Experiment-2

Experiments on Solar Cell

Objectives:

1. I-V Characterization of solar cell under dark and illuminated conditions
2. Using the solar cell as power source

The experimental setup uses a black box shown in Figure 1. It comprises of a solar cell and an LED bank consisting of 24 white LEDs.

Figure 1: Solar cell characterization module.

Measurement of I-V characteristics

Dark conditions:

1. Connect the circuit as shown in the Figure 2

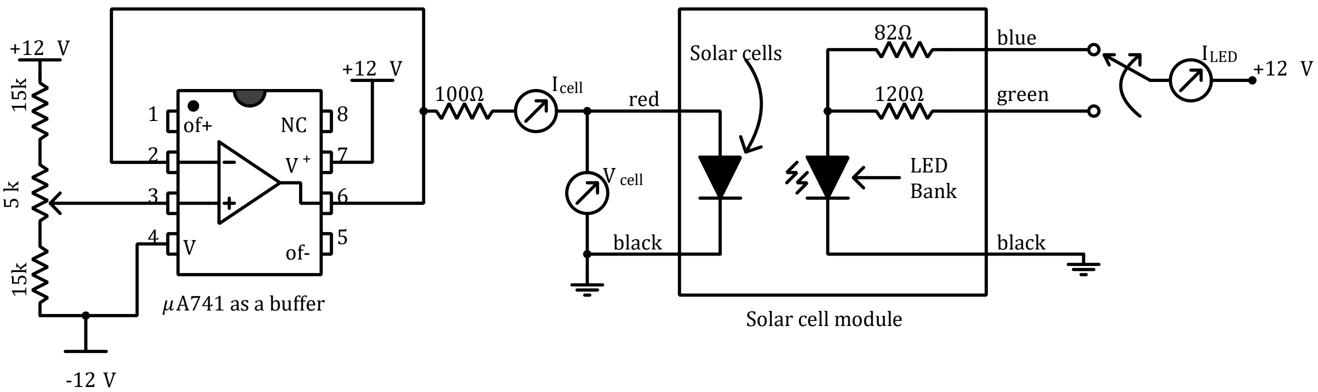

Figure 2: Solar cell I-V characterization circuit.

2. Make sure that the solar cell box is properly covered and the 12 V voltage supply applied to the LED bank is turned OFF.

3. This part of the experiment measures the I-V characteristics of the solar cell in forward and reverse bias under no illumination. Set voltage range of DMM to 2 V and current range to 20 mA. Take all the readings with these settings. Adjust the potentiometer to vary V_{in} from -2V to 2V and note down current and voltage through the solar cell under "Dark" condition as I_{cell} and V_{cell} respectively. (Please note the polarity of I_{cell} and V_{cell} while taking readings.)

Illuminated conditions:

In this part of the experiment, we will measure the I-V characteristics for two different levels of illumination, I_1 and I_2. The level of illumination is changed by changing the current through the LED bank by connecting appropriate series resistance. In this part of the experiment, take many readings in the fourth quadrant (positive voltage and negative current).

1. Now connect the LED bank to the 12 V power supply and select the 120 Ω resistor by connecting the wire to the "Green" terminal marked for intensity I_1. Note down the current through the LED bank.

2. Once the I_{LED} is measured, the LED panel can directly be connected to the 12V source and the ammeter can be disconnected and be used across the solar cell for the V_{cell} or I_{cell} measurements.

3. Adjust the potentiometer to vary V_{in} from -2V to 2V and note down current and voltage through the solar cell under "Lighted" condition as I_{cell} and V_{cell} respectively. (Please note the polarity of I_{cell} and V_{cell} while taking readings.)

4. Next, repeat the experiment by connecting the power supply to the "Blue/Red" (the one marked for I_2) terminal marked for intensity I_2 (82 Ω) of the LED bank and take another set of I-V readings.

5. Tabulate as observations as follows:

Dark			Illuminated I_1			Illuminated I_2	
I_{cell}	V_{cell}		I_{cell}	V_{cell}		I_{cell}	V_{cell}

6. Plot the I-V characteristic of the solar cell that you measure for dark intensity I_1 and Intensity, I_2.

Solar cell as power source

1. Connect the circuit shown in Figure 3. You can now use the 0-32 V variable supply for LED bank. Adjust both the potentiometers for minimum resistances.
2. Shine light on the solar cell for intensity I_1 by connecting "Green" terminal of LED bank and setting V supply to 12 V. Note the LED current (It should be same as the one in the earlier experiment for I_1).

