ECE 196 DevBoard

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The DevBoard is the second ECE 196 hands-on project. This project is more involved than the light meter. The project began with Collin, the director of the Envision Makerspace, demonstrating the process of putting the board together. The process is as follows:

1. Place the board in the jig provided.
2. Align the stencil as accurately as possible.
3. Tape the stencil on one edge.
4. Press the stencil so it does not bow and tape the opposite edge.
5. Use the solder syringe to apply a line of solder along the top of the board.
6. Use a spreader to evenly apply the paste across the stencil.
7. Verify the application, there should not be any shiny pads.
8. Hold the stencil in place and peel up one side of the tape.
9. Use the tape to pull away the stencil like a door.

If an error occurs:

a. Clean the board with Kim wipes and alcohol.
    i. Dab the Kim wipes on the alcohol dispenser (yellow or green containers).
    ii. Wipe the DevBoard until clean.
    iii. Use dry Kim wipes on the board.
b. Clean the stencil
c. Clean the jig.
d. Return to step 2.

For the USB-C socket, special attention is needed. The legs need to be dipped in solder to create a mechanical bond to the board. Otherwise when a USB is attached to the board the socket with tear off. The legs can be dipped in the excess solder remaining on the spreader. The pins of the USB-C socket are most vulnerable to bridging. Care must be taken during the solder application verification to ensure this won't happen.

After the demonstration and a separate lecture, we began to work in groups to put together the DevBoards. I worked with Tahseen to get his board together as quickly as possible. While he placed his components I went to grab the next set of components to avoid mixing any of them up. I observed Tahseen's placement method and the challenges faced in extracting the small components from the strips of component reels we were given. We completed his board moments after the first individual put their's in the oven. A handy technique I learned from watching Tahseen is to take the xlsx file and copy it into Google Sheets. Then add a checkmark to the right of the BOM to mark off items as they are added.

	A	B	C	D
1	Comment	Designator	Quantity	
2	SW4.2x3.2	BOOT1, RST1, SW1, SW2	4	☑
3	10uF	C1, C2, C4, C5, C6, C7, C8	7	☑
4	0.1uF	C3	1	☑
5	green	CHRG, LED1, PWR	3	☑
6	SS12-E3/61T	D1, D2	2	☑
7	esp32-mini-s3	ESP1	1	☑
8	Header1x20	H1, H2	2	☐
9	MTLW-102-05-L-	J1	1	
10	yellow	LED2	1	☑
11	MCP73831T-2AC	MCP1	1	☑
12	1k	R1, R7, R8, R9	4	☑
13	10k	R3, R10, R11	3	☑
14	5.1k	R4, R5	2	☑
15	2k	R6	1	☑
16	SlideSwitch	SS1	1	☑
17	USB4105-GF-A	USB1	1	☑
18	AP2112K-3.3TRG	VREG1	1	☑
19				

Figure 1: Google Sheets Mark Off Sheet

I then headed home for the evening and returned to Envision early the next day. I gathered the supplies to assemble the DevBoard and got to work. I started by stenciling the solder paste onto the DevBoard. I suspected that the USB-C connecter may bridge but continued knowing I should be able to fix it post-baking. I placed components starting with the capacitors. Then, moving on to the resistors. These two are the smallest component types and do not have polarity. Afterward, I placed the LEDs and diodes. Following these I acquired and placed the MCP1 and VREG1 one at a time to avoid mixing the two up since they share the same footprint. I placed the switches, USB-C socket, and finally the ESP 32 S3 module.

