NOTORIOUS EMG

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Design Review 2.1

Muscle Guide

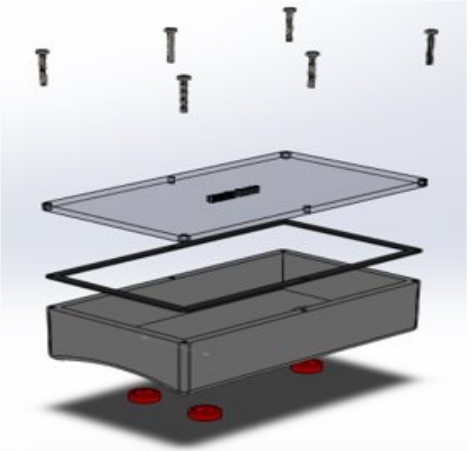
Notorious EMG: Chris Anderson (EE), Jacob Gamboa (EE), Marshall Kabat (ME), Vi Tran (EE)

Concept:

Compact, wearable device comprised of conductive fabric and electrodes for surface electromyography (SEMG) detection. All detection, filtering, amplification, and transmission circuitry will be housed in a wearable sleeve enclosure.

- **Use data to detect muscle fatigue and analyze muscle-movement force and power**
- **Improve workout sessions by targeting muscle groups that have not been properly conditioned**

CAD Drawings



Approach:

Detection, amplification, filtering, and wireless transmission via Bluetooth will take place on the user's arm:

- **A Real-Time Communications (RTC) box will receive, process, and report results graphically**
- **Calculate the power output, EMG waveform, and muscle fatigue factor of user in real time**
- **Micro-SD storage will be provided for the purpose of historical analysis**

Budget:

Funds Spent:

- **$144.69**

Estimated Remaining Funds:

- **$150.00**

External Funding Provided:

- **$0.00**

SAFETY SPECIFICATIONS

Name	Threshold	Objective
S001 – Wire length	Loose Wires Minimized	Loose Wires Eliminated
S002 – Sleeve Conductivity	Three re-usable conductive strips	N/A
S003 – Current Exposure	≤ 3 mA	≤ 1 mA
S004 – Ease-of-Use	Worn Unobtrusively	Eliminate Equipment Interference
S005 – Marketing Clearance	Standards Compliant with FDA 501(k) Review Process	N/A
S006 - Battery/Electrical Safety	UL 4200 A and UL 1642 Standards Compliant	N/A

CUSTOMER APPEAL SPECIFICATIONS

Name	Threshold	Objective
C001 - Weight	500 g /1.1 lbs	180 g /0.40 lbs
C002 - Size	6" x 3.1" x 1.5"	4" x 2.25" x 0.75"

DURABILITY SPECIFICATIONS

Name	Threshold	Objective
D001 - Dust/Water Resistance	Expel Water and Dust - IP45 Rating	IP56 Rating
D002 - Strength	Withstand Vertical fall of 1 m upright	Vertical Fall of 2 m At different orientations

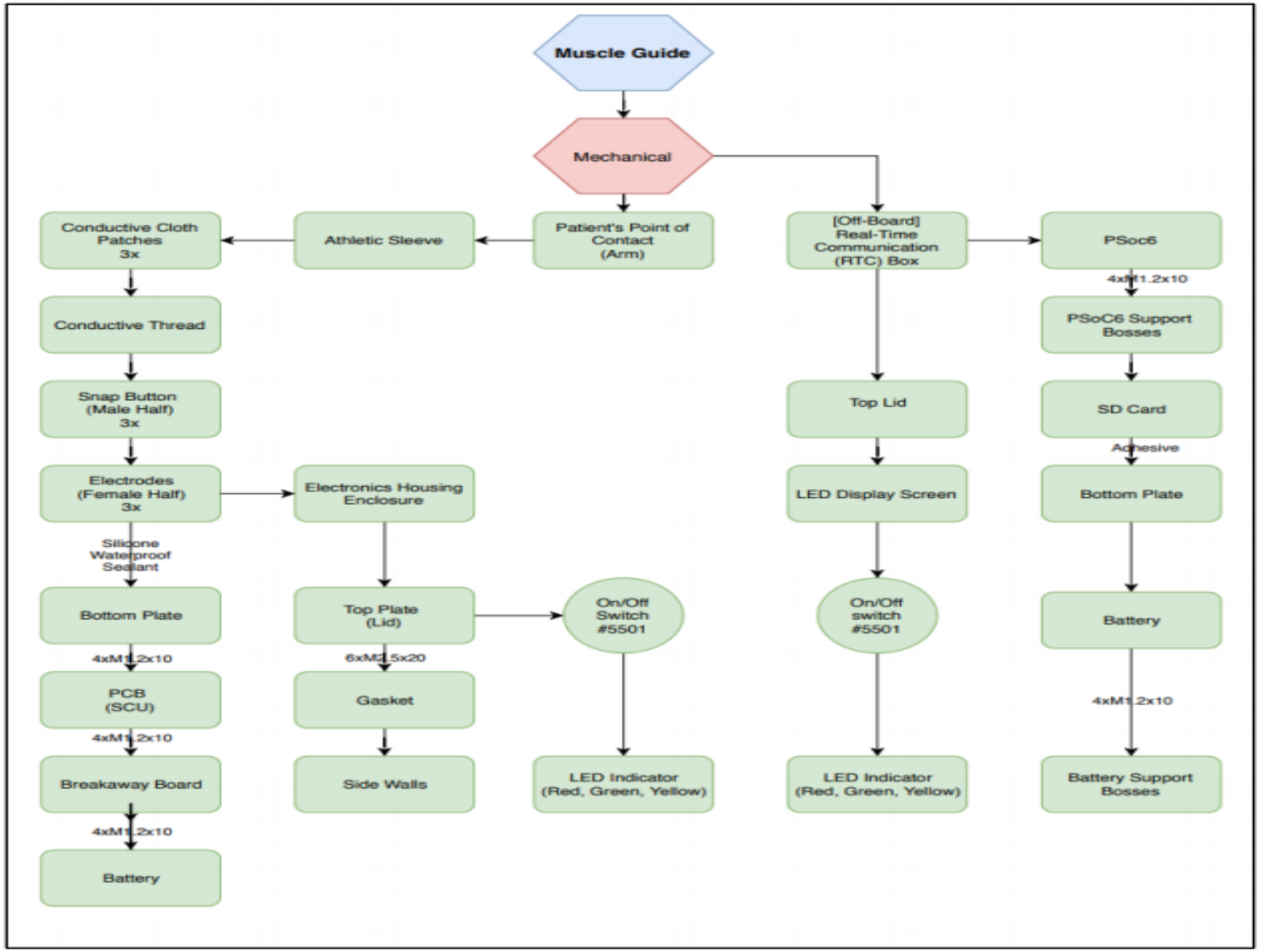
RELIABILITY SPECIFICATIONS

Name	Threshold	Objective
R001 - Integration	Signal conditioning unit integrated with MCU 2	N/A
R002 - Acquisition	20ft	30ft
R003 – Signal Conditioning	30mV	50mV
R004 – Data Processing & Reporting	Accurate, continuous processing	N/A
R005 – Sampling Rate	500 Hz – 750 Hz	750 Hz – 1000 Hz
R006 – Power Supply	Rechargeable	N/A
R007 – Battery Life	4hrs	6.5hrs
R008 – Data Storage	1.5 GB	2.0 GB
R009 - Data Rate	700 kbps	2.0 Mbps

