EMERGENCY RESPONDER
THERMAL IMAGING

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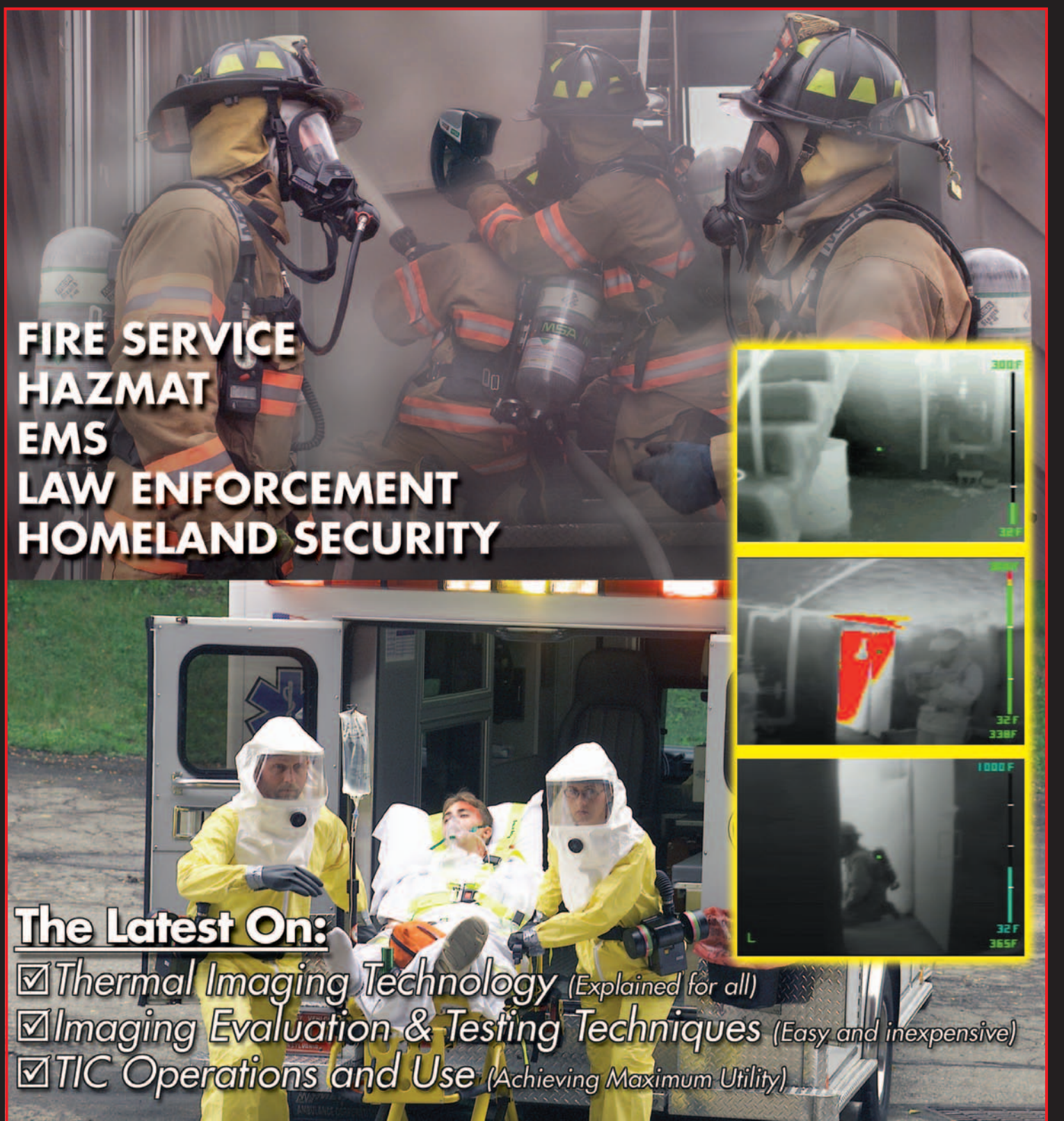

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TIC Performance – It's All About SAFETY:

The growing use of Thermal Imaging Cameras by Firefighters and Emergency Responders over the past ten years has been driven by their expanding needs and applications. Some of these include:

- Structural Firefighting
- Search and Rescue
- HAZMAT
- Emergency Medical/Triage
- Fireground Accountability
- Inspection and Investigation
- Security and Surveillance
- Urban Search And Rescue

Ultimately, SAFETY is the fundamental issue with each of these TIC applications. Whether it is the personal SAFETY of the TIC user, or the SAFETY of those they serve, with TIC usage – It's all about SAFETY. When properly used, TICs can become an invaluable tool at an emergency scene. Only Thermal Imaging Cameras can provide visual information of the natural occurring heat signatures that are invisible to the human eye. TICs provide this information instantly for quick discovery, decision and action in emergency situations.

A TIC's Performance is directly tied to SAFETY, and involves the follow questions:

- Can the TIC maintain image quality across a broad range of temperatures?
- Does the TIC provide warning indicators?
- What new emerging technologies will transform the thermal imaging camera into an even greater SAFETY tool?

These SAFETY and performance issues will be examined in this issue of

EMERGENCY RESPONDER THERMAL IMAGING.

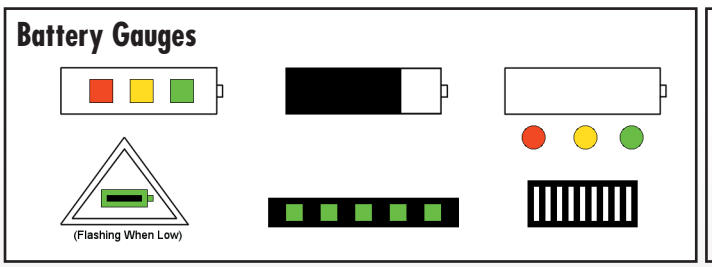
Eliminating Thermal Imaging Confusion!

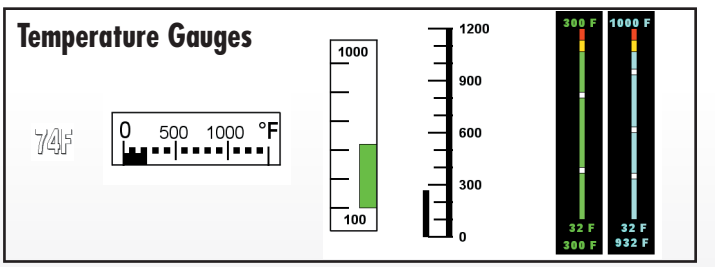
Sensitivity? Color Pixels? Microbolometer? DYNAMIC RANGE? Digital Temp?
BST? NEDT? Vanadium Oxide? 55° FOV? 50 milliKelvin (mK)?

FEELING A LITTLE CONFUSED?

It seems that every TIC has a different term, designation, color indicator, setting, and spec for the same function found on other cameras. For example, different Fire Service TICs show battery usage by different gauges, LEDs, icons, and symbols. All are confusing and difficult to interpret, especially when various TICs are used by the same Fire Department.

The same situation exists with Fire Service TICs that measure temperature, show hot objects in different colors, and change sensitivity modes as the heat of the fire increases.





Then there are the TIC Manufacturers' Product Specifications that contain lots of technical information generally expressed in numbers followed by Hz, μm, °C, mm, microns or VDC labels!

