CSE 260
Digital Logic Design

Combinational Circuit-3

BRAC University

Arithmetic Circuits: Comparator

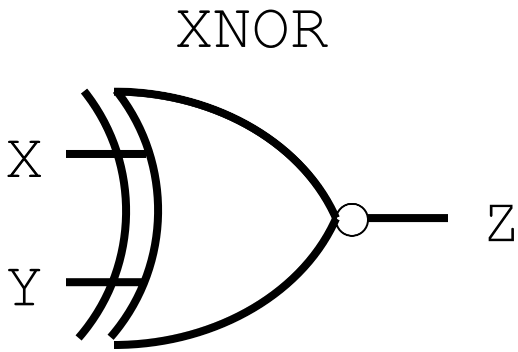
- Magnitude comparator: compares 2 values A and B, to see if A>B, A=B or A<B.
- How do we compare two 4-bit values A ($a_3a_2a_1a_0$) and B ($b_3b_2b_1b_0$)?

  If ($a_3 > b_3$) then A > B

  If ($a_3 < b_3$) then A < B

  If ($a_3 = b_3$) then if ($a_2 > b_2$) ….

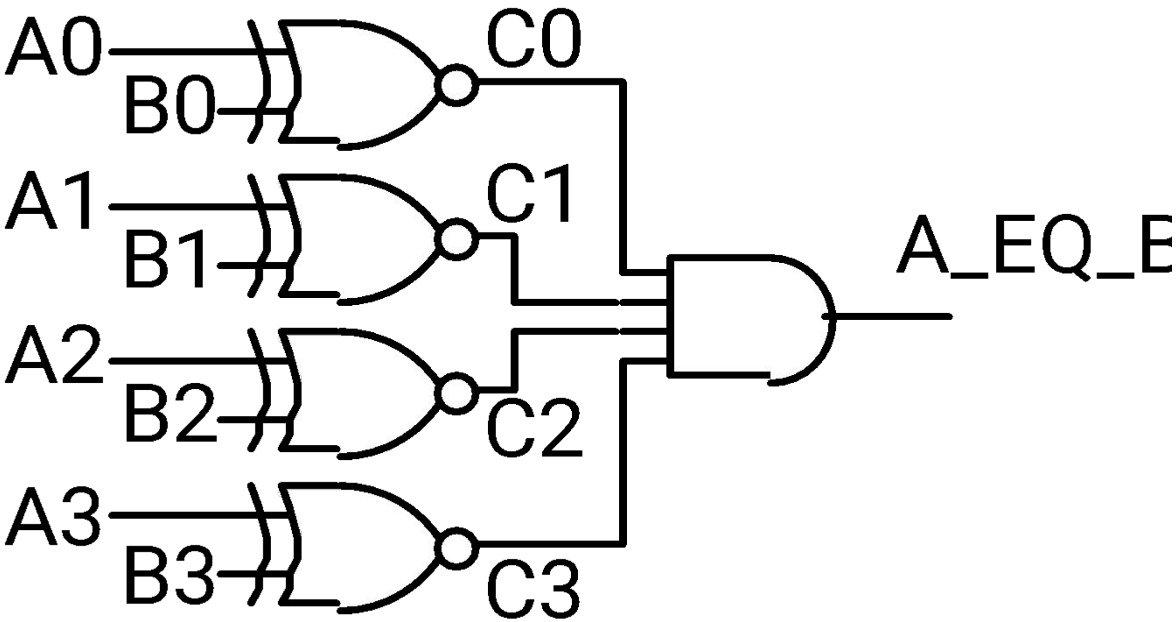
Equality Comparator



X	Y	Z
0	0	1
0	1	0
1	0	0
1	1	1

$Z = !(X \oplus Y)$

