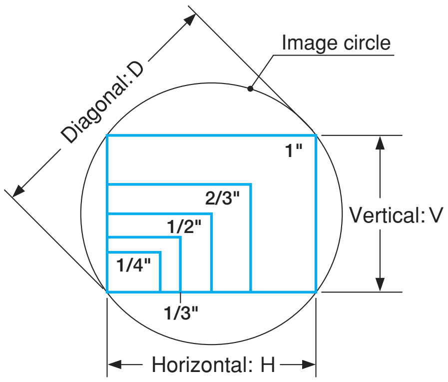
Terminology

Image Sizes



There are several types of imaging sensors for CCTV cameras, with different image sizes.
The aspect ratio of CCTV 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, S	1/2"	6.4	4.8	8.0
Y, T	1/3"	4.8	3.6	6.0
Q	1/4"	3.6	2.7	4.5
35mm camera lens (Reference)	35mm Film	36.0	24.0	43.3

C/CS-Mount

CCTV cameras have either C-mount or CS-mount.

Standard

	C-mount	CS-mount
Flange back focal length (mm)	17.526 *1	12.5 *1
Diameter of screw thread (mm)	1-32UNF	

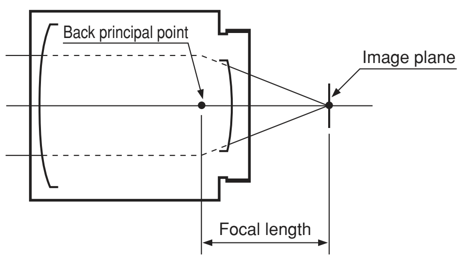
Interchangeability

	C-mount camera	CS-mount camera
C-mount lens	○	○*2
CS-mount lens	×	○

*1 Length in air
*2 Will need a C-mount adapter ring (5mm) when fitting a C-mount lens to a CS-mount camera.

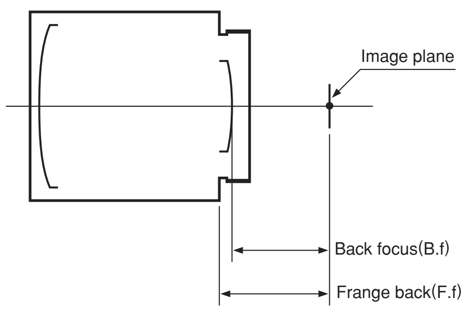
Focal Length

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



Flange Back and Back Focal Distance

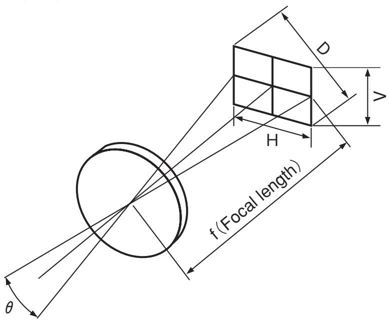
Flange back will be the distance between the mechanical mount surface and image plane.
Back focal distance will be the distance between the rear end of the lens part to the image plane.



Terminology

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

Example

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

Y' : 6.4
f : 12.5

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

Brightness of a Lens (F and T 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 scale on the iris ring of lens uses a ratio of 2, because the value of light incident on a lens is proportional to the cross section of luminous flux (square of diameter). In other words, the brightness decreases by half each time the F No. is increased by one F stop.
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. To eliminate this inconvenience, a system has been developed to consider both F No. and spectral transmittance, the T No.. The T No. and the F No. are related to each other as shown in Right:

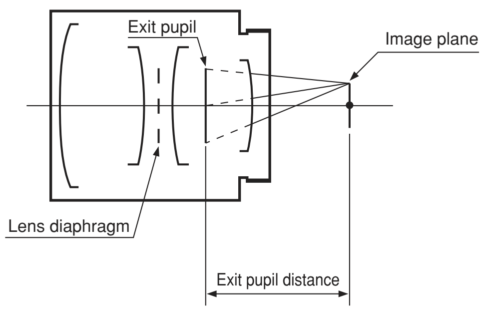
$$\text{F No.} = \frac{f}{d}$$

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

$$\text{T No.} = \frac{\text{F No.}}{\sqrt{\text{Transmittance (\%)}}} \times 10$$

Exit Pupil Position

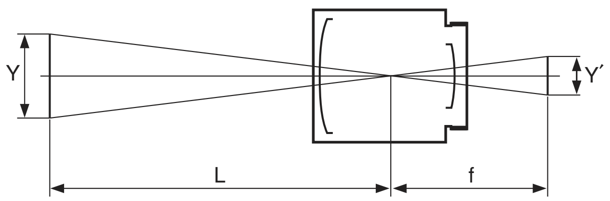
The exit pupil is the image (virtual image) reflected by the lens located at the back of the lens diaphragm. The exit pupil position is generally represented with the distance between the image plane and the exit pupil. "- (minus)" indicates closer to the object, and "+ (plus)" toward the camera.



M.O.D.

The M.O.D. (minimum object distance) is the closest distance to the object at which a image can be taken. This is the distance from the vertec of the front lens.

Field of View and Focal Length



Y : Object size
Y' : Image size
L : Object distance
f : 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.

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

Example: 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

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

(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.

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

Example: a 1/3" CCD camera is used, and the distance to the object is 3m and the horizontal width of the object is 2m. The focal length to capture the complete object size can be calculated as follows.