60 Hz, 48 μm, 500°C, 8.5 mm, F1.2, 8-14 microns, 60 Hz, 12-24VDC, 500°C, 60 Hz, 12-24VDC, 48 μm, 8.5 mm, F1.2, 8-14

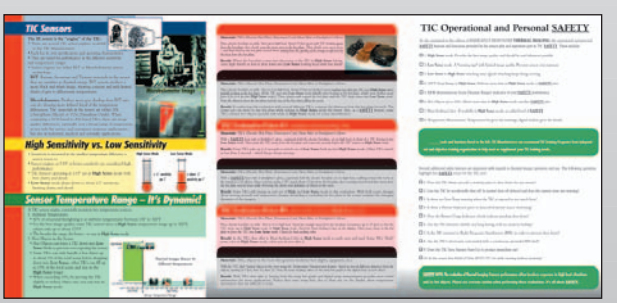
It's not just about specifications. What about industry standards? It is hard to tell which TICs are designed to match the standards currently in place for comparable Fire Service and Emergency Response products. Standards that address drop, dunk, radio frequency interference, vibration, high heat and flame currently applied to similar **SAFETY** equipment?

IP 67 Classification Direct Flame/Heat Exposure NFPA 1981–2002 Edition, NFPA 1982-1998 Edition
Vibration - MIL-STD-810E Category 1 *Radio Frequency Interference - CE/EN 50081-2:1992, EN 50082-2:1992, FCC Part 15*
Rollover - NFPA 1901-12, 1.7

Interestingly, most TIC users recognize, that when properly evaluated and trained upon, the right TIC is rugged, simple, safe, easy to use – and gets the job done! Their appreciation of, and reliance upon a TIC continues to grow with every use.

The purpose of this issue of EMERGENCY RESPONDER THERMAL IMAGING is to clear up some of the confusion by providing simplified information on TIC operational and **SAFETY** features that Firefighters and Emergency Responders need to know.

This issue also contains six quick and easy TIC Evaluation Points that can be performed in an office or conference room setting. Most of the Evaluations are performed with a single burner electric hot plate (less than $10 cost) to help determine some of the capabilities and capacities of a TIC. There is also a **Pull Out Checklist** (shown above) in the center section of this issue to use when conducting overall TIC performance evaluations.

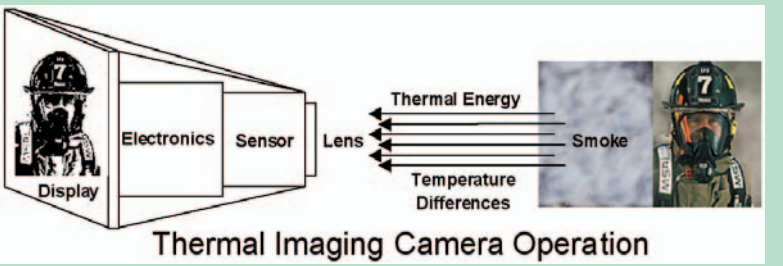


Please note that various product specifications referenced in this issue are derived from the current product information available on the TIC manufacturers' websites.

Sensors – The Thermal Imaging of Infrared Energy

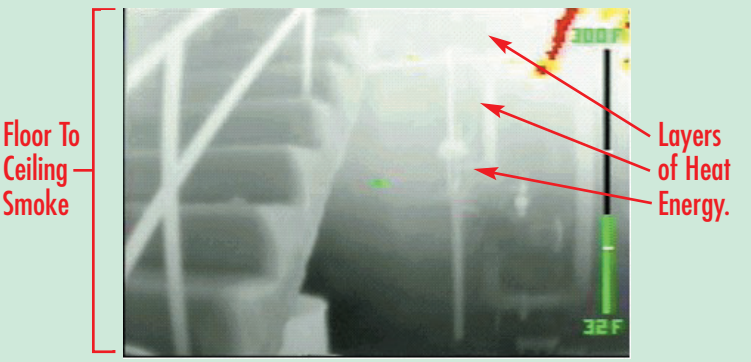
TICs see a different type of energy than the human eye sees. TICs see heat or thermal energy – also called infrared or IR energy, in very small temperature increments. Our eyes only see light energy. Without light, our eyes stop seeing. A TIC never stops seeing heat energy.

Science tells us that everything in nature above a temperature of –460°F (that's Absolute Zero) has heat or thermal energy associated with it. A TIC's IR sensor sees an object's small increments of temperature difference and translates them into an image that the human eye can see on the TIC's display.

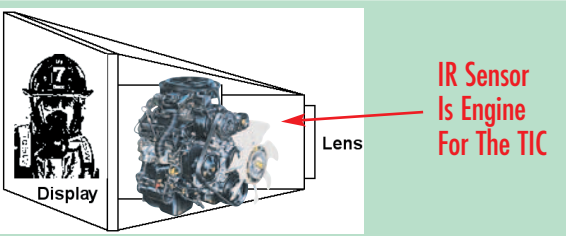


Thermal Imaging Camera Operation

Since the IR sensor sees thermal energy without the need for light energy, TICs see everything in full light or total darkness – or anywhere in-between. TICs also see thermal energy coming through heavy smoke in firefighting and other emergency situations where smoke, dust, and even tree foliage are present. A high performance Firefighting TIC can also see layers of heat in a structural fire, giving advance warning of a developing high heat, and possibly explosive, situation.



The IR sensor is the "engine" of the TIC. There are several TIC sensor engines available to the TIC Manufacturers, each having its own specifications and operating characteristics. Those sensor engines are tuned for performance at the different sensitivity and temperature ranges. That's why some TIC sensors produce clearer images in a wider range of temperatures than others do.



Today, most Fire Service and Emergency Response TIC sensor engines use either BST or Microbolometer sensor technology. The general differences between the two are:

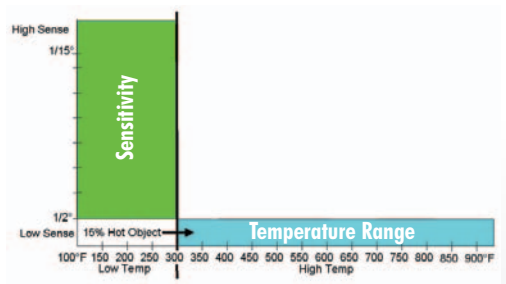
BST
Name: Derived from the mixture of Barium, Strontium and Titanate materials in the sensor that are sensitive to thermal energy.
Image Type: BST sensors produce a more black and white image, showing contrast and with limited shades of grey to differentiate temperatures.

Microbolometer
Name: Derived from the sensor's ability to measure energy changes. The materials in the sensor that are sensitive to thermal energy are either ASi (Amorphous Silicon) or VOx (Vanadium Oxide).
Image Type: Microbolometers produce more grey shading than BST sensors do, showing more defined detail of the temperature differences.

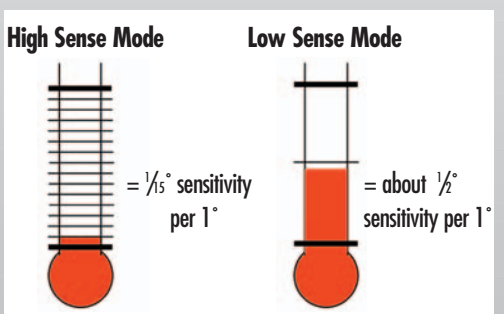
ASi vs. VOx Microbolometers: When comparing VOx-based to ASi-based TICs there are image quality differences, especially over a broad temperature range in not only fire service and emergency response applications, but also industrial, medical and scientific TIC applications.

