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Objectives

- Familiarization with 1-bit comparator using logic gates.
- Realization and implementation of 2-bit comparator using logic gates on breadboard.
- Implementation of 4-bit magnitude comparator on breadboard using IC 7485.
- Implementation of 8-bit magnitude comparator on Proteus using IC 7485

Components Required

- Breadboard
- IC Type 7486 Quadruple 2-input XOR Gate
- IC Type 7408 Quadruple 2-input AND gates.
- IC Type 7400 Quadruple 2-input NAND gates.
- IC Type 7410 Triple 3-input NAND gates.
- IC Type 74L85 4-bit magnitude comparator.
- Switches for inputs and
- LED displays for outputs.

Theory Overview

Magnitude Comparators

The Digital Comparator is another very useful combinational logic circuit used to compare the value of two binary digits. Digital or Binary Comparators compare the digital signals present at their input terminals and produce an output depending upon the condition of those inputs. These outputs are either A>B, or A=B or A<B.

1-bit Magnitude Comparator

A comparator used to compare two 1-bit binary numbers. It has two binary inputs A, B and three binary outputs: greater than, equal and less than relations. Figure below shows the block diagram and truth table

of a 1-bit magnitude comparator

Block Diagram

Figure 1: Block Diagram

Truth Table

A	B	A=B	A<B	A>B
0	0	1	0	0
0	1	0	1	0
1	0	0	0	1
1	1	1	0	0

Figure 2: Truth Table

Circuit Diagram

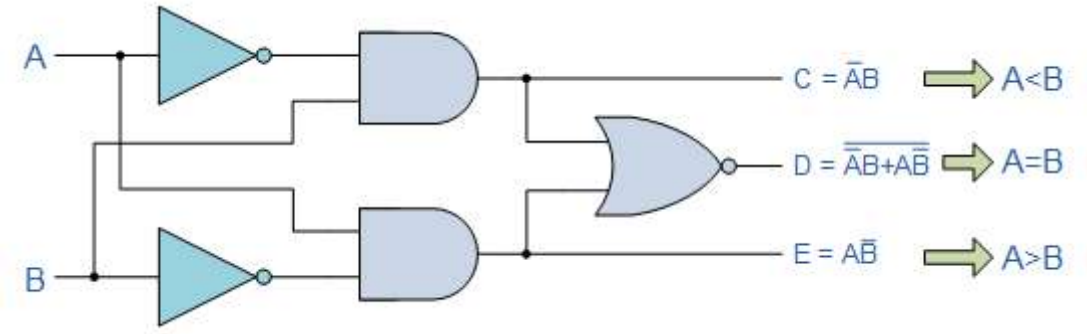


Figure 3: Circuit Diagram of 1 Bit Comparator

Breadboard Implementation:

