APPLICATION NOTE

Get a far-sighted infrared view with a 4x or 2x telephoto lens from Fluke

Many technicians already know the value of using an infrared camera for industrial, commercial, or utilities inspections. An infrared camera allows you to conduct inspections from a safe distance. That means you may not have to shut down the operation or suit up in full personal protective equipment. It saves production time as well as exposure to hazardous environments. However, for some applications, you need to capture images of objects that would be very difficult to get close enough to without entering a danger zone, climbing a ladder or maybe even using a lift or a helicopter. For these applications, the new Fluke 4x and 2x telephoto infrared lenses magnify your view so you can see a lot more detail from the ground or from a safe distance.

Top SIX

Applications for Fluke telephoto lenses

1. **Overhead transmission lines**
2. **Power substations**
3. **Tall stacks in petrochemical plants**
4. **Maintenance, electrical, and process inspections**
5. **Metals refining**
6. **Building inspection**

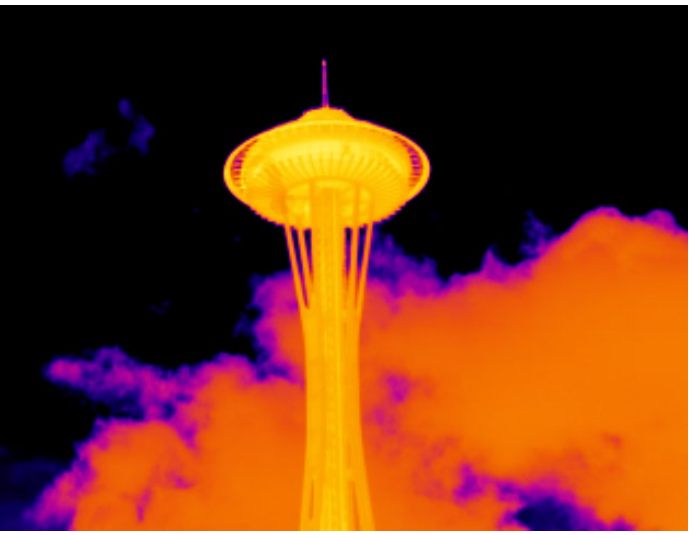


Figure 1. This shot of the Space Needle in Seattle, Washington (height 184 m [605 feet]) was captured from the ground with a Fluke TiX560 infrared camera and a standard lens.

These high-quality telephoto lenses go far beyond simply bringing the image closer. They can help you capture enhanced details while increasing your spatial resolution to help you see and possibly even measure an anomaly that you might not have been able to see with the standard lens. This can help you assess the possible issue while still on site.

These capabilities make Fluke telephoto lenses a great choice for a wide range of applications including power generation, power transmission, and power distribution; chemical and oil and gas manufacturing; metals refinement; building inspection or any large industrial or commercial operation.

Capture the level of detail and data you need

Fluke standard infrared lenses offer the spatial resolution and field of view required for many short- to medium-distance scans where you need to find hot and cold spots but don't require an extreme level of detail.

Fluke telephoto lenses provide the infrared detail and thermal data you need for applications where you can't get close enough to see the detail you need. Perhaps the hazardous nature of the target requires that you stay a distance away, or the target is too high or difficult to access. You can use telephoto lenses to scan switches, connectors, transformers, lightning arrestors, etc. in substations as well as check overhead high voltage power lines. Or scan vents, wiring, duct work or ceilings several stories high without having to climb a ladder or power up a lift.

You can choose from two magnification strengths based on your distance to spot (D:S) and the level of detail you require. The following images show the differences between a standard lens and 2x and 4x telephoto lenses to help you select the right one for your applications.

