Justin The

Biomedical Engineering Student

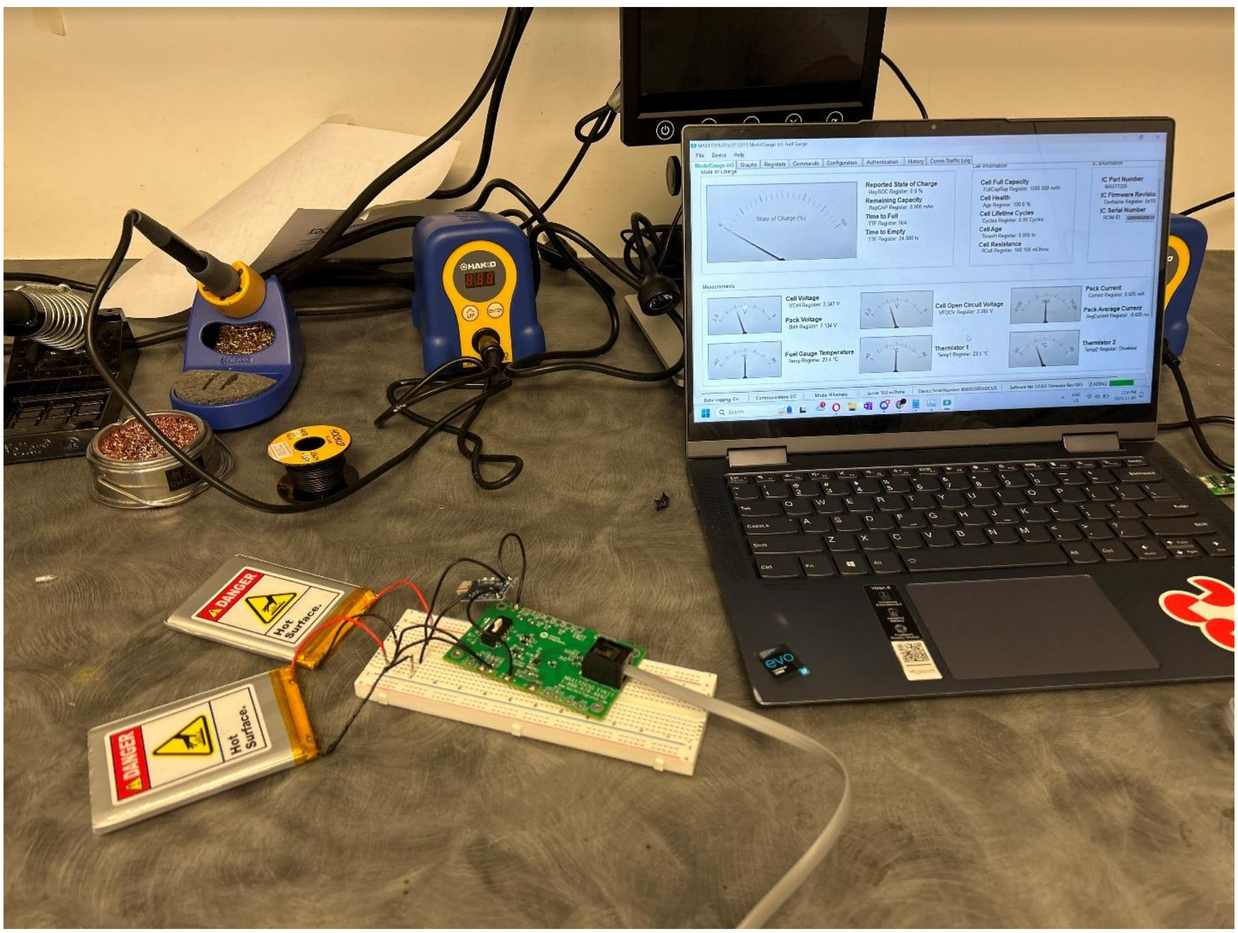
Technical Projects

UBC Bionics

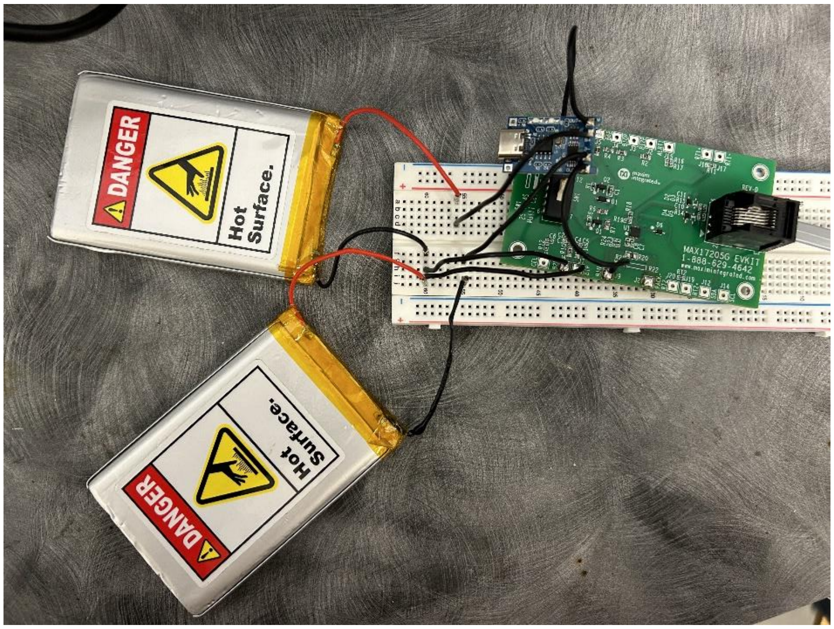
Responsible of the battery management system and power delivery to the bionic arm. Implemented battery management system using the Maxim MAX17205 Fuel Gage Board for optimal battery delivery.

