



Guide for IR Camera or Pyrometer?



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Should I make non-contact temperature measurements with a single spot infrared sensor or use an infrared camera with temperature measurement capabilities?



In general, there are two popular measurement instruments for measuring the temperature of objects remotely. While an infrared camera provides thermal imaging capabilities and measures multiple points to visualize temperature distributions over a surface or scene, an infrared pyrometer provides instantaneous temperature measurements of a specific point without visual imaging capabilities.

Traditionally, most non-contact IR temperature measurements in process industries (glass, metals, plastic, paper, etc.) were made with affordable single-spot sensors that delivered temperature measurement values for a single spot with a detector wavelength most suited to the material to be measured. Short-wave infrared sensors would be used for metals measurements, mid-wave IR sensors for glass measurements, and long-wave sensors for ambient temperature measurements on plastic parts and other products with high emissivity. Infrared cameras were frequently priced beyond budget allocations and were not equipped to withstand harsh production environments.

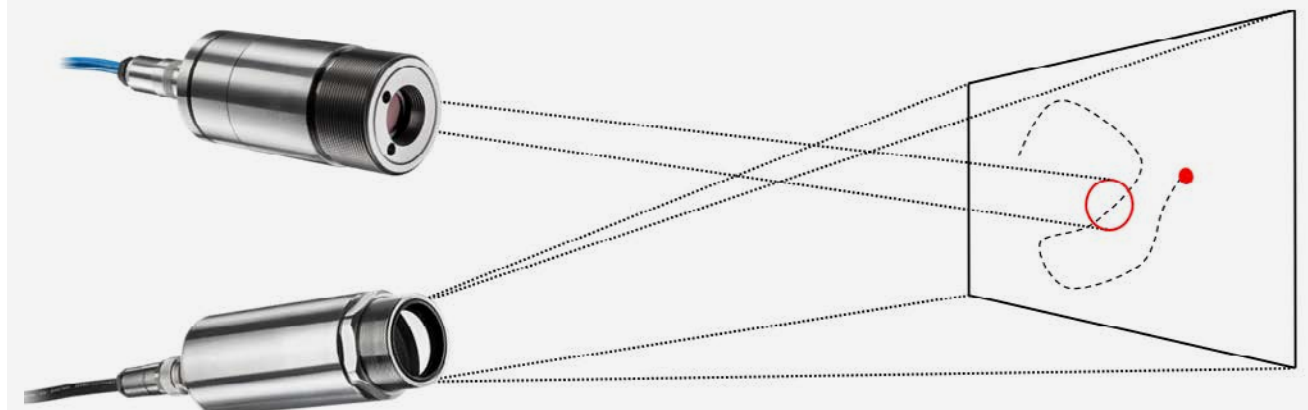
The availability of low-cost focal plane detector arrays now offers the opportunity to make temperature measurements with an infrared camera using any one of the thousands of detector elements focused on the part to be measured. Infrared cameras built for process environments are now available in the same price range as pyrometers. This allows an engineer to choose a spot sensor or an IR camera, depending on what is most suitable for the application.

Therefore, process engineers are initially tasked to decide if an infrared camera or a pyrometer is best for a temperature measurement task. The following discussion highlights the fundamental advantages of both sensor technologies and offers some guidance.

When is an IR camera a better solution?

1 When you do not know where the hot spot is.

Many process engineers need to know the hottest temperatures on a given part. Single spot sensors require the mounting and targeting a single spot, so the pyrometer delivers a temperature measurement of the spot framed by the sensor optics. An infrared camera can search the entire area on any part and report the highest (or lowest) temperature of the part. In short, **a spot pyrometer is a good tool when you know precisely where you want to make your measurement. However, an IR camera is the right choice to detect the hottest spot on a target when you do not know where it will occur.**



