Experiment No. 4

Title: Design and Implement Magnitude Comparator.

Batch: B-1 **Roll No.: 16010422234** **Name: Chandana Ramesh Galgali**

Experiment No.: 4

Aim: Design and Implement Magnitude Comparator.

Resources needed: Simulation Platform, Kit

Theory:

Introduction

A magnitude digital comparator is a combinational circuit that compares two digital or binary numbers in order to find out whether one binary number is equal, less than or greater than the other binary number. We logically design a circuit for which we will have two inputs one for A and other for B and have three output terminals, one for A > B condition, one for A = B condition and one for A < B condition.

Figure-1: Block Diagram of Comparator

1-Bit Magnitude Comparator: A comparator used to compare two bits is called a single bit comparator. It consists of two inputs each for two single bit numbers and three outputs to generate less than, equal to and greater than between two binary numbers. The truth table for a 1-bit comparator is given below:

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

Figure-2: Truth Table of 1-Bit Comparator

From the above truth table logical expressions for each output can be expressed as follows:

A > B : AB'

A < B : A'B

A = B : A'B' + AB

By using these Boolean expressions, we can implement a logic circuit for this comparator as given below :

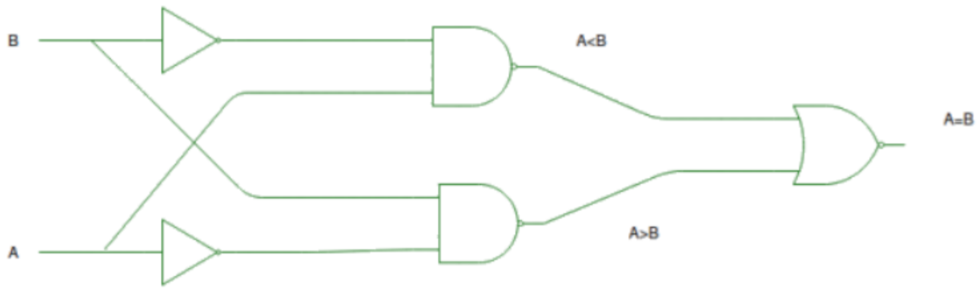

Figure-3: Logic Circuit of 1-Bit Comparator

2-Bit Magnitude Comparator: A comparator used to compare two binary numbers each of two bits is called a 2-bit magnitude comparator. It consists of four inputs and three outputs to generate less than, equal to and greater than between two binary numbers.

Procedure:

a) Design a 2 bit Magnitude comparator
b) Explore the datasheet of IC 7485(link in references)
c) Design 4 bit comparator using IC 7485.
d) Implement and verify the same using Hardware kit/simulation software.
e) Create a document with screenshots mentioned above, Outcome and Conclusion.
f) Please note every document uploaded as Lab Write-up should be labelled as Exp_<No>_<RollNo.pdf

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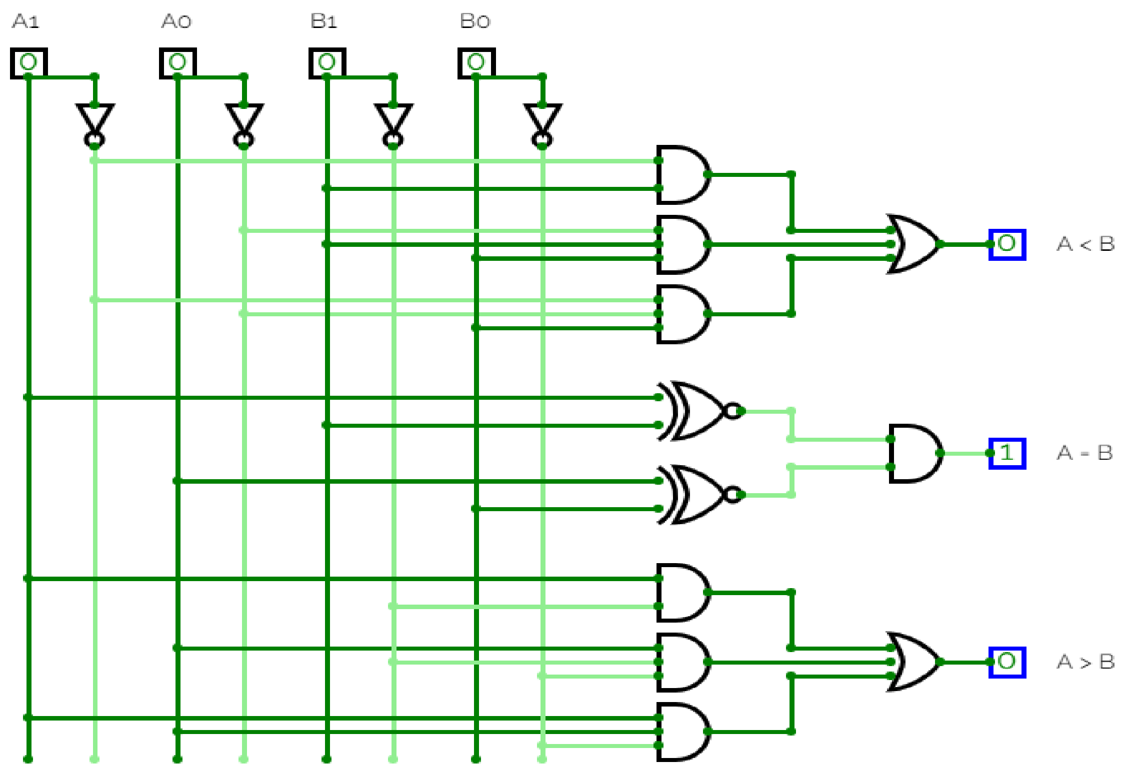
Observations and Results:

