

Chapter 7

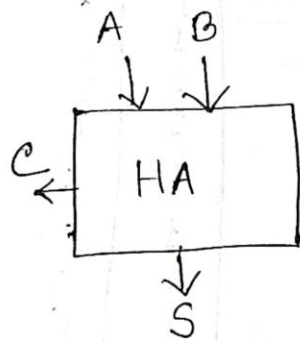
Arithmetic and Comparator Circuits

7.2 Adders

i) Half - Adder (HA)

ii) Full - Adder (FA)

7.2.1 Half Adder (HA)



(a) Block diagram

A	B	C	S
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

(b) Truth Table

C:

A \ B	0	1
0		
1		1

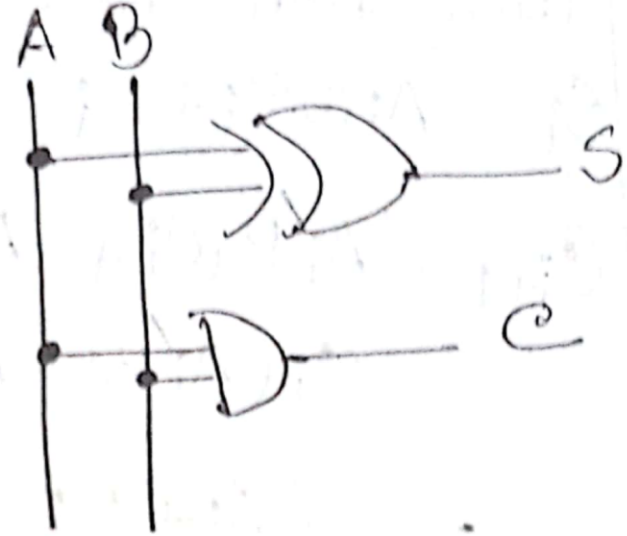
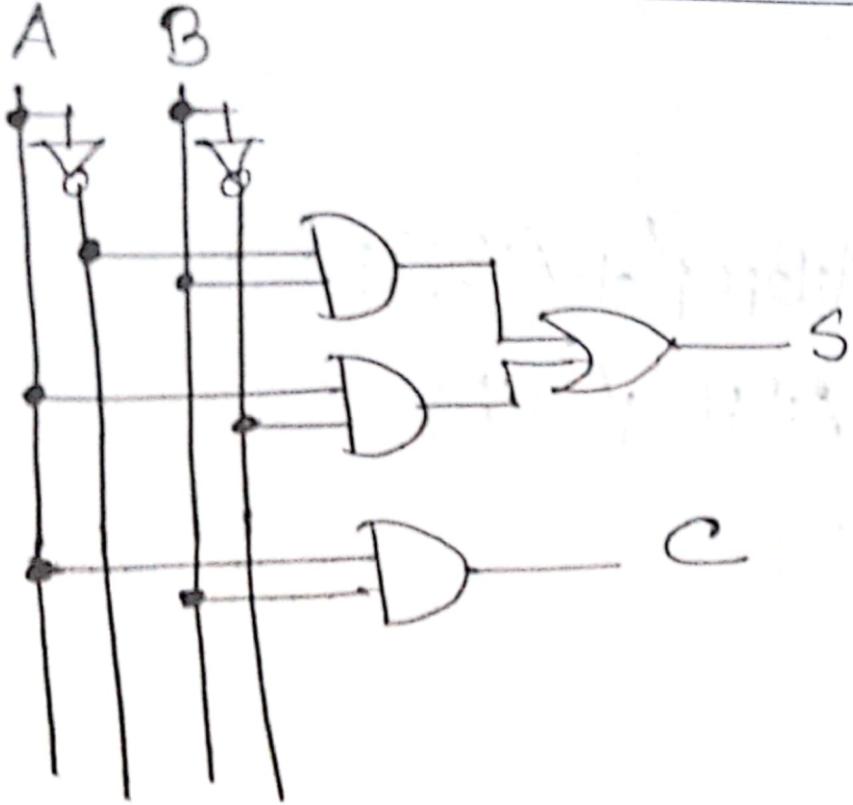
$$C = AB$$

S:

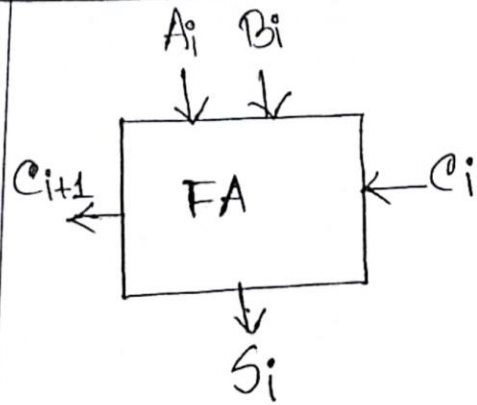
A \ B	0	1
0		1
1	1	

$$S = A'B + AB'$$

$$S = A \oplus B$$



7.2.2 Full-Adder



(a) Block Diagram

$A_i B_i C_i$	C_{i+1}	S_i
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

(b) Truth Table

K-Map:

C_{i+1} :

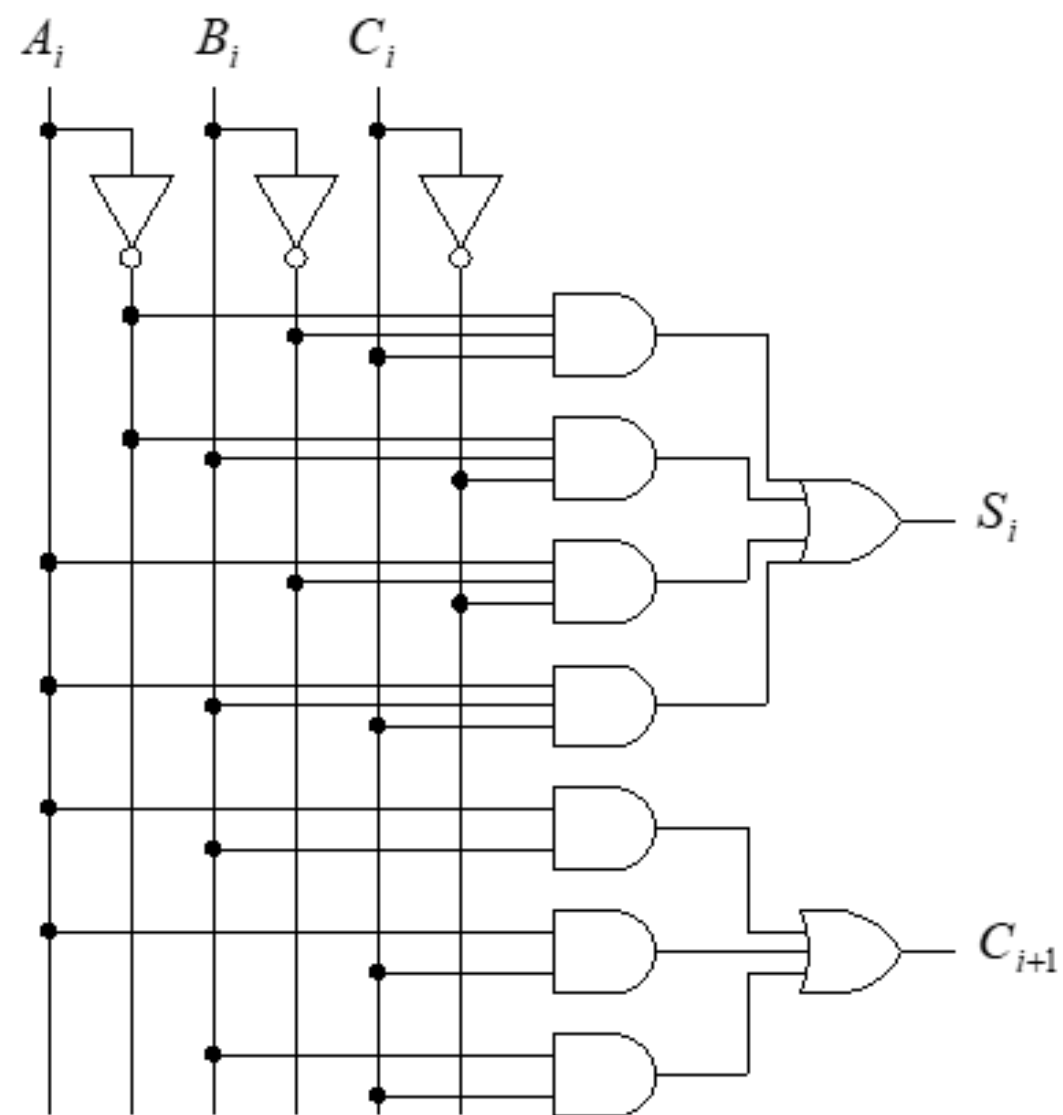
	$B_i C_i$	00	01	11	10
A_i	0			1	
	1		1	1	1

$$C_{i+1} = B_i C_i + A_i C_i + A_i B_i$$

S_i :

