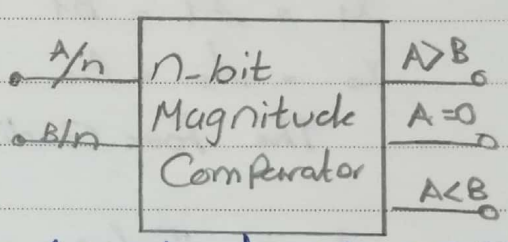
4 bit magnitude Comparator

Take two binary numbers as input and Compare whether one number is greater Than, less Than or equal The other number.

2 inputs → 3 output

The true Condition gives us [1]



* first let's discuss 1 Bit Comparator A & B has length 1 BiT

→ (A=B) Coloumb (Ex-Nor gate) when The inputs are similar output = 1, when They are different output = 0

$A \odot B = (\overline{A \oplus B})$ $(\bar{A}\bar{B} + AB)$

→ (A<B) Coloumb $\bar{A} \cdot B$

→ (A>B) Coloumb $A \cdot \bar{B}$

input		output		
A	B	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

* 4 bit magnitude Comparator.

2 inputs each one has length 4bit (8 inputs)

→ no. of Rows $2^8 = 256$ row not logical to use ordinary Metho

Assume First number = $A_3 A_2 A_1 A_0$

Second number = $B_3 B_2 B_1 B_0$

if $A_3 A_2 A_1 A_0 = B_3 B_2 B_1 B_0$ → (A=B) Coloumb = 1

$A_3 A_2 A_1 A_0 > B_3 B_2 B_1 B_0$ → (A>B) Coloumb = 1

$A_3 A_2 A_1 A_0 < B_3 B_2 B_1 B_0$ → (A<B) Coloumb = 1

* [equal] Coloumb Conditions :

$x_3 = A_3 = B_3 = \overline{(A_3 \oplus B_3)}$

$x_2 = A_2 = B_2 = \overline{(A_2 \oplus B_2)}$

$x_1 = A_1 = B_1 = \overline{(A_1 \oplus B_1)}$

$x_0 = A_0 = B_0 = \overline{(A_0 \oplus B_0)}$

The Four Conditions must be true

$\therefore A = B$ if $(A_3 = B_3 \; \& \; A_2 = B_2 \; \& \; A_1 = B_1 \; \& \; A_0 = B_0)$

$(A = B) \longrightarrow \overline{(A_3 \oplus B_3)} . \overline{(A_2 \oplus B_2)} . \overline{(A_1 \oplus B_1)} . \overline{(A_0 \oplus B_0)}$

$= x_3 . x_2 . x_1 . x_0$

* [Greater Than] Coloumb $A > B$

$\Rightarrow$ if $(A_3 > B_3)$ $A_3 = 1 \; \& \; B_3 = 0$

Boolean equ : $A_3 . \overline{B_3}$

$\Rightarrow$ if $(A_3 = B_3 \; \& \; A_2 > B_2)$ $A_2 . 1 \; \& \; B_2 = 0$

$\hookrightarrow \overline{(A_3 \oplus B_3)}$

$\hookrightarrow A_2 . \overline{B_2}$

Boolean equ : $\overline{(A_3 \oplus B_3)} . (A_2 \overline{B_2})$

$\Rightarrow$ if $(A_3 = B_3 \; \& \; A_2 = B_2 \; \& \; A_1 > B_1)$ $A_1 . 1 \; \& \; B_1 = 0$

$\hookrightarrow \overline{(A_3 \oplus B_3)}$

$\hookrightarrow \overline{(A_2 \oplus B_2)}$

$\hookrightarrow A_1 . \overline{B_1}$

Boolean equ : $\overline{(A_3 \oplus B_3)} . \overline{(A_2 \oplus B_2)} . (A_1 . \overline{B_1})$

$\Rightarrow$ if $(A_3 = B_3 \; \& \; A_2 = B_2 \; \& \; A_1 = B_1 \; \& \; A_0 > B_0)$

