CmpE 124 Lab 7: Traffic Light State Machine Phase 1, 2 & 3

Phat Le, 012067666, CmpE 124 Spring 2019, Lab Section 5

***Abstract*—Design and build signal light controller for pedestrians and car traffic.**

I. Introduction

The purpose of this lab is to create a signal controller for car and pedestrians using logic gates. For phase 1, design a two state machine for car and pedestrian. In phase 2, the circuit is redesigned using 74LS163 as a 4 bit counter. Phase 3 is about making both pedestrian and car signal can be used simultaneously as an actual traffic signal.

II. Design Methodology

A. Parts List

- 74LS163
- 74LS00
- 74LS10
- 74LS20
- 74LS04
- 74LS08
- 74LS74
- 1k Ohm resistor
- 10MHz crystal

B. Truth Tables

pre	clr	D	clk	q+	qn+
L	H	-	-	H	L
H	L	-	-	L	1
L	L	-	-	H(+)	H(+)
H	H	↗	H	H	L
H	H	↗	L	L	L
H	H	L	-	Q0	Q0’

Table 1: Truth table for 74LS74

PS			NS		Output		
State	**Q**	**reqPsrv**	**State**	**D**	**Red**	**Green**	**ClrPS**
S0	0	0	S0	0	1	0	0
S0	0	1	S1	1	1	0	0
S1	1	-	S0	0	0	1	1

Table 2: Truth table for pedestrians request (phase 1)

PS				NS			Output			
State	**Q 1**	**Q 0**	**req Csrv**	**State**	**D 1**	**D 0**	**Red**	**Yellow**	**Green**	**Clr Cs**
S0	0	0	0	S0	0	0	1	0	0	0
S0	0	0	1	S1	0	1	1	0	0	0
S1	0	1	-	S2	1	0	0	0	1	0
S2	1	0	-	S3	1	1	0	0	1	0
S3	1	1	-	S0	0	0	0	1	0	1

Table 3: Truth table for car request (phase 1)

74LS163				Car			Pedestrian	
QD	**QC**	**QB**	**QA**	**R**	**G**	**Y**	**R**	**G**
0	0	0	0	1	0	0	1	0
0	0	0	1	0	1	0	0	1
0	0	1	0	0	1	0	0	1
0	0	1	1	0	1	0	0	1
0	1	0	0	0	1	0	0	1
0	1	0	1	0	1	0	0	1
0	1	1	0	0	1	0	0	1
0	1	1	1	0	1	0	0	1
1	0	0	0	0	1	0	0	1
1	0	0	1	0	1	0	0	1
1	0	1	0	0	1	0	0	1
1	0	1	1	0	1	0	0	1
1	1	0	0	0	0	1	0	1
1	1	0	1	0	0	1	0	1
1	1	1	0	0	0	1	0	1
1	1	1	1	0	0	1	0	1

Table 4: Truth table using 74LS163 that indicates 16 states clocks signals (phase 2)

C. Karnaugh Maps

DC	BA	00	01	11	10
00		0	0	0	0
01		0	0	0	0
11		1	1	1	1
10		0	0	0	0

Table 5: K-map for Yellow signal. QD, QC is the column and QB, QA is the Row.

Phat Le, phat.le@sjsu.edu

D. Original and Derived Equations

- Phase 1:
  - Pedestrian:
    - Red = Q'
    - Green = ClrPS = Q
    - D = Q'reqPsrv
  - Car:
    - Red = Q1'Q0'
    - Green = Q1'Q0 + Q1Q0'
    - ClrCS = Yellow = Q1Q0
    - D1 = Q1'Q0 + Q1Q0'
    - D0 = Q1'Q0'reqCsrv + Q1Q0'
- Phase 2:
  - Pedestrian:
    - Red = QA'QB'QC'QD'
    - Green = (Red)'
  - Car:
    - Red = QA'QB'QC'QD'
    - Green = (Red + Yellow)'
    - Yellow = QDQC

