Lab Report 3: Combinational Logic Circuit

EE 102

Section 02

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Purpose of the Experiment

The purpose of this experiment was to teach us how to set up a logic circuit on a breadboard. There was no FPGA board this time, and the circuit was supposed to take inputs from a 4-bit counter. Afterwards, it was supposed to show the outputs on LEDs, which we would then use to form a truth table.

Design Specifications

For this design, we were asked to take input from the 74HC163 which would be set to count mode and display the outputs using LEDs.

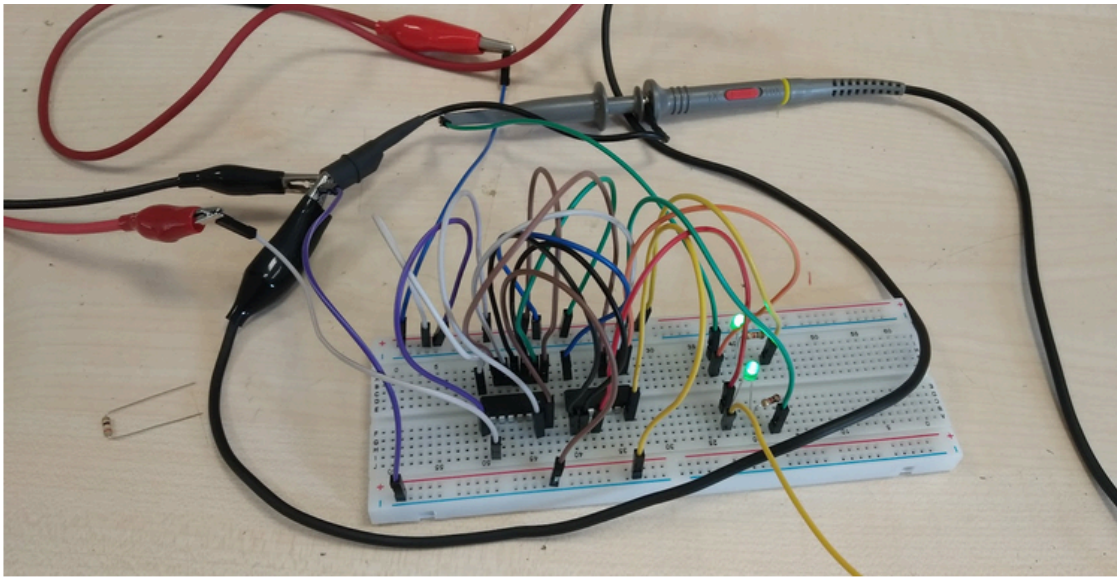

Figure 1.1: Design of the Circuit

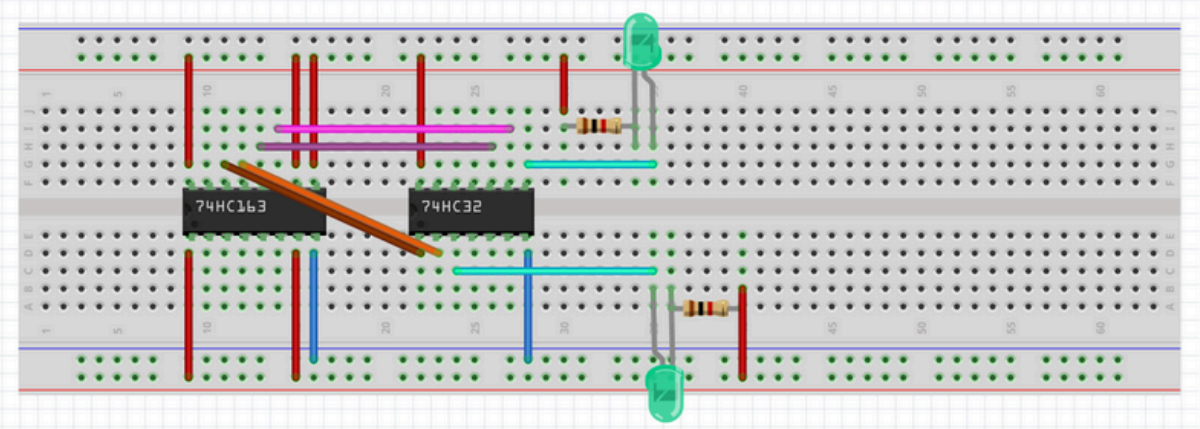

Figure 1.2: Design of the Circuit (Digital, Without the Supplies or Oscilloscope)

