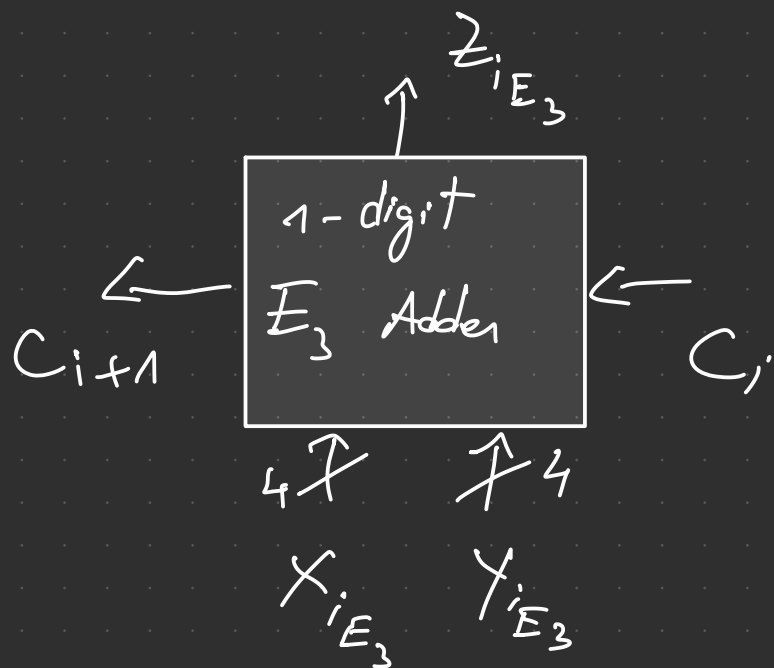
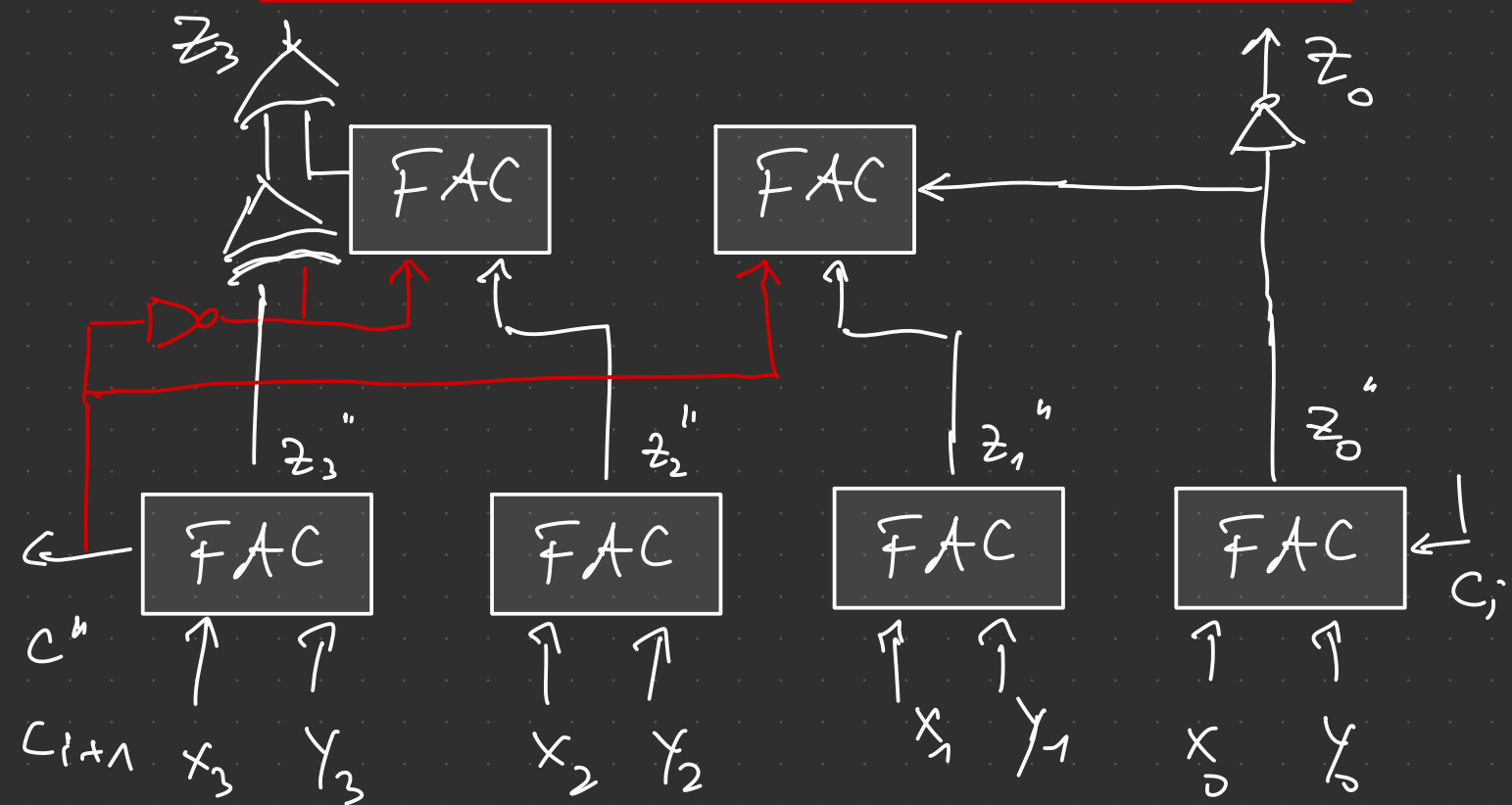


