Autonomous Underwater Robots Spring Progress Presentation

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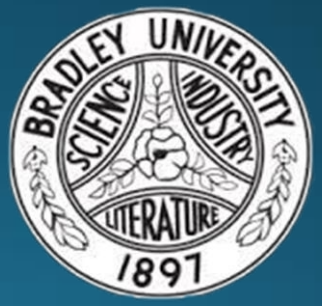
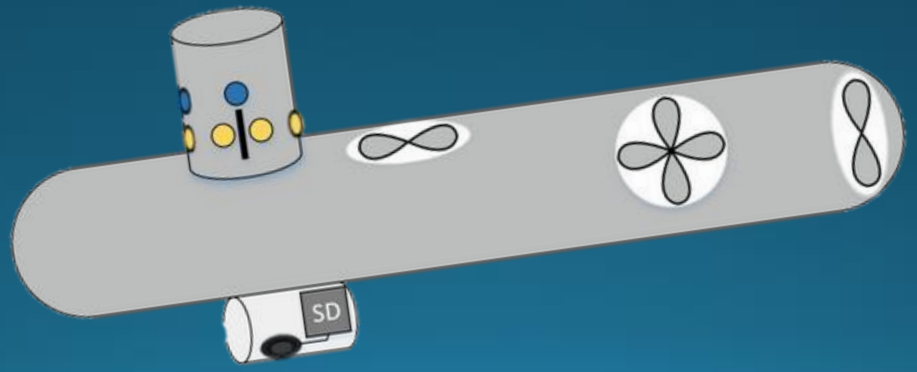
FEBRUARY 24, 2014

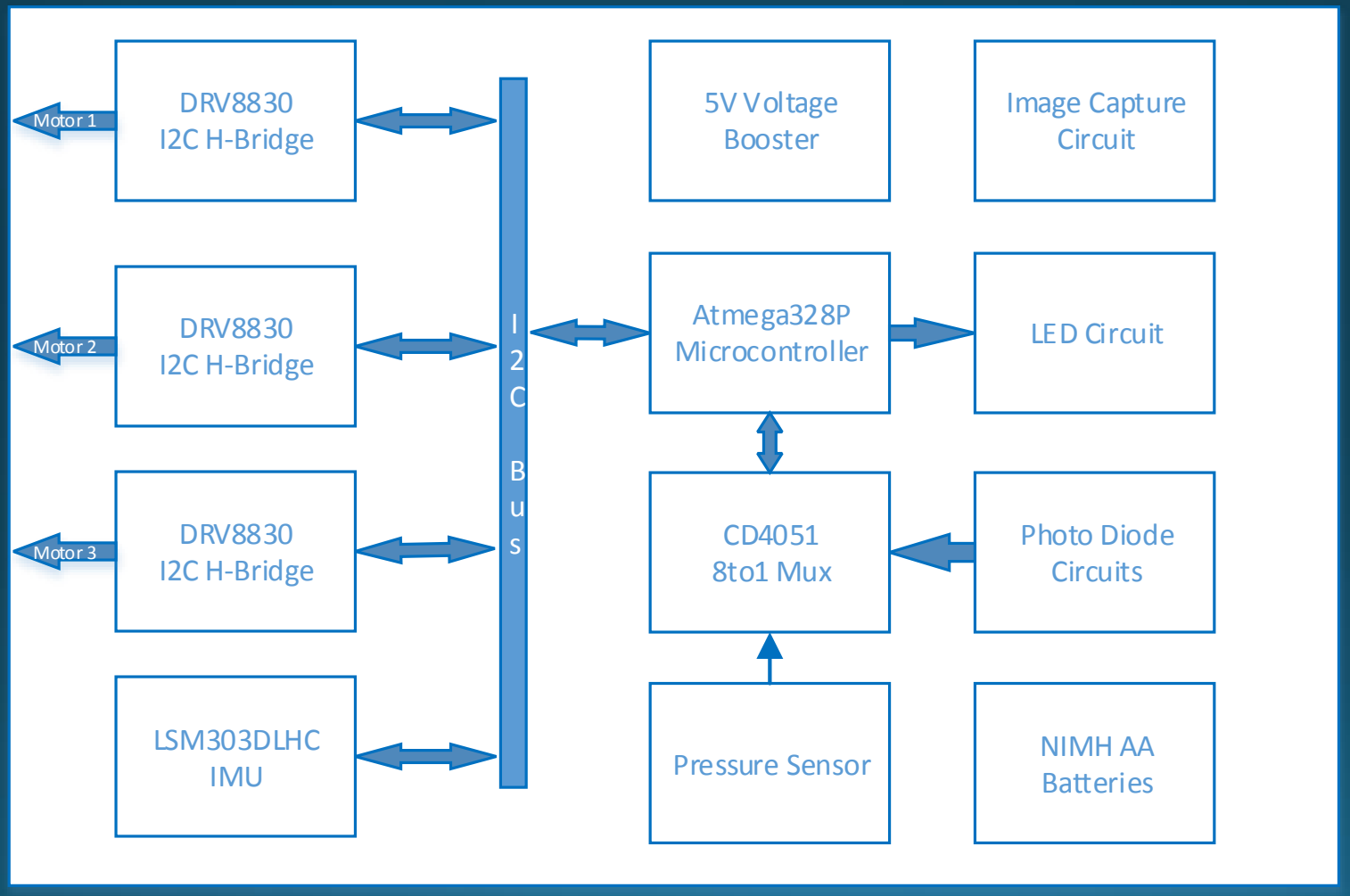


Project Objectives

- Map underwater terrain
  - Swarm of UAV's
  - Avoid obstacles
  - Generate final image from smaller images



System Block Diagram

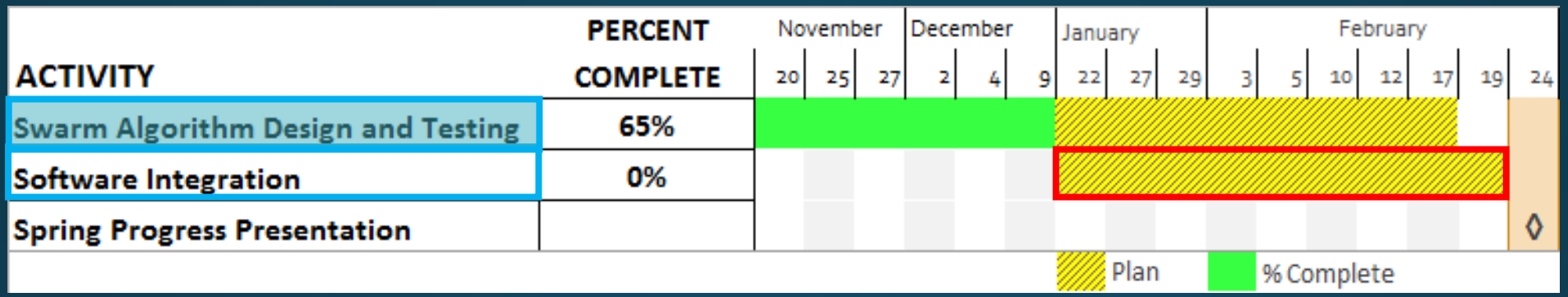


Division of Labor

- Cameron – hardware
- Nick - software
- Ryan – hardware and software

Gantt Chart – Nick Sikkema

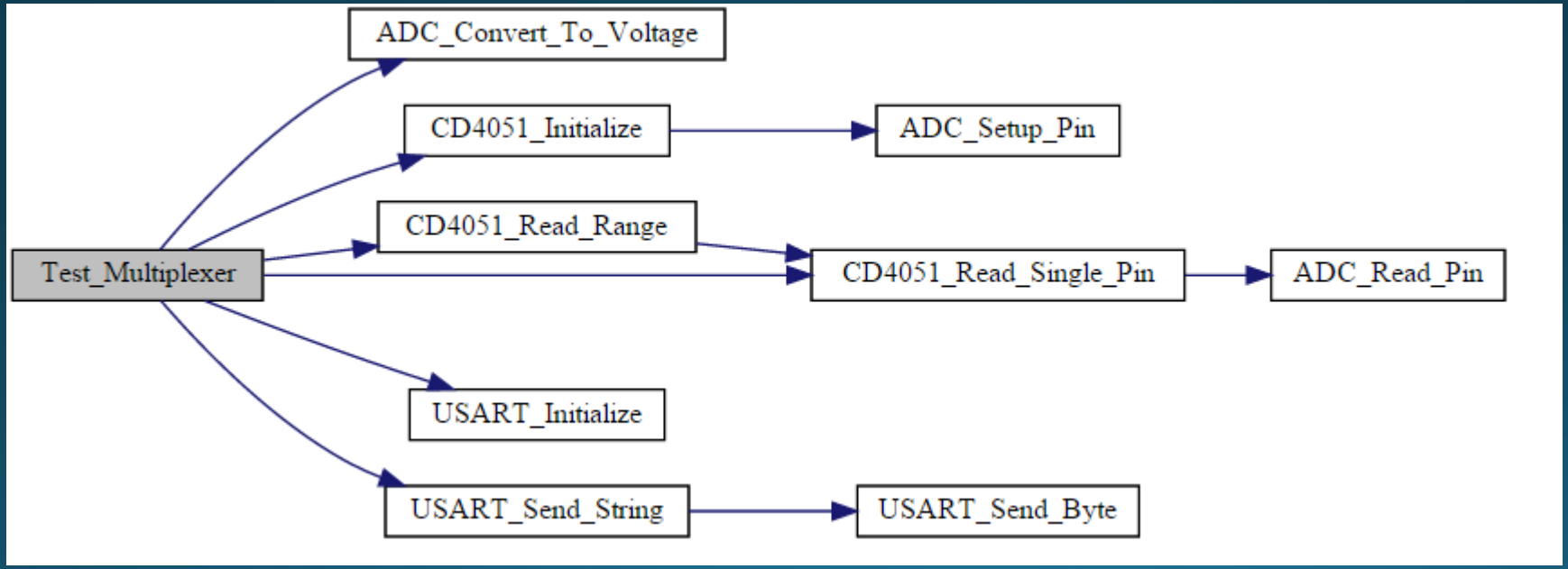
Task 1



Task 1: Software Integration

Design

- Combining code for subsystems
  - Optimization
  - Functional programming style

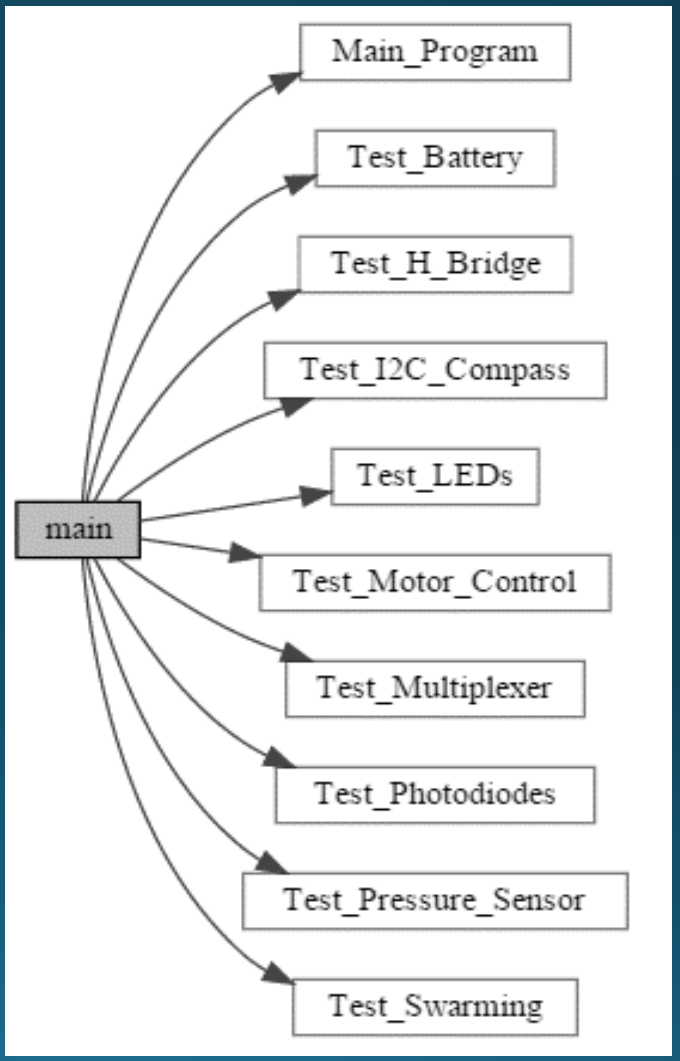


Doxygen output for the multiplexer

Task 1: Software Integration

Design

- Debugging
  - Unit testing
  - Doxygen comments



Doxygen output for the main function

Task 1: Software Integration

Research

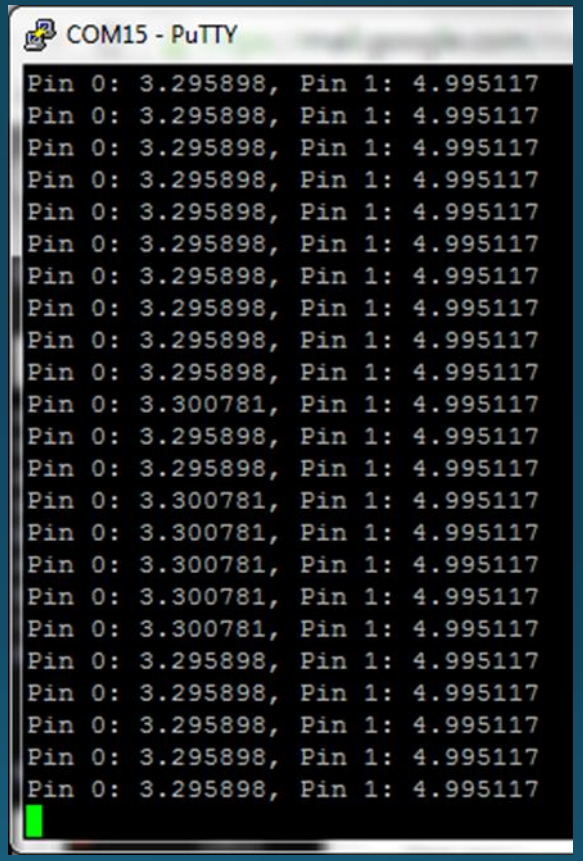
- Step-up regulator
  - Input minimum 2.5 volts
  - Output 5 volts
- Reference voltage
- Noise isolation

