

## Detection / Recognition / Identification (DRI) Table for LWIR Uncooled Thermal Imaging Systems

Definition of terms.

**Detection** - The perception of an object image as being present at a particular location and distinct from its surroundings.

**Recognition** - The determination that an object belongs to a particular functional category (e.g., human, truck, tank, etc.).

**Identification** - The most detailed level of description of particular object within functional category (unarmed male civilian, four-door truck).

Detection, Recognition and Identification values are affected by a number of factors that are related to environment, object, thermal system itself and operator who uses it. The lists of factors provided below are not exhaustive, other factors may also affect DRI values.

Thermal System Characteristics	Environment Characteristics	Human Factors
<ul style="list-style-type: none"><li>• Thermal sensor pixel pitch</li><li>• Thermal sensitivity</li><li>• Optical magnification</li><li>• Objective lens aperture</li><li>• Display type and size</li><li>• Non-Uniformity Correction (NUC) techniques</li></ul>	<ul style="list-style-type: none"><li>• Fog</li><li>• Rain</li><li>• Haze</li><li>• Sand</li><li>• Other climatic obscurities</li><li>• Atmospheric attenuation (e.g. atmospheric turbulence caused by solar heating)</li><li>• Air density and temperature</li></ul>	<ul style="list-style-type: none"><li>• Training</li><li>• Experience</li><li>• Expectations for possible targets</li><li>• Stress</li><li>• Concurrent task load</li><li>• Clarity of vision</li><li>• Fatigue</li><li>• Set electronic zoom</li><li>• Set FPA gain level</li><li>• Set display brightness level</li><li>• Set image polarity</li><li>• Optics focusing</li><li>• Cleanliness of optics</li><li>• Placement of thermal system</li></ul>
Object Characteristics		
<ul style="list-style-type: none"><li>• Object-Scene contrast ratio</li><li>• Camouflage</li><li>• Object's speed and direction of motion</li></ul>		

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The table provided below shows distances (in meters) at which objects of specified dimensions can be detected (D), recognized (R) and identified (I). Based on Johnson's criteria table - 3 pixels are needed to detect an object, 6 - to recognize and 12 to identify it. This approach gives a 50% probability to successfully accomplish a task of object detection/recognition/identification and corresponds to maximum DRI values. To increase the said probability to 90%, the number of pixels needs to be increased by 1.8 times, and more specifically to 5.4 pixels for detection, 10.8 for recognition and 21.6 for identification. Consequently, DRI values are decreased by the same factor of 1.8 and correspond to minimum DRI values in each section. The calculated DRI values listed in the table are for reference only and may not correlate with results obtained in real-world conditions as in some cases many more pixels need to be distinctively seen to successfully detect/recognize/identify an object. This will in turn significantly impact the distances at which an object is detected/recognized/identified. Note that instantaneous field of view (IFOV) derived from pixel pitch and lens focal length defines DRI values while the detector resolution defines the field of view of a thermal image.

Detector Resolution and Pitch	25mm Lens			50mm Lens			
	D	R	I	D	R	I	
384x288, 17µm	640-1150	240-430	130-240	1290-2310	480-870	250-460	Human (1.7x0.5m)
	870-1560	320-580	170-300	1730-3120	650-1170	350-620	Vehicle (2.3x2.3m)
640x480, 17µm	640-1150	240-430	130-240	1290-2310	480-870	250-460	Human (1.7x0.5m)
	870-1560	320-580	170-300	1730-3120	650-1170	350-620	Vehicle (2.3x2.3m)

Detector Resolution and Pitch	75mm Lens			100mm Lens			150mm Lens			
	D	R	I	D	R	I	D	R	I	
384x288, 17µm	1920-3460	720-1300	380-690	2560-4610	960-1730	510-930	3850-6920	1440-2590	770-1380	Human (1.7x0.5m)
	2600-4680	980-1760	520-940	3470-6240	1300-2340	690-1250	5200-9360	1950-3520	1040-1870	Vehicle (2.3x2.3m)
640x480, 17µm	1920-3460	720-1300	380-690	2560-4610	960-1730	510-930	3850-6920	1440-2590	770-1380	Human (1.7x0.5m)
	2600-4680	980-1760	520-940	3470-6240	1300-2340	690-1250	5200-9360	1950-3520	1040-1870	Vehicle (2.3x2.3m)

The table above shows the predicted DRI values for a variety of lenses and two thermal detectors. For each setup there are two values, forming a range. Maximum value in each range represents predicted DRI value at 50% probability of successful task accomplishment, minimum value - at 90% as it requires more pixels to successfully detect, recognize and identify an object.

**References:**

1. Johnson, J., (1958), "Analysis of Image Forming Systems", Proceedings of the Image Intensifier Symposium, 6-7 October 1958: AD220-160, U.S. Army Engineer Research and Development Lab, Fort Belvoir, VA, 249-273
2. Vollmerhausen, Richard, and Van Hodgkin, "Range performance benefit of contrast enhancement," Proceedings of SPIE Vol. 6543 65430B, 2007.