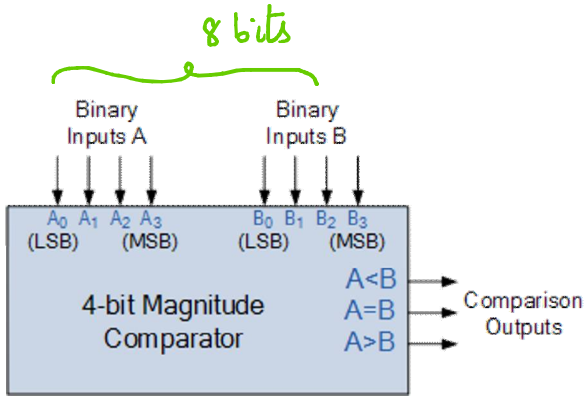
4-Bit Magnitude Comparator



2^8 combinations

MSB LSB

$$A = A_3 \; A_2 \; A_1 \; A_0 = 1 \; 1 \; 1 \; 0$$

$$B = B_3 \; B_2 \; B_1 \; B_0 = 0 \; 1 \; 0 \; 0$$

$A > B$

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

$$A = B \implies AB + \bar{A}.\bar{B} \implies A \odot B$$

$$x_i = A_i B_i + \bar{A}_i \bar{B}_i \implies A_i \odot B_i$$

where $i = 0, 1, 2, 3$.

$$x_0 = A_0 B_0 + \bar{A}_0 \bar{B}_0 \implies A_0 \odot B_0$$

$$x_1 = A_1 B_1 + \bar{A}_1 \bar{B}_1 \implies A_1 \odot B_1$$

$$x_2 = A_2 B_2 + \bar{A}_2 \bar{B}_2 \implies A_2 \odot B_2$$

$$x_3 = A_3 B_3 + \bar{A}_3 \bar{B}_3 \implies A_3 \odot B_3$$

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

1. If A3 = 1 and B3 = 0 $\Longrightarrow A_3 \overline{B}_3$

2. If A3 = B3 and A2 = 1 and B2 = 0 $\Longrightarrow (A_3 \odot B_3) \cdot A_2 \overline{B}_2$

   $\Longrightarrow x_3 \cdot A_2 \overline{B}_2$

3. If A3 = B3, A2 = B2 and A1 = 1 and B1 = 0 $\Longrightarrow (A_3 \odot B_3) \cdot (A_2 \odot B_2) \; A_1 \cdot \overline{B}_1$

   $\Longrightarrow x_3 \cdot x_2 \cdot A_1 \cdot \overline{B}_1$

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

   $(A_3 \odot B_3)\,(A_2 \odot B_2)\,(A_1 \odot B_1)\; A_0 \overline{B}_0$

   $x_3 \cdot x_2 \cdot x_1 \cdot A_0 \overline{B}_0$

$$\boxed{A > B \Longrightarrow A_3 \cdot \overline{B}_3 + x_3 \cdot A_2 \overline{B}_2 + x_3 \cdot x_2 \cdot A_1 \overline{B}_1 + x_3 x_2 x_1 \cdot A_0 \overline{B}_0}$$

B) Similarly the condition for A<B can be possible in the following four cases:

1. If A3 = 0 and B3 = 1 $\Longrightarrow \overline{A}_3 B_3$

2. If A3 = B3 and A2 = 0 and B2 = 1 $\Longrightarrow (A_3 \odot B_3)\; \overline{A}_2 B_2$

   $x_3 \cdot \overline{A}_2 B_2$

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

   $(A_3 \odot B_3)\,(A_2 \odot B_2)\; \overline{A}_1 B_1$

   $(x_3)\,(x_2)\; \overline{A}_1 B_1$

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

$$(A_3 \odot B_3)\ (A_2 \odot B_2)\ (A_1 \odot B_1)\ \bar{A}_0 B_0$$

$$x_3 \cdot x_2 \cdot x_1 \cdot \bar{A}_0 B_0$$

$$\boxed{A < B \Rightarrow \bar{A}_3 B_3 + x_3 \cdot \bar{A}_2 B_2 + x_3 \cdot x_2 \cdot \bar{A}_1 B_1 + x_3 x_2 x_1 \cdot \bar{A}_0 B_0}$$

