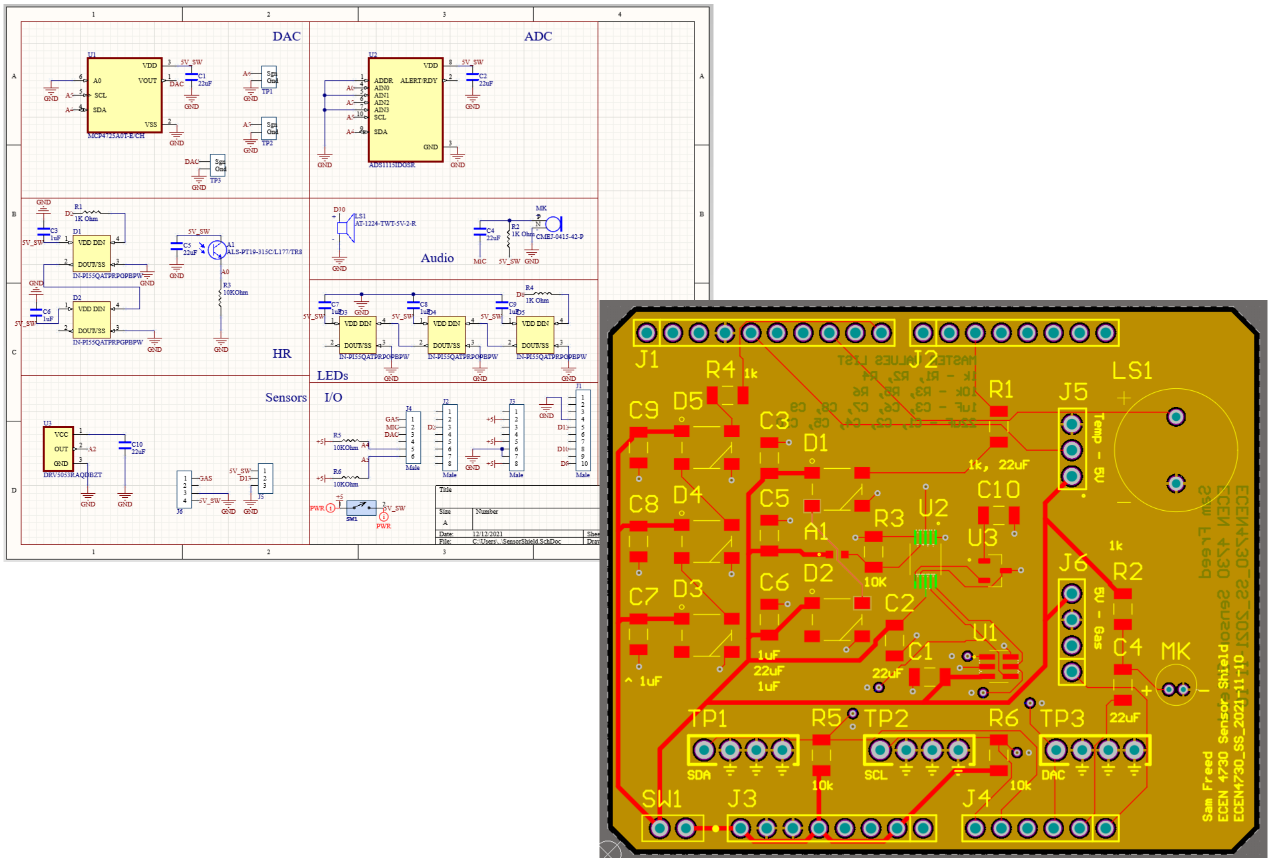
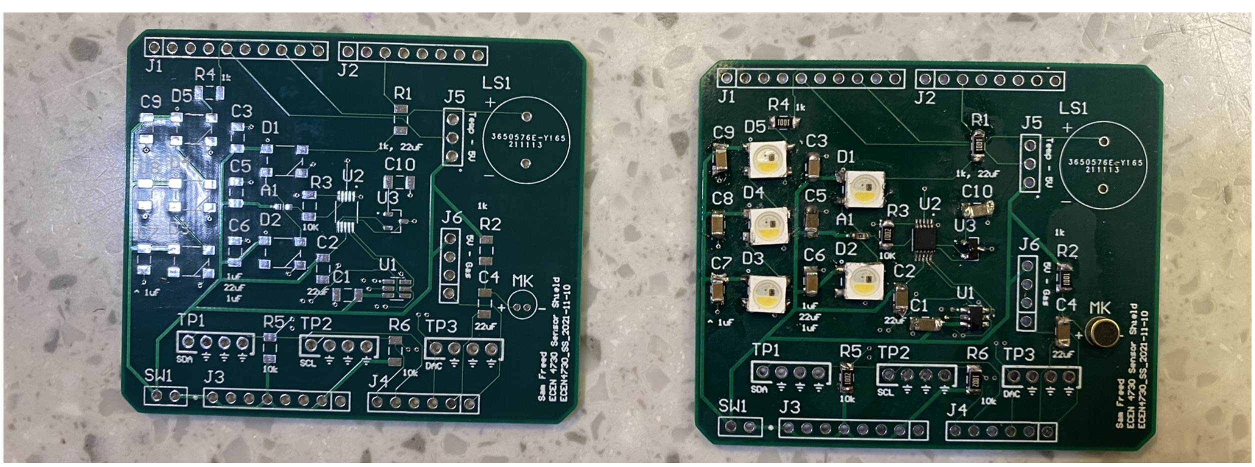
Board 4 Report - Sam Freed