E. Schematics

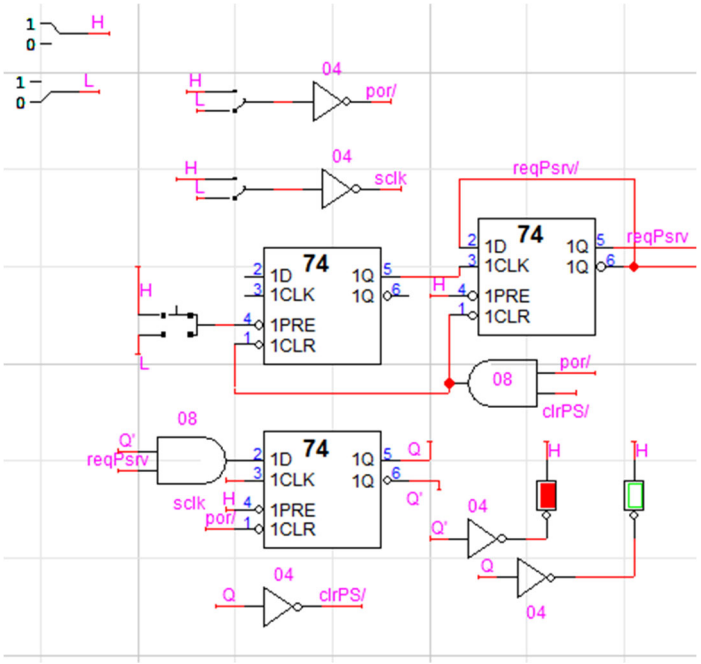

Figure 1: Schematics for phase 1 pedestrian.