LOGIC SPECIFICATIONS

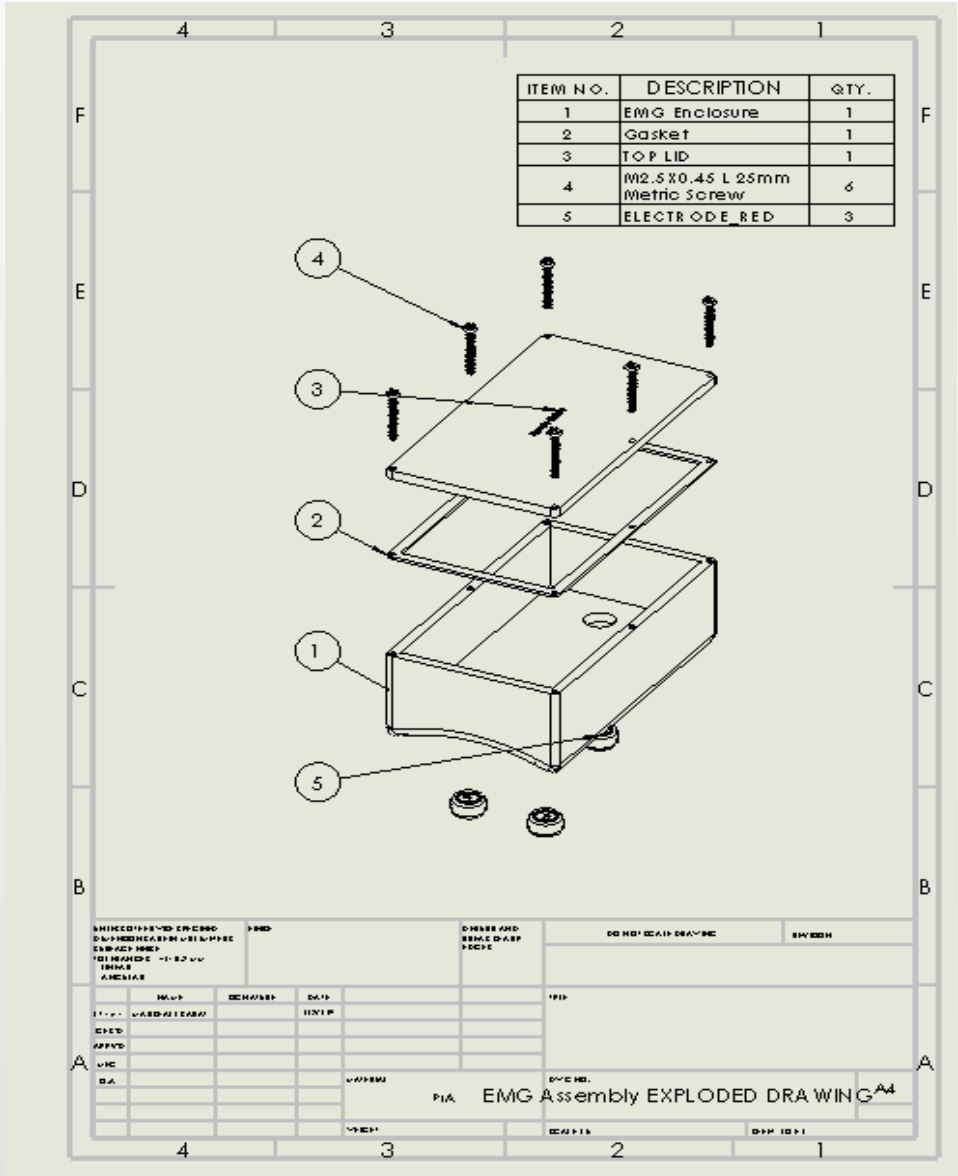
Name	Threshold	Objective
L001 – Array Size	50 elements	N/A
L002 – EMG Signal Display	Bound to 1027 on the x & y-axis	N/A
L003 – Data Calculation	Within 5% of 60mV	Within 2.5% of 60mV
L004 – SD Card	500Hz	1000Hz

