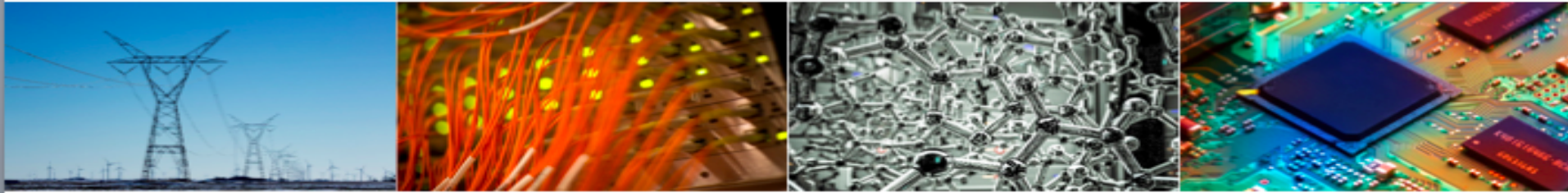


Autonomous Dog Entertainment



Group #16:
Aimee Rogala
Mary Abbott
Robert Scheuneman

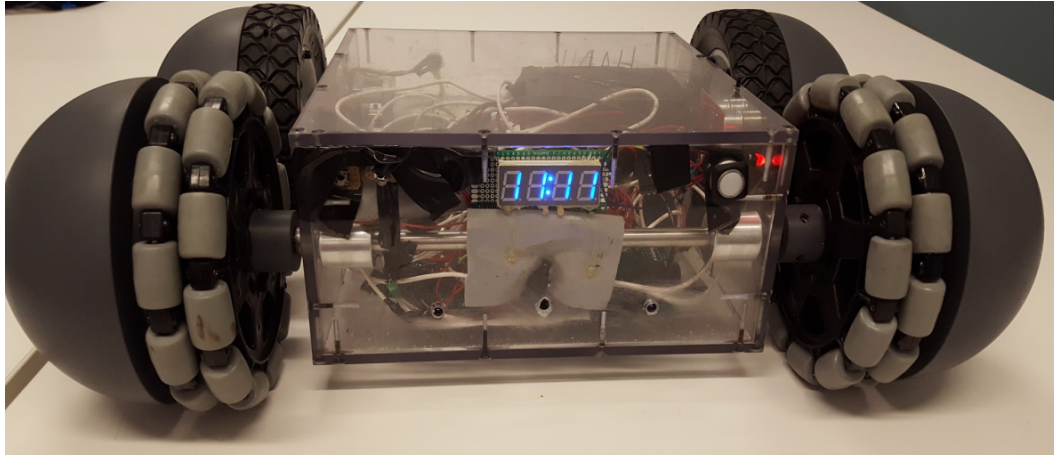
Acknowledgements

- Luke Wendt
- Scott McDonald
- Gregory Bennett
- Professor Seth Hutchinson

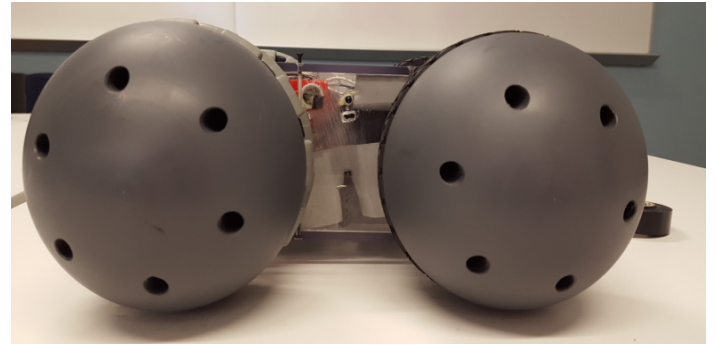
Introduction

- Entertainment for dogs while owners are away from home
- A sense of reassurance for dog owner's
- Objectives
 - Detect and avoid items of furniture
 - Attract a dog for 20 minutes
 - Continue to function correctly when dropped on any side

