56 Sparta Avenue • Newton, New Jersey 07860
(973) 300-3000 Sales • (973) 300-3600 Fax
www.thorlabs.com

THORLABS

CAMERA LENSES FOR MACHINE VISION

- **Lenses for 1/2", 2/3", 1", 4/3", and 35 mm Sensor Formats**
- **C-Mount (1.00"-32) Threaded or F-Mount Lenses**
- **Zoom or Fixed Focal Length Lenses**

MVL12M43
12 mm Fixed Focal Length,
4/3" Format, C-Mount

MVL16M1
16 mm Fixed Focal Length,
1" Format, C-Mount

MVL25TM23
25 mm Fixed Focal Length,
High Resolution (10 MP),
2/3" Format, C-Mount

Application Idea
MVL25M23 C-Mount Camera Lens
with 1500M-GE Scientific Camera

MVL25 - December 17, 2014

Item # MVL25 was discontinued on December 17, 2014. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

OVERVIEW

Features

- Lenses with Fixed Focal Lengths of 3.5 mm to 100 mm
- Zoom Lens with Focal Length Range of 18 mm to 108 mm
- Fast Lenses with Large Maximum Apertures up to f/0.95
- 1/2", 2/3", 1", 4/3", or 35 mm Lens Design Formats
- Manual Focus and Aperture Control
- Lenses with C-Mount (1.00"-32) Thread are Compatible with Most of Our CCD and CMOS Cameras
- F-Mount Compatible Lens for 35 mm Full Frame Cameras Available

Sensor Format	Compatible Cameras
1/3"[a]	DCU223M, DCU223C, DCC1645C[b], 340M-GE, 340UV-GE
1/2"	DCU224C, DCU224M, DCC1545M[b]
1/1.8"[a]	DCC1240C, DCC1240M, DCC3240M, DCC3240C, DCC3240N,
2/3"	1500M-CL, 1500M-CL-TE, 1500M-GE, 1500M-GE-TE
4/3"	4070M-GE, 4070M-GE-TE, 8050M-GE. 8050M-GE-TE

- While we do not offer lenses specifically designed for the 1/3" or 1/1.8" sensor formats, lenses on this page designed for a larger sensor format can be used with these cameras with a reduced field of view (see the *Camera Lens Tutorial* tab for details).
- These CS-Mount cameras are compatible with these lenses when using a CS- to C-Mount adapter (included with each camera).

The Camera Lenses sold here are specifically designed to be used with 1/2", 2/3", 1", 4/3", or 35 mm sensor format cameras and are well-suited for machine vision applications. Thorlabs offers lenses with fixed focal length (i.e., prime lenses) that offer superior optical performance at focal lengths from 3.5 mm to 100 mm, as well as a 2/3" format zoom lens with an adjustable focal length of 18 mm to 108 mm. Because of the simplified optical design, some of our prime lenses are designed as fast lenses with large maximum apertures up to f/0.95 (see the *Camera Lens Tutorial* tab for details). All lens models except item # MVL25 are equipped with lockable focus and aperture rings.

Selecting an appropriate camera and lens pair can significantly improve image quality. A lens should generally not be used with camera sensors that have a larger format than the lens. While these lenses can be used with a smaller format camera, the resultant image will be cropped (see *Camera Lens Tutorial* tab for details). See the table above for a list of sensor formats for Thorlabs cameras.

Lenses that are equipped with C-Mount (1.00"-32) threads are fully compatible with most of our C-Mount CCD and CMOS Cameras and our line of Scientific-Grade Cameras. CS-Mount cameras, such as the DCC1545M and DCC1645C, are compatible with these lenses when using a CS- to C-Mount adapter. An unanodized CS- to C-Mount adapter is included with each of these cameras and we also offer the black-anodized CML05 adapter.

Thorlabs offers a lens for 35 mm sensor formats that is compatible with Nikon F-Mount cameras. The SM2NFM F-Mount to SM2 Adapter allows F-Mount lenses to be used with SM2-threaded (2.035"-40) components.

CAMERA LENS TUTORIAL

Aperture

The aperture of the lens controls the amount of light that a lens can collect; the more light a lens collects, the brighter the image. Because of this, the aperture size affects the exposure time and therefore the speed of the camera. Thorlabs provides the maximum aperture size in the tables below for each lens in terms of the f-number, which is expressed using the symbol f/# (e.g., f/1.4). As the f-number increases, the aperture opening becomes smaller and less light is collected by the lens.

