

Experiment # 5: Implementation of 4-bit Magnitude Comparator

Objective:

- Designing a 4-bit Magnitude Comparator circuit with proper truth tables.

Required Components:

1. IC 7408
2. IC 7432
3. IC 7404
4. IC 4077

Theory:

The comparison of two numbers is an operation that determines if one number is greater than, less than or equal to the other number. A magnitude comparator is a combinational circuit that compares two numbers A and B and determines their relative magnitudes. The outcome of the comparison is specified by three binary variables that indicate $A > B$, $A = B$, or $A < B$.

The algorithm is a direct application of the procedure a person uses to compare the relative magnitudes of two numbers. Consider the two numbers A, and B, with four digits each. Write the coefficients of the numbers with descending significance as follows:

$$\begin{aligned} A &= A_3A_2A_1A_0 \\ B &= B_3B_2B_1B_0 \end{aligned}$$

where each subscripted digit represents one of the digits in the number.

The two numbers are equal if all pairs of significant digits are equal i.e., if $A_3=B_3$, $A_2=B_2$, $A_1=B_1$ and $A_0=B_0$. When the numbers are binary the digits are either 1 or 0 and the equality relation of each pair of bits can be expressed logically with an equivalence function:

$$x_i = A_i B_i + A_i' B_i', \quad i=0, 1, 2, 3$$

where $x_i=1$ only if the pair of bits in position i are equal, i.e., if both are 1's or both are 0's.

The equality of the two numbers A and B is displayed in a combinational circuit by an output binary. This binary variable is equal to 1 if the input numbers A and B are equal and it is equal to zero otherwise. For an equality condition to exist, all x_i variables must be equal to 1. This indicates an AND operation of all variables:

$$(A=B) = x_3 x_2 x_1 x_0$$

To demonstrate if A is greater than or less than B, we inspect the relative magnitude of pairs of significant digits starting from the most significant position. If the two digits are equal, we compare the next lower significant pair of digits. This comparison continues until a pair of unequal digits is reached. If the corresponding digit of A is 1 and that of B is 0, we conclude that $A > B$. If the corresponding digit of A is 0 and B is 1,

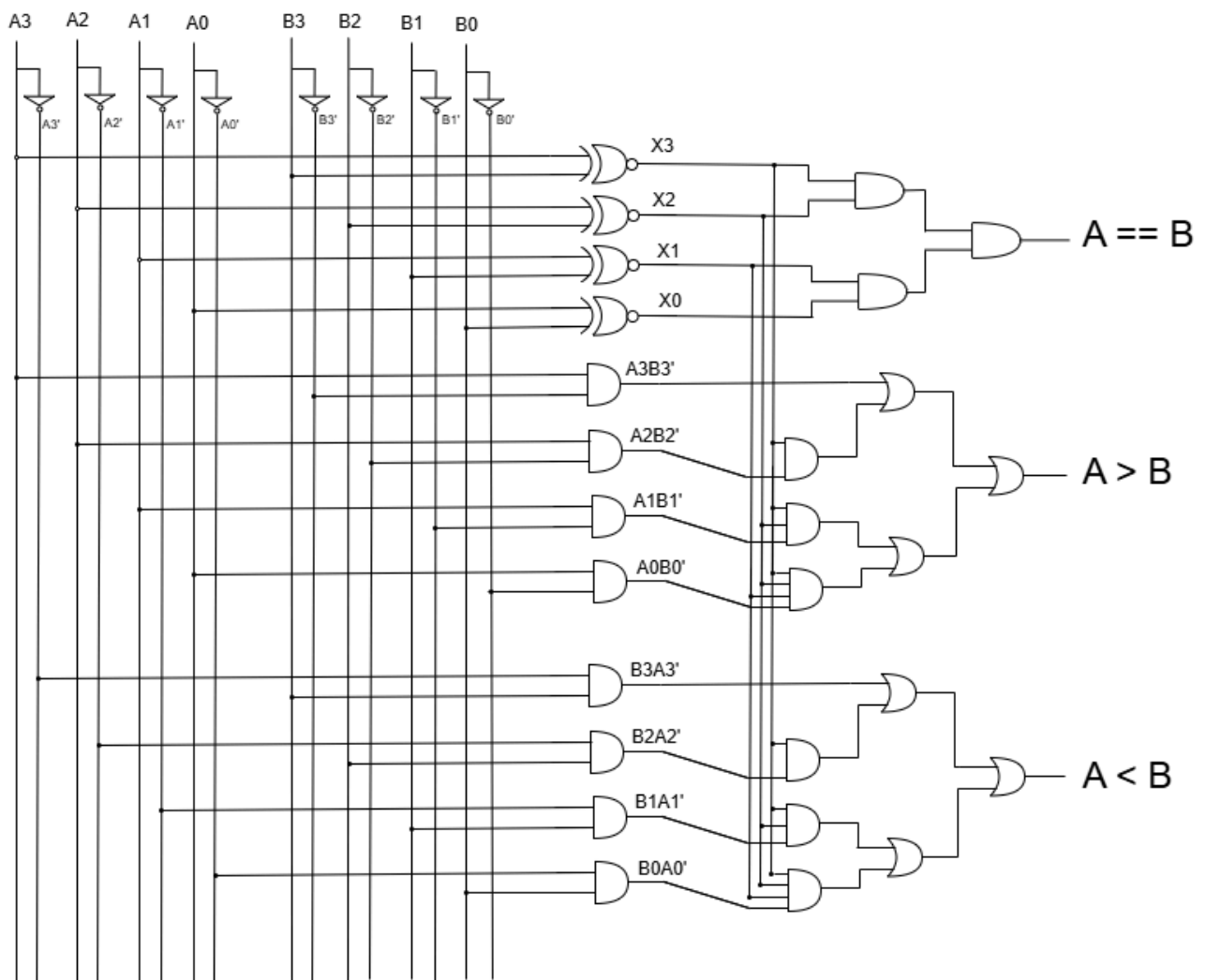
we have that $A < B$. The sequential comparison can be expressed logically by the following two Boolean functions:

$$(A > B) = A_3 B_3' + x_3 A_2 B_2' + x_3 x_2 A_1 B_1' + x_3 x_2 x_1 A_0 B_0'$$

$$(A < B) = A_3' B_3 + x_3 A_2' B_2 + x_3 x_2 A_1' B_1 + x_3 x_2 x_1 A_0' B_0$$

Diagram:

Building a 4-bit magnitude comparator using and, or, not, xnor gate(s):



Procedure:

- Construct the Circuit Diagram on the breadboard.
- Remember to connect each IC's VCC pin to the "+5V" position of the DC Power Supply of the trainer board, and the GND or 0V pin to the "GND" position of the trainer board.
- Connect the inputs to the Data switches and outputs to any position of the LED Display.

Report:

Your report must have the following segments:

1. Name of the Experiment.
2. Objective.
3. Required Components.
4. Experimental Setup - Draw the Circuit Diagram.
5. Results - Complete the following truth table:

	A	B	$A == B$	$A > B$	$A < B$
a.	1011	0101			
b.	0100	1001			
c.	1000	1000			
d.	1101	1110			
e.	1001	1001			
f.	0010	0001			

6. Discussions - Answer the following questions:
 - a) Draw the circuit diagram of a circuit that compares if a given 4-bit number is greater than 12.
 - b) Draw the circuit diagram of a circuit that compares if a given 3-bit number is less than 5.