

Europe / Middle East / Africa

FUJIFILM Europe GmbH
Heesenstr. 31, 40549 Duesseldorf, Germany
TEL: +49 (0) 211 5089 0 FAX: +49 (0) 211 5089 8900
<http://www.fujifilm.eu>
E-mail: cctv@fujifilm.eu

FUJIFILM France S.A.S.
16 Rue Etienne Jules Marey - BP 34
78391 BOIS D'ARCY Cedex - France
TEL: +33 (0)1-3014-3456 FAX: +33 (0)1-3460-1660
<http://www.fujifilm.eu>
E-mail: webmaster@fujifilm.fr

Fujifilm Russia
1st Magistralny tup., 5a, business center Magistral Plaza,
4th floor, 123290, Moscow, Russia
TEL: +7 (495)797-35-12 FAX: +7 (495)797-35-13
<http://www.fujifilm.eu>
E-mail: cctv@fujifilm.eu

Japan / North East Asia
FUJIFILM Corporation
Optical Device & Electronic Imaging Products Div.
1-324 Uetake, Kita-ku, Saitama City Saitama, 331-9624,
Japan
TEL: +81 (0)48-668-2152 FAX: +81 (0)48-651-8517
<http://www.fujifilm.co.jp/>

China

FUJIFILM (China) Investment Co., Ltd.
Optical Device Business Division
28F, Shanghai ONELUJIAZUI, No.68 YinCheng Road(M),
Pudong New Area, Shanghai, P.R.China 200120
TEL: +86-21-5010-6000 *384
FAX: +86-21-5010-6730
<http://www.fujifilm.com.cn>

Hong Kong / Taiwan

FUJIFILM Hong Kong Limited
Optical Device Division
Unit 1001-1007, 10/F., Metroplaza Tower 2,
223 Hing Fong Road, Kwai Fong, N.T., Hong Kong.
Tel: (852) 2376-0998 Fax: (852) 2724-1118

Southeast Asia & West Asia

Fujifilm Asia Pacific Pte Ltd.
10 New Industrial Road, Fujifilm Building Singapore 536201
TEL: +65 (0)63839933 FAX: +65 (0)63835666
<http://www.fujifilm.com.sg/>

Oceania

FUJIFILM Australia Pty Ltd.
114 Old Pittwater Road, Brookvale, N.S.W. 2100, Australia
TEL: +61 (0)2-9466-2600 FAX: +61 (0)2-9905-3801
<http://www.fujifilm.com.au/>

North & Latin America

FUJIFILM North America Corporation
Optical Devices Division
10 High Point Drive, Wayne, NJ 07470
TEL: +1-973-633-5600 FAX: +1-973-633-5216
<http://www.fujifilmusa.com>



FUJINON
Machine Vision Lenses

Authorized Fujifilm Service Agent.



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All photos, illustrations, drawings and other images in this brochure are intended for illustrative purpose only.





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

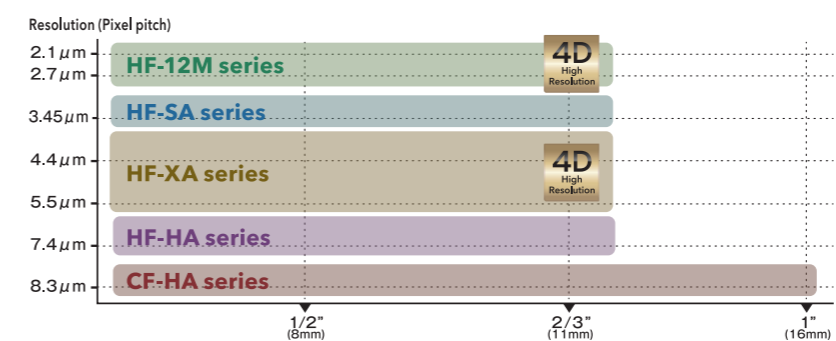
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Lens Selection Guide



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.



NEW HF-12M series 12 Megapixel, 2/3" 4D High Resolution



<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%

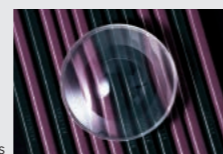
- The lenses' unique optical design minimizes troublesome distortion. In industrial applications requiring accuracy such as dimension measurement. The series boasts an industry-leading low distortion rate of no more than 0.05%*2.
- The aspherical glass*3 mold lens enabled the smallest body and low distortion.

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

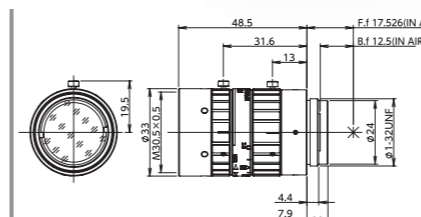


Aspherical lens



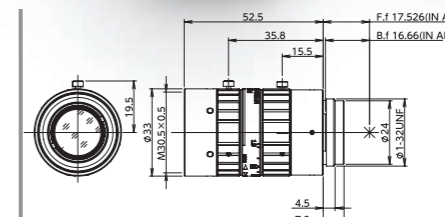
General MV lens only with spherical lenses

MV lens with an aspherical lens



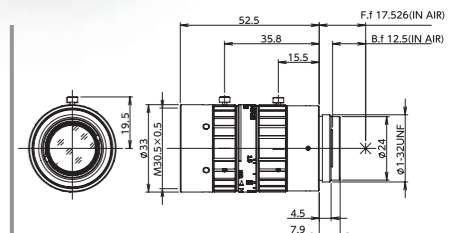
HF818-12M

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



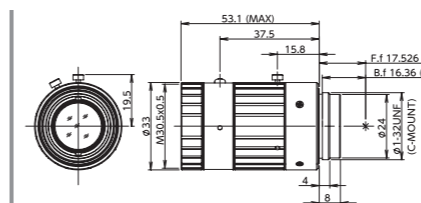
HF1218-12M

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



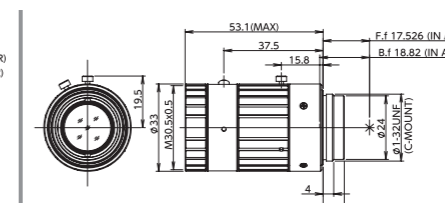
HF1618-12M

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

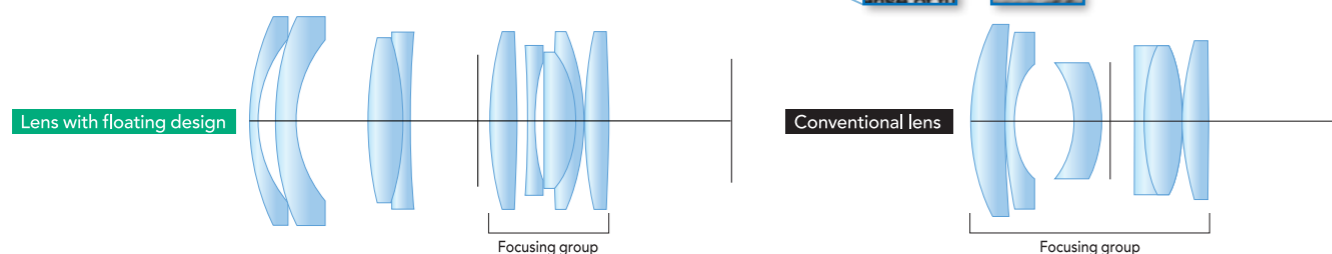
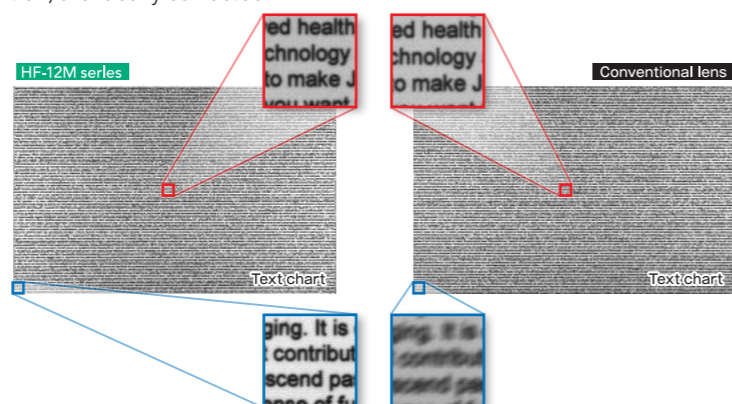
Maintaining High-Resolution is about Controlling Aberration.

