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ECEN 5730 – Fall 2025

Board 3 Report: A Golden Arduino PCB

Objective

The objective of this lab is to implement best design practices to design a Golden Arduino Board (GAB) with less noise than a Commercial Arduino Board (CAB).

Plan of record

- Add 0.5 ohm sense resistor to measure inrush current
- Add a TVS chip to protect the data pins from ESD
- Add test points for D+, D-, TX, RX lines
- A switch to select between between usb connector and power plug
- 3.3 LDO to output 3.3V
- A 12 MHz resonator for CH340g
- A 16 MHz resonator for Atmega 328 microcontroller
- Header pin footprint should be same as a commercial Arduino board
- Measure and compare noise on a CAB and a GAB

Component Listing

The bill of materials is listed in the table below.

Name	Quantity	Name	Quantity	Name	Quantity
22uF	8	FB_10uH_1206	1	Push Button Switch	1
22pF	4	Red	5	3 Pin Switch	1
1uF	1	Green	1	2 Pin Switch	1
47nF	1	Power Jack	1	10x Probe TP	11
8 Header Connector	4	AMS1117-3.3	1	ATMEGA328P-ANR	1
6 Header Connector	2	1M Ohm	2	TESD5V0V4UCX6_RFG	1
USB Mini	1	1k Ohm	5	CH340G	1
10 Header Connector	2	500m Ohm	1	12MHz Crystal Res	1
22uF	8	10k Ohm	1	16MHz Crystal Res	1

Circuit Diagram

A sketch of the schematic is shown in Fig. 1 and the actual schematic is shown in Fig. 3. A screenshot of the board layout is shown in Fig. 1. By The fabricated board and the assembled board are shown in Fig. 2.

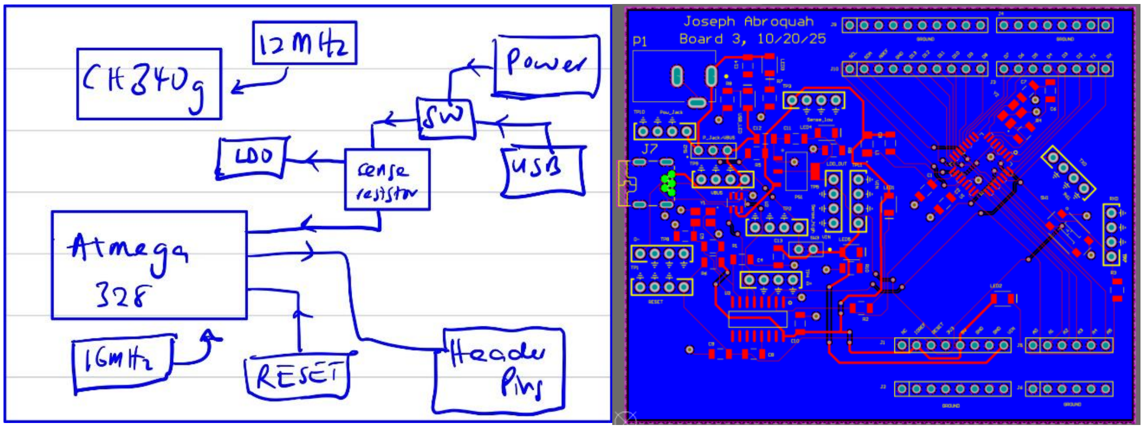

Fig. 1. Sketch of circuit (left) and layout of circuit (right)

