Electric Vehicle Range Extension

Team 2

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Presentation Overview

- Project Scope
- Project Progress
- Testing & Results
- Future Project Plans

Project Scope

Goal Statement

"To increase the range of the electric vehicle by at least 15% through non-traditional power adders while minimizing the reduction in acceleration and top speed."

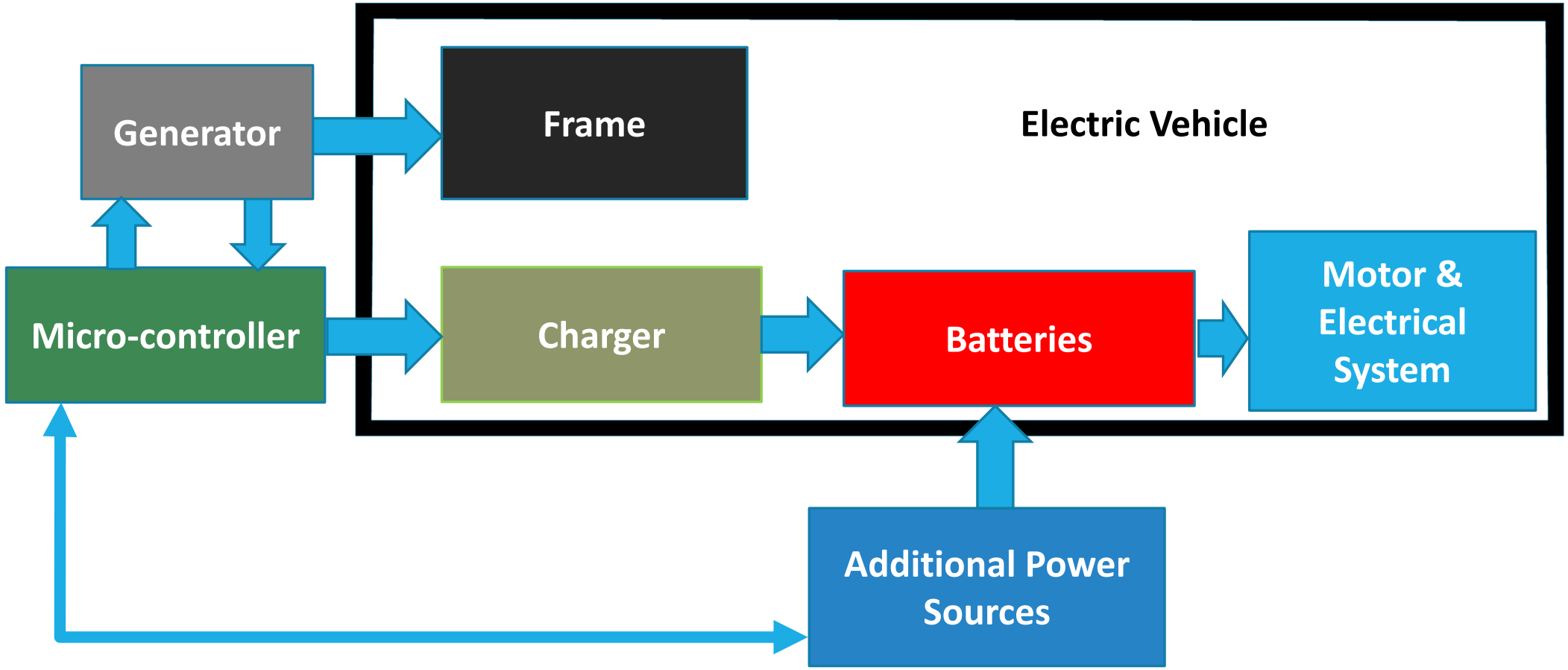
Objectives

- Document current vehicle performance
- Research variety of possible power adders
- Procure/incorporate additional sources
- Reconfigure overall vehicle circuitry
- Increase vehicle range by 15%

Constraints

- Fuel supply cannot be increased
- Vehicle must be able to carry 4 people
- Top speed cannot be reduced by more than 10%
- Acceleration cannot be reduced by more than 10%

