



Thermal Imaging Cameras for the Fire Service

Market Survey Report

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FOREWORD

The National Urban Security Technology Laboratory (NUSTL) is a federal laboratory within the U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T). Located in New York City, NUSTL is the only national laboratory focused exclusively on supporting the capabilities of federal, state, local, tribal, and territorial responders to address the homeland security mission. The laboratory assists responders with the use of technology to prevent, protect against, mitigate, respond to, and recover from homeland security threats and incidents. NUSTL provides expertise on a wide range of subject areas, including chemical, biological, radiological, nuclear, and explosive detection, personal protective equipment, and tools for emergency response and recovery.

NUSTL manages the System Assessment and Validation for Emergency Responders (SAVER®) program, which provides information on commercially available equipment to assist response organizations in equipment selection and procurement. SAVER publications provide information on equipment that falls under the categories listed in the DHS Authorized Equipment List (AEL), focusing primarily on two main questions for the responder community: “What equipment is available?” and “How does it perform?” The SAVER program works with responders to conduct objective, practitioner-relevant, operationally-oriented assessments and validations of commercially available emergency response equipment. Having the right tools provides a safer work environment for responders and a safer community for those they serve.

NUSTL is responsible for all SAVER activities, including selecting and prioritizing program topics, developing SAVER publications, and coordinating with other organizations to leverage appropriate subject matter expertise. NUSTL conducted a market survey of commercially available thermal imaging cameras. This equipment falls under the AEL reference number 03OE-02-TILA-Optics, titled “Thermal Imaging and/or Light Amplification” and 04MD-01-IREL, titled “Camera, Infrared (IR)”.

SAVER reports are available at www.dhs.gov/science-and-technology/SAVER.

Visit the NUSTL website at www.dhs.gov/science-and-technology/national-urban-security-technology-laboratory or contact the lab at NUSTL@hq.dhs.gov.

U.S. Department of Homeland Security



System Assessment and Validation for Emergency Responders ©

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EXECUTIVE SUMMARY

Thermal imaging cameras (TICs) detect small temperature variations to create images corresponding to temperature differences at the scene of a fire. Firefighters use these images to navigate through smoke filled environments, identify hotspots and sources of fire, allow faster access to victims, and increase personnel safety. Price, image quality, and durability are key considerations when purchasing TICs. The National Fire Protection Association (NFPA) 1801:2021 *Standard for Thermal Imagers for the Fire Service* addresses these considerations and provides minimum performance requirements for TICs [1].

Between March 2024 and May 2025, the Systems Assessment and Validation for Emergency Responders (SAVER) program conducted a market survey of commercially available thermal imaging cameras. This market survey report is based on information gathered from manufacturer and vendor websites, internet research, industry publications, and a government-issued [request for information](#) that was posted on the System of Award Management website. The U.S. Department of Homeland Security (DHS) Science and Technology Directorate's (S&T's) Technology Scouting Group also contributed to the market research used in the development of this report. Due diligence was performed to develop a report that is representative of products in the marketplace. Performance of the products and information included in this report has not been independently verified by the SAVER program.

This survey identifies 16 products from seven manufacturers that range in price from \$2,949 to \$8,601. The TICs in this report range from simple systems with a single image mode to those with several operating modes and large image storage capabilities. All have the minimum image quality specifications required by NFPA 1801:2021. Some self-contained breathing apparatus (SCBA) manufacturers have integrated TICs into their SCBAs, which provides the advantage of hands-free operation. Three of these systems are included in this report. These TICs may not have the image quality of the handheld TICs in this report but do provide useful thermal imaging capabilities without the need for an additional piece of equipment.

The purpose of this market survey is to provide emergency responders with information that will guide firefighting agencies in making operational and procurement decisions. Emergency responder agencies should consider overall capabilities, technical specifications, and limitations of TICs in relation to their agency's operational needs when making equipment selections.

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1.0 INTRODUCTION

Handheld thermal imaging cameras (TICs) display an object's heat signature making them a valuable tool for fire service personnel. Firefighters use TICs to navigate smoke filled structures, identify hotspots and sources of fire, reduce damage caused by the fire, allow faster access to fire victims, and increase the safety of firefighters. Between March 2024 and May 2025, the System Assessment and Validation for Emergency Responders (SAVER) program conducted a market survey of TICs. This market survey report is based on information gathered from manufacturer and vendor websites, internet research, industry publications, and a government-issued [request for information](#) (RFI) that was posted on the System of Award Management website. The U.S. Department of Homeland Security (DHS) Science and Technology Directorate's (S&T's) Technology Scouting Group also contributed to the market research used in the development of this report. Due diligence was performed to develop a report that is representative of products in the marketplace. Performance of the products and information included in this report has not been independently verified by the SAVER program.

To be included in this report, the TIC had to be commercially available and meet the following criteria. The product must:

- Be designed for the fire service community
- Have a minimum refresh rate of 25 Hertz (Hz)
- Have a minimum camera resolution of 76,800 pixel (320 x 240)
- Use an uncooled microbolometer

Some self-contained breathing apparatus (SCBA) manufacturers have integrated TICs into their SCBAs, which provides the advantage of hands-free operation. Section 4 provides a description of three of these systems. Various configurations include a TIC that attaches to the SCBA facepiece, a TIC integrated with the remote pressure gauge, a TIC integrated with the handheld radio frequency (RF) personal alert safety system (PASS) transceiver as well as a TIC attached to a helmet which uses the facemask head-up display (HUD) for display [2]. Integrated TICs frequently have lower resolutions, refresh rates, sensitivities, and have less flexibility in terms of viewing modes.

2.0 TECHNOLOGY OVERVIEW

All objects radiate energy in the form of electromagnetic waves, which can be generalized into two categories: visible waves and invisible waves. Light is a visible electromagnetic wave. Thermal imagers can detect invisible electromagnetic waves in the infrared (IR) frequency range using an IR detector and convert them to visible light. Although the amount of IR radiation emitted from an object depends on its temperature, material, surface treatment and shape, hotter objects generally emit more IR radiation than cooler objects. The ratio of the radiation emitted by a surface to the radiation emitted by a blackbody at the same temperature is called emissivity.

TICs use a sensitive radiant heat measurement device called a microbolometer to allow users to see this IR radiation. The microbolometer converts thermal energy photons into electrons to create an image corresponding to the temperature differences in the scene, but only photons at the energy level corresponding to the 3,000 to 14,000 nanometer (nm) wavelength are detected. TICs generally have a spectral response from 8 to 14 microns, that is 8,000 to 14,000 nm. Middle wave infrared (MWIR) or short wave infrared (SWIR) cameras that operate below this portion of the IR spectrum (below 8 microns) are not suitable for firefighting applications due to their unreliable performance in smoky conditions.

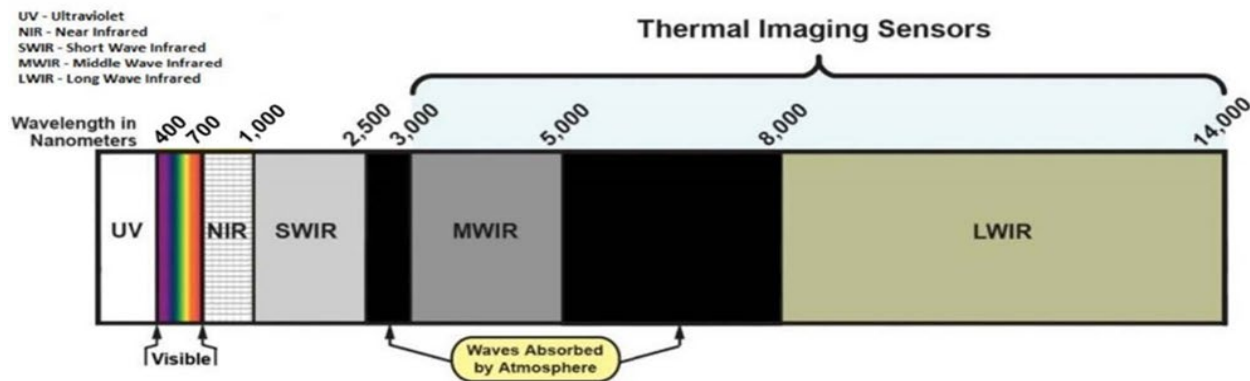


Figure 2-1 Electromagnetic Spectrum

Image Credit: Space and Naval Warfare Systems Center Atlantic

2.1 Current Technologies

Advances in technology have led to smaller, lighter-weight and more affordable thermal imaging devices, allowing more firefighters access to this tool. TICs used by firefighters today are often handheld with an external LCD display. They have uncooled microbolometers that use thin films with either vanadium oxide or amorphous silicon as the sensing material. They are powered by rechargeable lithium-ion batteries and rechargeable lithium iron phosphate batteries. The National Fire Protection Association (NFPA) 1801:2021 *Standard for Thermal Imagers for the Fire Service* provides minimum performance requirements for TICs that are helpful to consider while exploring TICs for procurement [1]. The standard was jointly developed by firefighters and manufacturers of TICs and provides requirements for minimum image quality, standard operation, durability, and nonincendive safety.

2.2 Technology Features

The following features are important to consider when purchasing and using TICs.

2.2.1 Image Resolution

Image resolution is an indicator of its ability to resolve detail in an image. Higher resolution allows for a clear, high-quality image. A higher resolution imager uses more pixels, allowing more detail of the scene to be captured and displayed. The image resolution of a TIC is determined by both the IR detector resolution and the display resolution, which may be different from one another. In those cases, the display cannot produce higher resolution than what is provided by the weaker of these two features. NFPA 1801 requires a camera and display resolution of 76,800 pixels (320 × 240).

2.2.2 Refresh Rate

The refresh rate, provided in Hertz (Hz), is the number of times each second that the image is updated. Higher refresh rates reduce motion blur and choppy motions on the display and may also aid in reducing eye strain. The three most common refresh rates are 9 Hz, 30 Hz, and 60 Hz. In general, TICs with higher refresh rates cost more than similar models with lower refresh rates. For “persistence of vision,” where moving individual images look smooth to the human eye, 25 Hz is considered sufficient. NFPA 1801:2021 requires a refresh rate of >25 Hz.

2.2.3 Video Polarity

“Video polarity” refers to the color gradients or shades displayed to indicate IR differences. Video polarity aids in understanding the various heat levels emitted from people and objects in the surrounding area. The three most common video polarity display modes are white hot, black hot, and color. Most TICs feature user-selectable display modes. In white hot display mode, hotter temperatures appear lighter while cooler temperatures appear darker. The opposite is true in black hot display mode. Typically, a white hot display mode provides more details of a specific person or object within a scene and a black hot display mode provides better details of the overall scene. Some TICs also associate colors such as yellow, orange, and red with progressively hotter specific temperature ranges. Operators should be thoroughly familiar with the specific TIC they are using as functions may vary from camera to camera.

