

# Low Mag Video Lenses



- Video lenses for machine vision inspection.
- Macro zoom lenses for close-up inspection.
- Up to 2K sensor coverage.
- Megapixel lenses.
- Telecentric lenses.
- Motorized lenses.
- Fujinon lenses.
- SWIR lenses.

# Low Mag Video Lenses



## All Video Lenses are Not Created Equal

Navitar and Fujinon video lenses are the benchmark against which all lenses should be measured. Quality construction, coupled with precision engineering, result in video optics that are sharp, high resolution and optically precise.

We offer a complete range of video lenses for every industrial application. Video lenses from Navitar are the ideal choice for applications ranging from PC board inspection to viewing glass bottles on a production line.

## Video Lens Selection

There are a growing number of video imaging applications in which a single, constant magnification factor and a fixed working

distance are required in order to maximize contrast and performance. Navitar has responded to this need with a wide range of fixed focal length lenses.

Determining the necessary parameters for video lens selection, including focal length, field of view and image sensor size, does not need not be an intimidating process. An understanding of some basic optical terms and relationships is all that's required.

The information on the following pages will help you select the lens that will work best for your application. If you require further assistance, please feel free to call Navitar and speak directly to one of our engineers.

## Understanding Focal Length and F/Number

Video lenses can be classified into three categories according to focal length: standard, wide angle and telephoto. Focal length is the distance between the camera sensor and the center of the lens. The greater the focal length, the larger the image will appear. Therefore, the greater the focal length, the more the lens becomes telephoto in application.

### Standard Lens

A standard lens doesn't change the size of the object being viewed.

### Wide Angle Lens

A wide angle lens provides a wider field of view and therefore a smaller image of the object being viewed than a standard lens.

### Telephoto Lens

A telephoto lens produces a larger image of a distant object. The longer the focal length, the larger the object will appear.

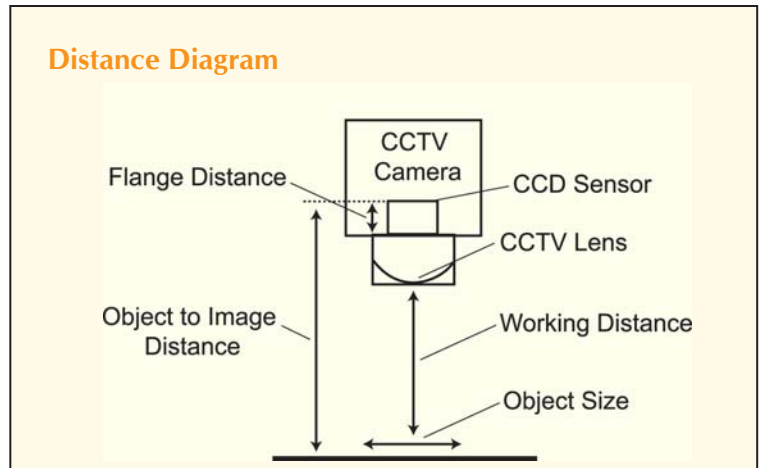
The *f*/number is an indication of the brightness of the lens. It is the measurement of the ratio between the focal length and the diameter of the entrance pupil (where the light enters the lens). The *f*/number is directly proportional to the focal length and inversely proportional to the effective diameter of the lens. It determines the amount of light reaching the camera sensor. The smaller the value, the larger the opening and the brighter the image produced by the lens.



## How to Determine the Lens Focal Length Required

To choose the proper lens for a particular application, the following factors must be considered:

- Field of View - The size of the area to be imaged.
- Working Distance (WD) - Distance from the camera lens to the object or area under surveillance.
- CCD - The size of the camera's image sensor device.
- You must be consistent. If you are measuring the width of your object, then use the horizontal CCD specifications, etc. If you are working in inches, then do your calculations in inches and convert to millimeters at the end.



$$FL = \frac{CCD \times WD}{FOV}$$

Consider this example: You have a 1/3" C-mount CCD camera (4.8 mm horizontal). There is a 12" (305 mm) distance between the object and the front of the lens. The field of view, or object size, is 2.5" (64 mm). The conversion factor is 1" = 25.4 mm (round up).

### Calculation in mm:

$$FL = 4.8 \text{ mm} \times 305 \text{ mm} / 64 \text{ mm}$$

$$FL = 1464 \text{ mm} / 64 \text{ mm}$$

$$FL = 23 \text{ mm Lens Required}$$

### Calculation in inches:

$$FL = 0.19" \times 12" / 2.5"$$

$$FL = 2.28" / 2.5"$$

$$FL = 0.912" \times 25.4 \text{ mm/inch}$$

$$FL = 23 \text{ mm Lens Required}$$

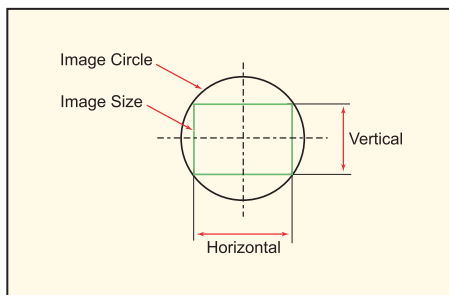
Please do not confuse working distance with object to image distance. Working distance is measured from the front of the lens to the object being viewed. Object to image distance is measured from the CCD sensor to the object. To calculate the lens focal length required, you must use working distance.

# Optical Characteristics of Video Lenses

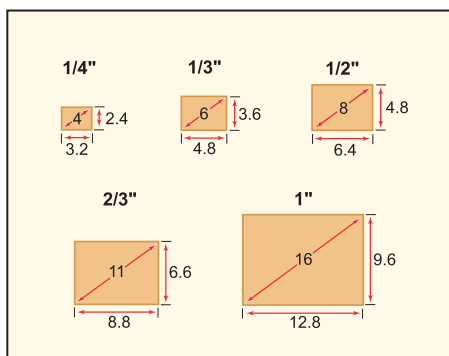
## Image Size Chart

Image Sensor	Image Circle	Horizontal	Vertical
1/4"	Ø4.0 mm	3.2 mm	2.4 mm
1/3"	Ø6.0 mm	4.8 mm	3.6 mm
1/2"	Ø8.0 mm	6.4 mm	4.8 mm
2/3"	Ø11.0 mm	8.8 mm	6.6 mm
1"	Ø16.0 mm	12.8 mm	9.6 mm

## Image Size



## Image Sensor Size (units in mm)



## Camera to Monitor Magnification

Camera Format	Monitor Size (diagonal)					
	9"	14"	15"	18"	20"	27"
1/4"	57.2X	88.9X	95.3X	114.3X	127X	171.5X
1/3"	38.1X	59.2X	63.5X	76.2X	84.6X	114.1X
1/2"	28.6X	44.5X	47.6X	57.2X	63.5X	85.7X
2/3"	20.8X	32.3X	34.6X	41.6X	46.2X	62.3X
1"	14.3X	22.2X	23.8X	28.6X	31.8X	42.9X

## Image Size

A lens produces images in the form of a circle, called the image circle. In a video camera, the imaging element has a rectangular sensor area (the image size) that detects the image produced within the image circle. The ratio of the length of the horizontal to vertical sides of a video image is called the aspect ratio, which is normally 4:3 (H:V) for a standard video camera.

