

# Sistemas Digitales

## Suma y Resta Digital

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# Suma Binaria

Tabla de la Suma

<i>X</i>	<i>Y</i>	<i>X+Y</i>
0	0	0
0	1	1
1	0	1
1	1	10

$$\begin{array}{r}
 X \quad 190 \\
 Y \quad + 141 \\
 \hline
 X+Y \quad 331
 \end{array}
 \quad
 \begin{array}{r}
 \phantom{+} 1 \ 0 \ 1 \ 1 \ 1 \ 1 \ 1 \ 0 \\
 + 1 \ 0 \ 0 \ 0 \ 1 \ 1 \ 0 \ 1 \\
 \hline
 1 \ 0 \ 1 \ 0 \ 0 \ 1 \ 0 \ 1 \ 1
 \end{array}$$

$$\begin{array}{r}
 X \quad 173 \\
 Y \quad + 44 \\
 \hline
 X+Y \quad 217
 \end{array}
 \quad
 \begin{array}{r}
 \phantom{+} 1 \ 0 \ 1 \ 0 \ 1 \ 1 \ 0 \ 1 \\
 + 0 \ 0 \ 1 \ 0 \ 1 \ 1 \ 0 \ 0 \\
 \hline
 1 \ 1 \ 0 \ 1 \ 1 \ 0 \ 0 \ 1
 \end{array}$$

# Suma Binaria

$$\begin{array}{r} \text{C} \\ \text{X} \quad 127 \\ + \text{Y} \quad + 63 \\ \hline \text{X+Y} \quad 190 \end{array}$$

$$\begin{array}{r} 011111110 \\ 01111111 \\ + 00111111 \\ \hline 10111110 \end{array}$$

$$\begin{array}{r} \text{C} \\ \text{X} \quad 170 \\ + \text{Y} \quad + 85 \\ \hline \text{X+Y} \quad 255 \end{array}$$
$$\begin{array}{r} 00000000 \\ 10101010 \\ + 01010101 \\ \hline 11111111 \end{array}$$

# Resta Binaria

Tabla de la Resta

X	Y	X+Y
0	0	0
0	1	-
1	0	1
1	1	0
10	1	01
100	1	011
1000	1	0111

Debe prestar 1, produciendo la nueva resta  $10 - 1 = 1$

Después del prime préstamo, la nueva resta para esta columna es  $0 - 1$  prestar 1, de modo que debemos prestar de nuevo

El préstamo se repite a través de tres columnas para llegar a un 1 transportable, es decir,  $100 - 1 = 011$  (los bits modificados) +1 (el préstamo)

minuend    X    229  
 subtrahend    Y    - 46  
 difference    X - Y    183

$$\begin{array}{r}
 \phantom{0} 10 \phantom{1} \phantom{1} 10 \phantom{10} \\
 1 \phantom{1} \phantom{1} \phantom{1} \phantom{0} \phantom{0} \phantom{1} \phantom{1} \phantom{1} \phantom{0} \phantom{1} \\
 - 0 \phantom{0} \phantom{0} \phantom{1} \phantom{0} \phantom{1} \phantom{1} \phantom{1} \phantom{1} \phantom{0} \\
 \hline
 1 \phantom{0} \phantom{1} \phantom{1} \phantom{1} \phantom{0} \phantom{1} \phantom{1} \phantom{1} \phantom{1}
 \end{array}$$

X    210  
 Y    - 109  
 X - Y    101

$$\begin{array}{r}
 \phantom{0} 10 \phantom{10} \phantom{0} \phantom{1} 10 \phantom{0} 10 \\
 1 \phantom{1} \phantom{1} \phantom{0} \phantom{1} \phantom{0} \phantom{0} \phantom{1} \phantom{0} \\
 - 0 \phantom{1} \phantom{1} \phantom{0} \phantom{1} \phantom{1} \phantom{0} \phantom{1} \phantom{0} \phantom{1} \\
 \hline
 0 \phantom{1} \phantom{1} \phantom{0} \phantom{0} \phantom{0} \phantom{1} \phantom{0} \phantom{1}
 \end{array}$$

