اونيۏرسيتي مليسيا ڤهڠ السلطان عبدالله

UNIVERSITI MALAYSIA PAHANG AL-SULTAN ABDULLAH

FAKULTI TEKNOLOGI KEJURUTERAAN ELEKTRIK DAN ELEKTRONIK

PROJECT

BVI 1214

Technology Skill and Development in Electronic Automation II

Group Members:		
BIL	**STUDENT ID**	**NAME**
1	VC23047	SYAMSUL ARIFIN BIN AWI BOWO
2	VC23053	MUHAMMAD AMIRUL ADLY BIN MOHD RASHIDI
3	VC23052	MOHAMAD AQMAR HARITH BIN KAMAROLZAMAN

TABLE OF CONTENTS

LIST OF DIAGRAM

LIST OF TABLE

1.0 INTRODUCTION

A logic probe is a diagnostic tool used for analyzing digital circuits. It helps determine the logical states of signals within a circuit, indicating whether they are in a high logic state (1) or a low logic state (0). Logic probes typically feature LED indicators that light up based on the detected logic level. They work with both TTL (transistor-transistor logic) and CMOS (complementary metal-oxide semiconductor) logic families and allow you to view the logic level at a specific point in your circuit. Keep in mind that logic probes observe one signal at a time and do not store a record of the signal.

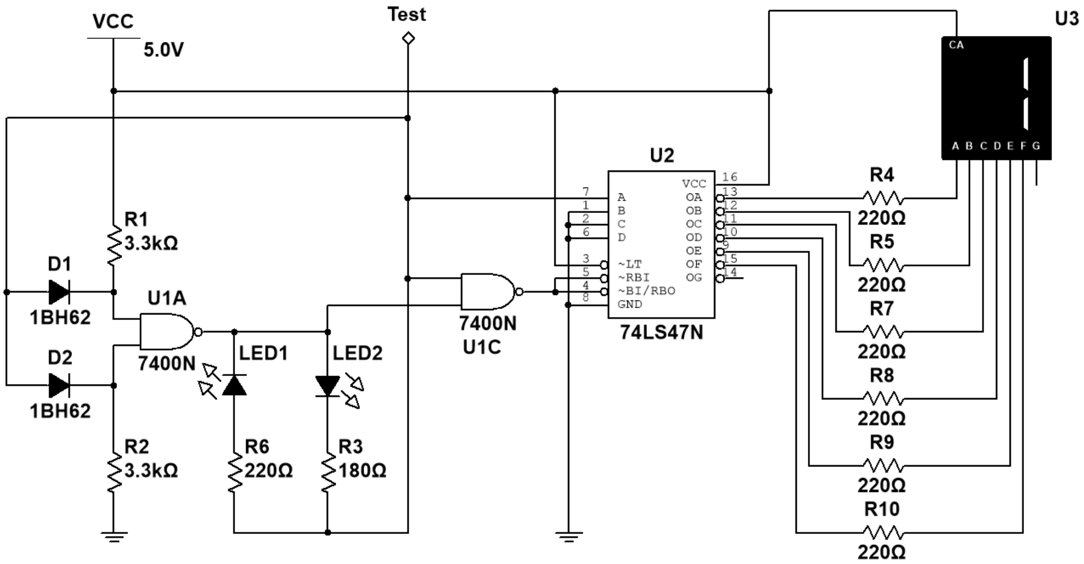

Diagram 1.1 Active low BCD to 7-segment

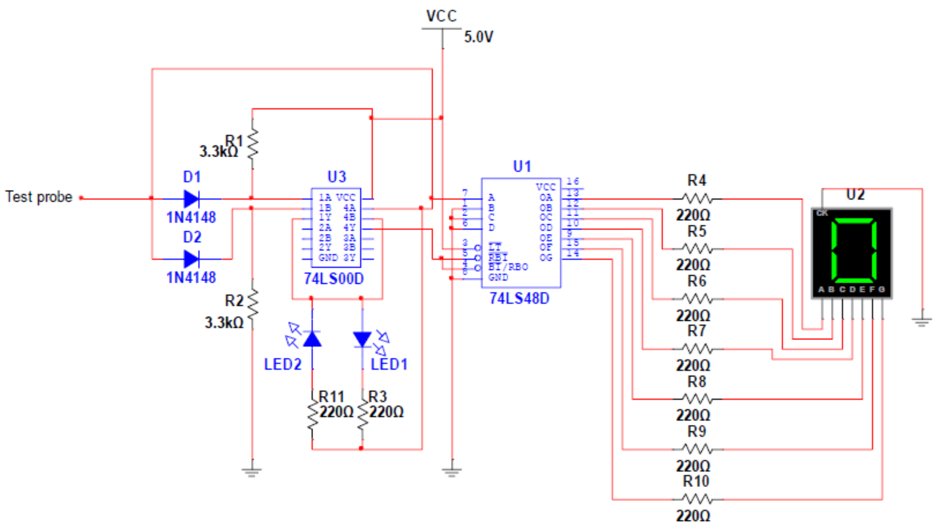

Diagram 1.2 Active High BCD to 7-segment

1.1 BASIC GATE

In the circuit given, there is one basic gate use that is basic gate NAND and IC used in the circuit is IC 74LS00D. IC 74LS00D is IC basic gate NAND

- **Definition**

Digital circuits use the NAND gate, which is a basic logic gate that stands for "not AND gate." If every one of its inputs is true, it yields a low output (0), if not, it yields a high output (1). Stated otherwise, it executes the logical NAND operation. In essence, an AND gate's opposite is a NAND gate. An AND gate and a NOT gate is connected to make its circuit. The symbol for a NAND gate resembles that of an AND gate, but with a bubble drawn at the output point of the AND gate.

- **Truth table and Boolean expression**

$$X = \overline{A.B}$$

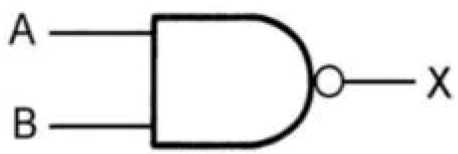

Diagram 1.3 Symbol and Boolean Expression NAND Gate

INPUT		OUTPUT
A	**B**	**X**
0	0	1
0	1	1
1	0	1
1	1	0

Table 1.0 Truth Table NAND Gate

1.2 BCD TO 7 SEGMENT DECODER

In the circuit figure 1a and 1b that used 2 different BCD to 7 segment decoder is 74LS47N and 74LS48D.

- **74LS47N**

  The 7447 IC is an integrated circuit that is a member of the 74xx family of logic devices. It functions as a decoder for BCD (Binary-Coded Decimal) to 7-segment displays. Its main function is to translate a BCD input into an output for a 7-segment display. For display reasons, it specifically decodes BCD values into their corresponding decimal representations. Applications for the 7447 IC include digital counters, clocks, calculators, and other measuring devices.

