SoC Controller for EEG-Based Sleep Tracker Battery

Spring 2024: Parker Parmacek in Co-Development with Brandon Chea, Austin Cable

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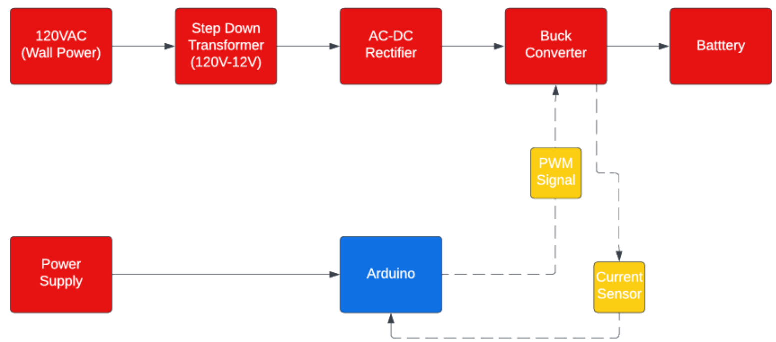
Abstract

This capstone project aims to develop a State of Charge (SoC) Algorithm Controller for an EEG-Based Sleep Tracker Battery. The primary objective is to design and implement an efficient charging device that utilizes a SoC Estimation Algorithm to optimize the battery charging process. The project will involve simulation using Simulink, breadboard testing, and Perf Board design to determine the optimal system parameters, including RLC components and PWM frequency and duty cycles for the buck converter. Research will be conducted to explore SoC estimation algorithms and integrate a current-controlled device with the microcontroller for precise charging control. The successful completion of this project will contribute to the advancement of battery charging technologies and improve the performance of wearable devices in sleep monitoring applications.

Design

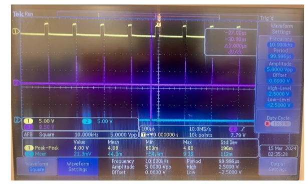


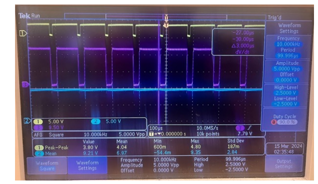
Key Features

Current Control

```
// Current Control accounting for desired duty cycle
float currentRatio = batteryCurrent - current_mA;
if (currentRatio > 0) {
    intDutyCycle += 1;
} else if (currentRatio < 0) {
    intDutyCycle -= 1;
} else {
    // Do nothing if current is within the desired range
}
```

Buck Converter (Voltage Range)





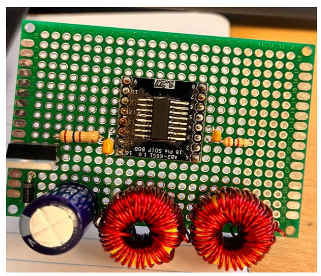
Background

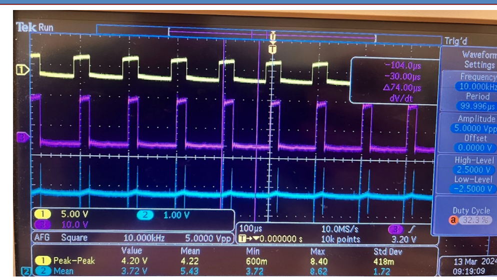
Sleep is crucial for various aspects of human development, yet modern life often disrupts sleep patterns, leading to health issues. To address this problem, there is a need for an affordable and convenient sleep tracking device. My primary objective is to create a charging device for the battery powering the sleep tracker. The goal is to ensure that the battery can sustain the device throughout a full night's rest, typically lasting 8 to 10 hours. The affordability of the product is a key consideration, as making it accessible to a wide range of consumers ensures that it can benefit a broader demographic, ultimately contributing to its positive impact on public health and well-being.

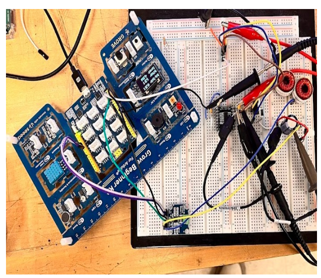
References

[1] Q. Ouyang, Z. Wang, K. Liu, G. Xu and Y. Li, "Optimal Charging Control for Lithium-Ion Battery Packs: A Distributed Average Tracking Approach," in IEEE Transactions on Industrial Informatics, vol. 16, no. 5, pp. 3430-3438, May 2020, doi: 10.1109/TII.2019.2951060.

Results



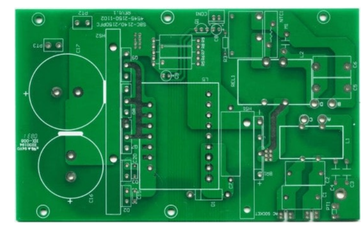




Future Direction

Future Goals:

1. Implement Buck Converter with Analog Controls
2. Design and Build PCB for Circuit
3. Build housing unit for charging device.



Acknowledgements

Amr Radwan, Xichen Jiang, Reza Afshari, John Lund

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Capstone Project
Electrical & Computer Engineering Program