Pololu U3V12F5 [3]

Task 1: Software Integration

Results

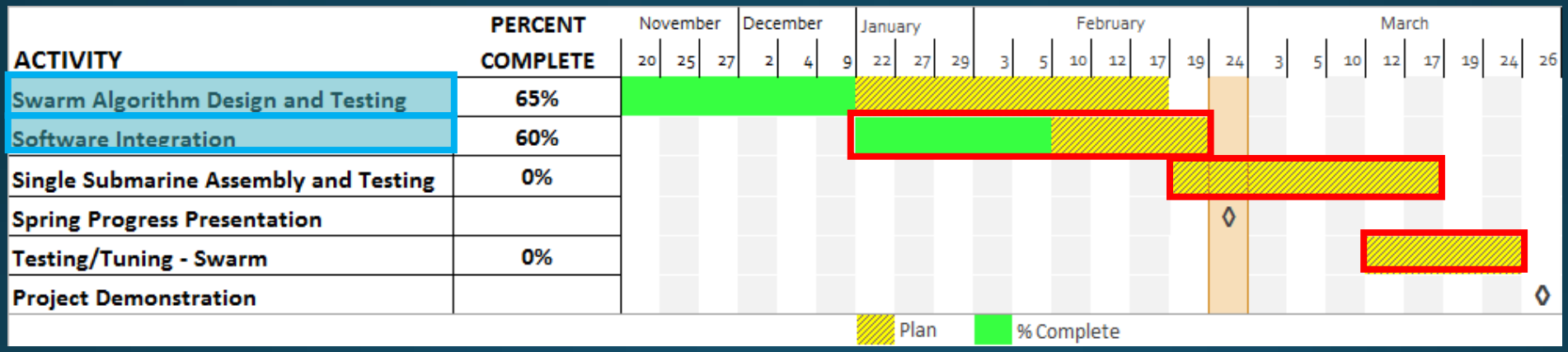
- Step-up regulator
  - Input minimum 2.5 volts
  - Output 5 volts
- Reference voltage
- Noise isolation



Console Output for Regulator and Multiplexer

Gantt Chart – Nick Sikkema

Future work

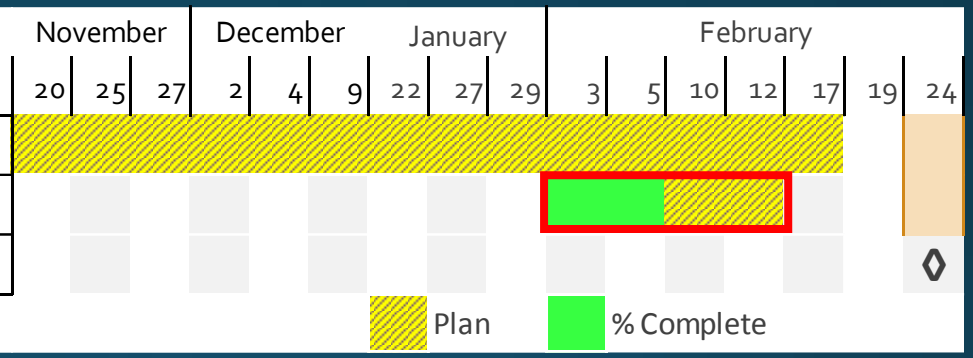


Gantt Chart – Ryan Lipski

Task 1

Previously named directional guidance

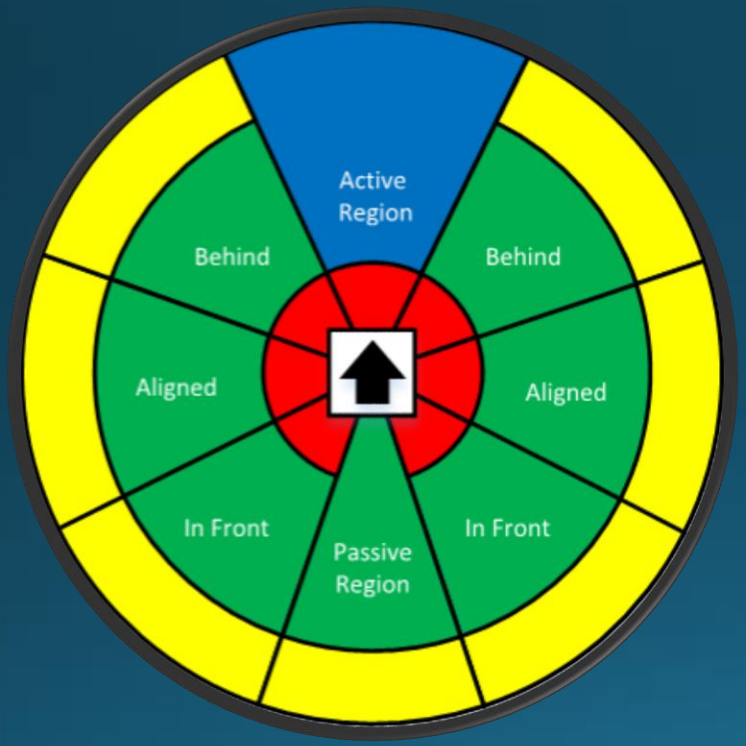
ACTIVITY	PERCENT COMPLETE
Swarming Algorithm Design and Testing	0%
Circuit and System Layout	35%
Spring Progress Presentation	



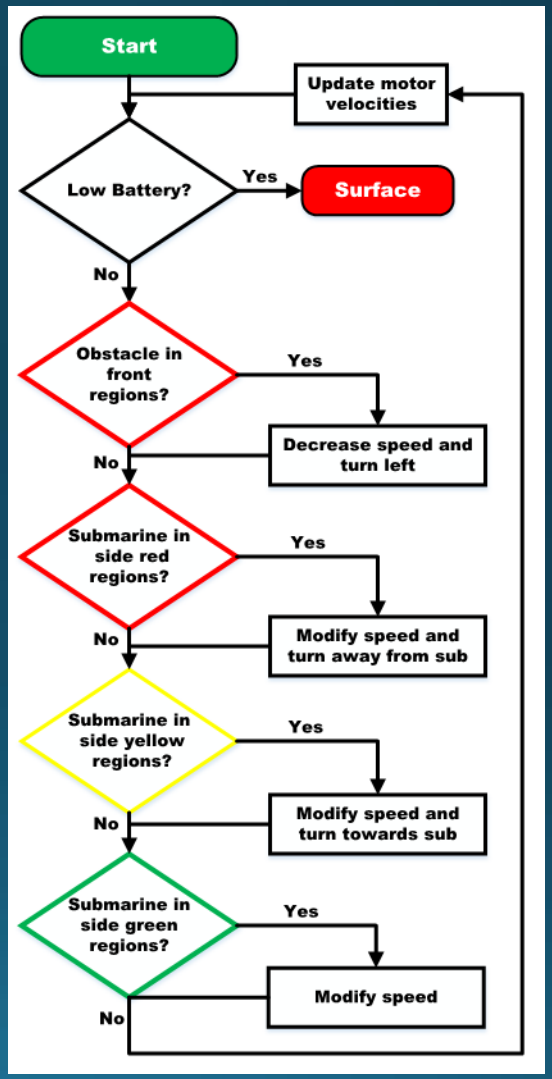
Task 1: Swarming Algorithm

Design

- Flowcharts were first design step



Detection zones

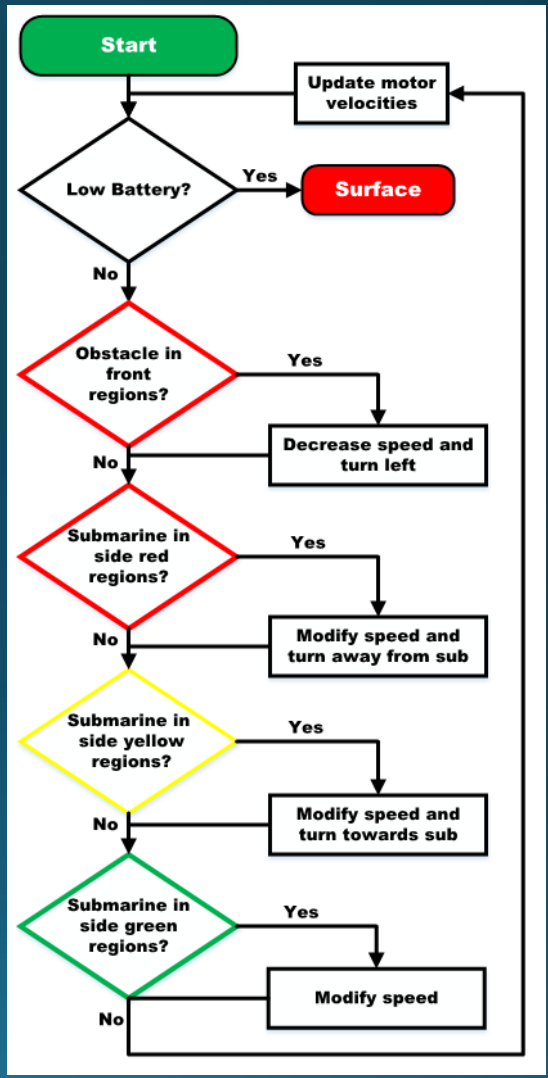


Simplified swarming flowchart

Task 1: Swarming Algorithm

Design

- Multiple iterations before coding
  - Zone checking priority
  - Integrating with rest of code
- Zone checks alter variables that factor into the motor control
  - Only applies to X and Y motors
- Motors updated after all zones checked
- Code runs until low battery voltage is detected



Simplified swarming flowchart

Task 1: Swarming Algorithm

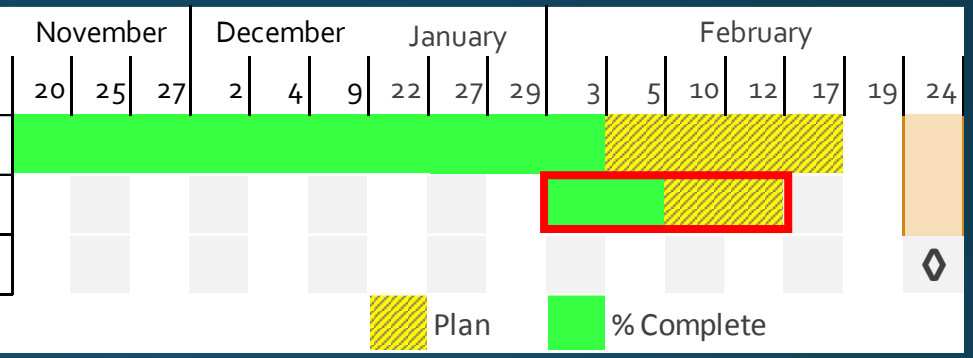
Design

- Design of this algorithm is complete
- Algorithm can be partially tested on a bench top
- Full testing will be possible only when the swarm is constructed
- May need to alter weighting of variables or radii of the different zones

