	
325 x 244	271	542	813	1083	1693	3438	5026	
350 x 263	292	583	875	1167	1823	3698	5412	
375 x 281	313	625	938	1250	1953	3958	5799	
400 x 300	333	667	1000	1333	2083	4219	6186	
425 x 319	354	708	1063	1417	2214	4479	6572	
450 x 338	375	750	1125	1500	2344	4740	6959	
475 x 356	396	792	1188	1583	2474	5000	7345	
500 x 375	417	833	1250	1667	2604	5260	7732	
525 x 394	438	875	1313	1750	2734	5521	8119	
550 x 413	458	917	1375	1833	2865	5781	8505	
575 x 431	479	958	1438	1917	2995	6042	8892	
600 x 450	500	1000	1500	2000	3125	6302	9278	
625 x 469	521	1042	1563	2083	3255	6563	9665	
650 x 488	542	1083	1625	2167	3385	6823	10051	

Lens Extensions Table, Working Distances in Millimeters

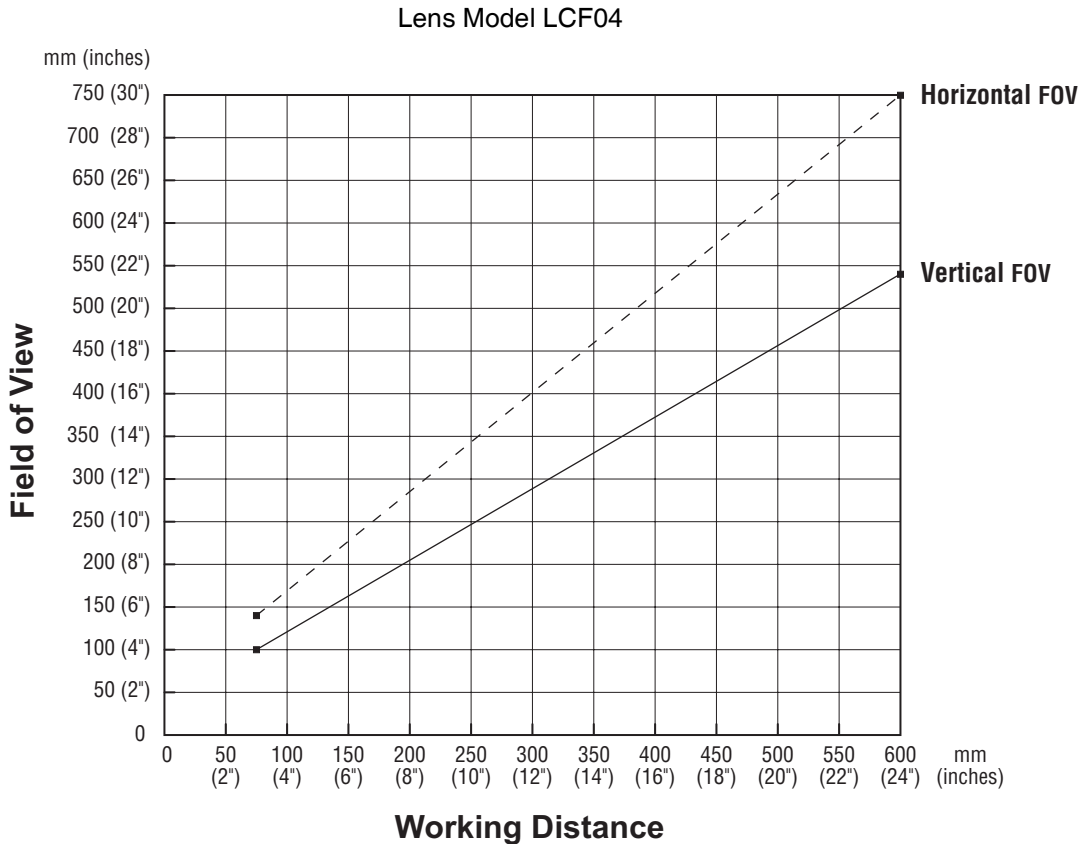
These extensions, in lengths of 0.5, 1.0, 5.0, 10, and 20 millimeters, may be combined to achieve a desired focal length. Extension lengths are in parenthesis.

