Purpose

The goal of the third lab is to make students more used to using lab equipment, logic gates and similar circuit elements to be used on breadboards. This lab specifically makes the students knowledgeable about counters and logic gates to be implemented on breadboards.

Design Specifications

This design was made up of 3 inputs and 1 output, and the overall design was simply a 3 input AND circuit with the help of a 3 input AND gate (74 LS/HC 11). The inputs were posed in green and the sole output was shown in red LEDs, and the LEDs turned on as the value of an input or output turned to ‘1’. The scenario for this could be a simple voting scenario, where the voters make an important decision and only the situation where everyone agrees on the same decision applies.

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

Table 1: Truth Table of the Design

Basic Equation: A.B.C = D

Inputs: A, B, C

Output: D

Methodology and Results

Firstly, I placed the counter and AND gate, horizontally in the middle of the breadboard and connected their Vcc and Ground pins to the (+) and (-) of the breadboard consecutively. Later, I needed to make sure that the counter work properly, so I checked it by connecting it to an oscilloscope. After that, I connected the ‘CEP’, ‘PE’, ‘CET’ and ‘MR’ pins of the counter to the positive side, and left ‘CP’ open ended to connect it to the signal generator cable’s positive side when the design is completed. Later I connected jumper cables to the Q0-Q2 outputs of the counter to connect it to the inputs 1A-1C of the AND gate. I then had my design’s output at 1Y, and was ready to make a path for observations by placing LEDs.

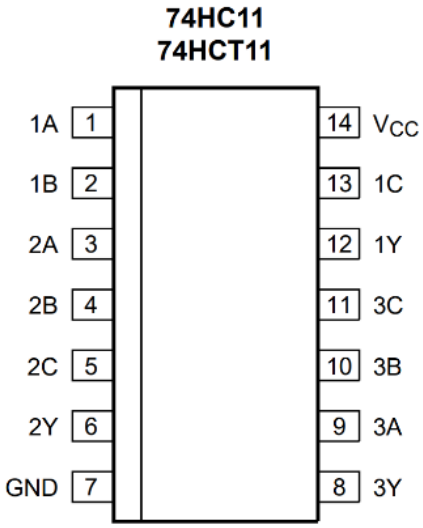

Figure 1: Pins of the 3 input AND gate

I connected each input to a green LED, and the output to a red LED, through a 1K resistor. This is made to make sure that the LEDs do not get harmed by providing an initial voltage drop. The LEDs plus sides are connected to 1K resistors and their negative sides are placed into the negative side of the breadboard. I placed extra jumper cables on the positive and negative sides of the breadboard for connections to power supply and signal generator, and since I did make use of two sides of the breadboard's (+) and (-) sides, I connected them with extra jumpers. I lastly connected the oscilloscope probe to the resistor that connected to the output red LED, and had another extra jumper to the negative side.

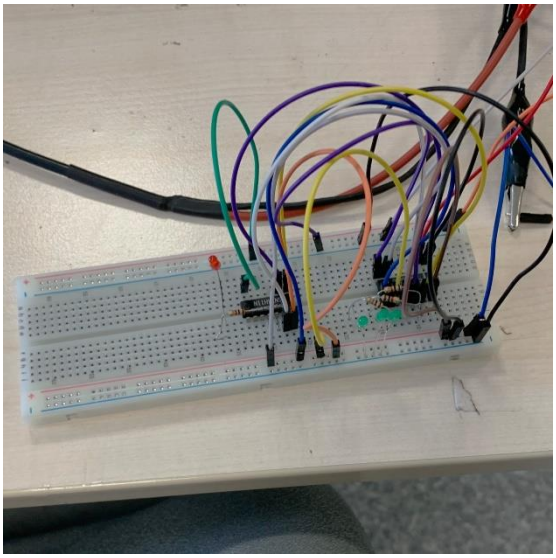

Figure 2: Final Design

The power supply was set to 5V, and the signal generator was set to 2.5 Vpp and 1 Hz, and the final behavior of the circuit was as in figures 3-10.