4-Bit Equality Comparator

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FIELD A = [A0..3];
FIELD B = [B0..3];
FIELD C = [C0..3];
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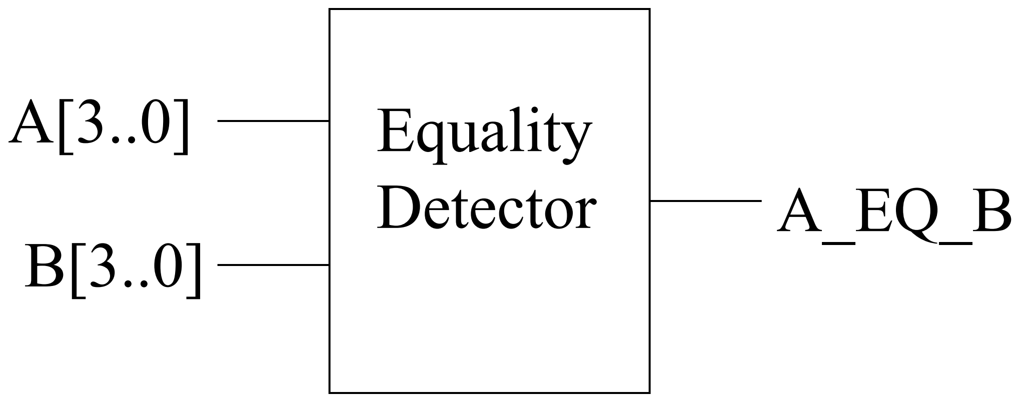
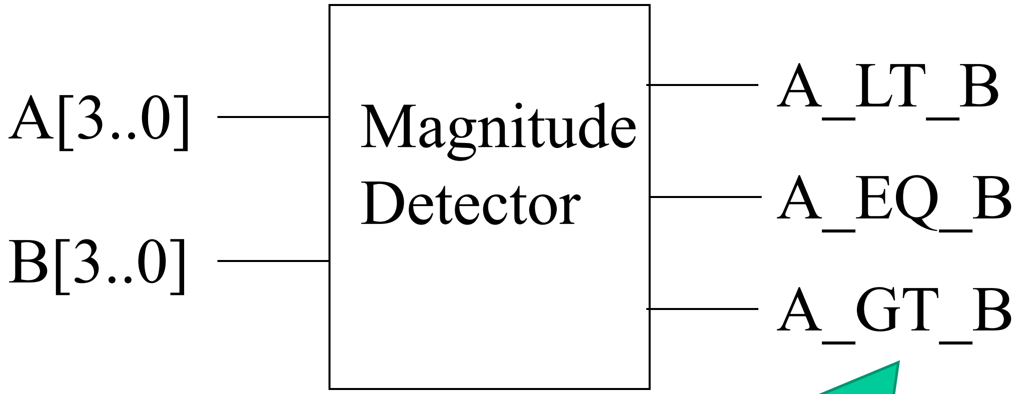
4-bit Equality Detector

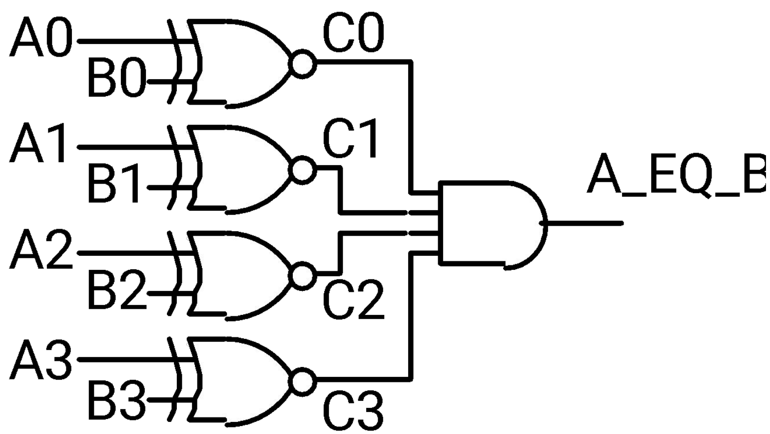


4-bit Magnitude Comparator



Note: here EQ stands for ‘equal’, LT stands for ‘less than’ and GT stands for ‘greater than’.

Magnitude Comparator

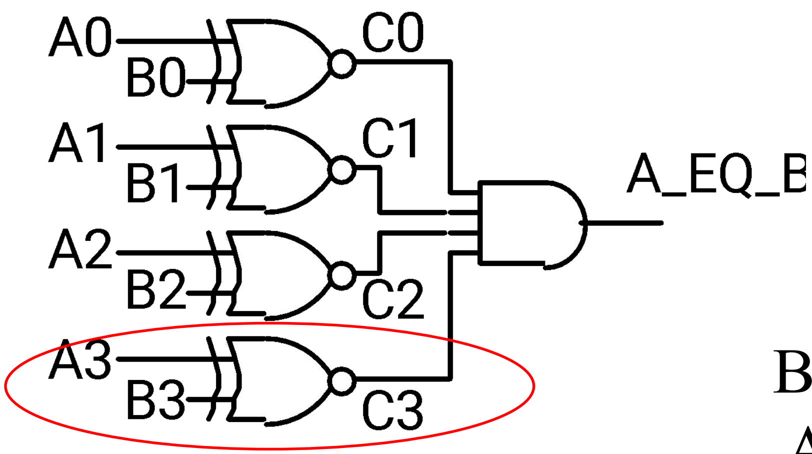


How can we find A_GT_B?

