MagnitudeComparator

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Magnitude Comparator

It is a combinational logic circuit.

Digital Comparator is used to compare the value of two binary digits.

There are two types of digital comparator

(i) Identity Comparator
(ii) Magnitude Comparator.

IDENTITY COMPARATOR: This comparator has only one output terminal for when A=B, either A=B=1 (High) or A=B=0 (Low)

MAGNITUDE COMPARATOR: This Comparator has three output terminals namely A>B, A=B, A<B. Depending on the result of comparison, one of these output will be high (1)

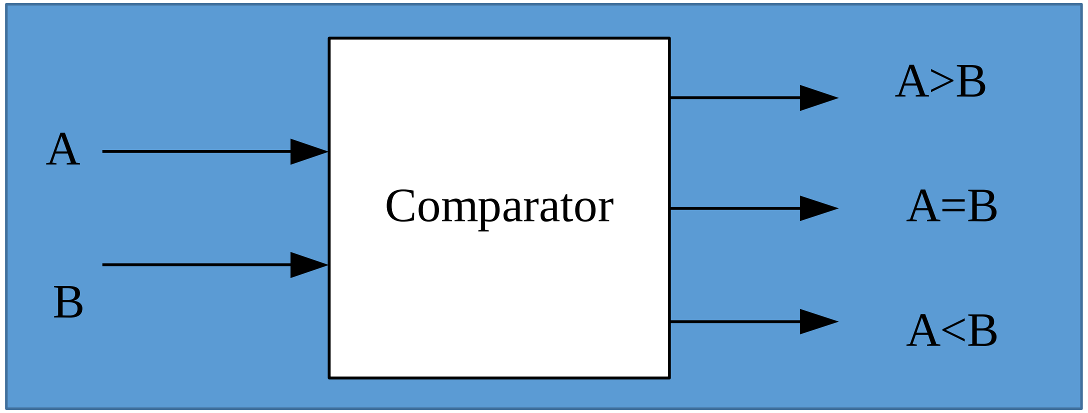
LOGIC DESIGN PROCEDURE

Magnitude comparator is a combinational circuit that compares two numbers and determines their relative magnitude in order to find out whether one number is equal, less than or greater than the other digital number. The output of comparator is usually 3 binary variables indicating:

A>B

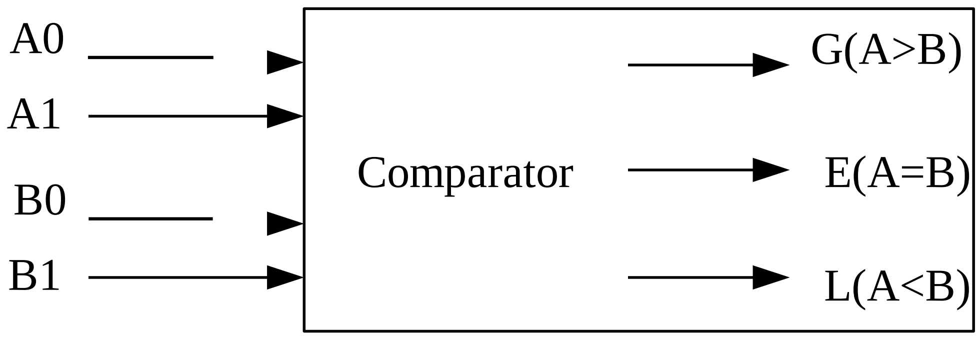
A=B

A<B



LOGIC DESIGN FOR 2-BIT COMPARATOR

- A comparator which is used to compare two binary numbers each of two bits is called a 2-bit magnitude comparator.
- Here the block diagram of 2-Bit magnitude comparator.
- It has four inputs and three outputs.
- Inputs are A_0 ,A_1,B_0 and B_1 and Outputs are E, G and L.
- **E (is 1 if two numbers are equal)**
- **G (is 1 when A > B)** and
- **L (is 1 when A < B)**



GREATER THAN (A>B)