Gantt Chart – Ryan Lipski

Task 2

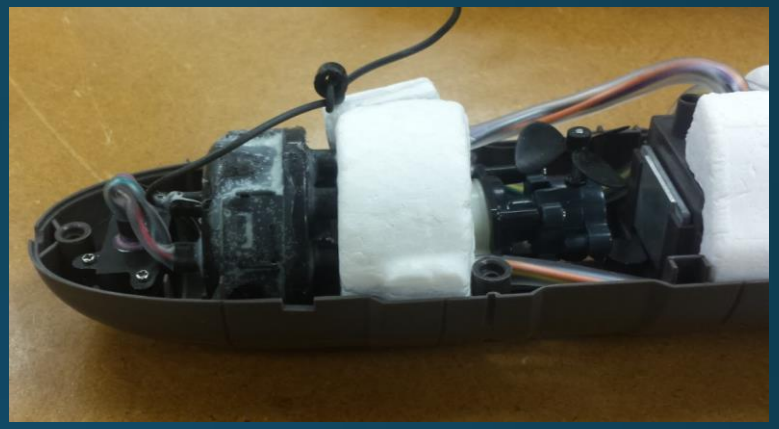
ACTIVITY	PERCENT COMPLETE
Swarming Algorithm Design and Testing	75%
Circuit and System Layout	35%
Spring Progress Presentation	



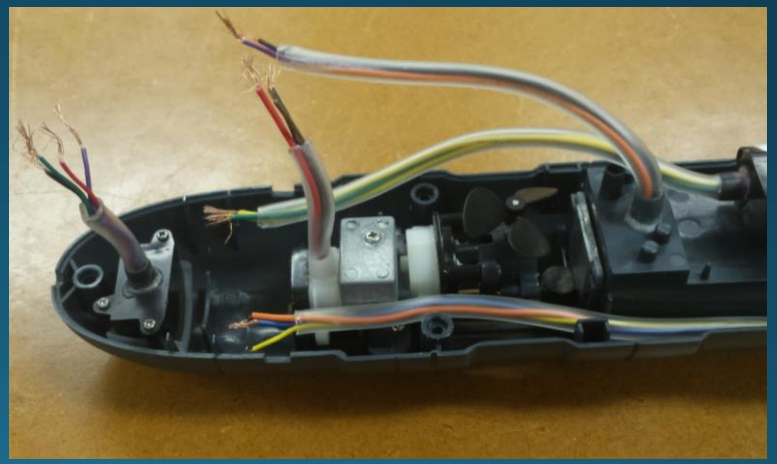
Task 2: Circuit and System Layout

Analysis

- Submarine dissection
  - Each motor has 2 leads along with a third wire
    - Determined to be a ground wire
  - Battery compartment has a 4.8 V, 3.6 V and ground lead
  - Switch has 4 leads
    - Identified each lead
  - First submarine is now prepped for assembly



Original submarine

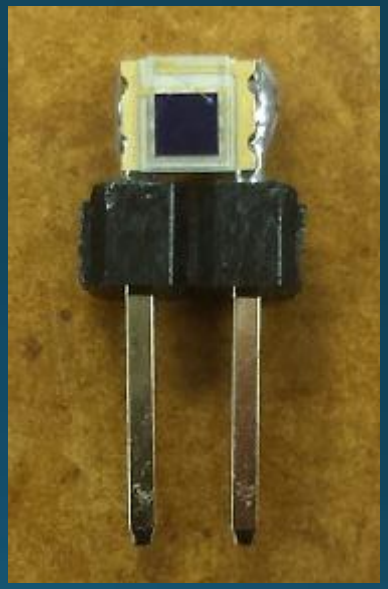


Disassembled submarine

Task 2: Circuit and System Layout

Design

- Everlight photodiodes
  - Planned to solder strands wires to each side
    - Difficult to solder without bridging the leads
    - 2.1 mm between the leads
  - Solution: Use small section of straight header pins to extend leads
    - Reduces soldering difficulty
    - Much more rigid connection
    - Plastic section of header pins doubles as a mounting point

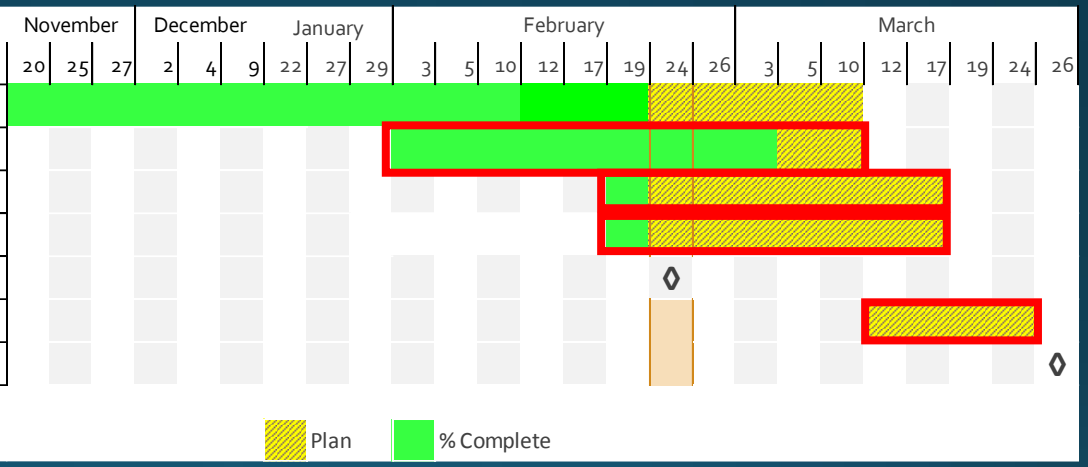


Everlight photodiode soldered to section of header pins

Gantt Chart – Ryan Lipski

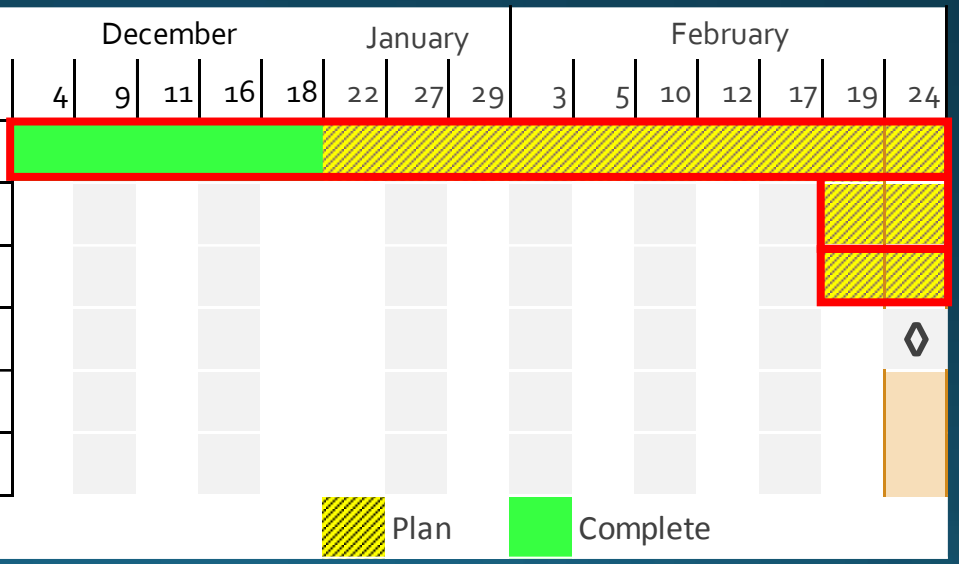
Future work

ACTIVITY	PERCENT COMPLETE
Swarming Algorithm Design and Testing	75%
Circuit and System Layout	85%
Single Submarine Assembly and Testing	5%
Assembly - Swarm	5%
Spring Progress Presentation	
Testing/Tuning - Swarm	0%
Project Demonstration	



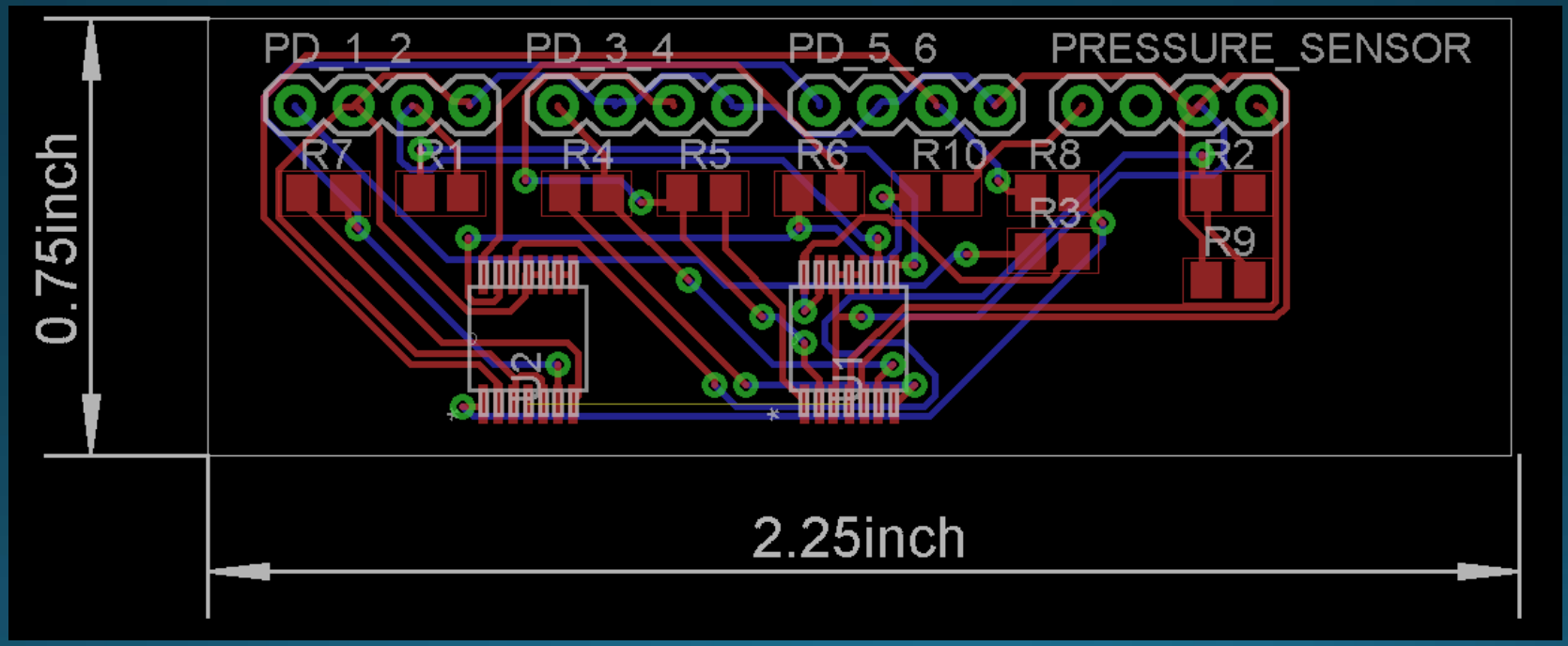
Gantt Chart – Cameron Putz

ACTIVITY	PERCENT COMPLETE
Circuit and System Layout	35%
Single Submarine Assembly and Testing	0%
Assembly - Swarm	0%
Spring Progress Presentation	
Testing/Tuning - Swarm	0%
Project Demonstration	