Engineering Requirements

1. The four-layer board is set up with two signal planes and two ground planes, in the order from top to bottom signal, ground, ground, signal.
2. Board is powered using the 5V pin from the Arduino.
3. A switch separates the Arduino power from the power to the rest of the board.
4. A heartbeat sensor is set up to read the user's heartbeat, with adjustable LEDs in order to use the best wavelengths of light to read the heartbeat.
5. A temperature and humidity sensor can be connected using a separate jumper and then can communicate data.
6. A Hall effect sensor can read magnetic field strength and can communicate data.
7. A carbon monoxide sensor can be connected using a separate jumper and then communicates data.
8. A microphone is used to capture audio.
9. A buzzer is used to make sounds.
10. A 12-bit digital to analog converter is set up to translate I2C commands to scaled voltages.
11. A 16-bit analog to digital converter is used to measure voltage differences from the sensors that output voltage-scaled data.
12. A chain of adjustable LEDs can be programmed to light up in different colors.

Board Images





*Note: this image was taken before pins were added. I also misplaced the buzzer, so it was not added to the board.

Design Verification

Design verification for this board would have come in the form of running Arduino code on my Board 3 “golden” Arduino. However, during the testing of this board on my Arduino, I accidentally switched the probe pin and ground pin while attempting to read a 5V power line’s noise and shorted out multiple output pins on said Arduino. I did not have access to another Arduino at this time, and as such was unable to complete much further verification. Instead, I confirmed continuity on all paths I could access using a multimeter.

Seven Steps

1. POR - The basic structure of the plan of record was provided by the lab guidance, with the goal being to create a four-layer board that fits on top of an Arduino and has extra sensors to interact with.
2. Preliminary BOM - This was also based on the lab guidance, with all of the sensors and other chips provided to us already.
3. Final Schematic and BOM - These were finalized as I created the board in my own structure, adding resistors and capacitors as needed.
4. Board Layout and Parts - Completing my own layout was only different than in other boards in awareness of how to handle the four-layer structure. This included understanding how to set up the middle two planes in a way to minimize ground and the use of the secondary vias next to the signal vias in order to reduce return path inductance.
5. Assembly - As was the point of this lab, assembly was somewhat difficult! I started with the small ICs and worked my way up to the bigger parts.
6. Bring Up/Troubleshoot/Test - Verification of connectivity and part functionality was done by hand as well as by running Arduino code for each sensor.
7. Documentation - Documentation is being developed as I type this document!

Takeaways

I think the most important takeaway from this board's development was the importance of utilizing the resources available to me when I have them. Due to various personal reasons, I was unable to utilize lab time as effectively as I had hoped. This led to lots more stress and time concerns during a busy time in the semester. Also from a lab and testing standpoint, I certainly learned my lesson on why it's important to ensure the orientation of a test point probe is proper - by reversing the orientation while trying to check a 5V test point, I ended up grounding my 5V traces and shorting out portions of my board!

In terms of design, I was happy to gain experience in designing boards with more than two layers and in designing to Arduino specifications, both of which I had not done before but now have more confidence to do so. A refresher of the I2C standard was also beneficial, especially with so many different devices and addresses to work with.