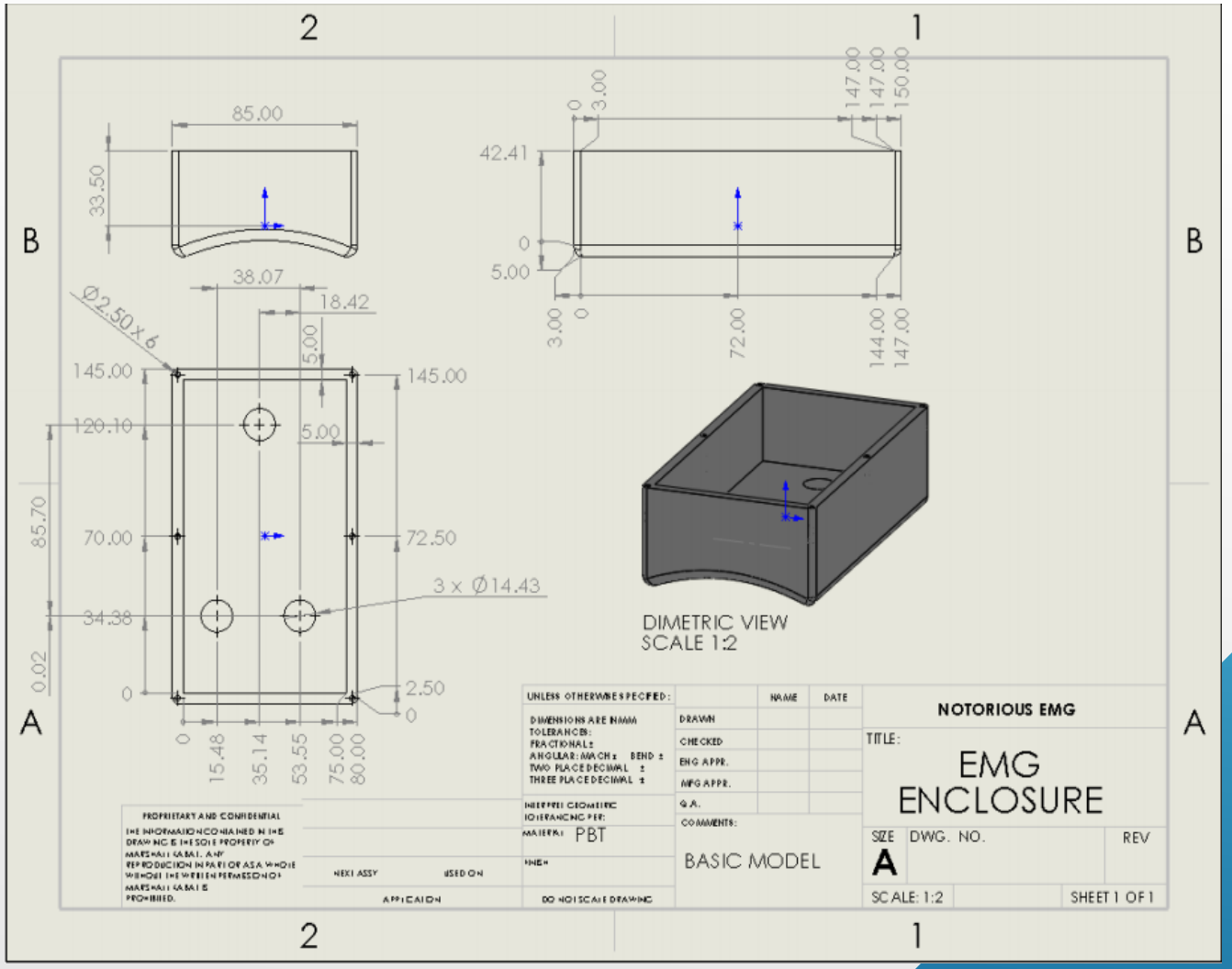
MECHANICAL BLOCK DIAGRAM



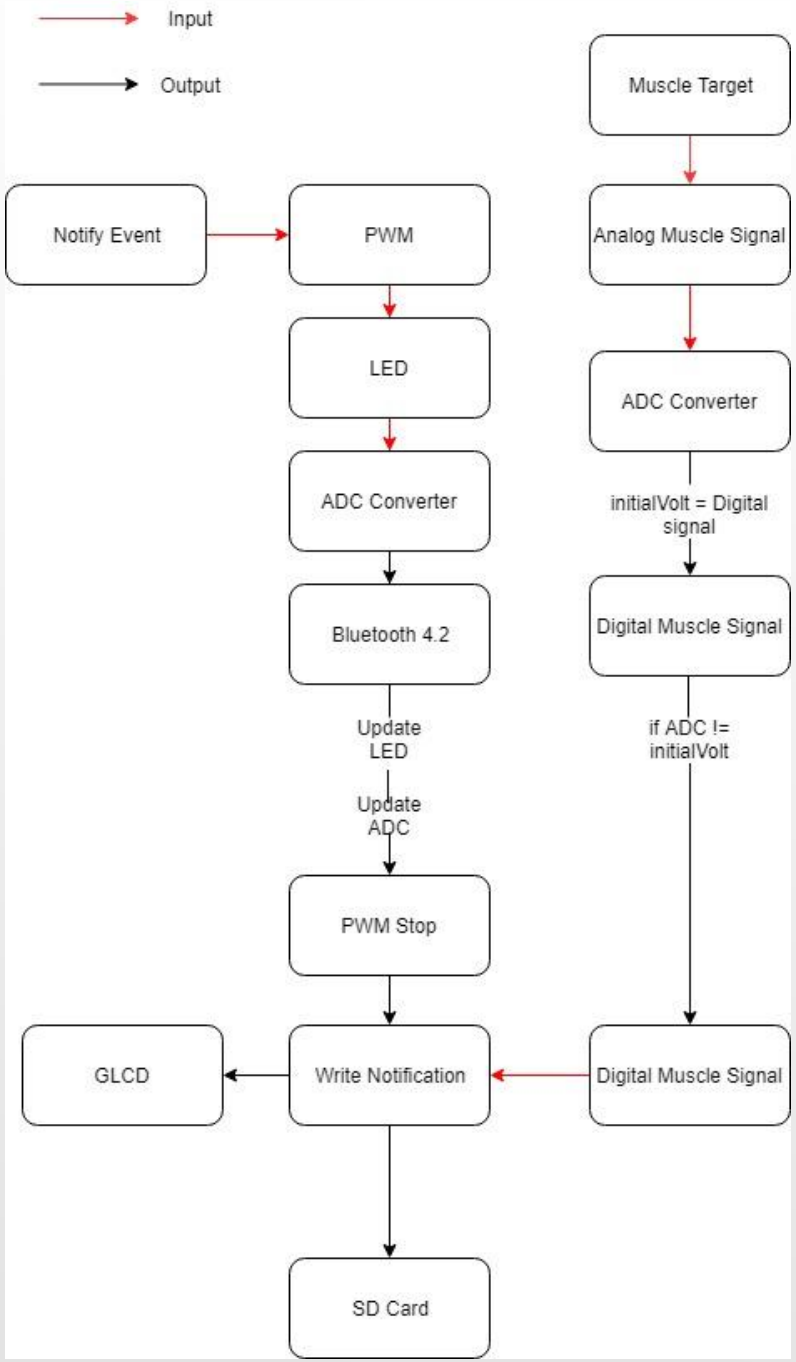
Mechanical Block Diagram 2

MECHANICAL DRAWINGS

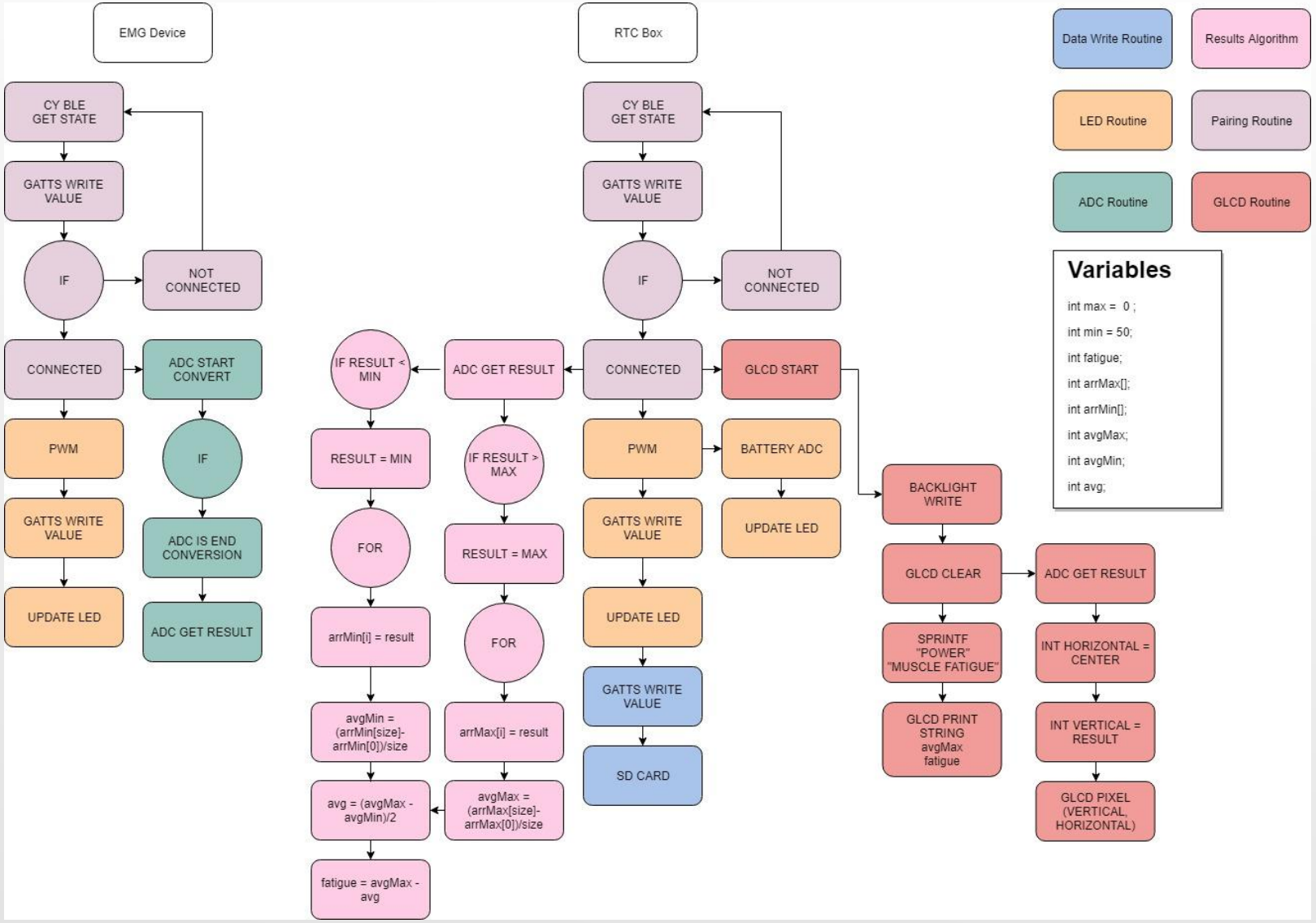




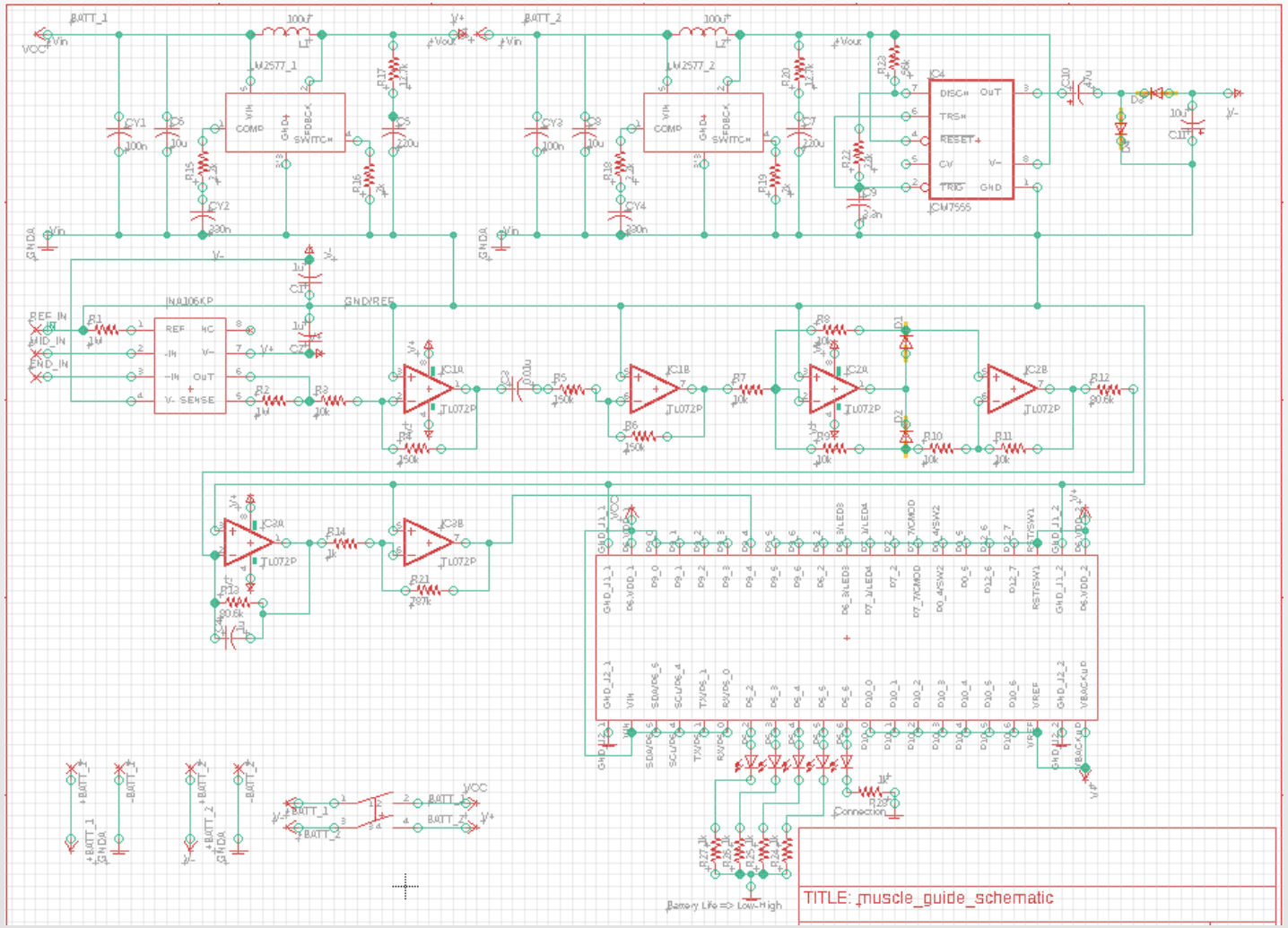
SOFTWARE ARCHITECTURE



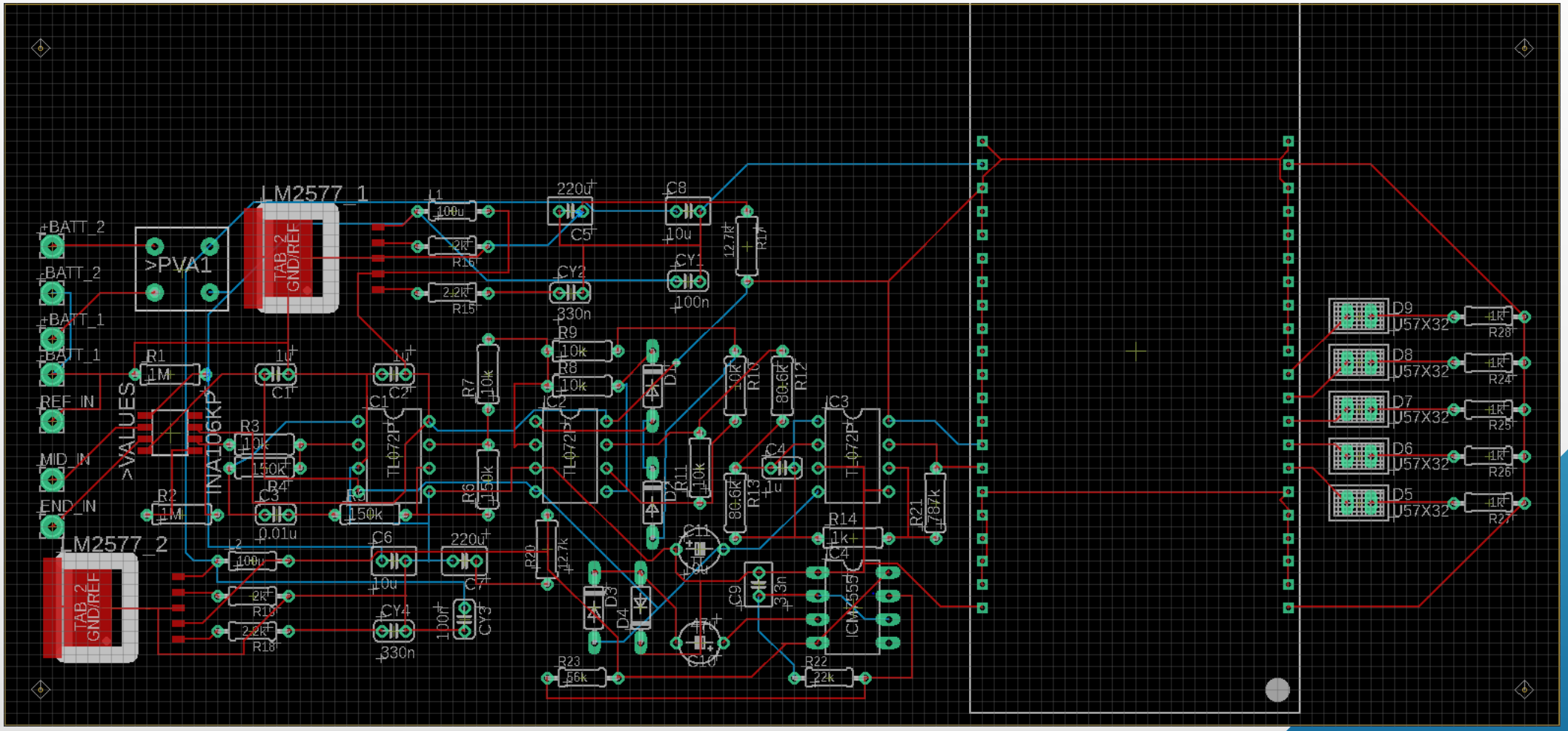
SOFTWARE ROUTINES



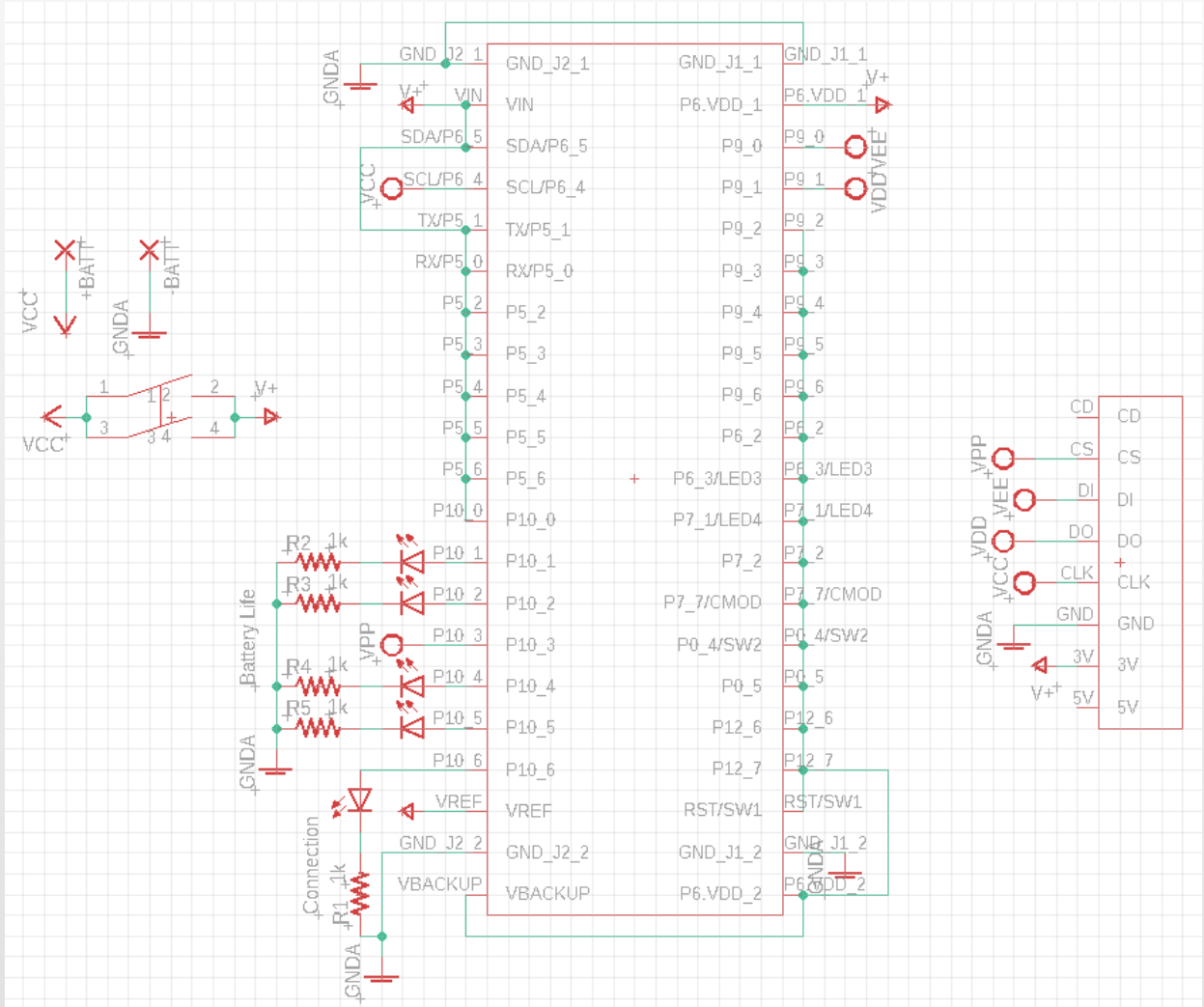
SCHEMATIC:
SIGNAL CONDITIONING UNIT



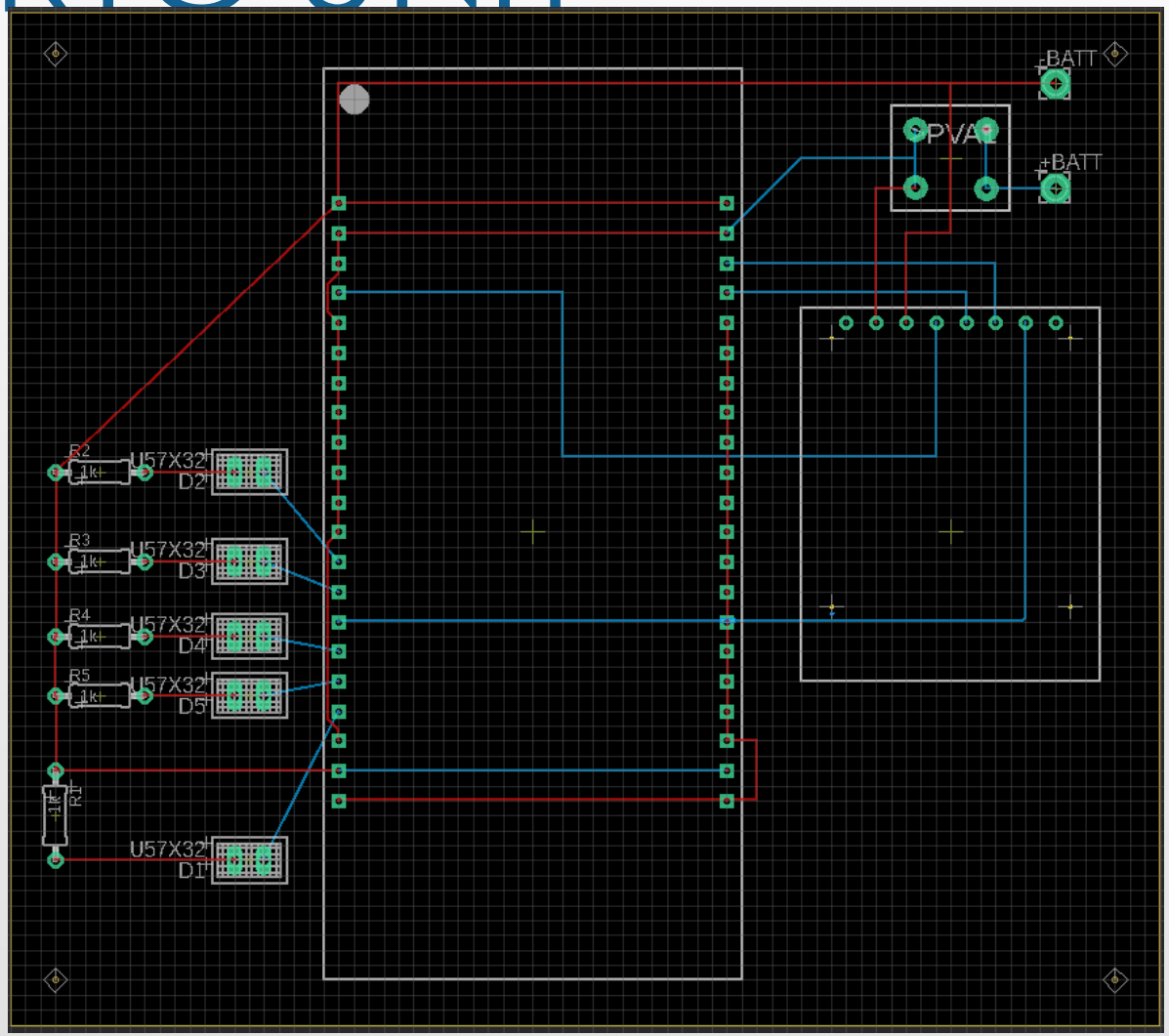
PCB:
SIGNAL CONDITIONING UNIT



SCHEMATIC: RECEIVER UNIT



PCB:
RTC UNIT


+BATT
PVA
+BATT
R2
1k
U57X32
D2
R3
1k
U57X32
D3
R4
