

Hyperfocal distance tutorial

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Hyperfocal distance can be defined as the point upon which you focus which will place infinity at the far end of your depth of field. In other words, if you want everything to be acceptably sharp from infinity to as close as possible to the camera you would focus on the hyperfocal distance.

Hyperfocal distance is usually applied to landscapes and is therefore a non-issue for scenes which do not include infinity.

Before we proceed, let's review the subjects of:

Depth of field;

Focus; and

Infinity.

Depth of field - (DOF)

It is a fact of optical physics that when a lens is focused on an object, that object is the only place where focus is exact. The picture may appear to be sharp some distance behind and in front of the object but as you look closer or further you will find that the image slowly becomes less sharp. The area where the picture appears to be sharp is the depth of field.

Generally, the depth of field extends two thirds beyond where you have focused and one third in front of where you have focused.

This is a generalization as there are many factors (too complicated to address now) which determine this ratio of 2:1 ($\frac{2}{3} : \frac{1}{3}$). To be more specific, the depth of field is mostly 2:1 but is sometimes 1:1. (At 1:1 the DOF is equidistant from the focus point.)

What determines DOF?

- Small apertures (large $f/$ numbers) produce more DOF than large apertures.
- Depth of field is greater when focused at far distances and shorter when focused at near distances.
- Shorter focal length lenses give more DOF than longer ones.

For the very maximum depth of field you would use your shortest focal length lens at the smallest aperture and focus at a far distance. (To be exact, you would focus on the hyperfocal distance.)

There are several factors which determine what appears to be sharp in the area of the DOF.

- The acuity of the human eye. The human eye is very forgiving and tries to send a clear image to the brain even if the image is not quite clear.
- The size of the circle of confusion (COC).
- The degree of magnification or size of the image.
- The display medium used to view the picture.
- The distance at which the picture is viewed.

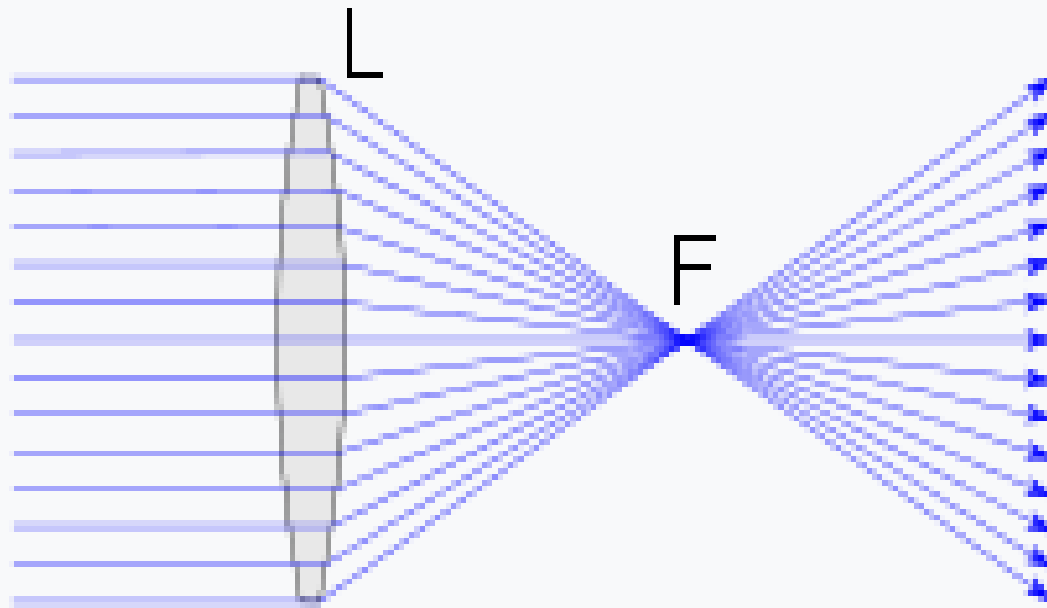


Fig.1

In a perfect lens L all the rays pass through a focal point F. However at other distances from the lens the rays form a circle.

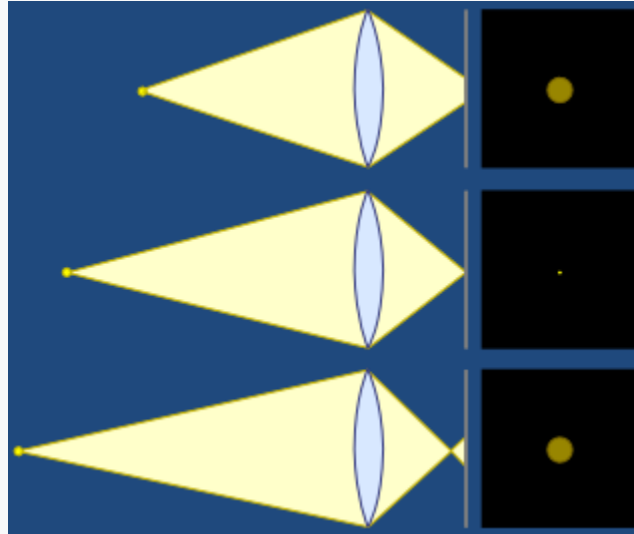


Fig. 2

The depth of field is the region where the COC is less than the resolution of the human eye (or of the display medium).