Here is the documentation for the BMS that we made: [BMS Documentation]

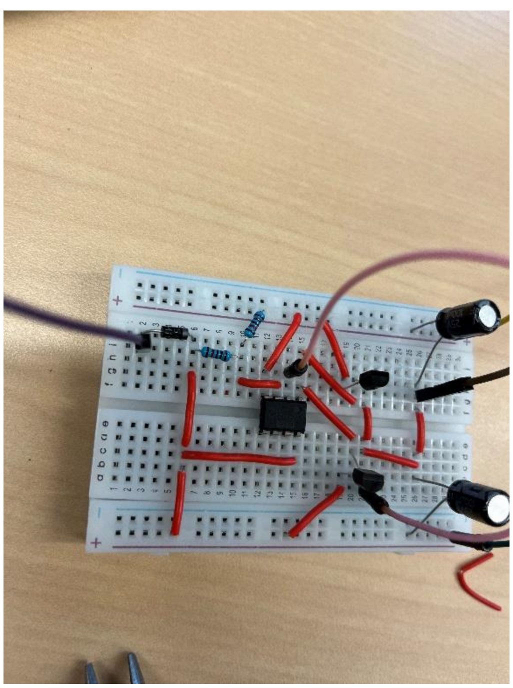
Moreover, here are some photos showing the tested MAX17205 board with the TCP4056A overprotection circuit with two 3.7V nominal voltage, 6000mAh, 906090, rechargeable LiPo batteries.

