Eight-bit Adder-Subtractor

• Eight-bit Adder

One Bit Full Adder

A full adder is a combinational circuit that performs that adds two bits and a carry and outputs a sum bit and a carry bit. When we want to add two binary numbers, each having two or more bits, then we can use a **one-bit adder** as a submodule and give output as **sum and carry out.** The carry resulting from the addition of the LSBs is carried over to the next significant column and added to the two bits in that column. So, in the second and higher columns, the two data bits of that column and the carry bit generated from the addition in the previous column need to be added.

Truth Table of One Bit Full Adder

INPUT			OUTPUT	
A	B	Cin	Sum	Cout
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

K-map of One Bit Full Adder

K map of **Sum** output Bit

AB	Cin	
	0	1
00	0	1
01	1	0
11	0	1
10	1	0

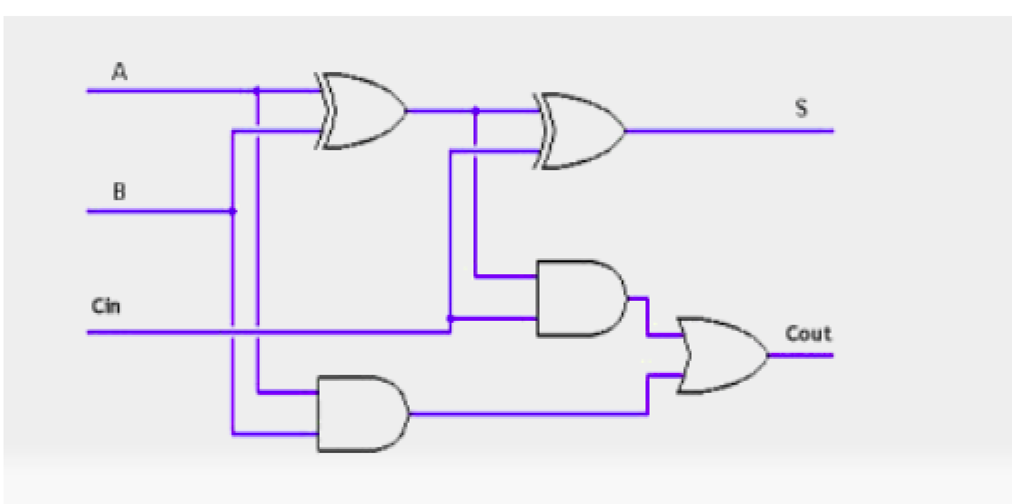
$$Sum = (A \oplus B \oplus Cin)$$

K map of **Carry-Out** output Bit

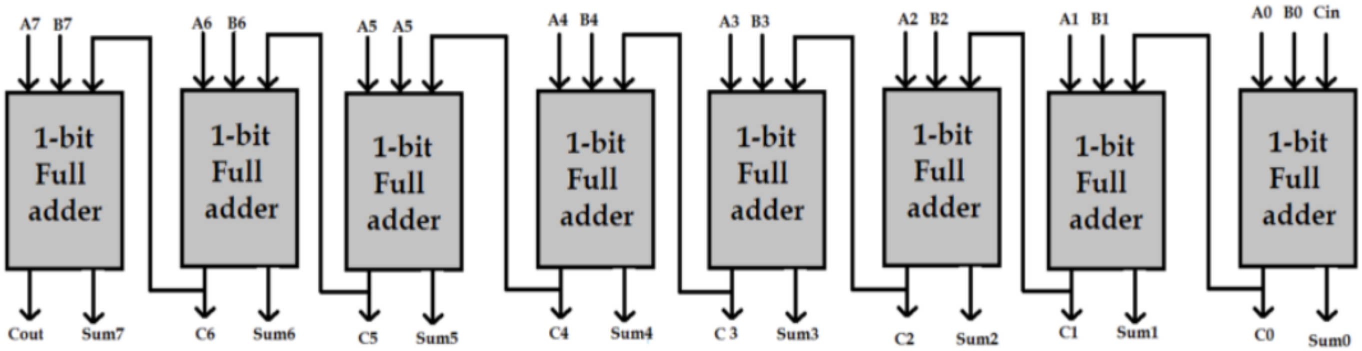
AB	Cin	
	0	1
00	0	0
01	0	1
11	1	1
10	0	1

$$Cout = (A . B) + Cin . (A \oplus B)$$

Logic Circuit of One Bit Full Adder



8-Bit Full Adder Block Diagram



• Eight-Bit Full Subtractor

We will make Eight Bit Full Subtractor using One-bit Full Subtractor as a submodule.

One-Bit Full Subtractor

A full subtractor is a combinational circuit that subtracts two bits and borrow and outputs a difference bit and a borrow out bit. When we want to subtract two binary numbers, each having two or more bits, then we can use a **one-bit subtractor** as a submodule and give output as **Difference and Borrow out.** The borrow resulting from the addition of the LSBs is carried over to the next significant column and subtracted from the two bits in that column. So, in the second and higher columns, the two data bits of that column and the borrow bit generated from the subtraction in the previous column need to be subtracted.