And now let's take a look at focus.

Focus -

When your picture includes a specific subject you should focus on that subject. If not, maximize your depth of field.

If you want to emphasize the subject you should throw your background out of focus so that your eye is not drawn to the objects in the background.

In fact you can completely obliterate the background into Bokeh.

How do we throw the background out of focus? By using:

- a large aperture or
- a longer focal length lens or
- closing the distance from the camera to the subject or
- any combination of the above. (all three would be best)

If you are taking a portrait of either a person or an animal your should focus on the eye, specifically the nearest eye.

There have been whole books written about focus especially the autofocus of digital cameras but we will not go into that for now. For this article the above explanations will suffice.

Infinity -

What is infinity?

A definition of infinity is a distance that has no bounds.

The infinity symbol is a long figure 8 laying on its side.

What is infinity to the human eye?

To the human eye, it is the farthest thing that we can see e.g. the place where the train tracks merge into a single point in the distance, the horizon, the moon etc.

What is infinity in a camera lens?

The answer to this question is..... it depends.

For instance it depends on the focal length of the lens, the size of the sensor, the optical design of the lens and a few other obscure factors.

You will notice that your lenses which have distance scales do not give a distance for infinity. There will be a number of progressively larger distances marked then a space and the infinity sign.

So infinity is a nebulous distance that you can't put your finger on but if you mentally extrapolate by comparing the spacing between the distance marks on the scale you can get a decent approximation where infinity starts for that lens.

What you will notice is that usually, the longer the focal length, the larger the last distance shown on the distance scale before the infinity symbol.

I will give some examples of the last distance shown before the infinity sign from three lenses that I own:

100 ft, on a 35mm lens

150 ft. on a 50mm lens.

300 ft. on a 135 mm lens.

Note: the infinity distance can change on some zoom lenses as the focal length is changed.

Most kit lenses do not have a distance scale. More expensive lenses have a distance scale and an infinity mark.

Most likely the focus will not stop at infinity but the focusing ring will rotate further.

This was always annoying to me until I found the reason.

The autofocus motor will find infinity by passing it slightly then coming back to make a soft but firm stop.

If the lens did not rotate beyond infinity the focus motor would slam into the end of rotation at infinity and that would put undue stress on the mechanical components of the lens.

If you want to manually focus at infinity just line up the distance marker with the infinity symbol.

Now what about landscapes? -

What should you aim to have within the depth of field in a landscape picture?

The answer is:

EVERYTHING

(or as much as possible.)

Hyperfocal Distance -

As I stated in the beginning, hyperfocal distance is the point upon which you focus which will place infinity at the far end of your depth of field.

How many times have you focused on infinity when taking a landscape? By doing so, you have just wasted the a huge part of your depth of field.

Q. When should you focus on the hyperfocal distance?

A. When you want to maximize your depth of field in a picture which includes infinity, usually landscapes.

Q. When shouldn't we us the hyperfocal distance?

A. When there is a specific subject and infinity is of no interest.

Q. How do I know what the hyperfocal distance is for a given set of circumstances.

A. It can be calculated using the following equation.

$$H' = \frac{f^2}{Nc}$$

where:

H' is the hyperfocal distance, (mm)

f is the lens focal length, (mm)

N is the aperture number

c is the circle of confusion, (mm)