- **Pin Layout 74LS47N**

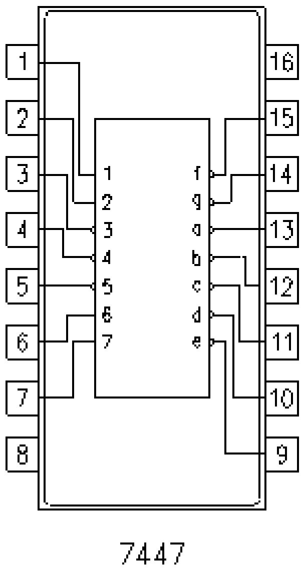

Diagram 1.4 Pin Layout IC 74LS47N

- **Pin Description 74LS47N**

Pin Number	Description
1	BCD B Input
2	BCD C Input
3	Lamp Test
4	RB Output
5	RB Input
6	BCD D Input
7	BCD A Input
8	Ground
9	7-Segment e Output
10	7-Segment d Output
11	7-Segment c Output
12	7-Segment b Output
13	7-Segment a Output
14	7-Segment g Output
15	7-Segment f Output
16	Vcc – Positive Supply

Table 1.1 Pin Description IC 74LS47N

- **Logic diagram 74LS47N**

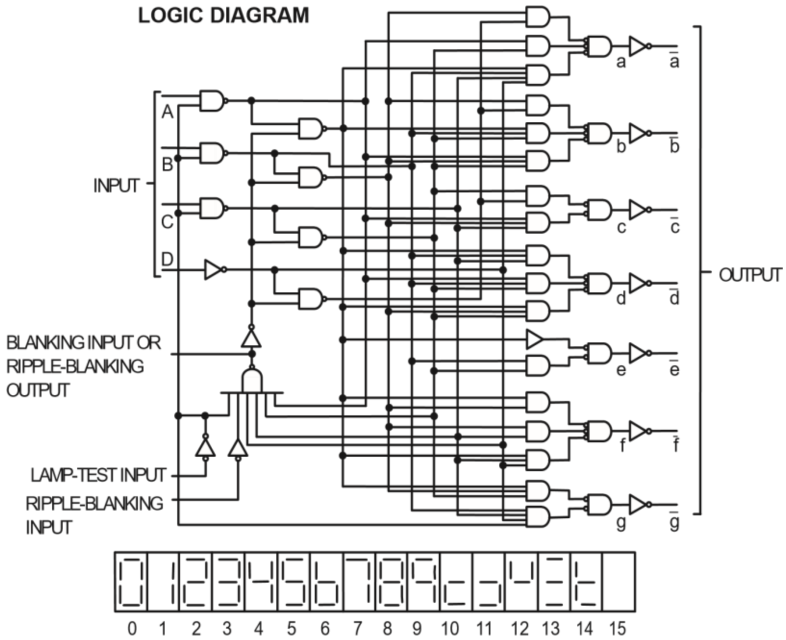

Diagram 1.5 Logic Diagram IC 74LS47N

- **Truth table 74LS47N**

Decimal or Function	Inputs							Outputs						
	LT'	**RBI'**	**A**	**B**	**C**	**D**	**BI / RBO'**	**a**	**b**	**c**	**d**	**e**	**f**	**g**
0	H	X	L	L	L	L	H	L	L	L	L	L	L	H
1	H	X	L	L	L	H	H	H	L	L	H	H	H	H
2	H	X	L	L	H	L	H	L	L	H	L	L	H	L
3	H	X	L	L	H	H	H	L	L	L	L	H	H	L
4	H	X	L	H	L	L	H	H	L	L	H	H	L	L
5	H	X	L	H	L	H	H	L	H	L	L	H	L	L
6	H	X	L	H	H	L	H	H	H	L	L	L	L	L
7	H	X	L	H	H	H	H	L	L	L	H	H	H	H
8	H	X	H	L	L	L	H	L	L	L	L	L	L	L
9	H	X	H	L	L	H	H	L	L	L	H	H	L	L
10	H	X	H	L	H	L	H	H	H	H	L	L	H	L
11	H	X	H	L	H	H	H	H	H	L	L	H	H	L
12	H	X	H	H	L	L	H	H	L	H	H	H	L	L
13	H	X	H	H	L	H	H	L	H	H	L	H	L	L
14	H	X	H	H	H	L	H	H	H	H	L	L	L	L
15	H	X	H	H	H	H	H	H	H	H	H	H	H	H
BI'	X	X	X	X	X	X	L	H	H	H	H	H	H	H
RBT'	H	L	L	L	L	L	L	H	H	H	H	H	H	H
LT'	L	X	X	X	X	X	H	L	L	L	L	L	L	L

H = HIGH voltage
L = LOW voltage
X = Don't care

Table 1.3 Truth Table IC 74LS47N

- **74LS48D**

IC 74LS48D is a BCD to 7segment decoder IC. IC 74LS48D takes a 4-bit BCD input (A, B, C, D) and converts it into the 7segment display pattern. It commonly used to display numeric value 0-9 on a segment display. 74LS48D is design for common cathode display only.

- **Pin layout 74LS48D**

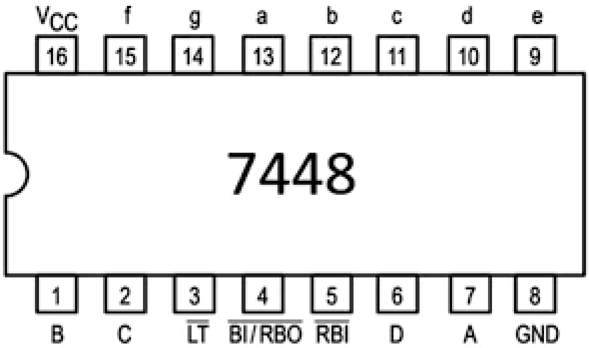

Diagram 1.6 Pin Layout 74LS48D

❖ **Pin Description 74LS47N**

Pin Number	Description
1	BCD B Input
2	BCD C Input
3	Lamp Test
4	RB Output
5	RB Input
6	BCD D Input
7	BCD A Input
8	Ground
9	7-Segment e Output
10	7-Segment d Output
11	7-Segment c Output

12	7-Segment b Output
13	7-Segment a Output
14	7-Segment g Output
15	7-Segment f Output
16	Vcc – Positive Supply

