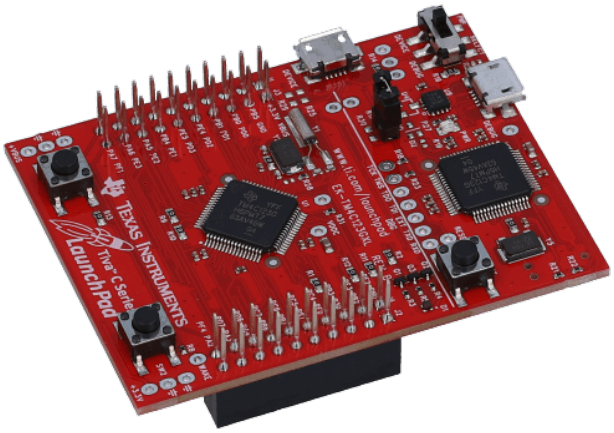
CSE-3442: Embedded Systems 1
Term Project: Circuit Design and Mechanical Assembly Report



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1 Introduction

This report includes the circuit design and mechanical assembly for the Embedded 1 term project.

2 Circuit Design

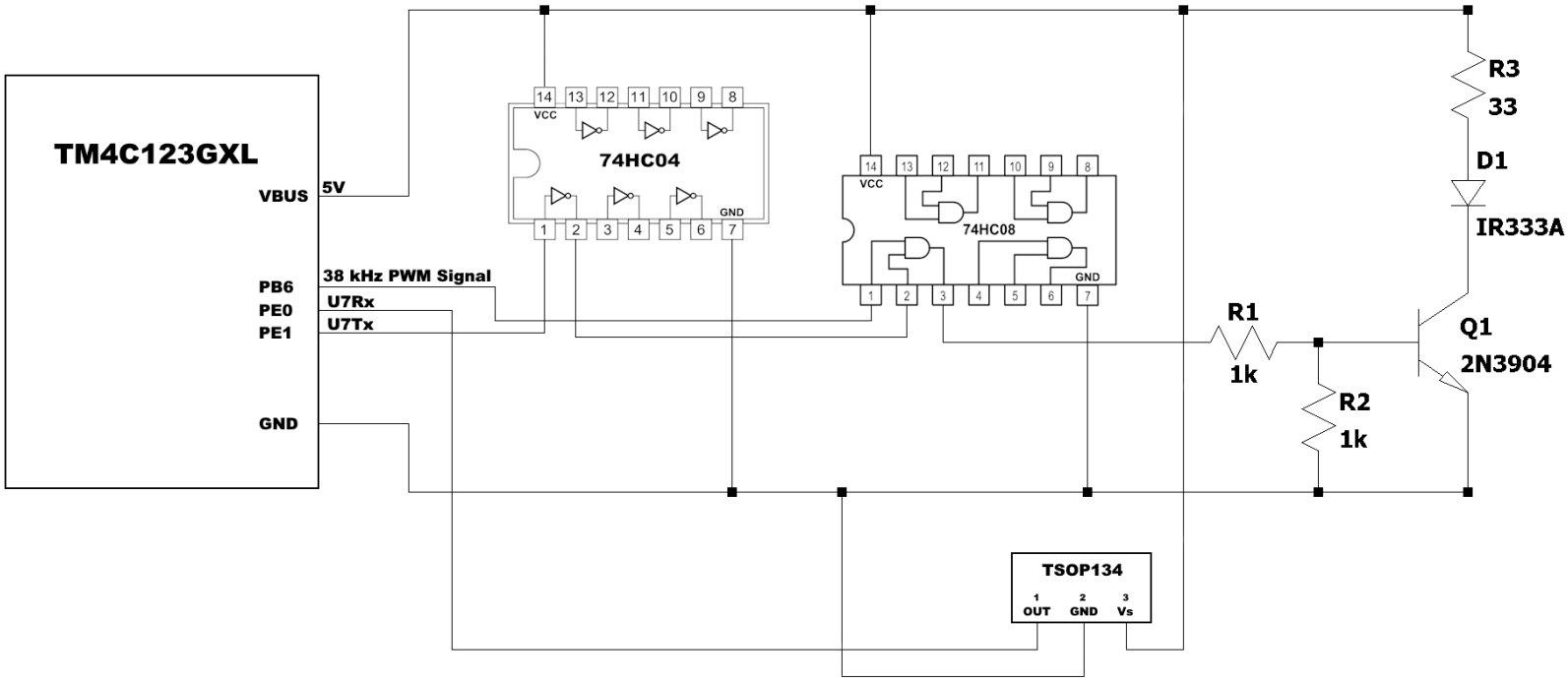

Figure 1: Complete Project Circuit Diagram

The complete project circuit diagram can be seen above, and I designed this using LTspice (for the circuit on the right), and then I just added the rest of the things in it using paint.net.

