Aperture

The aperture is the physical lens opening on your camera. It is adjusted to open and close in f-stop increments, allowing more or less light in with a larger or smaller opening. The iris diaphragm inside the lens of your camera is adjusted to alter the quantity of light that will reach your film. Each aperture opening, or f-stop, lets in twice as much light as the smaller f-stop before it, and half as much light as the larger f-stop after it. For example, f5.6 will let in twice as much light as f8, and half as much light as f4.

One thing to keep in mind is that the higher the number, the smaller the diaphragm. Conversely, if you use a smaller the number, there will be a larger the opening of the shutter of your camera. A larger opening is a case when we have less of a depth of field than we have with a smaller opening.

One of the other attributes of the aperture is that is controls how much depth of field you have when taking your photograph.

The depth of field refers to the nearest and farthest points in your photograph that are in relative focus in your photograph. A lens can only focus on one single distance completely, but with a wide depth of field, areas both closer and further from that one point are relatively in focus as well. Stopping down to a smaller aperture increases the depth of field, and will result in more of the photograph being in focus.

When you increase the aperture, you lose depth of field. Sometimes this is the only way to produce a useable image. If you cannot sacrifice some depth of field, there are several alternatives you can use: select a faster film, increase the camera-to-subject distance, select a shorter focal length lens, or change the camera angle, so the relative motion of the subject to the camera is decreased.

Sometimes you will want to shoot with a small depth of field. If you want to draw attention to the subject and throw everything out of focus is a situation where you will want to use a narrow depth of field.

There are many different aperture sizes possible with the diaphragm, and each aperture size has a different value. Consequently, a system was devised for marking them so they could be used with consistency. The factorial system has become the most widely used. This system uses a set of markings commonly called the f/system. By using the diaphragm control ring, you can bring the index mark into line with the numbers that indicate the measured f/stop of the aperture. Remember, as these index numbers increase in size, the opening decreases in size. Furthermore, these numbers are chosen by moving the index pointer to the next larger number, and the amount of light admitted is cut in half. The first or lowest number in the series is usually an exception as it is not exactly a full stop difference.

Another area of confusion for most photographers is the infamous “f-stop”. What does it mean? Where does it come from? What does it measure? Does it really make a difference? Which one should I use?

Here we are going to try to define what this all means and how to use it properly.

The “f-stop” defines the ratio of the lens aperture diameter to the lens focal length. Thus, a 100mm lens whose aperture is set at 25mm diameter has an f-number (factor) of f4. As the aperture is made larger or smaller, more or less light is transmitted by the lens onto the film (or digital receptor).

Lenses come with aperture settings in the following sequence: f1, f1.4, f2, f2.8, f4, f5.6, f8, f11, f16, f22, f32, f45, f64 and so on. While these numbers may seem random to you, they are in actuality a mathematical formula. The fact is that each step is 1.414 times the previous step. 1.414 is the square root of two. Each increment, or f-stop, represents a doubling or halving of the amount of light reaching the film. For example, if the film receives ten Foot-candles of light intensity at a lens setting of f8, it will receive five Foot-candles at f11 or twenty FC at f5.6.

All these numbers may not exactly reduce the amount of light admitted by one half, but they are sufficiently close for all practical purposes. However, all of these values are in proportion to the squares of their numbers. For example, f/4 admits four times more light than f/8 because the square of f/4 is contained in the square of f/8 exactly four times. Thus, 4^2=4x4=16 • 8^2=8x8=64

One easy method to remember the sequence of numbers above is to realize that every number is two times the second number before it. For example, f1 skip a number is f2; skip a number is f4.

The amount of light admitted to the film remains inversely proportional to the square of the f/stop, and the exposure required is always directly proportional to it.

To use lenses correctly, the photographer must understand the relationship between the aperture of a lens and the brightness of the image produced at the focal plane. The aperture of a lens is simply the opening through which light passes. The aperture is controlled by an adjustable diaphragm or iris. Each setting of the diaphragm is called an f/stop and is always read as a number, not as a fraction or true ratio. It is referred to as the f/stop opening. This value is designated by a lowercase f with a slant (/) or occasionally a dash (-) between the f and the value. For example, f/8 means that the diameter of the opening in the diaphragm is one eighth of the lens focal length, but only when the lens is focused on infinity. In this example, f/8 is the effective aperture. If the lens were focused at other than infinity, f/8 would then be the relative aperture. In the study of the relationship between aperture and image brightness, the term relative aperture is used frequently. The term relative aperture then refers to the ratio between the effective aperture of the lens and its focal length. The relative aperture of a lens is controlled by two factors:

1. The diameter of the beam of light passed by the lens
2. The focal length of the lens, which governs the size of the area over which the light is spread

It seems that most photographers have come to use the f-stop notation, not only for defining lens aperture, but also for specifying any parameter, which affects the amount of light reaching the film. For instance, if a 500-watt photoflood lamp were illuminating a scene, doubling its power to 1000 watts would be stated as "increasing the light by one stop." If a filter is used which passed only one half the light through it, it would be referred to as having a "one stop loss". The same would apply to film speed. Each time the speed of the film (measured in ASA/ISO) is doubled, it means it is twice as sensitive – it is "one stop faster". If we doubled the film speed, we will need one stop less light or one half the amount of light.