Sensitivity Modes

A TIC's **sensor engine performance** depends on how well its sensitivity and temperature range work together. **High sensitivity** delivers clearer, sharper, and more detailed images than **low sensitivity**. Temperature range determines the maximum temperature in which those images can be seen.



Let's start with sensor Sensitivity – which is measured in the smallest temperature difference a sensor reacts to. Sensor engines at 1/15° or better sensitivity are considered high performance. That's a measurement of 15 or more temperature differences for each degree of heat in the scene. More temperature differences mean more image detail. Sensors operating at this level are in **High Sense mode**. Most TICs also have a **Low Sense mode** that drops down to about 1/2° sensitivity or only 2 temp differences for each degree – limiting image clarity and detail. **Low Sense** performance is like an engine running on only one cylinder. **High Sense** is like running on all eight!



High Sense vs. Low Sense

Why a Low Sense mode?
It's a SAFETY feature that automatically activates when the TIC is out of its **High Sense** temperature range. For Firefighters, **Low Sense** mode is a "**warning sign**", providing limited sensitivity to extend the use of the TIC in higher temperatures – and to prevent sensor over-exposure. (Note: Some TICs show an "EI" or "L" symbol on the TIC display when in **Low Sense** mode, while others give no indication at all other than the loss of image clarity and detail.) Most Fire Service and Emergency Response TICs have both a **High Sense** mode and a **Low Sense** mode. It is important to understand the operation, limits and benefits of both modes.

Please note that BST based TICs have only one mode which can be adjusted either manually or automatically (depending on the make and model) to prevent sensor over-exposure. Therefore the TIC operational explanations that follow do not apply to BST based TICs. The Evaluation Points though, can and should include BST based TICs if they are being considered.

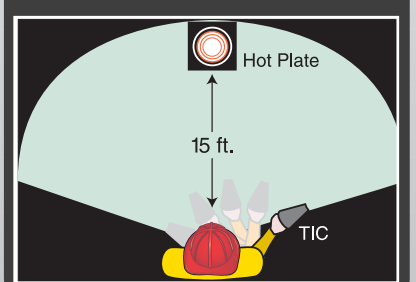
TIC Evaluation Point #1:
Comparing ***High Sense*** *and* ***Low Sense*** *mode*

Materials: TICs, Electric Hot Plate, Extension Cord, Heat Mitt or Firefighter's Glove

Objective: Compare High Sense and Low Sense mode activation and the resulting imagery.

Steps: *Place electric hot plate on table. Turn up to high heat. Stand 15 feet away with TIC looking away from the hot plate; then slowly scan the room over to the hot plate. Then slowly scan away from – and than back to the hot plate several times noting how the quality of the image is affected by the heat from the hot plate.*

Result: When the hot plate comes into the scene, is the TIC in High Sense (sharp, clear, high detail) or does it drop down into Low Sense (with EI or L displayed), looking fuzzy with lost detail? Some TICs drop to Low Sense immediately when heat is detected, restricting the imagery. Other TICs stay in High Sense over a wider temp range, even with hot objects (usually colored red) in the scene.



Sensor Temperature Range

It's Dynamic!

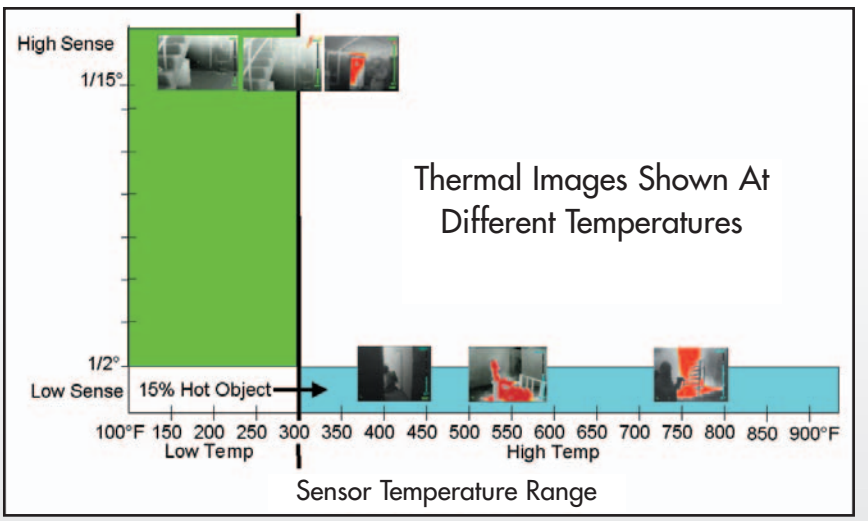
As stated earlier, a sensor engine's performance depends on how well its Sensitivity and Temperature Range work together. **High Sense** imagery over a wide temperature range is a good performance package.

Temperature Range Basics:

A TIC sensor engine constantly monitor two temperature sources, the scene's ambient temperature, and the temperature of hot objects in the scene. The dynamics between these two temperature sources, and the sensor's temperature range for each, causes the TIC to change sensitivity modes as the dynamics of the scene change.

Ambient Temperature: Fire Service and Emergency Response TICs have a total temperature range of around 1000°F. Most of their applications rarely see those high temperatures. Even in structural firefighting, most Firefighters say that they spend 80% or more of their time in temperatures between 150° to 300°F. That's why some TICs have a 300°F **High Sense** temp range. Other TICs have a lower **High Sense** temp range of about 175°F to 200°F. A wider **High Sense** temp range of 300°F simply keeps the TIC in **High Sense** mode longer than one with a 200°F range.

Hot Objects: Even at room temperatures, heat from a hot object in the room can over-expose a sensor engine and drop it down into **Low Sense** mode. For some TICs the hot object can be as small as a light bulb – filling less than 1% of the total scene. Other TICs can handle larger, hotter objects that fill up to 15% of the total scene, and stay in the **High Sense** much longer. When those larger objects exceed 15% of the scene, **High Sense** can be maintained by moving the TIC slightly and reducing the size of the object in the display – which instantly put the TIC back into **High Sense** mode.



TIC Evaluation Point #2:

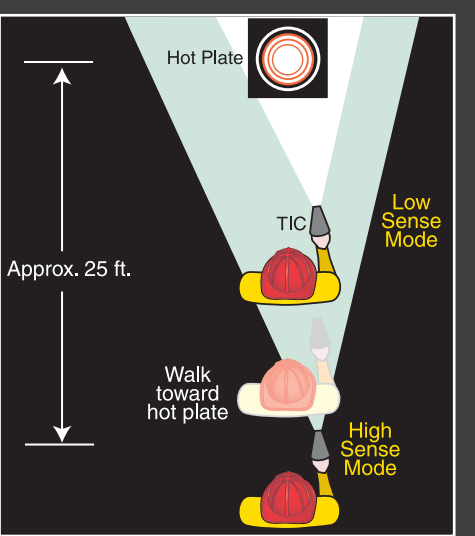
High Sense with Hot Objects in the scene

Materials: TICs, Electric Hot Plate, Extension Cord, Heat Mitt or Firefighter's Glove

Objective: To see if the TIC stays in High Sense mode when Hot Objects are present in the scene.

