APPLICATION NOTE

FLUKE ®

Take infrared diagnostics to a near microscopic level with Fluke macro thermography

Over the last 20 years thermal imager technology has transformed maintenance, troubleshooting, quality control, and research and development in virtually every industry. A huge increase in detail and performance coupled with a reduction in cost and simplified interfaces have made thermal imagers a common everyday tool choice in a growing number of applications. Because thermal imagers can provide radiometric detail—the temperature data of each measurement point within an infrared image—without touching the target, they are ideal for inspecting targets that could be damaged or contaminated through contact measurement or that are so small it would be almost impossible to measure them with a contact tool.

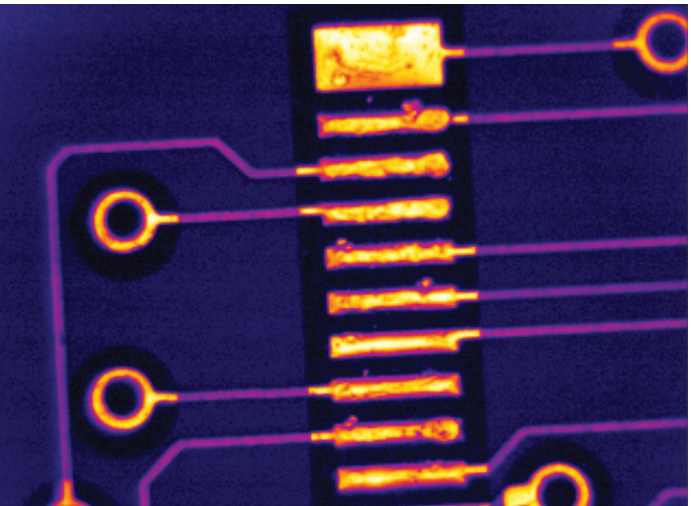
Top THREE

Applications for Fluke macro infrared lenses

1. Finding faults in near microscopic detail
2. Pinpointing manufacturing irregularities
3. Testing product reliability and performance life

Fluke is now offering a range of macro lenses that are compatible with our expert series cameras to give you the detail you need to inspect very small components. These include three macro lens options for Fluke TiX1000, TiX660, and TiX640 thermal imagers and a 25 micron macro lens for Fluke TiX560 and TiX520 thermal imagers. The 25 micron macro lens brings improved spatial resolution capable of showing temperature differences in details as small as 25 microns—smaller than the average human hair. Paired with a Fluke TiX560 or TiX520 thermal imager, the 25 micron macro lens provides a level of thermal detail that helps you identify problems that you wouldn't be able to catch with a standard lens. This level of detail is critical for ensuring the design integrity and production quality of constantly shrinking PCBs and microelectronic components.

Figure 1. The uneven application of metal indicates an inferior manufacturing process. This is not a board you would want to mount components on.



The value of a macro view throughout the product cycle

Because the Fluke 25 micron macro infrared lens can focus so precisely on such small targets, it is of tremendous value for analyzing:

Material integrity/quality

A 25 micron macro infrared lens shows thermal patterns that can indicate disjoints, lattice mismatches or other non-uniform conditions. Consistent thermal anomalies on multiple samples can point to manufacturing defects.

For example, Figure 1 shows a board with poor metallization. Rather than rectangular shaped connector pads, the poor metallization process has left globs of metal that could easily cause faults.

Material performance parameters

All materials and components have operational specifications such as temperature range and humidity. Thermal patterns can indicate whether a component or material is behaving as expected under those specified conditions. The ability to find heat differences between details as small 25 microns can help you find potential failure in near microscopic-sized components.

Material lifecycle and reliability

Capturing thermal patterns of materials over an extended test period with a macro lens can help R&D engineers determine the expected life of a component and identify areas of concern that could potentially lead to early failure.

See the difference that near-microscopic detail makes

To put things in perspective, the Fluke 25 micron macro lens lets you see near microscopic details. But what does that mean from a visual standpoint?