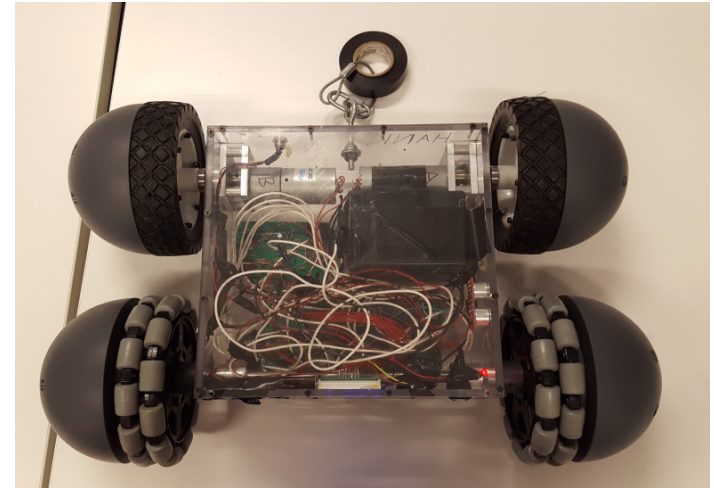
Final Design



Front View

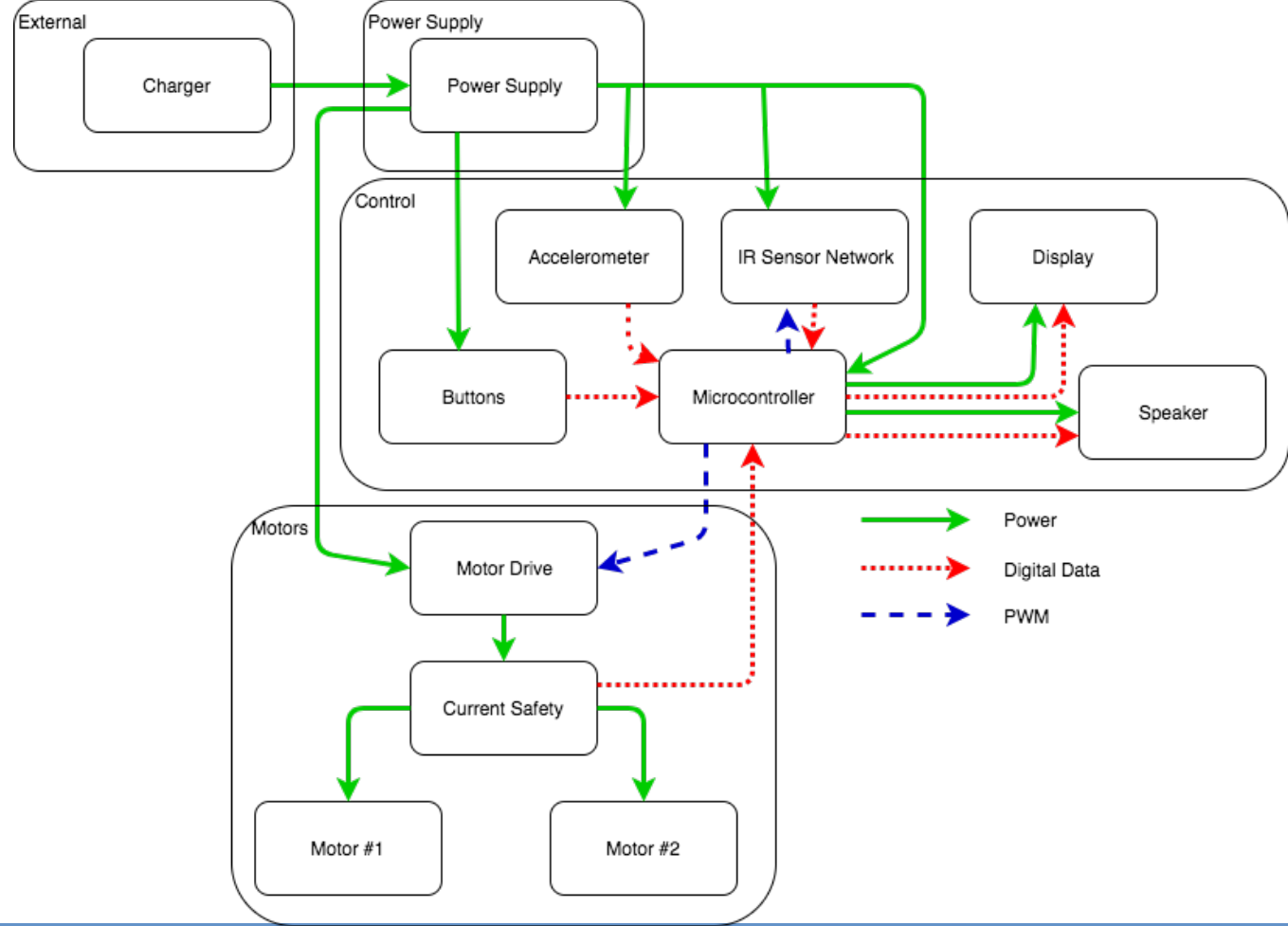


Side View



Top View

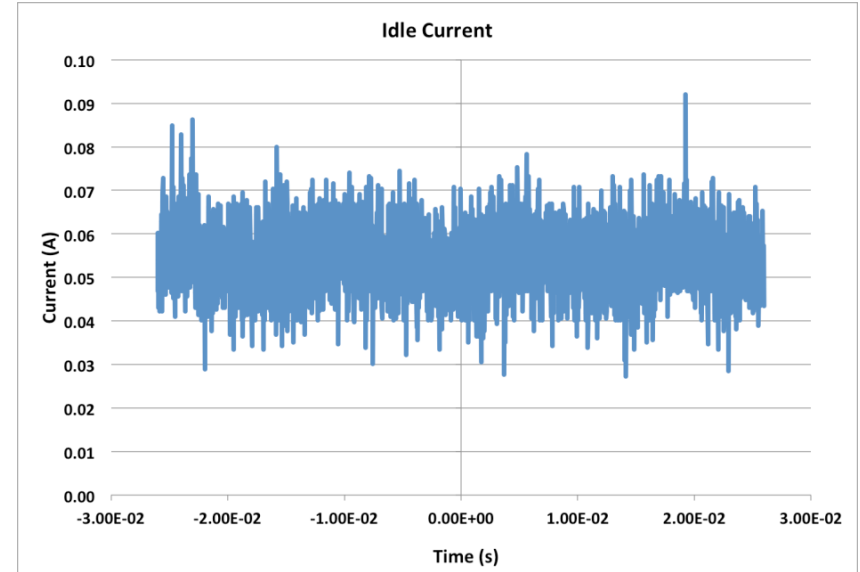
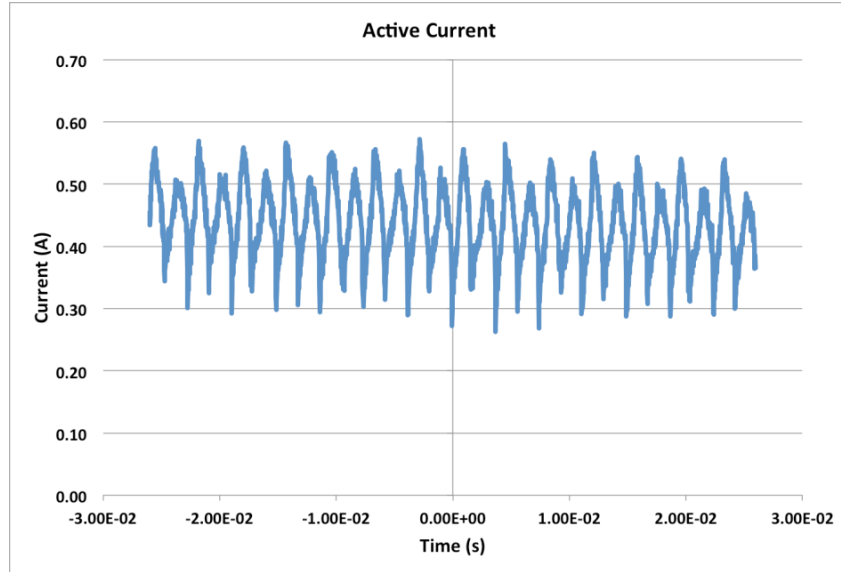
Block Diagram



Power Supply

- Inputs
 - Battery: 12V
- Outputs
 - 3.3V
 - Control Module and Motor Module: 5V
 - Motor Module: 12V