Project Progress - Original System



Project Progress - Wiring

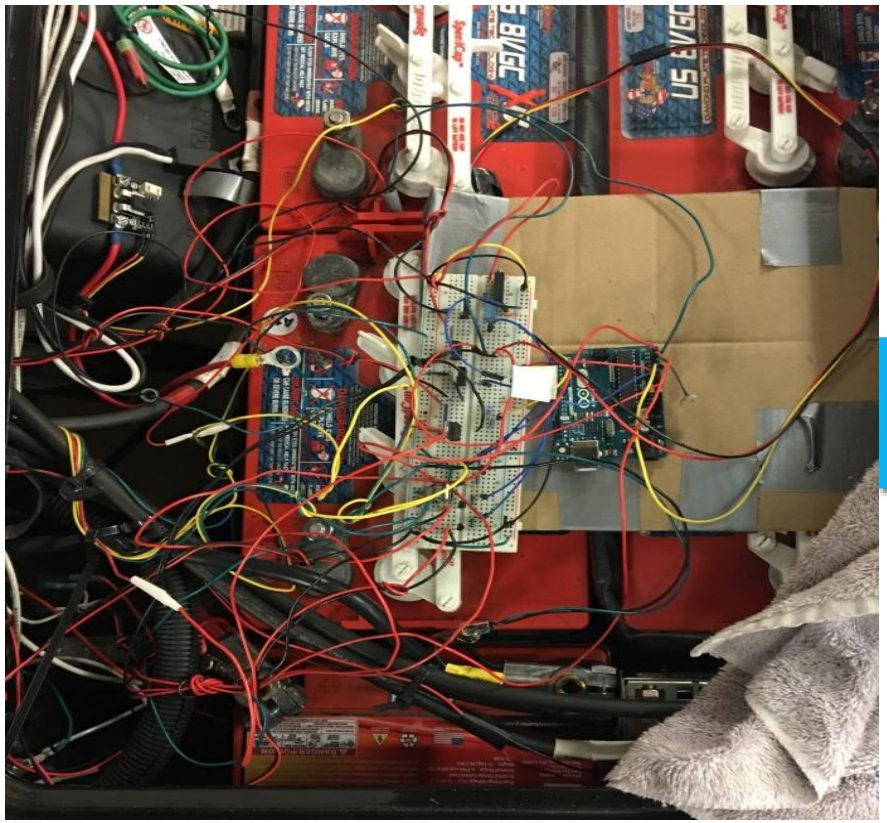


Figure 1. Original Circuitry Configuration

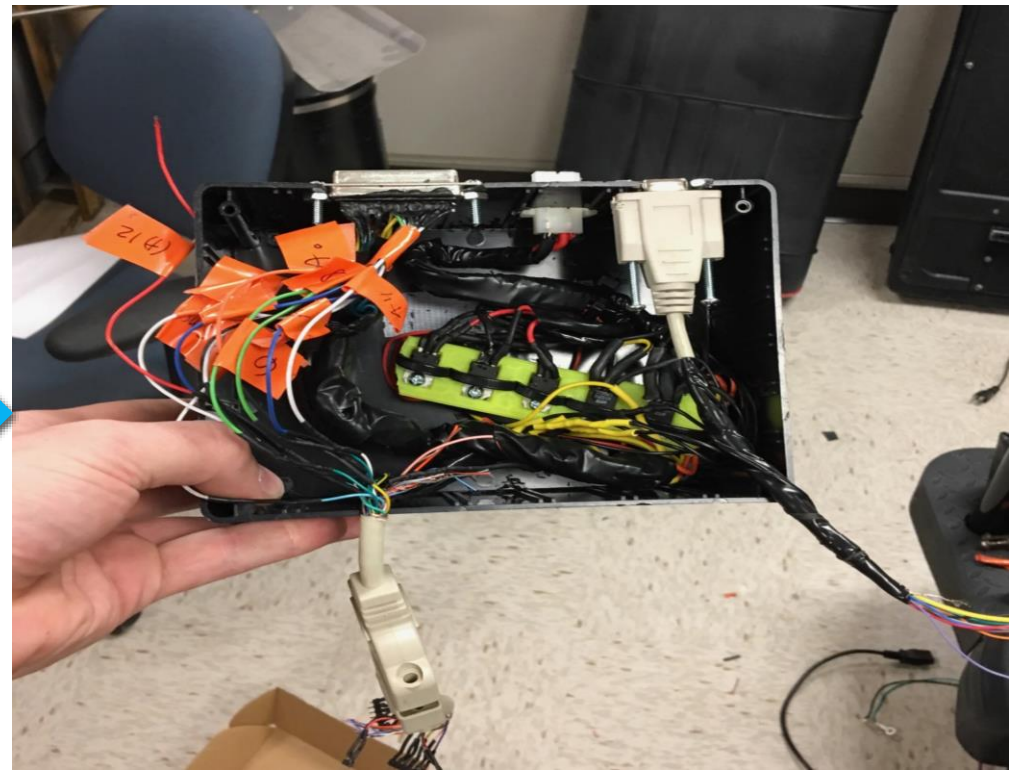


Figure 2. Updated Circuitry with Housing

Component Improvements

- 3D-Printed converter fan covers
- 3D-Printed LCD mount
- New LCD screen

Figure 3. New LCD with 3D-printed mount

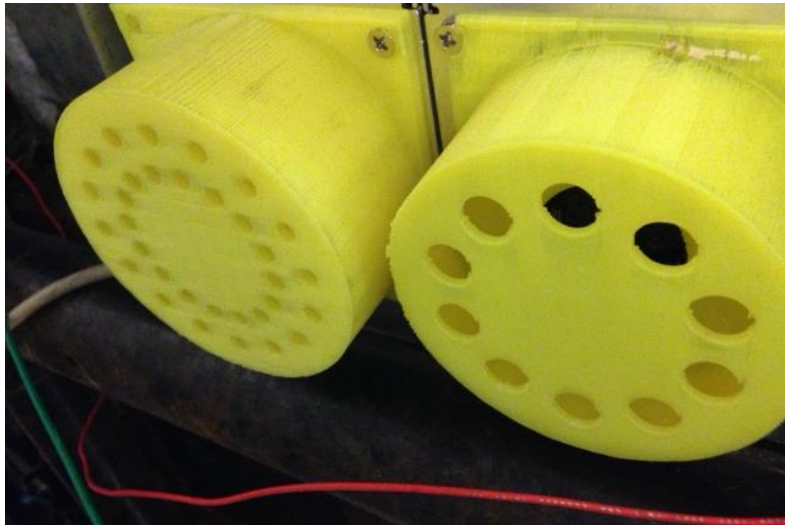


Figure 4. 3D-Printed converter fan covers