2.2.4 Electronic Zoom

Many handheld thermal imagers feature an electronic zoom capability that changes a distant view to a closer view by enlarging the image, and, thereby, reducing the field of view. When used, electronic zoom magnifies the image by cropping the image and enlarging the pixels. Since pixels are larger and fewer in the resulting image, electronic zoom reduces the overall resolution of the image. Selecting a TIC with a higher resolution can help compensate for the reduction in resolution caused when electronic zoom is used.

2.2.5 Field of View

“Field of view” is the angle of observation visible through a TIC – measured in degrees – and varies depending on the model and/or lens selected. A TIC with a wide field of view will produce an image that captures more of the surrounding environment than a TIC with a narrow field of view. Typically, TICs with a larger field of view are better for scanning the immediate area while TICs with a smaller field of view are better for long range operations. NFPA 1801 specifies that a TIC should have a horizontal field of view of at least 36 degrees and a vertical field of view of at least 20 degrees to be certified as meeting the standard.

2.2.6 Thermal Sensitivity and Dynamic Range

Thermal sensitivity, also referred to as noise equivalent temperature difference (NETD), describes the thermal imager’s ability to detect and display IR differences, even when the differences are minimal. Thermal sensitivity is rated in millikelvin (mK) and generally ranges from 25 mK to 250 mK. The lower the mK rating, the greater the sensitivity to small temperature differences, which results in a cleaner image.

Each TIC has a dynamic range, a specific temperature range in which it can detect and differentiate people and objects with different intensities of IR waves. Objects outside a TIC’s dynamic range appear to have the same intensity. This is known as thermal saturation and occurs when everything in the viewing area is heated to temperatures beyond the capabilities of the TIC being used. The overall area being viewed will lose all contrast and appear whiter and featureless. TICs designed for law enforcement generally differentiate temperatures up to 140° F, whereas some thermal imagers designed for firefighter applications can accurately differentiate temperatures up to 2,000° F.

All fire service TICs automatically switch sensitivity mode based on the manufacturer’s predetermined specifications regarding the overall heat detected within the field of view and the percentage of pixels affected by the heat. The majority of TICs have two modes: low sensitivity mode which indicates high heat conditions and possible danger and high sensitivity mode which indicates lower temperatures (generally 300° F and lower) and allows for more detail in an image. Low sensitivity mode effectively increases the dynamic range of the TIC. NFPA 1801 states that when a TIC switches to low sensitivity, a green equilateral triangle will appear in the upper left-hand corner of the viewing area.

2.2.7 Image and Video Capture

Many TICs feature the ability to capture images and video during operations. Stored images and videos allow for improved fire investigation analysis and can also be used as training tools by showing firefighters how a real life search or fire attack was conducted.

2.3 Applications

Thermal imaging cameras may be used in the fire service to:

- Aid firefighters in the navigation of smoky environments
- Determine location of victims in areas with poor visibility
- Detect hot spots and hidden fires
- Identify the source and spread of a fire
- Track vapor clouds and determine liquid levels in containers during hazmat operations

- Act as an assessment and training tool

Different specific features of the TIC are crucial to particular applications. For example, fire attack¹ and search and rescue efforts in a structural fire require a TIC with a high dynamic temperature range. In these structural fire use cases, cameras must be durable, able to withstand fire and high temperatures, and have simple controls that are usable while wearing bulky, structural firefighting gloves. Hazmat operations require cameras with good resolution and zoom capabilities. They should be able to detect small temperature differences to identify a person or chemical that's temperature is very similar to its surroundings. This makes it possible, for example, for TICs to identify different gas layers or to determine how much product remains in a vessel, among other uses during hazmat response. Overhaul² and wildfire fighting applications frequently use TICs after the main fire has passed or the structural fire is mostly extinguished. For these applications, it is important that the TIC can easily identify the hottest area, so that any remaining hot spots can be extinguished.

2.4 Use of Grant Funds for Certain Telecommunications and Video Surveillance Equipment or Services

The John S. McCain National Defense Authorization Act for Fiscal Year 2019 (NDAA), Pub. L. 115-232, Section 889 (NDAA) [3] prohibits the use of federal funds, including loan, cooperative agreement and grant funds, to procure, obtain, extend or renew contracts for certain telecommunications and video surveillance equipment or services manufactured by certain foreign entities or to enter into contracts with entities that use those technologies. The Secure and Trusted Communications Networks Act of 2019, Pub. L. 116-124, 133 Stat. 158 (2020) (codified as amended at 47 U.S.C. §§ 1601-1609) [4] directs the Federal Communications Commission (FCC) to maintain a list of equipment and services (Covered Equipment or Services) that are deemed to pose an unacceptable risk to the national security of the United States or the security and safety of United States person.

Any entity, including federal grant recipients, expending federal funds on emergency response equipment are responsible for ensuring that no grant or loan funds are used to procure or obtain Covered Equipment Services, either directly or as a substantial or essential component of a system.

The restriction also applies to systems that use the covered equipment or services as a substantial or essential component, and to subsidiaries or affiliates of those companies listed on the FCC website here: [List of Equipment and Services Covered By Section 2 of The Secure Networks Act](#) [5].

Costs associated with Covered Equipment and Services are “unallowable” for grant funding. Grant recipients are responsible for ensuring funds are used only for allowable costs and would be obligated to refund the government for unallowable costs.

¹ Fire attack can be offensive, defensive, or transitional with offensive involving interior attack, defensive remaining external to the structure and transitional a combination of the two depending on conditions at the fire.

² Overhaul is a late stage in fire-suppression process during which the burned area is carefully examined for remaining sources of heat that may re-kindle the fire.

2.5 Cybersecurity Considerations

2.5.1 Encrypting Data at Rest & in Transit

While TIC data is unlikely to be a target of interest for theft or unauthorized access, it is still best practice to encrypt stored data that might be of a sensitive nature or used in court cases to preserve its integrity and confidentiality. Data at rest should be encrypted, with strict controls in place to prevent unauthorized access or disclosure of sensitive information. Data in transit refers to the transmission of data via a communication medium such as wireless or cellular technology and should also be protected via encryption if possible. Cellular data running on 4G LTE or 5G is encrypted by default.

2.5.2 Software & Technology Integration

Any new software introduced into a network-connected system must be integrated in with cybersecurity considerations in mind. Systems that require active internet connections or new firewall rules to communicate should be reviewed to ensure they don't present any additional risks to the network. Software patches, regular updates, and security vulnerability scanning should be conducted on a regular basis for any new software installation. Only trusted applications should be installed on company cell phones.

Please refer to the U.S. Department of Justice's [Criminal Justice Information Services \(CJIS\) Security Policy](#) document for further information [6].

2.6 Emerging Technologies

Manufacturers are advancing TIC technology by reducing component costs, size, weight, and power needs, all of which enhance their accessibility and potential applications. TICs could soon be mounted on command vehicles or aerial ladders to monitor structure fires, assessing heat levels, and roof integrity. Integration with firefighting tools, such as helmets, radios, and SCBA systems, is already underway, with the DHS funding development of helmet-mounted visualization and navigation systems [7]. Additional research is exploring combining thermal imaging with other sensors, like visible light, audio, ultrasound, and Fourier transform infrared spectrometer (FTIR)³, to improve situational awareness.

Manufacturers are exploring ways to use AI and machine learning (ML) to automate image interpretation, improving thermal pattern recognition and highlighting hazards for enhanced firefighter safety. This could enable TICs to detect subtle thermal differences that might be missed, such as detecting fire spread or hazmat reactions.

Research is also investigating how TICs could capture data to help develop better personal protective equipment (PPE) and track firefighter health risks. FTIR and other imaging techniques could be used to document exposure to hazardous substances, supporting initiatives like the National Institute for Occupational Safety and Health (NIOSH) National Firefighter Registry for Cancer.

³ FTIR is a specific type of IR spectroscopy where all frequencies of light are measured simultaneously. The IR spectrum is then obtained using a mathematical conversion called Fourier transformation [13].

2.7 Standards/Certification Programs

The terminology used and the concepts addressed in testing and performance standards provide an accepted framework to characterize system capabilities. Standards developing organizations coordinate formal, consensus-based processes for stakeholders from industry, government agencies, test laboratories, and end-users to determine requirements and laboratory test methods to consistently ensure that products are fit for purpose. While some standards are the basis for formal certification programs, even where there is no formal certification program, manufacturers may cite conformance to particular standards in their product specifications. [8]

The National Fire Protection Association (NFPA) released NFPA 1801 *Standard for Thermal Imagers for the Fire Service*, 2021 edition [1]. NFPA 1801 requires TICs to meet standards on expected image quality (including image contrast, image spatial resolution, and thermal sensitivity), spot temperature accuracy, and durability (including ingress protection, heat/flame resistance, impact acceleration, vibration resistance, and corrosion), as well as nonincendive safety and electromagnetic requirements.

NFPA 1801 also standardizes screen icons and some controls to ensure that firefighters trained to use a TIC that complies with the NFPA standard will be able to use any other manufacturer's NFPA-approved TIC with minimal additional training. According to the standard all TICs must have a green power button and an NFPA "TI BASIC" mode. TI BASIC mode operation includes grayscale imagery with white hot polarity, a power source status indicator, an internal electronics overheat indicator, and a thermal imager "on" indicator. BASIC mode may also include heat-indicating color and a heat color reference bar; audio, video, and data recording; and audio, video, and data transmission. NFPA-compliant TICs may also offer a "TI BASIC PLUS" mode that includes all TI BASIC functions but may include additional features specific to the manufacturer. Users must take a special action to access TI BASIC PLUS mode: the green button cannot be used for activating BASIC PLUS to avoid firefighters accessing features for which they may not have been trained. One of the major changes in the 2021 edition was the movement of the spot measurement temperature feature from TI BASIC mode to the TI BASIC PLUS mode. The spot measurement is an advanced feature that requires additional training to appropriately use. The spot measurement is an approximate measurement of a defined area and not of the entire image. This temperature is dependent upon many variables including the emissivity of the object, distance from the object, and atmospheric conditions. The reported temperature is based on a preset emissivity of .95-.97 at a preset distance and calibrated in a factory. These measurements of "apparent temperatures" can be off by up to several hundred degrees from the actual measurement based on emissivity of the target and other variables. Spot measurements do not provide an accurate depiction of the thermal environment and should not be used to make tactical decisions [9].

As NFPA 1801 stipulates that TICs be rated for nonincendive safety, another relevant standard applicable to TICs is ANSI/UL 1211, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*. A thermal imaging camera in compliance with this standard, specifically with the Class 1 Division 2 requirements, provides nonincendive safety. This means these TICs are designed to prevent ignition of surrounding flammable gases, vapors, or dust, ensuring safe operation in hazardous conditions.

