

# Muscle Guide

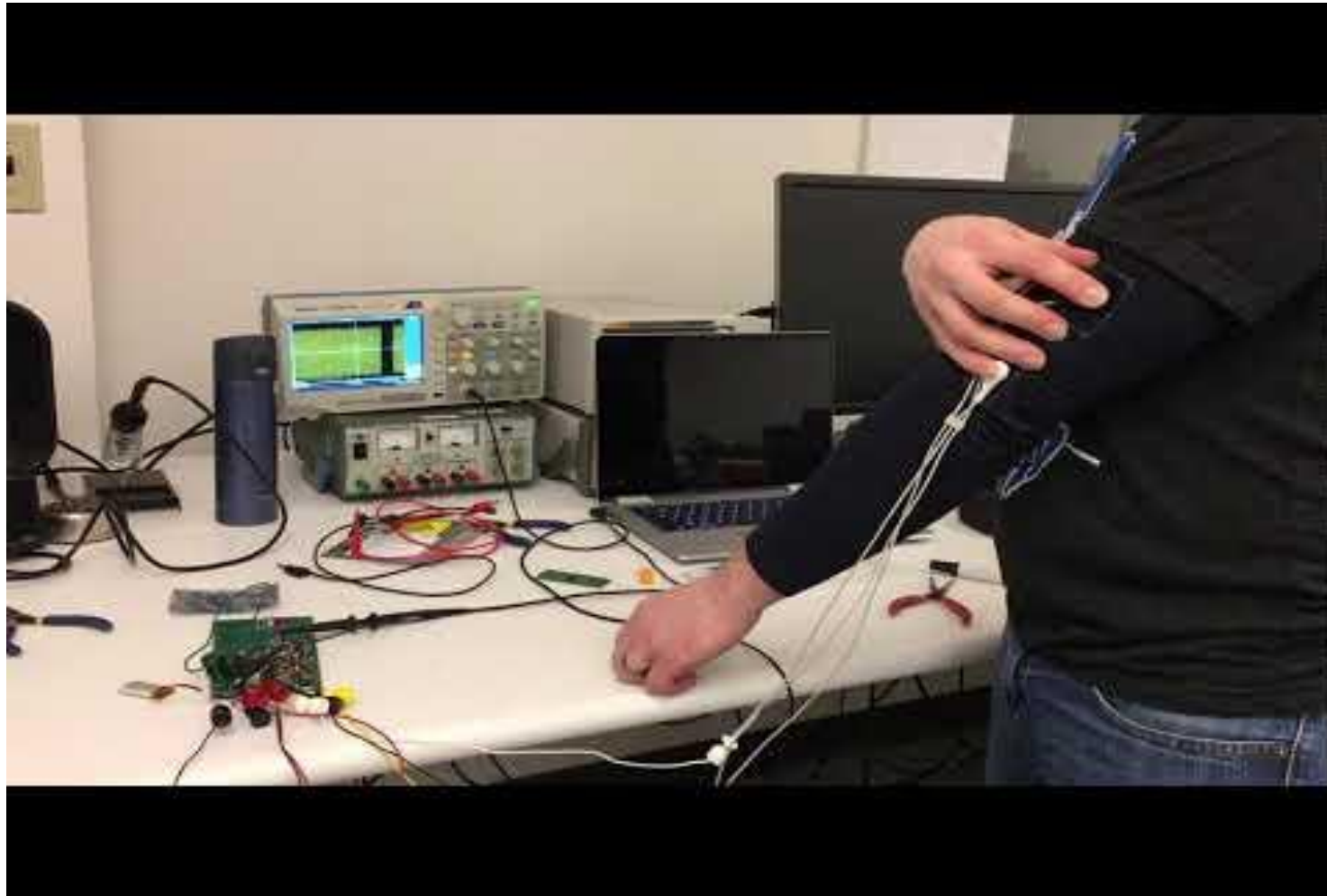
Notorious EMG

DR2.2

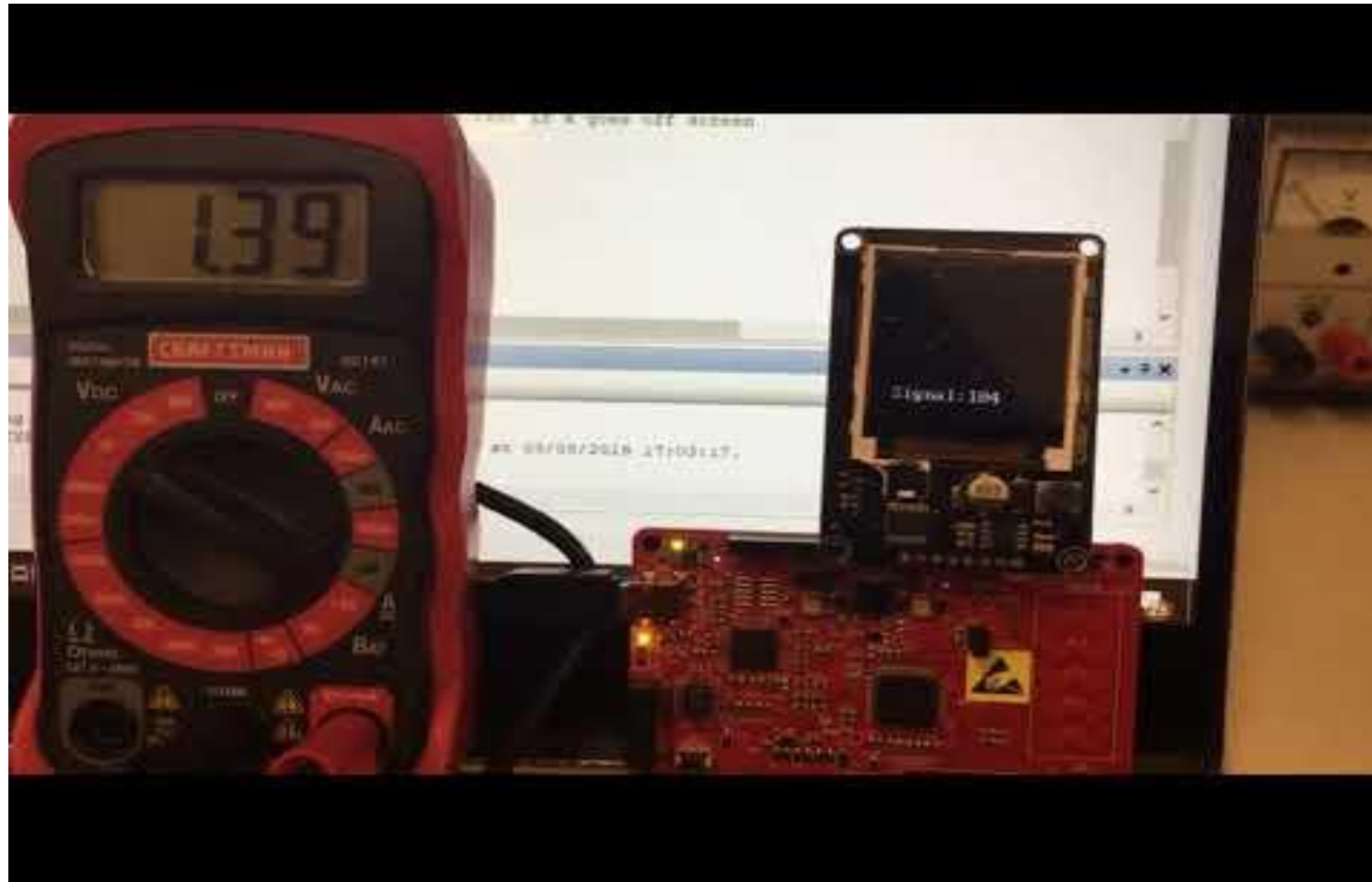
3/12/2019

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

# Demo - EMG device signal conditioning

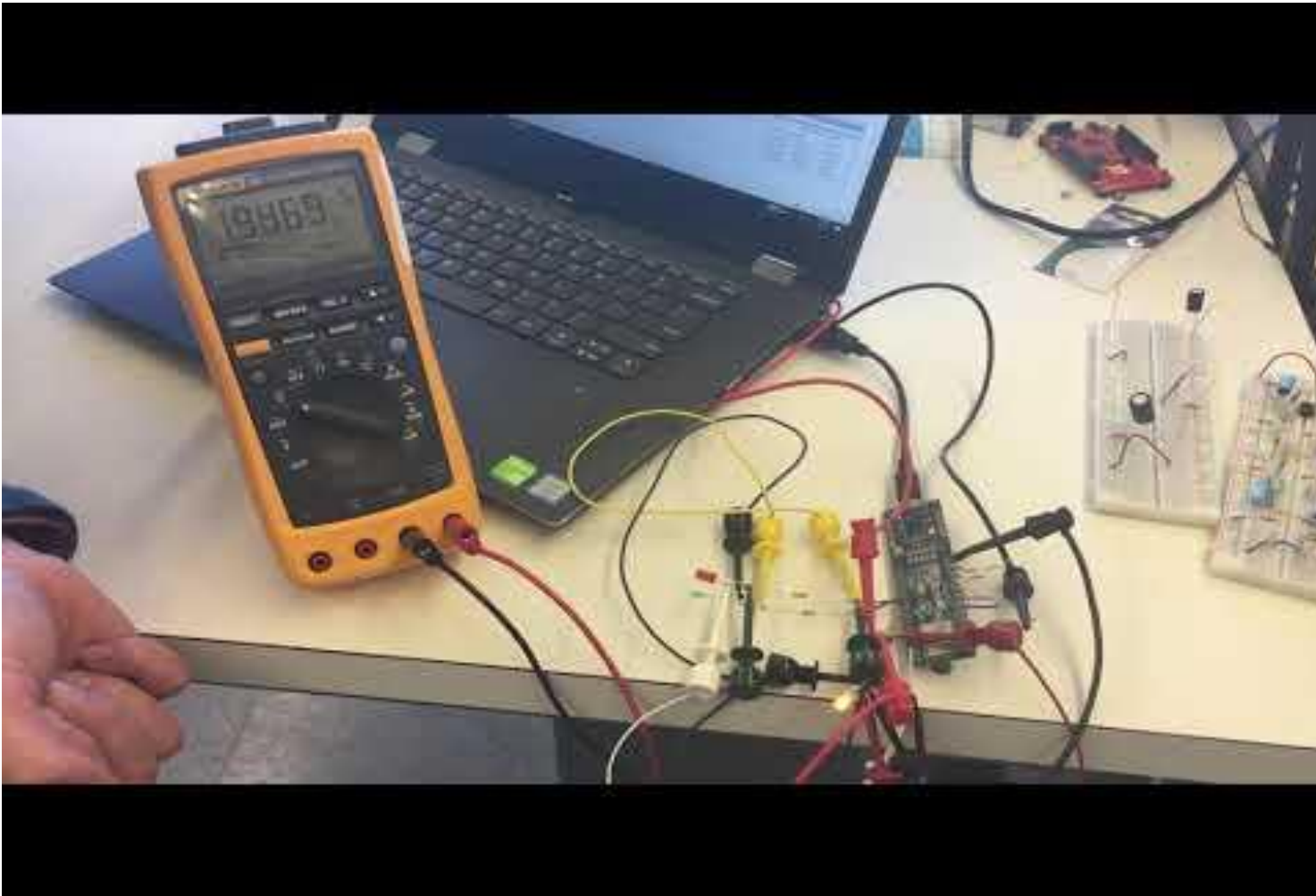


# Demo - GLCD EMG signal waveform display (PSOC4)



- ▶ In person demo shows waveform from MyoWare Muscle Sensor
- ▶ Smoother waveform is displayed using a power supply

# Demo - LEDs for battery level



- ▶ GREEN - FULL BATTERY
- ▶ YELLOW - ½ BATTERY
- ▶ RED - LOW BATTERY

# Specifications status

Specification Number	Specification	Status	DR 2.2 Justification	Plans to meet full specs
S001	Wire Length	Met & tested	Shows that there are no wires visible outside of the EMG device housing	N/A
S002	Sleeve Conductivity	Met & tested	Shows that the EMG sleeve is fabricated with conductive fabric and thread	N/A
S003	Current Exposure	Unmet, confident can be met	Designed and built to be standards compliant with UL 2595 for battery-powered appliances	Implement a diode to ensure there is no current feed back
S006	Battery/Electrical Safety	Unmet, confident can be met	Designed to be standards compliant with UL 2595 for battery-powered appliances	Consult user manual for mention of ALL standards/regulations in compliance