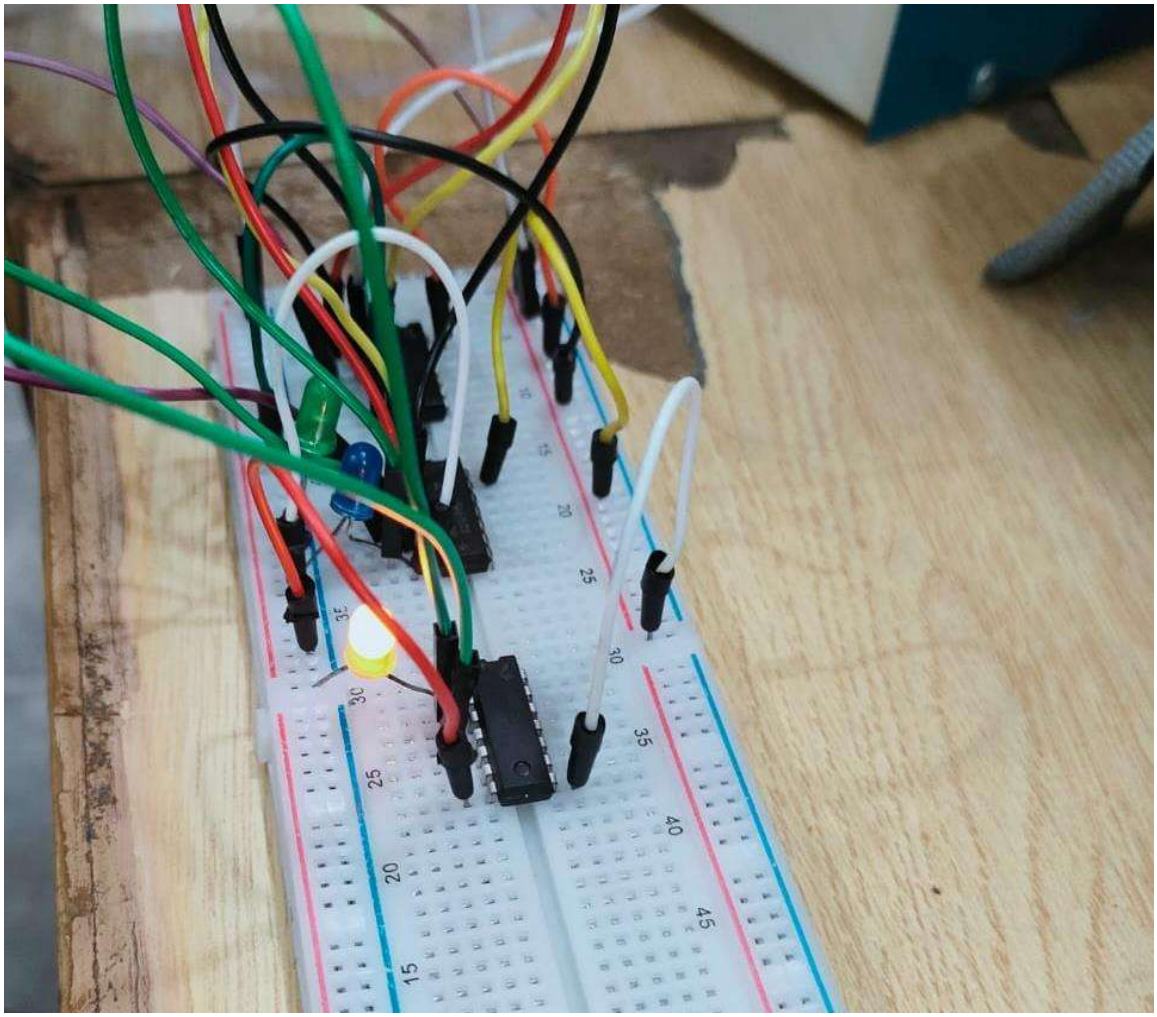


Figure 4: ! bit Magnitude Comparator

2-bit Magnitude Comparator

A comparator used to compare two 2-bit numbers. It has 4 binary inputs (number A: A1A0, number B: B1B0) and 3 binary outputs: greater than, equal and less than relations. Figure below shows the block diagram and truth table of a 2-bit magnitude comparator.

Block Diagram : 2-bit Comparator

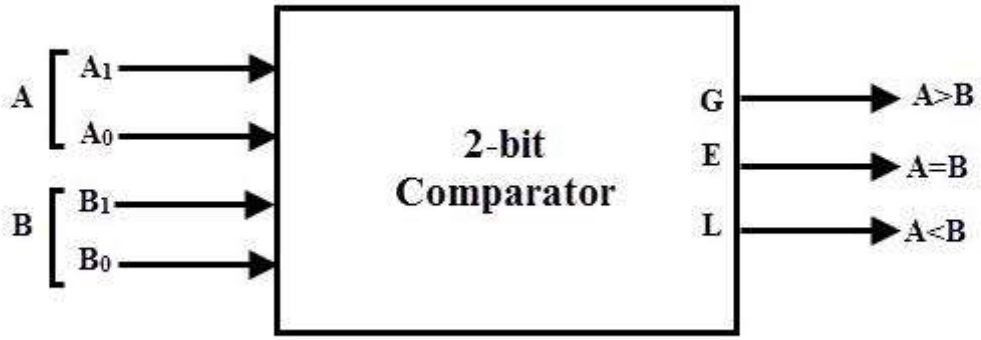


Figure 5: Block Diagram

Truth Table

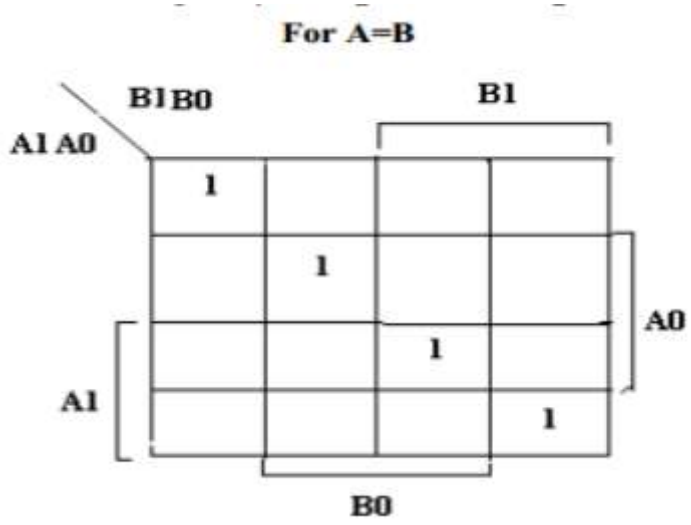
Inputs				Outputs		
A_1	A_0	B_1	B_0	A>B	A=B	A<B
0	0	0	0	0	1	0
0	0	0	1	0	0	1
0	0	1	0	0	0	1
0	0	1	1	0	0	1
0	1	0	0	1	0	0
0	1	0	1	0	1	0
0	1	1	0	0	0	1
0	1	1	1	0	0	1
1	0	0	0	1	0	0
1	0	0	1	1	0	0
1	0	1	0	0	1	0
1	0	1	1	0	0	1
1	1	0	0	1	0	0
1	1	0	1	1	0	0
1	1	1	0	1	0	0
1	1	1	1	0	1	0

Figure 6 : Truth Table

Equation Solving using KMAPs

Using key-map, the simplified Boolean function for the outputs A>B, A=B and A<B is shown below:

For A=B:



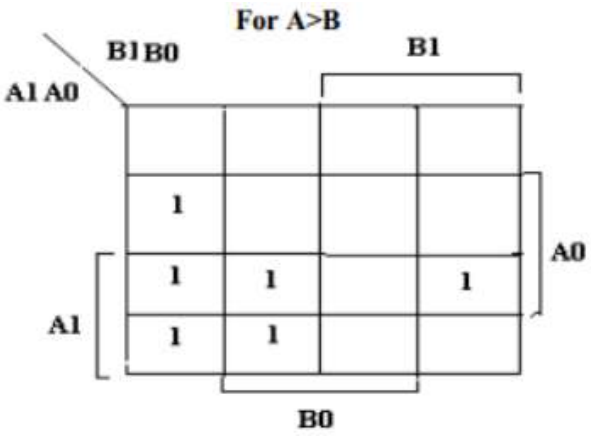
=A1 'A0 'B1 'B0 '+ A1 'A0B1 'B0+ A1 A0 'B1 B0 '+ A1A0B1B0

