Miniaturized Power Conversion for Kinetically Charged Batteries – Development & Optimization

Gwen Eging, Engineering (Robotics)
Mentor: Ayan Mallik, Assistant Professor
Fulton Schools of Engineering

Wouldn't it be nice to be able to go about your busy life without worrying about charging your device, essentially living life untethered?

Background

Kinetically charged batteries are an important next step in sustainable power. By using a kinetically charged battery in combination with an average chargeable battery and you have a device that can last the whole day. This research was done with a watch battery in mind, like a Seiko Kinetic SKA553 watch. The average watch battery works from 1.5 V - .8 V which is the constraint the circuit had to operate within. The constant output chosen was 5 V, amounting to 5 W, as that is the voltage needed for most devices, such as a smart watch.

Process

1) Circuit type selection
2) LTSpice simulation
3) Component selection
4) Testable Prototype
5) Printed PCB
6) Voltage sensor & MOSFET driver adjustment
7) Minimize the components & circuit size.

*Process steps 5-7 were unable to be completed due to time constraints.

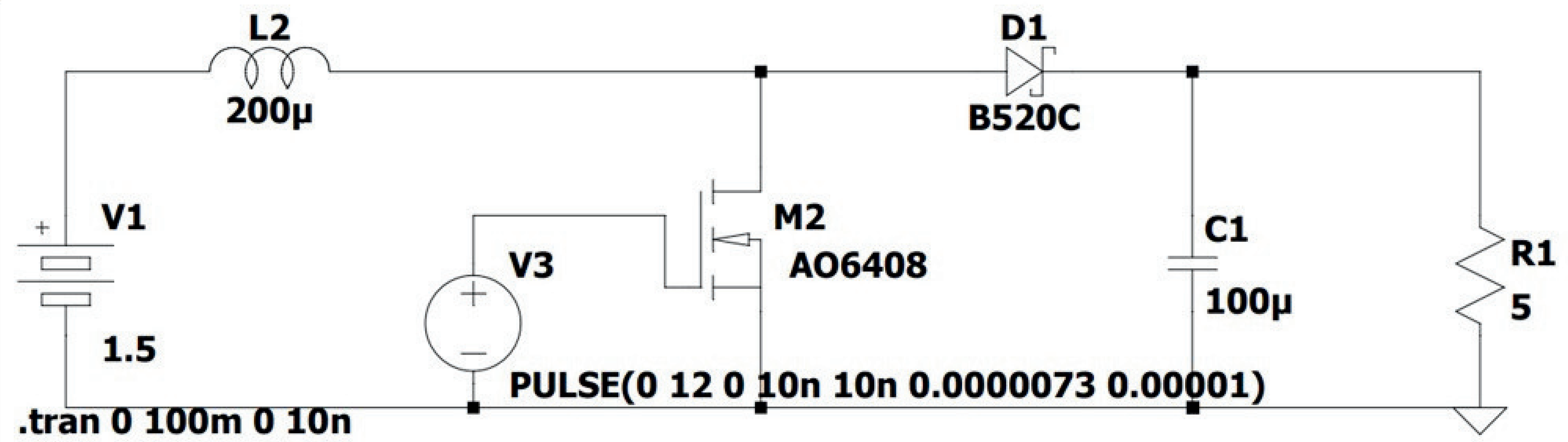
Findings

It is possible to get a constant output of 5V with both the 1.5 V input and the .8 V input. In order to do this the duty cycle of the MOSFET needs to change.

