CONDITION MONITORING, PROCESS, AND QUALITY ASSURANCE SOLUTIONS

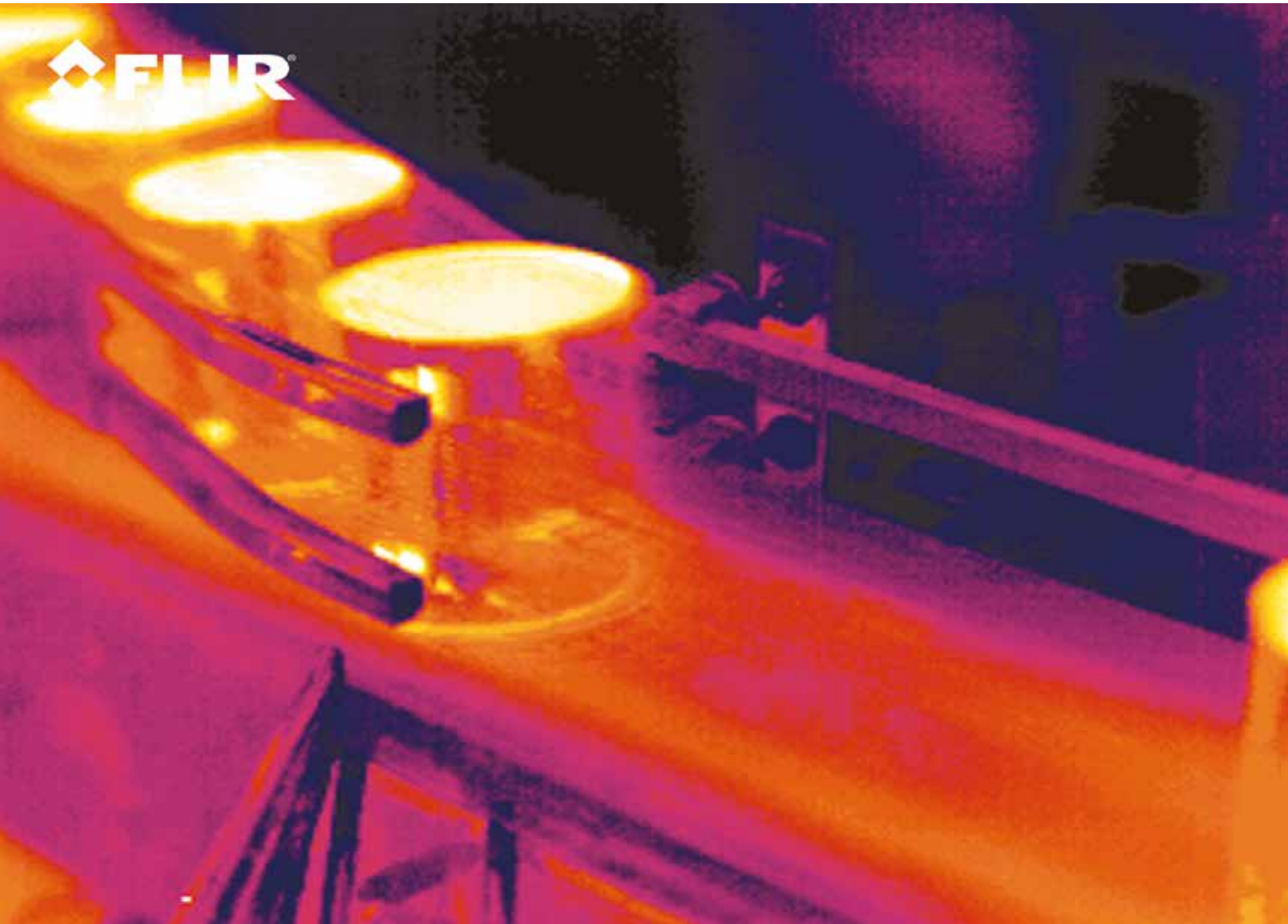
for the Food and Beverage Industry

About Teledyne FLIR

Teledyne FLIR designs, develops, manufactures, markets, and distributes technologies that enhance perception and awareness. We bring innovative sensing solutions into daily life through our thermal imaging, visible-light imaging, video analytics, measurement and diagnostic, and advanced threat detection systems.

