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**FUJIFILM**  
 Value from Innovation



**FUJINON**  
 Machine Vision Lenses

**Authorized Fujifilm Service Agent.**

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Be certain to read the instructions for use before using any equipment.

FFBX2017 03.

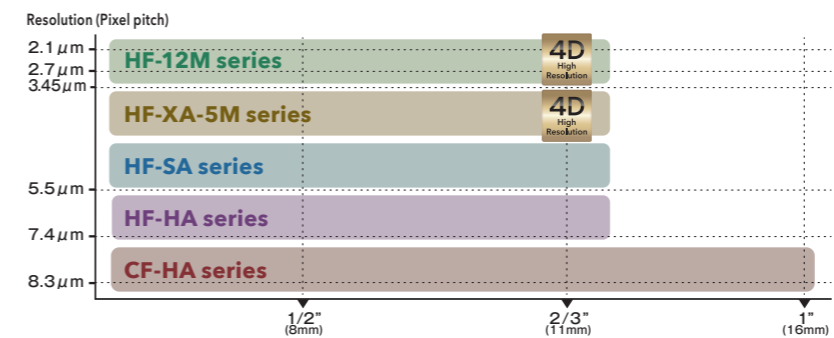




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## Lens Selection Guide



**4D High Resolution**

The "4D High Resolution" is the FUJINON lenses' unique performance. It maintains a high level of consistent image sharpness at the center as well as around the edges, while mitigating resolution degradation that typically occurs when changing a working distance or aperture value.





# HF-12M series 12 Megapixel, 2/3"



## <Main features>

### ■ Advanced optical performance suitable for the top-of-the-range series

- When the iris (aperture) is set at the orange F4 marker on the lens barrel, the HF-12M series delivers the resolving power greater than 2.1μm pixel pitch on a 2/3-inch sensor (equivalent to 12 megapixels) \*1.
- The HF-12M series is capable of maintaining ultra-high definition with a 2.7 μm pixel pitch within the whole frame area. Each pixel with high optical performance enables stable checking of product dimensions and appearance.
- The HF-12M series bring out maximum performance of the image sensor with 3.45μm pixel pitch(IMX250).



Orange-colored F4 marker on the lens barrel

### ■ FUJINON lenses' unique "4D High Resolution" performance.



General machine vision lenses share the issue of resolution degradation when the working distance or aperture is changed. The HF-12M features FUJINON lenses' unique "4D High Resolution" performance. It maintains a high level of consistent image sharpness at the center as well as around the edges, while mitigating resolution degradation that typically occurs when changing a working distance or aperture value. This enables the consistent delivery of high-resolution images under a wide variety of installation and shooting conditions.

### ■ Ease of installation and high reliability

- Despite being high-resolution lenses with 2.7μm pixel pitch, all the five models come in a compact form factor with the external dimension of just φ33mm. This allows installation flexibility even in manufacturing facilities with space constraints.
- General machine vision lenses use iris and focus locking screws with a head protruding out from the lens body, potentially causing interference within the machine vision system. The HF-12M series come with regular locking screws as well as headless compact screws, which can be countersunk into the lens body to minimize interference with the machine vision system, thereby increasing flexibility in system installation and design.
- The lenses are built with a metal barrel for durability and robustness.



When locked with a head-less compact screw. No head protruding from the lens body.

### ■ Industry-leading low distortion design of no more than 0.05%

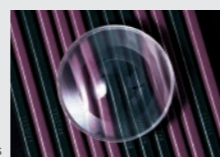
- The lenses' unique optical design minimizes troublesome distortion. In industrial applications requiring accuracy such as dimension measurement. The series boasts an industry-leading low distortion rate of no more than 0.05%\*2.
- The aspherical glass\*3 mold lens enabled the smallest body and low distortion.

\*1: At the working distance of 50cm \*2: In the case of HF1618-12M \*3: Installed to HF818-12M and HF1218-12M

## Technology Supporting the "HF-12M Series"

### High-precision glass mold aspherical lens technology –Achieving both miniaturization and low distortion–

- In lens design, reducing the number of lenses and forming an image by abruptly bending light that enters the lens achieves miniaturization. Distortion cannot be controlled if the lenses are only composed of the commonly used spherical lens. However, the aspherical lens can yield the same results of using multiple spherical lenses, enabling the control of distortion with far fewer lenses.



Aspherical lens

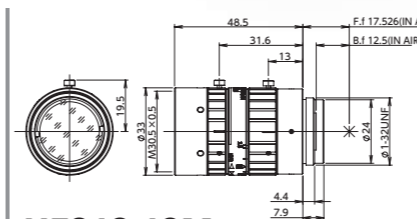
- Aspherical lenses require precision processing. Fujifilm can design and manufacture aspherical lens within its own group. The precision processing required in the design stage and its mass production is realized by accurate die machining technology.



General MV lens only with spherical lenses

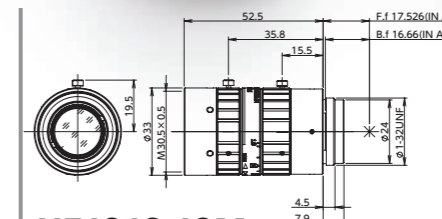
MV lens with an aspherical lens

- The HF-12M series realizes both miniaturization and low distortion by implementing the high-precision glass mold aspherical lenses.



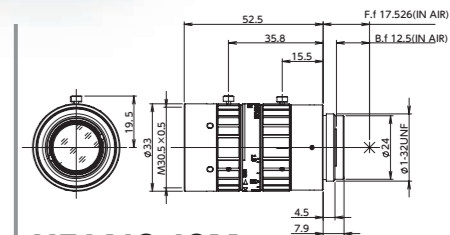
### HF818-12M

Focal length [mm]	8
Iris range (F. no)	F1.8-F22
Angle of view	56.9°×43.9° (2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M30.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	95
Sensor size (max.)	2/3"
TV distortion [%]	-1.03
Dimension [mm]	φ33×48.5



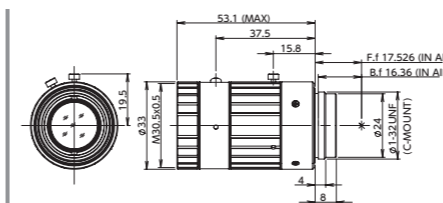
### HF1218-12M

Focal length [mm]	12
Iris range (F. no)	F1.8-F22
Angle of view	39.3°×30.0° (2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M30.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	85
Sensor size (max.)	2/3"
TV distortion [%]	0.18
Dimension [mm]	φ33×52.5