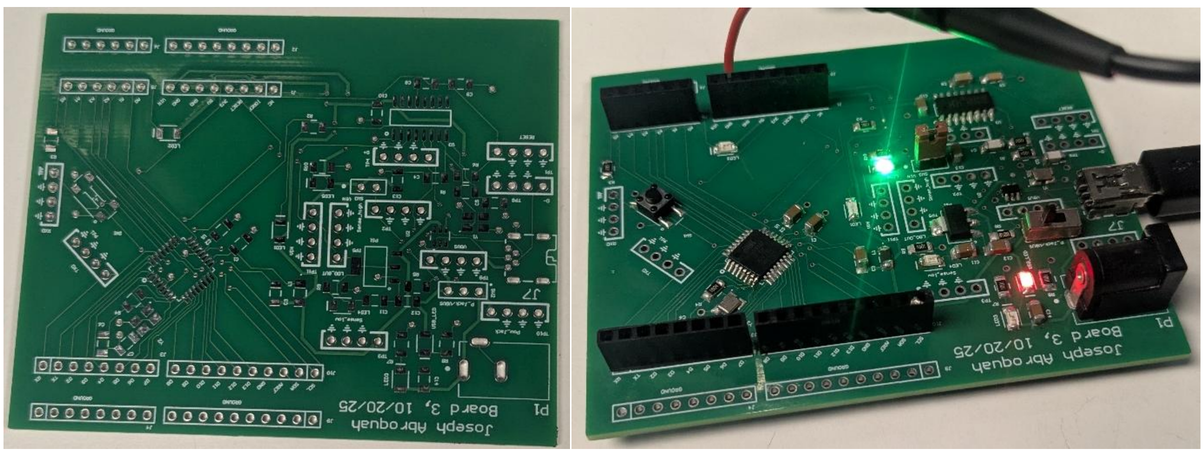

Fig. 2. Fabricated (unassembled) board on the left and assembled board on the right

Measurement and Discussion

To verify that the board is functioning properly, the voltage on the VCC power rail and the output of the LDO were measured. Fig. 4 shows that the VCC line provides 5 V, while the LDO output is 3.3 V. Additionally, the oscillation frequencies of the 12 MHz and 16 MHz crystal oscillators were checked. As shown in Figure 5, both oscillators operate correctly at their expected frequencies of 12 MHz and 16 MHz.

