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Board 2 Final Report
11/5/19

Final Report: Golden Arduino Board

1. Plan of Record

a. Purpose

The purpose of this board is to have the exact same functionality as an Arduino Uno, but with improved design features. It will include design features to reduce noise such as improved routing and decoupling capacitors. We will keep the standard Arduino board pin-out footprint so that it is compatible with shields; however, a row of return pins will be added outside of this footprint to improve the board layout by reducing cross-talk for signals coming off the board. Furthermore, a 16 MHz crystal will be used for the system clock instead of a resonator to increase clock accuracy and stability.

b. Power Budget

The input power will be the same as what is required for powering an Arduino Uno. The recommended range of input voltage is 7 to 12 volts. If supplied with less than 7 V, the 5 V output pin may supply less than five volts and the board may become unstable. If using more than 12 V, the voltage regulator could overheat and damage the board. The Atmega 328 will be utilizing 5 V instead of 3.3 V to have the fastest clock speed.

c. Risk Management

i. Potential Risks

1. Receiving faulty components is a potential risk that can be mitigated by ordering extras.
2. Miss-orienting the IC chips like the Atmega 328 could result in incorrect connections to the pins. We will check for the correct orientation before soldering it in..
3. The mechanical stresses placed on the output pins could break connections. We will use through-hole mounts to ensure this doesn't happen.
4. When soldering there is the potential for cold solder joints. We can mitigate this by inspecting each connection after the joint is formed.
5. Identifying where parts go on the board could become difficult. The inclusion of silk screen identifications will make this easier.