Benchmarking

- Must document current vehicle performance
- Select suitable rout with elevation and stops
- Data recorded/analyzed through microcontroller and current sensor
- Selected 150 Amp AC/DC Current Sensor Module

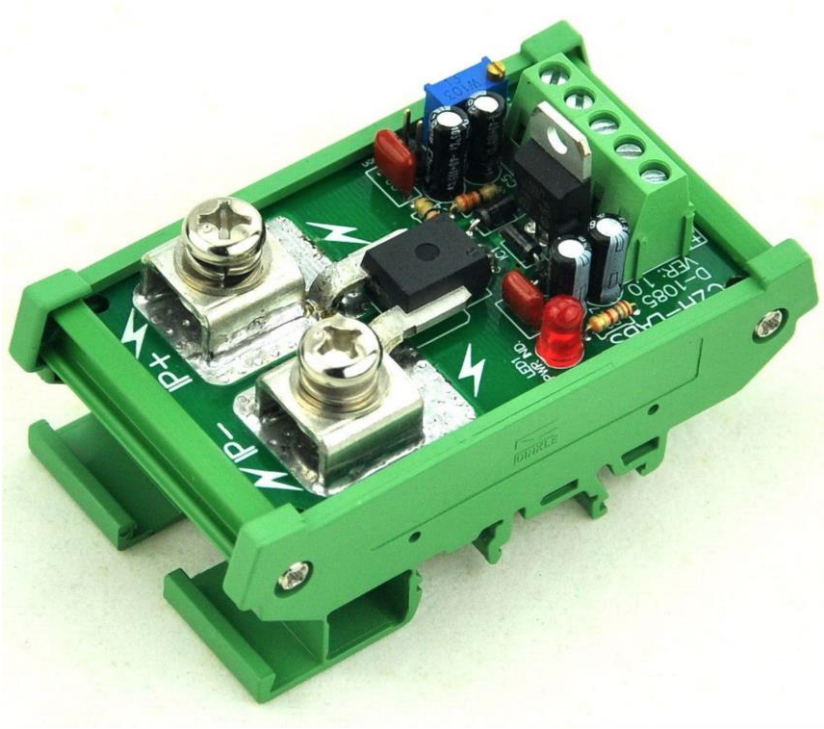


Figure 5. 150 Amp AC/DC Current Sensor Module

Testing

W Paul Dirac Drive Loop

- Distance: 1.37 miles/lap
- Low traffic
- 2 stop signs
- Small hills
- Some tree cover