FOV in Millimeters (horizontal x vertical)	Working Distances in Millimeters			
	4 mm Lens	25 mm Lens	50 mm Lens	75 mm Lens
5 x 4			104 (40)	115 (40)
10 x 8			156 (30)	230 (30)
15 x 11		78 (10)	208 (20)	285 (20)
20 x 15		104 (10)	260 (15)	370 (15)
25 x 19		130 (7)	313 (10)	425 (10)
30 x 23		156 (5)	365 (5)	510 (10)
35 x 26		182 (1)	417 (1)	595 (5)
40 x 30		208 (1)	469 (1)	640 (5)
45 x 34		234 (1)		
50 x 38		260 (1)		
60 x 45	50 (0.5)	313 (1)		
70 x 53	58 (0.5)	365 (1)		
80 x 60	67 (0.5)			
90 x 68	75 (0.5)			
100 x 75	83 (0.5)			
110 x 83	92 (0.5)			
120 x 90	100 (0.5)			
130 x 98	108			
140 x 105	117			
150 x 113	125			
160 x 120	133			
170 x 128	142			
180 x 135	150			
190 x 143	458			
200 x 150	167			
225 x 169	188			
250 x 188	208			
275 x 206	229			
300 x 225	250			
325 x 244	271			
350 x 263	292			
375 x 281	313			
400 x 300	333			
425 x 319	354			
450 x 338	375			
475 x 356	396			
500 x 375	417			
525 x 394	438			

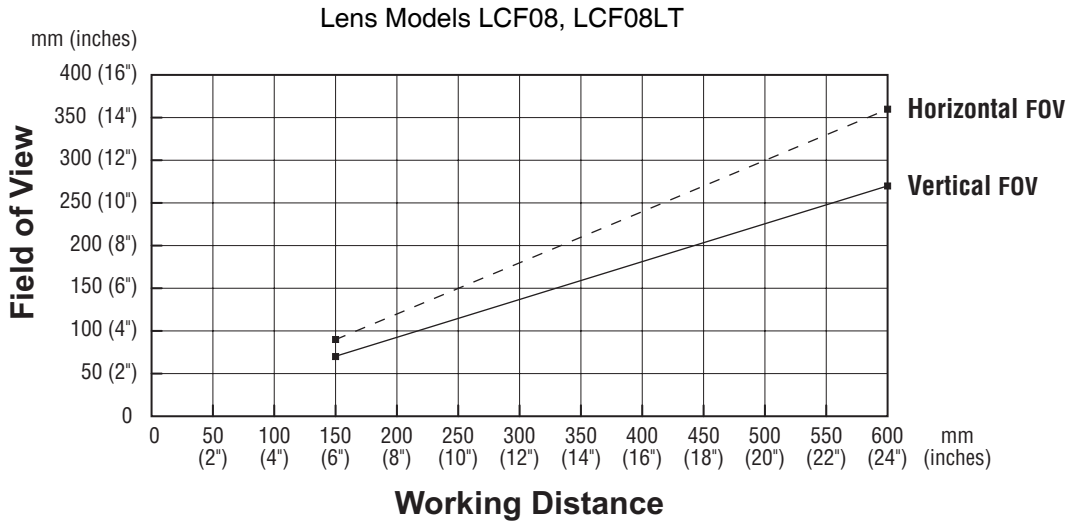
Working Distance vs. FOV Graphs

The graphs in this section provide a visual comparison of FOV as a function of working distance for lenses of the various focal lengths.