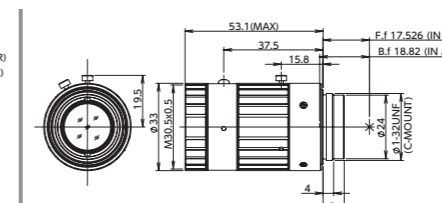
### HF1618-12M

Focal length [mm]	16
Iris range (F. no)	F1.8-F22
Angle of view	30.8°×23.3° (2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M30.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	90
Sensor size (max.)	2/3"
TV distortion [%]	-0.03
Dimension [mm]	φ33×52.5



### HF2518-12M

Focal length [mm]	25
Iris range (F. no)	F1.8-F22
Angle of view	20.0°×15.1° (2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M30.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	85
Sensor size (max.)	2/3"
TV distortion [%]	0.02
Dimension [mm]	φ33×53.1



### HF3520-12M

Focal length [mm]	35
Iris range (F. no)	F2.0-F22
Angle of view	14.7°×11.0° (2/3")
Working Distance (*) [mm]	∞-200
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M30.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	85
Sensor size (max.)	2/3"
TV distortion [%]	0.01
Dimension [mm]	φ33×53.1

\* From front of lens barrel

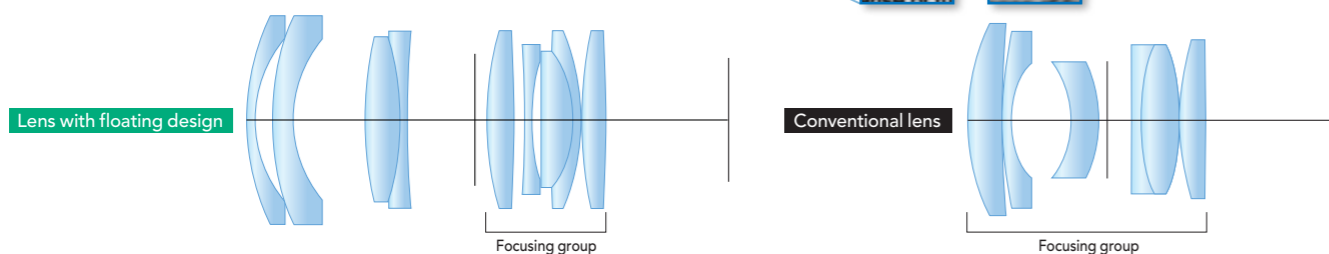
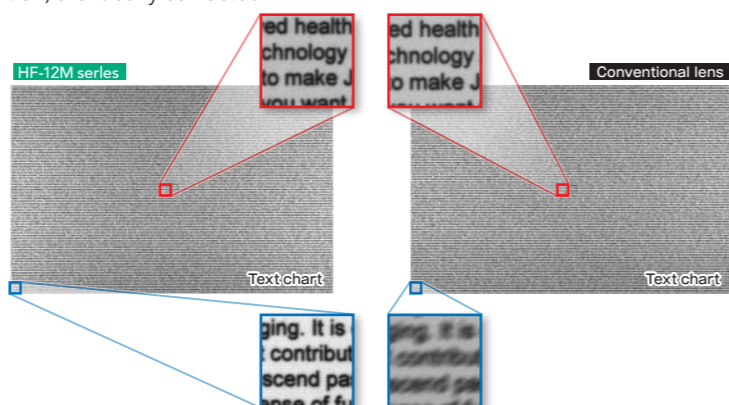
# Maintaining High-Resolution is about Controlling Aberration.

## 3 Technologies Supporting "4D High-Resolution"

### 1 Floating design technology

–Controls the drop in resolution caused by changing shooting distances–

- The lenses are designed to show the best resolution at the shooting distance most commonly used (designed distance). At this distance, the aberrations (color fringe/peripheral blur/distortion) are ideally corrected.
- Although conventional lens design technology optimally controlled aberration at the designed distance, aberration occurred at other distances and lowered resolution. The wide angle lens in particular had issues with its tendency for curvature of field (peripheral blur).
- The HF-12M series has implemented "floating design technology". "Floating lens elements" behind the iris move to focus and enable the HF-12M series to retain its highest resolution regardless of the shooting distance.



### 2 Eccentricity adjustment technology

–Retaining consistent resolution to the periphery of the image–

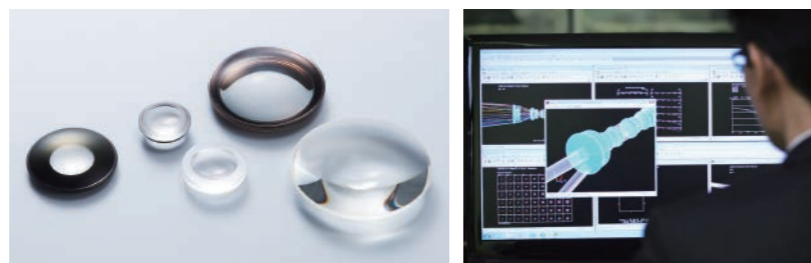
- Misalignment of the axis of the lenses during the manufacturing process prevents the intended performance from being exhibited. It is crucial to align the axis of the lenses to the micrometer level during its manufacturing process.
- The HF-12M series realized high-resolution consistent all the way to the periphery of the image. This is accomplished by detecting all lens core misalignment using proprietary inspection equipment of Fujifilm manufacturing technology and aligning the whole lens constructions with micrometer level adjustments.
- Fujifilm's proprietary manufacturing technology is utilized by applying the precision technology needed for manufacturing broadcast lenses that require high-dimensional and consistent qualities, to the manufacture of miniature lenses such as camera modules for mobile phones.



### 3 Glass matching technology (Fujifilm original optical design software "FOCUS")

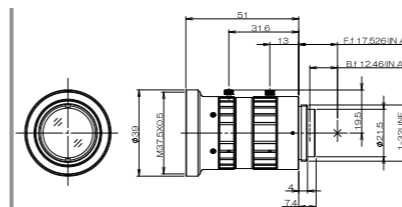
–Controls the drop in resolution caused by changing aperture value–

- "Lateral chromatic aberration (color fringe)" is the main cause for the drop in resolution when changing the aperture value. Due to the different refractive index of the wavelength, imaging position sometimes differs by colors. This leads to the color fringing at the edge of the frame. To control of this aberration combination of the glass materials matters. While general glass materials can correct only the 2 colors of RGB(Red, Green, Blue), Extra-low Dispersion glass material enables the correction of all three colors at high level.
- By implementing glass with Extra-low Dispersion characteristics to control lateral chromatic aberration, the HF-12M series have succeeded to maintain the high resolution even when changing the aperture value.
- Fujifilm's has developed its original lens design software "FOCUS (Fujifilm Optical Class Library and Utilities System)", which enables to decide the best glass materials from the infinite combination of possibilities.



