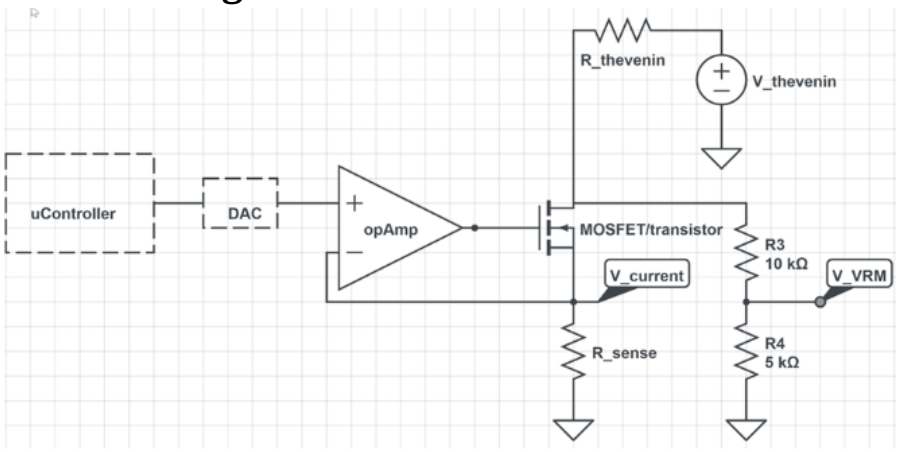
ECEN 4730 Board4 Report

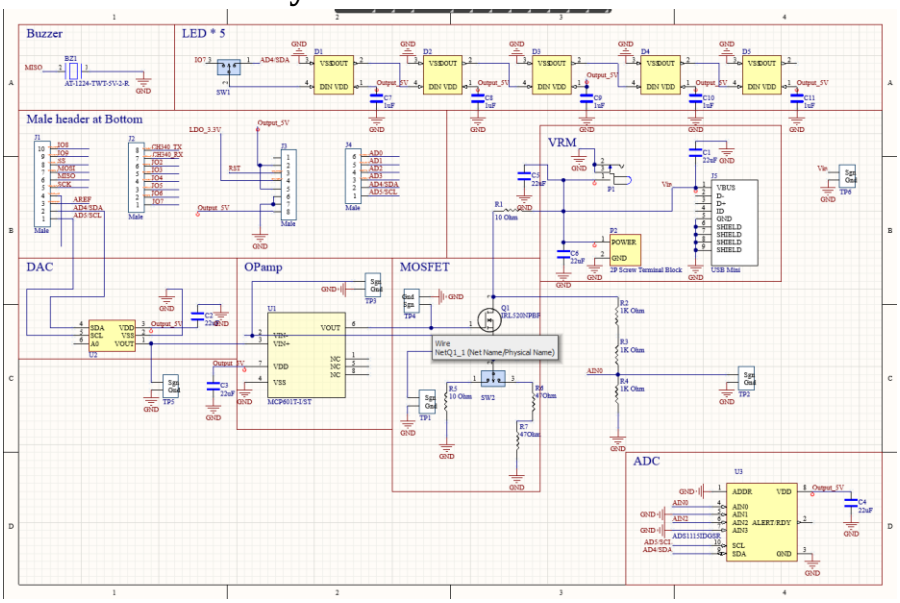
Chengming Li

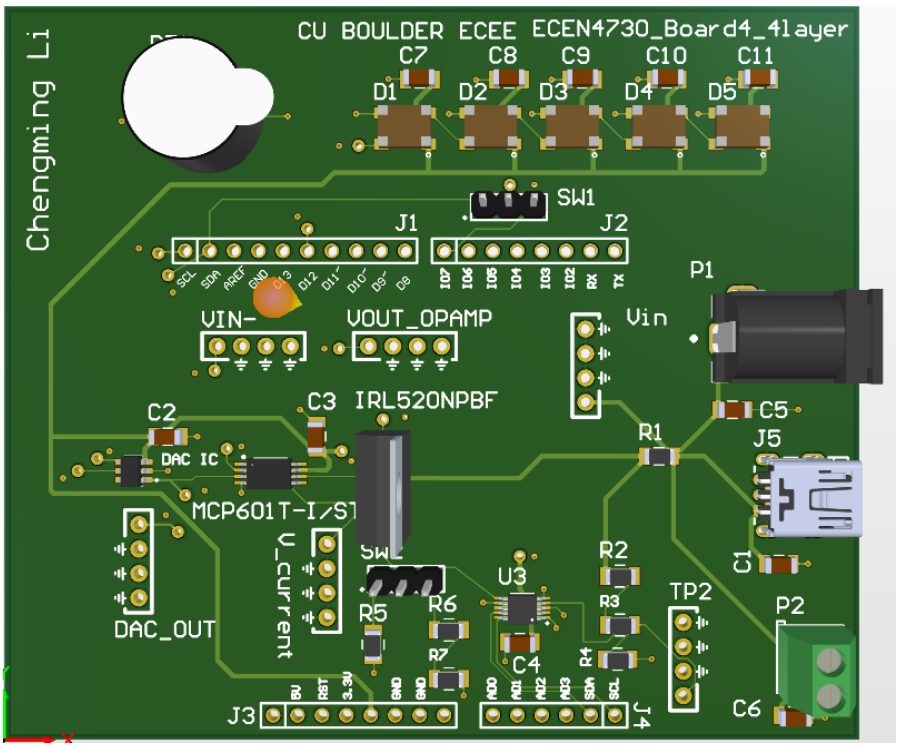
12/07/2022

- ## Circuit Design

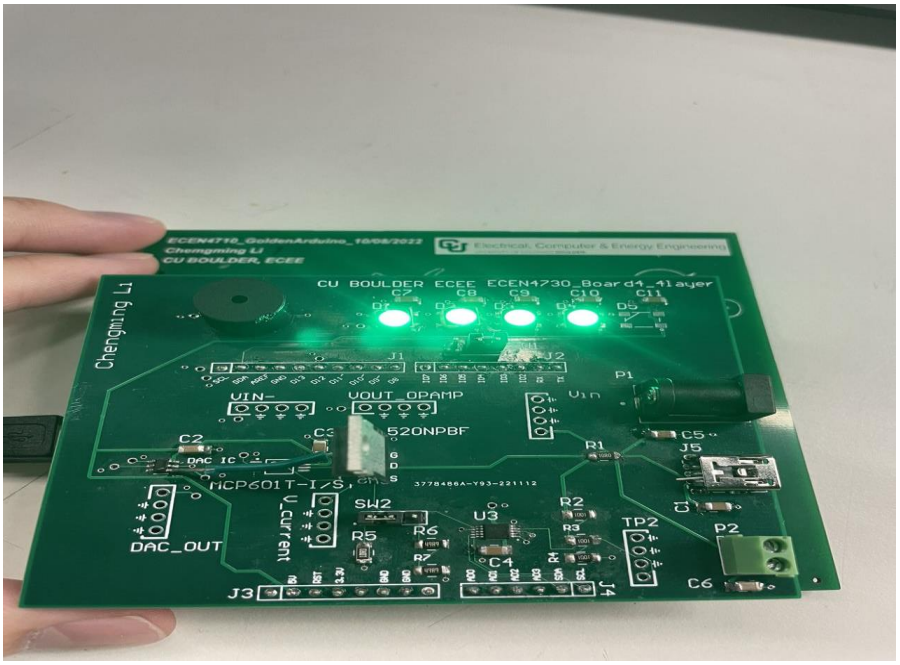


- ## Schematic and Layout





- **LEDs**



- **What worked and what didn’t work**

  In this board design, the LEDs and Buzzer work as shown in the picture above. since the audio cannot be included in this document. The demo for the buzzer is not included. And

the DAC, MOSFET, ADC, and 3 Power supply are working as expected. I can measure the output impedance given the voltage sources.

What didn't work initially was the I2C bus on the shield. The DAC is working when the code only runs the DAC. And it stops working when the code runs the ADC as well. It took me a while to figure out the reason. It is because the SCL and SDA on the top side of the board are not connected to the bottom side of the board. And two Pull-up resistors are missing from the design. Thus, when the ADC comes in, the I2C can't figure out which address it should be communicated with. Then, Arduino can't control the DAC and ADC.

The way I fixed it was by shorting the SCL and SDA lines between the top and bottom sides of the shield and connecting two 10k resistors to the Vdd (5V).

