Combinational Circuit

- A combinational circuit is a connected arrangement of logic gates with a set of inputs and outputs. To design combinational circuit following procedure is involved:
  - The problem is stated.
  - The input and output variables are assigned letter symbols.
  - The truth table that defines the relationship between inputs and outputs is derived.
  - The simplified Boolean functions for each output are obtained.
  - The logic diagram is drawn

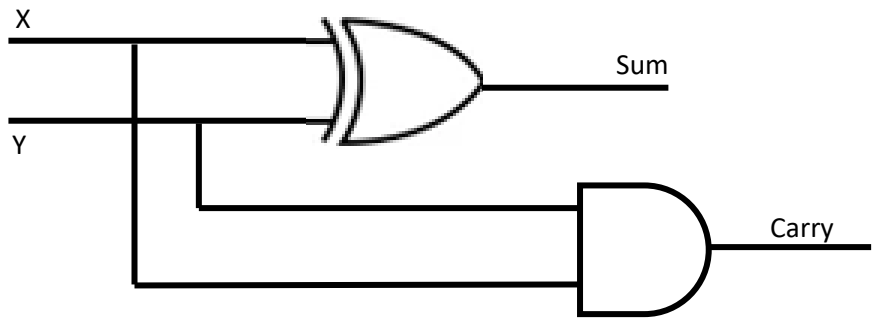
Half Adder

A combinational circuit that performs the arithmetic addition of two bits is called a half-adder.

Input		Output	
X	Y	Sum	Carry
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

Block Diagram

Carry: x.y **Sum: x'y +xy' (or) x ⊕ y**



Logic Diagram

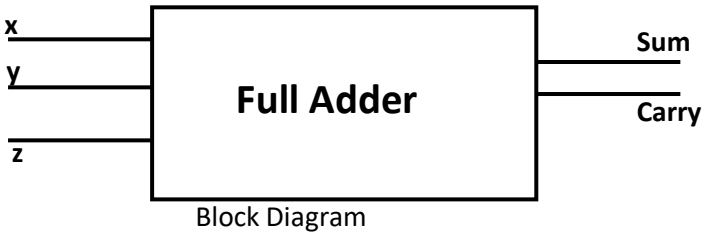
Full Adder

A full-adder is a combinational circuit that forms the arithmetic sum of three input bits

Number of inputs: 3 Number of Output: 2

Carry : x.y+(x ⊕ y)z

Sum: x ⊕ y ⊕z



Block Diagram

Truth Table:

Inputs			Outputs	
X	**Y**	**Z**	**CARRY**	**SUM**
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**

Carry = x'yz + xy'z + xyz' + xyz

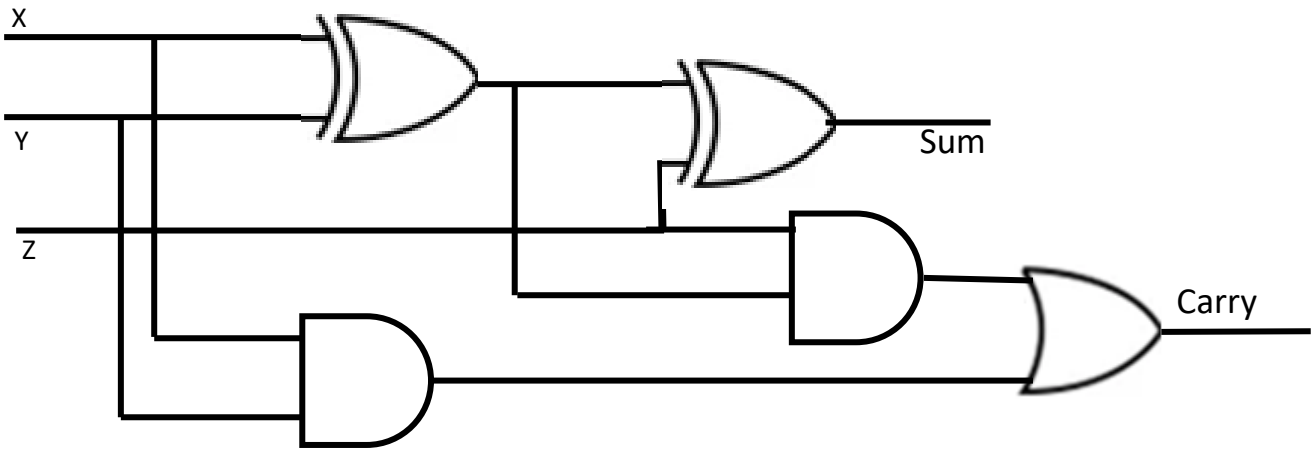
=z(x'y + xy')+xy(z'+z)

