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EE102-02

EE-102 LAB 3 REPORT: COMBINATIONAL LOGIC CIRCUIT

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Purpose

The aim of this lab was to implement a combinational logic design on the breadboard by using 4-bit counter, various logic gates and LEDs to simulate inputs as binary numbers starting from “0000” to “1111” and corresponding output values from the logic gates.

Design Specifications

On the breadboard, one 4-bit counter(74HC163), one Quad 2-input NOR gate (74 LS/HC 02), one Quad 2-input NAND gate (74 LS/HC 00) are used. The inputs A, B, C, D are generated by the 4-bit counter. Inputs are designed to simulate truth table, starting from “0000” and to “1111” increasing by 1, synch synchorinized to the clock set on function generator. 4 red LEDs are representing inputs, coming from the 4-bit counter. The yellow LED represents the output. LEDs are on when the value of the output is 1, off when the value of the output is 0.

Methodology

In order to obtain a clean result, I decided to design a simple yet apparent circuit. My design is the following:

$$F = (A \bigoplus B) \bigodot (C \bigoplus D)$$

$$\bigoplus \ : NOR\ Gate$$

$$\bigodot \ : NAND\ Gate$$

Truth Table:

A	B	C	D	F
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1

1	1	1	1	1

Firstly, the red rail(positive) on the breadboard is connected to the channel 3 DC Supply, which is constant on (5V,3A), the blue rail(negative) on the breadboard is connected to the ground of the DC Supply. 4-bit counter (74HC163) is embedded on the breadboard. Pin No 1,7,9,10 and 16 are connected to the positive rail, ground is connected to the negative rail. Pin no 2, which is the clock pin that takes the clock input is connected to the Synch port of the function generator. The frequency is adjusted to the 1 Hz to get visually clear results, the function generator generates square waves. A (Most Significant Digit), B, C and D (Least Significant Digit) corresponds to Q3, Q2, Q1, Q0 pins on the 4-bit counter, respectively. The inputs belonging to the 4-bit counter are connected to red LEDs, which displays the binary increment from “0000” to “1111”. Afterwards, the inputs Q0 and Q1 are connected to the Pin no 2 and 3, Q5 and Q6 are connected to the pin no 5 and 6. The two outputs coming from pin no 1 and pin no 4 from the NOR gate is connected to the first and second pins of the NAND gate. Finally, the output of the NAND gate, coming from pin no 3, is connected to the yellow LED. For the LEDs, 1K Ω resistors are used to prevent possible overloading on LEDs. The tip of the probe is connected to the same colon with the yellow LED. The waveform graph of the output is obtained via oscilloscope.

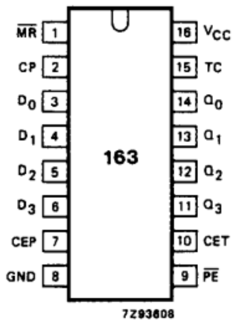
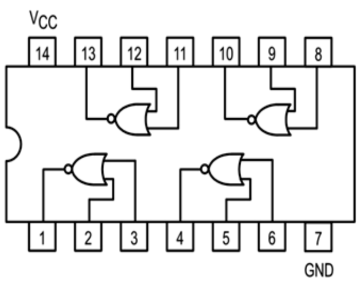


Fig.1 Pin configuration.

Figure 1: “74HC163” 4-bit counter



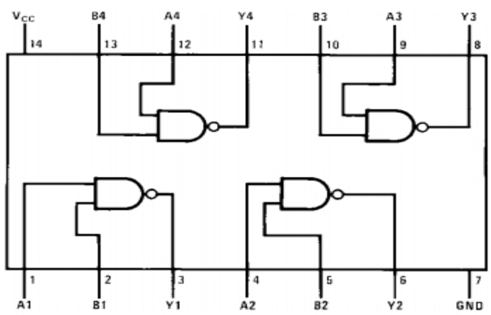


Figure 2: “74 LS/HC 02” NOR Gate Pin Configiration Configiration

Figure 3: “74 LS/HC 00” NAND Gate Pin

Results

As it can be seen from the truth table, the only situation when the F = 0 is when A,B,C and D are 0.

