UNIVERSITY OF WEST LONDON

Digital Electronics

Pelican crossing assignment

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17/05/2019

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Introduction

The task for this assignment was to design, test and build the control circuit of a pelican crossing. This had to be done using OrCAD for which first the logic of the circuit had to be thought through by thinking of the concept of the circuit. Then, the truth tables were used to show that the concept worked. Afterwards, by doing a k-map of the truth table it was possible to know what components to use for the circuit. After that, all the components had to be tested using an OrCAD simulation and if the circuit worked as expected by following the sequences of the truth tables, the circuit could be built and tested. This assignment contains a list of equipment were all the components used are listed, Truth Table and Calculation, Circuit Diagram were the circuit used is shown and explained, Results and Discussion were all the recorded signals of the simulation are shown and discussed and Conclusion. The aims of this assignment are to test the knowledge of basic digital electronics control circuits by asking to design, build and analyse a logic circuit containing a combination of combinational and sequential components. It also by asking to assemble and simulate the circuit using OrCAD it test the student's proficiency with the program.

List of Components and Equipment

6 D flip-flops: 74HC74

2 3x8 decoders: 74HC138

4 inverters: 74H05

1 ORgate: 74HC32

1 ANDgate: 74HC08

5 LEDs: MLED81

5 resistors: 350 Ω

Oscilloscope: TDS2022B C030471

Power supply: 326498

Truth Tables

Table 1 shows the truth table of the 4-bit counter that was used in this circuit, the since the counter counts for 0 to 15 a k-map was not needed because all the states were used to the truth table is counting up asynchronous counter. Table 2 shows the truth table of the two decoders, the truth table shows the counter values and next to it the pin activated in the decoder for the counter value, it also shows the after the counter reaches number 7 the first decoder gets deactivated and the second gets activated, then it shows order in which the LEDs that light up, the green LED for cars lights up for the first 6 stages, the yellow for 7 to 9 and red form 9 to 15, the green for the pedestrian activates for the red being activated and the red for the pedestrians when green or yellow are activated.

current state				**next state**			
flip-flop4	flip-flop3	flip-flop2	flip-flop1	flip-flop4	flip-flop3	flip-flop2	flip-flop1
0	0	0	0	0	0	0	1
0	0	0	1	0	0	1	0
0	0	1	0	0	0	1	1
0	0	1	1	0	1	0	0
0	1	0	0	0	1	0	1
0	1	0	1	0	1	1	0
0	1	1	0	0	1	1	1
0	1	1	1	1	0	0	0
1	0	0	0	1	0	0	1
1	0	0	1	1	0	1	0
1	0	1	0	1	0	1	1
1	0	1	1	1	1	0	0
1	1	0	0	1	1	0	1
1	1	0	1	1	1	1	0
1	1	1	0	1	1	1	1
1	1	1	1	0	0	0	0

Table 1: counter truth table

counter				decoder 1								decoder 2								LED	
Df4	Df3	Df2	Df1	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	g	r_p
0	0	0	0	1	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X	g	r_p
0	0	0	1	0	1	0	0	0	0	0	0	X	X	X	X	X	X	X	X	g	r_p
0	0	1	0	0	0	1	0	0	0	0	0	X	X	X	X	X	X	X	X	g	r_p
0	0	1	1	0	0	0	1	0	0	0	0	X	X	X	X	X	X	X	X	g	r_p
0	1	0	0	0	0	0	0	1	0	0	0	X	X	X	X	X	X	X	X	g	r_p
0	1	0	1	0	0	0	0	0	1	0	0	X	X	X	X	X	X	X	X	g	r_p
0	1	1	0	0	0	0	0	0	0	1	0	X	X	X	X	X	X	X	X	g	r_p
0	1	1	1	0	0	0	0	0	0	0	1	X	X	X	X	X	X	X	X	y	r_p
1	0	0	0	X	X	X	X	X	X	X	X	1	0	0	0	0	0	0	0	y	r_p
1	0	0	1	X	X	X	X	X	X	X	X	0	1	0	0	0	0	0	0	y	r_p
1	0	1	0	X	X	X	X	X	X	X	X	0	0	1	0	0	0	0	0	r	g_p
1	0	1	1	X	X	X	X	X	X	X	X	0	0	0	1	0	0	0	0	r	g_p
1	1	0	0	X	X	X	X	X	X	X	X	0	0	0	0	1	0	0	0	r	g_p
1	1	0	1	X	X	X	X	X	X	X	X	0	0	0	0	0	1	0	0	r	g_p
1	1	1	0	X	X	X	X	X	X	X	X	0	0	0	0	0	0	1	0	r	g_p
1	1	1	1	X	X	X	X	X	X	X	X	0	0	0	0	0	0	0	1	r	g_p

