

Photomacrography

If you want to photograph small subjects, you need a macro lens.

Macro lenses are small-format camera lenses specially designed to be used at small object distances.

They can magnify the subject image size to life-size or greater, by attaching tubes or bellow extensions.



Figure 1.1. Tokina D 100mm macro lens for digital single-lens reflex (SLR) cameras with APS-C size sensors, digital SLRs with full frame sensors and SLR film cameras.

Macro Magnification

Macro magnification refers to the ratio of the image size captured on film or the sensor to the actual subject size. For example, if a subject 3cm in size is captured as a 1cm image on film, the magnification is “1:3”. By knowing the size of the sensor(I) and the subject’s size(O), the following formula can be used to determine the magnification(X); where $X = I/O$.

A subject of 5cm in size captured as by a 1cm sensor has a magnification of 1:5.

$I = 1\text{cm}$

$O = 5\text{cm}$

$X = I/O$; $X = 1/5$ OR 1:5X.

Other magnifications: 0.5x (1:2), 1X (1:1), 2X (2:1) etc.

The lens marking indicates the focus distance scale and focus distance index (Figure 1.2).



Figure 1.2. 100mm macro lens markings. The macro magnification is indicated above the focus distance (in meters).

Exposure Compensation

When the macro magnification is increased, the brightness at the film plane will decrease. Exposure compensation is required due to the increase image distance.

Macro Magnification	Exposure Magnification	Aperture openings
1:10	1.23	1/3
1:5	1.47	1/2
1:2	2.31	1 1/5
1:1	4.00	2

Table 1.1. Exposure magnification and aperture openings at different macro magnifications of 1;10 and above.

Focus and Working Distance

A 100-macro lens in auto mode (AF) position, can focus very close for a 1:1 ratio, and a working distance (lens-to-subject) of approximately 8cm. If the lighting condition affect the AF mode, switch the lens to MF. Set manually the desired magnification, and move the camera in and out, until the subject is in focus.

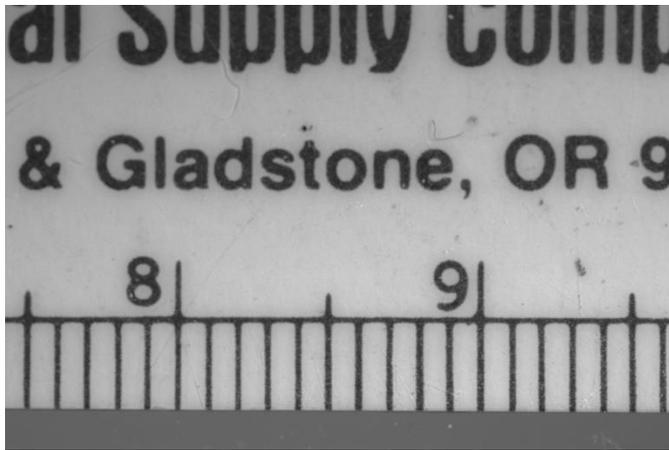


Figure 1.3. A metric ruler photographed at 1:1 macro magnification.

Depth of Field

Subjects which require depth of focus require small apertures larger than f16.

The image of the bougainvillea was taken at a lens aperture of f-11 (too shallow), in comparison, an image of a ruler taken at the same time shows the blur background (Figure 1.4).

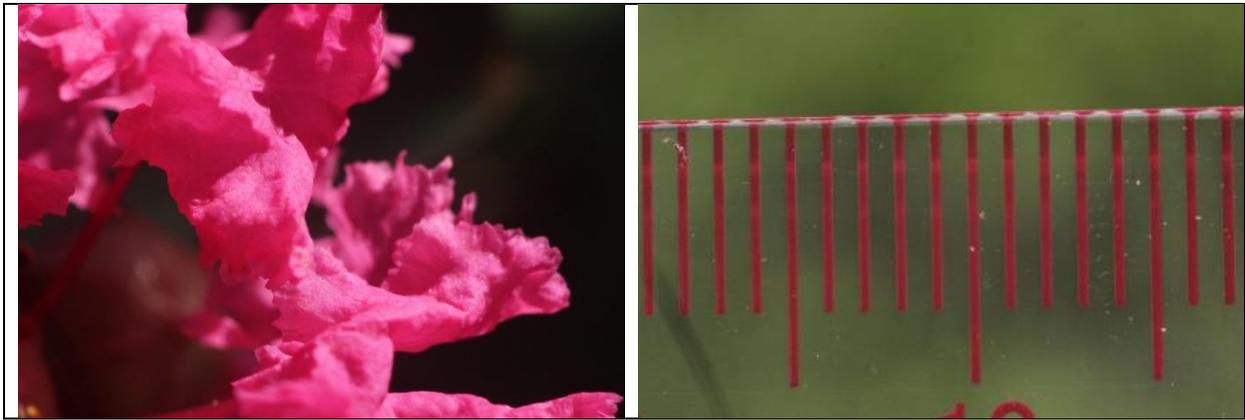


Figure 1. 4. DSLR Canon with Vivitar-LU 1:3.5 50mm enlarger lens. f11 @1/250 sec. ISO 800.