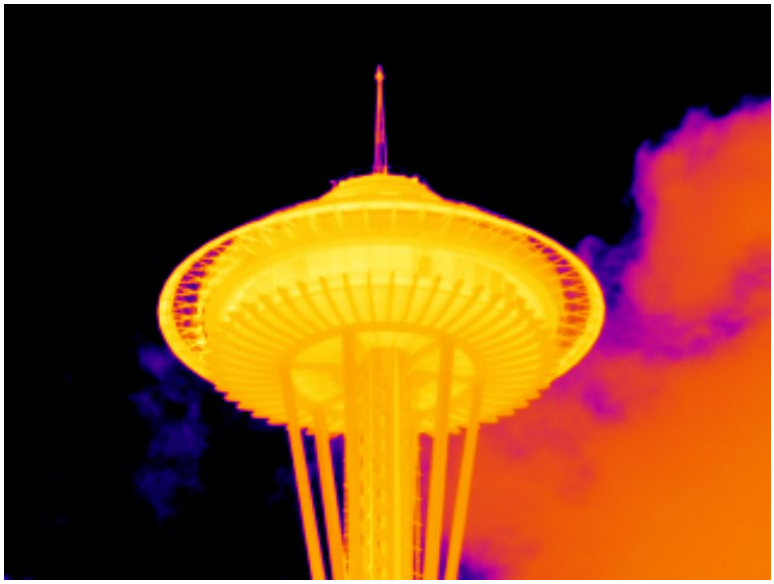


Figure 2: This image was captured from the same location with a TiX560 infrared camera and a Fluke 2x telephoto infrared lens.

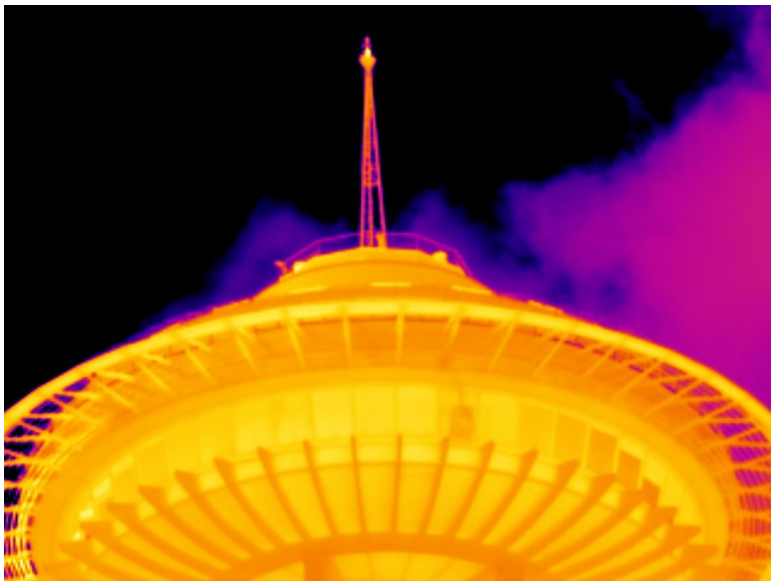


Figure 3: This third image was captured with a TiX560 infrared camera from the same location, with a Fluke 4x telephoto infrared lens.

2x telephoto lens

Fluke 2x telephoto lenses are a good choice for small to medium sized targets when you cannot get quite close enough to see the needed detail with a standard lens. For example, if your infrared camera with a standard lens has a D:S ratio of 764:1, then you could stand 764 cm (7.6 meters, 25.1 feet) from an object and see a spot size of 1 cm (.4 inches). With the same camera and a 2x telephoto lens your D:S will approximately double, giving you ~1530:1 (15.3 m (43.6 ft) from a 1 cm (.4 in) spot). This would give you the ability to see the same spot size from nearly twice the distance or approximately 0.5 cm^2 (.2 in^2) area from the same distance. As you can see in Figure 2, the 2x lens provides quite a bit more detail than the standard lens. That means it can reduce your need to enter the hazard zone in your plant or to climb a tall ladder to capture critical troubleshooting or maintenance data. This makes it very useful for inspecting electrical, electromechanical, and process equipment. It is also a good choice for scanning overhead vents, duct work, or wiring or possibly for scanning below grade to see details in a vault or a small sump.