Battery Life



$$I_{\text{active}} * h_{\text{active}} = 0.47\text{A} * 0.33\text{h} = 0.1551\text{Ah}$$

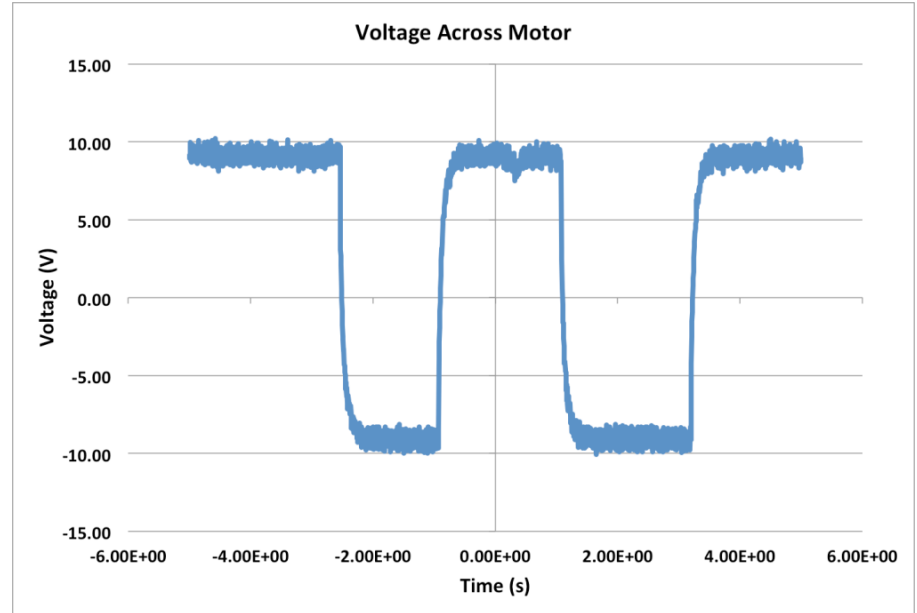
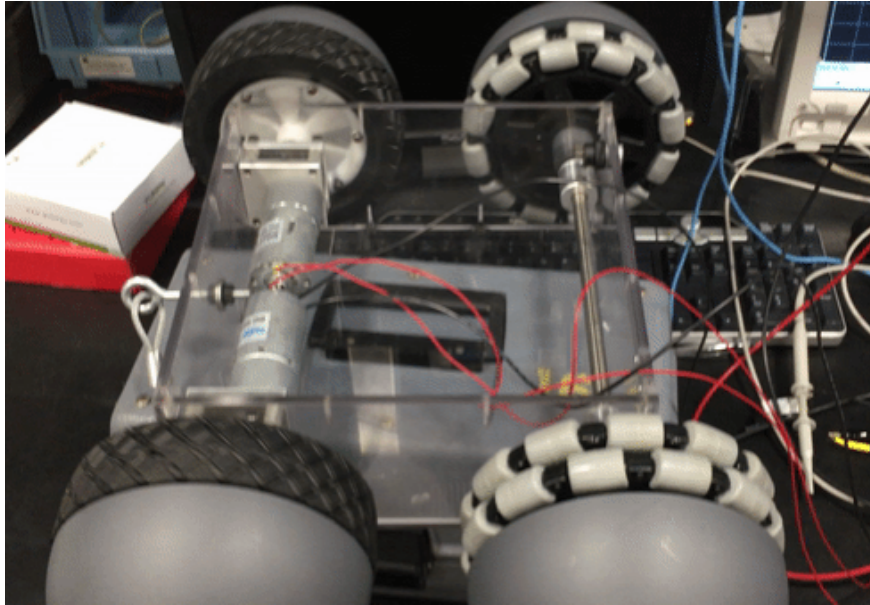
$$5\text{Ah} - 0.1551\text{Ah} = 4.845\text{Ah}$$

$$4.845\text{Ah} = 0.055\text{A} * h_{\text{idle}} \Rightarrow h_{\text{idle}} = 88.1\text{hours}$$

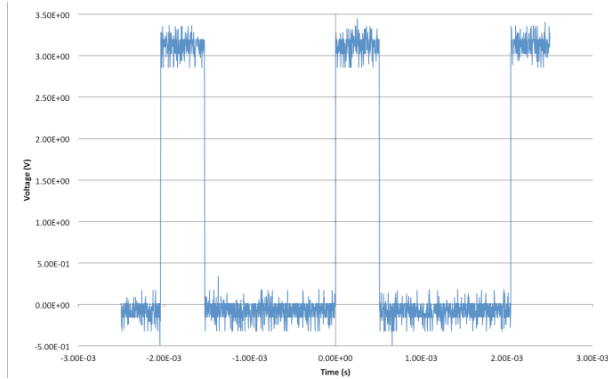
Motors Module

- Inputs
 - Power Supply: 12V, 5V
 - Microcontroller: PWM for motors
- Outputs
 - Microcontroller: Motor Stall

