LAB 3 Pre-Labwork

Design of Adders

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SC22B146

① Logic circuit to add two 4-bit BCD numbers and with proper correction circuit to get correct BCD output (Addition using carry look ahead adder).

Implementation:

- 4-bit carry look ahead binary adder for initial addition
- logic circuit to detect sum greater than 9. or a carry.
- one more 4-bit adder to add $(0110)_2$ or 6_{10} if the sum ≥ 9 or carry is 1.

Eg

6	0 1 1 0	
+8	1 0 0 0	
14	1 1 1 0	← Invalid BCD
	+ 0 1 1 0	← Add 6 for correction.
	0 0 0 1	0 1 1 0 ← BCD for 14
	1	4

Truth Table: (Detecting if sum > 9)

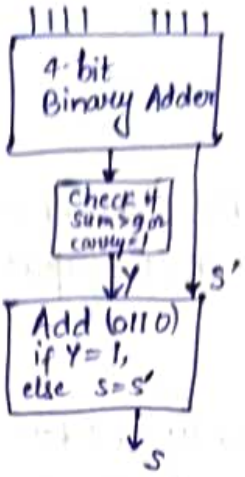
	S_3	S_2	S_1	S_0	Output (Y)
0→	0	0	0	0	0
1→	0	0	0	1	0
2→	0	0	1	0	0
3→	0	0	1	1	0
4→	0	1	0	0	0
5→	0	1	0	1	0
6→	0	1	1	0	0
7→	0	1	1	1	0
8→	1	0	0	0	0
9→	1	0	0	1	0
10→	1	0	1	0	1
11→	1	0	1	1	1
12→	1	1	0	0	1
13→	1	1	0	1	1
14→	1	1	1	0	1
15→	1	1	1	1	1

K-Map:

S_3S_2 \ S_1S_0	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	0	0	1	1

Output, $Y = S_3S_2 + S_3S_1$

Sketch:



Circuit diagram:

For $A = A_3\ A_2\ A_1\ A_0\ C_{in}$

$B = B_3\ B_2\ B_1\ B_0$

$Sum = C_{out}\ S_3\ S_2\ S_1\ S_0$

$+\ 0\ 1\ 1\ 0$ ← if Sum > 9 or $C_{out} = 1$

$S_i = P_i \oplus C_i$

$C_{i+1} = G_i + P_i C_i \quad (P_i = A_i \oplus B_i,\ G_i = A_i B_i)$

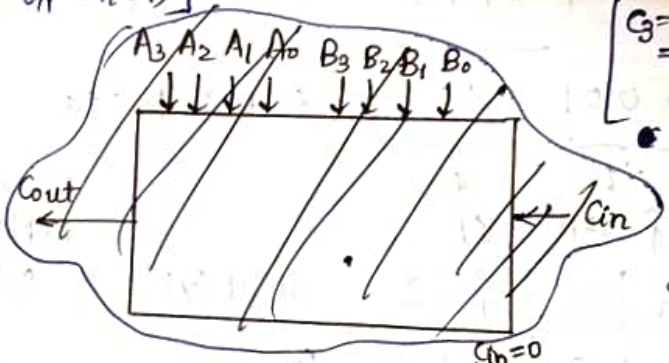
$C_1 = G_0 + P_0 C_0$

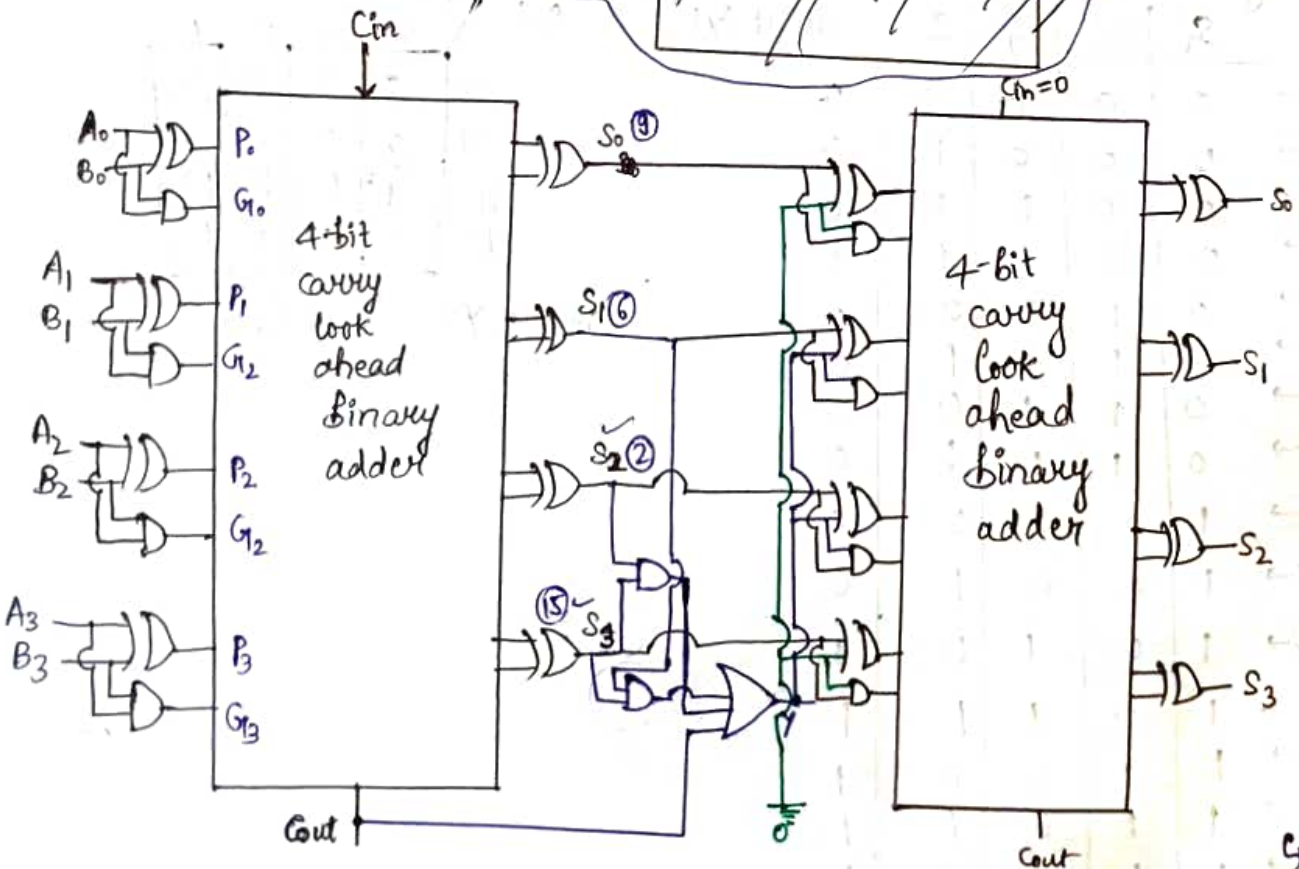
$C_2 = G_1 + P_1 C_1$

$= G_1 + P_1 G_0 + P_1 P_0 C_0$

$C_3 = G_2 + P_2 C_2$

$= G_2 + P_2 G_1 + P_2 P_1 G_0 + P_2 P_1 P_0 G_0$





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② 3 bit signed binary adder circuit (4 bits, 1 bit for sign) to add two negative numbers; control logic to predict whether the number is negative or not and based on that do the addition.

Soln:

