Personal Hydroelectric Generator
Team 7

Design Review II

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Date: March 17, 2016

Presentation Overview

Project Background

- Background
- Problem Scope
- Needs Statement
- Goal Statement
- Objectives
- Constraints

Current State

- Design CAD
- Design Components
- Testing and Results
- Financial Update

What Remains

- Gantt Chart
- Experiments
- Future Work
- Shark Tank Competition

Background

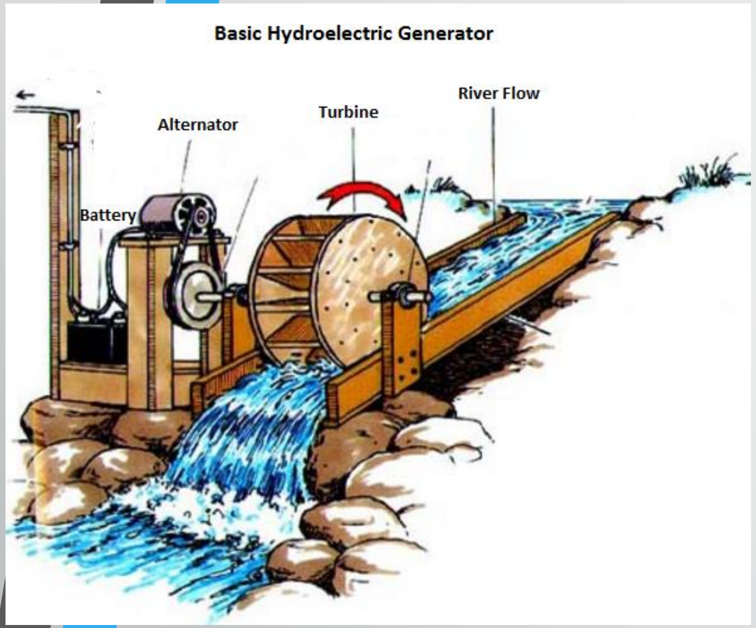


Fig. 1 – Basic Hydroelectric Generator

- Takes kinetic energy of flowing water and converts it to electrical energy
- Flowing water spins turbine which spins alternator to charge a battery
- Process is more environmentally friendly than traditional methods
- Better approach than building a hydroelectric dam which destroys the river below it
- Drawback is that not nearly as much electric potential is stored as in other methods

Problem Scope

This project will consist of creating a marketable power generation system that will harness power from flowing water as well as remain portable. This generator will create affordable and clean power in locations with a reasonable amount of flowing water.

Needs Statement & Goal Statement

- Need Statement:

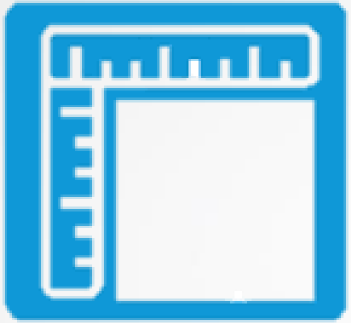
"People in remote locations do not have access to electricity for powering their electrical devices."

- Goal Statement:

"Develop a portable device that transforms organic kinetic energy into usable electricity."

Benefits

Easy installation and maintenance



Minimal Space Required

Noise Free

Sustainable source of electricity

No environmental impact

Target Market

American Red Cross

U.S.ARMY

Objectives

- Produce enough power to satisfy the need of our target consumers.
  - Supplemental emergency power generation
  - Environmentally conscious recreational camper
  - Companies in remote locations

- Maximize portability
  - Modular design so weight can be distributed to multiple sources
  - Fast and simple assembly and disassembly
  - Minimize weight for ease of portability

- Environmentally friendly and safe
  - Minimize physical footprint during installation and operations
  - Protected from harming or obstructing local wildlife in their natural habitats
  - Obvious warning signs of generator in use to protect other people using waterway

