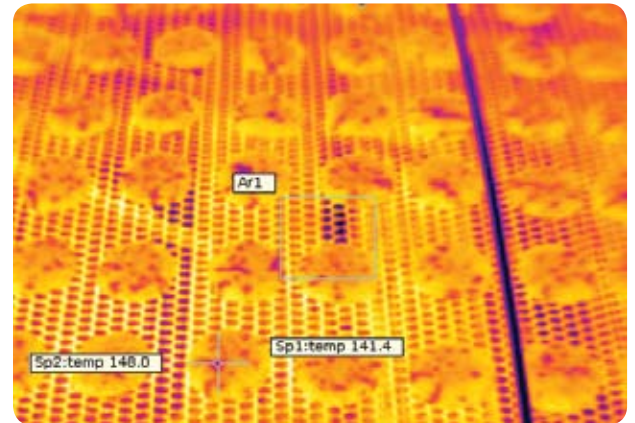


## Food Process Monitoring

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. Infrared (IR) thermography is such a tool. Using FLIR™ IR cameras, you can make automated non-contact temperature measurements in many food processing applications. Analog video outputs can be viewed on video monitors, and digital temperature data, including MPEG4 video outputs, can be routed to a computer via Ethernet.



### INCREASED SAFETY AND PROCESS EFFICIENCY

- Accurate, non-contact temperature measurements
- Real-time imaging plus data recording
- Send images and data to a remote computer via Ethernet
- Spots problems that compromise safety and production
- Ideal for cooking equipment, package sealing, filling lines, and drying operations
- Better than thermocouples and other temperature sensors
- Earliest possible warning with trend analysis software
- Detects abnormal process variations before product is ruined
- Helps avoid incomplete (unsafe) cooking
- Easily integrated with other inspection and process control systems

This publication is one of the FLIR Solution Series that describes important applications for IR camera systems. This Series is designed show our customers how FLIR systems can be used to help reduce costs by protecting their assets, improving production automation and machine vision processes, and increasing the value of their predictive/preventative maintenance operations. Your feedback on this Series will be sincerely appreciated; you can respond by email to [insert address], by telephone to [insert phone no.], or by letter to [insert address].

### How It Works

The main elements of automated thermography for food processing are an IR camera and associated software. They act as “smart” non-contact sensors to perform 100% inspections, measuring the temperature of equipment, refrigerated products, and cooked foods as they exit the cooking process. They are easy to use, small, and can be positioned almost anywhere as needed. Measurement accuracy is typically  $\pm 2^{\circ}\text{C}$ .

IR cameras are also used to inspect package sealing, and improve efficiency in other food processing operations. FLIR 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.

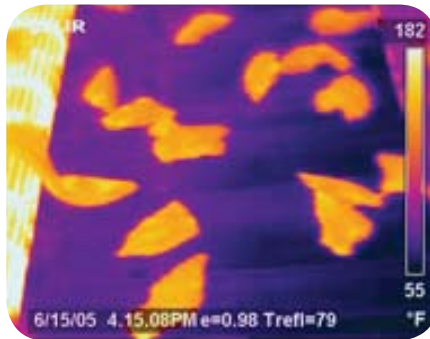
The use of IR cameras in food processing is growing for applications such as:

- Oven baked goods
- Microwave cooked meats
- Microwave drying of parboiled rice and other grains
- Inspecting ovens for proper temperature
- Proper filling of frozen entrée package compartments
- Checking integrity of cellophane seals over microwave entrées
- Inspecting box flap glue of overwrap cartons
- Monitoring refrigerator and freezer compartments

### Thermography For QA And Product Safety

IR thermography 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. A permanently mounted IR camera can record the temperature of, for example, chicken tenders as they exit a continuous conveyor oven. The objective is to make sure they are done enough but not over-cooked and dried out. Reduced moisture content also represents yield loss on a weight basis.



IR cameras can also be used for inspection on microwave precooking lines. Besides improving product quality and safety, overall throughput is increased with thermography augmented cooking systems. An additional benefit is reduced energy costs.

### Equipment Monitoring

In addition to cooked food inspections, IR thermography can monitor conveyor ovens. They can even be part of a feedback loop to help control oven temperature.

Another use of IR for conveyor ovens is monitoring temperature uniformity across the width of the conveyor oven cooking belt. If a heating element inside an electric oven fails, or you get uneven heating across an air impingement oven, one side of the product stream may be cooler. This can be quickly discovered with thermographic images and the IR camera’s alarm system. Quality inspections of this sort are much more difficult with conventional contact type temperature sensors. Thus, IR can help correct variability and improve quality before a lot of product is scrapped.