4x telephoto

The Fluke 4x telephoto lens is excellent for capturing thermal profiles of small targets from a much greater distance. For example, if the D:S of your infrared camera is 764:1 with the standard lens, it would be approximately 4x that—~3056:1—with a 4x telephoto lens (30.6 m (100.3 ft) from a 1 cm (.4 in) spot). So if you stand 7.6 meters from the object you would detect a spot size approximately 0.25 cm^2 (.1 in^2). A Fluke 4x telephoto lens is an excellent choice for many applications including:

- Overhead transmission lines
- Power substations
- Tall stacks in petrochemical plants
- Metals refinement
- Other hard to reach, energized or unsafe areas

With a 4x telephoto lens, you can see critical detail from a distance that would not be easily viewable any other way, so you can identify potential issues on a transmission line splice or failing refractory that could create product quality issues, an unsafe working environment, and/or lost revenue.

Bring long distance details into clear focus

Adding a Fluke 2x or 4x telephoto lens to an infrared camera can multiply the advantages of that camera. Telephoto lenses help you capture much more detail than a standard lens from a greater distance so you can perform deeper diagnostic analysis. The following examples illustrate just a few of the applications where telephoto lenses come in handy.

Figure 4. An exterior scan of exterior equipment at a substation with a TiX560 infrared camera and a standard lens captured an anomaly on one of the phase switches.

Figure 5. Scanning the same area with a Fluke 2x telephoto lens shows a definite hot spot on the switch.

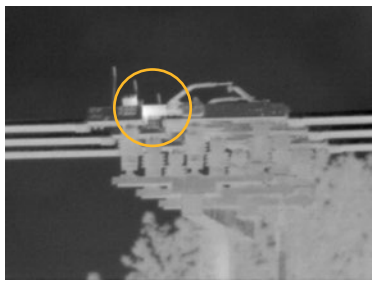


Figure 6. This third image of the substation transmission line, captured with a Fluke 4x telephoto lens clearly shows a hot spot or high resistance on a knife switch.

Proactive maintenance for substations and switchyards

Substations and switchyards have many complex electrical systems and equipment that handle very high voltage and current. To help ensure safe and consistent performance, more and more utilities are using infrared cameras to run proactive maintenance inspections on equipment ranging from oil-filled transformers to lightning arrestors, to high voltage transmission lines coming in and out of the substation. Infrared cameras can help to quickly find over– or under-performing components that might indicate a problem.

Finding problems at an early stage can save hundreds of thousands of dollars in replacement costs, overtime, and the associated downtime. Finding just one issue can usually justify the cost of an infrared camera and the training to help understand how to read thermograms.

We recently saw an example of this when we scanned a substation with a Fluke TiX560 camera and a standard lens, a 2x lens, and a 4x lens. After scanning much of the substation's equipment with a standard lens, we found an anomaly in one section (Figure 4) where one of the three phases appeared to be at a more elevated temperature than the others.

Because that image wasn't definitive with a standard lens, we replaced the standard lens with the Fluke 2x telephoto infrared lens and scanned the same area (Figure 5) from the same distance. This provided much more detail, and you can see in the highlighted area that one of the switches looks warmer than the other two.

Next we swapped out the 2x telephoto lens for the Fluke 4x telephoto lens (Figure 6), which clearly shows abnormal heating in a knife switch. Because there appears to be high resistance a short distance from the switch, that overheating could lead to a failure. Finding this situation in a routine inspection could save the utility and its customers a major power outage.

Maintaining the integrity of high voltage transmission lines

All kinds of things can affect the performance of a high voltage transmission line. Loose connections, corrosion, or weakened or failing cable splices can increase resistance, causing areas that can compromise the integrity of the transmission system. Power lines run through all kinds of terrain and have to stand up through high winds, ice storms, and intense heat. Any weakness in the system can be amplified by those conditions causing a significant power outage.

To minimize that risk, utility companies regularly inspect their transmission equipment. In the past, this often required hiring a helicopter or climbing into a lift to get close enough to capture necessary details on transmission towers. This was time consuming, expensive, and potentially dangerous.