# Sumator tetradů exces de 3



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

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

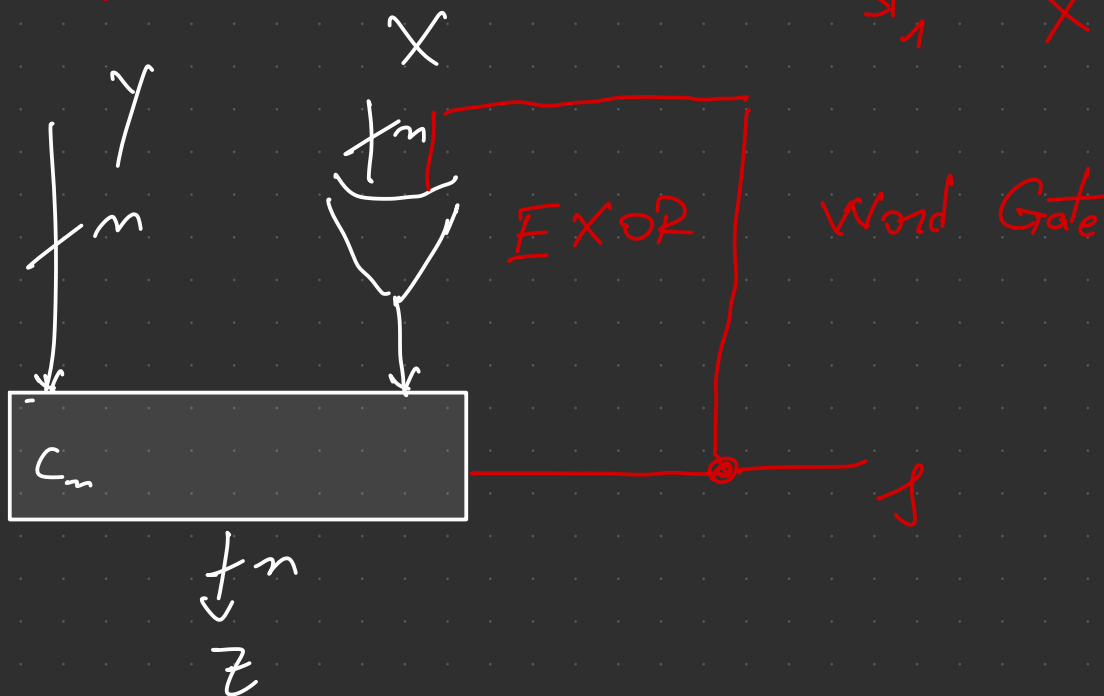
## Scăzătoare serială

$$Z = Y - X$$

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

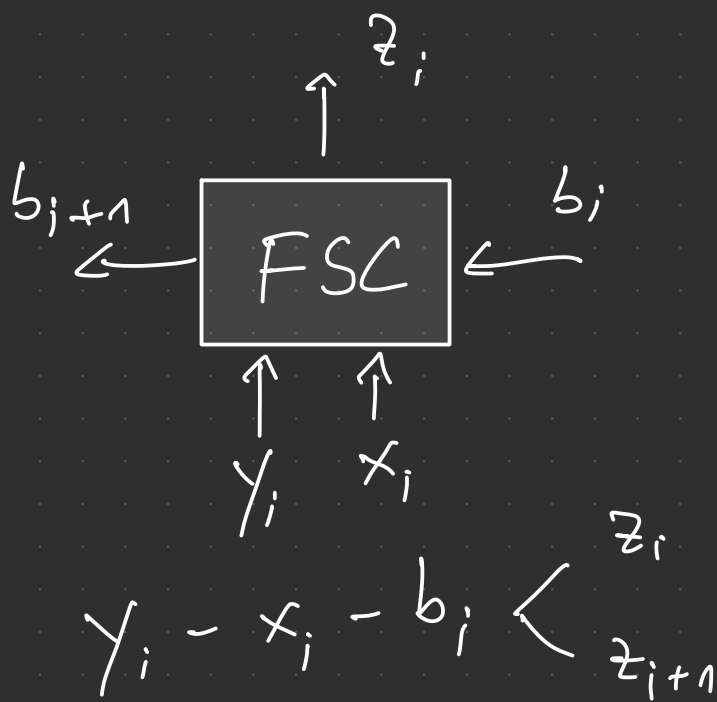
Adder Subtractor

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



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

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



$y_i$	$x_i$	$b_i$	$z_i$	$b_{i+1}$
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

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

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

## Subtractor BCD

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

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

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

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

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

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

