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## Deciphering Figure Of Merit (FOM) in Night Vision

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All image intensifier tubes on the market are graded by the two major performance characteristics: Resolution and Signal-to-Noise Ratio (SNR).

Let's begin with **resolution** of an image intensifier tube (I2 tube). It is expressed in lp/mm (line pairs per millimeter) and experimentally determined for each tube right at the factory. Once delivered to OEM customer, tubes can be evaluated by "go-no-go" field tester. It includes an array of patterns: three vertical and three horizontal lines. Spacing between the lines decreases from pattern to pattern, so the narrower the width, the greater resolution of an I2 tube is needed. During the test, an operator has to clearly discern both horizontal and vertical lines of a certain patters and then refer to an original tube's datasheet. Resolution starting at 60 lp/mm and above delivers high levels of detail of an image.

However, don't be misled by the resolution numbers alone. The performance of an I2 tube is also defined by another significant parameter: **signal-to-noise ratio (SNR)**. It is a dimensionless value that determines I2 tube's performance in low-light conditions. SNR is determined by dividing light signal that reaches operator's eye by the perceived noise. The image on the right gives a visual representation of a high- and low values of SNR.

Typically, a good performing I2 tubes have values of SNR starting at 20 and above. This means that signal received by the tube is 20 times higher than the background noise.

FOM is a parameter that defines overall performance of a I2 tube. It is calculated as a product of image intensifier's resolution and signal-to-noise ratio:

$$\text{FOM} = \text{Resolution} \times \text{Signal-to-Noise Ratio}$$

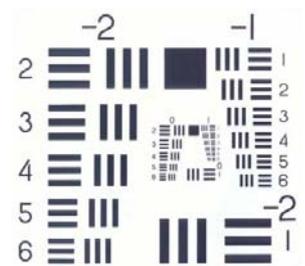
It is noteworthy that each I2 tube is slightly different even within the same production batch. This is why manufacturers give ranges of FOM rather than some exact values.

When supplying a night vision device, a manufacturer has to provide a customer with a spec sheet for the image intensifier tube that states tube's characteristics and its compliance with advertised specs.

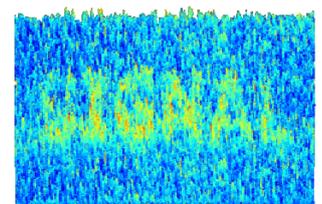
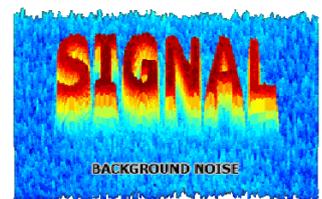
**FOM** also used as parameter which allows to determine "exportability" of the NV System.

### *Special points of interest:*

- I2 Tube Resolution
- Signal-to-Noise Ratio
- Definition of FOM
- Dare to Compare Leading Brands' Image Quality to GSCI's?



*Test target for qualitative assessing resolution of an image intensifier tube.*



*Visual representation of high (top image) and low (bottom image) values of Signal-to-Noise Ratio.*

# Dare to Compare?

In this newsletter we have unveiled the meaning of FOM and examined two characteristics responsible for I2 tube's performance: resolution and signal-to-noise ratio. When you choose a night vision device, always ask a manufacturer for I2 tube's resolution and SNR values.

We always encourage everyone to compare characteristics of I2 Tubes that GSCI uses to those from the next leading brands.



Links to previous GSCI newsletters:

1. [F-number Explained](#)
2. [Image Quality in Thermal Imaging: Resolution](#)
3. [Image Quality in Thermal Imaging: Sensitivity](#)
4. [Image Quality in Thermal Imaging: Refresh Rate](#)

References:

1. [http://en.wikipedia.org/wiki/Figure\\_of\\_merit](http://en.wikipedia.org/wiki/Figure_of_merit)
2. [http://en.wikipedia.org/wiki/Signal-to-noise\\_ratio](http://en.wikipedia.org/wiki/Signal-to-noise_ratio)
3. <http://www.cambridgeincolour.com/tutorials/image-noise.htm>
4. [http://en.wikipedia.org/wiki/Image\\_resolution](http://en.wikipedia.org/wiki/Image_resolution)
5. [http://en.wikipedia.org/wiki/Image\\_intensifier](http://en.wikipedia.org/wiki/Image_intensifier)



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