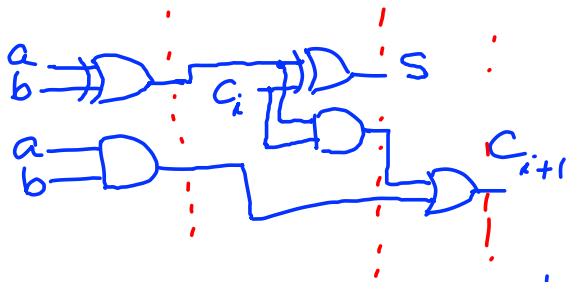
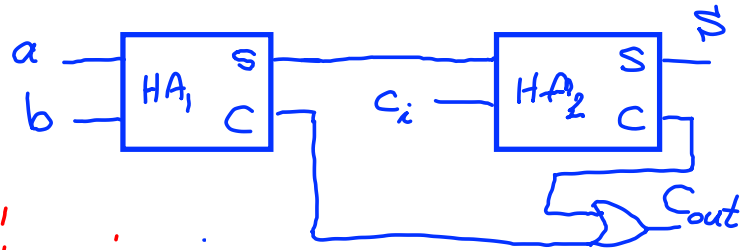


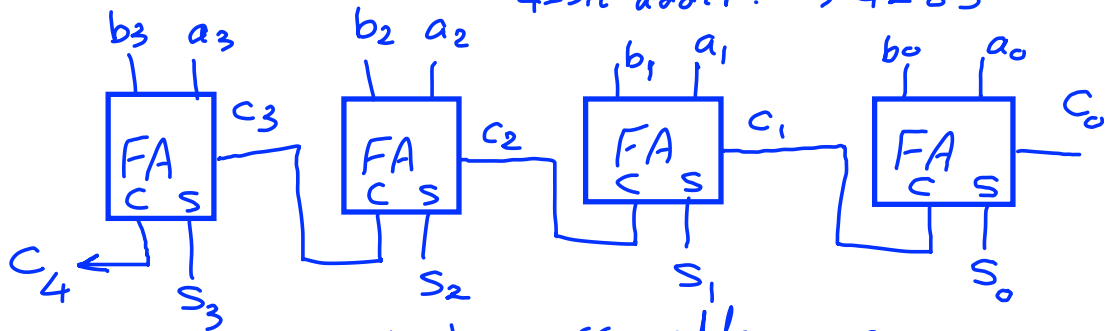
$$\begin{array}{r}
 c_4 \ c_3 \ c_2 \ c_1 \ c_0 \\
 A = a_3 a_2 a_1 a_0 \\
 + B = b_3 b_2 b_1 b_0 \\
 \hline
 s_3 \ s_2 \ s_1 \ s_0
 \end{array}$$



7480: FA

$$2^9 = 512$$

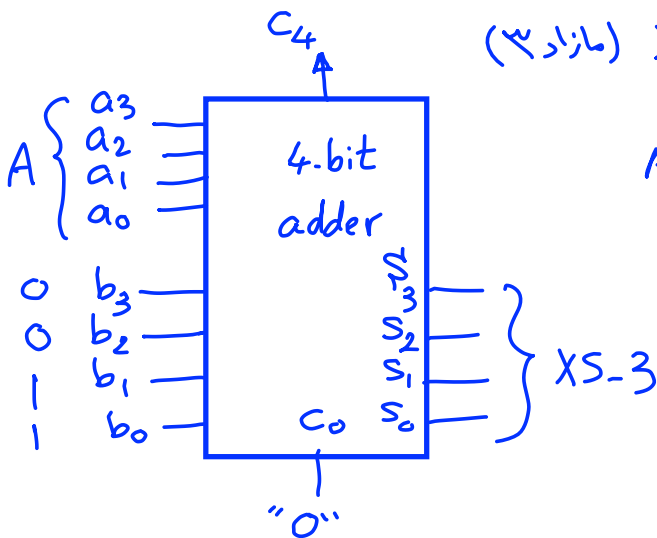
4-bit adder: 74283



ripple carry adder = rca

تأخير rca = n - بیتي = 2n گیت + تأخیر HA

مثال: تبدیل که BCD به XS-3 (مازاد ۳)