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

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

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

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

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

$$x_i = x_3 x_2 x_1 x_0$$

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

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

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

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

pt.  $\Gamma_3 \rightarrow$

modificare 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

# Calcul paralel a sumei

Carry Look-Ahead  
pur teoretic

F-CLA

• semnale propagate / generate

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

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

$$C_4 = g_3 + p_3 C_3$$

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

$G_{0,3}$

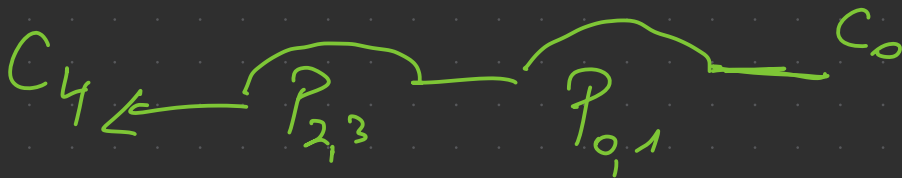
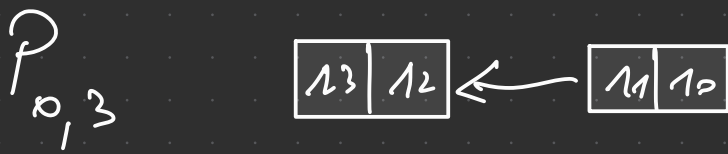
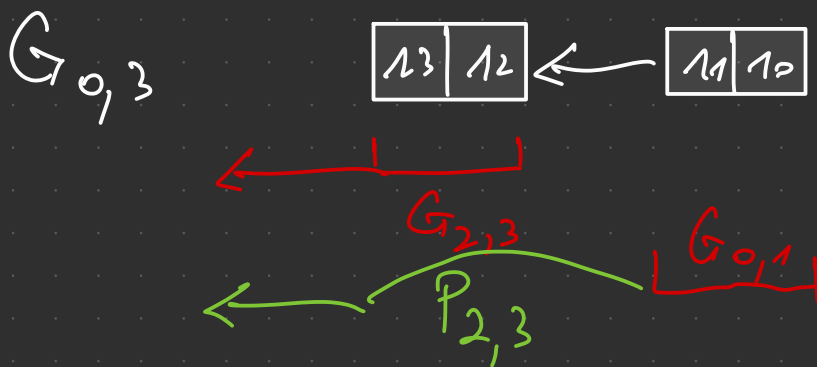
$$C_{i+1} = g_i + p_i C_i$$