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Current Design

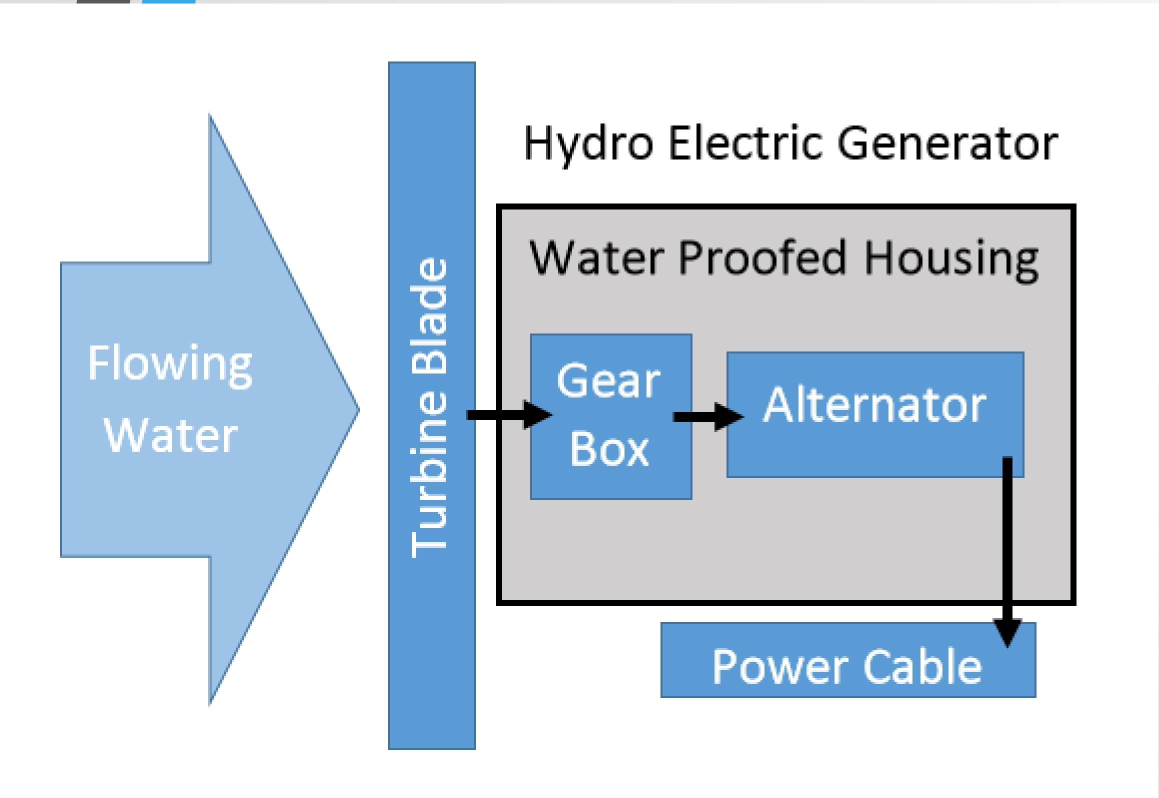

Fig. 2 – Design Flowchart

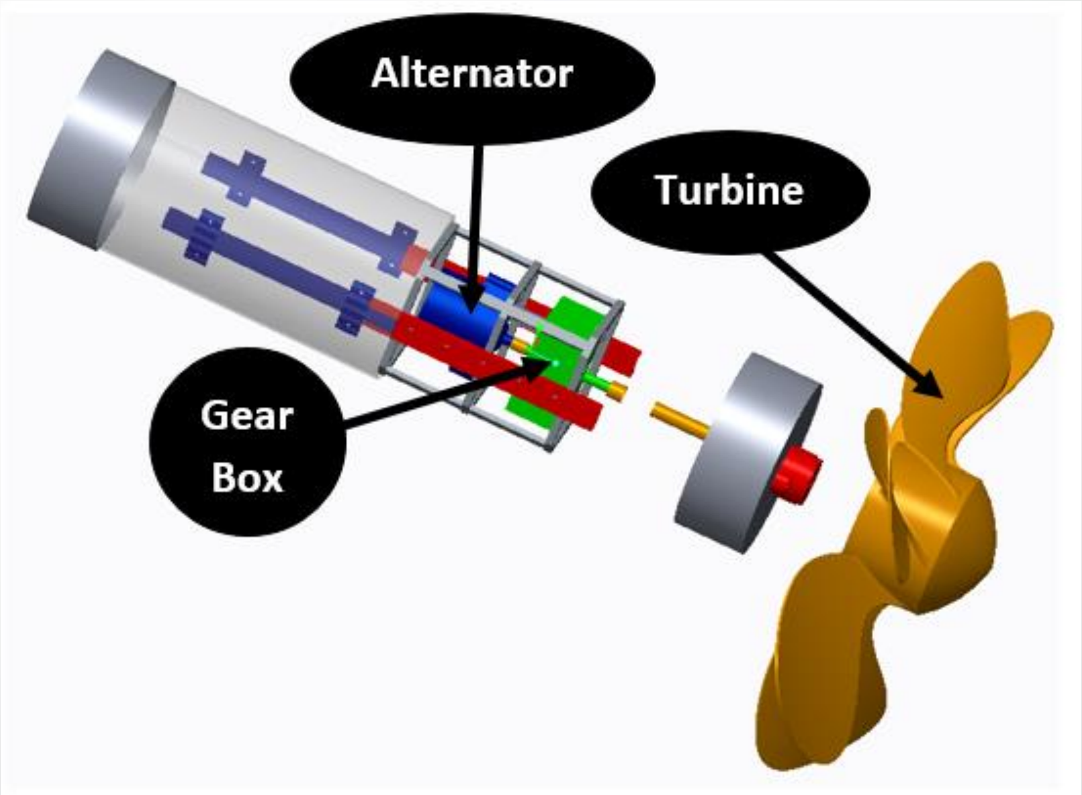

Fig. 3 – Design Overview

Detailed CAD Schematic

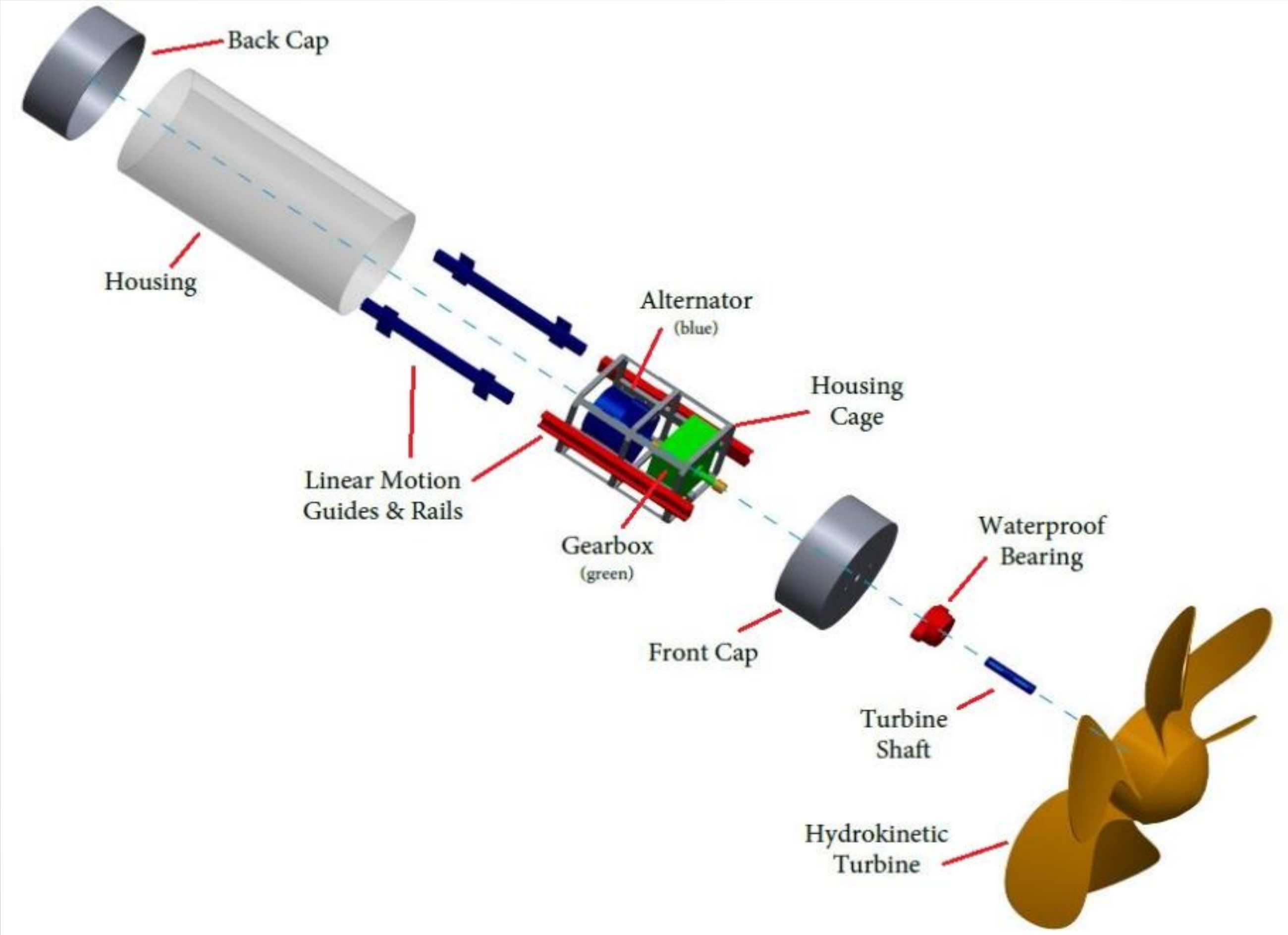

Fig. 4 – Hydroelectric Generator CAD

Detailed CAD Schematic

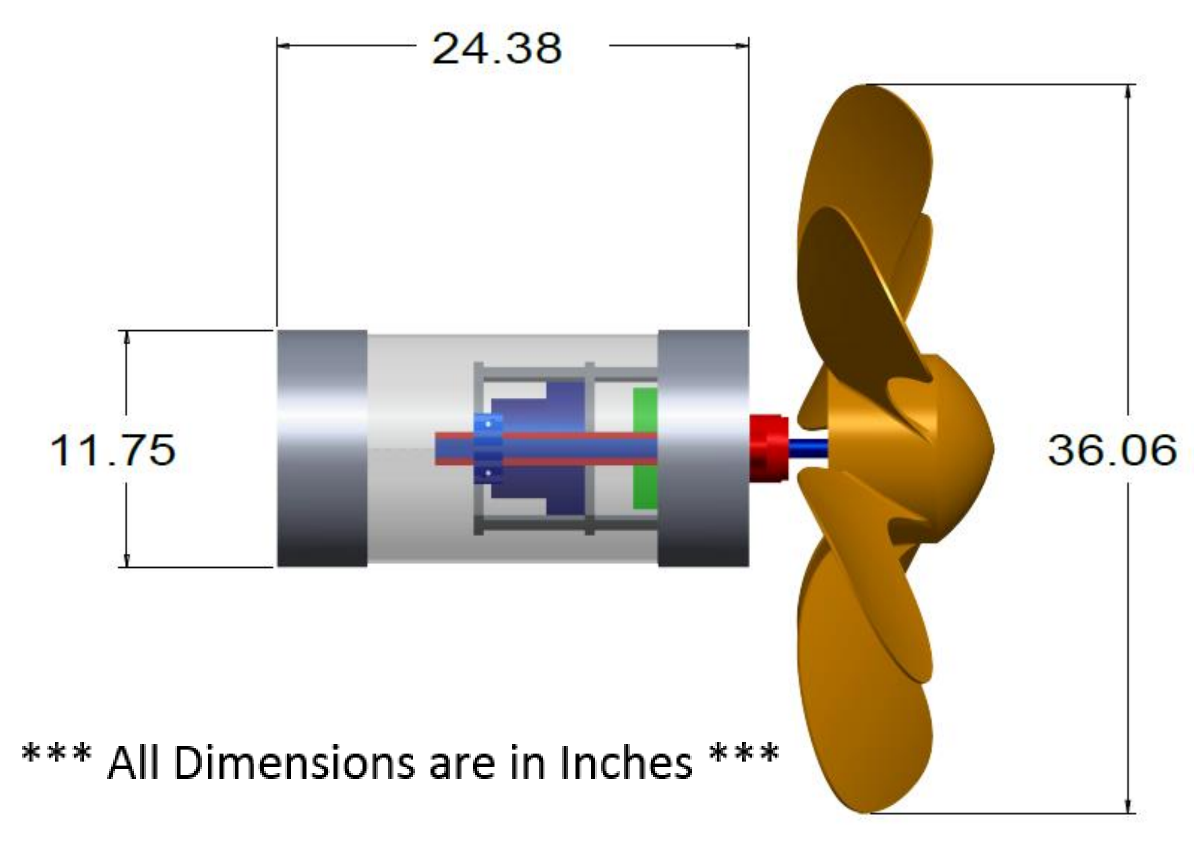

Fig. 5 – Hydroelectric Generator CAD with Dimensions Side - View

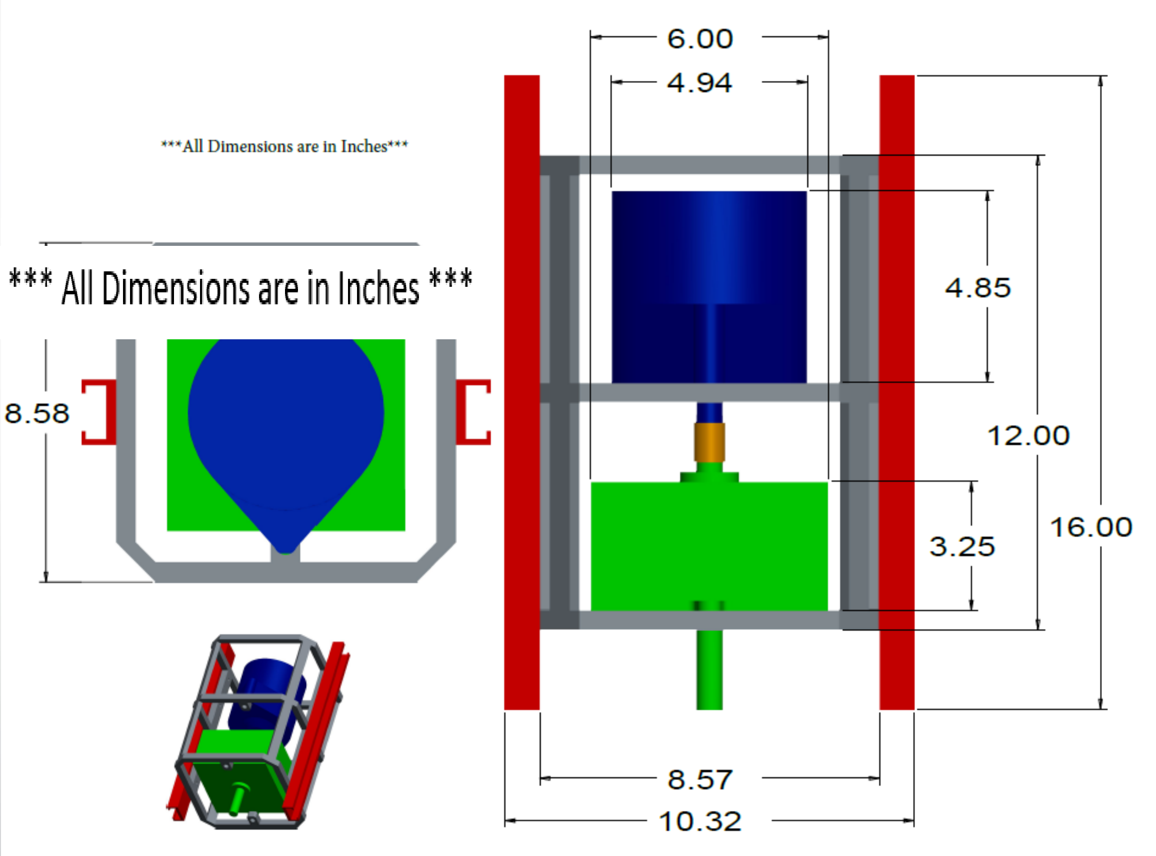

Fig. 6 – Hydroelectric Generator Cross-Sectional View with Dimensions

Design Components

Component Status Update

Table 1. Component status

Component	Complete	Needs to be Attached	Needs to be Built or Machined
Alternator Housing	X		
Electrical Wiring		X	
Sliding Guide Rails	X		
Waterproofed External Housing	X		
Cap with Bearing	X		
Gearbox Housing			X
Main Shaft		X	
Turbine Blade		X	
Charge Controller Mount			X

Turbine Blade


Fig. 7 - 3 ft. diameter aluminum turbine blades

Selected Turbine Specs

- # of Blades: 4
- Diameter: 3ft
- Pitch: 35°

Tip-Speed Ratio

$$\lambda = \frac{Tip\ speed\ of\ blade}{speed\ of\ water} = \frac{\omega R}{v_{water}}$$

For the **average 4 blade turbine**, the **tip-speed ratio is equal to 3**.