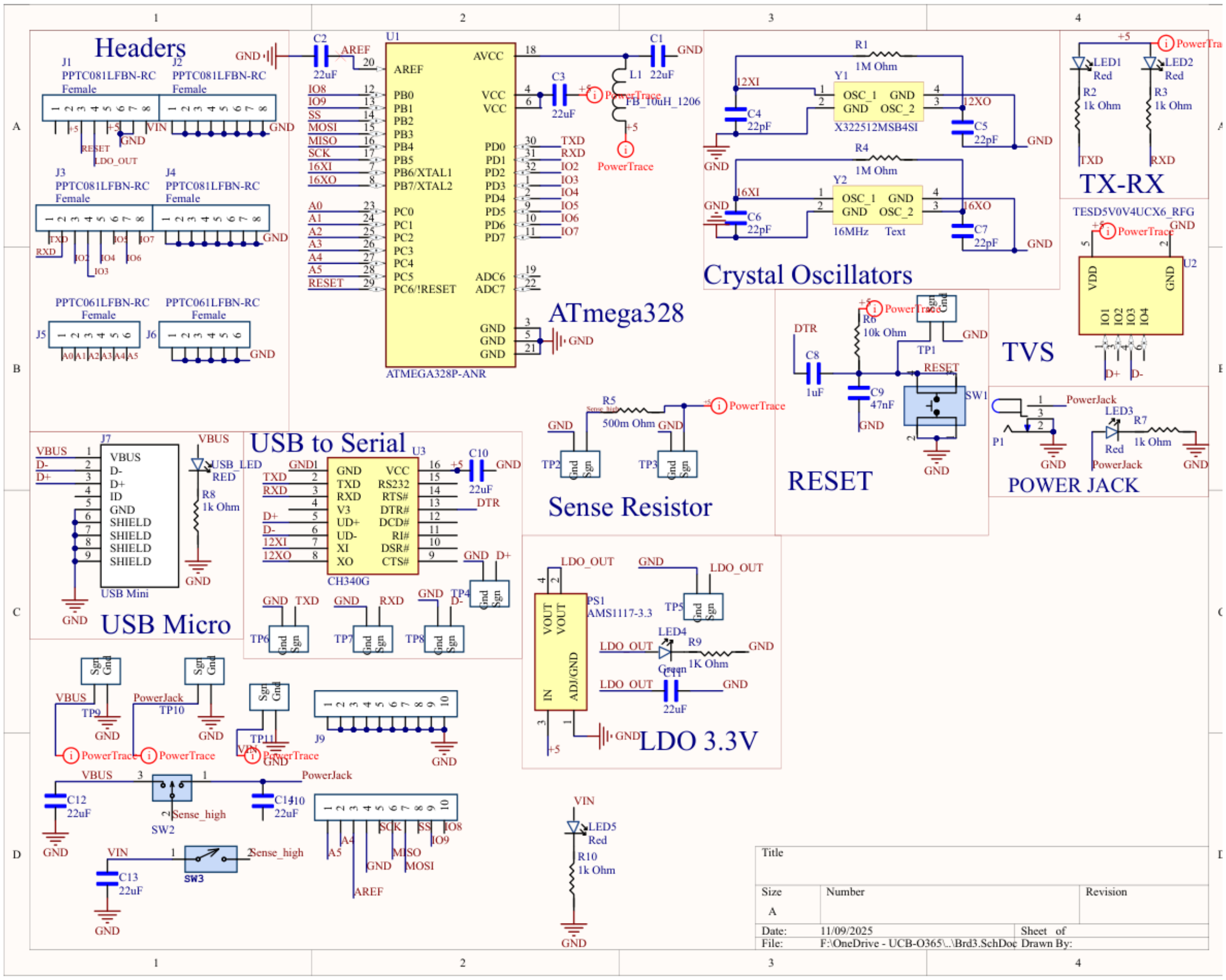

Fig. 3. Actual schematic of circuit

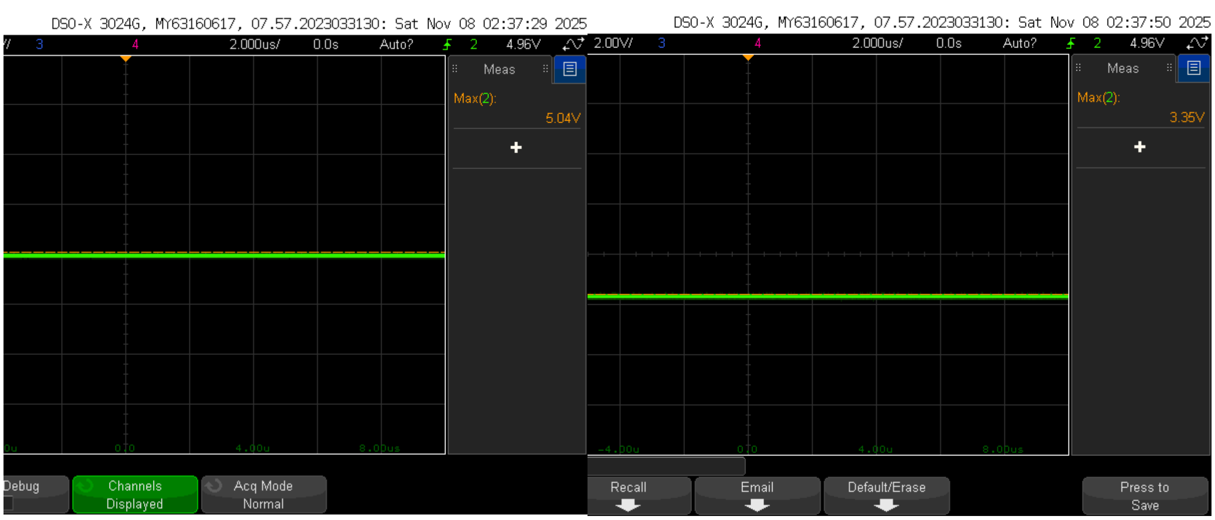

Fig. 4. 5 V and 3.3 V power rails

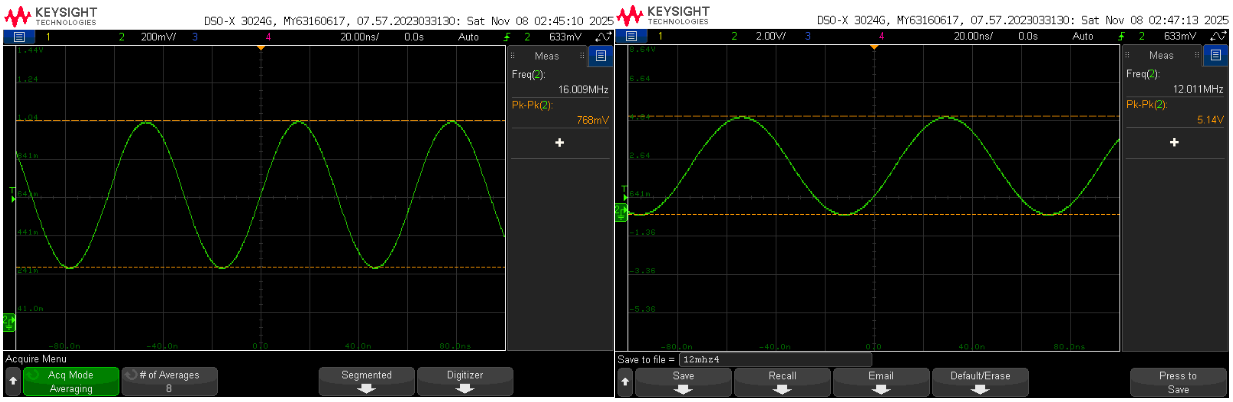

Fig. 5. 16 MHz and 12 MHz oscillations

Fig. 6 shows the voltage noise on the 5 V power rail. It can be seen that the CAB exhibits slightly higher voltage noise than the GAB, measuring 44 mV compared to 40 mV.

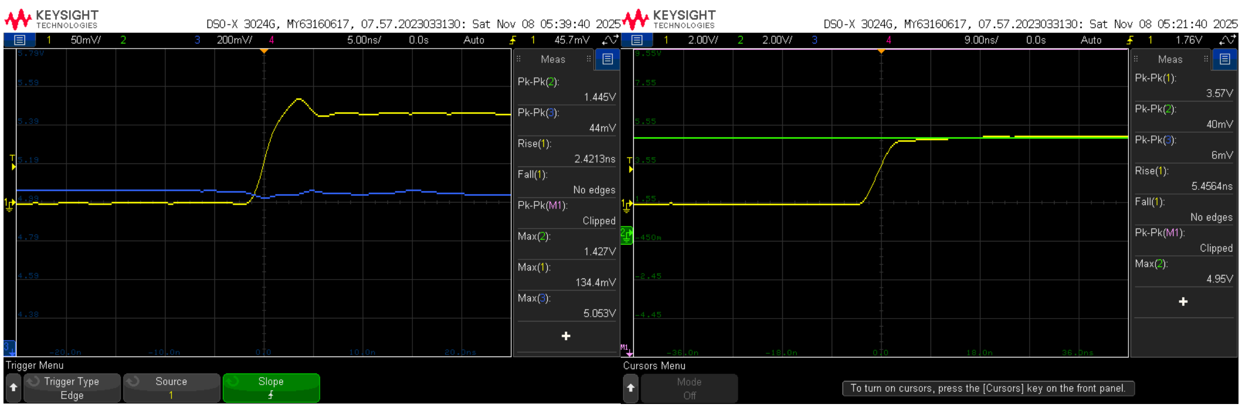

Fig. 6. Voltage noise on the 5V power rail (CAB on the left and GAB on the right)