A_1	A_0	B_1	B_0
1	0	0	1
1	1	1	0
0	1	0	0

1. If A_1= 1 and B_1= 0 then A>B
2. If A_1 and B_1 are same, i.e A_1=B_1=1 or A_1=B_1=0 and A_0=1, B_0=0 then A>B

LESS THAN (A<B)

Similarly,

1. If A_1= B_1=1 and A_0= 0, B_0=1, then A<B
2. If A_1= B_1= 0 and A_0= 0, B_0=1 then A<B

TRUTH TABLE

INPUT				OUTPUT		
A_1	A_0	B_1	B_0	$Y_1=A<B$	$Y_2=(A=B)$	$Y_3=A>B$
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

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

$$A < B: L = \overline{A1}\ B1 + \overline{A0}\ B1\ B0 + \overline{A1}\ \overline{A0}\ B0$$

K-Map for A=B:

A_1A_0 \ B_1B_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

$$A = B: E = \overline{A1}\ \overline{A0}\ \overline{B1}\ \overline{B0} + \overline{A1}\ A0\ \overline{B1}\ B0 + A1\ A0\ B1\ B0 + A1\ \overline{A0}\ B1\ \overline{B0}$$

$$= \overline{A1}\ \overline{B1}\ (\overline{A0}\ \overline{B0} + A0\ B0) + A1\ B1\ (A0\ B0 + \overline{A0}\ \overline{B0})$$

$$= (A0\ B0 + \overline{A0}\ \overline{B0})\ (A1\ B1 + \overline{A1}\ \overline{B1})$$

$$= (A0 \text{ Ex-NOR } B0)\ (A1 \text{ Ex-NOR } B1)$$

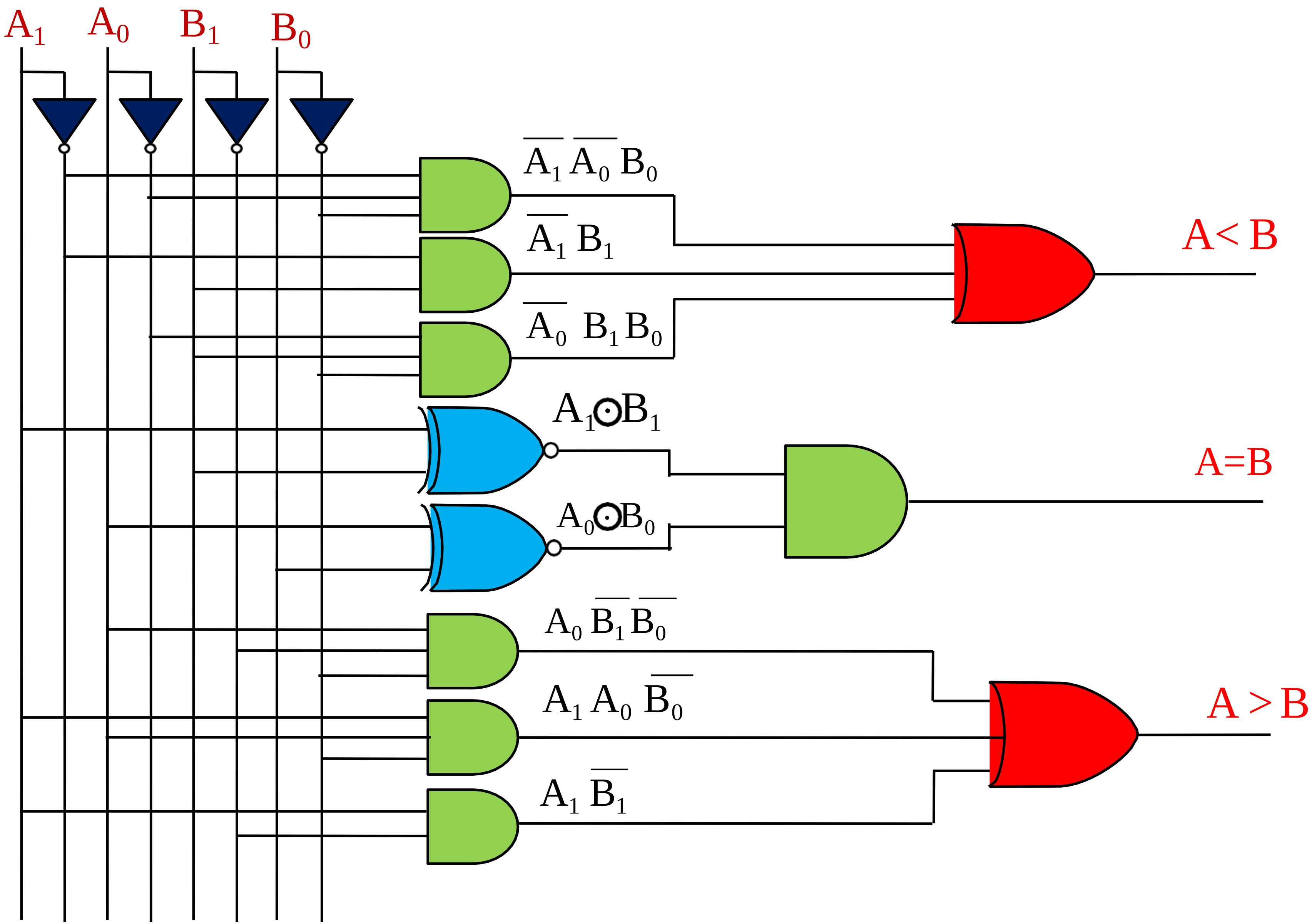
$$= (A_1 \oplus B_1)'\ (A_0 \oplus B_0)'$$