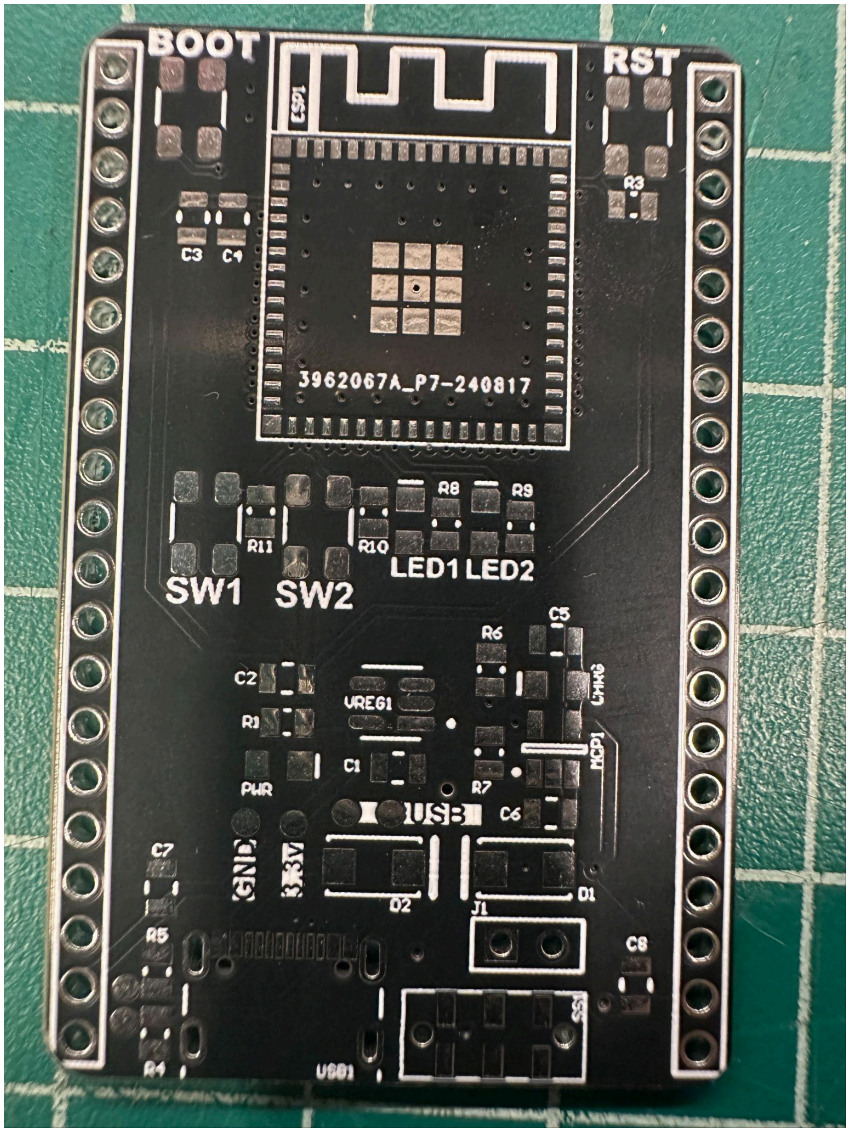

Figure 2: Unpopulated DevBoard

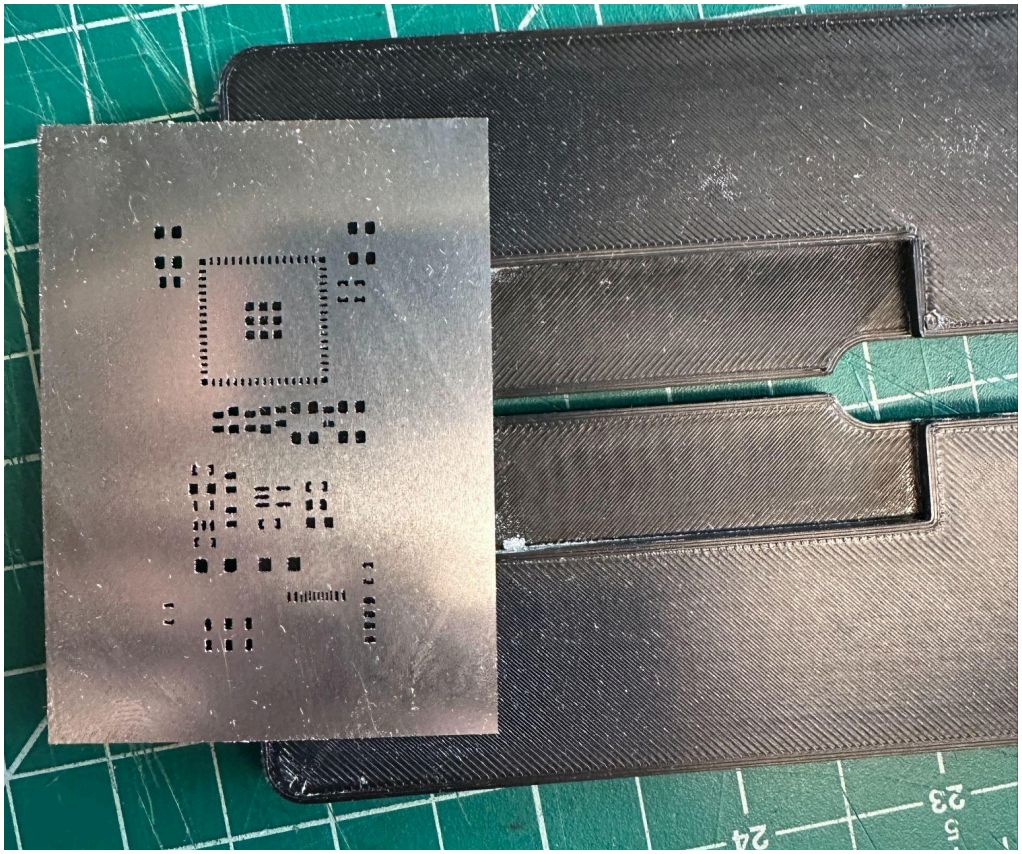

Figure 3: Stencil (left) and Jig (right)