	$B_i C_i$	00	01	11	10
A_i	0		1		1
	1	1		1	

$$S_i = A_i' B_i' C_i + A_i' B_i C_i' + A_i B_i' C_i' + A_i B_i C_i$$



$A_i B_i C_i$	C_{i+1}	S_i
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

(b) Truth Table

From Truth Table:

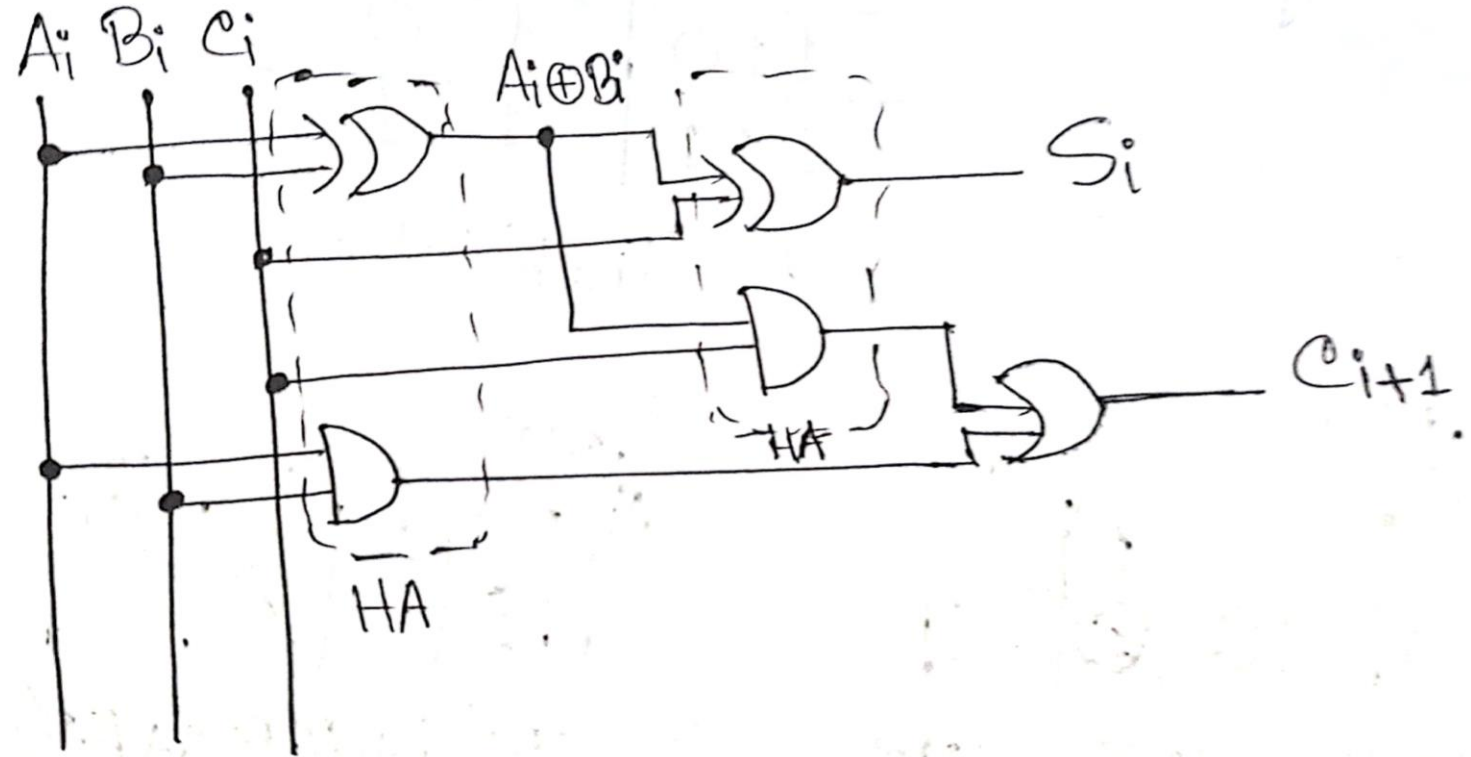
$$S_i = A_i \oplus B_i \oplus C_i$$

$$\begin{aligned}
 C_{i+1} &= A_i' B_i C_i + A_i B_i' C_i + A_i B_i C_i' + A_i B_i C_i \\
 &= C_i (A_i' B_i + A_i B_i') + A_i B_i (C_i' + C_i) \\
 &= (A_i \oplus B_i) C_i + A_i B_i
 \end{aligned}$$

