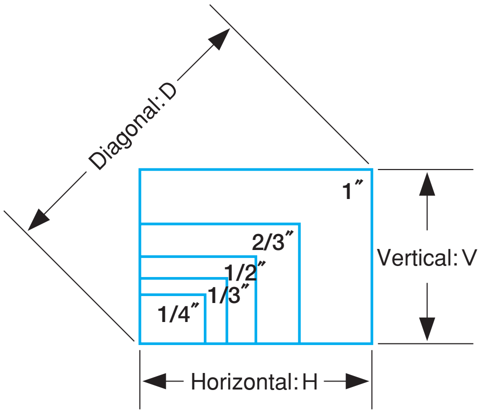
Terminology/Technical Reference

Image sizes



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

Product symbol	Imaging element	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 the C-mount or the 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	

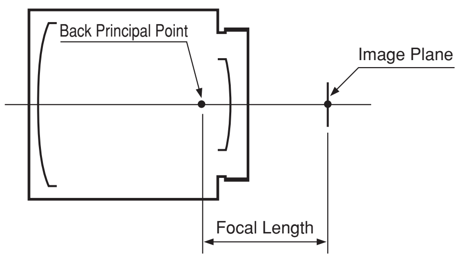
Interchangeability

	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.

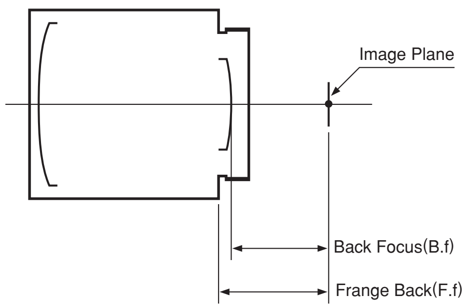
Focal Length

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



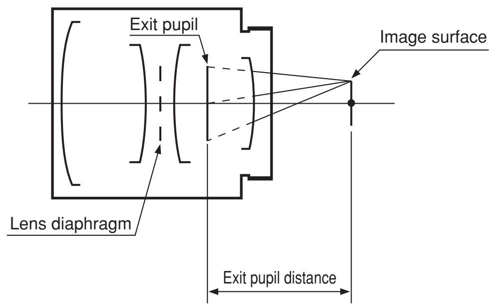
Flange back and back focal distance

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.



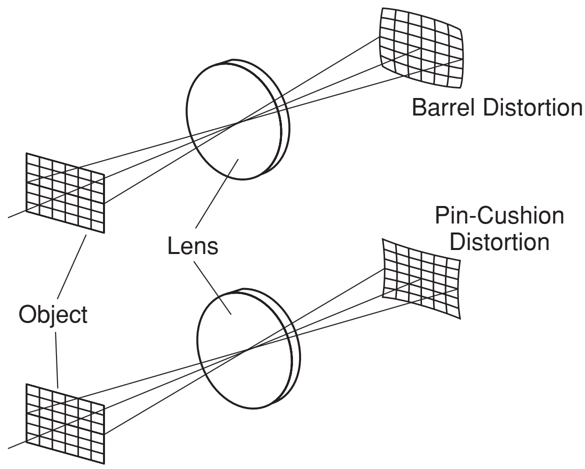
Exit pupil position

Exit pupil is the image (virtual image) reflected by the lens located at the back of the lens diaphragm.
Exit pupil position is generally represented with the distance between the image surface and the exit pupil.



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.



Brightness of a Lens (F and T Numbers)

The F number is an indication of the brightness of lens. The smaller the value, the brighter the image produced by the lens. The F number is inversely proportional to the effective diameter of the lens and directly proportional to the focal length.

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

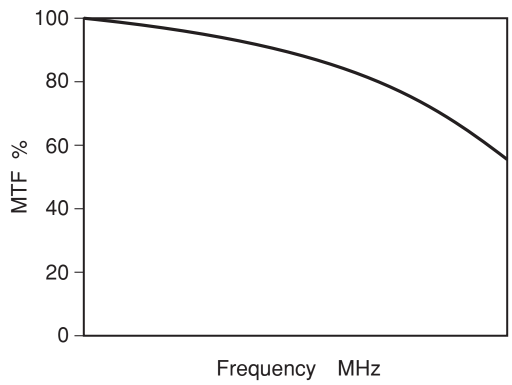
f : Focal length of a lens
d : Effective diameter of a lens

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 number is increased by one F stop.
The F number 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 number can have different levels of brightness. To eliminate this inconvenience, a system has been developed to consider both F number and spectral transmittance, the T number. The T and F numbers are related to each other as follows:

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

MTF (Modulation Transfer Function)

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



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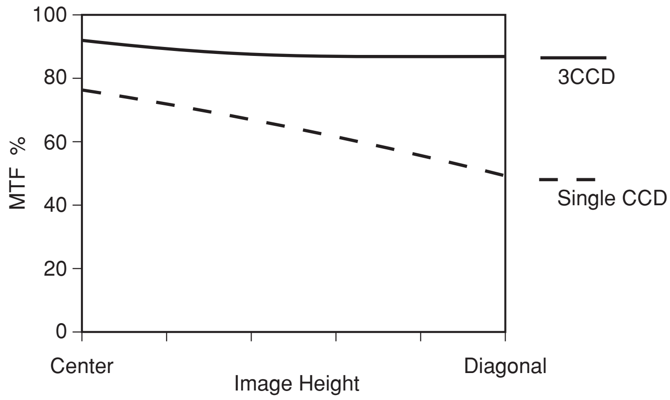
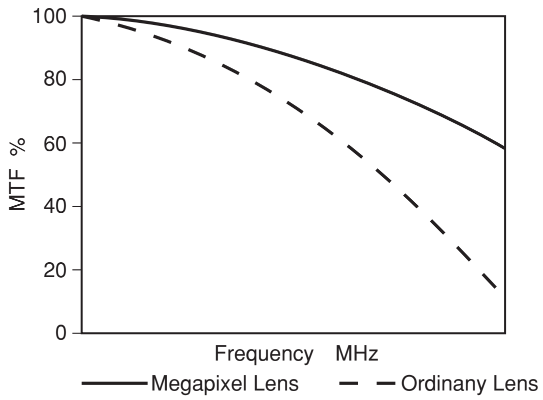
3CCD Camera Lens