Truth Table of One Bit Full Subtractor

INPUT			OUTPUT	
Borrow_in	B	A	Difference	Borrow_out
0	0	0	0	0
0	0	1	1	0
0	1	0	1	1
0	1	1	0	0
1	0	0	1	1
1	0	1	0	0
1	1	0	0	1
1	1	1	1	1

K-Map of One Bit Full Subtractor

K map of **Difference** output Bit

AB	Bin	
	0	1
00	0	1
01	1	0
11	0	1
10	1	0

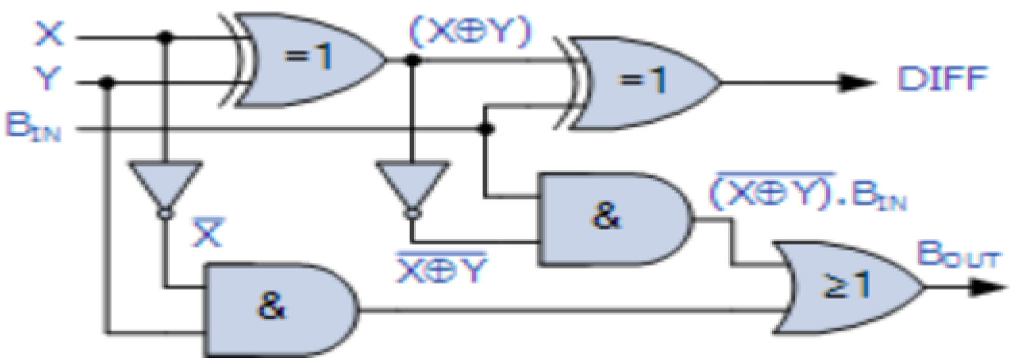
$$Diff = (A \oplus B \oplus Bin)$$

K map of **Borrow-Out** output Bit

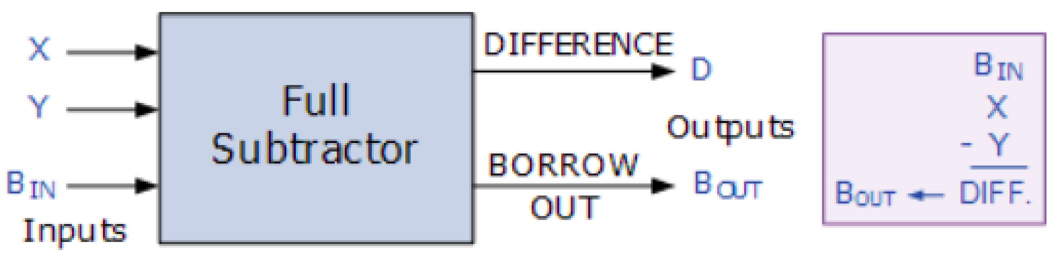
AB	Bin	
	0	1
00	0	1
01	1	1
11	0	1
10	0	0

$$Bout = (\bar{A}\,.\,B) + Bin\,.\,(\overline{A \oplus B})$$

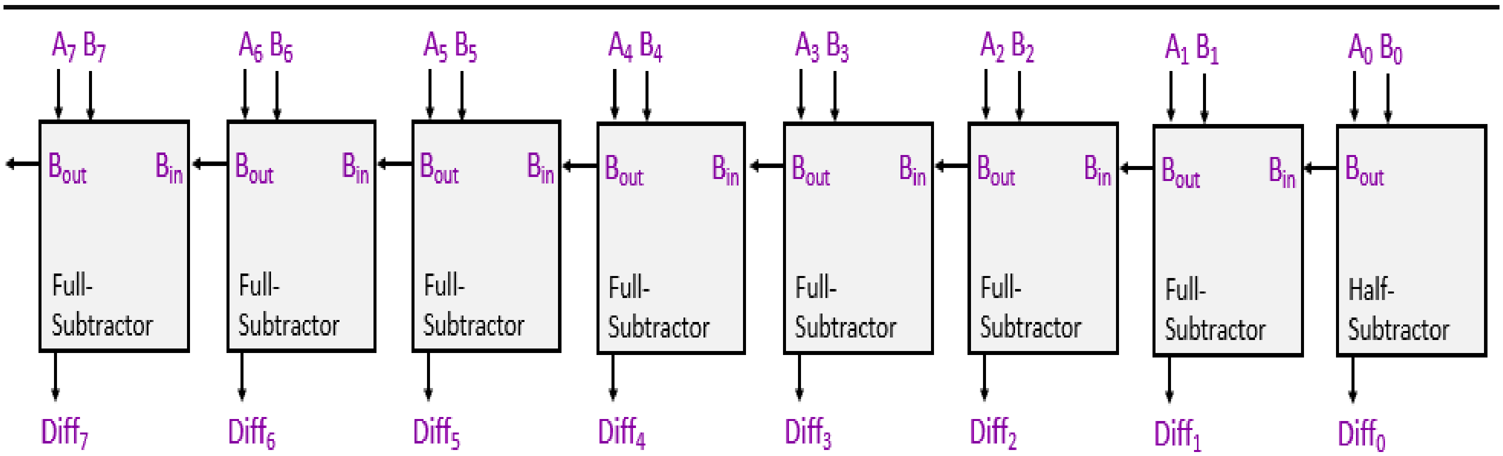
Logic Circuit of One Bit Full Subtractor



Block Diagram of One Bit Full Subtractor



8-Bit Full Subtractor Block Diagram



• Eight-Bit Adder Subtractor

On combining Logic of both Adder and Subtractor, we came to the conclusion that

For One-Bit Full Adder/Subtractor :

$$Sum/Diff \;=\; (A \oplus B \oplus Cin/Bin)$$ (depending on the opcode)

$$Cout \;=\; (A\,.\,B) \;+\; Cin\,.\,(A \oplus B)$$ (if opcode == 0)

$$Bout \;=\; (\bar{A}\,.\,B) \;+\; Bin\,.\,\overline{(A \oplus B)}$$ (if opcode == 1)

Circuit Diagram for Eight-Bit Adder Subtractor