How many rows would a truth table have?

$$2^8 = 256!$$

Magnitude Comparator



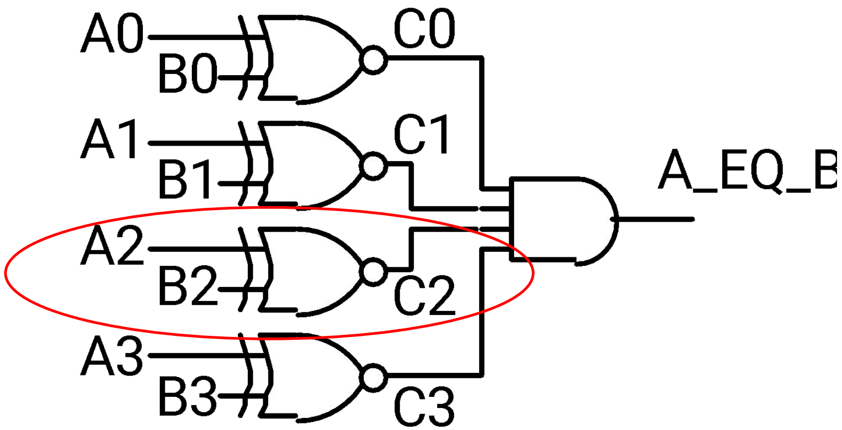
Find A_GT_B

Because A3 > B3, which means
A=1 and B=0
i.e. A3 & !B3 = 1

Therefore, one term in the logic equation for A_GT_B is A3 & !B3

If A = 1001 and
B = 0111
is A > B?
Why?

Magnitude Comparator



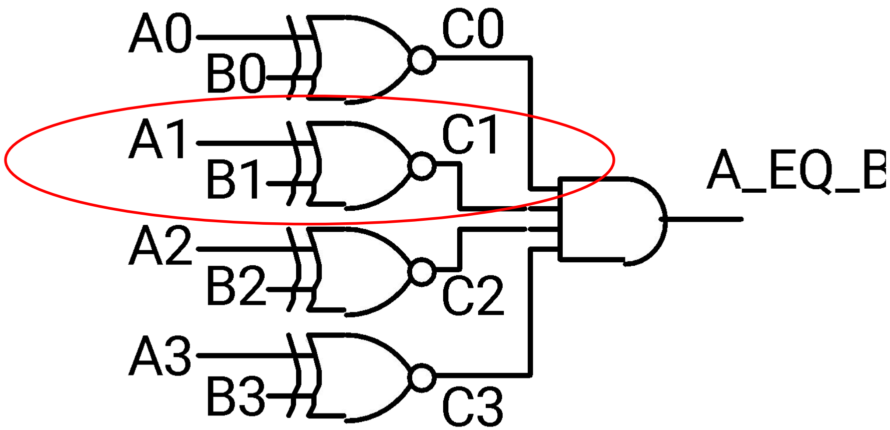
A_GT_B = A3 & !B3
+ .....

Because A3 = B3 and
A2 > B2
i.e. C3 = 1 and
A2 & !B2 = 1

If A = 1101 and
B = 1011
is A > B?
Why?

Therefore, the next term in the logic equation for A_GT_B is C3 & A2 & !B2

Magnitude Comparator



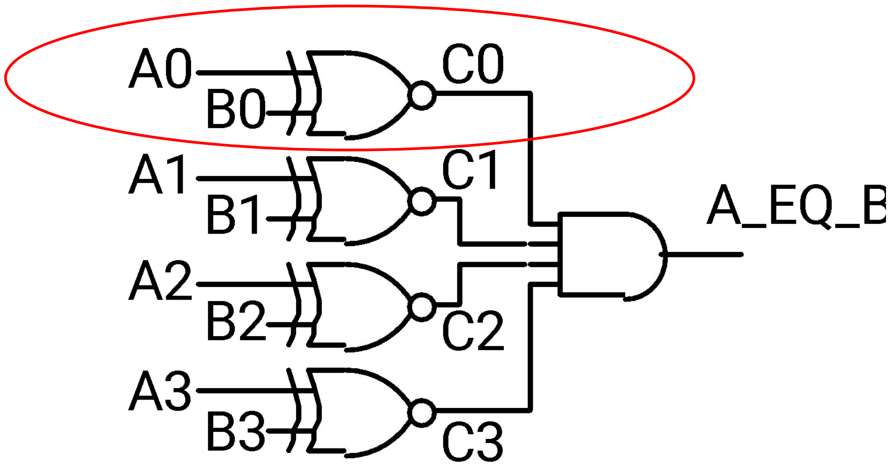
A_GT_B = A3 & !B3
+ C3 & A2 & !B2
+ .....

