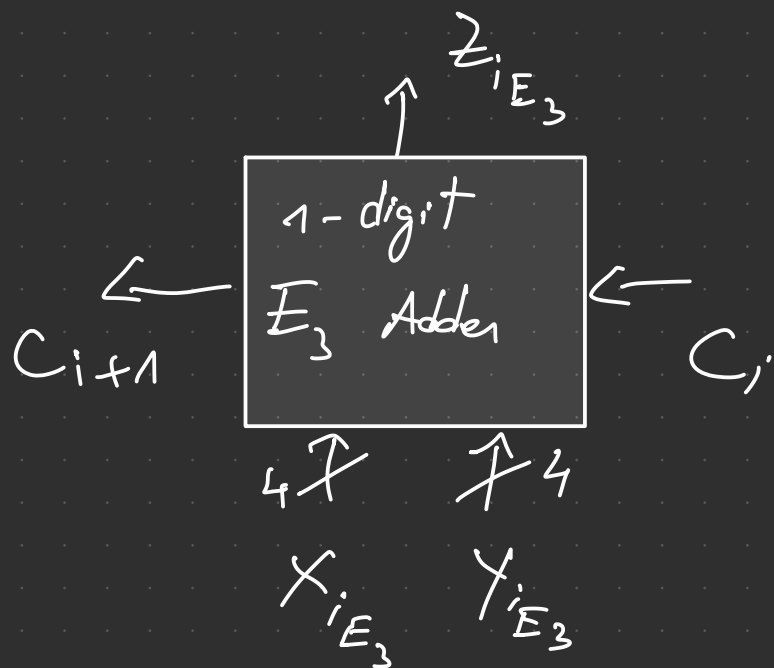
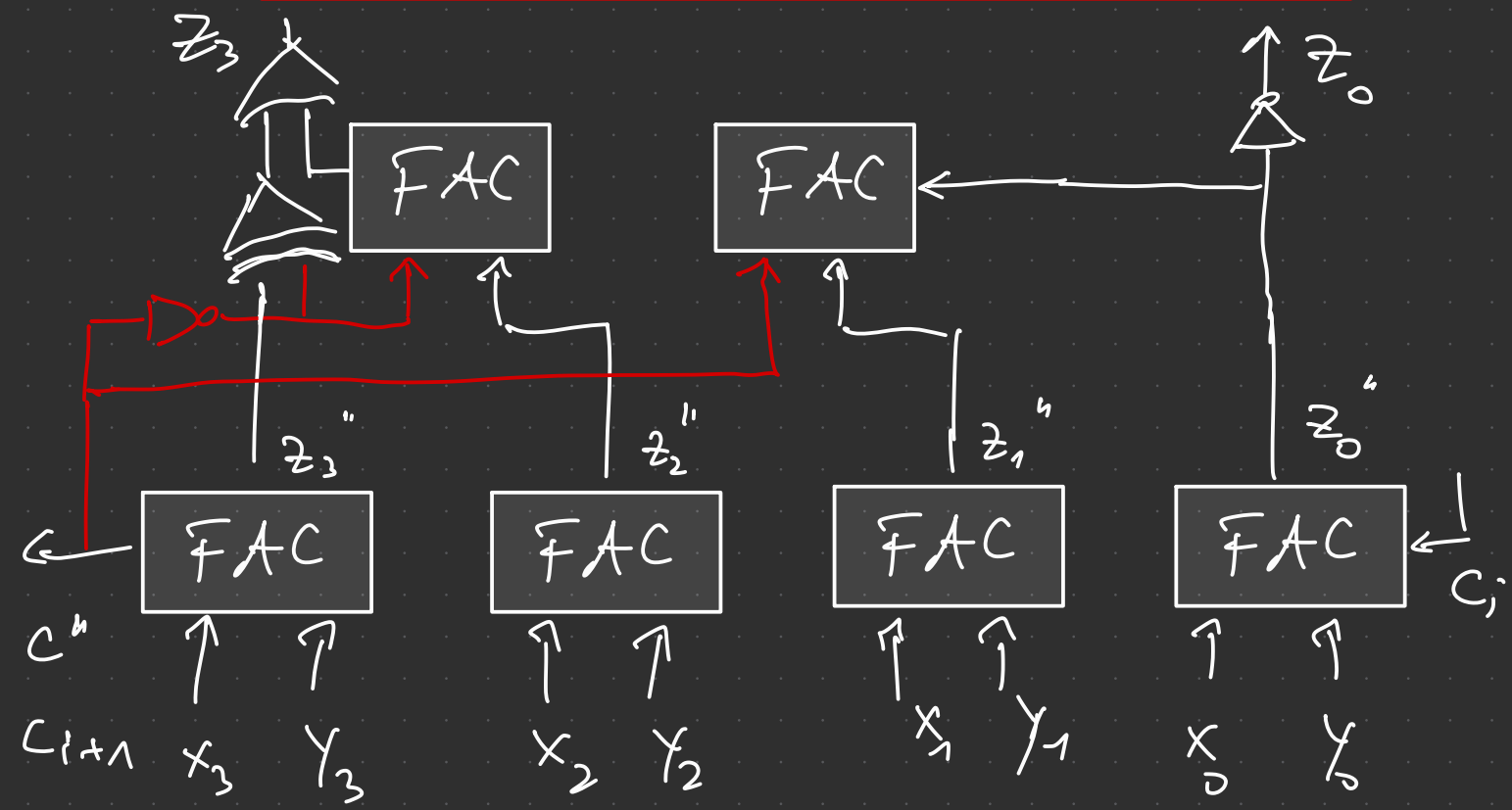