Teledyne FLIR offers a diversified portfolio that serves a number of applications in government & defense, industrial, and commercial markets. Our products help first responders and military personnel protect and save lives, promote efficiency within the trades, and innovate consumer-facing technologies. We're trusted across the globe, by municipalities, small manufacturers, and Fortune 500 companies to ensure power keeps running, facilities stay open, and production processes flow efficiently. Teledyne FLIR strives to strengthen public safety and well-being, increase energy and time efficiency, and contribute to healthy and intelligent communities.

Teledyne FLIR building in Täby, Sweden



Condition Monitoring in the Food Industry

In the food industry, it's essential to carefully control the temperature of perishable goods throughout production, transportation, storage, and sales. Repeated warnings about illnesses due to tainted and improperly cooked foods highlight the need for tighter process control. Because this almost always involves a human factor, food processors need tools that automate crucial operations in a way that helps minimize human error while holding down costs. They also need non-contact inspection tools to perform regular predictive maintenance surveys on equipment across the manufacturing process. These ensure faults are found early enough to schedule repairs, thus avoiding any unplanned downtime and maintaining consistent production.

Using FLIR thermal and acoustic imaging cameras, you can discover compressed air, vacuum, and specialty gas leaks, prevent equipment failures, as well as automate non-contact temperature measurements for many food processing applications.

Thermal Imaging

FLIR thermal imaging cameras offer unique insight into the manufacturing process, whether you're using a handheld or fixed thermal camera to monitor equipment and predict maintenance requirements, or using a fixed camera to maintain product safety and quality control.

Fixed, smart sensor cameras offer easy IIoT data integration and are ideal for users who need built-in, on-camera analytics and alarm capabilities. Image streaming fixed cameras offer industry-standard GigE Vision protocols for communication with machine vision applications.

Acoustic Imaging

Undetected compressed air, vacuum, and food-grade carbon dioxide leaks can lead to serious consequences for the food and beverage industry, including the contamination of products, reduced efficiency, increased downtime, and safety risks. A FLIR acoustic imaging camera can identify even very small leaks promptly, improving the system's efficiency, reducing operating costs, and ensuring the quality and safety of food and beverage products.

How Thermal Imaging Works

The main requirements for non-contact temperature measurements in the food processing industry are a thermal imaging camera and associated software. Handheld or fixed thermal imaging cameras can be used to inspect or monitor electrical and mechanical equipment and predict maintenance needs, so repairs can be scheduled and unplanned downtime avoided. Fixed cameras can also act as "smart" non-contact sensors to measure the temperature of equipment, refrigerated products, and cooked foods as they exit the cooking process.

Thermal imaging cameras are easy to use, small, and can be positioned almost anywhere as needed. They can also be used to inspect package sealing and improve efficiency in other food processing operations.

FLIR fixed thermal imaging cameras have firmware and communication interfaces that enable their use in automated process control. Third-party software makes it easy to incorporate these tools into automated machine vision systems without the need for extensive custom-written control code.

The growing number of thermal imaging applications for the food industry include:

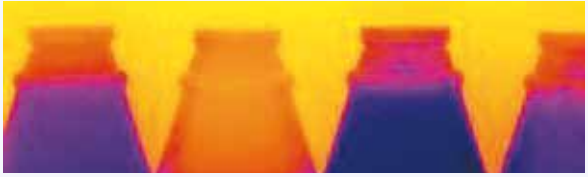
- Predictive maintenance for electro/mechanical systems across the manufacturing facility
- Monitoring the temperature of oven-baked goods
- Verifying the temperature of microwave-cooked meats
- Monitoring the use of microwaves when drying of parboiled rice and other grains
- Inspecting ovens for proper temperature
- Verifying the proper filling of frozen meal package compartments
- Checking integrity of cellophane seals over microwave meals
- Inspecting box flap glue of overwrap cartons
- Monitoring refrigerator and freezer compartments
- Performing ignition-risk T-class surveys in zoned areas
- Continuously monitoring for fire risk and high-touch temperature issues

Thermography for Quality Assurance And Product Safety

Thermal imaging is first and foremost a quality assurance (QA) tool. Controlling the quality and safety of cooked meat products is an excellent use of this technology. For example, a fixed-mount thermal imaging camera trained above a continuous conveyor oven can record the temperature of chicken tenders as they exit the oven.

