48550 Renewable Energy Systems (Spring 2019)

Solar Photovoltaic Power Generation Experiment

Objectives

- To familiarize with the non-linear electrical property of solar PV generation;
- To investigate the effects of solar radiation, shading and tilt angle of a solar panel on the electrical characteristic of solar cells;
- To determine the optimal conditions for operating a PV panel in a circuit with a known load and understand maximum power point tracking principle (MPPT), and
- To collect measurement data for construction of a PV array for the individual assignment.

Apparatus and Materials

- 1 x 10W solar panel on a stand with adjustable tilt angles
- 2 x Digital multi-meters
- 1 x Adjustable resistor load bank
- Some insulated wires with banana plugs

Safety and Warning - Electrical Shocks and Burn Hazards

Photovoltaic (PV) modules generate electricity when exposed to light, even when they are not connected in a circuit. Shocks and burns can result from contact with module output wiring. The voltage for a single panel used in this experiment is not considered hazardous. When multiple modules are interconnected to increase array output current or voltage you need to take precautions to avoid possible injury.

Cover module front surfaces completely with an opaque cloth or other opaque material before performing any operation involving module or system electrical connections. Use appropriate safety equipment (insulated tools, insulating gloves, etc.) and procedures.

Metal objects such as the panel frame can be heated in strong sun. Check the temperature before grasping items which may have been heated.

Experimental Work

1. The aim of this experiment is to plot the I-V and P-V curves of the given solar panel under different insolation (solar intensity) levels, e.g. choosing different times of the day, using different tilt angles, etc. You will need to plot at least 3 curves which represent three different levels of insolation.
2. The efficiency of the solar panel will depend on the angles of the panel relative to the sun. The azimuth can be adjusted by moving the base frame and checking the shadows of the frame legs. The elevation (tilt) can be adjusted in 10 degree steps using the knob and slotted sector on the side of the frame.
3. Ideally, the data points for each curve should be corresponding to a certain insolation values. However it is difficult to keep that insolation level due to changing weather, passing clouds and objects, etc. Hence to minimise the variation, choose an open area without much shading to perform your experiment. Taking the data points quickly will also help reduce this data error.
4. Connect the experiment according to Fig. 1. Fig. 2 shows the schematic of connecting the equipment together. For the digital meter using as an ammeter, select the mA scale to obtain better readings.

5. Measure the panel's open circuit voltage and record the value in the given table. Record the measuring conditions, such as weather, date, time and tilt position of the panel. Measure the light intensity and ambient temperature using the QM1594 multifunction environment meter.
6. Measure the short circuit current and panel output voltage in the same conditions as in step 4. Record both values. The panel voltage will be small (0) for this condition.
7. The load bank has two resistive elements. One element is switch selectable to fixed values of resistance, the other is continuously variable from 0 to 50 ohms. Using the switched resistances begin with the near open circuit condition, (i.e., maximum resistance), lower the load resistance so that the panel voltage decreases from open circuit toward zero. Record panel voltage and current at each step. You may connect the variable 50 ohm load in series with the switched resistances to get additional data points around the maximum power point. Plot the results of I versus V and P versus V using some mathematical software package such as Excel and MATLAB.
8. Repeat Steps 4 to 6 under two other very different insolation conditions, i.e., different weathers, shading half a cell or different time of a day.

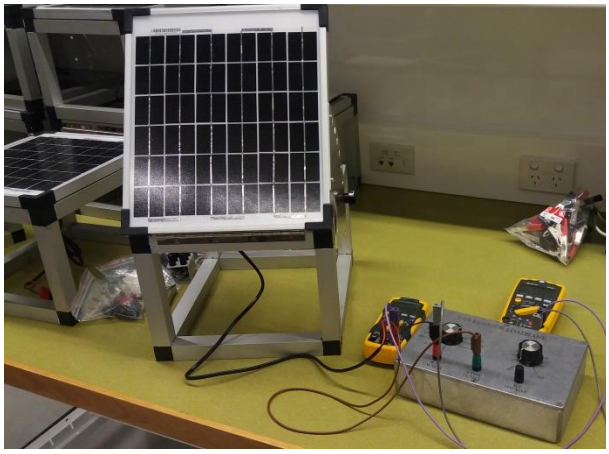

Fig. 1 Experimental setup for PV panel measurement

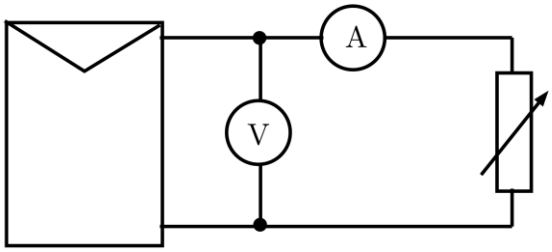

Fig. 2 Schematic of connections for the PV experiment

Fig. 3 Use the screw-type knob to change the tilt angle of the PV panel

Group Report

1. Briefly explain the mechanism of solar PV generation with the aid of diagram(s).

2. Explain the three test conditions and show the results in both table format and graphical plots.

3. Locate on the graphs the estimated maximum power points (MPPs). Comment on any variation of the MPPs and the implication of loading impedance values for the PV panel to maintain at MPPs under all solar intensity conditions.

Submit the report via UTSOnline in PDF format. Submission deadline is on 11 August at 23:59 (Sunday).

Data collection and plotting

Set 1 (Condition and setting): _____

Voltage	Current	Resistance	Power	Voltage	Current	Resistance	Power

Set 2 (Condition and setting): _____

Voltage	Current	Resistance	Power	Voltage	Current	Resistance	Power

Set 3 (Condition and setting): _____

Voltage	Current	Resistance	Power	Voltage	Current	Resistance	Power