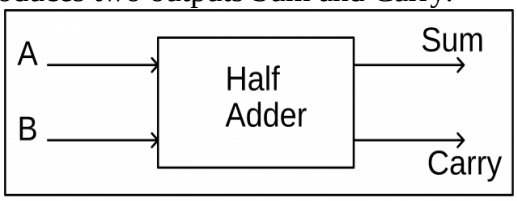
ADDER:

An adder is a digital logic circuit in electronics that is extensively used for the addition of numbers. In many computers and other types of processors, adders are even used to calculate addresses and related activities and calculate table indices in the ALU and even utilized in other parts of the processors.

HALF ADDER

A combinational circuit that performs the addition of two bits is called a Half Adder. It receives two inputs and produces two outputs Sum and Carry.



DESIGNING OF HALF ADDER:

1. Problem: addition of two bits.
2. The number of available inputs are two.
3. The input and output variables are assigned letter symbols. Let's represent the inputs by A AND B, and the outputs SUM and Carry by S and C respectively.
4. Truth Table

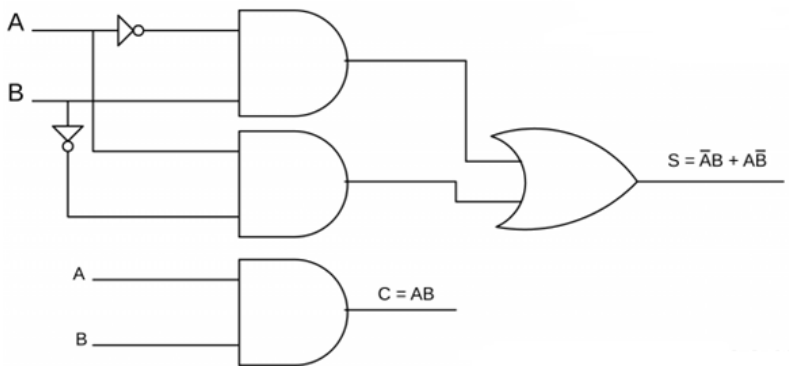
TRUTH TABLE:

Input		Output	
A	B	Sum = S	Carry = C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$\text{Sum}(A,B) = \bar{A}B + A\bar{B}$

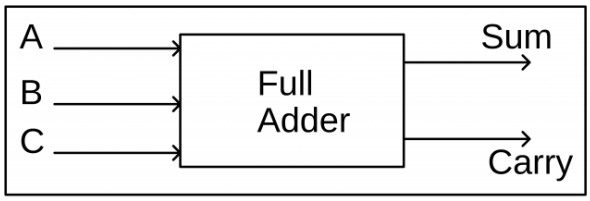
$\text{Carry}(A,B) = AB$

LOGIC DIAGRAM:



FULL ADDER:

A combinational circuit that performs the addition of three bits is called a Full Adder. It receives three inputs and produces two outputs Sum and Carry.



DESIGNING OF FULL ADDER:

The designing of Full Adder involves the following steps.

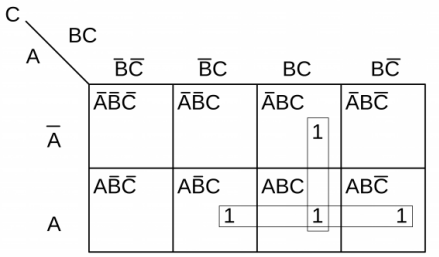
- Problem: Addition of three Bits.
- The number of available inputs are three.
- The input and output variables are assigned letter symbols. Let we represent the inputs by A, B, and C; and the outputs by S and C i.e. S for Sum and C for Carry.
- Truth Table

Input			Output	
A	B	C	Sum = S	Carry = C
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

$$\text{Sum}(A,B,C) = \bar{A}\bar{B}C+\bar{A}B\bar{C}+A\bar{B}\bar{C}+ABC$$
$$\text{Carry}(A,B,C) = \bar{A}BC+A\bar{B}C+AB\bar{C}+ABC$$