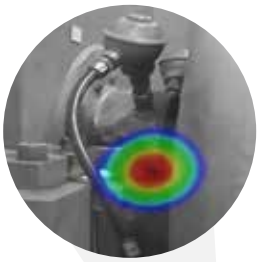
The objective is to make sure they reached a safe temperature without becoming over-cooked and dried out. Food producers can also use thermal imaging cameras to inspect microwave precooking lines. Besides improving product quality and safety, overall throughput can be increased. An additional benefit is reduced energy costs.

This thermal image shows bottles being filled automatically so bottles that are over-or under-filled can be removed. Thermal imaging is especially effective when inspecting dark-colored glass or opaque plastic bottles, as the internal temperature creates an image that visible light cameras can't see.



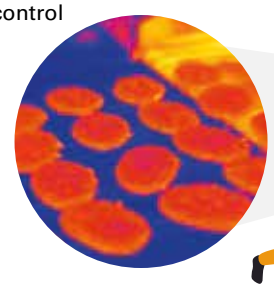
Solutions for the Food and Beverage Industry

1. Compressed air or gas leak inspection

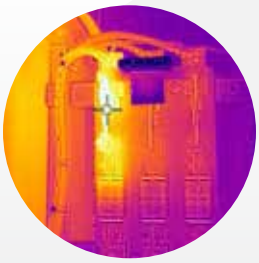


2. Fill-level control for non-transparent packaging

3. Incoming product temperature control



4. Predictive maintenance



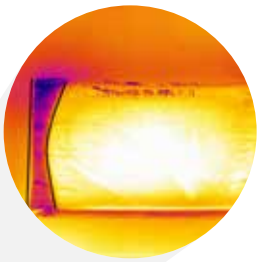
5. In-line wall thickness control

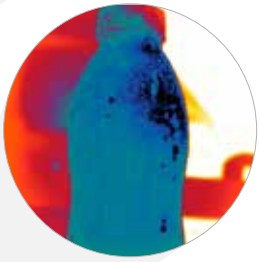
1. Acoustic imagers can detect invisible compressed air, CO_2, nitrogen or other specialty gas leaks, reducing the risk of reduced product quality, increased operating costs, and reduced consumer safety.
2. Fill-level of hot or cold beverage inside an opaque bottle can be checked. Shortwave and midwave IR cameras can also see through certain plastics.
3. Temperature of hot or cold incoming products can be checked to determine whether they've reached but not exceeded the correct temperature. This can help avoid burning.
4. Electrical and mechanical assets can be inspected regularly for signs of failure, allowing maintenance crews to predict when repairs are needed and avoid unscheduled downtime.
5. Preforms can be checked before going into the mold for temperature uniformity to ensure proper wall thickness of the plastic bottles.

6. In-line dipper quality control

7. In-line cap seal integrity inspection

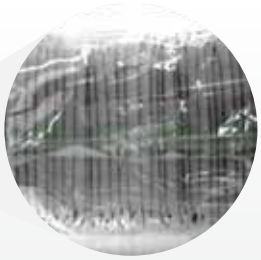
8. Seal check pouches on conveyor





9. In-line contamination detection

10. Cardboard packaging hot glue control



11. Product counting quality control through packaging

6 A high-speed infrared camera can easily detect regions where the elastic glue gaps are needed to prevent quality defects in dippers, as shown in the picture with 600 ppm line speed.

7 Induction seal bottle cap can be observed under an infrared camera to detect the quality of seal. A midwave infrared camera can even see the heat radiation though plastic caps.

8 The heat generated in the sealing of pouches can be detected by an infrared camera while machine vision software can analyze the quality of seal based on the shape.

9 Liquid contaminates that are not visible by vision camera can easily be detected with an infrared camera.

10 Hot glue on cardboard or plastic boxes after the box is closed can be analyzed with infrared camera to detect missing glue points.