I used two 1kΩ resistors, two green LEDs, a 74HC163 counter, and a 74HC32 quad 2-input OR gate. Connections were made between the gates and the counter's outputs. As shown in Figure 2.1 and Figure 2.3, the 74HC163 counter, and a 74HC32 quad 2-input OR gate have specific legs for which they take an input or give an output. Connections were made between Q_0 and Q_1 to the inputs of the OR gate which are 1A and 1B. Another set of connections were made between Q_2 and Q_3 to the inputs of the OR gate which are 2A and 2B. After making the connections, relative outputs which were 1Y and 2Y respectively were connected to the LEDs.

Methodology

To complete this task, I first examined the laboratory document that was sent to us carefully. Since there was a single task to be completed, I wanted to make sure everything was right. After having a good understanding of the document, I started trying to implement a circuit using my breadboard, lots of jumper wires, LEDs, resistors, a 74HC163 counter, and a 74HC32 quad 2-input OR gate. After placing each component to their respective places, I tried testing to see whether I did everything correctly or not. I made sure that I connected the LEDs as indicated in the laboratory

document since it was connected the “opposite” way. In other words, during the LOWs the LED would turn on, whereas on the HIGHs, the LED would turn off. I did the checking using an oscilloscope.

Results

In the beginning, I inspected the datasheet that was sent to us of 74HC163. I connected the V_{CC} and GND to positive and ground respectively. Then, to set the 74HC163 to count mode, I inspected the function table and made the necessary connections as indicated.

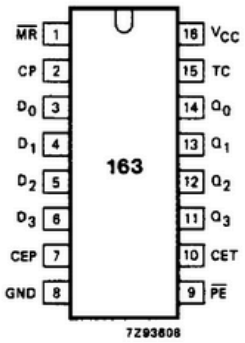

Figure 2.1 Pin configuration

OPERATING MODE	INPUTS						OUTPUTS	
	$\overline{MR}$	CP	CEP	CET	$\overline{PE}$	D_n	Q_n	TC
reset (clear)	l	↑	X	X	X	X	L	L
parallel load	h h	↑ ↑	X X	X X	l l	l h	L H	L (1)
count	h	↑	h	h	h	X	count	(1)
hold (do nothing)	h h	X X	l X	X l	h h	X X	q_n q_n	(1) L

Figure 2.2 Function Table

I decided to pick the 74HC32 quad 2-input OR gate by looking at the LogicGates.pdf that was sent to us. We were told to use two types of logic gates at most, so I decided to go with just one. I checked the pin configuration of 74HC32 and connected the Q_n from 74HC163 to the inputs of the OR gates on 74HC32. Afterwards, I took the outputs from the 74HC32 and connected them to two different points on my breadboard. Adjacent to

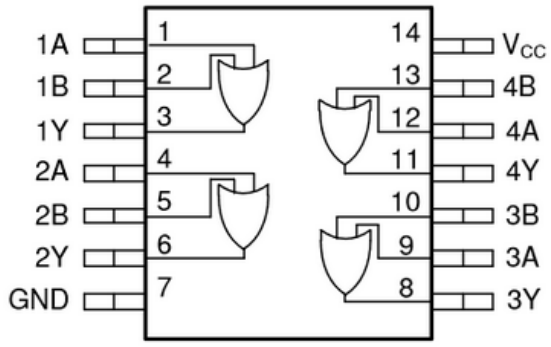

Figure 2.3 Pin configuration

each of those wires, I placed an LED and a resistor to prevent accidents. Following this, I was able to observe the outputs on the LEDs. By observing these, I formed a truth table as it can be seen below named Table 1.1.

