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What is Combinational Circuit ?

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Combinational circuits are very well known components in digital electronics which can provide output instantly based on the current input. Unlike sequential circuits, a combinational circuit listens for input signal and generates output no matter what is the past input or state as it has no feedback or memory component. It only cares about present input and state.

They are specially designed using multiple interconnected logic gates such that the output will be generated by computing the logical combinations of the present input only. No clock pulse is present here. Moreover, no previously stored value or state is taken into consideration here. The output is independent of previous states.

Features of Combinational Circuit

- In this output depends only upon present input.
- It's Speed is fast.
- Easy designed.
- There is no feedback between input and output.
- It is time independent.
- Elementary building blocks are Logic gates.
- Used for both [arithmetic](#) and [boolean operations](#).
- Combinational circuits don't have the capability to store any state.

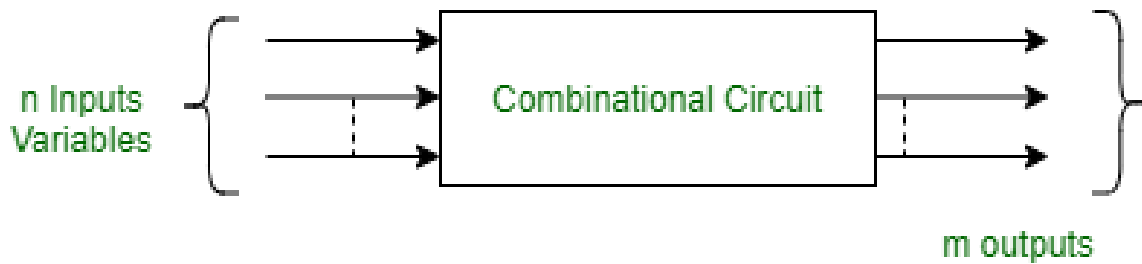


Figure - Block diagram of Combinational circuit

Examples of Combinational Circuits

- **Adders and Subtractors:** Combinational circuits are used to perform mathematical operations of [binary numbers](#). [Adders and Subtractors](#) and Subtractor uses combinational circuit logic where it takes two or more binary numbers as input and performs addition/subtraction to generate output.
- **Multiplexers and Demultiplexers:** [Multiplexer](#) is a special kind of combinational circuit where several number of inputs are present. From that one input can be selected and that will be transmitted as an output based on selection signal. In the other hand, [Demultiplexers](#) also select one input signal but transmits it to one of the several outputs.
- **Encoders and Decoders:** [Encoders](#) also uses combinational circuits to convert a multiple set of input signal to smaller set of output signal but the resultant value is unchanged. Inversely, [Decoders](#) converts a small set of input signal to a large set of output signal without changing the resultant value. Basically input of Encoder = output of Decoder and vice versa.

Applications of Combinational Circuit

In modern technologies, combinational circuits are widely used for its simple functionality and ability to give instant output. Some of the applications are discussed below:

- **Arithmetic and Logic Units (ALUs):** As combinational circuits are capable of performing various mathematical tasks like arithmetic and logical operations so, these circuits are used in calculators and

processors as a fundamental component of [Arithmetic and Logic Units \(ALUs\)](#).

- **Data Encryption and Decryption:** In information protection fields, combinational circuit are used for [Data Encryption](#) and decryption of data for secure communication. Encryption/decryption algorithms are also a complex mathematical formula which can be performed by combinational circuits.
- **Data Multiplexing and Demultiplexing:** It is just a practical implementation of multiplexer and demultiplexer. By using it we can optimize network bandwidth by effectively reducing network traffic as combinational circuit allows to transmit multiple data signals over a single communication channel.
- **Traffic Light Control:** In traffic lights control mechanism, combinational circuits are used to instantly determine the timing and sequence of traffic light changes based on the inputs of timers and [sensors](#).

Advantages of Combinational Circuit

Some basic advantages of combinational circuits has made them very popular among modern technologies which are discussed below:

- **Simplicity:** Combinational circuits are very easy to implement and absence of memory or feedback element has made it more straightforward which is reducing complexity in digital systems and providing faster prototype building mechanism.
- **Real-time Operation:** Combinational circuits don't face any delay which is very much essential for quick-response applications like data transmission and signal processing.
- **Deterministic Behavior:** Combinational circuits generate output based on present input only which ensures predictable and repeatable results which is essential for applications in which consistency and reliability is required.

Disadvantages of Combinational Circuit

- **Limited Functionality:** As it provides output only based on present input and there is no way to store previous data so we can't use this

circuit to any memory-based applications or where previous data is recalled for doing operations.

- **Lack of Flexibility:** Once the design of logic gates is done then for changing a small design required the entire redesigning of the circuits which is monotonous and time-consuming.
- **Increased Complexity for Large Designs:** For large designs the number of [logic gates](#) will increase gradually which means the management of input and output ports will become very complex. This may lead to higher production costs and increased design errors.

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