Finally, the International Electrotechnical Commission standard IEC 60529, *Degrees of protection provided by enclosures (IP Code)* is also applicable for a TIC fulfilling the NFPA 1801 standard. Ingress protection or “IP” ratings signal how well a piece of equipment’s enclosures protect it against intrusion by particulates (the first digit of an IP rating) and water (the second digit). Appendix A of this report explains the degrees of protection in detail. The TICs included in this market survey meet the NFPA 1801 requirement of being rated at least IP 67, which means they are “dust tight” (the highest rating in against particulates) and protected against temporary immersion in water (the second highest rating against water ingress).

NFPA 1408: Standard for Training Fire Service Personnel in the Operation, Care, Use, and Maintenance of Thermal Imagers, 2020 Edition provides information on training requirements for the use of TICs by the fire services as well as requirements addressing the operational limits of thermal imagers [10]. The standard states that all participants shall understand the functions, modes, and use of accessories specific to the TIC they are using. All participants shall understand that accurate image interpretation is affected by the following factors: environmental conditions such as rain, snow, and heat which affect image clarity and depth perception, glass, mirrors, shiny objects, and water all cause reflectivity making image interpretation more difficult and actual temperatures of objects with different emissivity values in the field of view can be very different from the reported temperature. End users must be aware of those operational limits and not set expectations outside of those limits

NFPA 1801 was recently incorporated into the first edition of NFPA 1930: Standard on Fire and Emergency Service Use of Thermal Imagers, Two-Way Portable RF Voice Communication Devices, Ground Ladders, Rescue Tools, Fire Hose, and Fire Hose Appliances, 2025 Edition [11]. NFPA 1930 consolidates five standards as part of the emergency response and responder safety (ERRS) document consolidation project (nfpa.org/errs), which was approved by the NFPA Standards Council in April 2019. The requirements for thermal imagers are in Chapters 4 through 8. Changes over the last edition of NFPA 1801 include revised hazardous location requirements to correlate with updated requirements for personal protective equipment that operates in the same environments, revised image quality requirements, and many changes to improve the clarity and repeatability of test methods. The transition period for implementation of the new standard is 18 months, meaning that after June 6, 2026, manufacturers can no longer label products as certified to NFPA 1801.

3.0 PRODUCT INFORMATION

This section provides information on 16 products from seven manufacturers. All products feature rechargeable batteries. All the TICS meet the following durability requirements:

- IP67-compliant (See Appendix A for details on IP ratings)
- Can withstand a drop from a height of 6 feet onto concrete
- Can withstand temperatures up to 1022° F for a minimum of 5 minutes
- Resists corrosion from various chemicals and environmental factors
- Buttons, keys, and switches can be operated with a single gloved hand and have a service life of at least 50,000 cycles
- Meets the ANSI/UL 121201 standard for nonincendive safety, ensuring they can be safely used in potentially explosive environments

Table 3-1 provides general characteristics and specifications of the products, which are listed alphabetically by manufacturer. The product information that appears in section 3.0 has not been independently verified by the SAVER program.

Below are definitions of the features in the product information in table 3-1, listed in column order and in the individual product descriptions.

Manufacturer and Product refers to the manufacturer or vendor of the TIC and the product name.

Dimensions refers to the length, width, and height of the product, in inches (in).

Weight refers to the weight of the product, including batteries, in pounds (lb).

Display refers to the diagonal of the display screen in inches. The type of display – either LCD, LCD with in-plane switching (IPS), or thin-film transistor LCD (TFT LCD) technology – is also provided. IPS provides a wide viewing angle of 85° in all directions. A TFT LCD is an active-matrix LCD where an individual transistor is used to drive each individual pixel, allowing for faster response times.

Backlight refers to the display brightness in candela per square meter (cd/m²).

Battery Type refers to the type(s) of battery sources used to power the product. All devices in the report can be powered with rechargeable batteries. Lithium iron phosphate (LiFePO₄) batteries have a longer life cycle and are less likely to ignite than other lithium-ion (Li-ion) batteries.


Operating Time refers to the vendor-reported life of the battery in hours, which typically assumes the instrument is in continuous use. Actual battery life will vary depending on ambient temperature, display screen brightness, battery age, optional accessory use, etc.

Recharge Time refers to the amount of time a spent battery needs to charge to full power, in hours.

Startup Time refers to the time to boot up the product in seconds.

Resolution refers to the level of detail and definition in the product's images represented in its number of pixels.

NETD/Sensitivity refers to the product's ability to detect and display IR differences and is given in millikelvin (mK). The lower the mK rating, the greater the sensitivity to small temperature differences, which results in a cleaner image.



Dynamic Range refers to the specific temperature range in which the product can detect and differentiate people and objects with different intensities of IR waves in degrees Fahrenheit.

Refresh Rate refers to the number of times an image is updated per second in Hertz (Hz).

Zoom refers to whether the product has the capability to electronically magnify the image.; If available, electronic zoom can magnify an image two times (2X) or four times (4X).

Image Capture refers to the number of images that can be taken and stored on the product.

Video Recording refers to the number of hours of video recording that can be stored on the product.

NFPA 1801-compliant refers to the product having met the requirements to be certified to the NFPA 1801: *Standard for Thermal Imagers for the Fire Service*, 2021 edition.

MSRP refers to the list price of the product as provided by the vendor or listed on the vendor website and rounded to the nearest U.S. dollar.

Table 3-1 Product Comparison Matrix

Manufacturer and Product	Dimensions H x W x L (in.)	Weight (lb)	Display (in)	Backlight (cd/m ²)	Battery Type	Operating Time (hr)	Recharge Time (hr)	Start-up Time (seconds)	Resolution (pixel)	NETD/Sensitivity (mK)	Dynamic Range (° F)	Refresh Rate (Hz)	Zoom	Image Capture	Video Recording (hr)	NFPA 1801- Compliant	MSRP (\$)
3M Scott V320 Thermal Imager	5.2 x 4.8 x 9.4	2.2	3.5 LCD	> 250	Li-ion	8	2.5	< 5	320x 240	<70	-4 to 1202	> 25					\$4,633
Avon Protection Systems, Argus Mi-TIC E-1,3	8.0 x 3.7 x 2.8	1.7	2.7 LCD	400	LiFePO ₄	>4 @ 72 °F	<4	5	320x 240	<50	-40 to 1400	60	2X, 4X*	1000*	16*	✓	1-button \$5,460, 3-button \$5,905
Avon Protection Systems, Argus Mi-TIC EL-1,3	8.5 x 4.3 x 3.2	1.9	3.5 LCD	350	LiFePO ₄	>4 @ 72 °F	<4	5	320x 240	<50	-40 to 1400	60	2X 4X*	1000*	16*	✓	1-button \$6,239, 3-button \$6,699
Avon Protection Systems, Argus Mi-TIC 320-3	8.0 x 3.7 x 2.8	1.7	2.7 LCD	400	LiFePO ₄	>4 @ 72 °F	<4	5	320x 240	<50	-40 to 2000	60	2X 4X	1000	16	✓	\$7,025
Avon Protection Systems, Argus Mi-TIC S-3	8.5 x 4.3 x 3.2	1.9	3.5 LCD	350	LiFePO ₄	>4 @ 72 °F	<4	5	320x 240	<50	-40 to 2000	60	2X 4X	1000	16	✓	\$7,850
Bullard DXT	5.4 x 4.6 x 8.2	2.5	3.5 LCD IPS	1000	Li-ion	<8.5 @ 68° F	4.25 to 80%	12	320x 240	<60	1022	60	2x 4x [∞]	30,000 [†]	8 [†]		\$4,549
Bullard NXT Pro	5.4 x 4.6 x 8.2	2.5	3.5 LCD IPS	1000	Li-ion	<6.5 @ 68° F	4.25 to 80%	12	640x 480	<50	1200	60	2x 4x [∞]	30,000 [†]	8 [†]	✓	\$7,249
Bullard QXT Pro	5.4 x 4.6 x 8.2	2.5	3.5 LCD IPS	1000	Li-ion	<6.5 @ 68° F	4.25 to 80%	12-	640x 480	<50	1200	60	2x 4x [∞]	30,000 [†]	8 [†]		\$6,499

Manufacturer and Product	Dimensions H x W x L (in.)	Weight (lb)	Display (in)	Backlight (cd/m ²)	Battery Type	Operating Time (hr)	Recharge Time (hr)	Start-up Time (seconds)	Resolution (pixel)	NETD/Sensitivity (mK)	Dynamic Range (° F)	Refresh Rate (Hz)	Zoom	Image Capture	Video Recording (hr)	NFPA 1801- Compliant	MSRP (\$)
Bullard TXS	4.7 x 4.6 x 7.1	1.6	3.5 TFT LCD	400	Li-ion	<6 @ 68° F	3.50 to 80%	9	320x 240	<60	1022	30					\$2,949
Dräger, UCF FireVista	5.3 X 3.5 X 5.3	1.9	3.5 LCD	700	LiFePO ₄	5 @ 73° F	2 to 4	3	320x 240	50	-4 to 1202	30					\$4,900
FLIR K65	4.7 x 4.9 x 11	2.4	4.0 LCD	--	Li-ion	4 @ 77° F	2 to 85%	<17	320x 240	<30	-4 to 1202	60	2X	α	α	✓	\$4,995
FLIR K53, K55	4.7 x 4.9 x 11	2.4	4.0 LCD	--	Li-ion	4 @ 77° F	2 to 85%	<17	320x 240	<30	-4 to 1202	60	2X	α	α		K53 \$3,995, K55 \$4,495
Seek Thermal AttackPRO+	11 x 4.5 x 5	2.5	3.5 LCD	500	Li-ion	>6 >3†	4	<5	320x 240	<35	-4 to 1022	>25				✓	\$4,674
Seek Thermal AttackPRO VRS	11 x 4.5 x 5	2.5	3.5 LCD	500	Li-ion	>6 >3†	4	<8	320x 240	<35	-4 to 1200	>25			5		\$4,174
Tempest TIC 3.3	6.5 x 5.5 x 3.4	1.9	3.5 LCD	800	LiFePO ₄	<8§	2	<5	320x 240	<50	-40 to 2100	60	2X 4X	1000	8		\$6,093 to \$8,601#

Empty box indicates product does not have feature or capability.