K-Map For A>B

A_1A_0 \ B_1B_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

$$A>B: G = A0\,\overline{B1}\;\overline{B0} + A1\,\overline{B1} + A1\;A0\,\overline{B0}$$

LOGIC DIAGRAM OF 2-BIT COMPARATOR:

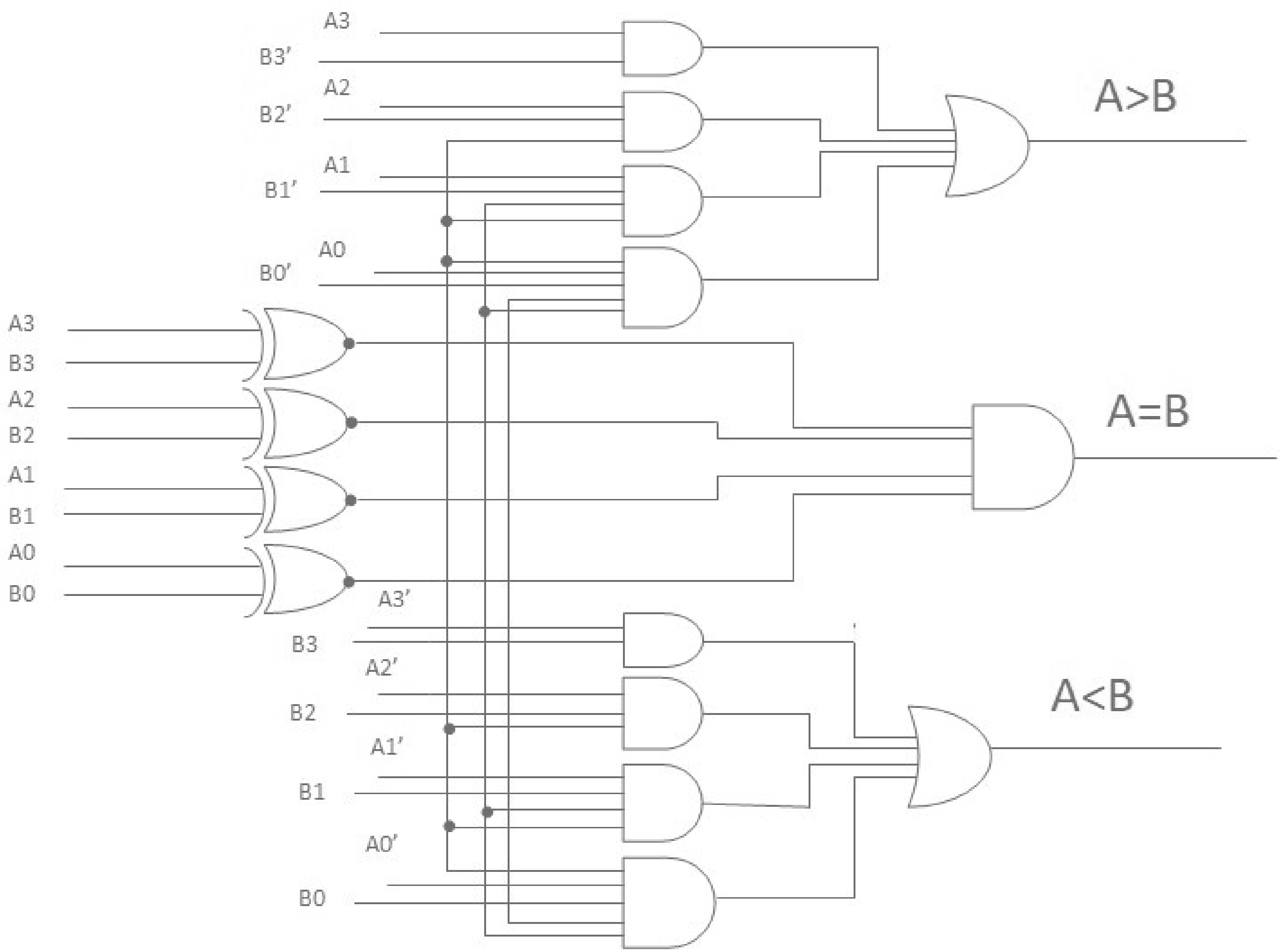


4-BIT COMPARATOR

The procedure for binary numbers with more than 2 bits can also be found in the similar way. Figure shows the 4-bit magnitude comparator.

Input: $A=A_3A_2A_1A_0$

$B=B_3B_2B_1B_0$



CASE 1: A=B

$A_3=B_3$, $A_2=B_2$, $A_1=B_1$, $A_0=B_0$

xi = AiBi + Ai'Bi'

