I-V Characteristics of Solar Cell

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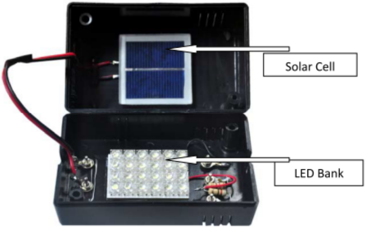
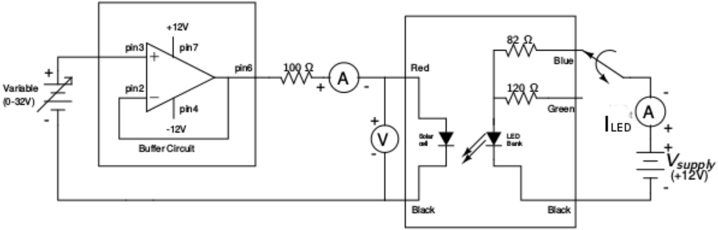
Experimental set-up

- The experimental setup for this experiment uses a black box shown in figure comprises of a solar cell and an LED bank consisting of 24 white LEDs.



Part 1: Measurement of I-V characteristics



- Connect the circuit as shown in figure. (Refer slide no. 9 for the details of buffer circuit.)
- Make sure that the solar cell box is covered and no voltage is applied to the LED bank.

- A) Dark I-V
  This part of the experiment measures the I/V characteristics in forward and reverse bias of the solar cell in the dark.
  Set voltage range of DMM to 2V and current range to 20mA. Take all the readings with these settings. Vary the variable power supply(0-32V) from -2V to 2V and note down current and voltage through the solar cell under "Dark" condition as I_D and V_D respectively.
- Note that you will have to change the polarity of solar cell voltage manually while changing from $-$ ve bias to $+$ve bias voltage.

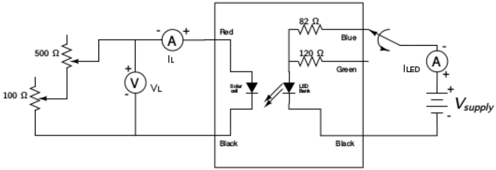
B) **Current-Voltage characteristics under light** :
In this part of the experiment, we will measure the current-voltage characteristics for two different levels of illumination I1 and I2. The level of illumination is changed by changing the current through the LED bank by connecting appropriate series resistance. In this part of the experiment, take more readings in the fourth quadrant (positive voltage and negative current) to get smooth plot.

a Connect the LED bank to power supply and select the 120Ω resistor ("Green") terminal marked for intensity I1.
Note down the current through the LED bank.

b Vary solar cell voltage from -2V to 2V and note down current and voltage through the solar cell under "lighted" condition as I and V respectively.

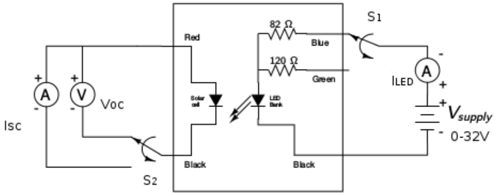
c Follow above steps (a and b) by connecting the power supply to the "Blue" terminal marked for intensity I2 (series resistance of 82Ω) of the LED bank for another set of I and V readings.

Part 2 : Solar cell as power source



- In this part, the solar cell will be illuminated by the LED bank. The cell will drive the variable load (two series connected potentionmeters).
- Connect the circuit shown in figure. You can now use the 0-32V variable supply for LED bank.
- Shine light on the solar cell for I1 by connecting "Green" terminal to Vsupply set at 12 V. Note I_{LED}. (It should be same as the one in Part I for I1).
- Measure I_L and V_L by varying potentiometers. Adjust both the potentiometers for minimum resistance for current closed to I_{sc}. Use 100Ω pot for fine and 500Ω pot for coarse variation. Take the readings till the current I_L falls to almost zero (closed to V_{OC}).
- Repeat step 3 for I2 by connecting "Blue" terminal. Note LED current (It should be same as the one in Part 1 for I2). (Note: The characteristic is nonlinear. Take more readings in the "knee" region of the curve.)

Part 3 : Measurement of V_{OC} and I_{SC} at different illumination levels

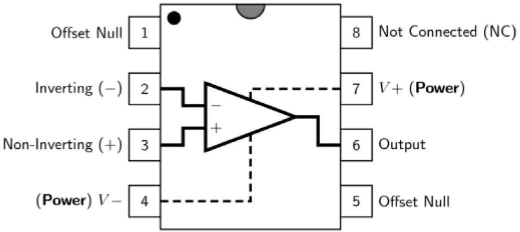


- Connect the LED bank to the variable power supply (0-32V) by connecting Vsupply to "Blue" terminal via a DMM (for measuring I_{LED}) and another DMM across the solar cell as shown in figure. The DMM conected across the solar cell is manually swapped to emulate the switch S_2 for measuring voltage and current to record both V_{OC} and I_{SC} for a given value of I_{LED}.
- Set $I_{LED} = 10$ mA by adjusting Vsupply.
- Measure V_{OC} and I_{SC}.
- Repeat the above steps for I_{LED} 10 mA to 50 mA in steps of 5 mA by varying Vsupply.

Report

- Plot the I-V characteristic of the solar cell that you measured from Part 1 for dark, intensity I1 and Intensity I2. (You can get the FF from here also).
- From the data from Part 2, plot I as a function of V. From this graph find Isc, and Voc for two intensities I1 and I2.
- Using the data collected in Part 2, 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 FF = I_{MP}* V_{MP} / (Isc*Voc).
- Superimpose the readings of Part 1 obtained in the fourth quadrant and readings obtained in Part 2. Do they match?
- Plot Isc v/s light intensity (I_{LED}) and Voc v/s ln I_{LED}.
- Comment on the graphs you plotted above.

IC 741: Operational amplifier



- In the circuit arrangement of Part 1 the operational amplifier IC741 is used as a voltage buffer. The buffer is a singleinput device which has a gain of 1, mirroring the input at the output. The current through solar cell is required to sink in the fourth quadrant. The pushpull arrangement in the output stage of the opamp provides "sink path" to the reverse current in the solar cell.