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Lab normal # 07

Objectives:

How to make different comparators using different logic gates ICs.

Required equipments:

Battery

logic gates

Bread board

Digital equipmental board

Wires

Used Softwares

Multisim logic by

Experiments

• Comparators

• 32, 4-bit comparators

• Boolean expression for comparators

• Use & applications of comparators

## What is comparator?

A magnitude comparator is a combinational input that compares two digits or binary numbers and determines their relative magnitude in order to find out whether one number is equal, less than or greater that other digital numbers.

Comparator symbols are
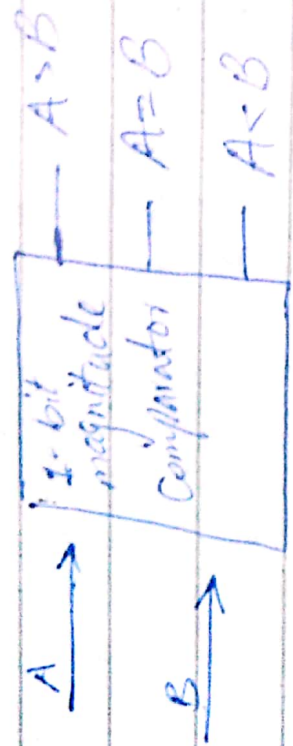
$A = B, A \to B, B > A$
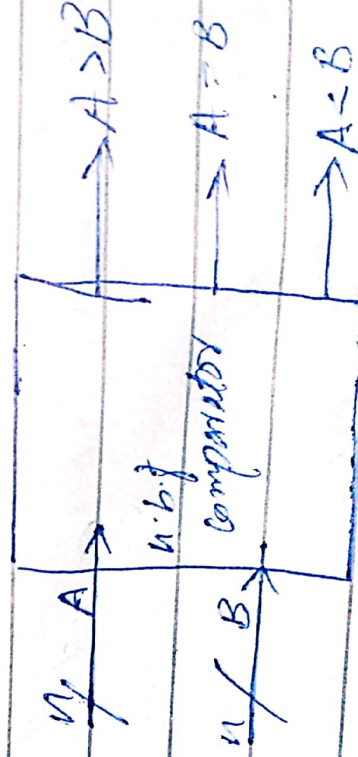


## 1-Bit magnitude comparator

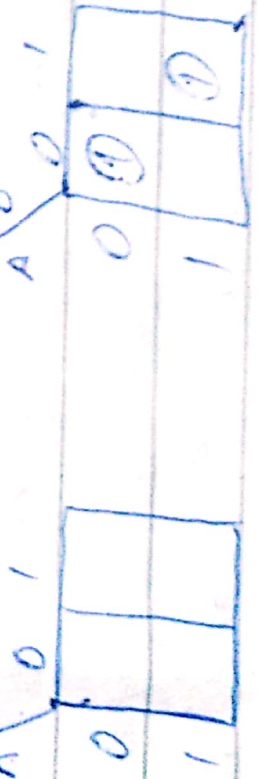A comparator used to compare two 1-bit binary numbers.

It has two binary inputs A, B and three input, four TC.

For equal and less than

$A \longrightarrow$ | 1-bit magnitude Comparator | $\longrightarrow A>B$
$\quad\quad\quad\quad\quad\longrightarrow A=B$
$B \longrightarrow$ | $\longrightarrow A<B$

| A | B | A>B | A<B | A>B |
|---|---|-----|-----|-----|
| 0 | 0 | 0   | 0   | 0   |
| 0 | 1 | 1   | 0   | 0   |
| 1 | 0 | 0   | 1   | 1   |
| 1 | 1 | 1   | 1   | 0   |

K-Map for $A<B$, $A=B$ & $A>B$

$A<B$
| A\B | 0 | 1 |
|-----|---|---|
| 0   |   | 1 |
| 1   |   |   |

$A=B$
| A\B | 0 | 1 |
|-----|---|---|
| 0   | ① |   |
| 1   |   | ① |

$A>B$
| A\B | 0 | 1 |
|-----|---|---|
| 0   | 0 | 0 |
| 1   | ① | 0 |

$Y_1 = A<B \ ; \ Y_1 = \bar{A}B$
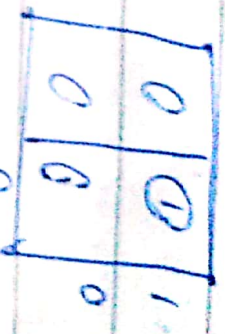
$Y_2 = A=B \ ; \ Y_2 = \bar{A}\bar{B} + AB$