## Relationship Between Angle of View and Image Sensor Size

An important factor to remember is that cameras with different image sensor chip sizes (such as 1/4", 1/3", 1/2", 2/3" and 1"), using the same focal length lens, will each yield a different field of view.

Lenses designed for a larger image sensor device will work on a new, smaller size camera. However, if a lens designed for a smaller format image sensor device (i.e. 1/3") is placed on a larger one (i.e. 2/3"), the image on the monitor will have dark corners.

Image sensor sizes are in a ratio of 1:0.69:0.5:0.38:0.25. This means that a 1/2" format is 50% of a 1" format, a 1/2" format is 75% of a 2/3" format and a 1/3" format is 75% of a 1/2" format.

## Minimum Object Distance

Minimum object distance (M.O.D.) indicates how close the lens can be placed to the object for shooting. It is measured from the vertex of the front glass of the lens.

### Flange Distance

Distance between mechanical mount surface and the image sensor (in air).

C-Mount = 17.526 mm / .690"  
 CS-Mount = 12.526 mm / .493"

### Back Focal Length

Distance between vertex of the rear element lens and image sensor.

### C-Mount and CS-Mount Lens Compatibility

When using a C-mount lens for a CS-mount camera, a C/CS-mount adapter (5 mm thick) is required between the lens and the camera.

### Angle of View and Field of View

The angle of view is the shooting range that can be viewed by the lens given a specified image size. It is usually expressed in degrees. Normally the angle of view is measured assuming a lens is focused at infinity. The angle of view can be calculated if the focal length and image size are known. If the distance of the object is finite, the angle is not used. Instead, the dimension of the range that can actually be shot, or the field of view, is used.

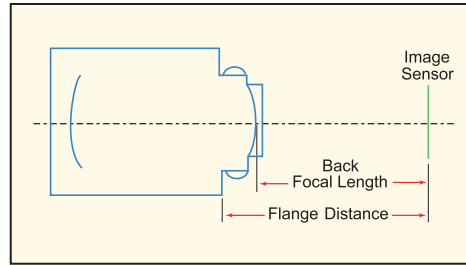
### Focal Length

Parallel incident light transmitted into a convex lens converges to a point on the optical axis. This point is the focal point of the lens. The distance between the principle point in the optical system and the focal point is referred to as the focal length. For a single thin lens, the focal length is equal to the distance between the center of the lens and the focal point.

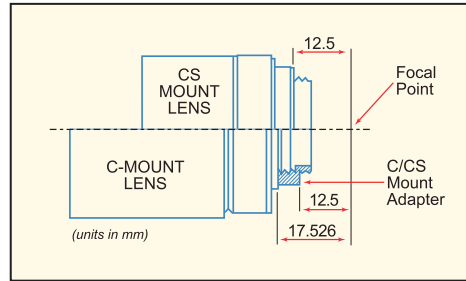
### Zoom Ratio

Zoom ratio is the ratio of the focal length at the telephoto end to that at the wide end. A zoom lens can change the size of an object appearing on the monitor to the extent specified by the zoom ratio.

### Flange Distance and Back Focal Length



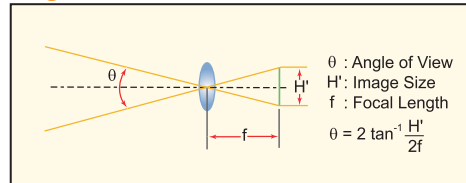
### C-Mount and CS-Mount Lenses



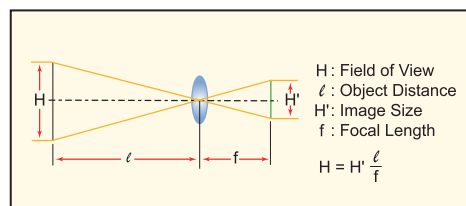
### C-Mount and CS-Mount Lens/ Camera Compatibility

Compatibility	C-Mount Camera	CS-Mount Camera
<b>C-Mount Lens</b>	OK	OK (w/ adapter)
<b>CS-Mount Lens</b>	NO	OK

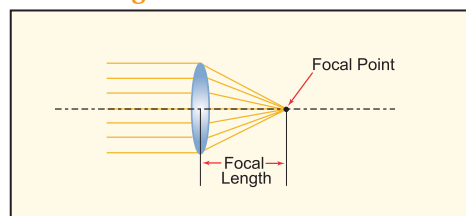
### Angle of View



### Field of View



### Focal Length



# General Lens Formulas

### Focal Length

$$FL = CCD \times WD/FOV$$

### Magnification

$$m = \text{Image Size}/\text{Object Size}$$

### Object to Image Distance

$$OI = [FL \times (1 + m)^2] / m$$

$$OI = m(FL) + (FL + VOA + BF) + FL/m$$

$$VOA = \text{Vertex to Vertex Lens Length}$$

### Object to Lens Distance

$$OL = FL + FL(m)$$

### Lens to Image Distance

$$LI = FL + FL/m$$

(Approximate distance to the nodal points:  $FL + FL(m)$  to the front vertex.)