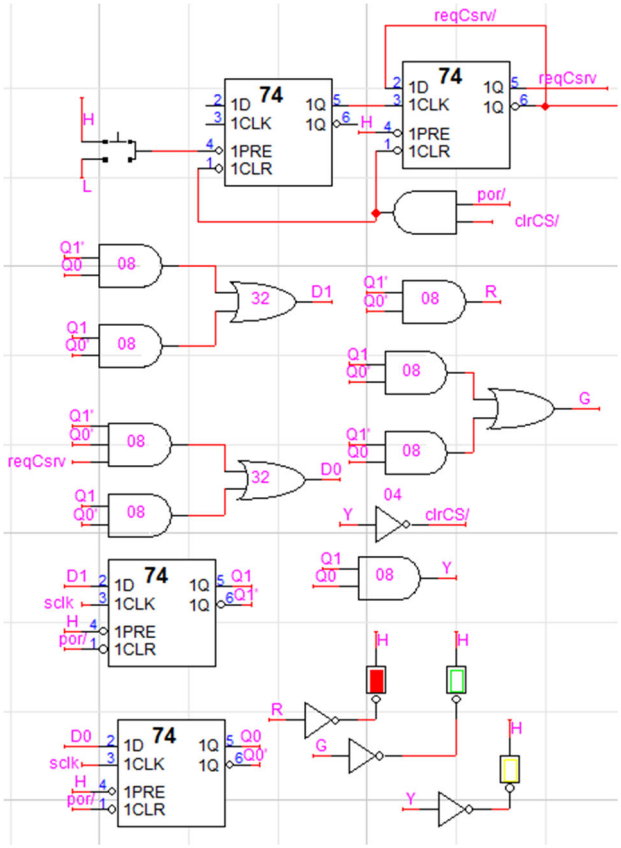

Figure 2: Schematics for phase 1 car signal

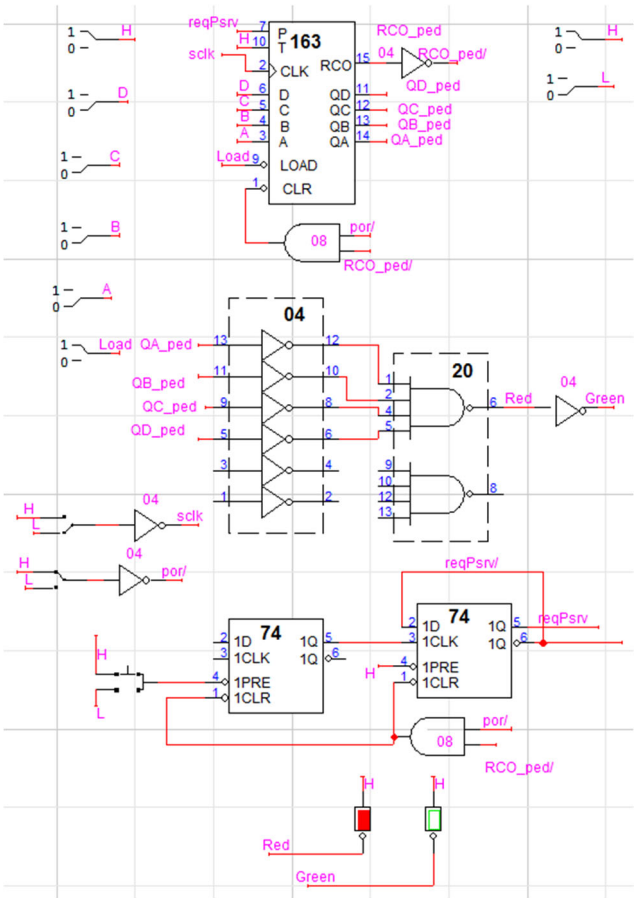

Figure 3: Schematics for phase 2 pedestrian.

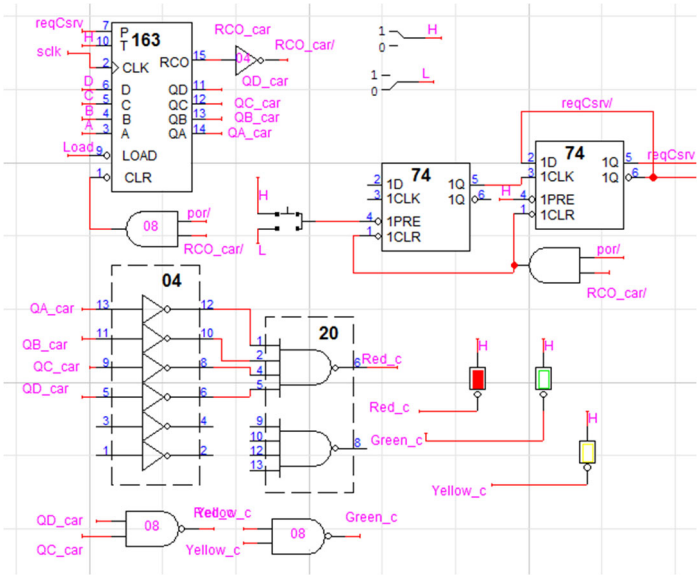

Figure 4: Schematics for phase 2 car signal.

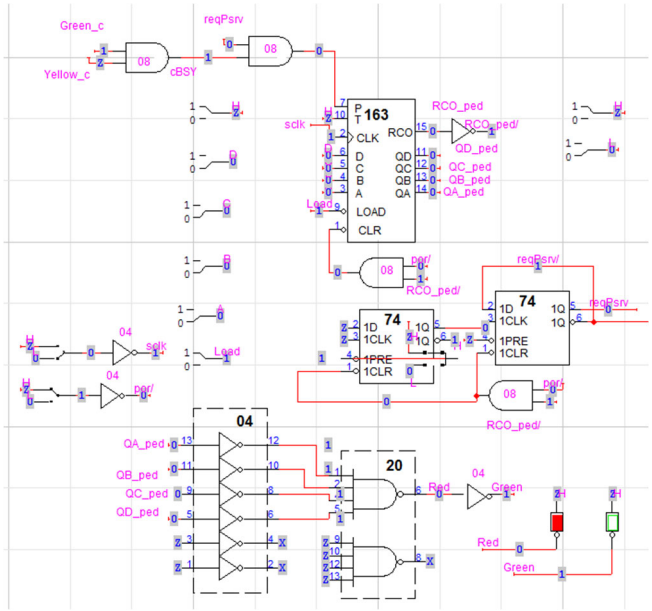

Figure 5: Schematics for phase 3 pedestrian.