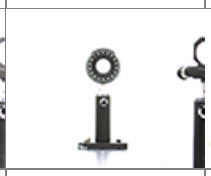
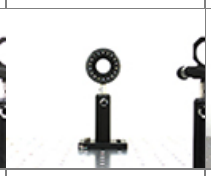
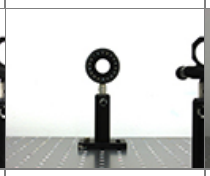
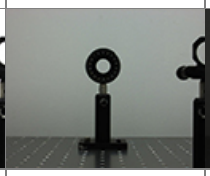
Specifically, f-number is defined as:

$$f/\# = \frac{f}{d}$$

where f/# is the f-number, f is the focal length and d is the entrance pupil diameter.

Camera lenses that can collect a lot of light (i.e., a low f-number) are known as fast lenses as they can be used with shorter exposure times and are ideal for low-light conditions. For example, a 50 mm focal length lens with a f/1.4 aperture has a bigger aperture and is therefore faster than a lens at the same focal length with a f/2.5 aperture. While using larger apertures increases light collection, doing so reduces the axial in-focus region of the image, known as the depth of field. To illustrate the effect of different aperture sizes visually, the table below shows a sequence of images taken with the same lens (MVL12M43 on a DCU224C 1/2" format camera) for increasing f-numbers. Because the images were taken at constant exposure, for each f/# increase (by a factor of ~1.4) the amount of light

collected by the lens is reduced by half.

Aperture Size Effects (Click Photos to Enlarge)						
f/2	f/2.8	f/4	f/5.6	f/8	f/11	f/22
						
Click for Raw Image	Click for Raw Image	Click for Raw Image	Click for Raw Image	Click for Raw Image	Click for Raw Image	Click for Raw Image

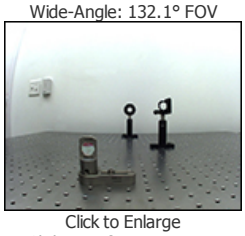
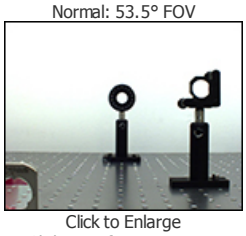
Focal Length

The focal length (FL) is roughly defined as the distance from principal plane to the focal plane. For a camera lens, the focal length determines the field of view of the camera system; the longer the focal length, the smaller the field of view. As a general guideline, a 50 mm focal length lens and 35 mm format camera combination produces roughly the same field of view as the human eye (~53° diagonal). The table below lists the focal lengths needed to achieve the same field of view as the human eye for different sensor formats.

There are three general classifications for lenses related to the image field of view. A lens with a focal length close to the diagonal length of the sensor format produces an image with a near-human field of view and is considered a normal lens for that sensor format. A wide-angle lens has a focal length shorter than normal, which produces a wider field of view but has a tendency to exhibit barrel distortion effects towards the edge of the image. Finally, a lens with a focal length longer than normal is known as a telephoto lens, which has a smaller field of view and a greater magnification of objects in the image.

To illustrate this, the sequence of three images to the right were taken with the same camera with three different lenses. As focal length of the lens increases, magnification of the objects in the photos increases while the field of view decreases. The items in the image are each roughly spaced in 10" (254 mm) increments in the following order: Polaris™ Fixed Monolithic Mirror Mount (10" from camera), Ø1/2" post with KM100 mirror mount (20" from camera), and post-mounted RSP1 rotation mount (30" from camera). The MVL4WA used to shoot the first image is a wide angle lens which clearly distorts the door frame on the left edge of the image.

DCU224C 1/2" Format CCD Camera

MVL4WA - 3.5 mm FL Wide-Angle: 132.1° FOV	MVL8M1 - 8 mm FL Normal: 53.5° FOV	MVL25M23 - 25 mm FL Telephoto: 17.5° FOV
		
Click to Enlarge Click Here for Raw Image (1280 x 1024)	Click to Enlarge Click Here for Raw Image (1280 x 1024)	Click to Enlarge Click Here for Raw Image (1280 x 1024)