Sumator tetradů exces de 3



$$\begin{array}{r} 497 + \\ 485 \\ \hline 982 \end{array}$$

$\begin{array}{c} 1 \\ 0 \end{array}$	$\begin{array}{c} 1 \\ 0 \end{array}$	$\begin{array}{c} 1 \\ 0 \end{array}$	E_3
0111	1100	1010	
0111	1011	1000	
<hr/>			
01111	11000	10010	$+$
1101	0011	$\rightarrow 0011$	
<hr/>	<hr/>	<hr/>	
1100	1011	0101	
<hr/>	<hr/>	<hr/>	
9_{E_3}	8_{E_3}	$2 \text{ in } E_3$	

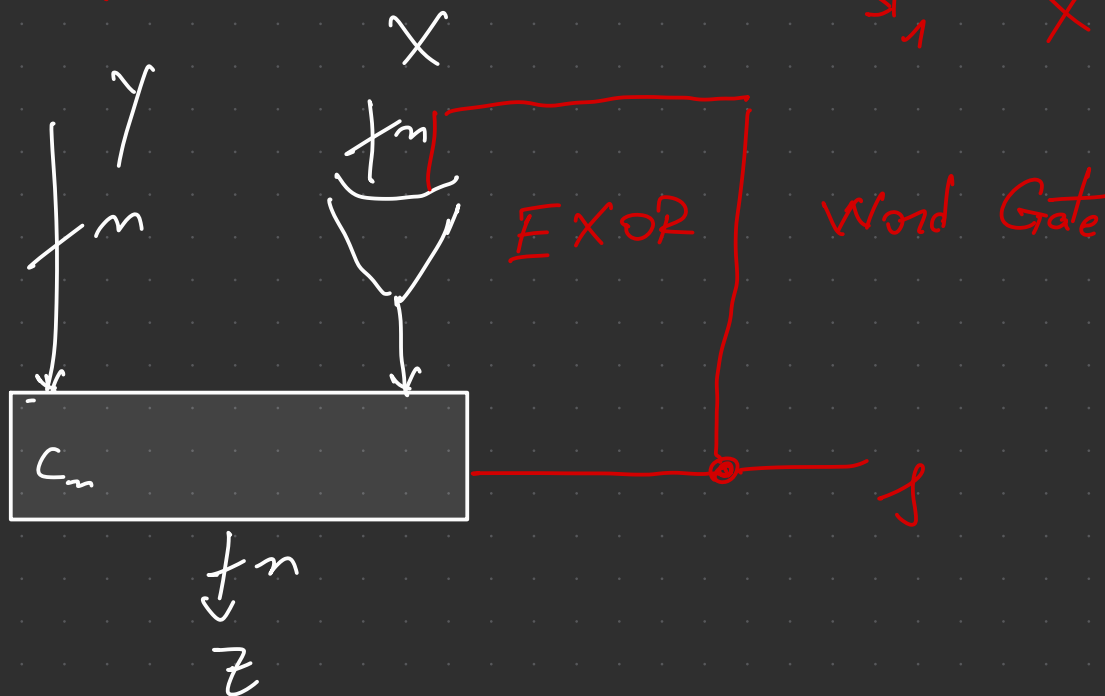
Scăzătoare serială

$$Z = Y - X$$

$$(A) \quad Y - X = Y + (-X)$$

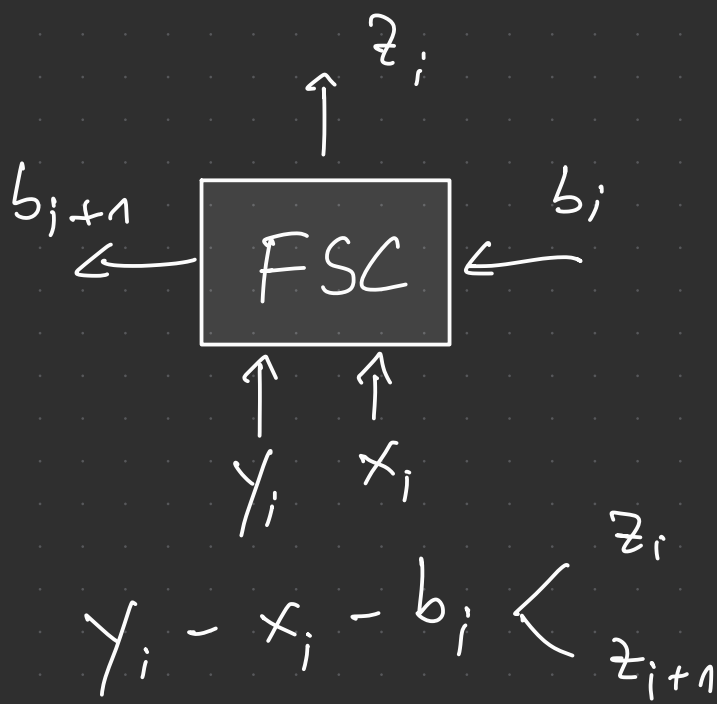
Adder Subtractor

$$X^x: \begin{array}{l} 1 \rightarrow 0 \\ 0 \rightarrow 1 \end{array} \quad \begin{array}{l} x^x = x \\ x^x = \overline{x} \end{array}$$



$$\begin{array}{l} 0: Z = Y + X + 0 = Y + X \\ 1: Z = Y + \overline{X} + 1 = Y - X \end{array}$$

$\underbrace{\overline{X} + 1}_{-X} (C_2)$



y_i	x_i	b_i	z_i	b_{i+1}
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

$$z_i = y_i \oplus x_i \oplus b_i$$