Steps: *Place electric hot plate on table. Turn it on to high heat. Stand 25 feet (or further) away making sure that the TIC is in High Sense when initially looking at the hot plate. (If the TIC goes into Low Sense mode initially when looking at the hot plate, simply move farther away from it for it to go into High Sense mode.) Then, slowly walk toward the hot plate until the TIC drops down into Low Sense mode. Note the distance from the hot plate and the size of the hot object filling the scene.*

Result: As some point when walking toward the hot plate, the TIC will drop down into Low Sense mode. If conducting this evaluation with several different TICs, compare the distances from the hot plate for each. The closer you can move to the hot plate while staying in High Sense mode the better. Also, as a safety feature, some TICs colorize hot objects (usually red) while in High Sense mode for easier identification.



TIC Evaluation Point #3:

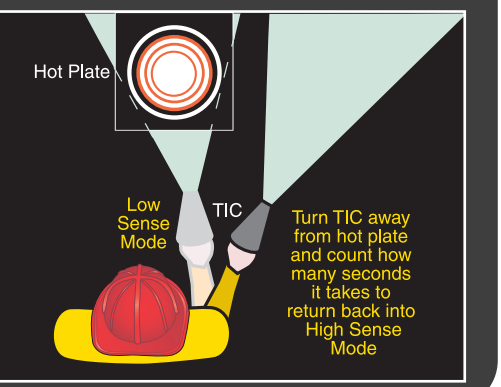
Sensitivity Mode Switching Time

Materials: TICs, Electric Hot Plate, Extension Cord, Heat Mitt or Firefighter's Glove

Objective: To determine the length of time in switching between High and Low Sense mode.

Steps: *With a safety heat mitt of firefighter's glove, cautiously hold the electric hot plate, set on high heat, in front of a TIC forcing it into Low Sense mode. Then point the TIC away from the hot plate and count the seconds before the TIC returns to High Sense mode.*

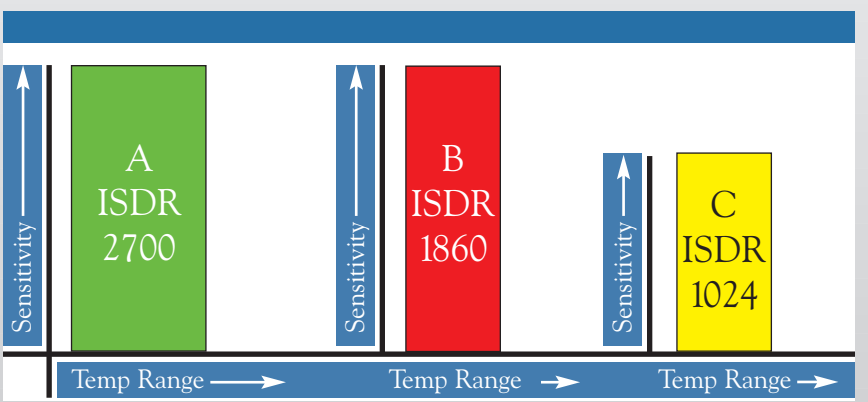
Result: Some TICs take up to 5 seconds to switch out of Low Sense back up into High Sense mode. Other TICs switch in less than 1 second – which keeps things moving.



TIC Performance Measurement: ISDR

ISDR – What is it? Instantaneous Scene Dynamic Range is the combined value of a sensor's sensitivity (down to 1/1000° or mK for milliKelvin) and its temperature range (in degrees °C). It is the way to determine the number of temperature differences a sensor can see at any given instant. Simply divide the temperature range by the sensitivity for the ISDR value. The greater the ISDR value, the better the performance of the sensor. ISDR helps explain the differences in image quality when comparing various TICs over a broad range of temperatures. Here are some current specifications on Fire Service and Emergency Response TICs – along with a graphic comparison below that illustrates the ISDR differences:

Temp Range	÷	Sensitivity	=	ISDR
TIC A 135°C	÷	.050 (50mK)	=	2700
TIC B 93°C	÷	.050 (50mK)	=	1860
TIC C 87°C	÷	.085 (85mK)	=	1024



ISDR shows how TIC performance results from the right combination of **sensitivity** and **temperature range**.

TIC Evaluation Point #4:

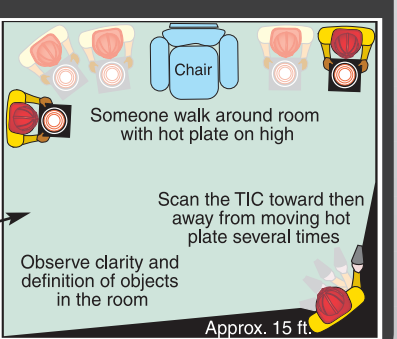
Moving the Hot Plate to show Scene Dynamics

Materials: TICs, Electric Hot Plate, Extension Cord, Heat Mitt or Firefighter's Glove

Objective: To view different scenes influenced by changes in heat.

Steps: *With a safety heat mitt or firefighter's glove, cautiously hold the electric hot plate set on high heat, walking around the room as the extension cord allows. Have someone using a TIC stand about 15 feet from the hot plate, first scanning toward and then away from the hot plate several times while observing the clarity and definition of objects in the room.*

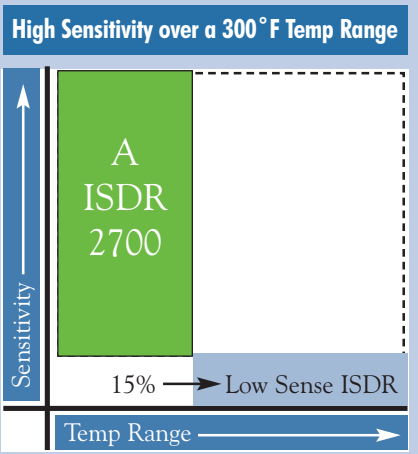
Result: Some TICs will change in and out of High and Low Sense mode in this evaluation. With both scene changes (from moving around) and temperature changes (including or excluding the hot plate in the scene) compare the changing dynamics of the imagery.

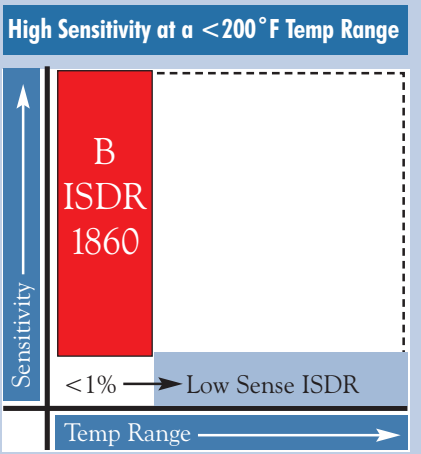


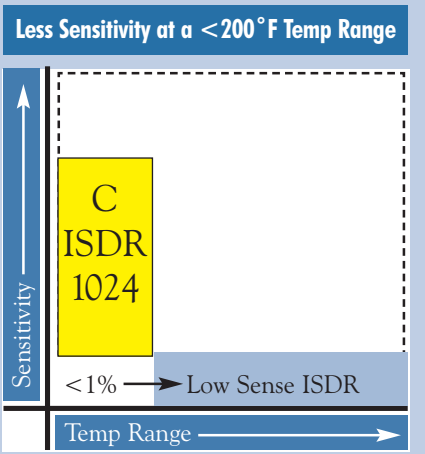
Here's one way to evaluate TIC performance in sensing dynamic temperature changes.

