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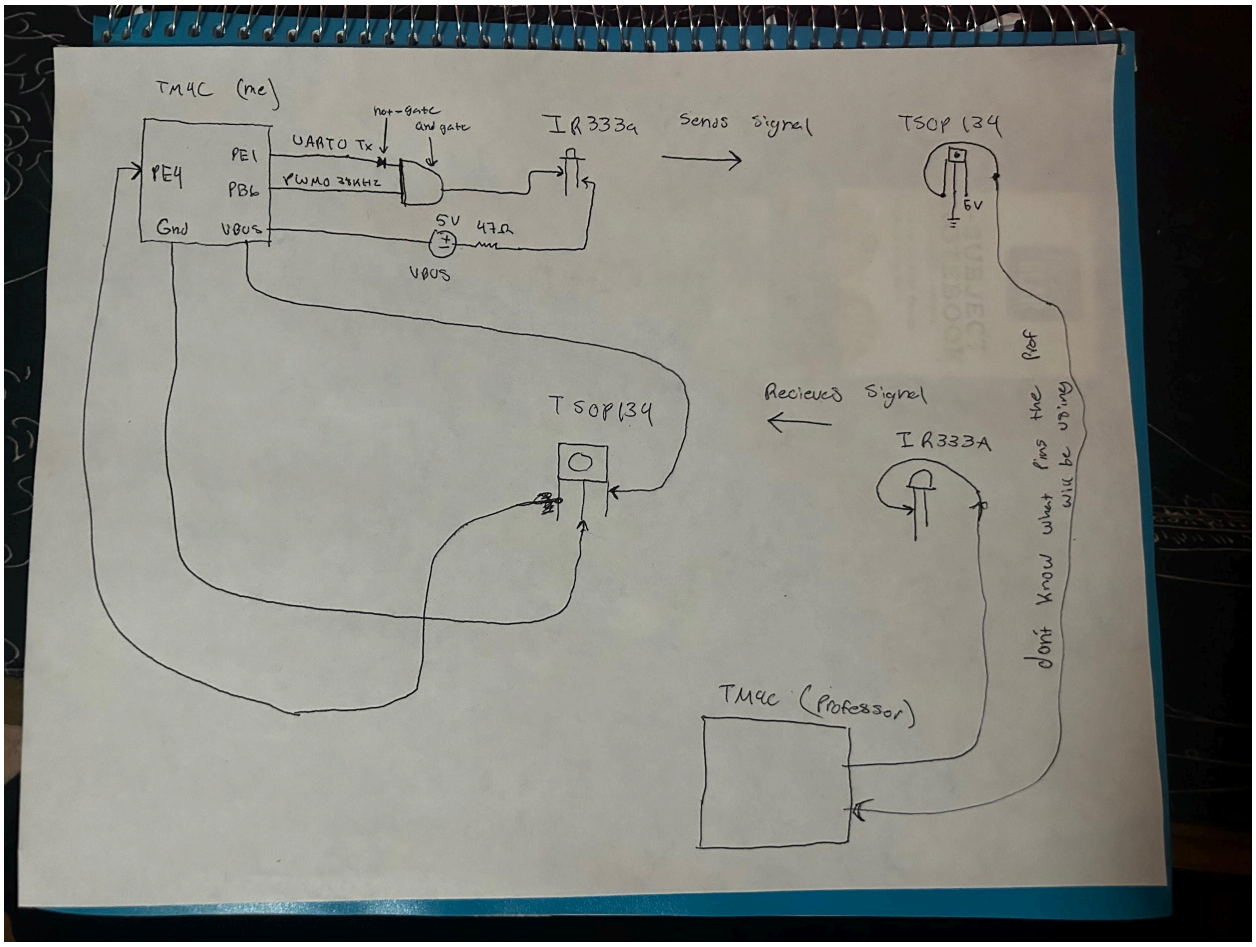
Introduction

The purpose of this project is to implement a full-duplex IR communication link using two TM4c123 boards (one set up by me and another from the professor), the IR333a, and the TSOP134 sensor. Each board will send and receive data at 300 baud, which will come from UART0 and UART7. Since the TSOP134 can only receive at 38KHz, the TIVA board will modulate the UART using a PWM generator. The PWM signal will come from PB6, and the modulation will be done via an AND gate. The incoming IR signals must be demodulated to be interpreted as UART data. To achieve this, the TIVA board will use a GPIO with interrupts to demodulate the signal coming from the professor's TIVA board.

Block Diagram



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Timing Constraints:

- ISR must be less than 200 microseconds to avoid sampling errors at 300 baud
- UART to PC will be 115200 baud to help with troubleshooting/debugging
- The Input going into the IR must be modulated at 38Khz so that the TSOP134 can read the signal from the IR
- The message length must be limited to 20 bytes; however, I will try and extend it to the goal requirement, where it is no more than 12 bytes.