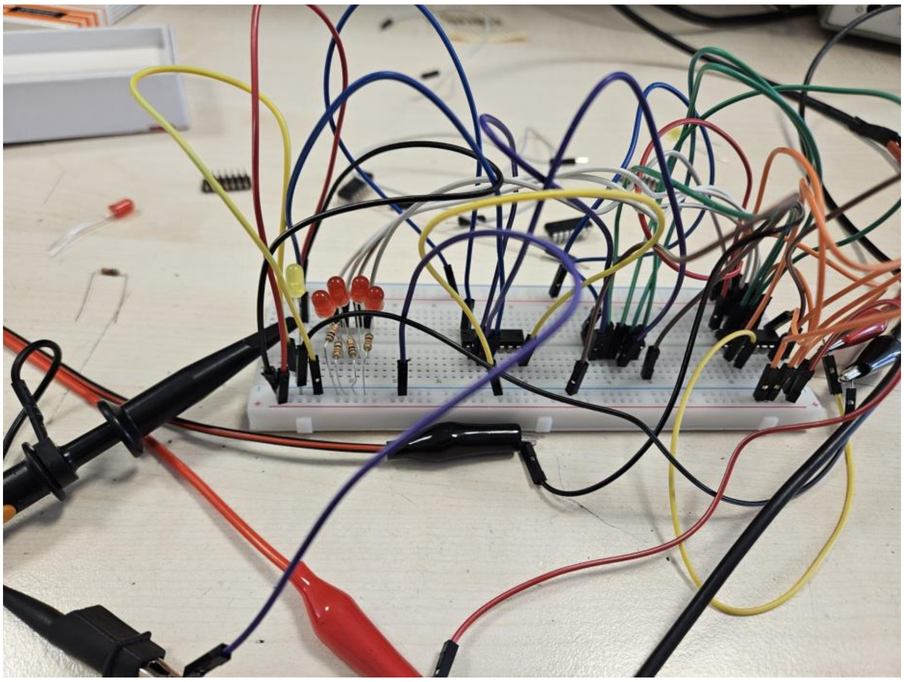


Figure 4: Input “0000”, Output “0”

Any input rather than “0000” will make the yellow LED on. The some of the images below are the examples.

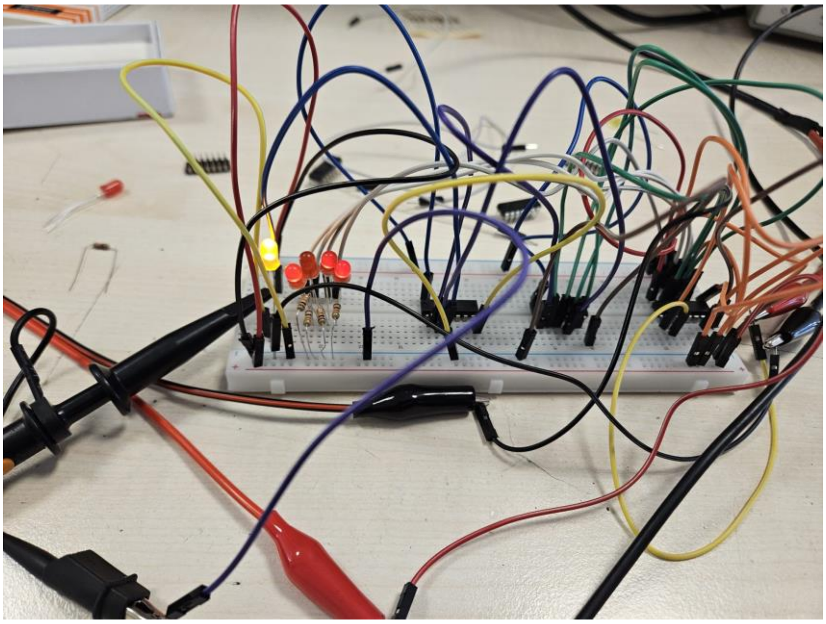


Figure 5: Input “1101”, Output: “1”