Why at room temperature do some TICs look better than others that have a high ISDR? It all has to do with the way the TIC's sensor is designed to react to the heat dynamics of a scene. Every sensor design reacts differently. Some TICs with good **High Sense** imagery at room temperature, quickly drop down to **Low Sense** mode once small amount of heat is introduce in the scene. A room temperature TIC evaluation without a hot object (like a hot plate) to show both **High** and **Low Sense** imagery, does not demonstrate the range of performance needed in a Fire Service and Emergency Response TIC.

What about Low Sense ISDR? Just about all Fire Service and Emergency Response TICs have the same **Low Sense** ISDR since they all drop down to about 1/2° sensitivity with a temperature range of around 1000°F. That is why TICs with a wider **High Sense** Temp Range (and a better **High Sense** ISDR) have better overall performance. Here's three graphs that show how **Low Sense** ISDR is added to the **High Sense** ISDR to illustrate sensor differences:

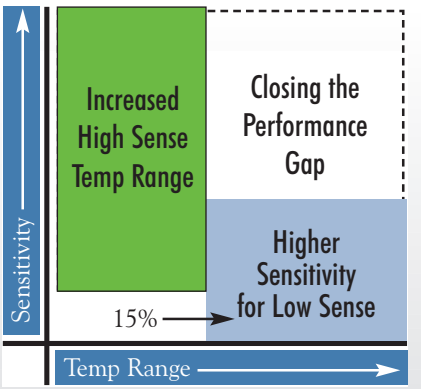






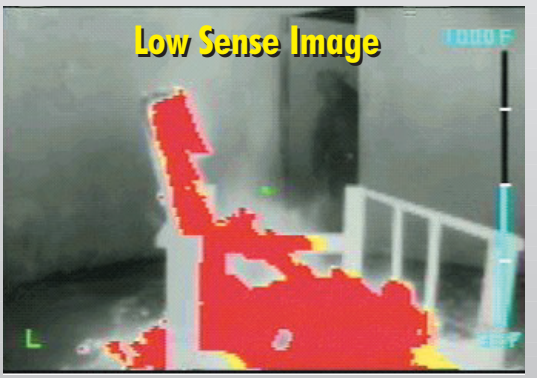
TIC A, depicted above, delivers **High Sense** imagery over a wide 300°F range. In addition, it can also handle heat from hot objects in up to 15% of the scene, keeping the TIC in **High Sense** mode longer. TIC B and C have either less temperature range – or less sensitivity – or both. Also, TIC B and C have a hot object limit of <1% of the scene before dropping down into **Low Sense** mode and losing image quality.

Can ISDR be increased for better performance? The TIC Manufacturers working with the IR Sensor Manufacturers are always working on improved sensor performance. Using ISDR as the measure, there are two goals. The first would be to increase the **High Sense** temperature range to benefit from **High Sense** image quality at higher temperatures. The second goal would be to increase sensitivity in **Low Sense** to improve image quality in very high temperatures. These improvements would increase the overall ISDR value and further close the performance gap, as seen in the example shown on the right.



Using a TIC's Heat-Seeking Color

Two of the most popular optional features on a Fire Service TIC are **Temperature Measurement** and **Heat-Seeking Color.**



Generally, both are automatic and provide useful information. Temperature Measurement displays the temperature of an object in the scene lined up in the crosshairs of the display. Totally separate from Temperature Measurement is Heat-Seeking Color which will color any object in the scene when it reaches a pre-set temperature.

Generally, Heat-Seeking Color shows hot objects in red. Firefighters experienced in using a TIC with Heat-Seeking Color can use it to also determine the direction of the fire and its intensity. Heat-Seeking Color is a warning sign and an important SAFETY feature.

Not every TIC has Heat-Seeking Color available. Some TICs only offer Heat-Seeking Color in **Low Sense** mode, set to activate at about 900°F. When any objects in a **Low Sense** scene reach 900°F and above, those objects are colored red. Some TICs provide yellow, red and graduated heat-seeking color to provide more information on the range of heat of the colorized objects.

Heat-Seeking Color is also available in **High Sense** mode on some TICs, colorizing hot objects beginning at 275°F. Heat-Seeking Color in **High Sense** mode is especially helpful in applications where ambient temperatures are not yet extreme – but heat is rising. In those conditions, Heat-Seeking Color can indicate the direction to the source of the fire. **High Sense** mode Heat-Seeking Color can quickly find a bad electrical ballast. Heat-Seeking Color, combined with the clarity and definition of **High Sense** mode, enhances **SAFETY** and makes the TIC a more versatile tool.

TIC Evaluation Point #5:

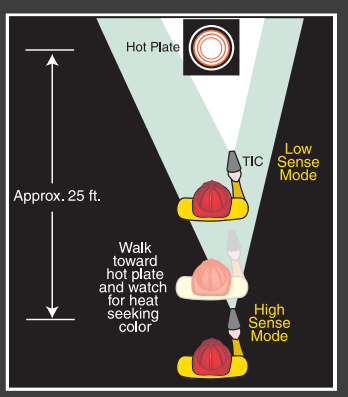
Heat-Seeking Color in High Sense mode

Materials: TICs, Electric Hot Plate, Extension Cord, Heat Mitt or Firefighter's Glove

Objective: To determine the extent of Heat-Seeking Color in High Sense mode.

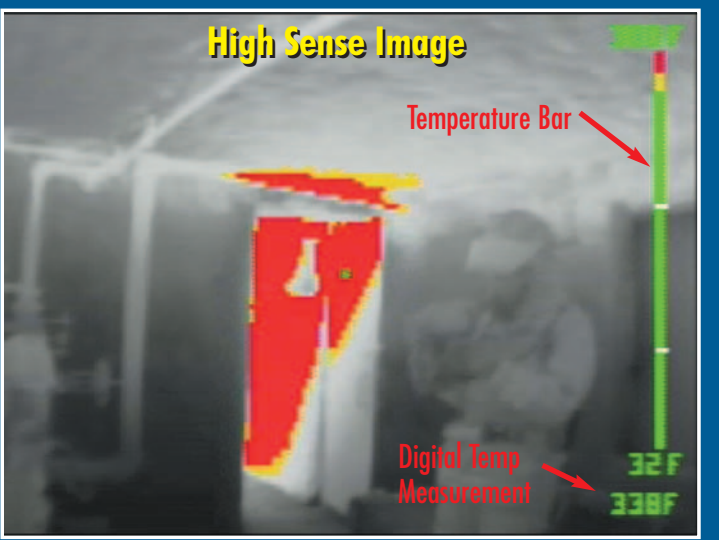
Steps: *Place electric hot plate on table. Turn it on to high heat. Stand far enough away from the hot plate (sometimes up to 25 feet) so that the TIC starts out in High Sense mode. In High Sense mode, check for heat-seeking color on the display. Then move closer to the hot plate to force the TIC into Low Sense mode. Check for heat-seeking color.*

Result: In the TICs that offer it, Heat-Seeking Color in High Sense mode is easily seen and used. Some TICs "flash" some color in High Sense mode, but not long enough to be of any use. On other TICs, Heat-Seeking Color it is not offered in either Low Sense of High Sense mode.



