Photography Group: Pictorial Session



# – a basic guide

**by Stephen Jones** 



### There are three main characteristics that define a lens:

Focal length

Aperture

Film/sensor format









Each of the individual lenses (biconconvex, planoconvex .... biconcave) are called "*Elements*".

Camera lenses usually have several elements fixed together in a "Group".

"Prime" lenses have fixed focal lengths.

Because they have a minimum of elements and groups, they can usually produce images of higher resolution/contrast than more complicated lenses. They also usually have larger maximum apertures.

"Zoom" lenses, in order to achieve their variable focal lengths, are necessarily more complicated.



Zoom lens at wide-angle setting



f-number =  $\frac{\text{focal length of the lens}}{\text{Diameter of the aperture}}$ 

For example

f2 on a 25 mm lens means that the diameter of the aperture is 12.5 mm

f2 on a 50 mm lens means that the diameter of the aperture is 25 mm

f2 on a 100 mm lens means that the diameter of the aperture is 50 mm

f-number =  $\frac{\text{focal length of the lens}}{\text{Diameter of the aperture}}$ 

#### For a 50 mm lens:

	Aperture	diameter	Aperture area			
f2.0	25.0	mm	490.9	sq.mm		
f2.8	17.9	mm	250.5	sq.mm		
f4	12.5	mm	122.7	sq.mm		
f5.6	8.9	mm	62.6	sq.mm		
f8	6.3	mm	30.7	sq.mm		
f11	4.5	mm	16.2	sq.mm		
f16	3.1	mm	7.7	sq.mm		
f22	2.3	mm	4.1	sq.mm		

It can be seen that decreasing the aperture by one "stop", the light coming in through the lens is halved.

This means that, for example, by reducing aperture by one stop, and doubling the shutter speed, the overall exposure remains the same.

All these represent substantially the same exposure:

f2 @ 1/1000 sec f2.8 @ 1/500 sec f4 @ 1/250 sec f5.6 @ 1/125 sec f8 @ 1/60 sec f11 @ 1/30 sec f16 @ 1/15 sec f22 @ 1/8 sec

Almost all lenses nowadays include an automatic aperture mechanism.

This allows you to view the image through the viewfinder at the lens' maximum aperture and when you press the shutter button, at the instant of exposure, the camera automatically stops down the lens to the chosen aperture value, the photo is taken, then the camera opens up the aperture again to the lens' maximum.

This photograph shows a Canon electro-magnetic diaphragm which is used to control aperture at the point of exposure.

Note that this mechanism is built-in to the barrel of the lens.



Question: What is a "standard" lens ?

A "standard" lens is one which provides a natural perspective to us and so it should have a diagonal angle of view of about 50-55<sup>0</sup>. This is roughly equivalent to a lens of focal length equal to the diagonal length of the sensor (film size).

Different film or sensor sizes will have different focal length standard lenses

Sensor Name	Medium Format	Full Frame	APS-H	APS-C	4/3	1"	1/1.63"	1/2.3"	1/3.2"
Sensor Size Sensor diagonal Sensor Area	53.7 x 40.2mm <b>67 mm</b> 21.59 cm <sup>2</sup>	36 x 23.9mm 43 mm 8.6 cm²	27.9x18.6mm <b>34 mm</b> 5.19 cm <sup>2</sup>	23.6x15.8mm <b>28 mm</b> 3.73 cm <sup>2</sup>	17.3x13mm <b>22 mm</b> 2.25 cm <sup>2</sup>	13.2x8.8mm <b>16 mm</b> 1.16 cm <sup>2</sup>	8.38x5.59mm <b>10 mm</b> 0.47 cm <sup>2</sup>	6.16x4.62mm <b>8 mm</b> 0.28 cm <sup>2</sup>	4.54x3.42mm <mark>6 mm</mark> 0.15 cm²
Crop Factor	0.64	1.0	1.29	1.52	2.0	2.7	4.3	5.62	7.61
Image									-
Example						0		2015 B	
Lenr									-

NB. Sensor sizes appear to have evolved over time and different manufacturers appear to have slightly differing sensor sizing, so use this table as a guide only.

Crop factor



Crop factor

Using the "crop factor", we can compare different lenses across different sensor formats.

The 35 mm format is considered the "standard" and has a crop factor of 1. All other formats are compared against this standard.

Focal length equivalent = 35 mm format lens focal lengththe crop factor

**Crop factor - Examples** 

1 What is the equivalent focal length lens in a micro four-thirds (4/3) format to a 35 mm format telephoto lens of 200 mm focal length ?

Focal length equivalent =  $\frac{200 \text{ mm}}{2}$  = 100 mm

2 What is the equivalent focal length lens in a 1/2 format to a 35 mm format wide angle lens of 35 mm focal length ?

Focal length equivalent =  $\frac{35 \text{ mm}}{5.41}$  = 6.5 mm

<sup>3</sup> What is the equivalent focal length lens in a medium format to a 35 mm format standard lens of 50 mm focal length ?

Focal length equivalent = 
$$\frac{50 \text{ mm}}{0.64}$$
 = 78 mm

#### Other lens characteristics:

Most modern interchangeable lenses are attached to the camera body by a bayonet fitting. Lenses with screw fittings used to be common.

Most lenses provide auto-focussing with high speed motor(s) fixed inside the lens barrel. This cutaway diagram shows the latest Sony 100-400 mm with twin focussing drives.



Many modern telephoto and telephoto zoom lenses include an optical stabiliser which acts to counter the effects of camera-shake. This photo shows a Canon Vibration Reduction unit.



VR Lens Unit

#### Other lens characteristics:

To reduce flare and minimise ghosting lens elements are provided with coatings on their outside surface.

Aspherical lenses minimise spherical aberration and astigmatism.

Low dispersion glass ("UD", "ED") can be used in lens elements in order to maintain contrast and colour reproduction

Lenses made from fluorite minimise chromatic aberrations.



Canon 70-200 mm F2.8L IS II zoom lens for a full frame 35 mm sensor (23 elements in 19 groups)

Lenses – a basic guide



Sony 70-200 mm F2.8 zoom lens for a full frame 35 mm sensor (23 elements in 18 groups)



Nikon AF-S NIKKOR 50mm f/1.8G for a full frame 35 mm sensor (7 elements in 6 groups)



Sony 24-70 mm F2.8 zoom lens for a full frame 35 mm sensor (18 elements in 13 groups)