With this and an estimated average **water velocity of 3.75ft/s**, the turbine's angular velocity can be approximated:

$$\omega = \frac{\lambda v_{water}}{R} = \frac{(3)(3.75\frac{ft}{s})}{1.5ft} = 7.5\frac{rad}{s} = 1.194\frac{rev}{s} = \mathbf{71.62\ rpm}$$

Gearbox

A gear box is needed to increase the RPM output of the turbine to the necessary input level for the alternator.

The WindBlue DC-540 Low Wind Permanent Magnet Alternator runs efficiently above 600 rpm. Given an **input angular velocity of 71.62 rpm**, a **10:1 gearbox** would increase the **alternator's angular velocity to 716.2 rpm**.

<u>**Selected Gearbox Specs:**</u>

Anaheim Automation: GBPH-0601-NP-010

10:1 gear ratio

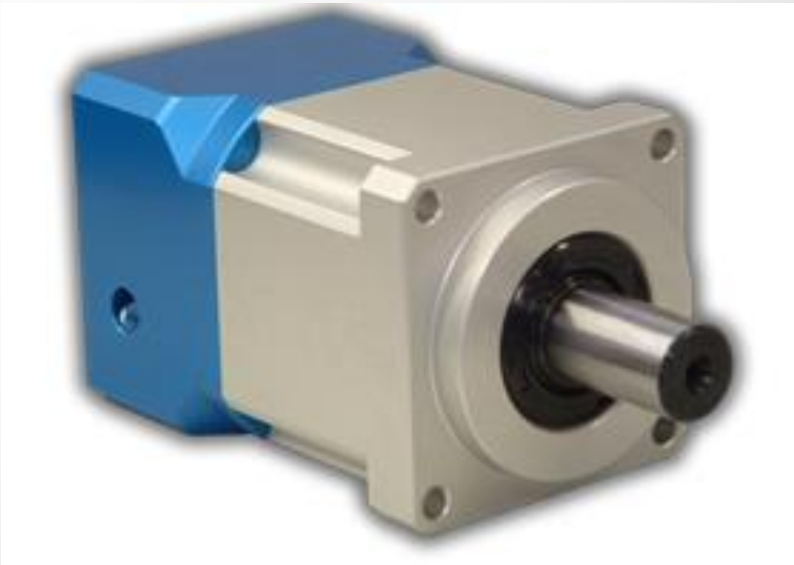

Fig. 8 - Anaheim Automation: GBPH-0601-NP-010 Gearbox

Alternator

These pictures show the alternator secured in its custom caging, which is to be secured to the housing's linear guide rails.

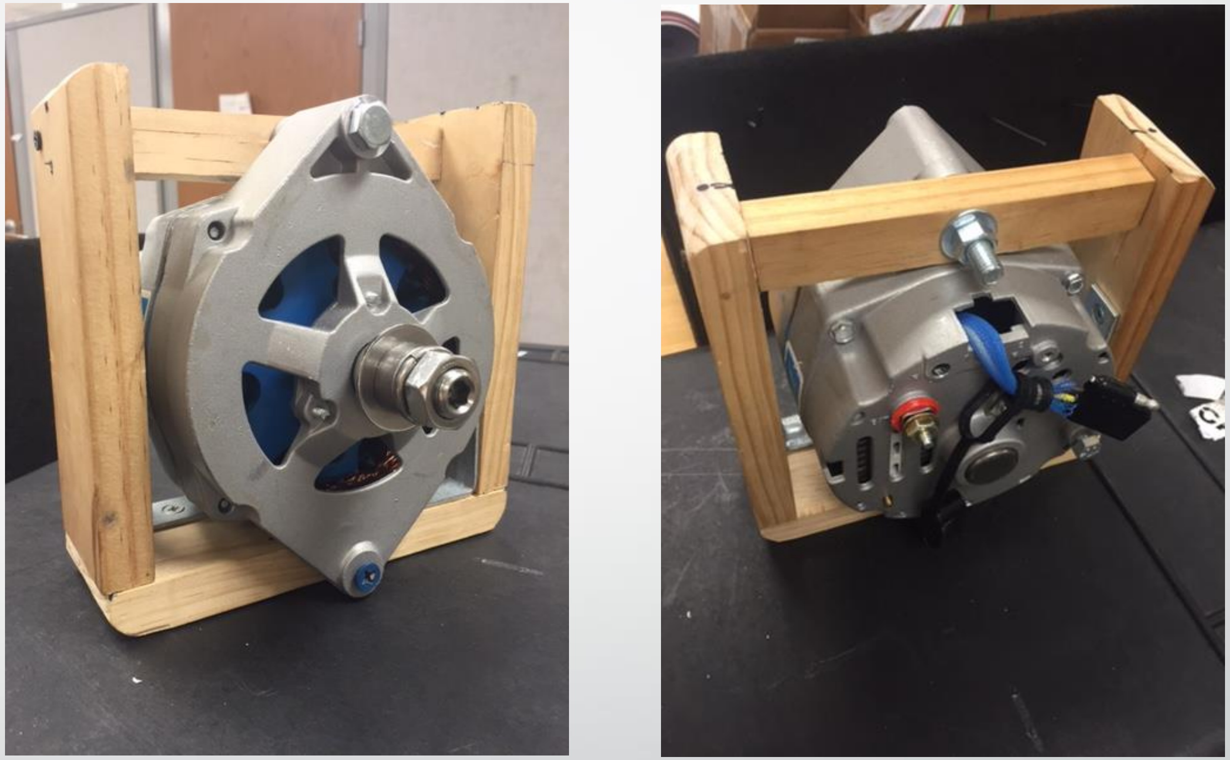

Fig. 9 - The WindBlue DC-540 Low Wind Permanent Magnet Alternator

Electronic Components – Overview

- 3 Phase DC-540 Alternator from Wind Blue Power
- 12 V / 25 A Charge Controller from Wind Blue Power
- LCD Display Wattmeter from Wind Blue Power