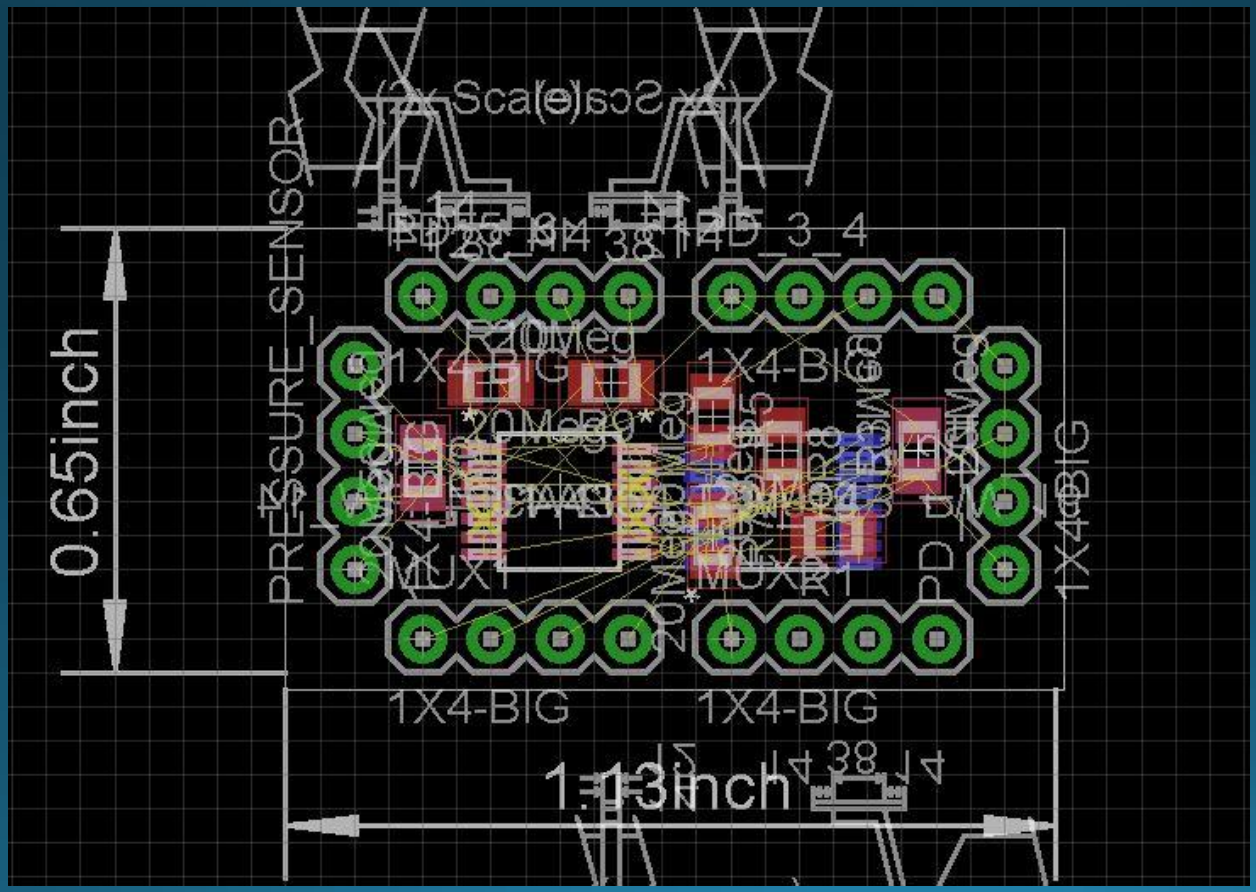
Task 1: Circuit Layout

- Eagle 7.1.0
  - Photodiode board rev. 1



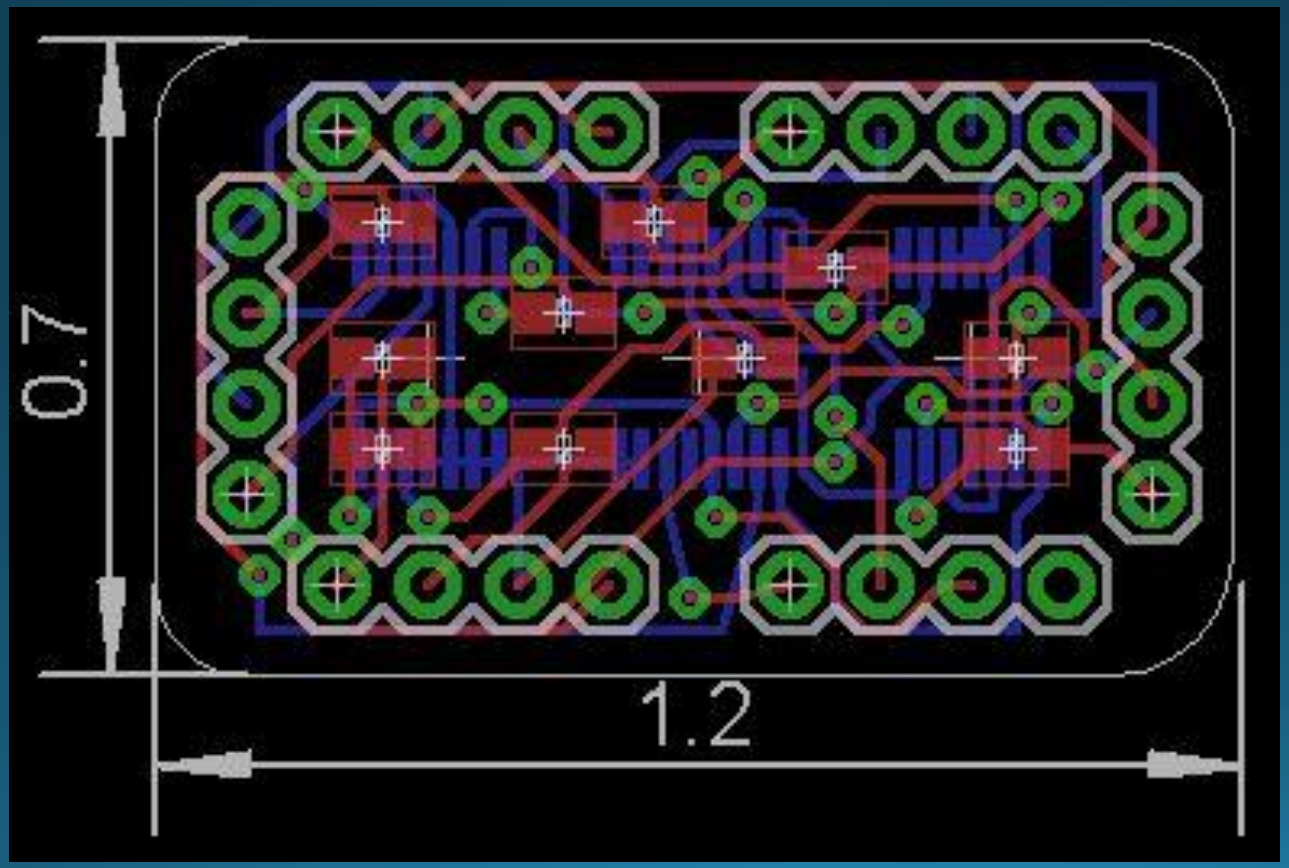
Task 1: Circuit Layout

- Eagle 7.1.0
  - Photodiode board rev. 2



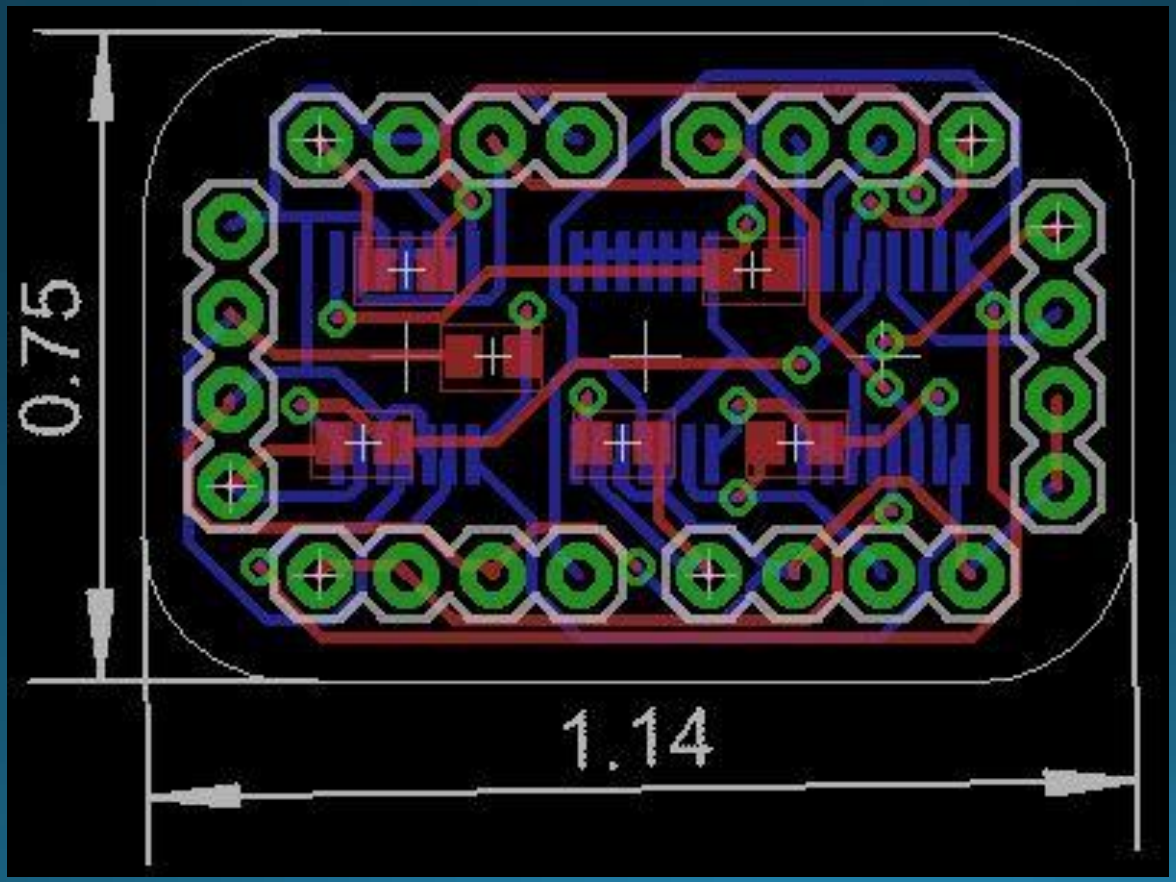
Task 1: Circuit Layout

- Eagle 7.1.0
  - Photodiode board rev.3



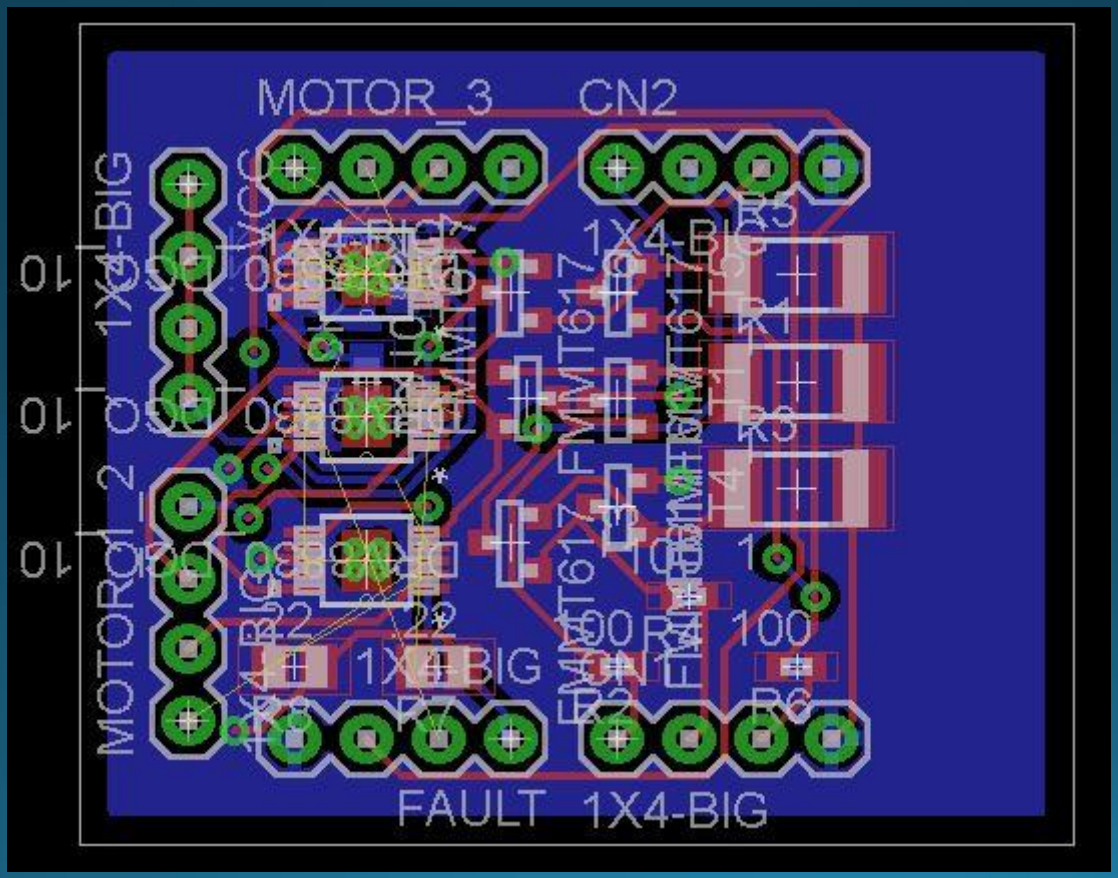
Task 1: Circuit Layout

- Eagle 7.1.0
  - Photodiode board rev.4



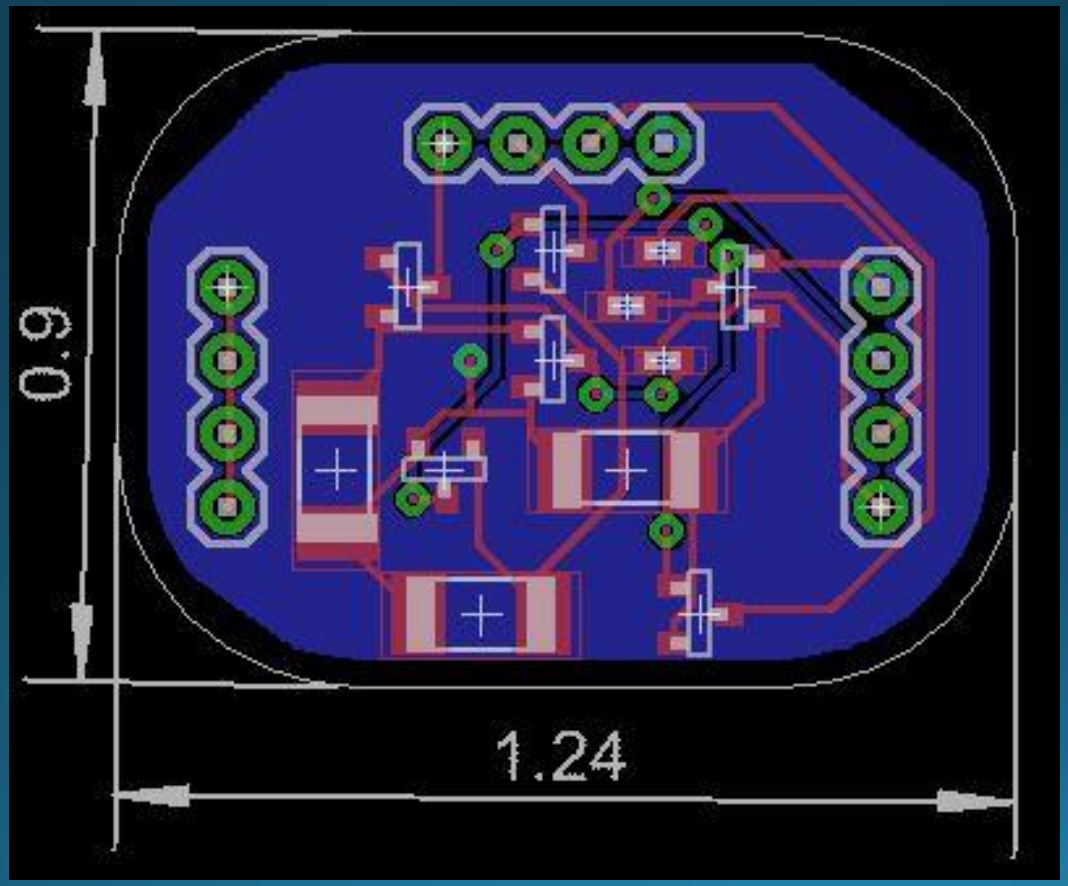
Task 1: Circuit Layout

- Eagle 7.1.0
  - High current board rev. 1



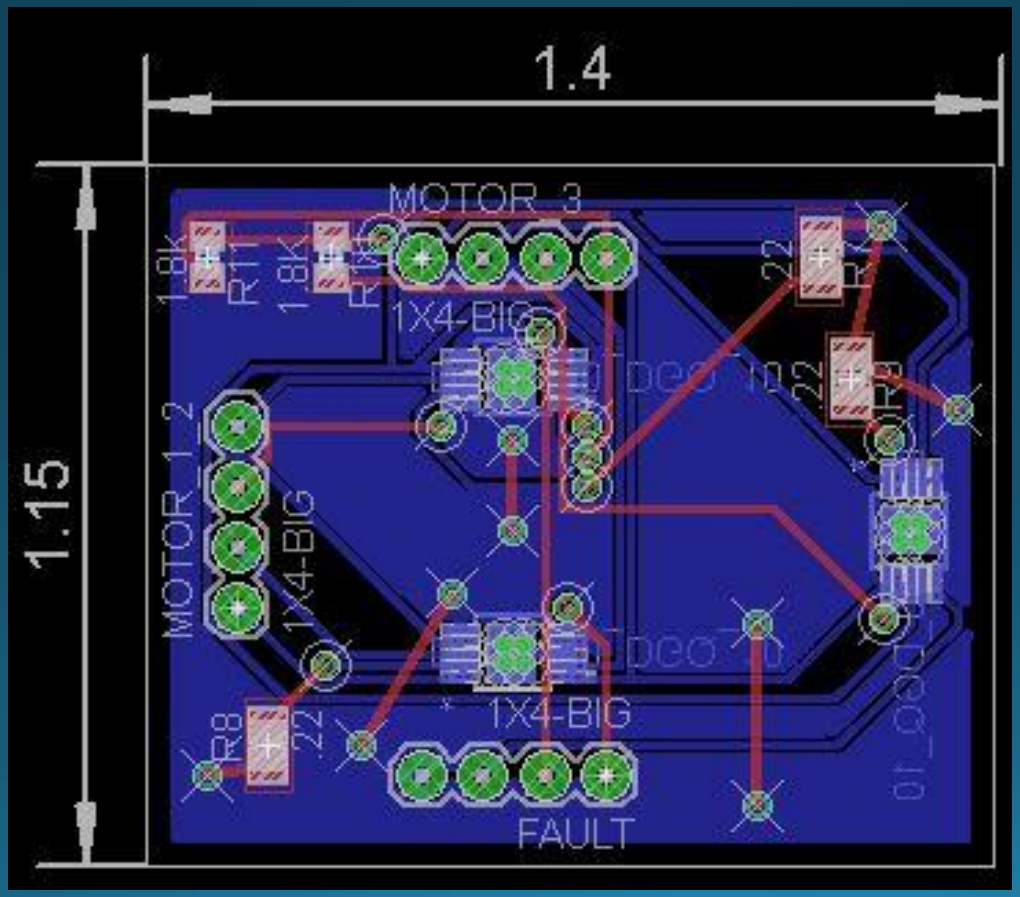