$$b_{i+1} = \overline{y_i} x_i + \overline{y_i} b_i + x_i b_i$$

Scăzător BCD

$X^{(k)}$, $Y^{(k)}$ k -digit BCD 8421 number

$$Z^{(k)} = Y^{(k)} - X^{(k)}$$

X_i = BCD digit $X_i = x_3 x_2 x_1 x_0$

$\hookrightarrow \overline{X_i}^*$ = 9's complement of X_i

$$\overline{X_i}^* = 9 - X_i$$

$$\overline{x^{*}}^{(k)} = \overline{x_{n-1}^{*}} \overline{x_{n-2}^{*}} \dots \overline{x_0^{*}}$$

$$= \underbrace{999 \dots 9}_k - x_{k-1} x_{k-2} \dots x_0$$

$$\boxed{\overline{x^{*}}^{(k)} = 10^k - 1 - x^{(k)}}$$

$$Z^{(k)} = \left(y^{(k)} - x^{(k)} \right) \bmod 10^k$$

$$= \left(y^{(k)} + \underbrace{10^k - 1 - x^{(k)} + 1}_{\overline{x^{*}}^{(k)}} \right) \bmod 10^k$$

$$Z^{(k)} = \left(y^{(k)} + \overline{x^{*}}^{(k)} + 1 \right) \bmod 10^k$$

$$x_i = x_3 x_2 x_1 x_0$$

$$\overline{x_i^{*}} = 9 - x_i = x_3^{*} x_2^{*} x_1^{*} x_0^{*}$$

$$\left\{ \begin{array}{l} x_3^{*} = \overline{x_3 + x_2 + x_1} \\ x_2^{*} = x_2 \oplus x_1 \\ x_1^{*} = x_1 \\ x_0^{*} = \overline{x_0} \end{array} \right.$$