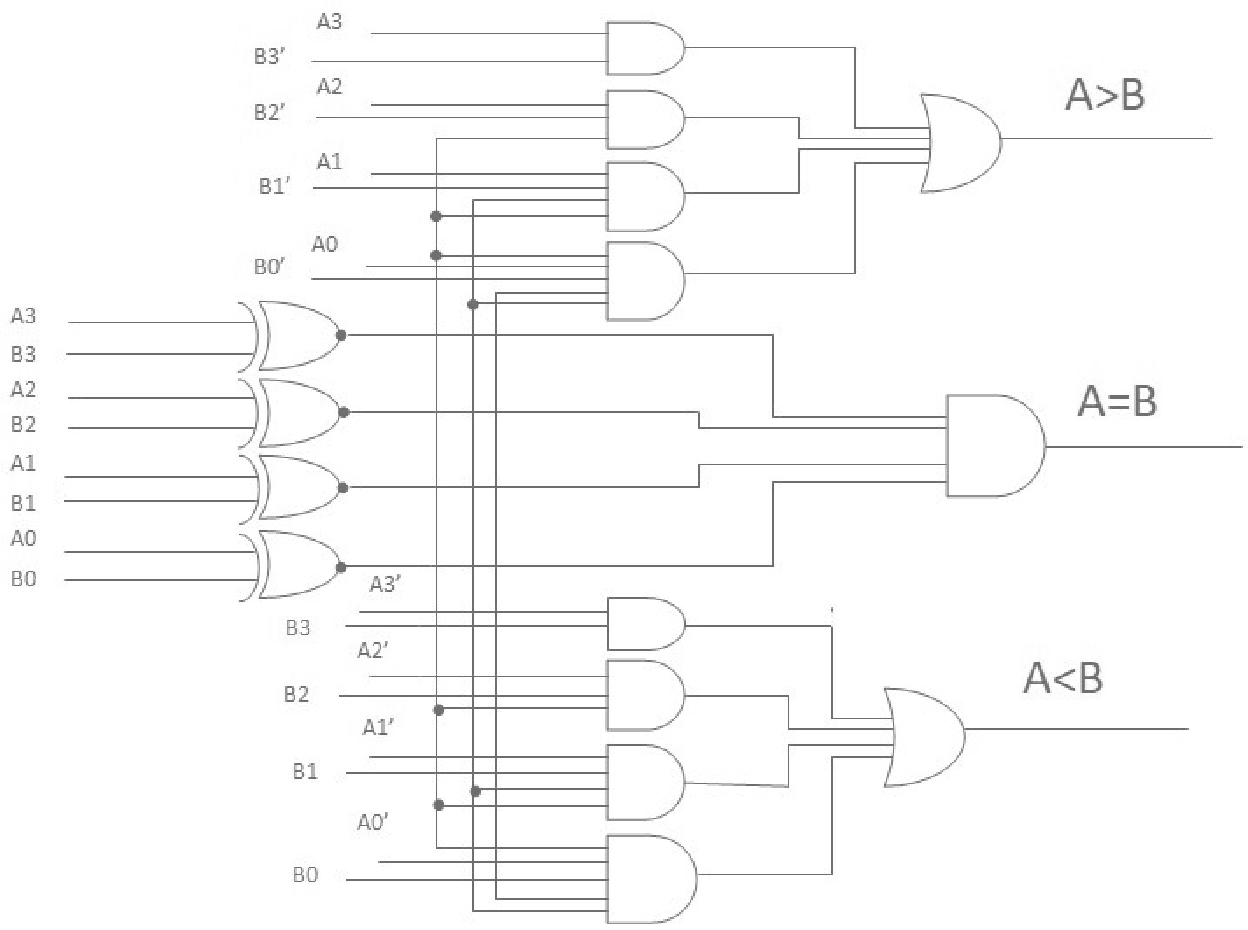
x3 = A3B3 + A3'B3'

x2 = A2B2 + A2'B2'

x1 = A1B1 + A1'B1'

x0 = A0B0 + A0'B0'

Output: $X_3X_2X_1X_0$



CASE 2: A>B

Output: $A_3B'_3 + X_3A_2B'_2 + X_3X_2A_1B'_1 + X_3X_2X_1A_0B'_0$

CASE 3: A<B

Output: $A'_3B_3 + X_3A'_2B_2 + X_3X_2A'_1B_1 + X_3X_2X_1A'_0B_0$

Truth table of 4-Bit Comparator						
COMPARING INPUT				OUTPUT		
A3, B3	A2, B2	A1, B1	A0, B0	A > B	A < B	A = B
A3 > B3	X	X	X	H	L	L
A3 < B3	X	X	X	L	H	L
A3 = B3	A2 >B2	X	X	H	L	L
A3 = B3	A2 < B2	X	X	L	H	L
A3 = B3	A2 = B2	A1 > B1	X	H	L	L
A3 = B3	A2 = B2	A1 < B1	X	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 > B0	H	L	L
A3 = B3	A2 = B2	A1 = B1	A0 < B0	L	H	L
H = High Voltage Level, L = Low Voltage, Level, X = Don’t Care						

Applications Comparators

- These are used in the address decoding circuitry in computers and microprocessor based devices to select a specific input/output device for the storage of data.
- These are used in control applications in which the binary numbers representing physical variables such as temperature, position, etc. are compared with a reference value. Then the outputs from the comparator are used to drive the actuators so as to make the physical variables closest to the set or reference value.
- Process controllers
- Servo-motor control