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F-Number in Electro-Optics

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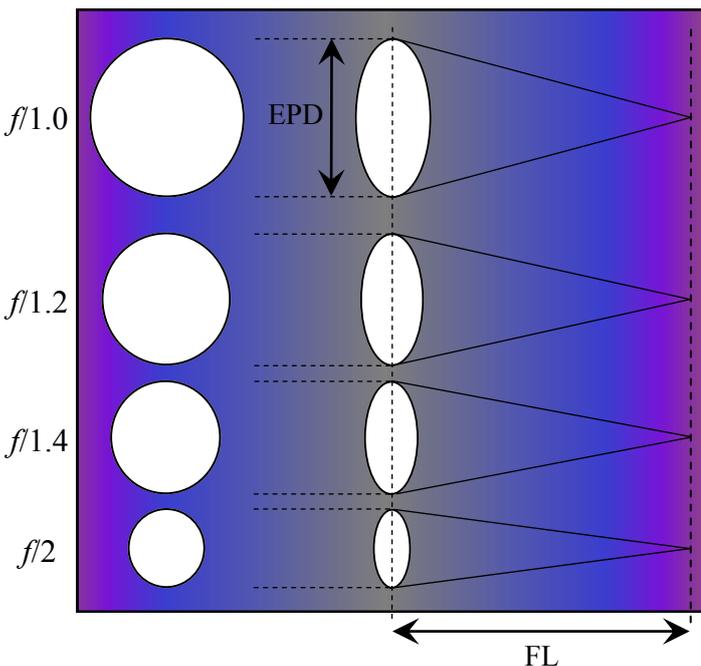
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F-Number. What is it?

In Optics, the F-Number (sometimes called focal ratio, f-ratio, f-stop, or relative aperture) of an optical system is the ratio of the lens' focal length to the diameter of the entrance pupil. This means that the smaller the numerical F-number value, the larger the entrance diameter and more light passes through to the image intensifier tube.

It is easy to understand that a lens with a big aperture diameter (or opening) allows for more light, or infrared radiation in the case of thermal imaging, to go through it. Consequently, more infrared radiation will reach the detector, meaning the detector will react more to the incoming radiation (as there is more of it to go around). Under the same circumstances, with the same detector, a thermal camera will produce much crispier and clearer image when the device is equipped with a lens with a large inner diameter or low F-number. F-number is directly responsible for such parameters of an electrooptical device as sensitivity and operating distance.

F-Number. The Formula.



The diagram on the left schematically shows four different situations when the focal length (FL) of the front lens is the same but entrance pupil diameter (EPD) is different. As a result, F-numbers for these cases vary significantly. The expression for calculation of F-number is simple:

$$\text{F-number} = \frac{\text{FL}}{\text{EPD}}$$

Typical F-numbers	Relative Light-Gathering Ability
f/1.0	4 times more
f/1.4	2 times more
f/2.0	1



When a human's eye focuses on one object it acts as a lens with variable F-number and fixed focal length. In the dark the pupil dilates to capture as much light as possible.

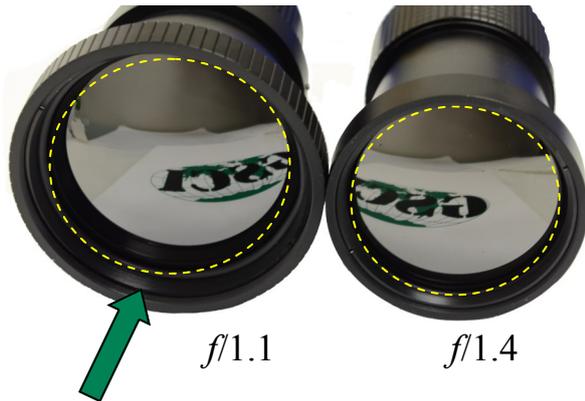
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Low F-Number Vs. High F-Number: Visual Comparison.

Example A: 100mm Germanium lenses



Take a look at the lens' *inner* diameter. Lenses with greater inner diameter (but the same focal length) have lower F-number.

Example B: 75mm Germanium lenses on Thermal Weapon Sights



Dare to Compare?

Now you know what F-Number is, how to calculate it and what are "good" and "bad" F-numbers. You are armed with information to compare night vision and thermal imaging products based on their visual appearance. You can ask suppliers to provide you with a front objective lens' focal length and entrance pupil diameter. Using the above formula you can easily calculate the real F-number and thus determine the quality of optics yourself. Manufacturers that provide quality lenses, will not have anything to hide. GSCI encourages you to compare GSCI products to the next leading brands. Feel free to contact GSCI for Detection/Recognition/Identification (DRI) values for our systems.



References:

1. <http://en.wikipedia.org/wiki/F-number>
2. <http://www.oxforddictionaries.com/definition/english/f-number>



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