Table 2: decoder truth table

Circuit diagram

Figure 1 shows the logic circuit used for the pelican crossing. This circuit consists of four main components. The first is the frequency divider that uses two D flip-flops to divide by 4 the inputted frequency. This is done by connecting the Q output of the first flip-flop to the clock of the second one and connecting their Q-not output back into the D pin, then the Q output of the second flip-flop is used for the clock of the first counter. The counter consists of 4 D flip-flops, the counter used is an asynchronous counter which means that their clocks have different timing. This was done by connecting the Q-not output to the clock of the next counter and connecting it that same output to the D pin and the Q output was used for the count, this counter counts up to 15. The output of the counter is used to control the two 3x8 decoders used and the last D flip-flop that is acting as the most significant figure in the count is used to determine which decoder is activated, this allows to effectively double the amount of stage in the decoder increasing the time the LED are going to be light up. The last part is the LEDs that use the different single output stages of the decoder to control the sequence in which they light up. The green LED for the cars has 7 stages of the decoder connected to it, the yellow LED has 3 and the red LED has 6. The red LED for the pedestrians uses ORgate to get both input of the green and yellow LED so is activated in all stages involving does LEDs. The green LED for the pedestrians is connected to the signals red LED for car so it will be only activated when is red for the cars. Afterwards, the signal for the green LED for the pedestrian is used for the audio signal in combination with a 555timer and a and gate to activated only when the green LED is activated.