-- indicates no information is available

* indicates available with three-button model

∞ indicates option available when the "basic feature pack" is purchased

† indicates option available when the "advanced feature pack" is purchased

‡ with flashlight on

§ with 2 batteries

α200 files total with maximum duration of 30 minutes

indicates this information is from third party website

3.1 3M Scott V320 Thermal Imager



Figure 3-1 3M Scott V320 Thermal Imager
Image Credit: 3M Scott



Figure 3-2 Screen View
Image Credit: 3M Scott

Dimensions (inches)	5.2 x 4.8 x 9.4
Weight (pounds)	< 2.2
Display Diagonal (inches)	3.5 LCD
Backlight (cd/m2)	> 250
Battery Type	Li-ion
Operating Time (hours)	Up to 8
Recharge Time (hours)	2.5
Start-up Time (seconds)	< 5
Resolution (pixels)	320 x 240
NETD (Sensitivity)	<70 mK
Dynamic Range	-4 to 1202° F
Refresh Rate	>25 Hz
Field of View (°)	55 horizontal (H) x 42 vertical (V)
Zoom	N/A
Image Capture	N/A
Video Recording	N/A
Image Modes	One mode
NFPA 1801-Compliant	No
MSRP	\$4,633

- The V320 thermal imager does not require the user to change modes for different fireground operations; its internal core has been configured to perform in multiple environments. The V320 has only one button to press for operation.
- Standard accessories include two rechargeable batteries, a retractable lanyard, a desktop battery charger, a desktop charger power supply, and a reusable shipping carton.
- The manufacturer’s warranty lasts three years and covers the camera and batteries. The manufacturer provides 48-hour turn-around time on warranty service work to the equipment and returns the TIC to user in normal, usable condition within 72 hours, or provides comparable equipment on loan until the product is repaired.

3.2 Avon Protection Systems, ARGUS Mi-TIC E-1,3



Figure 3-3 Argus Mi-TIC E-1,3
Image Credit: Avon Protection



Figure 3-4 Image Modes
Image Credit: Avon Protection

Dimensions (inches)	8.0 x 3.7 x 2.8
Weight (pounds)	1.7
Display Diagonal (inches)	2.7 LCD
Backlight (cd/m ²)	400
Battery Type	LiFePO ₄
Operating Time (hours)	≤ 4 @ 72° F
Recharge Time (hours)	< 4
Start-up Time (seconds)	5
Resolution (pixels)	320 x 240
NETD (Sensitivity)	< 50 mK
Dynamic Range	-40 to 1400° F
Refresh Rate	60 Hz
Field of View (°)	50 H x 37.5 V x 62 diagonal (D)
Zoom	2X and 4X*
Image Capture	1,000 images*
Video Recording (hours)	Up to 16*
Image Modes	See details below
NFPA 1801-Compliant	Yes
MSRP	One-button \$5,460 Three-button \$5,905 Volume discounts available

- The “IGNIS Engine” technology increases contrast between the fire and important details at lower temperatures such as exit points and obstacles. The Argus TICs automatically switch to the optimum level of sensitivity to give the lowest amount of noise over the widest possible temperature range.
- This TIC has several image modes. Fire Mode is available on one-button TIC. All modes available on three-button TICs.
 - Fire Mode: High dynamic range and imaging for interior structural firefighting, used in TI BASIC mode.
 - Fire Plus Mode: High dynamic range and imaging with spot temperature measurement for interior structural firefighting.
 - Overhaul Mode: Quickly identify hottest spots with red colorization.
 - Size-Up Mode: Easy colorization for size-up from outside of the fire scene.
 - Inspection Mode: Full color scale for preventative maintenance applications.
 - White Hot Mode (grayscale only): White hot for general applications with no heat colorization.
 - Missing Person Mode: Optimized contrast and blue colorization used to enhance search efforts in non-fire applications (wilderness, auto accidents, etc.).
- The TIC can be carried in hand, inside a pocket, clipped outside a pocket, clipped to a lanyard or hung around neck.
- Desktop/in-truck charger station charges both the TIC and spare battery. Multiple charger stations can be daisy-chained together up to a maximum of six units.
- Standard accessories include: two lithium iron phosphate battery packs, desktop/vehicle charger station, charger power supply, retractable lanyard, pocket clip, quick start guide.
- Optional accessories include AA battery pack, hard case (black), soft carry case, neck strap.
- Manufacturer’s warranty information: 3-year camera warranty, 5-year battery warranty, 10-year focusing lens and sensor warranty.
- User training is arranged at the time of delivery and includes operation and basic care of the device. Repairs will require the product to be returned to the repair center. The customer care team is available 7:30–17:00 (EST), Monday to Friday at 888-286-6440.

* available on three-button model only

3.3 Avon Protection Systems, ARGUS Mi-TIC EL-1,3



Figure 3-5 Argus Mi-TIC EL-1, 3
Image Credit: Avon Protection



Figure 3-6 Image Modes
Image Credit: Avon Protection

Dimensions (inches)	8.5 x 4.3 x 3.2
Weight (pounds)	1.9
Display Diagonal (inches)	3.5 LCD
Backlight (cd/m ²)	350
Battery Type	LiFePO ₄
Battery Life (hours)	≤ 4 @ 72 ° F
Recharge Time (hours)	< 4
Start-up Time (seconds)	5
Resolution (pixels)	320 x 240
NETD (Sensitivity)	< 50 mK
Dynamic Range	-40 to 1400 ° F
Refresh Rate	60 Hz
Field of View (°)	50 H x 37.5 V x 62 D
Digital Zoom	2X and 4X*
Image Capture	1,000 images*
Video Capture (hours)	Up to 16*
Image Modes	Details in section 3.2
NFPA 1801-Compliant	Yes
MSRP	One-button \$6,239 Three-button \$6,699 Volume discounts available

- The “IGNIS Engine” technology increases contrast between the fire and important details at lower temperatures such as exit points and obstacles. The Argus TICs automatically switch to the optimum level of sensitivity to give the lowest amount of noise over the widest possible temperature range.
- Can be carried in hand, inside a pocket, clipped outside a pocket, clipped to a lanyard, or hung around neck.
- Desktop/in-truck charger station charges both the TIC and spare battery. Multiple charger stations can be daisy-chained together up to a maximum of six units.
- Standard accessories include: two NFPA lithium iron phosphate battery packs, desktop/vehicle charger station, charger power supply, retractable lanyard, pocket clip, quick start guide.
- Optional accessories include “AA” battery pack, black hard case, soft carry case, neck strap.
- Manufacturer’s warranty information: 3-year camera warranty, 5-year battery warranty, 10-year focusing lens, and sensor warranty.
- User training is arranged at the time of delivery and includes operation and basic care of the device. Repairs will require the product to be returned to the repair center. The customer care team is available 7:30–17:00 (EST), Monday to Friday at 888-286-6440.

* available on three-button model only

3.4 Avon Protection Systems, ARGUS Mi-TIC 320-3



Figure 3-7 Argus Mi-TIC 320-3
Image Credit: Avon Protection



Figure 3-8 Image Modes
Image Credit: Avon Protection

Dimensions (inches)	8.0 x 3.7 x 2.8
Weight (pounds)	1.7
Display Diagonal (inches)	2.7 LCD
Backlight (cd/m ²)	400
Battery Type	LiFePO ₄
Battery Life (hours)	≤ 4 @ 72 ° F
Recharge Time (hours)	< 4
Start-up Time (seconds)	5
Resolution (pixels)	320 x 240
NETD (Sensitivity)	< 50 mK
Dynamic Range	-40 to 2000° F
Refresh Rate	60 Hz
Field of View (°)	50 H x 37.5 V x 62 D
Digital Zoom	2X and 4X
Image Capture	1000 images
Video Capture (hours)	Up to 16
Image Modes	Details in section 3.2
NFPA 1801-Compliant	Yes
MSRP	\$7,025 Volume discounts available

- The Mi-TIC 320-3 includes a heat seeker to locate hottest spot in the scene and cold seeker option to locate coldest spot in scene.
- The “IGNIS Engine” technology increases contrast between the fire and important details at lower temperatures such as exit points and obstacles. The Argus TICs automatically switch to the optimum level of sensitivity to give the lowest amount of noise over the widest possible temperature range.
- Can be carried in hand, inside a pocket, clipped outside a pocket, clipped to a lanyard, or hung around neck.
- Desktop/in-truck charger station charges both the TIC and spare battery. Multiple charger stations can be daisy-chained together up to a maximum of six units.
- Standard accessories include two NFPA lithium iron phosphate battery packs, desktop/vehicle charger station, charger power supply, retractable lanyard, pocket clip, quick start guide.
- Optional accessories include “AA” battery pack, black hard case, soft carry case, neck strap.
- Manufacturer’s warranty information: 5-year camera warranty, 5-year battery warranty, 10-year focusing lens, and sensor warranty.
- User training is arranged at the time of delivery and includes operation and basic care of the device. Repairs will require the product to be returned to the repair center. The customer care team is available 7:30–17:00 (EST), Monday to Friday at 888-286-6440.

3.5 Avon Protection Systems, ARGUS Mi-TIC S-3



Figure 3-9 Argus Mi-TIC S-3
Image Credit: Avon Protection



Figure 3-10 Image Modes
Image Credit: Avon Protection

Dimensions (inches)	8.5 x 4.3 x 3.2
Weight (pounds)	1.9
Display Diagonal (inches)	3.5 LCD
Backlight (cd/m ²)	350
Battery Type	LiFePO ₄
Battery Life (hours)	≤ 4 @ 72 ° F
Recharge Time (hours)	< 4
Start-up Time (seconds)	5
Resolution (pixels)	320 x 240
NETD (Sensitivity)	<50 mK
Dynamic Range	-40 to 2000 ° F
Refresh Rate	60 Hz
Field of View (°)	50 H x 37.5 V x 62 D
Digital Zoom	2X and 4X
Image Capture	1000 images
Video Capture (hours)	Up to 16
Image Modes	Details in section 3.2
NFPA 1801-Compliant	Yes
MSRP	\$7,850 Volume discounts available

- The Mi-TIC S-3 includes a heat seeker to locate hottest spot in the scene and cold seeker option to locate coldest spot in scene.
- The Mi-TIC S-3 includes an electronic compass for greater scene awareness and laser pointer aligned to the spot temperature zone.
- The “IGNIS Engine” technology increases contrast between the fire and important details at lower temperatures such as exit points and obstacles. The Argus TICs automatically switch to the optimum level of sensitivity to give the lowest amount of noise over the widest possible temperature range.
- Can be carried in hand, inside a pocket, clipped outside a pocket, clipped to a lanyard, or hung around neck.
- Desktop/in-truck charger station charges both the TIC and spare battery. Multiple charger stations can be daisy-chained together up to a maximum of six units,
- Standard accessories include two NFPA lithium iron phosphate battery packs, desktop/vehicle charger station with AC/DC power cords, USB cord, mounting bracket, retractable lanyard, pocket clip, quick start guide.
- Optional accessories include “AA” battery pack, black hard case, soft carry case, neck strap.
- Manufacturer’s warranty information: 5-year camera warranty, 5-year battery warranty, 10-year focusing lens, and sensor warranty.
- User training is arranged at the time of delivery and includes operation and basic care of the device. Repairs will require the product to be returned to the repair center. The customer care team is available 7:30–17:00 (EST), Monday to Friday at 888-286-6440.