$$\begin{array}{r} 803 - \\ 279 \\ \hline 524 \end{array} \quad \begin{array}{r} 803 + \\ 720 \\ \hline \cancel{524} \end{array}$$

$$\begin{array}{r} 999 - \\ 279 \\ \hline 720 \end{array}$$

pt. $\Gamma_3 \rightarrow$

modifier le tabel
complement de 9

	x_3	x_2	x_1	x_0	x_3^*	x_2^*	x_1^*	x_0^*
0	0	0	1	1	1	1	0	0
1	0	1	0	0	1	0	1	1
2	0	1	0	1	1	0	1	0
3	0	1	1	0	1	0	0	1
4	0	1	1	1	1	0	0	0
5	1	0	0	0	0	1	1	1
6	1	0	0	1	0	1	1	0
7	1	0	1	0	0	1	0	1
8	1	0	1	1	0	1	0	0
9	1	1	0	0	0	0	1	1

$x_3^* = \overline{x_3} \cdot x_2 + \overline{x_3} x_1 x_0 = \overline{x_3}$

$x_1 x_0$	00	01	11	10
$x_3 x_2$	d	d	1	d
00	d	d	1	d
01	1	1	1	1
11		d	d	d
10				

$x_2^* = \overline{x_3} x_2 + \overline{x_2} x_1 x_0 = \overline{x_2}$

$x_1 x_0$	00	01	11	10
$x_3 x_2$	d	d	1	d
00	d	d	1	d
01				
11		d	d	d
10	1	1	1	1

$x_1^* = \overline{x_1} x_2 \overline{x_1} + \overline{x_3} \overline{x_2} \overline{x_1} + \overline{x_3} \overline{x_2} \overline{x_1} x_0 = \overline{x_1}$

$x_1 x_0$	00	01	11	10
$x_3 x_2$	d	d		d
00	d	d		d
01	1	1		
11	1	d	d	d
10	1	1		

$x_0^* = \overline{x_3} x_1 \overline{x_0} + \overline{x_3} x_2 \overline{x_0} + \overline{x_3} x_2 \overline{x_0} = \overline{x_0}$

$x_1 x_0$	00	01	11	10
$x_3 x_2$	d	d		d
00	d	d		d
01	1			1
11	1	d	d	d
10	1			1

Calcol parallel a sume

Carry Look-Ahead
pur teoretic

F-CLA

• semnale propagate / generate

$$g_i = x_i \cdot y_i \rightarrow 1d$$

$$p_i = x_i + y_i \rightarrow 1d$$

$$C_4 = g_3 + p_3 C_3$$

$$C_4 = g_3 + p_3 g_2 + p_3 p_2 g_1 + p_3 p_2 p_1 g_0 + \underbrace{p_3 p_2 p_1 p_0}_{P_{0,3}} C_0$$

$G_{0,3}$

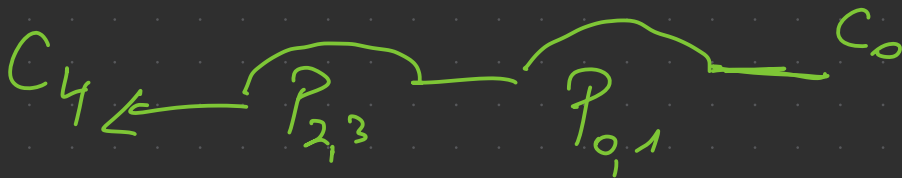
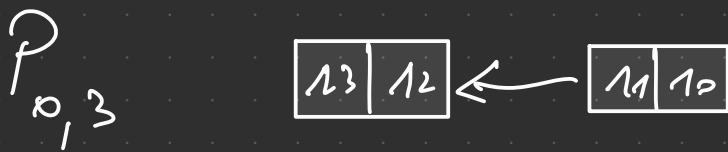
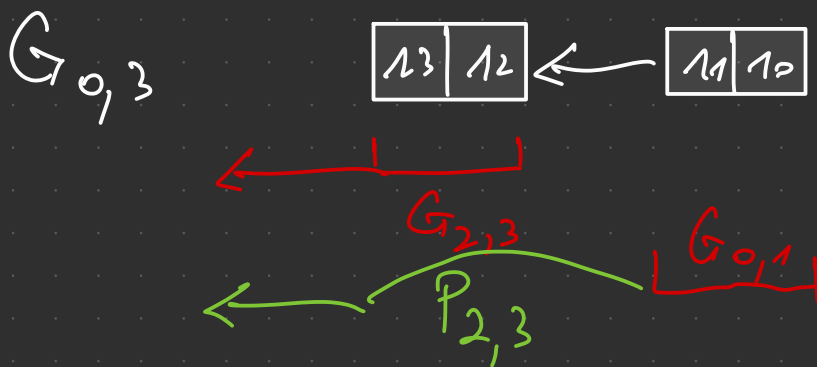
$$C_{i+1} = g_i + p_i C_i$$



