EEE 3101: Digital Logic and Circuits

Magnitude Comparator

Course Teacher: Nafiz Ahmed Chisty

Head, Department of EEE
Associate Professor, Department of EEE & CoE
Faculty of Engineering
Room# D0105, D Building
Email: chisty@aiub.edu
Website: http://engg.aiub.edu/faculties/nafiz
Website: www.nachisty.com

Nafiz A. Chisty| Head, Dept of EEE; Associate Professor, Dept. of EEE & CoE, FE

The Digital Comparator

Another common and very useful combinational logic circuit is that of the **Digital Comparator** circuit. Digital or Binary Comparators are made up from standard AND, NOR and NOT gates that compare the digital signals present at their input terminals and produce an output depending upon the condition of those inputs.

For example, along with being able to add and subtract binary numbers we need to be able to compare them and determine whether the value of input A is greater than, smaller than or equal to the value at input B etc. The digital comparator accomplishes this using several logic gates that operate on the principles of Boolean Algebra.

There are two main types of Digital Comparator available, and these are.

1. **Identity Comparator** – an *Identity Comparator* is a digital comparator that has only one output terminal for when A = B either "HIGH" A = B = 1 or "LOW" A = B = 0

2. **Magnitude Comparator** – a *Magnitude Comparator* is a type of digital comparator that has three output terminals, one each for equality, **A = B** greater than, **A > B** and less than **A < B**

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The purpose of a **Digital Comparator** is to compare a set of variables or unknown numbers, for example A (A1, A2, A3, …. An, etc) against that of a constant or unknown value such as B (B1, B2, B3, …. Bn, etc) and produce an output condition or flag depending upon the result of the comparison.

For example, a magnitude comparator of two 1-bits, (A and B) inputs would produce the following three output conditions when compared to each other.

$$A > B,\quad A = B,\quad A < B$$

Which means: A is greater than B, A is equal to B, and A is less than B

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1-bit Digital Magnitude Comparator

Truth Table:

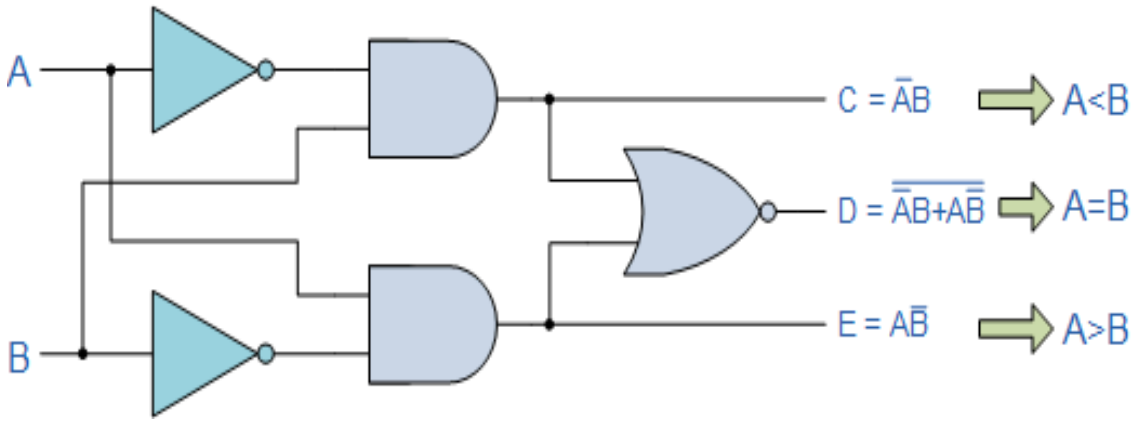
Inputs		Outputs		
B	A	A > B	A = B	A < B
0	0	0	1	0
0	1	1	0	0
1	0	0	0	1
1	1	0	1	0

Logic Expression:

$X_0 = A_0B_0 + A_0'B_0'$

$(A=B)=X_0$, $(A<B)= A_0'B_0$, $(A>B)= A_0B_0'$

Logic Diagram:



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2-bit Digital Magnitude Comparator

Logic Expression:

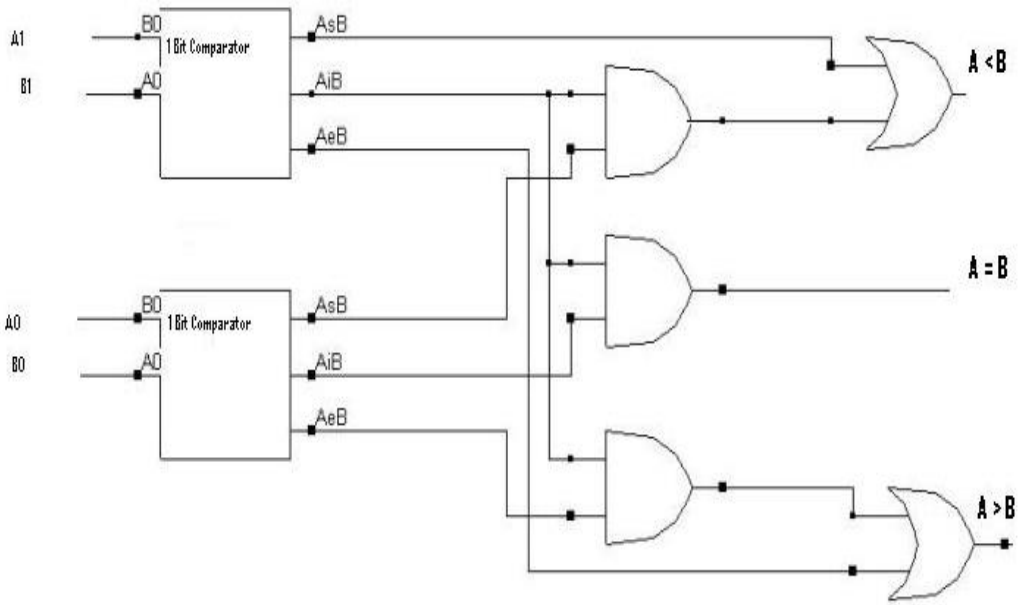
$X_n = A_nB_n + A_n'B_n'$

$(A=B) = X_1X_0$

$(A<B) = A_1'B_1 + X_1A_0'B_0$

$(A>B) = A_1B_1' + X_1A_0B_0'$

Block Diagram:



3-bit Digital Magnitude Comparator

Logic Expression:

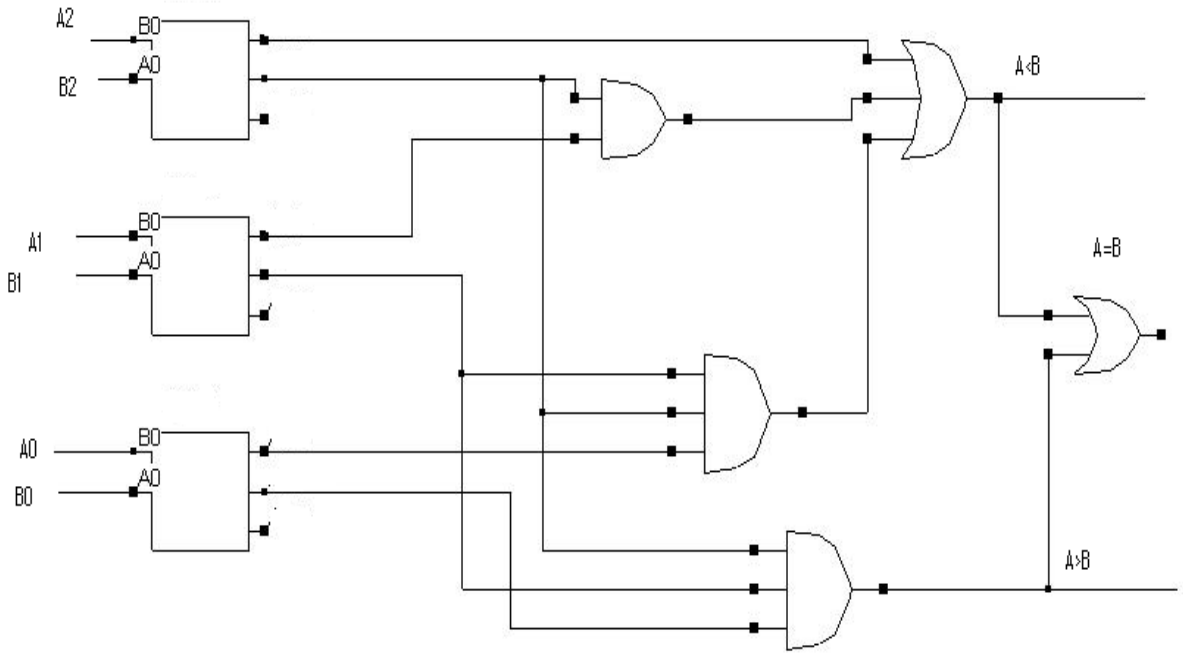
$X_n = A_nB_n + A_n'B_n'$

$(A=B) = X_2X_1X_0$

$(A<B) = A_2'B_2 + X_2A_1'B_1 + X_2X_1A_0'B_0$

$(A>B) = A_2B_2' + X_2A_1B_1' + X_2X_1A_0B_0'$

Block Diagram:



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5-bit Digital Magnitude Comparator

Logic Expression:

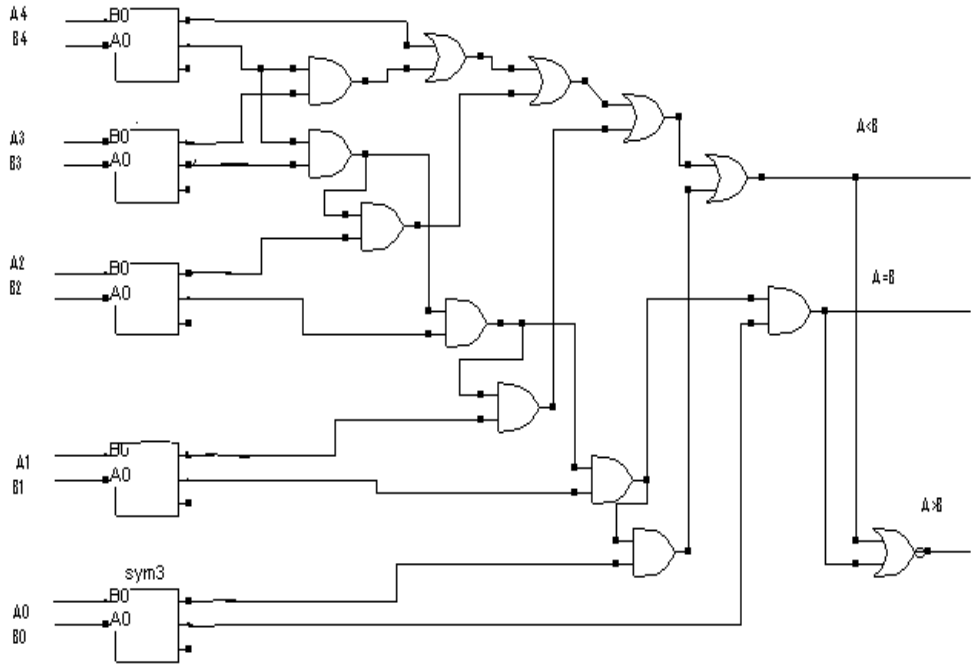
$X_n = A_nB_n + A_n'B_n'$

$(A=B) = X_4X_3X_2X_1X_0$

$(A<B) = A_4'B_4 + X_4A_3'B_3 + X_4X_3A_2'B_2 + X_4X_3X_2A_1'B_1 + X_4X_3X_2X_1A_0'B_0$

$(A>B) = A_4B_4' + X_4A_3B_3' + X_4X_3A_2B_2' + X_4X_3X_2A_1B_1' + X_4X_3X_2X_1A_0B_0'$

Block Diagram:



Reference:

[1] Thomas L. Floyd, "Digital Fundamentals" 11th edition, Prentice Hall.
[2] M. Morris Mano, "Digital Logic & Computer Design" Prentice Hall.

Thanks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