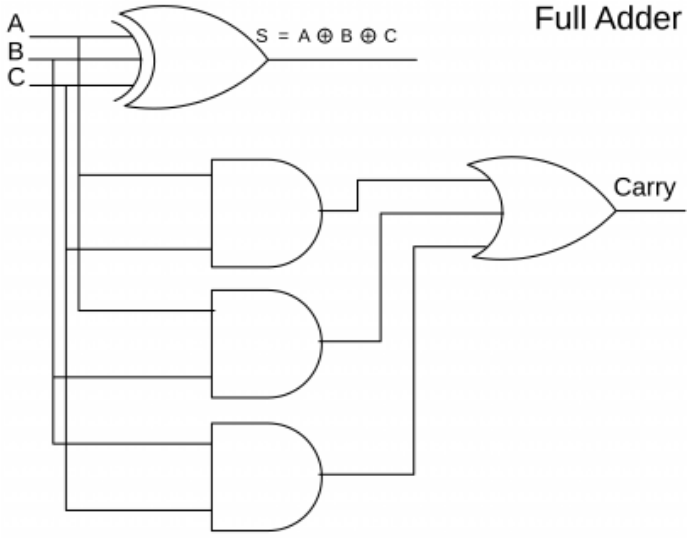
S	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	$\bar{A}\bar{B}\bar{C}$	$\bar{A}\bar{B}C$ 1	$\bar{A}BC$	$\bar{A}B\bar{C}$ 1
A	$A\bar{B}\bar{C}$ 1	$A\bar{B}C$	ABC 1	$AB\bar{C}$

$$\text{Sum}(A,B,C) = \bar{A}\bar{B}C+\bar{A}B\bar{C}+A\bar{B}\bar{C}+ABC$$

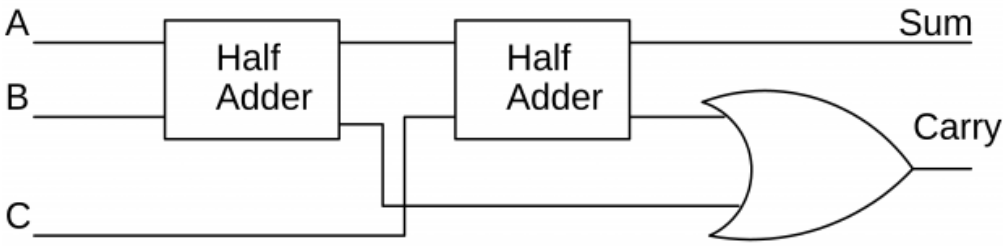


Carry = C = AC + AB + BC

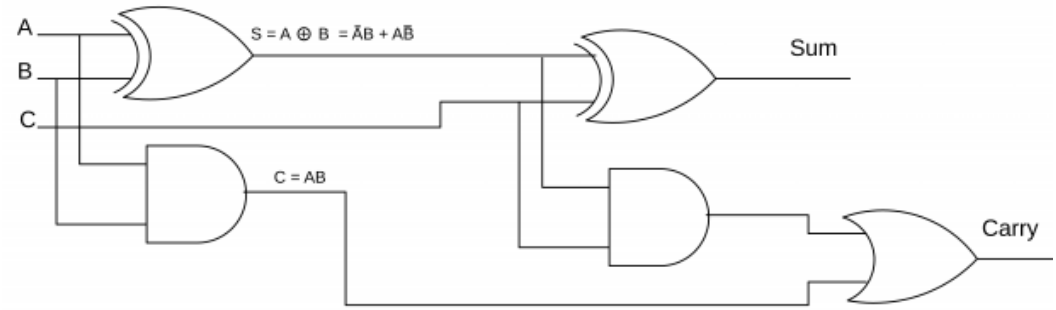
LOGIC DIAGRAM:



FULL ADDER BLOCK DIAGRAM USING TWO HALF ADDERS



LOGICAL DIAGRAM OF THE FULL ADDER USING TWO HALF ADDERS:



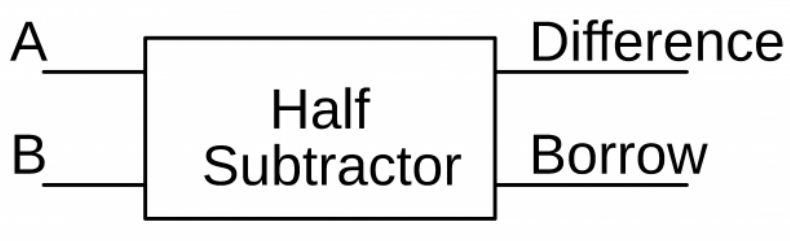
SUBTRACTOR:

A combinational circuit that performs the subtractions of bits is called a Subtractor. There are two types of Subtractors.

