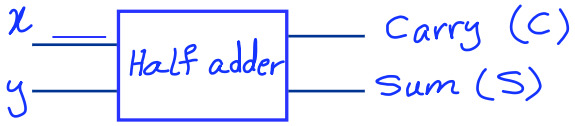
Adders and Subtractors

(Adder) جمع کننده

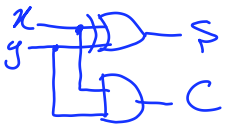


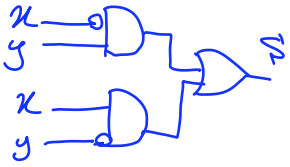
x	y	C	S
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

$\Rightarrow$

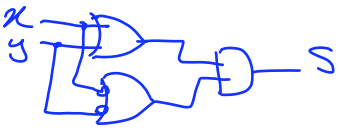
$S = x'y + xy' = x \oplus y$

$C = x \cdot y$

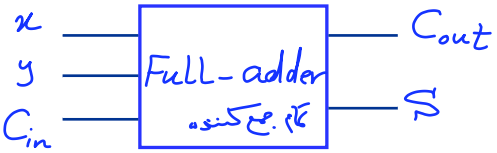




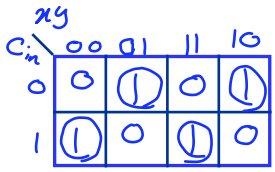
$S = (x+y) \cdot (x'+y')$



C_2 C_1
$a_1 a_0$
$+ b_1 b_0$
S_1 S_0

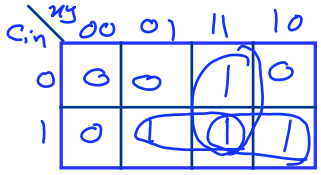


x	y	C_{in}	C_{out}	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1



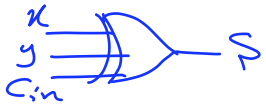
$S = x'y'C_{in} + x'yC_{in}' + xyC_{in} + xy'C_{in}'$

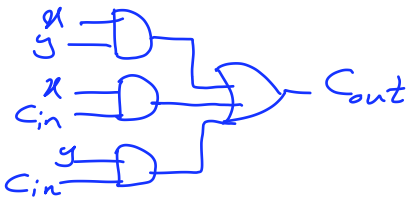
$S = x \oplus y \oplus C_{in}$ (تعداد فرد "1")

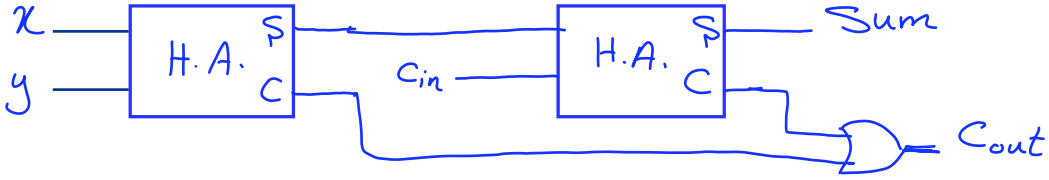


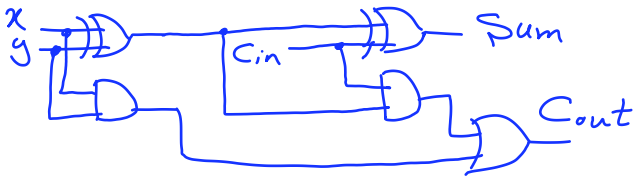
$C_{out} = yC_{in} + xC_{in} + xy$ ~~$+ xyC_{in}$~~

majority function = تابع اکثریت

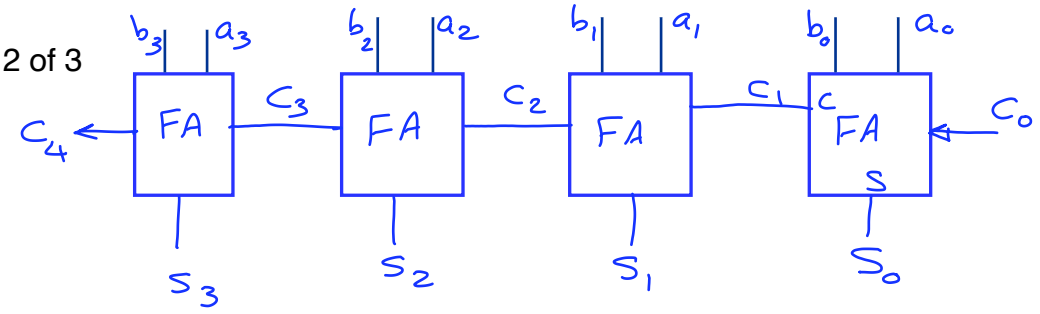








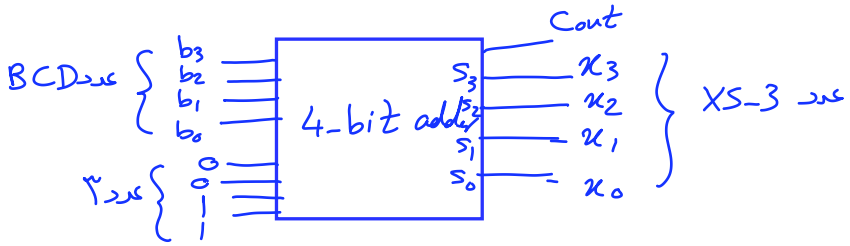
Full-Adder 7480
7482
4-bit ← 74283
IC : Integrated Circuit



$$\begin{array}{r} c_1\ c_0 \\ a_3\ a_2\ a_1\ a_0 \\ +\ b_3\ b_2\ b_1\ b_0 \\ \hline c_4\ s_3\ s_2\ s_1\ s_0 \end{array}$$

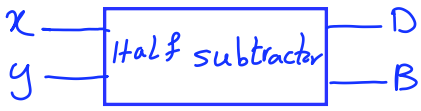
4-bit adder

مثال: مداری طراحی کنید که کد BCD را به کد مازاد ۳ (Excess-3) تبدیل کند.