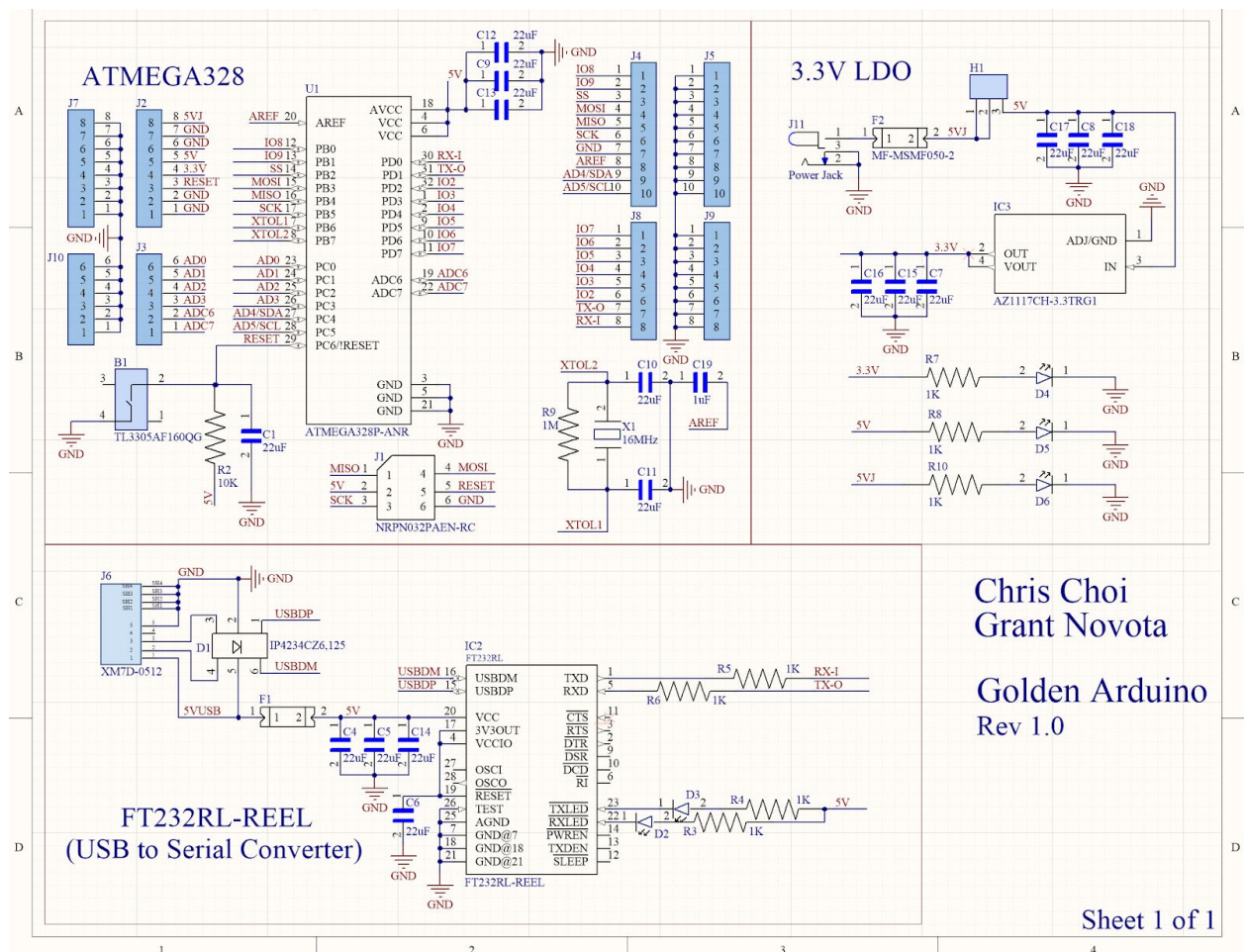
ii. Bring-Up Plan

Switches will be placed to isolate the board's subcircuits and allow us to assemble and test pieces of the board one at a time and ensure that each piece is working correctly before moving on and assembling the rest of the board.

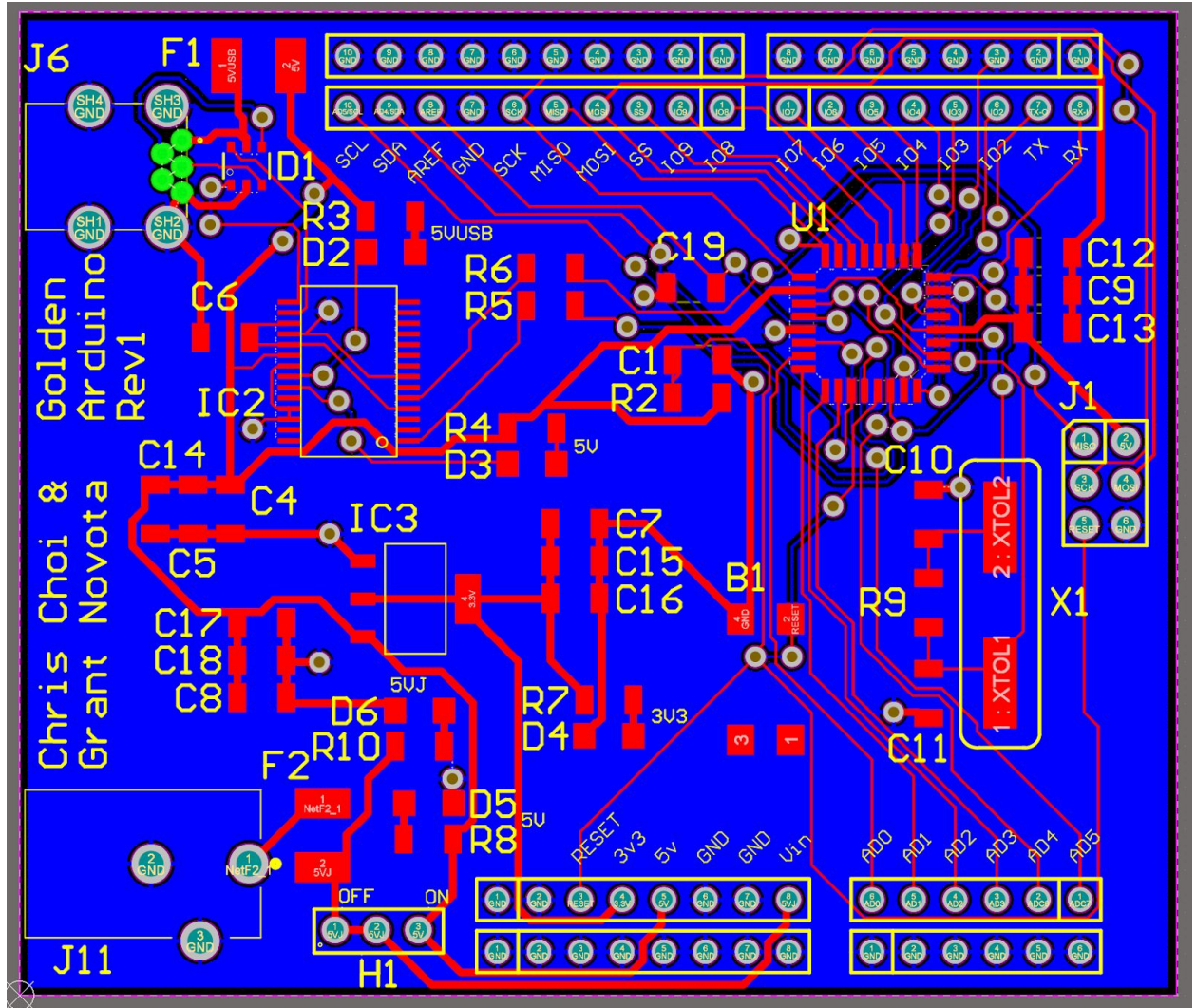
2. Bill of Materials - Unique Components