Y' : 4.8
L : 3000
Y : 2000

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

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 (mm)
1"	0.03
2/3"	0.021
1/2"	0.015
1/3"	0.011
1/4"	0.008

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

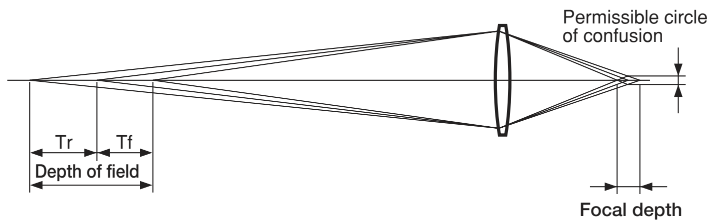
Backward depth of field $Tr = \dfrac{\delta \cdot F \cdot L^2}{f^2 - \delta \cdot F \cdot L}$

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

Depth of field $= Tr + Tf$

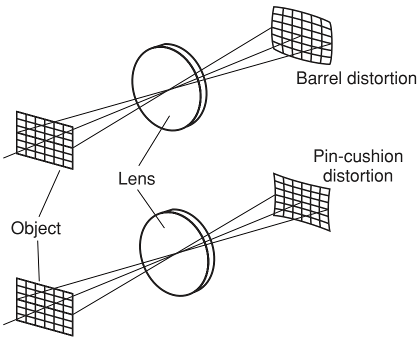
Focal depth $= 2\delta \cdot F$

f : Focal distance
F : F No.
δ : Permissible circle diameter of confusion
L : Object distance



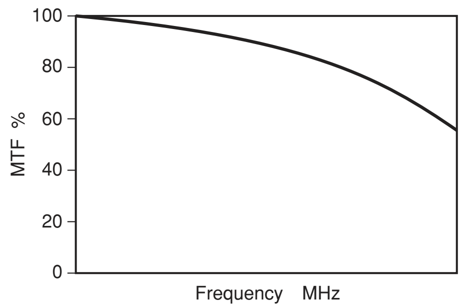
Distortion

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.



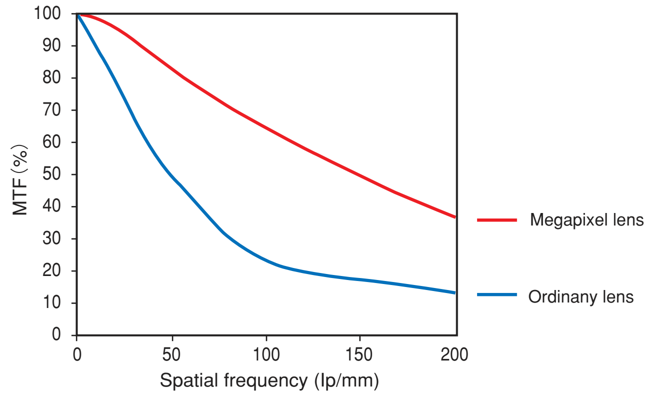
MTF (Modulation Transfer Function)

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



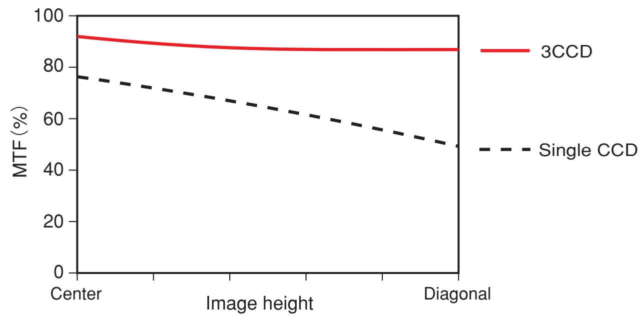
Megapixel Supporting Lens

We have realized a high resolution, compact, and lightweight lens supporting to megapixel by thoroughly reducing aberrations based on design technology cultivated from broadcast TV lenses.
The chart shown at the right compares megapixel supporting lens and the MTF of an ordinary CCTV lens. As the number of TV lines increases, the disparity in MTF becomes bigger.



3CCD Camera Lens

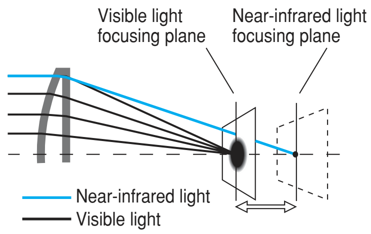
3CCD cameras have thicker glass between the lens and the CCD than single CCD cameras because they have three CCDs to correspond with the red, blue and green colors separated in the prism. Fujinon 3CCD lenses are designed to optimally match with 3CCD cameras. The chart shown at the right explains the difference in MTF when a 3CCD lens and a single CCD lens is mounted on a 3CCD camera.



Day&Night Lens

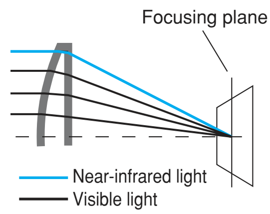
The day&night lens uses an advanced optical design, special optical glass, and other state-of-the-art technologies to focus light (visible to near-infrared 400-1000nm) on the same plane to prevent the focus to become blurry enabling sharp images.

■ A standard lens (for visible light)
is mounted on a day&night camera, and used under near-infrared light.



Result: Blurry image

■ A day&night lens
is mounted on a day&night camera, and used under near-infrared light.



Result: Clear image without getting blurry