1k
U57X32
D4
R5
1k
U57X32
D5
R1
1k
U57X32
D1

ENGINEERING ANALYSIS LIST

UPDATED ANALYSES IN RED, UNCHANGED ANALYSES IN GREEN

- ELECTRICAL ANALYSES
  - POWER CONSUMPTION
  - DATA RATE
  - DATA STORAGE
  - EMG DATA ANALYSIS
- MECHANICAL ANALYSES
  - FDA COMPLIANCE
  - SIZE
  - WEIGHT

POWER CONSUMPTION ANALYSIS (REVISED)

EMG Device

- Boost Converter
  - 3.7V, 300mAh Lithium Ion Battery
  - 23.18mA consumed
- Signal Conditioning Unit
  - 23.1mA consumed
- MCU1
  - 12.7mA current consumed

Overall Battery Life: 5.1 hours

RTC Box

- GLCD Screen
  - 160mA consumed
- MicroSD card
  - 100mA consumed
- MCU2
  - 3.7V, 1.2Ah Lithium Ion Battery
  - 12.7mAh current consumed

Overall Battery Life: 4.4 hours

EMG DATA ANALYSIS (ADDED)

Electromyography, or EMG, is a medical technique for evaluating and recording electrical activity produced by muscles. An important function of EMG is to measure how well a muscle can be activated, therefore we plan to use this aspect of EMG to evaluate weight lifters. Doctors use what is called *maximum voluntary contraction* to analyze the peak force generated by muscles, specifically in core-related exercises. Therefore the amplitudes of the EMG signal has the potential to provide a measure of the magnitudes of the muscle force. "The signal measured at an EMG electrode is a voltage differential set up by the summed effect of multiple motor units depolarizing at varying distances from the electrode. The nature of the conduction of these signals through the muscle tissue, the interaction of the signals of different motor units, and variable firing rates of different motor units will all affect the voltage signal that is ultimately measured at an electrode" (Hof 1984; Farina et al. 2004).