The switching noise between the CAB and GAB for the rising edge is shown in Fig. 7. It can be seen that the GAB exhibits a peak-to-peak rail collapse that is 1.7× smaller than that of the CAB. As expected, the GAB has a longer rise time, which helps reduce the amount of switching noise. Table 1 summarizes the overall comparison between the CAB and the GAB.

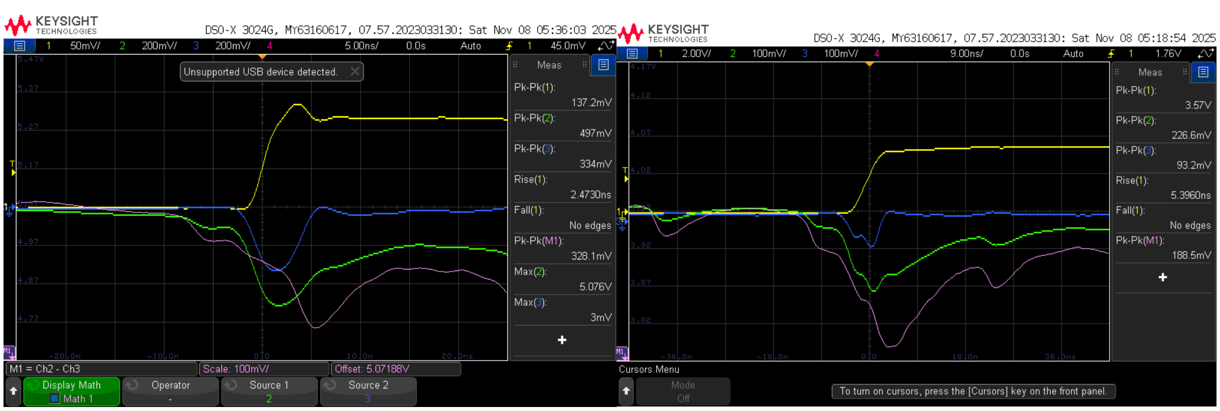

Fig. 7. Switching noise comparison on the rising edge (CAB on the left and GAB on the right)

Similarly, for the falling edge, the GAB is more robust (3x better) to switching noise than the CAB.