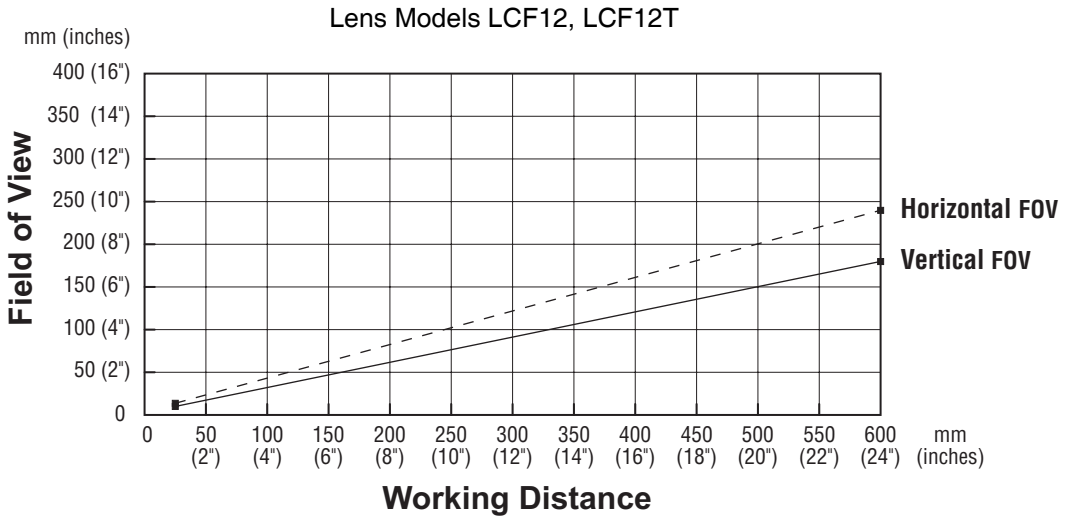
Note: Working distance and FOV must be known in order to use these graphs. See [Field of View](#) on page 1 and [Determining Working Distance](#) on page 3.