Software Approach

Threads of Execution:

- The code will set the PB6 pin as a PWM frequency generator, where it constantly runs at 38KHz
- The red LED on the TM4C will be configured so that it turns on for 1 second when an error occurs
- The blue LED on the TM4C will be configured so that it lights while the ISR is running
- The common terminal interface will be used to send data. The interface will have 1 argument, “send”, and anything that comes after “send” will be sent via the IR link
- UART0 will send data via the PE1 pin on the TM4C. This pin will be ran through a “NOT” logic gate, which will then feed into an “AND” logic gate along with the PWM frequency. The output of the AND gate will feed into the anode of the IR333a.
- The receiver will use pin E4 to receive data from the professor's IR LED. The Pin will use an ISR to detect the start bit, and then receive the rest of the data after the start bit has been detected. It will use a falling edge to trigger the interrupt since the UART is constantly sending out a high signal.

Detailed Thread Parameters:

IR Send path:

The input will come from the common terminal interface, where the characters after “send” will be sent via UART0 PE1, encoded 8E1. The PWM frequency will come from Pin PB6, and will constantly output a frequency of 38Khz. These 2 inputs will then feed into an AND gate. The output of the AND gate will feed into circuit 2a from lab 3, where the output of the outgate replaces the “blue” input of the original gate.

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IR Receive path:

The receiver will use pin E4 to receive data from the professor's IR LED. The Pin will use an ISR to detect the start bit, and then receive the rest of the data after the start bit has been detected. It will use a falling edge to trigger the interrupt since the UART is constantly sending out a high signal. While the ISR is running, the blue LED will remain lit up. The receiving pin will be pin pe0.

Requirements That Will be met:

Full duplex operation is guaranteed since the receiver's ISR runs at high priority, while transmission occurs in the background and does not require precise timing beyond enabling or disabling the PWM. The error detection goal will be satisfied because the sampling routine directly checks the parity bit and validates the stop bit, lighting up the red LED if a framing or parity error occurs. A falling-edge interrupt on PE4 detects the start bit, and then samples the 8E1 bits at fixed 3333-µs intervals. Because each timer interrupt executes basically instantly, interrupt latency never affects the accuracy of information being received. The send side also meets requirements because the 38-kHz carrier is generated entirely by the PWM hardware, meaning the TIVA board can send out UART signals without any timing sensitivity.

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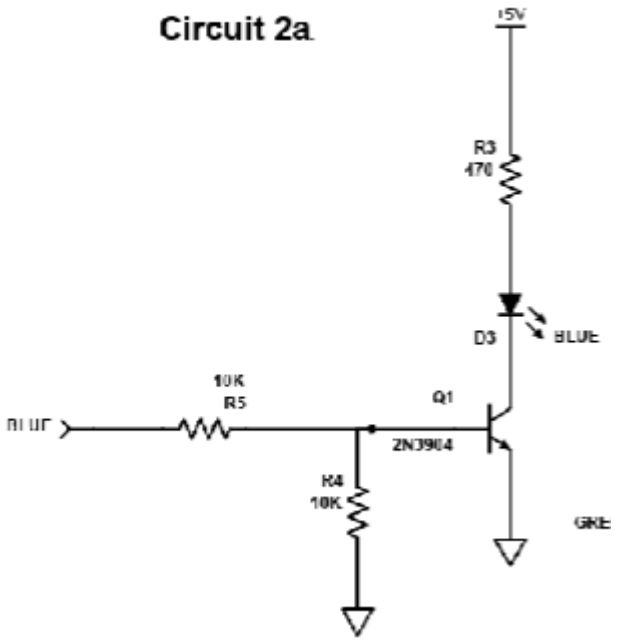
Hardware Checkout

For minimal testing purposes, I will reuse the code from Lab 5 part 2, to send a UART signal from PE1. Since the UART is constantly sending high, I will invert the signal using a NOT gate to accommodate the IR333a. I will also reuse the code from Lab 7 with slight modifications to set up the PWM frequency at 38 kHz. These 2 inputs will feed into an AND gate to modulate the UART signal, and then the modulated output will feed into the following



circuit:
In the circuit, the modulated UART signal would replace the input “BLUE” on the left side. This circuit will be reused from lab 3 with changes in resistors to make sure the IR LED has a continuous current of 100 mA.

For receiving, the TSOP sensor will be powered by the Vbus pin and grounded from the GND pin, both coming from the TIVA board. The OUT pin on the TSOP will be hooked up to an oscilloscope to verify that the characters being sent from the UART are arriving properly.