# Resta Binaria

$$\begin{array}{r} \text{C} \\ \text{X} \quad 170 \\ + \text{Y} \quad + 85 \\ \hline \text{X+Y} \quad 85 \end{array}$$

$$\begin{array}{r} 010101010 \\ 10101010 \\ + 01010101 \\ \hline 01010101 \end{array}$$

$$\begin{array}{r} \text{C} \\ \text{X} \quad 221 \\ + \text{Y} \quad + 76 \\ \hline \text{X+Y} \quad 145 \end{array} \quad \begin{array}{r} 000000000 \\ 11011101 \\ + 01001100 \\ \hline 10010001 \end{array}$$

# Suma Binaria

$X$	$Y$	$Cin$	$S$	$Cout$
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

$$S = \bar{X} \cdot \bar{Y} \cdot Cin + \bar{X} \cdot Y \cdot \overline{Cin} + X \cdot \bar{Y} \cdot \overline{Cin} + X \cdot Y \cdot Cin$$

$$S = (\bar{X} \cdot \bar{Y} + X \cdot Y) \cdot Cin + (\bar{X} \cdot Y + X \cdot \bar{Y}) \cdot \overline{Cin}$$

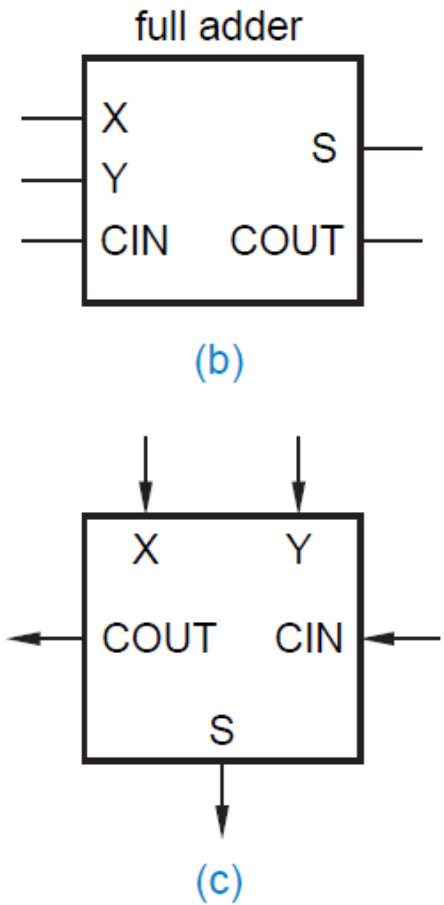
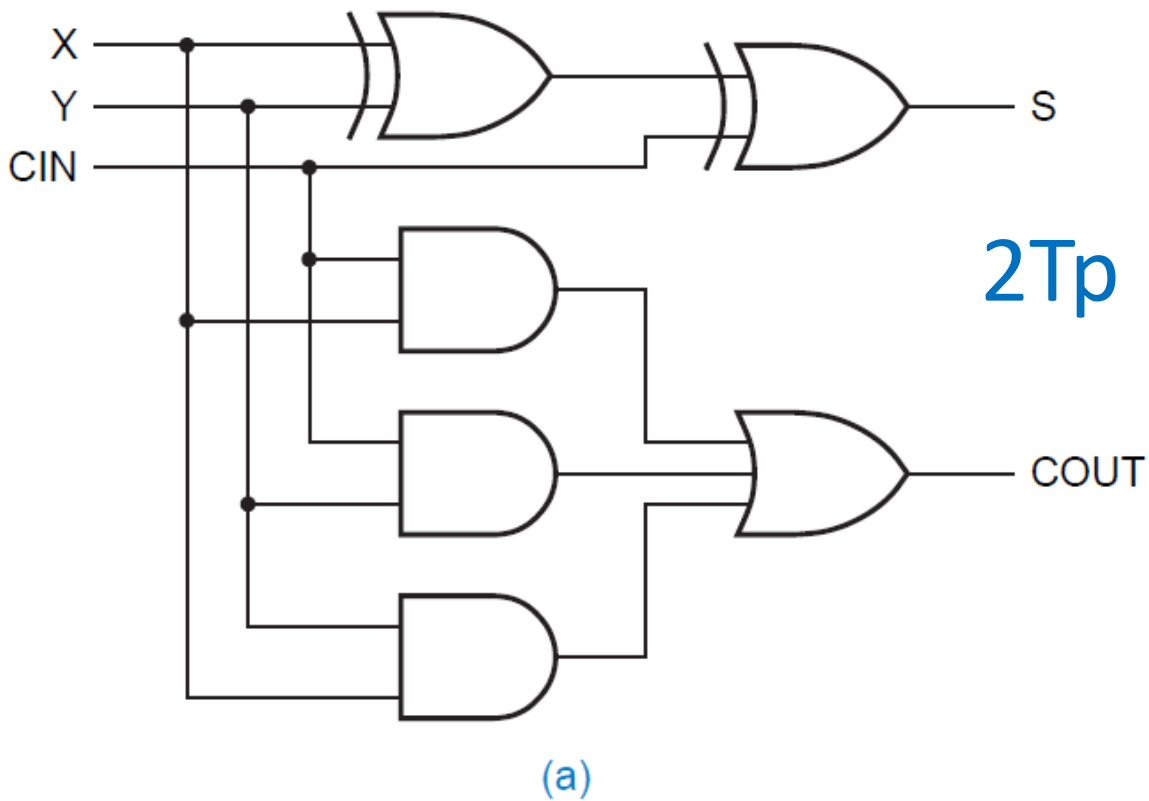
$$S = (\overline{X \oplus Y}) \cdot Cin + (X \oplus Y) \cdot \overline{Cin}$$