Limiting the Focus Distance Range

The Tokina has a focus-limiting switch, which makes it ideal for use as a portrait lens.

FULL: The lens will focus from 0.3m to infinity.

LIMIT: The lens will focus from approximately 0.38m to infinity OR from approximately 0.38m to 0.36m in the macro range.



Figure 1.5. Tokina 100mm macro lens with limiting focus distance range.

Extension Tubes

For greater magnifications than 1:1, extend the distance between the camera and the lens with hollow tubes, or bellows extension. These devices enable a lens to focus closer than normal.

Extension tubes have rings connected to each other for the desired magnification. Some have auto-focus and TTL auto exposure, compatible with digital cameras. The AF extension tube shown in figure 1.6 has three rings (12mm., 20mm. and 36mm.).

When attached to a 100-macro lens can increase the subject's magnification up to three times.



Figure 1.6. 68mm extension tube.

The macro setup shown in figure 1.7 shows a DSLR camera, extension tubes, and 100mm macro lens on a copy stand. The maximum magnification of the system is approximately three times (3X).

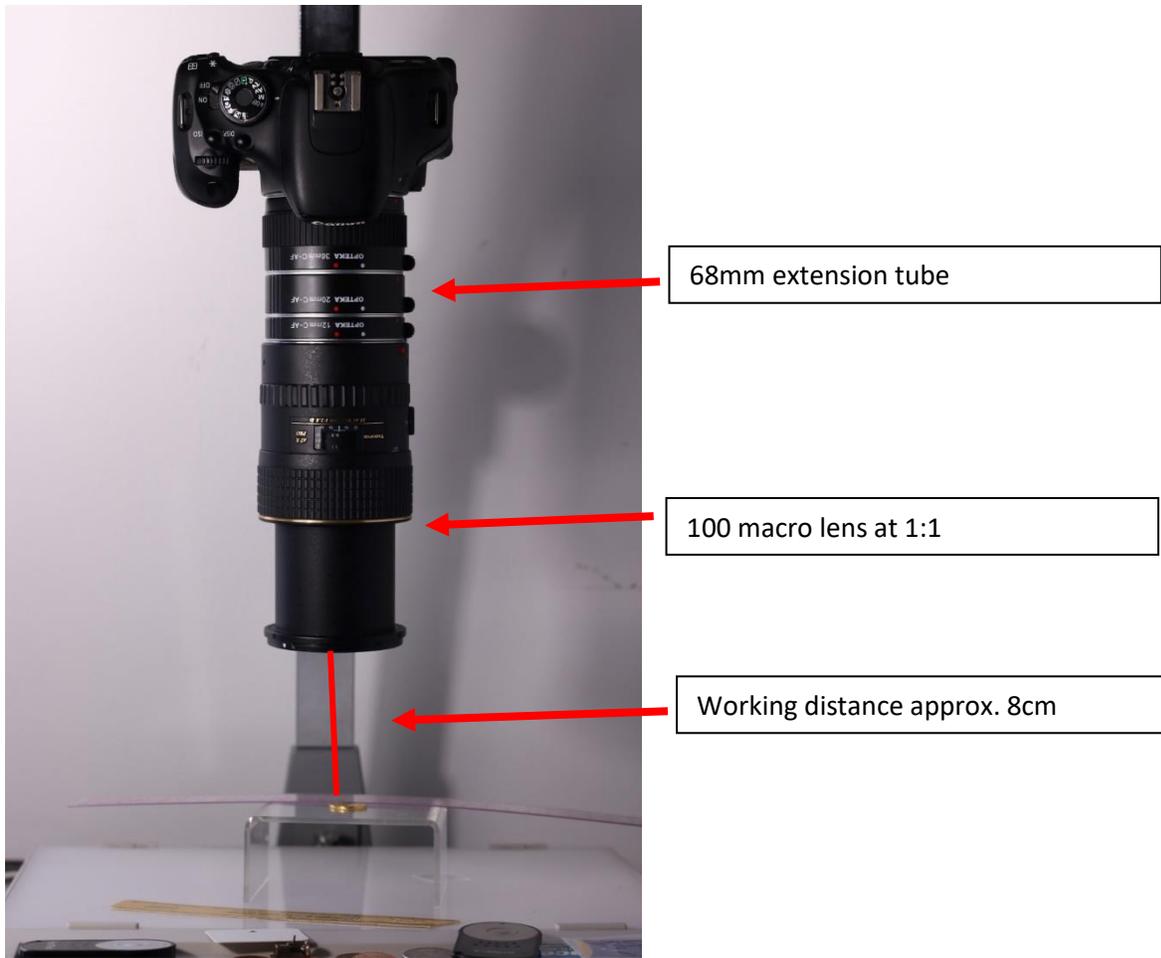


Figure 1. 7. Magnification setup

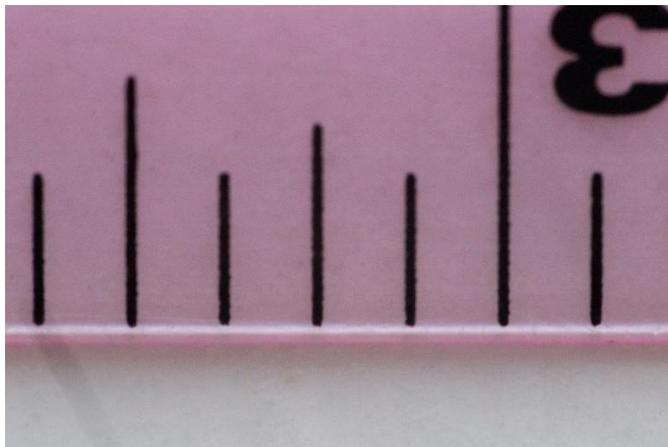