Table 1.4 Pin Description IC 74LS48D

- **Logic diagram 74LS48D**

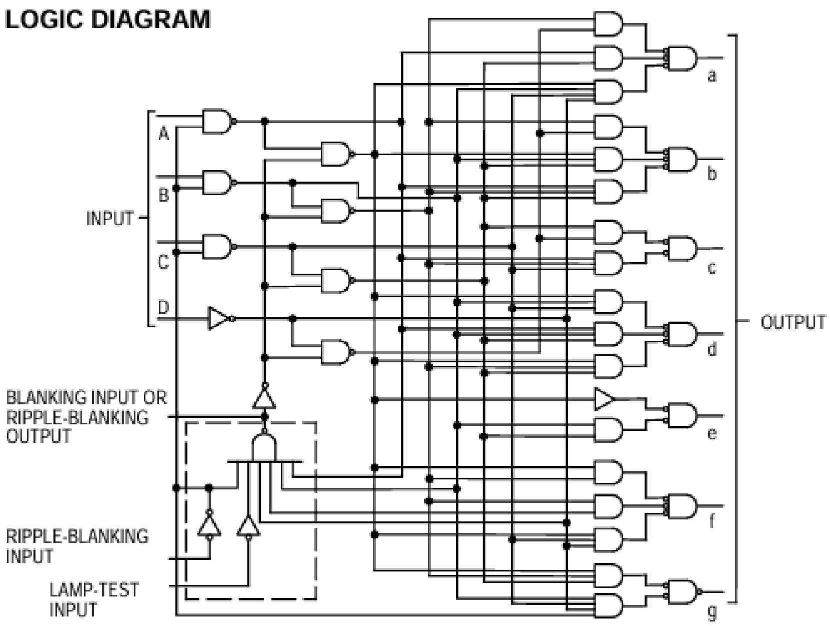

Diagram 1.7 Logic Diagram IC 74LS48D

- **Truth table 74LS48D**

Decimal or Function	Inputs							Outputs						
	LT'	**RBI'**	**A**	**B**	**C**	**D**	**BI / RBO'**	**a**	**b**	**c**	**d**	**e**	**f**	**g**
0	H	X	L	L	L	L	H	H	H	H	H	H	H	L
1	H	X	L	L	L	H	H	L	H	H	L	L	L	L
2	H	X	L	L	H	L	H	H	H	L	H	H	L	H
3	H	X	L	L	H	H	H	H	H	H	H	L	L	H
4	H	X	L	H	L	L	H	L	H	H	L	L	H	H
5	H	X	L	H	L	H	H	H	L	H	H	L	H	H
6	H	X	L	H	H	L	H	L	L	H	H	H	H	H
7	H	X	L	H	H	H	H	H	H	H	L	L	L	L
8	H	X	H	L	L	L	H	H	H	H	H	H	H	H
9	H	X	H	L	L	H	H	H	H	H	L	L	H	H
10	H	X	H	L	H	L	H	L	L	L	H	H	L	H
11	H	X	H	L	H	H	H	L	L	H	H	L	L	H
12	H	X	H	H	L	L	H	L	H	L	L	L	H	H
13	H	X	H	H	L	H	H	H	L	L	H	L	H	H
14	H	X	H	H	H	L	H	L	L	L	H	H	H	H
15	H	X	H	H	H	H	H	L	L	L	L	L	L	L
BI'	X	X	X	X	X	X	L	L	L	L	L	L	L	L
RBT'	H	L	L	L	L	L	L	L	L	L	L	L	L	L
LT'	L	X	X	X	X	X	H	H	H	H	H	H	H	H

H = HIGH voltage
L = LOW voltage
X = Don't care

Table 1.6 Truth Table IC 74LS48D

1.3 7-SEGMENT DISPLAY

A seven-segment display is a form of electronic display device for displaying decimal numerals that is an alternative to the more complex dot matrix displays. Seven-segment displays are widely used in digital clocks, electronic meters, basic calculators, and other electronic devices that display numerical information.

- **Type of 7 segment display**

  7segment have 2 type which is a common anode and common cathode. Every type of this display has a different functionality with 2 configurations, that is common anode usually connect its common pin to VCC while the common pin of the common cathode connects to ground.

- **7 Segment available for Active Low**

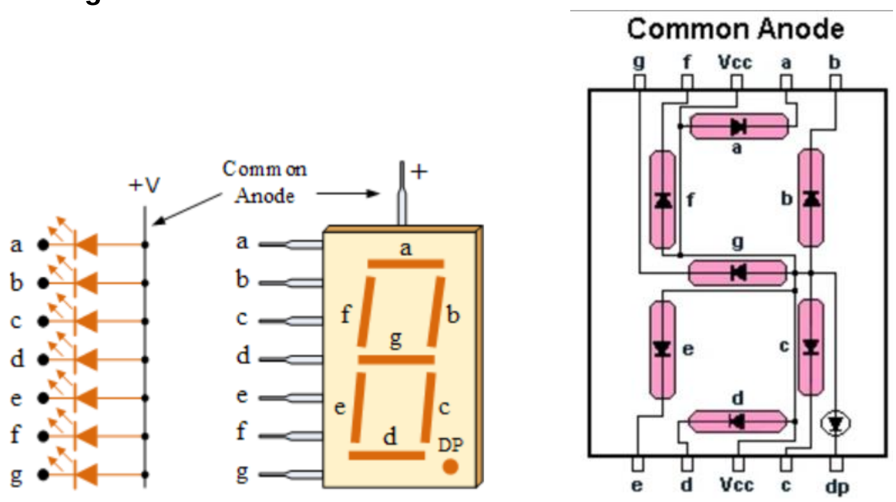

Diagram 1.8 7-segment Active Low

- **7 Segment available for Active High**

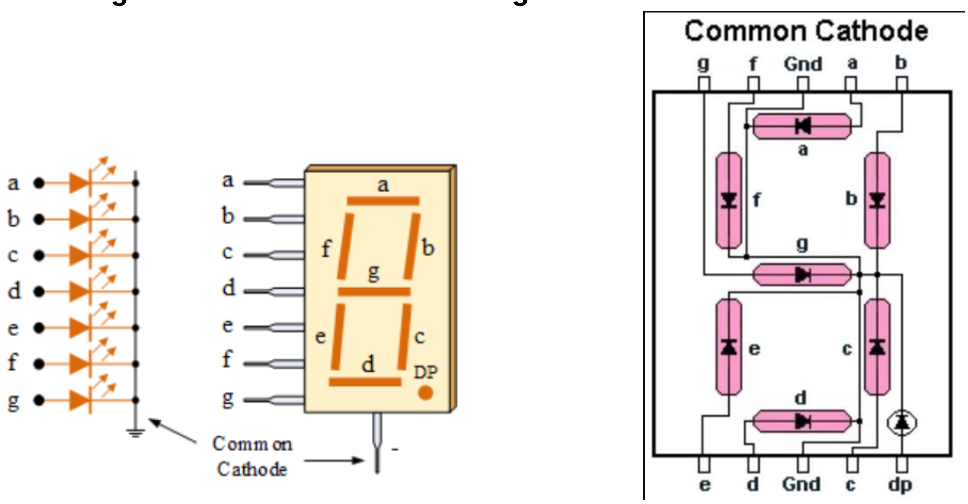

Diagram 1.9 7-segment Active High

2.0 SIMULATION AND DESIGN PCB

We have two major tasks to complete for this project: Task 2 and Task 3. In Task 2, the circuit is virtually built using specialized software tools. This enables us to replicate the functioning of the circuit in a regulated setting. Task 3, on the other hand, focuses to develop the circuit physically using hardware components. We can now test and use the circuit during actual conditions because of this stage of development.