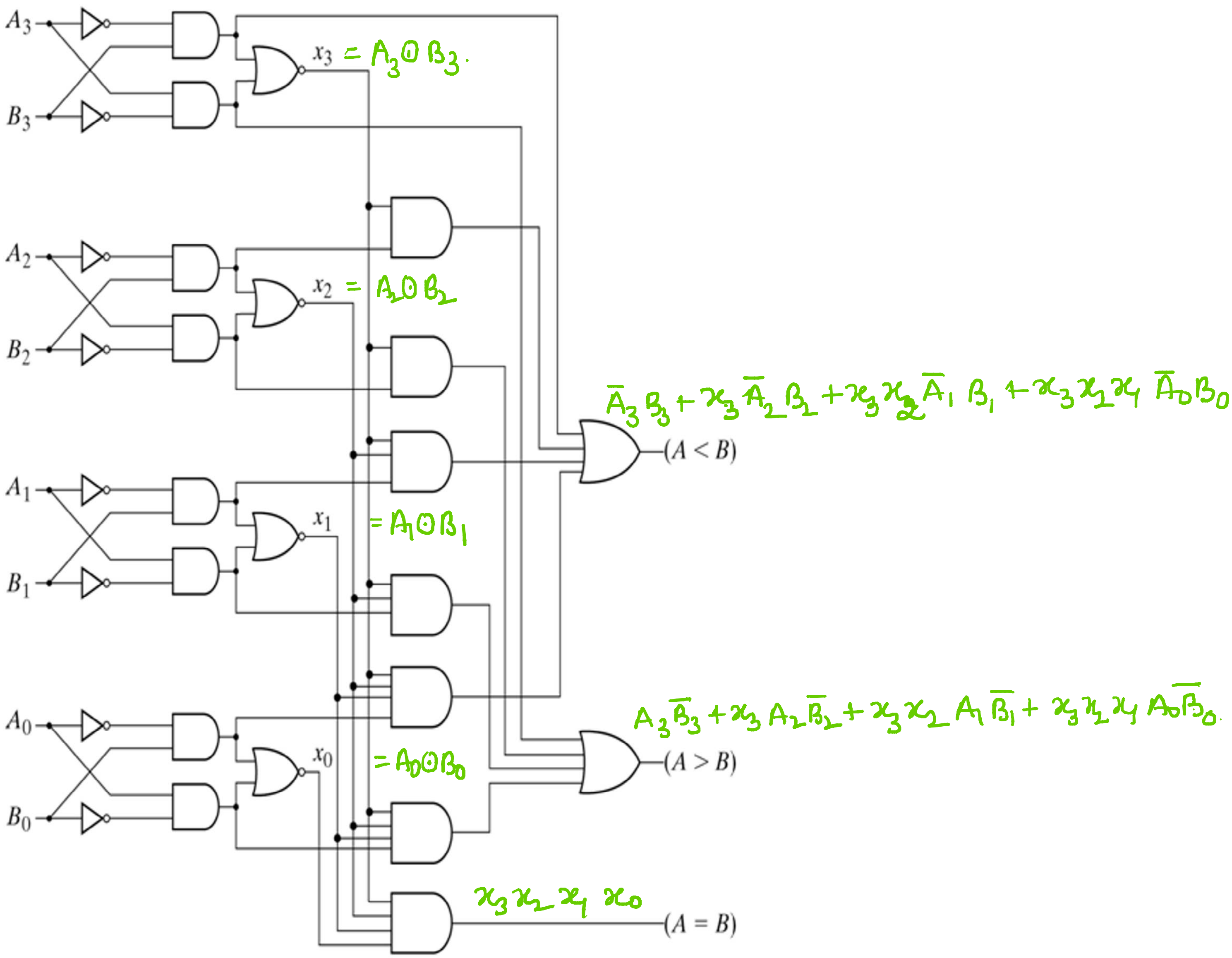

Fig. 4-17 4-Bit Magnitude Comparator