Keysight Technologies
Thermography for Photovoltaic Panel Using the U5850 Series True*IR* Thermal Imager

Application Brief

- Identify potential faults faster without disrupting the system
- Easily detect the location of anomalies

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Unlocking Measurement Insights

Introduction

In many countries, solar power is gaining popularity because the cost of photovoltaic (PV) modules and systems is rapidly decreasing; making it more competitively priced against electricity generated from fossil fuels. Some countries have reached grid parity, meaning solar, or another renewable power source, generates electricity at costs equal to, or less than, the conventional fossil fuel sources. In areas where the conventional electrical grid is hard to reach, solar energy has become a substantial alternative energy source. Solar energy is a clean, inexhaustible energy source and according to the International Energy Agency (IEA) publication, Technology Roadmap: Solar Photovoltaic Energy, Edition 2014, it could be a significant source of electricity by 2050.

PV systems use a collection of PV panels to convert sunlight into electrical energy using the photoelectric effect. Each panel is made up of a few PV modules, which in turn consist of a matrix of PV cells that convert the solar irradiance into electricity. The failure of any PV cell may lead to a drop in power generation causing output yield losses. When a cell is shaded or not working, the cell consumes power from the adjacent series of solar cells instead of generating power. On solar farms, which may consist of up to a few thousand PV panels, electrical testing at each individual PV panel is time consuming and cumbersome. This application note looks at the use of thermal imaging as a method to expedite identification of faulty PV cells.

Identifying Hotspots

As the PV modules have negative temperature coefficient for the maximum power, the increase of the temperature reduces power output. This heat makes thermography scanning an effective test method for detecting solar cells that are overheating and for identifying other anomalies that could cause a PV module to fail. Figure 1 show hotspots detected on overheated solar module cells using the Keysight Technologies, Inc. U5850 Series True*IR* thermal imager.

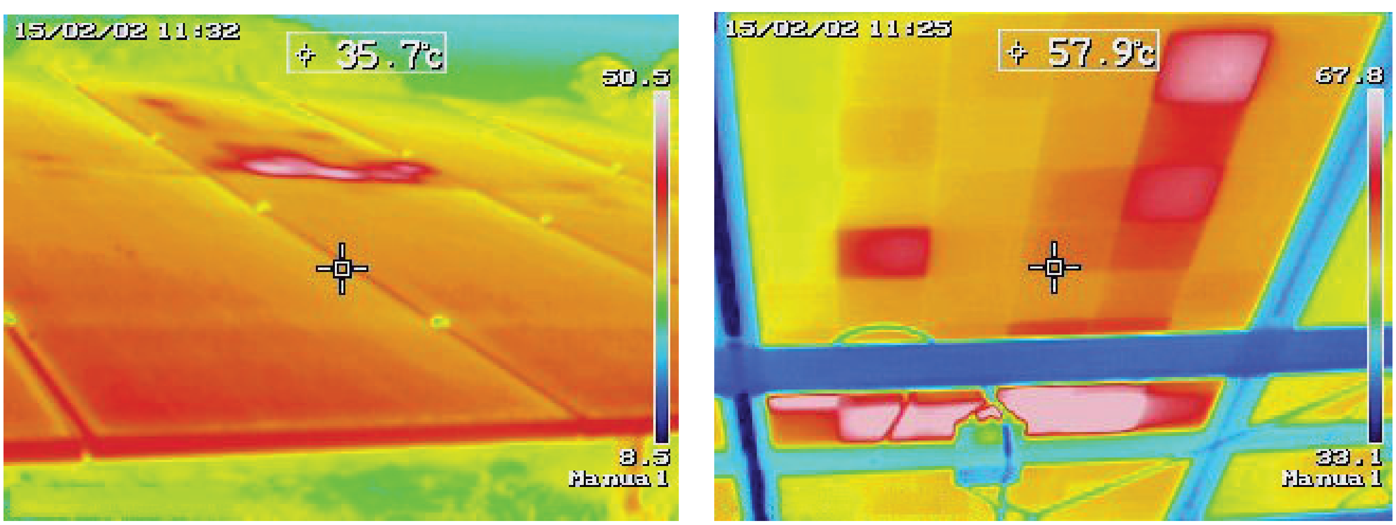

Figure 1. Thermography scan with thermal images using Keysight U5855A True*IR* thermal Imager shows multiple hotspots detected on a solar panel, indicated in pink/red

To minimize hotspots produced by shade (the shading effect), manufacturers normally install bypass diodes in the solar panels. However, bypass diodes can degrade or become defective, leading to overheating issues. If the affected cells continue to heat up the adjacent cells, the power generated will be greatly reduced.

The Keysight U5855A thermal imager has 320x240 fine resolution that delivers a high-quality thermal image, which reveals finer details and enables users to quickly spot the problem. It works from –20 to 350 °C, with thermal sensitivity as narrow as 0.07 °C. This allows even a small variation of temperature to be detected and produces a clear image for problem analysis.

To easily detect the location of anomalies, especially for a matrix of solar cells on a solar farm, the fusion camera mode in Keysight U5855A adds the IR image on top of the visible image. The captured images can be imported to the True*IR* Analysis and Reporting software tool, where it is easy to analyze and edit thermal images and quickly generate reports using pre-made templates (see Figure 2). The thermal images and visual images can be displayed side-by-side for further analysis.