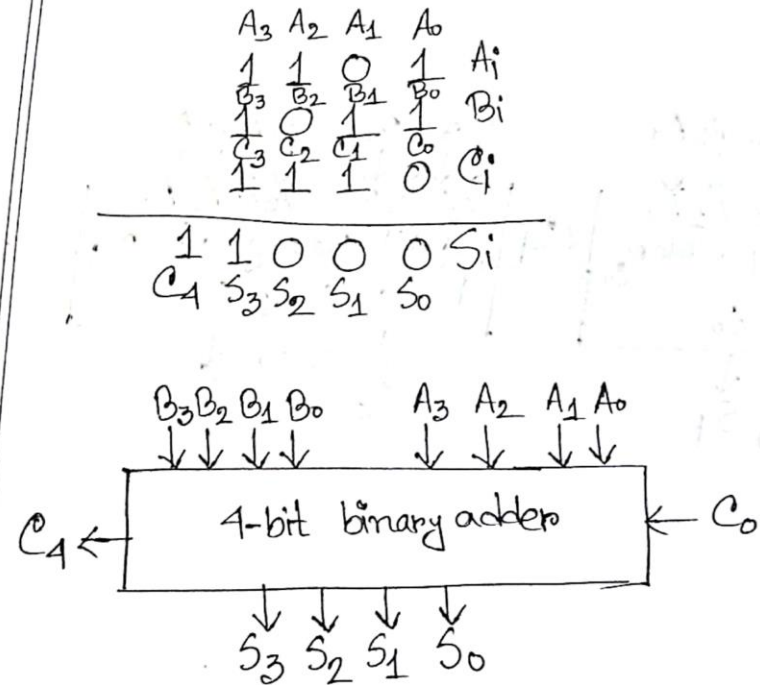
From Truth Table:

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

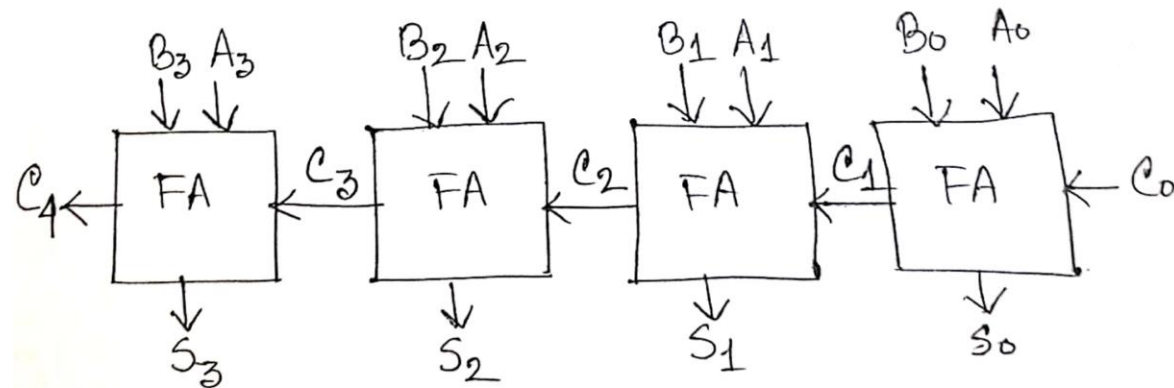
$$\begin{aligned} C_{i+1} &= A_i' B_i C_i + A_i B_i' C_i + A_i B_i C_i' + A_i B_i C_i \\ &= C_i (A_i' B_i + A_i B_i') + A_i B_i (C_i' + C_i) \\ &= (A_i \oplus B_i) C_i + A_i B_i \end{aligned}$$