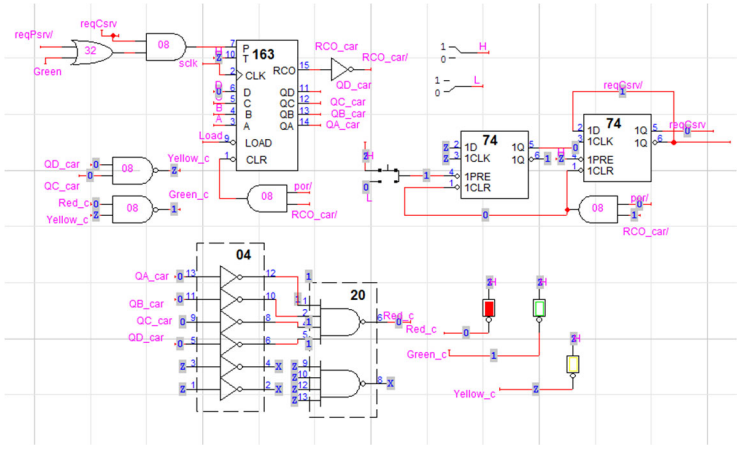

Figure 5: Schematics for phase 3 pedestrian.

III. TESTING PROCEDURES

The testing procedure should be broken down into steps:
Phase 1:

- The switch circuit is reset (cleared) by either the power-on reset signal (por/) or the clear-pedestrian-switch (clrPS/) signal or clrCs/ signal.
- The switches are asynchronous.
- Activate the switch (as if a pedestrian approaches the crossing).
- Apply a clock and see if the RED LED turns off and the GREEN LED turns on
- Apply a clock and see if the GREEN LED turns off and the RED LED turns on.the
- Activate the switch (as if a car approaches the crossing).
- Apply a clock and see if the GREEN LED turns on
- Apply a clock and see if the YELLOW LED stays on
- Apply a clock and see if the RED LED turns on.

Phase 2:

- Activate the switch (as if a pedestrian approaches the crossing).
- Apply a clocks and see if the GREEN LED turns on and stays on for the specified number of clocks.
- Apply a clock and see if the RED LED turns on.
- Activate the switch (as if a car approaches the crossing).
- Apply a clock and see if the GREEN LED turns on and stays on for the specified number of clocks
- Apply a clock and see if the YELLOW LED stays on for the specified number of clocks
- Apply a clock and see if the RED LED turns on.

Phase 3: It is similar to phase 2 but the light signal for car and pedestrian need to interlock with each other.

IV. TESTING RESULTS

The testing result for phase 1 and 2 is as expected. Specifically, we can toggle the clock switch as well as the button for car and pedestrian signal. The LED light did run from Red to Green and Yellow for car signal as expected. However, phase 3 is not output properly. It run successfully at first run, but when both signal are pressed, the pedestrian signal remain constant green signal.

V. CONCLUSION

Both phases were successfully built and produced outputs as expected. Circuit 3 need to have more focus on creating proper truth table. This is a tough lab that requires the knowledge from all learnt topic. However, dividing the problems into small phases makes it easier to design the states and understand the problem.
Circuit 3 did not work because there must have been a problem with the use of AND, and OR gates when converting the word problem into signal language. If I can do this lab again, I would create better state machine before creating any truth table. Especially for phase 3, I need to figure out what state for car and pedestrian should be if I press the signal at the same time or during different states.

VI. APPENDICES AND REFERENCES

All the references of Schematic for the request signal are based on Lab 7 instruction.