Table 2. Specifications of DC-540

Wind Blue Power	**DC – 540 PMA**
Tested at 7 ohm Resistance	
Voltage Production	**8.3 V** @ 272rpm
Amperage Production	**8.66 A** @ 272rpm
Wattage Production	**71.878 W** @ 272rpm
Energy Production after 8 hours	**0.575 kWh** @ 272rpm

Electronic Components – Circuit Schematic

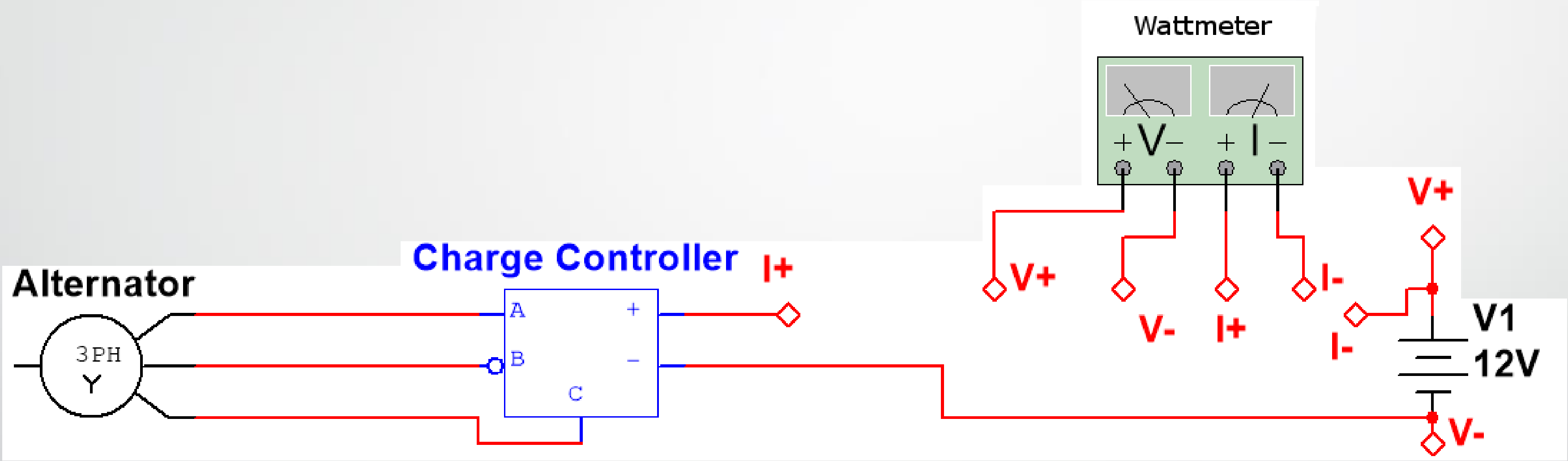

Fig. 10 - Circuit Schematic

Electrical Components - Wiring

Flex Connector	
Size	3/8”

Fig. 11 – PVC to Flex connector

Specifications of Flexible Conduit	
Working Temp	-20°C to 80°C
Conduit	Steel
External	PVC Jacket
Size	3/8”

Fig. 12 – Liquidtight Flexible Steel Conduit

External PVC Housing

Fig. 13 – Profile of outer PVC housing

Fig. 14 – Inside of outer PVC housing and railing

Fig. 15 – Railing system fully extended

Detachable linear guide rails were fixed to the inside of the PVC housing to serve as anchor spots for the gearbox and alternator cages. Implementing these rails allows for **easy access to the internal components** of the system without fully disassembling it.

System Buoyancy

- In order to achieve maximum energy transfer from water to alternator, the entire turbine blade needs to be submerged.
- When completely submerged, the device will displace a specific volume of water.
- If the device weighs more than the weight of this volume of displaced water, the device will sink.
- At current design specifications, the device would need to weigh 82.39 pounds to be neutrally buoyant.
- The current total weight of our apparatus is 44.7 lbs.

$$W_{fluid} = \rho_{fluid} * V_{fluid}$$

$$\rho_{water} = 1000 \frac{kg}{m^3}$$

$$V_{water} = 0.03737\ m^3$$

$$\boxed{W_{water} = 37.37\ kg = 82.39\ lb}$$

Testing and Results

Waterproof Testing and Results

- Experiment #1
  - Submerging the body into a cooler of water determined that there was a leak in the housing
- Experiment #2
  - Filling the end caps with water demonstrated that the seams in the end caps were the source of the leak
- Conclusions
  - Marine grade epoxy has been added to the end cap seams
  - Super absorbent PVA sponge to be placed in bottom of tube to provide a fail safe in case of slow leaks

Fig. 16 – PVA sponge

Electrical Testing and Results

- The internal resistance of a battery can be calculated based on voltage drop of the battery under a known load. The results will ultimately be affected by technique and environmental condition.