Task 1: Circuit Layout

- Eagle 7.1.0
  - LED driver board rev. 1



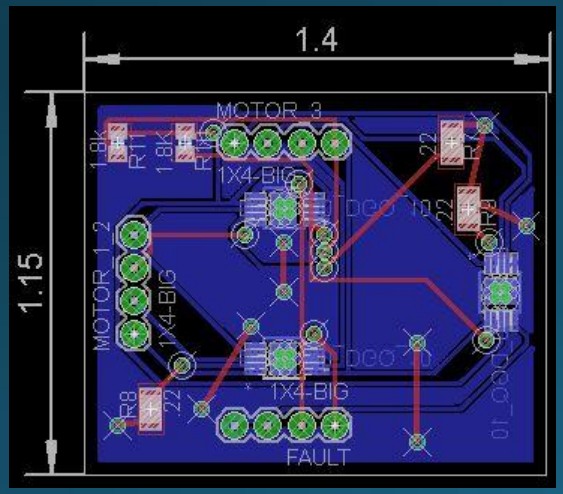
Task 1: Circuit Layout

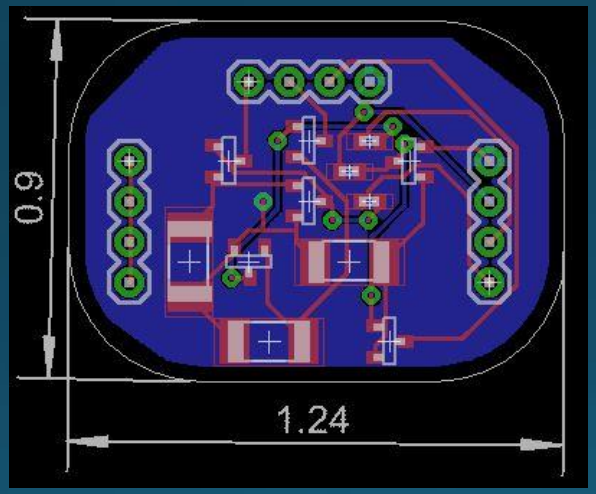
- Eagle 7.1.0
  - Motor driver board rev. 1

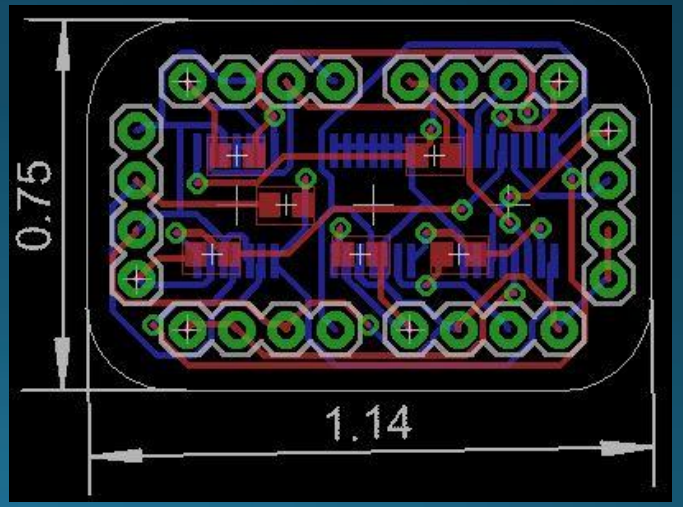


Task 1: Circuit Layout

- Eagle 7.1.0
  - Boards Sent to OSH Park

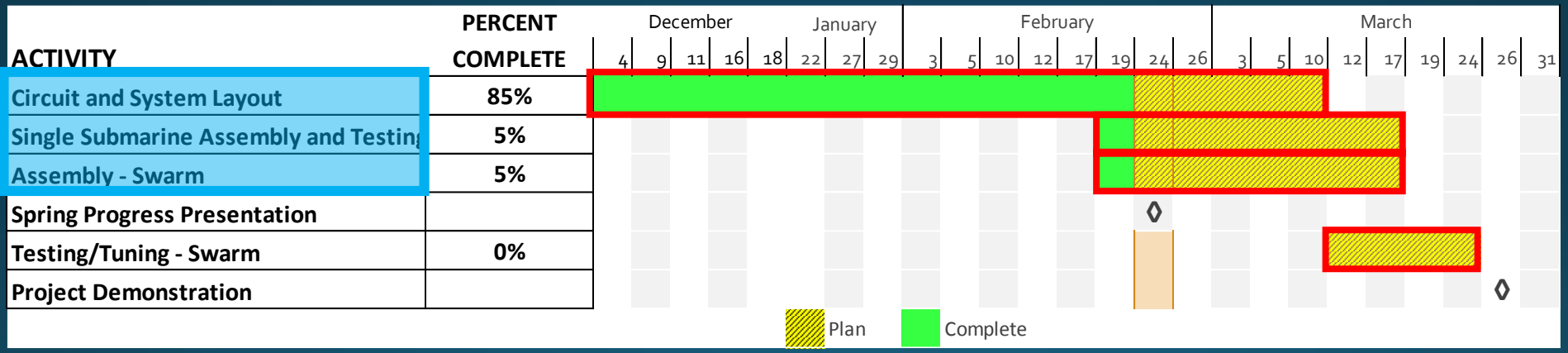






Gantt Chart – Cameron Putz

Future work



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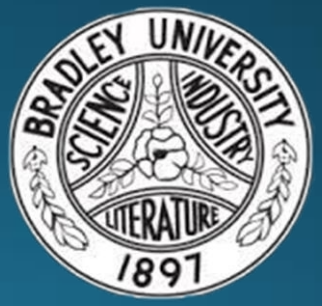
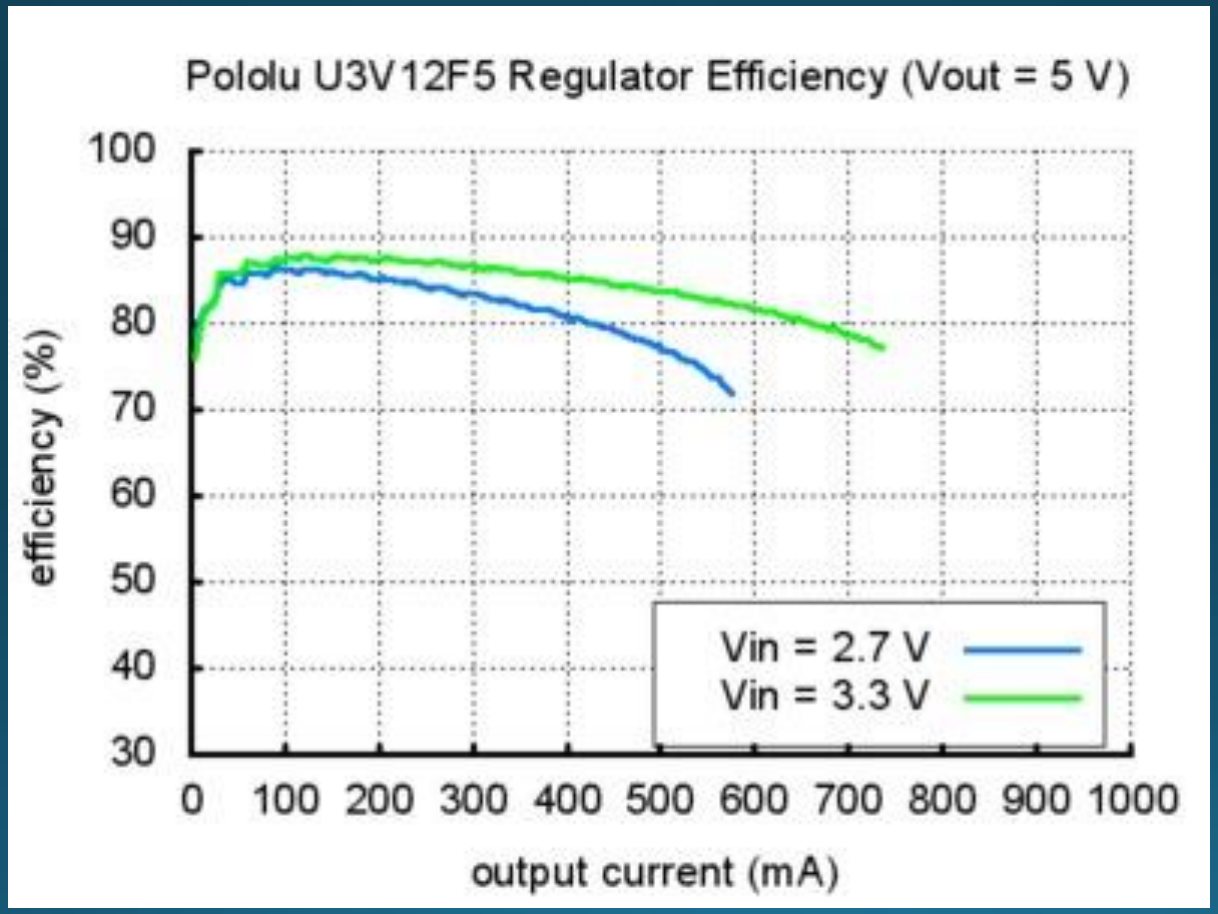