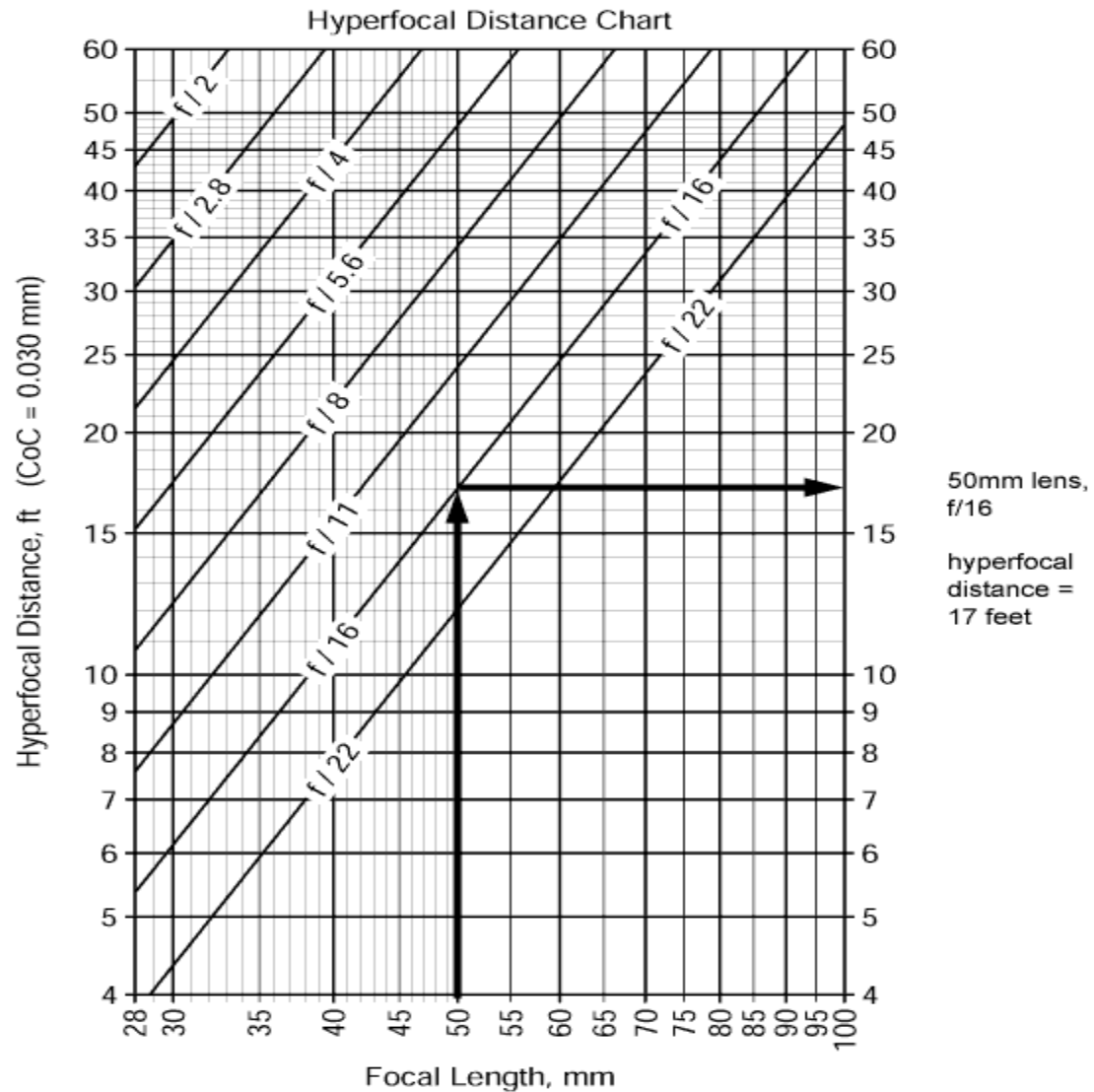
Or you can use a hyperfocal distance chart.

The three variables used to establish the hyperfocal distance are:

- The focal length of the lens;
- The aperture at which the lens is set;
- The circle of confusion (COC) which is dependent on the size of the camera's sensor

When using a hyperfocal distance chart you set the COC, select the focal length of your lens and the aperture which you will be using then read off the hyperfocal distance.

The following chart is an example.



Find the lens' focal length on the horizontal axis. Read up to the f-number to find the hyperfocal distance at that f-number. For example, the arrows on the chart above illustrate how to read the hyperfocal distance for a 50mm lens set to f/16. This chart uses a COC of 0.30 so it is for a full frame camera.