Q_0	Q_1	Q_2	Q_3	1Y	2Y
0	0	0	0	0	0
1	0	0	0	1	0
0	1	0	0	1	0
1	1	0	0	1	0
0	0	1	0	0	1
1	0	1	0	1	1
0	1	1	0	1	1
1	1	1	0	1	1
0	0	0	1	0	1
1	0	0	1	1	1
0	1	0	1	1	1
1	1	0	1	1	1
0	0	1	1	0	1
1	0	1	1	1	1
0	1	1	1	1	1
1	1	1	1	1	1

Table 1.1 Truth Table

Following the forming of the truth table, I was curious whether the oscilloscope would match with the results that I have obtained. Thus, I connected it to the first LED (which has its output represented with 1Y) and observed the waves that formed as it can be seen in Figure 2.4. To observe the waves better, I increased the frequency a little.

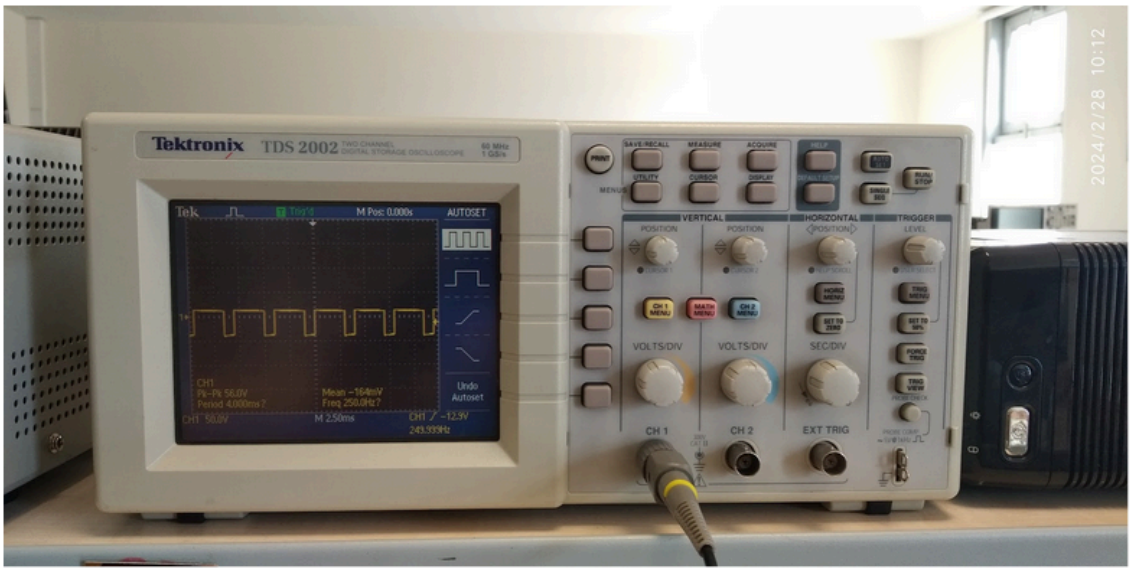

Figure 2.4 Waves on the Oscilloscope

As it can be seen in the figure, the waves have high's and low's which match the results I found in the truth table. It is important to note that what I have observed on the LEDs were the opposite of what one would expect normally, since it was connected the other way around.

Conclusion

By completing this laboratory task, I got much more familiar with implementing circuits on the breadboard. Many errors and problems were faced during both the setting up and the testing processes. For example, when I first started building the circuit on the breadboard, I did not realize that one of the wires that I was using was not functional. While I was trying to get the logic circuit implementation to work, it took me a while to understand what was wrong with my circuit. Another problem that I faced was during the testing process, where the LEDs were on constantly. I later came to the realization that it was not because the LEDs were constantly on, but because the

frequency was so high I could not distinguish the on/offs of the cycle. After adjusting the frequency, I was able to overcome this problem as well. All in all, this laboratory was a little challenging due to me not having any experience on designing such a circuit on a breadboard before. However, I learned a lot during this laboratory and believe that I am ready to design similar circuits with ease now.