Because A3 = B3 and
A2 = B2 and
A1 > B1
i.e. C3 = 1 and C2 = 1 and
A1 & !B1 = 1

If A = 1010 and
B = 1001
is A > B?
Why?

Therefore, the next term in the logic equation for A_GT_B is C3 & C2 & A1 & !B1

Magnitude Comparator



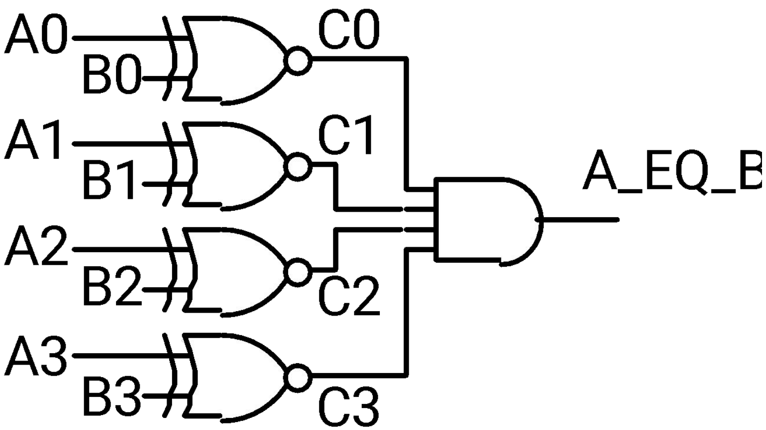
A_GT_B = A3 & !B3
+ C3 & A2 & !B2
+ C3 & C2 & A1 & !B1
+ .....

If A = 1011 and
B = 1010
is A > B?
Why?

Because A3 = B3 and
A2 = B2 and
A1 = B1 and
A0 > B0
i.e. C3 = 1 and C2 = 1 and
C1 = 1 and A0 & !B0 = 1

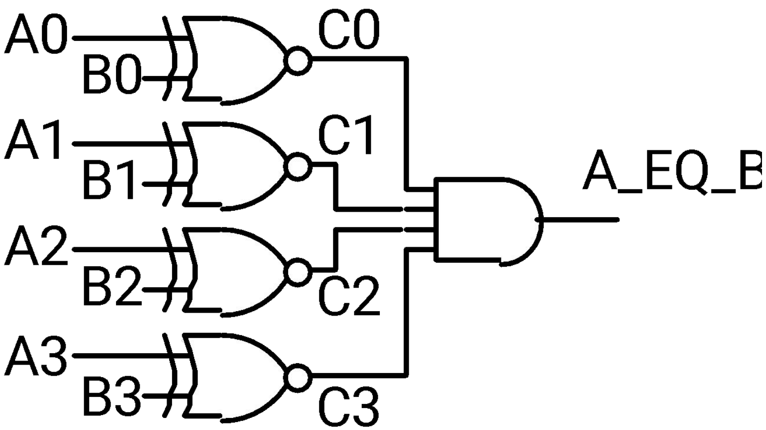
Therefore, the last term in the logic equation for A_GT_B is C3 & C2 & C1 & A0 & !B0