Boolean equ : $\overline{(A_3 \oplus B_3)} \; \overline{(A_2 \oplus B_2)} \; \overline{(A_1 \oplus B_1)} \; (A_0 \overline{B_0})$

(Combine For all Conditions)

$(A > B) = A_3 \overline{B_3} + \overline{(A_3 \oplus B_3)} (A_2 \overline{B_2}) + \overline{(A_3 \oplus B_3)} \; \overline{(A_2 \oplus B_2)} \; (A_1 \overline{B_1}) + \overline{(A_3 \oplus B_3)} \; \overline{(A_2 \oplus B_2)} \cdot \overline{(A_1 \oplus B_1)} \cdot (A_0 \overline{B_0})$

* less than coloumb $A < B$

if $(A_3 < B_3)$

boolean equ: $\overline{A_3} \cdot B_3$

if $(A_3 = B_3 \text{ \& } A_2 < B_2)$

boolean equ: $(\overline{A_3 \oplus B_3}) \cdot (\overline{A_2} B_2)$

if $(A_3 = B_3 \text{ \& } A_2 = B_2 \text{ \& } A_1 < B_1)$

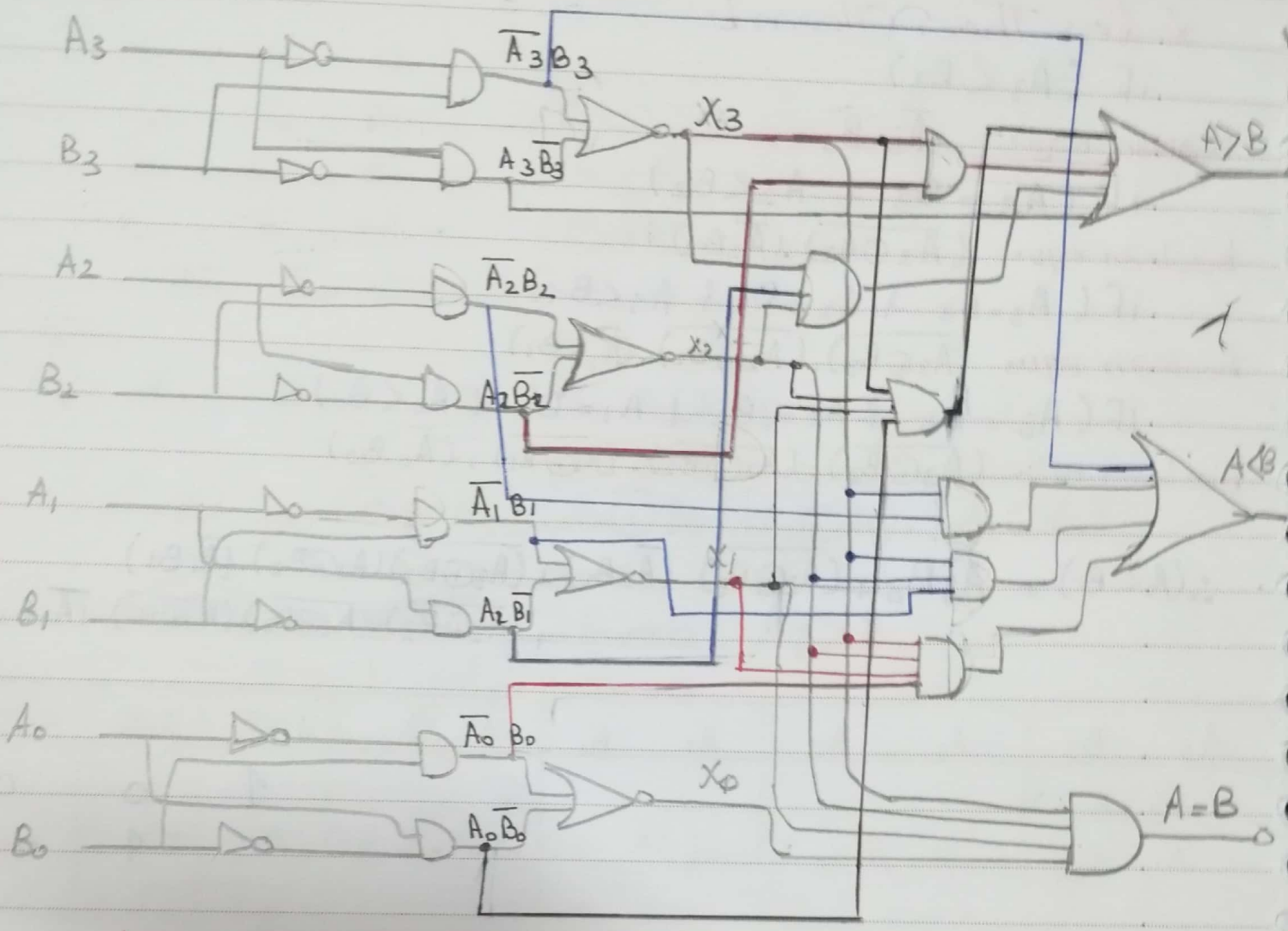
boolean equ: $(\overline{A_3 \oplus B_3}) \cdot (\overline{A_2 \oplus B_2}) \cdot (\overline{A_1} \cdot B_1)$

