

Shutter Speed in Digital Photography

[Notes from Alan Aldrich as presented to the Hawkesbury Camera Club in April 2014]

Light is a form of energy and as such behaves as formulated in the general power equation.

$$E = hv$$

Where h = is plancks constant

v = is frequency and

E = is energy

$$6573 \text{ angstroms} = 6.573 \text{ e-7 m} = \text{wavelength } (\lambda)$$

First we must use: $v = c/\lambda$

where c is the speed of light

$$v = (3.00 \text{ e8 m/s}) / (6.573 \text{ e-7 m}) = 4.564\text{e14/s}$$

$$E = (6.63 \text{ e-34 J x s}) (4.564 \text{ e14/s}) = 3.026 \text{ e-19 J}$$

Without resorting to such complicated calculations all we need to know is a suitable quantity of light to fall on our recording medium in suitable time.

Think about this amount of light symbolised by various cylinders. Each of which varies in length and diameter. These cylinders are trapped quantities of light travelling at the speed of light, 299,792,458 m/s or as usually stated 300,800,000 m/s or for the old at heart 186,000 miles/second.

If we consider our focal plan to be fixed, then our quantity of trapped light is controlled by the size of the cylinder i.e. its length and diameter (aperture) travelling at 300,800,000 m/s and the time taken to pass into the focal plane (shutter speed). Our ISO is the reactivity of the recording medium on that focal plane.

What is Shutter Speed?

Shutter speed is 'the amount of time that the shutter is open'.

In film photography it was the length of time that the film was exposed to the scene you're photographing and similarly in digital photography shutter speed is the length of time that your image sensor 'sees' the scene you're attempting to capture.

The basics of Shutter Speed

- Shutter speed is measured in seconds – or in most cases fractions of seconds. The bigger the denominator the faster the speed (ie 1/1000 is much faster than 1/30).
- Normally photographers use shutter speeds of 1/60th of a second or faster. This is because anything slower than this is very difficult to use without getting camera shake. Camera shake is when your camera is moving while the shutter is open and results in blur in your photos.
- A slow shutter speed (anything slower than 1/60) will require the use of either a tripod or some type of image stabilization (more and more cameras are coming with this built in).

- Shutter speeds available on cameras will usually double (approximately) with each setting. As a result you'll usually have the options for the following shutter speeds – 1/500, 1/250, 1/125, 1/60, 1/30, 1/15, 1/8 etc. This 'doubling' is handy to keep in mind as aperture settings also double the amount of light that is let in – as a result increasing shutter speed by one stop and decreasing aperture by one stop should give you similar exposure levels.
- Some cameras also have the option for very slow shutter speeds that are not fractions of seconds but are measured in seconds (for example 1 second, 10 seconds, 30 seconds etc). These are used in very low light situations, when you're going after special effects and/or when you're trying to capture a lot of movement in a shot. Some cameras also give you the option to shoot in 'B' (or 'Bulb') mode. Bulb mode lets you keep the shutter open for as long as you hold it down.
- When considering what shutter speed to use in an image, always ask yourself whether anything in your scene is moving and how to capture that movement to best effect. If there is movement in the scene the option of either freezing the movement (so it looks still) or letting the moving object intentionally blur (giving it a sense of movement).
- To **freeze movement** in an image choose a faster shutter speed.
- To let the **movement blur** requires a slower shutter speed. The actual speed chosen will vary depending upon the speed of the subject in the shot and how much blur needed.
- **Motion** is not always bad. Some photographers like to freeze any movement however there are times when motion is good. For example when photographing a waterfall and want to show how fast the water is flowing, or when shooting a racing car and want to give it a feeling of speed. Star circles show how the stars move over a longer period of time. In all of these instances choosing a longer shutter speed will produce the desired result. **A tripod is necessary for long exposures.**

Additional points

- Focal Length and Shutter Speed - another thing to consider when choosing shutter speed is the focal length of the lens in use. Longer focal lengths will accentuate the amount of camera shake and so choose a faster shutter speed (unless image stabilization is inbuilt in the camera). The 'rule' of thumb to use with focal length in non image stabilized situations) is to choose a shutter speed with a denominator that is larger than the focal length of the lens. For example if the lens is 50mm, 1/60th is a minimum but if you have a 200mm lens shoot at around 1/250.
- Shutter Speed – Bringing it Together
- Remember that thinking about Shutter Speed in isolation from the other two elements of the Exposure Triangle (aperture and ISO) is essential. As you change shutter speed the need to change one or both of the other elements is necessary to compensate.
- For example if changing shutter speed one stop (for example from 1/125th to 1/250th) the effect is to halve the light entering the camera. To compensate for this increase your aperture one stop (for example from f16 to f11). The other alternative would be to choose a faster ISO rating (ie ISO 100 to ISO 200 for example).

When is it necessary to change Shutter Speed?