a) Design of Magnitude Comparator.
<u>2 bit Magnitude comparator</u>



INPUT				OUTPUT		
A1	A0	B1	B0	A<B	A=B	A>B
0	0	0	0	0	1	0
0	0	0	1	1	0	0
0	0	1	0	1	0	0
0	0	1	1	1	0	0
0	1	0	0	0	0	1
0	1	0	1	0	1	0
0	1	1	0	1	0	0
0	1	1	1	1	0	0
1	0	0	0	0	0	1
1	0	0	1	0	0	1
1	0	1	0	0	1	0
1	0	1	1	1	0	0
1	1	0	0	0	0	1
1	1	0	1	0	0	1
1	1	1	0	0	0	1
1	1	1	1	0	1	0

Figure-4: Truth Table of 2-Bit Comparator

From the above truth table logical expressions for each output can be expressed as follows:

A > B : $A_1B_1' + A_0B_1'B_0' + A_1A_0B_0'$

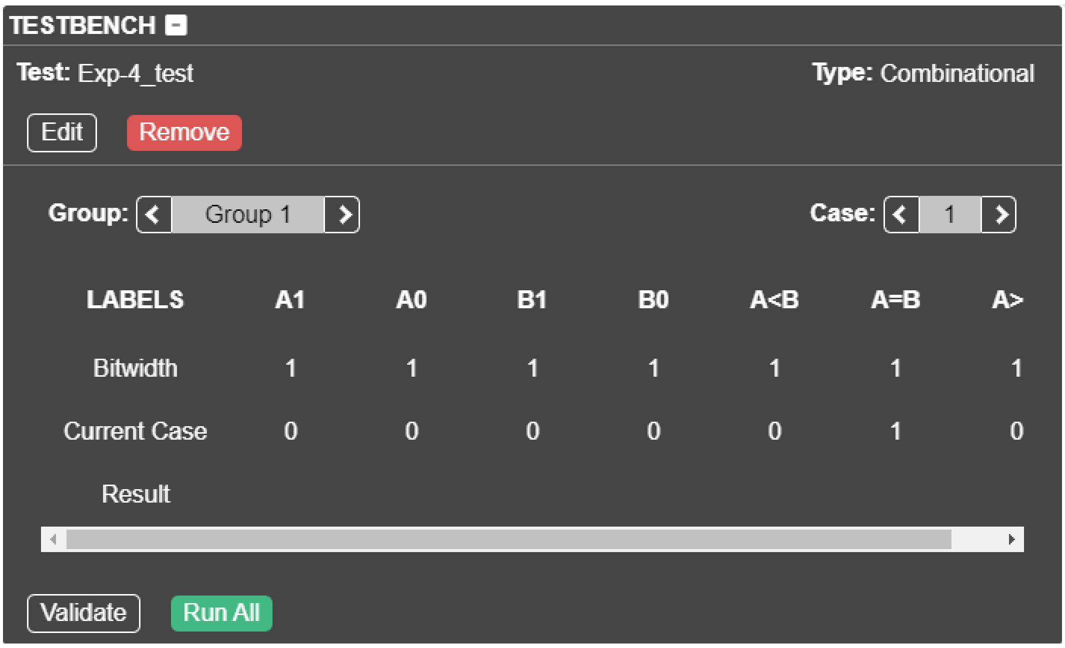
A = B : $A_1'A_0'B_1'B_0' + A_1'A_0B_1'B_0 + A_1A_0B_1B_0 + A_1A_0'B_1B_0'$