Basically, it works the same as described in my plan and design.

So, the TM4C board will generate a 38 kHz PWM signal on PB6, and that will be connected directly into the first AND gate on the 74HC08, which is the AND gate IC we have in the lab.

Then, PE0 is the UART7 RX pin, which is connected to the TSOP134 receiver.

PE1 is the UART7 TX pin, which is connected first to the NOT gate in the 74HC04 IC, also the one in the lab, and then, the output of the NOT gate will go into the AND gate.

The output of the AND gate will be the signal that has the transmitted data at 38 KHz, which is then connected to the NPN transistor circuit that contains the IR LED.

The NPN transistor circuit uses two 1k ohm resistors and a single 33 ohm resistor on the collector, which is connected to the IR transmitting LED, and also to 5V. The emitter, on the other hand, is grounded.

Additionally, the GND and 5V voltage source comes from the GND pin and the VBUS pin on the TM4C.

3 Mechanical Assembly (Breadboard)

After designing the circuit diagram, I also built it on the breadboard to see it and test if it works.

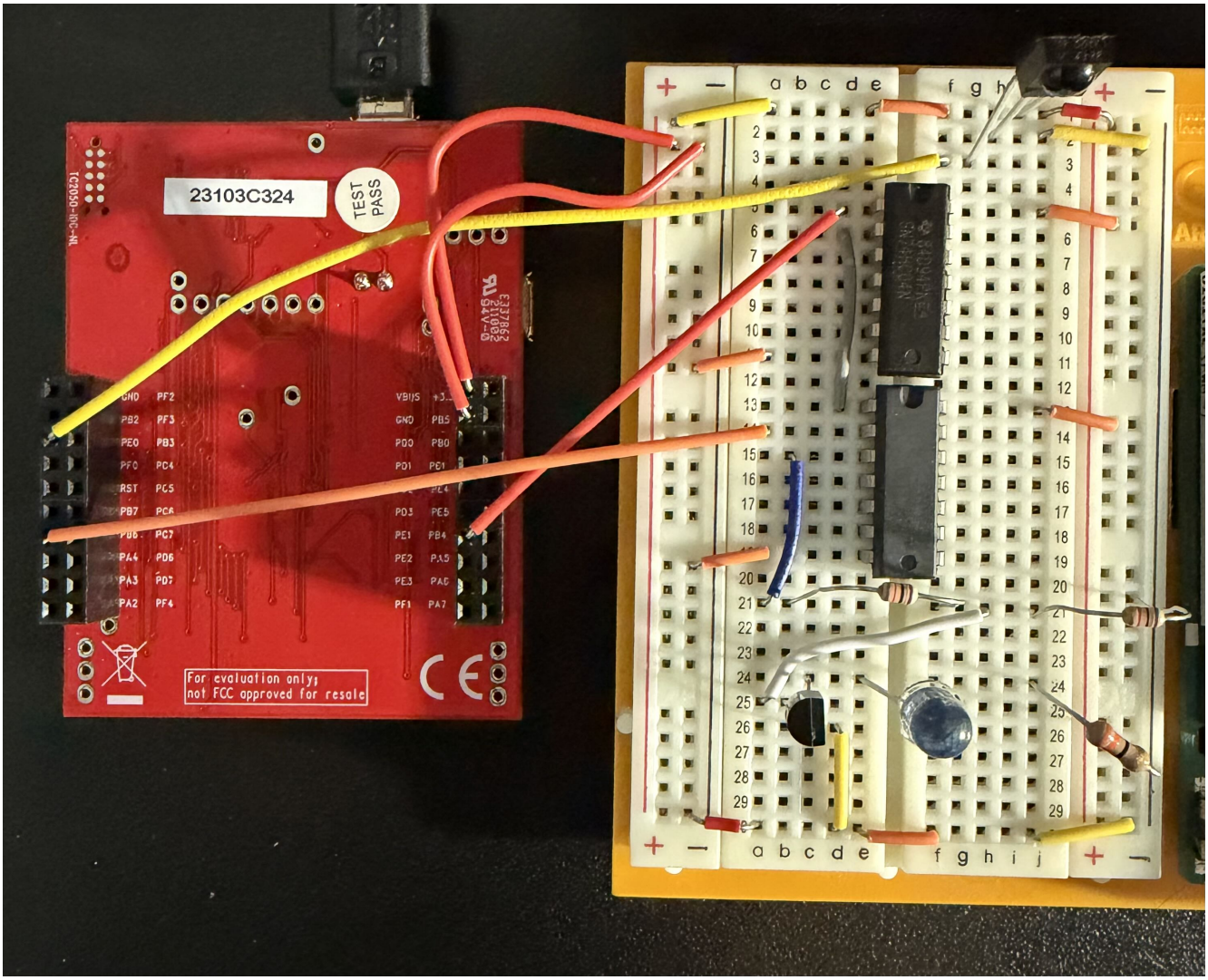

Figure 2: Project Circuit on Breadboard

I built the circuit on the breadboard I had at home, which is pretty small, but I believe I got it working.

In the image, I have the 5V VBUS signal connected to the entire top row, and the GND signal connected to the entire bottom row.

I decided to put the transmitter at the top, and connected the 5V, GND, and output respectively. The output is then connected to the PE0 pin (UART7 RX) on the TM4C.

Below that, you can see the two ICs, the top one being the NOT IC, and the bottom one being the AND IC. Both of the ICs have orange wires connecting VCC and GND appropriately.

In the top NOT gate, I have PE1 (UART7 TX) connected, and the negated signal is sent to the AND gate.

The AND gate also has the PWM signal from PB6, and the output of that goes into the first 1k resistor and the rest of the transistor circuit. The NPN transistor emitter is grounded appropriately, the other 1k resistor is grounded, and the 33 ohm resistor is connected to 5V.

4 Verification