Adding a Fluke 2x or 4x telephoto lens to a Fluke infrared camera, like the TiX560, can help overcome those challenges. With these telephoto infrared lenses, a worker can inspect towers and transmission lines from much greater distances.

Figure 7: High voltage power pole, captured with a TiX560 camera and standard lens.

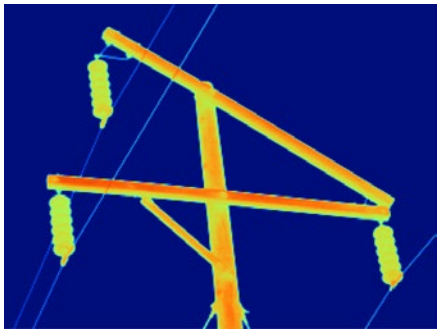


Figure 8: The same power pole captured from the same distance as in Figure 7, but with a Fluke 2x telephoto lens.

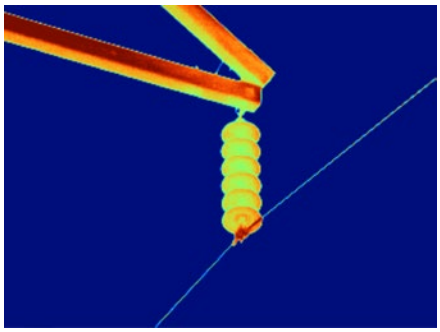


Figure 9: The right hand connection point captured from the same distance as in Figure 7, but with a Fluke 4x telephoto lens. The 4x telephoto lens gives you the level of detail needed to verify whether you have a possible issue or if maybe it's just a reflection, as in this case.

Here are some of the benefits to a few additional applications:

Intrinsically safe areas/zones —these lenses could allow you the ability to get the information you need, possibly without having to enter these areas, and without having to get a hot work permit or declassify an area to enter with your equipment. See image 1.

Areas that are too hot to get close to—metal manufacturers that deal with very high temperatures need to stand at a safe distance to measure and see their application as in image 2.

Tall stacks at a refinery or similar manufacturer make it difficult and potentially unsafe to gather information, but with the addition of these cameras and telephoto lenses you can now capture this data from a great distance, safely, as seen in image 3.

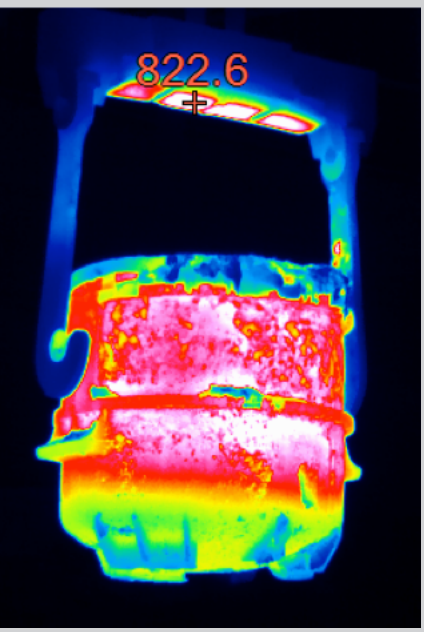


Image 1.

Image 2.

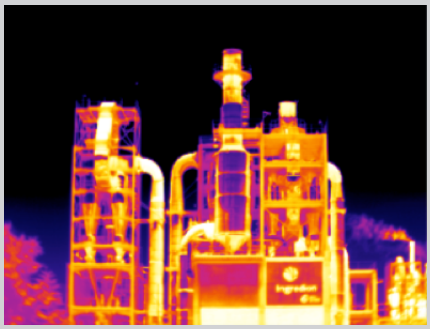


Image 3.

In the above examples, we inspected a power pole with a standard lens on a TiX560 camera (Figure 7). This image clearly shows the power lines and the insulators, but doesn't provide the detail to indicate any thermal issues.