Another method of EMG measurement would be ARV, or average rectified EMG. EMG can also be used to indicate muscle fatigue, this would be seen in an increase in the mean absolute value of the signal, increase in the amplitude and duration of the muscle action potential and an overall shift to lower frequencies. While it does depend on surface vs. intrusive electrodes and where the electrodes are placed at the targeted muscles, significant EMG activities occur between 5-450Hz. (Melaku et al, IEEE TNSRE, 2003).

PROJECT DEMONSTRATION PLAN

At the end of winter quarter we will demonstrate

1. A conductive athletic sleeve with electronics and electrodes embedded
2. An RTC box with a GLCD screen to display muscle fatigue and power values, along with a graphical representation of the muscle signal in real-time

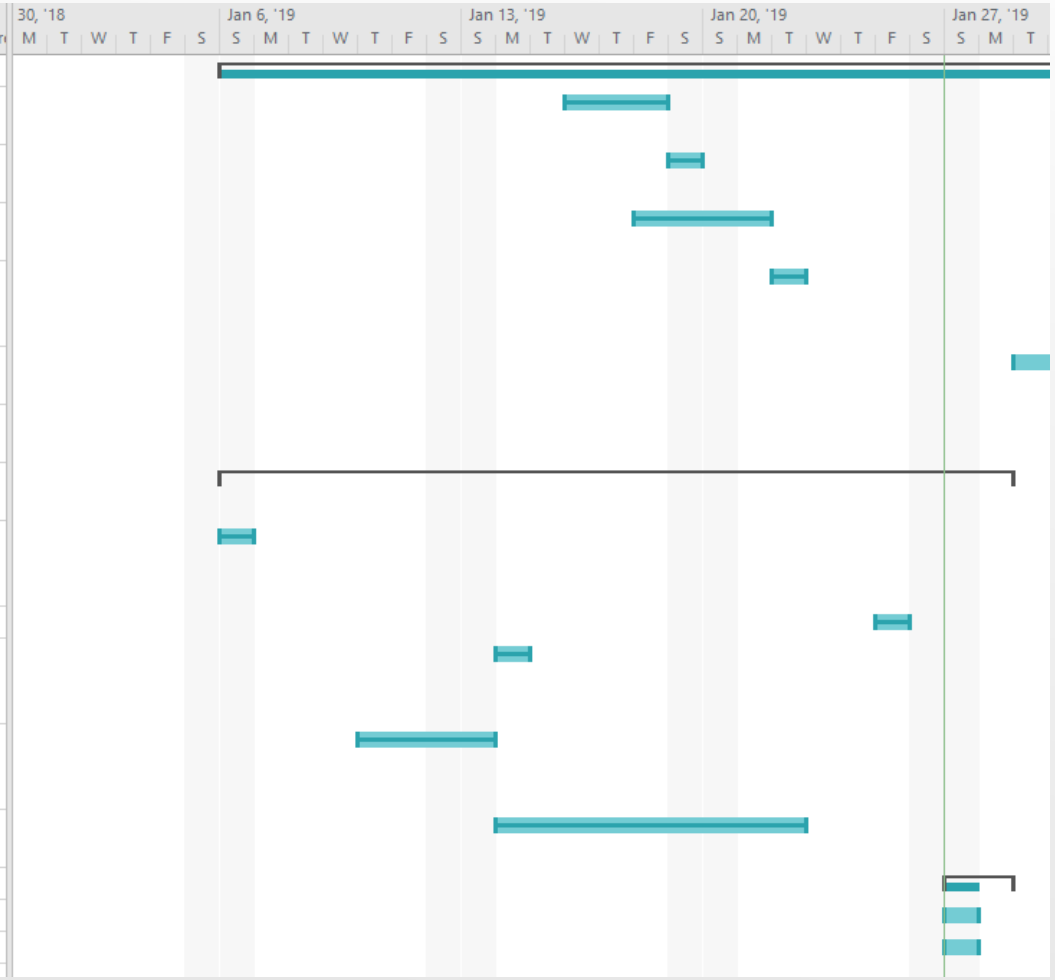
PROJECT STATUS

- Next components to purchase:
  - PCB for RTC box
  - Conductive sleeve material and snap buttons
  - MicroSD card
- Next components to build:
  - Boost converters
  - SEMG Conductive Sleeve
- Next components to code:
  - GLCD Screen
  - BLE data acquisition

*Due to the addition of the RTC box, a second PCB will be designed and ordered later this week