2.1 Sub-circuit

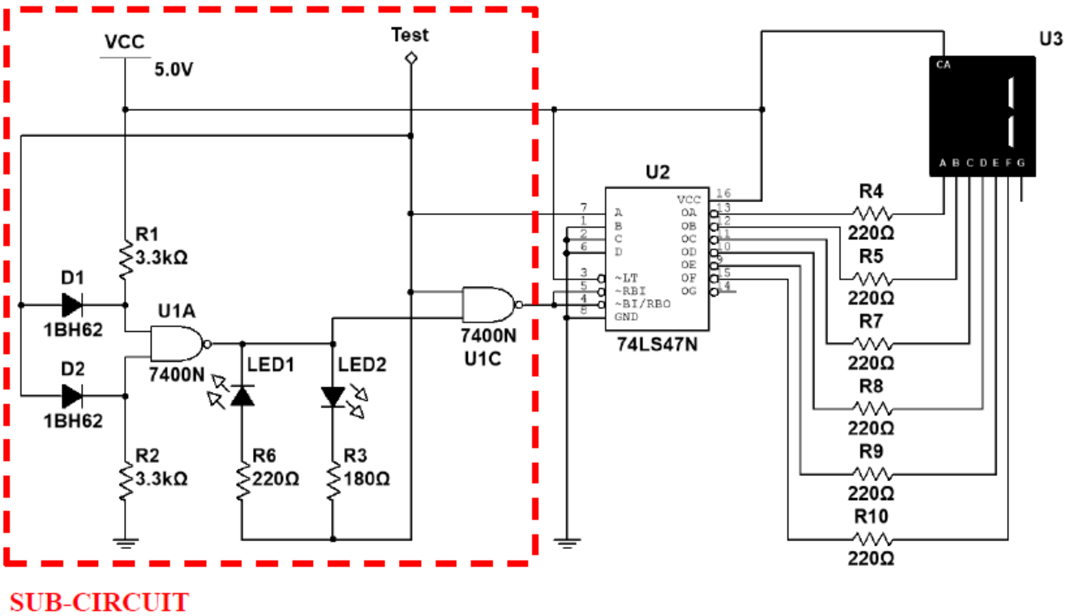

Diagram 2.0 Sub-Circuit

- **Simulation and Discussions**

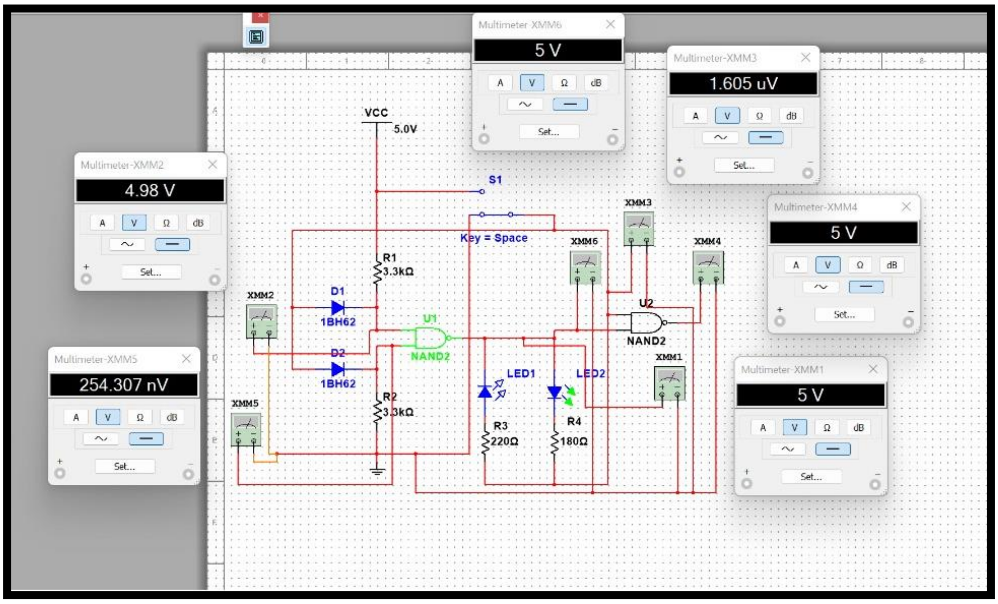

Diagram 2.1 Test Input Low Using Multisim

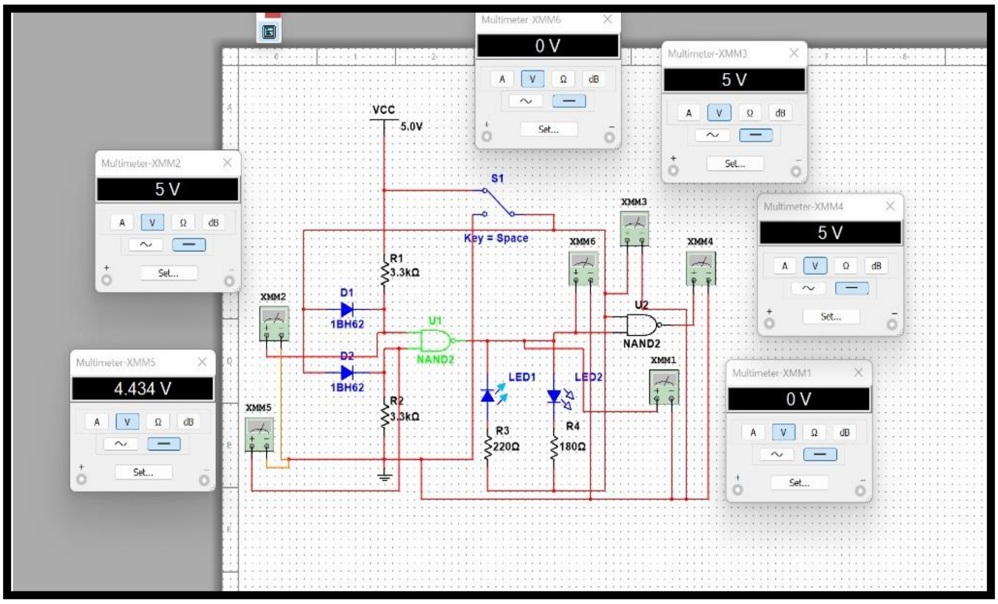

Diagram 2.2 Test Input High Using Multisim

Test	Voltage Input gate		Voltage Output	Led 1	Led 2
	A	B			
Low	4.98V	0V	5V	Off	On
High	5V	4.4V	0V	On	Off

Table 1.7 Result of Simulation Sub-circuit

When the Test Switch is Low, the voltage of the input A is 1(High) and the input B is 0(Low) so the output of the and gate will be 0 but in this situation 0 output will be inverted to 1 because of the NAND gate and led 2 will turn ON because it is an Active High Led.