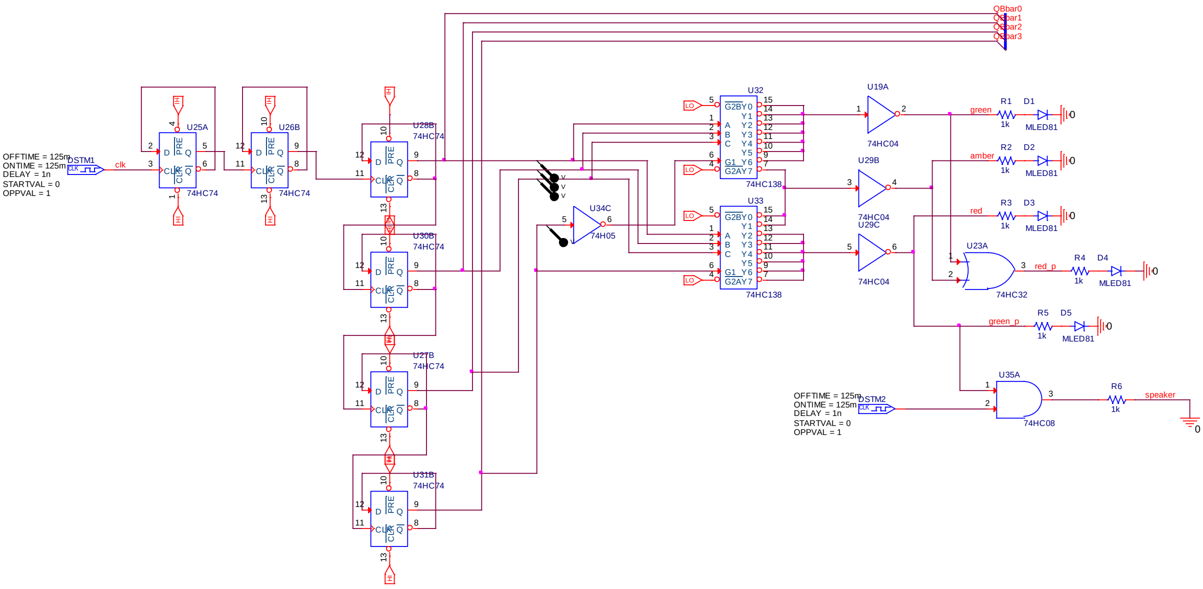

Figure 1: shows the circuit diagram

Results and Discussion

Figure 2, shows the output of both flip-flops that were part of the frequency divider. They are working as expected the signal from the clock is being divided by changing the signal every rising edge of the clock plus this is happening in both flip-flops. In figure 3 shows the signal generated by the counter, the is effectively counting from 0 to 15 by following the right sequence. Figure 4 shows the output of the green LED the signal is lighting up for the first 6 stages of the decoder so is working as expected but there is a minor glitch that causes a pulse after the signal from the LED turns off. Figure 5 shows the yellow LED signal. This signal works, as predicted, is active for 3 stages of the decoder and is active from 7 to 9 and here again there are glitches that cause unexpected pulses. Figure 6, shows the red LED signal, this signal works as planned, with a minor glitch, by being active stage 10 to 15 of the decoder. Figure 7, shows all the signal combined this was done to show that there is no conflict between the signal and that they are following the expected sequence. Figure 8 and figure 9 show the signals of the red and green LED respectively both signals work as planned, and they do not conflict with each other, as shown in figure 10 where both signals are displayed and work by following the expected sequence.