Figure 1.7. Image of a 7.3mm metric ruler, equivalent to a magnification of 3X.



Figure 1. 8. A coin of approx. 11.5mm. Applying the formula, $X= I/O$; $X= 22.3\text{mm}/11.5\text{mm} = 1.93$ OR approx. twice the objects' size.

Bellows Extension

Greater magnification is achieved with a bellows extension, shown below. The magnification is adjusted with a knob. The one shown here, extends to 14cm.



Figure 1. 9. Bellows extension with adjustable knob.

The macro setup attached to a copy stand, with bellows extension mounted to a 100-macro lens allowed a 3:1 ratio or 3 times the subject' size. (Figure 1.10)



Figure 1.10. Bellows + macro lens on a copy stand.

Ruler: 7.5mm.

Applying the formula, $X = I/O$. $X = 22.3\text{mm}/7.5\text{mm} = 2.97$.

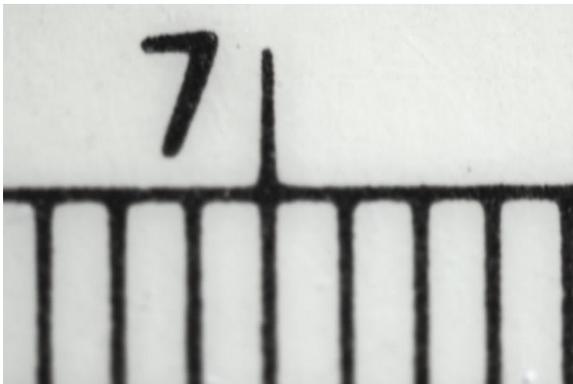


Figure 1.11. Metric ruler of 7.5mm. Approximately 3 times the size.

Extension Tube + Bellows Extension

The images of the ruler and other object were taking with this macro system (Figure 1.12). The working distance is small, approx. 7 centimeters.

The magnification ratio is close to 4:1, a per the formula $X = I/O$.

$I = 22.3\text{mm}$

O=5.6mm
 $X=22.3/5.6 = 3.98X$

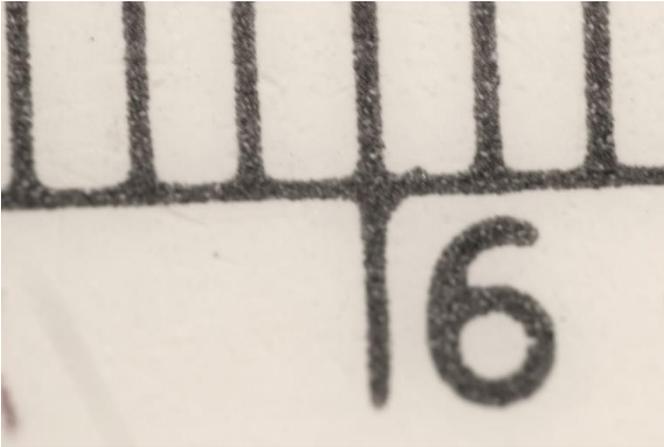


Figure 1.12. Metric ruler magnified 4 times.