Component	Digikey Catalog	Count	Cost
Atmega 328	ATMEGA328PB-AURCT-ND	1	\$1.46
FTDI USB interface chip	768-1141-1-ND	1	\$2.22
TSV diode array	IP4234CZ6,125	1	\$0.41
Resettable fuse	MF-MSMF050-2	1	\$0.47

3. Schematic Capture



4. Board Layout

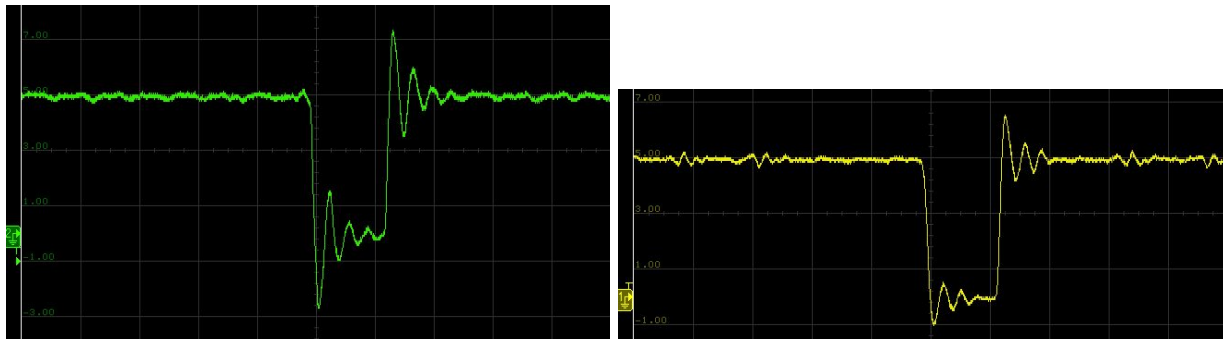


5. Documentation of Switching Noise

Below are two images where the switching noises from pins 9-13 are compared. The green scope shots represent the commercial board, the yellow scope shots represent our in house board, and the blue signals represent trigger signals to get a clean, consistent scopeshot.