3.6 Bullard, DXT



Figure 3-11 Bullard, DXT
Image Credit: Bullard

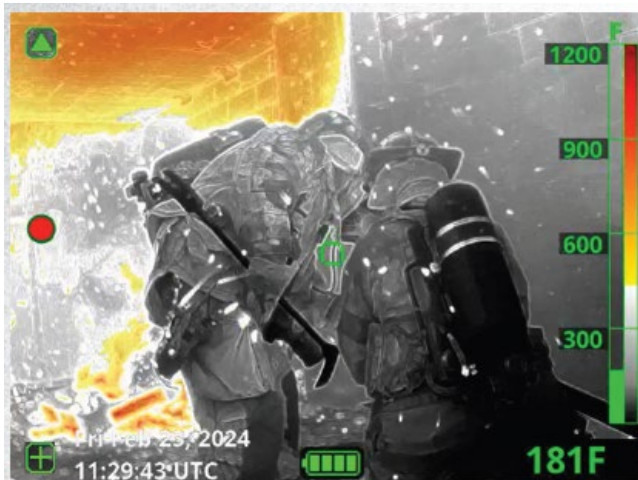


Figure 3-12 X-Factor 2.0 Image Enhancement
Image Credit: Bullard

Dimensions (inches)	5.4 x 4.6 x 8.2
Weight (pounds)	2.5
Display Diagonal (inches)	3.5 IPS LCD
Backlight (cd/m ²)	1000
Battery Type	Li-ion
Battery Life (hours)	< 8.5
Recharge Time (hours)	< 4.25
Start-up Time (seconds)	12
Resolution (pixels)	320 x 240
NETD (Sensitivity)	< 60 mK
Dynamic Range	1022° F
Refresh Rate	60 Hz
Field of View (°)	50 H x 40 V
Digital Zoom	2X and 4X [∞]
Image Capture	30,000 images [†]
Video Capture (hours)	8 [†]
Image Modes	Standard and Advanced (details below)
NFPA 1801-Compliant	No
MSRP	\$4,549

- The DXT uses new X-Factor 2.0 Image Enhancement technology, which sharpens the distinction between objects and background using white edges for highlighting to help users recognize people and objects more quickly. Seamless gain transition enables shutterless automatic transition between low and high gain mode depending on scene temperature.
- This TIC has two operational modes: A single press of the main power switch puts the TIC in the default image for standard firefighting. In the default mode lower temperatures are colorized black to white (with white for the hottest objects) and a yellow/orange/red colorization scheme kicks in at temperatures above 500° F. Advanced mode is entered by employing a secondary pair of switches for activating and adjusting advanced features, including a manual colorization³ mode, and other optional capabilities. Bullard does not have image modes for specific use cases but provides training on how to use multi-purpose features in situations such as fire attack, person search, overhaul, size up, and wildland firefighting.
- There are two optional feature packs available. The “basic” feature pack includes electronic thermal throttle, hot area detector, cold area detector, and zoom. Electronic thermal throttle allows users to throttle sensitivity up and down to visually isolate warmer items in any type of scene. The “advanced” feature pack includes everything in the basic feature pack as well as image capture, video recording, and on-screen playback. The basic feature pack costs \$499; the advanced, \$749.
- Can be carried in hand or attached to retractable strap (optional purchase).
- A wireless desktop charger is included with purchase. Optional accessories include wireless truck mount charger, USB connection, retractable strap, and hard case.
- Multiple outer housing colors including blue (standard), red, yellow, lime-yellow, orange, and black are available for departmental identification.
- A 5-year manufacturer’s warranty covers the TIC and battery.
- Training sources are available on the Bullard website, a YouTube channel with instructional videos, and can be provided by an on-staff trainer, all of which are included with purchase.

[∞] Optional feature available in the basic feature pack.

[†] Optional feature available in the advanced feature pack. This feature allows approximately eight hours of video, or approximately 30,000 still images to be recorded, using the same memory (meaning that image storage and video storage are the same so the more video is stored, the available image count decreases) but works on an automatic overwrite where the oldest file will be deleted to make room for the new file should the storage become full. The DVR can also be configured by the customer to be “always on” so that it is recording any time the imager is in operation.

3.7 Bullard, NXT Pro



Figure 3-13 Bullard, NXT Pro
Image Credit: Bullard

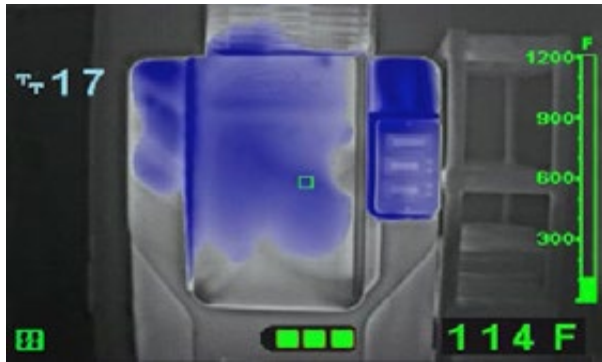


Figure 3-14 Electronic Thermal Throttle
Image Credit: Bullard

Dimensions (inches)	5.4 x 4.6 x 8.2
Weight (pounds)	2.5
Display Diagonal (inches)	3.5 IPS
Backlight (cd/m ²)	1000
Battery Type	Li-ion
Battery Life (hours)	< 6.5
Recharge Time (hours)	< 4.25
Start-up Time (seconds)	12
Resolution (pixels)	640 x 480
NETD (Sensitivity)	60 mK
Dynamic Range	1200° F
Refresh Rate	60 Hz
Field of View (°)	50 H x 40 V
Digital Zoom	2X and 4X [∞]
Image Capture	30,000 images [†]
Video Capture (hours)	8 [†]
Image Modes	TI BASIC and TI BASIC PLUS (details below)
NFPA 1801-Compliant	Yes
MSRP	\$7,249

The NXT Pro replaces the NXT which has been discontinued.

- The NXT Pro uses new X-Factor 2.0 Image Enhancement technology, which sharpens the distinction between objects and background using white edges for highlighting to help users recognize people and objects more quickly. Seamless gain transition enables shutterless and seamless automatic transition between low and high gain mode depending on scene temperature.
- This TIC has two modes: TI BASIC and TI BASIC PLUS. TI BASIC uses white hot (grayscale) and super red hot (yellow-orange-red gradient) for temperatures above 500° F. TI BASIC PLUS offers a manual colorization mode as well as optional zoom, image capture and video recording capabilities.
- Bullard does not have image modes for specific use cases but provides training on how to use multi-purpose features in situations such as fire attack, person search, overhaul, size up, and wildland firefighting.
- There are two optional feature packs available. The “basic” feature pack includes electronic thermal throttle, hot area detector, cold area detector, and zoom. Electronic thermal throttle allows users to throttle sensitivity up and down to visually isolate warmer items in any type of scene. The “advanced” pack includes everything in the basic feature pack as well as image capture, video recording, and on-screen playback. The basic feature pack costs \$499; the advanced, \$749.
- Can be carried in hand or attached to retractable strap (optional purchase).
- A wireless desktop charger is included with purchase. Optional accessories include wireless truck mount charger, USB connection, retractable strap, and hard case.
- Multiple outer housing colors including red (standard), blue, yellow, lime-yellow, orange, and black are available for departmental identification.
- A 5-year manufacturer’s warranty covers the TIC and battery.
- Training sources are available on the Bullard website, a YouTube channel with instructional videos, and provided by an on-staff trainer, all of which are included with purchase.

∞ Optional feature available in the basic feature pack.

† Optional feature available in the advanced feature pack. This feature allows approximately eight hours of video, or approximately 30,000 still images to be recorded, using the same memory (meaning that image storage and video storage are the same so the more video is stored, the available image count decreases) but works on an automatic overwrite where the oldest file will be deleted to make room for the new file should the storage become full. The DVR can also be configured by the customer to be “always on” so that it is recording any time the imager is in operation.

3.8 Bullard, QXT Pro



Figure 3-15 Bullard, QXT Pro

Image Credit: Bullard

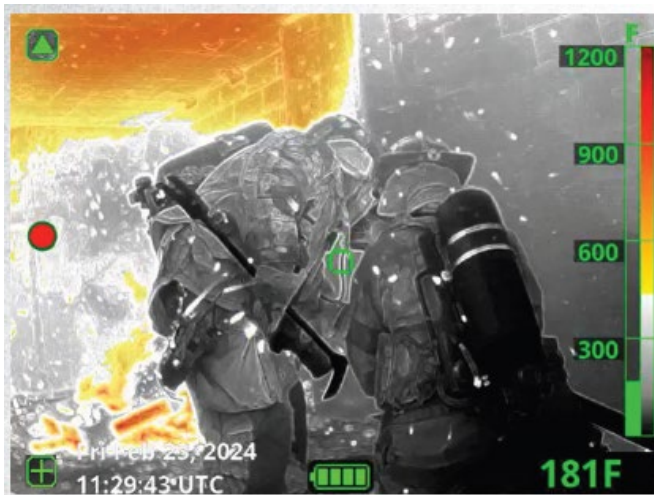


Figure 3-16 X-Factor 2.0 Image Enhancement

Image Credit: Bullard

Dimensions (inches)	5.4 x 4.6 x 8.2
Weight (pounds)	2.5
Display Diagonal (inches)	3.5 LCD IPS
Backlight (cd/m ²)	1000
Battery Type	Li-ion
Battery Life (hours)	< 6.5
Recharge Time (hours)	< 4.25
Start-up Time (seconds)	12
Resolution (pixels)	640 x 480
NETD (Sensitivity)	< 50 mK
Dynamic Range	1200° F
Refresh Rate	60 Hz
Field of View (°)	50 H x 40 V
Digital Zoom	2X and 4X [∞]
Image Capture	30,000 images [†]
Video Capture (hours)	8 [†]
Image Modes	Standard and Advanced (details below)
NFPA 1801-Compliant	No
MSRP	\$6,499

- The QXT Pro uses new X-Factor 2.0 Image Enhancement technology, which sharpens the distinction between objects and background using white edges for highlighting to help users recognize people and objects more quickly. Seamless gain transition enables shutterless and seamless automatic transition between low and high gain mode depending on scene temperature.
- This TIC has two operational modes: A single press of the main power switch puts the TIC in the default image for standard firefighting. In the default mode lower temperatures are colorized black to white (with white for the hottest objects) and a yellow/orange/red colorization scheme kicks in at temperatures above 500° F. Advanced mode is entered by employing a secondary pair of switches for activating and adjusting advanced features, including a manual colorization mode, and other optional capabilities. Bullard does not have image modes for specific use cases but provides training on how to use multi-purpose features in situations such as fire attack, person search, overhaul, size up, and wildland firefighting.
- There are two optional feature packs available. The “basic” feature pack includes electronic thermal throttle, hot area detector, cold area detector, and zoom. Electronic thermal throttle allows users to throttle sensitivity up and down to visually isolate warmer items in any type of scene. The “advanced” pack includes everything in the basic feature pack as well as image capture, video recording, and on-screen playback. The basic feature pack costs \$499; the advanced, \$749.
- Can be carried in hand or attached to retractable strap (optional purchase).
- A wireless desktop charger is included with purchase. Optional accessories include wireless truck mount charger, USB connection, retractable strap, and hard case.
- Multiple outer housing colors including red (standard), blue, yellow, lime-yellow, orange, and black are available for departmental identification.
- A 5-year manufacturer’s warranty covers the TIC and battery.
- Training sources are available on the Bullard website, a YouTube channel with instructional videos, and provided by an on-staff trainer, all of which are included with purchase.

