



## Thermal Imaging Cameras

### What does a thermal image look like?

A thermal image is black and white. On a relative scale, it shows hot items as white and cold items as black.

Temperatures between the two extremes are shown as gradients of gray. Some thermal imagers have color images. The color is artificially generated by the camera's video enhancement electronics, based upon the thermal attributes seen by the camera.

### What is a pixel?

A pixel is the smallest single individual image element of detection on the thermal imaging sensor.

### What is a focal plane array (FPA)?

A focal plane array is a group of pixels organized into a rectangular grid. The size of the array is measured by multiplying the horizontal number of pixels by the vertical number of pixels. Most fire service thermal imaging cameras on the market today contain 160 x 120 or 320 x 240 FPAs.

### What frequency range does the thermal imaging sensor detect?

Thermal imaging sensors are designed to detect long-wave infrared radiation between 8 to 14 microns. This energy, unlike visible light, can pass through smoke and is undetected by the naked eye.

### What is a BST detector?

BST stands for "barium strontium titanate," and this type of detector was developed by Raytheon Corporation.

Ceramic-like thermal energy sensing material is used to make BST focal plane arrays, which measure heat by storing it as a fixed value (similar to a capacitor) at each pixel. When the grid of pixels, or focal plane array, is monitored simultaneously, a thermal image is generated.

Because of their fixed-image properties, BST pixels must be refreshed regularly in order to maintain the perception of real-time imaging.

The device used to refresh the image is called a “chopper”. The “blade” of the chopper wheel passes in front of the detector to effectively change the scene temperatures “sensed” with each pass. The speed of the chopper determines the “refresh rate” (see definition) and is typically 30 Hz.

### **What is a microbolometer?**

A microbolometer is the latest type of thermal imaging FPA, which consists of materials that measure heat by changing resistance at each pixel. The most common microbolometer material is vanadium oxide (VOx). Amorphous silicon (ASi) is another relatively new microbolometer material, but currently is available in a 160 x 120 FPA. In addition, the ASi model has poor dynamic range and isothermal scene performance which limits the current version(s) for many fire service applications.

Although microbolometers do not require a chopper to refresh the image, they must occasionally be recalibrated for the pixels to provide a consistent output and to avoid oversaturation. The device that occasionally (every 30 seconds to 5 minutes) and automatically recalibrates the FPA is called a “shutter” (see definition).

### **What does ferroelectric mean?**

A TIC's detectors that are ferroelectric in nature detect heat by storing it as a value on each individual pixel. BST and pyroelectric vidicon tubes are examples of ferroelectric detectors.

### **What does thermoelectric mean?**

TIC's detectors that are thermoelectric in nature detect heat by changing each pixel's resistance. Microbolometers are examples of thermoelectric detectors.

### **What is MRTD?**

MRTD stands for minimum resolvable temperature difference. This is a relatively inaccurate measurement of the smallest temperature difference that a thermal imaging camera can detect.

### **What is NETD?**

NETD stands for noise-equivalent temperature difference. This is a measurement of the smallest temperature difference that a thermal imaging camera can detect in the presence of electronic circuit noise for a particular lens f-number.

### **What is dynamic range?**

Dynamic range is the range of temperature variance that a TIC can see without saturating. A microbolometer has a much larger dynamic range (eg. 360° F or 200° C) when compared to a BST which has a much smaller dynamic range (eg. 45° F or 25° C). This allows the microbolometer to demonstrate gradients of gray in environments (generally at higher temperatures) where BST sensors become saturated and appear as a black & white image.

To further enhance the image, the Evolution 4000 microbolometer automatically extends the dynamic range even farther to 1080°F (600°C) in high temperatures (indicated by the 'EI' indicator on display).

### **What is meant by field of view (FOV)?**

The field of view describes the area visible by the thermal imaging camera. FOV is measured in degrees and can be specified in horizontal, vertical, or diagonal measurement. The lens and its position generally determine the camera's FOV.

### **What is standby mode?**

The standby mode turns all major components in a TIC off except for the sensor core. This feature allows the camera to be in ready mode so that the camera can power up without the standard 15 - to 30 second sensor core warm-up time.

### **What is the purpose of an iris?**

Generally used on ferroelectric (pyroelectric vidicon tubes and BST) sensors, the iris is a mechanical aperture that operates much like the iris of the human eye. It opens and closes to control the amount of infrared energy that enters the camera and strikes the sensor.