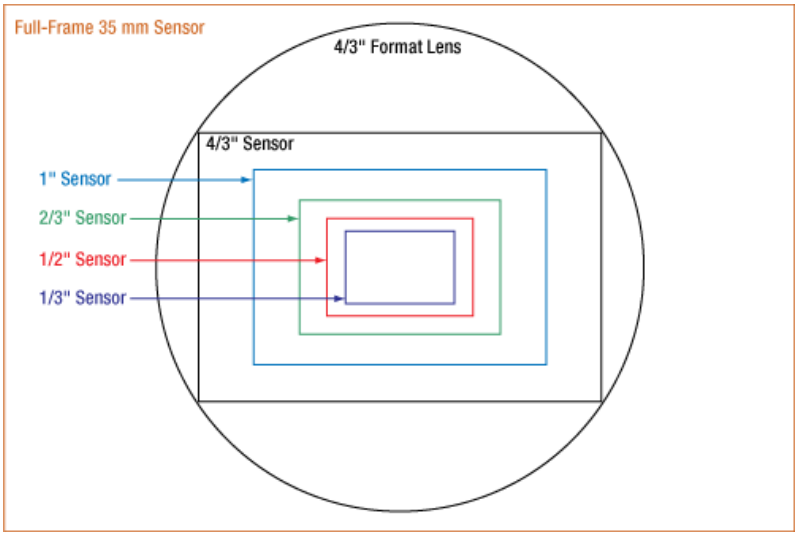
Sensor/Lens Combinations for Human Eye Field of View	
Sensor Format	**Lens Focal Length**
1/3" (6 mm Diagonal)	6.9 mm
1/2" (8 mm Diagonal)	9.2 mm
1/1.8" (9 mm Diagonal)	10.4 mm
2/3" (11 mm Diagonal)	12.7 mm
1" (16 mm Diagonal)	18.5 mm
4/3" (23 mm Diagonal)	26.6 mm

Combining Different Camera Sensor and Lens Formats

Modern cameras that use CCD or CMOS sensors are specified for a camera sensor format, and similarly, lenses are designed to provide optimal imaging for a specific camera format. This format designation (e.g., 1/2", 2/3", 4/3") is a hold-over convention from when video was recorded using cathode-ray tubes and refers to the outer diameter of the video tube required for a given image size. The diagram to the right illustrates the size difference between several standard camera formats. In the ideal imaging system, a camera and lens would be designed for the same format, however, it is also possible to use camera/lens combinations with different formats. Doing this will have an effect, either vignetting or cropping, on the resulting image.

Vignetting

Vignetting occurs when the lens format is smaller than the camera format. When this occurs, the area of the sensor is incompletely exposed, causing a dark ring to appear around the borders of the image. The vignetting effect is illustrated in the two images below, which were both captured using the same 4/3" format camera. In the image to the left, using a 12 mm focal length, 4/3" format lens produces a full image with slight dimming around the edges. This minor example of vignetting is due to the lens design which has decreased transmission at the edge of the lens. On the other hand, a 2/3" format lens at the same focal length produces a prominent dark ring around the photo edge. As the latter example is very visually apparent, we do not recommend using lenses with smaller formats than the camera sensor for imaging.

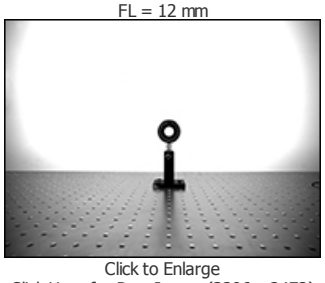


Crop Factors for Different Sensor/Lens Combinations[a]						
Sensor Format	**Lens Design Format**					
	1/3"	**1/2"**	**1/1.8"**	**2/3"**	**1"**	**4/3"**
1/3" (6 mm Diagonal)	1	1.33	1.50	1.83	2.67	3.83
1/2" (8 mm Diagonal)	-	1	1.13	1.38	2.00	2.88
1/1.8" (9 mm Diagonal)	-	-	1	1.22	1.78	2.56
2/3" (11 mm Diagonal)	-	-	-	1	1.45	2.09
1" (16 mm Diagonal)	-	-	-	-	1	1.44
4/3" (23 mm Diagonal)	-	-	-	-	-	1

- Larger crop factors correspond to more overfilling of the camera sensor. For details, see the text.

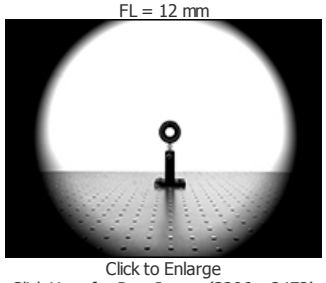
Vignetting: 8050M-GE 4/3" Format Camera

MVL12M43 4/3" Format Lens
FL = 12 mm



Click to Enlarge
Click Here for Raw Image (3296 x 2472)

MVL12M23 2/3" Format Lens
FL = 12 mm



Click to Enlarge
Click Here for Raw Image (3296 x 2472)

Cropping

When the lens format is larger than the camera format, the effect on the resultant image is known as cropping. In this case, a full image is produced but at a smaller size (i.e. cropped) because the sensor is only capturing a fraction of the complete image. A crop factor or focal length multiplier quantifies the amount of cropping and is defined as the ratio of the diagonal length of the lens' design format divided by the diagonal length of the sensor format. The crop factor for all possible 1/3", 1/2", 1/1.8", 2/3", 1", and 4/3" format lens/sensor combinations are shown in the table to the right.