- **What I learn from this project/ What I will do in the future**

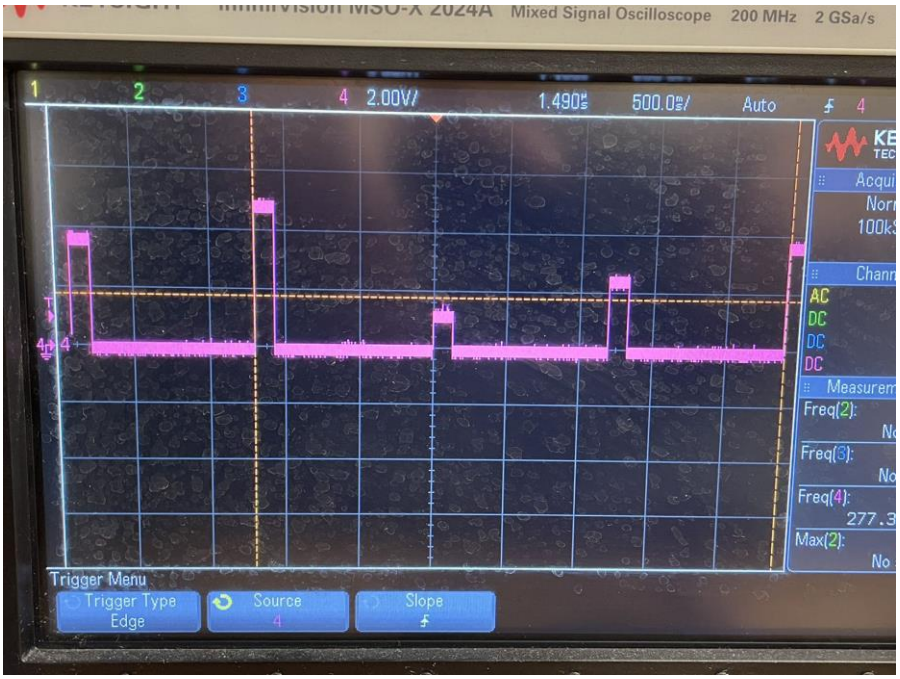
  If I get a chance to redesign this board, I will connect the SCL and SDA lines between the top and bottom sides of the shield. And I will also connect two Pull-up resistors to the I2C lines. In the future design, I will definitely have two pull-up resistors connected to I2C lines if the I2C feature is involved.

  Also, I managed to solder every component to the PCB board. It was a great experience to practice my soldering skill.

  In this design, I don't have enough test points to test all crucial signals on board and enough isolation switches. Having as many test points as I need provides me a chance to debug the circuit easier and conveniently. Having isolation switched can isolate the root cause of the bugs on board. And it is easy for me to decide the root error of the circuit.

  In this design, I realized that the 4-layer board provides me with a good chance to have a clear connection between the pins and have less cross-under on the ground plane.

- **Test Demo**



The above picture shows the output of the DAC when the code changes the current load. The jump of amplitude in each pulse shows the increase in the current load.

```
16:43:13.941 -> 1,  12.919,  9.2205,  9.0896,  0.1324
16:43:15.155 -> 2,  25425,  9.2205,  8.961,  0.1263
16:43:16.338 -> 3,  37.38,  9.2205,  8.8359,  0.133
16:43:17.555 -> 4,  50.281,  9.2205,  8.7112,  0.1285
16:43:18.748 -> 5,  62.800,  9.2206,  8.5841,  0.1356
16:43:19.960 -> 6,  75.538,  9.2206,  8.4551,  0.1342
16:43:21.163 -> 7,  88.081,  9.2208,  8.3282,  0.1337
16:43:22.363 -> 8,  100.731,  9.2206,  8.1997,  0.1348
16:43:23.565 -> 9,  113.275,  9.220,  8.0732,  0.1304
16:43:24.769 -> 10,  125.869,  9.2208,  7.9455,  0.1318
16:43:25.976 -> 11,  138.813,  9.2208,  7.8143,  0.1331
16:43:27.169 -> 12,  151.238,  9.2208,  7.6886,  0.1311
16:43:28.341 -> 13,  163.750,  9.2208,  7.5621,  0.1299
16:43:29.537 -> 14,  176.313,  9.2209,  7.4348,  0.1304
16:43:30.744 -> 15,  188.837,  9.2209,  7.3078,  0.1307
16:43:31.962 -> 16,  201.663,  9.2209,  7.1779,  0.1310
16:43:33.159 -> 17,  214.319,  9.2210,  7.0504,  0.1279
16:43:34.355 -> 18,  226.856,  9.2210,  6.9233,  0.1286
16:43:35.571 -> 20,  239.456,  9.2210  6.7956,  0.1288
```