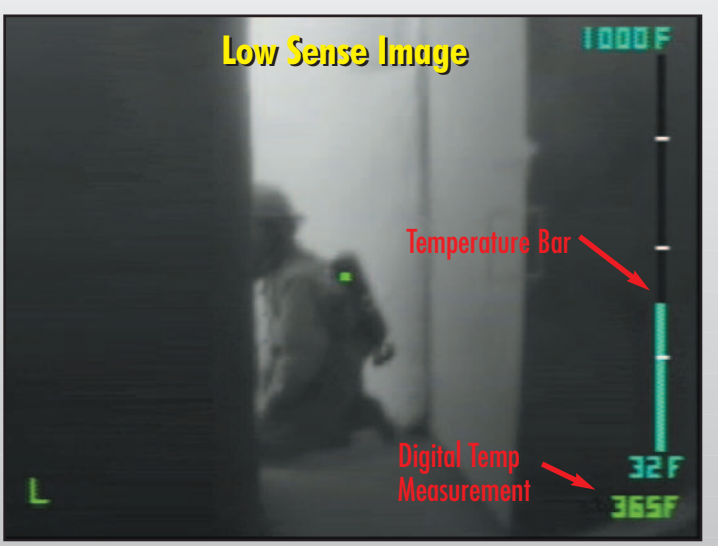
Measuring Temperature and Temperature Differences

Temperature Measurement is the other popular feature on most Fire Service and Emergency Response TICs. It is both a **SAFETY** feature and a valuable tool with many applications. It measures the temperature of an object in the scene – that is lined up in the crosshairs on the display. The temperature reading is then displayed on a temperature bar graph or as a digital number – or both.



Temperature Bar Graph: As the temperature of the object in the crosshairs increases, the bar graph fills like a thermometer. The bar graph is a real "attention getter", especially when the thermometer starts "jumping". Some TICs use the same bar graph to show temperature measurement in both **High** and **Low Sense** mode – even though their temperature ranges differ. Other TICs have a bar graph that adjusts its temperature increments automatically to the correct **High** and **Low Sense** temperature range for easier reading and interpretation.

Digital Temp Measurement: TICs that display the temperature reading as a digital number provide more temperature information that is easier to register and compare. This is helpful in applications where knowing temperature differences is important (e.g. monitoring rising heat).



TIC Evaluation Point #6:

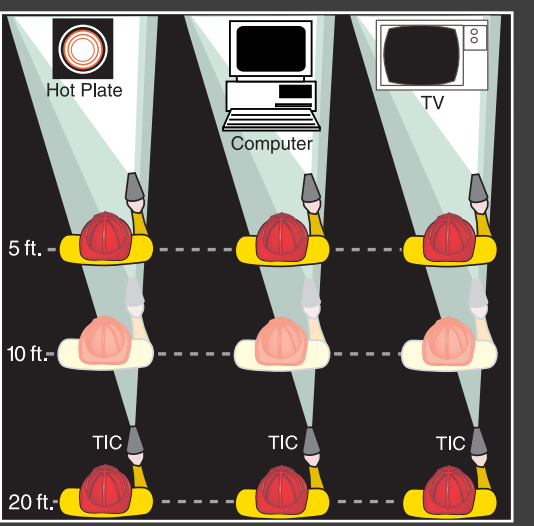
Measuring Temperature and Temperature Differences

Materials: TICs, objects in the room that generate moderate heat (lights, electrical equipment, etc.)

Objective: To evaluate temp bar graphs and digital temp measurement

Steps: *With the TIC, find heated objects in the room using the Temperature Measurement feature. Stand at several different distances from the objects, starting at 5 feet, then 10, then 20. Note the temp readings either on the temp bar graph or the digital temp of each object – at each distance.*

Result: With TICs that offer it, having both the temp bar graph and digital temp measurement provides more useful information for more applications. Generally, the temp readings taken from assorted Fire Service and Emergency Response TICs are in the same ballpark at +/- 10% error. That's due to several factors outside of the control of the sensor. Also notice that some temp bars, due to their size on the display, show temperature increments that are difficult to read.



What About TIC Durability and Reliability?

So far, in this issue of *EMERGENCY RESPONDER* THERMAL IMAGING the focus has been on sensor engine performance. Just as important is the performance of the total TIC package – or what most think of when **Durability and Reliability** are discussed. Will the TIC survive drops, dunks, vibration, high heat, and direct flame? How long will the batteries last? Can I depend on it?

What about TIC standards? Currently there is not a specific Fire Service TIC Standard. What is available to all TIC manufacturers are Fire Service, Mil Spec, Federal and International standards developed for existing similar Fire Service and Emergency equipment. These standards cover drop, dunk, RFI, vibration, and exposure to high heat and direct flame. It is obvious what the Fire Service and Emergency Responders expect when it comes to durability and reliability in a TIC.

Here are some standards that have been applied to current TICs by some TIC Manufacturers:

Water/Dust Ingress	**International Standard CEI, IEC 529, IP 67 Classification**
Direct Flame/ Heat Exposure	**Simulated NFPA 1981–2002 Edition, NFPA 1982-1998 Edition**
Vibration	**MIL-STD-810E Category 1 Loose Cargo Transport**
Radio Frequency Interference	**CE/EN 50081-2:1992, EN 50082-2:1992, FCC Part 15**
Rollover (Truck Charger)	**Simulated NFPA 1901-12, 1.7**

TIC Manufacturers' product specifications generally disclose which of the existing Fire Service standards they have designed their TICs to pass, and how the tests are conducted. Check and compare TIC product specifications for more information.

SAFETY Features:

The Questions You Should Ask!

As also examined in this issue of *EMERGENCY RESPONDER* **THERMAL IMAGING**, the SAFETY features and functions provided by the sensor play and important part in TIC SAFETY. They include:

- ☐ 1. **High Sense** Mode: Provides the best image quality – should be used whenever possible
- ☐ 2. **Low Sense** Mode: A "warning sign" with limited image quality – prevents sensor over-exposure
- ☐ 3. **Low Sense** to **High Sense** Switching Time: Quick switching keeps things moving
- ☐ 4. 300°F Temp Range in **High Sense**: Delivers more time in **High Sense** mode – a SAFETY PLUS
- ☐ 5. ISDR: **I**nstantaneous **S**cene **D**ynamic **R**ange – Indicator of total SAFETY Performance
- ☐ 6. Hot Objects up to 15%: Allows more time in **High Sense** – another SAFETY PLUS
- ☐ 7. Heat-Seeking Color: If available in **High Sense** mode – an added level of SAFETY
- ☐ 8. Temperature Measurement: Temp bar gives the warnings, digital readout gives the details

Professional Training on TIC Operation and Use goes a long way in developing a solid understanding of the TIC SAFETY tools and functions listed to the left. TIC Manufacturers can recommend TIC Training Programs from independent and objective training organization to help meet or supplement your TIC training needs.

SAFETY NOTE: The evaluation of Thermal Imaging Camera performance often involves exposure to high heat situations and/or hot objects. Please use extreme caution when performing these evaluations. It's all about SAFETY.

Several additional TIC SAFETY features are important with regards to TIC operation and use. The following questions highlight SAFETY issues for the TIC user:

- ☐ 1. Does the TIC always provide a warning prior to shut down – for any reason?
- ☐ 2. Can the TIC be accidentally shut off? Is normal shut off delayed and with a warning?
- ☐ 3. Is there an **Over-Temp Warning** when the TIC is exposed to too much heat?
- ☐ 4. Is there a **Shutter Indicator** prior to (microbolometer) sensor shuttering?
- ☐ 5. Does the **Battery Usage Indicator** clearly indicate pending shutdown?
- ☐ 6. Are the TIC batteries reliable and long lasting – with no memory buildup?
- ☐ 7. Is the TIC resistant to **Radio Frequency Interference** (RFI) to prevent shut down?
- ☐ 8. Are the TIC electronics surrounded with a continuous, grounded, RFI shell?
- ☐ 9. Does the TIC have **Instant Start Up** to get things moving?
- ☐ 10. Is the sensor lens **FOV (Field of View) 55°** for wide viewing without panning?

