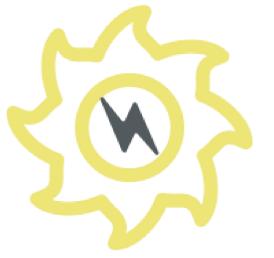


Design and Implementation of a High Luminosity Lantern Using Photovoltaic Generation of Electrical Power



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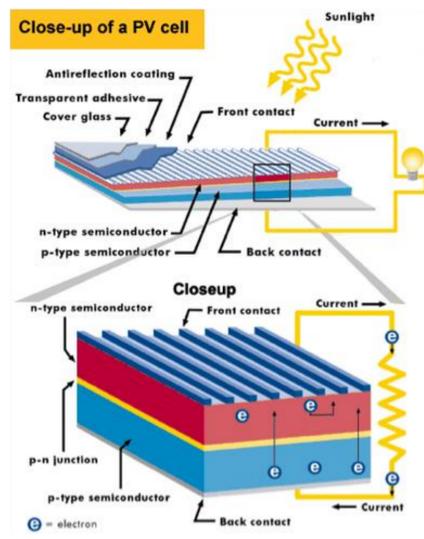
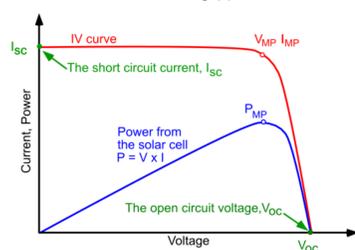
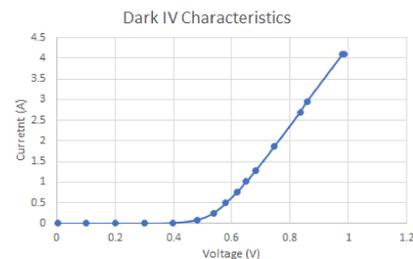
Introduction

The aim of this project is to understand the theory of operation of the lantern and its components and the process of design and implementation. The proposed high luminosity lantern should be capable of providing 1500 lumens of isotropic light for roughly 3 hours/day for approximately 3 days. On one charge, the lantern should be able to provide up to 9 hours of light. In today's world, this project is relevant as global warming is accelerating. This proposed project will help to promote a widespread use of a high luminosity lantern using solar power and help to provide energy to those who do not have access to the power grid.

The team began the project by first researching and understanding the theory behind solar cells. Focusing on the physics of PV cells, their characteristics and their interconnection to form a PV panel, and the difference between off-grid and grid-tied generation systems were the major tasks in the first half of the year. Load calculations and requirements were then calculated after thorough research. The design, development, and testing of each component then occurred in the second half of the year.

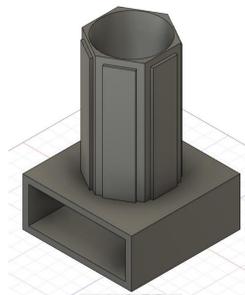
Background

Solar cells are semiconductor devices that convert sunlight into electricity by the photovoltaic effect. When photons of light are absorbed by the cell, electricity is produced when charge carriers are excited. Solar cells can be considered as a larger flat diode. In the dark, a solar cell models like a diode. In light, the IV curve of a solar cell is the superposition of the characteristics of the solar cell diode in the dark. The maximum power point on an IV and PV curve shows where the solar cell should be operated at to give maximum output power. This is important to get the highest efficiency and operation.



Design Concepts

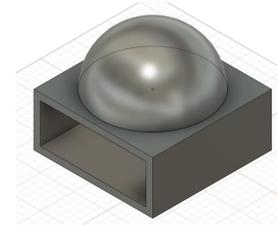
The team initially focused on an LED layout that involves the initial design that was hexagonal shape. Initially, the team obtained an aluminum heat sink with a row of LEDs and we found that it was not flexible enough to work around with and decided to move on with individual surface mounted LEDs. With the introduction of the surface mounted LEDs, it provided more flexibility to the design by making it more compact to a dome shape. It also provided more even lighting to be dispersed evenly throughout the room.