$$R_{internal} = \frac{(E - V_{external})}{I}$$

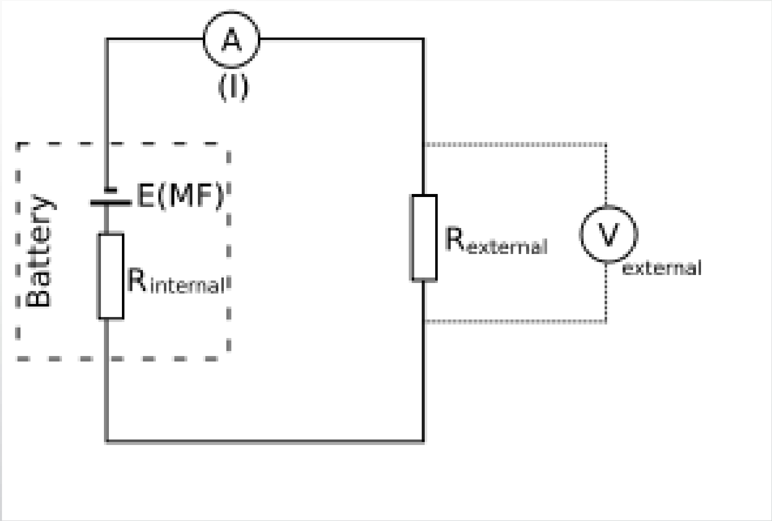

Fig. 17 – Circuit diagram of test

168Ω Resistive Testing and Results

High resistive testing

- Represents a fully discharged battery
- Resistive load of 7 – 12V LED Lights

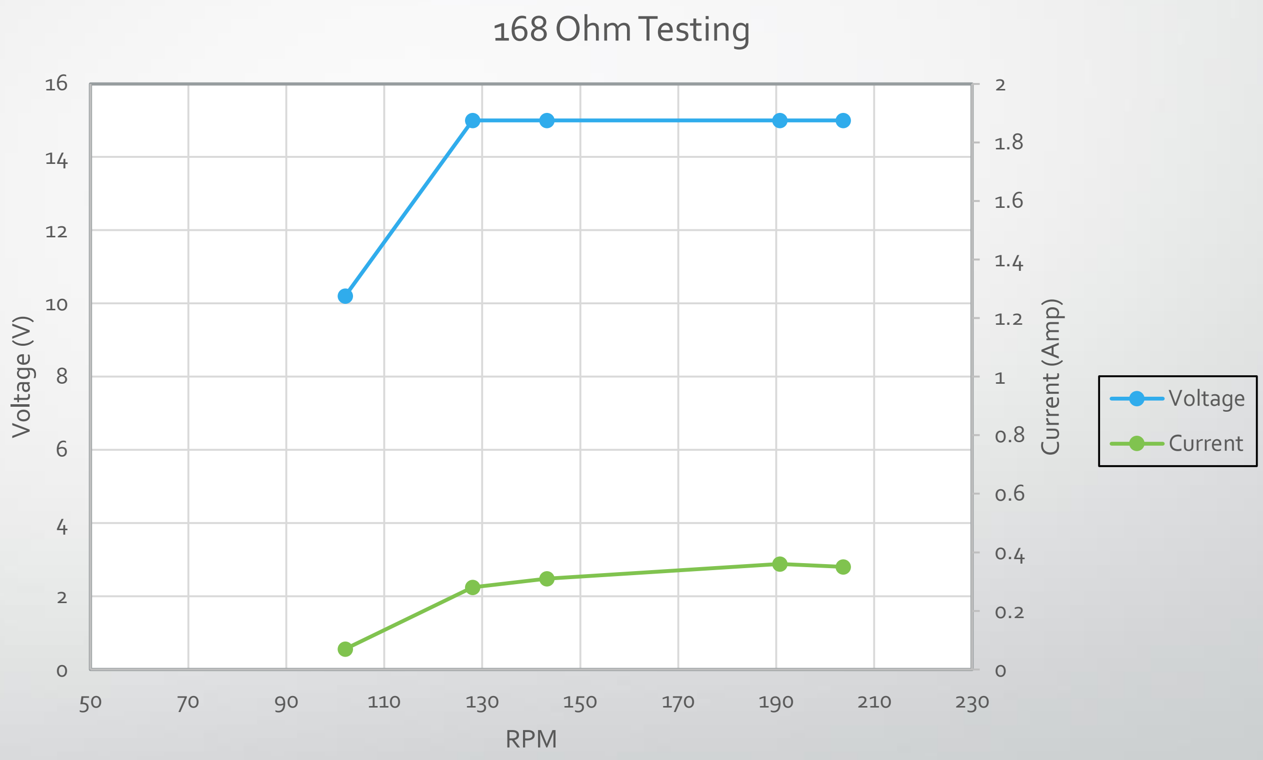

Fig. 18 – Current and Voltage reading of an empty battery

7Ω ResistiveTesting and Results

Low Resistive Testing

- Represents a battery reaching full charge

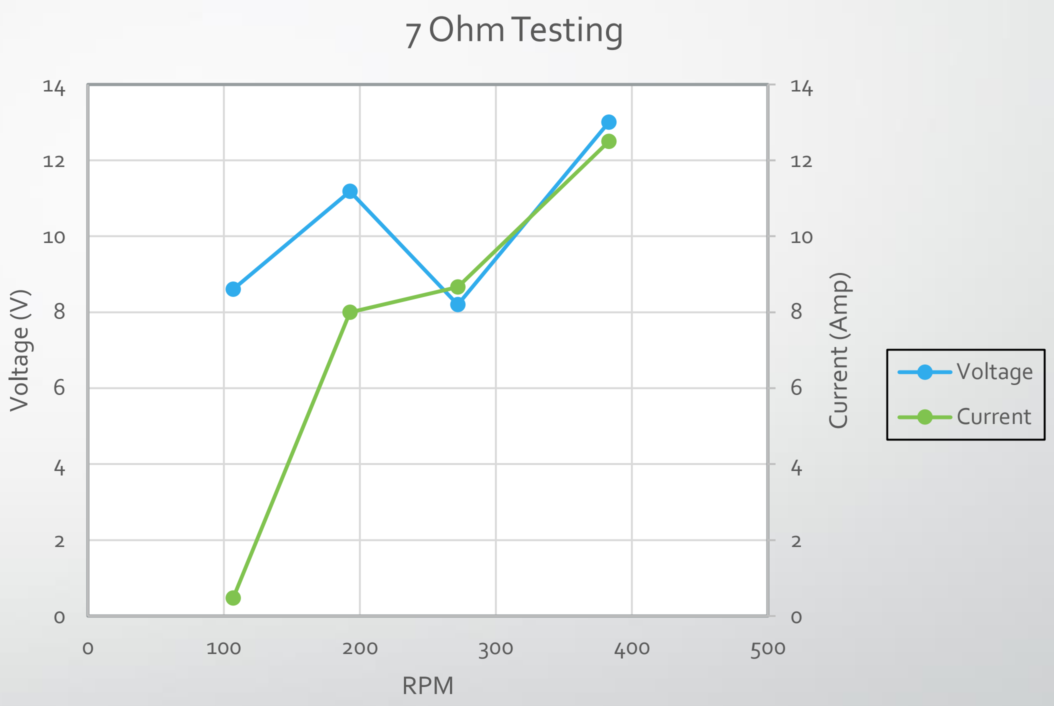

Fig. 19 – Current and Voltage reading of semi - healthy battery

2Ω ResistiveTesting and Results

Low Resistive Testing

- As the battery reaches full charge it requires less mechanical power to produce electrical power

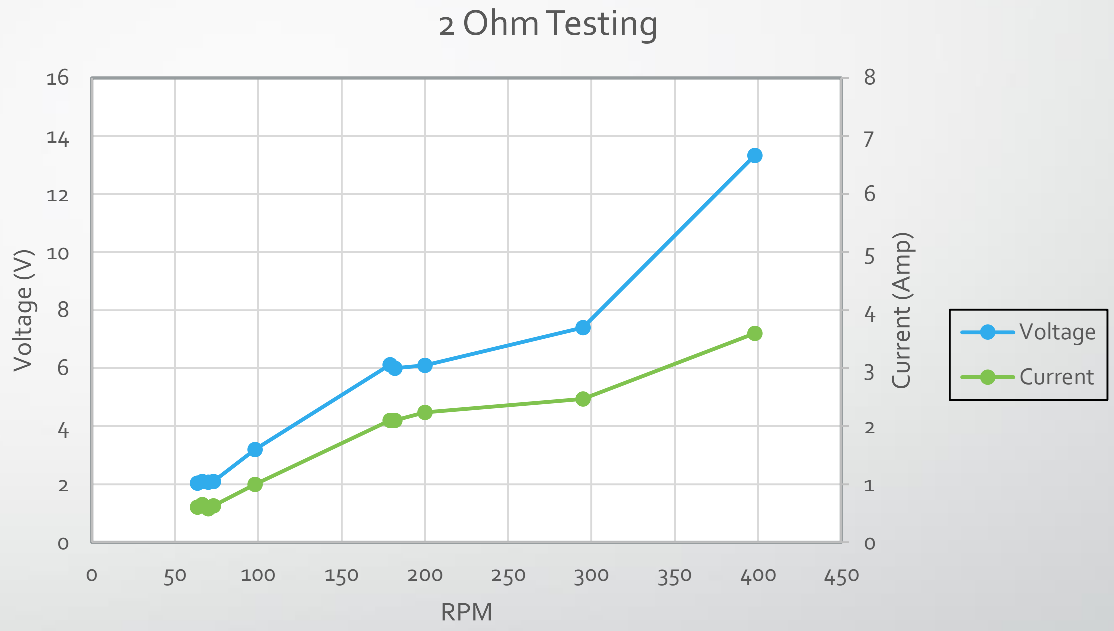

Fig. 20 – Current and Voltage reading of healthy battery

Heat Dispersion Testing and Results

- Experimental Procedure:
  - Place the alternator within housing
  - Attach electric drill with socket and extension to the alternator's input shaft
  - Spin the drill at desired voltages and take temperature with a temperature gun every 30 seconds for five minutes to observe temperature change

Fig. 21 – Heat testing of alternator

Heat Dispersion Testing and Results

- Conclusion:
  - Heat should **not** be a problem
  - The heat had a max plateau of 76°F at 40V
  - The apparatus will be operating at 12V

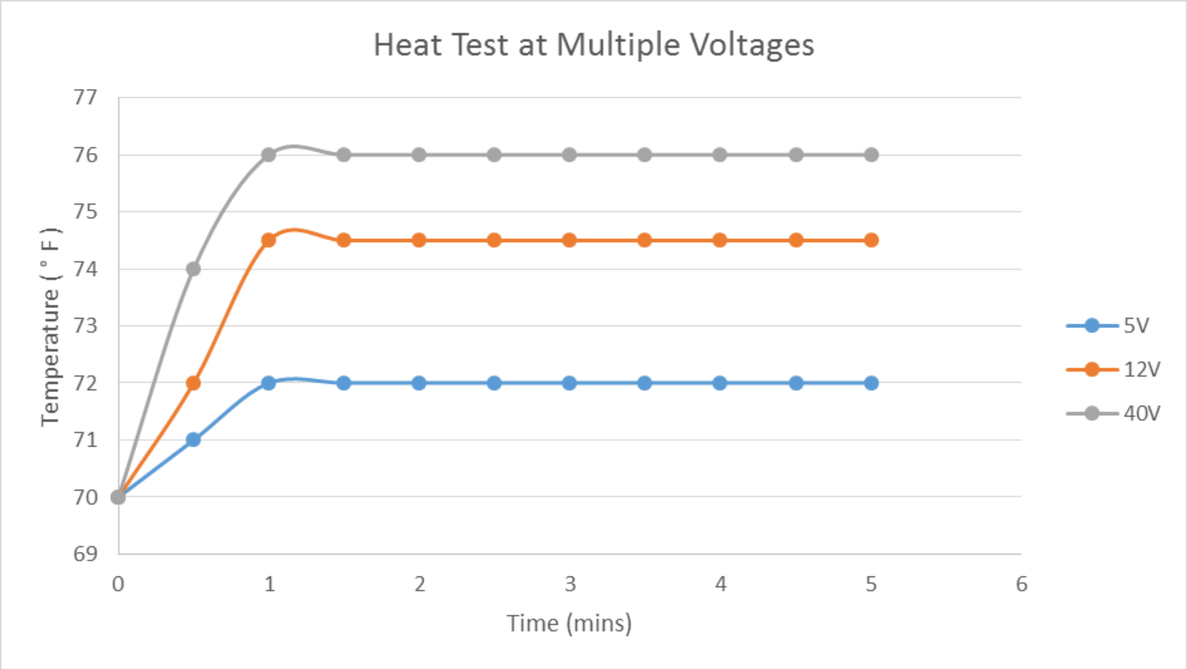

Fig. 22 – Heat testing results

Financial Update

Allocated Resources (Total Budget – $2000)

Our team initially started with a $1500 budget, but recently got a $500 increase in order to pay for more crucial components like the gearbox.