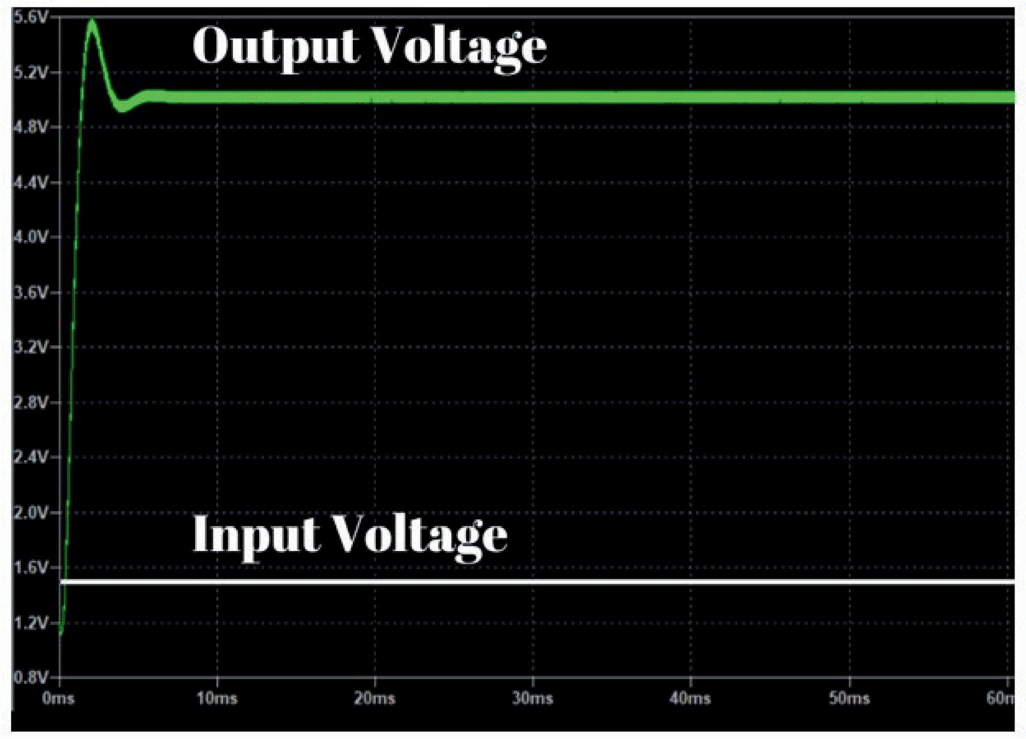
1.5 V	69.9% Duty Cycle
.8 V	84% Duty Cycle

Acknowledgments

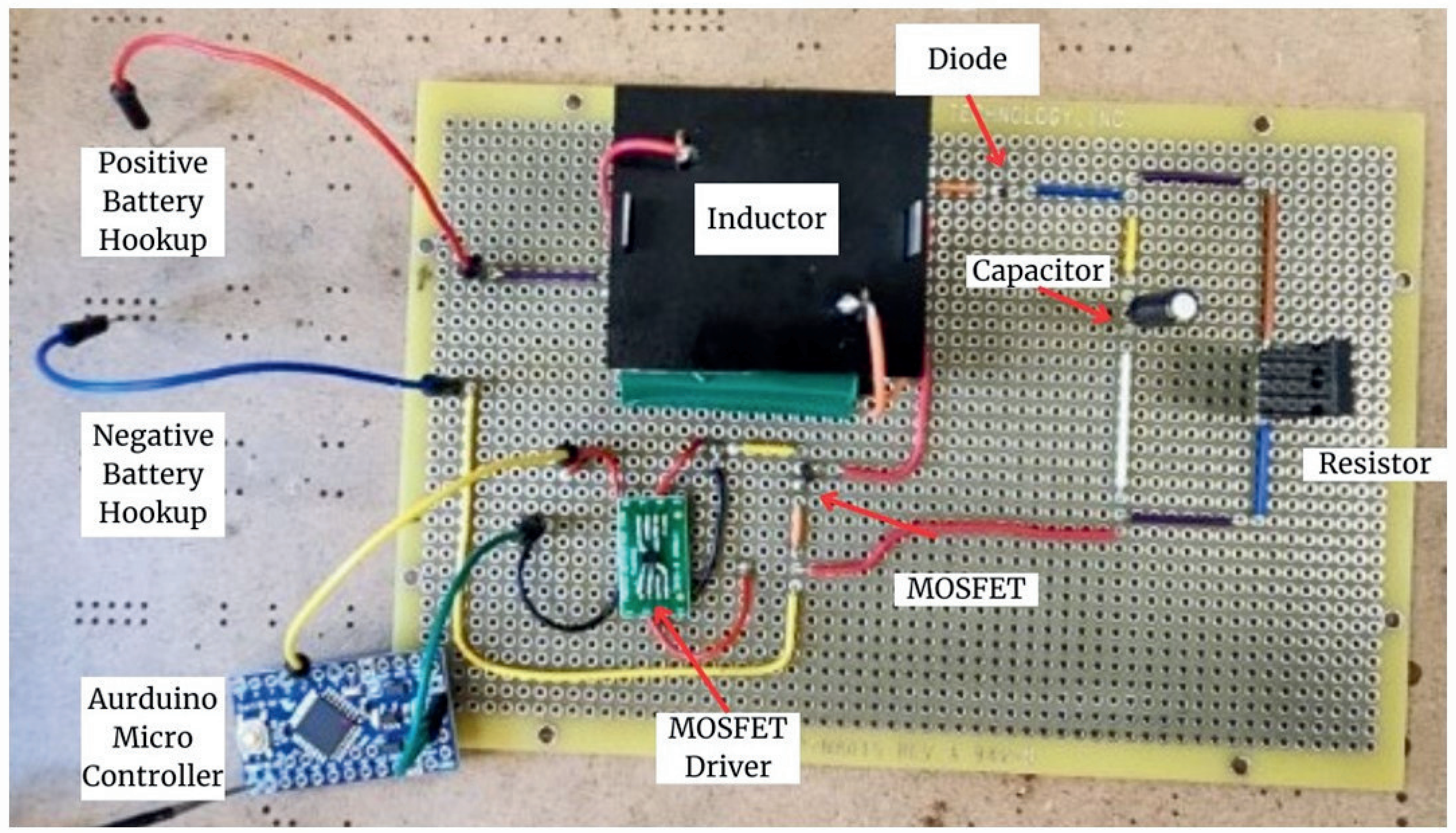
Ayan Mallik and the graduate students in the Power Electronics and Control Engineering Laboratory