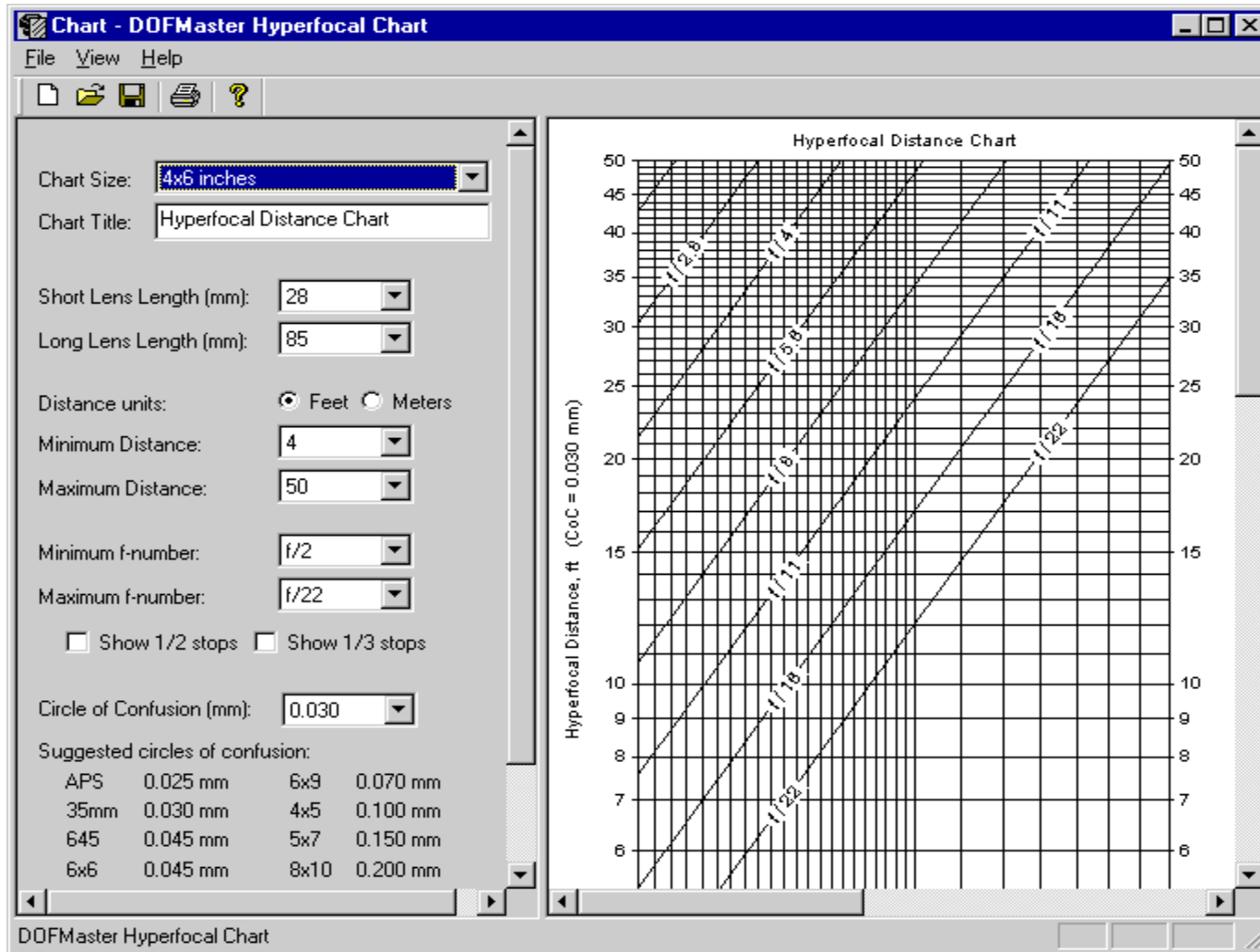
You can go to the following free website and make your own chart. Enter the information for the range of focal length lenses that you would be using for landscapes. You may want to make two or more charts, one for your wide angle lenses and another for your medium focal length lenses. You would not be using your big telephoto lens for landscapes so don't bother making a chart.

If you try to get them all on one chart it may be too cramped or the range of apertures will be off the chart for the focal length lens that you will want to use.

Use .01 for the COC if you have a "1 inch" sensor, .02 for an APSC sensor, and .03 for a full frame sensor.

Enter the appropriate information for your gear and print off a chart. It is a free download.

Make your own chart



<http://www.dofmaster.com/charts.html>

I would suggest that you enter $f/8$ for the maximum aperture as you won't be using anything larger than that for a landscape and the chart will be more usable.

You will quickly see the results of your input on the chart so you should arrange it so that it gives you a hyperfocal distance which you can read off for the focal length of the lenses that you have.

Are there any questions? You say you don't want to go through all of this just to take a landscape picture?

Well if all of this is too technical or confusing for you there is a quick and dirty, sort of rule of thumb shortcut which will approximate the hyperfocal distance.

It won't be exact but it will be very close and it will be much easier than making a calculation and easier than consulting a chart and it will certainly be better than focusing on infinity when taking a landscape.

Hyperfocal distance shortcut -

Compose your picture including the foreground, but be realistic and not include any foreground which is only inches in front of the camera. (If your scene must include an in-focus foreground very close to the camera use the focus stacking method to get the desired result.)

- Estimate the distance from your camera to the closest part of the foreground at the bottom of your composition.

- Estimate a point which is double that distance and focus on whatever is at that doubled distance.

(If you use back button focus this will be very easy, otherwise use spot focus, press the shutter halfway to focus and recompose.)

- Take the picture and infinity should be at the far end of your DOF and your foreground should also be within the DOF.

The two major contributors to making the hyperfocal distance shortcut work are the increased DOF achieved by:

- Using a short focal length lens for landscapes and
- Never shooting a landscape with a large aperture.

The preferred apertures for landscapes are $f/8$, $f/11$ and $f/16$.

Figures 1 and 2 were taken off the Wikipedia website. The charts were taken from the free website dofmaster.