Otherwise, if the Test Switch become High, the both input of the gate will be 1(High) and the output will be 0(Low) because NAND gate will invert the output value of the and gate. Then the Led 1 is ON because of the active low function while Led 2 will turn Off if receiving Low input value.

2.2 Full Circuit

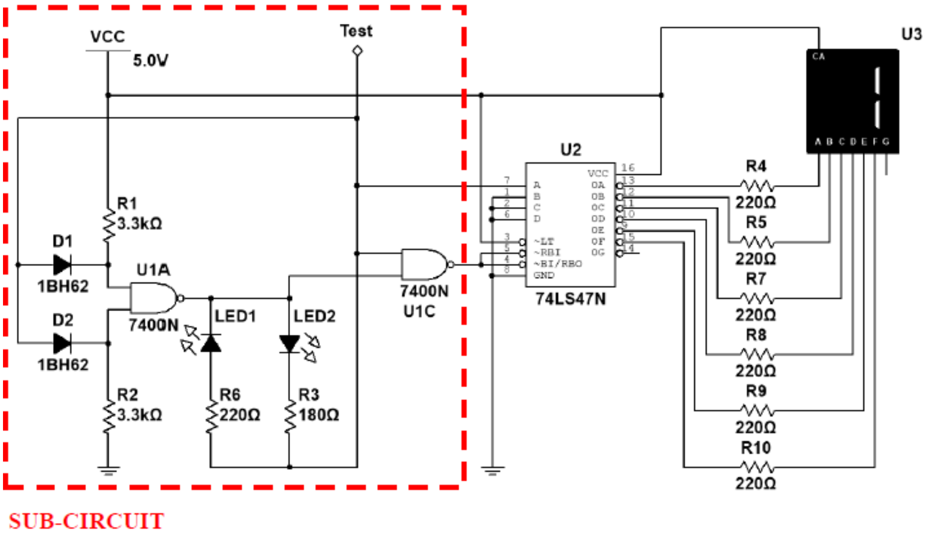

Diagram 2.3 Full Circuit

- **Simulation And Discussions**

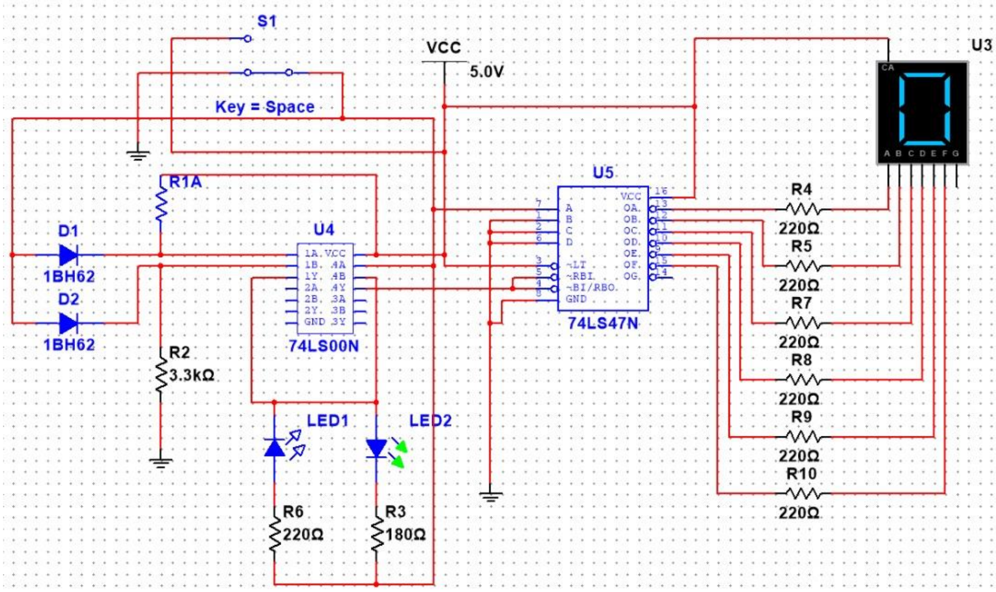

Diagram 2.4 Test low, led 1off and led 2 on then 7segment display ‘0’

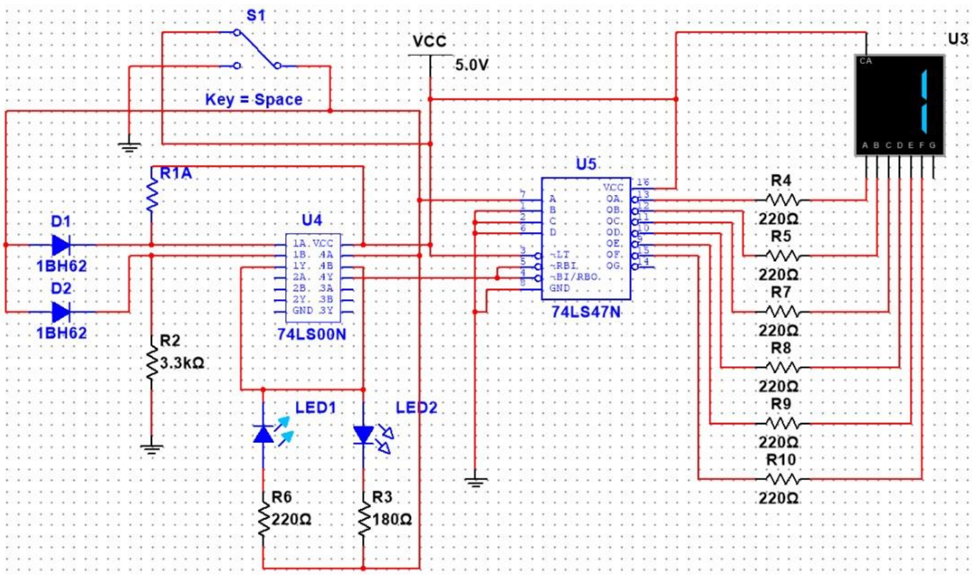

Diagram 2.5 Test High, led 1 on and led 2 off then 7segment display ‘1’

TEST	U4						LED 1	LED 2	7 SEGMENT DISPLAY
	1A	1B	1Y	4A	4B	4Y			
Low	1	0	1	0	1	1	Off	On	0
High	1	1	0	1	0	1	On	Off	1

Table 1.8 Result of Simulation Full Circuit

The 7-segment display circuit is depicted in Figure 3. This circuit only displays the decimal numbers 0 and 1. Simulate the circuit and respond to the following question. To understand the circuit operation, please refer to the IC7447 datasheet. Test your circuit using DC Interactive Voltage.