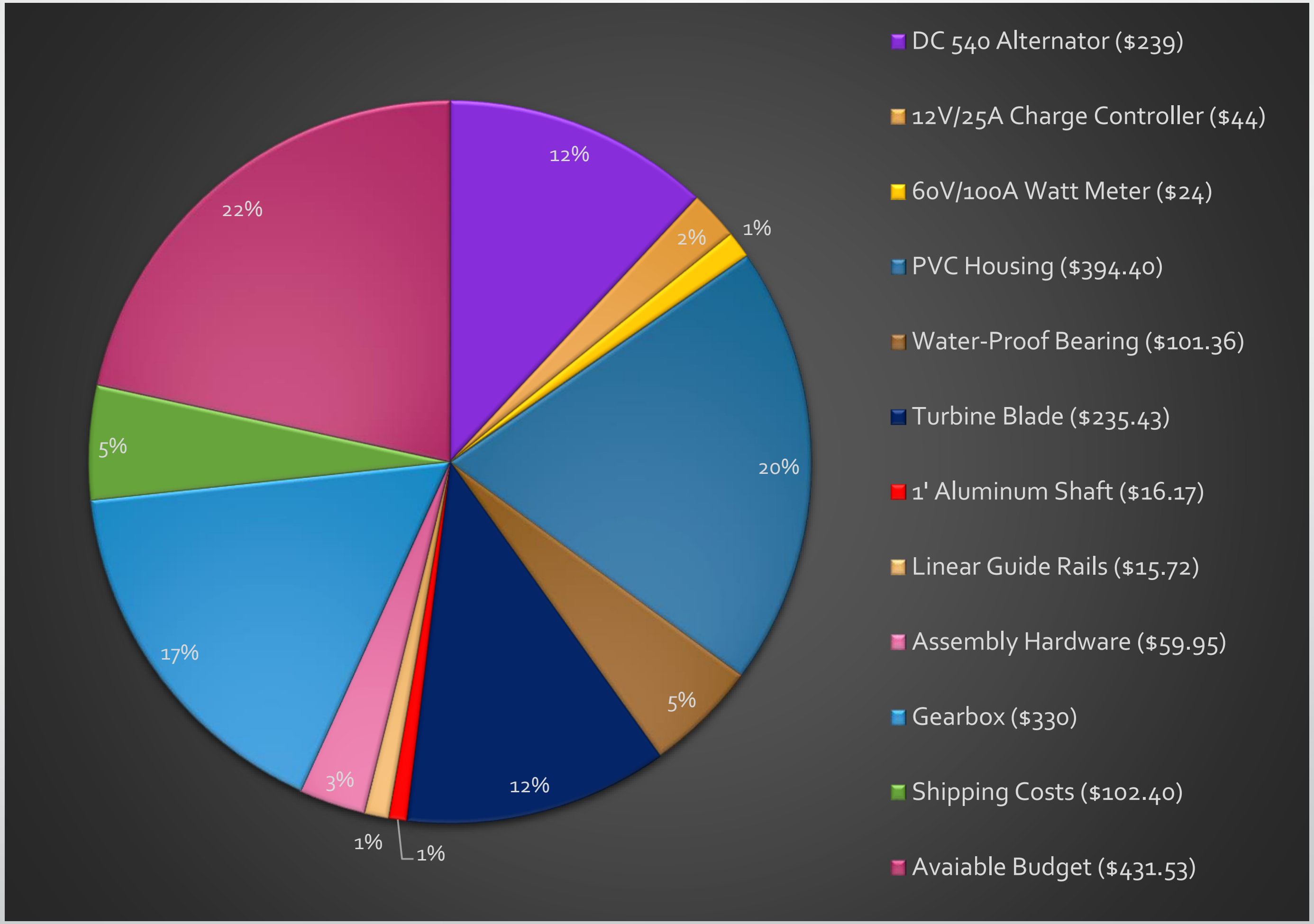

Fig. 23 – Budget report

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Scheduling

Task Name	Durati	Start	Finish
Part Acquisition	**15 days**	**Mon 2/29/16**	**Fri 3/18/16**
Gearbox	15 days	Mon 2/29/16	Fri 3/18/16
Shafts/Couplings	5 days	Mon 3/14/16	Fri 3/18/16
Wiring	3 days	Mon 3/14/16	Wed 3/16/16
Assembly	**15 days**	**Mon 3/14/16**	**Fri 4/1/16**
Rail System	5 days	Mon 3/14/16	Fri 3/18/16
Gearbox Housing	6 days	Sat 3/19/16	Fri 3/25/16
Shafts/Couplings	3 days	Sat 3/26/16	Tue 3/29/16
Turbine	4 days	Tue 3/29/16	Fri 4/1/16
Wiring	6 days	Sat 3/26/16	Fri 4/1/16
Testing	**14 days**	**Mon 3/28/16**	**Thu 4/14/16**
Waterproofing	14 days	Mon 3/28/16	Thu 4/14/16
RPM	3 days	Wed 3/30/16	Fri 4/1/16
Power Output	4 days	Sat 4/2/16	Wed 4/6/16
Balancing/Bouyancy	6 days	Thu 4/7/16	Thu 4/14/16

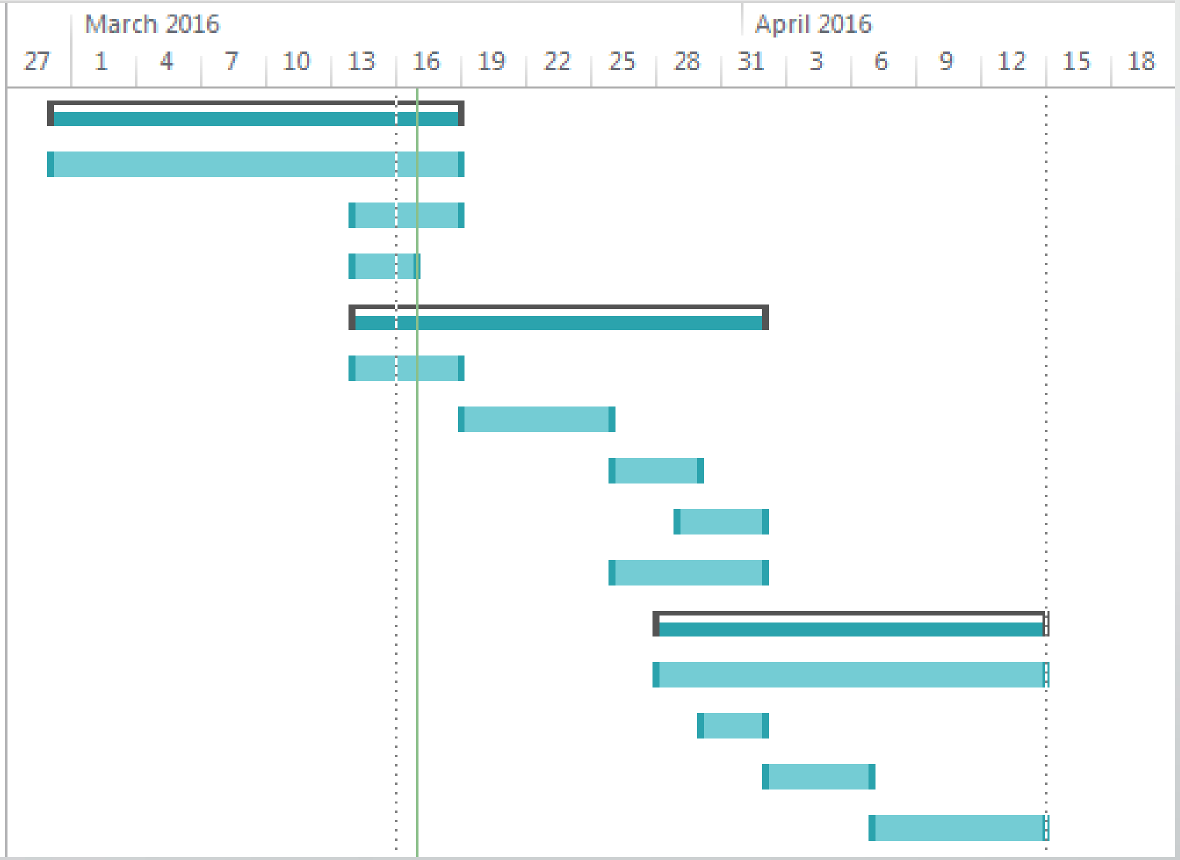


Fig. 24 – Gantt Chart

Experiment Forecast

- Final stages of waterproof testing will be conducted as the group nears completion of the prototype
- Device will be tested in the Wakulla River at Shadeville road at full functionality
- Readings from the wattmeter will be used to gather data