See for yourself. Here are a few images of common objects that were captured with a Fluke TiX560 thermal imager equipped with a standard lens and with a 25 micron macro lens. The increased detail can mean the difference between finding a problem in a few minutes and spending hours or days troubleshooting.

Extinguished match

Figure 4. This image of a match right after it was extinguished was captured with a TiX560 camera and a standard lens.

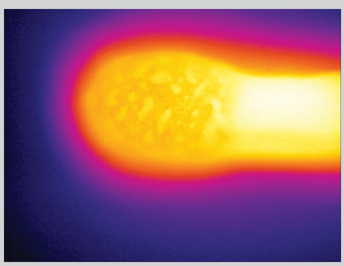


Figure 5. This image of an extinguished match was captured with a Fluke TiX560 camera and 25 micron macro infrared lens.

A British coin

Figure 6. This penny, approximately 20.3 mm in diameter, was captured with a TiX560 camera and a standard lens.

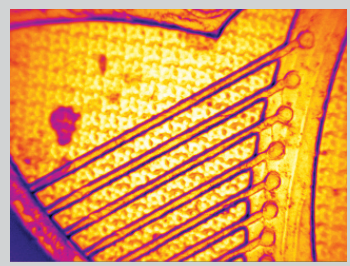


Figure 7. This image shows the same penny shown in Figure 6, captured here with a Fluke TiX560 and 25 micron macro lens. This demonstrates the very fine detail provided by the macro lens.

Putting macro lenses to work

Whether you're designing a new device, running quality control tests on components or fully assembled boards, or troubleshooting finished devices, the ability to see minor differences in thermal profiles of microelectronic components can help you diagnose trouble spots or pass boards or components faster. The following are just a few examples of how a macro lens can save you time, money, and frustration in designing, testing and manufacturing electronic devices.

Precise resistance

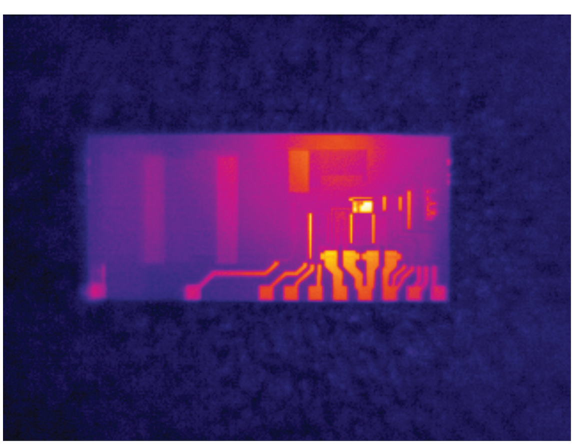


Figure 2. Precise resistance chip taken with standard lens and Fluke TiX560.

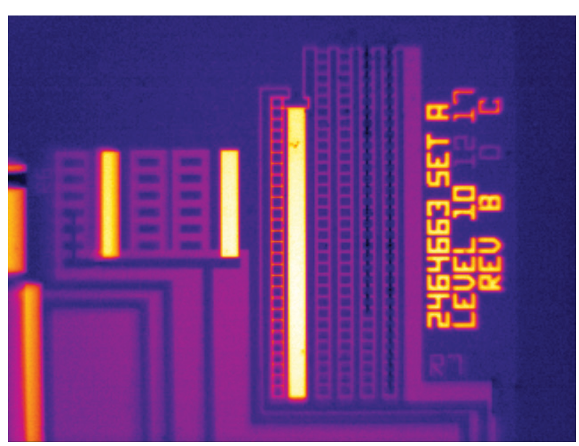


Figure 3. A closer view of pattern detail in the precise resistance chip, captured with a TiX560 and a 25 micron macro lens.

Find faults in parts you can't even see with a standard lens

In the first example (Figure 8) we scanned a circuit board and found a hot spot with a Fluke TiX560 and standard lens.