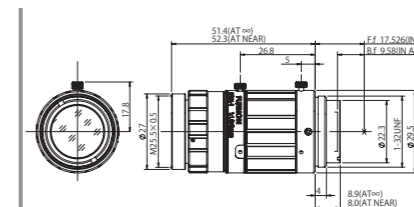
NEW

## HF-XA-5M series 5 Megapixel, 2/3"



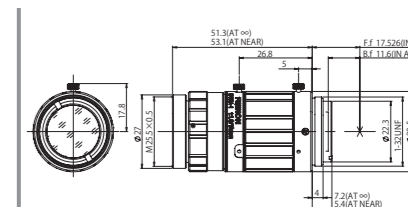
#### HF6XA-5M

Focal length [mm]	6
Iris range (F. no)	F1.9-F16
Angle of view	74.7°×58.1° (2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M37.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	100
Sensor size (max.)	2/3"
TV distortion [%]	-2.88
Dimension [mm]	φ39×51



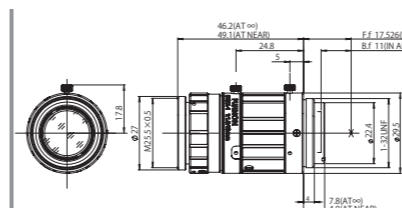
#### HF8XA-5M

Focal length [mm]	8
Iris range (F. no)	F1.6-F16
Angle of view	58.4°×44.6° (2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M25.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	79
Sensor size (max.)	2/3"
TV distortion [%]	-1.99
Dimension [mm]	φ29.5×51.5



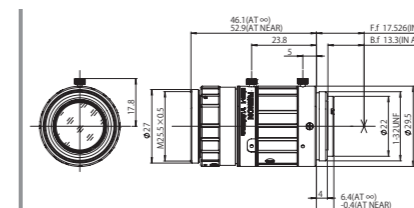
#### HF12XA-5M

Focal length [mm]	12
Iris range (F. no)	F1.6-F16
Angle of view	40.1°×30.3° (2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M25.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	79
Sensor size (max.)	2/3"
TV distortion [%]	-1.26
Dimension [mm]	φ29.5×51.5



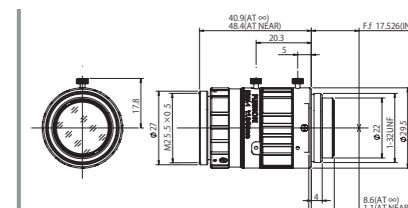
#### HF16XA-5M

Focal length [mm]	16
Iris range (F. no)	F1.6-F16
Angle of view	31.4°×23.7° (2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M25.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	71
Sensor size (max.)	2/3"
TV distortion [%]	-0.60
Dimension [mm]	φ29.5×46.0



#### HF25XA-5M

Focal length [mm]	25
Iris range (F. no)	F1.6-F16
Angle of view	20.0°×15.0° (2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M25.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	72
Sensor size (max.)	2/3"
TV distortion [%]	-0.07
Dimension [mm]	φ29.5×46.5



#### HF35XA-5M

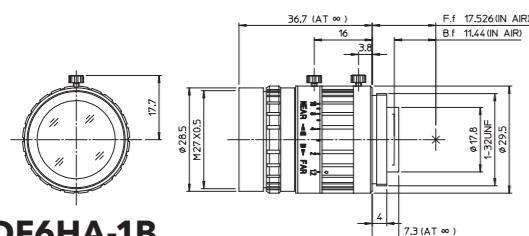
Focal length [mm]	35
Iris range (F. no)	F1.9-F16
Angle of view	14.2°×10.7° (2/3")
Working Distance (*) [mm]	∞-200
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M25.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	60
Sensor size (max.)	2/3"
TV distortion [%]	0.10
Dimension [mm]	φ29.5×41.5

\* From front of lens barrel



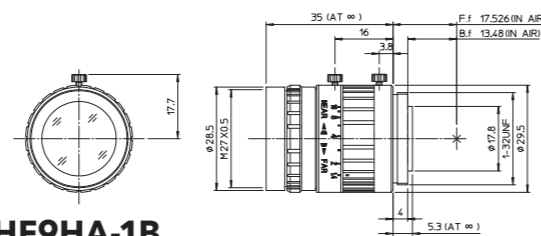


# HF-HA series 1.5 Megapixel, 2/3"



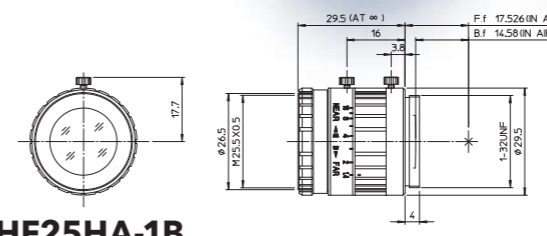
**HF6HA-1B**

Focal length [mm]	6
Iris range (F. no)	F1.2-F16
Angle of view	57.3°x 43.8°(1/2")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M27 x 0.5
Mount	C-mount
Weight (approx.) [g]	55
Sensor size (max.)	1/2"
TV distortion [%]	-1.84
Dimension [mm]	φ29.5×36.8



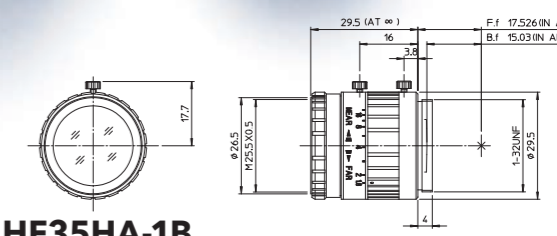
**HF9HA-1B**

Focal length [mm]	9
Iris range (F. no)	F1.4-F16
Angle of view	53.3°x 40.5°(2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M27 x 0.5
Mount	C-mount
Weight (approx.) [g]	55
Sensor size (max.)	2/3"
TV distortion [%]	-2.00
Dimension [mm]	φ29.5×35



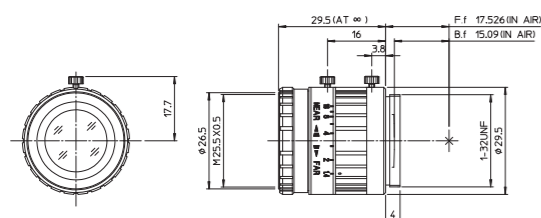
**HF25HA-1B**

Focal length [mm]	25
Iris range (F. no)	F1.4-F16
Angle of view	19.4°x 14.6°(2/3")
Working Distance (*) [mm]	∞-150
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M25.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	45
Sensor size (max.)	2/3"
TV distortion [%]	-0.19
Dimension [mm]	φ29.5×29.5



