Course Name: EMBEDDED SYSTEMS I / III

Course Number and Section: **14:332:493:03**

Year: Spring 2021

Lab Report #: 0

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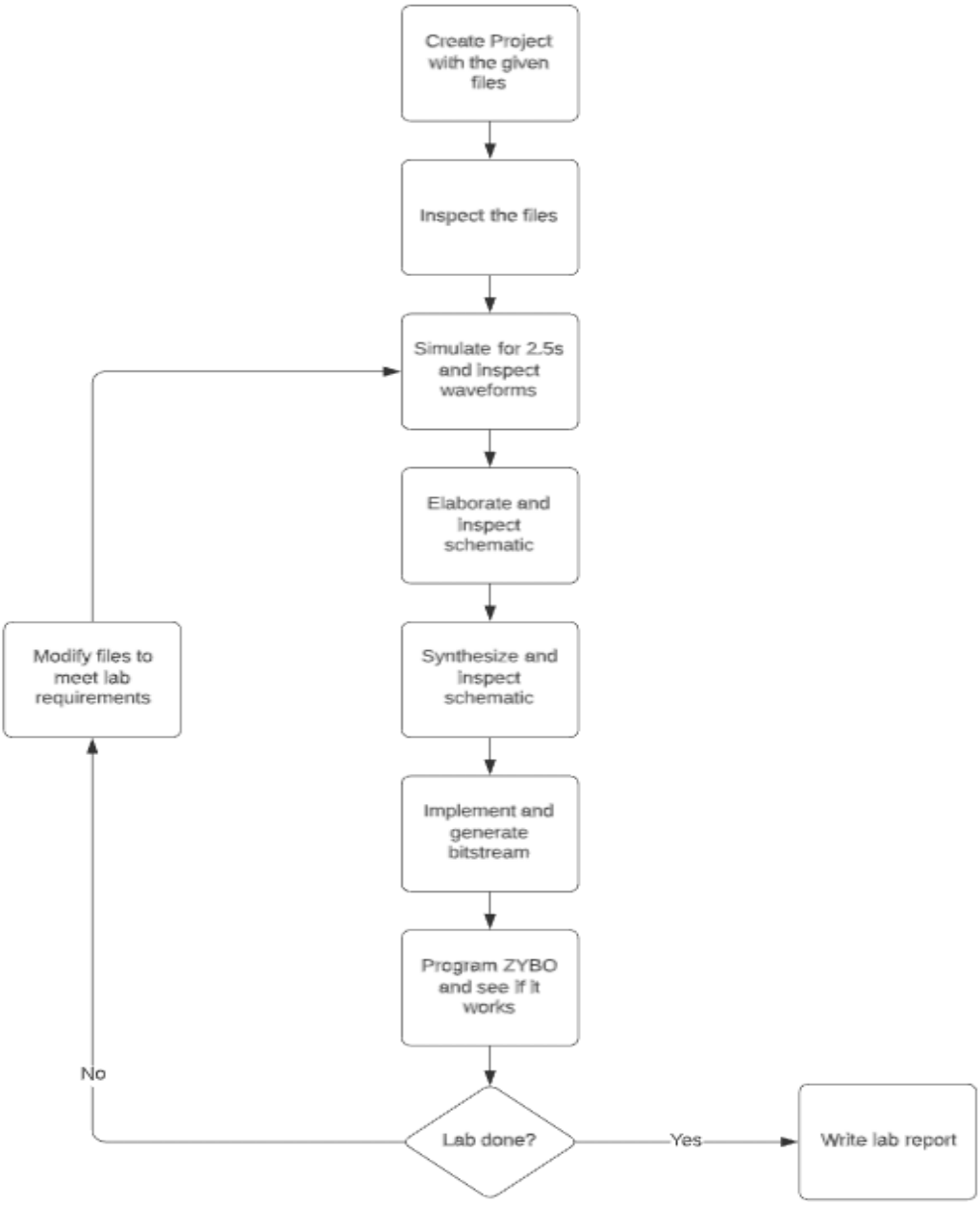
Date Submitted: 2/4/2021

