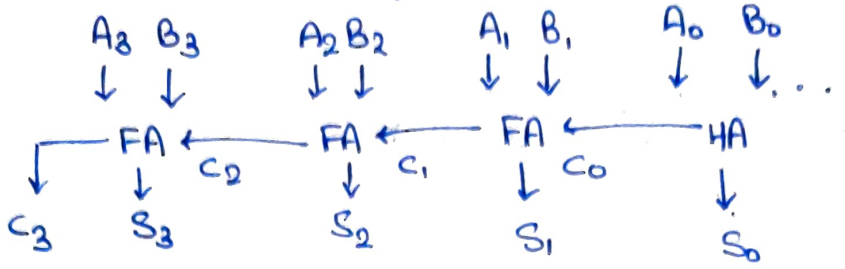
4 bit Parallel Binary Adder



Half Adder HA
Full Adder FA

Adding 4 one bit numbers

$$\begin{array}{cccccc} & A_3 & A_2 & A_1 & A_0 \\ + & B_3 & B_2 & B_1 & B_0 \\ \hline C & S_3 & S_2 & S_1 & S_0 \end{array}$$

$\Rightarrow$ Subtractors

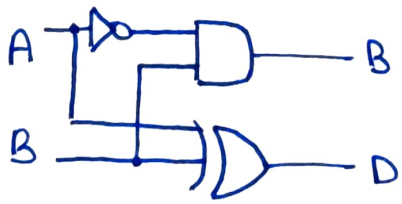
Half Subtracter

Subtracts one 2 bits of variables

A	B	Diff	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

$D = A'B + AB' = A \oplus B = \cancel{(A+B}$

$B = A'B$



Full Substractor

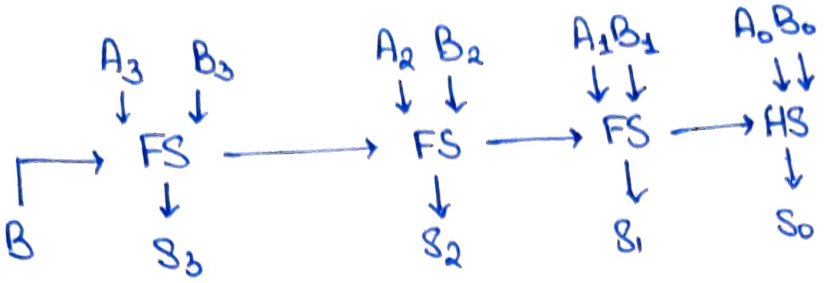
Substracts 3 one bit variables

A	B	C	Diff	Borrow
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

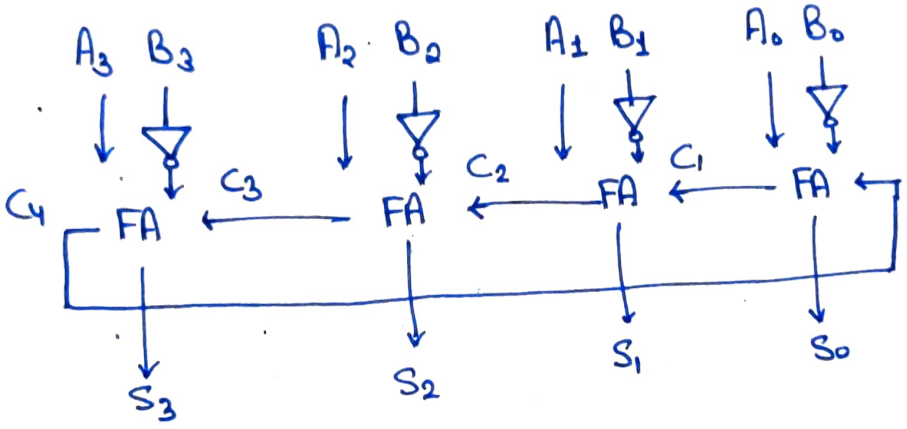
$B = A'C + \cancel{A'B}\, AB' + BC'$

$D = A \oplus B \oplus C$

4 bit Parallel Bit Subtracter



Parallel 4 Bit 1's complement Subtractor



Eg. 1101 - 0110
= 0111

1) we invert 0110 and add

```
  1101
+ 1001
-------
1 0110
```

2) we add back the carry

```
  ~~1001~~
   0110
+     1
-------
   0111
```

3) which was the original difference

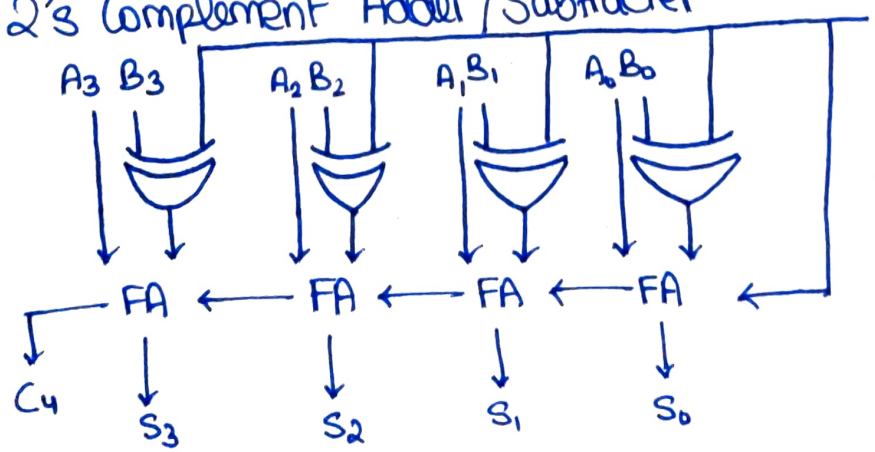
If no carry is generated,
then answer is in one's complement form and -ve

For final answer, invert the values

$S_3 S_2 S_1 S_0 \longrightarrow \overline{S_3}\,\overline{S_2}\,\overline{S_1}\,\overline{S_0}$

(Adding 1 to 1's complem → 2's complem)

2's Complement Adder/Subtracter



When SUB = 0
⇒ Adder Circuit

When SUB = 1
⇒ Subtractor Circuit