$Y_3 = A>B \ ; \ Y_3 = A\bar{B}$

Date:  /  /

$$Y_1 (A<B) = A'B$$
$$Y_2 (A=B) = A'B' + AB = (A \oplus B)'$$
$$Y_3 (A>B) = AB'$$



$Y_1 = A<B$
$\overline{A}B$

$\overline{A}\overline{B}$

$Y_2 = \overline{A}\overline{B} + AB$

$Y_3 = A\overline{B}$
$A>B$

$A$
$B$

2-Bit magnitude comparator

A comparator use of to compare two bit number. It has 4-binary inputs and 3 binary outputs



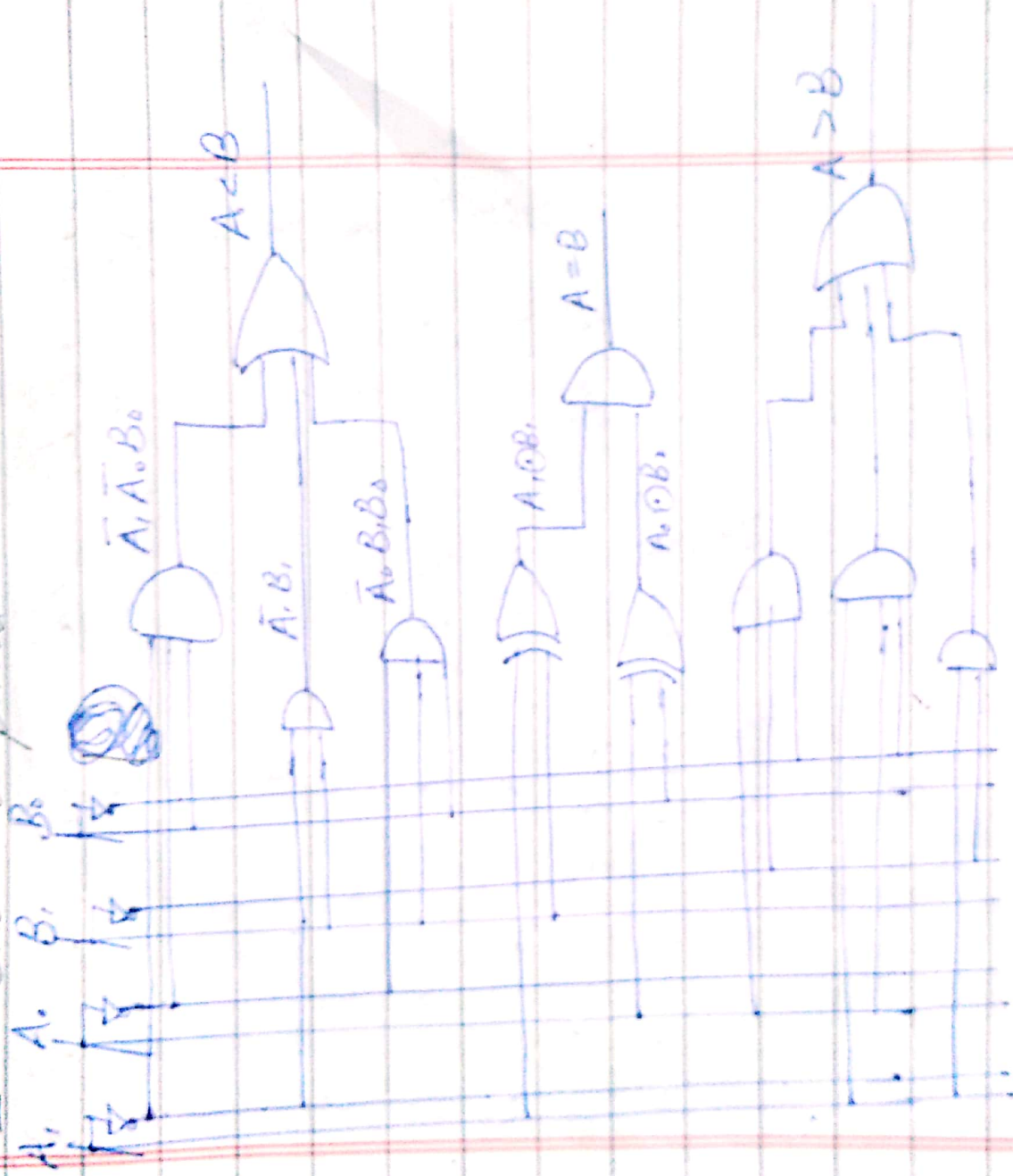$A \begin{cases} A_1 \\ A_0 \end{cases}$

2-bit magnitude comparator

$B \begin{cases} B_1 \\ B_0 \end{cases}$

$\rightarrow A>B$
$\rightarrow A=B$
$\rightarrow A<B$

## 2 - Bit comparator



$A_1$  $B_1$  $A_0$  $B_0$

$\bar{A_1}A_0B_0$

$A<B$

$A_1B_1$

$\bar{A_0}B_1B_0$

$A_1⊙B_1$

$A=B$

$A_0⊙B_0$

$A>B$
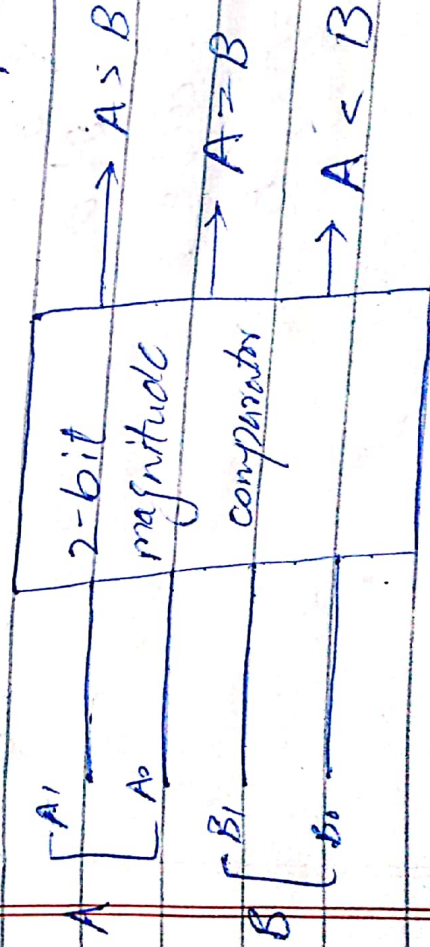
4-bit magnitude comparator

A 4-bit comparator is used to
compare two 4-bit words. The
two 4-bit numbers are word