$$F/\# = 1/(2NA)$$

$$F/\# = FL / \text{Entrance Pupil Diameter}$$

$$NA = 1/2 F/\#$$

$$NA = \sin \theta/2$$

### Effective F/#

$$\text{Eff. } F/\# = F/\# (m + 1)$$

### Clear Aperture (Minimum)

$$\text{Aperture} = FL/(F/\#)$$

### Depth of Focus

$$\text{DoF} = 0.00002/NA^2 \text{ (in inches)}$$

$$\text{DoF} = 0.0005/NA^2 \text{ (in mm)}$$

### Conversion Factors

$$1 \text{ Inch} = 25.4 \text{ Millimeters}$$

$$1 \text{ Meter} = 39.37 \text{ Inches}$$

$$1 \text{ Micron} = 0.001 \text{ Millimeter}$$

$$1 \text{ Degree} = \pi/180 \text{ Radians}$$

$$1 \text{ Degree} = 0.0174533 \text{ Radians}$$

$$1 \text{ Micron } (\mu) = 1,000 \text{ Nanometers (nm)}$$

$$1 \text{ Micron } (\mu) = 10,000 \text{ Angstroms } (\text{\AA})$$

# Navitar Machine Vision Lenses

## 1" Format Lenses

Megapixel Fixed Focal Length Lenses							
Model	NMV-8M1	NMV-12M1	NMV-16M1	NMV-25M1	NMV-35M1	NMV-50M1	NMV-75M1
<b>Focal Length (mm)</b>	8	12	16	25	35	50	75
<b>Iris Range/F-Stop</b>	1.4-16	1.4-16	1.4-16	1.4-16	1.4-16	1.4-16	1.8-16
<b>Control</b>	<b>Iris</b>	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ screw locks
	<b>Focus</b>	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws
	<b>Zoom</b>	—	—	—	—	—	—
<b>Object Area</b>	1"	196 x 143	331 x 244	252 x 186	161 x 120	110 x 82	122 x 91
	2/3"	130 x 96	223 x 165	170 x 127	109 x 82	75 x 56	84 x 63
	1/2"	93 x 69	160 x 119	123 x 92	79 x 59	54 x 41	61 x 46
	1/3"	70 x 52	120 x 89	92 x 69	59 x 44	40 x 31	46 x 34
	1/4"	47 x 35	80 x 59	62 x 46	39 x 29	27 x 20	30 x 23
<b>Focusing Range (meters)</b>	0.1 - ∞	0.3 - ∞	0.3 - ∞	0.3 - ∞	0.3 - ∞	0.5 - ∞	0.5 - ∞
<b>Filter Diameter</b>	Ø55 P=0.75	Ø27 P=0.50	Ø35.5 P=0.50	Ø35.5 P=0.50	Ø35.5 P=0.50	Ø40.5 P=0.50	Ø46 P=0.75
<b>Mount</b>	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount
<b>Weight (grams)</b>	200	150	140	125	130	200	180

Model	Fixed Focal Length		High Speed			Zoom
	DO-2514	DO-5018	DO-1795	DO-2595	DO-5095	DOZ-10X16
<b>Focal Length (mm)</b>	25	50	17	25.0	50	16 -160
<b>Iris Range/F-Stop</b>	1.4 - Close	1.8 - Close	0.95 - Close	0.95 - Close	0.95 - 16	2.0 - Close
<b>Control</b>	<b>Iris</b>	Manual	Manual	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws
	<b>Focus</b>	Manual	Manual	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws
	<b>Zoom</b>	—	—	—	—	—
<b>Object Area</b>	1"	241 x 180	255 x 190	363 x 272	243 x 182	140 x 105
	2/3"	165 x 123	174 x 130	250 x 187	167 x 125	97 x 72
	1/2"	120 x 90	126 x 71	182 x 136	121 x 91	70 x 53
	1/3"	90 x 67	95 x 71	136 x 102	91 x 68	53 x 40
	1/4"	60 x 45	63 x 47	91 x 68	60 x 45	35 x 26
<b>Focusing Range (meters)</b>	0.5 - ∞	1.0 - ∞	0.5 - ∞	0.5 - ∞	0.6 - ∞	1.5 - ∞
<b>Filter Diameter</b>	Ø43 P=0.75	Ø40.5 P=0.50	Ø40.5 P=0.50	Ø40.5 P=0.50	Ø62 P=0.75	Ø67 P=0.75
<b>Mount</b>	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount
<b>Weight (grams)</b>	81	145	170	140	490	829



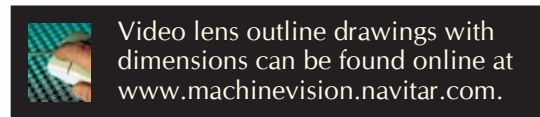
*Locking screws on focus and/or iris available on most lenses.*

# Navitar Machine Vision Lenses

## 2/3" Format Lenses

		Megapixel Fixed Focal Length Lenses						
Model		NMV-5M23	NMV-8M23	NMV-12M23	NMV-16M23	NMV-25M23	NMV-35M23	NMV-50M23
<b>Focal Length (mm)</b>		5	8	12	16	25	35	50
<b>Iris Range/F-Stop</b>		2.8 x 16	1.4 - close	1.4 - close	1.4 - 16	1.4 - 16	2.0 -16	2.8 - 22
<b>Control</b>	<b>Iris</b>	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws
	<b>Focus</b>	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws
	<b>Zoom</b>	—	—	—	—	—	—	—
<b>Object Area</b>	<b>1"</b>	—	—	—	—	—	—	—
	<b>2/3"</b>	196.8 x 147.6	117.3 x 88	110 x 82.5	112.8 x 84.4	71.1 x 53.3	47.9 x 35.8	29.3 x 21.9
	<b>1/2"</b>	110 x 105	84 x 63	79 x 59	80 x 60	51 x 38	33 x 26	21 x 16
	<b>1/3"</b>	82 x 78	63 x 47	59 x 44	60 x 45	38 x 28	25 x 19	16 x 12
	<b>1/4"</b>	55 x 52	49 x 31	39 x 29	40 x 30	25 x 14	16 x 13	10 x 8
<b>Focusing Range (meters)</b>		0.05 - ∞	0.12 - ∞	0.15 - ∞	0.2 - ∞	0.2 - ∞	0.2 - ∞	0.2 - ∞
<b>Filter Diameter</b>		Ø40.5 P=0.50	—	Ø27 P=0.50	Ø25.5 P=0.50	Ø27.0 P=0.50	Ø27.0 P=0.50	Ø27.0 P=0.50
<b>Mount</b>		C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount
<b>Weight (grams)</b>		85	83	75	81	89	89	92

		Fixed Focal Length Lenses						
Model		NMV-6	NMV-8	NMV-12	NMV-16	NMV-25	NMV-35	NMV-50
<b>Focal Length (mm)</b>		6	8	12	16	25	35	50
<b>Iris Range/F-Stop</b>		1.4 - 16	1.4 - 16	1.4 - 16	1.4 - 16	1.6 - 16	1.6 - 16	2.0 - 22
<b>Control</b>	<b>Iris</b>	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws
	<b>Focus</b>	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws	Manual w/ lock screws
	<b>Zoom</b>	—	—	—	—	—	—	—
<b>Object Area</b>	<b>1"</b>	—	—	—	—	—	—	—
	<b>2/3"</b>	367 x 251	260 x 184	237 x 173	111.8 x 82.6	119 x 89	126.6 x 94.7	85 x 63.6
	<b>1/2"</b>	264 x 181	187 x 132	170 x 125	80 x 60	86 x 64	91 x 68	61 x 46
	<b>1/3"</b>	198 x 136	140 x 99	127 x 93	60 x 45	64 x 48	68 x 51	46 x 34
	<b>1/4"</b>	132 x 90	93 x 66	85 x 62	40 x 30	43 x 32	45 x 34	30 x 23
<b>Focusing Range (meters)</b>		0.1 - ∞	0.1 - ∞	0.1 - ∞	0.2 - ∞	0.2 - ∞	0.35 - ∞	0.5 - ∞
<b>Filter Diameter</b>			Ø27.0 P=0.50	Ø27.0 P=0.50	Ø27.0 P=0.50	Ø27.0 P=0.50	Ø30.5 P=0.50	Ø30.5 P=0.50
<b>Mount</b>		C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount
<b>Weight (grams)</b>		63	60	63	55	58	85	88



Video lens outline drawings with dimensions can be found online at [www.machinevision.navitar.com](http://www.machinevision.navitar.com).