An image that is cropped appears as if it was taken with a lens of higher focal length (i.e. a smaller field of view), but does not magnify the image. The cropping effect can be quantified using an adjusted focal length (defined as the crop factor multiplied by the lens focal length). For example, an image taken using a 1" format, 50 mm focal

Adjusted Focal Length (AFL) for Various Sensor Formats[a]						
Item #	**1/3"**	**1/2"**	**1/1.8"**	**2/3"**	**1"**	**4/3"**
MVL4WA	4.6 mm	3.5 mm	-	-	-	-
MVL5WA	5.9 mm	4.5 mm	-	-	-	-
MVL5M23	9.2 mm	6.9 mm	6.1 mm	5 mm	-	-
MVL6WA	7.8 mm	6 mm	-	-	-	-
MVL8M23	14.6 mm	11 mm	9.8 mm	8 mm	-	-
MVL8L	14.6 mm	11 mm	9.8 mm	8 mm	-	-
MVL8M1	21.4 mm	16 mm	14.2 mm	11.6 mm	8 mm	-
MVL12WA	15.6 mm	12 mm	-	-	-	-
MVL12M23	22 mm	16.5 mm	14.6 mm	12 mm	-	-
MVL12L	22 mm	16.5 mm	14.6 mm	12 mm	-	-
MVL12M1	32 mm	24 mm	21.4 mm	17.4 mm	12 mm	-
MVL12M43	46 mm	34.6 mm	30.7 mm	25.1 mm	17.3 mm	12 mm
MVL16M23	29.3 mm	22 mm	19.5 mm	16 mm	-	-

length lens with a 1/2" format sensor will produce an image with an adjusted focal length of 100 mm. While the field of view is reduced as if using a 100 mm lens, objects in the image will remain at the same size. The table to the right lists all of the lenses offered on this page with the adjusted focal length for different sensor formats.

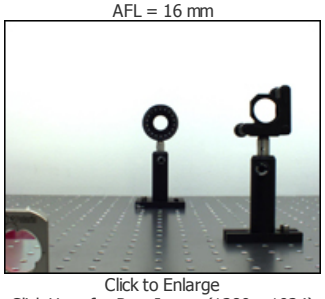
The images below illustrate this effect visually using two images taken using the same lens with 1/2" and 1/3" format cameras. The image taken using the smaller 1/3" format camera produces an image that is cropped compared to the image taken using the 1/2" format camera. Note, however, that the objects in both images remain at the same magnification.

MVL16L	29.3 mm	22 mm	19.5 mm	16 mm	-	-
MVL16M1	42.7 mm	32 mm	28.5 mm	23.2 mm	16 mm	-
MVL17HS	45.4 mm	34 mm	30.3 mm	24.7 mm	17 mm	-
MVL25M23	45.8 mm	34.4 mm	30.5 mm	25 mm	-	-
MVL25	45.8 mm	34.4 mm	30.5 mm	25 mm	-	-
MVL25HS	66.8 mm	50 mm	44.5 mm	36.3 mm	25 mm	-
MVL25M1	66.8 mm	50 mm	44.5 mm	36.3 mm	25 mm	-
MVL25M43	95.8 mm	72 mm	64 mm	52.3 mm	36 mm	25 mm
MVL35M23	64.1 mm	48.1 mm	42.7 mm	35 mm	-	-
MVL35M1	93.5 mm	70 mm	62.3 mm	50.8 mm	35 mm	-
MVL50M23	91.5 mm	68.8 mm	61 mm	50 mm	-	-
MVL50HS	133.5 mm	100 mm	89 mm	72.5 mm	50 mm	-
MVL50M1	133.5 mm	100 mm	89 mm	72.5 mm	50 mm	-
MVL75L	137.3 mm	103.1 mm	91.5 mm	75 mm	-	-
MVL75M23	137.3 mm	103.1 mm	91.5 mm	75 mm	-	-
MVL75M1	200.3 mm	150 mm	133.5 mm	108.8 mm	75 mm	-
MVL100M23	183 mm	138 mm	122 mm	100 mm	-	-

- The native format focal length of each lens is highlighted in green. See text to the left for an explanation of adjusted focal lengths.