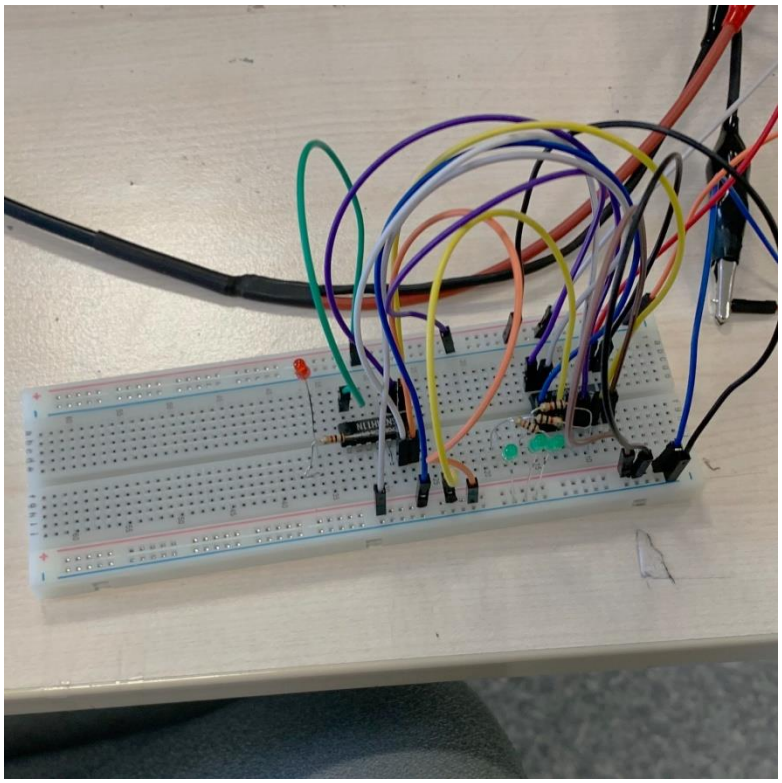

Figure 3: A=0 B=0 C=0 D=0

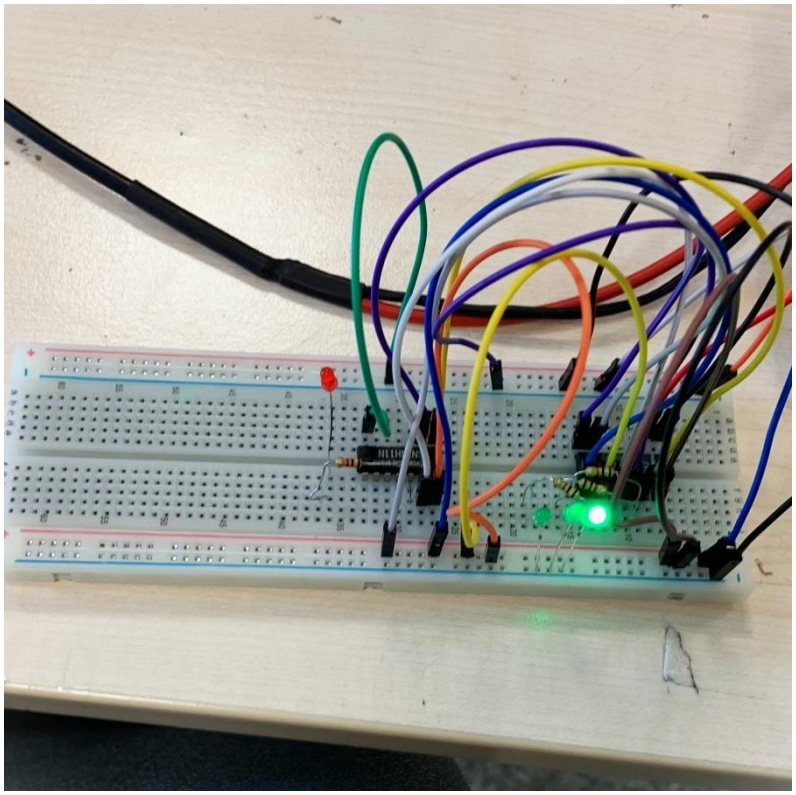

Figure 4: A=1 B=0 C=0 D=0

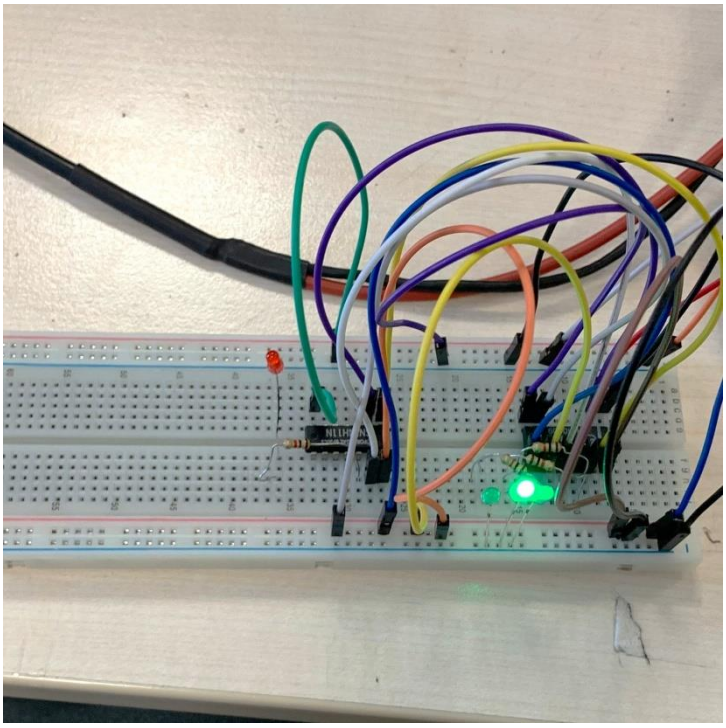

Figure 4: A=0 B=1 C=0 D=0

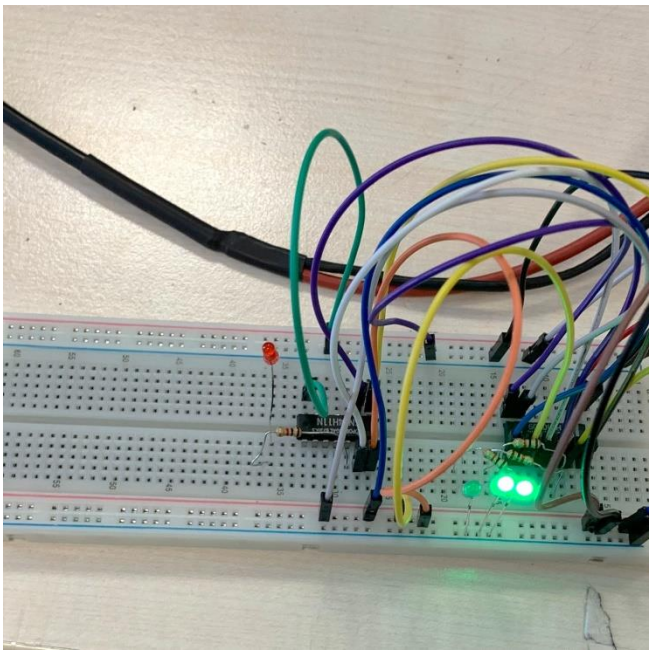

Figure 5: A=1 B=1 C=0 D=0

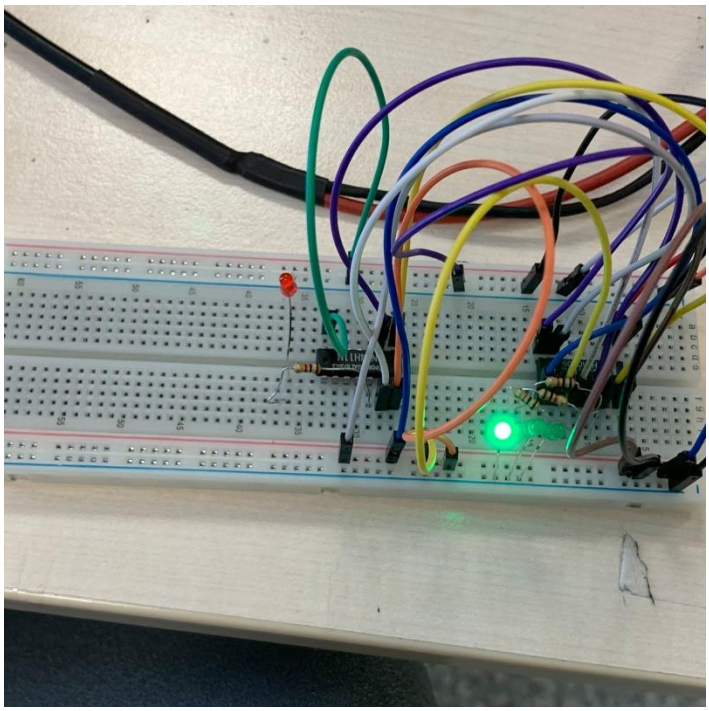

Figure 6: A=0 B=0 C=1 D=0