Using the Fluke 25 micron macro lens, we were able to see that the hot spot is actually two separate circuits in a single integrated circuit (Figure 9), both of which are working normally.

If one of the circuits had failed you would be able to see that clearly on the macro image. In that case only one rectangle would be hot; the other would be dark. The image captured with the standard lens does not show enough detail to indicate two circuits. Therefore if one was hotter than the other or cold (indicating a failure) you wouldn't be able to see that difference and would continue to investigate other areas of the board.

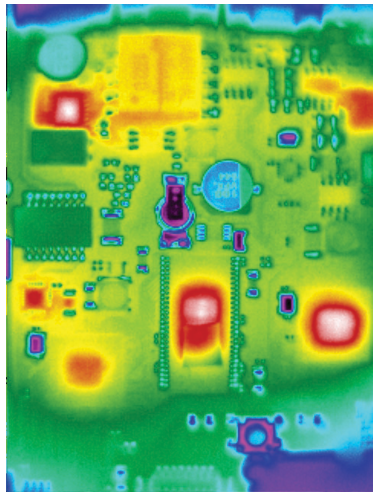


Figure 8. Image of section of PCB taken with a Fluke TiX560 and standard lens.

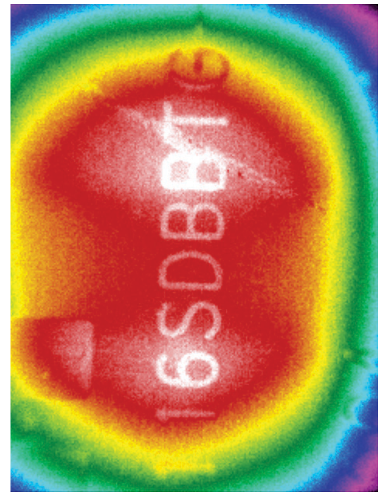


Figure 9. This image, captured with a Fluke TiX560 and 25 micron macro lens image shows that the hot spot is actually two circuits.

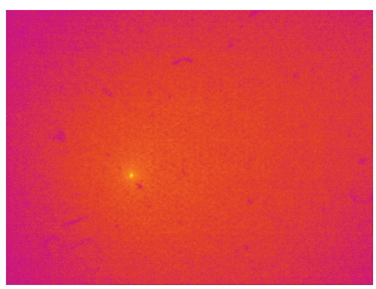


Figure 10. Pyroelectric detector scanned with Fluke TiX560 thermal imager and 25 micron macro infrared lens.

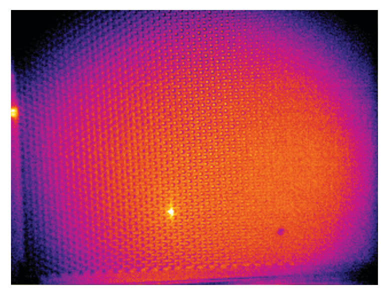


Figure 11. Silicon readout chip with ceramic material removed, scanned with Fluke TiX560 thermal imager and 25 micron macro lens.

Pinpoint manufacturing irregularities quickly

Diagnosing and resolving a manufacturing problem is critical to maximizing high product yield, as we discovered in one of our own Fluke manufacturing operations. We were suddenly experiencing a much higher than average number of failures in testing our ceramic-based pyroelectric detectors. A 50 % drop in yield pointed to a manufacturing issue. From a simple power test we found that the detector was drawing too much current, which indicated a short circuit. The problem was how to locate that short circuit.

We decided to run an infrared scan on the powered-up detector, using a TiX560 thermal imager. When we took an image with a standard lens attached, no anomaly appeared. However, when we attached the 25 micron macro lens, the resulting image showed a noticeable hot spot on the otherwise uniform surface (Figure 10).

Once we knew where the problem was, we removed the ceramic material from the detector and scanned the silicon readout chip again with the macro lens. This scan showed a clearly defined hot spot measuring about 100 microns in diameter (Figure 11).