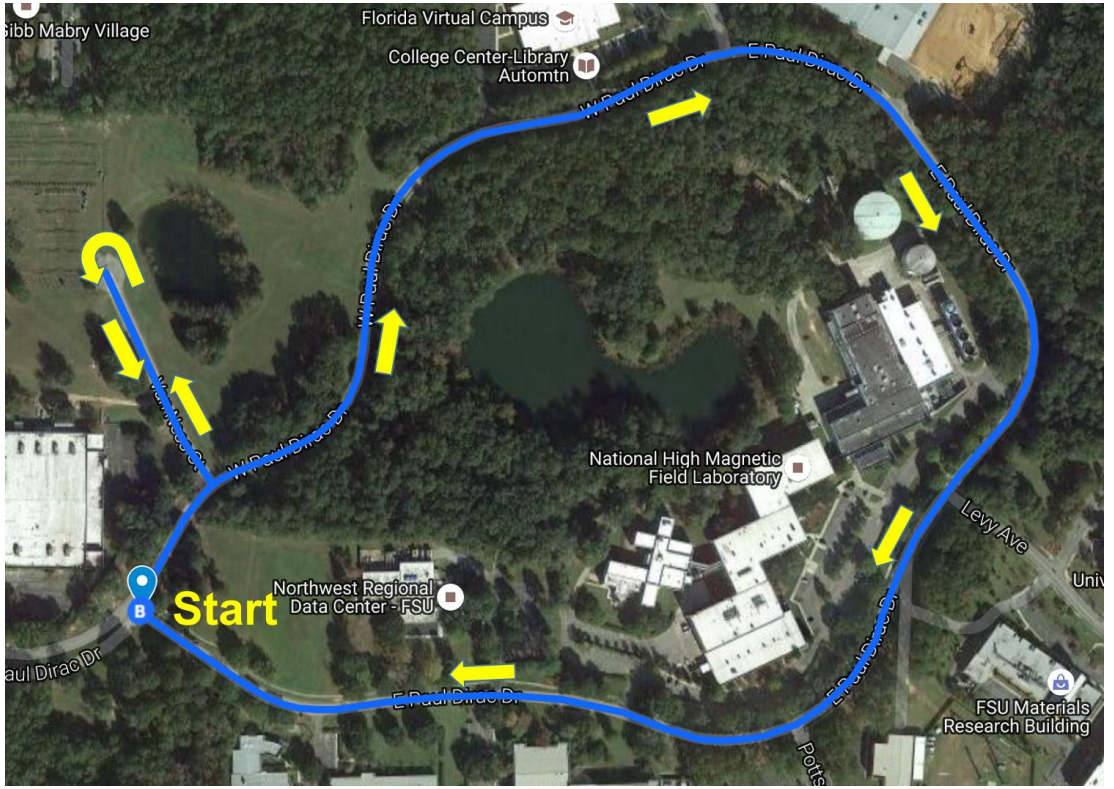
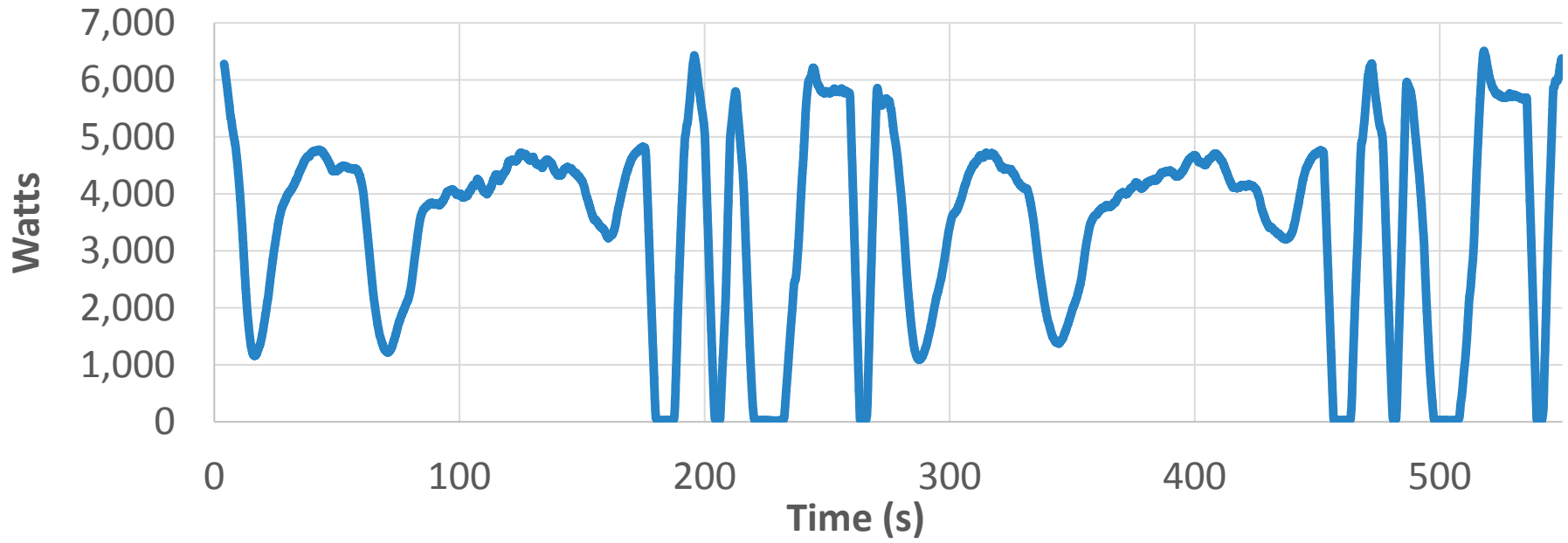