Magnitude Comparator



A_GT_B = A3 & !B3
+ C3 & A2 & !B2
+ C3 & C2 & A1 & !B1
+ C3 & C2 & C1 & A0 & !B0

Magnitude Comparator



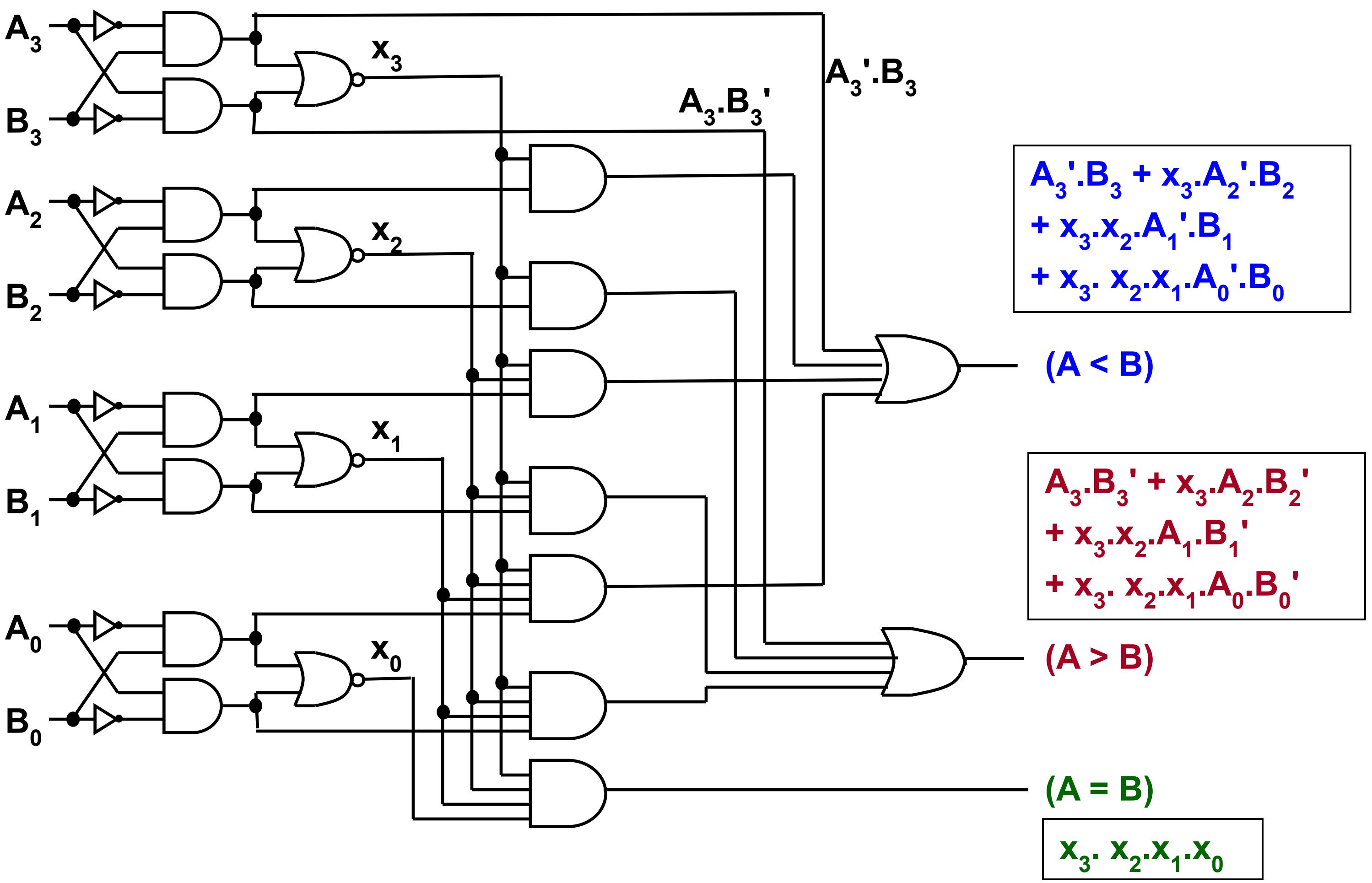
Now Find
A_LT_B

A_LT_B = !A3 & B3
+ C3 & !A2 & B2
+ C3 & C2 & !A1 & B1
+ C3 & C2 & C1 & !A0 & B0

Arithmetic Circuits: Comparator

Note: This is the circuit of Magnitude compar-ator !!!
All previous slides where for just understan-di ng!

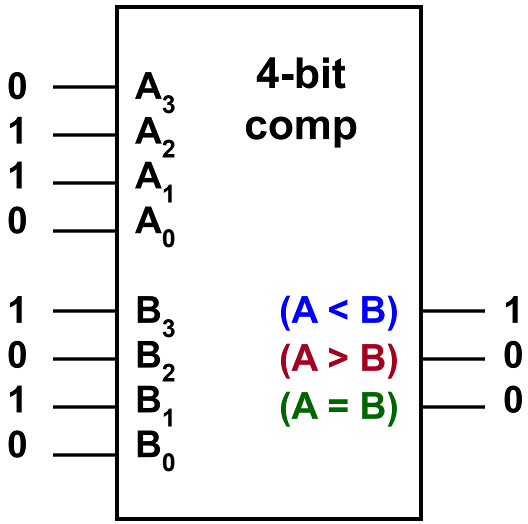
Let $A = A_3A_2A_1A_0$, $B = B_3B_2B_1B_0$; $x_i = A_i.B_i + A_i'.B_i'$



Important points

- **Note: We start by comparing digits in from MSB position. If those digits are equal, then we compare next 2 lower significant pairs of digits.**
- Same circuit of previous slide can be used for comparing relative magnitude of 2 BCD digits.

Arithmetic Circuits: Comparator



Block diagram of a 4-bit
magnitude comparator