Before soldering, I had to test and see if the circuit I built on the breadboard worked, and to do that, I used some of the verification procedures I stated in my Plan and Design report, but with some modifications since I got the software working.

So, I first verified the NPN circuit and resistor values in the first week of the project lab. I used my lab 3 code, and also the circuit from lab 3, but I replaced the LED with the IR333A. I was basically just testing which resistor values would actually turn on the IR LED, and the combination of the 2 1k ohm and 1 33 ohm resistors worked. To make sure it worked, I verified it with my laptop camera and also replaced the IR LED with a Blue LED to see if it was turning on.

Then, after writing most of the code, I had to test the UART7 communication. So, I just directly connected the UART7 RX pin to the UART7 TX pin (PE0 to PE1). This ensured that anything I transmitted from UART7 would be sent back to UART7, and that my UART7 RX interrupt handler was working.

It did not work the first time, but I did change the UART7 interrupt initialization, and I got the PE0 to PE1 communication working after a couple of hours.

Then, when I first built the circuit on the breadboard, it did not work again... I tested to see if I messed something up in the software, but the pin-to-pin connection was perfectly fine, so this told me that the circuit I built was wrong.

Then, in the lab, I tested all of the logic gates to see if something else was the problem. However, the PWM signal was at 38 kHz, the UART data was transmitting fine, it was negating the UART data fine, and the AND signal looked good as well, so I believe the first time I just built the circuit wrong.

In the end, I decided to rebuild the circuit with shorter wires and placed the receiver and LED further apart. I also tested it with the blue LED, so I could see if the LED was actually turning on/off and sending the data. Surprisingly, rebuilding the circuit worked, and the data was being sent/received correctly.

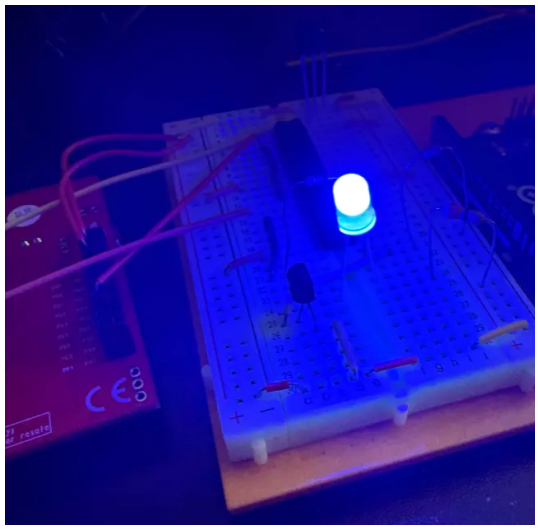

Figure 3: Blue LED replacing IR LED

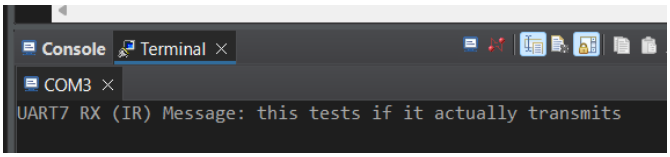

Figure 4: "send this tests if it actually transmits" (breadboard has the IR LED for this)

5 Mechanical Assembly (Soldered PCB)

After designing the circuit and getting it working on the breadboard, I soldered the final version onto a perfboard.