# Specifications status

Specification Number	Specification	Status	DR 2.2 Justification	Plans to meet full specs
S004	Ease-of-Use	Met & tested	Embedded into wearable, On/Off	N/A
S005	Marketing Clearance	Met & tested	Compliant with FDA CFR Title 21: 890.1175, 890.1375, 890.1575	N/A
CA001	Arm Unit Weight	Met & have confidence in	Weight: 0.549 lbs. PCB design	Smaller PCB design, orientational fixings
CA002	RTC Unit Weight	Met & tested	Weight: 0.564 lbs.	N/A

# Specifications status

Specification Number	Specification	Status	DR 2.2 Justification	Plans to meet full specs
CA003	Size	Unmet, confident can be met	Incorrectly sized PSOC 6 while designing PCB, used large boost converter circuits	Replace boost converters with smaller LMC7660 based circuits, use correct dimensions of PSOC 6
D001	Water Resistance	Met & have confidence in	Was focused on size, will focus on IP56 rating	Adding rubber gaskets, silicon around holes in housing
D002	Strength	Met & have confidence in	Supportive throughout, will add necessary ribs	Will add rib supports to add strength
R001	Integration	Met & tested	EMG data from electrodes received and read by MCU1	N/A

# Specifications status

Specification Number	Specification	Status	DR 2.2 Justification	Plans to meet full specs
R002	Data Acquisition	Met & tested	MCU2 receives data from MCU1 at 20 ft	N/A
R003	Signal Conditioning	Met & have confidence in	Initial testing suggests that signal amplification and filtering will reach specified magnitude, but PCB stopped functioning prior to measuring signal magnitude via oscilloscope	T/S PCB and test/measure with oscilloscope once board is functioning again
R004	Data Processing & Reporting	Met & have confidence in	PSOC ADC continuously processes data and transmits numerical values via graphical display	Untested due to PSOC6 GLCD incompatibility - will implement and test once TFT PSOC6 display arrives



# Specifications status

Specification Number	Specification	Status	DR 2.2 Justification	Plans to meet full specs
R005	Sampling Rate	Met & have confidence in	The software will sample the EMG signal at 1 kHz which is in the range of frequency for an EMG signal	Write test code to time sampling rate
R006	Power Supply	Met & have confidence in	Only need to purchase suitable li-po battery charger to demonstrate ability	Purchase appropriate battery charger early spring quarter
R007	Battery Life	Unmet, confident can be met	Planning to replace both boost converters with similar circuit that consumes significantly less current	Allow everything to run until battery is fully discharged & record run time
R008	Data Storage	Unmet, confident can be met	Data Storage analysis concludes the 2.0GB MicroSD card can accommodate for the needed 42.66MB of storage	Once SD card implemented, measure total

# Specifications status

Specification Number	Specification	Status	DR 2.2 Justification	Plans to meet full specs
R009	Data Rate	Met & have confidence in	UART samples at 115200 bits/sec	Once screen implemented, concurrently run with UART to calculate throughout
L001	Array Size	Unmet, confident can be met	Prioritized EMG signal display over muscle fatigue and maximum power values	The max & min voltage potentials stored will not exceed an array size of 50
L002	EMG Signal Display	Met & have confidence in	PSOC 6 requires EmWin Graphics library for GLCD screens, which remained unknown to us until too late	Will purchase TFT Display, capable of interfacing with PSOC6 & use with EmWin Graphics Library