3 Technologies Supporting "4D High-Resolution"

1 Floating design technology

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

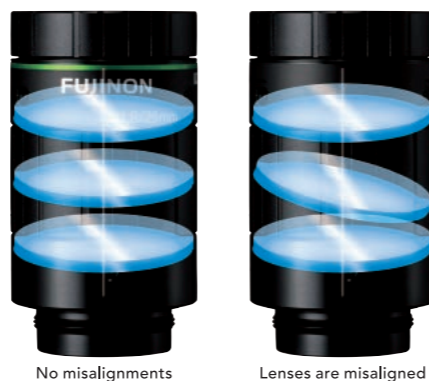
- The lenses are designed to show the best resolution at the shooting distance most commonly used (designed distance). At this distance, the aberrations (color fringe/peripheral blur/distortion) are ideally corrected.
- Although conventional lens design technology optimally controlled aberration at the 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–

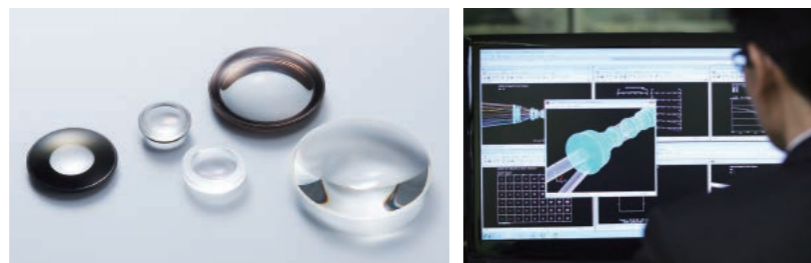
- Misalignment of the axis of the lenses during the manufacturing process prevents the intended performance from being exhibited. It is crucial to align the axis of the lenses to the micrometer level during its manufacturing process.
- The HF-12M series realized high-resolution consistent all the way 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.



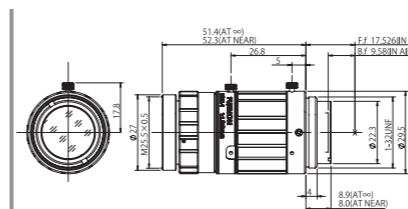
Please download the specification sheet and the drawing data.



NEW

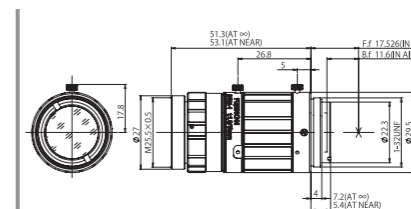
HF-XA series 3 Megapixel, 2/3"

4D
High
Resolution



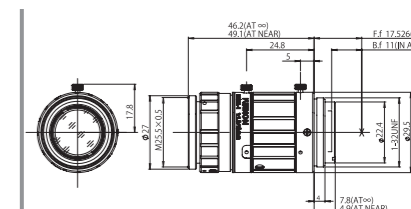
HF8XA-1

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



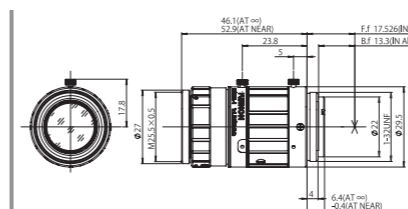
HF12XA-1

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



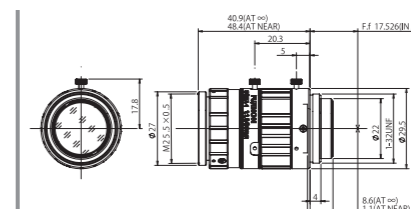
HF16XA-1

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-1

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



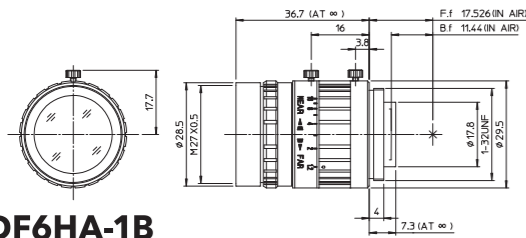
HF35XA-1

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

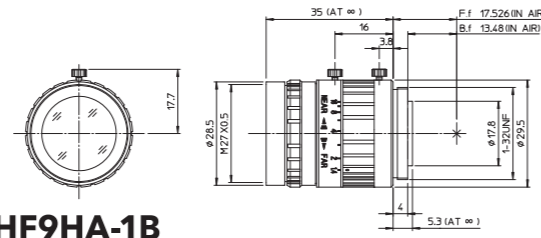


HF-HA series 1.5 Megapixel, 2/3"