# Navitar Machine Vision Lenses

## 2/3" Format Lenses

		Fixed Focal Length Lenses					
Model		NMV-75	NMV-100	NAV-1614	NAV-2514	NAV-3520	NAV-5028
Focal Length (mm)		75	100	16	25	35	50
Iris Range/F-Stop		2.5 - 22	2.8 - 32	1.4 - 16	1.4 - 16	2.0 - 22	2.8 - 22
Control	Iris	Manual w/lock screws	Manual w/lock screws	Manual w/lock screws	Manual w/lock screws	Manual w/lock screws	Manual w/lock screws
	Focus	Manual w/lock screws	Manual w/lock screws	Manual w/lock screws	Manual w/lock screws	Manual w/lock screws	Manual w/lock screws
	Zoom	—	—	—	—	—	—
Object Area	1"	—	—	—	—	—	—
	2/3"	50.8 x 38.1	36.8 x 27.6	119 x 89	72 x 54	46 x 34	66 x 50
	1/2"	37 x 27	27 x 20	87 x 65	52 x 39	33 x 25	48 x 36
	1/3"	28 x 20	20 x 15	65 x 49	39 x 29	25 x 19	36 x 27
	1/4"	18 x 13	13 x 10	43 x 32	26 x 19	17 x 13	24 x 18
Focusing Range (meters)		1.2 - ∞	2.0 - ∞	0.25 - ∞	0.25 - ∞	0.25 - ∞	0.5 - ∞
Filter Diameter		Ø34.0 P=0.50	Ø40.5 P=0.75	Ø25.5 P=0.75	Ø25.5 P=0.75	Ø25.5 P=0.75	Ø25.5 P=0.75
Mount		C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount
Weight (grams)		15	150	42	45	490	829

		Fixed Focal Length	Telecentric, Fixed Focal Length	Zoom	Macro Zoom	
Model		DO-1616CWO	TC-5028	DOZ-11110	Zoom 7000E	Zoom 7000 (MACRO)
Focal Length (mm)		16	50	11-110 (10x)	12.5 - 75 (6x) (Macro-Zoom)	18 - 108 (6x) (Close-up Focusing)
Iris Range/F-Stop		1.6	2.8 - Close	1.8 - Close	1.8 - Close	2.0 - Close
Control	Iris	Fixed	Manual	Manual	Manual	Manual
	Focus	Manual	Manual	Manual	Manual	Manual
	Zoom	—	—	Manual	Manual	Manual
Object Area	1"	—	—	—	—	—
	2/3"	170 x 126	8.1 x 6.1	Wide 995 x 736 Tele 100 x 75	Wide 504 x 378 Tele 83 x 64	Wide 252 x 195 Tele 43 x 33
	1/2"	122 x 91	5.9 x 4.4	Wide 713 x 531 Tele 73 x 55	Wide 367x 275 Tele 60 x 45	Wide 183 x 142 Tele 31 x 24
	1/3"	91 x 68	3.8 x 3.3	Wide 531 x 396 Tele 55 x 41	Wide 274 x 206 Tele 45 x 34	Wide 138 x 106 Tele 23 x 18
	1/4"	61 x 45	2.9 x 2.2	Wide 356 x 265 Tele 36 x 27	Wide 183 x 137 Tele 30 x 22	Wide 91 x 71 Tele 15 x 12
Focusing Range (meters)		0.3 - ∞	0.5 - ∞ *	1.3 - ∞	1.0 - ∞ (102 at Macro)	0.13 - ∞
Filter Diameter		Ø35.5 P=0.75	Ø37 P=0.75	Ø67 P=0.75	Ø49 P=0.75	Ø52 P=0.75
Mount		C-Mount	C-Mount	C-Mount	C-Mount	C-Mount
Weight (grams)		65	318	730	370	595



*Locking screws on focus and/or iris available on most lenses.*

# Navitar Machine Vision Lenses


## 1/2" Format Lenses

Model		Wide Angle Fixed Focal Length				Fixed Focal Length		Zoom
		NMV-4WA	NMV-5WA	NMV-6WA	NMV-12WA	NAV-614	DO-1212	DOZ-6X8.5
<b>Focal Length (mm)</b>		3.5	4.5	6	12	6	12.0	8.5 - 51
<b>Iris Range/F-Stop</b>		1.4 - 16	1.4 - 16	1.4 - 16	1.4 - 16	1.4 - 16	1.2 - Close	1.2 - Close
<b>Control</b>	<b>Iris</b>	Manual w/lock Screws	Manual w/lock Screws	Manual w/lock Screws	Manual w/lock Screws	Manual w/lock Screws	Manual	Manual
	<b>Focus</b>	Manual w/lock Screws	Manual w/lock Screws	Manual w/lock Screws	Manual w/lock Screws	Manual w/lock Screws	Manual	Manual
	<b>Zoom</b>	—	—	—	—	—	—	Manual
<b>Object Area</b>	<b>1"</b>	—	—	—	—	—	—	—
	<b>2/3"</b>	—	—	—	—	—	—	—
	<b>1/2"</b>	396 x 247	260 x 180	174 x 128	167 x 123	176 x 130	162 x 120	Wide 696 x 521 Tele 119 x 90
	<b>1/3"</b>	297 x 185	195 x 135	130 x 96	125 x 92	132 x 97	120 x 90	Wide 521 x 390 Tele 90 x 68
	<b>1/4"</b>	198 x 123	130 x 90	87 x 64	83 x 61	88 x 65	81 x 60	Wide 348 x 260 Tele 59 x 45
<b>Focusing Range (meters)</b>		0.2 - ∞	0.2 - ∞	0.2 - ∞	0.3 - ∞	0.5 - ∞	0.3 - ∞	1.0 - ∞
<b>Filter Diameter</b>		—	—	Ø25.5 P=0.50	Ø30.5 P=0.50	Ø30.5 P=0.75	Ø34 P=0.50	Ø52 P=0.75
<b>Mount</b>		C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount
<b>Weight (grams)</b>		73	71	60	60	50	75	440