We could obtain one-half the light *intensity* by halving the wattage of the bulb (or halving the BCPS of the flash) or we could leave the light intensity alone and halve the exposure time. It is then that each halving or doubling of exposure time can also be referred to as a one stop increase or decrease respectively.

As we are about to see, this is not entirely accurate. In another article, we will learn about the Inverse Square Law. In the meantime, we will discuss some information here that will explain what we just said.

In actuality, if we double the light-to-source distance, the result will not be a one-stop loss, but rather a two-stop loss. In order to achieve a one stop change in intensity by moving the light, we must remember the square root of two is 1.414 or its reciprocal the square root of one half (0.707). Thus increasing the light to subject distance by 1.4 (for example from ten feet to fourteen feet) will incur a one-stop loss. On the other hand, while moving it in to seven feet from ten feet would increase the illumination by one stop.

f/ Stop Applications

The formula to determine the f/stop of a lens is as follows: f=F/D

Where: F = focal length, D = diameter of the effective aperture, f = f/stop, or the relative aperture.

To find the f/stop of a lens that has a focal length of 8 inches and the diameter of the effective aperture is 2 inches, use the above formula. Therefore, the lens has a relative aperture of f/4. When the diameter of the opening (aperture) of the lens is made smaller, less light is admitted and the image formed by the beam of light passing through the smaller opening becomes dim. As the size of the opening is reduced, the ratio between the aperture and the focal length increases. Thus, an inverse relationship exists between the f/number and the relative aperture; as the f/stop becomes larger, the size of the relative aperture decreases. Since the f/stop is a ratio of focal length to the lens diameter, all lenses with the same f/stops regardless of focal length provide the same amount of light on the focal plane; that is, when all the other factors that affect image brightness remain constant.

Diaphragm

There is in every lens assembly a mechanical device for controlling the amount of light that passes through the lens. This mechanism may have a fixed size, or it may be designed to provide a selection among a number of sizes that can be given to the aperture in a lens. This device is a diaphragm, and its scale increments are called f/stops. It is located within the lens to cut off or obstruct the marginal light rays while permitting the more central rays to pass. Most lenses have a series of thin metal leaves, which serves this purpose. These leaves are arranged and shaped to provide an approximately circular opening that can be changed in size, when desired, and is called an iris or diaphragm. This opening is always concentric (centered) with, and perpendicular to the optical axis of the lens. Its location in the lens barrel is determined by the manufacturer when the lens is designed.

The diaphragm is also called an iris because it resembles the iris of an eye. If you are someone who wears glasses, try this experiment. Squint. When you squint, you are stopping down your own iris. In the process, you let in less light, but you will have more depth of field, more in focus. The iris of the lens on your camera works the same way. This might help you to understand how the iris on your camera works.

Rotating the diaphragm control ring in the direction that reduces the size of the aperture is termed stopping down. Moving the control ring so it enlarges the aperture size is termed opening up. When the diaphragm is set at the largest aperture, the lens is said to be wide open. The better the quality of the optics within the lens, the larger the possible maximum aperture. The size of the largest opening is the maximum working aperture of the lens and is called the lens speed. The diaphragm, along with the shutter, controls the amount of light passing through a lens, and hence the exposure the film receives.

In summary then: Light passes through an opening (aperture) of the lens. The diameter of the aperture can be changed. The openings are called f/stops. The f/stops indicate to the photographer that a lens with a specific f/stop allows a given amount of light to the film. Thus, a 12-inch focal length lens set at f/4.5 gives the same exposure as a 6-inch focal-length lens set at f/4.5. The f/stops represent a fraction of the focal length of the lens for a given lens; that is, an f/4 lens has an effective maximum opening of one fourth of its focal length. From one full f/stop to the next full f/stop, there is a constant factor of two. As the opening changes from f/8 to f/l1, the light passing through the lens is reduced by one half because the larger f/stop (f/11) is a smaller aperture. When the aperture is changed from f/8 to f/5.6, the light passed is doubled because the aperture has been made larger.

f/Stop Functions

f/stops have three functions:

1. They act as a partial control of exposure
2. They help control depth of field
3. The camera can adjust the aperture to the point of best definition of the lens, sometimes called the optimum or critical aperture.