In the final cooking process, it’s still a good idea to periodically sample meat product core temperatures with thermocouples or other types of contact sensors. Even there, thermographic images and temperature measurements can help inspectors give more attention to products likely to be outside the acceptable temperature range.

### Packaging Inspections

Software is available that allows a thermographic vision system to learn and locate objects and patterns in the images. One application for pattern matching is in the production of frozen entrées. IR machine vision can use pattern recognition software to check for proper filling of food tray compartments.

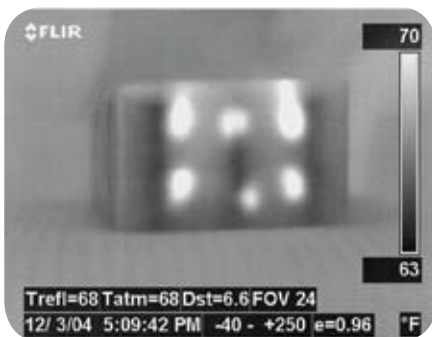
A related application is automated 100% inspection of the heat-sealed cellophane cover over finished microwave entrées. An IR camera can see heat radiating from the lip of the container where the cellophane heat-seal is formed. The temperature along the entire perimeter of the package can be checked by using the camera’s thermographic image with machine vision software. This type of

## Food Process Monitoring

program matches the geometric pattern in the image and its temperatures against the temperatures in a pattern stored in computer memory. An added function in such a system could be laser marking of a poorly sealed package so it can be removed at the inspection station.

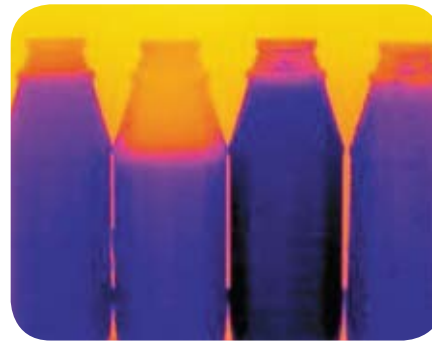
An issue affecting product safety indirectly is the integrity of cartons that overwrap and protect food containers. One of the most cost-effective ways of sealing overwrap cartons is to use heated glue spots on the carton flaps. In the past, the integrity of the spot gluing was determined by periodically doing destructive testing on several samples. This was time-consuming and costly.

Because the glue is heated, an IR camera can “see” through the cardboard to check the pattern and size of the applied glue spots. The camera can be set up to look at predefined areas of the flaps where glue should be applied, and verify spot sizes and their temperatures. The digital data collected is used for a pass/fail decision on each box, so bad boxes can be immediately removed from the production line. The data is automatically logged into the QA system for trend analysis, so a warning can be generated if an excessive number of boxes begin to fail.



Yet another application for thermography is monitoring container filling operations. Although this is seldom a product safety

issue, it does affect yield and compliance with regulations. Different areas on the bottle can be defined and used to trigger an alarm and remove bottles that are over- or under-filled. Thermography is a better alternative to visible light cameras when a bottle or jar is made of dark colored glass or plastic.



### Automating Thermographic Measurements

Application software currently available for thermographic cameras includes a wide variety of functions that support automated food processing applications. This software complements and works in conjunction with firmware built into IR cameras. The imaging tools and libraries in these packages are hardware- and language-independent, making it easy for food processing engineers to quickly implement thermographic monitoring and control systems.

IR cameras themselves provide the user with different operating modes that support correct temperature measurements under various conditions. Two functions commonly found in these cameras are a spotmeter and area measurements. The spotmeter finds the temperature at a particular point. The area function isolates a selected area of an object or scene and usually provides the maximum, minimum, and average temperatures inside that area. The temperature measurement range

typically is selectable by the user. As an adjunct to the temperature range selection, most cameras allow a user to set up a color scale or gray scale to optimize the camera image.