11 Infrared camera can see though plastic to count or analyze packages.

Learn more about thermal imaging and acoustic imaging solutions on www.flir.com

Maintain Facility Performance with Handheld Devices

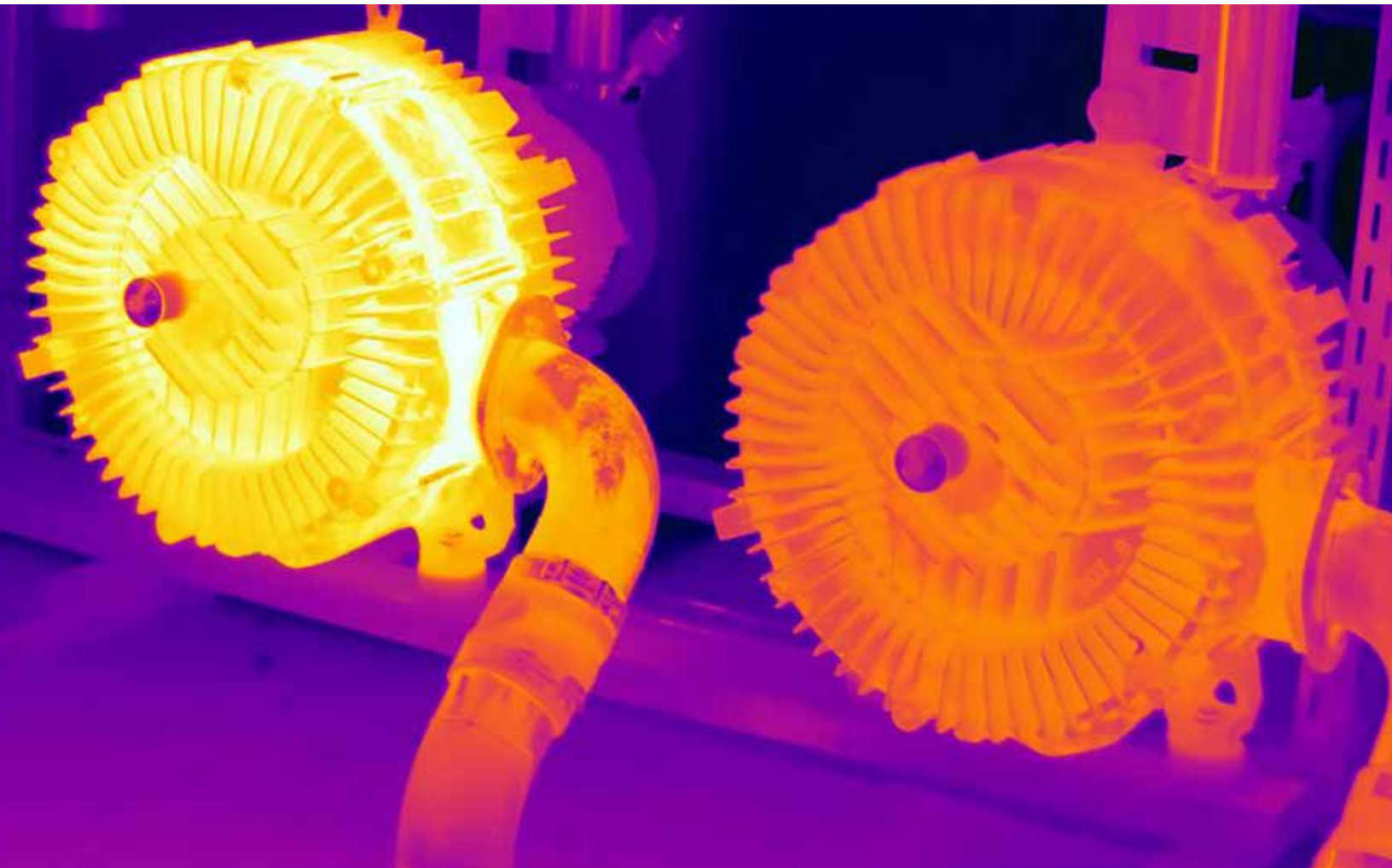
Equipment breakdowns lead to paused production lines and costly downtime. One solution is to empower your onsite maintenance team to locate issues more effectively, begin repairs sooner, and prevent breakdowns from happening in the first place with handheld thermal inspections.

Thermal imaging can inspect a wide variety of potential problem areas in the production process including mechanical equipment, electrical systems, and compressed air systems.

Mechanical parts grinding against each other generate heat through friction and easily show up through thermal imaging, speeding up inspections for areas like conveyor belts, motors, and automated packaging lines. Thermal imaging is likewise perfect for detecting the absence of heat in areas like industrial oven lines for example. Handheld thermal imaging devices are a safe, non-contact method of inspecting heating elements to guarantee entire assembly lines are being heated properly. Thermal imaging is also useful for ensuring proper insulation for both hot and cold environments. Handheld devices such as the FLIR C5, FLIR Exx-Series, or FLIR T-Series are perfect tools for scanning areas and guaranteeing your temperature-controlled environments are maintained. The pocket-sized FLIR C5 is the perfect tool for on-the-spot inspections, while a FLIR Exx- or FLIR T-Series camera offers higher thermal resolution for more precise temperature measurement and premium features such as pre-planned inspection routes.