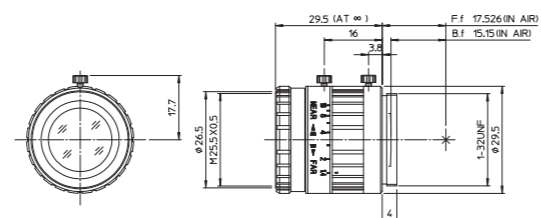
**HF35HA-1B**

Focal length [mm]	35
Iris range (F. no)	F1.6-F22
Angle of view	14.3°x 10.8°(2/3")
Working Distance (*) [mm]	∞-250
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M25.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	45
Sensor size (max.)	2/3"
TV distortion [%]	0.10
Dimension [mm]	φ29.5×29.5



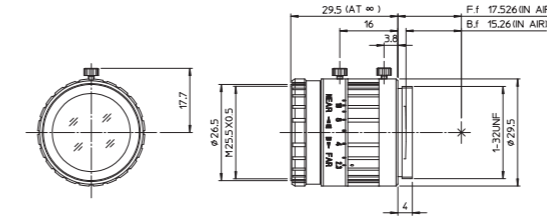
**HF12.5HA-1B**

Focal length [mm]	12.5
Iris range (F. no)	F1.4-F16
Angle of view	39.2°x 29.4°(2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M25.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	45
Sensor size (max.)	2/3"
TV distortion [%]	-1.95
Dimension [mm]	φ29.5×29.5



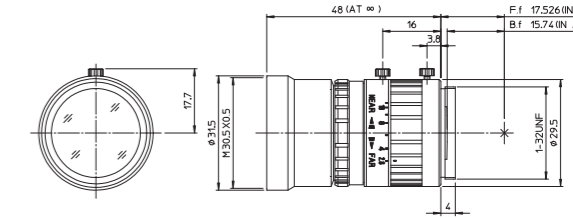
**HF16HA-1B**

Focal length [mm]	16
Iris range (F. no)	F1.4-F16
Angle of view	30.5°x 22.9°(2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M25.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	45
Sensor size (max.)	2/3"
TV distortion [%]	-0.87
Dimension [mm]	φ29.5×29.5



**HF50HA-1B**

Focal length [mm]	50
Iris range (F. no)	F2.3-F22
Working Distance (*) [mm]	10.1°x 7.6°(2/3")
Operation of focus	∞-500
Operation of iris	Manual
Filter thread [mm]	Manual
Mount	M25.5 x 0.5
Weight (approx.) [g]	C-mount
Sensor size (max.)	45
TV distortion [%]	2/3"
Dimension [mm]	0.06
Dimension [mm]	φ29.5×29.5




**HF75HA-1B**

Focal length [mm]	75
Iris range (F. no)	F2.8-F22
Angle of view	6.7°x 5.0°(2/3")
Working Distance (*) [mm]	∞-1,100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M30.5 x 0.5
Mount	C-mount
Weight (approx.) [g]	55
Sensor size (max.)	2/3"
TV distortion [%]	0.36
Dimension [mm]	φ29.5×48

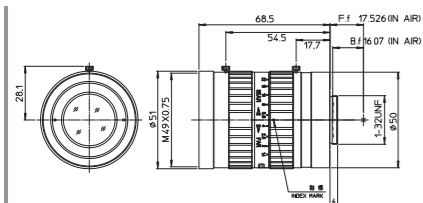
\* From front of lens barrel



Please download the specification sheet and the drawing data.

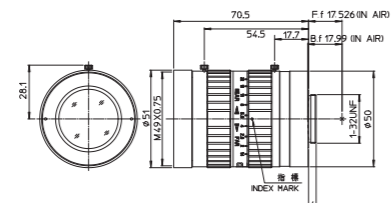


## HF-SA series 5 Megapixel, 2/3"



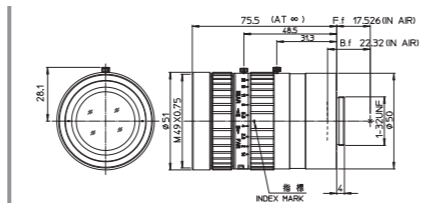
### HF12.5SA-1

Focal length [mm]	12.5
Iris range (F. no)	F1.4-F22
Angle of view	38.0°x 29.0°(2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M49 x 0.75
Mount	C-mount
Weight (approx.) [g]	295
Sensor size (max.)	2/3"
TV distortion [%]	-0.08
Dimension [mm]	φ51×68.5



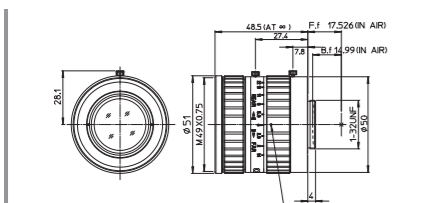
### HF16SA-1

Focal length [mm]	16
Iris range (F. no)	F1.4-F22
Angle of view	30.2°x 22.9°(2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M49 x 0.75
Mount	C-mount
Weight (approx.) [g]	285
Sensor size (max.)	2/3"
TV distortion [%]	0.11
Dimension [mm]	φ51×70.5



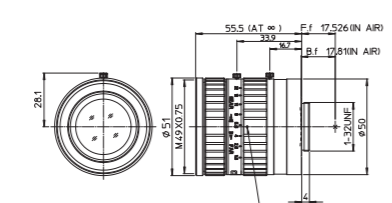
### HF25SA-1

Focal length [mm]	25
Iris range (F. no)	F1.4-F22
Angle of view	20.8°x 15.7°(2/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M49 x 0.75
Mount	C-mount
Weight (approx.) [g]	315
Sensor size (max.)	2/3"
TV distortion [%]	-0.06
Dimension [mm]	φ51×75.5



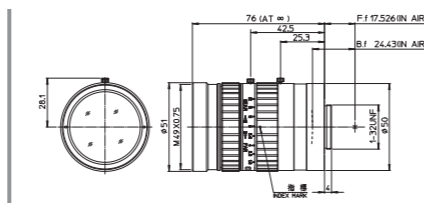
### HF35SA-1

Focal length [mm]	35
Iris range (F. no)	F1.4-F22
Angle of view	14.0°x 10.5°(2/3")
Working Distance (*) [mm]	∞-200
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M49 x 0.75
Mount	C-mount
Weight (approx.) [g]	185
Sensor size (max.)	2/3"
TV distortion [%]	0.07
Dimension [mm]	φ51×48.5