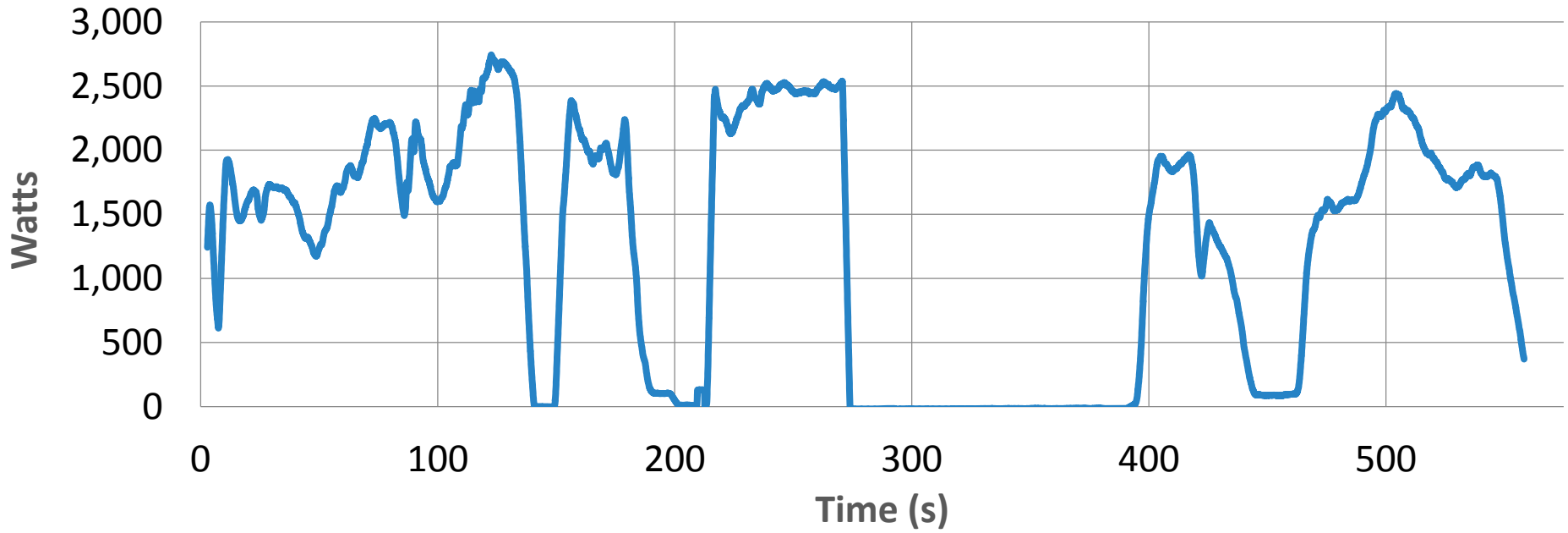
Figure 6. Selected Testing Track around W Paul Dirac Drive