I. What the difference between common cathode 7-segment and common anode 7-segment?

   Common cathode is active when give input active high (1), while common anode is active when give input active low (0)

II. What is the difference between IC7447 and IC7448?

   IC 7447 is suitable for circuit common anode display, while IC 7448 is suitable for common cathode display

III. Why is only input A linked to the Test input?

   Because display output of 7segment are depends on the BCD input A. Example if we give test input low so 7segment will show 0, while test input is high the 7segment will show 1

IV. Why are inputs B, C, and D are grounded?

   Because we want 7 segment display 1 and 0 only. To make 1 and 0 display input B, C, and D must be 0 and only input A will changeover 0 or 1. 0000 input is for display ‘0’ and 1000 is for display ‘1’ for the active low configuration.

V. Why is LT’ connected to VCC?

   To disable lamp test mode and allow IC 7447 to display the correct digit base on BCD input.

VI. What are the functions of RBI and BT/RBO?

   Function of RBI is to ripple blanking input when BCD input corresponds to a leading 0. While function RBO is to ripple blinking output manually blanks all segment for power saving and display control when it’s grounded.

VII. How does changing the RBI and BT/RBO' input values affect the decoder's output? Analyse the results and present them in a table.

RBI & RBO	7segment output						DISPLAY
	a	b	c	d	e	f	
0	0	0	0	0	0	0	blank
1	0	1	1	0	0	0	1

Table 1.9 Result of Simulation RBI & RBO

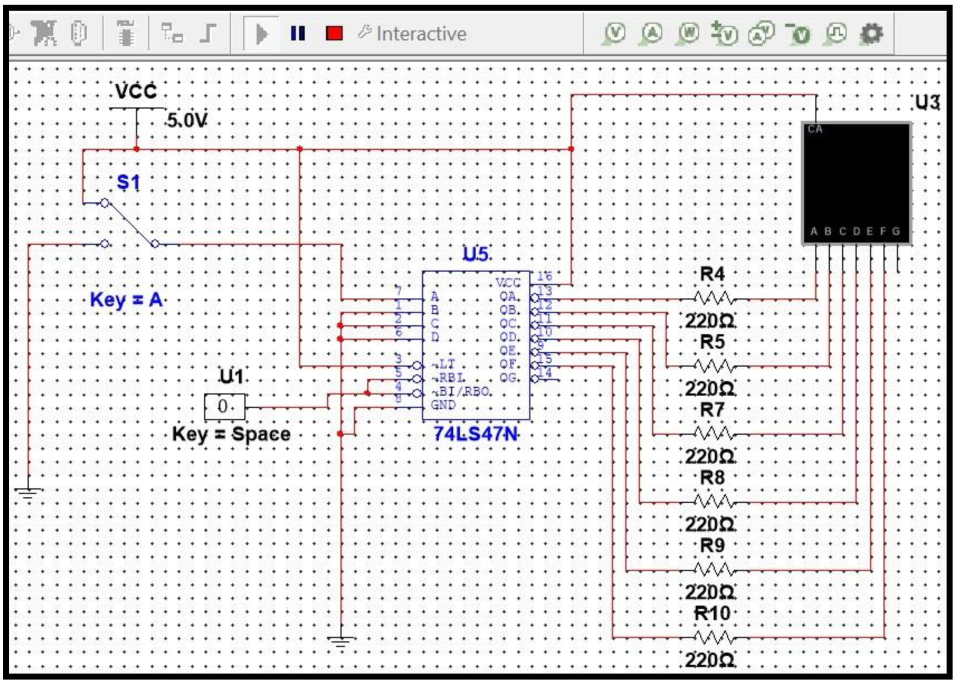

Diagram 2.6 When RBI & RBO is 0, display blank

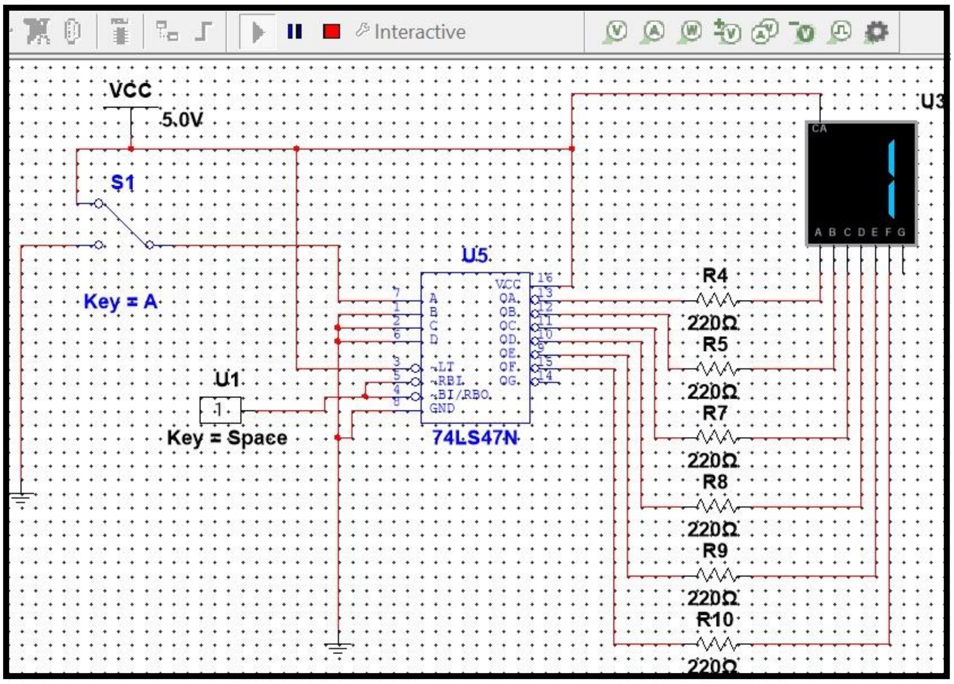

Diagram 2.7 When RBI & RBO is 1, display 1

2.3 Circuit on PCB

We have selected EasyEDA as our software tool to design a BCD (Binary-Coded Decimal) to 7-segment display circuit. EasyEDA offers a user-friendly interface, comprehensive component libraries, and easy for designing making it an excellent choice for this project.