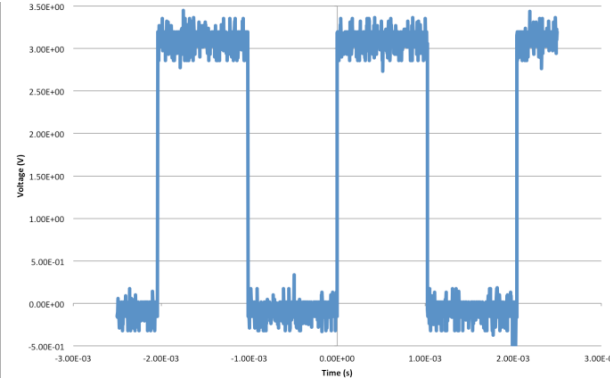
H-bridge



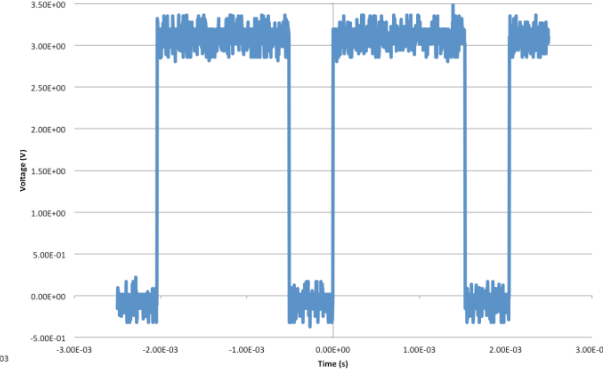
PWM Signals



25% Duty Cycle

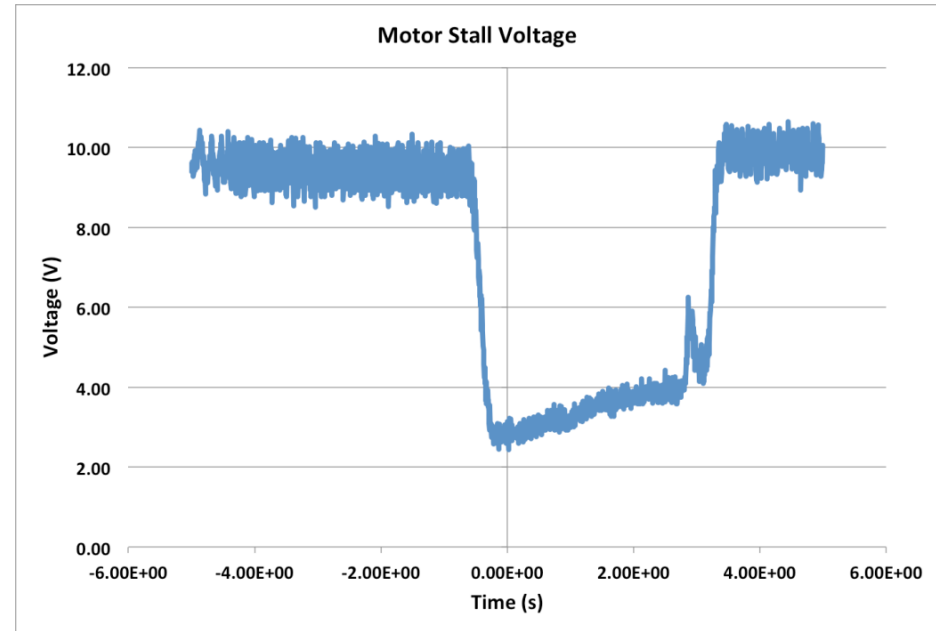
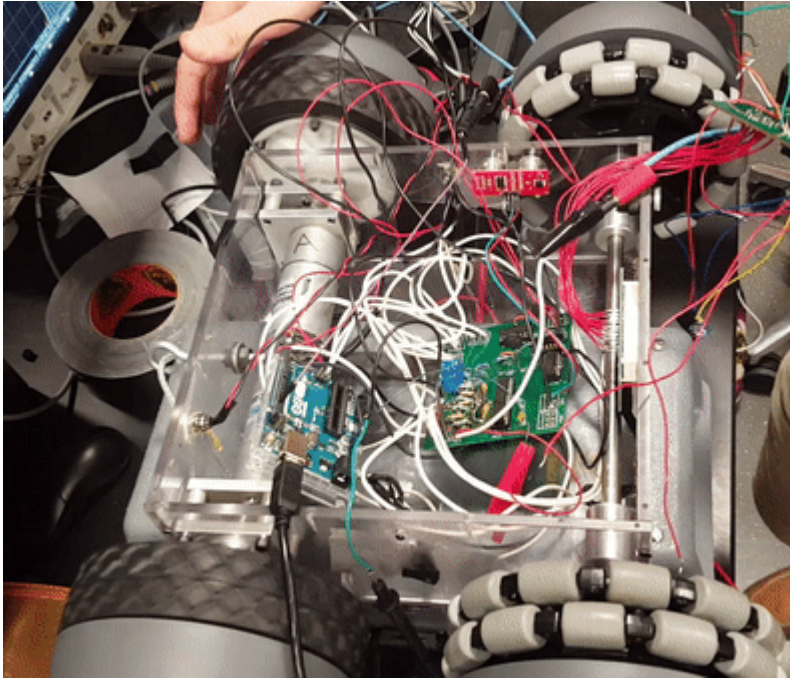


50% Duty Cycle

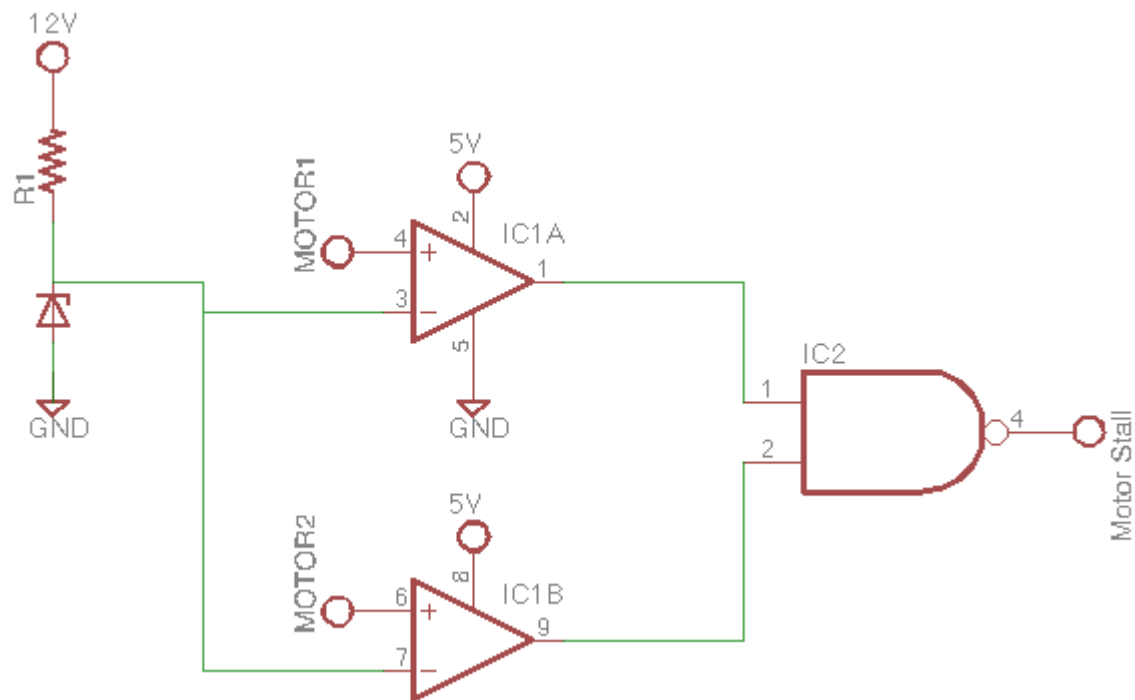


75% Duty Cycle

Current Safety



Current Safety Circuit



Device Speed

$$7\text{ft} \equiv 17.43\text{s} \Rightarrow \frac{60}{17.43} * 7 = 24.096 \frac{\text{ft}}{\text{min}}$$