Fig. 25 - Wakulla River

Future Work

Potential ideas:

- Anchoring
  - Create an effective way of offsetting the lack of weight in the system to make the system neutrally buoyant
- Land display
  - Design a small platform that allows the consumer to effectively read the wattmeter by the battery on land
- Performance optimization
  - The design may have room for improvement in output efficiency
- Ergonomics
  - All designs have the ability to be more efficient in the way that they are constructed

Fig. 26 Smart Free Stream Turbine by Smart Hydro Power

Previous Entrepreneurial Aspects

- Innolevation Challenge
  - Develop business model canvas
  - Eliminated at stage 4 among top 20 contestants
- ACC Challenge
  - 3 minute quick business pitch + 7 minutes of questions
  - Potential to pitch in front of investors if selected
  - Finished as a top 3 finalist for FSU

Current Market

Table 3. Analysis of Competitors

Power Production method	Power Production	Operating Conditions	Energy production (24 hrs.)
Solar – CS6X-300P	300W (2m^2)	Only operates at this level in full sunlight	2.7 kWh
Wind - WG450AW24V-WM	250W rated power	Runs 65-80% of the time, permanent installation	3.9 kWh
Our Design	130W @ 650 rpm	Can run 24/7, portable	3.12 kWh

Indirect Competitors:

- Solar Panels
    - Require more surface area to generate similar power to our design
- Wind Turbine
    - Bigger and more expensive
    - difficult to set up
    - Wind is less consistent than water

Direct Competitors:

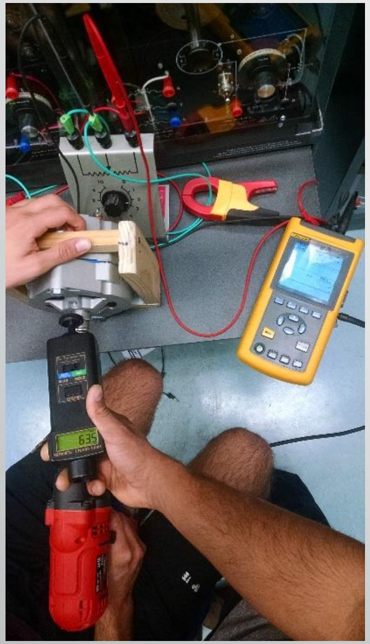
- Stream Bee
    - Very small scale
    - Basically only charges a phone

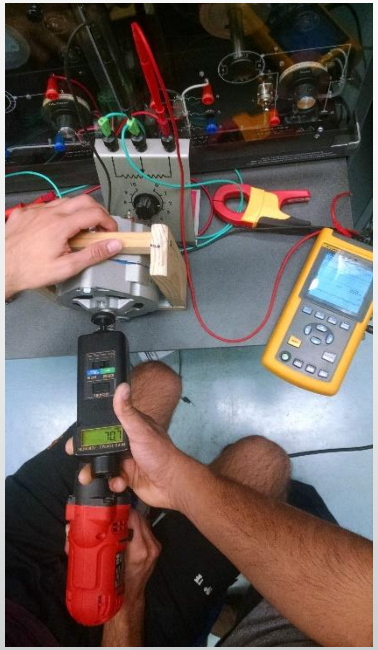
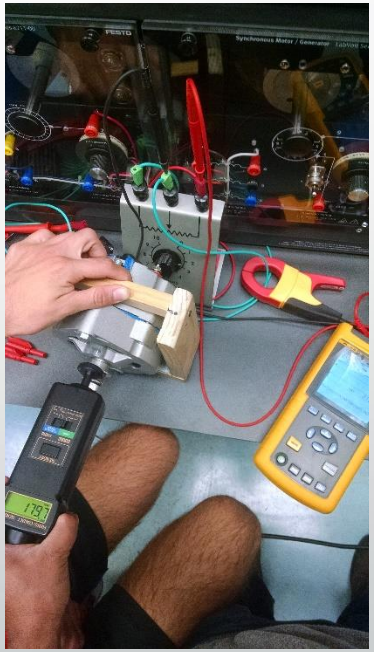
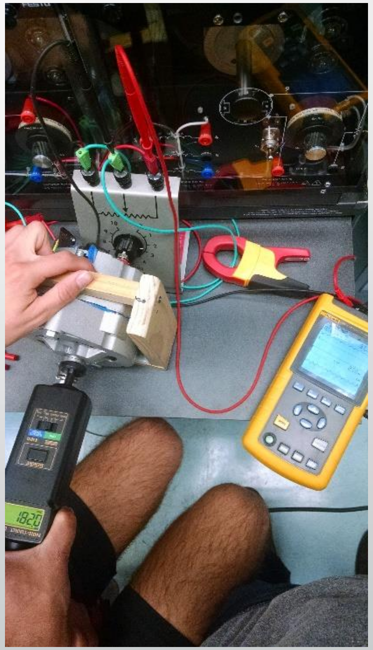
- **What**: A Business Pitch Competition for Technology Innovations in order to encourage entrepreneurial thinking
- **When**: Thursday, March 24, 5:15-5:30 pm
- **Prizes**: 1st $1,250 | 2nd $750 | People's Choice $500
- **Judging Criteria**: 7 judges consisting of FAMU & FSU employees
  - **Idea**: Idea validity, novelty, and potential impact
  - **Business Model**: Value proposition, target customer(s), market size, competitive advantages, etc.
  - **Entrepreneurship:** Team commitment, team expertise and knowledge
  - **Pitch delivery**
  - **Probability of Success**: Commercialization plan and probability of proceeding with the plan

QUESTIONS?