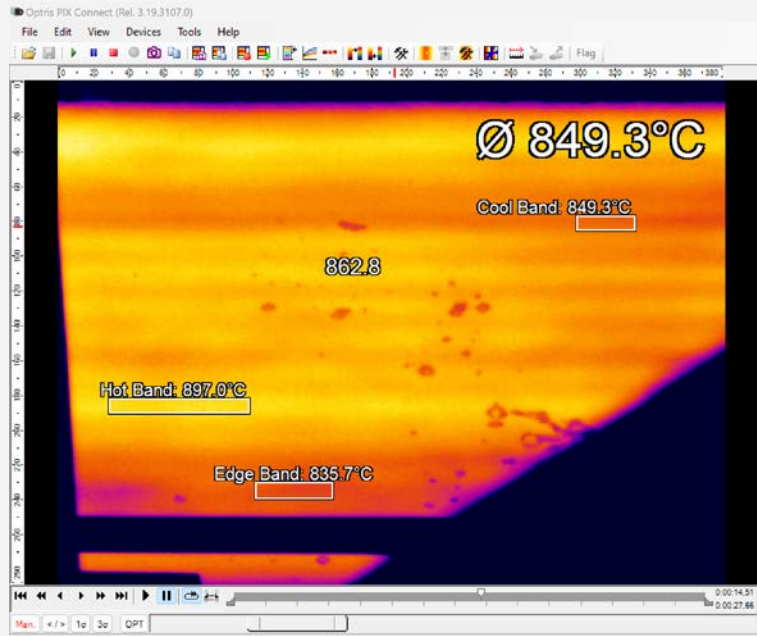
When is an IR camera a better solution?

2 When more than one measurement is preferable.

Large plastic parts such as automotive bumpers or aerospace parts can have substantial temperature variations, which may signal significant process problems. An infrared camera with the right optics can gather hundreds of spot measurements on small and large targets. Numerous spot pyrometers can also be deployed, but multiple infrared sensor mounting locations and outputs can be complicated and expensive. Many engineers may also prefer to use an IR camera instead of contact thermocouples when monitoring dozens of locations in an area, such as an automotive engine compartment under test. Two inexpensive IR cameras mounted on either side of any target under test will gather thousands of temperature measurements, with the advantage of detecting the hot spots where a thermocouple may not have been positioned.

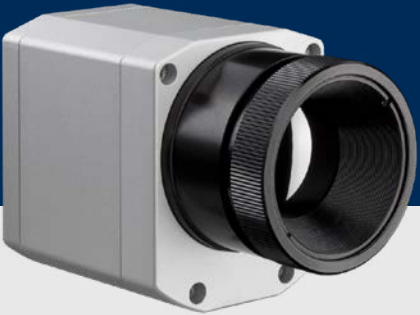
3 When process problems are signaled by temperature gradients.

Temperature gradients in many products produced in sheets (paper, glass, steel, plastic film, wallboard, etc.) are often monitored by infrared cameras or line scanning systems in manual mode. An operator adjusts dryers or heating elements based on color variations in an infrared image representing temperature differences. Multiple infrared pyrometers could gather numerous data points. Still, they would never deliver a comprehensive view and visual understanding of the gradual temperature variations on a product produced in a sheet-based manufacturing process. “Thermal Stripes” representing higher or lower temperatures become obvious with an IR camera but would be missed if the pyrometer was not aligned with the stripe. Optris camera and software can be converted to “line-scan mode” to capture temperature gradients across any sheet moving under the targeted line.

