# Keysight Technologies
# IR Thermography Inspection on Plant Electrical System Using the U5855A TrueIR Series Imager

Application Note


KEYSIGHT TECHNOLOGIES

# Introduction

Plant predictive maintenance has evolved from preventive and traditional run-to-failure maintenance methods and has been gaining popularity due to its benefits and advantages, which include reducing production downtime and optimizing maintenance costs.

When industrial or general manufacturing facilities use predictive maintenance, many voluntarily include IR imaging as part of electrical inspections. Some facilities are required to conduct IR evaluation in order to renew fire insurance policies. At these locations the insurance companies perform the inspection or may require that it be performed by a non-biased, third-party inspection company. In some locations, ISO requirements mandate that inspection be done by an independent third party.

This application note looks at the advantages and disadvantages of the predictive, preventative, and run-to-failure maintenance practices, and explains how preventative maintenance programs are enhanced using thermal imagers such as the Keysight Technologies new U5855A True***IR*** infrared imager.

# Comparing Maintenance Methods

A simple comparison between predictive, preventative, and run-to-failure maintenance practices is provided in Table 1.

Table 1. Comparison of predictive, preventive, and run-to-failure maintenance

| | **Predictive** | **Preventive** | **Run-to-Fail** |
|---|---|---|---|
| Description | Continuous monitoring or periodic maintenance inspection to detect any symptoms of system failure | Time-based or periodic maintenance. System is removed or stopped for maintenance even if there is no failure | Occurs only when a component, chain of failures, primary failure, or secondary system breaks down |
| Advantage | – Maintenance can be done when the plant is in operation, or when the system is offline<br>– Down time for repair is reduced<br>– Overall maintenance cost is reduced | – Scheduled and regular maintenance work<br>– Overall maintenance cost is easier to manage | – Less monitoring and inspection work for plant maintenance or facility personnel<br>– Eliminates need to create maintenance schedules |
| Disadvantage | – Heavy job loads with various inspections and monitoring methods for facility maintenance personnel | – Maintenance cost still high, parts are replaced even though they have not reached end of life | – Unexpected breakdowns and repairs disrupt production<br>– Risk of extended down-time if special parts must be ordered<br>– Overall cost is high since the production facility has to be shut down unexpectedly |

# Thermography Inspection

Typical predictive maintenance includes tasks such as vibration analysis on machines, acoustic, ultrasonic, and Infra-Red (IR) thermography inspection on electrical systems. Thermography is used to identify equipment hot spots. Typically this task is performed using temperature sensing instruments like thermo-couple sensors or other forms of thermometers. A limitation of this practice is that these types of instruments can only provide maintenance personnel with temperature readings on certain spots and not the overall electrical module or system.

Thermography inspection generally uses infrared instrumentation to scan and create a temperature profile of intended targets.

In a typical manufacturing plant, IR thermography inspections are done on electrical systems such as electrical switchboards, high-voltage distribution equipment, motors and corresponding controllers, transformers, other control panels. Figure 1 illustrates some examples of the thermal images or thermograms of electrical systems found in manufacturing facilities.

IR imaging is another way to scan and identify electrical hot spot (refer to Figure 2) and has the advantage of being able to obtain the overall temperature profile image (or thermograms) of the targeted electrical parts. This imaging provides better insight into the operating health of the targeted electrical systems.