BCD + "3" = XS-3

تفریق کننده (subtractor)



x y	B	D
0 0	0	0
0 1	1	1
1 0	0	1
1 1	0	0

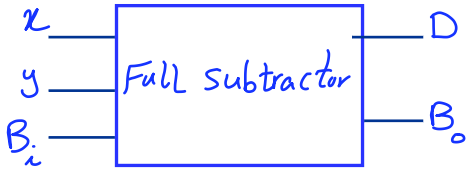
$x - y =$ B: borrow, D: difference

$$\begin{array}{r} x \\ -\ y \\ \hline \end{array}$$

$D = x'y + xy' = x \oplus y$

$B = x'y$

$$\begin{array}{r} B \\ a_1\ a_0 \\ -\ b_1\ b_0 \\ \hline d_0 \end{array}$$



x y Bi	Bo	D
0 0 0	0	0
0 0 1	1	1
0 1 0	1	1
0 1 1	1	0
1 0 0	0	1
1 0 1	0	0
1 1 0	0	0
1 1 1	1	1

KM →

$D = \bar{x}\bar{y}B_i + \bar{x}y\bar{B}_i + x\bar{y}\bar{B}_i + xyB_i$

$D = x \oplus y \oplus B_i$

$B_o = \bar{x}y + \bar{x}B_i + yB_i$

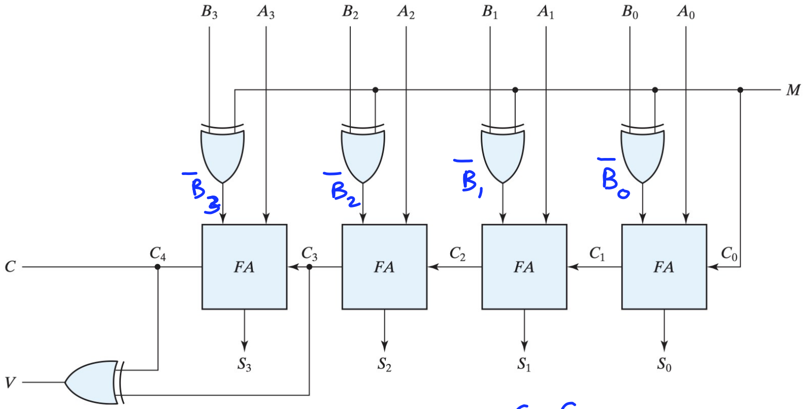


FIGURE 4.13
Four-bit adder–subtractor (with overflow detection)

$M = \begin{cases} 0 \rightarrow \text{عمل جمع} \\ 1 \rightarrow \text{عمل تفريق} \end{cases}$

0, a → XOR → a

1, a → XOR → a'

مكمل ٢ : تام بيصيرها NOT ونزيد 1 +

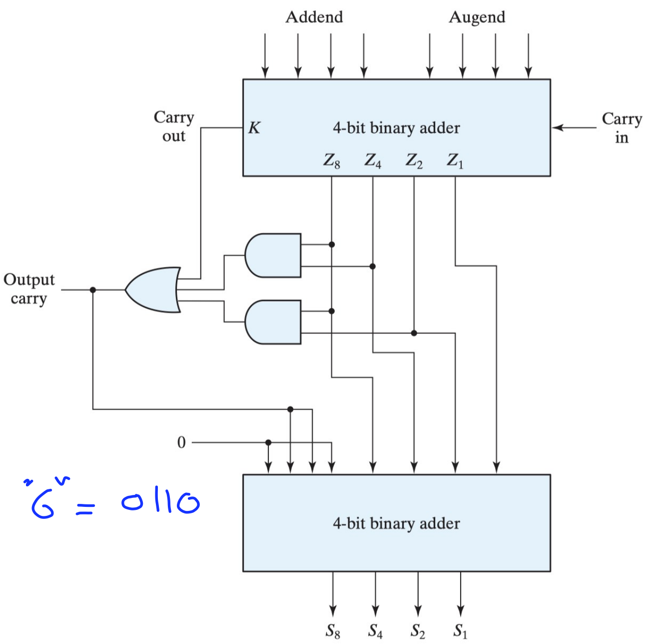
-3	(1)(0)00
	1101
-6	1010
-9	0111

$C_4\ C_3$	0 (1) 1
+2	0010
+6	+ 0110
+8	1000

1	
1001	9
+1011	+11
~~1~~0100	20

overflow = سرريز

B Addend, A Augend



"6" = 0110

FIGURE 4.14
Block diagram of a BCD adder

$Z_8Z_4Z_2Z_1$	
1001	9
1010	10
1011	11
1100	12
1101	13
1110	14
1111	15

$Z_8Z_4 + Z_8Z_2$