: $A_1'B_1'(A_0'B_0' + A_0B_0) + A_1B_1(A_0B_0 + A_0'B_0')$

: $(A_0B_0 + A_0'B_0')(A_1B_1 + A_1'B_1')$

: (A_0 Ex-Nor B_0) (A_1 Ex-Nor B_1)

A < B : $A_1'B_1 + A_0'B_1B_0 + A_1'Ao'Bo$



Test Result

Title: Exp-4_test

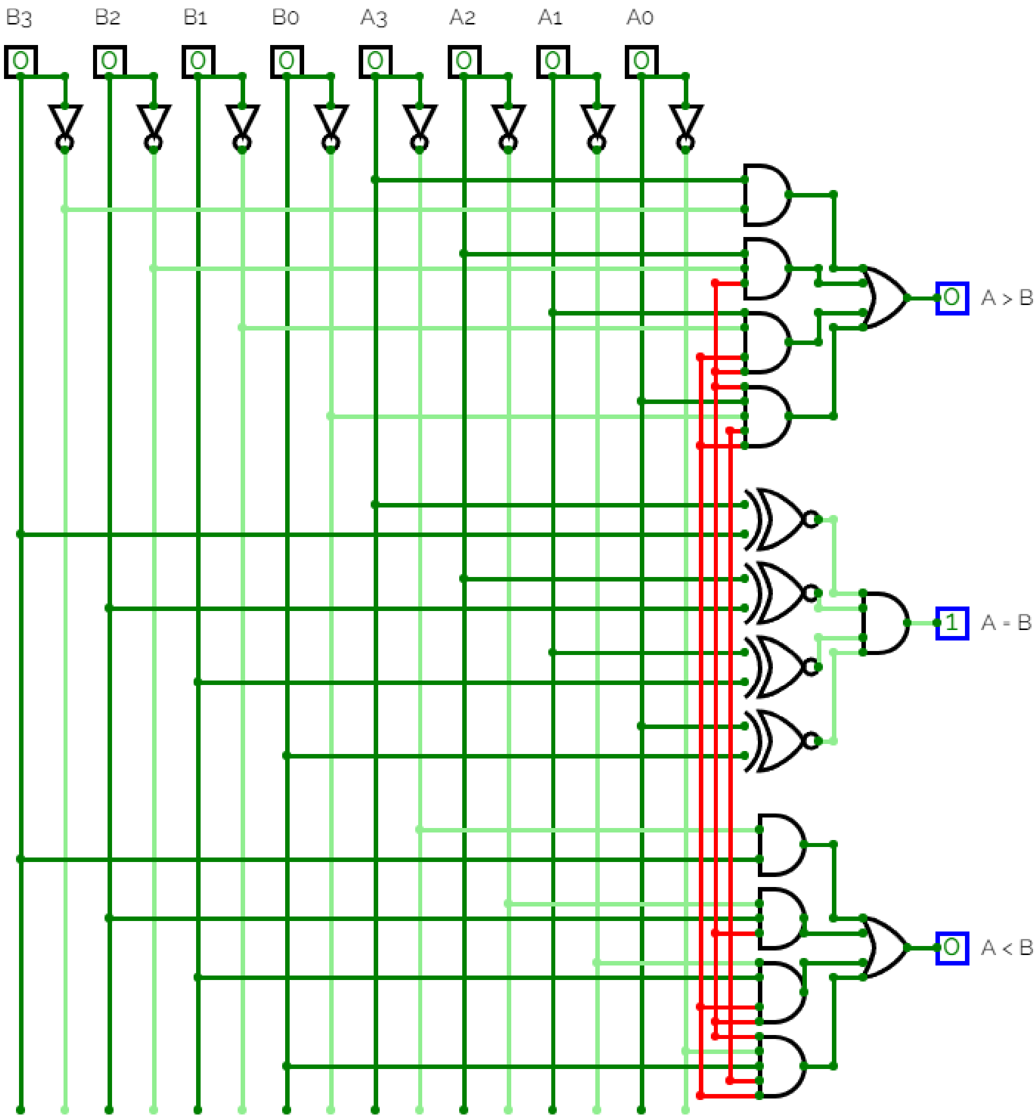
Sequential Test | Combinational Test

	INPUTS				OUTPUTS		
Label	A1	A0	B1	B0	A<B	A=B	A>B
Bitwidth	1	1	1	1	1	1	1

Group 1

0	0	0	0	0	0	1	1	0	0
0	0	0	1	1	1	0	0	0	0
0	0	1	0	1	1	0	0	0	0
0	0	1	1	1	1	0	0	0	0
0	1	0	0	0	0	0	0	1	1
0	1	0	1	0	0	1	1	0	0
0	1	1	0	1	1	0	0	0	0
0	1	1	1	1	1	0	0	0	0
1	0	0	0	0	0	0	0	1	1
1	0	0	1	0	0	0	0	1	1
1	0	1	0	0	0	1	1	0	0
1	0	1	1	1	1	0	0	0	0
1	1	0	0	0	0	0	0	1	1
1	1	0	1	0	0	0	0	1	1
1	1	1	0	0	0	0	0	1	1
1	1	1	1	0	0	1	1	0	0

4 bit Magnitude comparator



In a 4-bit comparator, the condition of A>B can be possible in the following four cases.

If A3 = 1 and B3 = 0

If A3 = B3 and A2 = 1 and B2 = 0

If A3 = B3, A2 = B2 and A1 = 1 and B1 = 0

If A3 = B3, A2 = B2, A1 = B1 and A0 = 1 and B0 = 0

Similarly, the condition for A<B can be possible in the following four cases.

If A3 = 0 and B3 = 1

If A3 = B3 and A2 = 0 and B2 = 1

If A3 = B3, A2 = B2 and A1 = 0 and B1 = 1

If A3 = B3, A2 = B2, A1 = B1 and A0 = 0 and B0 = 1

The condition of A=B is possible only when all the individual bits of one number exactly coincide with the corresponding bits of another number.

From the above statements, logical expressions for each output can be expressed as follows.

AA, 831331 r: (A3 Ex-Nor 33)A2132' a (A3 Ex-Nor 133) (A2 Ex-Nor 132)A131' a (A3 Ex-Nor 33) (A2 ENor132) (Al Ex-Nor 31)A01301

