White Paper

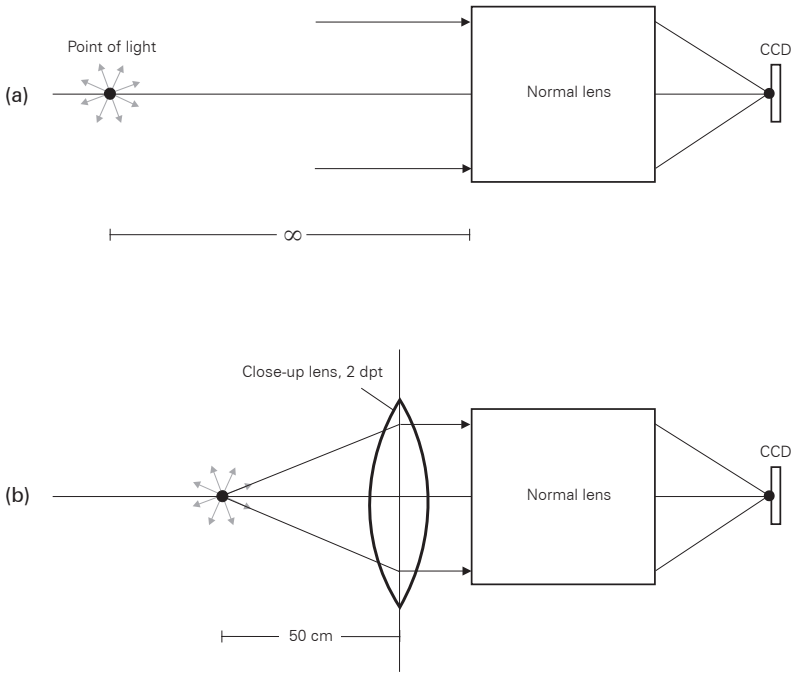
What You Need to Know about Close-up Lenses

THE IMAGINGSOURCE
TECHNOLOGY BASED ON STANDARDS

What You Need to Know about Close-up Lenses

Imagine that the distance of a normal lens is set to ∞ as shown in (a) at the left hand side. Additionally imagine some parallel rays of light created by a point of light in infinity (for instance a star). Directing the normal lens towards this point of light we see a sharp image on the CCD.

If we put a close-up lens of 2 dpt in front of the normal lens (keeping the settings of the normal lens as they are) our point of light needs to be only 50 cm apart to create a sharp image on the CCD.



The table at the right hand side shows the effect of other normal lens settings and close-up lenses.

Let us assume that the distance of the normal lens is set to 1 m. Without a close-up lens all objects at this distance are in focus. With a close-up lens of 5 dpt the distance decreases to 19 cm.

For more details please have a look at the next page.

Close-up lens	Working distance of the normal lens			
	∞	3 m	1 m	0.5 m
1 dpt	100 cm	75 cm	50 cm	33 cm
2 dpt	50 cm	43 cm	33 cm	25 cm
3 dpt	33 cm	30 cm	25 cm	20 cm
5 dpt	20 cm	19 cm	16 cm	14 cm
10 dpt	10 cm	10 cm	9 cm	8 cm

What You Need to Know about Close-up Lenses

What does "dpt" mean?

"dpt" is a measure of the refractive power of a lens. It is the abbreviaton of "diopter". The refractive power of a lens is the reciprocal of its focal length [given in m]. Thus, a lens with a focal lens of 50 mm has a refractive power of 20 dpt.

Why using diopters?

The basic advantage is simplicity. If you stack lenses their diopters add up. That makes life especially easy for ophthalmologists and therefore glasses are determined by diopters. Close-up lenses can be considered as glasses for normal lenses.

What is the purpose of close-up lenses?

Close-up lenses decrease the working distance of normal lenses. Thus, it is possible to obtain images with a higher magnification. Usually close-up lenses are screwed into the filter thread of normal lenses. For this setup the reciprocal of the new working distance is

$$d_{rn} = r + d_{rl}$$

d_{rn} : reciprocal of the new working distance [1/m]
r : refractive power [dpt]
d_{rl} : reciprocal of the lenses working distance [1/m]

The table shown on the previous page has been realized using this formular.

What You Need to Know about Close-up Lenses

What are the side effects of close-up lenses?

(1) Usually, the working distance of a normal lens can be ∞ (pls see drawing on the previous page). A close-up lens also decreases this maximum working distance. The table shown on the previous page illustrates this effect (column "∞").

(2) Close-up lenses do not only decrease the working distance of normal lenses but they also reduce their focal length:

$$f_{rn} = r + f_{rl}$$

f_{rn}: reciprocal of the new focal length [1/m]
r : refractive power [dpt]
f_{rl} : reciprocal of the lenses focal length [1/m]

Assuming a normal lens with a focal length of 50 mm (= 20 dpt) and a close-up lens with a refractive power of 5 dpt, the total refractive power is 25 dpt and thus we have a total focal length of 40 mm. This effect goes slightly against the magnifying effect of a lower working distance.

(3) Due to price reasons, usually close-up lenses only consist of a single lens and thus their image quality is weak. A typical problem of single lenses is the so-called chromatic aberration. It causes false colors that appear as cyan and violet object borders. The measure against this is the use of so-called achromatic close-up lenses. However, most close-up lenses are only available as single lens models.

Summary

Using close-up lenses is a simple and reasonable measure to obtain images with a higher magnification. The main disadvantages are the reduction of the working distance as well as the reduction of the image quality. If a high working distance and/or a high image quality are required, it is recommended to use special macro lenses.

THE IMAGINGSOURCE
TECHNOLOGY BASED ON STANDARDS

Headquarters: The Imaging Source Europe GmbH
Sommerstrasse 36, D-28215 Bremen, Germany
Phone: +49 421 33591-0
North & South America: The Imaging Source, LLC
6926 Shannon Willow Rd, S 400, Charlotte, NC 28226, USA
Phone: +1 704-370-0110
Asia Pacific: The Imaging Source Asia Co. Ltd.
6F-1, No.230, Sec.3, Ba-De Road,,Song-Shan District 10555,
Taipei City, Taiwan
Phone: +886 2-2577-1228
www.theimagingsource.com

Last update: February 2012

All weights and dimensions are approximate. Unless otherwise specified the lenses shown in the context of cameras are not shipped with these cameras.