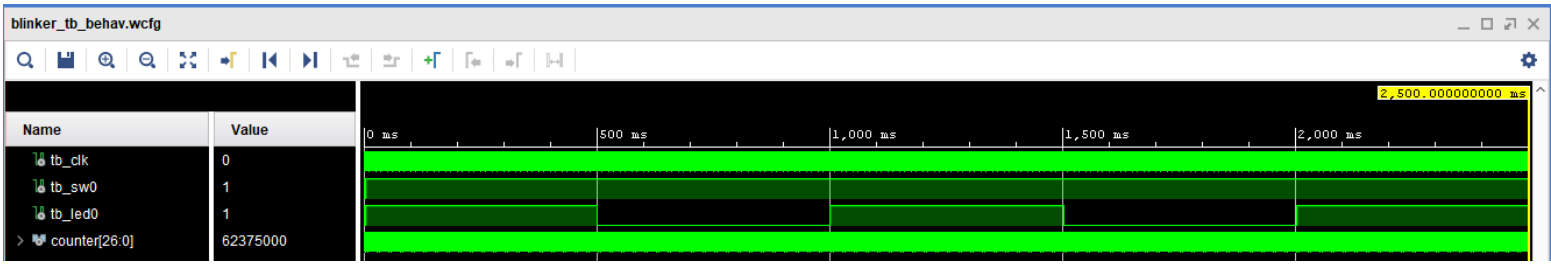
GitHub Link: https://github.com/sc1724/Embedded/tree/main/Lab0

Purpose/Objective: The purpose of this lab is to experiment and learn about VHDL and Vivado by testing given code, testbench, and constraint files. The given files are mean to create a blinker that flashes at a rate of 1Hz when a switch is turned on. We will then modify this code in order to use a different switch and a different led to blink at 2Hz.

Theory of Operation:



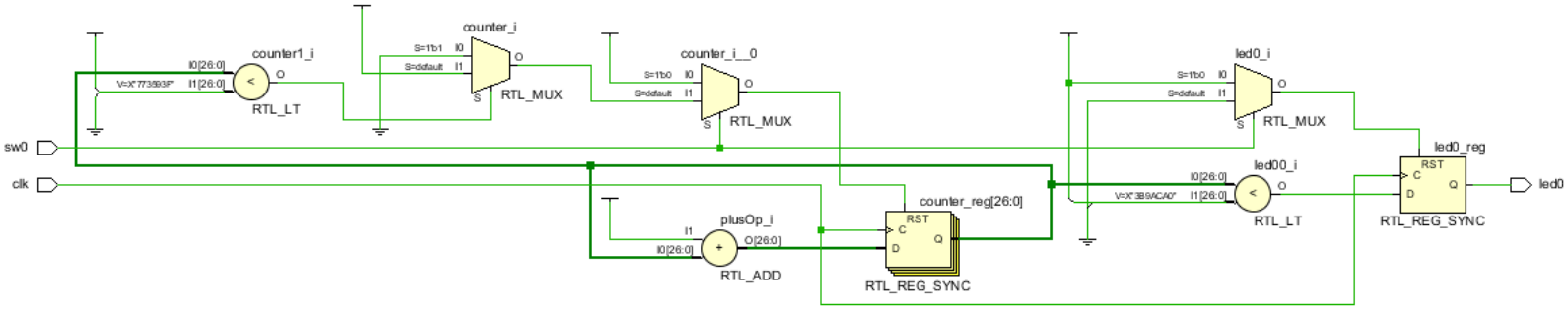
Simulation Waveforms 1:



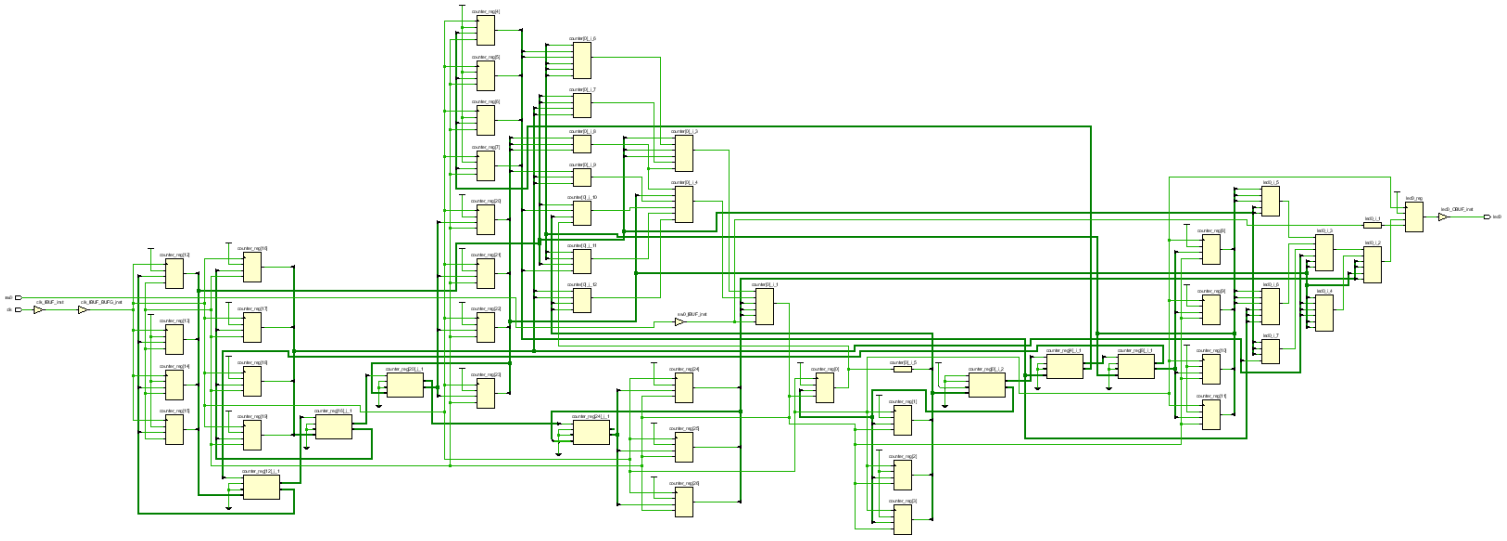
The simulation is run for 2.5 seconds. Since the led is set to a 1hz frequency it is on and off two times and then on for the last half second as seen on the wave diagram.

Vivado Schematics 1:

a) Vivado Elaboration Schematic



b) Vivado Synthesis Schematic



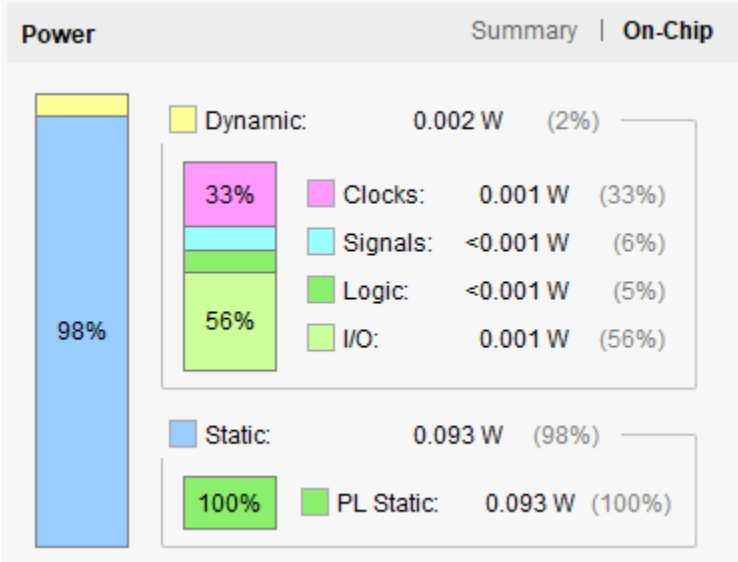
c) Post- Synthesis Utilization Table

Utilization | Post-Synthesis | Post-Implementation

Graph | Table

Resource	Estimation	Available	Utilization %
LUT	17	17600	0.10
FF	28	35200	0.08
IO	3	100	3.00
BUFG	1	32	3.13

d) On-Chip Power Graphs



I did not have to modify for the constraints file for this part of the lab.

Answers to Additional Questions 1:

1. We simulated the design for such a long period of time because the on and off time of the led combined is one second. By running the simulation for 2.5 seconds we can see the led turn on and off at least 2 times.