∞ Optional feature available in the basic feature pack.

† Optional feature available in the advanced feature pack. This feature allows approximately eight hours of video, or approximately 30,000 still images to be recorded, using the same memory (meaning that image storage and video storage are the same so the more video is stored, the available image count decreases) but works on an automatic overwrite where the oldest file will be deleted to make room for the new file should the storage become full. The DVR can also be configured by the customer to be “always on” so that it is recording any time the imager is in operation.

3.9 Bullard, TXS



Figure 3-17 Bullard, TXS
Image Credit: Bullard



Figure 3-18 X-Factor Lite Image Enhancement
Image Credit: Bullard

Dimensions (inches)	4.7 x 4.6 x 7.1
Weight (pounds)	1.6
Display Diagonal (inches)	3.5 TFT LCD
Backlight (cd/m ²)	400
Battery Type	Li-ion and field replaceable battery pack
Battery Life (hours)	≤ 6.0
Recharge Time (hours)	≤ 3.5
Start-up Time	9
Resolution (pixels)	320 x 240
NETD (Sensitivity)	< 60
Dynamic Range	1022° F
Refresh Rate	30 Hz
Field of View (°)	50 H x 40 V
Digital Zoom	N/A
Image Capture	N/A
Video Capture	N/A
Image Modes	One Mode White hot below 500° F and yellow-orange-red gradient for temperatures above 500° F
NFPA-1801Compliant	No
MSRP	\$2,949

- The TXS uses X-Factor Lite Image Enhancement technology, which provides automatic gain adjustment.
- The TXS has a one-button design for ease of use and simplicity. The TXS has one imaging mode, that uses white hot below 500° F and a yellow-orange-red gradient for temperatures above 500° F.
- Can be carried in hand or attached to retractable strap.
- A wireless desktop charger is included with purchase. Optional accessories include wireless truck mount charger, USB connection, retractable strap, and hard case.
- The TIC's outer housing color is melon yellow.
- A 5-year manufacturer's warranty covers the TIC and battery.
- Training sources are available on the Bullard website, YouTube channel with instructional videos, and provided by an on-staff trainer, all of which are included with purchase.

3.10 Dräger, UCF FireVista



Figure 3-19 Dräger, UCF Fire Vista
Image Credit: 3.11 Dräger

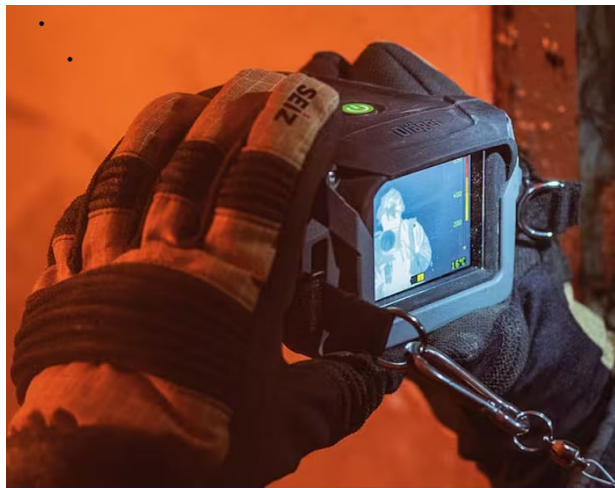


Figure 3-20 Display View
Image Credit: Dräger

Dimensions (inches)	5.3 x 3.5 x 5.3
Weight (pounds)	1.9
Display Diagonal (inches)	3.5 LCD
Backlight (cd/m ²)	700
Battery Type	LiFePO ₄
Battery Life (hours)	5
Recharge Time (hours)	2-4
Start-up Time (seconds)	3
Resolution (pixels)	320 x 240
NETD (Sensitivity)	50 mK
Dynamic Range	-4 to 1202° F
Refresh Rate	30 Hz
Field of View (°)	50 H x 37 V x 63 D
Digital Zoom	N/A
Image Capture	N/A
Video Capture	N/A
Image Modes	One mode
NFPA 1801-Compliant	No
MSRP	\$4,900

- The FireVista is optimized for structural firefighting. The TIC does not have additional functions such as digital zoom and image or video and focuses on optimized thermal imaging. The TIC has one on/off switch and one image mode and requires minimal training.
- Standard accessories include integrated battery, lanyard, truck charger and power cord, and instructions for use.
- A manufacturer's warranty covers the camera for one year.
- Simple operational training is provided at delivery.

3.11 FLIR, K65



Figure 3-21 FLIR. K65
Image Credit: FLIR

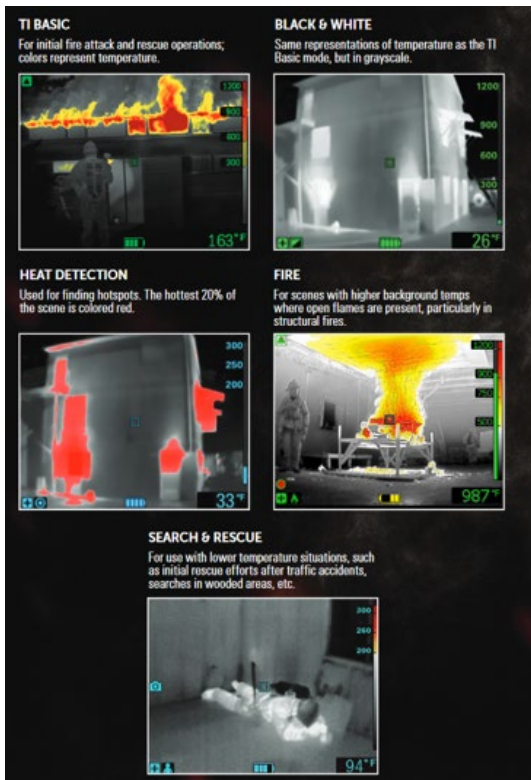


Figure 3-22 Image Modes
Image Credit: FLIR

Dimensions (inches)	4.7 x 4.9 x 11
Weight (pounds)	2.4
Display Diagonal (inches)	4 LCD
Backlight	Information not provided
Battery Type	Li-ion
Battery Life (hours)	4
Recharge Time (hours)	2 (to 85% capacity)
Start-up Time (seconds)	< 17, 4 from sleep mode
Resolution (pixels)	320 x 240
NETD (Sensitivity)	< 30 mK
Dynamic Range	-4 to 1202° F
Refresh Rate	60 Hz
Field of View (°)	51 H x 38 V
Digital Zoom	2X
Image Capture	200 files total with maximum duration of 30 minutes. (The total number of files depends on number of saved images, jpeg and videos.)
Video Capture (hours)	Same as above
Image Modes	5 modes including TI BASIC. See below.
NFPA 1801-Compliant	Yes
MSRP	\$4,995

- The K65 uses FLIR's proprietary FSX (Flexible Scene Enhancement) digital image processing to produce sharp, finely textured images that show additional details even in scenes with extreme temperature differences.
- This TIC has five image modes:
 - TI BASIC NFPA firefighting mode- for initial attack and rescue operations, colors represent temperatures.
 - Black-and-white firefighting mode- same representation of temperature as TI BASIC mode, but in grayscale.
 - Fire mode- for scenes with higher background temperatures where open flames are present, particularly in structural fires.
 - Search and rescue mode- for use in lower temperature situations, such as initial rescue after traffic accidents, searches in wooded areas, etc.
 - Heat detection mode- used for finding hotspots, the hottest 20% of the scene is colored red.
- The unit can be carried in hand, using a carabiner strap, lanyard strap, neck strap, and two retractable lanyards.
- Standard accessories include case, two batteries, desktop charger, power cords, USB cord, Torx screwdriver, lanyards, straps, outlet adapters, and quick start guide.
- Optional accessories include hard transport case, carabiner strap, retractable lanyard, extra batteries, in-truck charger, car charger, cigarette lighter adapter kit, and tripod adapter.
- Manufacturer's warranty covers the battery for two years, the workmanship and manufacturing for five years and includes a 10-year sensor warranty.
- Future software updates are downloadable from website.
- Information on online and in-person training courses is available at www.infraredtraining.com/en-US.
Mission Analytics, LLC, a distributor of this product contributed information for this report.

3.12 FLIR K53, K55



Figure 3-23 FLIR. K53, K55
Image Credit: FLIR

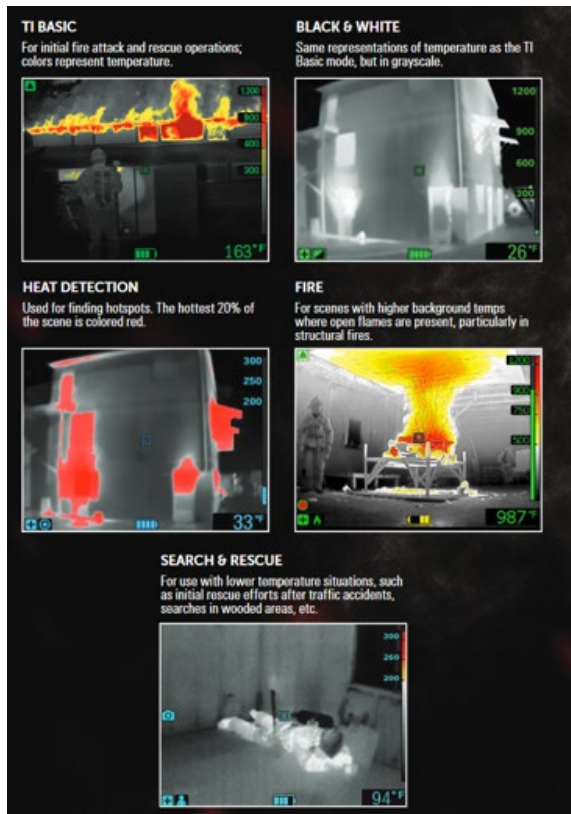


Figure 3-24 Image Modes
Image Credit: FLIR

Dimensions (inches)	4.7 x 4.9 x 11
Weight (pounds)	2.4
Display Diagonal (inches)	4 LCD
Backlight	Information not provided
Battery Type	Li-ion
Battery Life (hours)	4
Recharge Time (hours)	2
Start-up Time (seconds)	< 17, 4 from sleep mode
Resolution	320 x 240 pixel
NETD (Sensitivity)	< 30 mK
Dynamic Range	-4 to 1202° F
Refresh Rate	60 Hz
Field of View (°)	51 H x 38 V
Digital Zoom	2X
Image Capture	200 files total with maximum duration of 30 minutes. (The total number of files depends on the number of saved images, jpeg and videos.)
Video Capture (hours)	Same as above
Image Modes	K53: BASIC K55: BASIC plus four more modes. See Below,
NFPA 1801-Compliant	No
MSRP	K55 \$4,495 K53 \$3,995