=z(x $\oplus$ y)+xy

Sum = x'y'z+ x'yz'+ xy'z'+ xyz

= x'(y'z+ yz')+ x(y'z'+ yz)

= x $\oplus$ y $\oplus$ z



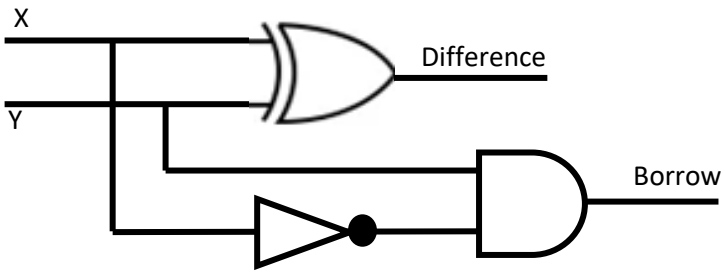
Logic Diagram

Half Subtractor

The half subtractor is a combinational circuit which is used to perform subtraction of two bits. [X:Minuend; Y:Subtrahend]

Difference: x ⊕ y **Borrow: x'.y**

Input		Output	
X	**Y**	**Diff**	**Borrow**
0	**0**	**0**	**0**
0	**1**	**1**	**1**
1	**0**	**1**	**0**
1	**1**	**0**	**0**



Logic Diagram

Full Subtractor

A full subtractor is a **combinational circuit** that performs subtraction of two bits, one is minuend and other is subtrahend, considering borrow of the previous adjacent lower minuend bit. This circuit **has three inputs and two outputs**. The three inputs A, B and Bin, denote the minuend, subtrahend, and previous borrow, respectively. The two outputs, D and Bout represent the difference and output borrow, respectively.

Inputs		Outputs		
X	Y	B_{in}	D	B_{out}
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Difference = $x'y' B_{in} + x'y B_{in}' + xy' B_{in}' + xy B_{in}$

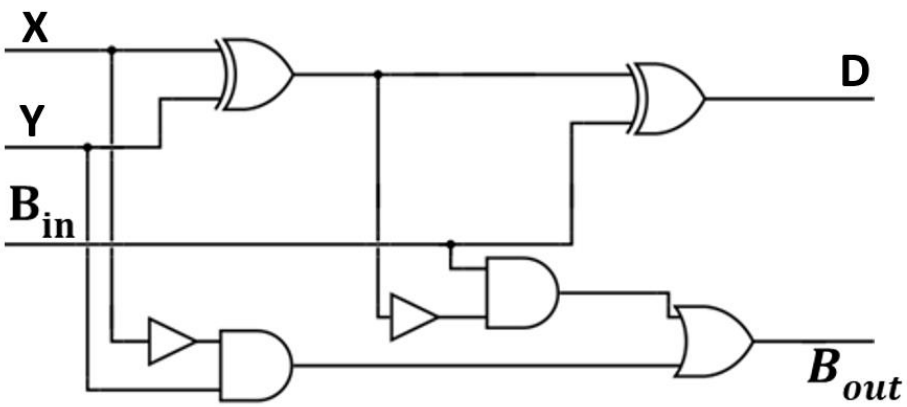
Difference = $x'(y' B_{in} + y B_{in}') + x(y' B_{in}' + y B_{in})$

Difference = $x \oplus y \oplus B_{in}$

Borrow = $x'y' B_{in} + x'y B_{in}' + x'y B_{in} + xy B_{in}$

Borrow = $B_{in}(x'y' + xy) + x'y(B_{in}' + B_{in})$

Borrow = $B_{in}(x \oplus y)' + x'y$



Logic Diagram