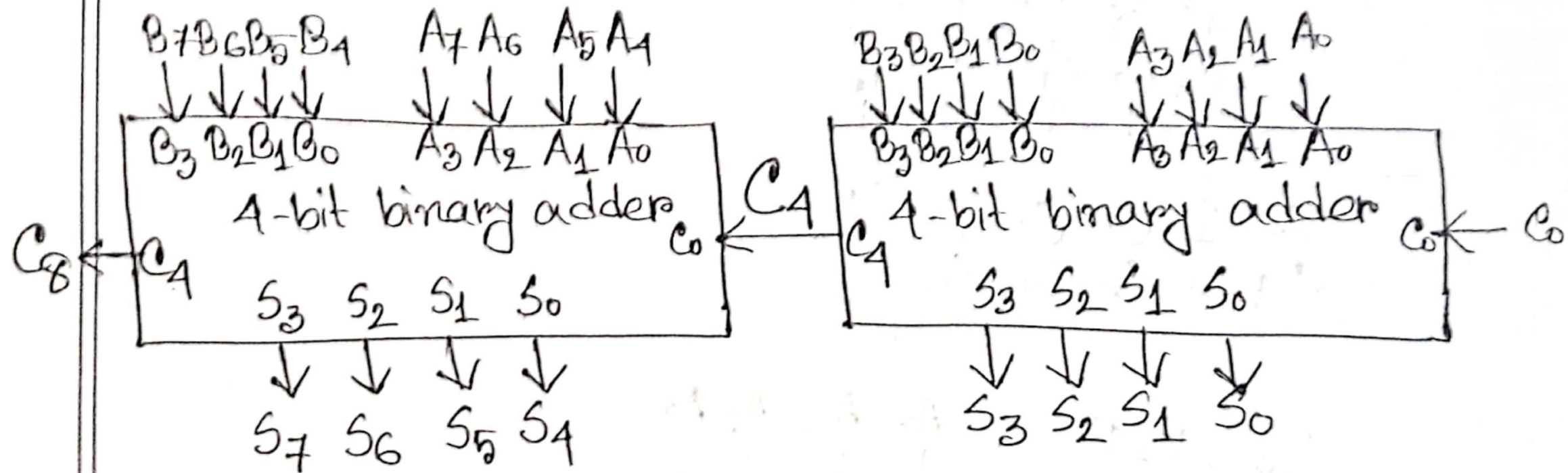
7.4 Binary Parallel Adder



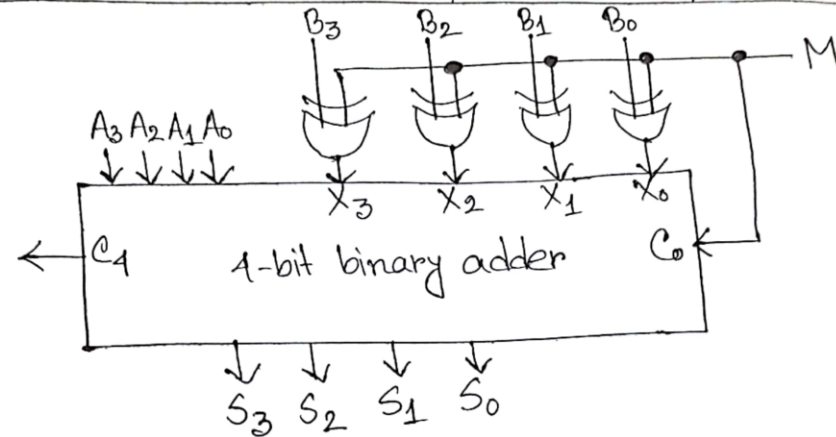
Implementation of a 4-bit binary adder using full-adders



Implementation of a 8-bit binary adder using 4-bit binary adder



7.6.3 Combined 2's Complement Adder/Subtractor



When $M=0$,

$$C_0 = 0$$

$$X = 0 \oplus B = B$$

$$\begin{aligned} A + X + C_0 &= A + B + 0 \\ &= A + B \text{ (Addition)} \end{aligned}$$

When $M=1$,

$$C_0 = 1$$

$$X = 1 \oplus B = B'$$

$$\begin{aligned} A + X + C_0 &= A + B' + 1 \\ &= A + (B' + 1) \\ &= A + (\text{2's complement of } B) \\ &= A + (-B) \\ &= A - B \text{ (Subtraction)} \end{aligned}$$