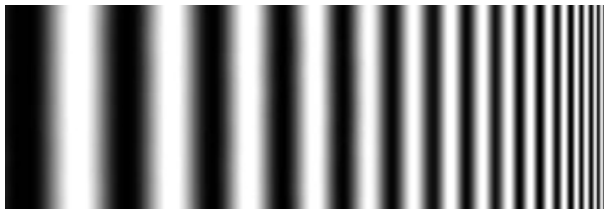


## Modulation Transfer Function (MTF)

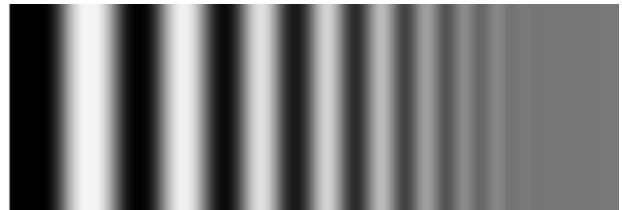
The MTF of an imaging night vision device is the major characteristic that illustrates how well this device can reproduce the contrast of the observed scene. The MTF is the most objective tool to predict the image quality of the I<sup>2</sup> tube at high light levels.

Depending on the optical characteristics of the device, the contrast of the image decreases as the spatial frequency increases. The spatial frequency range can be imaged through a line network. This is illustrated by the example below.

The observed image (target) is made of 100% contrast lines, the spatial frequency increases from left to right. The output image shows how the contrast – ie the MTF – decreases from low to high frequencies, until it lowers down to 4%, which approaches the limiting spatial resolution of the human eye, expressed in lp/mm (line pairs per mm).



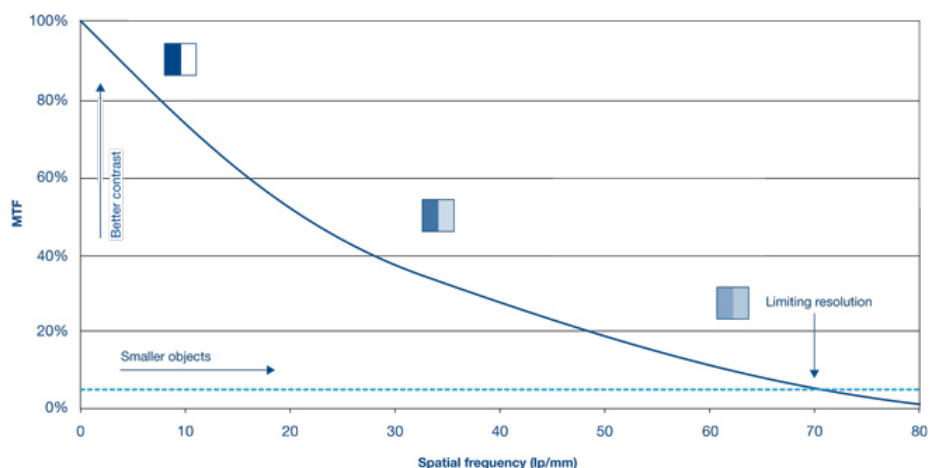
100% Contrast input image



Output image: the contrast decreases as the lines become thinner and thinner

The MTF curve is then simply the output contrast over input contrast ratio, at any frequency of the range of interest. Manufacturers often provide MTF data in tabular form at discrete spatial frequencies:

2.5 lp/mm	92 %
7.5 lp/mm	80 %
15 lp/mm	58 %
25 lp/mm	45 %
30 lp/mm	35 %



Typical MTF curve of an I<sup>2</sup> tube

High contrasts at low spatial frequencies reproduce perfectly large image details or objects; while high contrasts at high frequencies drive how well smaller images details are seen. A good level of contrast from low to medium frequencies, up to approximately 30 lp/mm, provides a clear image; however, low contrasts at high spatial frequencies will have little perceived influence.

The actual image quality is directly linked to the integrated MTF curve between 0 (zero) lp/mm and the limiting resolution, which means the richness of the information contained in the image is a function of the area below the MTF curve; in other words, the MTF curve overall shape is at least as important as the absolute limiting frequency.

The MTF curve at the left bottom of picture below is decently high over the whole spatial frequency range; this is typically the level of image quality an [XR5™](#) I2 tube will provide. The MTF at the top right of the image drops quickly at low frequencies, producing a low contrast and hazy image typical of low quality tube such as offered by Russian suppliers. This example illustrates how important is a broad MTF curve to clearly see the small details of an image – these details can enhance the soldier's environment awareness.



Influence of MTF on the image quality