$$S = X \oplus Y \oplus Cin$$

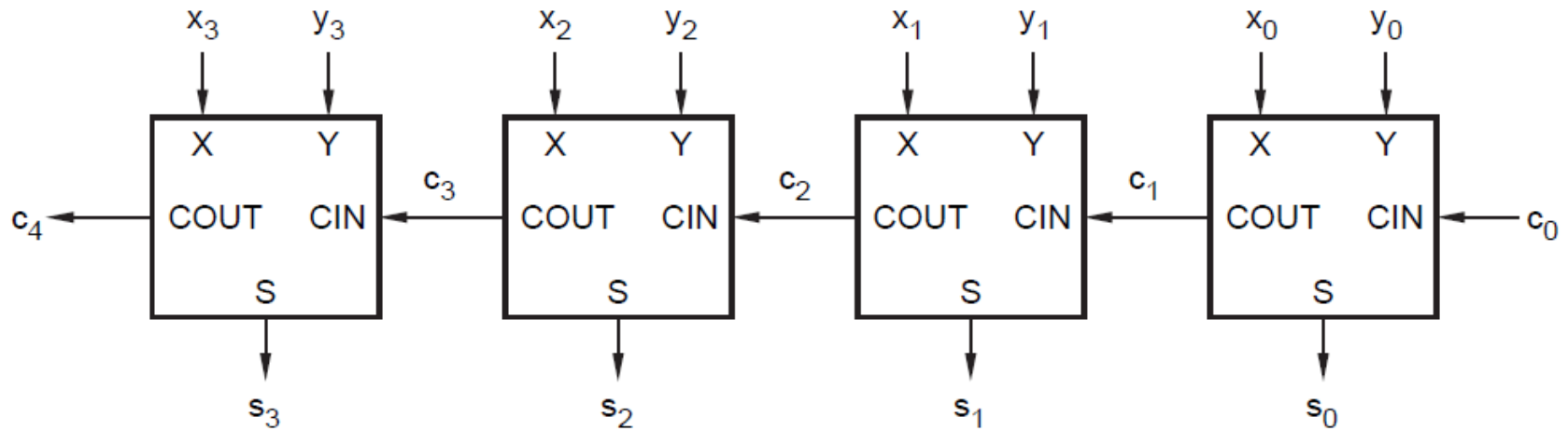
$$Cout = \bar{X} \cdot Y \cdot Cin + X \cdot \bar{Y} \cdot Cin + X \cdot Y \cdot \overline{Cin} + X \cdot Y \cdot Cin$$