Electrical connections and components tend to overheat before they fail but this can be difficult to detect with the naked eye. Current testing methods involve troubleshooting with circuit testers, digital multimeters, or other diagnostic systems that are either complex or require significant time. Thermal imaging can reveal stressed elements of the electrical installation before failure occurs, providing opportunity to plan maintenance and solve electrical issues before they turn into costly problems. Problems like loose connections, bad contacts, fuse issues, unbalanced loads, and stressed earth leakage all result in high temperatures, meaning a thermal imager can rapidly detect and locate them.

Compressed air, gas, and vacuum systems are susceptible to air leaks which drive up energy costs and potentially compromise product quality. Acoustic imaging cameras, such as the FLIR Si124-LD, display ultrasonic information visually in real time over a digital camera image, allowing for easy identification of pressurized leaks. Acoustic imaging is particularly useful for production lines that incorporate vacuum sealing, plastic injection molding, and CO_2 compression. This handheld solution can inspect large areas with pinpoint accuracy, even on noisy factory floors.



Asset Health Documentation

The ability to document and maintain historic records of how well a conveyor belt engine, electrical fuse, or compressed air system are functioning is key to maintaining the overall health of a production line. Plant and maintenance managers need to produce accurate, consistent reports on these critical assets as part of regular documentation; they also aid in spotting faults or potential failures as they develop.

Thermal reporting software such as FLIR Thermal Studio Suite makes this necessary documentation easy to accomplish by offering batch image processing, a range of temperature analysis tools, and customizable report templates. Instead of manually compiling information to fill out inspection documents, software tools such as FLIR Thermal Studio can help you organize thermal images and automate documentation. Even better, the software includes customized templates so you can standardize reporting across your team and ensure data is presented consistently.

A few basic image editing options should be included in your thermal reporting software. Features like color palette swapping, spot measurement, IR scale adjustment, and basic text annotations are crucial for all inspections and ensure you'll get the most detail out of an image. Batch processing features also automate editing and exporting thermal images, allowing you to quickly process large quantities of images and reduce desk time after inspections.

Cloud storage and asset synchronization across multiple devices can create huge time savings when it comes to post-inspection processes. FLIR Ignite can help you cut down on time spent synching data between devices and ensures that your files are available for analysis regardless of what machine you're on or what camera was used.

Inspection routes aren't always linear, and inspectors don't always follow the same order. They can sometimes skip certain assets and need to go back and forth across a facility. Creating preplanned routes with software like FLIR Route Creator Plugin ensures every asset is covered by displaying the inspection route on camera. This feature helps maintenance professionals stay organized when surveying large or multiple locations and standardizes inspection procedures.

iNspect - Simple Infrared Machine Vision Solution

For Food and Beverage producers who use Teledyne FLIR fixed thermal cameras, the GEVA 400 iNspect package offered by Teledyne DALSA is a simple and affordable solution. It is pre-loaded with iNspect software (now with 16-bit camera support) that connects to GigE-based FLIR thermal camera platforms including the FLIR A70, FLIR A400/A700, and FLIR A38/A68. This package is customizable for various thermal imaging-based machine vision applications and can be used for a wide range of manufacturing tasks including:

- Hot glue inspection
- Heat sealing & packaging inspection
- Thermal flow control and fill control
- Object counting and shape verification
- Critical asset monitoring