For general outdoor use my preference is to use the P setting on my Nikon camera (*pictured above*). For Canon users this is Tv.

By use of the front and rear control wheels and the compensator button the camera is easily controlled. *This setting also affords once setting adjustments rather the use of the M (manual) setting that needs at least two settings, one for speed control and one for aperture control.*

Change is necessary when particular circumstances are encountered.

Studio Settings: *M most cameras* have a maximum speed or synchronous shutter for flash. For Nikon its 1/250 others may differ. The aperture is dictated by the power of the flashes used.

The guide number is:

$$\text{Guide Number(GN)} = f/\text{stop} \times \text{Distance}$$

If we know the Guide Number is 38 then we can calculate the aperture at 100 ISO:

$$\text{GN } 38 / 3 \text{ metres} = f/8$$

$$\text{GN } 38 / 2.5 \text{ metres} = f/16$$

$$\text{GN } 38 / 6 \text{ metres} = f/6.3$$

$$\text{GN } 38 / 1.0 \text{ metres} = f/45$$

$$\text{GN } 38 / 1.5 \text{ metres} = f/25$$

$$\text{GN } 38 / 2 \text{ metres} = f/19$$

$$\text{GN } 38 / 8 \text{ metres} = f/4.5$$

The shutter speed also has an effect on exposure. As ambient light is introduced as the shutter speed is slowed. My preference is to choose one setting below the synchronous speed to ensure the shutter is wide open.

Luckily we have Flash Exposure Meters.

The Inverse Square Law controls all this.

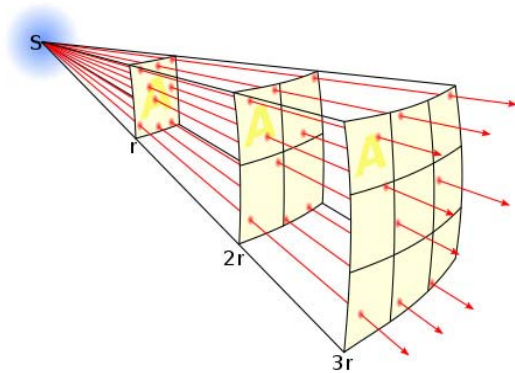
Inverse Square Law

Light intensity falls off rapidly with distance from its source. This is called the Inverse Square Law, which says the intensity varies with the square of the flash-to-subject distance, this way:

Light at 2x the distance is $\frac{1}{4}$ as bright, and light at $\frac{1}{2}$ the distance is 4x brighter (2 stops)

Light at 3x the distance is $\frac{1}{9}$ as bright, and light at $\frac{1}{3}$ the distance is 9x brighter (8x is 3 stops)

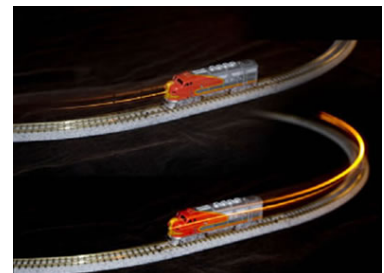
Light at 4x the distance is $\frac{1}{16}$ as bright, and light at $\frac{1}{4}$ the distance is 16x brighter (4 stops), etc.



Inverse Square Law is just a fancy name for a rather simple concept. Think of a flashlight – as the beam travels farther away from the source, the beam spreads out to illuminate a larger area, but becoming dimmer with distance. All light spreads this way, the sun, your flashlight, your table lamp, and your flash all weaken in this way too. We might imagine that if the light was twice as far away, it would be half as bright, but the correct answer is only $\frac{1}{4}$ as bright. The drawing below explains why it falls off so fast. The Inverse Square Law is only saying that the light spreads to cover a larger area as it travels.

Rear Curtain Sync

A shutter speed of a $\frac{1}{15}$ or slower is generally used. This causes the flash to fire as the second curtain moves closing the exposure and introduces light trails behind the subject as it moves through the view area. Not as front curtain sync does causing the light trail to be in front of the sharp image.



Landscape Photography

Some choose to use the A (aperture) setting. Depth of field is a very important property in landscape photography. Hence the aperture is set and the camera automatically changes the shutter assuming the ISO is constant.

Using Differential Focusing



Using Aperture Priority or modified Program it is possible to control the section of the image to have in the acceptable focus range. This allows such features as background blurring or highlighting a subject. This also allows elimination of out of focus distracting foreground. This means the aperture is the controlling element and the camera adjusts the shutter.

Macro or Close-up Photography

The A setting is a general preference as again depth of field is minimised by the camera as it is moved closer to the subject. In this type of photography varying the ISO will assist. Also investigate Focus stacking.



Action Photography

In this type of photography is included all the capture of movement to illustrate something the photographer has in mind. This may include but is not limited to sports, industrial and scientific photography. Obviously the most obvious is sports but think of all the photographers who work in scientific or industry.

The photographs following are examples of these genres, how would you capture these images?