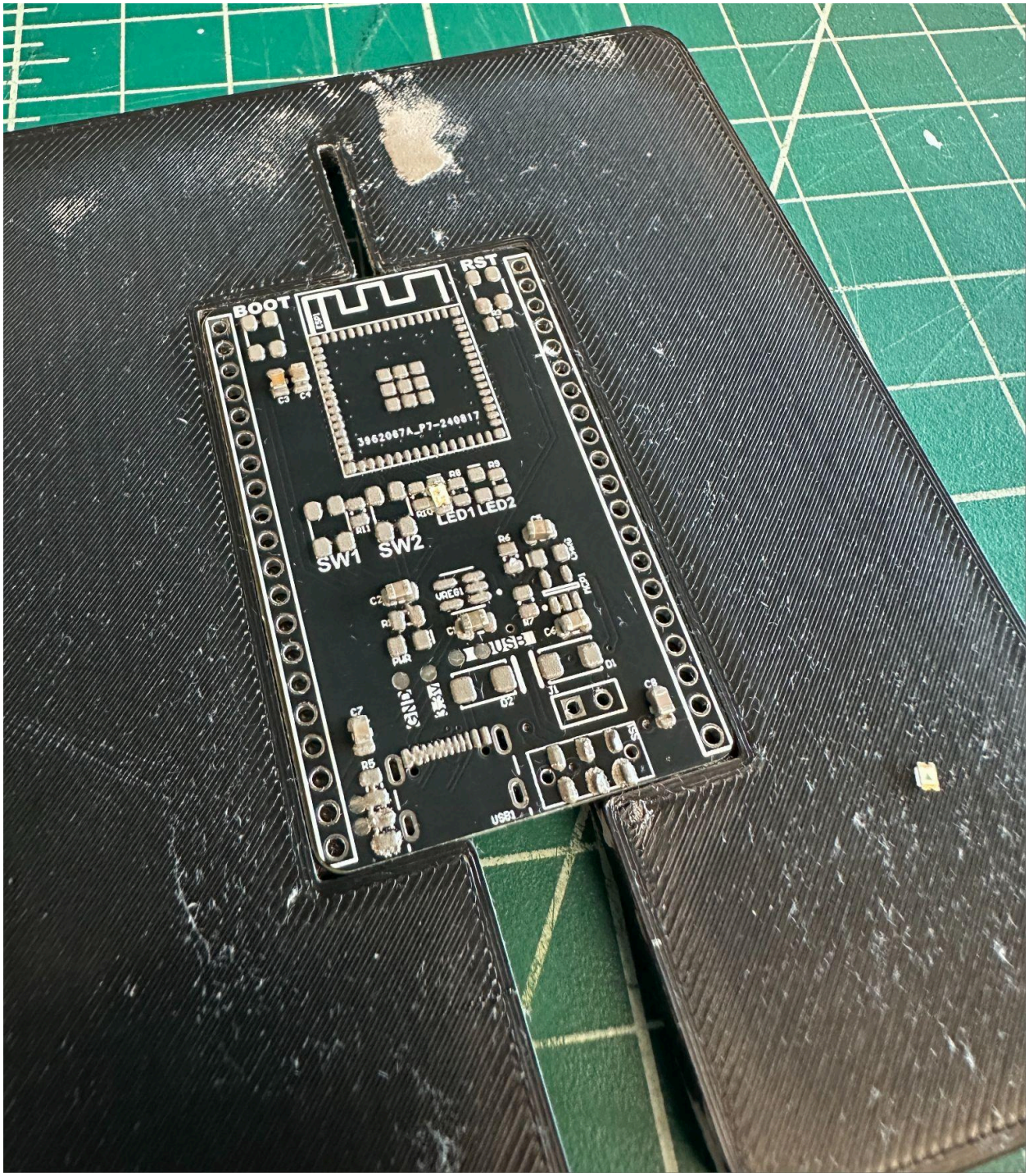

Figure 4: DevBoard in the Jig With Some Components Placed.

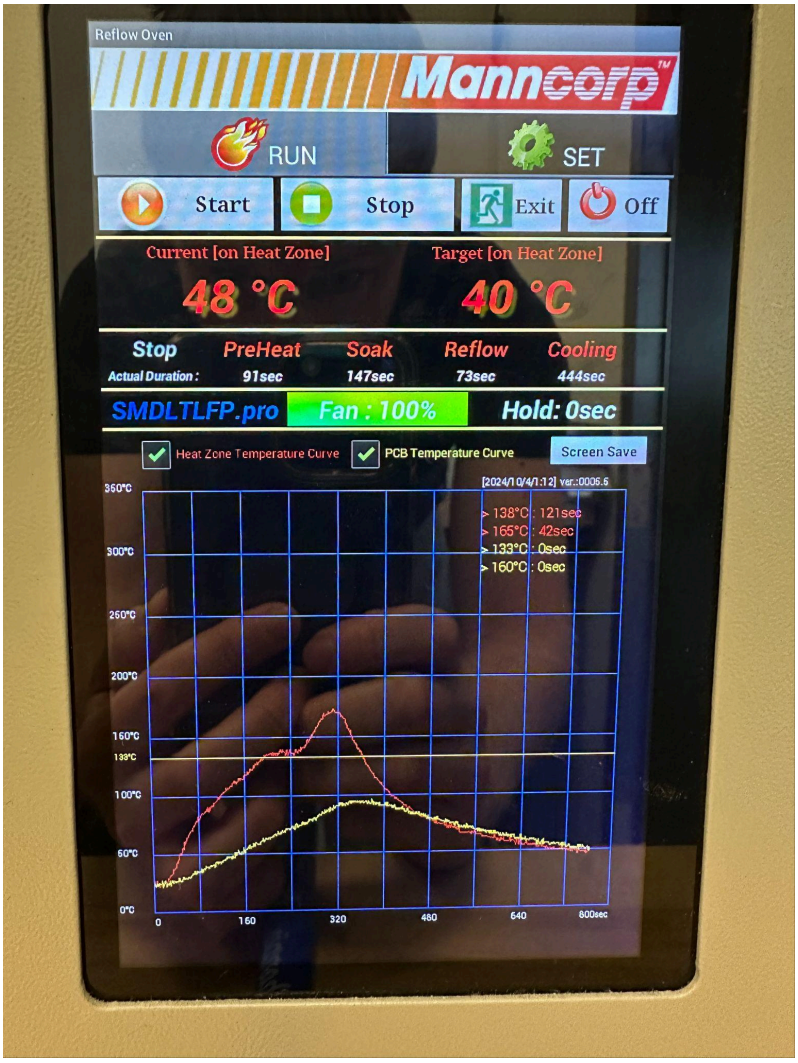

Figure 5: Reflow Oven Settings.

After checking the components on the board once over I worked with an Envision volunteer to get my board in the Reflow Oven. I went with the settings recommended by the volunteer. About 15 minutes later, the DevBoard is ready to be removed.