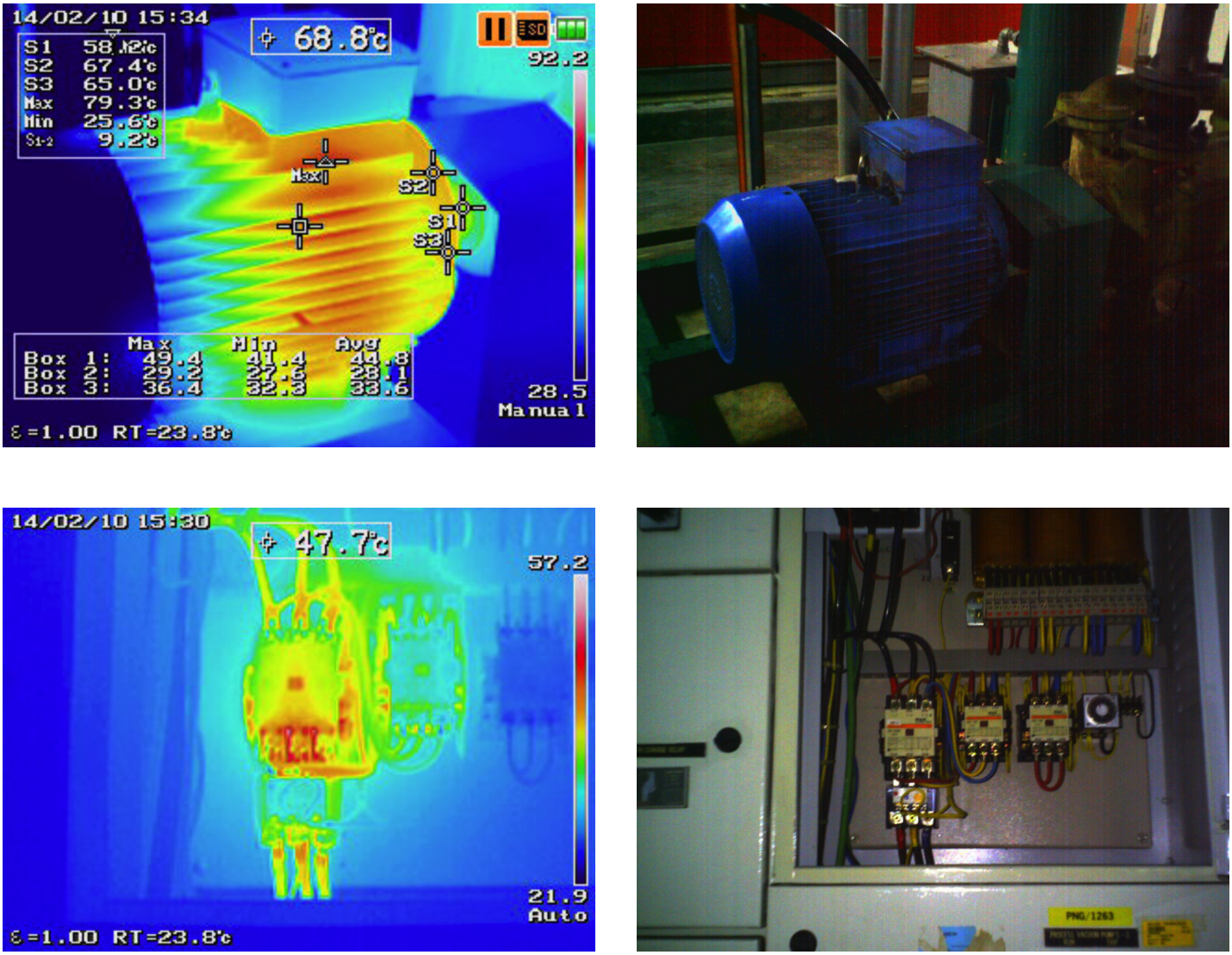


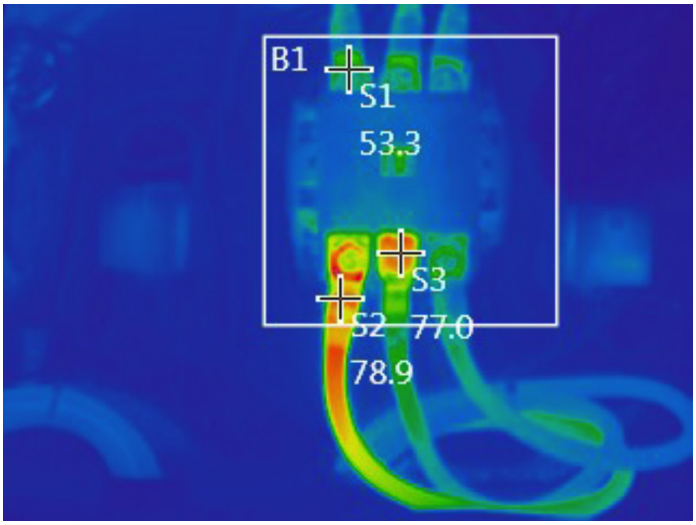

Figure 1. Thermal images (thermograms) and visible images of electrical systems

## Causes of Hot Spots

IR thermal inspection provides good qualitative temperature analysis and profiling of the targeted object. Often a valid hot spot is identified by comparing its temperature with other similar circuits, terminals, or systems. For example, in Figure 2, the hot spots on the terminals are valid as there appear hotter in comparison to the other similar terminals with similar electrical load. There are a few typical causes for electrical hot spots as illustrated in Table 2. Based on the severity of the electrical hot spots, these electrical parts and systems may be repaired and rectified. Some critical electrical problems have to be repaired immediately because they can cause severe breakdowns in machinery, and halt the production and operation. Other less critical repair jobs can be scheduled for a later date.