### HF50SA-1

Focal length [mm]	50
Iris range (F. no)	F1.8-F22
Angle of view	9.7°x 7.3°(2/3")
Working Distance (*) [mm]	∞-400
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M49 x 0.75
Mount	C-mount
Weight (approx.) [g]	240
Sensor size (max.)	2/3"
TV distortion [%]	0.08
Dimension [mm]	φ51×55.5




### HF75SA-1

Focal length [mm]	75
Iris range (F. no)	F1.8-F22
Angle of view	6.7°x 5.0°(2/3")
Working Distance (*) [mm]	∞-900
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M49 x 0.75
Mount	C-mount
Weight (approx.) [g]	305
Sensor size (max.)	2/3"
TV distortion [%]	0.01
Dimension [mm]	φ51×76

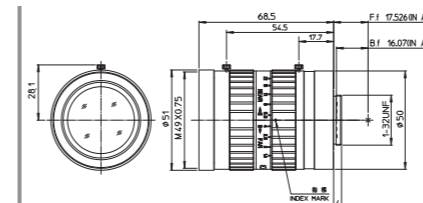
\* From front of lens barrel



Please download the specification sheet and the drawing data.

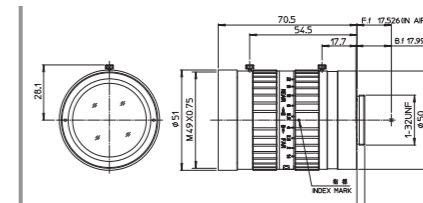


## CF-HA series 1.5 Megapixel, 1"



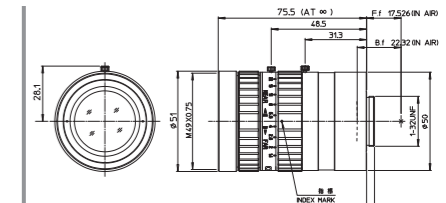
### CF12.5HA-1

Focal length [mm]	12.5
Iris range (F. no)	F1.4-F22
Angle of view	53.1°x 41.2°(1")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M49 x 0.75
Mount	C-mount
Weight (approx.) [g]	290
Sensor size (max.)	1"
TV distortion [%]	0.86
Dimension [mm]	φ51×68.5



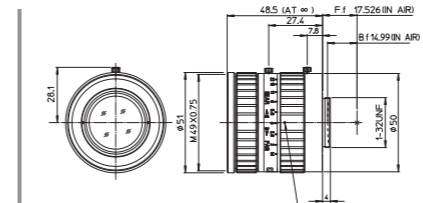
### CF16HA-1

Focal length [mm]	16
Iris range (F. no)	F1.4-F22
Angle of view	42.6°x 32.8°(1")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M49 x 0.75
Mount	C-mount
Weight (approx.) [g]	280
Sensor size (max.)	1"
TV distortion [%]	0.79
Dimension [mm]	φ51×70.5



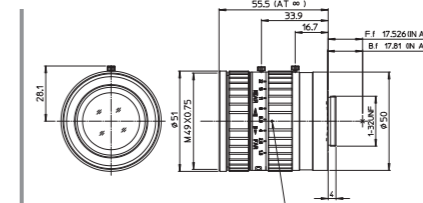
### CF25HA-1

Focal length [mm]	25
Iris range (F. no)	F1.4-F22
Angle of view	29.9°x 22.7°(1")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M49 x 0.75
Mount	C-mount
Weight (approx.) [g]	310
Sensor size (max.)	1"
TV distortion [%]	0.36
Dimension [mm]	φ51×75.5



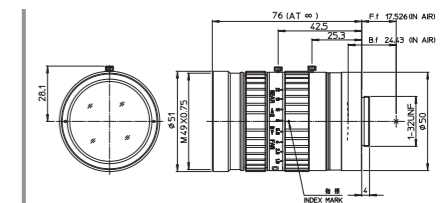
### CF35HA-1

Focal length [mm]	35
Iris range (F. no)	F1.4-F22
Angle of view	20.3°x 15.3°(1")
Working Distance (*) [mm]	∞-200
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M49 x 0.75
Mount	C-mount
Weight (approx.) [g]	180
Sensor size (max.)	1"
TV distortion [%]	0.18
Dimension [mm]	φ51×48.5



### CF50HA-1

Focal length [mm]	50
Iris range (F. no)	F1.8-F22
Angle of view	14.1°x 10.6°(1")
Working Distance (*) [mm]	∞-400
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M49 x 0.75
Mount	C-mount
Weight (approx.) [g]	235
Sensor size (max.)	1"
TV distortion [%]	0.20
Dimension [mm]	φ51×55.5



### CF75HA-1

Focal length [mm]	75
Iris range (F. no)	F1.8-F22
Angle of view	9.8°x 7.3°(1")
Working Distance (*) [mm]	∞-900
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M49 x 0.75
Mount	C-mount
Weight (approx.) [g]	300
Sensor size (max.)	1"
TV distortion [%]	0.01
Dimension [mm]	φ51×76

\* From front of lens barrel





HF-XA-5M Seires

HF6XA-5M

Table for HF6XA-5M series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

HF8XA-5M

Table for HF8XA-5M series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

HF12XA-5M

Table for HF12XA-5M series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

HF16XA-5M

Table for HF16XA-5M series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

HF25XA-5M

Table for HF25XA-5M series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

HF35XA-5M

Table for HF35XA-5M series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

- \* This data shows simulation value.
\* When attached with a extension tube, the optical performance of the lenses is not covered under warranty.

Sensor size table showing dimensions for 1", 2/3", 1/2", and 1/3" sensors.

HF-HA Seires

DF6HA-1B

Table for DF6HA-1B series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

HF9HA-1B

Table for HF9HA-1B series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

HF12.5HA-1B

Table for HF12.5HA-1B series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

HF16HA-1B

Table for HF16HA-1B series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

HF25HA-1B

Table for HF25HA-1B series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

HF35HA-1B

Table for HF35HA-1B series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

HF50HA-1B

Table for HF50HA-1B series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

HF75HA-1B

Table for HF75HA-1B series showing Working Distance, Optical Magnification, Extension tube, and Field of View for various magnifications and distances.

- \* This data shows simulation value.
\* When attached with a extension tube, the optical performance of the lenses is not covered under warranty.

Sensor size table showing dimensions for 1", 2/3", 1/2", and 1/3" sensors.