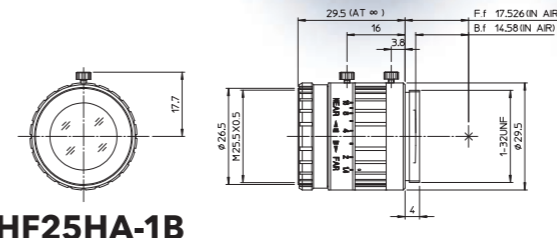
DF6HA-1B

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



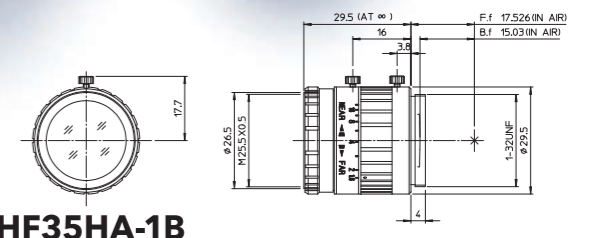
HF9HA-1B

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



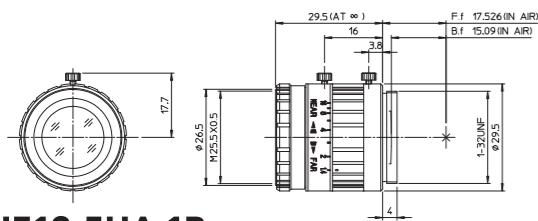
HF25HA-1B

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



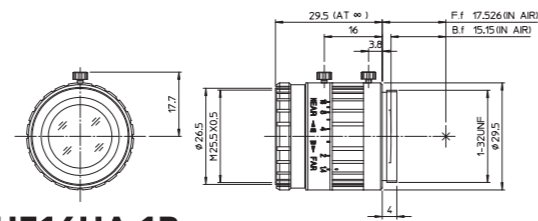
HF35HA-1B

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



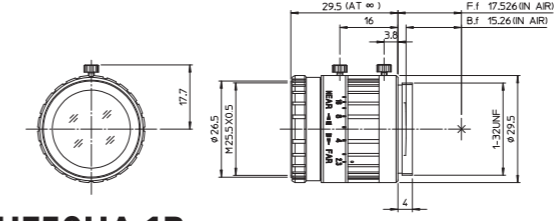
HF12.5HA-1B

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



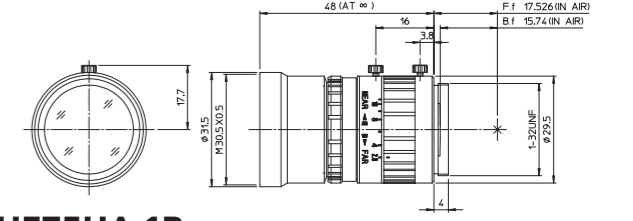
HF16HA-1B

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
	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

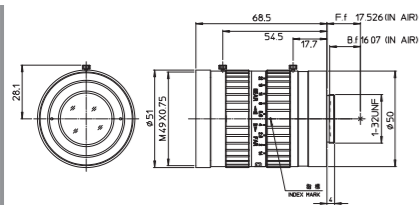
* From front of lens barrel



Please download the specification sheet and the drawing data.

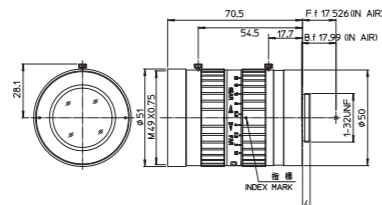


HF-SA series 5 Megapixel, 2/3"



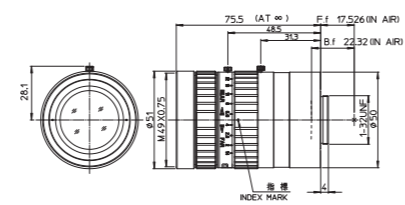
HF12.5SA-1

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



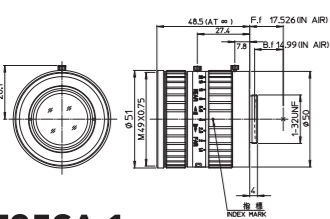
HF16SA-1

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



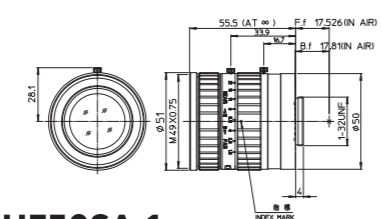
HF25SA-1

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



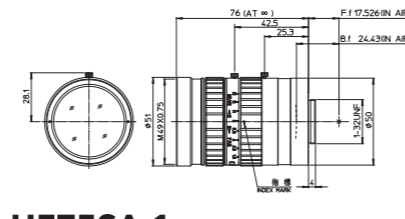
HF35SA-1

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

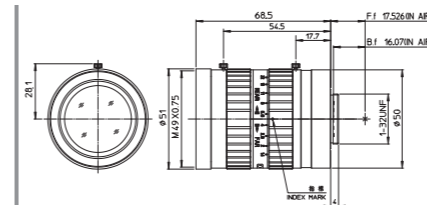
* From front of lens barrel



Please download the specification sheet and the drawing data.

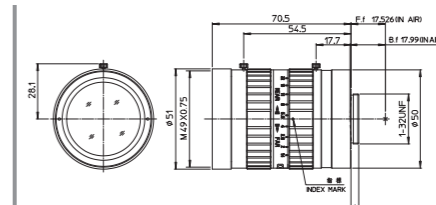


CF-HA series 1.5 Megapixel, 1"



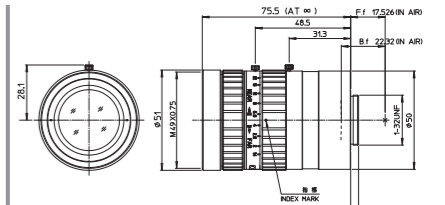
CF12.5HA-1

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



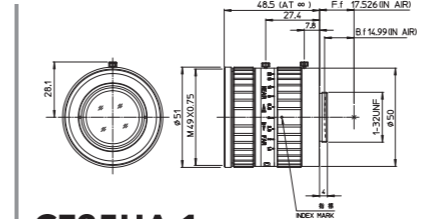
CF16HA-1

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



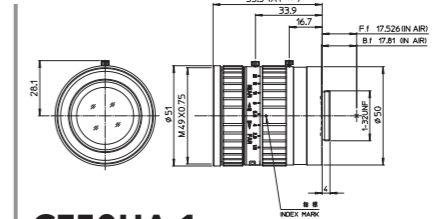
CF25HA-1

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



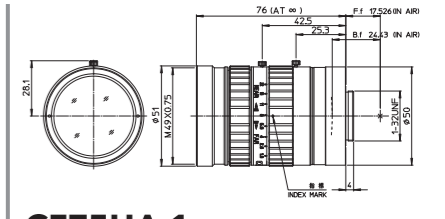
CF35HA-1

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

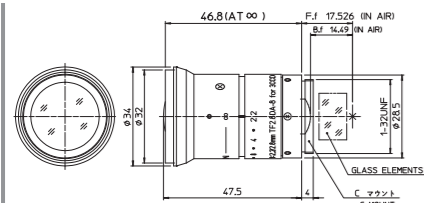
* From front of lens barrel



Please download the specification sheet and the drawing data.

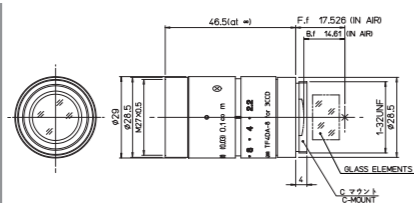


TF series 3CCD, 1/3"



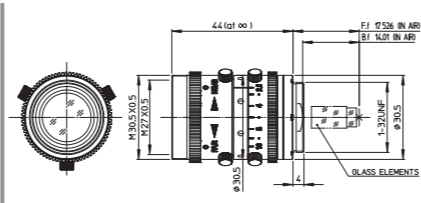
TF2.8DA-8

Focal length [mm]	2.8
Iris range (F. no)	F2.2-F16·Close
Angle of view	89.1°x 69.3°(1/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	-
Mount	C-mount
Weight (approx.) [g]	75
Sensor size (max.)	1/3"
TV distortion [%]	-6.25
Dimension [mm]	φ34x47.5



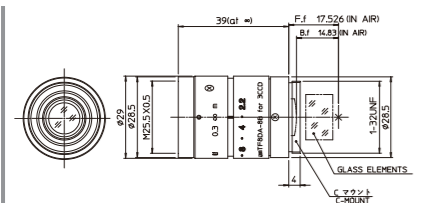
TF4DA-8

Focal length [mm]	4
Iris range (F. no)	F2.2-F16·Close
Angle of view	64.5°x 49.0°(1/3")
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]	70
Sensor size (max.)	1/3"
TV distortion [%]	-3.77
Dimension [mm]	φ29x46.5