The iris also manages the “dynamic range” (see definition) of ferroelectric sensors. The iris can be either manual or automatic and may also be called a “throttle” or “gain adjust.” All MSA TICs have irises which require no manual intervention.

### **What thermal imaging cameras currently available on the market are rated as intrinsically safe?**

To date, no TICs available on the market have an intrinsic safety rating. Products that are rated as intrinsically safe do not generate enough heat or spark which could serve as the ignition source for an explosion.

TICs require too much power and produce too much energy to qualify as intrinsically safe products. Technology is rapidly evolving to provide lower power components for TICs, so an intrinsically safe camera is not far away.

### **What is a shutter?**

A shutter is a mechanical device, generally shaped like a flag, which closes in front of the detector to activate the calibration for a uniform temperature (or black body).

This automatic, periodic calibration is necessary because pixels in microbolometers drift and cause image degradation.

### **What is “refresh rate”?**

Refresh rate (or frame update rate) is the number of times per second that a new image is “created” by the sensor. The refresh rate is determined by mechanical attributes (eg. chopper wheel), where applicable, and the speed of the electronics.

### What is white-out or over saturation?

White-out or oversaturation occurs when a thermal imaging detector is subjected to too much thermal energy, and the image, which appears as a white cloud, no longer identifies fine details in the scene.

Most thermal imaging cameras have an automatic iris or appropriate software to adjust system controls to avoid white-out immediately after intense thermal energy hits the detector. Pointing the TIC directly at superheated sources, such as the sun, is not recommended and may damage the detector.

### What makes a quality high resolution thermal imaging picture?

Thermal imaging picture quality is determined by a number of factors:

1. The quality of the lens that focuses the thermal image onto the FPA. One measurement of lens speed is the f-number. The smaller the f-number, the wider the lens, and the better the image quality. Generally, the main constraints to lens quality include weight and size (the better the lens, the bigger and heavier it will be).
2. The number of pixels on the FPA. With all other thermal system components being equal, the more pixels on the FPA, the finer the image details that can be resolved.
3. Whether it's microbolometer or BST. BST pixels are mechanically interconnected, whereas microbolometer pixels are mechanically isolated. The thermal energy seen by an individual BST pixel can therefore "bleed" onto nearby pixels, but isolated microbolometer pixels sense independently and provide clearer, crisper image lines.
4. The electronic signal processing (video enhancement electronics). Most fire service thermal imaging cameras are controlled by microprocessors, which not only monitor the system but also "enhance" the thermal image. For example, some cameras are able to generate near 320 x 240 FPA performance by using a 160 x 120 array and "averaging" to generate the remaining image points. Others are able to determine if a pixel is not functioning properly and approximate its correct output using surrounding pixels to generate a smoothed image.
5. The MRTD. (See definition)
6. The NETD. (See definition)
7. The Dynamic Range. (See definition)
8. The amount of system signal noise. Signal processing and components may add noise (or "snow") to the image. The cleaner the system, the better the image (difficult to measure but easy to see).
9. The display used to interface with the user. The better quality display provides a better image.

### Why do TICs have a Germanium window on the front of the camera?

The Germanium window allows thermal energy to transmit through it (unlike glass) and provides impact protection for the internal lens (also made of Germanium) that focuses the thermal image onto the detector's focal plane array.

## Use and Operation of MSA TICs

### Can the Evolution® TICs be connected to a video recording device (tape)?

Yes, via the BNC connector (standard on Evolution 4000; optional on Evolution 3000) using any NTSC (or PAL, if ordered) hookup.

### How does "red" color happen in Evolution 4000?

The "red" color of the Evolution 4000 TIC, known as the "Heat Seeker Indicator," is activated in two situations:

- a. When the TIC image is in an environment where the range of the surrounding objects is less than 392°F (200°C), or high sensitivity mode, the portion of the image above 392°F (200°C) will appear as red on the screen.
- b. When the TIC image is in an environment where the range of the surrounding objects is greater than 392°F (200°C) or low sensitivity/'EI' mode, the portion of the image above 1112°F (600°C) will appear as red on the screen.

### Can my Evolution camera be "upgraded"?

Yes. All upgrades are done at MSA's Repair and Service Facility near Pittsburgh, Pennsylvania.