# HF-SA series

## HF12.5SA

Working Distance [mm]	Optical Magnification	Extension tube [mm]	Field of View [mm]					
			2/3"		1/2"		1/3"	
			H	V	H	V	H	V
1000	0.013x	-	705.4	528.0	511.9	383.3	383.3	287.2
950	0.013x	-	670.9	502.2	486.9	364.6	364.6	273.2
900	0.014x	-	636.4	476.4	461.8	345.8	345.8	259.1
850	0.015x	-	601.9	450.5	436.8	327.1	327.1	245.1
800	0.016x	-	567.5	424.7	411.8	308.3	308.3	231.0
750	0.017x	-	533.0	398.9	386.7	289.6	289.6	217.0
700	0.018x	-	498.5	373.1	361.7	270.8	270.8	202.9
650	0.019x	-	464.1	347.3	336.7	252.1	252.1	188.9
600	0.021x	-	429.6	321.5	311.7	233.3	233.3	174.8
550	0.022x	-	395.1	295.6	286.6	214.6	214.6	160.8
500	0.025x	-	360.6	269.8	261.6	195.8	195.8	146.7
450	0.027x	-	326.2	244.0	236.6	177.1	177.1	132.7
400	0.030x	-	291.7	218.2	211.5	158.3	158.3	118.6
350	0.034x	-	257.2	192.4	186.5	139.6	139.6	104.6
300	0.040x	-	222.8	166.6	161.5	120.8	120.8	90.5
250	0.047x	-	188.3	140.7	136.4	102.1	102.1	76.5
200	0.058x	-	153.8	114.9	111.4	83.4	83.4	62.4
150	0.075x	-	119.3	89.1	86.4	64.6	64.6	48.4
100	0.105x	-	84.9	63.3	61.3	45.9	45.9	34.3

## HF25SA

Working Distance [mm]	Optical Magnification	Extension tube [mm]	Field of View [mm]					
			2/3"		1/2"		1/3"	
			H	V	H	V	H	V
1000	0.023x	-	378.4	283.4	274.8	205.9	205.9	154.4
950	0.025x	-	360.0	269.6	261.4	195.9	195.9	146.8
900	0.026x	-	341.6	255.9	248.1	185.9	185.9	139.3
850	0.027x	-	323.2	242.1	234.7	175.9	175.9	131.3
800	0.029x	-	304.9	228.3	221.4	165.9	165.9	124.3
750	0.031x	-	286.5	214.5	208.0	155.9	155.9	116.8
700	0.033x	-	268.1	200.8	194.7	145.8	145.8	109.3
650	0.035x	-	249.7	187.0	181.3	135.8	135.8	101.8
600	0.038x	-	231.3	173.2	167.9	125.8	125.8	94.3
550	0.042x	-	212.9	159.4	154.6	115.8	115.8	86.8
500	0.045x	-	194.6	145.7	141.2	105.8	105.8	79.3
450	0.050x	-	176.2	131.9	127.9	95.8	95.8	71.8
400	0.056x	-	157.8	118.1	114.5	85.8	85.8	64.3
350	0.063x	-	139.4	104.3	101.1	75.8	75.8	56.8
300	0.073x	-	121.0	90.5	87.8	65.7	65.7	49.3
250	0.086x	-	102.6	76.8	74.4	55.7	55.7	41.8
200	0.105x	-	84.2	63.0	61.1	45.7	45.7	34.3
150	0.135x	-	65.9	49.2	47.7	35.7	35.7	26.8
100	0.187x	-	47.5	35.4	34.3	25.7	25.7	19.2

## HF50SA

Working Distance [mm]	Optical Magnification	Extension tube [mm]	Field of View [mm]					
			2/3"		1/2"		1/3"	
			H	V	H	V	H	V
1500	0.034x	-	255.5	191.6	185.8	139.4	139.4	104.5
1450	0.036x	-	247.0	185.3	179.7	134.8	134.8	101.1
1400	0.037x	-	238.5	178.9	173.5	130.1	130.1	97.6
1350	0.038x	-	230.0	172.5	167.3	125.5	125.5	94.1
1300	0.040x	-	221.5	166.1	161.1	120.8	120.8	90.6
1250	0.041x	-	213.0	159.8	154.9	116.2	116.2	87.1
1200	0.043x	-	204.5	153.4	148.7	111.6	111.6	83.7
1150	0.045x	-	196.0	147.0	142.6	106.9	106.9	80.2
1100	0.047x	-	187.5	140.6	136.4	102.3	102.3	76.7
1050	0.049x	-	179.0	134.3	130.2	97.6	97.6	73.2
1000	0.052x	-	170.5	127.9	124.0	93.0	93.0	69.7
950	0.054x	-	162.0	121.5	117.8	88.4	88.4	66.3
900	0.057x	-	153.5	115.1	111.6	83.7	83.7	62.8
850	0.061x	-	145.0	108.7	105.4	79.1	79.1	59.3
800	0.064x	-	136.5	102.4	99.3	74.4	74.4	55.8
750	0.069x	-	128.0	96.0	93.1	69.8	69.8	52.3
700	0.074x	-	119.5	89.6	86.9	65.2	65.2	48.9
650	0.079x	-	111.0	83.2	80.7	60.5	60.5	45.4
600	0.086x	-	102.5	76.9	74.5	55.9	55.9	41.9
550	0.094x	-	94.0	70.5	68.3	51.2	51.2	38.4
500	0.103x	-	85.5	64.1	62.2	46.6	46.6	34.9
450	0.114x	-	77.0	57.7	56.0	42.0	42.0	31.5
400	0.129x	-	68.5	51.3	49.8	37.3	37.3	28.0
350	0.147x	1	60.0	45.0	43.6	32.7	32.7	24.5
300	0.171x	5	51.5	38.6	37.4	28.0	28.0	21.0
250	0.205x	5	43.0	32.2	31.2	23.4	23.4	17.5
200	0.256x	10	34.5	25.8	25.0	18.8	18.8	14.1
150	0.340x	15	25.9	19.4	18.8	14.1	14.1	10.6
100	0.507x	20	17.4	13.0	12.6	9.5	9.5	7.1

■ Sensor size

1"	12.8x9.6
2/3"	8.8x6.6
1/2"	6.4x4.8
1/3"	4.8x3.6

\* This data shows simulation value.  
\* When attached with an extension tube, the optical performance of the lenses is not covered under warranty.