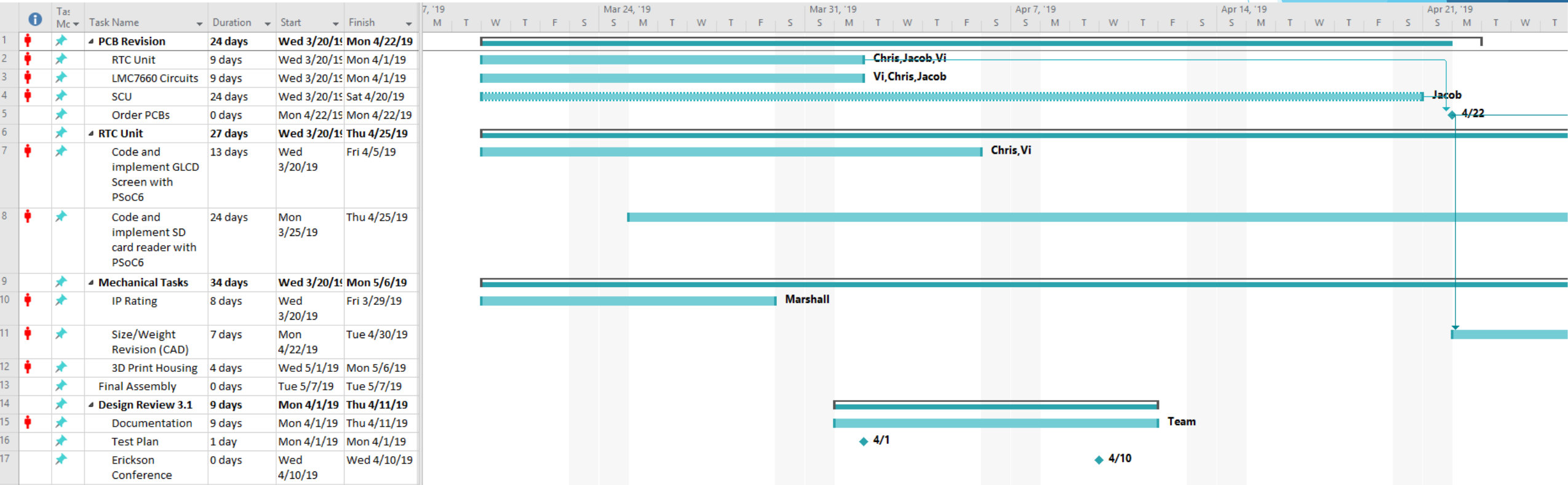
# Specifications status

Specification Number	Specification	Status	DR 2.2 Justification	Plans to meet full specs
L003	Data Calculation	Unmet, confident can be met	Prioritized EMG signal display over muscle fatigue and maximum power values	Max power - amplitude Min power - increase in amplitude
L004	SD Card Storage	Unmet, confident can be met	Prioritized BLE acquisition and EMG signal display over SD card storage	Interface SDcard using SPI mode 0

# Analysis Status

- ▶ Power
  - ▶ Expected battery life (EMG device): 3.61 hours with two boost converters included
    - ▶ Plan for spring to replace both boost converter circuits with two integrated circuits that are expected to consume less current
  - ▶ Expected battery life (RTC): 4.4 hours
- ▶ FDA Compliance
  - ▶ In accordance with 21 CFR 807.87(h) and 21 CFR 807.92
  - ▶ Surface EMG devices approved by the FDA include those that use a single electrode or a fixed array or multiple surface electrodes
    - ▶ The Muscle Guide meets requirements of FDACFR21 Title 21, Part 890 Subpart B (890.1175 - Electrode cable), (890.1375 - Diagnostic electromyography), and (890.1575 - Force-measuring platform).
- ▶ Weight
  - ▶ The RTC unit weighs 0.564 lbs. The EMG unit weighs 0.549 lbs. As we continue to make revisions regarding the PCB and other integrated circuits, we are confident we can reduce our weight and overall form factor
- ▶ Size
  - ▶ EMG unit is approximately 200x100x30 mm<sup>3</sup>
- ▶ EMG Data
  - ▶ Max power: Amplitudes of the EMG signal
  - ▶ Muscle fatigue: Increase in amplitude of EMG signal
- ▶ Bit Depth
  - ▶  $2^{12} = 4,096 \rightarrow 5VDC / 4,096 = 1.22mV/bit$
  - ▶ Absolute minimum level that the ADC can measure is represented by 1 bit of the ADC voltage range
- ▶ Data Transmission
  - ▶ Sampled at 1,000 Hz  $\rightarrow$  12 kb/s or 1.5 kB/s through 12-bit ADC
  - ▶ The Maximum Transmission Unit (MTU) size of an attribute has a valid range of 23 - 512 bytes. The required data transmission rate to process and transmit the digital muscle signal via Bluetooth is 16.1 kb/s or 2.01 kB/s.
- ▶ Data Storage
  - ▶ The 2.0GB of storage on the MicroSD card can accommodate for the needed 42.66MB of storage needed for overhead, IMU data, timestamps and calculated values

# Schedule



Questions?