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



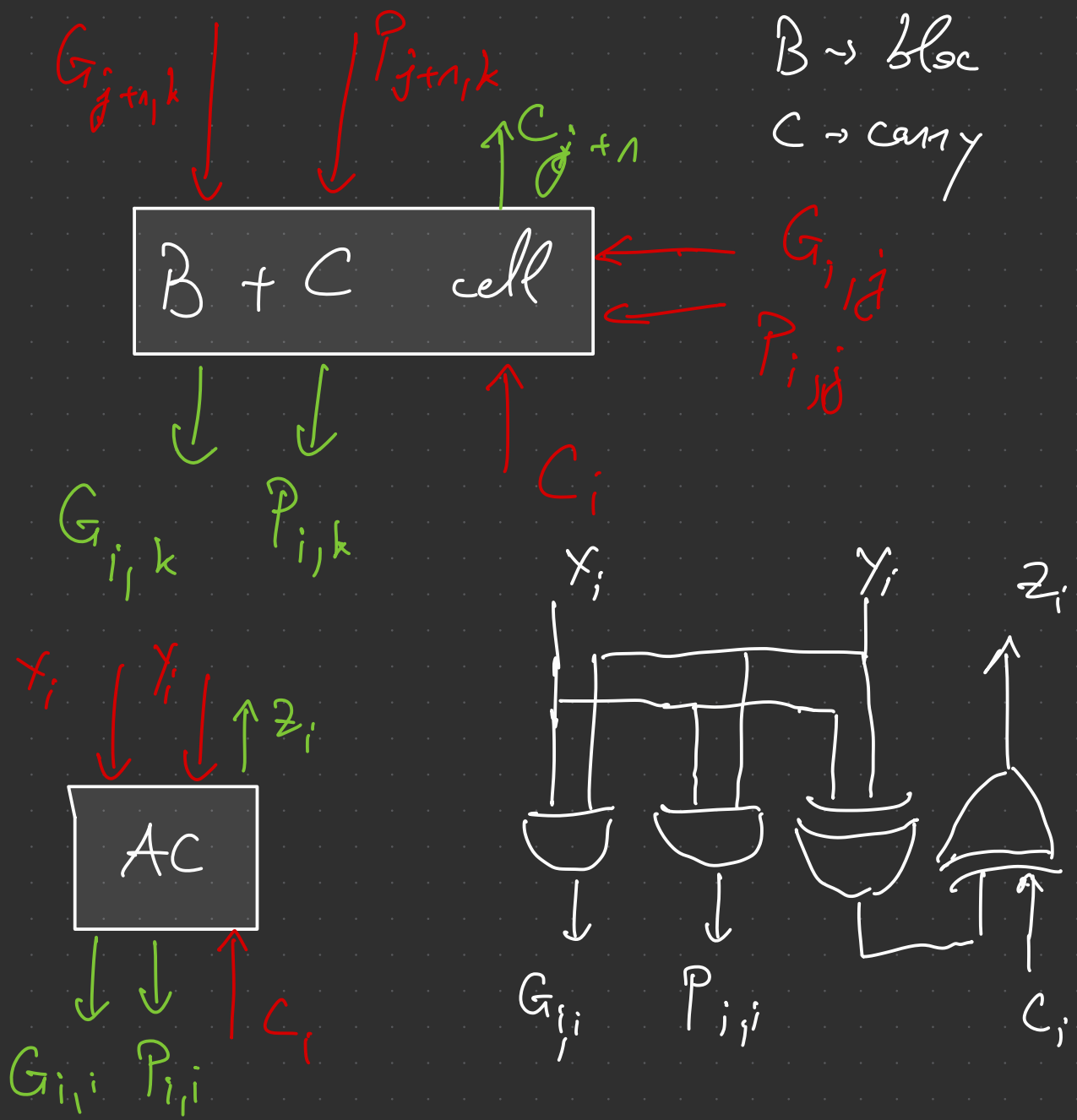
$$C_4 = g_3 + P_3 g_2 + P_3 P_2 (g_1 + P_1 g_0) + P_3 P_2 \cdot P_1 P_0 C_0$$