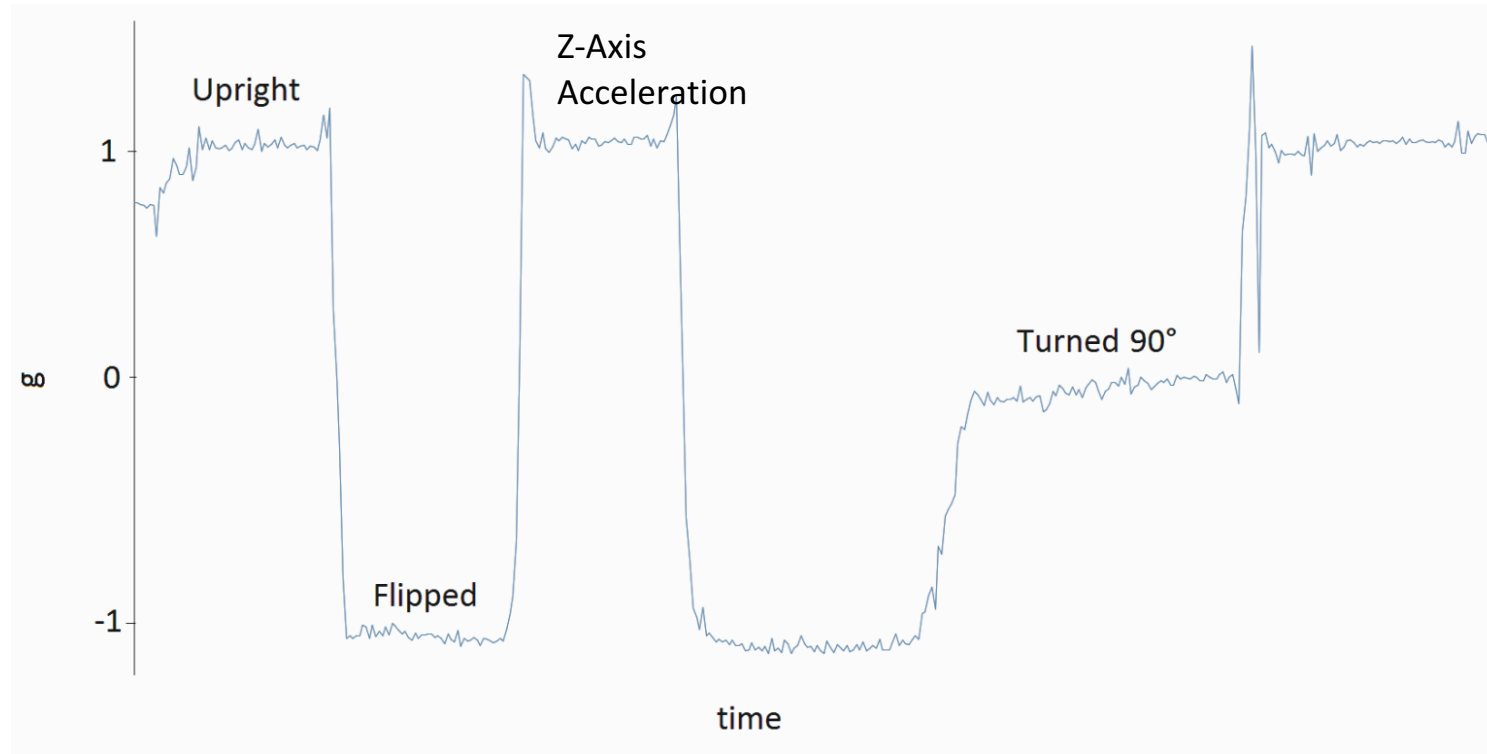
$$2 * \pi * 0.25 = 1.571 \frac{\text{ft}}{\text{rev}} \Rightarrow \frac{24.096}{1.571} = 15.34\text{rpm}$$