Find out more at www.flir.com/products/dalsa-geva-400-with-inspect-software

FLIR Fixed Thermal Imaging Cameras



Model	A50 & A70 Image Streaming (GigE)	A50 & A70 Smart Sensor	A500 & A700 Image Streaming (GigE)
IR resolution	464 × 348 (A50, A500); 640 × 480 (A70, A700)		
Thermal sensitivity/NETD	35 mK		<30 mK, 42° @ 30°C;
Visual resolution	1280 × 960 pixels (optional)		
Focus	Fixed, adjustable with included focus tool		Auto-focus, One-shot
FOV option	29°, 51°, 95°		2x Macro, DFOV (24°/14°),
Spectral range	7.5–14.0 µm		
Frame rate	30 Hz		
Measurement			
Object temperature range	A50: -20°C to 175°C, 175°C to 1000°C | A70: -20°C to 175°C, -20°C to 250°C, 175°C to 1000°C		A500: -20°C to 120°C, 0°C to 650°C, 300°C to 1500°C
Accuracy	±2°C or ±2% of reading, for ambient temperature 15°C to 35°C and object temperature above 0°C		±2°C or ±2% of reading, for ambient temp-
Measurement analysis (smart functions)			
Smart functions (advanced configuration)	-	10 Spotmeters, 10 Boxes or Polygons, 3 Deltas (difference any value/reference/external lock), 2 Isotherm (above/below/ interval), 2 Iso-coverage, 2 Lines, 1 Polyline, 1 Reference temperature	-
Measurement frequency	-	Up to 10 Hz	-
Measurement result Read-out (advanced configuration)	-	Ethernet/IP (poll), Modbus TCP server/client (poll/push), MQTT (push), REST API (read/write), Measurements and Still image, Web interface	-
Alarm			
Alarm output (advanced configuration)	-	Digital out, e-mail (SMTP) (push), Ethernet/IP (pull), file transfer (FTP) (push), Modbus TCP server/ client (poll/push), MQTT (push), RESTful API (pull), and store image or video	-
Video streaming			
Dual video streams	ONVIF/RTSP (Adv. config), Not in GigE stream but switching between visual and IR possible	ONVIF/RTSP (Adv. config)	ONVIF/RTSP (Adv. config), Not in GigE stream but switching between visual and IR possible
Camera configuration			
Web interface	Yes (only stream and camera settings)	Yes with smart features	Yes (only stream and camera settings)
Ethernet			
Ethernet communication	GigE Vision, GenICam (SFNC 2.4)	TCP/IP socket-based FLIR proprietary	GigE Vision, GenICam (SFNC 2.4)
Ethernet interface	Wired, Wi-Fi (optional)		
Ethernet power	Power over Ethernet, PoE IEEE 802.3af class 3		
Ethernet protocols	IEEE 1588, SNMP, TCP, UDP, SNTP, RTSP, RTP, HTTP, ICMP, IGMP, sftp (server), FTP (client), SMTP, DHCP, MDNS (Bonjour), uPnP	EtherNet/IP, IEEE 1588, Modbus TCP Client, Modbus TCP Server, MQTT, ONVIF-S, SNMP, TCP, UDP, SNTP, RTSP, RTP, HTTP, HTTPS, ICMP, IGMP, sftp (server), FTP (client), SMTP, DHCP, MDNS (Bonjour), uPnP	IEEE 1588, SNMP, TCP, UDP, SNTP, RTSP, RTP, HTTP, ICMP, IGMP, sftp (server), FTP (client), SMTP, DHCP, MDNS (Bonjour), uPnP
Ethernet type			
Digital input/output			
Digital input	2× opto-isolated, Vin (low) = 0 to 1.5 V, Vin (high) = 3 to 25 V		
Digital output	3× opto-isolated, 0 to 48 V DC, max. 350 mA (derated to 200 mA at 60°C). Solid-state opto relay,		
Power			
Power consumption (typical)	7.5 W at 24 V DC, 7.8 W at 48 V DC, 8.1 W at 48 V PoE		7.5 W at 24 V DC, 7.8 W at
External power operation	24/48 V DC 8 W max		
External voltage	Allowed range 18 V to 56 V DC		
Environmental data			
Operating temperature range	With cooling plates on at least three sides: -20 to 50°C; No cooling plates: -20 to 35°C		-20 to 50°C, Cooling plate is needed in temp-
Encapsulation	IEC 60529, IP66		IEC 60529, IP 54,
Shock	IEC 60068-2-27, 25 g		
Vibration	IEC 60068-2-6, 0.15 mm at 10–58 Hz and 2 g at 58–500 Hz, sinusoidal; IEC 61373 Cat 1 (Railway)		
Physical data			
Weight (including lens)	0.52 kg		0.82 kg
Size (L × W × H)	107 × 67 × 57 mm		123 × 77 × 77 mm
Export regulation	-		