Working Distance vs. FOV, 4 mm Lens

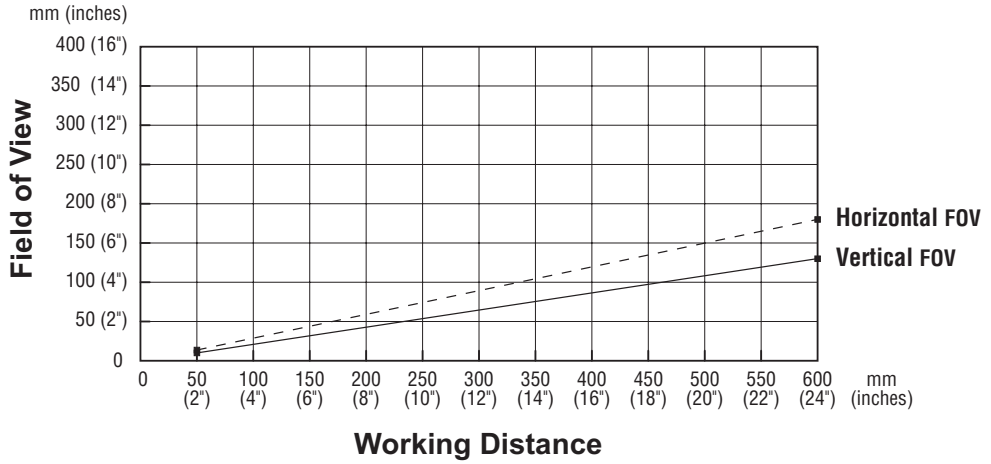


Working Distance vs. FOV, 8 mm Lens



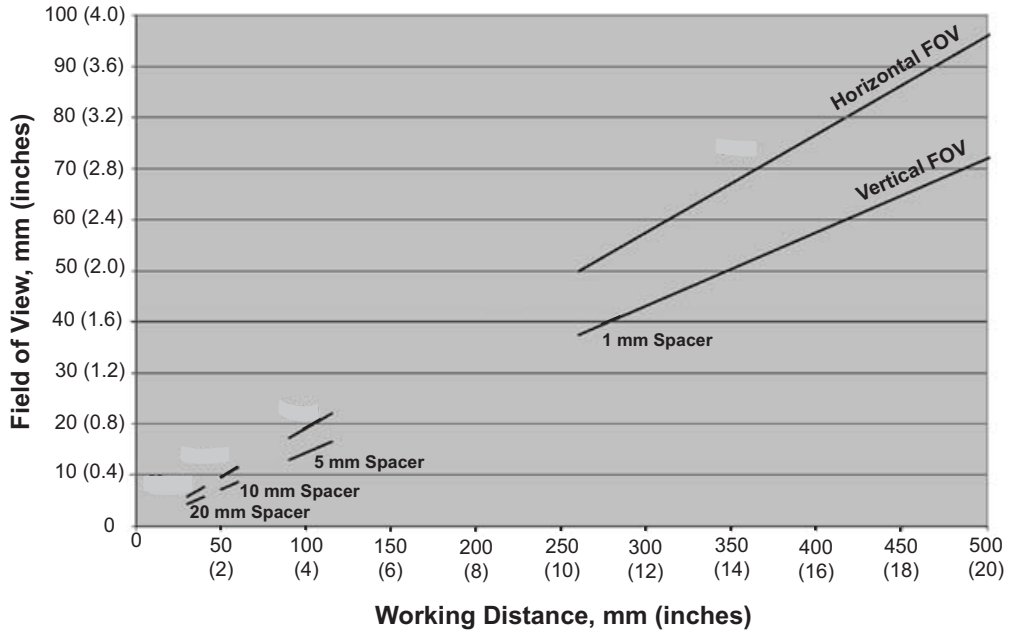
Working Distance vs. FOV, 12 mm Lens

Lens Models LCF16, LCF16LT



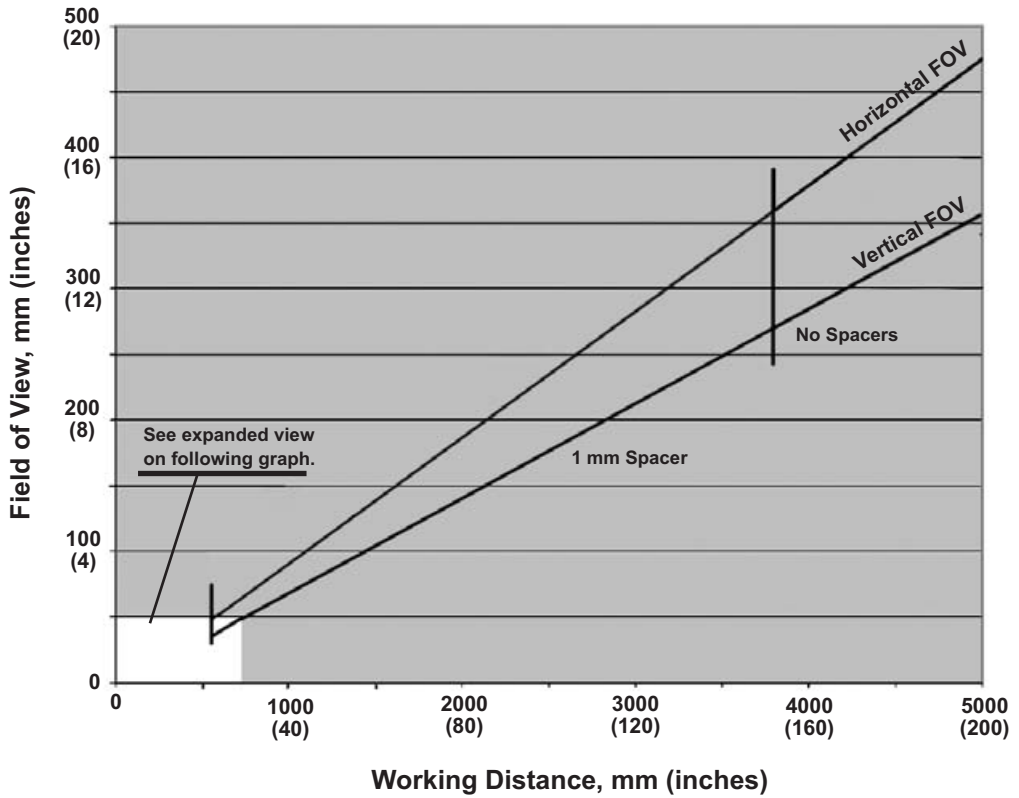
Working Distance vs. FOV, 16 mm Lens

Lens Models LCF25R, LCF25LR, LCF25LT



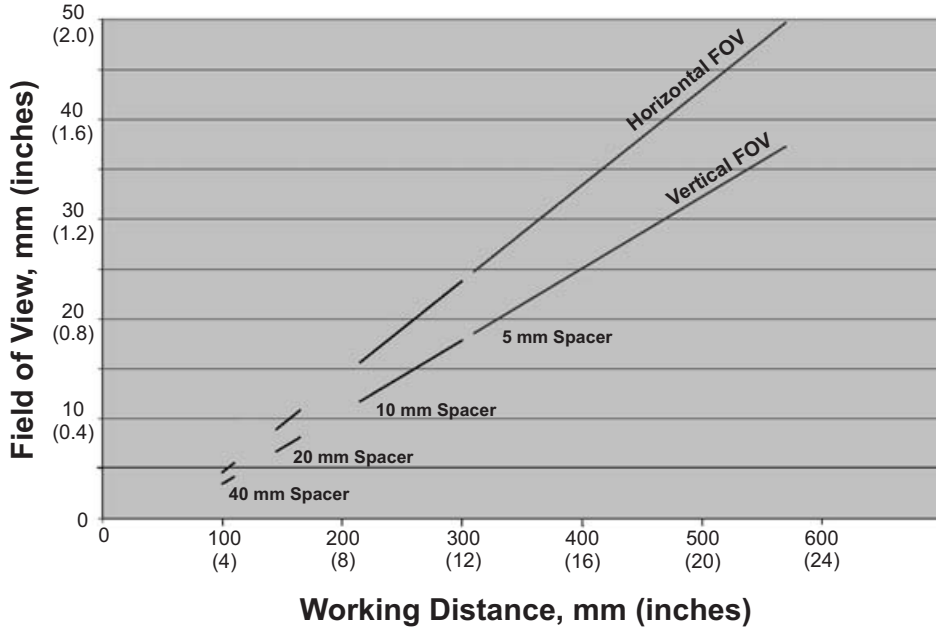
Working Distance vs. FOV, 25 mm Lens with Spacers

Lens Models LCF50L1R, LCF50L2R, LCF50LT



**Working Distance vs. FOV, 50 mm Lens with Spacers
(Showing Working Distance up to 5000 mm [200 inches])**

This graph is an expanded view of the points nearest the origin (0,0) in the previous graph.



**Working Distance vs. FOV, 50 mm Lens with Spacers
(Showing Working Distance up to 700 mm [28 inches])**

Focal Length Formula

