

# Difference Between Combinational and Sequential Circuits

Combinational and sequential circuits are the most commonly utilized electric circuits in digital electronics. Combinational and Sequential Circuits are two main categories of circuits identified in digital electronics, one of which is time-independent and the other which is time-dependent. It is an important part of the GATE ECE syllabus.

Metrics/Parameters	Combinational Circuit	Sequential Circuit
Usage of memory or Storage area	Combinational Circuit does not require any memory element to store the output.	Sequential Circuit requires a memory element to store the previous state output.
Feedback	It requires no feedback for generating the next output.	Sequential Circuit requires feedback as it relies on the previous output/feedback and the current input.
Speed	Combinational Circuit performs faster in comparison with sequential circuits.	Its performance is slow because it uses memory elements.
Elementary blocks	It uses logic gates as an elementary block.	Sequential Circuit uses flip-flops as elementary blocks.
Complexity	Combinational Circuit is easy to use and handle.	It is complex to use and handle in comparison to combinational circuits.
Example	Encoder, Decoder, Multiplexer, etc.	Flip-flops and Counters.

## What is a Combinational circuit?

A combinational circuit is one in which we combine the various different gates to form a circuit. The output of the combinational circuit is determined by the present inputs, regardless of the previous inputs. We have a variety of combinational circuits available to us for performing a variety of tasks such as Adder, Subtractor, Multiplexer, Demultiplexer, Encoder, Decoder, etc.



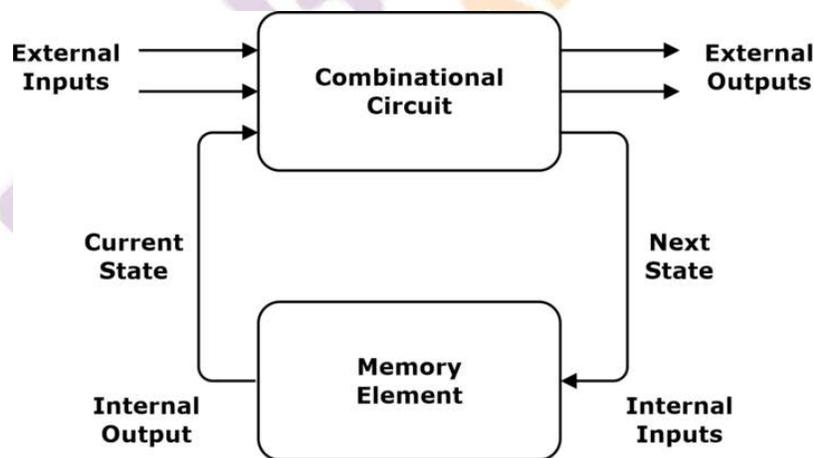
### Characteristics of a Combinational Circuit

Having known the definition of combinational circuits and their functionalities, let us now discuss the characteristics of the combinational circuit. Following are the characteristics:

- The Combinational circuits do not consist of any memory element.
- At any point in time, the output only depends on the present inputs
- There can be an “n” number of inputs and an “m” number of outputs possible for a combinational circuit where n and m are integers.

### What is a Sequential Circuit?

In simple language a combinational circuit with a memory element is a sequential circuit, this is the most basic difference between combinational and sequential circuits. It is a special circuit that has a sequence of inputs and outputs. Unlike combinational circuits, the output depends on the present inputs and previous outputs.



### Types of Sequential Circuits

Sequential circuits can be further divided into two types based on clock signal usage. These circuits are widely used in frequency division, pulse counting and finding the mod of the circuit, etc. Following are the two types:

- **Asynchronous sequential circuits:** They do not use the clock signals instead they make use of the pulses. The un-clocked flip-flops are the memory elements of asynchronous circuits. Though many differences between combinational and sequential

circuits the asynchronous sequential circuits are similar to combinational circuits along with feedback.

- **Synchronous Sequential circuits:** They make use of clock signals and synchronize the memory element's states with the clock signals. The output is stored in the memory elements called latches or flip-flops (Bi-stable multivibrator).