	A500 & A700 Smart Sensor	A38 & A68 (GigE)	A6751 (GigE)
		320 × 240 (A38), 640 × 480 (A68)	640 × 512
	<40 mK, 24° @ +30°C; <50 mK, 14° @ 30°C	<50 mK @ 25°C ambient	≤20 mK
		-	-
	contrast, Motorized, Manual	Fixed, adjustable	Manual
	6°, 14° 24° f/1.0	24°, 42°	17 mm, 25 mm, 50 mm, 100 mm, 200 mm
			3.0–5.0 µm
		60 Hz(A38), 30 Hz (A68)	Programmable; 0.0015 Hz to 125 Hz
	A700: -20°C to 120°C, 0°C to 650°C, 300°C to 2000°C	Non-radiometric	Standard: -20°C to 350°C; with optic: 45°C to 600°C (ND1) 250°C to 2000°C (ND2) 500°C to 3000°C (ND3)
	erature 15°C to 35°C and object temperature above 0°C	Non-radiometric	≤100°C ±2°C (±1°C typical), >100°C ±2% of reading (±1% typical)
	10 Spotmeters, 10 Boxes or Polygons, 3 Deltas (difference any value/reference/external lock), 2 Isotherm (above/below/interval), 2 Iso-coverage, 2 Lines, 1 Polyline, 1 Reference temperature	-	-
	Up to 10 Hz	-	-
	Ethernet/IP (poll), Modbus TCP server/client (poll/push), MQTT (push), REST API (read/write), Measurements and Still image, Web interface	-	-
	Digital out, e-mail (SMTP) (push), Ethernet/IP (pull), file transfer (FTP) (push), Modbus TCP server/client (poll/push), MQTT (push), RESTful API (pull), and store image or video	-	-
	ONVIF/RTSP (Adv. config)	-	-
	Yes with smart features	-	-
	TCP/IP socket-based FLIR proprietary	GigE Vision, GenICam	GigE Vision, GenICam
		Wired	Wired
		PoE	-
	EtherNet/IP, IEEE 1588, Modbus TCP Client, Modbus TCP Server, MQTT, ONVIF-S, SNMP, TCP, UDP, SNTP, RTSP, RTP, HTTP, HTTPS, ICMP, IGMP, sftp (server), FTP (client), SMTP, DHCP, MDNS (Bonjour), uPnP	GigE Vision	GigE Vision
	1000 Mbps		
		1x General purpose input	Sync-in, Trigger-in
	1× dedicated as fault output (NC)	1x General purpose output	Sync-out
	48 V DC, 8.1 W at 48 V PoE	2.8 W at 12V DC, 2.8 W at 24V DC, 3.5 W at 48 V DC PoE	<24 W steady state
		12/24V DC	24 VDC
		min 9V, max 57V DC	24 VDC
	eratures above 40°C, Maximum camera case temperature: 65°C	-35°C to 60°C	-20°C to 50°C
	IP66 with accessory	-	-
		See user manual	-
		See user manual	-
	0.82 kg	0.07 Kg	2.3 kg
	123 × 77 × 77 mm	29 × 36 × 59 mm	226 × 102 × 109 mm
			EAR 15 C.F.R. Sections 730-774