Total Active Mode Distance: 481.92 ft

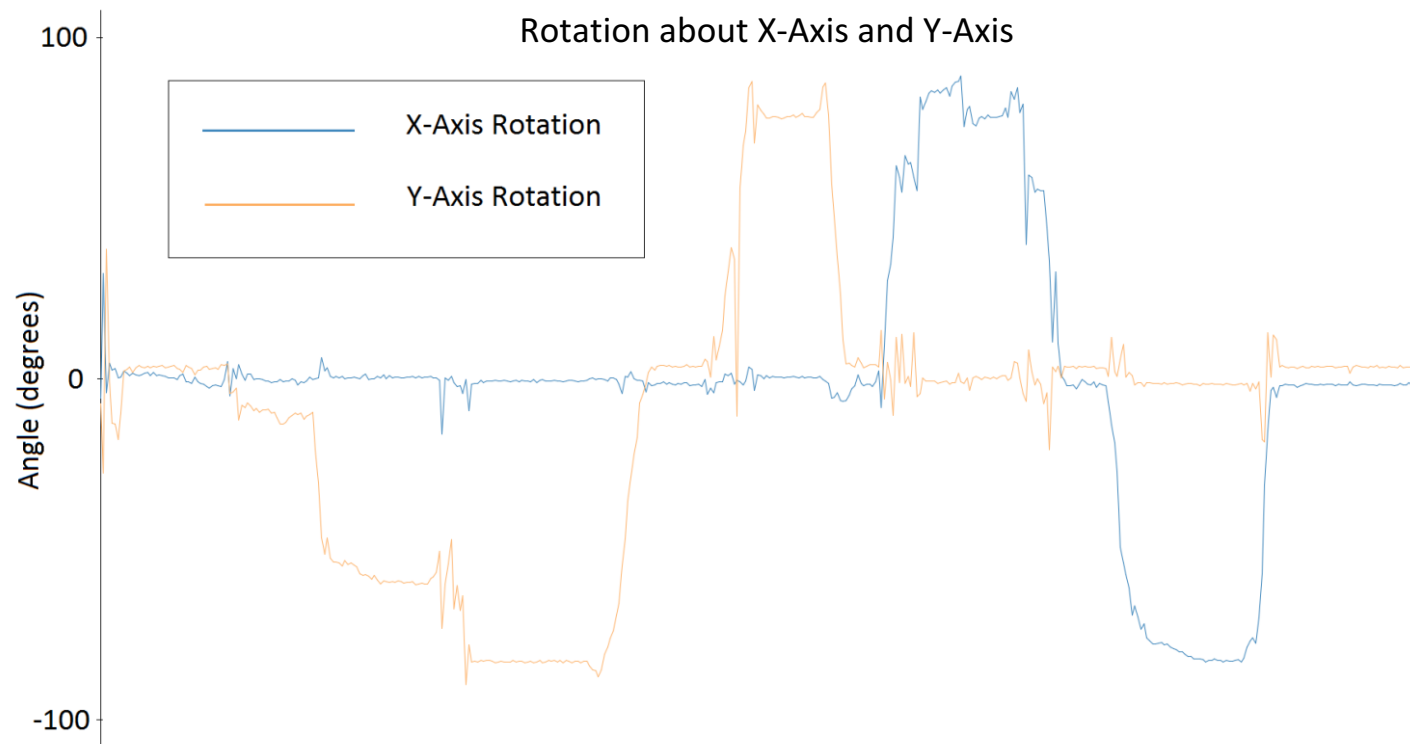
Control Module

- Inputs
 - Power Supply: 5V
 - Current Safety: Motor Stall Signal
- Outputs
 - Motor Drive: PWM Signal

Accelerometer Inversion Detection



Accelerometer Angle Detection



IR Sensor Network

- Frequency = 37.593 kHz

$$\text{Frequency} = \frac{1}{\tau} = \frac{1}{t_f - t_i} \Rightarrow \frac{1}{(1.42 * 10^{-5}) - (-1.24 * 10^{-5})} = 37.593 \text{ kHz}$$

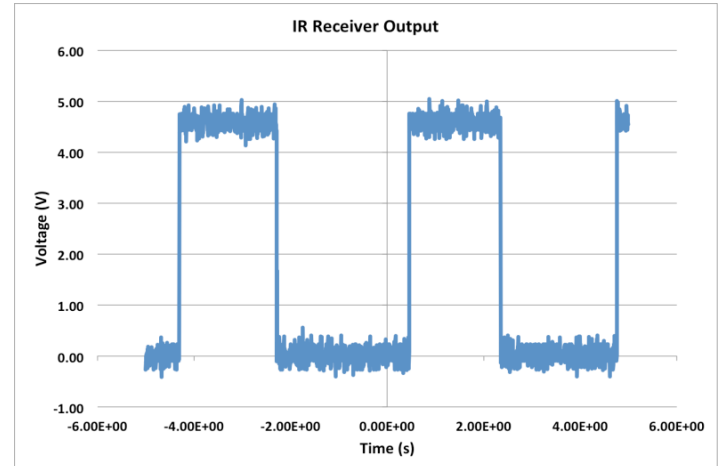
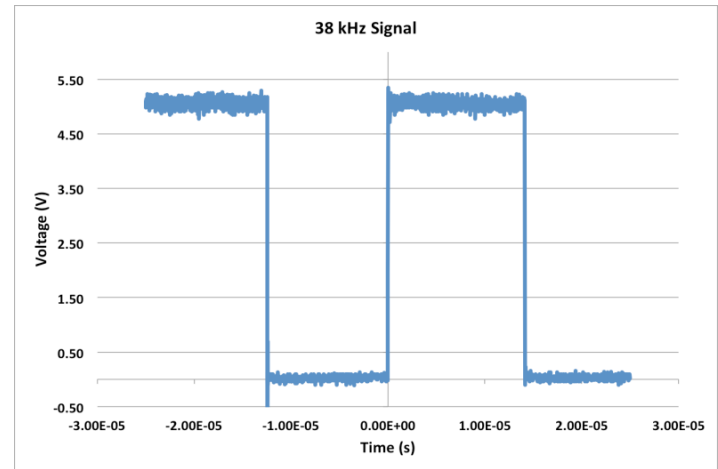
- Sensor Range = 26 in = 0.66 m

- Sensor Angle = 28.08°

$$\tan^{-1}\left(\frac{12 \text{ in}}{3 \text{ in}}\right) = 75.96^\circ \Rightarrow$$

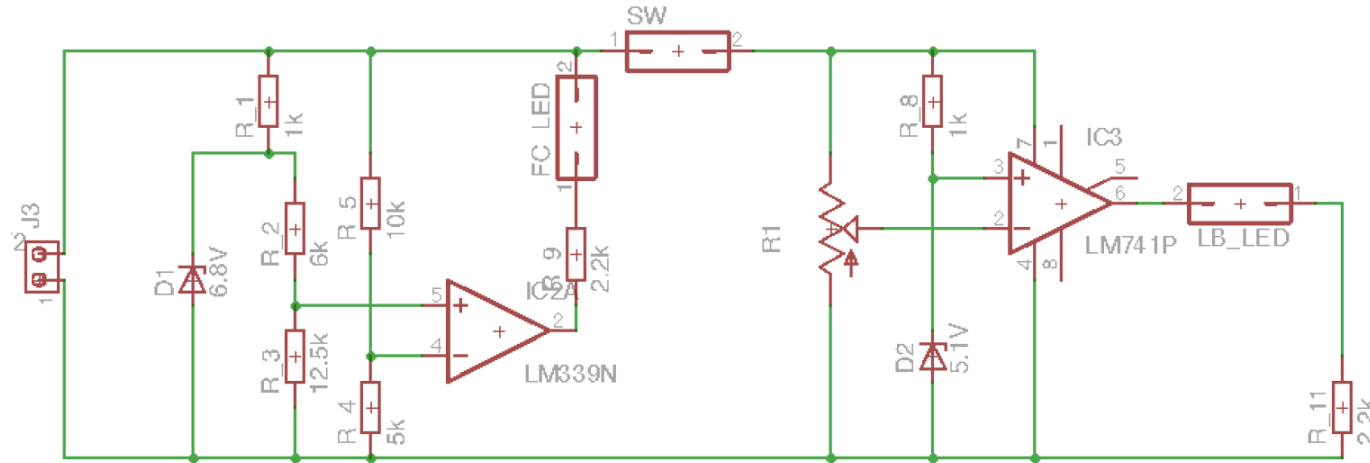
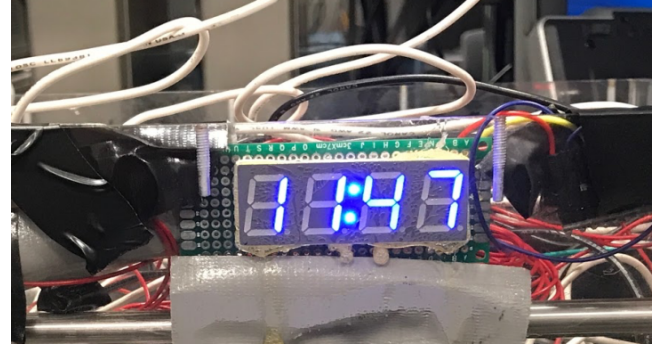
$$90^\circ - 75.96^\circ = 14.04^\circ \Rightarrow$$