$$C_4 = G_{0,3} + P_{0,3} \cdot C_0$$



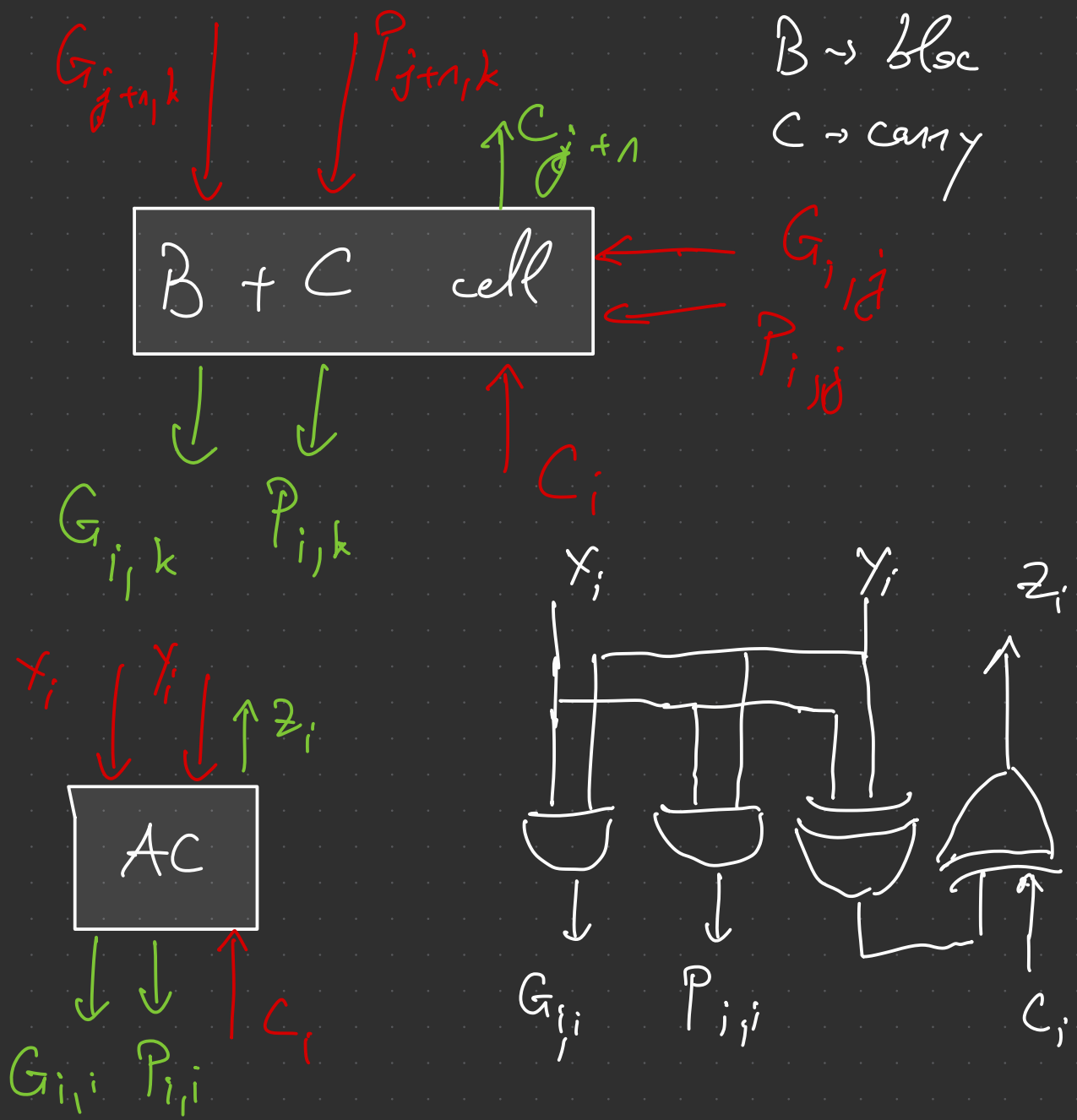
$$C_4 = g_3 + P_3 g_2 + P_3 P_2 (g_1 + P_1 g_0) + P_3 P_2 \cdot P_1 P_0 C_0$$