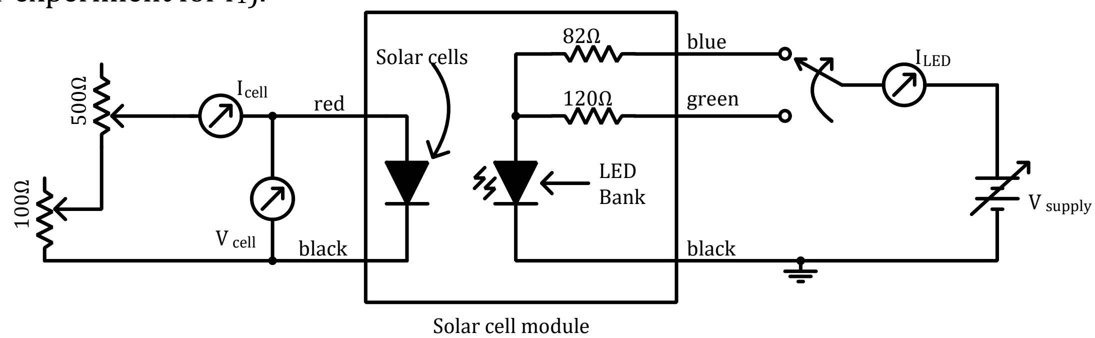

Figure 3: Solar cell as a power source

3. Once the I_{LED} is measured, the LED panel can directly be connected to the 12V source and the ammeter can be disconnected and be used across the solar cell for the V_{cell} or I_{cell} measurement.
4. Measure I_{cell} and V_{cell} by varying the potentiometers. Use 100 Ω pot for fine and 500 Ω pot for coarse variation. Take the readings till the current I_{cell} reduces to zero.
5. Repeat for intensity I_2 by connecting "Blue" terminal. Note LED current (It should be same as the one in the earlier experiment for I_2.) (Note: The characteristic is nonlinear. Take more readings in the "knee" region of the curve). Tabulate your observations.

6. Plot I_L (I_{cell}) vs $V_L(V_{cell})$. From this graph find I_{SC} and V_{OC} for the two intensities I_1 and I_2.
7. Plot Power P as a function of V on the same plot obtained above. Determine the voltage V_{MP} at which the power P reaches maximum. Find the current I_{MP} at the maximum power point.

   Using I_{MP} and V_{MP}, calculate the fill factor as,

$$FF = \frac{I_{MP}V_{MP}}{I_{sc}V_{oc}}$$

Illuminated I_1			Illuminated I_2	
I_{cell}	V_{cell}		I_{cell}	V_{cell}

Measurement of V_{OC} and I_{SC} at different illumination levels

1. Connect the LED bank to the variable power supply (0-32V) by connecting V_{supply} to "Blue" terminal via DMM (for measuring I_{LED}) and another DMM to across the solar cell as shown in Figure 4.
2. Connect a DMM across the cell such that just by swapping to voltage and current ranges you can record both V_{OC} and I_{SC} for a given value of I_{LED}. Note that there is no switch but you will manually swap the settings.

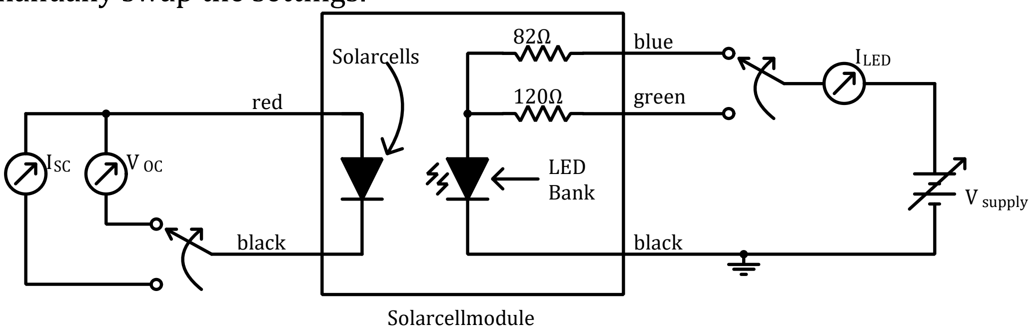

Figure 4: Solar cell characterization of *VOC* and *ISC*.

3. Set I_{LED} = 10 mA by adjusting V_{supply}.

4. Measure V_{OC} and I_{SC}.

5. Repeat the measurements for I_{LED} from 10 mA to 50 mA in steps of 5 mA by varying V_{supply} and note your observations.

I_{LED}	V_{OC}	I_{SC}
10 mA		
15 mA		
20 mA		
25 mA		
30 mA		
35 mA		
40 mA		
45 mA		
50 mA		

6. Plot I_{sc} v/s light intensity (LED current) and V_{oc} v/s log intensity (LED current). Comment on the nature of the graph.