# Hybrid Solar/Battery for Electronic Derailleur

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**Client and Advisor:** Dr. Raj Raman

## Introduction

**Problem Statement:**
The client requested a solar/hybrid battery to provide power to an electronic derailleur. The derailleur is currently powered by a battery that is charged through a wall outlet. The benefit of having the solar/hybrid battery is that the battery will never need to be taken off the derailleur to charge and, therefore, will hypothetically never die because the sun will be able to charge the battery since the bike is outside.

**Solution:**
The team determined a solar cell combined with a charge controller, LiPo battery, and DC/DC converter would be a suitable replacement for the original battery. To protect the circuit, the team designed and printed a 3D model case.

## Design Requirements

**Functional Requirements and Engineering Constraints**:
- Charge time: 6 hours
- Run time: 10 hours
- System must include a charge controller to protect the battery and prevent overcharging
- System must be mechanically robust
- Battery must use the existing battery's mechanism for attaching to the bike
- Must be weather resistant
- Must operate from the temperature range: -10C to 45C
- Battery and solar cell must be one unit
- Solar cell must be approximately 2 x 2.5 inches

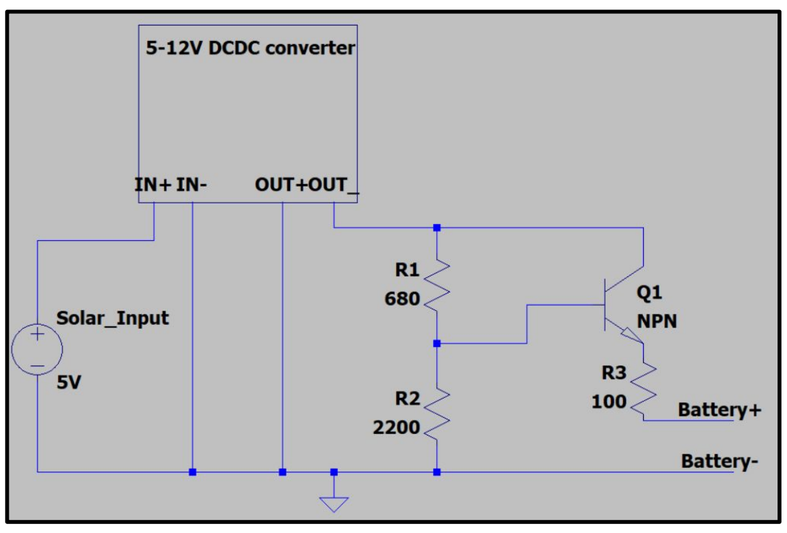
**Nonfunctional Requirements and Constraints**:
- Total cost for project is $500
- System must be sleek and compact

**Operating Environment**:
- The system will be used outside in all weather conditions

**Relevant Standards:**
- 1679.1-2017: Guide for the Characterization and Evaluation of Lithium-Based Batteries in Stationary Applications
- 1562-2021: IEEE Recommended Practice for Sizing Stand-Alone Photovoltaic (PV) Systems
- IP58: International Protection Rating 58

## Design Approach

**Electronic Schematic**
The figure below shows the electronic schematic of the circuit which was used to connect the solar cell to the battery. As seen in the figure, the team designed a charge controller as well.




## Technical Details

**3D model**
Figure 1 shows the 3D modeled case that was printed to hold all the electronic components. Figure 2 is a schematic of the case.