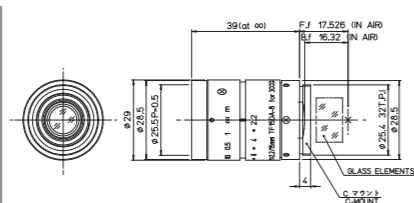
TF4XA-1 2MP

Focal length [mm]	4
Iris range (F. no)	F2.2
Angle of view	64.5°x 49.1°(1/3")
Working Distance (*) [mm]	∞-100
Operation of focus	Manual
Operation of iris	Manual
Filter thread [mm]	M27 x 0.5 (INSIDE) M30.5x0.5 (OUTSIDE)
Mount	C-mount
Weight (approx.) [g]	100
Sensor size (max.)	1/3"
TV distortion [%]	-4.27
Dimension [mm]	φ30.5x44



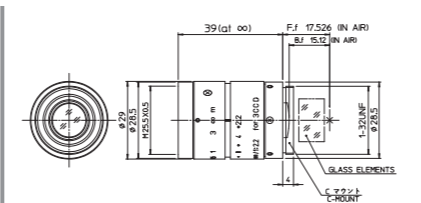
TF8DA-8B

Focal length [mm]	8
Iris range (F. no)	F2.2-F16·Close
Angle of view	33.4°x 25.1°(1/3")
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]	60
Sensor size (max.)	1/3"
TV distortion [%]	-1.30
Dimension [mm]	φ29x39



TF15DA-8

Focal length [mm]	15
Iris range (F. no)	F2.2-F16·Close
Angle of view	18.0°x 13.5°(1/3")
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]	60
Sensor size (max.)	1/3"
TV distortion [%]	-0.31
Dimension [mm]	φ29x39



TF25DA-8B

Focal length [mm]	25
Iris range (F. no)	F2.2-F16·Close
Angle of view	11.0°x 8.3°(1/3")
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.)	1/3"
TV distortion [%]	-0.06
Dimension [mm]	φ29x39

* From front of lens barrel

Optical Magnification Ratio Chart [Reference data]

SAMPLE		Product name		HF9HA-1B	
		Focal Length		f9	
Extension tube (mm)	Focus	Shooting range (HxV)			
		NEAR		FAR	
5	WD#	2		4	
	2/3"	15.4x11.1	17.7x12.8		
	1/2"	10.7x7.9	12.3x9.1		
	1/3"	7.9x5.9	9.1x6.7		
	mag	0.624x	0.542x		

※Working distance ← Lens magnification

Sensor size

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

HF-12M series

Extension tube (mm)	Product name	HF818-12M	HF1218-12M	HF1618-12M	HF2518-12M	HF3520-12M
	Focal Length	f8	f12	f16	f25	f35
	Focus	Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)
0	WD	100	100	100	100	200
	2/3"	123.7x92.0	84.8x63.5	66.6x49.8	42.3x31.7	53.2x39.8
	1/2"	89.1x66.6	61.6x46.2	48.3x36.1	30.7x23.0	38.6x29.0
	1/3"	66.6x49.8	46.2x34.6	36.1x27.1	23.0x17.2	29.0x21.7
	mag	0.072x	0.104x	0.133x	0.200x	0.000x
0.5	WD	48	67	77	90	183
	2/3"	67.5x50.1	61.1x45.7	53.7x40.2	38.6x28.9	48.9x36.6
	1/2"	48.6x36.2	44.3x33.2	38.9x29.2	28.0x21.0	35.5x26.6
	1/3"	36.2x27.1	33.2x24.9	29.2x21.8	21.0x15.7	26.6x20.0
	mag	0.133x	0.145x	0.165x	0.229x	0.180x
1	WD	28	48	62	81	169
	2/3"	46.5x34.5	47.8x35.7	45.0x33.7	35.5x26.6	45.2x33.9
	1/2"	33.4x24.9	34.6x25.9	32.6x24.4	25.8x19.3	32.8x24.6
	1/3"	24.9x18.6	25.9x19.4	24.4x18.3	19.3x14.5	24.6x18.5
	mag	0.193x	0.185x	0.197x	0.249x	0.195x
1.5	WD	18	36	51	73	157
	2/3"	35.5x26.3	39.2x29.3	38.7x29.0	32.9x24.6	42.1x31.5
	1/2"	25.5x19.0	28.4x21.3	28.1x21.0	23.9x17.9	30.6x22.9
	1/3"	19.0x14.2	21.3x15.9	21.0x15.8	17.9x13.4	22.9x17.2
	mag	0.254x	0.226x	0.229x	0.269x	0.210x
2	WD	12	28	42	67	146
	2/3"	28.7x21.3	33.3x24.9	34.0x25.4	30.6x22.9	39.3x29.5
	1/2"	20.6x15.4	24.1x18.0	24.6x18.5	22.2x16.6	28.6x21.4
	1/3"	15.4x11.5	18.0x13.5	18.5x13.8	16.6x12.5	21.4x16.1
	mag	0.314x	0.267x	0.261x	0.289x	0.224x
5	WD		6	17	42	103
	2/3"		17.5x13.0	19.6x14.7	21.7x16.2	28.3x21.2
	1/2"		12.6x9.4	14.2x10.6	15.7x11.7	20.5x15.4
	1/3"		9.4x7.1	11.9x8.9	11.7x8.8	15.4x11.5
		mag	0.511x	0.407x	0.452x	0.312x
10	WD			3	22	68
	2/3"			11.5x8.6	14.2x10.6	19.3x14.4
	1/2"			8.3x6.2	10.3x7.7	14.0x10.5
	1/3"			6.2x4.7	7.7x5.8	10.5x7.9
			mag	0.771x	0.624x	0.610x
15	WD				12	50
	2/3"				11.0x8.2	14.8x11.0
	1/2"				7.9x5.9	10.7x8.0
	1/3"				5.9x4.4	8.0x6.0
				mag	0.811x	0.601x
20	WD				5	41
	2/3"				8.8x6.6	11.1x8.3
	1/2"				6.4x4.8	8.0x6.0
	1/3"				4.8x3.6	6.0x4.5
				mag	1.011x	0.802x
25	WD					32
	2/3"					9.8x7.4
	1/2"					7.1x5.4
	1/3"					5.4x4.0
					mag	0.897x
30	WD					27
	2/3"					8.5x6.3
	1/2"					6.1x4.6
	1/3"					4.6x3.5
					mag	1.043x
35	WD					23
	2/3"					7.4x5.6
	1/2"					5.4x4.0
	1/3"					4.0x3.0
					mag	1.189x
40	WD					19
	2/3"					6.6x5.0
	1/2"					4.8x3.6
	1/3"					3.6x2.7
					mag	1.335x
45	WD					17
	2/3"					6.0x4.5
	1/2"					4.3x3.2
	1/3"					3.2x2.4
					mag	1.482x
50	WD					15
	2/3"					5.4x4.1
	1/2"					3.9x3.0
	1/3"					3.0x2.2
					mag	1.628x
70	WD					9
	2/3"					4.0x3.0
	1/2"					2.9x2.2
	1/3"					2.2x1.6
					mag	2.213x

■ SAMPLE

Extension tube (mm)	Product name		HF9HA-1B (mm)	
	Focal Length		f9	
	Focus		Shooting range (HxV)	
5	WD		2	4
	2/3"	15.4x11.1	17.7x12.8	
	1/2"	10.7x7.9	12.3x9.1	
	1/3"	7.9x5.9	9.1x6.7	
	mag	0.624x	0.542x	