References

- [1]"The 555 Timer IC." *The 555 Timer IC*. [Online]. 23 Feb. 2015.
- [2] Pololu 5V Step-Up Voltage Regulator U3V12F5, Pololu, [online] 2015, https://www.pololu.com/product/2115 (Accessed: 23 February 2015).
- [3] Integrated Silicon Pressure Sensor On-Chip Signal Conditioned, Temperature Compensated and Calibrated, Freescale Semiconductor, [online] 2012, http://www.freescale.com/files/sensors/doc/data_sheet/MPX5010.pdf (Accessed: 23 February 2015).
- [4] LiPo Vs NiMH Batteries, Lipo Manufacturer, [online] 2014, http://lipomanufacturer.blogspot.com/2014/03/lipo-vs-nimh-batteries.html (Accessed: 23 February 2015).

Step-Up Regulator Efficiency [2]



Pressure Sensor Output MPX5010 [3]

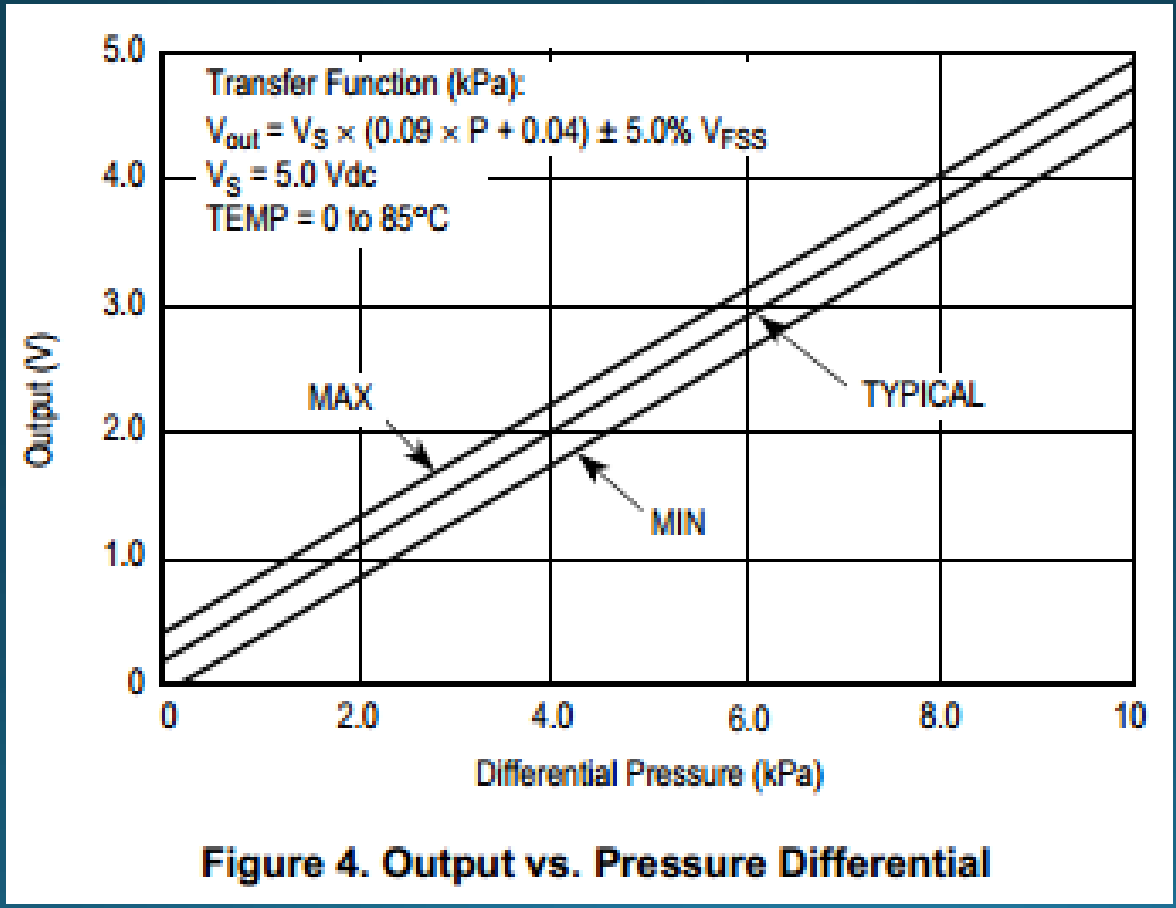


Figure 4. Output vs. Pressure Differential

Pressure Sensor Circuit Diagram MPX5010 [3]

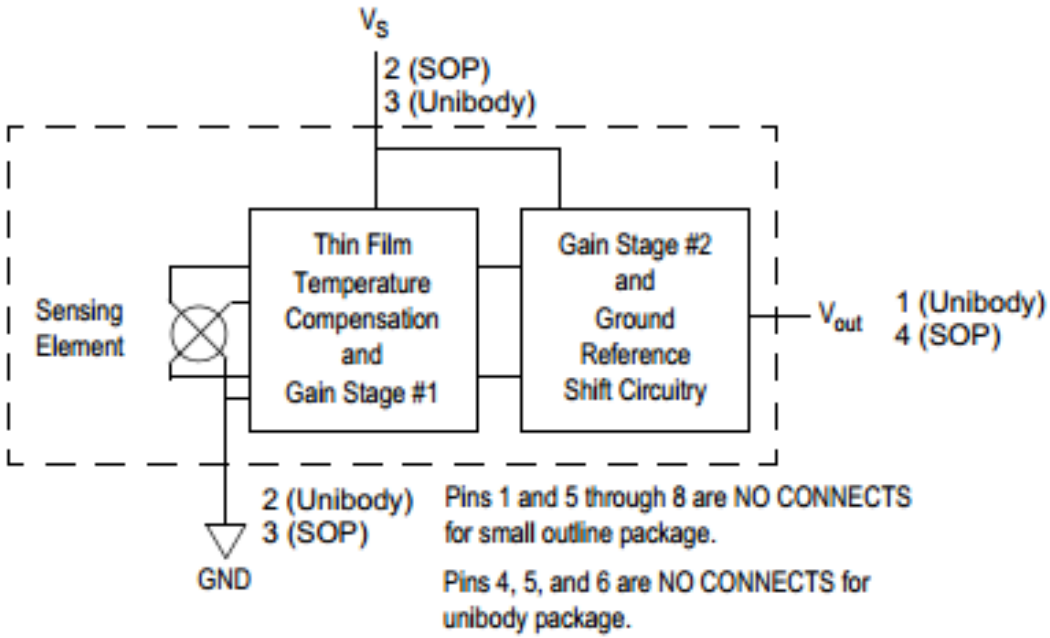
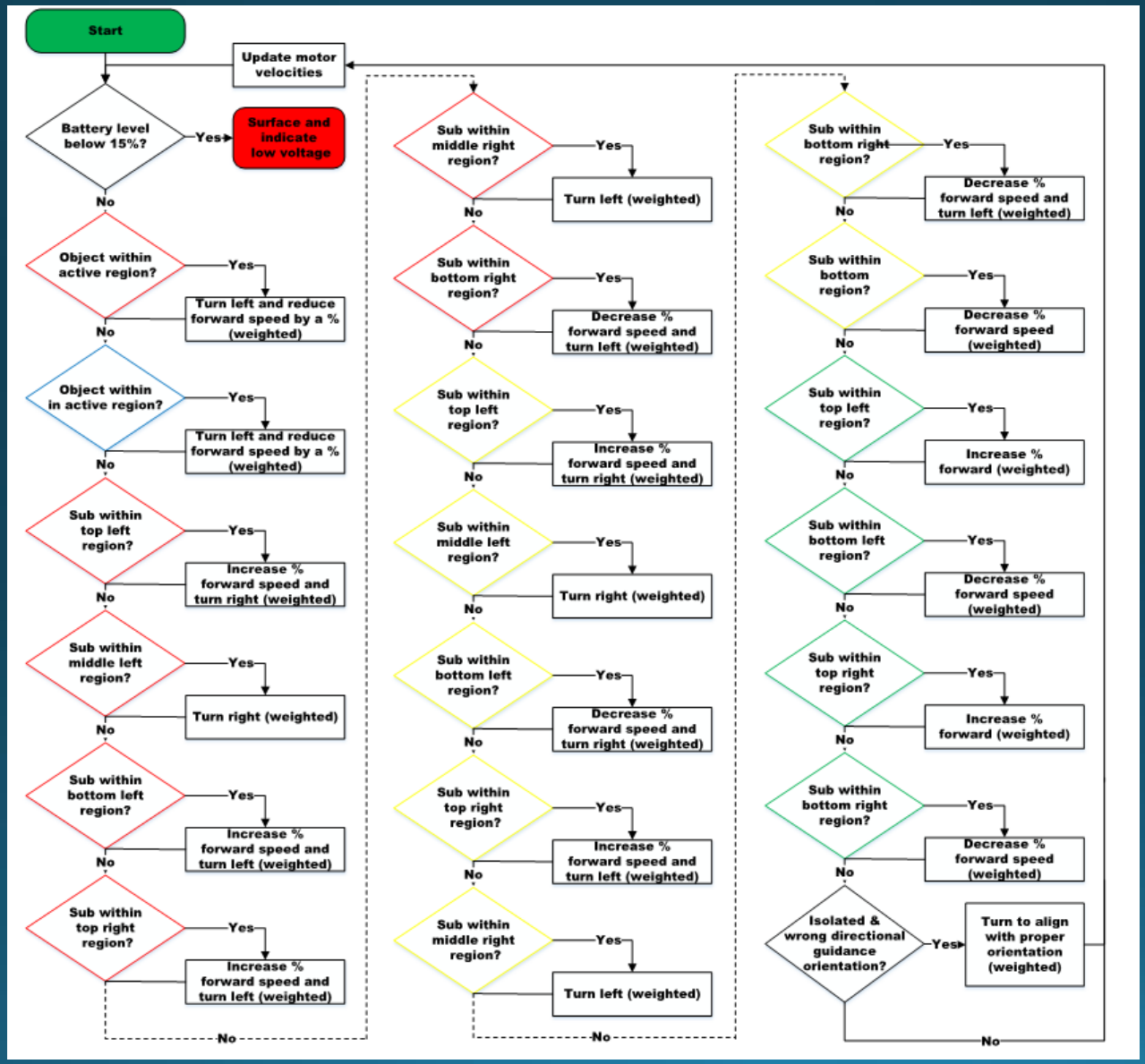


Figure 1. Fully Integrated Pressure Sensor Schematic

Complete Swarming Flowchart



Motor Control and Power

- 3 DC brushed motors (x, y, z configuration)
  - Y motor highest current draw: 860 mA peak draw
    - Recorded with only rear propeller submerged
  - X and y motor feedback: IMU
  - Z motor feedback: pressure sensor