Having located the region of interest, we examined the problem area on the silicon chip, with a scanning electron microscope (SEM). This examination revealed indentations in the silicon material that created a crack and caused a short circuit between the positive and negative power supply tracks. Retracing our steps in the manufacturing process we discovered that at one point in the process, the screening plate was making contact with the silicon chip, thus creating the indentation.

We adjusted the screen plate to prevent that contact, and the problem was resolved. Production yield recovered to previous levels. If we had not been able to narrow down the problem area with the macro infrared lens, it would have taken a lot longer to find the problem. We would have had to run the SEM all over the chip to find the problem, which could have taken hours rather than the minutes it took with the TiX560 thermal imager and 25 micron macro lens.

Quick tips for capturing optimal images

Capturing good infrared images is both an art and a science. It starts with selecting the correct camera and lens for the job. After that you can improve the quality of your infrared images—and the information they provide—by paying attention to key technical factors such as:

Distance to target

The distance to target is dictated both by the lens and the camera you're using. For example, with the TiX560 camera and the Fluke 25 micron lens you can focus accurately about 10 mm from the target. Keep in mind that navigating attached probes or large components may prevent you from getting that close, so be sure to select a camera and lens that matches the distance to target for your application.

Working range

The working range of the lens indicates the distance at which the target will be in focus. For example, the optimal working range for the Fluke 25 micron macro lens is from 8 mm to 14 mm.

Camera stability

For best performance you need to ensure that the camera remains stable and motionless while capturing images. We recommend that you attach the camera to a bench-top mounting system using the tripod mount thread on the TiX560 or TiX520. The TiX560 also includes a remote control feature so you can capture images from your computer while the camera remains undisturbed.

Compensating for the narcissus effect

The narcissus effect refers to an image of the lens that can sometimes appear in the scene due to heat bouncing back and forth between the image and the lens. Rather than the camera capturing the object being inspected, it captures the image of its own lens. To avoid this effect, move the camera a few degrees off of a 90 degree angle to the target.

Telecentric lenses vs. non-telecentric lenses

With a telecentric lens, everything within the working range of the lens appears flat—the same distance away from the camera. That means if you have a component that is 8 mm away and one that is 14 mm away they will both appear in focus at a 10 mm distance. Non-telecentric lenses require that you refocus as you inspect components of varying distances from the lens, which takes more time and requires more precise adjustments. The Fluke 25 micron macro lens for the TiX560 is telecentric, so all the components within its working range of 8 mm to 14 mm will appear at equal distance and in focus.

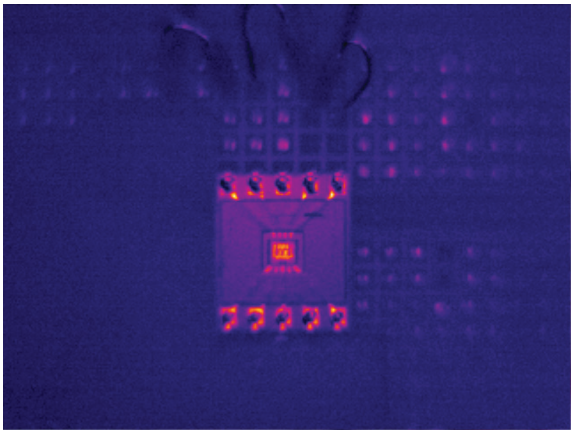


Figure 12: Unpowered resistor captured with a TiX560 camera and a standard lens.

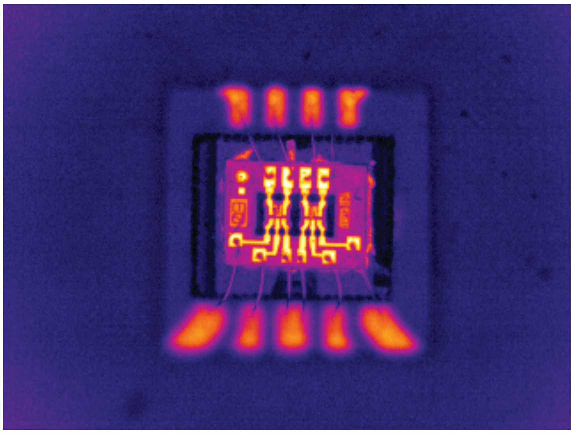


Figure 13. Same unpowered resistor as in Figure 12 but captured with a Fluke 25 micron macro lens.