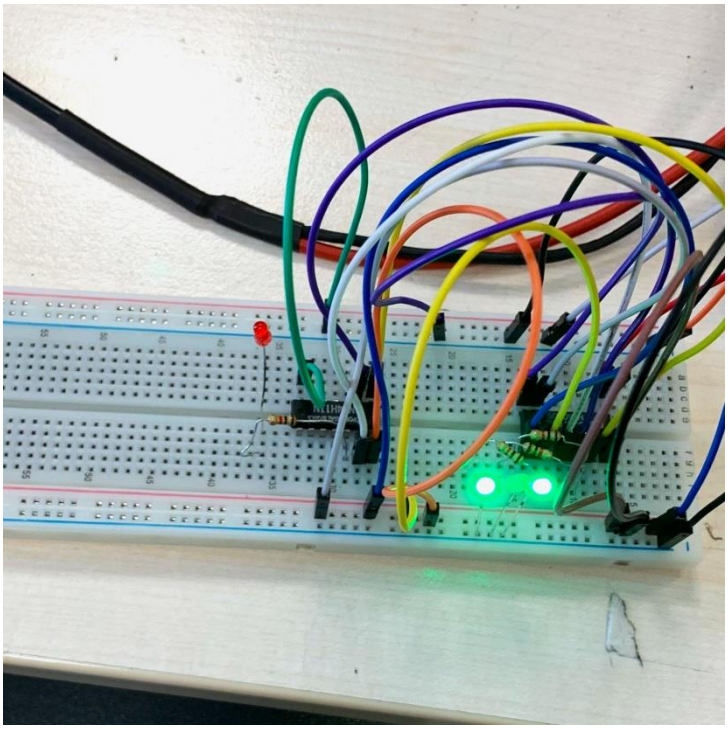

Figure 7: A=1 B=0 C=1 D=0

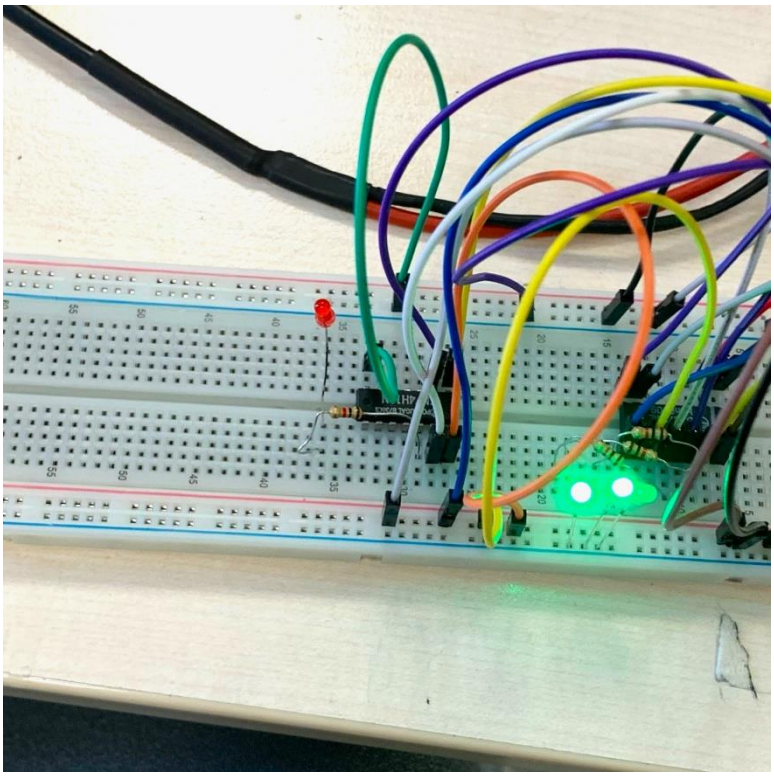

Figure 8: A=1 B=1 C=0 D=0

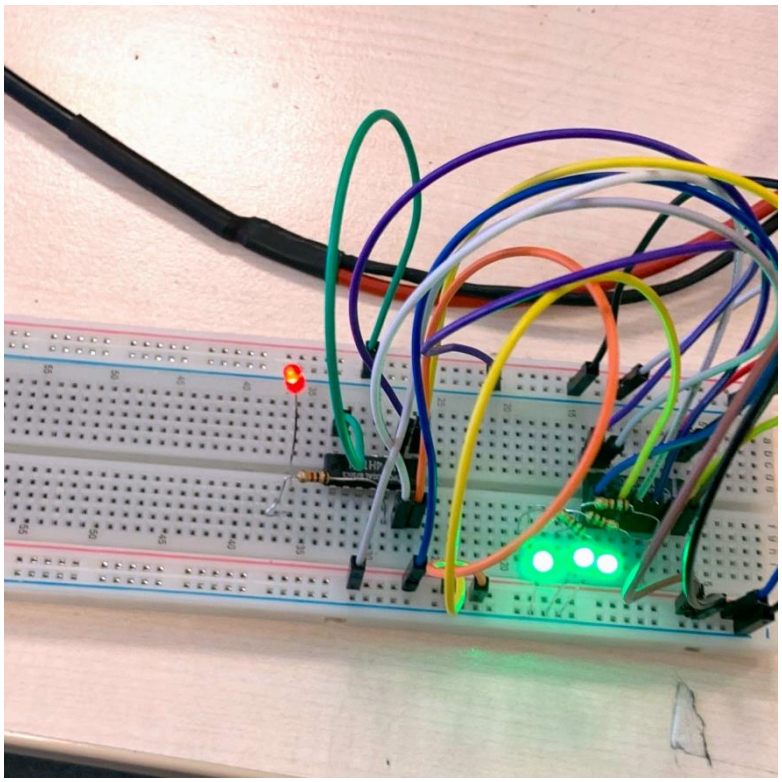

Figure 9: A=1 B=1 C=1 D=1

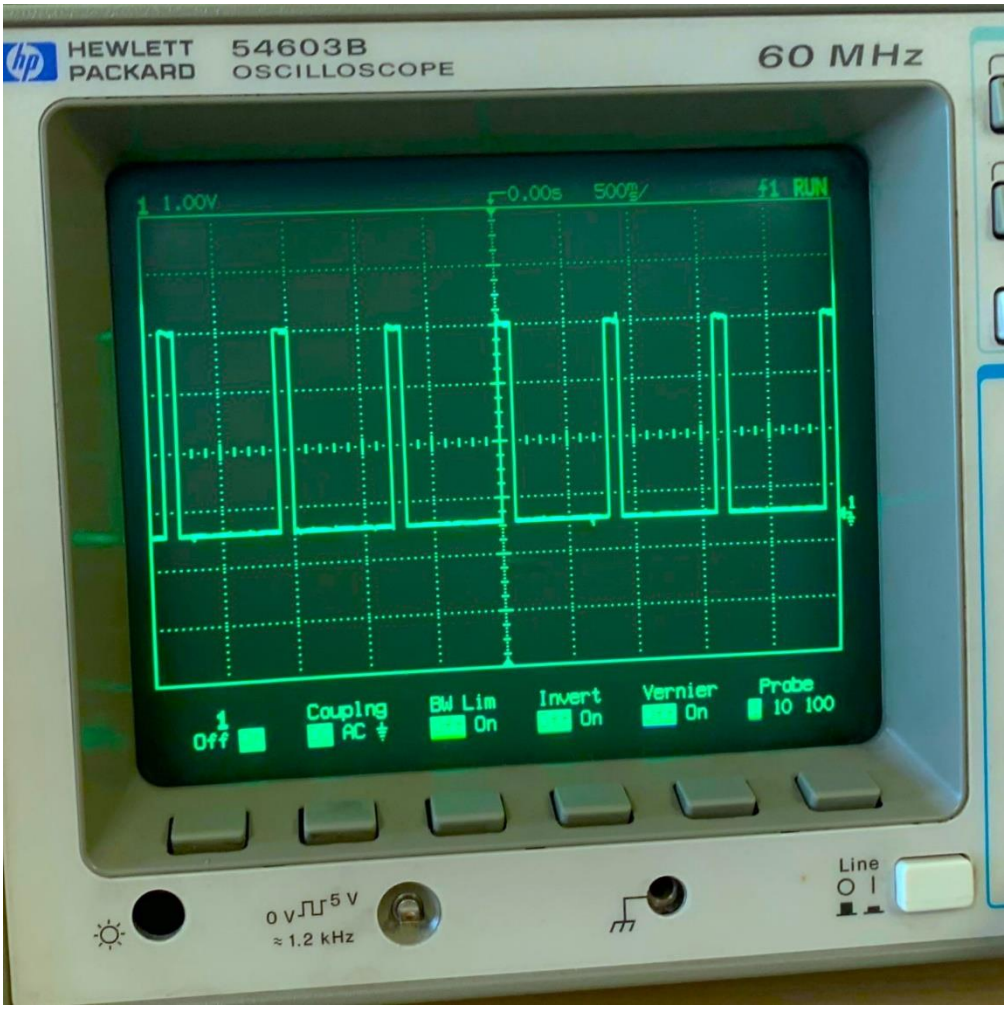

Figure 10: Image on Oscilloscope

Conclusion