$$14.04^\circ * 2 = 28.08^\circ$$



Display

- Full Charge Value: 12.1V
- Low Charge Value: 11.5V



Microcontroller

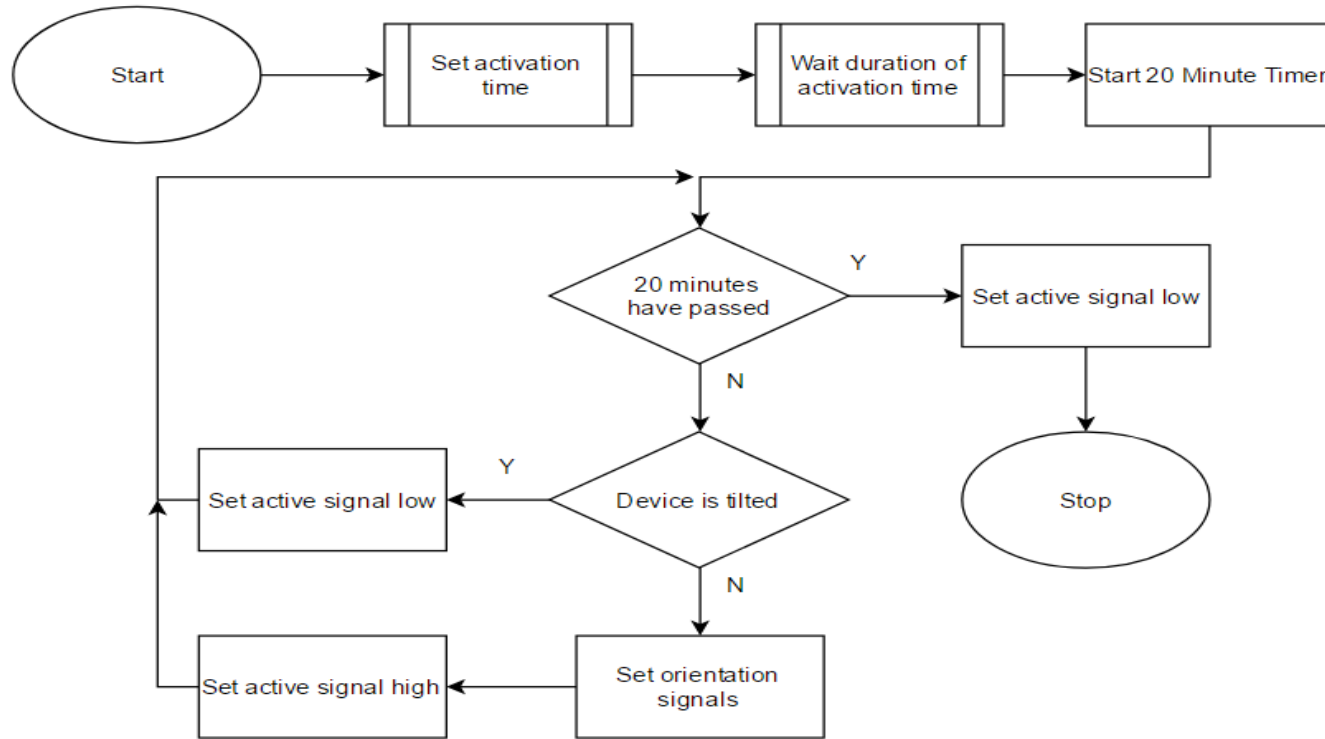
Active Signal

- Low when in sleep mode or tilted sideways
- Otherwise high

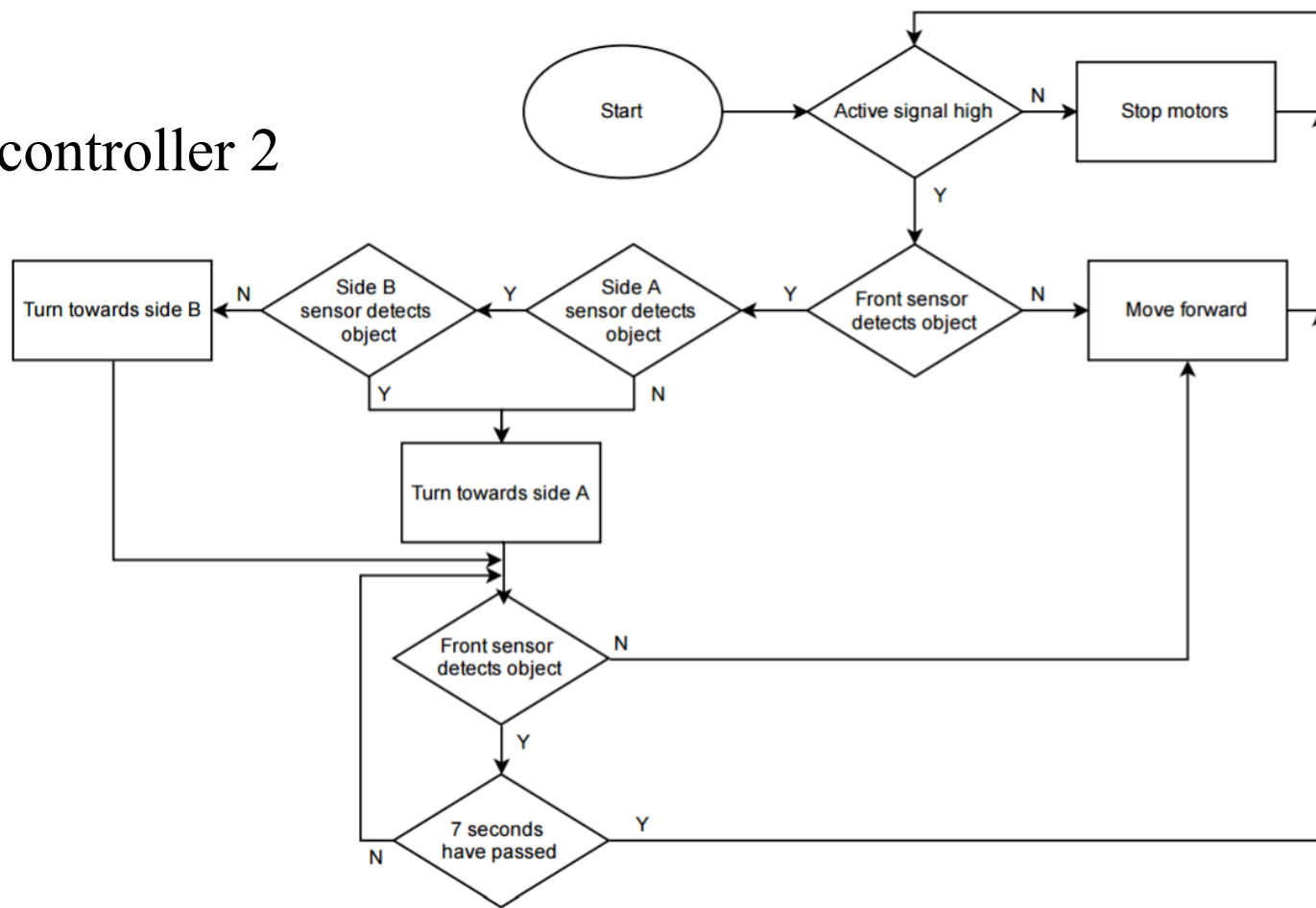
Two Orientation signals

- Detect if flipped
- Detect if the x or y axes are at an angle of greater than 30 degrees

Microcontroller 1

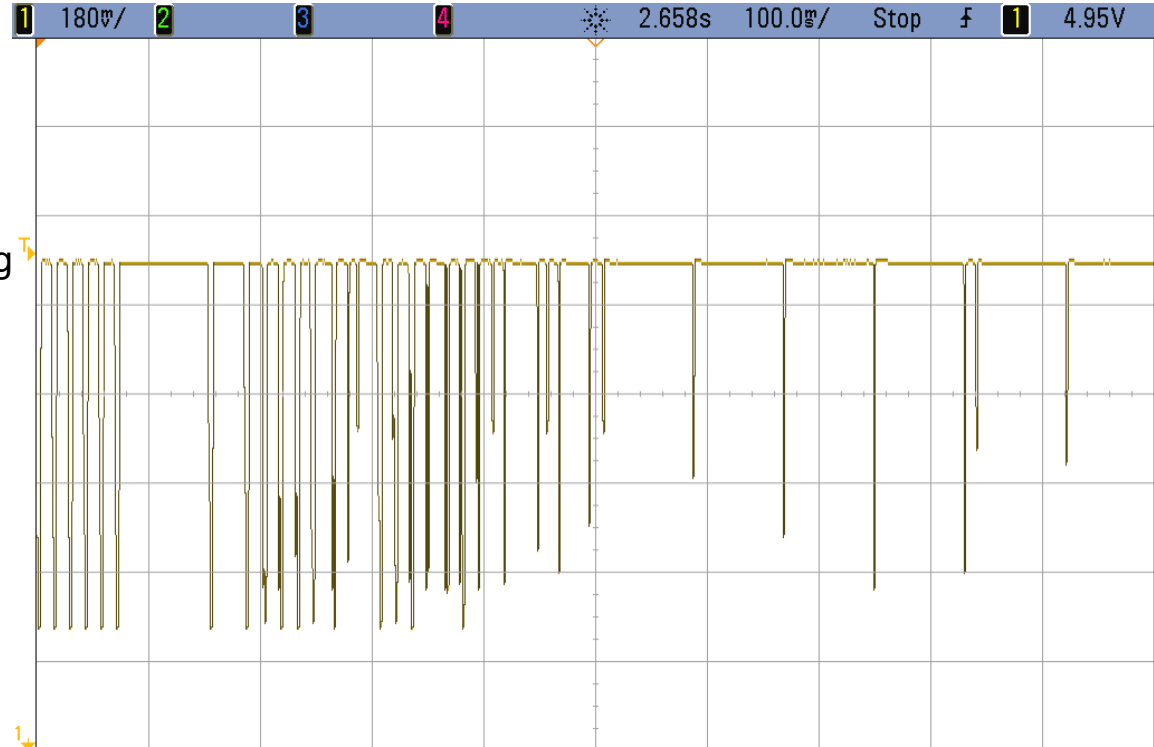


Microcontroller 2



Speaker

- 40kHz ultrasonic range finder
- Output bursts after receiving trigger signal
- Echo pin goes high for length of time proportional to distance of object (Only used for verification purposes)



Safety and Ethics

- Animal Safety
 - Durable
 - Minimize number of accessible small parts
- Safety to its Environment
 - Obstacle Detection
 - Wedge Detection
- Battery Safety
 - Lead-Acid Battery
 - Stall Logic
 - Water Resistant

Conclusions

X	Detect and avoid items of furniture
X	Continue to function correctly when dropped on any side
	Attract a dog's attention for 20 minutes

- Device exceeds half pound drag weight
- Device has a sensor range of 0.66 meters

Possible Improvements

- Integrate stall logic
 - Low pass filter
- Decrease detection blind spots
 - Adding more IR sensors
- Randomness in navigation
- Record Owner's voice
- Allow for multiple active periods and/or longer active periods

Thank You!

Questions?



Stall Current