Testing product reliability and performance life

Electronic component vendors all must test their products to ensure that they perform as expected under specified conditions and to determine their typical performance life. For example, a manufacturer of surface mount resistors (about 1 mm in size) would want to ensure the performance, reliability, and typical life expectancy of the components it supplies. The best way to accomplish that is to test the resistors at key points during design and development stages.

A resistor is primarily a device that limits current or voltage and dissipates heat depending on the currents and voltages applied. An thermal imager with a standard lens can't always show the level of detail required to distinguish the hot spots.

However, viewing the typical thermal patterns of a resistor under test with an thermal imager equipped with a macro lens allows a manufacturer to obtain extremely useful data about the design of the resistor and its behaviour as it dissipates heat energy. Those thermal patterns can indicate manufacturing related issues.

For example, Figure 12 shows an unpowered 400 ohm resistor on an AC/DC converter captured with a standard lens. Figure 13 shows the same component captured with a 25 micron macro lens. As you can see, the macro image provides much more detail about the resistor, even without power.

Next we, we powered up the converter and scanned it first with the standard lens (Figure 14) and then with the macro lens.

The image captured with the standard lens doesn't show any obvious problems. However, the much more detailed image captured with the 25 micron macro lens shows that the right side of the resistor far less current than the left side.

Temperature measurements are vital in calculating expected lifetime. The heat patterns of the resistor can be detailed enough to indicate hot spots. Such hot spots are very likely outside the specified working temperature of the component and can accelerate stresses in the material leading to early failure. With the information gained from the thermal images, the engineer would be able to change the design or the manufacturing process to mitigate the stress points that are creating the hot spots.

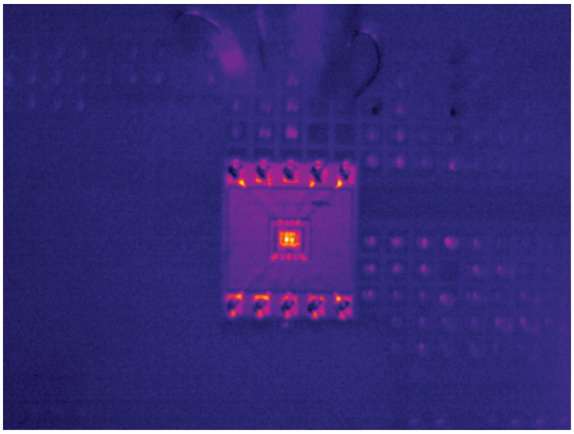


Figure 14. The powered up resistor captured with a standard lens doesn't show any obvious anomalies.

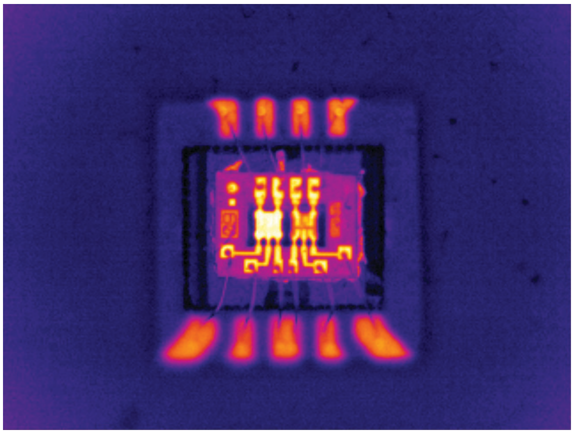


Figure 15. The powered up resistor captured with a Fluke 25 micron macro lens shows an obvious anomaly. The image reveals that the right side has far less current than the left side.

