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Eight bit Comparator

Objective

We need to design an 8 bit comparator using the 4-bit comparators and understand how it works.

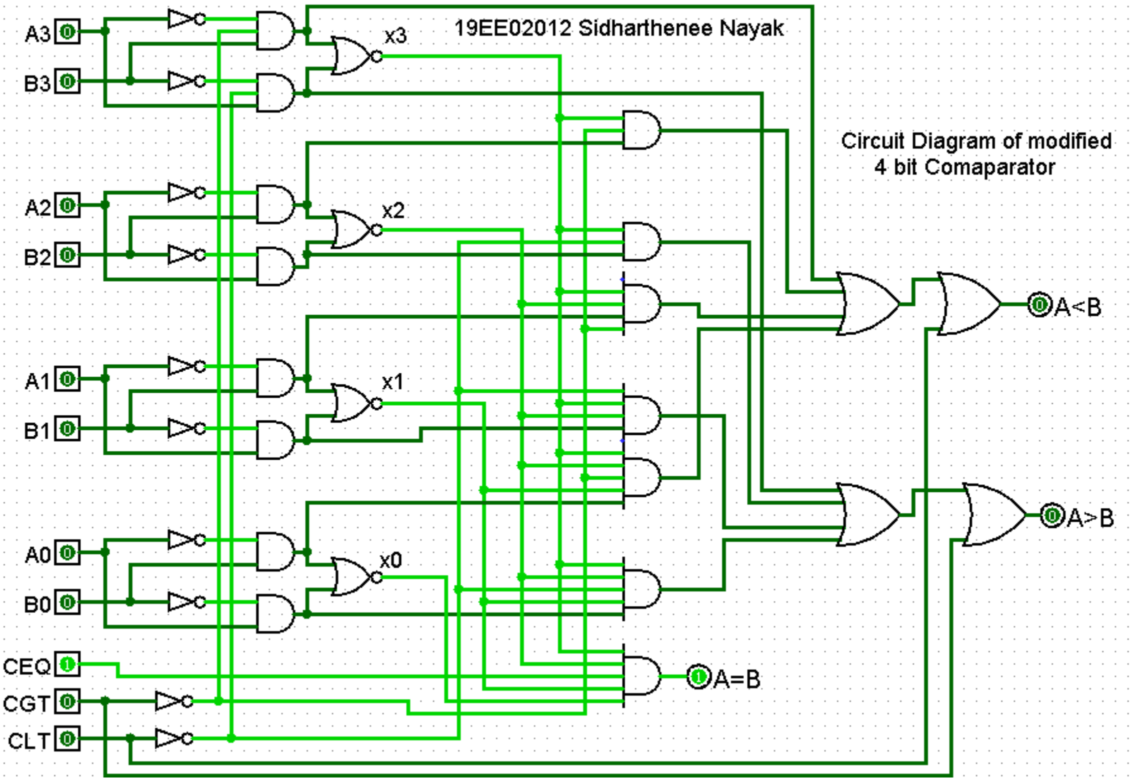
Theory

Let the two binary numbers be A = A7A6A5A4A3A2A1A0 and B = B7B6B5B4B3B2B1B0. Whenever we want to compare the two binary numbers, first we have to compare the most significant bits. If these MSBs are equal, then only we need to compare the next significant bits. But if the MSBs are not equal, then it would be clear that either A is greater than or less than B and the process of comparison ceases.