$$Cout = Y \cdot Cin + X \cdot Cin + X \cdot Y$$

# Suma Binaria



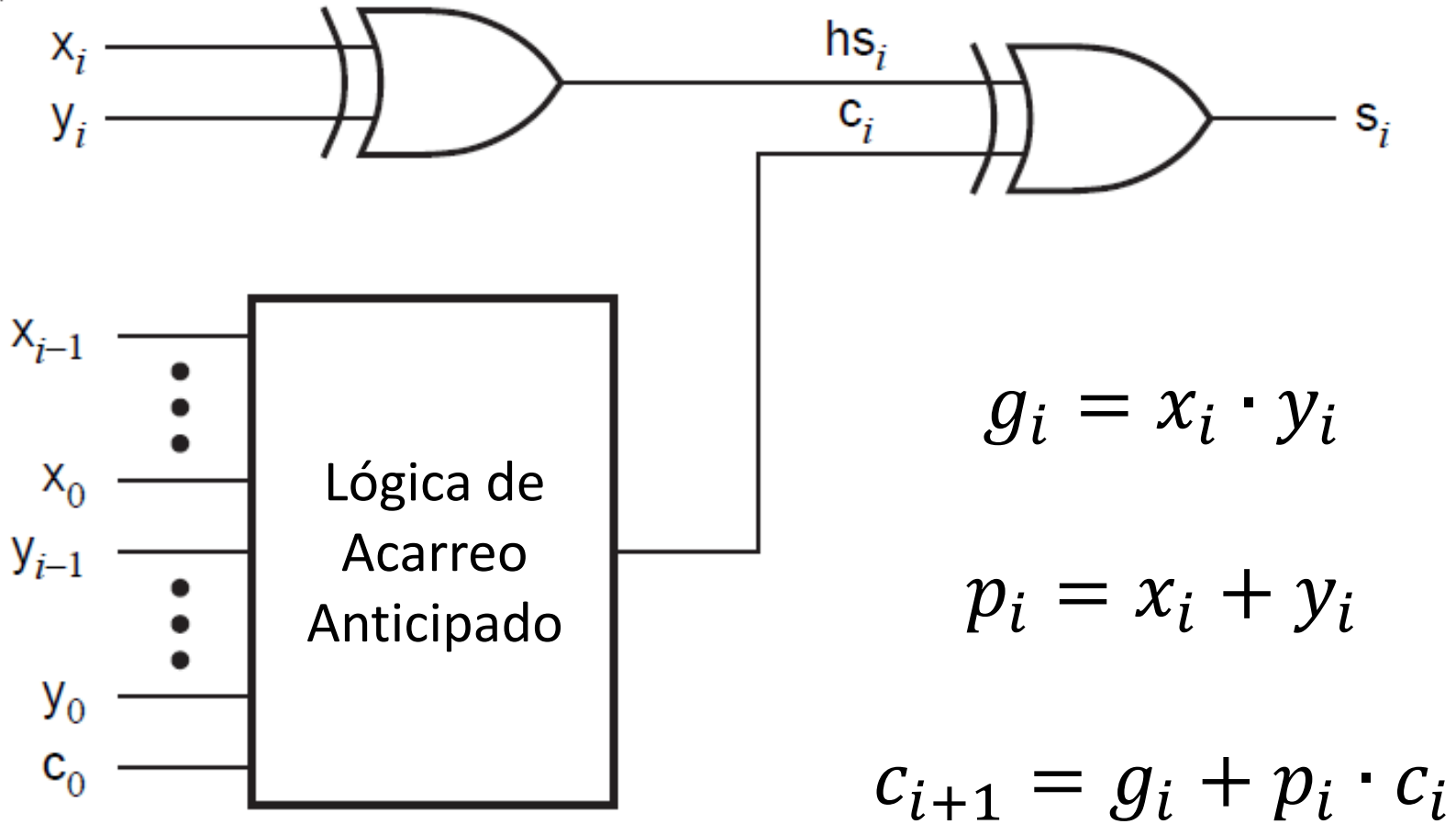
# Suma Binaria



$$2T_p + 2T_p + 2T_p + 2T_p = 8T_p$$



# Suma Binaria



# Suma Binaria

$$c_1 = g_0 + p_0 \cdot c_0$$

$$c_2 = g_1 + p_1 \cdot c_1 = g_1 + p_1 \cdot (g_0 + p_0 \cdot c_0)$$

$$c_2 = g_1 + p_1 \cdot g_0 + p_1 \cdot p_0 \cdot c_0$$

$$c_3 = g_2 + p_2 \cdot c_2 = g_2 + p_2 \cdot (g_1 + p_1 \cdot g_0 + p_1 \cdot p_0 \cdot c_0)$$