FLUKE®

Fluke infrared lenses at a glance

Lens	TiX560/ TiX520	Ti400/ 300/200	Ti32/ 29/27	TiX1000/ 660/640	Use for	Used by
Macro	25MAC2 25 micron			XLens/Macro1 81 micron (TiX1000) or 119 micron (TiX660/640) XLens/Macro2 32 micron (TiX1000) or 47 micron (TiX660/640) XLens/Macro3 35 micron (TiX1000) or 50 micron (TiX660/640)	Tiny to microscopic target, viewed from extremely close	Engineers and scientists working in: • Research and development • Electronics design and validation • Microscopic thermography Audience can be found in universities and research organizations, process development, and micro-electronics design companies
2x telephoto	TELE2	TELE2	TELE1	XLens/Tele	Small to medium sized target, viewed from a distance	• Maintenance, electrical, and process technicians–when equipment is too high, difficult to reach, or unsafe to approach • Building inspection–see fine detail from a distance
4x telephoto	4XTELE2	4XTELE2		XLens/SupTele	Small target, viewed from a great distance	Most relevant to those working in • Petrochemical–tall stacks • Power utilities generation and transmission–long distances • Metals refinement—too hot to approach; may have equipment near refinery that needs inspection
Wide angle	WIDE2	WIDE2	WIDE1	XLens/Wide angle XLens/SupWide	Large target, viewed from a relatively close distance	• Maintenance, electrical, and process technicians—when working in a tight space or needing to view a large area • Building inspectors—for roofing and industrial building inspections, save time by seeing a much greater area at once

The TiX560 thermal imager along with the 25 micron macro lens may be an ideal solution to your macro thermography needs.

1. **5.7 inch responsive touch-screen**–makes it quick and easy to change settings.
2. **Articulating lens**–allows you to place the screen at a comfortable viewing angle.
3. **4 times the resolution**–with SuperResolution mode, you can turn 320 x 240 images into 640 x 480 images for enhanced image quality and temperature measurement accuracy.
4. **Tripod mount thread**–securely attach the camera to a bench-top mounting system.
5. **Remote control**–take control of the camera from your PC so you can capture images and adjust settings from your computer while the camera remains undisturbed.
6. **One-button focus**–with the macro lens attached, pressing the LaserSharp® Auto Focus button sets the focus at the optimum distance for the lens, then you position the camera within the working distance from the target (~8 to ~14 mm) and adjust the distance from the target until the target comes into clear focus.
7. **Smart lens**–the macro lens comes pre-calibrated, so it does not need to be calibrated to a specific camera, and it is interchangeable between compatible cameras.

Quality images of small targets

As electronic devices get smaller and smaller, finding overheated near microscopic components gets harder. The Fluke TiX560 or TiX520 thermal imager with a 25 micron macro infrared lens provides the spatial resolution and thermal sensitivity you need to find hot spots and subtle temperature differences between details as small as 25 microns. The rich detail these tools provide for electronic component design, development, and production can help you improve quality, minimize time to market, avoid recalls, and reduce costs. To find out more about the infrared system that will work best for you, consult your Fluke sales representative or visit **www.fluke.com/infraredcameras**.

Fluke. *Keeping your world up and running.®*

Fluke Corporation
PO Box 9090, Everett, WA 98206 U.S.A.

Fluke Europe B.V.
PO Box 1186, 5602 BD
Eindhoven, The Netherlands

For more information call:
In the U.S.A. (800) 443-5853 or
Fax (425) 446-5116
In Europe/M-East/Africa +31 (0) 40 2675 200 or
Fax +31 (0) 40 2675 222
In Canada (800)-36-FLUKE or
Fax (905) 890-6866
From other countries +1 (425) 446-5500 or
Fax +1 (425) 446-5116
Web access: http://www.fluke.com

Printed in U.S.A. 6/2015 6005789a_en