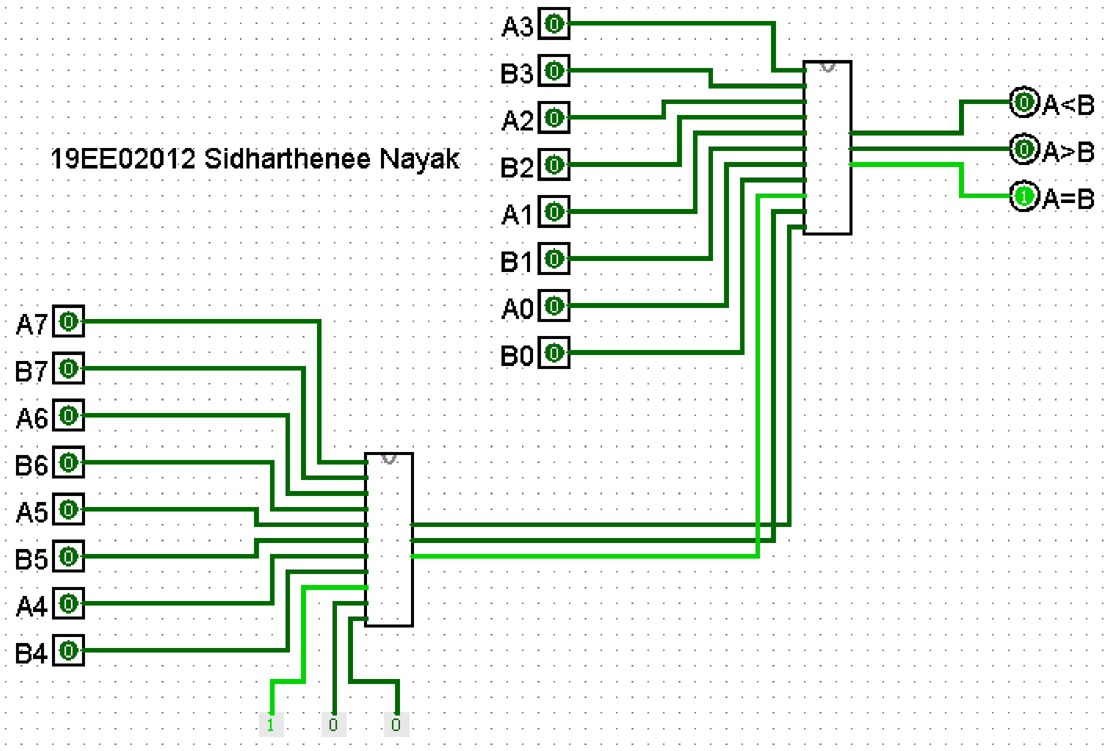
Therefore, to compare two 8-bit binary numbers using 4-bit comparators we first compare the first four most significant bits of A and B that is A7A6A5A4 and B7B6B5B4. Here we will use two 4-bit comparators in cascade. The comparator used in the previous part is slightly modified. I have added three extra input pins: CEQ, CGT and CLT which correspond to the value received from the previous 4-bit comparator. The four-bit comparator will only work when CEQ=1, CGT=0 and CLT=0. Basically, these three input pins will act as enable pins of the 4-bit comparator circuit.

To the first 4-bit comparator we pass the first four significant bits of A and B that is A7A6A5A4 and B7B6B5B4. If the first four most significant bits are unequal then it is decided whether A>B or A<B(in the first comparator itself) and the result of the first comparator is passed as CEQ, CGT and CLT to the next comparator(Since the first four bits of A and B are unequal it will act as enable pins for the next comparator and disable it). Only if all the first four bits of A and B are equal then the next four bits that is A3A2A1A0 and B3B2B1B0 are compared in the second 4-bit comparator and the output is given. Otherwise the second comparator is disabled and the output of the first comparator becomes the final output.