=(A1 'B1 '+ A1B1) (A0 'B0 '+ A0B0)

= (A1 ⊕B1) ' (A0 ⊕B0) '

=X1.X0

For A>B:



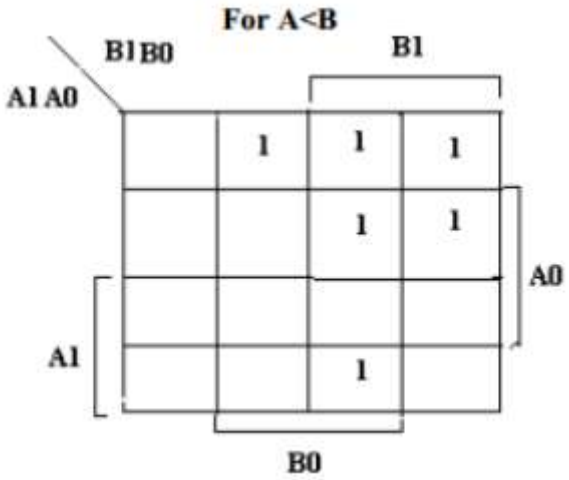
=A1B1'+A1'A0B1'B0'+A1A0 B1B0'

= A1B1'+A0B0'(A1'B1'+A1B1)

= A1B1'+A0B0'(A1 ⊕B1) '

=A1B1'+X1.A0B0'

For A<B:



=A1 'B1+A1'A0 'B1'B0+A1A0 'B1B0

= A1 'B1+A0 'B0(A1'B1'+A1B1)

= A1 'B1+A0 'B0(A1 ⊕B1) '

=A1 'B1+X1.A0 'B0

Circuit Diagram : 2-bit Comparator

Case 1: When A<B

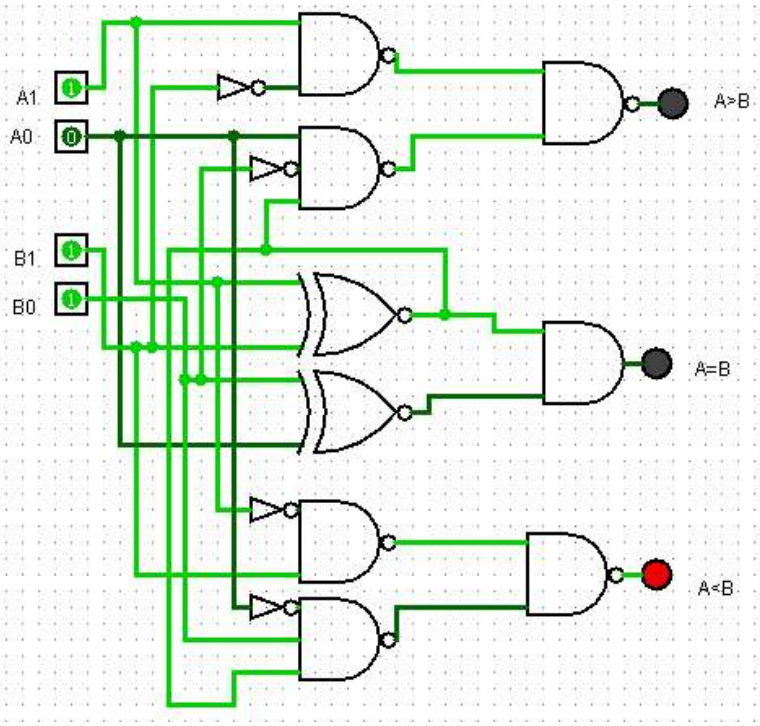
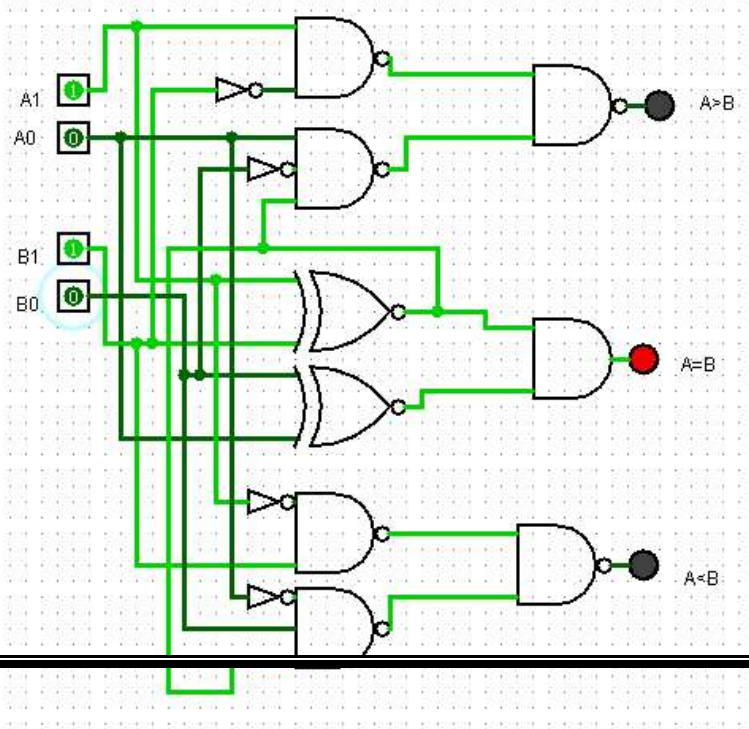