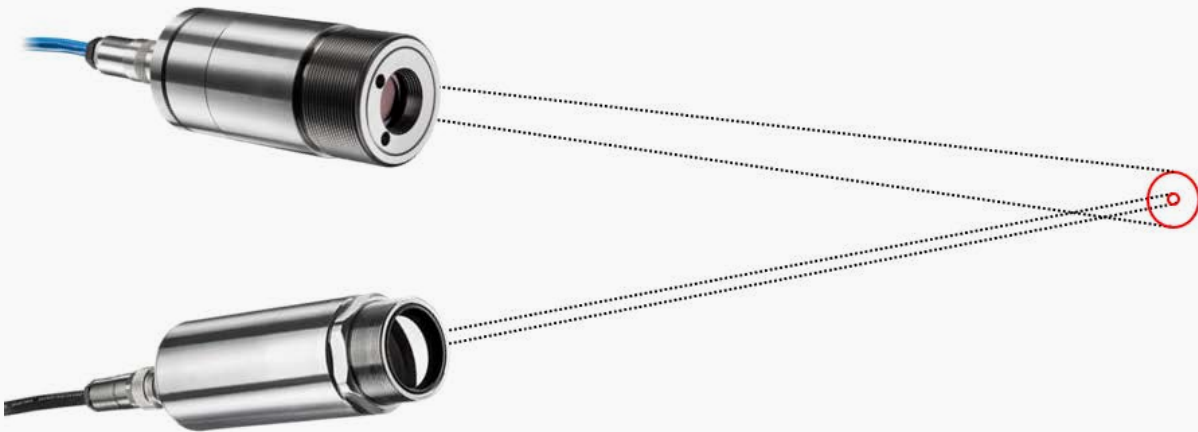


4 When the spot to be measured is very small.

Even when equipped with close-focus optics, accurate spot size measurements can be delivered with a pyrometer only on targets. Here, the distance-to-spot size ratio, also known as the D:S ratio or the distance-to-target ratio, is an important performance characteristic for infrared pyrometers. In the case of the long-wavelength domain, due to the used detector technology, current high-performance state-of-the-art pyrometers are limited to 75:1. This means that the diameter of the spot being measured is 1/75th of the distance from the pyrometer to the object. A pyrometer, which is positioned 75m away from the object, will measure the temperature of a spot with a diameter of 1m.



Due to the detector technology and detector size, a modern uncooled infrared camera with 17µm pixel pitch and commercial far-field optics achieves a superior distance-to-spot size ratio of 813:1. The advantages of small spot sizes are even more dramatic when measuring tiny objects in microscope applications. If small targets need to be measured, IR cameras are a better option, as the distance-to-spot size ratio is a magnitude better.



When is a spot pyrometer a better solution?

1 When budget restraints call for a very affordable measurement solution or a volume application.

Calibrated single-spot pyrometers that deliver accurate non-contact measurements on high emissivity targets can be purchased for the same price as industrial contact temperature instruments, making them the only non-contact measurement solution accessible to some users.

2 When the target material requires a wavelength response that is not available for an infrared camera.

Some materials, such as thin film plastics or metals under 450 °C (845 °F), require special wavelength sensors that are not available as detector options for infrared cameras, making a pyrometer the better choice.

Some companies have been using single-spot infrared sensors with a specific wavelength response for many years and may need a replacement IR sensor that operates in the same wavelength to match historical data. An example may be a pyrometer for glass measurement, which is responsive at 5.0 µm (microns). Because affordable IR cameras are not offered in this wavelength, replacing an older pyrometer with a new one responsive to the same wavelength may be best.

Type	Wavelength	Pyrometer	Infrared Camera
LT	8 ...14 µm	X	X
G7	7.9 µm	X	X
P7	7.9 µm	X	
G5	5 µm	X	
4M	2.2 ... 6µm	X	
F2	4.42 µm	X	
MT	3.9 µm	X	X
P3	3.43 µm	X	
3M	2.3 µm	X	
2M	1.6 µm	X	
1M	1.0 µm	X	X
08M	0.8 µm	X	X
05M	0.5 µm	X	X



3 When space or other environmental constraints make the placement of an IR camera impossible.

IR cameras are available in sizes as small as 36 mm (diameter) x 90 mm (length). Still, this size may be too large for some measurement requirements, which may include embedding a sensor into another instrument. A pyrometer can be packaged in a small sensor head of 14 mm (diameter) x 28 mm (length), making it the best solution for space-limited placements.

Small pyrometer sensor heads can also operate at ambient temperatures between 85 °C (185 °F) and 250 °C (482 °F) without cooling, making them the only solution for hot ambient environments.

Shock and vibration from process equipment can damage the shutter mechanism necessary for an infrared camera to produce accurate measurements. IR cameras are subject to shot and vibration limitations described in IEC 60068-2. Most infrared pyrometers are solid-state sensors and will sustain higher shocks, as no moving parts are usually integrated into the pyrometer.

When is a spot pyrometer a better solution?

4 When simple integration to a PLC is important.

An autonomous operation is a special feature of the Optris infrared camera in the Xi series. There is no need for a permanent connection to the software or a computer. Only a few settings must be set in advance in the software. Combined with modern field bus systems such as EthernetIP, ProfiNet, or Modbus TCP, cameras are easily integrated into existing PLC networks.