## HF16SA

Working Distance [mm]	Optical Magnification	Extension tube [mm]	Field of View [mm]					
			2/3"		1/2"		1/3"	
			H	V	H	V	H	V
1000	0.016x	-	556.0	416.9	404.3	303.1	303.1	227.2
950	0.017x	-	529.1	396.7	384.7	288.4	288.4	216.2
900	0.018x	-	502.1	376.5	365.1	273.7	273.7	205.2
850	0.019x	-	475.2	356.3	345.5	259.0	259.0	194.2
800	0.020x	-	448.2	336.0	325.8	244.3	244.3	183.1
750	0.021x	-	421.3	315.8	306.2	229.6	229.6	172.1
700	0.022x	-	394.3	295.6	286.6	214.8	214.8	161.1
650	0.024x	-	367.4	275.4	267.0	200.1	200.1	150.0
600	0.026x	-	340.4	255.2	247.4	185.4	185.4	139.0
550	0.028x	-	313.5	234.9	227.8	170.7	170.7	128.0
500	0.031x	-	286.5	214.7	208.2	156.0	156.0	117.0
450	0.034x	-	259.6	194.5	188.6	141.3	141.3	105.9
400	0.038x	-	232.6	174.3	169.0	126.6	126.6	94.9
350	0.043x	-	205.7	154.0	149.4	111.9	111.9	83.9
300	0.049x	-	178.7	133.8	129.7	97.2	97.2	72.8
250	0.058x	-	151.8	113.6	110.1	82.5	82.5	61.8
200	0.071x	-	124.8	93.4	90.5	67.8	67.8	50.8
150	0.091x	-	97.9	73.1	70.9	53.1	53.1	39.8
100	0.126x	-	70.9	52.9	51.3	38.4	38.4	28.7

## HF35SA

Working Distance [mm]	Optical Magnification	Extension tube [mm]	Field of View [mm]					
			2/3"		1/2"		1/3"	
			H	V	H	V	H	V
1000	0.035x	-	249.2	186.9	181.2	135.9	135.9	101.9
950	0.037x	-	236.9	177.6	172.2	129.2	129.2	96.9
900	0.039x	-	224.6	168.4	163.3	122.5	122.5	91.8
850	0.041x	-	212.3	159.2	154.3	115.7	115.7	86.8
800	0.044x	-	200.0	149.9	145.4	109.0	109.0	81.8
750	0.047x	-	187.7	140.7	136.4	102.3	102.3	76.7
700	0.050x	-	175.4	131.5	127.5	95.6	95.6	71.7
650	0.054x	-	163.1	122.2	118.5	88.9	88.9	66.7
600	0.058x	-	150.8	113.0	109.6	82.2	82.2	61.6
550	0.064x	-	138.5	103.8	100.6	75.5	75.5	56.6
500	0.070x	-	126.2	94.6	91.7	68.7	68.7	51.5
450	0.077x	-	113.9	85.3	82.7	62.0	62.0	46.5
400	0.087x	-	101.6	76.1	73.8	55.3	55.3	41.5
350	0.099x	-	89.3	66.9	64.8	48.6	48.6	36.4
300	0.115x	-	76.9	57.6	55.9	41.9	41.9	31.4
250	0.137x	-	64.6	48.4	46.9	35.2	35.2	26.4
200	0.169x	-	52.3	39.2	38.0	28.4	28.4	21.3
150	0.221x	2	40.0	29.9	29.0	21.7	21.7	16.3
100	0.320x	10	27.6	20.7	20.0	15.0	15.0	11.2

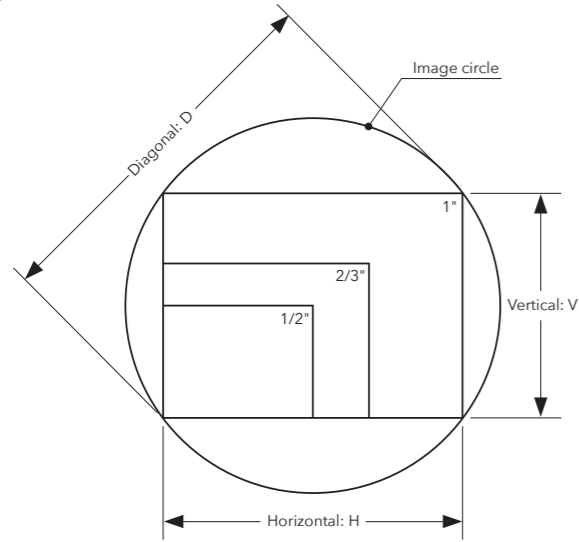
## HF75SA

Working Distance [mm]	Optical Magnification	Extension tube [mm]	Field of View [mm]					
			2/3"		1/2"		1/3"	
			H	V	H	V	H	V
2000	0.038x	-	230.8	173.1	167.9	125.9	125.9	94.4
1950	0.039x	-	225.0	168.7	163.6	122.7	122.7	92.0
1900	0.040x	-	219.1	164.3	159.3	119.5	119.5	89.6
1850	0.041x	-	213.2	159.9	155.1	116.3	116.3	87.2
1800	0.042x	-	207.4	155.5	150.8	113.1	113.1	84.8
1750	0.044x	-	201.5	151.1	146.5	109.9	109.9	82.4
1700	0.045x	-	195.6	146.7	142.3	106.7	106.7	80.0
1650	0.046x	-	189.8	142.3	138.0	103.5	103.5	77.6
1600	0.048x	-	183.9	137.9	133.7	100.3	100.3	75.2
1550	0.049x	-	178.0	133.5	129.5	97.1	97.1	72.8
1500	0.051x	-	172.2	129.1	125.2	93.9	93.9	70.4
1450	0.053x	-	166.3	124.7	120.9	90.7	90.7	68.0
1400	0.055x	-	160.4	120.3	116.7	87.5	87.5	65.6
1350	0.057x	-	154.6	115.9	112.4	84.3	84.3	63.2
1300	0.059x	-	148.7	111.5	108.1	81.1	81.1	60.8
1250	0.062x	-	142.8	107.1	103.9	77.9	77.9	58.4
1200	0.064x	-	137.0	102.7	99.6	74.7	74.7	



# Technical Information

## Image Sizes

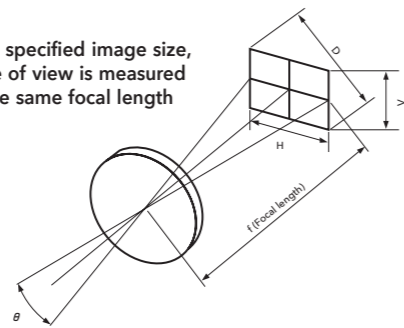


There are several types of imaging sensors for FA cameras, with different image sizes. The aspect ratio of FA camera is normally 4:3 (H:V).