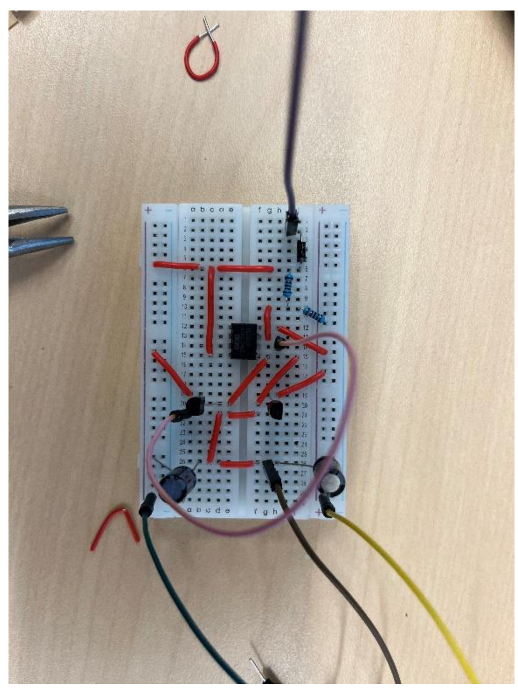


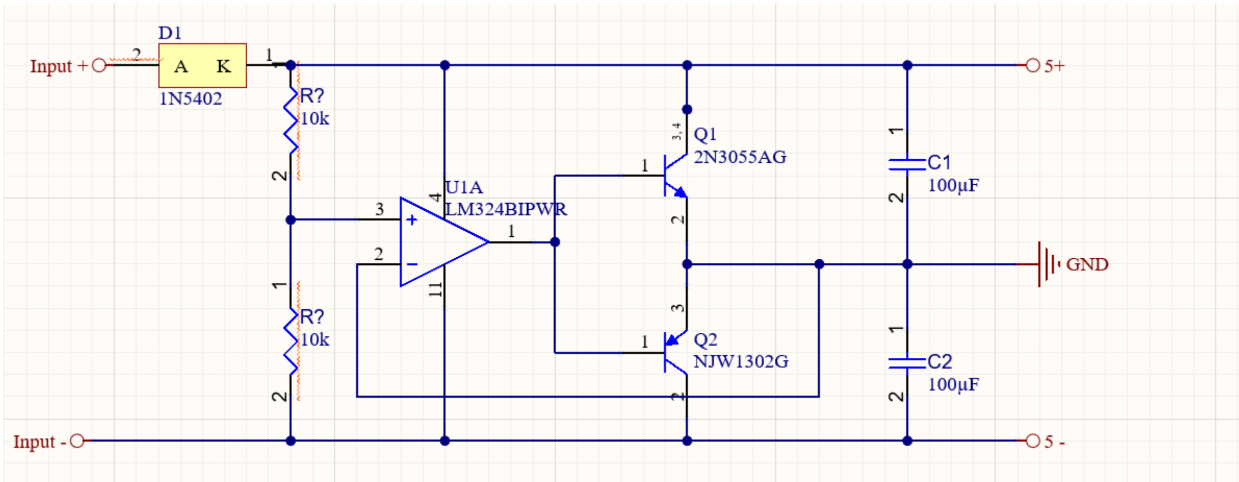
MAX17205 EV board with two batteries (left), Maxim BMS GUI (right) for SOC/SOH display



We also drafted initial circuit sketches to for split rail power delivery for the EMG system while maintaining optimal signal to noise ratio. The EMG team needed a $\pm 5V$ rail supply for their dual supply high precision instrumentation amplifiers so we formed an initial schematic sketch in Altium and breadboard for testing.







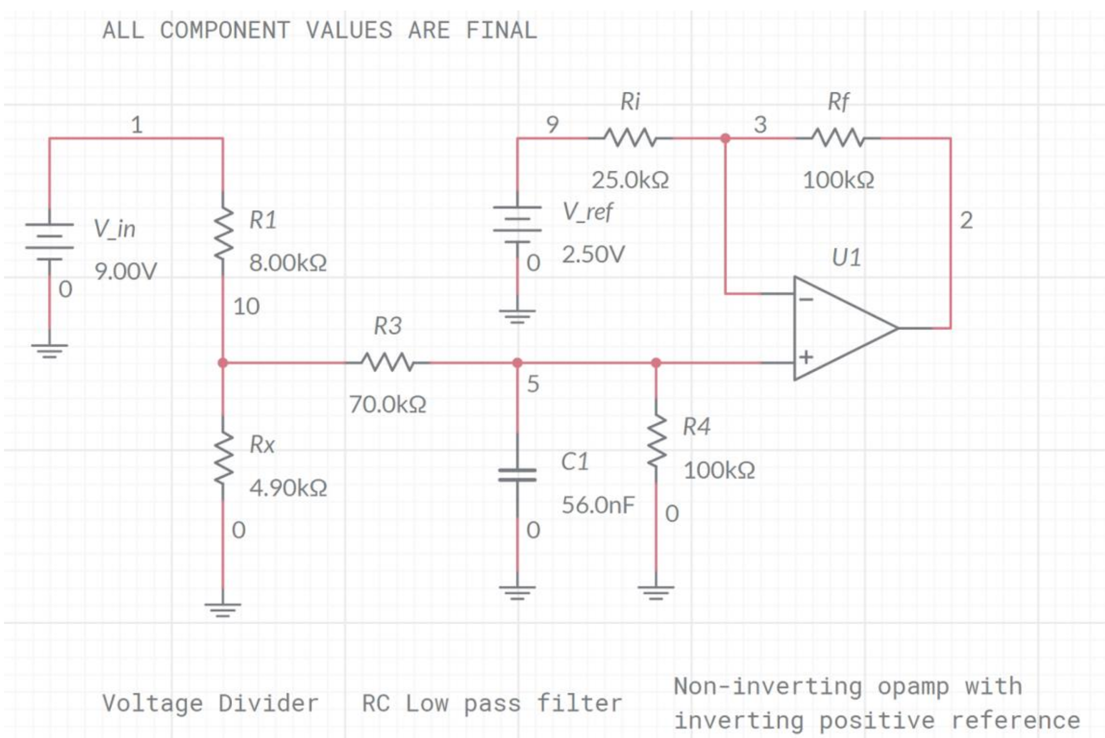
Infant Sepsis Monitor

[Design Files]

