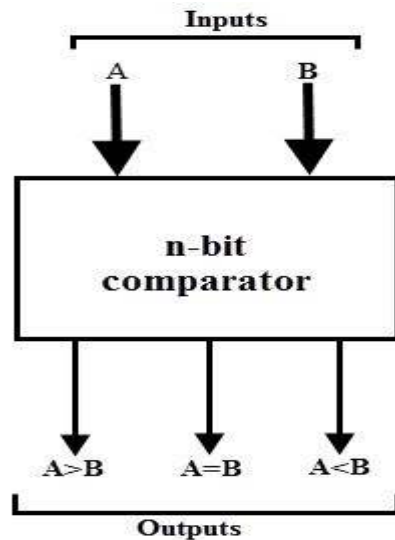


COMPARATOR

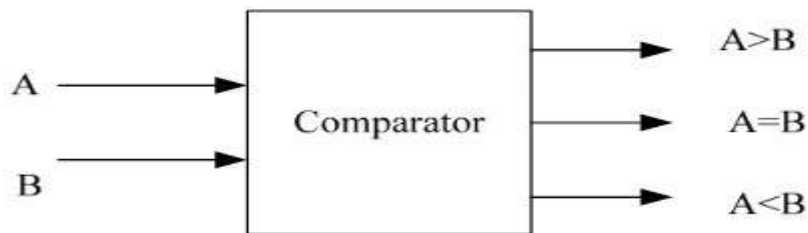
THEORY:

A digital comparator or magnitude comparator is a hardware electronic device that takes two numbers as input in binary form and determines whether one number is greater than, less than or equal to the other number. Comparators are used in Central Processing Units (CPUs) and microcontroller (MCUs).



One Bit Comparator: - a magnitude comparator of two 1-bits, (A and B) inputs would produce the following three output conditions when compared to each other.

Logic Diagram:



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

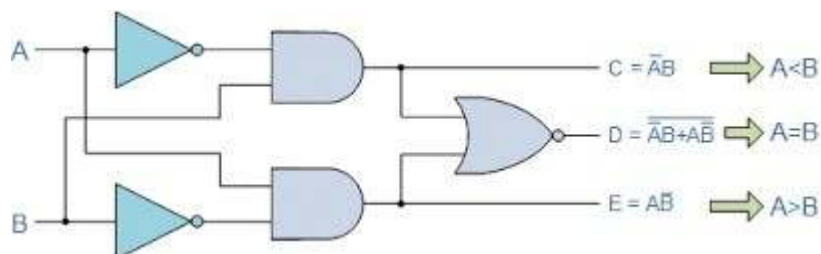
Equations for Output Columns:

$$A > B = AB'$$

$$A < B = A'B$$

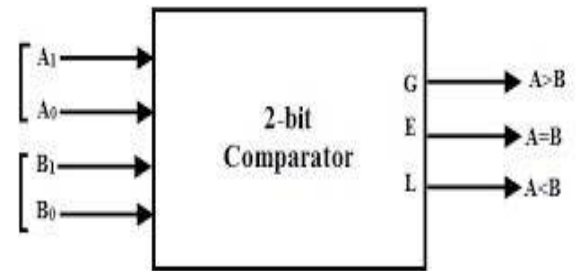
$$(A = B) = A'B' + AB = A \text{ EXOR } B$$

Circuit diagram of Equations:



Two Bit Comparator: - a magnitude comparator of two 2-bits, (A and B) inputs would produce the following three output conditions when compared to each other.

INPUT				OUTPUT		
A1	A0	B1	B0	A<B	A=B	A>B
0	0	0	0	0	1	0
0	0	0	1	1	0	0
0	0	1	0	1	0	0
0	0	1	1	1	0	0
0	1	0	0	0	0	1
0	1	0	1	0	1	0
0	1	1	0	1	0	0
0	1	1	1	1	0	0
1	0	0	0	0	0	1
1	0	0	1	0	0	1
1	0	1	0	0	1	0
1	0	1	1	1	0	0
1	1	0	0	0	0	1
1	1	0	1	0	0	1
1	1	1	0	0	0	1
1	1	1	1	0	1	0



Kmap for :