A: $A_3A_2A_1A_0$ and B: $B_3B_2B_1B_0$
This circuit has 8 inputs and

3 binary outputs

$A>B$ , $A=B$  &  $A<B$
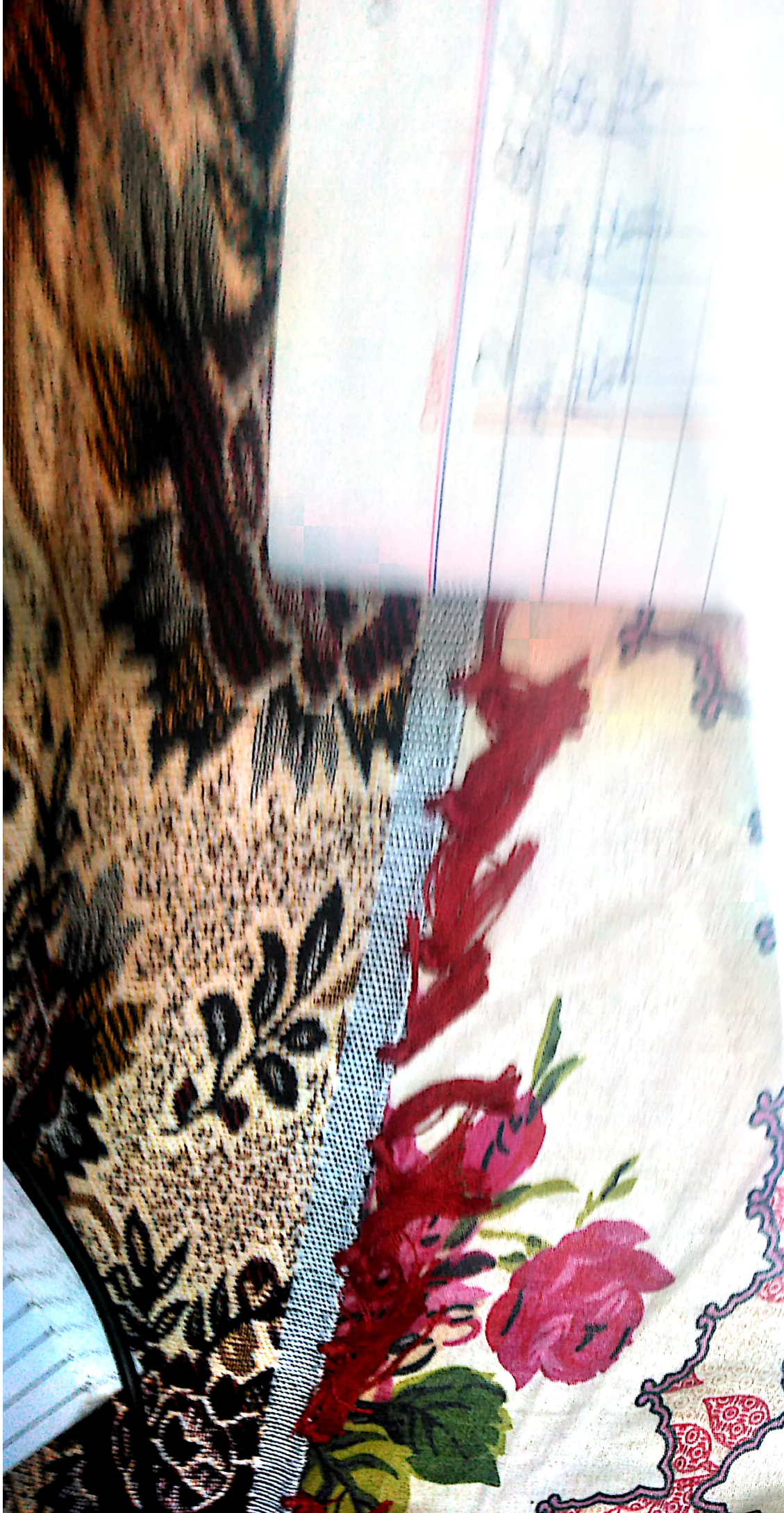
Date: / /

| $A_3B_3$ | $A_2B_2$ | $A_1B_1$ | $A_0B_0$ | $A>B$ | $A<B$ | $A=B$ |
|---|---|---|---|---|---|---|
| $A_3>B_3$ | x | x | x | 1 | 0 | 0 |
| $A_3<B_3$ | x | x | x | 0 | 1 | 0 |
| $A_3=B_3$ | $A_2>B_2$ | x | x | 1 | 0 | 0 |
| $A_3=B_3$ | $A_2<B_2$ | x | x | 0 | 1 | 0 |
| $A_3=B_3$ | $A_2=B_2$ | $A_1>B_1$ | x | 1 | 0 | 0 |
| $A_3=B_3$ | $A_2=B_2$ | $A_1<B_1$ | x | 0 | 1 | 0 |
| $A_3=B_3$ | $A_2=B_2$ | $A_1=B_1$ | $A_0>B_0$ | 1 | 0 | 0 |
| | | | $A_0<B_0$ | 0 | 1 | 0 |
| | | | $A_0=B_0$ | 0 | 0 | 1 |

# #07

## Inputs — Outputs

| A₁ | A₀ | B₁ | B₀ | 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 |

K-Map for A<B

| $A_1A_0$ \ $B_1B_0$ | 00 | 01 | 11 | 10 |
|----|----|----|----|----|
| 00 | 0 | 1 | 1 | 1 |