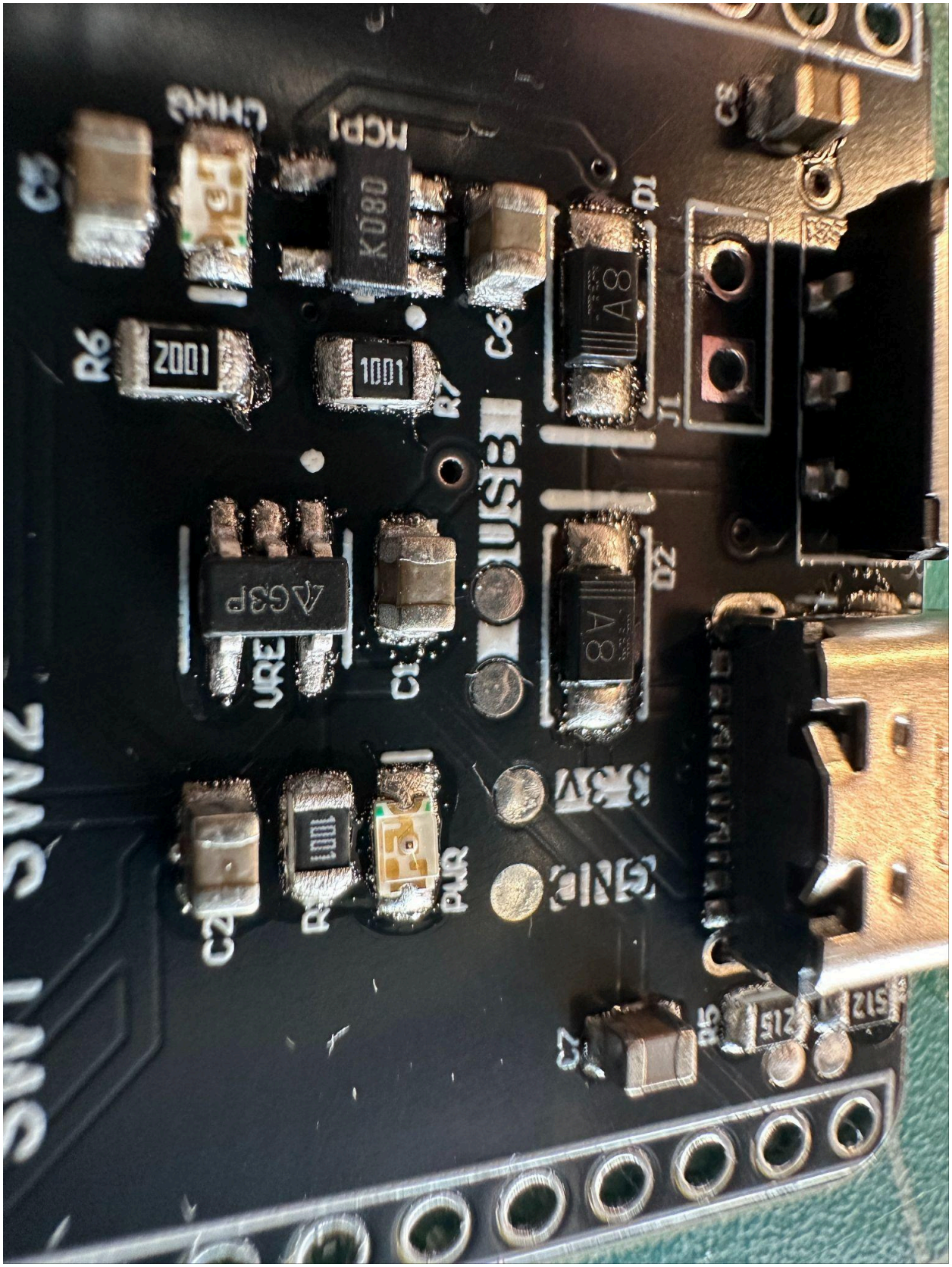

Figure 6: DevBoard after Reflow Oven Baking

The DevBoard after baking had an undercooked appearance to the solder joints and bridging on the USB-C connector pads. To fix this I went to the hot air reflow station. I began by heating the USB-C socket and lifting and resetting the socket onto the board. After a few attempts, the pins were bridge-free but had excess solder on them. I also added solder to the legs of the socket to fill the vias they attach to. I then reflowed the rest of the components to remove the sintered appearance of the solder joints. While the solder joints of the components came out great, the USB-C pins ended up bridging again. This time I used a solder wick to remove the excess solder and then reflowed the USB-C socket.