Testing – Battery Power



- Unforeseen current spikes
- 2 laps represented
- Average Power: 3,540 Watts
- Top Speed: 25mph

Testing - Generator Power



- Top Speed: 9mph
- Poor acceleration
- Generator cut-off
- Increased power efficiency

Results - Theoretical Range

Battery Power

- 15,840 kJ battery capacity
- =710 kJ/mile
- = (15,840 / 710) kJ = 22.3 miles

Generator Power

- 20 lbs. propane capacity
- = 0.271 lbs./mile
- = (20 / 0.271) lbs. = 73.8 miles

Total Theoretical Range

- = (22.3 + 73.8) miles = **96.1 miles**

Generator System Modification

- Generator to charge batteries while cart is in use
- Max Generator Output: 2,500 Watts
- AC/DC Converter Draw: 3,375 Watts
  - Causes generator to cut-off when overdrawn
  - Converters must be regulated

Figure 7. Cummins QG2800 Generator

Regulating Converter Output

- Converter power draw can be easily regulated
- Digital Potentiometer
- Microcontroller
- Current Sensors
- Allows for power generation while cart is not in use

Figure 8. Digital Potentiometer

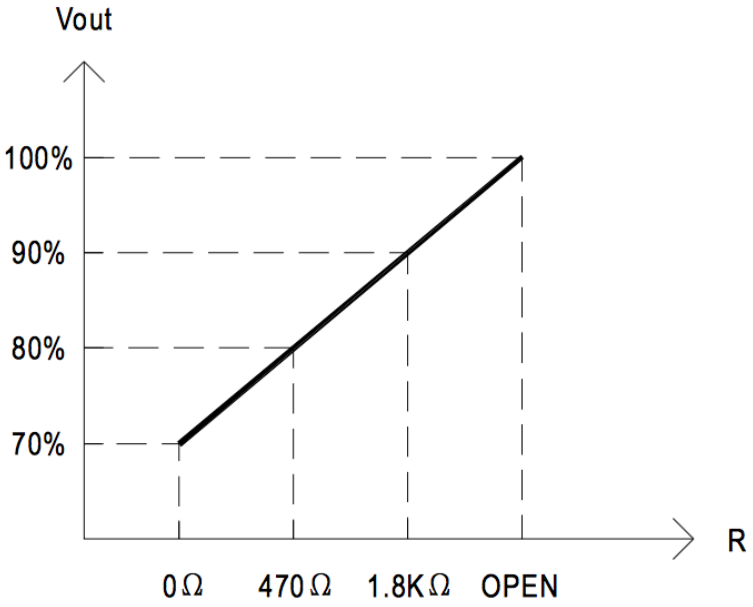
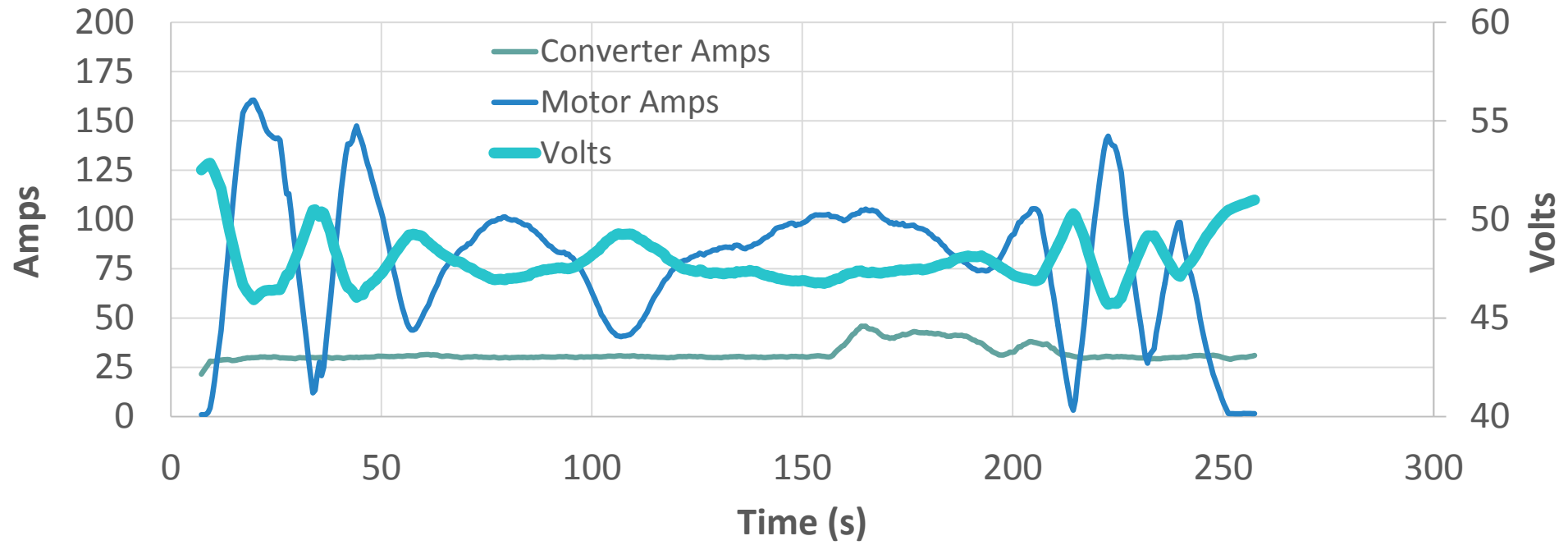