Product symbol	Image sensor	Image size (mm)		
		Horizontal:H	Vertical:V	Diagonal:D
C	1"	12.8	9.6	16.0
H	2/3"	8.8	6.6	11.0
D	1/2"	6.4	4.8	8.0
35mm camera lens (Reference)	35mm Film	36.0	24.0	43.3

## Angle of View

The angle of view is the object size that can be captured at a specified image size, which is represented by angular measure. Normally the angle of view is measured assuming a lens is focused at infinity. When using a lens of the same focal length with a different image size, the angle of view will differ.



$$\theta = 2 \tan^{-1} \frac{Y'}{2f}$$

$\theta$  : Angle of view  
 $Y'$  : Image size  
 $f$  : Focal length

Eg. The angle of view when the camera size is 1/2" and the focal length is 12.5mm:

$$\theta = 2 \tan^{-1} \frac{6.4}{2 \times 12.5} = 28.72^\circ$$

## Depth of Field

When focusing on a certain area in front of and behind the deep object appears in focus. This area is called the depth of field. This is because the focus appears sharp if the focus misalignment is under a certain volume. This certain volume is called the permissible circle of confusion.

- The depth of field has following properties.
- 1)The larger the F No. is, the wider the depth of field becomes.
  - 2)The shorter the focal length is, the wider the depth of field becomes.
  - 3)The longer the distance to the object is, the wider depth of field becomes.
  - 4)The backward depth of field is wider than the forward depth of field.

Image sensor	Permissible circle of confusion
1"	0.03 mm
2/3"	0.021 mm
1/2"	0.015 mm
1/3"	0.011 mm
1/4"	0.008 mm

The depth of field can be calculated by the following formula.

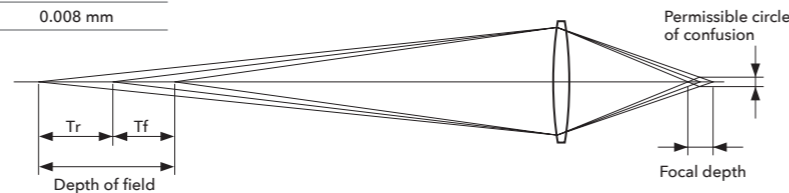
$$\text{Backward depth of field } Tr = \frac{\delta \cdot F \cdot L^2}{f^2 - \delta \cdot F \cdot L}$$

$$\text{Forward depth of field } Tf = \frac{\delta \cdot F \cdot L^2}{f^2 + \delta \cdot F \cdot L}$$

$$\text{Depth of field} = Tr + Tf$$

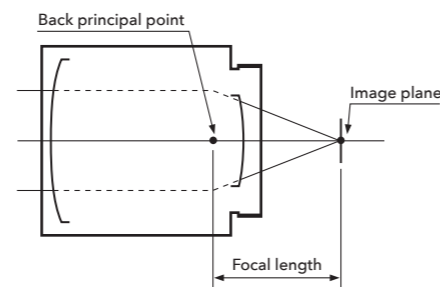
$$\text{Focal depth} = 2 \delta \cdot F$$

$f$  : Focal distance  
 $F$  : F No.  
 $\delta$  : Permissible circle diameter of confusion  
 $L$  : Object distance



## Focal Length

The focal length will be the distance from the back principal point to the image plane. Lower the focal length wider the image



## Brightness of a Lens (F No.)

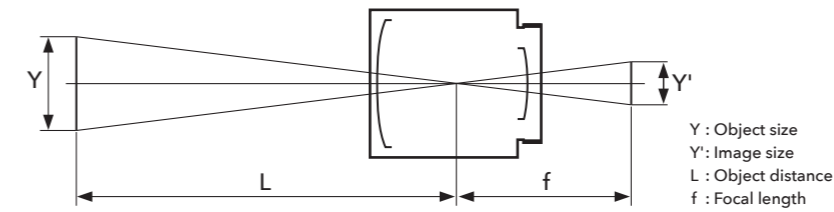
The F No. is an indication of the brightness of lens. The smaller the value, the brighter the image produced by the lens. The F No. is inversely proportional to the effective diameter of the lens and directly proportional to the focal length.

The F No. is a value determined on the assumption that the transmittance of the lens is 100%. Virtually all lenses however, have different spectral transmittance, and thus, the same F No. can have different levels of brightness.

$$F \text{ No.} = \frac{f}{d}$$

$f$  : Focal length of a lens  
 $d$  : Effective diameter of a lens

## Field of View and Focal Length



### (1) How to calculate the field of view

If the distance to the object is finite, you can use the following formula to calculate the field of view.

$$Y = Y' \cdot \frac{L}{f}$$

Eg. 1/3" CCD camera with an 8mm lens is used, and the distance to the object is 3m. The maximum horizontal width as viewed on the monitor can be calculated as follows.

$$Y = 4.8 \times \frac{3000}{8} = 1800 \rightarrow \text{Horizontal width 1.8 m}$$

$Y'$  : 4.8  
 $L$  : 3000  
 $f$  : 8

### (2) How to calculate focal length

If the distance to the object is finite, you can use the following formula to calculate the focal length.

$$f = Y' \cdot \frac{L}{Y}$$

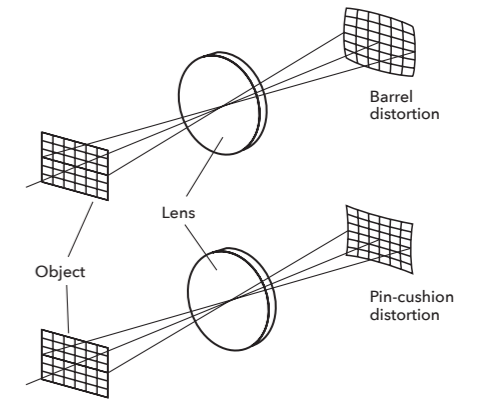
Eg. 1/3" CCD camera with an 8mm lens is used, and the distance to the object is 3m. The maximum horizontal width as viewed on the monitor can be calculated as follows.

$$f = 4.8 \times \frac{3000}{2000} = 7.2 \rightarrow \text{Focal length approx. 7 mm}$$

$Y'$  : 4.8  
 $L$  : 3000  
 $Y$  : 2000

## Distortion

Distortion is an aberration where the geometric figure of the object is not reproduced faithfully at the image plane. It is normally represented by the level shift of an image point from its ideal position by a percentage of image height or width.



## MTF (Modulation Transfer Function)

MTF (Modulation Transfer Function) represents the declining contrast rate when shooting a chart consisted of black and white lines.