NOTE: Working distance and FOV must be known in order to use this formula. See [Field of View](#) on page 1 and [Determining Working Distance](#) on page 3.

$$\text{Focal Length} = \frac{\text{Working Distance} \times \text{Camera Imager Width (Height)}}{\text{Horizontal (Vertical) FOV}}$$

PresencePLUS Pro Camera Imager Width = 4.8 mm.

PresencePLUS Pro Camera Imager Height = 3.6 mm.

For Vertical FOV, replace Camera Imager Width with Camera Imager Height.

Example:

What focal length is needed to view a 45-inch wide object from a distance of 200 inches?

$$\text{Focal Length} = \frac{200" \times 4.8 \text{ mm}}{45"} = 21.25 \text{ mm}$$

The best option is to use a 25 mm lens.

Lens Options Table

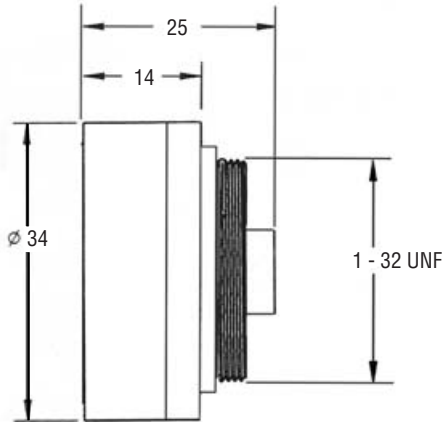
The table below lists available C-Mount lenses. Use the link listed under **Manufacturers Lens Specifications** for dimensions and aperture information where applicable.