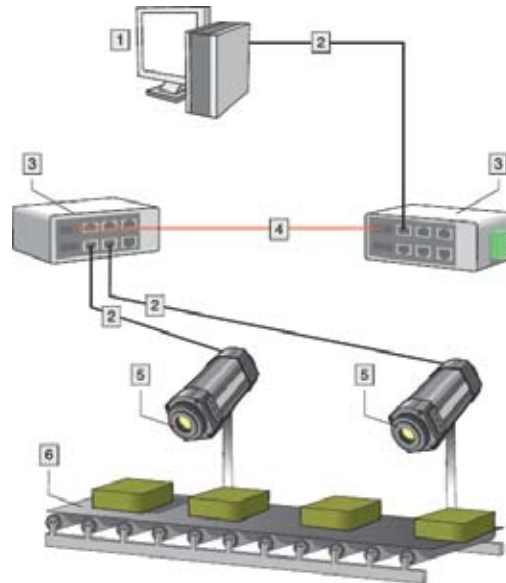
In conveyor oven applications, the area function is typically used because pieces of cooked product are often randomly located on the conveyor. The camera can be programmed to find and measure the minimum and maximum temperatures within the defined area. If one of those setpoint temperatures were to fall outside the user-defined limits, an application program running on a PC or PLC would instantly trigger an alarm, alerting the operator to check the thermographic image on a video monitor or PC to find and remove the bad product, and/or adjust the cooking temperature.

In the case of local monitoring, an IR camera’s digital I/O can be used to directly trigger an alarm device without additional software. However, food processing often benefits from higher level analytics that are available in third-party software that runs on a PC. These out-of-the-box solutions do not require the writing of application source code. By adhering to commonly used machine vision interface standards such as GigE Vision® and GenICam™, a wide range of functionality is supported by this software.

A simplified block diagram of conveyor monitoring is shown on page 4. One IR camera is adequate for many applications, or an IR camera may be combined with a visible light camera to record other target object attributes, such as color.

## Food Process Monitoring

- 1 Computer
- 2 CAT-6 Ethernet cable with RJ45 connectors
- 3 Industrial Ethernet switches with fiber optic ports
- 4 Fiber optic cable
- 5 ThermoVision® A320 cameras
- 6 Food process to be monitored, e.g., items on a conveyor belt



### Camera Specifications

<b>Detector</b>	320x240 pixel uncooled microbolometer focal plane array
<b>IR Spectral Band</b>	7.5 – 13µm
<b>Object Temperature Range (Selectable)</b>	-20°C to +120°C or 0°C to +350°C. Optionally +200°C to +1200°C
<b>Accuracy</b>	±2% or 2°C of reading
<b>Sensitivity</b>	0.07°C at 30°C
<b>Field of View (FOV)</b>	25°(horz.) x 18.8°(vert.)
<b>Focus</b>	Auto and manual with electronic zoom
<b>Min. Focus Dist.</b>	0.4m
<b>Spatial Resolution (Instantaneous FOV)</b>	1.36mrad
<b>Image Update Rate (Selectable)</b>	9 or 30 frames per second
<b>A/D Converter</b>	14-bit
<b>Interfaces</b>	NTSC/PAL video, Ethernet, and Digital I/O (10-30VDC)
<b>Electrical</b>	12/24VDC power
<b>Physical</b>	170x70x70mm, 0.7kg
<b>Mounting</b>	Tripod (UNC 1/4"x20) or 2xM4 threaded holes
<b>Environmental</b>	-15°C to +50°C operating range; 2g vib./25g shock per IEC 60068-2-6/29
<b>Optional Accessories</b>	Lenses with different focal lengths and FOVs, various housings and mounting options (consult factory)
<b>Included Software</b>	Allows easy camera setup, alarm configuration, thermal image and temperature data capture, trend analysis, and remote monitoring via Ethernet, ftp, and email

## WE KNOW INFRARED. LIKE NOBODY ELSE.

FLIR invented the infrared camera industry as we now know it. We brought the first commercial IR camera to market in the 1960s and have piled up more industry firsts in thermal imaging than anyone. Today we are the only global company totally dedicated to finding and fixing thermal problems through IR imaging systems. Our company's mission is to provide the most innovative systems available, with the highest possible quality, and show thermography practitioners how to get the most out of them. Our goals, now and in the future, are to provide greater insight into all types of thermal phenomena, and help our customers save money by applying this knowledge. This is supported by the most comprehensive and respected training courses in the industry.

FLIR's 'smart' IR cameras are used in basic research, non-destructive testing, product development, factory automation, equipment and building maintenance, asset protection, medical diagnostics, public safety, national defense, and a host of other applications. No other company offers the breadth of thermal imaging/temperature monitoring products supplied by FLIR, and none is as dedicated to technical excellence as our 350+ engineers. Within the past three years alone, FLIR has spent more than \$230 million on R&D. Our customers are the primary beneficiaries of this investment, enjoying an ROI that amounts to millions of dollars a year in direct savings from operating efficiencies and loss avoidance. As a result of this leadership, FLIR is the most trusted name in the industry.

### For more information:

Call: 1 800 464 6372

Web: [flir.com/thermography](http://flir.com/thermography)