Logical Design Lectures

Produced By Dr. Faris Llwaah

July 13, 2021

3 errors1 warning

Lecture 7 – Comparator & Flip Flop Circuits

- The Comparator is a combinational circuit that compares two digital or binary numbers in order to find out whether one binary number is equal, less than or greater than the other binary number. We logically design a circuit for which we will have two inputs one for A and other for B and have three output terminals, one for $A > B$ condition, one for $A = B$ condition and one for $A < B$ condition.

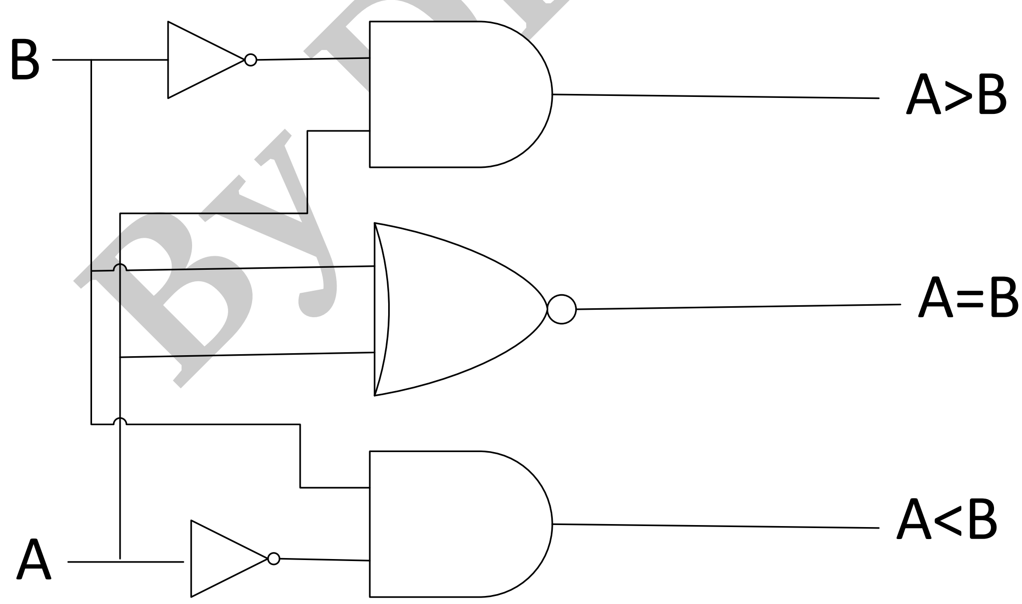
■ **1 Bit Comparator**

A comparator used to compare two bits is called a single bit comparator. It consists of two inputs each for two single bit numbers and three outputs to generate less than, equal to and greater than between two binary numbers.

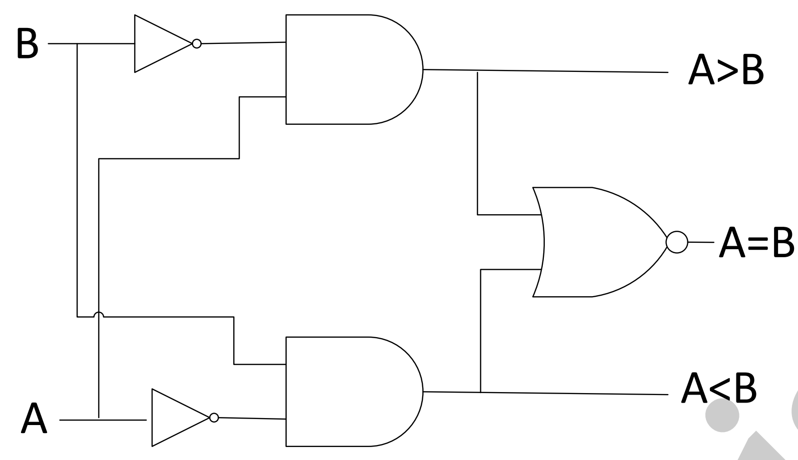
- First, we have design the truth table for a 1-bit comparator as given below:

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**

- So, we can express logical expressions from the above truth table logical as follows:
  $A > B = A\overline{B}$
  $A < B = \overline{A}B$
  $A = B = \overline{A}\,\overline{B} + AB$
  By using these Boolean expressions, we can implement a logic circuit for this comparator as given below:



OR



Example:

Design a 4-Bit comparator?