## 1/3" Format Lenses

Model		Fixed Focal Length			Zoom	
		DO-2814	DO-412	DO-812	DOZ-2X4	ZOOM 7010
<b>Focal Length (mm)</b>		2.8	4	8	4 - 8	8.5 - 90
<b>Iris Range/F-Stop</b>		1.4 - Close	1.2 - Close	1.2 - Close	1.4 - Close	2.5 - Close
<b>Control</b>	<b>Iris</b>	Manual	Manual	Manual	Manual	Manual
	<b>Focus</b>	Manual	Manual	Manual	Manual	Manual
	<b>Zoom</b>	—	—	—	Manual	Manual
<b>Object Area</b>	<b>1"</b>	—	—	—	—	—
	<b>2/3"</b>	—	—	—	—	—
	<b>1/2"</b>	—	—	—	—	—
	<b>1/3"</b>	579 x 414	373 x 275	183 x 136	Wide 386 x 281 Tele 196 x 147	Wide 170 x 127.8 Tele 16.8 x 12.6 (w/o close-up lens)
	<b>1/4"</b>	386 x 276	248 x 183	122 x 90	Wide 257 x 187 Tele 130 x 98	Wide 113 x 85 Tele 11 x 8 (w/o close-up lens)
<b>Focusing Range (meters)</b>		0.3 Fixed	0.3 - ∞	0.3 - ∞	Near - Far	0.18 - ∞
<b>Filter Diameter</b>		No Filter Thread	No Filter Thread	No Filter Thread	Ø30.5 P=0.50	No Filter Thread
<b>Mount</b>		CS-Mount	CS-Mount	CS-Mount	CS-Mount	C-Mount
<b>Weight (grams)</b>		60	45	33	100	437

\*Focusing range in non-telecentric mode.



Video lens outline drawings with dimensions can be found online at [www.machinevision.navitar.com](http://www.machinevision.navitar.com).

# Fujinon Vision Lenses

## 1" Format Lenses

Illustration Dimensions are in mm  
Conversion Factor: 25.4 mm = 1 inch

		Motorized Zoom Lenses	
Model		C22X17A-M41	C22X17B-S41
Focal Length (mm)		17 - 374 (22x)	17 - 374 (22x)
Iris Range/F-Stop		2.3 - 22	2.3 - 22
Control	Iris	Motor Drive	Auto
	Focus	Motor Drive	Motor Drive
	Zoom	Motor Drive	Motor Drive
Object Area	1"	Wide 2178 x 1633 Tele 99 x 74	Wide 2178 x 1633 Tele 99 x 74
	2/3"	Wide 1497 x 1123 Tele 68 x 51	Wide 1497 x 1123 Tele 68 x 51
	1/2"	Wide 1089 x 817 Tele 50 x 37	Wide 1089 x 817 Tele 50 x 37
	1/3"	—	—
	1/4"	—	—
Focusing Range (meters)		3 - ∞	3 - ∞
Filter Diameter		Ø82 P=0.75	Ø82 P=0.75
Mount		C-Mount	C-Mount
Weight (grams)		2500	2500



		Fixed Focal Length					
Model		CF12.5HA-1	CF16HA-1	CF25HA-1	CF35HA-1	CF50HA-1	CF75HA-1
Focal Length (mm)		12.5	16	25	35	50	75
Iris Range/F-Stop		1.4 - 22	1.4 - 22	1.4 - 22	1.4 - 22	1.8 - 22	1.8 - 22
Control	Iris	Manual	Manual	Manual	Manual	Manual	Manual
	Focus	Manual	Manual	Manual	Manual	Manual	Manual
	Zoom	—	—	—	—	—	—
Object Area	1"	120 x 90	100 x 75	65 x 48	73 x 55	76 x 57	79 x 59
	2/3"	—	—	—	—	—	—
	1/2"	—	—	—	—	—	—
	1/3"	—	—	—	—	—	—
	1/4"	—	—	—	—	—	—
Focusing Range (meters)		0.1 - ∞	0.1 - ∞	0.1 - ∞	0.2 - ∞	0.4 - ∞	0.9 - ∞
Filter Diameter		Ø49 P=0.75	Ø49 P=0.75	Ø49 P=0.75	Ø49 P=0.75	Ø49 P=0.75	Ø49 P=0.75
Mount		C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount
Weight (grams)		280	280	300	190	200	300



Video lens outline drawings with dimensions can be found online at [www.machinevision.navitar.com](http://www.machinevision.navitar.com).

# Fujinon Vision Lenses

## 2/3" Format Lenses

Model	Fixed Focal Length MEGAPIXEL					Fixed Focal Length			
	HF12.5SA-1	HF16SA-1	HF25SA-1	HF35SA-1	HF50SA-1	HF75SA-1	HF9HA-1B	HF12.5HA-1B	
<b>Focal Length (mm)</b>	12.5	16	25	35	50	75	9	12.5	
<b>Iris Range/F-Stop</b>	F1.4 - F22	F1.4 - F22	F1.4 - F22	F1.4 - F22	F1.8 - F22	F1.8 - F22	1.4 - Close	1.4 - Close	
<b>Control</b>	<b>Iris</b>	Manual	Manual	Manual	Manual	Manual	Manual	Manual	
	<b>Focus</b>	Manual	Manual	Manual	Manual	Manual	Manual	Manual	
	<b>Zoom</b>	—	—	—	—	—	—	—	
<b>Object Area</b>	<b>1"</b>	—	—	—	—	—	—	—	
	<b>2/3"</b>	83 x 62	69 x 51	44 x 33	50 x 38	70 x 52	101 x 76	108 x 81	78 x 58
	<b>1/2"</b>	60 x 45	50 x 37	32 x 24	37 x 27	51 x 38	74 x 55	79 x 59	57 x 42
	<b>1/3"</b>	45 x 34	37 x 28	24 x 18	27 x 21	38 x 28	55 x 41	59 x 44	42 x 32
	<b>1/4"</b>	—	—	—	—	—	—	44 x 33	32 x 24
<b>Focusing Range (meters)</b>	∞ - 0.1	∞ - 0.1	∞ - 0.1	∞ - 0.2	∞ - 0.4 *	∞ - 0.9 **	0.1 - ∞	0.1 - ∞	
<b>Filter Diameter</b>	Ø49 P=0.75	Ø49 P=0.75	Ø49 P=0.75	Ø49 P=0.75	Ø49 P=0.75	Ø49 P=0.75	Ø27 P=0.75	Ø25.5 P=0.50	
<b>Mount</b>	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	
<b>Weight (grams)</b>	295	285	315	185	240	300	55	45	

