Combinational circuit

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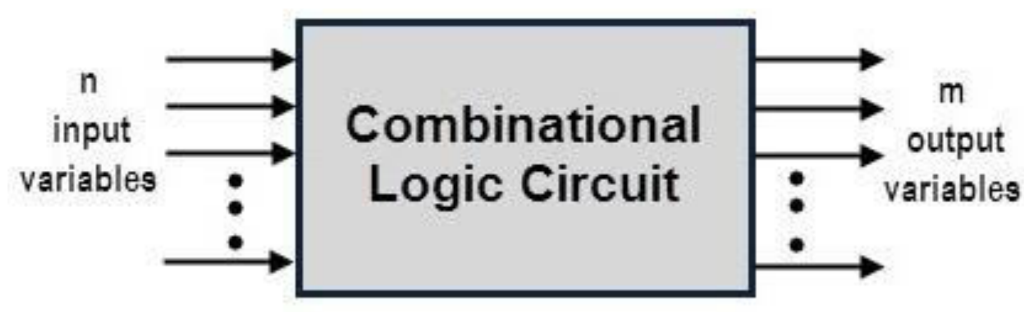
- A combinational circuit is a connected arrangement of logic gates with set of inputs and outputs.

- A combinational circuit comprises of input variables, logic gates and output variables. The logic gates accepts the inputs and depending on the type of functioning of the logic gate, output signals are generated from them.

- Diagram below shows the combinational circuit having n inputs and m outputs.

- The n number of inputs shows that there are 2^n possible combinations of bits at the input. Therefore, the output is expressed in terms m Boolean expressions.



Implementation steps

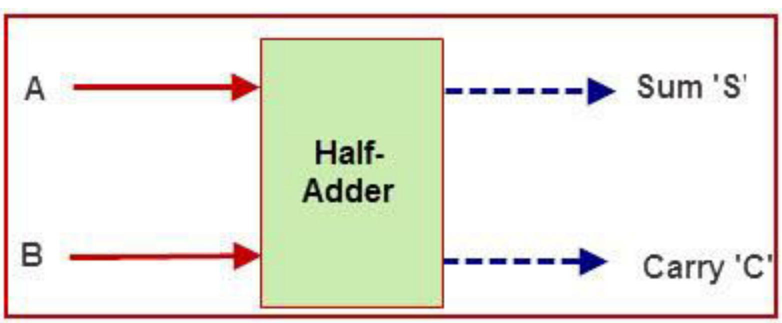
- Identify the input and output variables.
- Determine the relation between the input and output variables.
- Construct truth table according to input output specifications.
- Find out the Boolean expressions for outputs in terms of inputs.
- Minimize the Boolean expressions.
- The logic diagram is drawn.

1. Half Adder

- With the help of half adder, we can design circuits that are capable of performing simple addition with the help of logic gates.

- The half adder circuit has two inputs: A and B, which add two input digits and generate a carry and sum.

Block Diagram



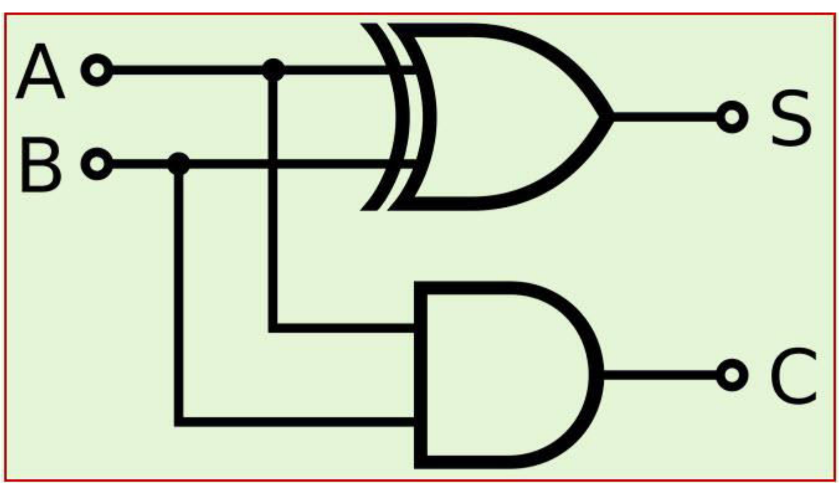
Truth Table

INPUTS		OUTPUTS	
A	B	SUM	CARRY
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

- 1-bit adder can be easily implemented with the help of the XOR Gate for the output 'SUM' and an AND Gate for the 'Carry'.
- When we need to add, two 8-bit bytes together, we can be done with the help of a full-adder logic.

$$\text{Sum} = \overline{A}\cdot B + A\cdot\overline{B}$$
$$\text{Carry} = A \bullet B$$

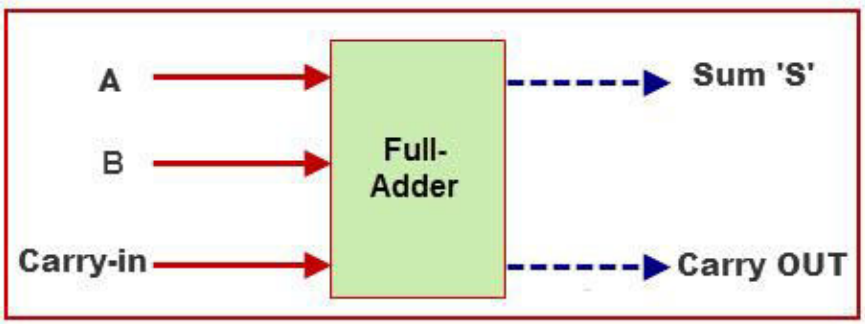
Circuit

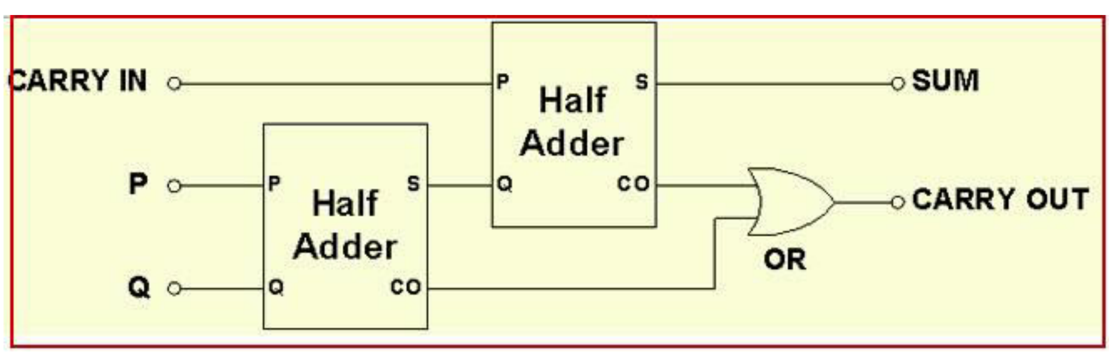


2. Full Adder

- A full-adder has three inputs and two outputs
- The first two inputs are A and B and the third input is an input carry as C-IN. The output carry is designated as C-OUT and the normal output is designated as S.

Block Diagram





Truth Table

INPUTS			OUTPUT	
A	B	C-IN	C-OUT	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

- So, we can implement a full adder circuit with the help of two half adder circuits. At first, half adder will be used to add A and B to produce a partial Sum and a second half adder logic can be used to add C-IN to the Sum produced by the first half adder to get the final S output.

Full Adder Logic Circuit