Figure 7 Case 1

Case 2: When A = B



Case 3 : A > B

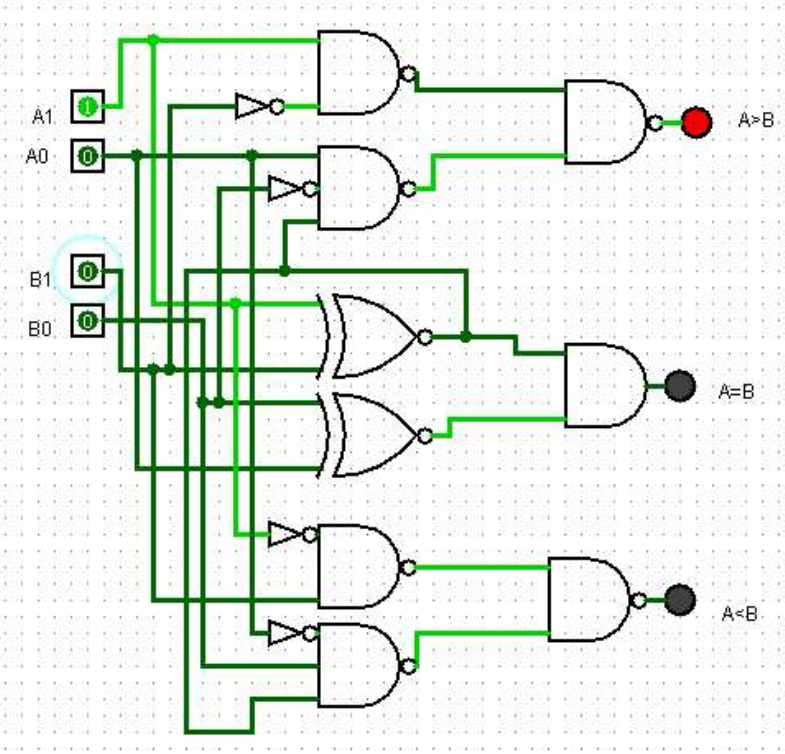
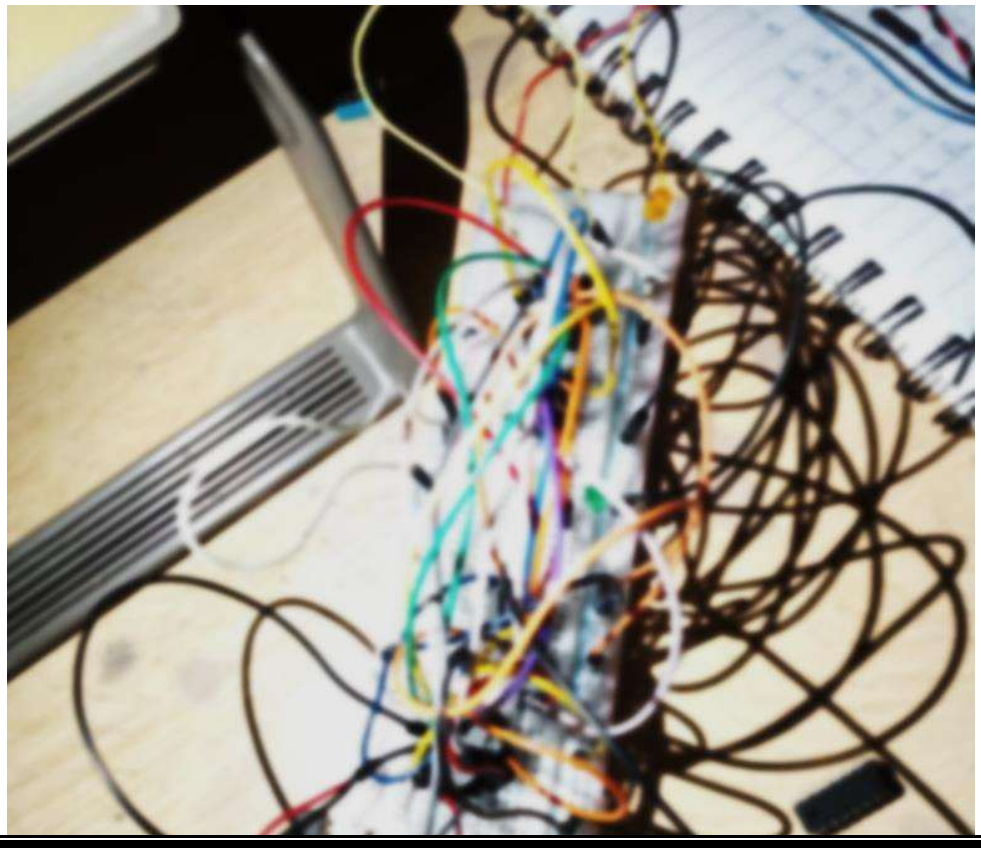


Figure 8Case 3

Breadboard Implementation 2-bit Magnitude Comparator



4-bit Magnitude Comparator

A comparator used to compare two 4-bit words. The two 4-bit numbers are word A: A3A2A1A0, and word B: B3 B2B1B0) So the circuit has 8 inputs and 3 binary outputs: A>B, A=B and A<B.