1. Half Subtractor
2. Full Subtractor

HALF SUBTRACTOR:

A combinational circuit that performs the subtraction of two bits is called Half Subtractor. It receives two inputs and produces two outputs Difference and Borrow.



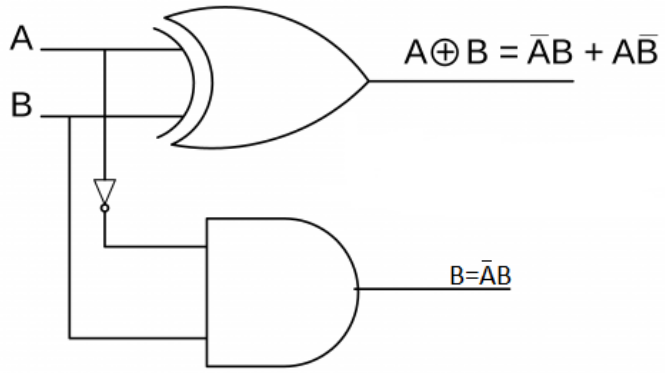
TRUTH TABLE:

Input		Output	
A	B	Difference = D	Borrow = B
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

$$\text{Difference } (A,B) = \bar{A}B + A\bar{B}$$

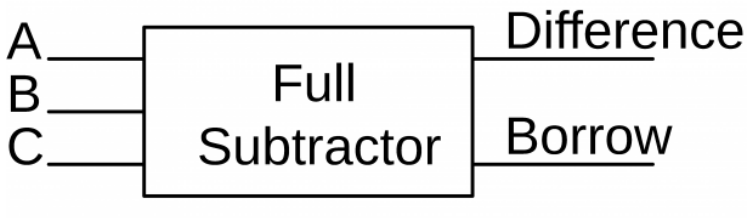
$$\text{Borrow}(A,B) = \bar{A}B$$

LOGIC DIAGRAM:



FULL SUBTRACTOR:

A combinational circuit that performs the subtraction of three bits is called a Full Subtractor. It receives three inputs and produces two outputs Difference and Borrow.



TRUTH TABLE:

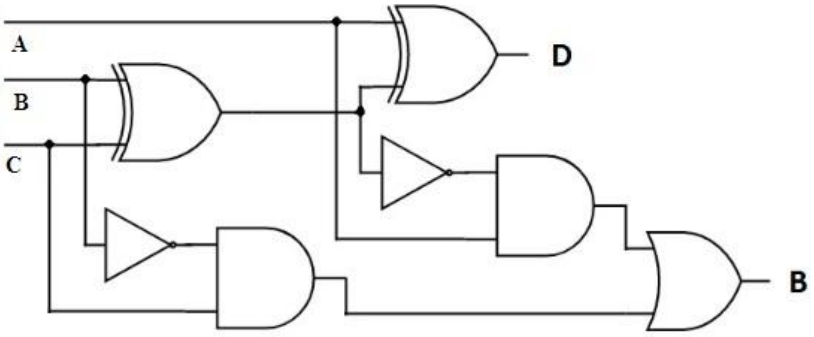
Input			Output	
A	B	C	Difference = D	Borrow = B
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

$$Difference(A,B,C) = D = \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C} + ABC$$

$$Borrow(A,B,C) = B = \bar{A}\bar{B}C + \bar{A}B\bar{C} + \bar{A}BC + ABC$$

D \ BC	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	$\bar{A}\bar{B}\bar{C}$	$\bar{A}\bar{B}C$ 1	$\bar{A}BC$	$\bar{A}B\bar{C}$ 1
A	$A\bar{B}\bar{C}$ 1	$A\bar{B}C$	ABC 1	$AB\bar{C}$

LOGIC DIAGRAM:


A
B
C
D
B