Figure 9. Output Voltage vs. Resistance

Generator System Modification



- Charge/Drain Batteries simultaneously
- Allows for maximum motor output

Further Range Extension

Through Generator Modification

- Max Consumption Rate: 2.3lbs./hr
  - For 20lbs. Propane = 8.7 hours
  - Generator Efficiency: 91%
- = (8.7hrs) x (3,600s/hr) x (2,500 W) x (0.91) = **71,253 kJ supplied**

Percent Range Increase

- = (71,253 / 710) kJ = 100.36 miles
- = **27% generator range increase**

Additional Power

- 220 Watt Universal Bolt-On Solar Kit
- Dimensions: 64.5” x 39”
- 10 - 15 mile range extension
- Cost: $800

Figure 10. 220 Watt Universal Solar Kit with parts

Budget

- Original Budget: $2000
- Money Spent: $397.43
- Remaining: $1602.57
  - - $800 for Solar Kit
  - Last $800 for further improvements/unexpected expenses

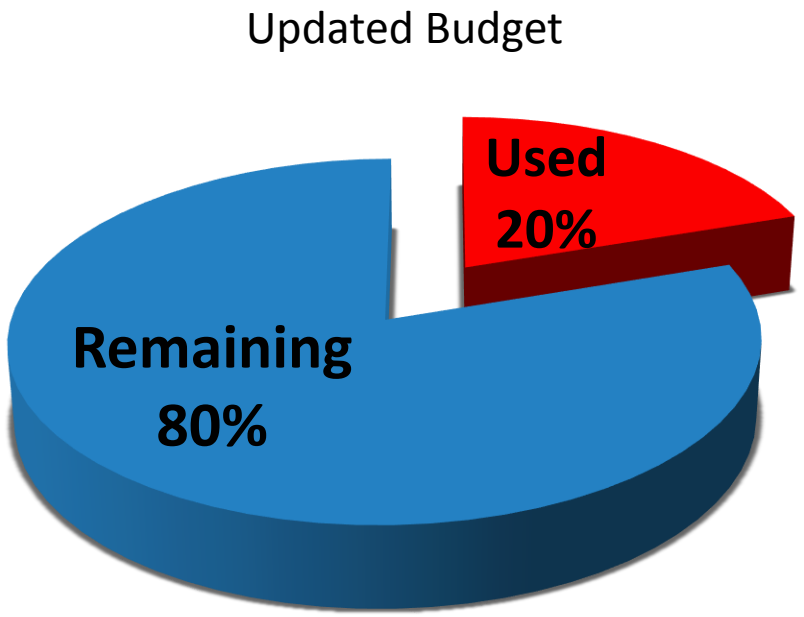


Figure 11. Pie chart illustrating budget use

Spring Timeline

Name	Begin date	End date
Design Circuit for Co...	1/9/17	1/12/17