$$C_{j+1} = G_{i,j} + P_{i,j} \cdot C_i \quad \forall i \leq j$$

$$G_{i,k} = G_{j+1,k} + P_{j+1,k} \cdot G_{i,j} \quad \forall i \leq j < k$$

$$P_{i,k} = P_{j+1,k} \cdot P_{i,j} \quad \forall i \leq j < k$$



Arhitectura CLA pe 4 biti

pt AC cell $G_{i,i}, P_{i,i} \rightarrow 1d$

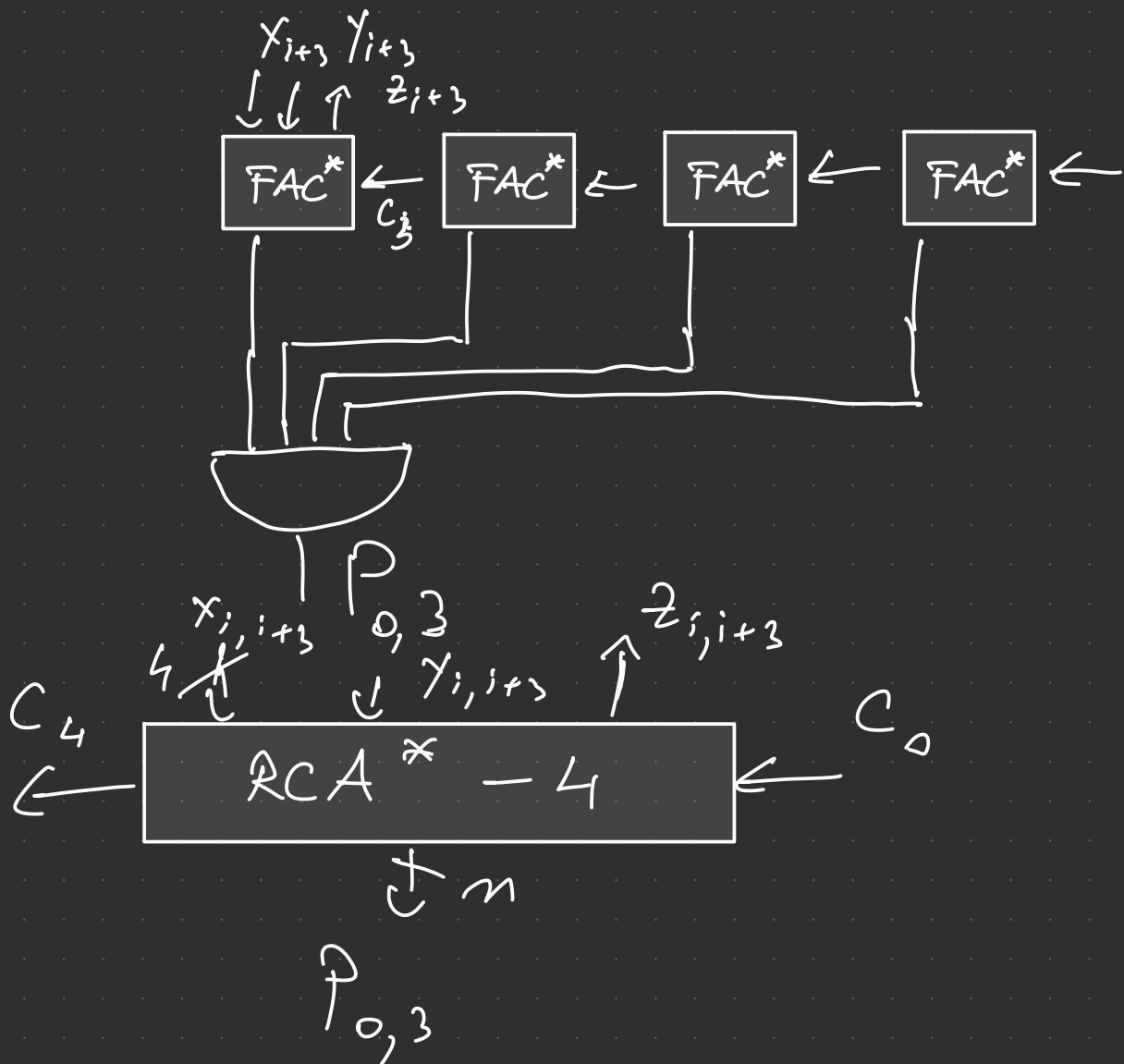