Block Diagram

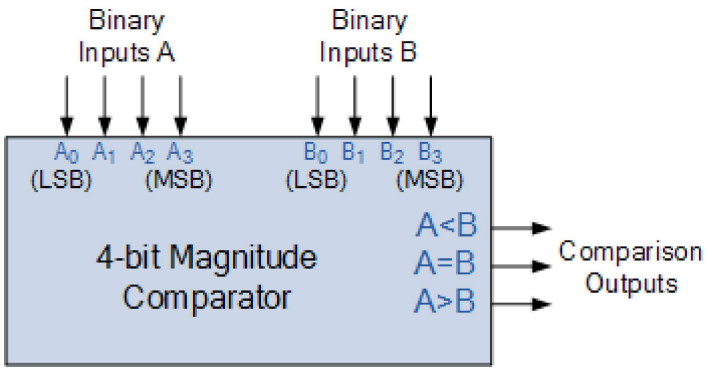
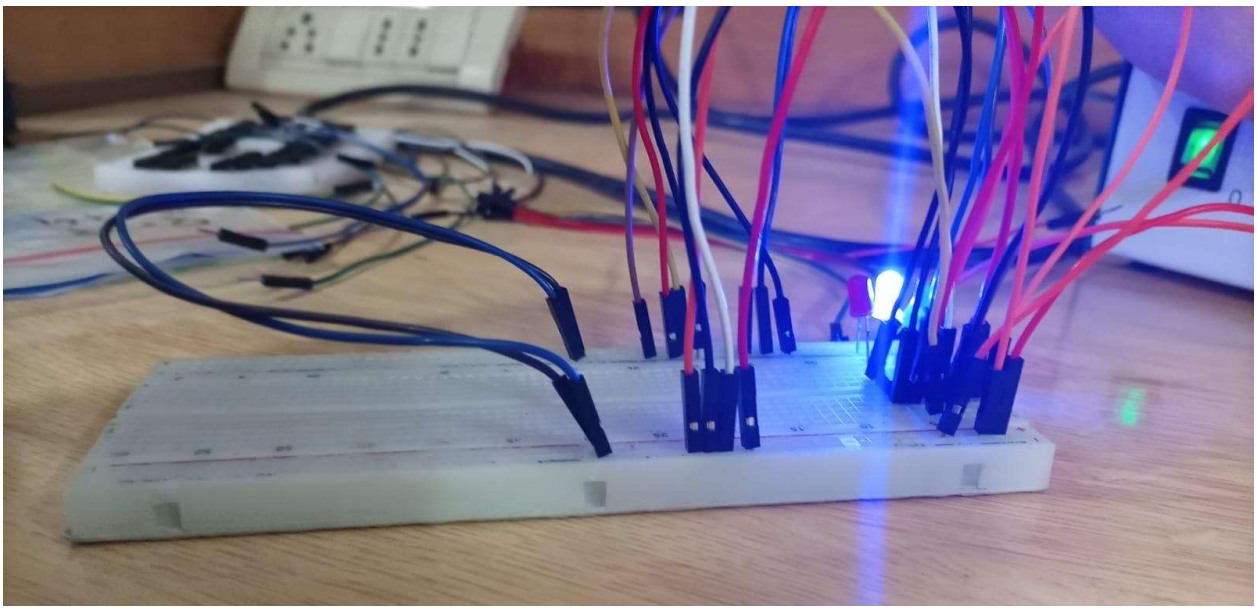