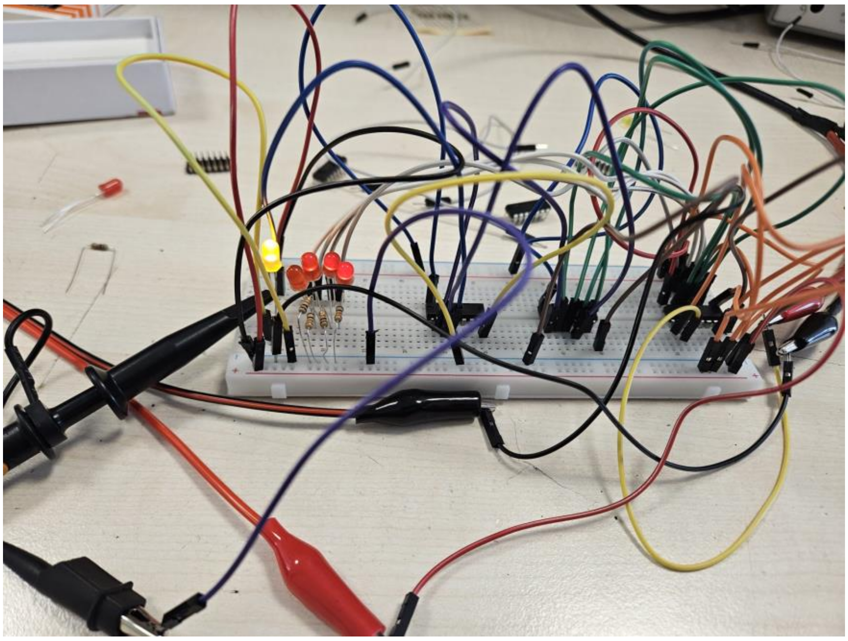


Figure 6: Input “1110”, Output “1”

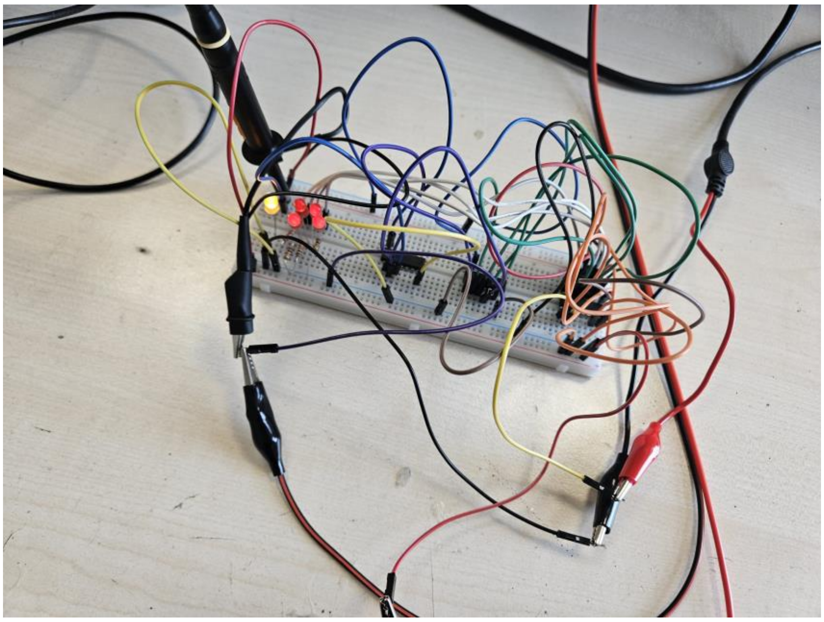


Figure 7: Input “1111”, Output: “1”