Table 2. Typical electrical system hot spots

| Potential causes | Description of the hot spots |
|---|---|
| Bad connection | Loose cable or wire connection causes additional resistance, triggering induced resistive heating |
| Broken copper strands in wire | Causes resistance to increase, followed by unwanted heating |
| Overload | The electrical system is loaded above the intended design and rating, causing higher heating at the terminals |
| Unbalanced load | Causes some of the power terminals (phase) to have higher load and higher operating temperatures than normal |
| Short circuit | Excessive current flow causing heating |
| Open circuit | No current flow at the terminals. It will appear cooler than the other similar terminals |



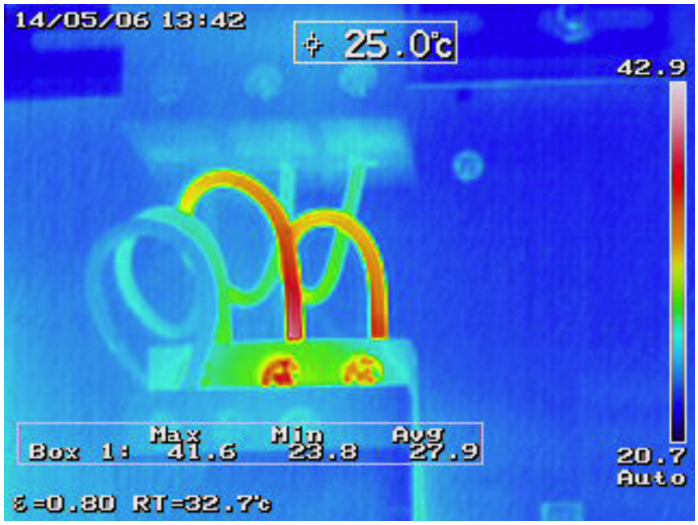




Figure 2. Hot spot on electrical system wiring

## Tips for Capturing Quality Images

Normally, a trained and experience IR thermographer is required to ensure the hot spots captured on the IR camera are valid. It is also crucial for the thermograph inspector to capture correct and accurate IR images. Listed below are a few simple guidelines to help a thermographer capture good-quality IR images on electrical systems.

1. Get the focus right on the target area for more accurate temperature readings.
2. Perform a quick scan the electrical panel/board/system. Set the both the temperature range and temperature scale in auto mode and pan the U5855A around the targeted area to look for hot spots.
3. Once a suspected hot spot is found, manually refocus on the hot spot area. The temperature scale can be adjusted by changing the scale to manual mode enabling the U5855A to capture a more stable thermal image.
4. Validate the hot spot by checking for any possible reflective heat sources or solar loading effects if the inspection is done in an open area or under sun light. Move from side to side to eliminate possible external or reflective heat sources.
5. Check the surface condition of the hot spot area and apply the suitable emissivity co-efficiency factor, Ɛ. Note: If the object's surface is polished or shinny in nature, both the Ɛ and emitted IR energy will be low. These surfaces can also reflect IR energy from other sources. In such cases, the low Ɛ and external reflected IR energy typically produces an inaccurate temperature measurement by IR thermographer imagers.
6. Capture and save the IR image for reporting purposes. Extra identification and information on the hot spot area can be done by photo tagging or simply writing down notes in a notebook.

Perform post-IR thermography analysis such as adding extra temperature spot measurements using PC software, such as the Keysight True***IR*** Analysis and Reporting Tool shown in Figure 3. This PC software also can be used to generate thermography reports with findings.

## Solution for IR Thermograph Inspection

IR thermograph inspection of electrical systems has been gaining popularity as an effective predictive maintenance practice for facilities and manufacturing plants. The Keysight Technologies U5855A True***IR*** Infrared Imager is an ideal tool to execute such a task. It is equipped with the state of the art Fine Resolution (FR) feature, effectively providing a 240 x 320 pixels IR image. The U5855A comes with a 4X digital zoom capability enabling it to focus in on small objects. It is also useful when performing thermography inspection on a hard to reach area because the target object or hot spots can be expanded on the U5885A's LCD. The U5855A is equipped with various measurement tools such as spot, box, and minimum, maximum and temperature difference. Free Keysight True***IR*** Analysis and Reporting Tool software provides the convenience of generating the IR thermography inspection reports and findings.


Figure 3. Keysight TrueIR analysis and reporting tool

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