Looking at the same target with a Fluke 2x telephoto lens (Figure 8), we compared the apparent temperatures of all three wire connections to the insulators. One connection appeared to be ~4 °C (~7.2 °F) warmer than the other two. The other two were within 1 °C (1.8 °F) of each other. Although that's not a huge variance from the average, it is enough to indicate a potential problem and document any findings.

With the 4x telephoto lens (Figure 9), we were able to see much more detail on the connection, and we determined that the apparently hot connection is actually the result of a reflection. If this had been diagnosed as an issue that required a team to come out and repair it, it could have been very costly.

Best practices for optimizing image detail with telephoto lenses

Capturing infrared images is a combination of art and science. To maximize the quality of your infrared program—and your return on investment—you need:

- **The right equipment.**
  You need to have the correct camera for the type of inspection you will be doing and the proper lenses for all of your applications.
- **Infrared training.**
  Understanding infrared technology will help you and your team minimize downtime. Levels of qualification training range from Level I for basic monitoring and proactive maintenance to Level II or III for advanced thermographers, who will be setting up and managing a thermography program. Level I training will prepare you to follow a standard work order written by a more experienced in-house or third-party thermographer.
- **Lens and camera stability.**
  When scanning with a 4x telephoto infrared lens, very small hand movements can create large adjustments, so camera stability can be critical. To ensure good stability, we recommend that you attach the camera to a tripod or lean against a solid surface as you are scanning the target. To further enhance stability for our 4x telephoto lens, Fluke designed a patent-pending lens attachment system that locks the lens securely in place.
- **Distance to spot ratio.**
  To understand the distance to targets to be inspected or measured with an infrared camera, you need to be aware of the D:S ratio of your camera and lens. The D:S ratio, often used with spot radiometers that typically only have one sensor, indicates the spot size you can detect from a specific distance. For example, if your D:S is 10:1, the diameter of the spot area is 1/10th of the distance to be measured from. When using a thermal imager you have an array of sensors, but this is true for each sensor or pixel.

Telephoto lenses multiply the D:S ratio of the standard lens by approximately two or four, depending on which lens strength you choose. The following are the D:S ratios for the TiX560 /520 camera with the various lenses:

Camera	Lens	D:S ratio
TiX560/520	Standard	764:1
TiX560/520	2x telephoto	1528:1
TiX560/520	4x telephoto	3056:1

- **Narrow field of view.**
  Because telephoto lenses present such a closely magnified image you will have a much smaller field of view than with a standard lens. That means you'll be able to see 2x or 4x the detail but you won't be able to see as large a target at one time. So you can either take more time to scan the target with a telephoto lens, or you can start with a standard lens to scan a wide target and then move up in magnification as you find potential anomalies.

Fluke infrared lenses at a glance

Lens	TiX580/ 560/520/ 500	Ti480/400/ 300/200	TiX1000/ 660/640	Use for	Target audience
2x telephoto	TELE2 smart lens	TELE2 smart lens	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 smart lens (not compatible with the TiX580)	4XTELE2 smart lens (not compatible with the Ti480)	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

Fluke TiX580, TiX560, TiX520 and TiX500 Expert Series cameras with a 2x or 4x telephoto lens provide a unique set of capabilities for fast and accurate utilities inspections.

1 **5.7 inch responsive touchscreen**–makes it quick and easy to change settings, and the image is large enough to see what you captured while you're still in the field.

2 **Rotating screen**–don't get a kink in your neck staring up at overhead lines. The articulating lens allows you to point the lens at the target and still view the screen at an angle that's comfortable for you.

3 **4 times the resolution**–with SuperResolution mode, you can turn 640 x 480 images into 1280 x 960 images, and 320 x 240 images into 640 x 480 images for enhanced image quality and increased temperature measurement accuracy.