I was a key member of a team of 6 students that developed a medical device that detects sepsis in infants under 3 months old. I was responsible for designing a highly accurate temperature sensing circuit using Wheatstone bridges, filters, and amplifiers.

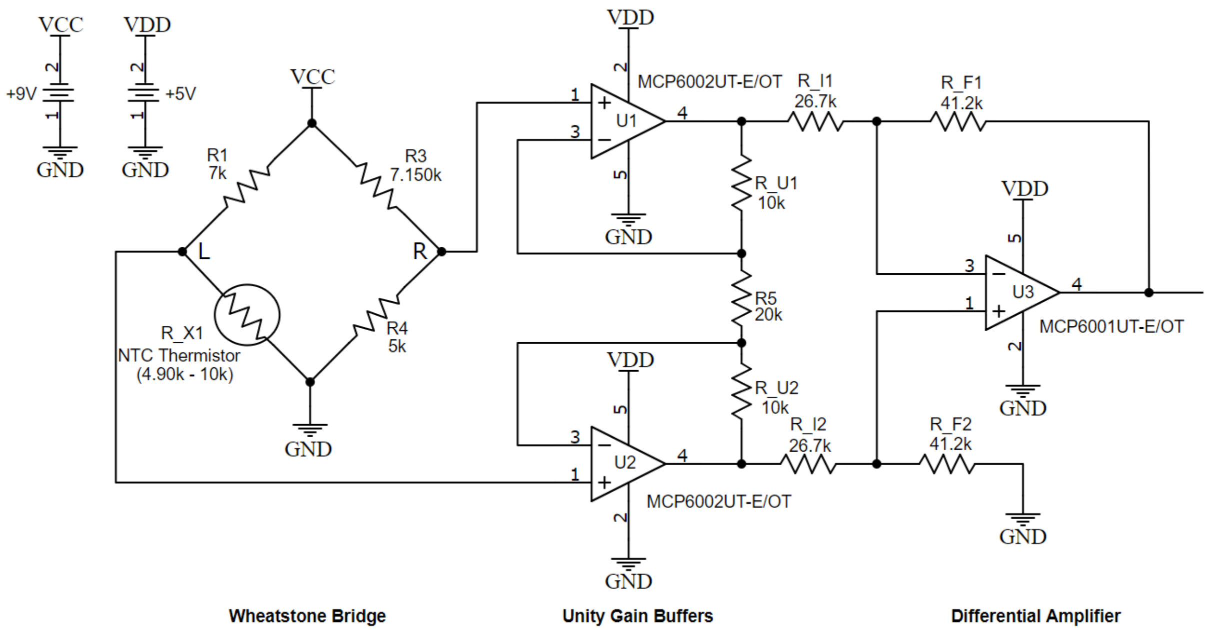
I formed two conceptual circuit designs for the temperature sensing unit.

Concept 1:



The idea was to use a +9V battery as an input to temperature sensing unit and R_x be an NTC Thermistor to read ambient temperature. The signal would then be fed through an RC low pass filter with a cutoff frequency of 40 Hz before it is fed though a non-inverting op-amp with an inverting positive reference to remove the voltage offset.