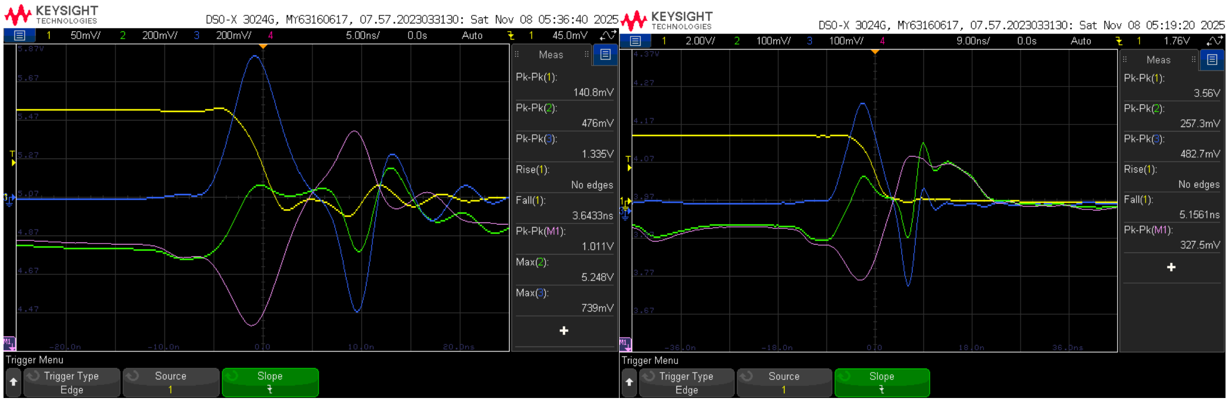

Fig. 8. Switching noise comparison on the falling edge (CAB on the left and GAB on the right)

The table below compares the rise and fall times as well as the peak-to-peak rail collapse of the CAB and GAB. We see that the GAB has better performance than the CAB.

	CAB	GAB
P2P (mv)	328	189
Rising Time (ns)	2.473	5.396
P2P (mV)	1011	328
Falling Time (ns)	3.643	5.156

The voltage across the 49 Ω is shown in Fig. 9. The current through the GAB and CAB is 35 mA and 47 mA respectively. Fig. 10 illustrates the inrush current for the GAB. The inrush current is 1.406/0.5 = 2.8A.

Fig. 9. Voltage across the resistor (CAB on the left and GAB on the right)

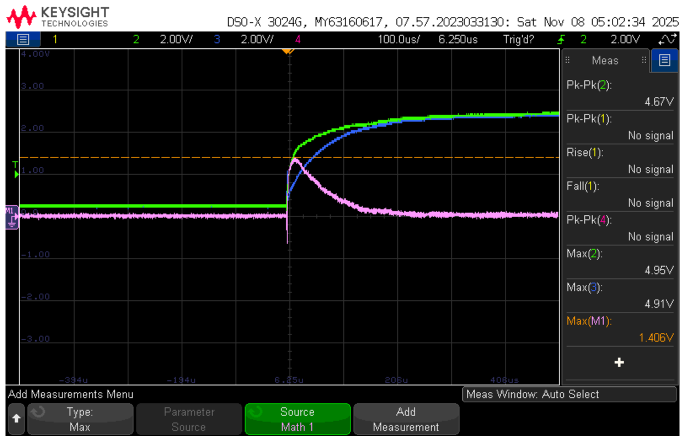

Fig. 10. Inrush current of the GAB

What worked and what I will improve in future designs

- The LED indicators for the power plug and USB worked as expected
- The voltage rails were at their expected levels, and the crystal oscillators were operating at their designated frequencies
- Test points had silk screen label that helped in knowing where to take measurements
- In future designs, I will lower the number and length of cross unders to lower the ground bounce.

Conclusion

It is shown in this report that the robustness to noise of the CAB can be improved by implementing good design practices.