Model	Fixed Focal Length					Motorized Zoom		
	HF16HA-1B	HF25HA-1B	HF35HA-1B	HF50HA-1B	HF75HA-1B	H16X10B-S41	H16X10A-M41	
<b>Focal Length (mm)</b>	16	25	35	50	75	10-160	10-160	
<b>Iris Range/F-Stop</b>	1.4 - Close	1.4 - Close	1.6 - Close	2.3 - Close	2.8 - Close	2.5 - 800	2.5 - 22	
<b>Control</b>	<b>Iris</b>	Manual	Manual	Manual	Manual	Auto	Motor Drive	
	<b>Focus</b>	Manual	Manual	Manual	Manual	Motor Drive	Motor Drive	
	<b>Zoom</b>	—	—	—	—	—	Motor Drive	Motor Drive
<b>Object Area</b>	<b>1"</b>	—	—	—	—	—	—	
	<b>2/3"</b>	63 x 47	53 x 40	59 x 44	77 x 57	114 x 85	Wide 862 x 620 Tele 54 x 40	Wide 862 x 620 Tele 54 x 40
	<b>1/2"</b>	46 x 34	38 x 29	43 x 32	56 x 42	83 x 62	Wide 627 x 470 Tele 39 x 29	Wide 627 x 470 Tele 39 x 29
	<b>1/3"</b>	34 x 26	29 x 22	32 x 24	42 x 31	62 x 47	Wide 470 x 353 Tele 29 x 22	Wide 470 x 353 Tele 29 x 22
	<b>1/4"</b>	26 x 19	22 x 16	24 x 18	31 x 24	47 x 35	Wide 314 x 235 Tele 19 x 14	Wide 314 x 235 Tele 19 x 14
<b>Focusing Range (meters)</b>	0.1 - ∞	0.15 - ∞	0.25 - ∞ *	0.5 - ∞	1.1 - ∞	1.0 - ∞	1.0 - ∞	
<b>Filter Diameter</b>	Ø25.5 P=0.50	Ø25.5 P=0.50	Ø25.5 P=0.50	Ø25.5 P=0.50	Ø30.5 P=0.50	Ø62 P=0.75	Ø62 P=0.75	
<b>Mount</b>	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	
<b>Weight (grams)</b>	45	45	45	45	55	900	900	

**NOTES:**

All Fujinon "HF" lenses come with focus and iris locking screws.

\* Using an extension tube longer than 5mm will increase the M.O.D. to 0.3m.

\*\* Using an extension tube longer than 5mm will increase the M.O.D. to 0.5m.

*Locking screws on focus and/or iris available on most lenses.*

# Fujinon Vision Lenses

## 1/2" Format Lenses

Illustration Dimensions are in mm  
Conversion Factor: 25.4 mm = 1 inch

Model	Fixed Focal Length		Motorized Zoom		
	DF6HA-1B*	D16X7.3B-S41	D16X7.3A-M41	D16X7.3A-R11	
<b>Focal Length (mm)</b>	6	7.3 - 117	7.3 - 117	7.3 - 117	
<b>Iris Range/F-Stop</b>	1.2 - Close	1.9 - 400	1.4 - 16	1.9 - 16	
<b>Control</b>	<b>Iris</b>	Manual	Auto	Motor Drive	
	<b>Focus</b>	Manual	Motor Drive	Motor Drive	
	<b>Zoom</b>	—	Motor Drive	Motor Drive	
<b>Object Area</b>	<b>1"</b>	—	—	—	
	<b>2/3"</b>	—	—	—	
	<b>1/2"</b>	122 x 92	Wide 824 x 618 Tele 51 x 39	Wide 824 x 618 Tele 51 x 39	Wide 824 x 618 Tele 51 x 39
	<b>1/3"</b>	92 x 69	Wide 618 x 464 Tele 39 x 29	Wide 618 x 464 Tele 39 x 29	Wide 618 x 464 Tele 39 x 29
	<b>1/4"</b>	69 x 52	Wide 412 x 309 Tele 26 x 20	Wide 412 x 309 Tele 26 x 20	Wide 412 x 309 Tele 26 x 20
<b>Focusing Range (meters)</b>	0.1 - ∞	1 - ∞	1 - ∞	1 - ∞	
<b>Filter Diameter</b>	Ø27 P=0.5	Ø62 P=0.75	Ø62 P=0.75	Ø62 P=0.75	
<b>Mount</b>	C-Mount	C-Mount	C-Mount	C-Mount	
<b>Weight (grams)</b>	45	900	900	900	

\*Locking screws on focus and iris are standard.

## 1/3" Format Lenses

Model	Fixed Focal Length				
	YF2.8A-2	YF4A-2	YF8A-2	YF16A-2	
<b>Focal Length (mm)</b>	2.8	4	8	16	
<b>Iris Range/F-Stop</b>	1.3 - Close	1.2 - Close	1.2 - Close	1.4 - Close	
<b>Control</b>	<b>Iris</b>	Manual	Manual	Manual	
	<b>Focus</b>	Manual	Manual	Manual	
	<b>Zoom</b>	—	—	—	
<b>Object Area</b>	<b>1"</b>	—	—	—	
	<b>2/3"</b>	—	—	—	
	<b>1/2"</b>	—	—	—	
	<b>1/3"</b>	241 x 157	132 x 99	71 x 53	153 x 115
	<b>1/4"</b>	157 x 110	99 x 73	53 x 40	115 x 86
<b>Focusing Range (meters)</b>	0.1 - ∞	0.1 - ∞	0.1 - ∞	0.5 - ∞	
<b>Filter Diameter</b>	No Filter Thread	No Filter Thread	No Filter Thread	No Filter Thread	
<b>Mount</b>	CS-Mount	CS-Mount	CS-Mount	CS-Mount	
<b>Weight (grams)</b>	40	30	30	25	

NOTE: The above lenses are all available with auto iris. Please call for part numbers.

