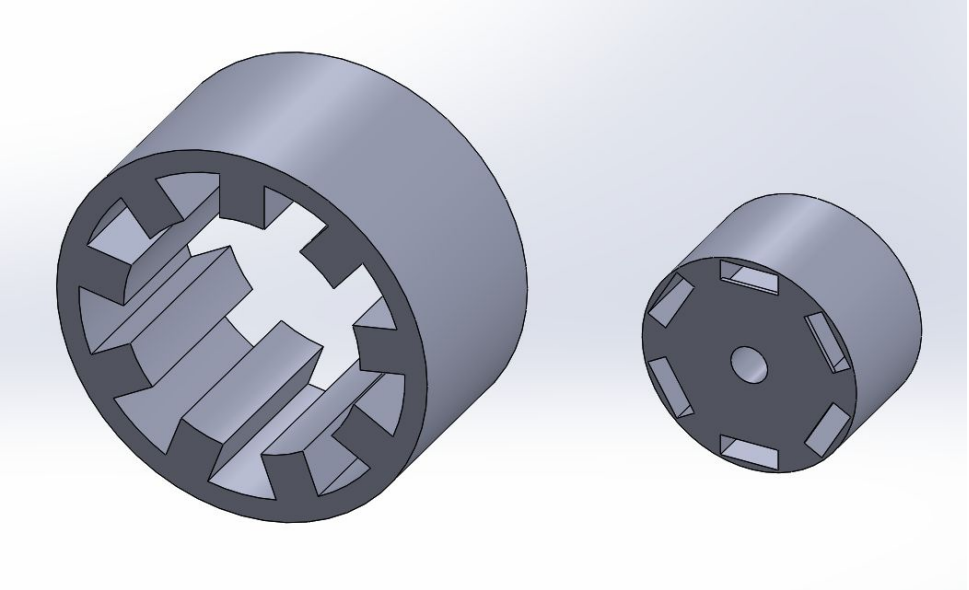
ELEC 391
Wind Turbine
DEMO 3

A8

Generator

- **Permanent Magnet Synchronous Generator (PMSG)**
- **6 magnetic poles (3 stacked magnets per pole, each 3158 surface Gauss)**
- **9 stator poles (3 coils x 70 Turns per coil, 26 AWG)**
- **Reluctance per phase: $19.25*10^{6}H^{-1}$**
- **3 Ohm coil impedance per phase**
- **7 V Peak per phase → 10 V through rectifier**
- **600mA peak short circuit current**



Generator

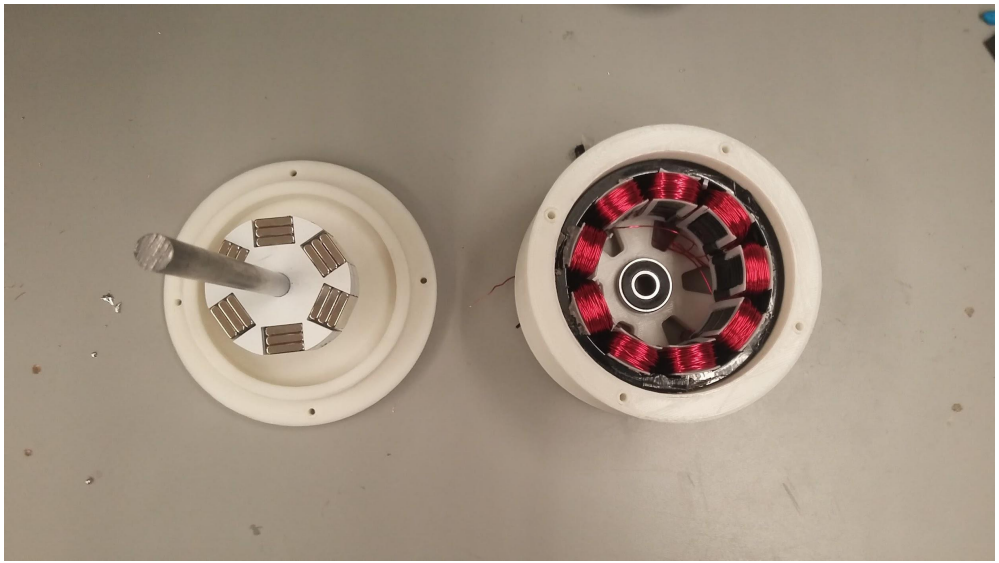
Problems:

With our topology and specifications, wiring as a motor/generator is inefficient as two coils will cancel eachother out

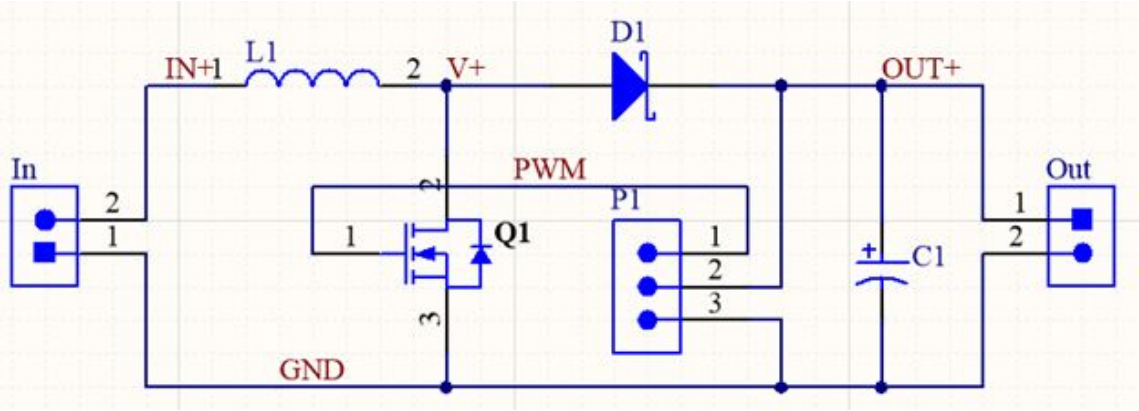
Solution: Wire up as strictly a generator

High cogging torque due to small airgap resulted in an optimization problem between rotation speed and air-gap as well as torque vs speed.

Solution: Increase the airgap until cogging is significantly reduced. Use a 5 blade design to improve torque.