The goal of this experiment was to get us more used to lab equipment and logic gates, more importantly counters and timing mechanisms. We used physical equipments in this lab to do that, and got used to checking datasheets and made contact with the theoretical knowledge on the physical world. We learned about 4 bit binary counters and logic gates, checked their documentation, for the first time used resistor to not burn LEDs, observed a pulse wave on the oscilloscope. I used a 3 input AND gate in this lab, a 74 LS/HC 11, and used a counter to check every single possible input, and observed this counting mechanism on LEDs. I mistakenly first set the Coupling on the oscilloscope to AC and firstly was not able to get the correct signal. This lab was useful in terms of understanding the connection between analog and digital components of electronics, way useful for next steps in digital design.

Appendices

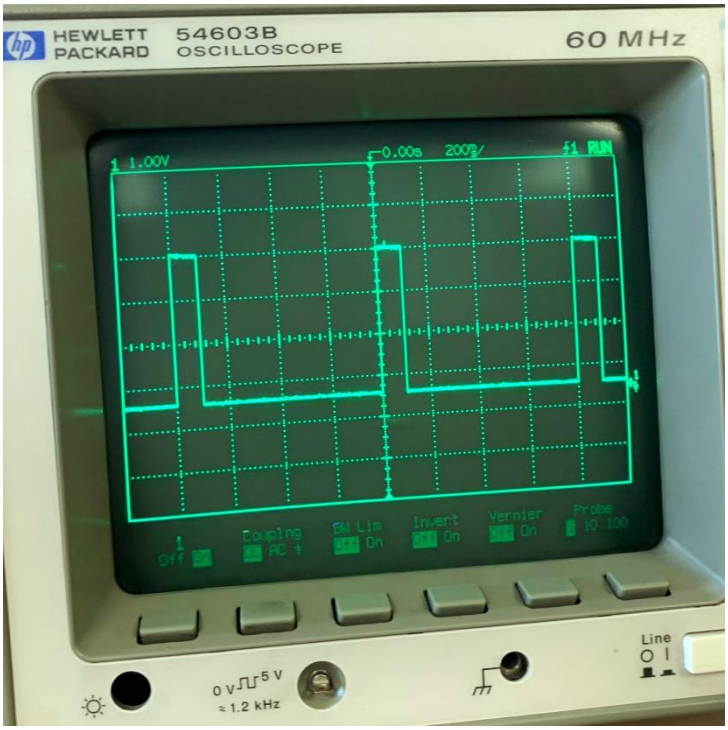

Figure 11: Output on Oscilloscope

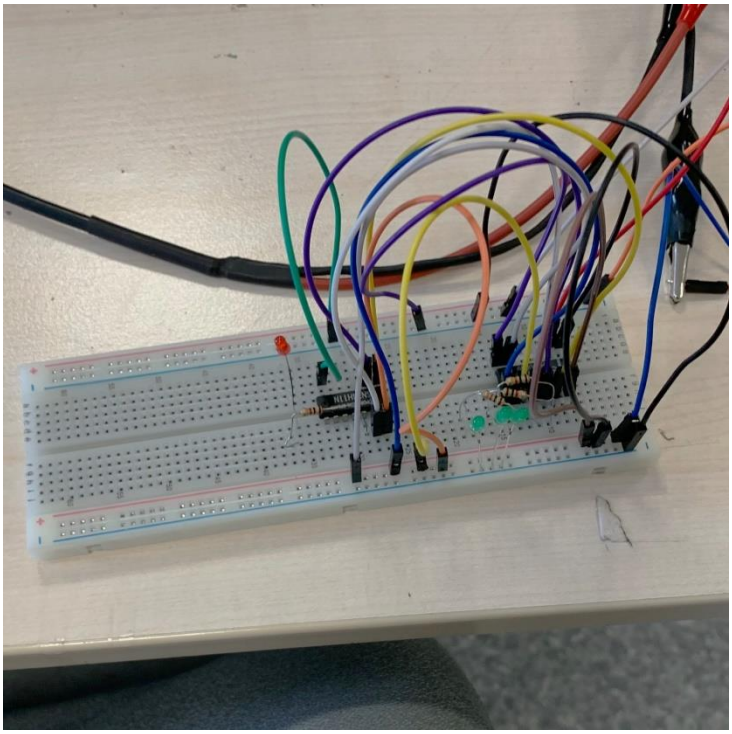

Figure 12: Overall Design