Circuit Diagrams



Circuit Diagram of modified 4-bit comparator

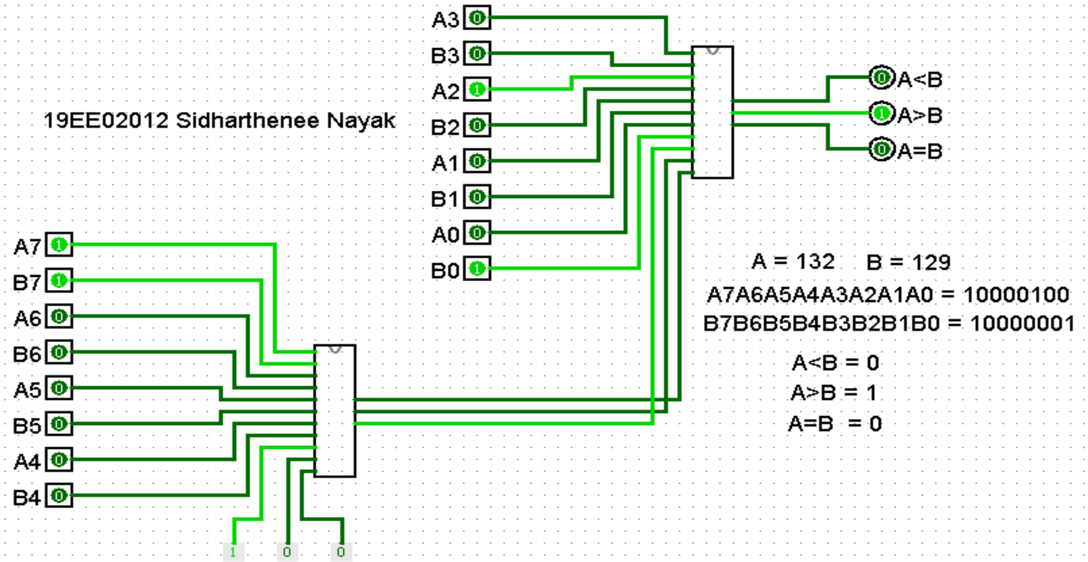


Circuit Diagram of 8 bit Comparator using two 4 bit comparators

Output for different values of A and B

When A=132, B=129, Expected Answer: A>B

A7A6A5A4A3A2A1A0 = 10000100 and B7B6B5B4B3B2B1B0 = 1000001

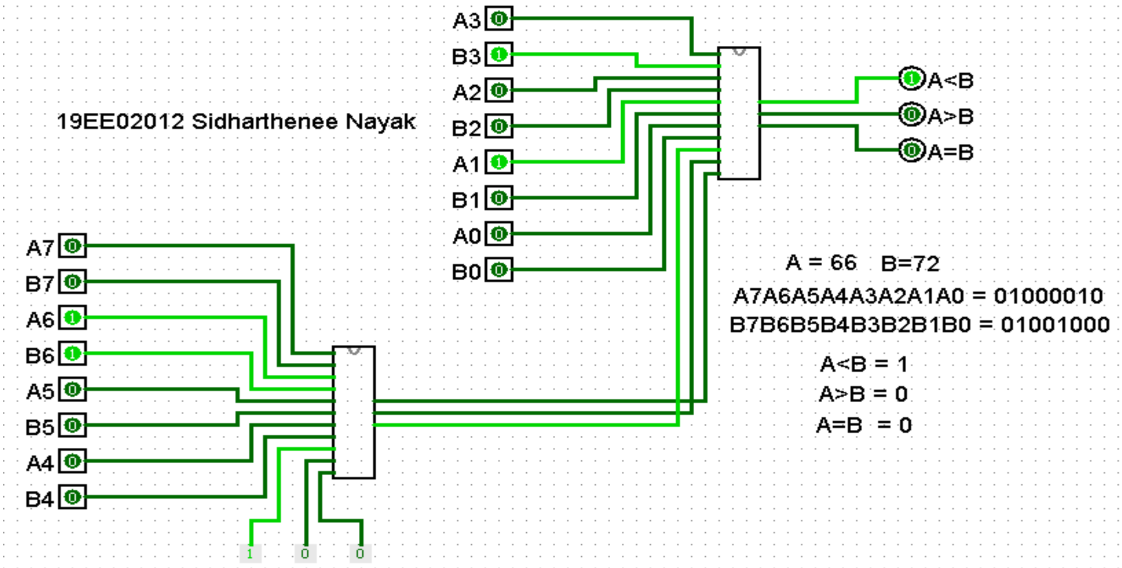


Circuit Diagram of 8 bit Comparator using two 4 bit comparators

Since (A>B)= 1, it implies A is greater than B

When A=66, B=72, Expected Answer: A<B

A7A6A5A4A3A2A1A0 = 01000010 and B7B6B5B4B3B2B1B0 = 01001000

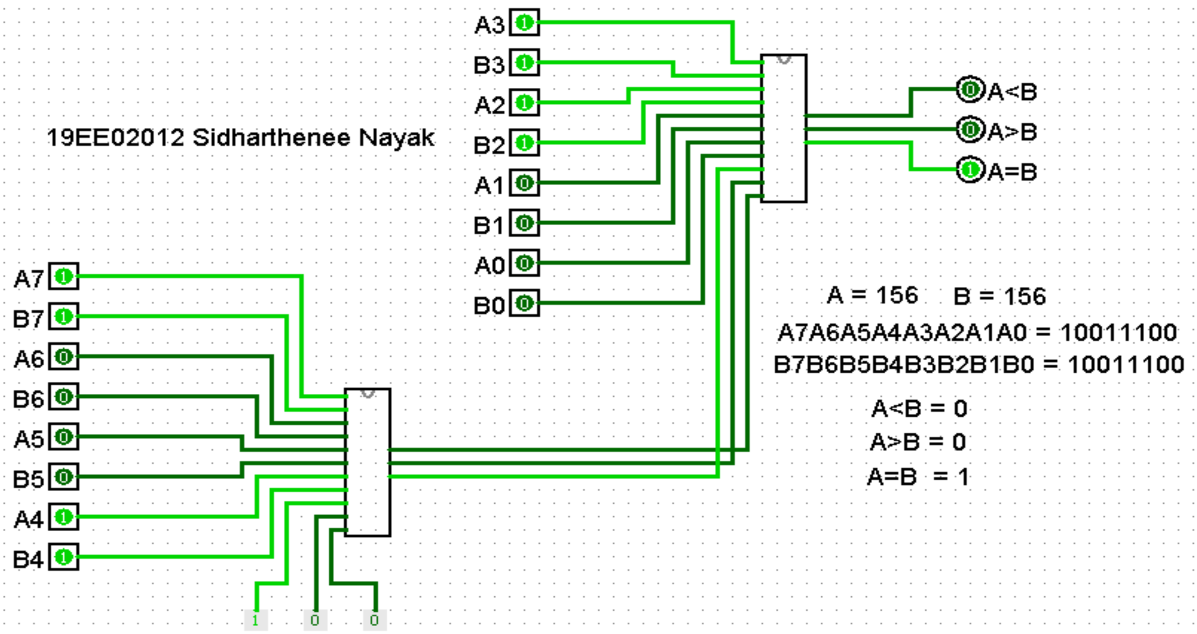


Circuit Diagram of 8 bit Comparator using two 4 bit comparators

Since (A<B)= 1, it implies A is less than B

When A=156, B=156, Expected Answer: A=B

A7A6A5A4A3A2A1A0 = 10011100 and B7B6B5B4B3B2B1B0 = 10011100

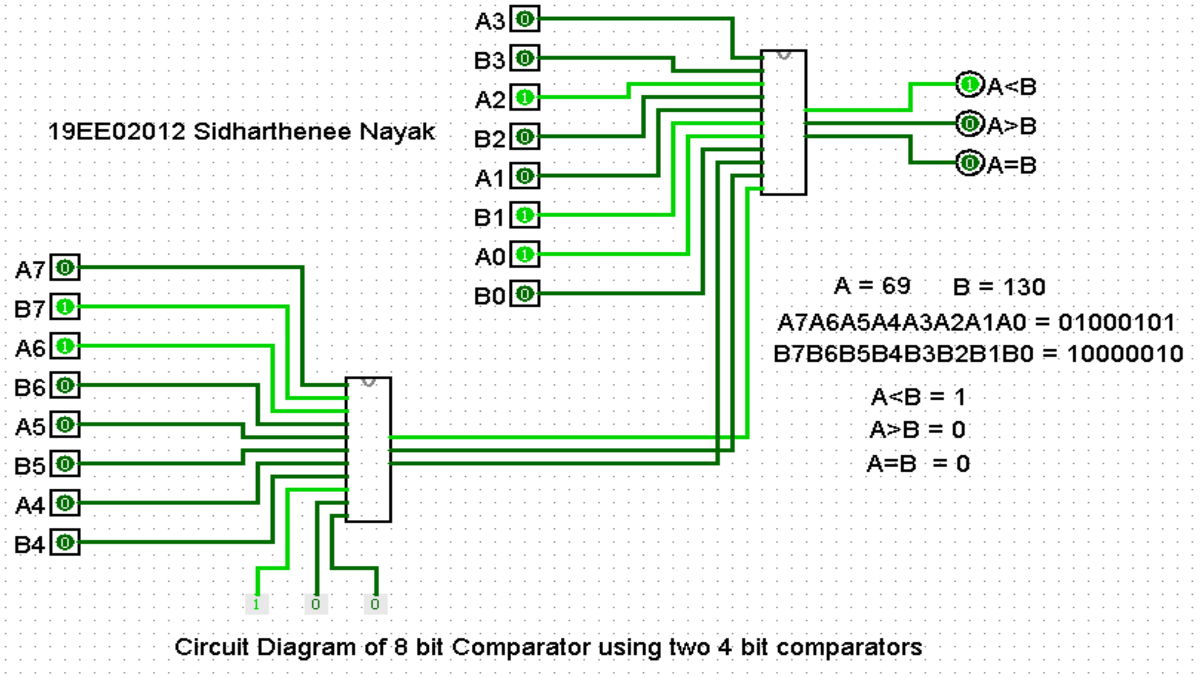


Circuit Diagram of 8 bit Comparator using two 4 bit comparators

Since (A=B)= 1, it implies A is equal to B

When A=69, B=130, Expected Answer: A<B

A7A6A5A4A3A2A1A0 = 01000101 and B7B6B5B4B3B2B1B0 = 10000010



Since (A<B)= 1, it implies A is less than B

Conclusion

Since we are getting the expected answer for different 8-bit binary numbers, we can say that our modified 4-bit comparator circuit and the 8-bit comparator circuit which uses two four-bit comparators in cascade is correct.

Discussion

Comparators are mostly used in the address decoding circuitry in computers and microprocessor based devices to select a specific input/output device for the storage of data. 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. Then the outputs from the comparator are used to drive the actuators so as to make the physical variables closest to the set or reference value. They are also used in Process controllers and in Servo-motor control.