## 1/3" Format Lenses for 3CCD Cameras

Model	Fixed Focal Length			Motorized Zoom		
	TF2.8DA-8	TF4DA-8	TF15DA-8	T16X5.5DA-R11	T16X5.5DA-M41	
<b>Focal Length (mm)</b>	2.8	4	15	5.5 - 88	5.5 - 88	
<b>Iris Range/F-Stop</b>	2.2 - Close	2.2 - Close	2.2 - Close	1.4 - 16	1.4 - 16	
<b>Control</b>	<b>Iris</b>	Manual	Manual	Auto	Motor Drive	
	<b>Focus</b>	Manual	Manual	Motor Drive	Motor Drive	
	<b>Zoom</b>	—	—	—	Motor Drive	
<b>Object Area</b>	<b>1"</b>	—	—	—	—	
	<b>2/3"</b>	—	—	—	—	
	<b>1/2"</b>	—	—	—	—	
	<b>1/3"</b>	218 x 153	131 x 98	36 x 27	Wide 819 x 614 Tele 59 x 44	Wide 819 x 614 Tele 59 x 44
	<b>1/4"</b>	145 x 102	87 x 65	24 x 18	—	
<b>Focusing Range (meters)</b>	0.1 - ∞	0.1 - ∞	0.1 - ∞	1 - ∞	1 - ∞	
<b>Filter Diameter</b>	No Filter Thread	Ø27 P=0.5	Ø25.5 P=0.5	Ø62 P=0.75	Ø62 P=0.75	
<b>Mount</b>	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	
<b>Weight (grams)</b>	75	70	60	900	900	

# SWIR Hyperspectral Lenses

Navitar's fixed focal length SWIR Hyperspectral lenses are specifically designed for SWIR (short wave infrared) cameras and applications. Lenses are available in 25mm, 35mm and 50mm focal lengths. These lenses are ideal for a variety of imaging applications where SWIR cameras are employed such as perimeter surveillance, food sorting, toll-way monitoring, border and port security, quality control or aerial imaging.



Model	Fixed Focal Length		
	SWIR-25	SWIR-35	SWIR-50
Focal Length (mm)	25	35	50
Iris Range/F-Stop	1.4 - 16	1.4 - 16	1.4 - 16
Control	Iris	Manual	Manual
	Focus	Manual	Manual
	Zoom	—	—
Object Area	1"	161h x 120v	122h x 91v
	2/3"	109h x 82v	84h x 63v
	1/2"	79h x 59v	61h x 46v
	1/3"	—	—
	1/4"	—	—
Focusing Range (meters)	0.3 - ∞	0.3 - ∞	0.5 - ∞
Filter Diameter	Ø35.5 P=0.5	Ø35.5 P=0.5	Ø40.5 P=0.5
Mount	C-Mount	C-Mount	C-Mount
Weight (grams)	125	130	200

## Video Lens Accessories



### Range Extenders (for use with all lenses except SWIR)

The use of a range extender, installed between a lens and a camera, will extend the focal length and increase the effective aperture (F/number) of a video lens. For example, using the 2XE range extender will extend the focal length by two times (2X) and double the effective aperture of the following lens:  
 (2X) 50 mm, F/1.3 lens = 100 mm F/2.6

We also offer an extension tube kit, which allows you to turn standard fixed focal length lenses into macro lenses. This kit includes six extender tubes (0.5 mm, 1 mm, 5 mm, 10 mm, 20 mm and 40 mm) for extension from 0.5 mm to 76.5 mm. The tube(s) mount between the camera and the lens, making it possible for you to focus a C-mount lens at a much closer distance.

### Available Range Extenders

Model	Description
HE15-1	1.5 X Extender, 13.08 mm long, Ø45
HE20-1	2.0X Extender, 13.74 mm long, Ø45
2XE	2.0X Extender, 11.12 mm long, Ø31.92
540E	Extension Tube Kit, 6 pieces, 76.5mm total (0.5 mm, 1 mm, 5 mm, 10 mm, 20 mm, and 40 mm)
3-6073	5 mm Extension Tube

### Close-up Lenses (for use with Fujinon lenses only)

Fujinon close-up lenses may be screwed to the front ring of your lens when you need to move closer to a subject than allowed by the minimum object distance (M.O.D.) of the lens. The Fujinon model number of the close-up lens designates the maximum image-to-lens distance at the telephoto end (in cm), as well as the filter diameter of the lens.

### Available Close-up Lenses

Model	Focusing Range (mm)	Filter Diameter(mm)
CL3355	333 - 250	Ø55
CL10055	1000 - 500	Ø55
ECL8072	800 - 463	Ø55
CL12072B	1200 - 574	Ø55

### Available Control Boxes (for use with Fujinon lenses only)

Model	Description
CRD-1A/B	Zoom and focus are motor-drive, auto-iris
CRD-2A/B	Iris, zoom and focus are auto-drive

A = 6-pin type connector, B = 4-pin type connector.

# Zoom 7000



## Features

- Working distance 5" to infinity.
- Parfocal over entire zoom range.
- Highest mag. 1.1X at 5" (at camera).

The Zoom 7000 is a close-focusing macro video lens with a working distance of 5 inches to infinity. This versatile lens is compatible with cameras 2/3" or smaller and is specifically designed for use in applications where objects over 1" in diameter must be imaged. It offers unsurpassed clarity and parfocal zoom capabilities over the entire zoom range.

The Zoom 7000 is ideal for quality assurance, biomedical imaging, or assembly applications where an easy-to-view, sharp and true-to-life magnified image of your product can mean the difference between a shippable, top-quality end product and a costly manufacturing failure.

The Zoom 7000 offers a 6:1 zoom ratio or a 6X magnification power over a focal range of 18 mm to 108 mm. It comes with a close-up lens for imaging at distances from 5" to 12". When the close-up lens is removed, the working distance extends from 24" to infinity. Focus and aperture control are standard Zoom 7000 features. Navitar also offers an 18-108 mm Bayonet Mount Zoom Lens (3CCD Camera) (1-11898) or a Zoom 7000 locking sleeve (1-11736).

## Example

**Object size =**  
100mm x 50mm

**Camera format =** 2/3"

**Criteria:** All edges should be visible at low magnification and high magnification should show the object at maximum magnification.

Looking at the chart below, a 10" working distance would allow a 108 mm wide object to be imaged into a 2/3" camera. Therefore, something slightly less than 10" would do for an object 100mm wide and would provide maximum magnification at high zoom.

