

REFLECTIVE ELECTRICAL ENGINEERING LEARNING (REEL2026)

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BUILDING SKILLS AND PROFESSIONALISM THROUGH INDUSTRIAL TRAINING



REEL 2026

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*"Building Skills and Professionalism
through Industrial Training"*

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Practical Hotspot Identification in Photovoltaic (PV) Modules Using Infrared Thermography for Commercial and Industrial Application: An Industrial Training Study

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One of the most important technologies that contributes to clean and sustainable energy generation is solar photovoltaic (PV) system. Because solar energy applications are growing in commercial and industrial applications, reliability and safety of PV systems are becoming increasingly important. A major problem with PV performance is the production of hotspots within the solar module which occur when one region of the module is shaded or dirty or contains faulty cells or internal electric defects, resulting in the hotspot being considerably hotter than the rest of the module. Hotspots may lead to inefficiency in the system, cause damage to module materials and present a potential safety risk if not identified early on.

During my industrial training, I had hands-on experience with the hotspot detection technique using infrared (IR) thermography which is extensively used in PV maintenance. IR thermography is based on the ability to perceive heat radiation emitted from the surface of an object and transform it into a thermal image. A temperature map of a healthy PV module will show an even temperature distribution, with darker hot areas indicating a fault.

During the inspection process I acquired one important technical skill, which was the analysis of the temperature difference, ΔT between the suspected hotspot and the neighbouring cells to assess the severity of the defect. The severity of the issues identified during the inspection are summarised in Table 1.

Table 1: Hotspot Severity Classification Based on Temperature Difference

ΔT (°C)	Category
> 50	Critical
30 - 50	Repair as soon as possible
10 - 29	Repair soon
< 10	Monitor

My main technical experience was carrying out a thermal inspection on a commercial PV installation site. I scanned several solar modules with an infrared camera to detect any abnormal heating that might be due to defects on the surface of the module as illustrated in Figure 1.

With thermal imaging, maintenance personnel can spot defects that may not be visible in normal visual inspections. This process gave me an understanding that the warning light from a single hot cell generally meant that the module was being damaged in that cell, whilst if the entire module was hot, it was likely to be due to a wider module connection problem, or system imbalance. The inspection process involved careful observation and comparison

to neighbouring modules to ensure that even temperature anomalies that were not visible could be identified. The most useful lesson learned during the inspection was the realization that it is not necessarily easy to interpret the images captured through the thermal camera. Temperature differences can be affected by other elements of the environment, such as cloud cover, wind speed, and variations in intensity of sunlight. I also found out the significance of setting the emissivity value correctly on the thermal camera. Each material emits infrared radiation differently and incorrect emissivity settings can lead to inaccurate temperature measurements.

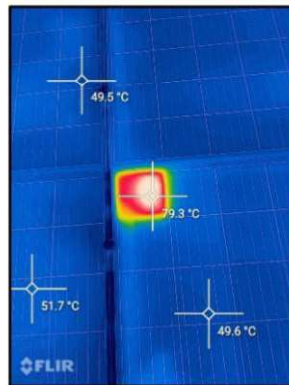


Figure 1: Thermal Image of Solar PV Panel Showing Hotspot Formation

One of the most memorable moments during my industrial training was on a rainy, cloudy morning immediately after the rain. One PV module indicated a temperature difference, ΔT of around 5°C during the inspection, which is normally in the “Monitor” category. Because of the weather conditions, however, we considered it advisable to conduct further physical inspection to confirm the reading. Upon visual inspection, we found burn marks were present on the backside of the burnt module, which indicated that overheating had caused material degradation before this point. This experience reminded me that there must always be a direct visual examination and engineering judgment when using thermal analysis. The inspection outcomes are summarized in Figure 2.

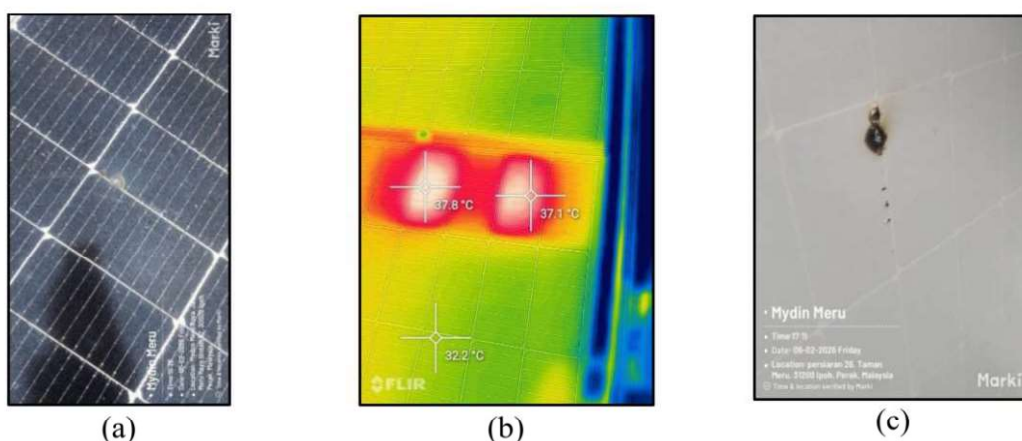


Figure 2: PV Module Inspection Observations under Three Different Conditions: (a) Visual Inspection, (b) Thermal Image, (c) Burn Mark

The system was temporarily bypassed by the damaged module and awaits replacement to prevent further damage and ensure overall system operation. By doing so, the operation of the rest of the PV string was not significantly affected, and they were still able to produce

electricity safely. The troubleshooting procedure highlighted the value of quick decision making and preventive maintenance to achieve long-term PV system reliability.

In the end, it was not only technical training, but an overall experience of industrial training. It helped me to understand the working environment, safety and practical issues in the renewable energy sector as a professional engineer. By learning the infrared thermography techniques, I was able to gain a good amount of exposure to the current PV maintenance practices helping in achieving energy sustainability and supplying reliable solar power generation in Malaysia. This experience has further motivated me in the domain of renewable energy technology, and it has shown me the significance of predictive maintenance in sustainable energy generation.

Authors' Biography



Zuhri Azfar bin Zainal Asmawi is a motivated student currently pursuing a Diploma in Electrical Engineering (Electronics) at Universiti Teknologi MARA (UiTM) Cawangan Pulau Pinang. As part of his academic programme, he is undertaking an internship at GSPARX Sdn. Bhd. from 2nd March to 21st June 2026. This practical experience provides valuable exposure to real-world engineering applications, particularly in solar energy systems, allowing him to strengthen his knowledge and technical skills in electrical engineering.



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