Evolution 4000 cameras can be upgraded to include:

- Quick Temp
- Remote Wireless Video Transmission
- New software releases

Evolution 3000 cameras can be upgraded to include:

- Direct temperature measurement (Pyrometer)
- Remote Wireless Video Transmission
- BNC Connector
- New software releases

### How long does it take to charge a battery?

Between 1 and 2 hours.

### Can the battery be overcharged?

No, the charger and battery have protection circuitry to prevent overcharging.

# Remote Wireless Video Transmission

## Should I use a high-gain or low-gain antenna?

There are tradeoffs when selecting antenna gain. Higher-gain antennas offer an advantage in that they can make a weaker signal appear much stronger. They can also greatly reduce the impact of multipath interference at the receiver location by rejecting signals off to the sides of the main signal path.

This characteristic of a narrow pattern of reception also requires that the antenna must be aimed more precisely than one of lower gain. Field evaluations of several different configurations are suggested.

## Can more than one video transmission system be operated at the same location?

Yes. You can simultaneously operate as many systems as there are channels. Under the proper circumstances in fixed point-to-point applications, it is possible to re-use channels.

## Will microwave or RF signals from other equipment affect the remote video transmission systems?

Only if those signals are at the same frequency as the system being used. The most common interferences to remote video transmission systems are large metal objects/structures or large power generators/lines in the transmission path.

## What is the range of the remote wireless video transmission system?

A minimum of 1 mile to over 10 miles, depending on the antenna gain, and provided the user has adequate antenna elevation. These range numbers assume a clear line of sight between the transmitter and receiver antennas.

Without a clear line of sight, the maximum range will be reduced by an amount dependent on the nature of obstructions. The system was designed to transmit through multiple interior and exterior walls of a building.

## Is transmission of the image "real time"?

Yes, the receiver will display the image exactly as seen by the camera (with the exception of any noise interference that may be present).

## Does the signal propagate in a straight line?

Yes, however, the signal can bounce and reflect off various surfaces and go around corners.

## Will the microwave signals penetrate walls and other non-metal objects?

Yes. However, penetration of any object will reduce signal strength and therefore the detectable signal range.

## Do rain and snow affect remote transmission range?

No, not at this frequency (2.4GHz). However, snow accumulation on the antennas can have a significant adverse effect on performance.

## When using remote wireless video transmission, can two cameras use the same receiver?

Yes, but one receiver display cannot view both images at one time (i.e. no split screen), and the receiver operator must toggle between channels to view each camera. Two separate receivers can detect two different cameras provided the transmitter/receiver pairs are utilizing different channels.

## What is multipath interference?

Multipath is basically "self-interference." It results when the receiver antenna picks up reflected signals from the transmitter as well as the transmitter signal that travels directly to the receiver.

## How does multipath affect the performance of a wireless video system?

When multipath occurs, it can reduce the signal range, thus causing the picture to get noisy or disappear. It can also cause changes in the color hue and intensity.

## Are there potential health hazards associated with operating this equipment?

According to the best knowledge of technical experts, there are no known or suspected health hazards from the level of radiation emitted. MSA equipment complies with the recommended IEEE/ANSI specification for uncontrolled emissions.

**Note:** This Bulletin contains only a general description of the products shown. While uses and performance capabilities are described, under no circumstances shall the products be used by untrained or unqualified individuals and not until the product instructions including any warnings or cautions provided have been thoroughly read and understood. Only they contain the complete and detailed information concerning proper use and care of these products.



ID 3400-06-MC / Oct 2001  
© MSA 2001 Printed in U.S.A.

**Corporate Headquarters**  
P.O. Box 426, Pittsburgh, PA 15230 USA  
Phone 412-967-3000  
[www.MSAnet.com](http://www.MSAnet.com)

**U.S. Customer Service Center**  
Phone 1-800-MSA-2222  
Fax 1-800-967-0398

**MSA Canada**  
Phone 800-267-0672  
Fax 905-238-4151

**MSA Mexico**  
Phone 52 (2) 1 22 57 30  
Fax 52 (5) 3 59 43 30

**MSA International**  
Phone 412-967-3354  
Fax 412-967-3451

**Offices and representatives worldwide**  
For further information:



**MSA**