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

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

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



## 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

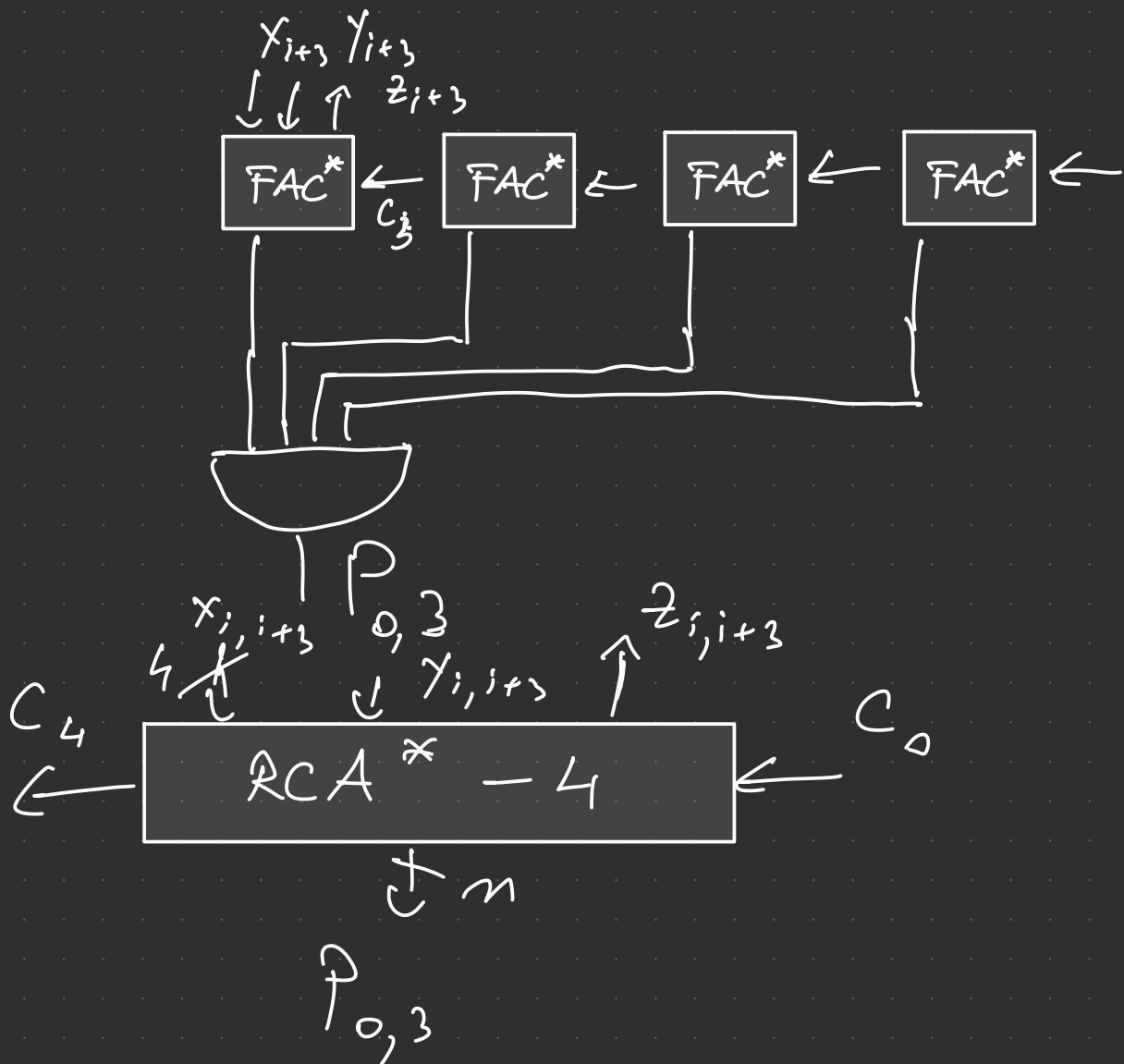