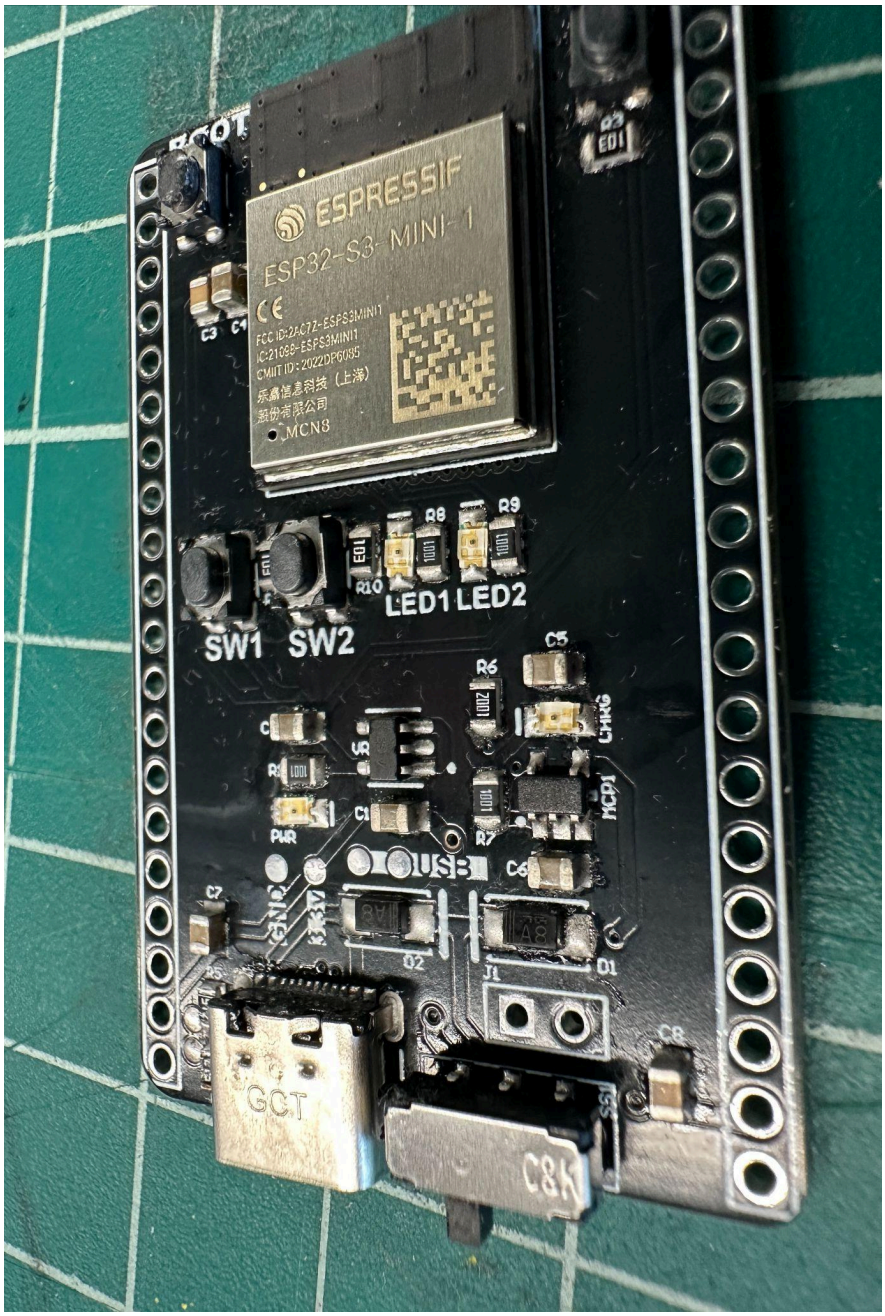

Figure 7: Completed DevBoard (without Headers)

After I was happy with the results I cleaned the remaining flux off the board the best I could and tested the board by plugging it into my Macbook and opening the Arduino IDE.

