**Title** **–** Development of a portable electroluminescence measurement system for photovoltaic modules

**Description –** Investigations of PV modules benefit from electroluminescence (EL) imaging technique is widely used indoors and outdoors. This technique enables to identify inactive and defective cell areas as well as varying series resistance contributions. PV modules are measured in forward bias condition, i.e., by forcing current flow through the module with an external power supply. The EL signal is then detected by a camera.

An electric DC power supply capable of applying Isc of the module of interest is required. The power supply must be able to provide sufficient voltage to achieve the short-circuit current ISC of the module (typically around 10 A). Depending on the module technology, the required voltage may be approximately equal to the open circuit voltage VOC of the module (typically around 50 V).

This project will develop a portable EL measurement system enabling for measuring individual modules. To enhance image quality, a modulation needs to be integrated (illustrated in the figure below): A sequence of “dark” (no current through module) and “bright” (current through module) are taken. The average of the difference (bright – dark) of this image sequence allows to filter out noisy background.

Chart, scatter chart

Description automatically generated

Example images:

|  |  |  |
| --- | --- | --- |
| Dark | Bright | Difference |
|  |  |  |

**Goals –** In your project, you will develop:

* A modulator setup that integrates with a camera (i.e. triggers the camera in dark/bright sequence), and with a current source.
* A current source based on a portable Li-Ion battery (e.g. a bike battery), that is integrated in the modulator and has variable current and voltage limits.
* Overall system control could be either through a separate laptop, or a single-board computer (e.g. Raspberry Pi).

**Requirements**

* Electronic skills and use of hand tools.
* Programming knowledge, for example using RaspberryPi or Arduino board for the modulator.
* A current source that can deliver a user-variable constant current through the solar panel (typically approx. 10A).
  + The source is a portable (bike) battery pack (48V or 52V).
  + Usually module voltages are within the voltage range, but larger modules may require a voltage step-up conversion
  + Additional current limit / safety fuses required to avoid overloading the battery or damaging the module
  + The current source needs to have an external trigger (for integration in the main setup). This could be as simple as a MOSFET or Relay.
* The main setup will use a RaspberryPi or Arduino (or similar) as “brain”.
  + User options: Frequency, camera integration time, number of images
  + This will integrate with the current source (switch on/off at selected frequency)
  + This will also trigger the external camera.
    - In a first instance we would like to try out the latest RaspberryPi camera. This needs to be modified (infrared filter removed).
    - Later we might move to a more expensive full-frame modified camera for EL, so we need some flexibility how this trigger is integrated
  + The integration time, frequency, and number of images will affect image quality.
  + The hardware should integrate with an external computer/laptop. The external computer can perform more compute intensive tasks, such as subtracting bright and dark images.
* There will be some minor hardware/mechanical work, for integrating the components in a portable container (this can be off the shelve, rugged box).
* Some testing with real modules will be part of the project.

Some resources

<https://iea-pvps.org/wp-content/uploads/2020/01/Review_on_IR_and_EL_Imaging_for_PV_Field_Applications_by_Task_13.pdf>

<https://raspberry.piaustralia.com.au/products/raspberry-pi-hq-camera#description>

<https://iea-pvps.org/wp-content/uploads/2020/01/Review_on_IR_and_EL_Imaging_for_PV_Field_Applications_by_Task_13.pdf>