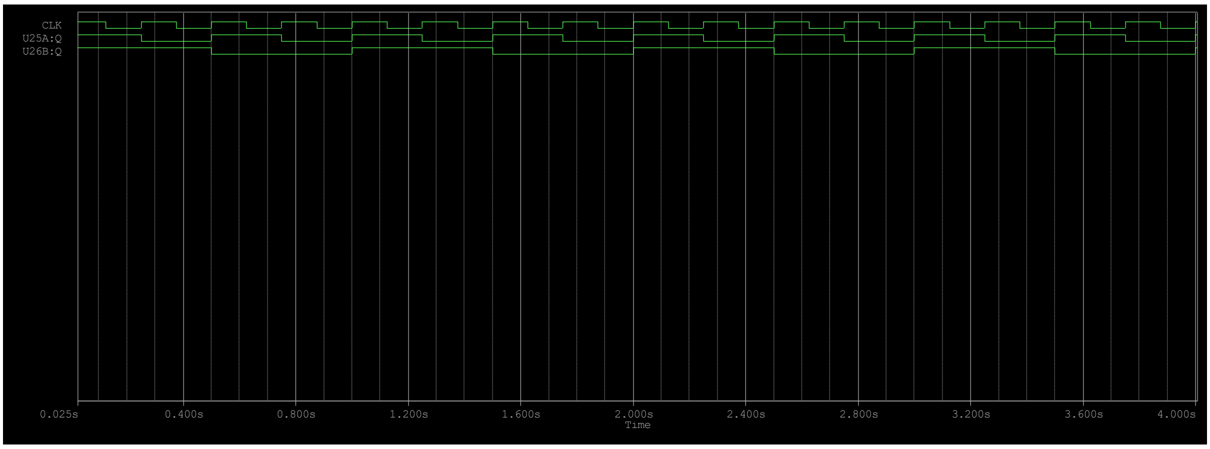

Figure 2: shows the frequency divider output

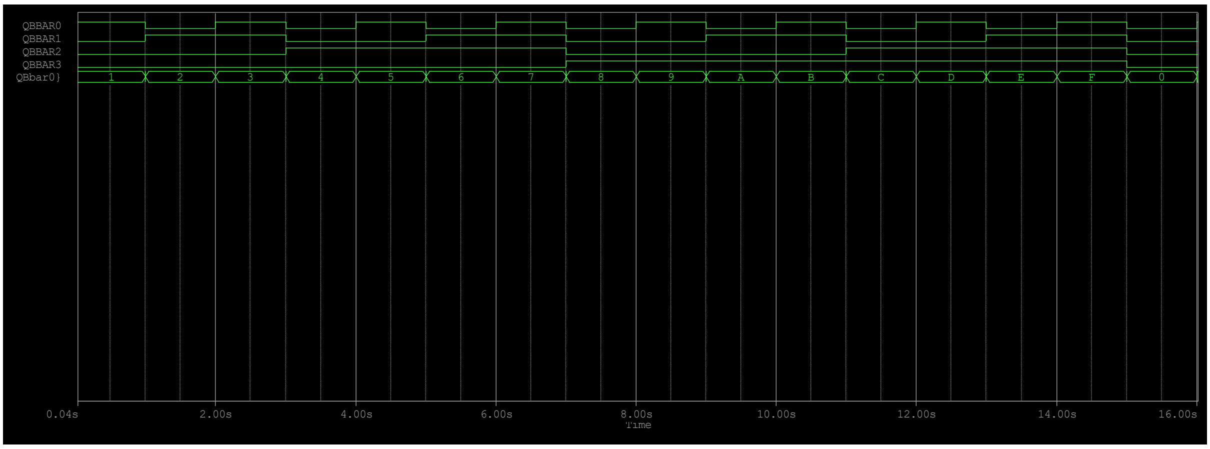

Figure 3: shows the output of the counter

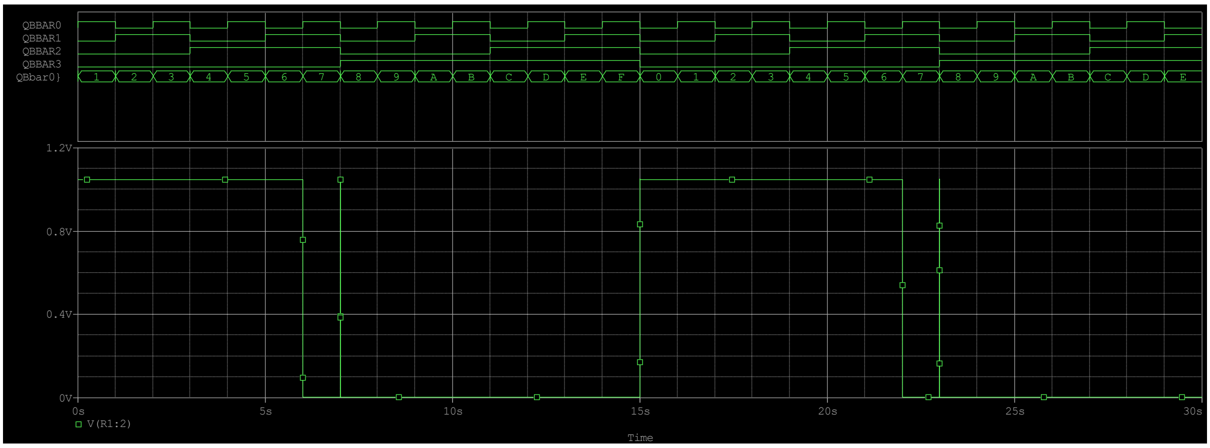

Figure 4: shows the output of the green LED

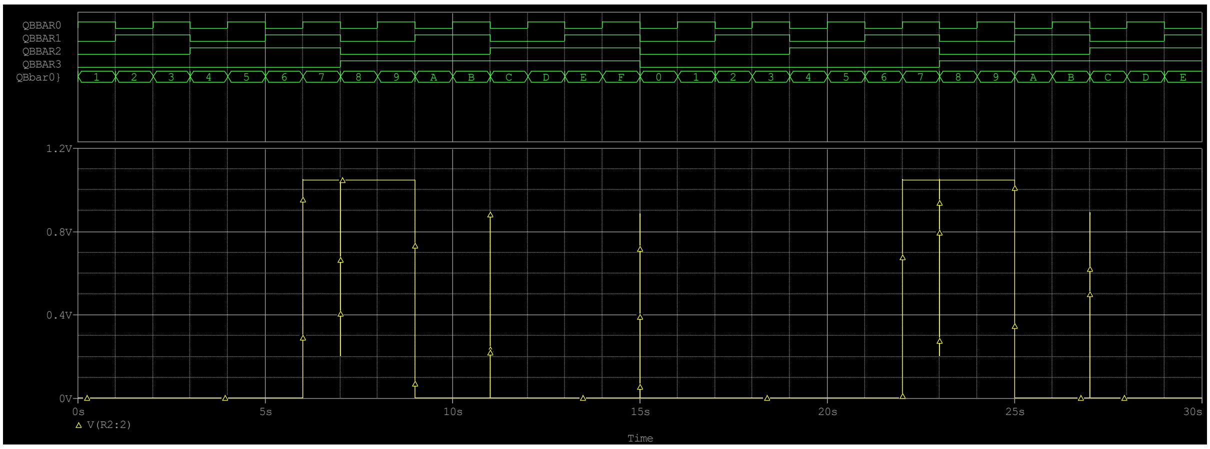

Figure 5: shows the output of the yellow LED

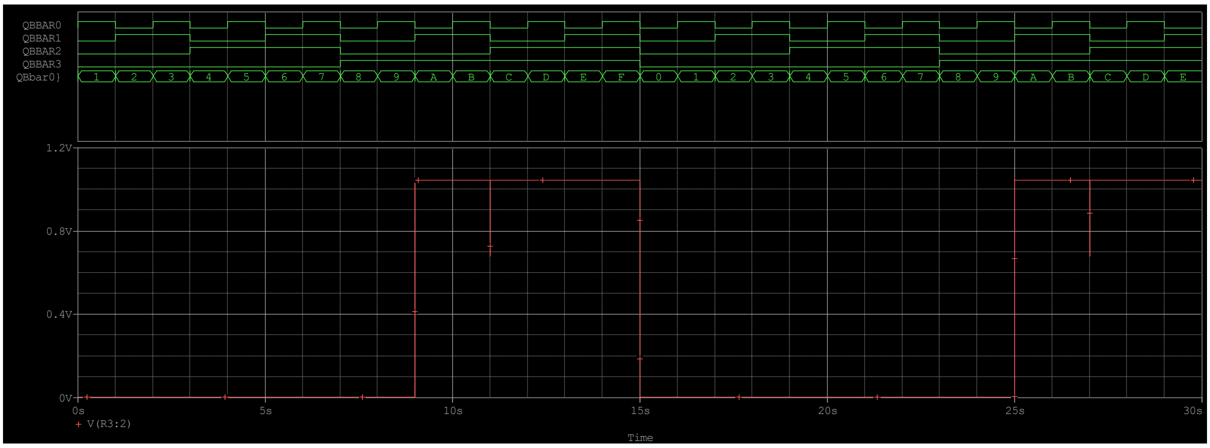

Figure 6: shows the output of the red LED

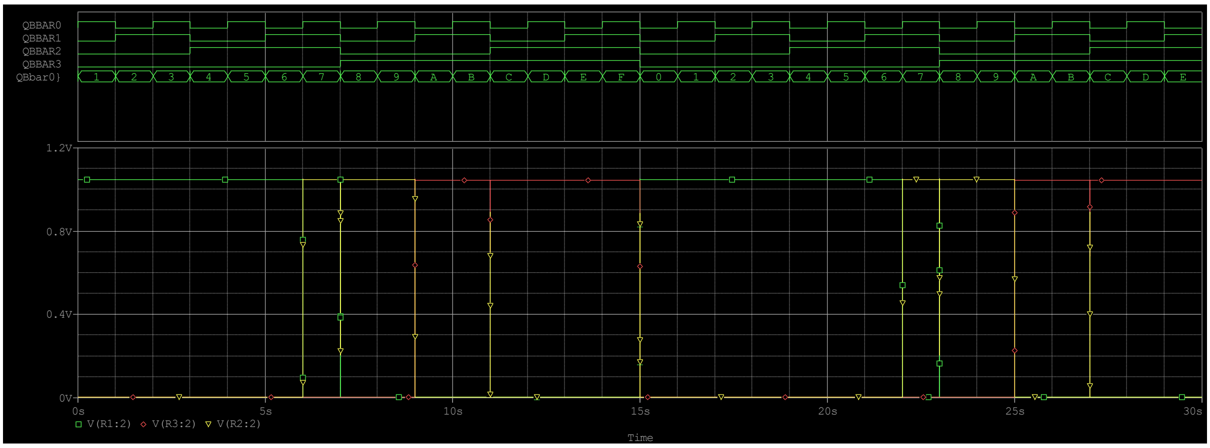

Figure 7: shows all the outputs of the LEDs in sequence