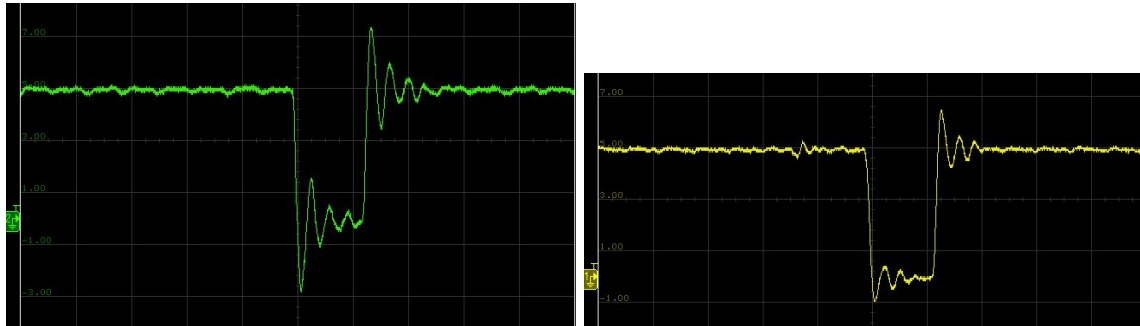
Pin 9

It is hard to see the labeling on the scope shots, but the commercial board (green) has a peak to peak switching noise of about four volts. Our in House board has a switching noise of approximately two volts. This is a 50% reduction in switching noise on pin 9.



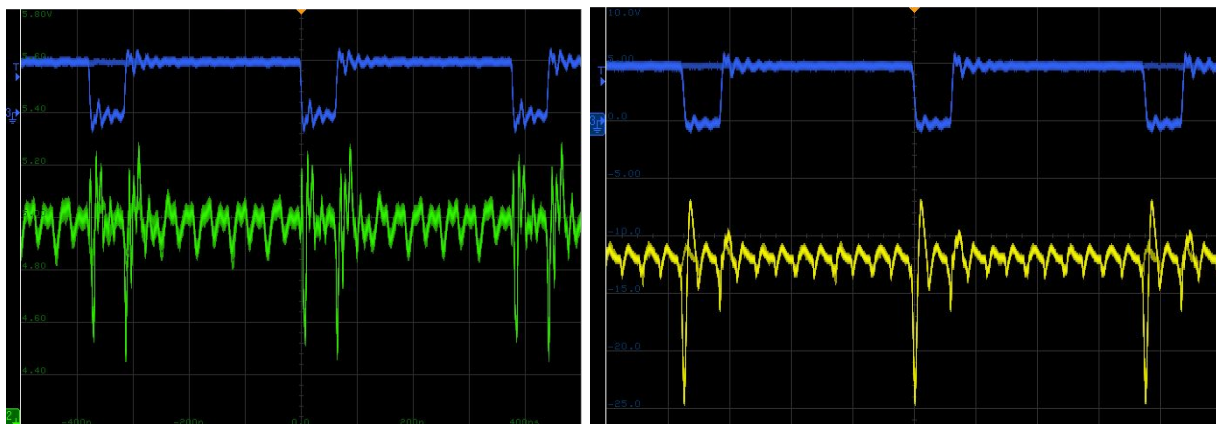
Pin 10

On pin 10, the switching noise on the commercial board is greater than four volts. It is sitting at approximately 4.2 volts peak to peak. On our in house board, the switching noise is just above two volts peak to peak. This is about a 50% reduction in switching noise.