Boost Converter



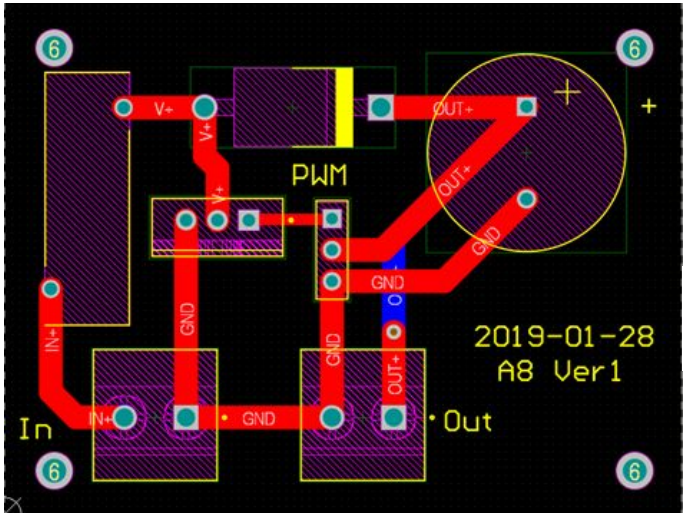
Inductor: ~100µH

Mosfet: IRF540N

Diode: 20V 5A Schottky

Capacitor: 50V 1000µF Electrolytic

Input/Output Terminals: 2 Hole Screw Terminal

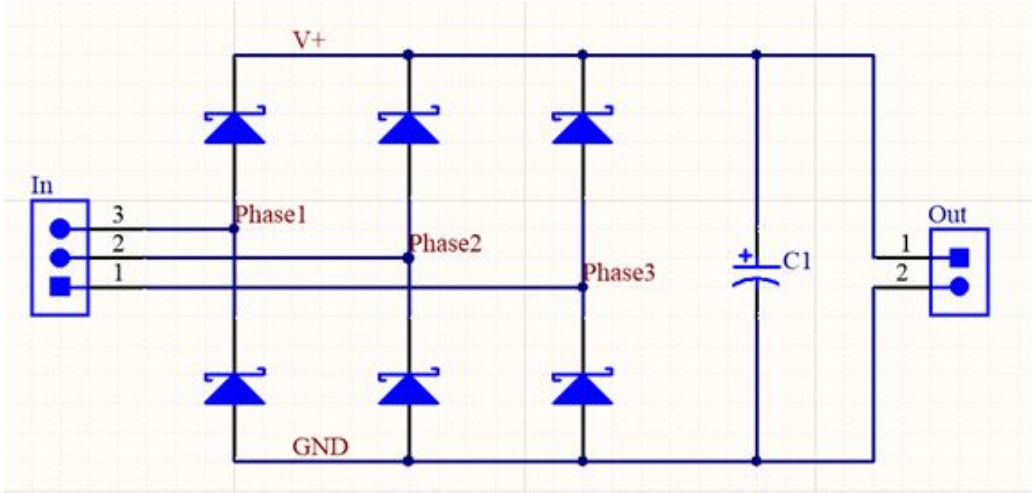


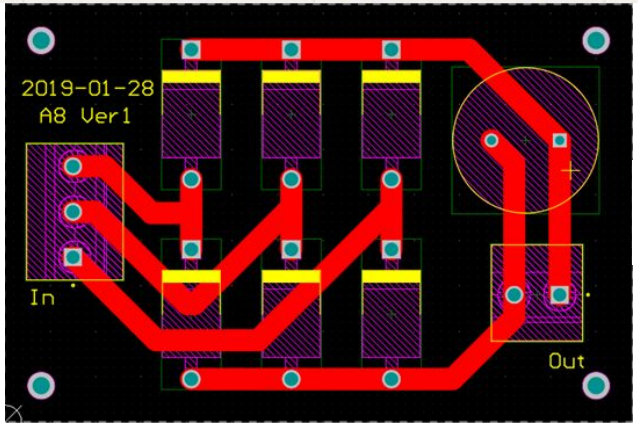
3-Phase Rectifier

Diode: 20V 5A Schottky

Capacitor: 35V 3300µF Electrolytic

Input/Output Terminals: 2/3 Hole Screw Terminals



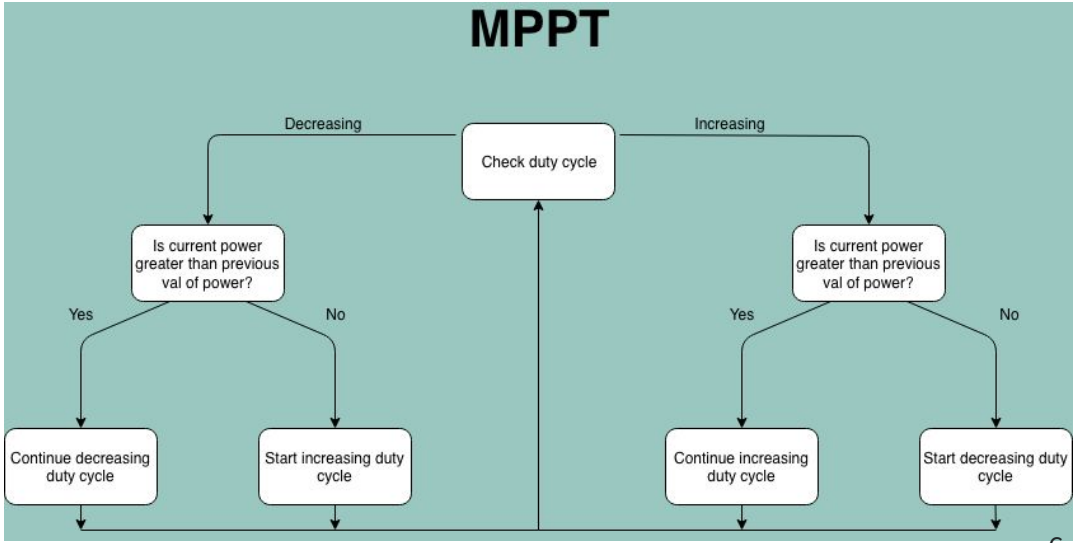


6.9cm

6.9cm

Control 1

- **MPPT**: Using perturb and observe method to maximize power
- Everytime interrupt trigger mppt() function, compare current power to old power
- If power increased or equal to previous val, continue doing current change of duty cycle, else do the opposite