FLIR Handheld Solutions




Specifications	Compact		Point and Shoot			Professional				High-Performance		
Model	**C3-X**	**C5**	**E5 Pro**	**E6 Pro**	**E8 Pro**	**E54**	**E76**	**E86**	**E96**	**T530**	**T540**	**T560**
IR resolution	128 × 96 (12,288 pixels)	160 × 120 (19,200 pixels)	160 × 120 (19,200 pixels)	240 × 180 (43,200 pixels)	320 × 240 (76,800 pixels)	320 × 240 (76,800 pixels)	320 × 240 (76,800 pixels)	464 × 348 (161,472 pixels)	640 × 480 (307,200 pixels)	320 × 240 (76,800 pixels)	464 × 348 (161,472 pixels)	640 × 480 (307,200 pixels)
UltraMax® resolution	-					-	307,200 pixels	645,888 pixels	1.2 MP	307,200 pixels	645,888 pixels	1.2 MP
MSX® image enhancement	Yes		Yes			Yes				Yes		
Thermal sensitivity	<0.07°C		<0.07°C	<0.06°C	<0.05°C	<0.04°C	<0.03°C			<0.03°C		
Accuracy	0°C to 100°C (32°F to 212°F): ±3°C (±5.5°F); 100°C to 300°C (212°F to 572°F): ±3%	0°C to 100°C (32°F to 212°F): ±3°C (±5.5°F), 100°C to 400°C (212°F to 752°F): ±3%	±2°C (±3.6°F) or ±2% of the reading			±2°C (±3.6°F) or ±2% of the reading				±2°C (±3.6°F) or ±2% - within entire operating temperature range, with all lenses		
Temperature range	-20°C to 300°C (-4°F to 572°F)	-20°C to 400°C (-4°F to 752°F)	-20°C to 550°C (-4°F to 1022°F)			-20°C to 650°C (-4°F to 1,202°F)		-20°C to 1,500°C (-4°F to 2,732°F)		-20°C to 650°C (-4°F to 1,202°F)	-20°C to 1,500°C (-4°F to 2,732°F)	
							Optional to 1,000°C (1,832°F)			Optional to 1,200°C (2,192°F)		
Focus modes	Focus free		Focus free			Manual	Continuous laser distance meter (LDM), one-shot LDM, one-shot contrast, manual			Continuous laser distance meter (LDM), one-shot LDM, one-shot contrast, manual		
Field of view	54° × 42°		33° × 25°			24° × 18°	Lens dependent			Lens dependent		
Available lenses	-		-			-	Dual field of view, 80° wide angle			Dual field of view, 80° wide angle		
Measurement tools	Spotmeter (center spot), area box (max/min)		Spotmeter (center spot), area box (max/min), isotherm (above/below/ interval)			No measurement, center spot, hot spot, cold spot, 3 spots, hot spot-spot*	3 spotmeters, 3 area boxes (max/min), hot spot, cold spot, User Presets (1 & 2), Delta T			3 spotmeters, 3 area boxes (max/min), hot spot, cold spot, User Presets (1 & 2), Delta T		
Communication modes	USB, Wi-Fi, Bluetooth, FLIR Ignite™ Cloud Service		USB, Wi-Fi, FLIR Ignite™ Cloud Service			USB 2.0, Wi-Fi, Bluetooth, DisplayPort				USB 2.0, Wi-Fi, Bluetooth, DisplayPort		
Touchscreen	3.5 in (8.9 cm)		3.5 in (8.9 cm)			4 in (10.16 cm)				4 in (10.16 cm)		
On-screen text, image sketch	Touch keyboard for text only		Yes			Yes				Yes		
Voice annotation	-		-			Yes				Yes		
Laser pointer	-		-			Yes				Yes		
METERLiNK®	-		-			Yes				Yes		
Radiometric JPEG	Yes		Yes			Yes				Yes		
IR video storage	-		-			Yes				Yes		
Built-in GPS/ Compass	-		-			Yes				Yes		
FLIR Inspection Route	Not available		Not available			Yes				Yes		
1-touch Level/ Span	Not available		Yes			Yes				Yes		

*Hot spot to center spot Delta measurement

Specifications	Acoustic	
Model	**Si124-LD**	**Si124-LD Plus**
Acoustic measurement	124 low-noise MEMS microphones	
Dynamic range, low limit	<-15 dB (frequency-dependent)	
Dynamic range, high limit	> 120 dB (frequency dependent)	
Distance	0.3 m (1.0 ft) up to 130 m (430 ft)	
Leak rate	In typical industrial environment: >0.032 l/min @ 3 bar from 3 m (9.8 ft) >0.05 l/min @ 3 bar from 10 m (32.8 ft) Absolute minimum detection in quiet environment: 0.016 l/min @ 1.2 bar from 0.3 m (1.0 ft)	In typical industrial environment: 0.011 l/min @ 3 bar from 3 m (10 ft.) 0.024 l/min @ 3 bar from 10 m (33 ft.) Absolute minimum detection in quiet environment: 0.004 l/min @ 1.2 bar from < 1 m (3.0 ft.)
Bandwidth	2 kHz to 65 kHz, adjustable range	
Focus modes	Focus free	
Field of view	62° × 49°	
Available lenses	-	
Severity assessment	Automatic AI-based severity assessment including recommended actions in FLIR Acoustic Camera Viewer or FLIR Thermal Studio	
Communication modes	USB, Wi-Fi	
Display	5 in (12.7 cm)	
Zoom	2x digital zoom	
Video recording	Yes, up to 5 min	
Internal storage	32 GB, 1000 snapshots on non-removable SD card	
External storage	8 GB / 500 snapshots (typical) USB mass storage, provided with device	

For more information visit www.flir.com/about/general-inquiries

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