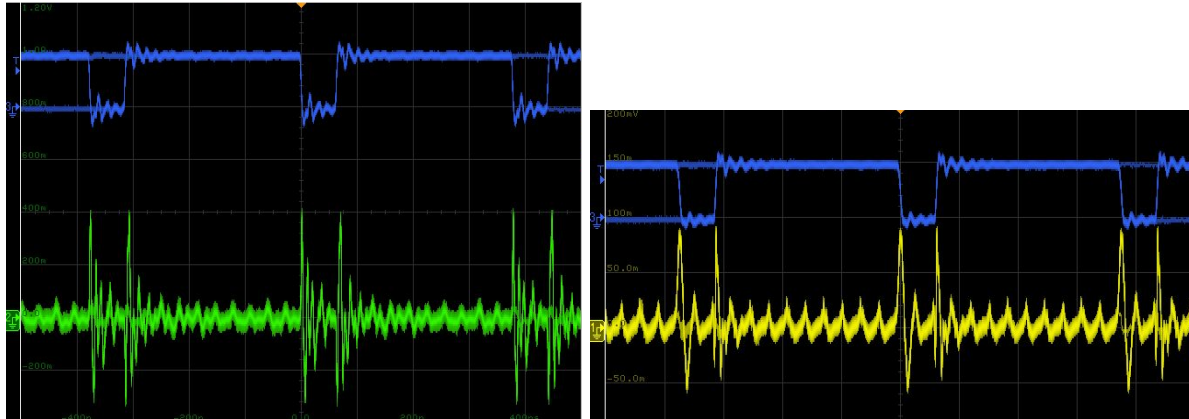
Pin 11

On pin 11 on the commercial board, the switching noise on the high-to-low is about 800 mV and the low-to-high switching noise is about 900 mV. On our in house board, the switching noise on the high-to-low is about 800 mV and our switching noise on the low-to-high is approximately 200mV. We reduced the low-to-high switching noise dramatically, but did not really affect the high-to-low switching noise.



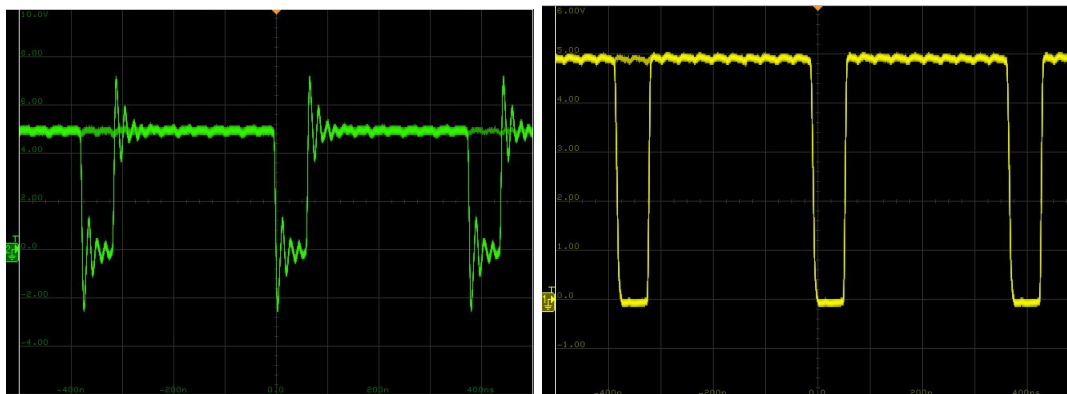
Pin 12

On pin 12, we used a switching IO to trigger the scope shots in both the commercial board and the in house board. In the commercial board, the switching noise is about 700mV peak to peak and the in house board has a peak to peak of 150mV. This is approximately a 20% decrease in the switching noise.