Common 3CCD cameras have a ticker glass protection than a single CCD camera between the lens and the CCD because three CCDs are placed to correspond with the red, blue and green color separation.
Therefore, if a lens intended for a single CCD camera is used on a 3CCD camera, the performance will not be as high as expected due to the efect on the optics structure inside of the camera.
Fujinon 3CCD lens are designed to match perfectly with the common 3CCD cameras in the market today.
The chart shown at the right explains the difference in MTF when a single CCD lens and a 3CCD lens is put on the 3CCD camera.



Fixed focal length lens corresponding to megapixel

We have realized a high resolution compact lens corresponding to mega pixel by adopting the high technical skills cultivated from broadcast lenses and optical beam splitters.
The chart shown at the right compares MTF of an ordinary CCTV lens and a mega pixel corresponding lens. As the frequency increases, the disparity in MTF becomes bigger.

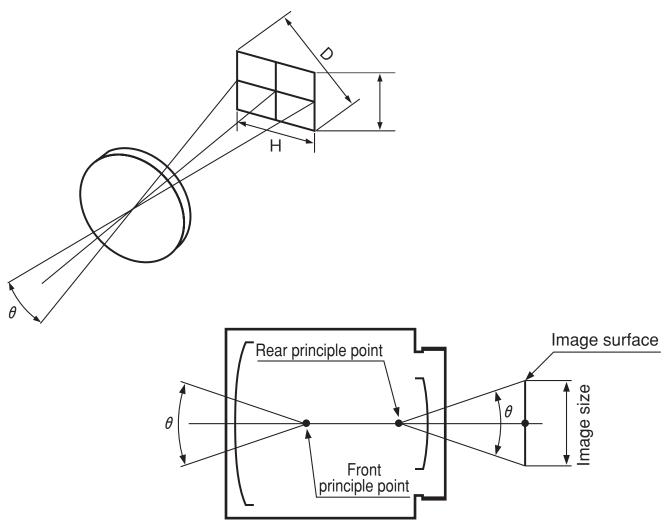


Angle of view

The angle of view is the shooting range that can be viewed by the lens given a specified image size. Normally the angle of views is measured assuming a lens is focused at infinity. The angle of view is obtained by calculation if the focal length and the image size are known.

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

θ : Angle of view
Y' : Image size
f : Focal length



Example

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

Y' : 6.4
f : 12.5

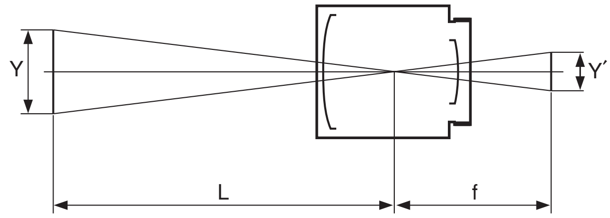
$$\theta = 2\tan^{-1}\frac{6.4}{2\times 12.5} = 28.72^\circ$$

Field of view

If the object distance is limited then the field of view can be calculated from the following formula.

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

Y : Objects size
Y' : Image size
L : Distance from lens to object
f : Focal length of the lens



Example
The horizontal size where the object can be fully projected on the monitor when the camera size is 1/2", the focal length is 12.5mm, and the distance from the lens to the object is 5m:

Y' : 6.4
L : 5000
f : 12.5

$$Y = 6.4 \times \frac{5000}{12.5} = 2560\text{mm}$$

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 in sharp if the focus misalignment is under a certain quantity. This certain quantity is called the permissible circle of confusion.

The depth field has following properties.

1) The larger F number 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 depth of field becomes.
4) The backward depth of field is wider than the forward depth of field.

Image size	Permissible Circle of Confusion (mm)
1"	0.04
2/3"	0.028
1/2"	0.02
1/3"	0.015
1/4"	0.011

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

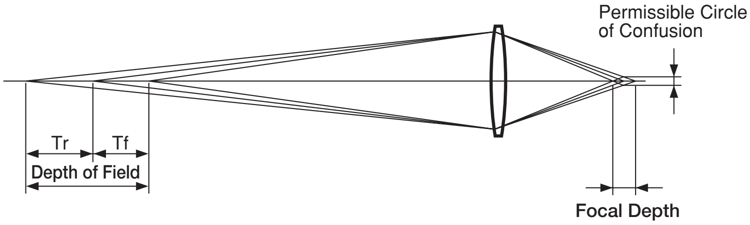
Backward Depth of Field $Tr = \frac{\delta \cdot F \cdot L^2}{f^2 - \delta \cdot F \cdot L}$

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 number
δ : Permissible Circle diameter of Confusion
L : Object Distance



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