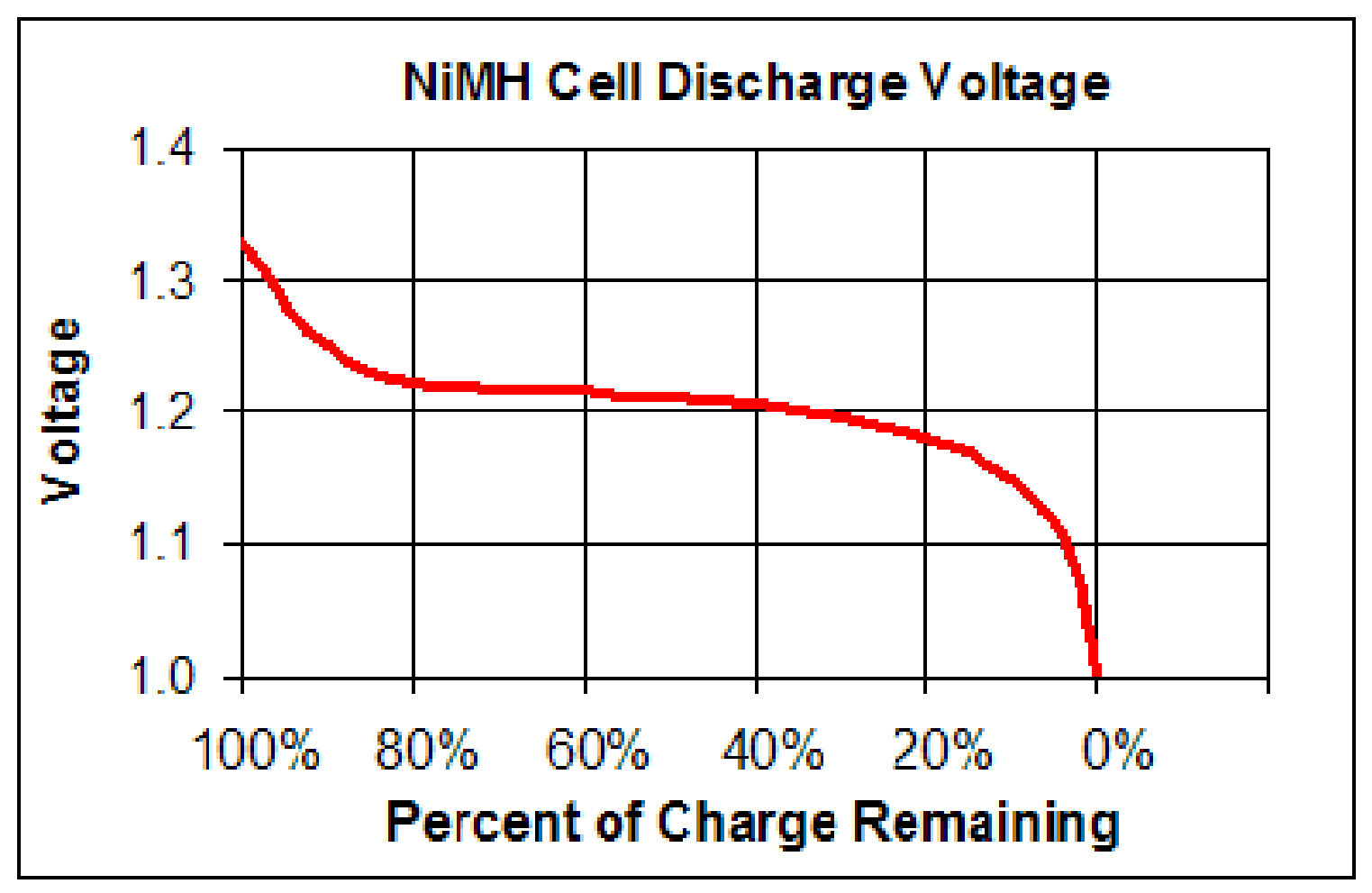
Motor Control and Power

- I2C h-bridge (DRV8830)
  - Single channel, PWM controlled h-bridge
  - 1 A, 2.75 - 6.8 V
  - Cost: $2.44
  - Total cost per submarine: $2.44 * 3 = $7.32

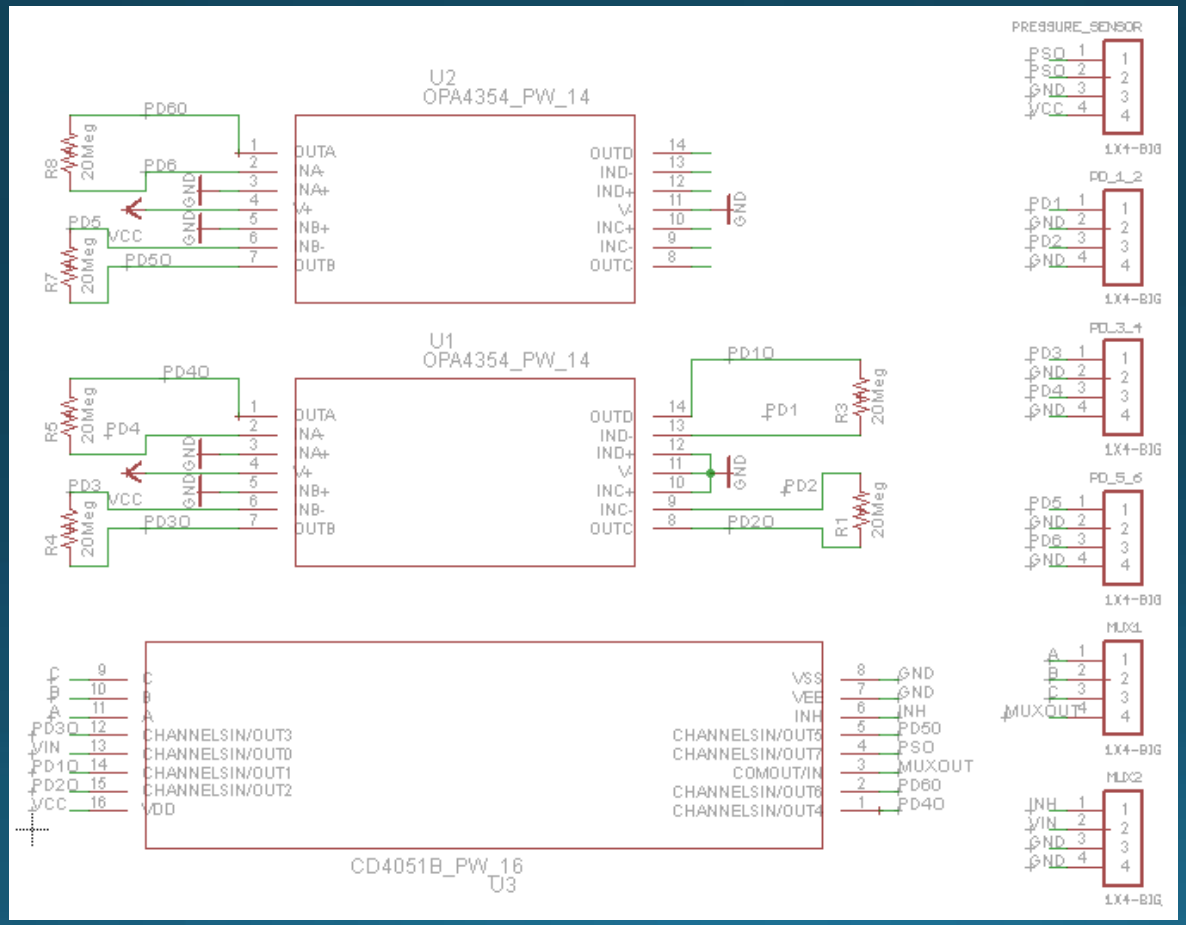
Motor Control and Power

- Power
  - 4 NIMH AA batteries
    - 1.2 V per cell
    - 2500 mAh
  - Battery life estimation
    - Estimated average current draw: 1770 mA
    - Estimated run time: 1.4 hours

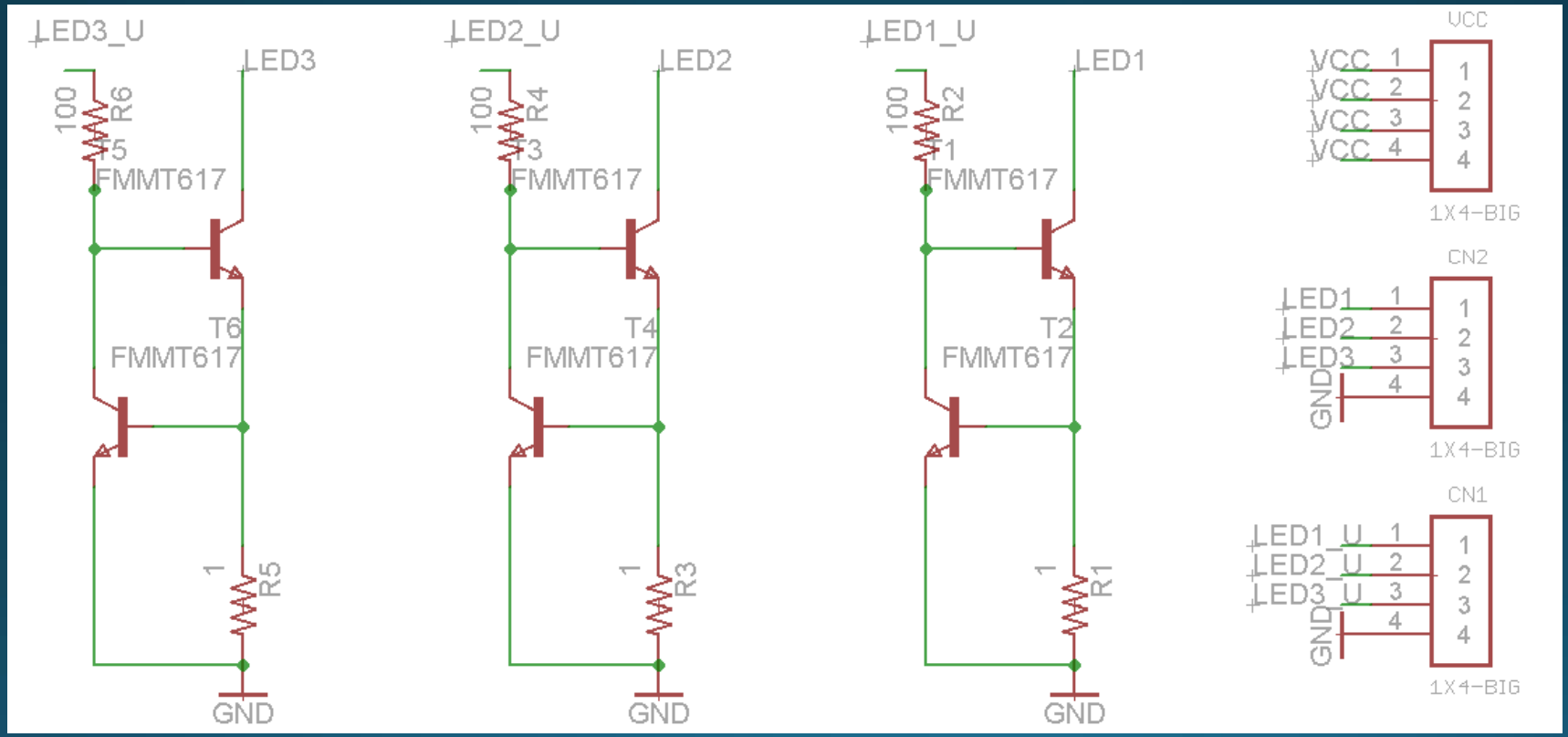
Motor Control and Power [4]