Decision Time.

One of Your Most Critical Command Decisions: Choosing The Right TIC.

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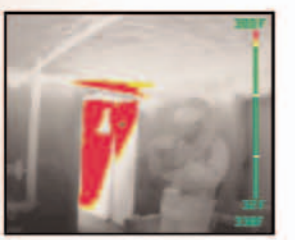
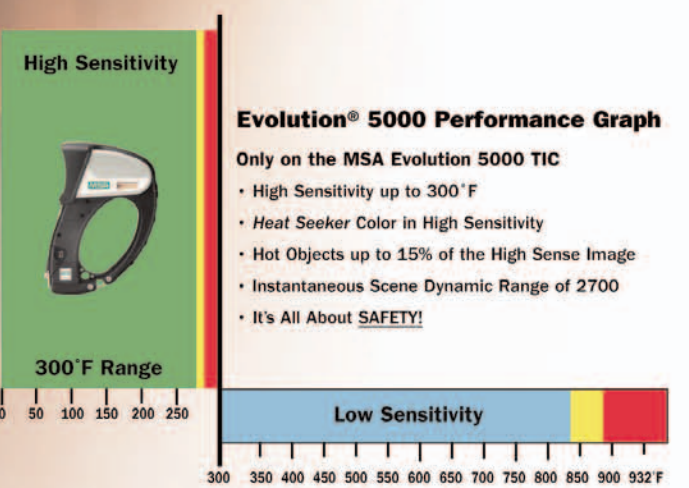
- High-impact construction and an internally housed battery system protect the camera's crucial components from the harsh firefighting environment.
- A wide field of view and highly functional Heat Seeker and dual-mode Quick-Temp options provide a comprehensive display of fire-scene information in high- and low-temperature environments.





Evolution® 5000 Performance Graph

Only on the MSA Evolution 5000 TIC

- High Sensitivity up to 300˚F
- *Heat Seeker* Color in High Sensitivity
- Hot Objects up to 15% of the High Sense Image
- Instantaneous Scene Dynamic Range of 2700
- It's All About SAFETY!

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EMERGENCY RESPONDER

THERMAL IMAGING

WINTER 2005 Volume 1 Number 1

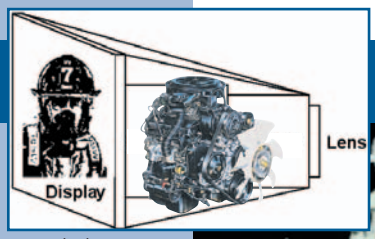
FIRE SERVICE
HAZMAT
EMS
LAW ENFORCEMENT
HOMELAND SECURITY

'TIC EVALUATION AND OPERATION CHECKLIST' PULLOUT SECTION

The Latest On:

- ☑ Thermal Imaging Technology (Explained for all)
- ☑ Imaging Evaluation & Testing Techniques (Easy and inexpensive)
- ☑ Operations and Use (Achieving Maximum Utility)

TIC Sensors



The IR sensor is the "engine" of the TIC.

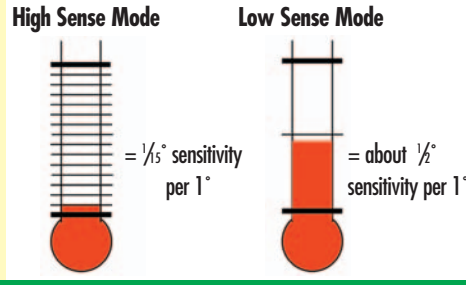
- There are several TIC sensor engines available to the TIC Manufacturers
- Each has its own specifications and operating characteristics
- They are tuned for performance at the different sensitivity and temperature ranges
- Sensor engines use either BST or Microbolometer sensor technology:

BST: Barium, Strontium and Titanate materials in the sensor are sensitive to thermal energy. BST sensors produce a more black and white image, showing contrast and with limited shades of grey to differentiate temperatures.

Microbolometer: Produce more grey shading than BST sensors do, showing more defined detail of the temperature differences. The materials in the sensor are either ASi (Amorphous Silicon) or VOx (Vanadium Oxide). When comparing a VOx-based to ASi-based TICs, there are image quality differences, especially over a broad range of temperature in not only fire service and emergency response applications, but also in industrial, medical and scientific applications.

High Sensitivity vs. Low Sensitivity

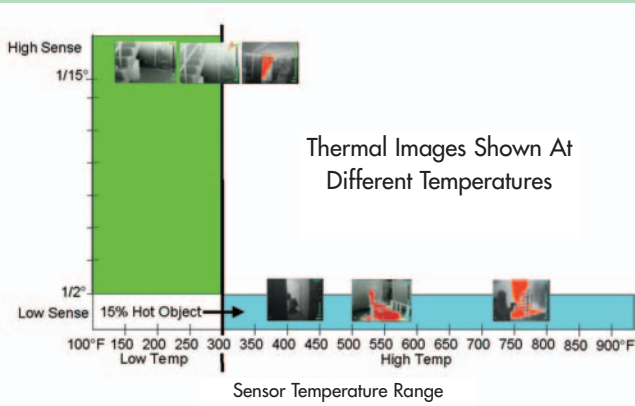
- Sensitivity is measured in the smallest temperature difference a sensor reacts to
- Sensor engines at 1/15° or better sensitivity are considered high performance
- TIC Sensors operating at 1/15° are in **High Sense** mode with best clarity and detail
- **Low Sense** mode drops down to about 1/2° sensitivity limiting clarity and detail



Sensor Temperature Range – It's Dynamic!

A TIC sensor engine constantly monitors two temperature sources:

1. Ambient Temperature:
   - 80% of structural firefighting is at ambient temperatures between 150° to 300°F
   - For the best image quality, some TIC sensors have a **High Sense** temperature range up to 300°F; others only up to about 175°F
   - The broader the range, the better – to stay in **High Sense** mode.
2. Hot Objects in the Scene:
   - Hot Objects can force a TIC down into **Low Sense** Mode to prevent over-exposing the sensor.
   - Some TICs can only handle a hot object up to about 1% of the total scene before dropping down into **Low Sense**; other TICs can fill up to 15% of the total scene and stay in the **High Sense** longer
   - When exceeding 15%, by moving the TIC slightly to reduce object size, you can stay in **High Sense** mode.



TIC Evaluation Point #1: *Comparing **High Sense** and **Low Sense** mode*

Materials: TICs, Electric Hot Plate, Extension Cord, Heat Mitt or Firefighter's Glove

Place electric hot plate on table. Turn up to high heat. Stand 15 feet away with TIC looking away from the hot plate; then slowly scan the room over to the hot plate. Then slowly scan away from – and than back to the hot plate several times noting how the quality of the image is affected by the heat from the hot plate.

Result: When the hot plate comes into the scene, is the TIC in **High Sense** (sharp, clear, high detail) or does it drop down into **Low Sense** looking fuzzy with lost detail?