Figure 9 Block Diagram

Implementing 4-bit Comparator using 7485 IC



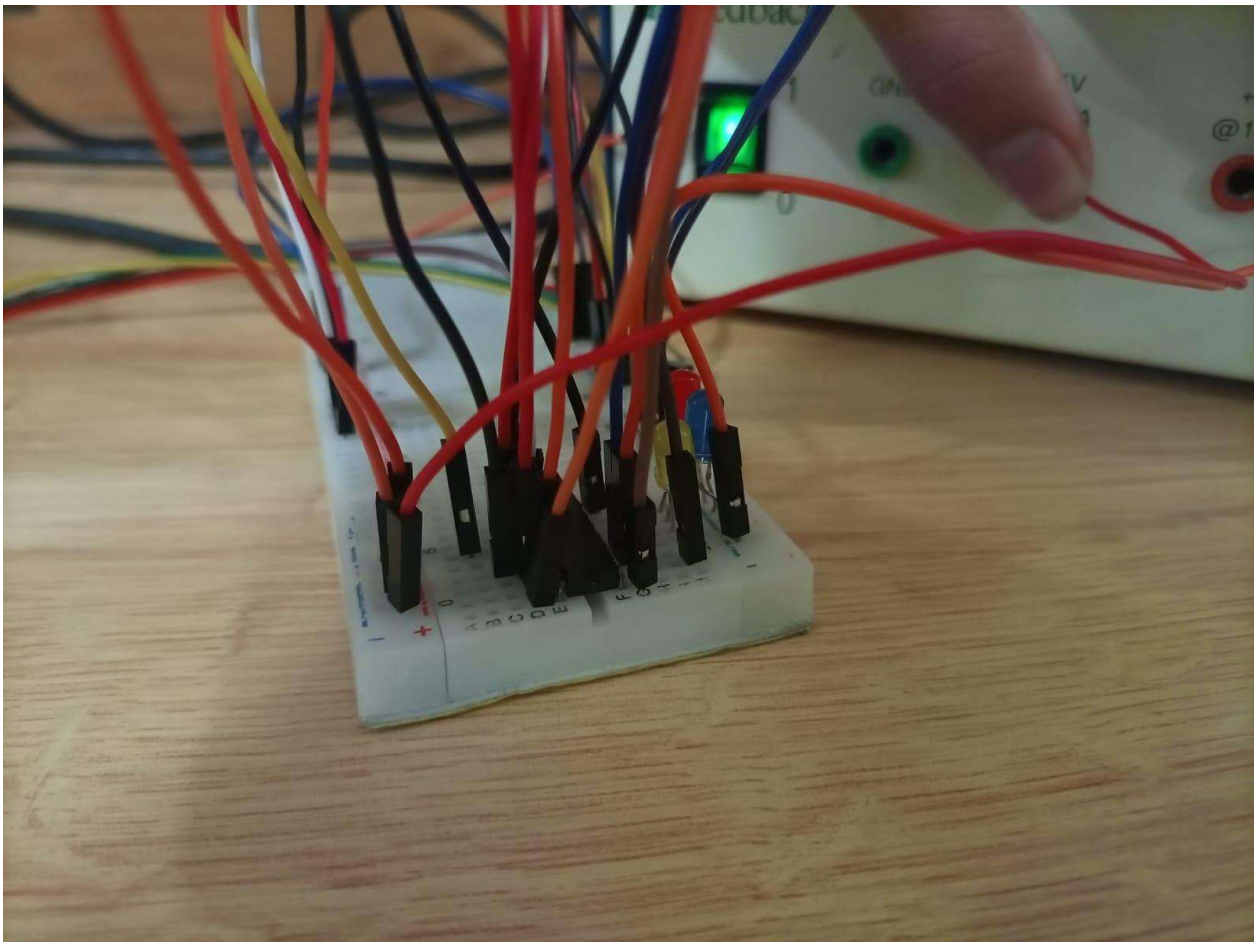


Figure 9 : 4-bit Magnitude Comparator

Working of 4-bit Comparator

Case : A= B :-

Word A equal word B iff: A3=B3, A2=B2, A1=B1, A0=B0.

Case : A<B or A>B :-

- If A3 = 1 and B3 = 0, then A is greater than B (A>B). Or
- If A3 and B3 are equal, and if A2 = 1 and B2 = 0, then A > B.
- If A3 and B3 are equal & A2 and B2 are equal, and if A1 = 1, and B1 = 0, then A>B. Or
- If A3 and B3 are equal, A2 and B2 are equal and A1 and B1 are equal, and if A0 = 1 and B0 = 0, then A > B.
- If A3 = 0 and B3 = 1, then A is less than B (A<B). Or
- If A3 and B3 are equal, and if A2 = 0 and B2 = 1, then A < B. Or
- If A3 and B3 are equal & A2 and B2 are equal, and if A1 = 0, and B1 = 1, then A<B. Or

- If A3 and B3 are equal, A2 and B2 are equal and A1 and B1 are equal, and if A0 = 0 and B0 = 1, then A < B.

Procedure

Part A: Lab Tasks

1. Check all the components for their working.

2. Insert the appropriate ICs into the IC base.

3. Make connections as shown in the circuit diagram in figure.

4. Verify the Truth Table and observe the outputs.

5. Repeat the same steps but for the circuit diagram in figure and apply inputs in the following table.

Record the outputs for the given values of A and B.

A	B	Output
1001	0110	**A>B**
1100	1110	**A<B**
0011	0101	**A<B**
0101	0101	**A=B**