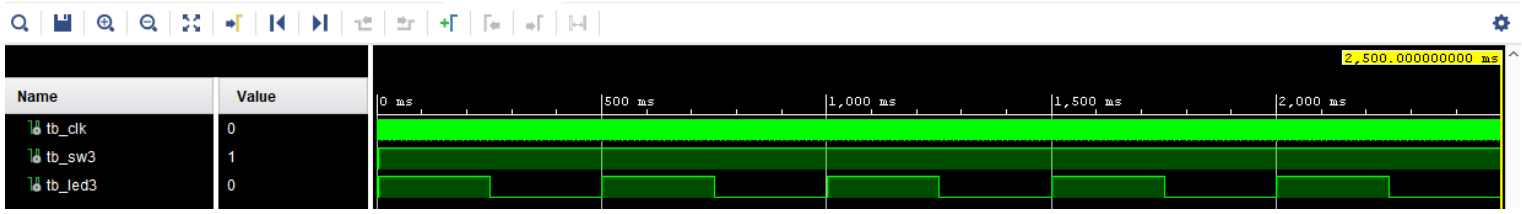
2. Before the switch was high the counter was simply staying at a value of 0. After the switch went high it started incrementing by one with every rising edge of the

clock signal until 124999999 and then resetting to 0 before continuing to increment by one.

3. The counter was set to 124999999 because the clock was at a frequency of 125Mhz, which is 125000000 cycles per second. That means that if the counter counts 124999999 rising edges of the clock signal, then one second will have passed. This will let the led have a 1hz rate.

4. Comparing the vhdl code and simulation results I do believe that the simulation behaved as expected. As the waveform shows, the led turns on and off one time every second when the switch is turned on.

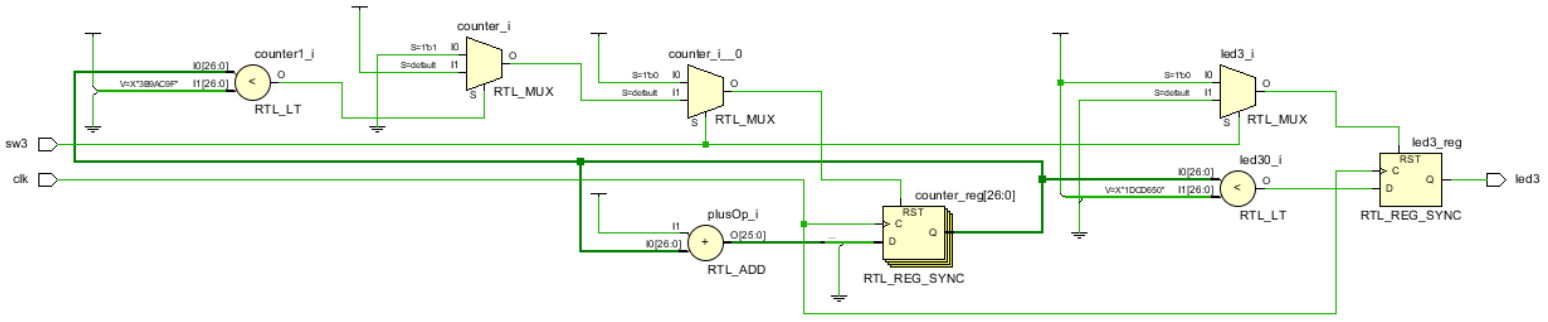
Simulation Waveforms 2:



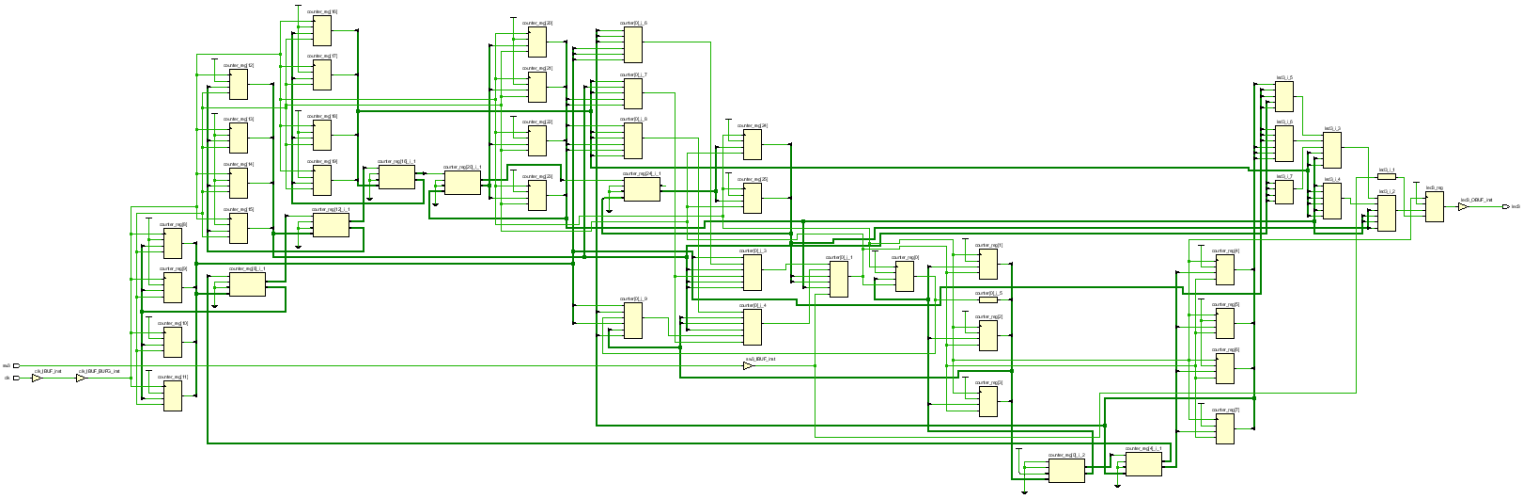
Since the new frequency is 2hz, the led should turn on and off two times every second. As indicated in the waveform chart, this is indeed the case.