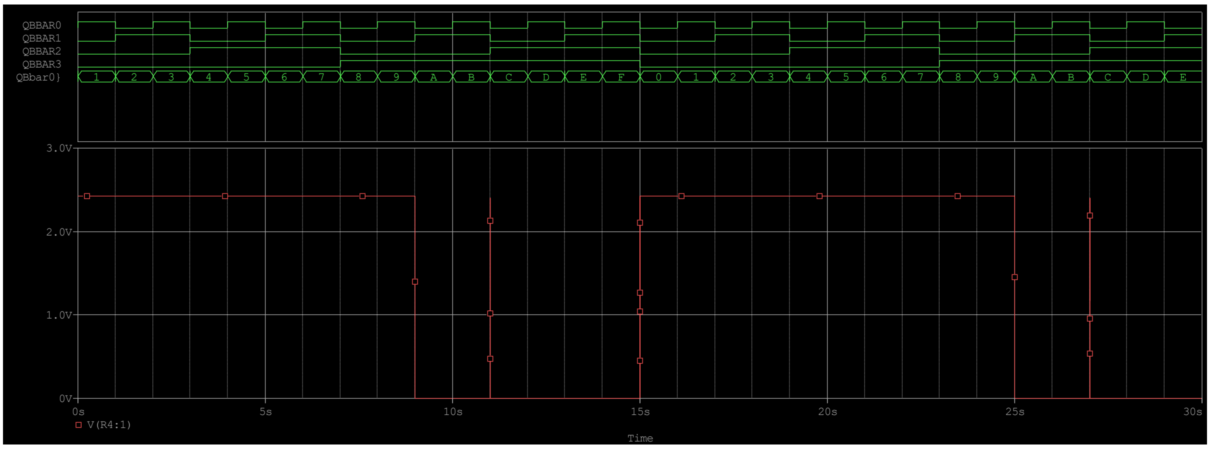

Figure 8: shows the output of the red LED for the pedestrians

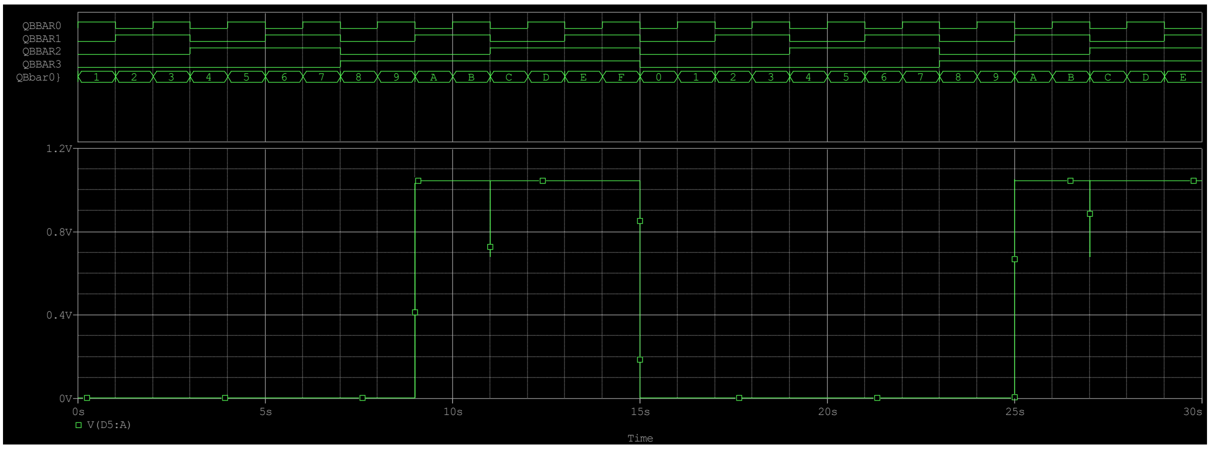

Figure 9: shows the output of green LED for the pedestrian

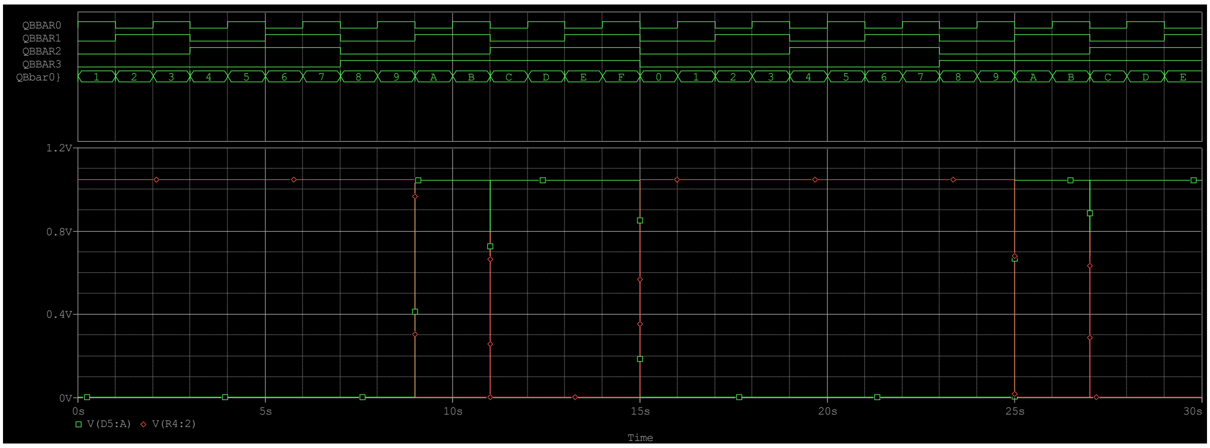

Figure 10: shows the output of both LEDs in sequence

Conclusion

In conclusion, this assignment consisted of designing and testing the logic circuit for a pelican crossing. This was done by using OrCAD to design all the components and simulate the circuit. The result of the simulations shows that the circuit work as expected all the signals follow the right sequence and there is no conflict between signals in the simulations. While building this circuit the idea was to make the simples and smallest design possible, for this reason for the counter and the frequency divider D flip-flop were used. For the counter, the count goes for 0 to 15 to give as much time as possible to the LED to display the sequence without using more flip-flop for the frequency divider. For the decoder, it was planned to use a 4x16 decoder to make the circuit smaller, but since their availability in stock was limited 2 3x8 decoder had to be used instead. For the LED, to reduce the amount of ORgate and ANDgate required, the decoder outputs pins were connected into a LED wanted and only 1 ORgate was used for the red pedestrian LED, so it will be active when green is active or yellow. In the end, only 14 digital components were used 6 D flip-flops, 4 inverters, 2 decoders, 1 ORgate and 1 ANDgate for the speaker, making for a simple and compact design.