- To design a 4-Bit comparator that will be used to compare two binary numbers each of four bits, we need eight inputs each for two four bit numbers and three outputs to generate less than, equal to and greater than between two binary numbers.

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

1− If $A_3 = 1$ and $B_3 = 0$

2− If $A_3 = B_3$ and $A_2 = 1$ and $B_2 = 0$

3− If $A_3 = B_3, A_2 = B_2$ and $A_1 = 1$ and $B_1 = 0$

4− If $A_3 = B_3, A_2 = B_2, A_1 = B_1$ and $A_0 = 1$ and $B_0 = 0$

- And the condition of $A < B$ can be possible in the following four cases:

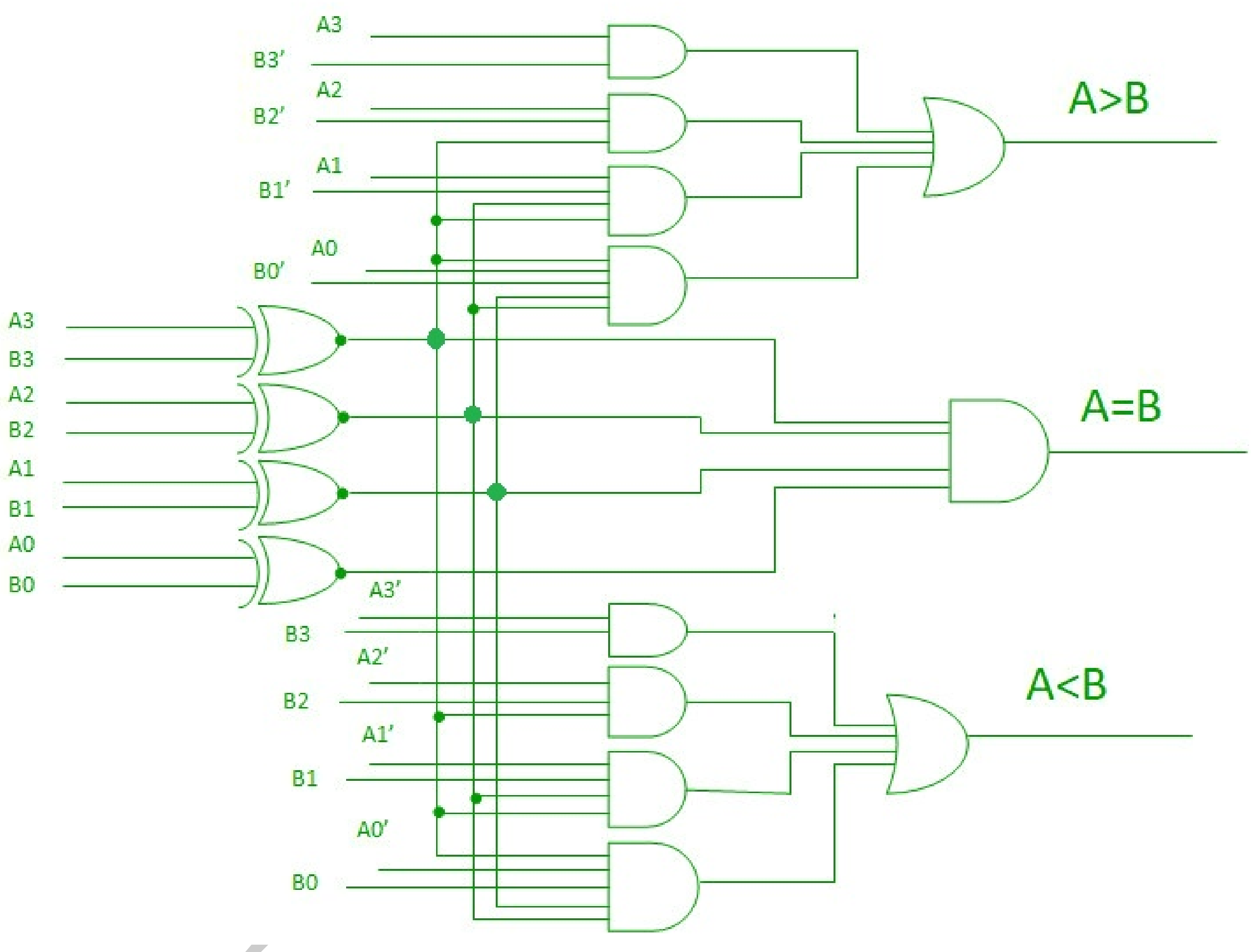
1− If $A_3 = 0$ and $B_3 = 1$

2− If $A_3 = B_3$ and $A_2 = 0$ and $B_2 = 1$

3− If $A_3 = B_3, A_2 = B_2$ and $A_1 = 0$ and $B_1 = 1$

4− If $A_3 = B_3, A_2 = B_2, A_1 = B_1$ and $A_0 = 0$ and $B_0 = 1$