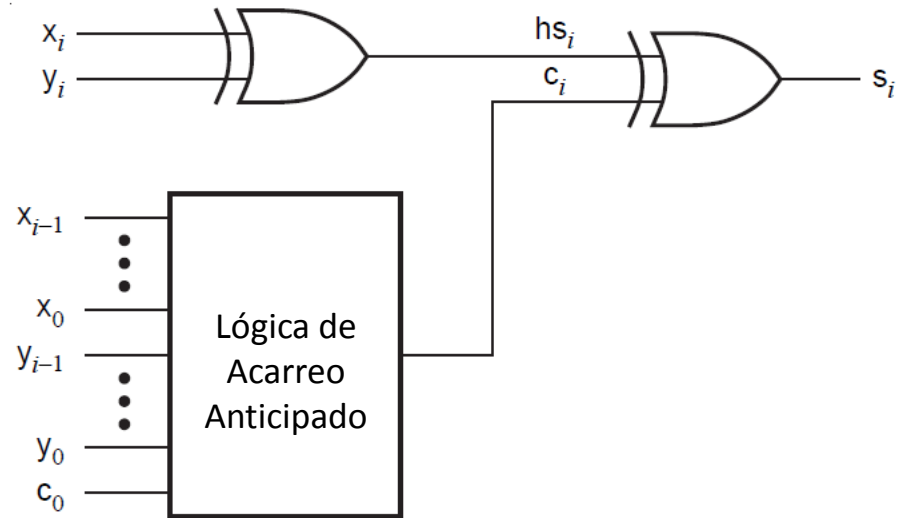
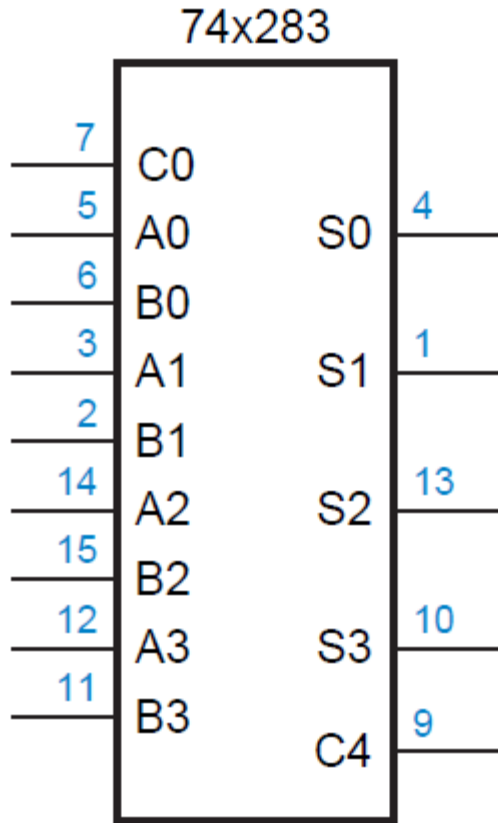
$$c_3 = g_2 + p_2 \cdot g_1 + p_2 \cdot p_1 \cdot g_0 + p_2 \cdot p_1 \cdot p_0 \cdot c_0$$

$$c_4 = g_3 + p_3 \cdot c_3$$

$$c_4 = g_3 + p_3 \cdot (g_2 + p_2 \cdot g_1 + p_2 \cdot p_1 \cdot g_0 + p_2 \cdot p_1 \cdot p_0 \cdot c_0)$$

$$c_4 = g_3 + p_3 \cdot g_2 + p_3 \cdot p_2 \cdot g_1 + p_3 \cdot p_2 \cdot p_1 \cdot g_0 \\ + p_3 \cdot p_2 \cdot p_1 \cdot p_0 \cdot c_0$$