Control 2

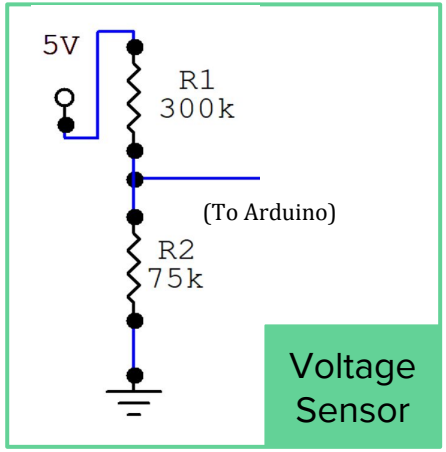
- **Wind Sensor**: Measure voltage from potentiometer
- Choose the voltage of the potentiometer when it is in the middle as reference
- If the potentiometer voltage is greater than reference, then stepper motor rotates clockwise until potentiometer is within +-0.1 V of its reference
- If potentiometer voltage is less than reference, stepper motor rotates counter clockwise

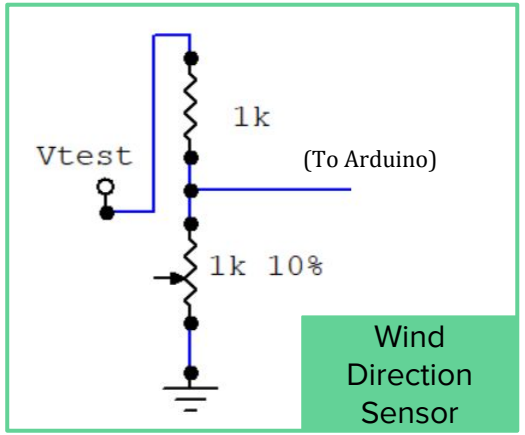
Sensors

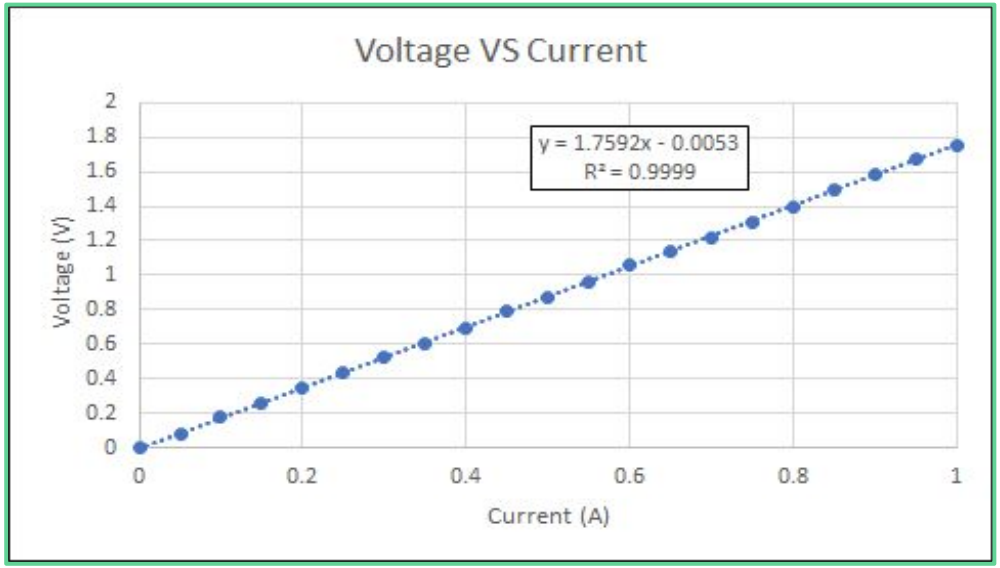
- **Voltage sensor:**
  - Accurate to 0.05V
  - Voltage divider
    - R1 = 300k Ohms
    - R2 = 75k Ohms
    - R2/(R1+R2)
  - 1 /5 ratio

- **Current sensor:**
  - Accurate to 0.01A
  - Shunt with opamp
  - Linear relationship
  - Expected range 100mA-200mA