Nevertheless, additional software, which runs on additional hardware, for advanced image processing or very complex applications, might become a fundamental part of a customized solution. Addressing every pixel in the image instead of one temperature value drives the complexity of software solutions and hardware resources.

Pyrometers offer less complexity as, most often, only a single temperature value needs to feed a control application. All spot sensors in the Optris product line support common analog (voltage, current) and digital output standards such as EthernetIP, ProfiNet, ProfiBus, CANBus, ModbusTCP, and other serial communication as RS232 and RS485.

5 When speed matters.

Most IR cameras built for production environments cannot provide temperature feedback on targets below 450 °C that exceeds 8 ms. New detector materials for infrared pyrometers can respond to temperature changes as fast as 0.3 ms, making them the preferred solution for high-speed measurements on fast-moving targets or temperature testing with ultra-fast temperature transients. One exception to IR camera speed limitations is the short-wave cameras used for high temperatures (450 °C, 842 °F), which deliver unique temperatures at a rate of one millisecond.

When is a spot pyrometer a better solution?

6 When special applications require ratio or two-color wavelength measurement.

Some production processes produce substantial dust or other particulate matter in the sensor line-of-site that attenuates the infrared signal emitted by the part to be measured. The resulting errors can be eliminated when outputs from two-color wavelength sensors are incorporated into a ratio temperature calculation.

These unique pyrometers offer less emissivity depending on the temperature method, which calculates temperature by comparing the intensity of infrared radiation emitted. These devices are useful in various industrial applications such as steel production, ceramics manufacturing, and glass processing; when emissivity is unknown, the optical path is attenuated by dust, or the measurement is partly blocked.

A guide on whether to select a single-point pyrometer or a ratio pyrometer can be found here: [ADD LINK](#)

7 When target temperatures are between 2000°C (3632°F) and 3000°C (5432°F).

Short-wave infrared cameras for high-temperature metal measurement typically measure up to 2000 °C. Short- or short-wave ratio sensors can be calibrated to temperatures up to 3000 °C. This is related to some detector working principles only available in pyrometers, oversaturation of bolometers at high temperatures, and a superior dynamic range of analog electronics.

Conclusion and next steps



Before deciding on a non-contact infrared measurement solution, the best practice is to decide which technology (infrared camera or pyrometer) best serves the application. The next step is to select the best sensor wavelength to optimize accurate measurements. Next to choosing the optic options that most efficiently frame your target or targets, the correct interface option needs to be selected.

A detailed guide on how to select the optimal infrared camera can be found here: [ADD LINK](#).

A detailed guide on how to select the optimal pyrometer can be found here: [ADD LINK](#).

Nevertheless, it is always a good idea to discuss the application with an Optris-trained application engineer, who ensures the selection of the optimal instrument to deliver accurate non-contact temperature measurements.

Our application engineers or distributor support these considerations with extensive knowledge: [ADD LINK](#)

Why choosing Optris?

We are one of the leading companies in the field of noncontact temperature measurement. We appreciate your interest and hope that you join the satisfied customers who choose to use our measurement technology – featuring the highest quality as well as groundbreaking measurement and application concepts.

Tradition and Innovation

Thanks to their extensive know-how and innovative concepts, our experienced engineers and physicists continuously inspire with outstanding solutions.

Top Quality at Fair Prices

We provide cutting-edge infrared technology. Cost advantages arising from bulk purchasing of semiconductor products and from the production process are passed directly on to our customers.

Global Presence

We keep in close contact with our global sales partners and ensure that every customer project can be realized locally using the best-suited technology. Our international distributors are not only familiar with Optris products – they also know their country-specific attributes.

Made in Germany

In order to ensure the high quality of Optris products, 90 percent of the production – as well as our product development – is carried out at our headquarters in Berlin. This is also where we coordinate our global sales.

Responsibility

We take our corporate responsibility seriously – that is why we ensure sustainable production and a secure working environment for our employees.

Certified Quality

To guarantee the consistently high quality of our products, all Optris in-house processes are certified according to DIN EN ISO 9001:2015. This ensures smooth product manufacturing processes.

Comprehensive Service

As a globally operating company, comprehensive global customer support is vital to Optris. This is not only based on providing advice on infrared technology and new products, but is a living exchange of experience. With our international network of service partners, Optris is perfectly positioned for future development.



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