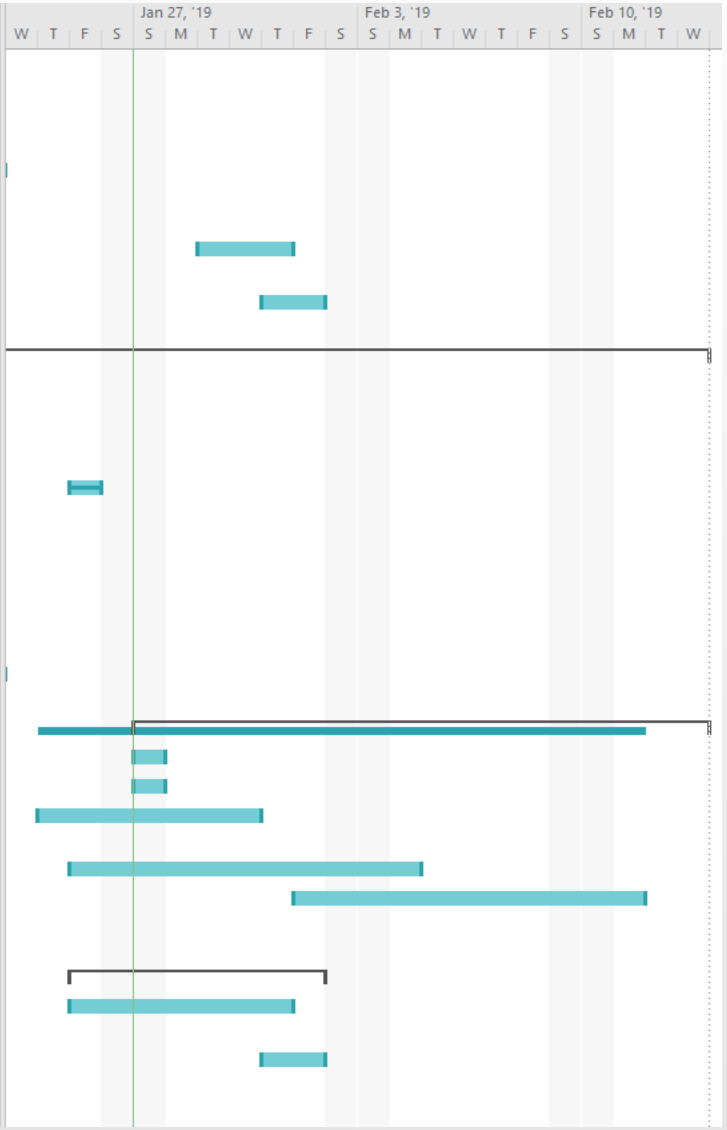
STATUS – COMPLETED TASKS

		Task Mc	Task Name	Duration	Start	Finish
1			**Power Supply**	**26 days**	**Sun 1/6/19**	**Fri 2/8/19**
2	✓		Determine Power supply	3 days	Wed 1/16/19	Fri 1/18/19
3	✓		Order power supply	1 day	Sat 1/19/19	Sat 1/19/19
4	✓		Design Boost converter	2 days	Fri 1/18/19	Mon 1/21/19
5	✓		Order materials for boost converter	1 day	Tue 1/22/19	Tue 1/22/19
6			Build Boost converter	3 days	Tue 1/29/19	Thu 1/31/19
7			Test boost converter	2 days	Thu 1/31/19	Fri 2/1/19
8			**EMG Device**	**16 days**	**Sun 1/6/19**	**Mon 1/28/19**
9	✓		Order Myoware sensor	1 day	Sun 1/6/19	Sun 1/6/19
10	✓		Order Psoc6	1 day	Fri 1/25/19	Fri 1/25/19
11	✓		Meeting with Sam, Collin & Adam	1 day	Mon 1/14/19	Mon 1/14/19
12	✓		Determine how to analyze EMG data	3 days	Thu 1/10/19	Sun 1/13/19
13	✓		Draft PCB1 Design	7 days	Mon 1/14/19	Tue 1/22/19
14			**RTC Box**	**2 days**	**Sun 1/27/19**	**Mon 1/28/19**
15			Order GLCD	1 day	Sun 1/27/19	Sun 1/27/19
16			Order LEDs	1 day	Sun 1/27/19	Sun 1/27/19



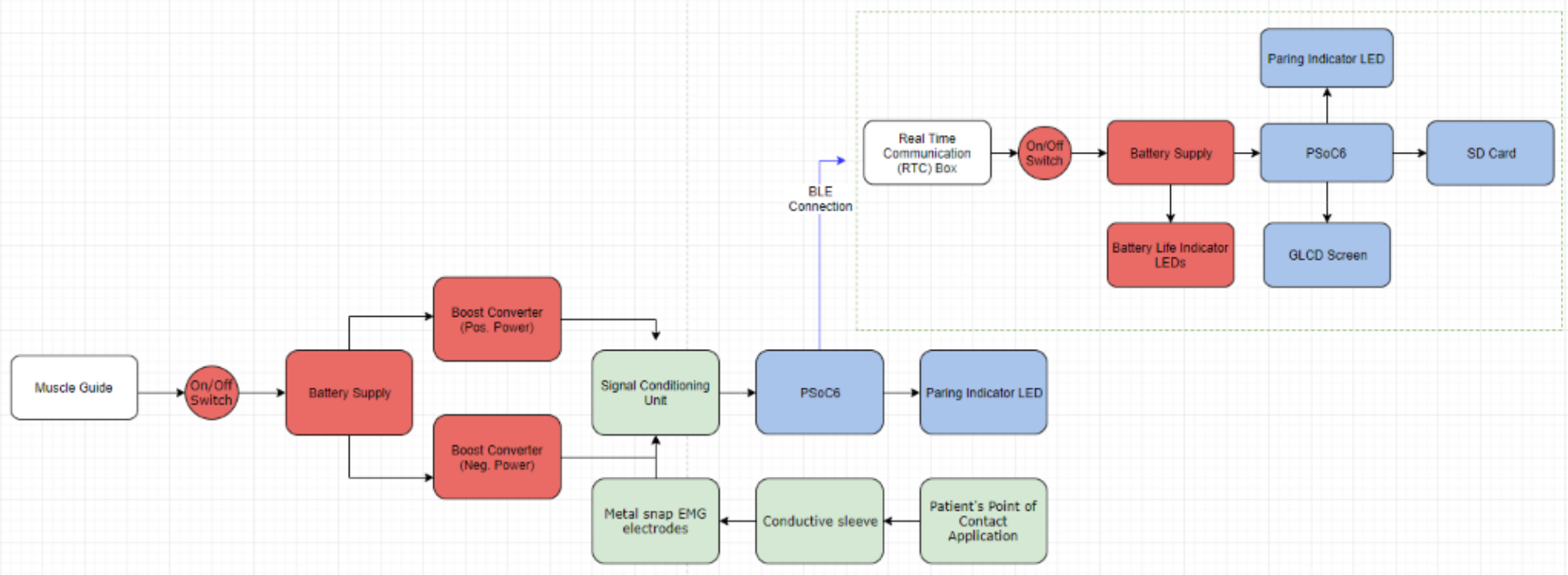
STATUS – UPCOMING TASKS

	Tas Mc	Task Name	Duration	Start	Finish	Pr
3	✓	Order power supply	1 day	Sat 1/19/19	Sat 1/19/19	
4	✓	Design Boost converter	2 days	Fri 1/18/19	Mon 1/21/19	
5	✓	Order materials for boost converter	1 day	Tue 1/22/19	Tue 1/22/19	
6		Build Boost converter	3 days	Tue 1/29/19	Thu 1/31/19	
7		Test boost converter	2 days	Thu 1/31/19	Fri 2/1/19	
8		**EMG Device**	**28 days**	**Sun 1/6/19**	**Wed 2/13/19**	
9	✓	Order Myoware sensor	1 day	Sun 1/6/19	Sun 1/6/19	
10	✓	Order Psoc6	1 day	Fri 1/25/19	Fri 1/25/19	
11	✓	Meeting with Sam, Collin & Adam	1 day	Mon 1/14/19	Mon 1/14/19	
12	✓	Determine how to analyze EMG data	3 days	Thu 1/10/19	Sun 1/13/19	
13	✓	Draft PCB1 Design	7 days	Mon 1/14/19	Tue 1/22/19	
14		**RTC Box**	**14 days**	**Sun 1/27/19**	**Wed 2/13/19**	
15		Order GLCD	1 day	Sun 1/27/19	Sun 1/27/19	
16		Order LEDs	1 day	Sun 1/27/19	Sun 1/27/19	
17		Draft PCB2 Design	5 days	Thu 1/24/19	Wed 1/30/19	
18		Code GLCD	7 days	Fri 1/25/19	Mon 2/4/19	
19		Code Battery Life Indicator	7 days	Fri 2/1/19	Mon 2/11/19	
20		**Mechanical**	**6 days**	**Fri 1/25/19**	**Fri 2/1/19**	
21		Design sleeve	5 days	Fri 1/25/19	Thu 1/31/19	
22		Order materials for sleeve	2 days	Thu 1/31/19	Fri 2/1/19	



QUESTIONS?

ADDITIONAL SLIDES
ELECTRIC BLOCK DIAGRAM



ADDITIONAL SLIDES
WIRING DIAGRAM