		A > B			
		B1B0	00	01	11
A1A0	00	0	0	0	0
	01	1	0	0	0
	11	1	1	0	1
	10	1	1	0	0

		A = B			
		B1B0	00	01	11
A1A0	00	1	0	0	0
	01	0	1	0	0
	11	0	0	1	0
	10	0	0	0	1

		A < B			
		B1B0	00	01	11
A1A0	00	0	1	1	1
	01	0	0	1	1
	11	0	0	0	0
	10	0	0	1	0

Equations are:

$$A > B: G = A_0 \bar{B}_1 \bar{B}_0 + A_1 \bar{B}_1 + A_1 A_0 \bar{B}_0$$

$$A = B: E = \bar{A}_1 \bar{A}_0 \bar{B}_1 \bar{B}_0 + \bar{A}_1 A_0 \bar{B}_1 B_0 + A_1 A_0 B_1 B_0 + A_1 \bar{A}_0 B_1 \bar{B}_0$$

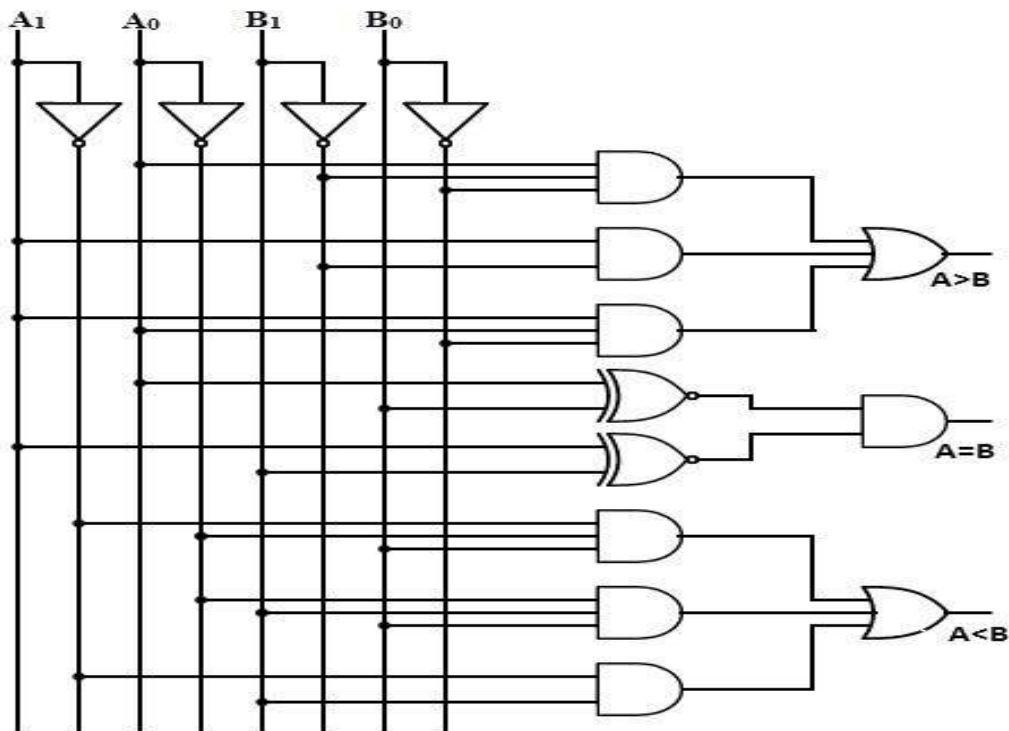
$$= \bar{A}_1 \bar{B}_1 (\bar{A}_0 \bar{B}_0 + A_0 B_0) + A_1 B_1 (A_0 B_0 + \bar{A}_0 \bar{B}_0)$$

