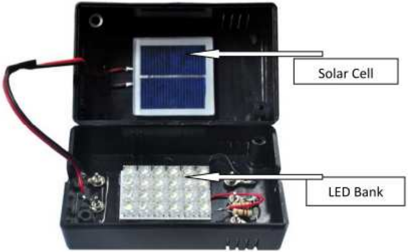
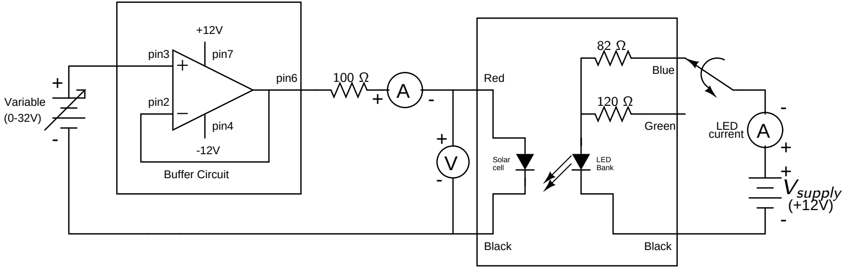
I-V Characteristics of Solar Cell

Wadhwani Electronics Lab

Department of Electrical Engineering
Indian Institute of Technology Bombay
August 2014.

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





- Connect the circuit as shown in the figure above. (Refer page 11 for details on the buffer circuit.)
- Make sure that the solar cell box is properly covered and the 12V voltage supply applied to the LED bank is turned OFF.

I-V of Solar Cell (Dark)

- 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 2V and current range to 20mA. Take all the readings with these settings. With the variable power supply vary V_{supply} from -2V to 2V and note down current and voltage through the solar cell under "Dark" condition as I_D and V_D respectively.
  (Please note the polarity of I_D and V_D while taking readings.)

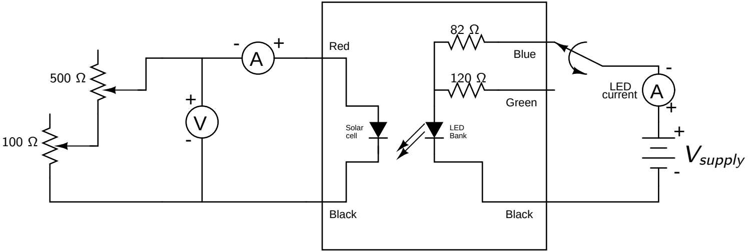
- Note that you will have to change the input polarity of V_{supply} of solar cell arrangement manually while changing from -ve bias to +ve bias voltage.

I-V of Solar Cell (Light)

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).

i. Now connect the LED bank to the 12V 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.
Vary V_{supply} from -2V to 2V and note down current and voltage through the solar cell under "lighted" condition as I and V respectively.

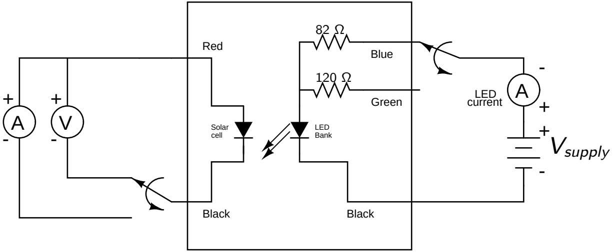
ii. Follow step i, by now connecting the power supply to the "Blue" terminal marked for intensity I_2 (82 Ω) of the LED bank and take another set of I-V readings.



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

- Measure I_L and V_L by varying potentiometers. Use 100 Ω pot for fine and 500 Ω pot for coarse variation. Take the readings till the current I_L falls to almost zero.
- Repeat step 3 for I_2 by connecting "Blue" terminal. Note LED current (It should be same as the one in Part I for I_2).

  (Note: The characteristic is nonlinear. Take more readings in the "knee" region of the curve.)

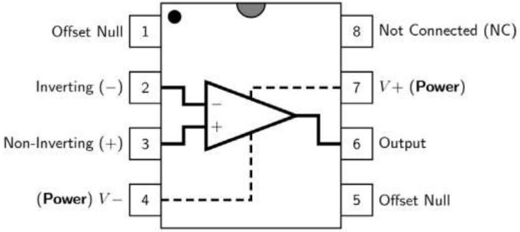


Connect the LED bank to the variable power supply (0-32V) by connecting V_{supply} to "Blue" terminal via DMM (for measuring I_{LED}) and another DMM to across the solar cell as shown in figure. Connect a DMM across the cell such that just by swapping to voltage and current ranges you can record both 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.

Part 3 Continued...

- 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 V_{supply}.

- Plot the I-V characteristic of the solar cell that you measured from Part 1 for dark, intensity I_1 and Intensity I_2. (You can get the Fill Factor (FF) from here also).
- From the data from Part 2, Plot 1 as a function of V. From this graph find I_{sc} and V_{oc} for two intensities I_1 and I_2.
- 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 as, FF = I_{MP}* V_{MP} / (I_{sc}*V_{oc}).
- Superimpose the readings of Part 1 obtained in the fourth quadrant and readings obtained in Part 2. Do they match?
- 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.



In the circuit arrangement of Part 1, the operational amplifier IC741 is used as a voltage buffer. The buffer is a single input 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.