Install Solar Panel	1/16/17	1/20/17
Optimize Generator	1/23/17	1/27/17
Develop Code for Ge...	1/23/17	2/3/17
Test Range Extension	2/3/17	2/17/17
Develop LCD/Control...	2/3/17	2/28/17
Finalize Component ...	3/1/17	3/10/17
Order necessary com...	3/13/17	3/24/17
Final Design Impleme...	3/20/17	4/20/17

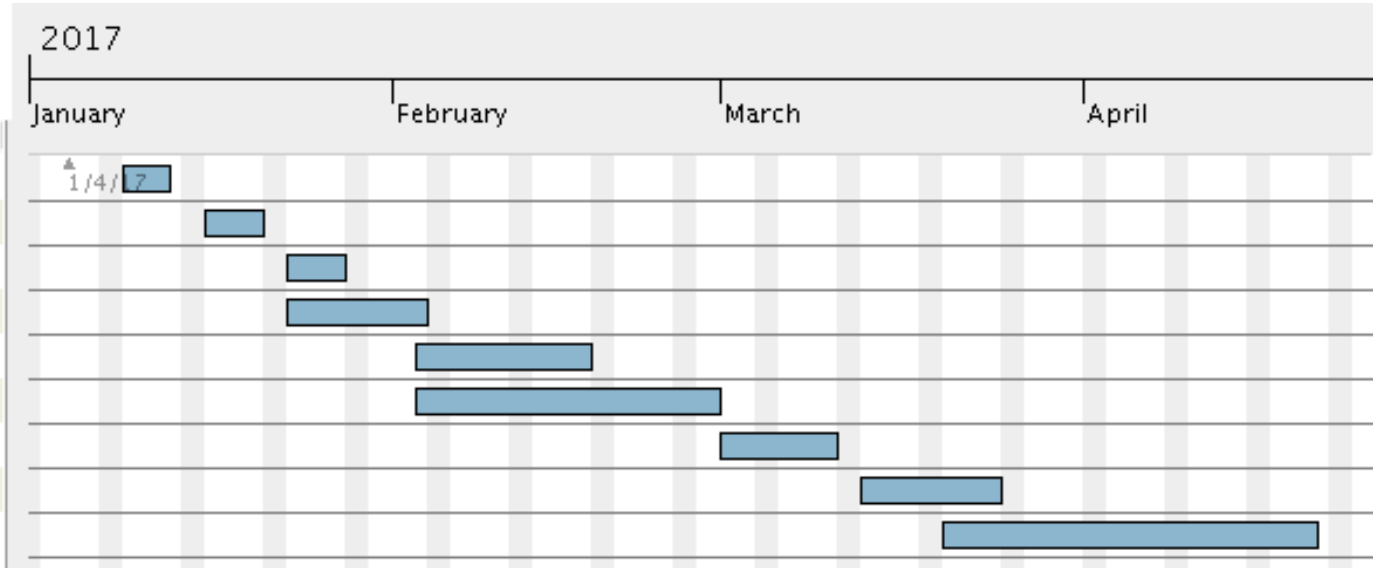


Figure 12. Gantt Chart for future project planning

Challenges

- Mounting of Solar Kit
- Possible Microcontroller coding issues
- Component Circuitry
- Continuing to work safely with the electrical system

References

[1] “Battery University" in BU-403: Charging Lead Acid. [Online].

[2] "Product specs," Solar EV Systems - Solar Golf Carts, Roof, Tops, Solar Panel LSV Cart Kit for EZGO, Club Car, STAR, Yamaha, Bad Boy. [Online].

[3] "How to charge sealed lead acid batteries," in Power Stream, 2000. [Online].

[4] "RV generator set Quiet Gasoline TM Series RV QG 28 00," in Cummins Onan Specification Sheet. [Online].