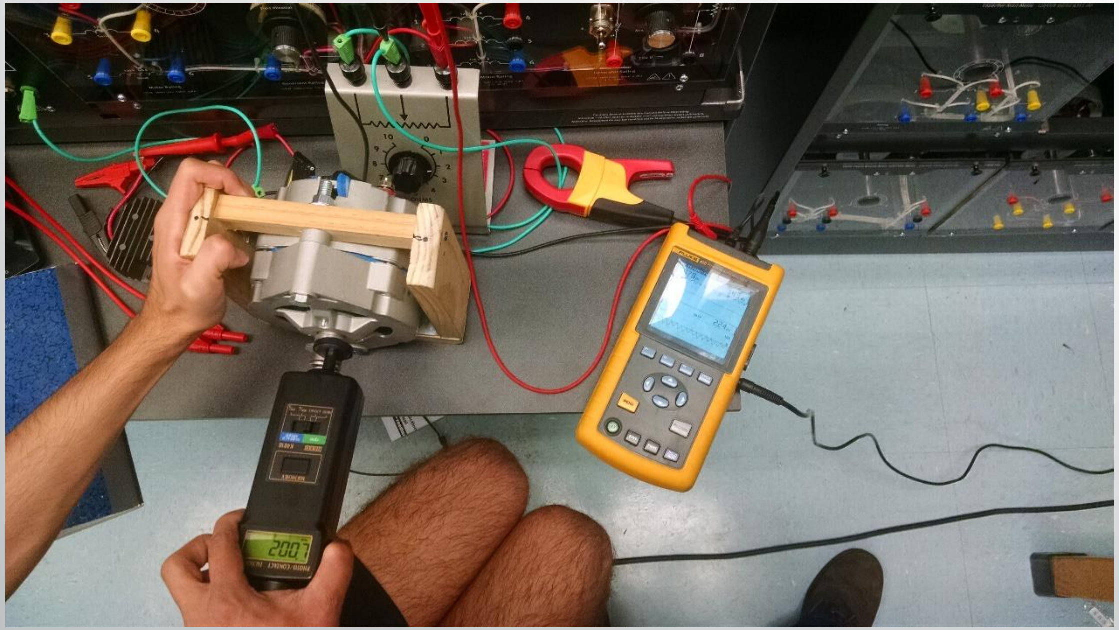
Appendices

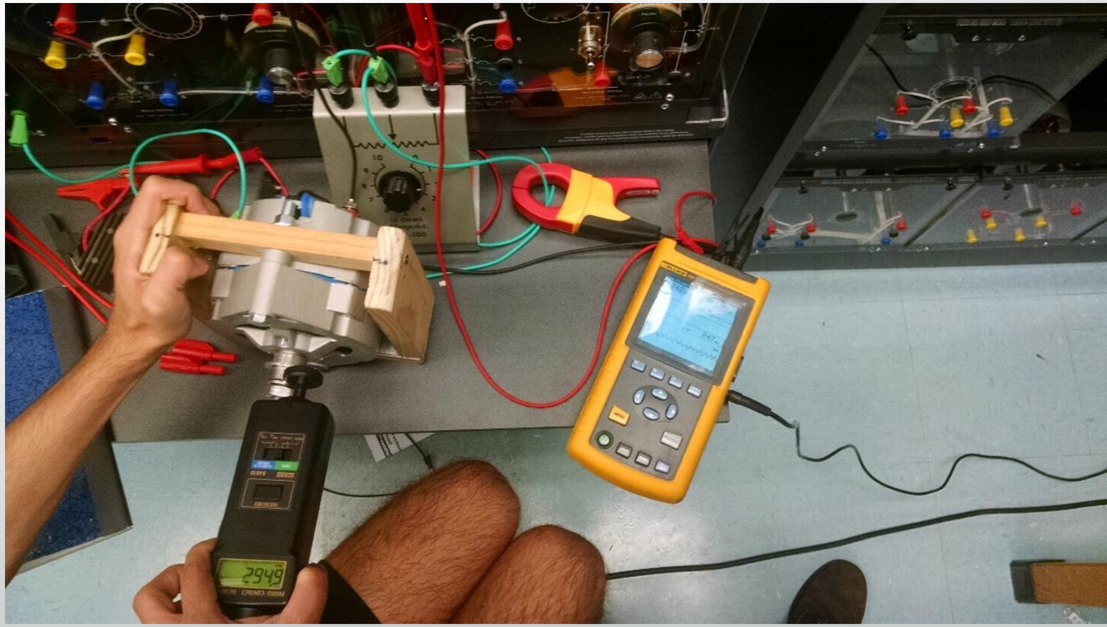
2Ω Testing



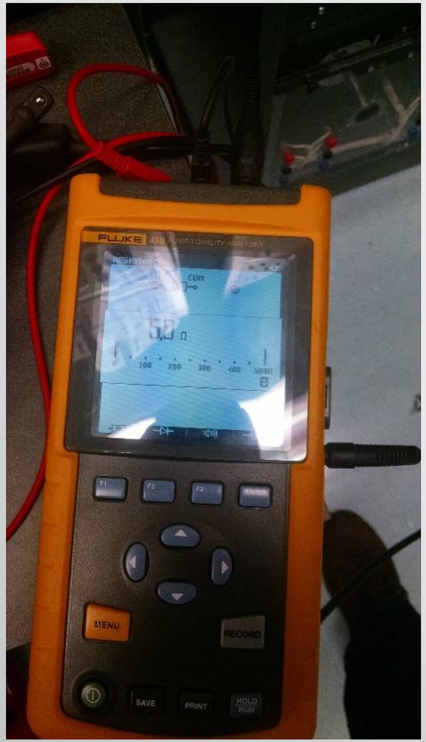




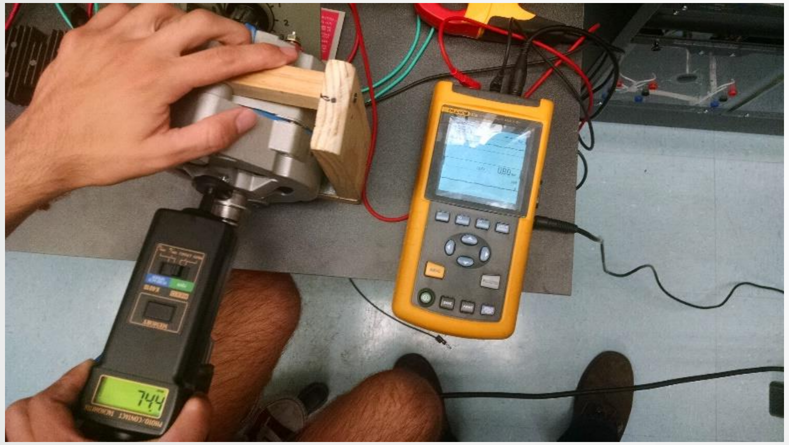
2Ω Testing

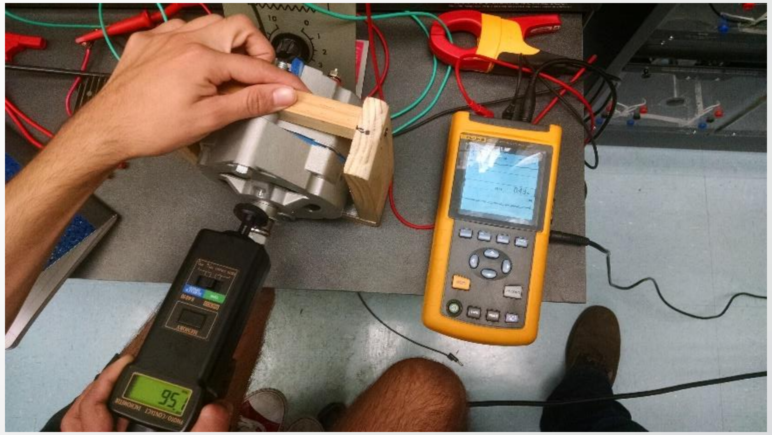




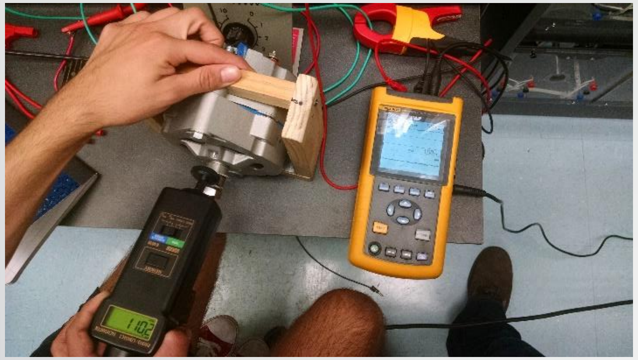
5Ω Testing

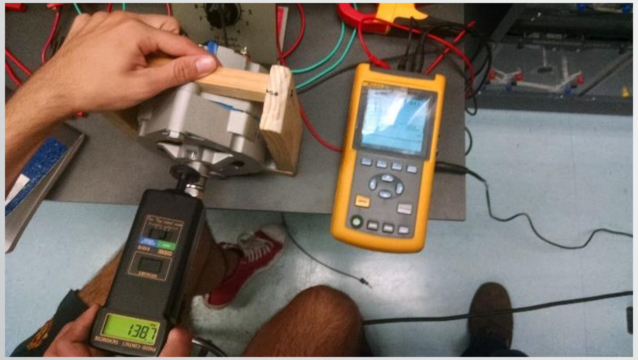


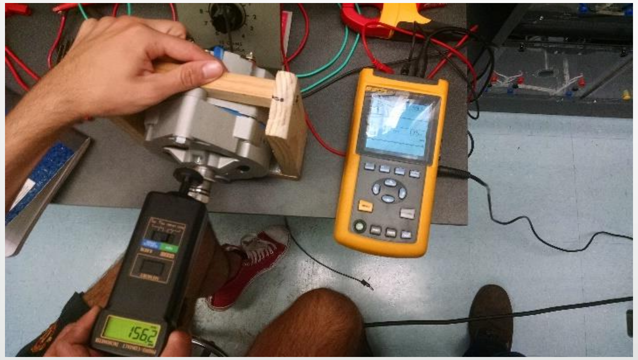


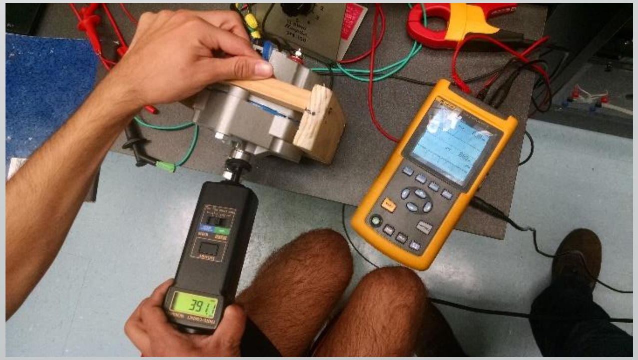


5Ω Testing

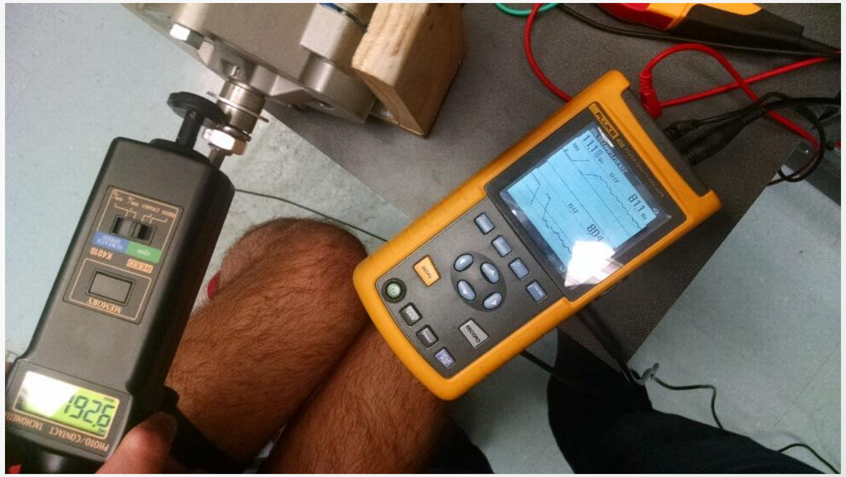








7Ω Testing



168Ω Testing