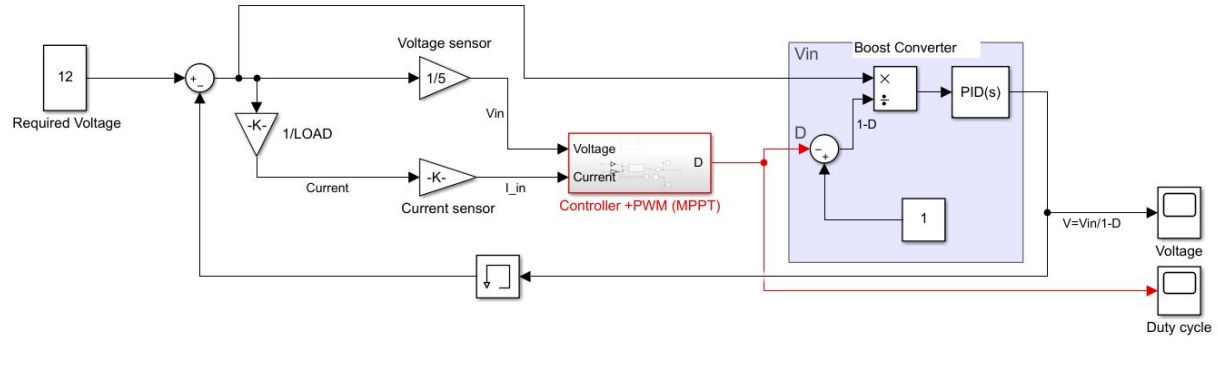
- **Wind direction sensor:**
  - 300 degrees of freedom
  - Voltage divider :
    - R1 = 1k Ohm resistor
    - R2 = 0-1k Ohm potentiometer
    - 5V input
  - Approx. 0-2.5V (0.5 ratio)

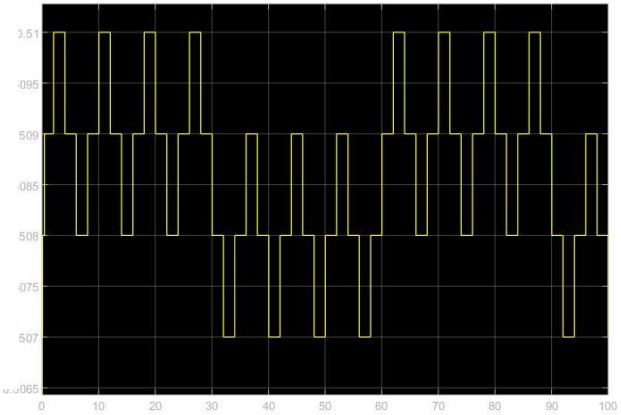


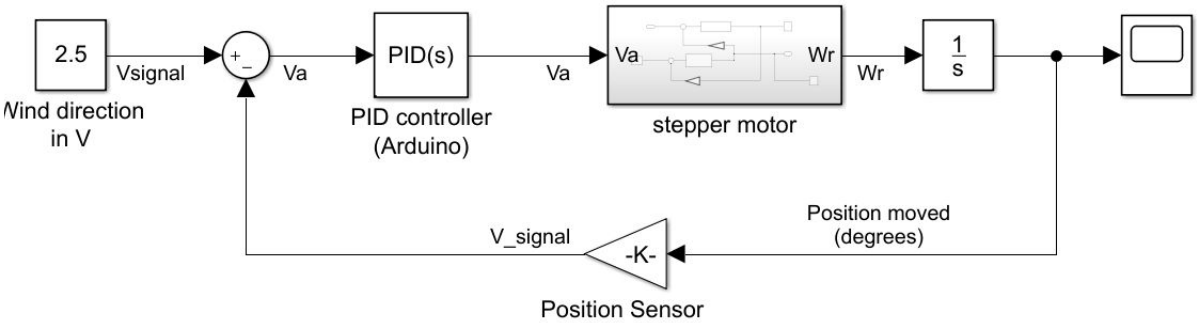


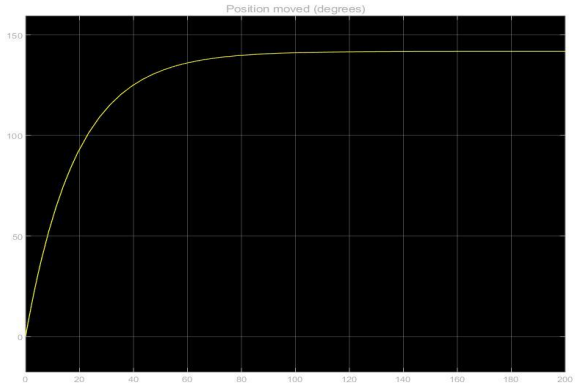


Simulink models









Bonus

1. Implemented a bluetooth module that allows a connected device to access the arduino’s serial port
2. Connect to port through javascript, then read and send data to web server
3. Created a web server using NodeJs, and tunnelled it a public URL, allowing anyone anywhere to access our web interface.
4. Plotted the live data streamed from the Arduino on our web interface.