if $(A_3 = B_3 \text{ \& } A_2 = B_2 \text{ \& } A_1 = B_1 \text{ \& } A_0 < B_0)$

boolean equ: $(\overline{A_3 \oplus B_3}) \cdot (\overline{A_2 \oplus B_2}) \cdot (\overline{A_1 \oplus B_1}) \cdot (\overline{A_0} \cdot B_0)$

$$\therefore (A < B) = \overline{A_3} B_3 + (\overline{A_3 \oplus B_3}) \cdot (\overline{A_2} B_2) + (\overline{A_3 \oplus B_3}) \cdot (\overline{A_2 \oplus B_2}) \cdot (\overline{A_1} B_1) + (\overline{A_3 \oplus B_3}) \cdot (\overline{A_2 \oplus B_2}) \cdot (\overline{A_1 \oplus B_1}) \cdot (\overline{A_0} B_0)$$

A_3 B_3	A_2 B_2	A_1 B_1	A_0 B_0	$A>B$	$A<B$	$A=B$
$A_3 > B_3$	X	X	X	1	0	0
$A_3 < B_3$				0	1	0
$A_3 = B_3 = x_3$	$A_2 > B_2$	X	X	1	0	0
	$A_2 < B_2$			0	1	0
$A_3 = B_3 = x_3$	$A_2 = B_2 = x_2$	$A_1 > B_1$	X	1	0	0
		$A_1 < B_1$		0	1	0
$A_3 = B_3 = x_3$	$A_2 = B_2 = x_2$	$A_1 = B_1 = x_1$	$A_0 > B_0$	1	0	0
			$A_0 < B_0$	0	1	0
$A_3 = B_3 = x_3$	$A_2 = B_2 = x_2$	$A_1 = B_1 = x_1$	$A_0 = B_0 = x_0$	0	0	1



Where

X_3 is $\overline{(\bar{A}_3 B_3 + A_3 \bar{B}_3)}$

$X_2 = \overline{(\bar{A}_2 B_2 + A_2 \bar{B}_2)}$

$X_1 = \overline{(\bar{A}_1 B_1 + A_1 \bar{B}_1)}$

$X_0 = \overline{(\bar{A}_0 B_0 + A_0 \bar{B}_0)}$

equal equ: $X_3\ X_2\ X_1\ X_0$

Greater equ : $A_3 \bar{B}_3 + X_3(A_2 \bar{B}_2) + X_3 X_2 (A_1 \bar{B}_1) + X_3 X_2 X_2 (A_0 \bar{B}_0)$

less equ : $\bar{A}_3 B_3 + X_3 . \bar{A}_2 B_2 + X_3 X_2 (\bar{A}_1 . B_1) + X_3 X_2 X_1 (\bar{A}_0 B_0)$