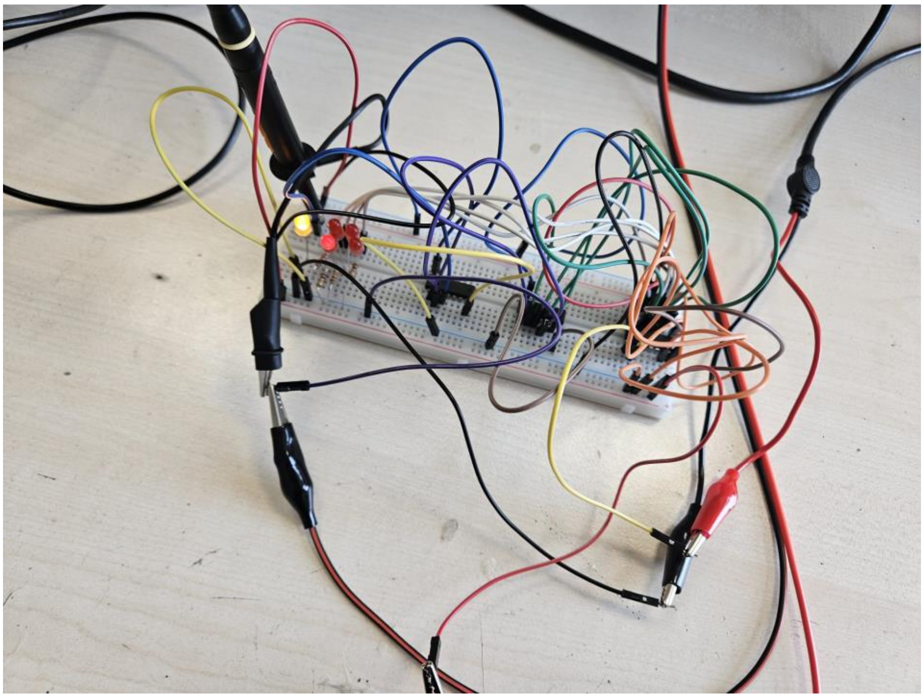


Figure 8: Input “1000”, Output: “1”

The waveforms obtained from the same colon with the yellow LED, which is the final output of the circuit agrees with the truth table. The drops on the graph indicates the sole input of “0000”, whose output is “0”. Others are “1” as expected.

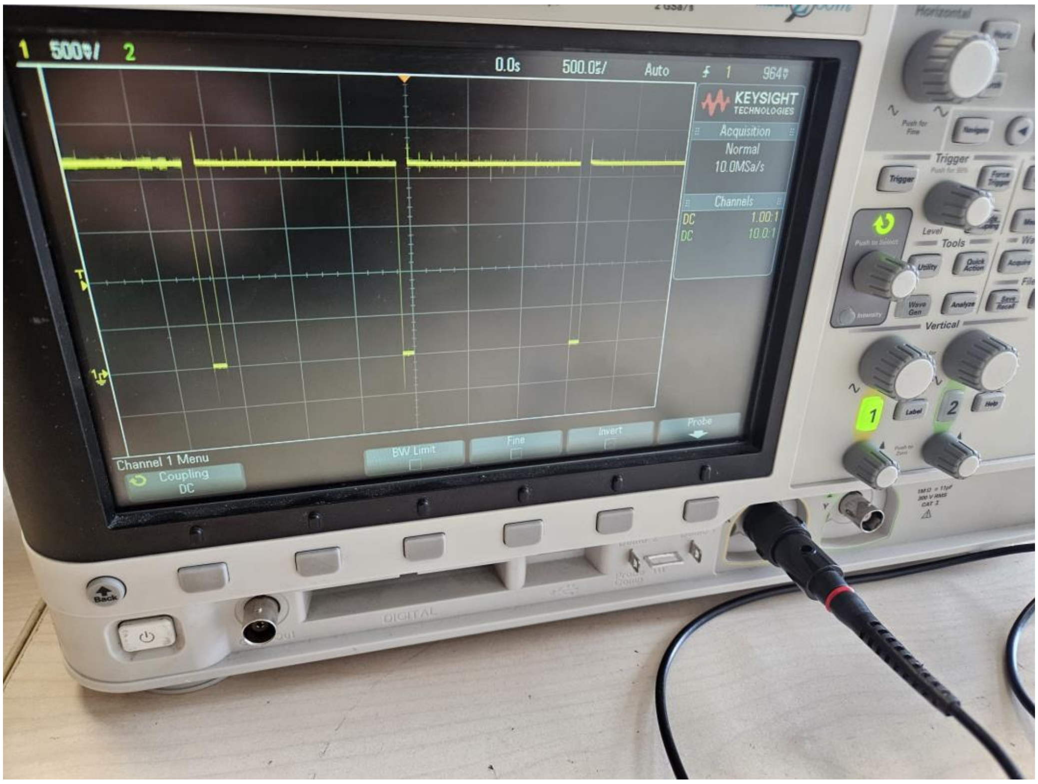


Figure 9: Waveform of the Combinational Circuit

Conclusion

The goal of this lab was to create a combinational logic circuit using some of the gates and a 4-bit counter. I did not design the circuit on any purpose, my intention was to have a circuit design that is as simple as possible in terms of variety of outputs. Although building the design was a little challenging due to usage of many numbers of jumper cables, my design and lab was successful. I learned what counters are used for and the usage of these components gave some ideas about my final project for the course.

Referance

https://makerselectronics.com/product/7402-ic-quad-2-input-nor-gate-dip-14

https://www.angelfire.com/electronic2/motegi/ch7400.htm

74_HC_163.pdf

LogicGates.pdf