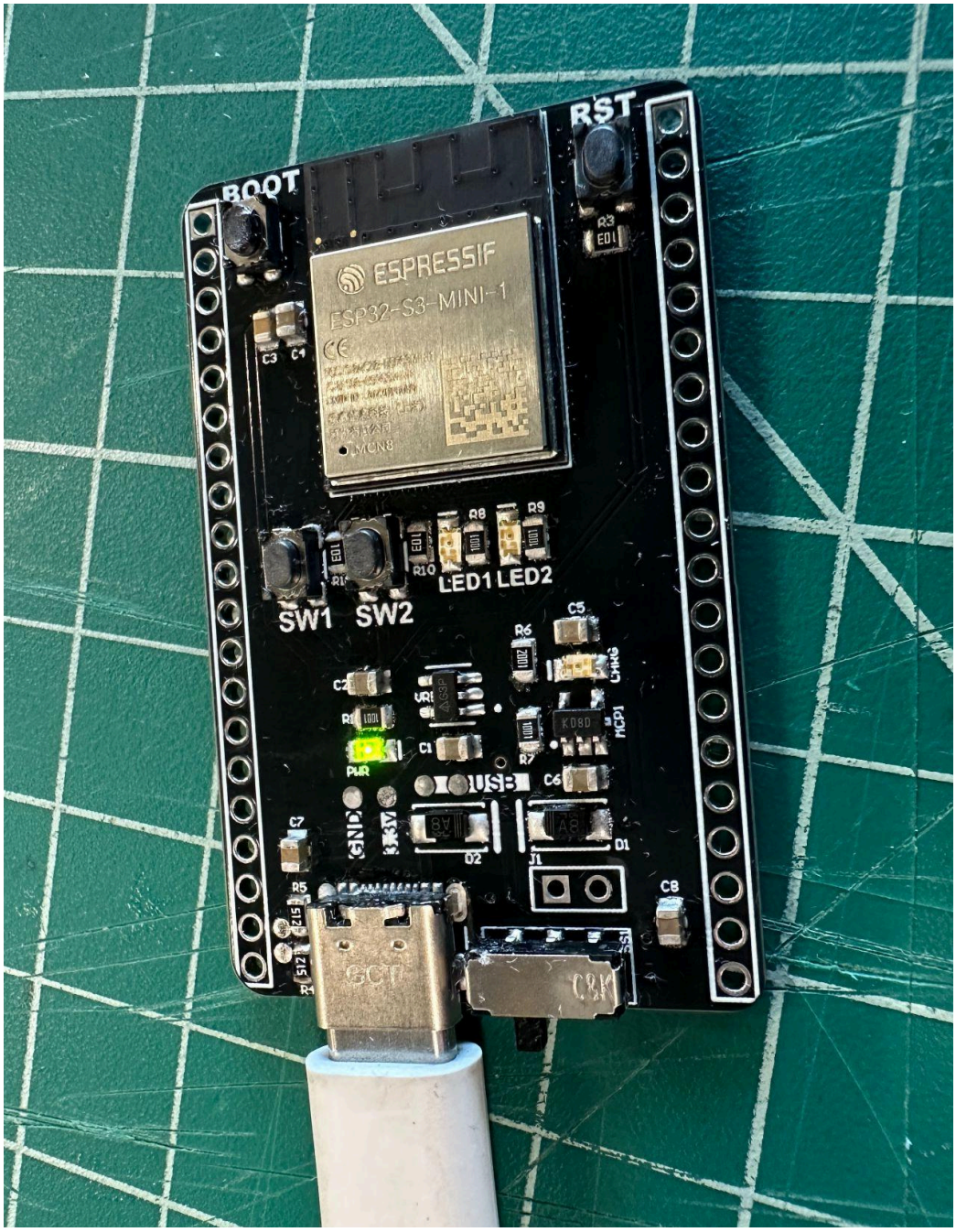

Figure 8: Powered DevBoard

The power LED lit up and the Arduino IDE recognized the board as an ESP32 S3. I considered this a success and cleaned up my workspace completely.

After reflecting on the process I would do a few things differently. Firstly, I would take a little more care during the stenciling step. I made multiple passes over the stencil and this pushed too much solder paste onto the pads of the USB-C pins, resulting in bridging. Second, I would NOT add solder paste to the legs of the USB-C socket. By not adding paste to the legs it would be easier to fix any bridges on the socket pins. Then, once the socket pins are confirmed to be correctly soldered I would add solder by hand with a soldering iron and wire solder. Lastly, I would take the time to find the correct heating profile of the solder paste used to match what is displayed on the reflow oven. This would ensure that the reflow process works correctly to fully melt the solder paste.

Overall, I enjoyed the project and learned a lot about stenciling, placing, and reflowing SMD components on a circuit board. I look forward to more projects of this variety.

Note: for the time being I am leaving the DevBoard headless so that it fits in my backpack more conveniently.