※ Working distance
← Lens magnification

■ Sensor size

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

Optical Magnification Ratio Chart

■ HF-XA series

Extension tube (mm)	Product name		HF8XA-1		HF12XA-1		HF16XA-1		HF25XA-1		HF35XA-1	
	Focal Length		f8		f12		f16		f25		f35	
	Focus		Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)	
0	WD		100	INF	100	INF	100	INF	100	INF	200	INF
	2/3"	124.6x91.5	-x-	82.7x61.3	-x-	65.6x48.8	-x-	38.8x29.0	-x-	48.5x36.3	-x-	
	1/2"	88.6x65.6	-x-	59.4x44.2	-x-	47.3x35.3	-x-	28.1x21.1	-x-	35.2x26.4	-x-	
	1/3"	65.6x48.8	-x-	44.2x33.1	-x-	35.3x26.4	-x-	21.1x15.8	-x-	26.4x19.8	-x-	
	mag	0.074x	0.000x	0.109x	0.000x	0.137x	0.000x	0.228x	0.000x	0.282x	0.000x	
0.5	WD		50	126	69	293	78	486	91	1241	186	2472
	2/3"	68.9x50.6	154.0x113.1	60.4x44.8	224.3x166.3	53.4x39.7	283.6x211.4	35.7x26.7	442.3x331.4	45.0x33.7	617.9x463.8	
	1/2"	49.0x36.3	109.5x81.1	43.4x32.3	161.1x120.0	38.5x28.7	204.9x153.1	25.9x19.4	321.3x240.9	32.7x24.5	449.7x337.4	
	1/3"	36.3x27.0	81.1x60.4	32.3x24.2	120.0x89.7	28.7x21.5	153.1x114.6	19.4x14.5	240.9x180.6	24.5x18.4	337.4x253.1	
	mag	0.135x	0.060x	0.150x	0.040x	0.168x	0.032x	0.248x	0.020x	0.312x	0.014x	
1	WD		31	57	52	139	63	234	84	612	174	1236
	2/3"	47.7x35.0	77.1x56.6	47.6x35.3	112.2x83.1	45.1x33.5	142.0x105.8	33.0x24.7	221.3x165.7	41.9x31.4	309.1x231.9	
	1/2"	33.9x25.1	54.8x40.5	34.2x25.5	80.6x60.0	32.4x24.2	102.5x76.6	23.9x17.9	160.7x120.4	30.5x22.8	224.9x168.7	
	1/3"	25.1x18.7	40.5x30.2	25.5x19.0	60.0x44.8	24.2x18.1	76.6x57.3	17.9x13.4	120.4x90.3	22.8x17.1	168.7x126.5	
	mag	0.195x	0.120x	0.190x	0.081x	0.200x	0.063x	0.210x	0.040x	0.268x	0.014x	
1.5	WD		21	34	41	88	53	150	77	403	163	824
	2/3"	36.5x26.7	51.4x37.7	39.3x29.1	74.8x55.4	39.0x28.9	94.8x70.6	30.8x23.0	147.6x110.5	39.3x29.4	206.1x154.6	
	1/2"	25.9x19.1	36.5x27.0	28.2x21.0	53.7x40.0	28.0x20.9	68.4x51.1	22.3x16.7	107.2x80.3	28.5x21.4	150.0x112.5	
	1/3"	19.1x14.3	27.0x20.1	21.0x15.7	40.0x29.9	20.9x15.6	51.1x38.2	16.7x12.5	80.3x60.2	21.4x16.0	112.5x84.4	
	mag	0.255x	0.181x	0.230x	0.121x	0.231x	0.095x	0.288x	0.060x	0.224x	0.043x	
2	WD		15	22	32	62	44	108	72	298	154	618
	2/3"	29.5x21.6	38.6x28.3	33.4x24.8	56.1x41.6	34.3x25.5	71.2x53.0	28.8x21.5	110.7x82.9	36.9x27.7	154.6x116.0	
	1/2"	20.9x15.5	27.4x20.3	24.0x17.9	40.3x30.0	24.7x18.4	51.3x38.3	20.9x15.6	80.4x60.2	26.8x20.1	112.5x84.4	
	1/3"	15.5x11.5	20.3x15.1	17.9x13.4	30.0x22.4	18.4x13.8	38.3x28.7	15.6x11.7	60.2x45.2	20.1x15.1	84.4x63.3	
	mag	0.315x	0.241x	0.271x	0.161x	0.263x	0.126x	0.308x	0.080x	0.239x	0.057x	
5	WD		1	2	11	16	19	32	49	110	115	247
	2/3"	13.8x10.1	15.5x11.3	17.7x13.1	22.5x16.6	20.1x14.9	28.7x21.3	20.8x15.5	44.4x33.2	27.2x20.4	61.9x46.4	
	1/2"	9.8x7.2	11.0x8.1	12.7x9.4	16.1x12.0	14.4x10.7	20.6x15.4	15.0x11.2	32.2x24.1	18.4x14.8	45.0x33.8	
	1/3"	7.2x5.4	8.1x6.0	9.4x7.1	12.0x9.0	10.7x8.0	15.4x11.5	11.2x8.4	24.1x18.1	14.8x11.1	33.8x25.3	
	mag	0.677x	0.602x	0.513x	0.403x	0.452x	0.315x	0.428x	0.199x	0.324x	0.142x	
10	WD						5	7	30	47	82	124
	2/3"					12.0x8.8	14.5x10.7	14.2x10.6	22.3x16.6	18.9x14.2	31.0x23.2	
	1/2"					8.5x6.3	10.4x7.7	10.3x7.7	16.1x12.1	13.7x10.3	22.5x16.9	
	1/3"					6.3x4.7	7.7x5.8	7.7x5.7	12.1x9.0	10.3x7.7	16.9x12.7	
	mag					0.767x	0.630x	0.627x	0.399x	0.466x	0.284x	
15	WD						21	26	64	82	137	200
	2/3"					10.8x8.0	14.9x11.1	14.5x10.9	20.7x15.5	17.4x13.4	28.4x21.6	
	1/2"					7.8x5.8	10.8x8.0	10.5x7.9	15.0x11.3	12.7x9.4	20.6x15.4	
	1/3"					5.8x4.4	8.0x6.0	7.9x5.9	11.3x8.4	9.4x7.1	15.4x11.5	
	mag					0.827x	0.598x	0.608x	0.427x	0.513x	0.333x	
20	WD						15	15	53	63	76	109
	2/3"					8.7x6.5	11.2x8.3	11.8x8.8	15.5x11.6	12.7x9.4	20.6x15.4	
	1/2"					6.3x4.7	8.1x6.0	8.5x6.4	11.3x8.4	9.4x7.1	15.4x11.5	
	1/3"					4.7x3.5	6.0x4.5	6.4x4.8	8.4x6.3	7.2x5.4	12.3x9.1	
	mag					1.026x	0.798x	0.751x	0.569x	0.677x	0.444x	
25	WD						11	9	46	49	63	88
	2/3"					7.3x5.4	8.9x6.7	9.9x7.4	12.4x9.3	10.3x7.7	16.9x12.7	
	1/2"					5.3x3.9	6.5x4.8	7.2x5.4	9.0x6.8	7.7x5.8	12.7x9.4	
	1/3"					3.9x2.9	4.8x3.6	5.4x4.0	6.8x5.1	5.8x4.4	9.4x7.1	
	mag					1.226x	0.997x	0.893x	0.711x	0.863x	0.569x	
30	WD						8	5	41	41	55	76
	2/3"					6.3x4.7	7.5x5.6	8.5x6.4	10.3x7.7	9.4x7.1	15.4x11.5	
	1/2"					4.5x3.4	5.4x4.0	6.2x4.6	7.5x5.6	6.3x4.7	9.4x7.1	
	1/3"					3.4x2.5	4.0x3.0	4.6x3.5	5.6x4.2	4.7x3.5	7.2x5.4	
	mag					1.425x	1.197x	1.035x	0.853x	1.026x	0.798x	
35	WD						37	35	133	133	179	247
	2/3"					7.5x5.6	8.9x6.6	9.9x7.4	12.4x9.3	10.3x7.7	16.9x12.7	
	1/2"					5.4x4.1	6.4x4.8	7.2x5.4	9.0x6.8	7.7x5.8	12.7x9.4	
	1/3"					4.1x3.1	4.8x3.6	5.4x4.0	6.8x5.1	5.8x4.4	9.4x7.1	
	mag					1.177x	0.996x	0.893x	0.711x	0.863x	0.569x	
40	WD						33	31	117	117	155	211
	2/3"					6.7x5.0	7.8x5.8	8.8x6.6	11.3x8.4	10.3x7.7	16.9x12.7	
	1/2"					4.9x3.6	5.6x4.2	6.4x4.8	8.1x6.0	7.2x5.4	10.3x7.7	
	1/3"					3.6x2.7	4.2x3.2	4.8x3.6	6.1x4.5	5.4x4.0	7.7x5.8	
	mag					1.320x	1.138x	1.026x	0.853x	1.026x	0.798x	
45	WD						31	27	102	102	133	180
	2/3"					6.0x4.5	6.9x5.2	7.8x5.8	10.3x7.7	9.4x7.1	15.4x11.5	
	1/2"					4.4x3.3	5.0x3.8	5.8x4.8	7.5x5.6	6.3x4.7	9.4x7.1	
	1/3"					3.3x2.5	3.8x2.8	4.4x3.3	5.6x4.2	4.7x3.5	7.2x5.4	
	mag					1.462x	1.280x	1.138x	0.906x	1.138x	0.853x	
50	WD						29	25	92	92	117	155
	2/3"					5.5x4.1	6.2x4.6	7.2x5.4	9.0x6.8	7.7x5.8	12.7x9.4	
	1/2"					4.0x3.0	4.5x3.4	5.2x3.9	6.8x5.1	5.8x4.4	9.4x7.1	
	1/3"					3.0x2.2	3.4x2.5	4.0x3.0	5.0x3.7	4.4x3.3	6.1x4.5	
	mag					1.604x	1.422x	1.280x	1.026x	1.280x	0.906x	
70	WD						23	18	67	67	88	117
	2/3"					4.1x3.0	4.4x3.3	5.0x3.8	6.4x4.8	5.8x4.8	8.1x6.0	
	1/2"					2.9x2.2	3.2x2.4	3.8x2.8	4.8x3.6	4.0x3.0	5.6x4.2	
	1/3"					2.2x1.7	2.4x1.8	2.8x2.1	3.4x2.5	2.8x2.1	3.8x2.8	
	mag					2.173x	1.991x	1.791x	1.422x	1.791x	1.333x	