Soldering did take me quite some time, as the holes on the board were pretty small, and sometimes the solder would get into the incorrect holes, leading me to try and suck it out for 10 minutes... However, I got it done in the end, and I do think my soldering skills improved!

Overall, the soldered board follows the same circuit diagram at the beginning of this doc. I put the 5V and GND rails all on the top, had the ICs in the middle, and tried to route everything neatly and accordingly to the diagram.

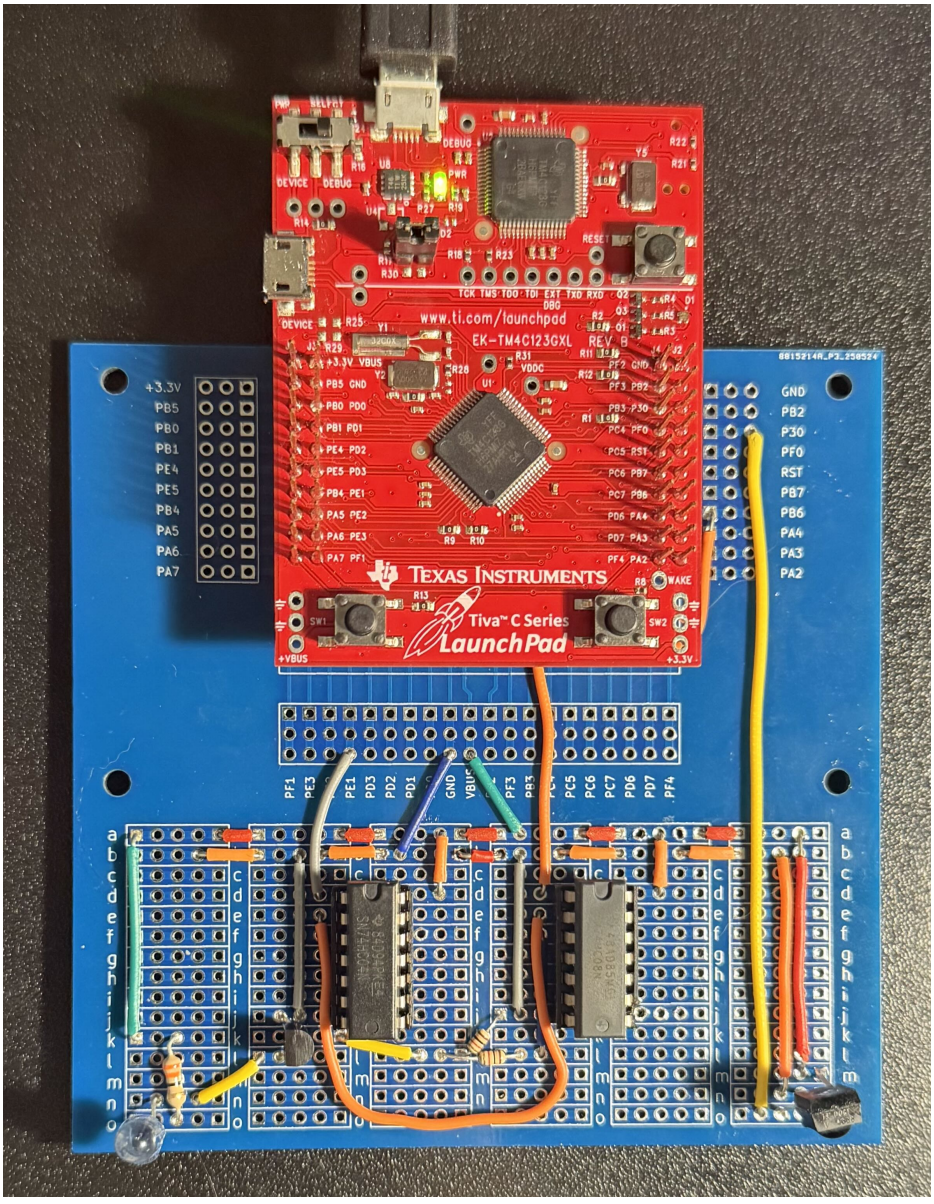

Figure 5: Complete Soldered Project