,13: A3'03 a (A3 Ex-Nor 33)A211:12 a (A3 Ex-Nor 83) (A2 Ex-Nor 132)Ar131 a (A3 Ex-Nor 33) (A2 Ex-Nor32) (Al Ex-Nor 131)A0N30

A=B: (A3 Ex-Nor B3) (A2 Ex-Nor 82) (Al Ex-Nor BI) (AO Ex-Nor BO)

b) Observe and understand the simulated/implemented logical circuits.

Outcomes: Understand the basic building blocks, techniques used in digital logic design.

Posttest:

All the comparisons made by comparator is done using ____________ .

- (selected) a: 1 circuit
- b: 2 circuits
- c: 3 circuits
- d: 4 circuits

One that is not the outcome of magnitude comparator is ___________ .

- a: a > b
- (selected) b: a – b
- c: a < b
- d: a = b

If two numbers are not equal then binary variable will be ___________ .

- (selected) a: 0
- b: 1
- c: A
- d: B

Which one is a basic comparator?

- a: AND
- b: Ex-OR
- c: NAND
- (selected) d: Ex-NOR

Comparators are used in ___________ .

- a: Memory
- b: Motherboard
- (selected) c: CPU
- d: Hard drive

Submit Quiz

5 out of 5

Conclusion:

In this experiment, we successfully designed and implemented both 2-bit and 4-bit magnitude comparators using CircuitVerse. The purpose of the experiment was to compare the magnitudes of two binary numbers and determine their relationship (greater than, less than, or equal).

Grade: AA / AB / BB / BC / CC / CD /DD

Signature of faculty in-charge with date

References:

Books/ Journals/ Websites:

1. R. P. Jain, "Modern Digital Electronics", Tata McGraw Hill.
2. https://de-iitr.vlabs.ac.in/exp/comparator-using-logic-gates/theory.html
3. https://pdf1.alldatasheet.com/datasheet-pdf/view/8074/NSC/7485.html