- Finally, the condition of $A = B$ is possible only when all of the individual bits of one number exactly match with corresponding bits of another number. From the above statements logical expressions for each output can be expressed as follows:
  Based on the above statements, we can implement a logic circuit for this comparator as given below:

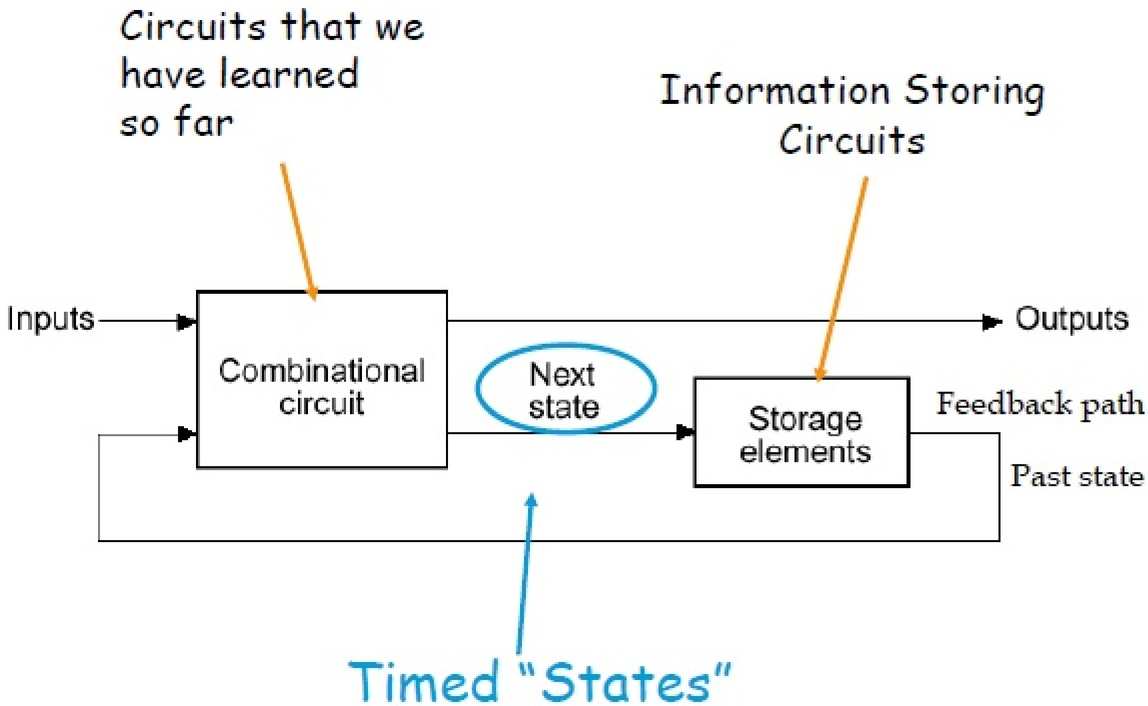


■ Flip Flops (FF)

Flip- flop is a digital memory element which forms the basic key component of any sequential or combinational circuits in digital electronics. It has two stable states : logic 0 state and logic 1 state.

- **Sequential Circuits**

  The Output of these circuits depends on both the current input, and also on past input values. So, to provide the previous input or output a memory element is required. Also the timing parameters are needed be taken into consideration.



Block Digram of a Sequential circuit