A focusing rail mounted on a tripod helps to fine tune the focus (Figure 1.13).



Figure 1.13. Macro system with bellow and tubes.



The Lincoln Memorial on the back of the penny features 12 columns. The coin has 18 millimeters in diameter. The interior columns are separated by 1 mm in distance. Figure 1.14 shows various magnifications taken with a 100-macro lens attached to extension tubes and bellows extension.



Figure 1.14a. 1.2X magnification with a 100-macro lens.



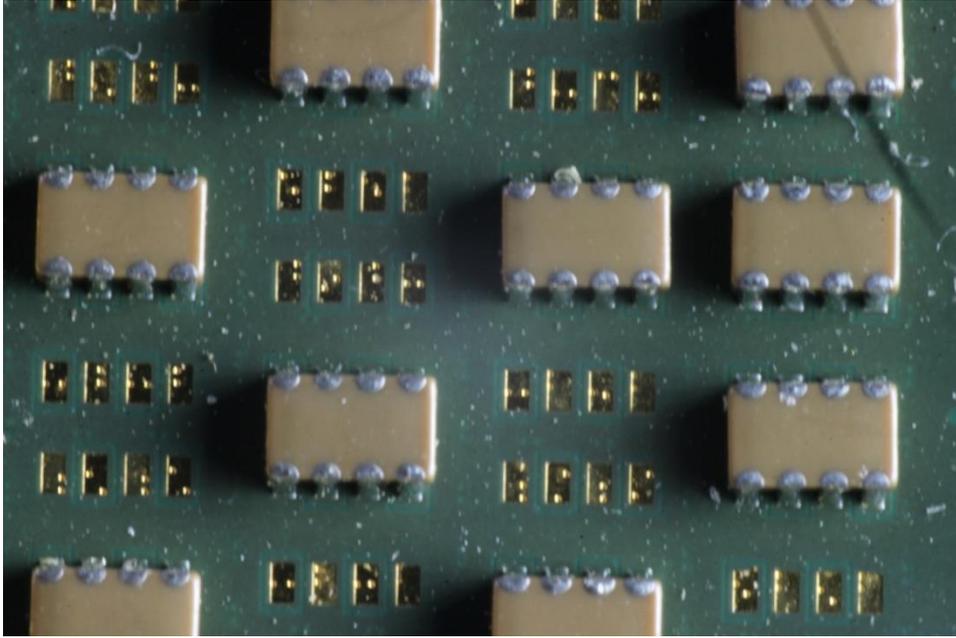
Figure 1.14b. 2.6X magnification with extension tubes.



Figure 1.14c. 4X magnification with extension tubes and bellows.



High magnification images taken with bellows and extension tubes shown below.







1X Magnification.







Enlarging Lens

There are enlarging lenses for the desired scale of reproduction.

An enlarger lens attached to an extension tube using a plate between the enlarging lens and the extension tube (Figure 1.15).

Focus: The working distance is approx. 8 centimeters.



Figure 1. 15. DSLR Canon with Vivitar-LU 1:3.5 50mm enlarger lens.

Below, the filament and anther of an African Violet 1:1.



Figure 1. 16. Macro with an enlarging lens.

Lighting

Direct sunlight has contrast. Keep in mind, what are you shooting, the lighting conditions, and have the gear to fill the shadow areas.

In macro work, carry small flashes and diffusers of various sizes, depending on the subject.

The flashes mount on camera or off-camera with a trigger; the diffusers can be attached on the flash or on the lens. Outdoors, a set of flashes and diffusers can fill shadows.

Off-camera flash and diffusers enhance the lighting. A flash trigger and diffusers attach to the flash or the lens.

Accessories

I find the tripod can slow you down in the field, although it serves a support for consistency on framing, composition and fine focus, specially using heavy lenses and attachments.

In the camera bag, I always carry a minimum of three lenses per camera, lens filters, batteries, chargers, lens cleaning kit, SD cards, flashes, diffusers, flashlights and LED lights.

Instructor's Notes

Realize that photography is physical, be aware of the weight of the macro system and the environmental conditions.