DIGITAL LOGIC DESIGN

CSE-260

LAB Report - 6

GROUP - 4

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Name of the experiment: Implemen-tation of 4 bit magnitude comparator.

Objective:

(i) To get the idea of how comparator works
(ii) To gain experience working with comparator
(iii) To ~~simplify~~ Understand the complexity of comparator

Required components and Equipments:

(i) Bread Board
(ii) Trainer Board,
(iii) Jumper wires
(iv) AND (IC-7408
(v) OR (IC-7432)
(vi) NOT (IC-7404)
(vii) XOR (IC-7486

Experimental setup:

Let us think of the number as,

1st number → $A_3\ A_2\ A_1\ A_0$

2nd number → $B_3\ B_2\ B_1\ B_0$

For $A=B$ the equations for the magnitud compa-rator will be,

if $A_3 = B_3$: x_3 : $A_3' B_3' + A_3 B_3$

if $A_2 = B_2$: x_2 : $A_2' B_2' + A_2 B_2$

if $A_1 = B_1$: x_1 : $A_1' B_1' + A_1 B_1$

if $A_0 = B_0$: x_0 : $A_0' B_0' + A_0 B_0$

The final equation : $x_3 \cdot x_2 \cdot x_1 \cdot x_0$

To do this practically, we need to take a XOR gate and place it on to Bread board.

CamScanner

After that we need connect ground to pin 7, Vcc to pin 7 ~~pbl~~ of the IC. Then, I need to connect A_3, B_3 input to the XOR IC's pin 1 and Pin 2. The out ~~put~~ will be in pin 3. We need to place a NOT Gate below the XOR IC and connect ~~GN~~ GND and Vcc as like XOR Gate. We will take input ~~fa~~ from pin 3 ~~&~~ of XOR IC and connect it with NOT Gate's pin 1. Out-put of Not get will generate at pin 2. We will place an AND Gate in the Breadboard and connect Vcc and GND to pin 14, pin 7 of the IC. After that we will take input from pin 2 of Not Gate and connect it to pin 1 of AND Gate. Furthermore, we will take input A_2, B_2 to Pin 4, Pin 5 of XOR IC. The output will be generate in Pin 6 of XOR IC. This output we will take as an input of pin 3 of Not Gate. The output in the Not Gate will be generated in pin pin 4. This output of Not Gate will be taken as an input of pin 2 of the AND Gate. The output will be generated in pin 3 of AND Gate. This pin 3 will be taken as an input in Pin 13 of AND Gate.

~~After, 1~~ Moreover, we will take A_1, B_2 as the input in XOR Gate pin 10, 9. The output will be generated in Pin 8.

We will ~~take pin 8~~ connect pin 8 with the Not gate's pin 5 and the output of NOT Gate will generate in pin 6. We will take this output and take it as an input to the AND Gates IC pin 9. Lastly we will take A_0, B_0 as an input and connect it to pin 12, 13 of XOR Gate IC. The output of XOR Gate will generate in pin 11 of the XOR Gate IC. We will connect pin 11 of XOR Gate with pin 9 of NOT Gate. The Not Gate's output will generate in pin 8. We will take pin 8's output and connect it to the pin 10 of AND gate IC. The output will generate in pin 8 of AND gate IC. We will take this output as an input to the pin 12 of the AND gate. By this we will get the final output of equal comparator. ~~If we get 1~~ we will connect this output to the display of trainer board.

E. Results and Discussion:

For all 3 of these comparator we need to define X_3, X_2, X_1, X_0.

Here,

$$X_3 = A_3' B_3' + \cancel{A_3 B} A_3 B_3$$

$$X_2 = A_2' B_2' + A_2 B_2$$

$$X_1 = A_1' B_1' + A_1 B_1$$

$$X_0 = A_0' B_0' + A_0 B_0$$

~~H~~ Here, $A_3 A_2 A_1 A_0$ are the digits of a binary number. same goes for $B_3 B_2 B_1 B_0$. If 1011 is a ~~1~~ binary number then $A_3 = 1$, ~~B~~ $A_2 = 0$, $A_1 = 1$, $A_0 = 1$

~~And~~ Moreover, for X_3 will provide 1 if ~~Bot~~ both A_3 and B_3 are equal. If both are not equal X_3 will provide 0 in the output. ~~so~~

① Comparator for A= B

As we want to make a 4 bit comparator where it will show 1 if ~~Bo~~ both of number A = B and give output 0 if $A \neq B$.

As, x_3, x_2, x_1, x_0 all of them gives output 1 if a single digit from two number is equal.

As, we have 4 bit or 4 digits we need to give output 1 if all of the sequential digits are same. If 1 digit does not match with the other number than it will give output 0. So, the "Equal ~~converter~~ comparator" equation will be;

$x_3 \cdot x_2 \cdot x_1 \cdot x_0$ ← Equal comparator,

Lets assume two numbers,

A = 1101

B = 1100

Here,

$A_3 = 1$, $A_2 = 1$, $A_1 = 0$, $A_0 = 1$

$B_3 = 1$, $B_2 = 1$, $B_1 = 0$, $B_0 = 0$

$$X_3 = A_3'B_3' + A_3B_3 = 1$$

$$X_2 = A_2'B_2' + A_2B_2 = 1$$

$$X_1 = A_1'B_1' + A_1B_1 = 1$$

$$X_0 = A_0'B_0' + A_0B_0 = 0 \quad [A_s\ A_0 \neq B_0]$$

$\therefore$ ~~$x_3 \cdot A$~~ $x_3 . x_2 . x_1 . x_0 = 0$

So, the numbers are not equal.