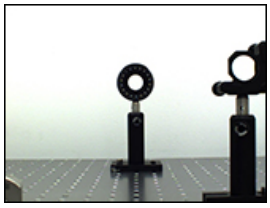
Cropping: MVL8M1 8 mm FL, 1" Format Lens

DCU224C Camera: 1/2" Sensor Format
AFL = 16 mm



Click to Enlarge
Click Here for Raw Image (1280 x 1024)

DCU223C Camera: 1/3" Sensor Format
AFL = 21.4 mm



Click to Enlarge
Click Here for Raw Image (1024 x 768)

25 - 28 mm Fixed Focal Length

The native format specifications of each lens are highlighted in green.

Photo (Click to Enlarge)							
Item #	MVL25M23	MVL25TM23	MVL25	MVL25HS	MVL25M1	MVL25M43	MVL28LF[a]
Focal Length	25 mm	25 mm	25 mm	25 mm	25 mm	25 mm	28 mm
Aperture (Max)	f/1.4	f/1.8	f/1.6	f/0.95	f/1.4	f/2.0	f/2.8
Min Object Distance	200 mm (7.9")	100 mm (3.9")	210 mm (8.3")	500 mm (19.7")	300 mm (11.8")	150 mm (5.9")	300 mm (11.8")
Design Format[b]	2/3"	2/3"	2/3"	1"	1"	4/3"	35 mm
10 MP Compatible (Click for MTF Plot)	No	Yes[c]	No	No	No	No	No
Field of View (35 mm)[d]	N/A	N/A	N/A	N/A	N/A	N/A	78.8°
Field of View (4/3")[d]	N/A	N/A	N/A	N/A	N/A	49.4°	42.2°
Field of View (1")[d]	N/A	N/A	N/A	35.5°	36.6°	35.5°	-
Field of View (2/3")[d]	24.3°	24.9°	24.8°	24.8°	25.2°	24.8°	-
Field of View (1/1.8")[d]	19.6°	20.5°	20.4°	20.4°	20.5°	20.4°	-
Field of View (1/2")[d]	17.5°	18.2°	18.2°	18.2°	18.3°	18.2°	-
Field of View (1/3")[d]	13.2°	13.7°	13.7°	13.7°	13.8°	13.7°	-
Filter Threading	M27 x 0.5	M25.5 x 0.5	M25.5 x 0.5	M40.5 x 0.5	M35.5 x 0.5	M40.5 x 0.5	M72 x 0.75
Camera Threading	C-Mount (1.00"-32)						F-Mount[e]

a. Photo of the MVL28LF is not to scale.
b. These lenses can be used with smaller format camera sensors; however, this will result in a reduced field of view. Please see the *Camera Lens Tutorial* tab for details.
c. Raw Data for this plot is available in the *10 MP Lens Data* tab above.
d. The field of view is specified for the diagonal.
e. This lens is compatible with F-Mount cameras. For compatibility with SM2-threaded (2.035"-40) components, please use our SM2NFM F-Mount Adapter Ring.

Based on your currency / country selection, your order will ship from Newton, New Jersey

+1	Qty	Docs	Part Number - Universal/Imperial		Price	Available / Ships
+1			**MVL25M23**	25 mm EFL, f/1.4, for 2/3" C-Mount Format Cameras, with Lock	$192.00	√ Today
+1			**MVL25TM23**	NEW! 25 mm EFL, f/1.8, for 2/3" C-Mount Format Cameras, with Lock, 10 Megapixels	$872.00	√ Today
+1			**MVL25**	25 mm EFL, f/1.6, for 2/3" C-Mount Format Cameras, without Lock	$207.10	Lead Time
+1			**MVL25HS**	25 mm EFL, f/0.95, for 1" C-Mount Format Cameras, with Lock	$852.00	√ Today
+1			**MVL25M1**	25 mm EFL, f/1.4, for 1" C-Mount Format Cameras, with Lock	$412.00	√ Today
+1			**MVL25M43**	NEW! 25 mm EFL, f/2.0, for 4/3" C-Mount Format Cameras, with Lock	$1,250.00	√ Today
+1			**MVL28LF**	NEW! 28 mm EFL, f/2.8, for 35 mm F-Mount Cameras, with Lock	$1,350.00	√ Today

Add To Cart