Description	Model	P/N	Manufacturer's Lens Specifications
Standard C-Mount Lenses			
4 mm	LCF04	68884	See 4- to 16-mm Lens Specifications on page 18.
8 mm, focus locking	LCF08	57298	See 4- to 16-mm Lens Specifications on page 18.
12 mm, focus locking	LCF12	57299	See 4- to 16-mm Lens Specifications on page 18.
16 mm, focus locking	LCF16	56522	See 4- to 16-mm Lens Specifications on page 18.
25 mm, plastic	LCF25R	68885	http://www.isorainbow.com/pdf/lens_specs/g25_g25m_g50.pdf
25 mm, focus locking, iris locking, metal	LCF25LR	68886	http://www.isorainbow.com/specs/1_inch/g25.html
50 mm, focus locking, iris locking, plastic	LCF50L1R	68887	http://www.isorainbow.com/pdf/lens_specs/s50wi.pdf
50 mm, focus locking, iris locking, metal	LCF50L2R	68888	http://www.isorainbow.com/specs/1_inch/g50.html
75 mm, focus locking, iris locking, metal	LCF75LR	70545	http://www.isorainbow.com/specs/1_inch/g75.html
High-Performance C-Mount Lenses			
6.5 mm, focus locking	LCF06LT	70031	http://www.tamron.com/cctv/23fm65.htm#specs
8 mm, focus locking	LCF08LT	70032	http://www.tamron.com/cctv/23fm08l.htm#specs
12 mm, focus locking, iris locking	LCF12LT	70033	http://www.tamron.com/cctv/23fm12l.htm#specs
16 mm, focus locking	LCF16LT	70034	http://www.tamron.com/cctv/23fm16l.htm#specs
25 mm, focus locking	LCF25LT	70035	http://www.tamron.com/cctv/23fm25l.htm#specs
50 mm, focus locking	LCF50LT	70036	http://www.tamron.com/cctv/23fm50l.htm#specs
Lens Extension Kit			
Lens Extension Kit	LEK	69052	n/a

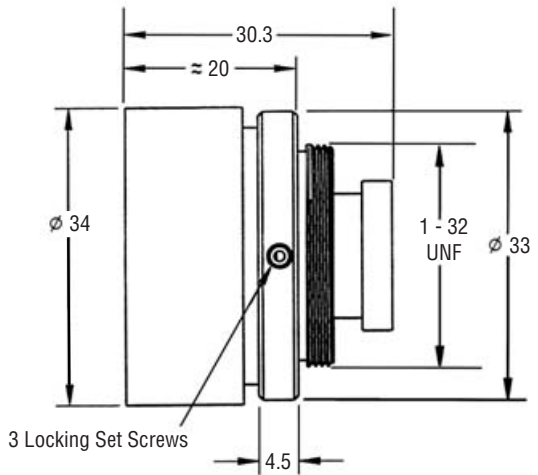
4- to 16-mm Lens Specifications

NOTE: All dimensions are in millimeters except thread diameter, which is 1 inch for all lenses.

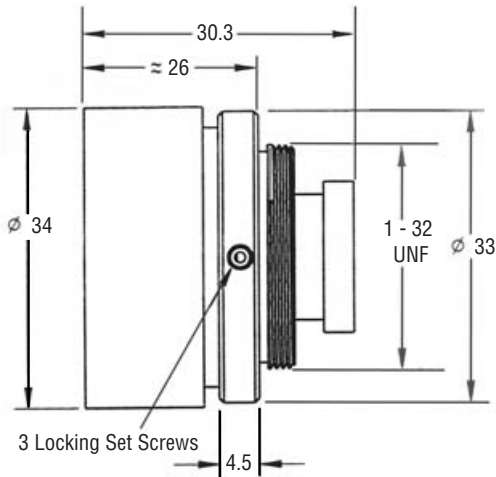
LCF04, 4 mm Lens



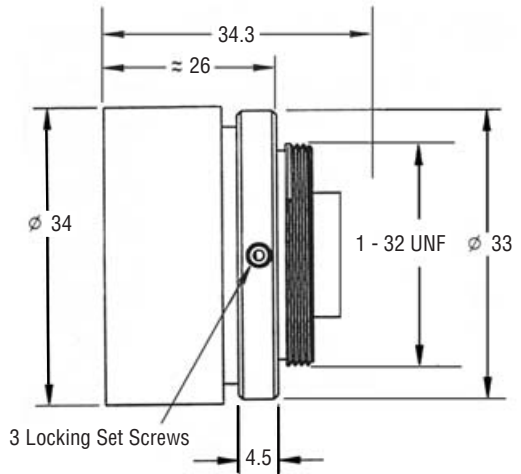
LCF08, 8 mm Lens



LCF12, 12 mm Lens



LCF16, 16 mm Lens



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more sensors, more solutions

WARRANTY: Banner Engineering Corp. warrants its products to be free from defects for one year. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture found to be defective at the time it is returned to the factory during the warranty period. This warranty does not cover damage or liability for the improper application of Banner products. This warranty is in lieu of any other warranty either expressed or implied.

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