**Programs**
Arduino
AutoCAD Fusion 360
LTSpice

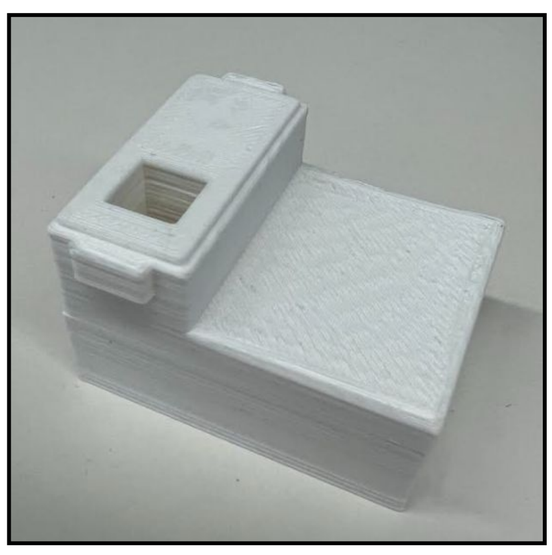


Figure 1

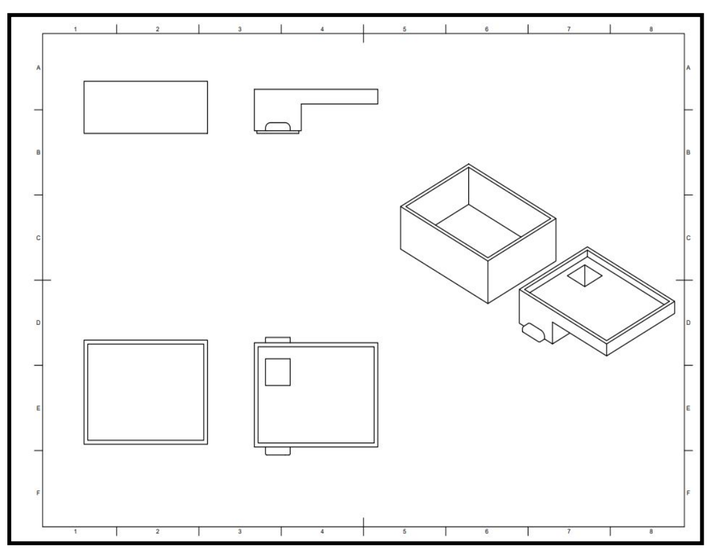
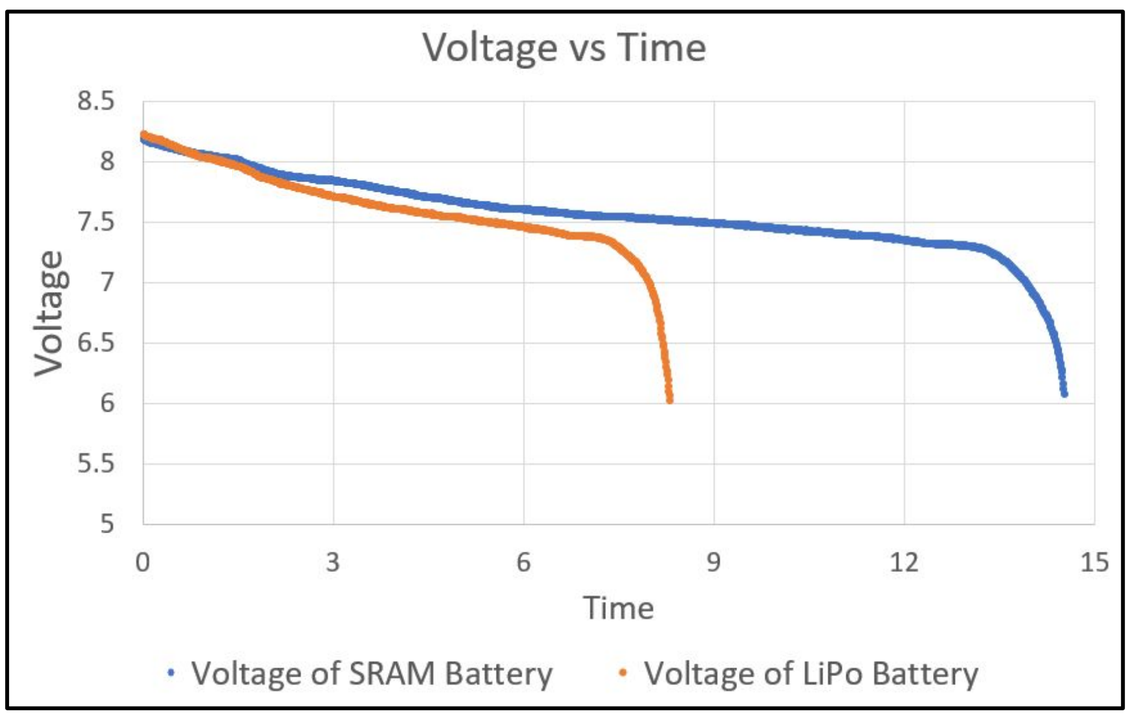


Figure 2

## Background Information

**Derailleur:**
A derailleur automatically shifts the bike between gears, which changes the position of the chain, when the user pushes a button. The derailleur that the team used for the project was SRAM'S Rival Etap Axs Rear Derailleur, a picture of the derailleur can be seen above. The red component is where the battery attaches to the derailleur.

**Intended Users and Uses:**
The intended audience for the derailleur is the client, Dr. Raj Raman. The client intends to use the derailleur on his recumbent bike which he uses to commute to and from campus daily.




## Testing

**Component Testing**
- Individual component testing was conducted to ensure components worked accordingly to meet requirements.

**Battery Testing**
- The graph above demonstrates the SRAM battery and LiPo battery run time. This verified the battery met the 6 hour run time.

**Water Testing**
- Submersed the system for 12 hour in water. After 12 hours, there was no water in the system.

**Dust Testing**
- Poured sand over the system and agitated the system around to see if sand was able to get into the system. There was no sand in the system after the test.

**Vibration Testing**
- A vibration of 40 Hz was delivered to the system by a massage gun for 1 hour to verify the system was resistant to vibration.

**Shock Testing**
- With the battery attached to the derailleur, the bike was dropped from various heights to ensure the battery remain attached.

**Overall**
- This testing verified that the system met the electronic design requirements and IP58 standards are met for water and dust.


*Above*: Battery encased in the white case attached to the derailleur

*Left*: Solar Cell attached to bike in correct position for optimal performance