Initial Design



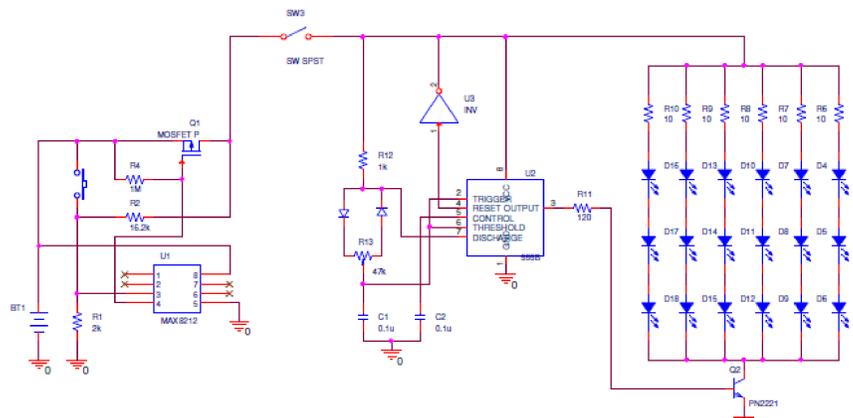
SMD LED



Revised Design

In the revised design, the team kept the battery slot base since it seemed to fit well with the dome top, so the base remained the same. This design is significantly more compact as the pitch between each LED could be controlled. The SMD LEDs used for this design allowed for a more compact design which uses 15-20 of these LEDs in a parallel series configuration as shown in the following diagram.

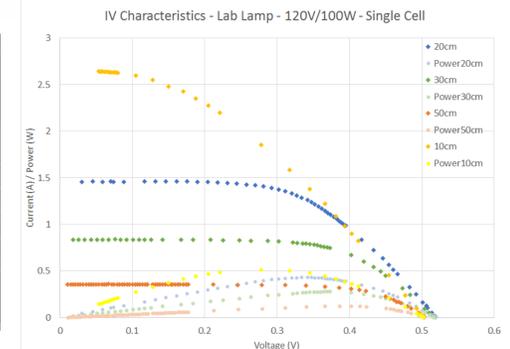
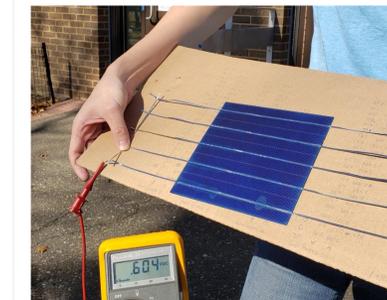
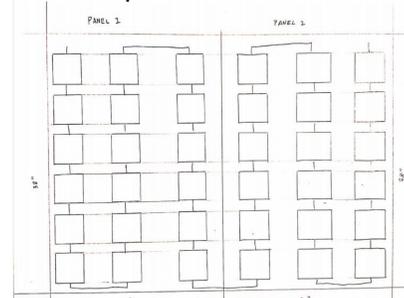
Circuit Design



A battery disconnect circuit was included to cut the connection between the battery and the lantern if the voltage goes below a certain point. A simple on and off switch was also included as well as a dimmer.

Solar Panel & Battery

The proposed final design of the solar panel would consist of two 20" x 28" panels connected in series. Each panel would have 18 cells connected in series. The total number of cells would be 36 cells in series. With each cell having $V_{oc}=0.5V$ and $I_{sc}=6-8A$, each panel would produce 9V and 6-8A making the total output of both panels combined to be roughly 18V and 6-8A. Combined panels would be connected to a PWM charge controller and to a 12V 22Ah lead-acid battery. A charge controller is a necessary safety precaution to prevent overcharging. The lifespan of the battery can also be preserved with the use of a charge controller.



Glossary

- PV: Photovoltaic
- SMD: Surface Mounted Device
- Voc: Open Circuit Voltage
- Lumens: a measure of the total amount of visible light from a light source
- PWM: Pulse Width Modulation
- Isc: Short Circuit Current

Acknowledgements

VARK would like to thank Professor Parekh for being our advisor for this project. He has helped push the group towards the right direction by answering all of our questions. We would like to give a special thanks to Tony and Professor Eisaman for giving us pointers and helping us out during our testing phase. Finally, we would like to thank Professor Dhadwal and the ECE Department. Thank you all for the extensive support and opportunity to work on a valuable project.