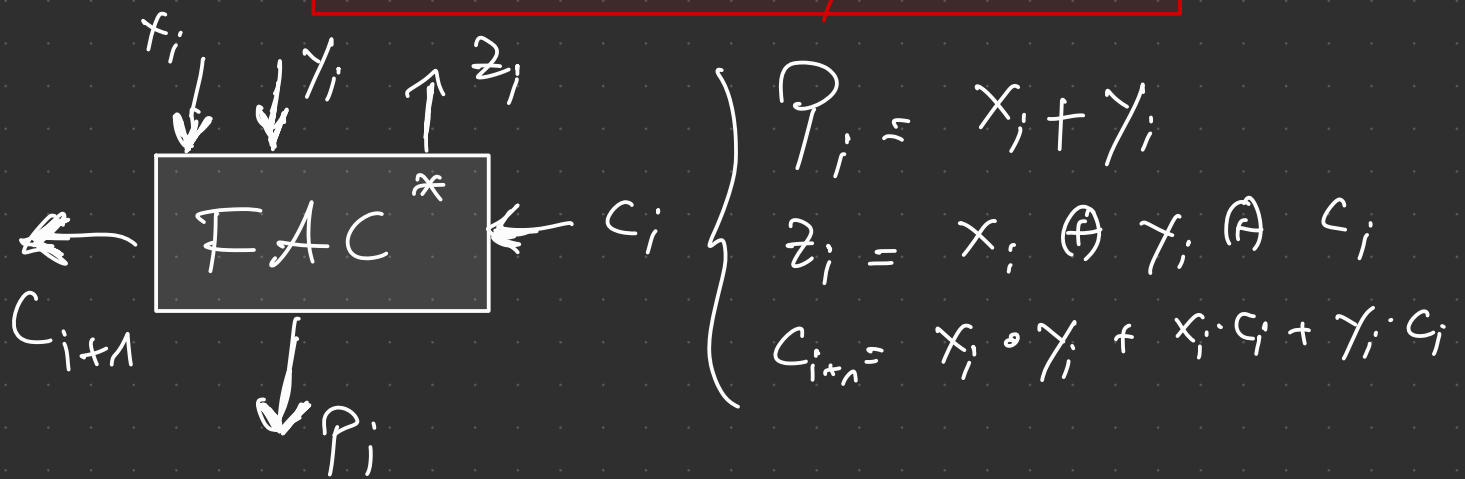
$z_i \rightarrow \Delta_{C_i} + 2d$

pt. B + C cell

Δ

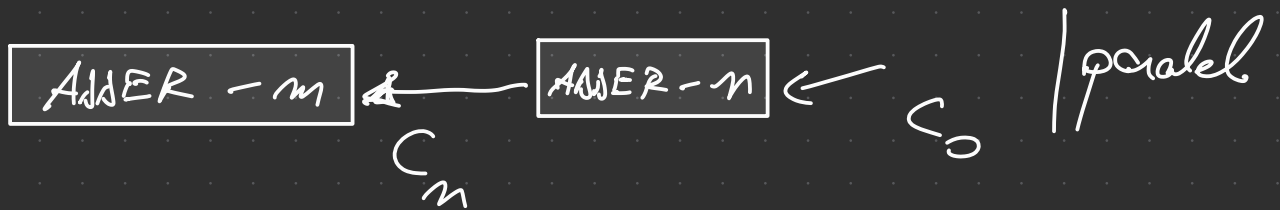
$$\Delta_{m2-CLA-4} = 9\Delta - 2 \lceil \lg_2 n \rceil d$$

Sumator Carry Skip



CMOS pre-discharge

→ toate semnalele carry vor fi
pre-descărcate (val. 0) înainte de
calcul



16 biti