DC – DC Boost Converter



*LTSpice Simulation data with 1.5V input



Challenges Faced

- The engineering discipline this project falls under is not my area of expertise. While being a robotics major, I lean mechanical in terms of strengths. This was the largest challenge as it meant there was a considerable amount to learn
- Time played a large factor in terms of constraints. With less than a full semester for the entire project some steps in the process were unable to be completed.
- Circuit design was the longest step in the process. It was tricky calculating and selecting the components in order to get the 5 V output in the simulation software, LTSpice.

Future Development

This project will be continued into the spring semester. The next step is to print a PCB board to minimize the size of the circuit. Next is to develop a voltage sensor using the micro controller. This will allow the duty cycle to be recalculated and changed according to the input voltage. Using this method, the output will constantly be 5 V. The final step to this research project is to then minimize the size of the circuit.

Component	Part Number	Specifications	Calculated Requirements
Capacitor	EEU-FC0J101B	100 µF 6.3 V Aluminum Electrolytic Capacitors Radial	100 µF
Resistor	PWR221T-30-5R00F	5 Ohms ±1% 30W Through Hole Resistor TO-220-2 Full Pack Automotive AEC-Q200	5 Ohms
Inductor	CPQ4228-221M	220 µH Shielded Wirewound Inductor 17.5 A 11.5mOhm Max Nonstandard Flat Wire	200 µH
MOSFET Driver	IX4310TTR	2A low side gate driver. The output is capable of sourcing and sinking 2A of peak current, and has a maximum voltage rating of 24V	N/A
Arduino	DEV-11113	ATmega328 Arduino Pro Mini 328 5V/16MHz AVR® ATmega AVR MCU 8-Bit Embedded Evaluation Board	N/A
N-Channel MOSFET	DMN204L-7	N-Channel 20 V 6.4A (Ta) 780mW (Ta) Surface Mount SOT-23-3	N/A
Diode	BAT60AE6327 HTSA1	10 V 3A Surface Mount	Minimal resistance.

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Ira A. Fulton Schools of Engineering
Arizona State University