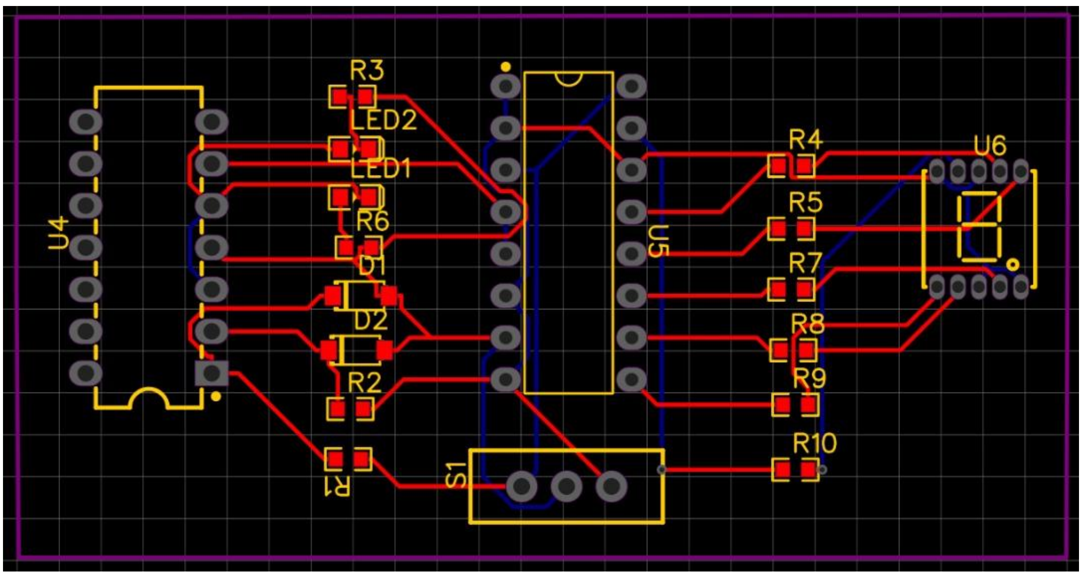

Diagram 2.8 Design PCB on EasyEDA

3.0 HARDWARE IMPLEMENTATION

This is a list of components required to perform hardware installation:

I. Breadboard
II. Diode 1BH62
III. Resistor 3.3KΩ
IV. Resistor 220Ω
V. LED Diode
VI. IC 74LS00D
VII. IC 74LS48P
VIII. 7-segment Cathode

- **Result and Discussions**

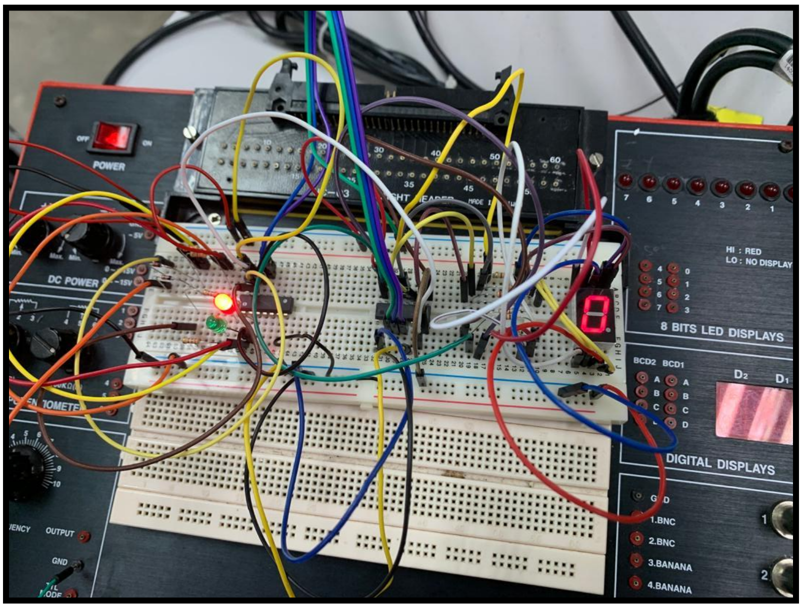

Diagram 2.9 Result of Implement 1

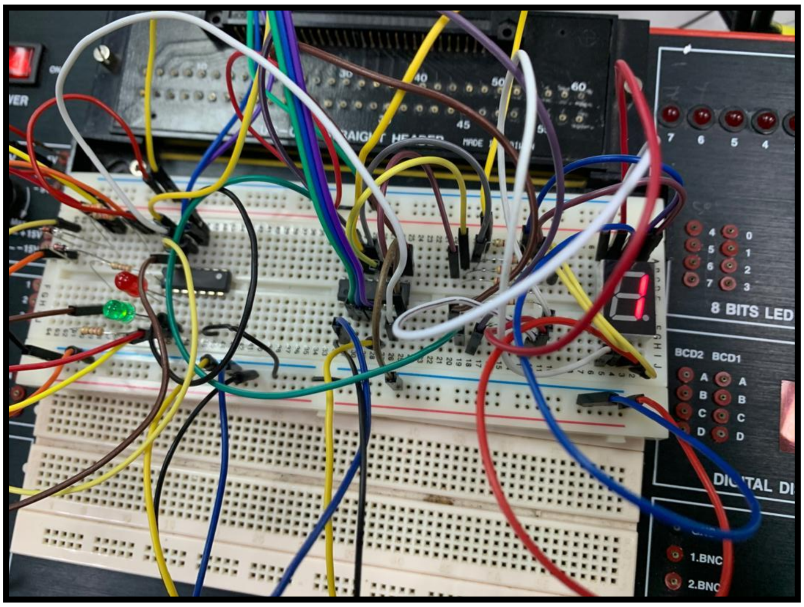

Diagram 3.0 Result of Implement 2

Test	Voltage Input gate		Voltage Output	Led 1	Led 2
	A	B			
0	1.51V	0.67V	3.3V	Off	On
1	2.85V	2.11V	0.25V	On	Off

Table 2.0 Result of Hardware Implementation

In this case, the NAND gate will cause the 0 output to be inverted to 1, turning on led 2 because it is an active high led. When the test probe is low, the voltage of input A is 1 (High) and the input B is 0 (Low), resulting in the output of the and gate being 0.

If the test probe becomes high, on the other hand, the NAND gate will flip the output value of the and gate, resulting in both the input and output of the gate being 1 (High) and 0 (Low). Then, due to the active low function, led 1 is ON, and Led 2 will switch off if it receives a low input value.

- **Comparison Result**

Here some discussion about comparison result between Simulation and Hardware Voltage I/O result

Voltage Inputs :

In the Low test condition, the simulation voltage input A is more higher (4.98V) compared to the hardware voltage input A (1.51V), simulation voltage input B are slightly lower (0V) than hardware voltage input B (0.67V). In the High test condition, the simulation voltage input A also more higher (5V) than hardware voltage input A (2.85V) while simulation voltage input B more higher (4.4V) than voltage input B (2.11V).