Part B: Post Lab Task

1. Design an 8-bit comparator using two chips of IC 7485. The connections are given below.

2. Verify the given truth table.

A	B	A>B	A=B	A<B
0000 0000	0000 0000	0	1	0
0001 0001	0000 0000	1	0	0
0000 0000	0001 0001	0	0	1

8 BIT Magnitude Comparator

PIN Diagram for 7485 IC

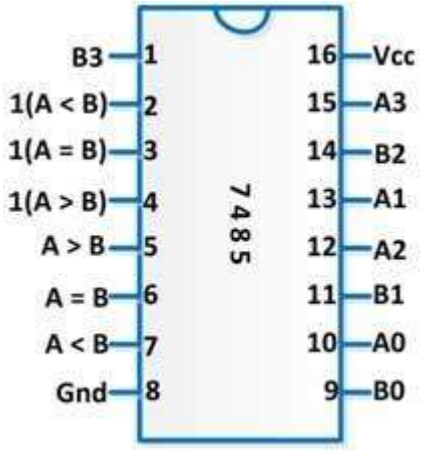
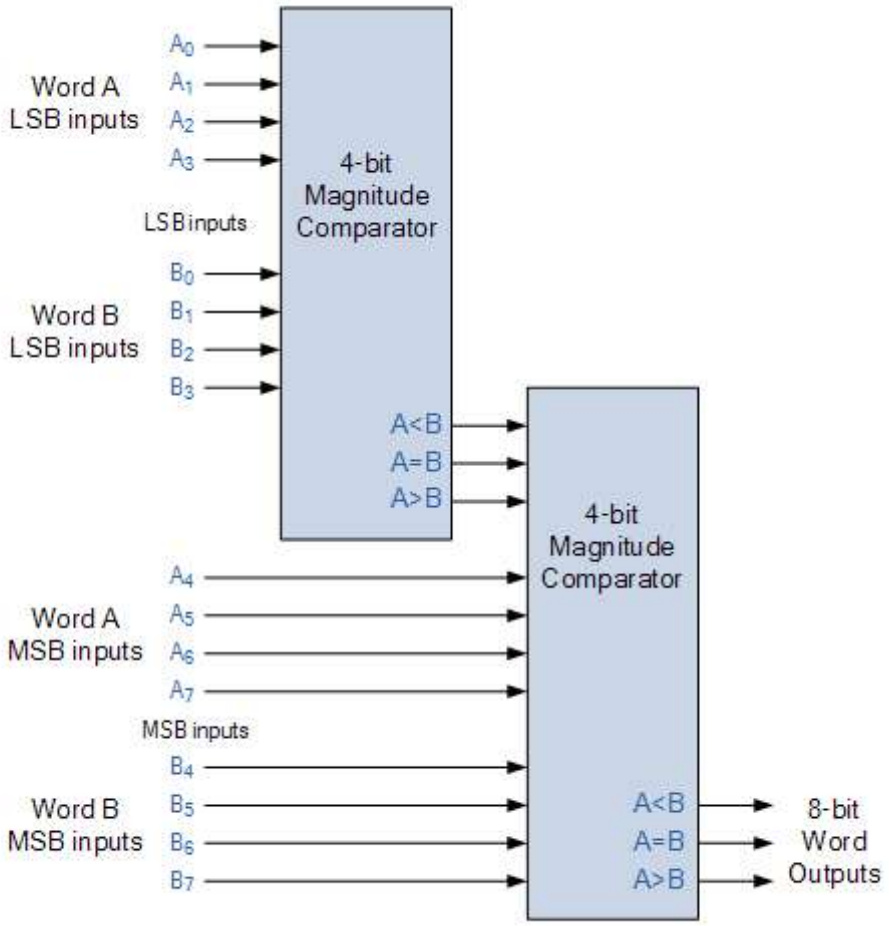


