

Please answer the following questions on this sheet and bring to your analysis section

- a) Based on your I-V curve, what are the current, voltage, and power output at the maximum power point? What is your $\$/W$? Please fill in below:
- i. $V_{\text{mpp}} =$

 - ii. $I_{\text{mpp}} =$

 - iii. $P_{\text{mpp}} =$

 - iv. $\$/W$
- b) Your supremely-awesome (and incredibly humble) TA provided you with estimates on the series and shunt resistance by fitting the non-ideal diode equation (reproduced on the back of this sheet) to your dark I-V curve using a super-slick MATLAB[®] script. They should be posted online a few hours after your I-V measurements were taken. Please reproduce the values below:
- i. $R_{\text{sh}} =$

 - ii. $R_{\text{s}} =$
- c) Based on your answers in (b) and (c), please estimate the power lost in your device due to shunt and series resistance at the maximum power point. Please write the equation you use to estimate these losses. It may help to study the non-ideal diode equation to answer this question! Hint: these equations require one line of computation!
- i. $P_{\text{Rsh}} =$

 - ii. $P_{\text{Rs}} =$
- d) Based on your answer in part (c), what is the percent of your power output is lost to:
- i. Shunting?

 - ii. Series Resistance?

- e) Now you know what is robbing your of precious power output, which technique do you wish to analyze your device (lock-in thermography, Suns Voc, or EQE/IQE?) Please explain why, but limit to 2 sentences! Also descriptions of the 3 different techniques can be found below.

The non-ideal diode equation:

$$I = I_L - I_0 \exp\left(\frac{q(V + IR_S)}{nkT}\right) - \left(\frac{V + IR_S}{R_{SH}}\right)$$

Lock-in Thermography

Using an infrared camera, you can see where sections of your solar cell are heating up under either forward or reverse bias. This primarily enables you to visualize areas or sections of your cell that are shunted. A lot of current will pass through a shunt, and this current leads to Ohmic heating in that area, which is why you can see shunts with an infrared camera.

Suns Voc

This is a tool created by Sinton consulting that measures the V_{oc} of your cell as a function of illumination intensity. The analysis done by the tool's software will yield a "pseudo light I-V" curve which eliminates the effect of series resistance. Comparing this measurement to your actual I-V curve will give you a precise measure of series resistance.

EQE/IQE

This can tell you the diffusion length of the photo-excited carriers in your device. Additionally it can tell you the blue-response of your device, which can often yield insight to carriers lost due to recombination in your emitter.

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