■ HF-HA series

Extension tube (mm)	Product name		DF6HA-1B		HF9HA-1B		HF12.5HA		HF16HA-1B		HF25HA-1B		HF35HA-1B		HF50HA-1B		HF75HA-1B	
	Focal Length		f6		f9		f12.5		f16		f25		f35		f50		f75	
	Focus		Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)	
0	WD		100	INF	100	INF	100	INF	100	INF	150	INF	250	INF	500	INF	1100	INF
	2/3"																	
	1/2"	126.0x92.3	-x-	114.4x83.6	-x-	80.9x59.8	-x-	57.9x43.0	-x-	63.8x47.2	-x-	53.6x40.0	-x-	59.3x44.4	-x-	77.6x58.2	-x-	
	1/3"	92.3x68.2	-x-	59.8x44.5	-x-	43.0x32.0	-x-	34.1x25.5	-x-	29.0x21.7	-x-	32.3x24.2	-x-	42.3x31.8	-x-	62.1x46.6	-x-	
	mag	0.054x	0.000x	0.082x	0.000x	0.113x	0.000x	0.142x	0.000x	0.166x	0.000x	0.149x	0.000x	0.113x	0.000x	0.077x	0.000x	
0.5	WD		31	61	55	157	71	318	80									

SAMPLE		Product name		HF9HA-1B	
Extension tube (mm)		Focal Length		f9	
Focus		Shooting range (HxV)		Sensor size	
		NEAR	FAR	1"	12.8x9.6
5	WD	2	4	2/3"	8.8x6.6
	2/3"	15.4x11.1	17.7x12.8	1/2"	6.4x4.8
	1/2"	10.7x7.9	12.3x9.1	1/3"	4.8x3.6
	1/3"	7.9x5.9	9.1x6.7		
	mag	0.624x	0.542x		

※Working distance
←Lens magnification

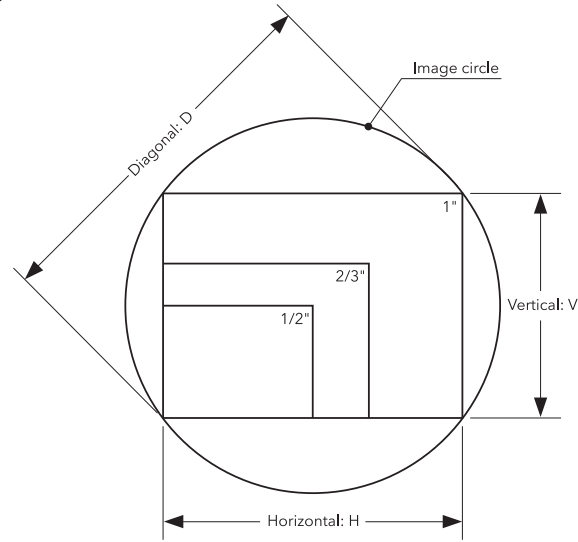
Sensor size	
1"	12.8x9.6
2/3"	8.8x6.6
1/2"	6.4x4.8
1/3"	4.8x3.6