- The K53 and K55 use FLIR's proprietary FSX - FLEXIBLE SCENE ENHANCEMENT digital image processing produces sharp, fine -textured images that show additional details even in scenes with extreme temperature differences.
- The K53 and K55 both have BASIC firefighting mode. The K55 model also has four additional modes:
 - Black-and-white firefighting mode- same representation of temperature as BASIC mode, but in grayscale.
 - Fire mode- for scenes with higher background temperatures where open flames are present, particularly in structural fires.
 - Search and rescue mode- for use in lower temperature situations, such as initial rescue after traffic accidents, searches in wooded areas, etc.
 - Heat detection mode- used for finding hotspots, the hottest 20% of the scene is colored red. Black-and-white firefighting mode.
- Standard accessories include case, two batteries, desktop charger, power cords, USB cord, lanyards, straps, outlet adapters, and quick start guide.
- Optional accessories include hard transport case, carabiner strap, retractable lanyard, extra batteries, in-truck charger, car charger, cigarette lighter adapter kit, and tripod adapter.
- Manufacturer's warranty covers the battery for two years, workmanship and manufacturing for five years, and includes 10-year sensor warranties.
- Future software updates are downloadable from website.
- All service to be done by FLIR service department. Online and in-person training courses are available at www.infraredtraining.com/en-US.

3.13 Seek Thermal, AttackPRO+



Figure 3-25 Seek Thermal AttackPRO+
Image Credit: Seek Thermal



Figure 3-26: TI Basic (L) TI Basic+ (R) Image Modes
Image Credit: Seek Thermal

Dimensions (inches)	11 x 4.5 x 5
Weight (pounds)	2.5
Display Diagonal (inches)	3.5 LCD
Backlight (cd/m ²)	500
Battery Type	Li-ion
Battery Life (hours)	> 6 without flashlight, > 3 with flashlight
Recharge Time (hours)	4
Start-up Time (seconds)	< 5
Resolution (pixels)	320 x 240
NETD (Sensitivity)	< 35 mK
Dynamic Range	-4 to 1022° F
Refresh Rate	> 25 Hz
Field of View (°)	57 H x 42 V
Digital Zoom	N/A
Image Capture	N/A
Video Capture	N/A
Image Modes	TI BASIC NFPA TI BASIC + Survey mode added in 2025.
NFPA 1801-Compliant	Yes
MSRP	\$4,674

- Seek's AttackPRO+'s Mixed Gain Mode allows firefighters to see details in the hottest and coolest regions of the scene at the same time, eliminating the need for switching between high gain and low gain modes. Mixed-gain pixel technology allows each pixel to individually adjust to high or low gain with no delay.
- The AttackPRO+ has a single greyscale and colorization imaging mode that complies with TI BASIC per NFPA documentation. Additionally, a reticle, the green box on the image in TI BASIC PLUS mode that defines the area where the temperature reported in the bottom right corner is being taken, can be enabled and complies with TI BASIC PLUS. Survey mode which is optimized for lower temperature scenes to help identify hotspots during size up and overhaul operations was added in 2025.
- Seek recommends using a GearKeeper retractor (parts number RT3-4504 or FR-PAA) to attach the TIC.
- A 300 lumen LED flashlight is available. Standard accessories include two batteries and a charging dock.
- All cords and charging accessories are available to purchase, including a truck charger accessory. Options also include enhanced warranties.
- A 5-year standard manufacturer's warranty covers material and manufacturing defects; a 2-year warranty applies to the battery. A 5-year enhanced warranty is available for purchase for US customers.
- Seek field representatives provide basic support. Additional training is available for purchase.

Seek Thermal also offers the AttackPRO which has the same specifications as the AttackPRO+ but is not NFPA 1801 certified, does not have survey mode and costs \$3174. The AttackPRO S has the same specifications as the AttackPRO+, is not NFPA 1801 certified and costs \$3674.

3.14 Seek Thermal, AttackPRO VRS



Figure 3-27 Seek Thermal AttackPRO VRS
Image Credit: Seek Thermal

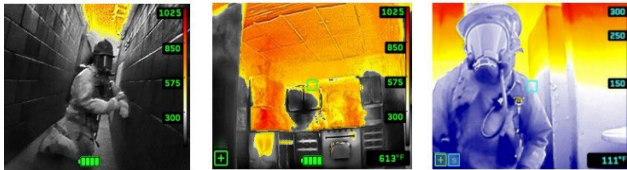


Figure 3-28 TI Basic (L) TI Basic+ (C) Survey (R) Image Modes
Image Credit: Seek Thermal

Dimensions (inches)	11 x 4.5 x 5
Weight (pounds)	2.5
Display Diagonal (inches)	3.5 LCD
Backlight (cd/m ²)	500
Battery Type	Li-ion
Battery Life (hours)	> 6 without flashlight, > 3 with flashlight
Recharge Time (hours)	4
Start-up Time (seconds)	< 8
Resolution (pixels)	320 x 240
NETD (Sensitivity)	< 35 mK
Dynamic Range	-4 to 1200° F
Refresh Rate	> 25 Hz
Field of View (°)	57 H x 42 V
Digital Zoom	N/A
Image Capture	N/A
Video Capture	> 5 hours
Image Modes	TI BASIC NFPA TI BASIC + Survey
NFPA 1801-Compliant	No
MSRP	\$4,174

- Seek's AttackPRO VRS's Mixed Gain Mode allows firefighters to see details in the hottest and coolest regions of the scene at the same time, eliminating the need for switching between high gain and low gain modes. Mixed-gain pixel technology allows each pixel to individually adjust to high or low gain with no delay.
- The AttackPRO VRS has a greyscale and colorization imaging mode that complies with TI BASIC. Additionally, a reticle, the green box on the image in TI BASIC PLUS mode that defines the area where the temperature reported in the bottom right corner is being taken, can be enabled and complies with TI BASIC PLUS. Survey mode has early colorization (150° F) and is used to enhance size-up and overhaul operations.
- Seek recommends using a GearKeeper retractor (parts number RT3-4504 or FR-PAA) to attach the TIC.
- A 300 lumen LED flashlight is available. Standard accessories include two batteries and a charging dock.
- All cords and charging accessories are available to purchase, including a truck charger accessory. Options also include enhanced warranties.
- A 5-year standard manufacturer's warranty covers material and manufacturing defects; a 2-year warranty applies to the battery. A 5-year enhanced warranty is available for purchase for US customers.
- Seek field representatives provide basic support. Additional training is available for purchase.

3.15 Tempest TIC 3.3



Figure 3-29 Tempest TIC 3.3
Image Credit: Tempest

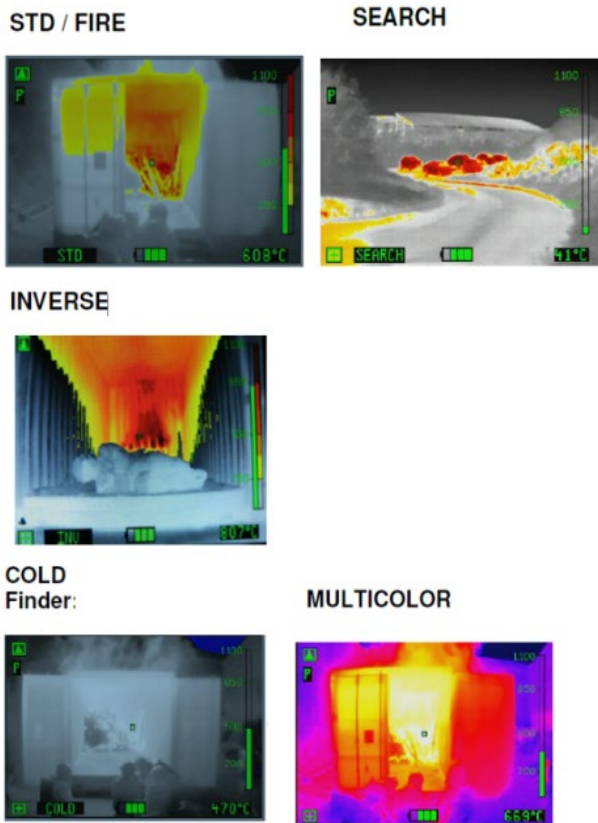


Figure 3-30 Image Modes
Image Credit: Tempest

Dimensions (inches)	6.5 x 5.5 x 3.4 (+4.33 with optional pistol grip)
Weight (pounds)	1.9 (with 2 batteries and side straps) (+0.37 pounds with optional pistol grip)
Display Diagonal (inches)	3.5 LCD
Backlight (cd/m ²)	800
Battery Type	LiFePO ₄
Battery Life (hours)	≤ 8 with 2 batteries
Recharge Time (hours)	2 for 2 batteries
Start-up Time (seconds)	< 5
Resolution (pixels)	320 x 240
NETD (Sensitivity)	< 50 mK
Dynamic Range	-40 to 2100° F
Refresh Rate	60 Hz
Field of View (°)	51 H x 40 V x 65 D
Digital Zoom	2X, 4X
Image Capture	1000 pictures. Available on 3.3 V and 3.3 VL models (V=Video +picture, L=laser)
Video Capture (hours)	≤ 8 Available on 3.3 V and 3.3 VL models
Image Modes	5 modes
NFPA 1801-Compliant	No
MSRP	\$6,093 to \$8,601 (from third party website)

- The TIC 3.3 has three sensitivity modes with automatic switching according to observed scene: high sensitivity temperature range (-40 to 300° F), medium sensitivity temperature range (-40 to 950° F), and low sensitivity temperature range (-40 to +2100° F).
- This TIC has five modes:
 - STD/FIRE: uses a spectrum from dark red (>1560° F) to yellow (> 400° F) for the hottest temperatures in the environment, then white for hot and black for cold.
 - INVERSE: this mode is the same as the standard/fire scheme but white indicates cold and black, hot.
 - SEARCH: hottest 2% colored in red and the 5% following the hottest appear in yellow-orange.
 - COLD Finder: blue is used for the coldest areas.
 - MULTICOLOR: for industrial applications.
- The unit features large buttons for use with gloves, which give access to all functions including ON/OFF, Zoom 2X, 4X, and laser pointer. The TIC 3.3 is also available with one button.
- An alternative four-inch diagonal screen version of the TIC 3.3 is available with one and three button models.
- The unit can be carried in hand or using retractable lanyard or neck strap made of flame-retardant material.
- Standard accessories include two batteries and a charging dock.
- Optional accessories include pack of two spare batteries, cable charger, watertight carrying case, vehicle charging bay, laser pointer, retractable lanyard, neck strap, protection hood, and removable pistol grip.
- Manufacturer's warranty covers five years on the camera, six years on batteries, 10 years on the thermal sensor, and one year on accessories (chargers, charging bay, etc.).