Voltage Outputs :

The voltage output of Low test condition in simulation are higher (5V) than hardware voltage output (3.3V). In the High test condition, hardware voltage output are slightly higher (0.25V) than simulation voltage output (0V).

LED States:

The LED states are consistent between the simulation and hardware results. In both cases, for the Low condition, LED 1 is Off and LED 2 is On, and for the High condition, LED 1 is On and LED 2 is Off.

4.0 IMPLEMENTATION TO DONUT BOARD

- When give input high to the circuit

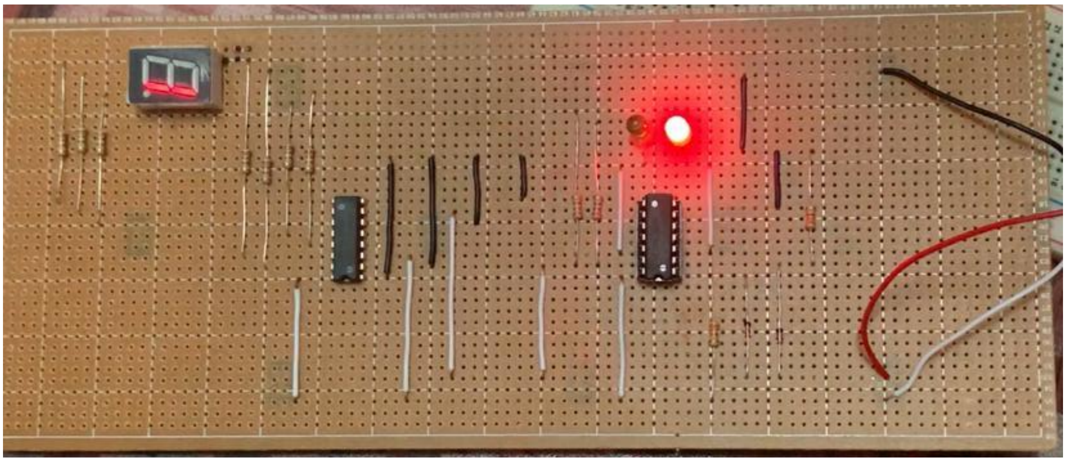

Diagram 3.1 Result for Hardware 1

- When give input Low to the circuit

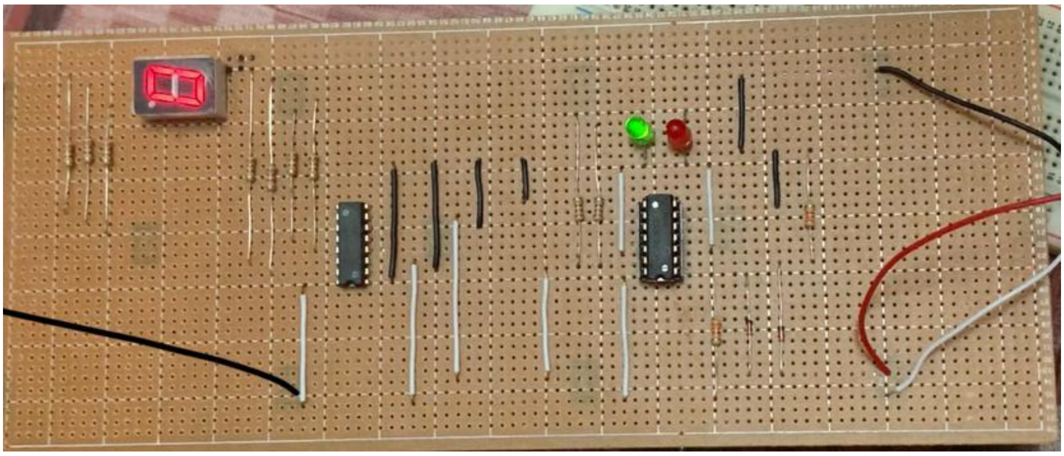

Diagram 3.2 Result for hardware 2

5.0 CONCLUSION

In this project, we set out to design, simulate, and build a digital logic circuit that converts a BCD (Binary-Coded Decimal) input into a display on a 7-segment screen using NAND gates and specific decoder ICs (74LS47N and 74LS48D). This process, from virtual simulation to physical creation, has shown us how theoretical concepts in digital electronics come to life.

We began by understanding how a logic probe works to diagnose digital circuits, identifying whether signals are high (1) or low (0). We then explored the operation of NAND gates, which are fundamental in digital circuits, reinforcing our understanding of basic logic operations.

Our investigation into BCD to 7-segment decoders focused on the 74LS47N and 74LS48D ICs. Learning the differences between these decoders was crucial for correctly using them with common anode and common cathode displays. Through examining pin descriptions, logic diagrams, and truth tables, we learned how these decoders translate BCD inputs into 7-segment display outputs.

Using Multisim for simulation, we tested and analyzed our circuit designs, allowing us to identify and fix potential issues before physical implementation. Designing the PCB with EasyEDA gave us hands-on experience in creating a physical board layout, preparing us for real-world PCB production.

Building the circuit on a breadboard enabled us to validate our simulations, observe actual behavior, and troubleshoot any discrepancies. We found that real-world conditions, such as variations in voltage levels, can affect the circuit differently than in simulations. We also addressed key questions, such as the differences between common cathode and common anode displays, the functions of IC7447 and IC7448, and the role of various inputs in the decoder ICs.

The project highlighted the practical applications of digital logic in everyday devices like digital clocks and counters. Future work could involve expanding the circuit to display more digits, incorporating microcontrollers for enhanced functionality, or exploring more complex display systems like dot matrix or LCDs.

In conclusion, this project provided a comprehensive understanding of digital logic circuits, from theory to practical implementation. The experience gained through simulation, PCB design, and hardware construction is invaluable for future projects in electronics and engineering. Our ability to troubleshoot, analyze, and improve our designs will be a strong foundation for tackling more complex projects in the future.

6.0 REFERENCE

alldatasheet.com. (n.d.-a). *74LS47D download*. Pdf1.Alldatasheet.com. Retrieved June 15, 2024, from https://pdf1.alldatasheet.com/datasheetpdf/download/12659/ONSEMI/74LS47D.html

alldatasheet.com. (n.d.-b). *74LS48 datasheet(pdf)*. Www.alldatasheet.com. Retrieved June 15, 2024, from https://www.alldatasheet.com/datasheetpdf/pdf/5727/MOTOROLA/74LS48.html

Electronics Tutorials. (2018, February 16). *7-segment display and driving a 7-segment display*. Basic Electronics Tutorials. https://www.electronics-tutorials.ws/blog/7-segment-display-tutorial.html

Logic AND Function - Digital Logic Gates. (2013, July 26). Basic Electronics Tutorials. https://www.electronics-tutorials.ws/boolean/bool_1.html