HF-SA series

Extension tube (mm)	Product name		HF12.5SA-1		HF16SA-1		HF25SA-1		HF35SA-1		HF50SA-1		HF75SA-1		
	Focal Length		f12.5		f16		f25		f35		f50		f75		
	Focus		Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)		Shooting range (HxV)		
		NEAR	FAR	NEAR	FAR	NEAR	FAR	NEAR	FAR	NEAR	FAR	NEAR	FAR	NEAR	FAR
0	WD	100	INF	100	INF	100	INF	200	INF	400	INF	900	INF		
	2/3"	82.8x61.7	-x	68.9x51.4	-x	47.5x35.4	-x	52.3x39.2	-x	68.5x51.3	-x	101.7x76.3	-x		
	1/2"	59.8x44.7	-x	49.8x37.3	-x	34.3x25.7	-x	38.0x28.4	-x	49.8x37.3	-x	74.0x55.5	-x		
	1/3"	44.7x33.5	-x	37.3x27.9	-x	25.7x19.2	-x	28.4x21.3	-x	37.3x28.0	-x	55.5x41.6	-x		
	mag	0.108x	0.000x	0.129x	0.000x	0.187x	0.000x	0.169x	0.000x	0.129x	0.000x	0.108x	0.000x		
0.5	WD	68	307	76	503	87	1124	184	2543	372	5347	838	11276		
	2/3"	61.3x45.6	227.7x170.3	56.0x41.8	288.2x216.0	42.7x31.9	423.8x317.5	48.3x36.2	628.6x471.6	63.7x47.8	909.2x682.2	94.5x70.8	1319.3x989.6		
	1/2"	44.2x33.0	165.1x123.5	40.5x30.2	209.4x156.9	30.9x23.1	307.8x230.7	35.1x26.3	457.3x343.0	46.3x34.7	661.6x496.3	68.7x51.5	959.6x719.7		
	1/3"	33.0x24.7	123.5x92.5	30.2x22.6	156.9x117.6	23.1x17.3	230.7x172.9	26.3x19.7	343.0x257.3	34.7x26.0	496.3x372.3	51.5x38.6	719.7x539.8		
	mag	0.146x	0.039x	0.159x	0.031x	0.208x	0.021x	0.183x	0.014x	0.138x	0.019x	0.093x	0.007x		
1	WD	50	143	59	237	77	548	170	1266	347	2673	784	5655		
	2/3"	48.7x36.2	114.2x85.3	47.2x35.2	144.5x108.1	38.9x29.0	212.1x158.8	44.9x33.6	314.5x235.9	59.6x44.6	454.7x341.2	88.2x66.1	659.7x494.8		
	1/2"	35.1x26.2	82.7x61.8	34.1x25.5	104.8x78.5	28.1x21.0	154.0x115.4	32.6x24.4	228.7x171.5	43.3x32.4	330.8x248.2	68.7x51.5	959.6x719.7		
	1/3"	26.2x19.6	61.8x46.3	25.5x19.1	78.5x58.8	21.0x15.7	115.4x86.5	24.4x18.3	171.5x128.7	32.4x24.3	248.2x186.2	48.1x36.1	359.9x269.9		
	mag	0.184x	0.078x	0.189x	0.061x	0.229x	0.042x	0.197x	0.148x	0.019x	0.148x	0.019x	0.100x	0.013x	
1.5	WD	38	88	47	148	68	356	158	840	326	1781	737	3781		
	2/3"	40.4x30.0	76.4x57.0	40.9x30.4	96.6x72.2	35.7x26.6	141.5x105.9	41.9x31.4	209.8x157.3	55.9x41.9	303.3x227.5	82.7x62.0	439.8x329.9		
	1/2"	29.1x21.7	55.2x41.3	29.5x22.0	70.0x52.4	25.8x19.3	102.7x76.9	30.4x22.8	152.5x114.4	40.6x30.5	220.6x165.5	60.1x48.1	319.9x239.9		
	1/3"	21.7x16.2	41.3x30.9	22.0x16.5	52.4x39.2	19.3x14.4	76.9x57.6	22.8x17.1	114.4x85.8	30.5x22.8	165.5x124.1	45.1x33.8	239.9x179.9		
	mag	0.223x	0.117x	0.220x	0.092x	0.250x	0.063x	0.211x	0.158x	0.029x	0.229x	0.107x	0.020x		
2	WD	29	60	38	103	61	260	147	627	307	1335	696	2844		
	2/3"	34.6x25.7	57.5x42.8	36.0x26.8	72.6x54.2	33.0x24.6	106.3x79.5	39.3x29.4	157.4x118.0	52.7x39.5	227.5x170.6	77.8x58.3	329.9x247.4		
	1/2"	24.9x18.5	41.5x31.0	25.9x19.4	52.6x39.3	23.8x17.8	77.1x57.7	28.5x21.4	114.4x85.8	38.3x28.7	165.5x124.1	56.6x42.4	239.9x179.9		
	1/3"	18.5x13.9	31.0x23.2	19.4x14.5	39.3x29.4	17.8x13.3	57.7x43.2	21.4x16.0	85.8x64.3	28.7x21.5	124.1x93.1	42.4x31.8	179.9x135.0		
	mag	0.261x	0.156x	0.250x	0.122x	0.271x	0.083x	0.225x	0.167x	0.056x	0.239x	0.113x	0.027x		
5	WD			10	23	33	87	104	244	228	533	523	1158		
	2/3"			21.1x15.6	29.5x21.9	22.6x16.8	42.7x31.9	28.7x21.4	63.1x47.3	39.2x29.3	91.1x68.3	57.5x43.1	132.0x99.0		
	1/2"			15.1x11.3	21.2x15.8	16.3x12.2	30.9x23.1	23.8x17.8	45.8x34.3	28.4x21.3	66.2x49.7	41.8x31.3	96.0x72.0		
	1/3"			11.3x8.4	15.8x11.8	12.2x9.1	23.1x17.3	15.6x11.7	34.3x25.7	21.3x16.0	49.7x37.2	31.3x23.5	72.0x54.0		
	mag			0.430x	0.306x	0.396x	0.208x	0.309x	0.140x	0.225x	0.097x	0.153x	0.067x		
10	WD					12	30	68	116	159	266	374	596		
	2/3"					14.9x11.1	21.5x16.0	19.7x14.8	31.6x23.7	27.4x20.5	45.6x34.2	40.1x30.0	66.0x49.5		
	1/2"					10.7x8.0	15.5x11.6	14.3x10.7	22.9x17.2	19.9x14.9	33.1x24.8	29.1x21.8	48.0x36.0		
	1/3"					8.0x6.0	11.6x8.7	10.7x8.0	17.2x12.9	14.9x11.2	24.8x18.6	21.8x16.4	36.0x27.0		
	mag					0.604x	0.417x	0.449x	0.280x	0.322x	0.193x	0.220x	0.133x		
15	WD							49	74	122	176	295	408		
	2/3"					15.0x11.3	21.1x15.8	21.1x15.8	30.4x22.8	30.7x23.0	44.0x33.0	44.0x33.0	66.0x49.5		
	1/2"					10.9x8.2	15.3x11.5	15.3x11.5	22.1x16.6	22.3x16.8	32.0x24.0	32.0x24.0	48.0x36.0		
	1/3"					8.2x6.1	11.5x8.6	11.5x8.6	16.6x12.4	16.8x12.6	24.0x18.0	24.0x18.0	36.0x27.0		
	mag					0.589x	0.420x	0.419x	0.290x	0.290x	0.287x	0.200x	0.200x		
20	WD							38	52	98	132	246	315		
	2/3"					12.2x9.1	15.8x11.8	17.1x12.8	22.8x17.1	24.9x18.7	33.0x24.8	33.0x24.8	48.1x36.0		
	1/2"					8.8x6.6	11.5x8.6	16.6x12.4	12.4x9.3	12.4x9.3	24.0x18.0	24.0x18.0	36.0x27.0		
	1/3"					6.6x4.9	8.6x6.4	9.3x7.0	12.4x9.3	13.6x10.2	18.0x13.5	18.0x13.5	24.0x18.0		
	mag					0.729x	0.560x	0.515x	0.387x	0.353x	0.353x	0.267x	0.267x		
25	WD							30	40	83	105	212	258		
	2/3"					10.2x7.6	12.7x9.5	14.4x10.8	18.3x13.7	20.1x15.7	26.4x19.8	26.4x19.8	38.5x28.8		
	1/2"					7.4x5.5	9.2x6.9	10.5x7.9	13.3x9.9	15.2x11.4	19.2x14.4	19.2x14.4	26.4x19.8		
	1/3"					5.5x4.1	6.9x5.2	7.9x5.9	9.9x7.5	11.4x8.6	14.4x10.8	14.4x10.8	19.2x14.4		
	mag					0.869x	0.700x	0.612x	0.483x	0.420x	0.333x	0.333x	0.267x		
30	WD							24	31	71	87	188	221		
	2/3"					8.8x6.6	10.5x7.9	12.5x9.3	15.2x11.4	18.1x13.6	22.0x16.5	22.0x16.5	32.1x24.0		
	1/2"					6.4x4.8	7.6x5.7	9.0x6.8	11.1x8.3	13.2x9.9	16.0x12.0	16.0x12.0	22.0x16.5		
	1/3"					4.8x3.6	5.7x4.3	6.8x5.1	8.3x6.2	9.9x7.4	12.0x9.0	12.0x9.0	16.0x12.0		
	mag					1.008x	0.839x	0.709x	0.580x	0.487x	0.400x	0.400x	0.267x		
35	WD							20	25	62	75	169	194		
	2/3"					7.7x5.8	9.0x6.8	11.0x8.2	13.1x9.8	15.9x11.9	18.9x14.1	18.9x14.1	27.5x20.6		
	1/2"					5.6x4.2	6.6x4.9	8.0x6.0	9.5x7.1	11.6x8.7	13.7x10.3	13.7x10.3	18.9x14.1		
	1/3"					4.2x3.1	4.9x3.7	6.0x4.5	7.1x5.3	8.7x6.5	10.3x7.7	10.3x7.7	13.7x10.3		
	mag					1.148x	0.979x	0.805x	0.677x	0.553x	0.467x	0.467x	0.267x		
40	WD							16	20	55	65	154	174		
	2/3"					6.9x5.1	7.9x5.9	9.8x7.3	11.4x8.6	14.2x10.7	16.5x12.4	16.5x12.4	24.0x18.0		
	1/2"					5.0x3.7	5.7x4.3	7.1x5.3	8.3x6.2	10.3x7.7	12.0x9.0	12.0x9.0	16.5x12.4		
	1/3"					3.7x2.8	4.3x3.2	5.3x4.0	6.2x4.7	7.7x5.8	9.0x6.7	9.0x6.7	12.0x9.0		
	mag					1.288x	1.119x	0.902x	0.773x	0.620x	0.534x	0.534x	0.267x		
45	WD							13	17	50	58	143	158		
	2/3"					6.2x4.6	7.0x5.3	8.8x6.6	10.1x7.6	12.8x9.6	14.7x11.0	14.7x11.0	21.4x16.0		
	1/2"					4.5x3.4	5.1x3.8	6.4x4.8	7.4x5.5	9.3x7.0	10.7x8.0	10.7x8.0	14.7x11.0		
	1/3"					3.4x2.5									