$$A + 3 = \text{XS-3}$$

$$\downarrow$$

$$0011$$

تفریق کننده

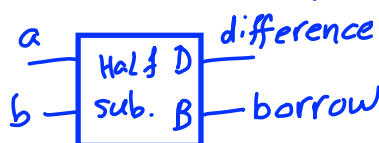
Half subtractor

a-b

a	b	B	D
0	0	0	0
0	1	1	1
1	0	0	1
1	1	0	0

$$D = a \oplus b$$

$$B = \bar{a}b$$



$$f = 1 \text{ GHz} = 10^9 \text{ Hz}$$

$$T = \frac{1}{f} = 10^{-9} \text{ sec} = 1 \text{ nsec}$$

$$10^{-12} = \text{pico}$$

$$5 \text{ ns} \rightarrow 200 \text{ MHz}$$

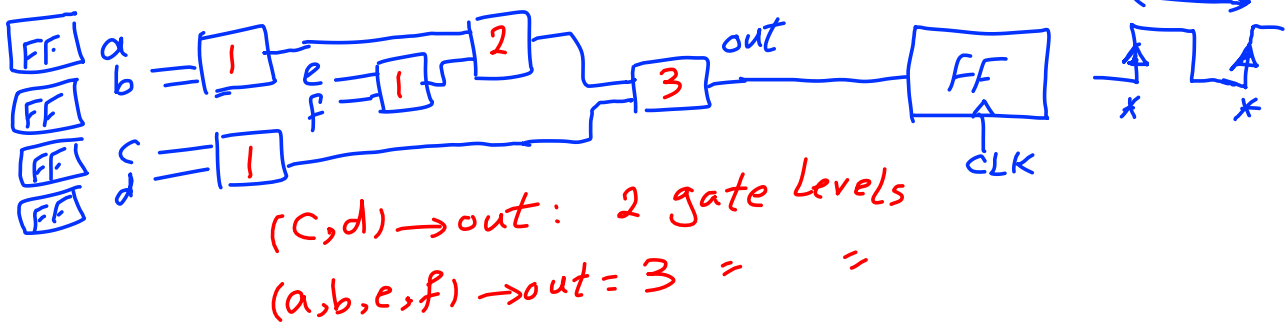
Full-subtractor

x	y	b_i	b_{out}	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

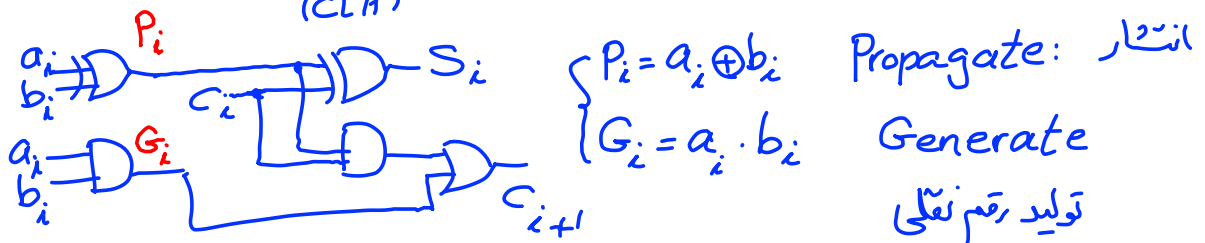
$$\Rightarrow d = x \oplus y \oplus b_i$$

$$b_{out} = \bar{x}y + \bar{x}b_i + yb_i$$

$$\begin{array}{r} b_2 b_1 \\ x_1 x_0 \\ - y_1 y_0 \\ \hline d_1 d_0 \end{array}$$



تسريع عمل جمع : روش پیش بینی رقم نقلی
 Carry Look-ahead (CLA)



$$a_4 a_3 a_2 a_1 + b_4 b_3 b_2 b_1 + C_1$$

$$S_i = P_i \oplus C_i$$

$$C_{i+1} = G_i + P_i \cdot C_i$$

$$C_2 = G_1 + P_1 C_1$$

$$C_3 = G_2 + P_2 C_2 = G_2 + P_2 (G_1 + P_1 C_1) = G_2 + G_1 P_2 + P_2 P_1 C_1$$

$$C_4 = G_3 + P_3 C_3 = G_3 + P_3 (G_2 + G_1 P_2 + P_2 P_1 C_1) = G_3 + G_2 P_3 + G_1 P_3 P_2 +$$

$$C_5 = \dots$$

SOP: 2-Level delay

تاخیر تولید تمام $C_n = 2$ گیت + تأخیر HA

4-bit CLA adder