4.0 INTEGRATED THERMAL IMAGING CAMERAS

Some manufacturers of self-contained breathing apparatus (SCBA) products include TICs integrated into the SCBA system. This allows firefighters to view a thermal image without carrying an additional piece of equipment. Various configurations include a separate TIC that attaches to the SCBA facepiece, a TIC integrated with the remote pressure gauge, a TIC integrated with the handheld radio frequency (RF) personal alert safety system (PASS) transceiver, and a TIC attached to a helmet. Integrated TICs frequently have lower resolutions, refresh rates, and sensitivities than their handheld counterparts and have less flexibility in terms of viewing modes.

4.1 3M Scott Sight In-Mask Thermal Imaging

The “Sight In-Mask Thermal Imaging” is currently available for the Air-Pak X3 Pro on the AV3000-HT facepiece platform (shown in Figure 4-1), A TIC is mounted to the side of the facepiece. It is wirelessly connected to the in-mask display (IMD) located inside the facepiece below the right eye and can be adjusted vertically for custom fit to the user’s line of sight. The device is equipped with an accelerometer that automatically turns off the system when not in use and includes a single-button power off component that controls the IMD and TIC.



Figure 4-1 3M Scott: Sight In-Mask Thermal Imaging for Air-PakX3 Pro on the AV3000-H

Image Credit: 3M Scott

A standby mode to temporarily dim the IMD screen can be activated with a single push of the TIC power button.

Other features include a hot-spot tracker, cold-spot tracker, and tactical video recording features that automatically record information shown on the IMD. The system is compatible with the 3M Scott Sight Mobile Configuration Application which can be downloaded on mobile devices (iOS and Android). The application configures the IMD to customize brightness, icon layouts, temperature displays, and display colors. This feature is available with the Pro Package version of the Sight In-Mask Thermal Imager or can be purchased separately.

4.2 MSA Integrated Thermal Imaging Camera (iTIC)

The integrated thermal imaging camera (iTIC) displays a thermal image on the color display of the control module (remote gauge). The MSA iTIC option is compatible via a simple field upgrade with all pre-existing versions of the G1 SCBA and requires no new or additional power sources. The camera sensor is built directly into the G1 SCBA control module (Figure 4-2) and includes a longer hose to provide increased mobility while scanning and viewing the thermal scene. The thermal image is shown in color on the display screen of the control module via a single long button press of the reset button. The user can toggle between five different user-defined color palettes via short presses of the reset button. The iTIC has a resolution of 220 x 176 pixel, a refresh rate of 30 Hz and an NETD of less than 100 mK. The G1 SCBA iTIC is compatible with all G1 SCBAs and can be ordered as an installed accessory or sold as a separate component.

Thermal imaging is also currently integrated with the MSA LUNAR handheld RF PASS transceiver (Figure 4-3). It includes an edge detection palette with bright green highlights to show egress, doors, and people. It does not stream video or save images.



Figure 4-3 MSA Thermal Imager Integrated into the Remote Gauge

Image Credit: MSA

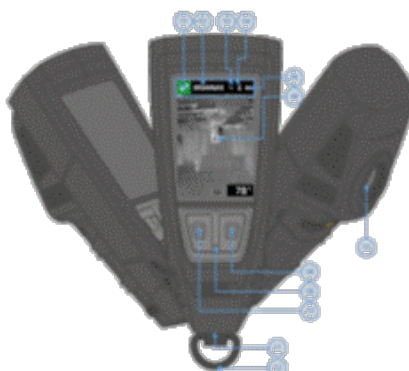


Figure 4-2 MSA Thermal Imager Integrated into LUNAR Handheld Transceiver

Image Credit: MSA

4.3 Dräger UCF FireCore

The Dräger UCF FireCore is an optional thermal imaging system that can be helmet-mounted to integrated with the Dräger FPS 7000 full-face mask and the Dräger HPS 7000 firefighter's helmet. The FireCore consists of an external helmet-mounted image sensor (Figure 4-4) and a wireless in-mask display (IMD) (Figure 4-5). The IMD acts as both the HUD for the SCBA, displaying remaining pressure, as well as displaying the live image feed from the external helmet-mounted image sensor. The helmet-mounted image sensor is adjustable and can be removed during use to allow the user to point the camera around corners or into attics/crawl spaces and see the live image inside the wearer's mask. The UCF FireCore is coupled with the FPS IMD within a few seconds by briefly holding the two components next to each other.



Figure 4-4 Dräger FireCore External Thermal Image Sensor

Image Credit: Dräger



Figure 4-5 Inside Dräger Mask with In-mask display (IMD) Installed

Image Credit: Dräger

5.0 MANUFACTURER AND VENDOR CONTACT INFORMATION

Additional information on the products included in this market survey report can be obtained from the manufacturers listed in Table 5-1.

Table 5-1 Manufacturer Contact Information

Manufacturer	Website	Address	Phone Number	Email Address/ Web Form
3M Scott	www.3m.com/3M/en_US/p/c/tools-equipment/thermal-imaging-cameras	3M Center St. Paul, MN 55144-1000	1-888-364-3577 1-704-291-8300	www.3m.com/3M/en_US/company-us/help-center
Avon Protection Systems	www.avon-protection.com	502 7th Street Cadillac, MI 49601	1-888-286-6440	support.avon-protection.com/hc/en-gb
Bullard	www.bullard.com	2421 Fortune Drive Lexington, KY 40509	1-859-234-6616	bullard.com/contact-us/
Dräger	www.draeger.com	7256 S. Sam Houston W Pky., Suite 100 Houston, TX 77085	1-800-437-2437	www.draeger.com/en-us_us/Contact
FLIR	www.flir.com	110 Lowell Road Hudson, NH 06051	1-866-477-3687	www.flir.com/about/general-inquiries
MSA	www.msasafety.com	1000 Cranberry Woods Drive Cranberry Township, PA 16066	1-877-672-3473	FIRE.CS@MSASAFETY.COM
Seek Thermal	www.thermal.com	6300 Hollister Avenue Santa Barbara, CA 93117	--	b2borders@thermal.com
Tempest	tempest.us.com/firefighting-equipment	4708 N. Blythe Avenue Fresno, CA 93722	1-800-346 2143 1-559-277-7577	response@tempest.us.com

6.0 CONCLUSIONS

TICs can detect small variations in the temperatures of objects allowing them to create an image corresponding to the temperature differences at the scene. Firefighters use these images to navigate through smoky environments, identify hotspots and sources of fire, allow faster access to fire victims, and increase their safety.

This market survey report provides information on 16 products from seven manufacturers that range in price from \$2,949 to \$8,601. The TICs in this report include those that feature one-button operation with one image mode and no additional features (such as zoom or image and video capture) while others have three buttons, several operating modes, zoom capabilities, and allow for hundreds of images and video recordings to be saved for future use. The TICs have varying resolutions, refresh rates, sensitivities, dynamic ranges, and prices. First responder organizations must decide which features are a priority for their use cases. Seven TICs are certified to NFPA 1801: *Standard for Thermal Imagers for the Fire Service*, which lists minimum requirements for image quality (including resolution and refresh rate), standard operation, durability (including ingress protection, heat/flame resistance, impact acceleration, vibration resistance and corrosion resistance), and nonincendive safety.

TICs have limitations and should be used as an additional tool, not a replacement for established firefighting procedures. TICs do not see through clear glass, most plastic, and water. These materials will reflect IR creating a mirror effect and the actual source of the image may be opposite the reflected surface. The focal point of a TIC is approximately three feet from the camera lens. Users viewing objects within three feet may be too close and may appear blurry, out of focus or featureless. Depth perception in TICs is rarely represented in a 1:1 ratio and may vary from camera to camera. Steam and condensation or fogging on the SCBA facepiece, display screen, and camera lens may distort the clarity of the image that is displayed and cause it to be featureless. Emergency responder agencies should carefully research the overall capabilities and limitations of TICs in relation to their agency's operational needs when making equipment selections.

Appendix A. INGRESS PROTECTION LEVELS (IP CODE)

This section provides information on the levels of ingress protection as specified by the 2-digit designations in the IEC 60529 standard [12]. Table A-1 provides levels of solid ingress protection (first digit). Table A-2 provides levels of liquid ingress protection (second digit).

Appendix Table A-1 Levels of Solid Ingress Protection per First Digit of IP Code

Digit	Object Size Effective Against	General Description
0	No Protection	No protection against contact and ingress of solids
1	> 50 mm	Large surfaces, e.g., back of hand, but no protection against deliberate contact with body part
2	> 12.5 mm	Prevents entry of fingers and similarly sized objects
3	> 2.5 mm	Prevents entry of tools, thick wires, etc.
4	> 1 mm	Prevents entry of most wires, screws, large ants, etc.
5	Dust Protected	Dust ingress not entirely prevented but does not enter in sufficient quantity to interfere with satisfactory operation of equipment
6	Dust Tight	No ingress of dust

Appendix Table A-2 Levels of Liquid Ingress Protection per Second Digit of IP Code

Digit	Water Exposure Protection	General Description
0	No Protection	No protection
1	Vertically dripping water	Vertically dripping water has no harmful effects
2	Dripping water, enclosure tilted up to 15 degrees	Vertically dripping water has no harmful effects when enclosure is tilted at an angle up to 15 degrees of normal vertical position
3	Spraying water	Water sprayed at angles up to 60 degrees from the vertical position has no harmful effects
4	Splashing water	Water splashed against the enclosure from any direction has no harmful effect
5	Water jets	Water projected by a nozzle (6.3 mm) against enclosure from any direction has no harmful effects
6	Powerful water jets	Water projected in powerful jets against the enclosure from any direction has no harmful effects

Digit	Water Exposure Protection	General Description
7	Temporary immersion in water	Ingress of water in harmful quantity is not possible when the enclosure is temporarily immersed in water under standard conditions or pressure and time
8	Continuous immersion in water	The equipment is suitable for continuous immersion in water under conditions more severe than for numeral 7

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