## Zoom 7000 Field of View

W.D.	2/3" High Mag.		2/3" Low Mag.		1/2" High Mag.		1/2" Low Mag.		1/3" High Mag.		1/3" Low Mag.		1/4" High Mag.		1/4" Low Mag.	
	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
5"	8	6	48	36	5.8	4.4	35	26.3	4.3	3.2	25.9	19.4	2.9	2.2	17.5	13.2
6"	10	7.5	60	45	7.3	5.5	43.8	32.9	5.4	4.1	32.4	24.3	3.7	2.8	21.9	16.5
7"	12	9	72	54	8.7	6.6	52.6	39.4	6.5	4.9	38.9	29.2	4.4	3.3	26.3	19.7
8"	14	10.5	84	63	10.2	7.7	61.3	46	7.6	5.7	45.5	34	5.1	3.9	30.7	23.0
9"	16	12	96	72	11.7	8.8	70.1	52.6	8.6	6.5	51.8	38.9	5.9	4.4	35.1	26.3
10"	18	13.5	108	81	13.1	9.9	78.8	59.1	9.7	7.3	58.3	43.7	6.6	5.0	39.4	29.6
11"	20	15	120	90	14.6	11	87.6	65.7	10.8	8.1	64.8	48.6	7.3	5.5	43.8	32.9
12"	22	16.5	132	99	16.1	12	96.4	72.3	11.9	8.9	71.3	53.5	8.1	6.0	48.2	36.2
<b>With Close-up Lens Removed</b>																
2'	42	30	252	180	30.7	21.9	184	131.4	22.7	21.1	136.1	97.2	15.4	11.0	92.0	65.7
2'6"	54	39	324	234	39.4	28.5	236.5	170.8	29.2	25.9	175	126.4	19.7	14.3	118.3	85.4
3'	66	48	396	288	48.2	35	289.1	210.2	35.6	25.9	213.8	155.5	24.1	17.5	144.6	105.1
3'6"	78	57	468	342	56.9	41.6	341.6	249.7	42.1	30.8	252.7	184.7	28.5	20.8	170.8	124.9
4'	90	66	540	396	65.7	48.2	394.2	289.1	48.6	35.6	291.6	213.8	32.9	24.1	197.1	144.6

Taken from 2/3", 1/2", 1/3" & 1/4" camera monitor systems with an approximate 10% overfill. All dimensions are in mm. Focus adjustment comes with locking screw. Iris and Zoom can be modified upon request.

# Zoom 7010



## Features

- Imaging at distances from 7-12".
- Working distance of 16" to infinity when the built-in close-up lens is removed
- Very high resolution.
- C-mount is standard with CS-mount also available.

## A 10X Macro Zoom Lens

The Navitar Zoom 7010 Macro Zoom lens is designed for use with a 1/3" or smaller camera. It has a 10X zoom ratio and a 7-12" working distance (W.D. of 16" to infinity when the built-in close-up lens is removed). The 10X Macro Zoom lens allows close-up image capture without extension tubes or close-up lenses and the up-to-10X magnification variable (zooming) capability allows small objects to be expanded for close-up observation. The high resolution Zoom 7010 is ideal for visual inspection of electronic and precision components, biomedical imaging, image processing, and magnification of documents as a visual aid. C-mount is standard.

## Zoom 7010 Field of View

W.D.	1/3" High Mag.		1/3" Low Mag.		1/4" High Mag.		1/4" Low Mag.	
	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
7"	7.36	5.52	74.40	55.80	4.88	3.66	49.60	37.20
8"	9.12	6.84	92.80	69.60	6.08	4.56	61.60	46.20
9"	10.96	8.22	111.20	83.40	7.28	5.46	74.40	55.80
10"	12.48	9.36	126.40	94.80	8.32	6.24	84.00	63.00
11"	13.92	10.44	140.80	105.60	9.28	6.96	93.60	70.20
12"	16.80	12.60	170.40	127.80	11.20	8.40	113.60	85.20
<b>With Close-up Lens Removed</b>								
1'4"	18.40	13.80	188.00	141.00	12.24	9.18	125.60	94.20
1'8"	25.00	18.00	244.00	183.00	16.00	12.00	162.40	121.80
2'	29.60	22.20	304.00	228.00	19.76	14.82	202.40	151.80
3'	44.80	33.60	456.00	342.00	29.84	22.38	304.00	228.00
4'	60.00	45.00	616.00	462.00	40.00	30.00	410.40	307.80

Taken from 1/3" and 1/4" camera monitor systems with an approximate 10% overfill. All dimensions are in mm.

# Zoom 7000E



## Features

- Eliminates eyestrain from prolonged microscope viewing.
- Can be used as a video overhead projector.
- Provides high-resolution color images.
- Connects with most video cameras and monitors.
- Works under room light conditions.

The Zoom 7000E system is specifically designed for use in educational applications where industrial inspection and imaging features are less essential. It offers a 6:1 zoom ratio over a focal range of 12.5 mm to 75 mm. The Zoom 7000E system incorporates many of the features of the Zoom 7000 and 7010 systems at an attractive price.

It allows group viewing of dissections as you perform them, without interchanging lenses and matching special adapters. It's ideal for continuous monitoring of slowly changing processes such as embryonic development or fish and chick hatching. The Zoom 7000E can also be used in conjunction with a VCR for taping classroom activities for future reference.

## Zoom 7000E Field of View with Macro

W.D.	2/3" High Mag.		1/2" High Mag.		1/3" High Mag.		1/4" High Mag.	
	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
1"	-	-	-	-	-	-	-	-
2"	64	45	46.7	32.9	34.6	24.3	23.4	16.5
3"	79	56	57.7	40.9	42.7	30.2	28.9	20.5
4"	94	67	68.6	48.9	50.7	36.2	34.3	24.5
5"	109	78	79.6	56.9	58.9	42.1	39.8	28.5
6"	124	89	90.5	65	67	48.1	45.3	32.5
7"	139	100	101.5	73	75.1	54	50.8	36.5
8"	-	-	-	-	-	-	-	-

Taken from 2/3", 1/2", 1/3" and 1/4" camera monitor systems with an approximate 10% overfill. All dimensions are in mm.

## Zoom 7000E Field of View without Macro

W.D.	2/3" High Mag.		2/3" Low Mag.		1/2" High Mag.		1/2" Low Mag.		1/3" High Mag.		1/3" Low Mag.		1/4" High Mag.		1/4" Low Mag.	
	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
Soft Focus to 3'	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3'	84	62	504	372	61.3	45.3	367.9	271.6	45.4	33.5	272.2	200.9	30.7	22.7	184.0	135.8
3' 6"	100	74	600	444	73	54	438	324.1	54	40	324	239.8	36.5	27.0	219.0	162.1
4'	116	86	696	516	84.7	62.8	508.1	376.7	62.6	46.4	375.8	278.6	42.4	31.4	254.1	188.4
4' 6"	132	98	792	588	96.4	71.5	578.2	429.2	71.3	52.92	427.7	317.5	48.2	35.8	289.1	214.6
5'	148	110	888	660	108	80.3	648	481.8	79.9	59.4	479.5	356.4	54.0	40.2	324.0	240.9
5' 6"	168	122	984	732	119.7	89.1	718.3	534.4	88.6	65.9	531.4	395.3	59.9	44.6	359.2	267.2
6'	180	134	1080	804	131.4	97.8	788.4	586.9	97.2	72.4	583.2	434.2	65.7	48.9	394.2	293.5

Taken from 2/3", 1/2", 1/3" and 1/4" camera monitor systems with an approximate 10% overfill. All dimensions are in mm.