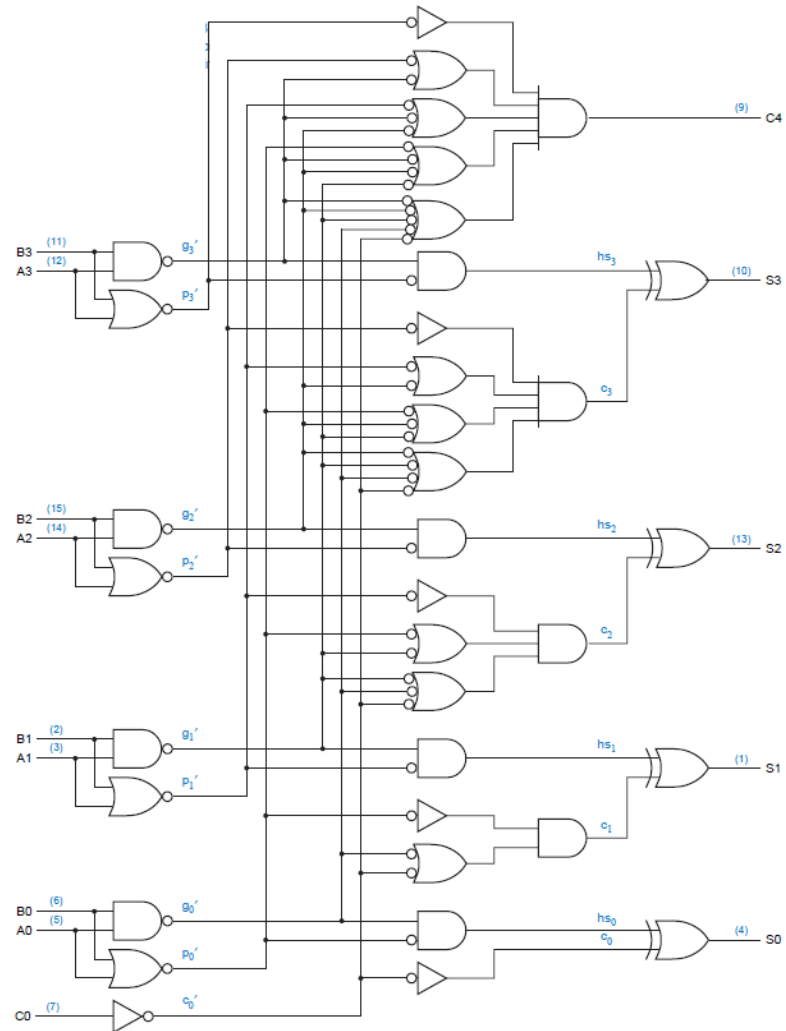
# Suma Binaria



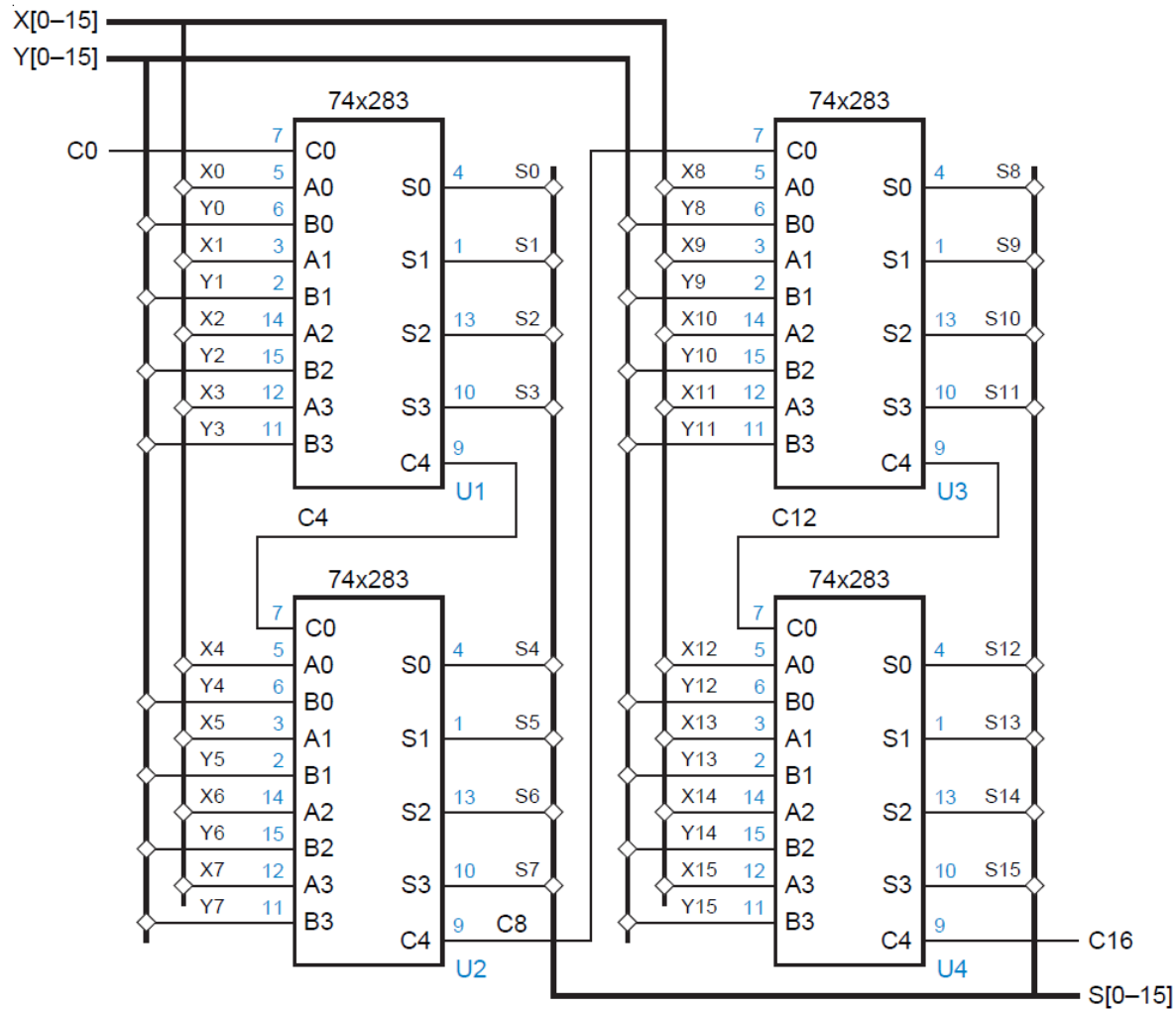
$$g_i, p_i \quad c_i$$

$$1TP \quad + \quad 2TP \quad + \quad 1TP \quad = \quad 4TP$$

# Suma Binaria



# Suma Binaria



# Suma Binaria con signo

$$\begin{array}{r} +3 \quad 0011 \\ + +4 \quad + 0100 \\ \hline +7 \quad 0111 \end{array}$$

$$\begin{array}{r} -2 \quad 1110 \\ + -6 \quad + 1010 \\ \hline -8 \quad 11000 \end{array}$$

Se descarta

$$\begin{array}{r} +6 \quad 0110 \\ + -3 \quad + 1101 \\ \hline +3 \quad 10011 \end{array}$$

$$\begin{array}{r} +4 \quad 0100 \\ + -7 \quad + 1001 \\ \hline -3 \quad 1101 \end{array}$$

# Desborde

$$\begin{array}{r} -3 \quad 1101 \\ + -6 \quad + 1010 \\ \hline -9 \quad 10111 = +7 \end{array}$$

$$\begin{array}{r} +5 \quad 0101 \\ + +6 \quad + 0110 \\ \hline +11 \quad 1011 = -5 \end{array}$$