TIC Evaluation Point #2: High Sense *with Hot Objects in the scene*

Materials: TICs, Electric Hot Plate, Extension Cord, Heat Mitt or Firefighter's Glove

*Place electric hot plate on table. Turn it on to high heat. Stand 25 feet (or further) away making sure that the TIC is in **High Sense** when initially looking at the hot plate. (If the TIC goes into **Low Sense** mode initially when looking at the hot plate, simply move farther away from it for it to go into **High Sense** mode.) Then, slowly walk toward the hot plate until the TIC drops down into **Low Sense** mode. Note the distance from the hot plate and the size of the hot object filling the scene.*

Result: If conducting this evaluation with several different TICs, compare the distances from the hot plate for each. The closer you can move to the hot plate while staying in **High Sense** mode the better. Also, as a **SAFETY** feature, some TICs colorize hot objects (usually red) while in **High Sense** mode for easier identification.

TIC Evaluation Point #3: *Sensitivity Mode Switching Time*

Materials: TICs, Electric Hot Plate, Extension Cord, Heat Mitt or Firefighter's Glove

*With a **SAFETY** heat mitt or firefighter's glove, cautiously hold the electric hot plate, set on high heat, in front of a TIC forcing it into **Low Sense** mode. Then point the TIC away from the hot plate and count the seconds before the TIC returns to **High Sense** mode.*

Result: Some TICs take up to 5 seconds to switch out of **Low Sense** back up into **High Sense** mode. Other TICs switch in less than 1 second – which keeps things moving.

TIC Evaluation Point #4: *Moving the Hot Plate to show Scene Dynamics*

Materials: TICs, Electric Hot Plate, Extension Cord, Heat Mitt or Firefighter's Glove

*With a **SAFETY** heat mitt or firefighter's glove, cautiously hold the electric hot plate set on high heat, walking around the room as the extension cord allows. Have someone using a TIC stand about 15 feet from the hot plate, first scanning toward and then away from the hot plate several times while observing the clarity and definition of objects in the room.*

Result: Some TICs will change in and out of **High** and **Low Sense** mode in this evaluation. With both scene changes (from moving around) and temperature changes (including or excluding the hot plate in the scene) compare the changing dynamics of the imagery.

TIC Evaluation Point #5: *Heat-Seeking Color in **High Sense** mode*

Materials: TICs, Electric Hot Plate, Extension Cord, Heat Mitt or Firefighter's Glove

*Place electric hot plate on table. Turn it on to high heat. Stand far enough away from the hot plate (sometimes up to 25 feet) so that the TIC starts out in **High Sense** mode. In **High Sense** mode, check for Heat-Seeking Color on the display. Then move closer to the hot plate to force the TIC into **Low Sense** mode. Check for heat-seeking color.*

Result: In the TICs that offer it, Heat-Seeking Color in **High Sense** mode is easily seen and used. Some TICs "flash" some color in **High Sense** mode, other just do not offer it.

TIC Evaluation Point #6: *Measuring Temperature and Temperature Differences*

Materials: TICs, objects in the room that generate moderate heat (lights, equipment, etc.)

With the TIC, find heated objects in the room using the Temperature Measurement feature. Stand at several different distances from the objects, starting at 5 feet, then 10, then 20. Note the temp readings either on the temp bar graph or the digital temp of each object.

Result: With TICs that offer it, having both the temp bar graph and digital temp measurement provides more useful information for more applications. Notice that some temp bars, due to their size on the display, show temperature increments that are difficult to read.

TIC Operational and Personal SAFETY

As also examined in this edition of *EMERGENCY RESPONDER* **THERMAL IMAGING**, the operational and personal SAFETY features and functions provided by the sensor play and important part in TIC SAFETY. These include:

☐ 1. **High Sense** mode: Provides the best image quality–and should be used whenever possible

☐ 2. **Low Sense** mode: A "warning sign" with limited image quality. Prevents sensor over-exposure

☐ 3. **Low Sense** to **High Sense** switching time: Quick switching keeps things moving.

☐ 4. 300°F Temp Range in **High Sense**: Delivers more time in **High Sense** mode–a SAFETY plus

☐ 5. ISDR (Instantaneous Scene Dynamic Range): Indicator of total SAFETY performance

☐ 6. Hot Objects up to 15%: Allows more time in **High Sense** mode–another SAFETY plus

☐ 7. Heat-Seeking Color: If available in **High Sense** mode, an added level of SAFETY

☐ 8. Temperature Measurement: Temperature bar gives the warnings, digital readout gives the details

Professional Training on TIC Operation and Use goes a long way in developing a solid understanding of the TIC SAFETY tools and functions listed to the left. TIC Manufacturers can recommend TIC Training Programs from independent and objective training organization to help meet or supplement your TIC training needs.

Several additional safety features are important with regards to thermal imager operation and use. The following questions highlight key SAFETY issues for the TIC user:

☐ 1. Does the TIC always provide a warning prior to shut down–for any reason?

☐ 2. Can the TIC be accidentally shut off? Is normal shut-off delayed and does the camera issue any warning?

☐ 3. Is there an Over-Temp warning when the TIC is exposed to too much heat?

☐ 4. Is there a Shutter Indicator prior to (microbolometer) sensor shuttering?

☐ 5. Does the Battery Usage Indicator clearly indicate pending shut-down?

☐ 6. Are the TIC batteries reliable and long lasting, with no memory buildup?

☐ 7. Is the TIC resistant to Radio Frequency Interference (RFI), in order to prevent shut-down?

☐ 8. Are the TIC's electronics surrounded with a continuous, grounded RFI shell?

☐ 9. Does the TIC have Instant Start-Up to prompt immediate use?

☐ 10. Is the sensor lens Field of View (FOV) 55°, for wide viewing without panning?

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TIC Fire Scene Progression

HIGH SENSE MODE

Scene 1. High Sense Mode with advancing heat

Scene 2. High Sense with first Heat Seeker color

Scene 3. High Sense with 338°F Hot Object at 15%

LOW SENSE MODE

Scene 4. Low Sense Mode at 365°F with no color

Scene 5. Low Sense at 500°F and Heat Seeker color

Scene 6. Low Sense with Temp Measurement at 740°F

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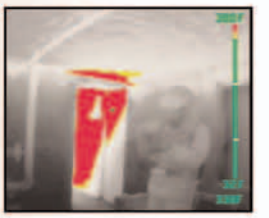

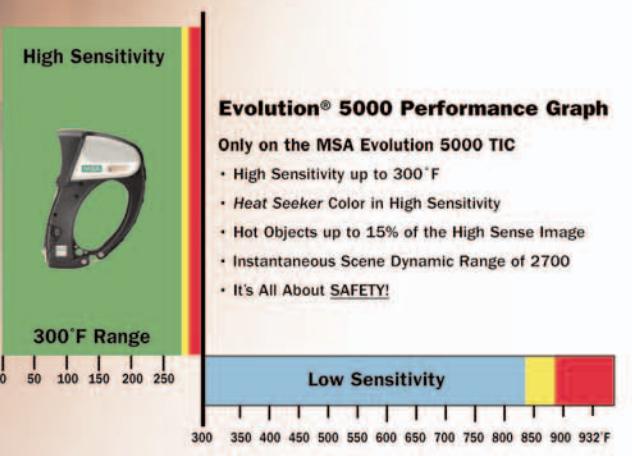

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