$A = \boxed{A_3}\ A_2\ A_1\ A_0$

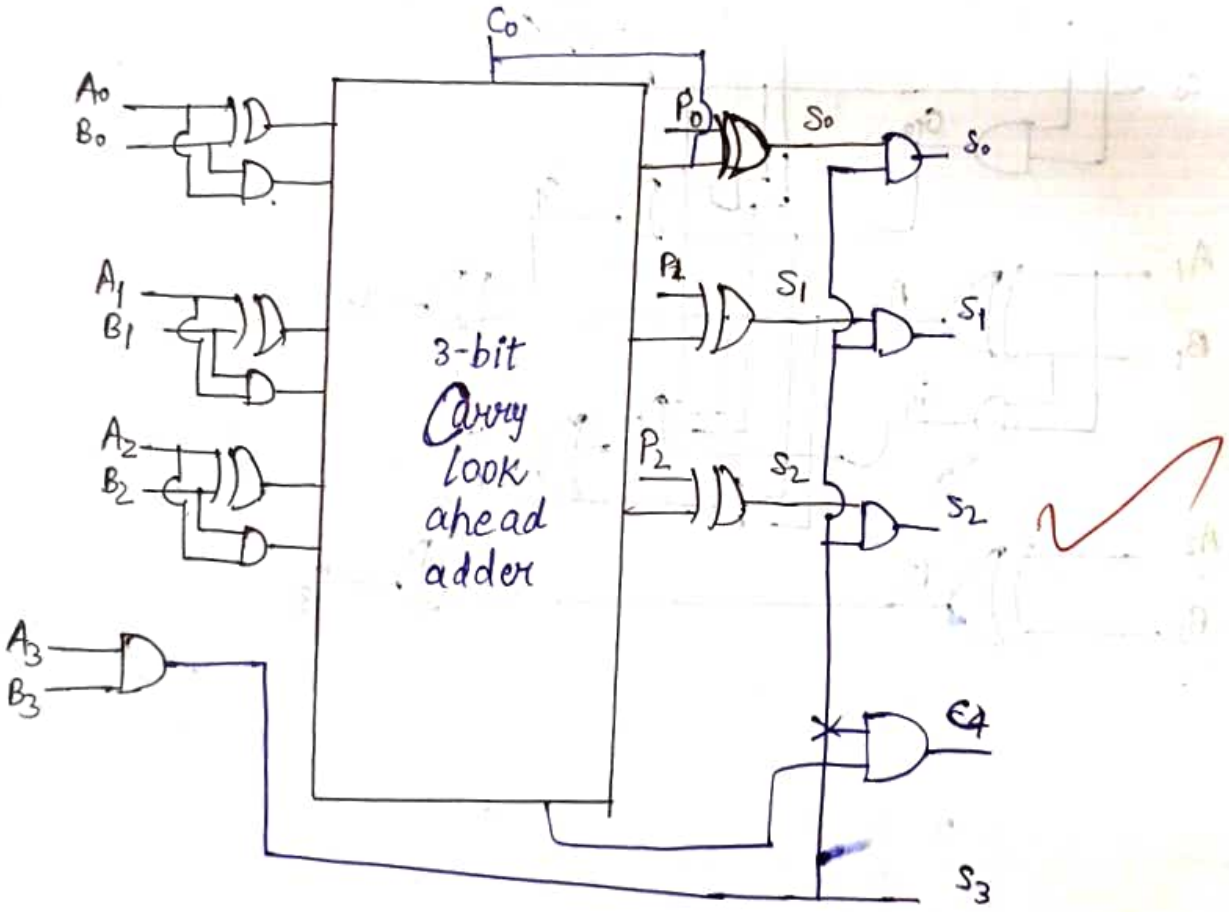
$B = \boxed{B_3}\ B_2\ B_1\ B_0$

$\boxed{S_3}\ S_2\ S_1\ S_0$

sign

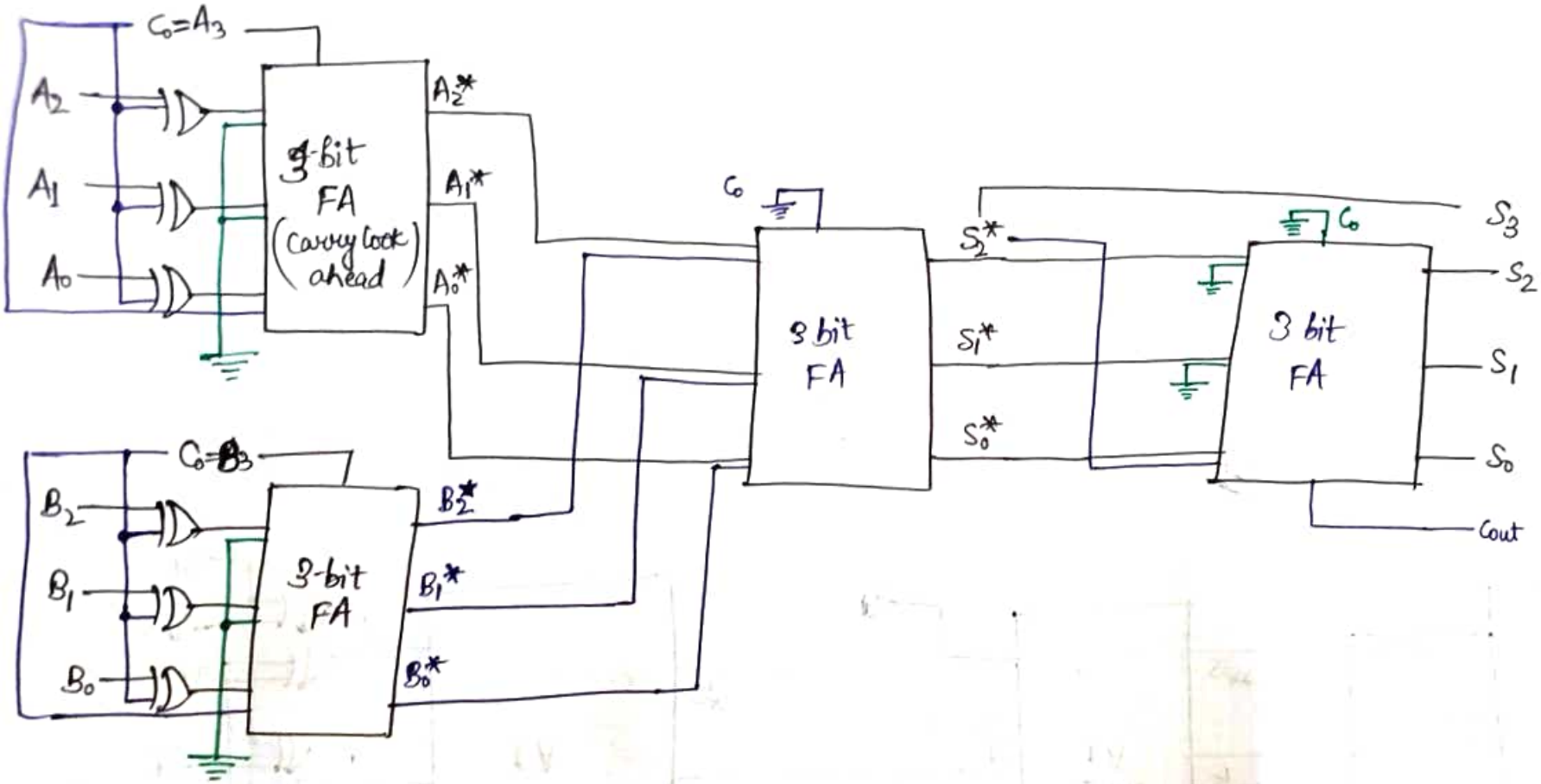
$S_3 = A_3 B_3$

Sig Magnitude Additia



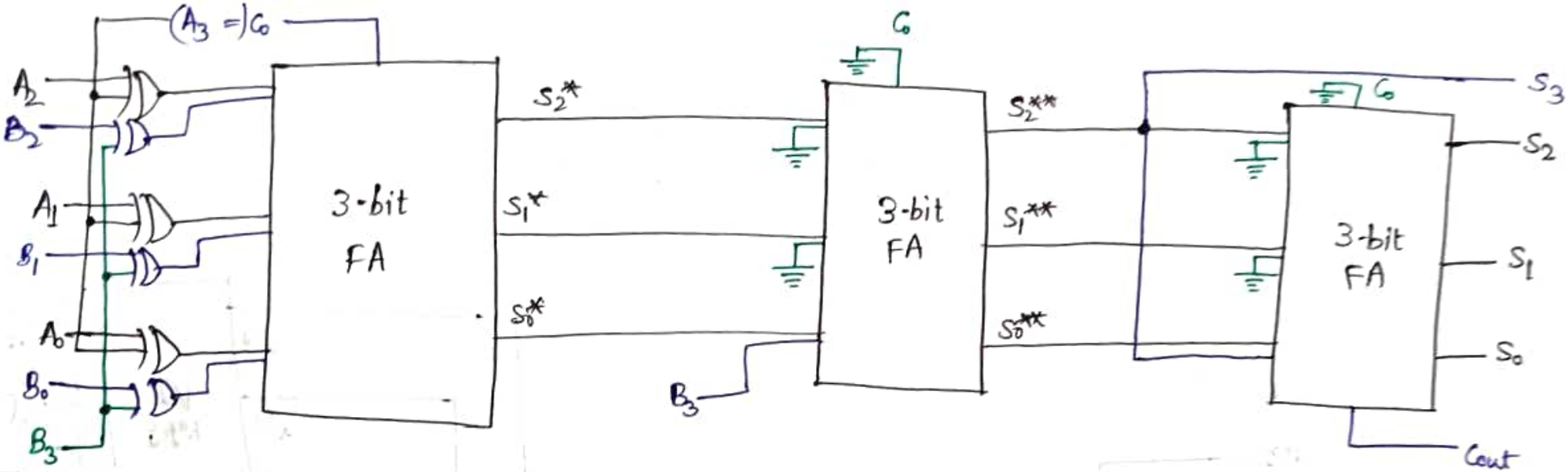
Good

Alternative Implementation



Alternative step

Yet another implementation (using 3 FAs only):



Carry look ahead adder:

$S_i = P_i \oplus C_i$ | $P_i = A_i \oplus B_i$

$C_{i+1} = G_i + P_i C_i$ | $G_i = A_i B_i$

$C_0 = C_0$

$C_1 = G_0 + P_0 C_0$

$C_2 = G_1 + P_1 C_1$

$= G_1 + P_1 G_0 + P_1 P_0 C_0$

$S_0 = P_0 \oplus C_0$

$S_1 = P_1 \oplus C_1$

$S_2 = P_2 \oplus C_2$