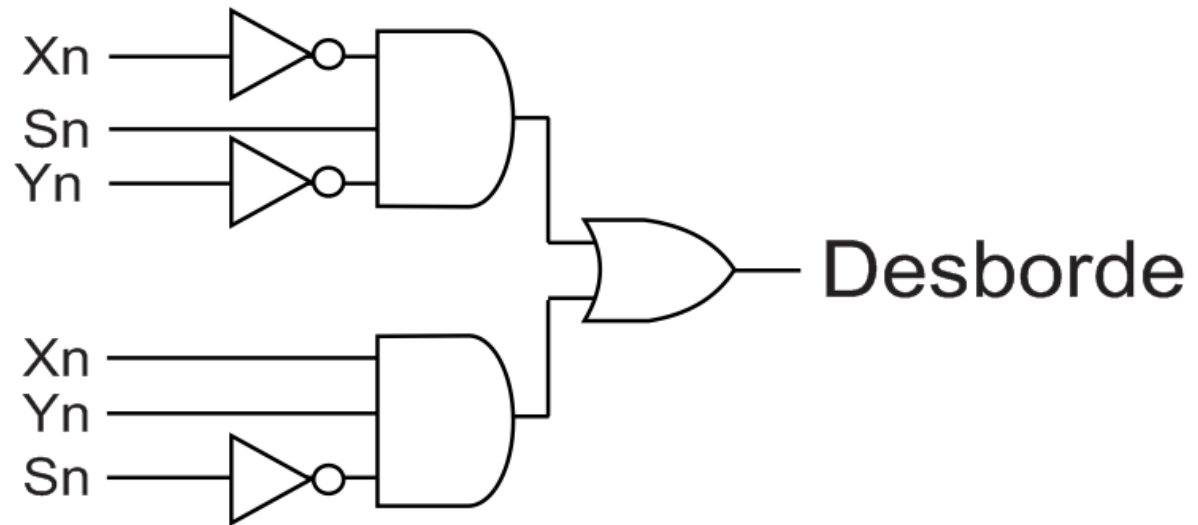
Se descarta

$$\begin{array}{r} -8 \quad 1000 \\ + -8 \quad + 1000 \\ \hline -16 \quad 10000 = 0 \end{array}$$

$$\begin{array}{r} +7 \quad 0111 \\ + +7 \quad + 0111 \\ \hline +14 \quad 1110 = -2 \end{array}$$

# Desborde

- Si los signos son distintos  $\rightarrow$  no se produce desborde
- Si los signos son iguales y el signo del resultado no es igual que el de los operandos  $\rightarrow$  se produce desborde





# Resta Binaria con signo

$$\begin{array}{r}
 +3 \quad 0011 \\
 - +4 \quad - 0100 \\
 \hline
 -1
 \end{array}
 \qquad
 \begin{array}{r}
 \phantom{+3} \quad 0011 \\
 + 1011 \\
 \hline
 1111
 \end{array}$$

**Complemento**

- Cambio 0 por 1 y viceversa
- Sumar 1

**Ejemplo**

$$+4 = 0100$$

$$-4 = 1011 + 1 = 1100$$

$$\begin{array}{r}
 +3 \quad 0011 \\
 - -4 \quad - 1100 \\
 \hline
 +7
 \end{array}
 \qquad
 \begin{array}{r}
 \phantom{+3} \quad 0011 \\
 + 0011 \\
 \hline
 0111
 \end{array}$$

# Resta Binaria con signo

$$\begin{array}{r} +4 \quad 0100 \\ - +3 \quad - 0011 \\ \hline +1 \end{array} \quad \begin{array}{r} \phantom{+4} \quad 0100 \\ + 1100 \\ \hline 10001 \end{array}$$

$$\begin{array}{r} -3 \quad 1101 \\ - -4 \quad + 1100 \\ \hline +1 \end{array} \quad \begin{array}{r} \phantom{-3} \quad 1101 \\ 0011 \\ \hline 10001 \end{array}$$

Se descarta

# Resta Binaria con signo