Vivado Schematics 2:

a) Vivado Elaboration Schematic



b) Vivado Synthesis Schematic



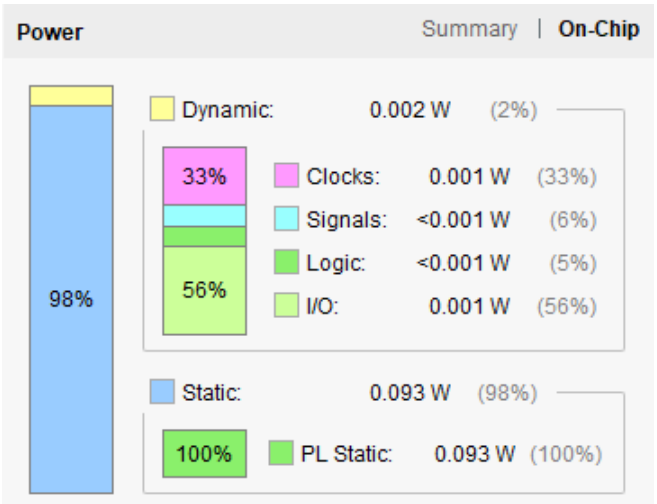
c) Post- Synthesis Utilization Table

Utilization — **Post-Synthesis** | Post-Implementation

Graph | **Table**

Resource	Estimation	Available	Utilization %
LUT	15	17600	0.09
FF	27	35200	0.08
IO	3	100	3.00
BUFG	1	32	3.13

d) On-Chip Power Graphs



The lines for led 0 and switch 0 had to be commented and the lines for led 3 and switch 3 needed to be uncommented in the constraints file in order to change which switch controls the led and to change which led blinks to meet the lab requirement.

Answers to Additional Questions 2:

1. The new counter value would be 62499999 since we want the counter to reset two times per second instead of one time per second in order to make the led blink at a rate of 2hz. The count value for the led to change from on to off also needs to be changed to 31250000 to have a 50% duty cycle.
2. In order to change the led that blinks to led 3 and the switch to control it to switch 3, the lines for led 0 and switch 0 had to be commented and the lines for led 3 and switch 3 needed to be uncommented in the constraints file. The appropriate signal and variable names for the led and switches in the vhd files also needed be updated with their respective corrected names of led3 and sw3.
3. The RTL and Synthesis schematics are almost the same with the difference of the switch and led changed to 3 instead of 0.

Conclusion: From this lab I learned how to modify to the constraints file in order to change the hardware that I wanted to use. Since the code for the other switches and leds were already included in the file it was simply a matter of commenting and uncommenting the one that I wished to use. The other part of the lab was increasing the frequency of the flashing to be 2Hz. This was a matter of dividing the counter limit by two as well as the led counter by two. This is clearly

demonstrated in the waveforms to show that led is on two times a second instead of one time a second.

Follow Up: The concepts that I feel that I understood from this lab were how to use to constraints file to utilize the hardware that I wanted. Another concept that I think I understand is how to use the clock signal to get a timing that I want.