| 01 | 0 | 0 | 1 | 1 |
| 11 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 1 | 0 |

$$Y_1 = \overline{A}_1 \overline{A}_0 B_0 + \overline{A}_1 B_1 + \overline{A}_0 B_1 B_0$$

K-map for A=B.

$B_1B_0$

$A_1A_0$

| | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | 1 | 0 | 0 | 0 |
| 01 | 0 | 1 | 0 | 0 |
| 11 | 0 | 0 | 1 | 0 |
| 10 | 0 | 0 | 0 | 1 |

$Y_1 = \bar{A_1}\bar{A_0}\bar{B_1}\bar{B_0} + \bar{A_1}A_0\bar{B_1}B_0 + A_1A_0B_1B_0$
$\quad + A_1\bar{A_0}B_1\bar{B_0}$

After simplification   $Y_3 = (A_1 \odot B_1)(A_0 \odot B_0)$

K-Map for A>B.

$B_1B_0$

$A_1A_0$

| | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | 0 | 0 | 0 | 0 |
| 01 | 1 | 0 | 0 | 0 |
| 11 | 1 | 1 | 0 | 1 |
| 10 | 1 | 1 | 0 | 0 |

$Y_3 = A_0\bar{B_1}B_0 + A_1\bar{B_1} + A_1A_0\bar{B_0}$

Conclusion

After performing above experiment we have understood that the working and designing of comparators.