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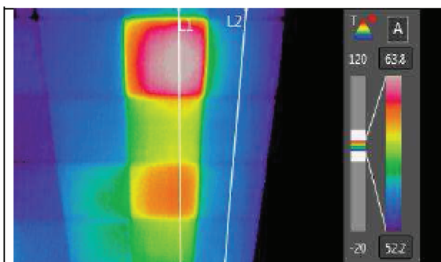
True*IR* Series

Penang Solar Farm, Feb 2nd, 2015

Thermal Imager, U5855A



Thermal Image Name:A0091_FR.JPG

Visual Image Name:A0091_VB.JPG

Measurements

Spot:
Data not available

Line:

Name	Min	Max	Average	Start Coordinates	End Coordinates	Max Coordinates	Min Coordinates
L1	55.6	64.2	60.46	(176,1)	(178,239)	(177,42)	(176,1)
L2	53.8	55.0	54.60	(248,1)	(225,239)	(226,237)	(248,8)

Box:
Data not available

Parameter:

Emissivity	0.85
Reflected Temp	26.2
Ambient Temp	25.0
Distance	1 m
Humidity	50 %

Remarks:

Bottom view of the suspected faulty module. Line profiles below indicate significant higher temperature on the suspected faulty cells comparing to adjacent cells.

Line Profile:

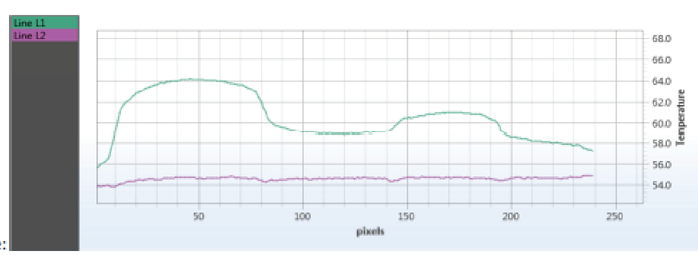


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Figure 2. Analysis report generated from the True*IR* Analysis and Reporting Tool using the pre-made templates

The Keysight True*IR* Analysis and Reporting software allows users to manually adjust the position of the thermal overlay to the desired position in fusion mode, as shown in Figure 3. The fusion of both IR and visible images makes it easy for users to identify abnormalities. Note: These images should be compared with a normal solar cell image and relevant electrical testing to confirm the anomalies detected.

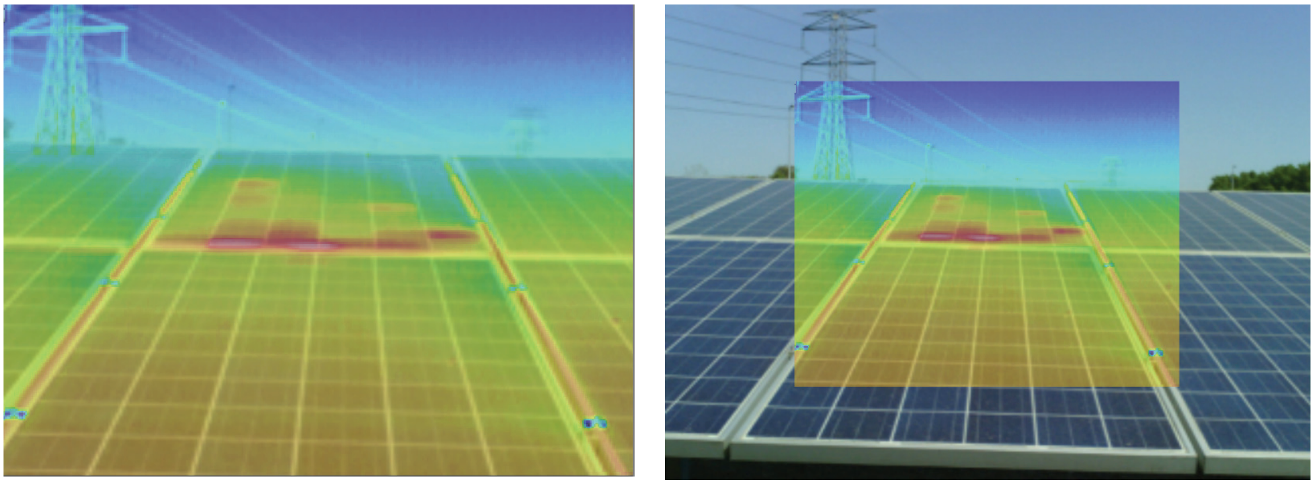

Figure 3. Fusion mode enables user to identify the location of the abnormalities easily with a combination of IR and visible images (Left: Blend mode, Right: Picture-in-picture mode)

Summary

IR thermography has been used for more than a decade to assess the performance of the photovoltaic panels. Malfunctions and material defects can be detected easily without disruption of the PV system using infrared analysis. Using a tool such as the U5850 Series True*IR* thermal imager provides the ability to detect anomalies and predict maintenance needs, allowing them to be prioritized based on the criticalness of the issues. This indirectly helps to reduce the maintenance cost.

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