



Macro (close-up) Imaging

Diopters

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Macro (close-up) Imaging using Diopters

Every lens has a minimum focus distance, which dictates how close you can get to what you want to image. A lens that has a macro capability can be used as a close-up lens, bringing you closer than you can get in non-macro mode. However, a macro lens is expensive and there are alternatives, diopters or extension tubes. A diopter is a supplementary lens similar to a filter that is screwed on to the front of your lens. The diopter is between camera lens and the subject, which alters the focusing distance and magnification ratio.



While they can be purchased singly, the best application of diopters is to have a set with varying strengths as it gives a great deal of flexibility in their use. The picture above is a set of Hoya diopters in strengths +1, +2, and +5. The numbers (+1, +2, and +5) express the fraction of a meter that you should be away from the subject. As an example, a +5 diopter will have a working distance about 1/5 meter from the subject. If you need to be closer to see more detail, add another diopter, stacking one onto another. Each diopter increases the size of an object being image by 25%. The amount of magnification can be calculated by the following formula:

$$\text{Magnification} = (d / 4) + 1 \quad \text{where } d = \text{the diopter number}$$

$$\text{Focal Length} = 1000 \text{ mm}/d$$

Common diopter/power relationships				
Diopter	Power	% larger	Focal Length	Focal Length
1	1.25X	25%	39"	1000 mm
2	1.50X	50%	20"	500 mm
3	1.75X	75%	13"	333 mm
4	2.00X	100%	10"	250 mm
5	2.25X	125%	8"	200 mm
7	2.75X	175%	5.5"	143 mm
8	3.00X	200%	5"	125 mm
9	3.25X	225%	4.5"	111 mm
11	3.75X	275%	3.75"	91 mm
13	4.25X	325%	3"	77 mm
16	5.00X	400%	2.5"	63 mm
18	5.50X	450%	2.25"	56 mm
20	6.00X	500%	2"	50 mm

If you have multiple lenses that take differing filter sizes, you'll need diopters to equal the filter sizes (thread). To have the most flexibility, use a step-down ring for various filter sizes. As an example, a 50mm lens (52mm filter) and 80-210mm zoom lens (58mm filter size) has different filter sizes for the lens. By having a set of 58mm diopters and a step-up ring, you can mount the 58mm diopters on the ring and the ring to the 52mm threads of the 50mm lens.

Adding a diopter to your lens will impact the quality of your image, most notably at the corners with large aperture settings. When large aperture settings are required with high magnification and serious image quality is desired, it would be best to use extension tubes. Extension tubes do not affect the image quality since there is no optical glass.

Mark Green from Digital West Imaging had this to say concerning Close-Up shots for high speed video:

“In the case where the intrinsic motion of the object to be recorded is the primary focus and not its behavior in the overall space in which it travels, we use the Photron supplied C-mount flange (available for every Photron camera) and we use either Navitar or Infinity long focal lens assemblies to get the best images. When the object of interest is to be tracked within a larger area then a combination of F-mount long focal length lens, extension tubes, optical extenders and or magnification diopters is used. The latter two additions will put extra demands on lighting the area of interest and may suggest the use of laser sheets or other lighting techniques to illuminate the subject or subjects in the area of travel. In either case you will have to insure the camera mounting provides a stable platform and micro-movement of the camera head is supported after the fashion of a microscope stage. There are many ways to accomplish this stability all of them dependent on the specific application”. Mark Green (Mark@DigitalWestImaging.com Toll Free (866) 593-1900)

Semih Sinik from Itronx Imaging Technologies had these comments about Close-Up lenses:

“We have several infinity lenses. We prefer 105 mm lens with extenders, 2X adapter and close up lenses. We use GE fiber optic light for illumination”. Semih Sinik (semih@itronx.com 818 865 0005)