Figure 10: Pinouts for IC

Logic Diagram

Figure 11: 8-bit Magnitude Comparator



8 BIT Magnitude Comparator Circuit

Case 1: When A>B

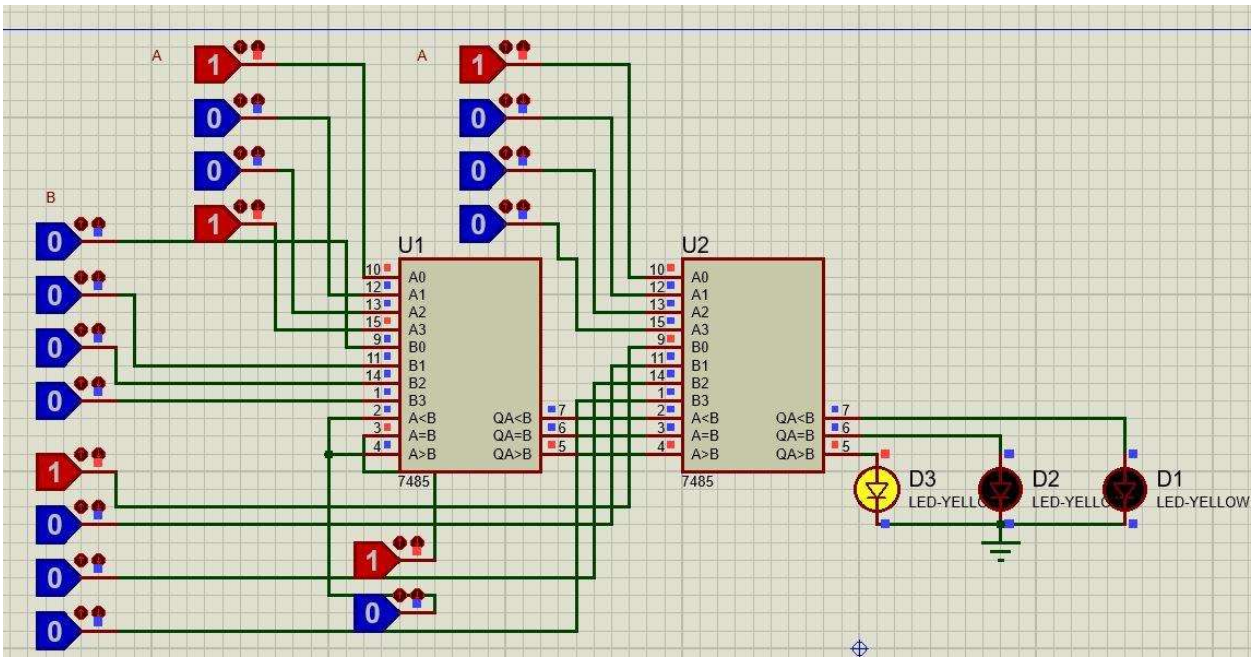


Figure 12: Case 1 of 8-bit

Case 2: When A=B

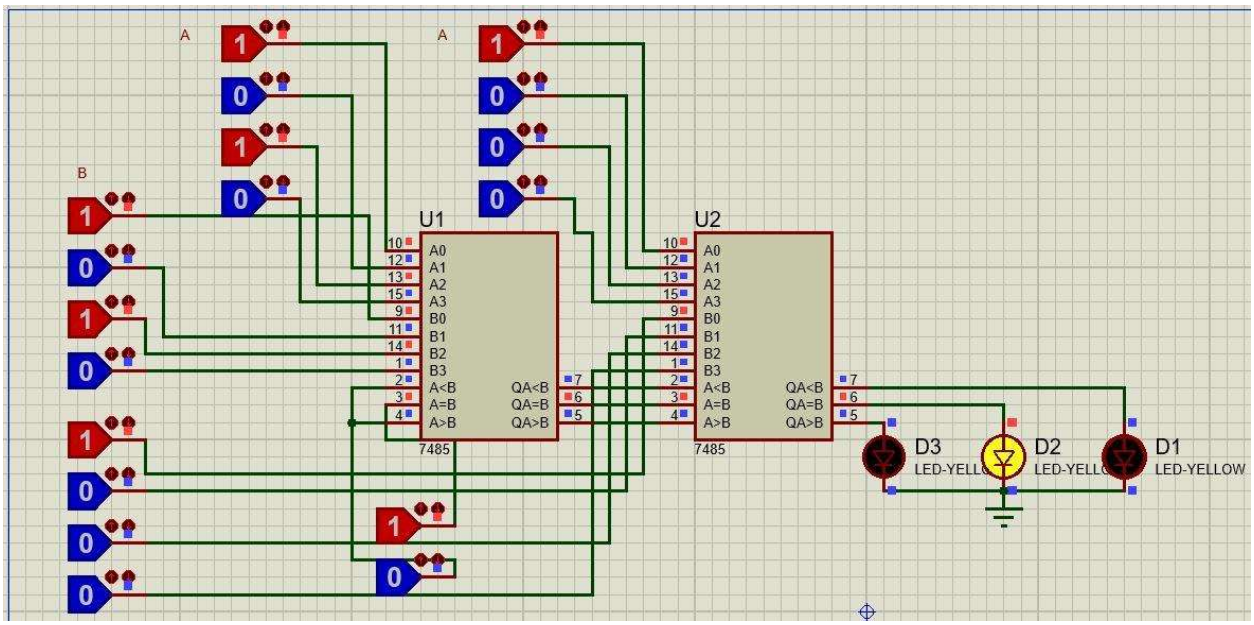


Figure 13 : Case of 8-bit

Case 3: When A<B

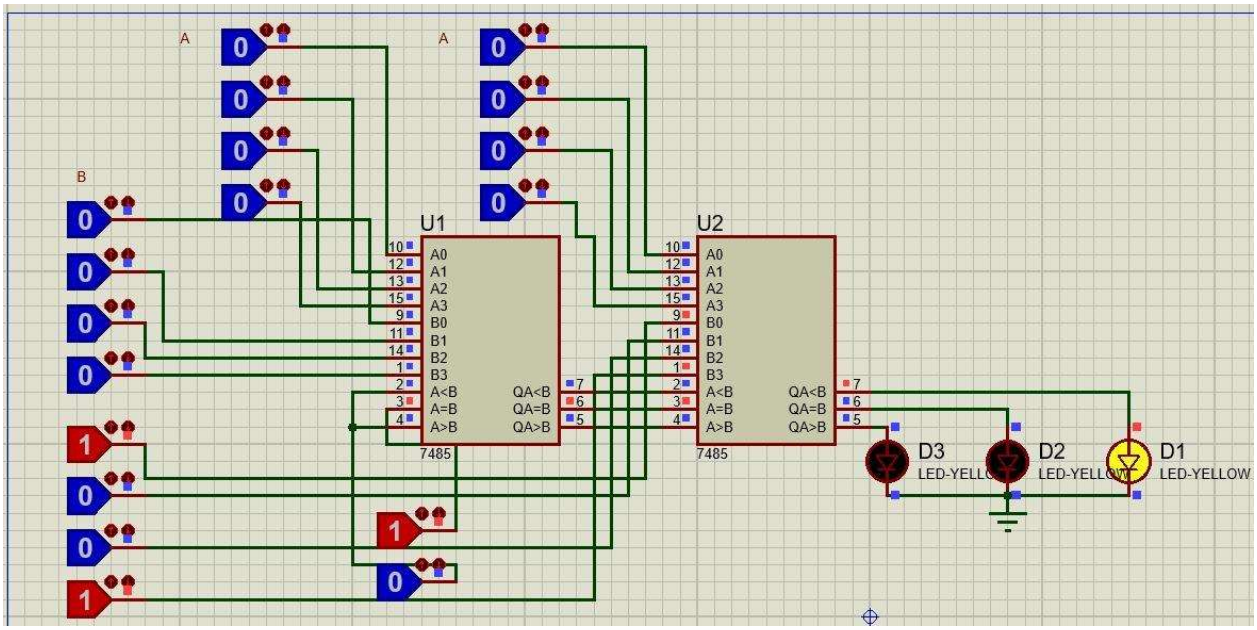


Figure 14: case 3 8-bit

Conclusion:

Magnitude Comparators of various lengths including 1-bit comparator, 2-bit Comparator, 4-bit Comparator and 8-bit comparator were studied and implemented. Few comparators were implemented using ICs, 8-bit comparator was implemented using Stimulation and designing software: Proteus while the rest of the comparators were implemented using discrete gates.

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