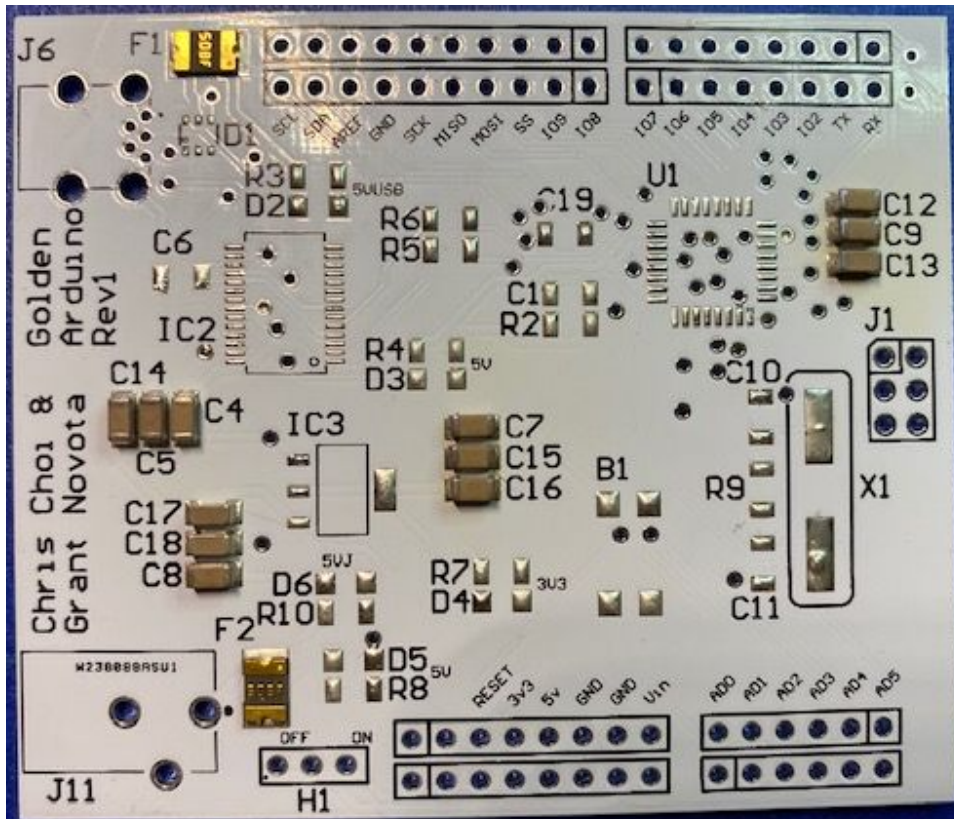
Pin 13

On pin 13, the commercial board shows a switching noise of four volts peak to peak and our in house board shows little to no switching noise. This is a massive difference and is cause for celebration.