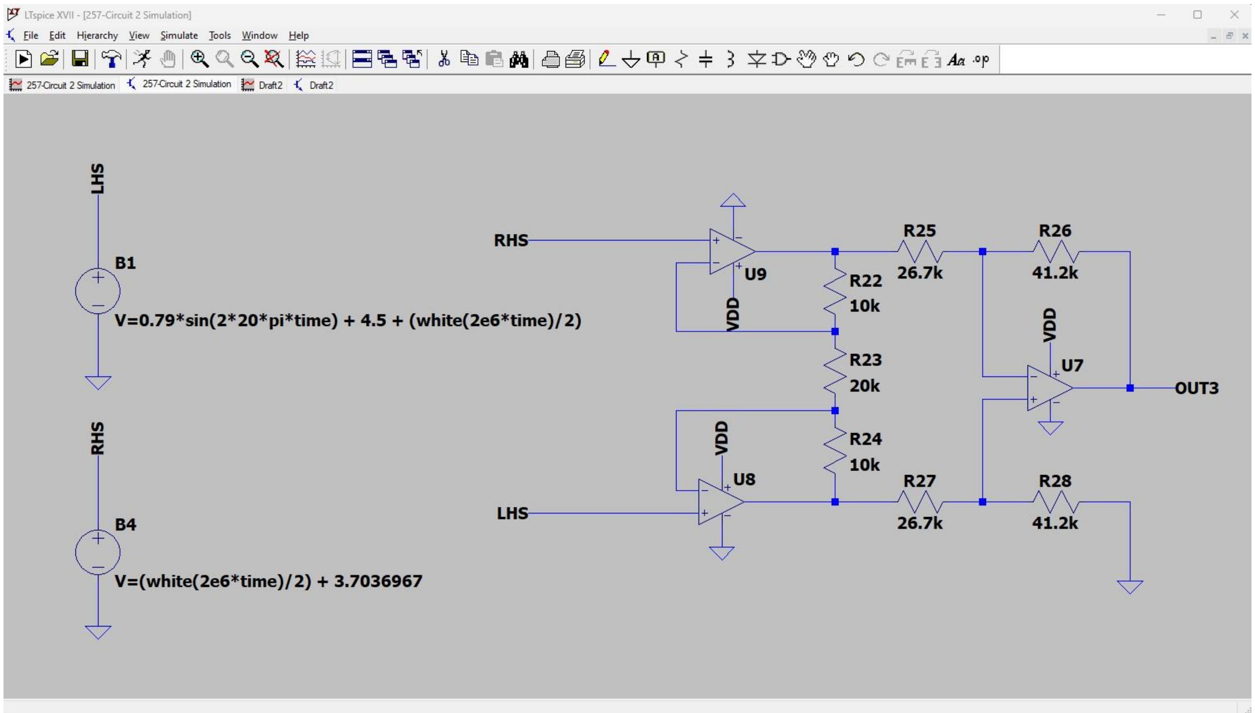
Concept 2:

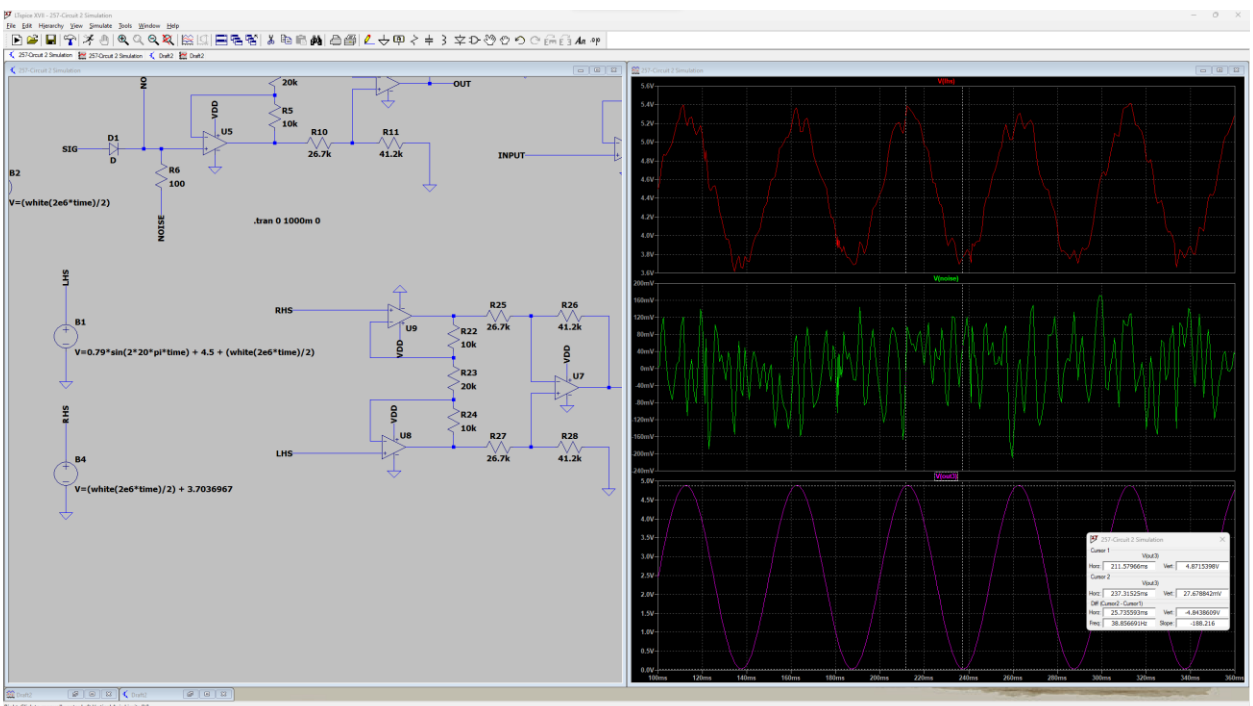


This design used a Wheatstone bridge to measure the change in voltage over the thermistor. The signal is then fed through an instrumentation amplifier, made from unity gain buffers and a differential amplifier.

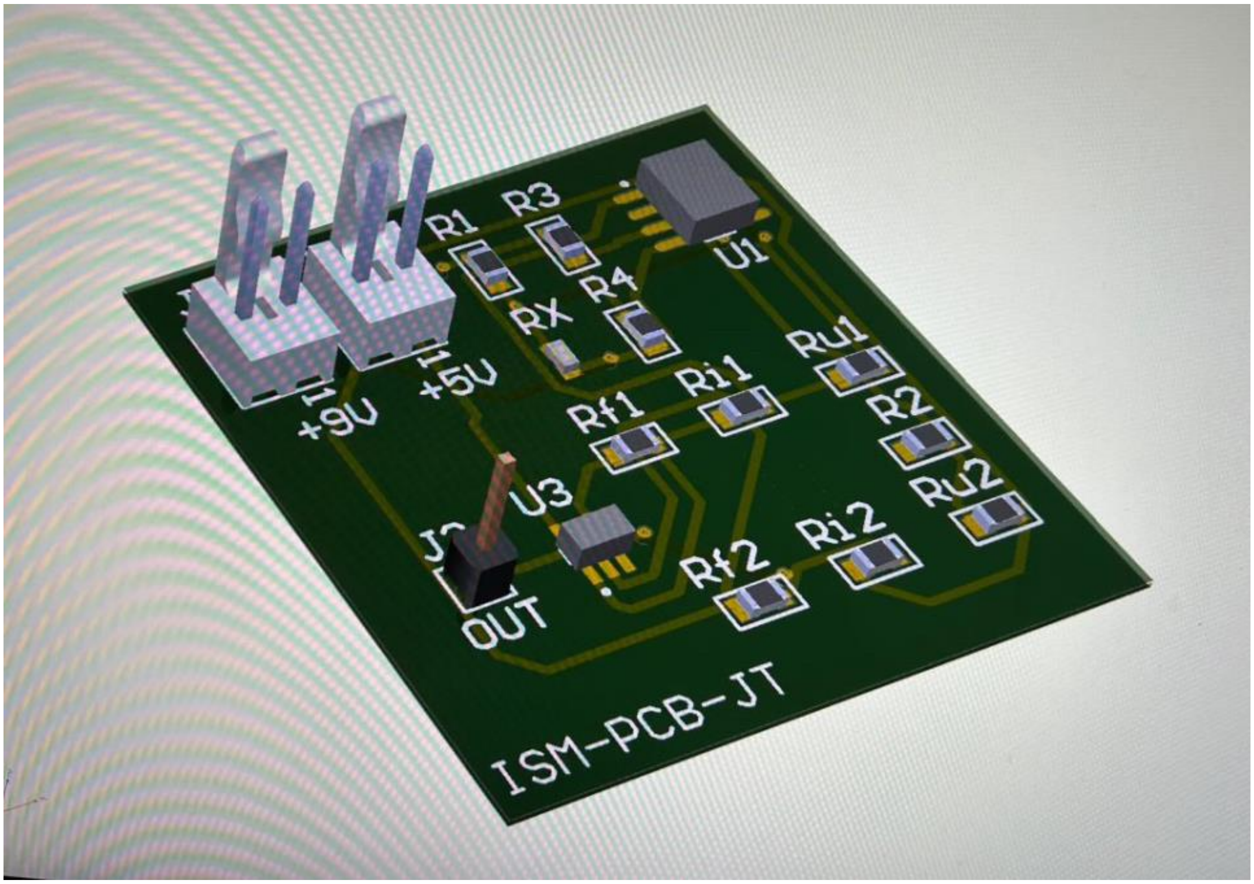
We ultimately chose design 2 over design 1 because a Wheatstone bridge allows for a larger voltage output range and reduces any fluctuating input noise from the supply that may affect the output voltage coupled with the instrumentation amplifier which did a better job at eliminating noise and maintaining high input impedance/low output impedance.