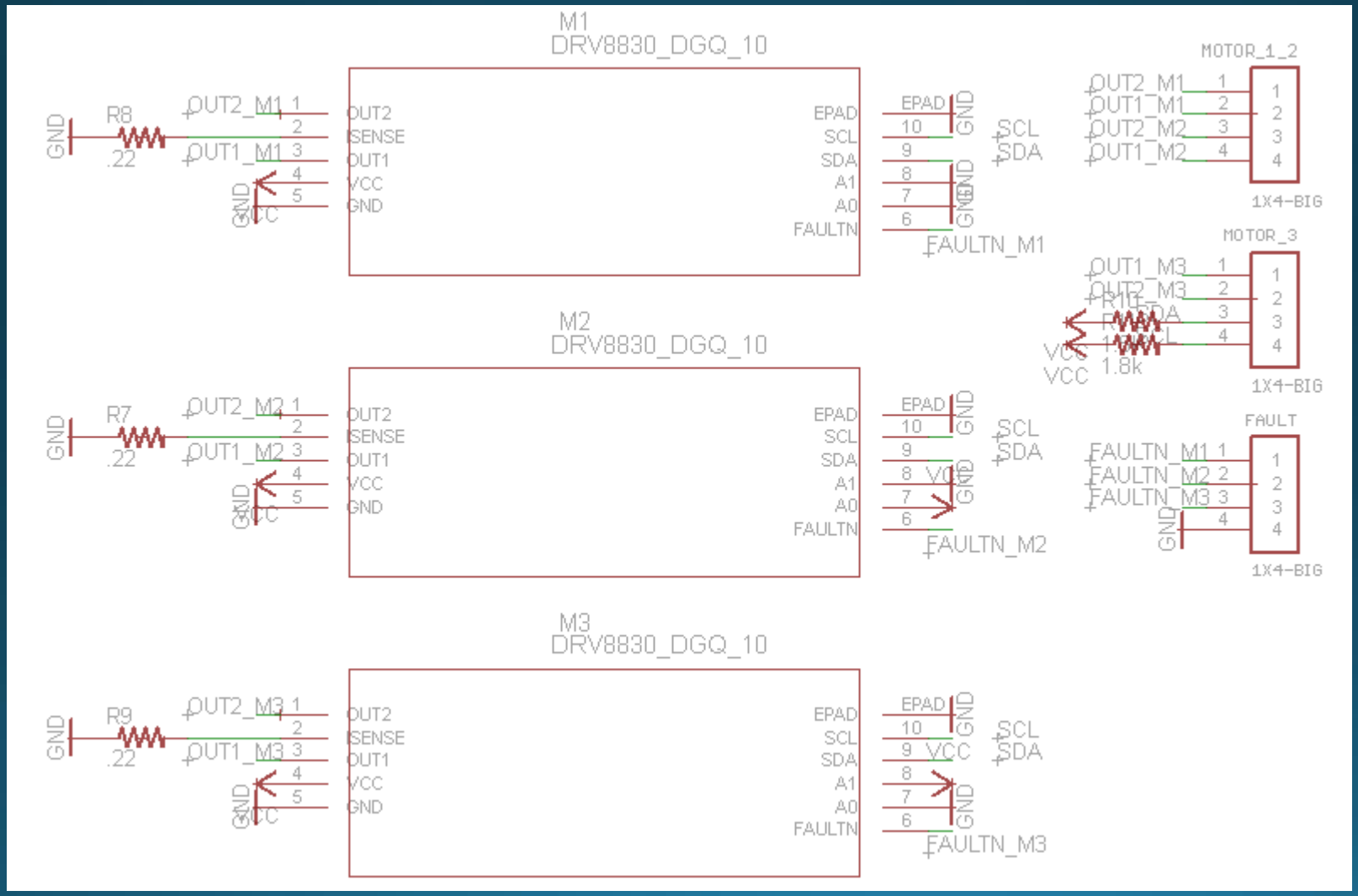
Eagle Schematic



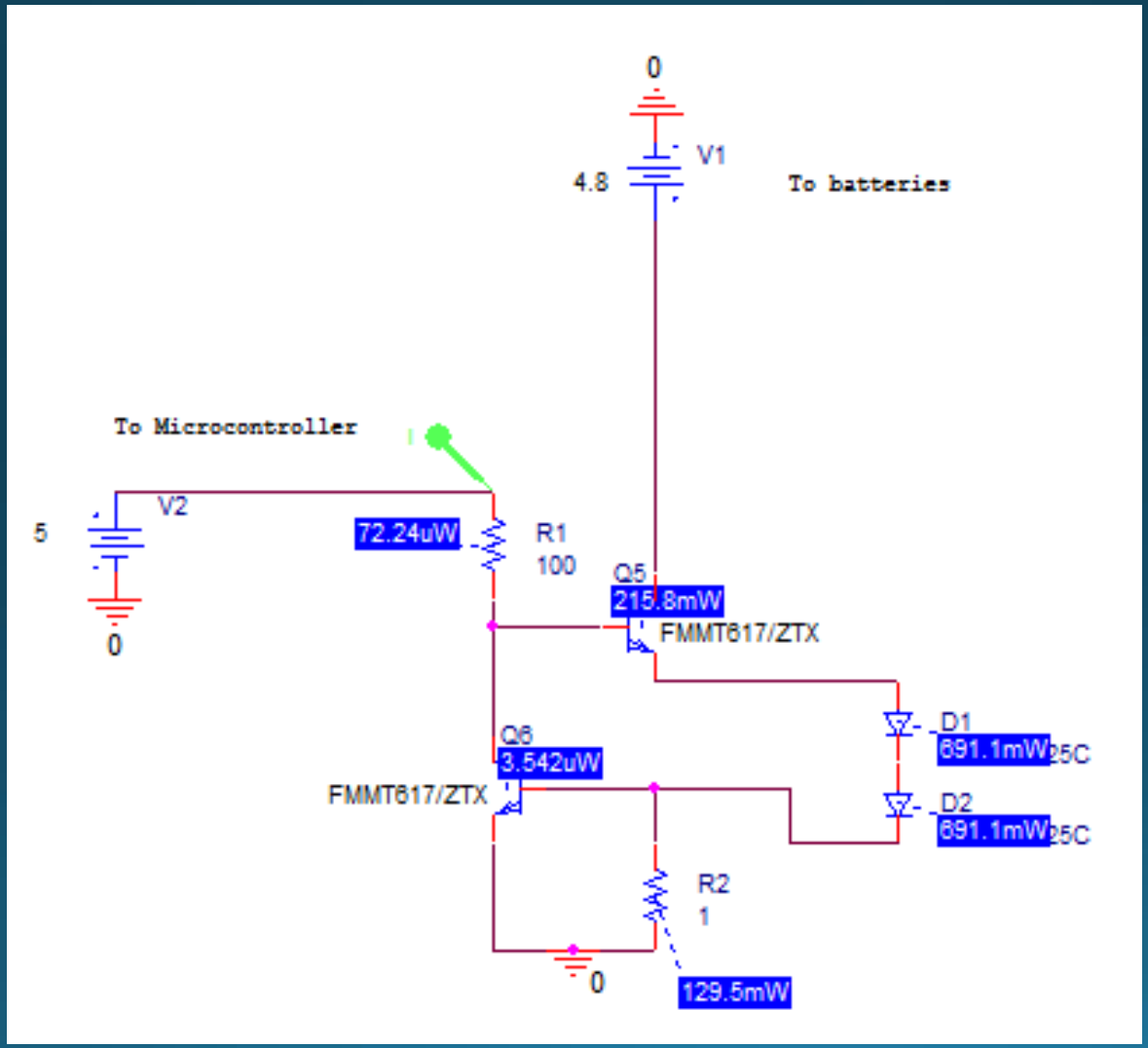
Eagle Schematic



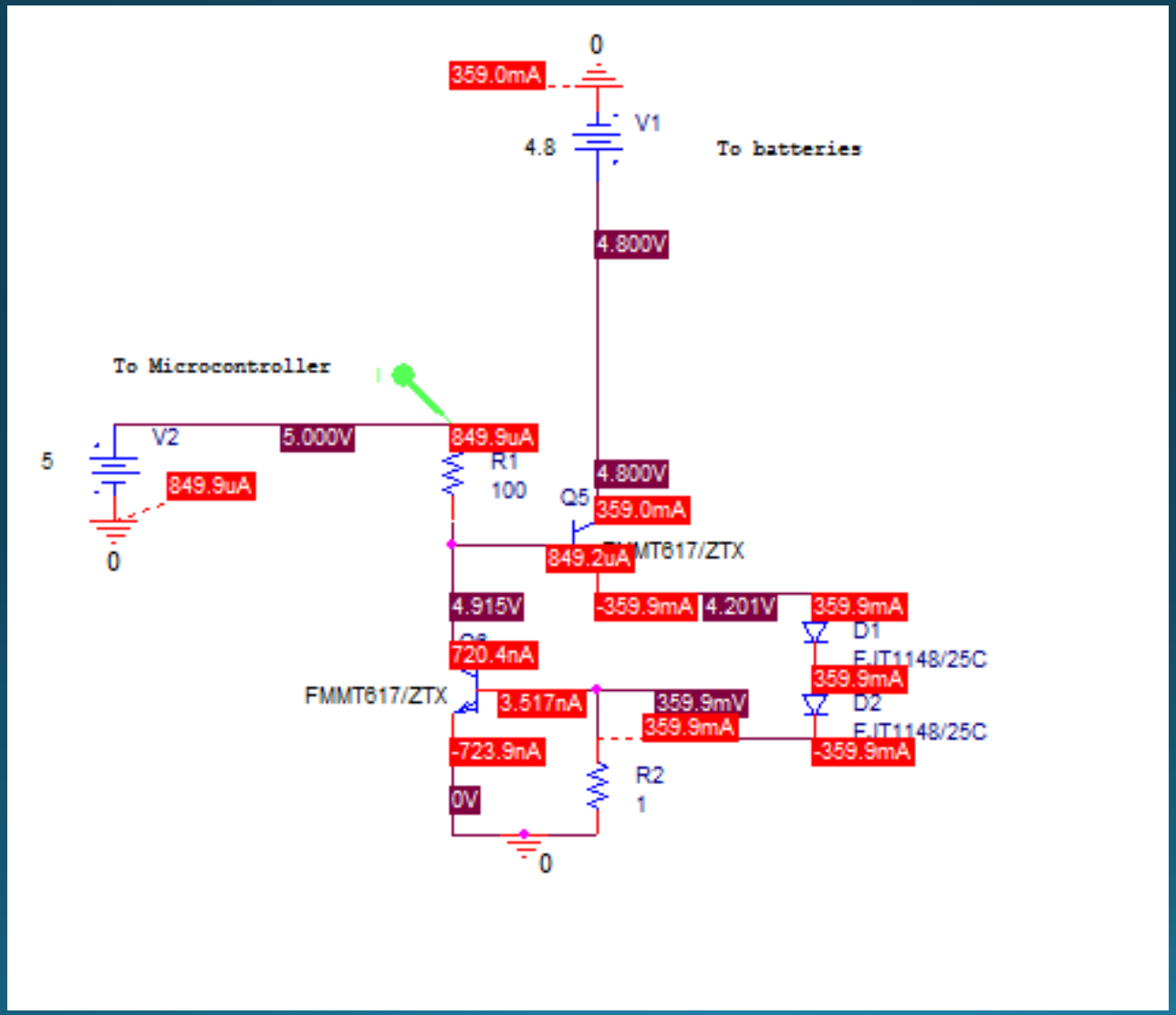
Eagle Schematic



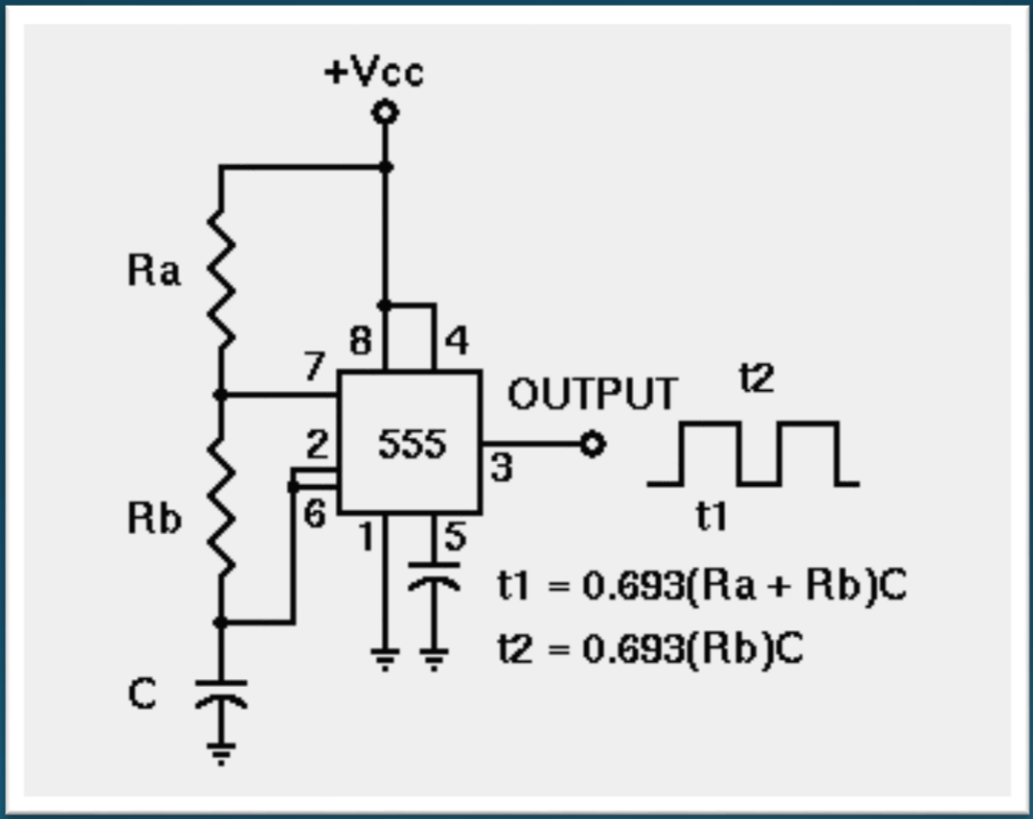
Current Source design



Current Source design

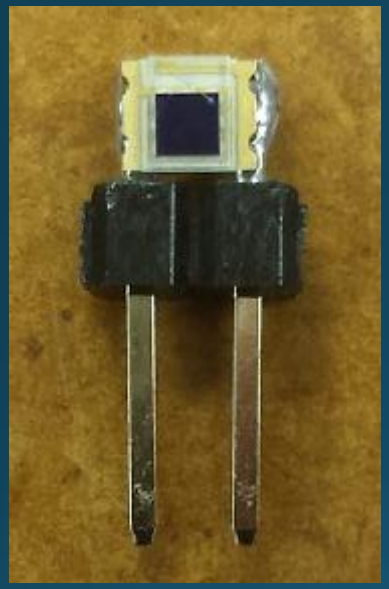


555 Timer for Camera



[1] 555 Timer

Assembly/Soldering



Everlight photodiode soldered to section of header pins

LED soldered to section of header pins