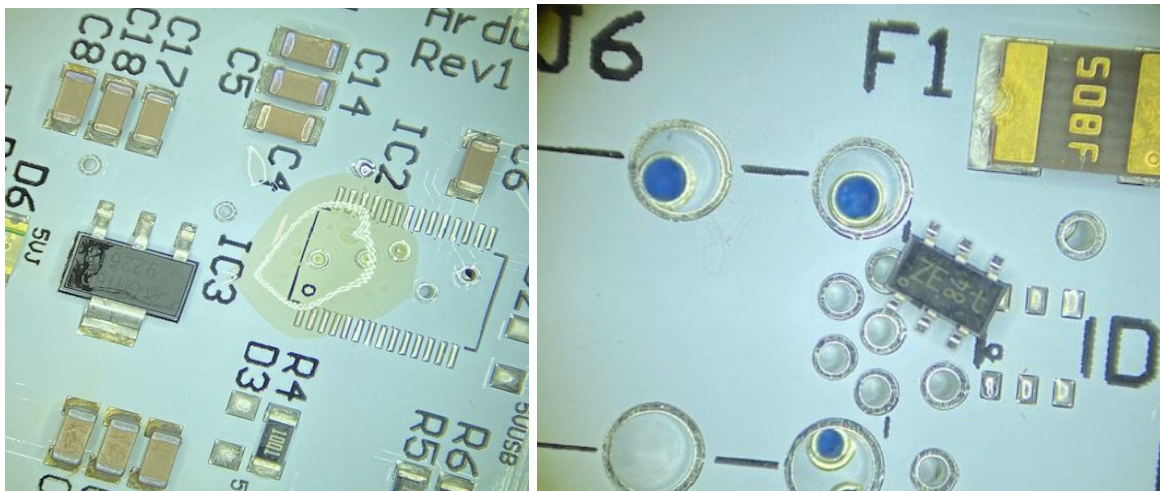


6. Assembling PCB

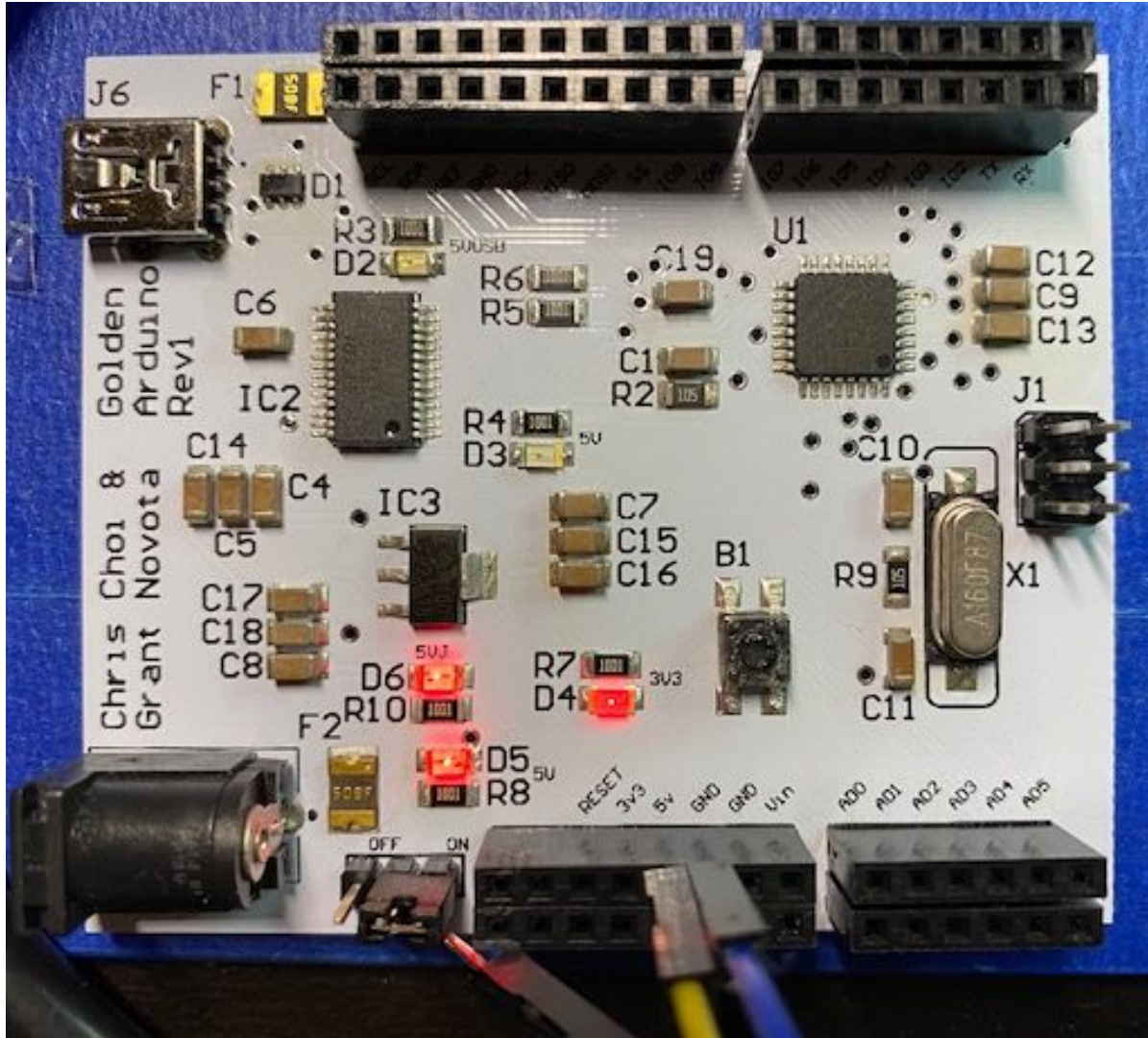
We started assembling the PCB with the decoupling capacitors and the Fuses.



We then soldered the power chips and the ESD diode chip. The ESD protection chip was difficult to solder due to the small chip size and the small pads, but we successfully completed the assembly.



Below is our final assembled board



We were able to get our board to flash the bootloader and run blink. We have verified our results with the professor and both got a Rule #9 hat.

We did encounter an issue where our board did not reset, but that was because our button was making poor contact. After pressing the button with some force, it returned to a functional state and worked as normal.

5/5 Points for the assembly and running Blink