The above picture shows the measurement of the output impedance of a voltage source that is plugged into it. The 9V voltage source is connected to a voltage adapter that is connected to the wall power. From the last column, we can tell the output impedance of this voltage source is 0.13 ohm.

```
16:51:38.652 -> 1,  12.919,  7.4718,  7.3391,  0.2722
16:51:39.879 -> 2,  25.438,  7.4719,  7.2105,  0.2743
16:51:41.094 -> 3,  37.944,  7.4719,  7.0815,  0.2883
16:51:42.287 -> 4,  50.301,  7.4719,  6.9548,  0.2807
16:51:43.499 -> 5,  62.813,  7.4719,  6.8265,  0.2758
16:51:44.680 -> 6,  75.594,  7.4719,  6.6953,  0.2740
16:51:45.859 -> 7,  88.119,  7.4719,  6.5666,  0.2736
16:51:47.090 -> 8,  100.794,  7.4719,  6.4361,  0.2759
16:51:48.293 -> 9,  113.331,  7.4719,  6.3073,  0.2755
16:51:49.493 -> 10,  125.931,  7.4719,  6.1779,  0.2750
16:51:50.701 -> 11,  138.882,  7.4719,  6.0446,  0.2767
16:51:51.896 -> 12,  151.313,  7.4719,  5.9169,  0.2763
16:51:53.102 -> 13,  163.800,  7.4719,  5.7885,  0.2770
16:51:54.267 -> 14,  176.382,  7.4719,  5.6589,  0.2783
16:51:55.497 -> 20,  188.939,  7.4719,  5.5294,  0.2812
16:51:55.497 -> done
```

The above picture shows the measurement of the output impedance of a voltage source that is plugged into it. The 7.5voltage source is powered by the power supply from Keysight. From the last column, we can tell the output impedance of this power supply is 0.27 ohm.

```
16:53:46.408 -> 1,  12.919,  10.9616,  10.8287,  0.2867
16:53:47.620 -> 2,  25.450,  10.9615,  10.6999,  0.2803
16:53:48.833 -> 3,  37.963,  10.9616,  10.5712,  0.2819
16:53:50.014 -> 4,  50.331,  10.9616,  10.4441,  0.2805
16:53:51.228 -> 5,  62.838,  10.9616,  10.3153,  0.2843
16:53:52.428 -> 6,  75.594,  10.9615,  10.1844,  0.2796
16:53:53.608 -> 7,  88.131,  10.9615,  10.0552,  0.2830
16:53:54.836 -> 8,  100.819,  10.9615,  9.9251,  0.2799
16:53:56.021 -> 9,  113.350,  10.9615,  9.7961,  0.2815
16:53:57.217 -> 10,  125.963,  10.9615,  9.6666,  0.2804
16:53:58.431 -> 11,  138.919,  10.9615,  9.5334,  0.2801
16:53:59.624 -> 12,  151.356,  10.9616,  9.4057,  0.2794
16:54:00.845 -> 13,  163.894,  10.9616,  9.2769,  0.2787
16:54:02.042 -> 14,  176.425,  10.9615,  9.1477,  0.2803
16:54:03.242 -> 15,  189.013,  10.9616,  9.0187,  0.2788
16:54:04.448 -> 16,  201.850,  10.9616,  8.8869,  0.2780
16:54:05.631 -> 17,  214.481,  10.9615,  8.7570,  0.2784
16:54:06.843 -> 18,  227.025,  10.9615,  8.6280,  0.2787
16:54:08.041 -> 19,  239.638,  10.9616,  8.4984,  0.2785
16:54:09.251 -> 20,  252.150,  10.9616,  8.3698,  0.2787
16:54:09.251 -> done
```

The above picture shows the measurement of the output impedance of a voltage source that is plugged into it. The 11-voltage source is powered by the power supply from Keysight. From the last column, we can tell the output impedance of this power supply is 0.27 ohm. And, this result is pretty consistent with the value I got from the last picture. So, the output impedance of this power supply is roughly 0.27 ohm.