Technical Information

Image Sizes

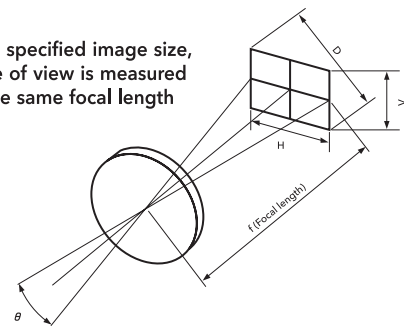


There are several types of imaging sensors for FA cameras, with different image sizes. The aspect ratio of FA camera is normally 4:3 (H:V).

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.



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

θ : 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:
 $Y' : 6.4$
 $f : 12.5$
 $\theta = 2 \tan^{-1} \frac{6.4}{2 \times 12.5} = 28.72^\circ$

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.

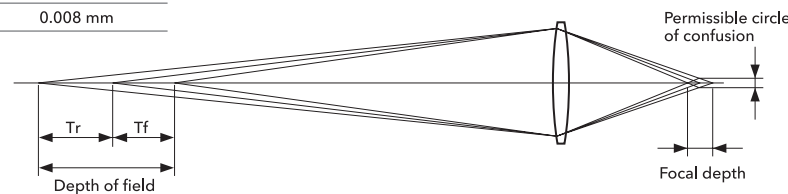
Image sensor	Permissible circle of confusion
1"	0.03 mm
2/3"	0.021 mm
1/2"	0.015 mm
1/3"	0.011 mm
1/4"	0.008 mm

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

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

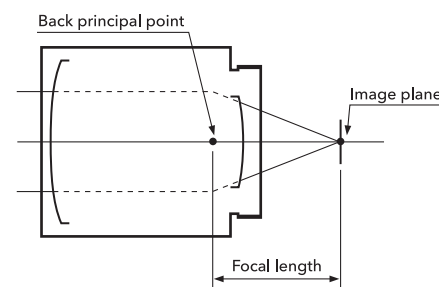
$$\text{Forward depth of field } Tf = \frac{\delta \cdot F \cdot L^2}{f^2 + \delta \cdot F \cdot L}$$

Depth of field = $Tr + Tf$
Focal depth = $2 \delta \cdot F$
 f : Focal distance
 F : F No.
 δ : 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.)

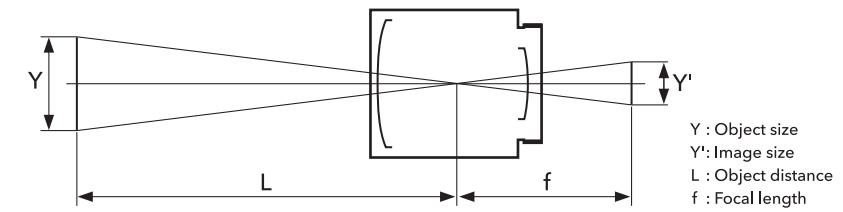
The F No. is an indication of the brightness of lens. The smaller the value, the brighter the image produced by the lens. The F No. is inversely proportional to the effective diameter of the lens and directly proportional to the focal length.

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.
 $Y' : 4.8$
 $L : 3000$
 $f : 8$
 $Y = 4.8 \times \frac{3000}{8} = 1800 \rightarrow$ Horizontal width 1.8 m

(2) How to calculate focal length

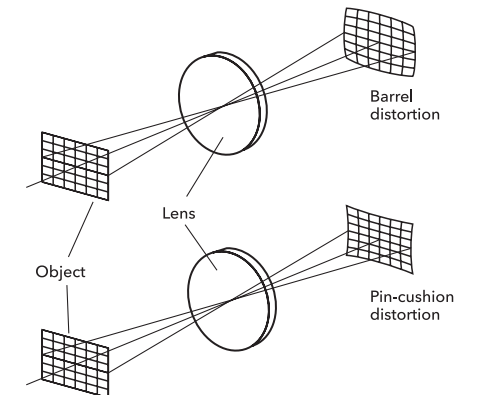
If the distance to the object is finite, you can use the following formula to calculate the focal length.

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

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.
 $Y' : 4.8$
 $L : 3000$
 $Y : 2000$
 $f = 4.8 \times \frac{3000}{2000} = 7.2 \rightarrow$ Focal length approx. 7 mm

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.