I then used LTSpice to create an accurate model of the sensing circuit and verify its performance before implementation. I injected a white noise into the input and verified the performance of the design.


LTspice XVII - [257-Circuit 2 Simulation]
File Edit Hierarchy View Simulate Tools Window Help
257-Circuit 2 Simulation
257-Circuit 2 Simulation
Draft2
Draft2
LHS
B1
V=0.79*sin(2*20*pi*time) + 4.5 + (white(2e6*time)/2)
RHS
B4
V=(white(2e6*time)/2) + 3.7036967
RHS
U9
VDD
R25
26.7k
R26
41.2k
R22
10k
R23
20k
VDD
U7
OUT3
VDD
U8
R24
10k
LHS
R27
26.7k
R28
41.2k

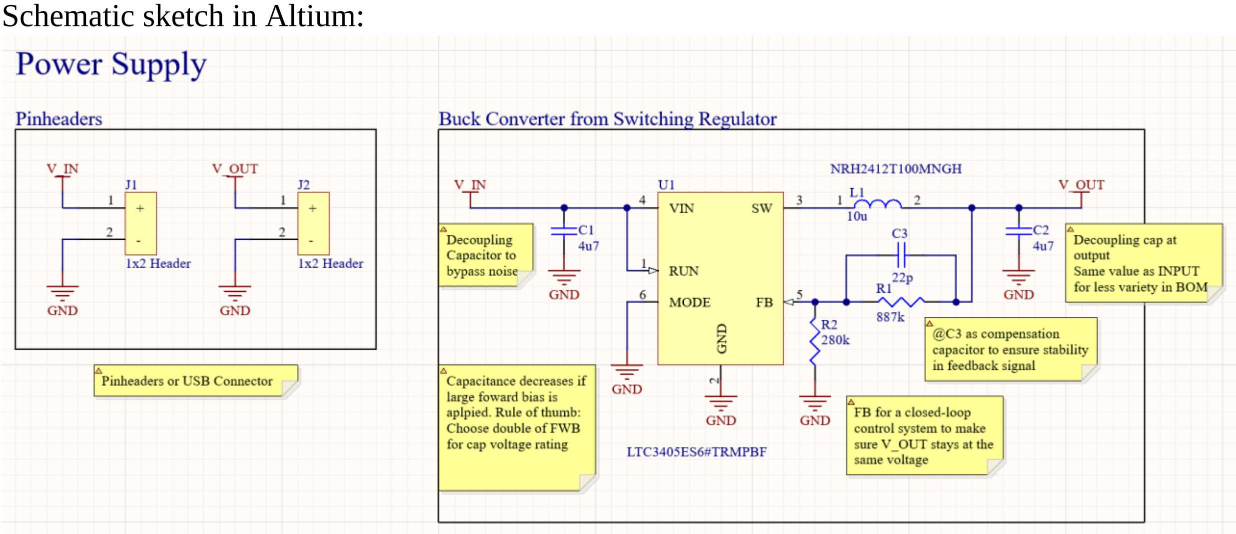

SIG
D1
U5
R5
10k
R10
26.7k
R11
41.2k
OUT
INPUT
R6
100
B2
V=(white(2e6*time)/2)
NOISE
.tran 0 1000m 0
LHS
B1
V=0.79*sin(2*20*pi*time) + 4.5 + (white(2e6*time)/2)
RHS
B4
V=(white(2e6*time)/2) + 3.7036967
RHS
U9
R22
10k
R23
20k
R24
10k
R25
26.7k
R26
41.2k
U7
U8
LHS
R27
26.7k
R28
41.2k

Outside of the course, I continued working on the project and designed a compact PCB layout for the temperature sensing unit with Alitum Designer to ensure a perfect fit within the small enclosure.



Additionally, I designed a buck converter using a LTC3405ES6 Switching Regulator to step down the input voltage of +9V to the +5V the for the instrumentation amplifier supply.

Schematic sketch in Altium:



I also made a PCB Layout in Altium, making sure to follow the switching regulator data sheet recommended PCB layout to minimize noise as much as possible.