If $A = 1011$

$B = 1011$,

Here, $x_3 = 1$

$x_2 = 1$

$x_1 = 1$

$x_0 = 1$

$\therefore x_3 x_2 x_1 x_0 = 1$

As the output is 1, which means both numbers are equal.

(11) $A > B$ Comparator,

same, as equal comparator A_3, A_2, A_1, A_0 and $B_3 B_2 B_1 B_0$ are the digits or bits of ~~a~~ two binary number, A, B.

As we ~~gonna count~~ are going to count from MSB, the steps will be.

Step 1 → $A_3 > B_3$ for it we need to write the equation $A_3 B_3'$, This equation is only going to provide 1 if $A_3 = 1$, $B_3 = 0$,

Step 2 → We need to go to step 2 from step ~~2~~ ~~3~~ 1 if ~~4~~ in step 1 $A_3 = B_3$, which will provide 0 in step 1, so the equation we will need in this step is $\cancel{A_3 A_2 B_2'}$ $x_3 A_2 B_2'$

As x_3 means $A_3 = B_3$ ~~and~~, x_3 is only 1 if A_3 and B_3 equal, also $A_2 B_2'$ only provide 1 if $A_2 = 1$, $B_2 = 0$,

Step 3 $\rightarrow$ If previous step is false, we need to come to this step, Equation of this step is $x_3 x_2 A_1 B_1'$. This step will provide 1 only if $A_3 = B_3$, $A_2 = B_2$ and $A_1 = 1$, $B_1 = 0$,

Step 4 $\rightarrow$ If previous steps are false, the We need to come to this step. Equation of this step is $x_3 x_2 x_1 A_0 B_0'$. This step is only going to provide 1 if $A_3 = B_3$, $A_2 = B_2$, $A_1 = B_1$ and $A_0 = 1$, $B_0 = 0$,

We need the output 1 if one of the

following step is true, so, the equation will be,

$$A_3 B_3' + x_3 A_2 B_2' + x_3 x_2 A_1 B_1' + x_3 x_2 x_1 A_0 B_0'$$

This equation is going to only provide 0 if all of the steps are false.

For number, $A = 1101$

$B = 1110$

Here,

$A_3 B_3' = 0$ [As $A_3 = B_3$]

$x_3 A_2 B_2' = 0$ [$A_2 = B_2$]

$x_3 x_2 A_1 B_1' = 0$ [$A_1 < B_1$]

$x_3 x_2 x_1 A_0 B_0' = 0$ [$x_1 = 0$]

$\therefore A \ngtr B$

For number,

$A = 1110$

$B = 1011$

Here,

$A_3 B_3' = 0$ [$A_3 = B_3$]

$x_3 A_2 B_2' = 1$ [$A_2 > B_2$]

$x_3 x_2 A_1 B_1' = 0$ [$x_2 = 0$]

$x_3 x_2 x_1 A_0 B_0' = 0$ [$x_2 = 0$]

$\therefore A > B$

(iii) $(A < B)$ comparator

As like $A > B$ comparator this equation will have kind of same but opposite equation.

For this comparator we need to consider some steps:

Step 1 → We need to give output 1 if $A_3 < B_3$, so, equation of this steps is, $A_3' B_3$. This equation is only going to generate 1 if $A_3 = 0$, $B_3 = 1$.

Step 2 → If step 1 is false, than we need to consider this step. Equation of this step is $x_3 A_2' B_2$. This equation only going to provide 1 if $A_3 = B_3$ and $A_2 = 0$, $B_2 = 1$.

Step 3 → We need to consider this step, if previous steps are false. The equation of this step is $x_3 x_2 A_1' B_1$. This ~~step~~ equation only going to provide 1 if $A_3 = B_3$, $A_2 = B_2$ and $A_1 = 0$, $B_1 = 1$,

Step 4 → If previous steps are false we need to consider this step. The equation of this step is $x_3 x_2 x_1 A_0' B_0$, This equation is only going to provide 1 if $A_3 = B_3$, $A_2 = B_2$, $A_1 = B_1$ and $A_0 = 0$, $B_0 = 1$,

As, we want to give the comparator output 1 only if one of these following steps are true.

So, the equation will be

$$A_3' B_3 + x_3 A_2' B_2 + x_3 x_2 A_1' B_1 + x_3 x_2 x_1 A_0' B_0$$

The following equation will only give output 0 if all of the steps are false.

For number,

$A = 1011$

$B = 1100$

Here,

$A_3' B_3 = 0$ $[A_3 = B_3]$

$x_3 A_2' B_2 = 1$ $[B_2 > A_2]$

$x_3 x_2 A_1' B_1 = 0$ $[x_2 = 0]$

$x_3 x_2 x_1 A_0' B_0 = 0$ $[x_2 = 0]$

$\therefore A < B$

For number,

$A = 1110$

$B = 1101$

Here,

$A_3' B_3 = 0$ $[A_3 = B_3]$

$x_3 A_2' B_2 = 0$ $[A_2 = B_2]$

$x_3 x_2 A_1' B_1 = 0$ $[A_1 > B_1]$

$x_3 x_2 x_1 A_0' B_0 = \cancel{1}\ 0$ $[x_1 = 0]$

$\therefore A \nless B$