$$= (A_0 B_0 + \bar{A}_0 \bar{B}_0) (A_1 B_1 + \bar{A}_1 \bar{B}_1)$$

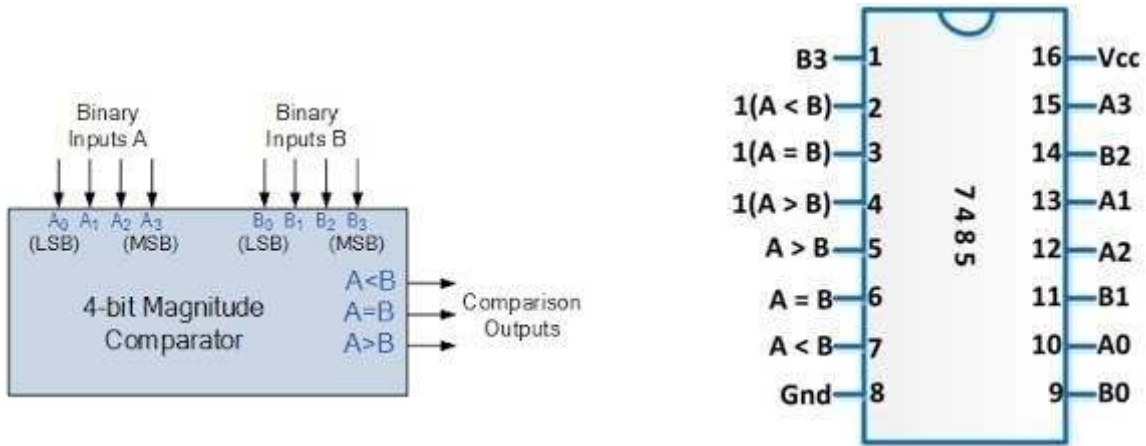
$$= (A_0 \text{ Ex-NOR } B_0) (A_1 \text{ Ex-NOR } B_1)$$

$$A < B: L = \bar{A}_1 B_1 + \bar{A}_0 B_1 B_0 + \bar{A}_1 \bar{A}_0 B_0$$

Circuit Diagram:



4 Bit Comparator IC 7485 :



The 4-bit comparator is mostly available in IC form and common type of this IC is 7485. This IC can be used to compare two 4-bit binary words by grounding **I (A>B), I (A<B) and I (A=B) connector inputs to Vcc terminal.**

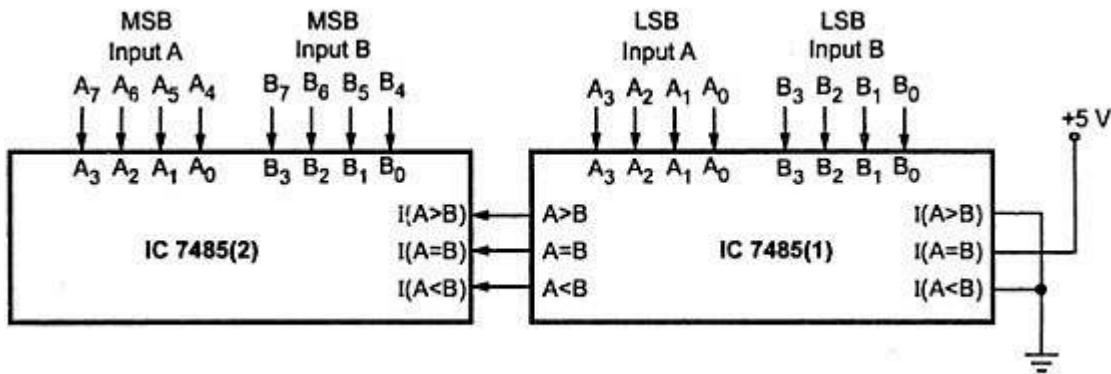
In addition to the normal comparator, this IC is provided with cascading inputs in order to facilitate the cascading several comparators. Any number of bits can be compared by cascading several of these comparator ICs.

COMPARING INPUTS				OUTPUT		
A3, B3	A2, B2	A1, B1	A0, B0	A > B	A < B	A = B
A3 > B3	X	X	X	H	L	L
A3 < B3	X	X	X	L	H	L
A3 = B3	A2 > B2	X	X	H	L	L
A3 = B3	A2 < B2	X	X	L	H	L
A3 = B3	A2 = B2	A1 > B1	X	H	L	L
A3 = B3	A2 = B2	A1 < B1	X	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 > B0	H	L	L
A3 = B3	A2 = B2	A1 = B1	A0 < B0	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	H	L	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	L	H

H = High Voltage Level, L = Low Voltage Level, X = Don't Care

8-Bit Comparator using IC 7485

- An 8-bit comparator compares the two 8-bit numbers by cascading of two 4-bit comparators. The circuit connection of this comparator is shown below in which the lower order comparator $A < B$, $A = B$ and $A > B$ outputs are connected to the respective cascade inputs of the higher order comparator.
- For the lower order comparator, the $A = B$ cascade input must be connected High, while the other two cascading inputs A, B must be connected to LOW. The outputs of the higher order comparator become the outputs of this eight-bit comparator.



Applications of Comparators

1. Comparators are used in central processing units (CPUs) and microcontrollers (MCUs).
2. These are used in control applications in which the binary numbers representing physical variables such as temperature, position, etc. are compared with a reference value.
3. Comparators are also used as process controllers and for Servo motor control.
4. Used in password verification and biometric applications.