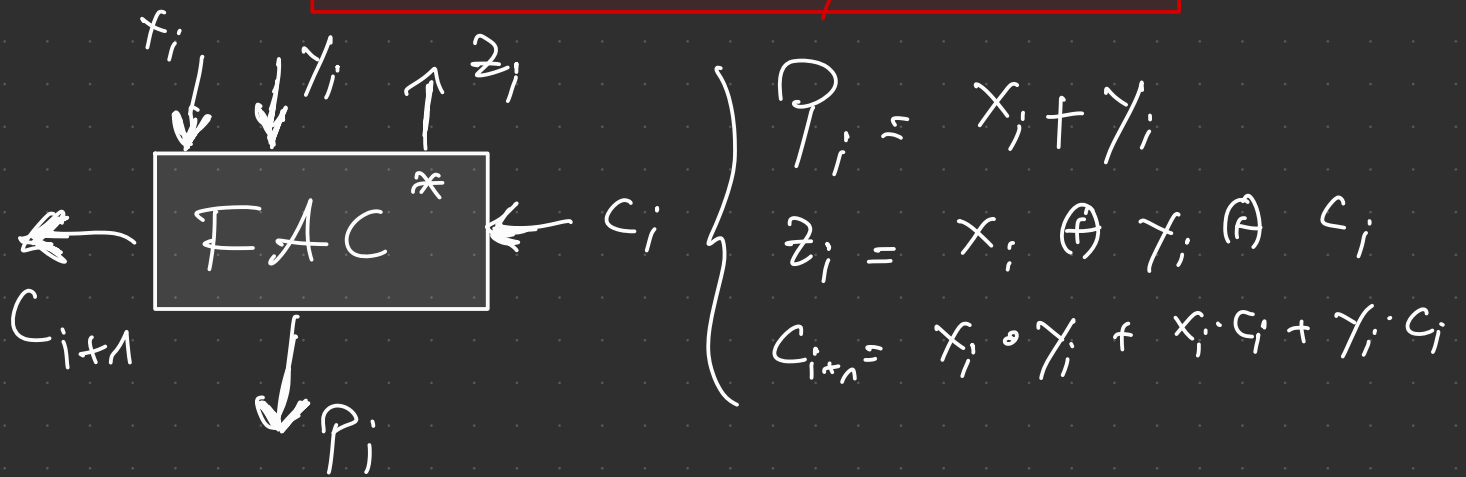
$\Delta$

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



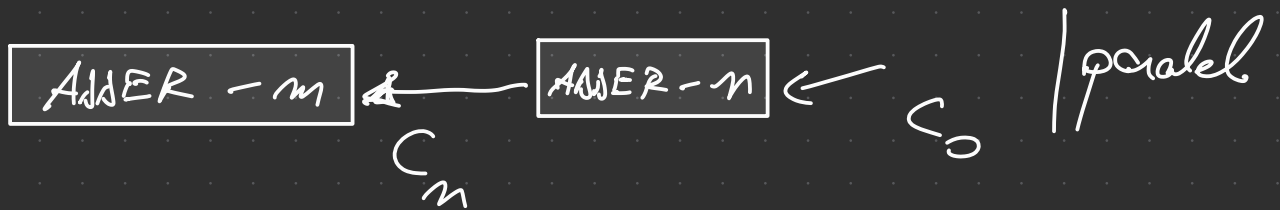


# Sumator Carry Skip



# CMOS pre-discharge

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



16 biti