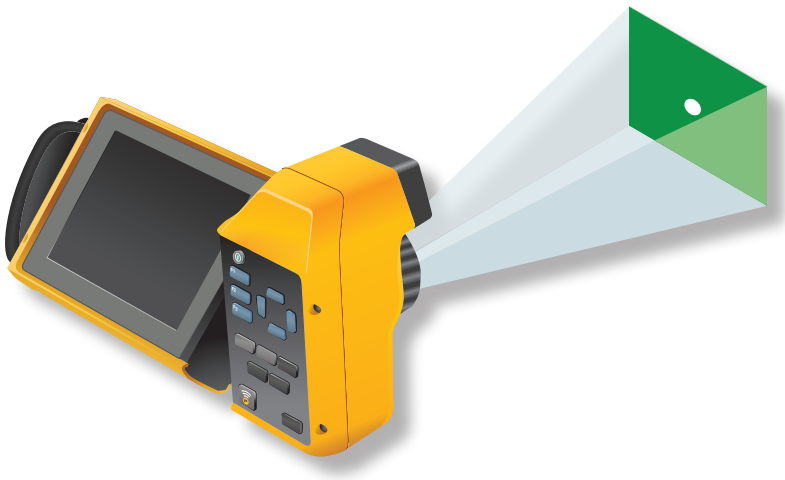
4 **On camera analytics**–analyze saved images in the field right on the camera.

5 **Post-capture image processing**–edit emissivity, background temperature, transmissivity, palettes, color alarms, and IR-Fusion, and enable/disable markers all on the camera.

6 **Fluke Connect**® wireless compatibility enables you to see, save, and share still images and video and measurements with others with the push of a button from your smart phone or PC. Just push the shortcut button to connect[1].

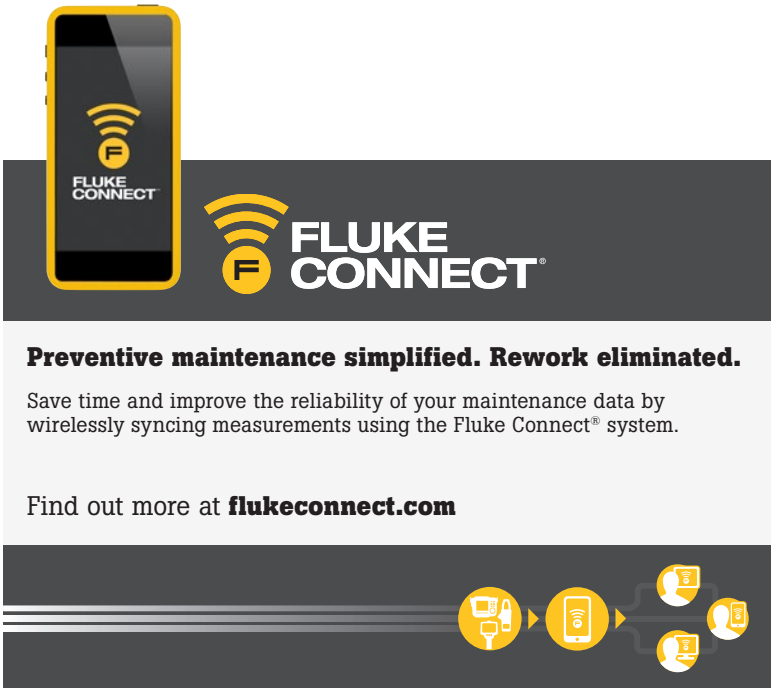
7 **Share lenses between compatible cameras**–the lenses for the TiX580, TiX560, TiX520, TiX500, Ti480, Ti450, Ti400, Ti300, and Ti200 are smart lenses, which means they do not need to be calibrated to a specific camera, and they are interchangeable between compatible cameras.*

* Not all optional lenses are compatible with all Fluke infrared cameras. Contact your local Fluke representative for more information.



Close the gap in thermal detail with Fluke telephoto infrared lenses

Any thermal inspection that requires scanning a target from a long distance, either because it is not possible or not safe to get closer, can be a good application for a Fluke infrared camera and telephoto lens. This combination will allow you to stay a safe distance away from hazardous areas and still get the precise thermal detail you need to identify potential points of failure. Identifying those anomalies early can help you prevent downtime or perhaps more catastrophic results. To determine if a 2x or 4x telephoto lens is right for you, contact your local Fluke representative.



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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