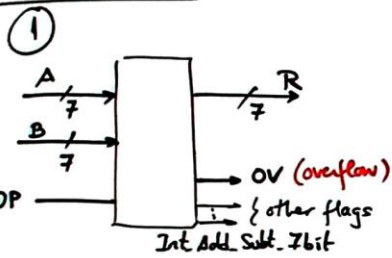
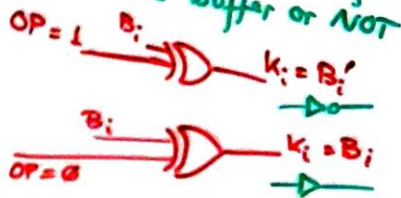
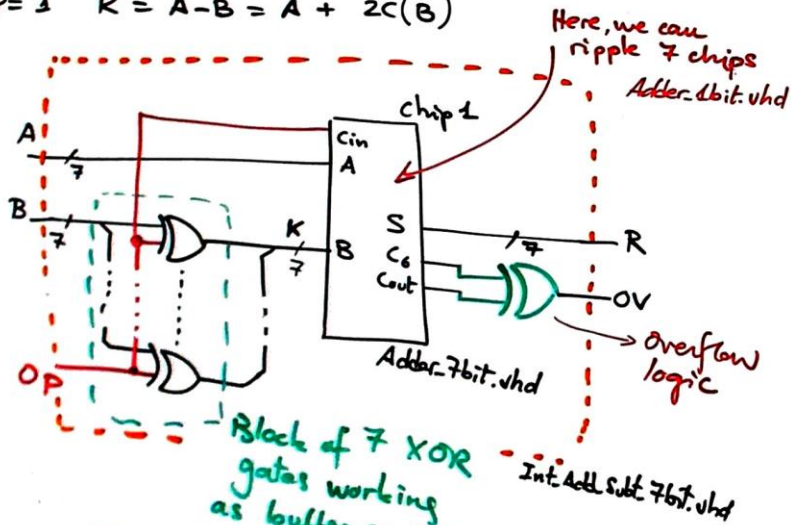


Problem 2



OP = '0' R = A + B

OP = '1' R = A - B = A + 2C(B)



② Range of 7-bit integers

$$-2^{N-1} \leq A, B, R \leq +2^{N-1} - 1$$

$$-64 \leq A, B, R \leq +63$$

$$OV = C_{out} \oplus C_6$$

when adding $S = A + k$, if $C_{out} \neq C_6 \Rightarrow OV = 1$

③ Example operations using the circuit:

a) $A = (+41)_{10} = [010101001]_2$

$B = ([10001010]_{2c}) = (-54)$

$$\begin{array}{r} 0110101 \\ + 1 \\ \hline 0110110 \end{array} = +54$$

b)

$A = ([0110110]_{2c}) = +54$

$B = (-55)$

$$[0110111] = +55$$

$$[1001000] = -55$$

$$\begin{array}{r} 1001001 \\ + 1 \\ \hline 1001001 \end{array} = -55$$

c) $A = +18$

$B = ([1101110]_{2c}) = -18$

$$\begin{array}{r} 0010001 \\ + 1 \\ \hline 0010010 \end{array} = +18$$

$R = A + B = + [0101001] + [1001010]$

$$\begin{array}{r} 0101001 \\ + 1001010 \\ \hline 1110011 \\ \text{OV} = 0 \end{array} = -13$$

$R = A - B = [0110110] - [1101110]$

$$\begin{array}{r} 0110110 \\ - 1101110 \\ \hline 1011000 \\ \text{negative number X} \end{array}$$

overflow +106 > +53

wrong result $OV = 1 = C_7 \oplus C_6$

$R = A + B$

$$\begin{array}{r} 0010010 \\ + 1101110 \\ \hline 0000000 \\ \text{OV} = 0 \end{array} R = 0$$

d) $A = (-29)_{10}$

$B = (0110110)_2 = (+54)_{10}$

$0011101 = +29$

1100010

$1100011 \rightarrow -29$

1001001

$1001010 \rightarrow (-54)$

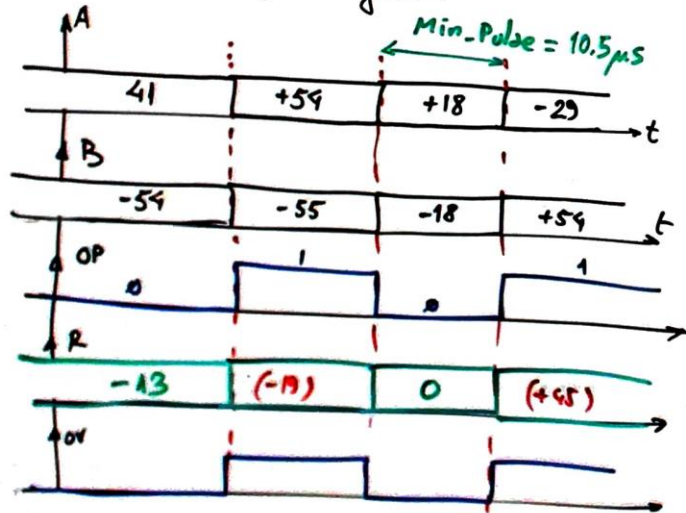
$R = A - B$

$-29 - 54 = -83 < -64 !!$
out of range

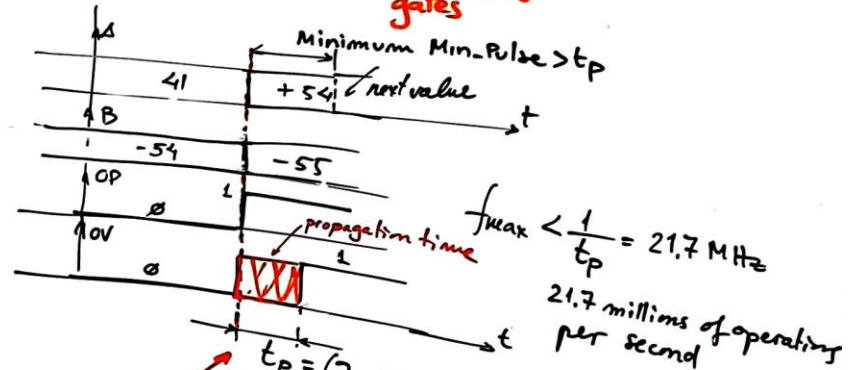
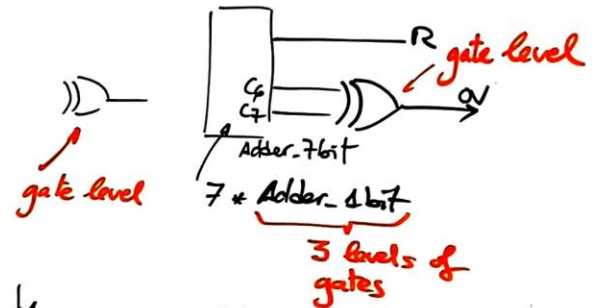
1100011
 $+ 1001010$
 0101101

$OV = C_6 \oplus C_5 = 1$
wrong result (+45)

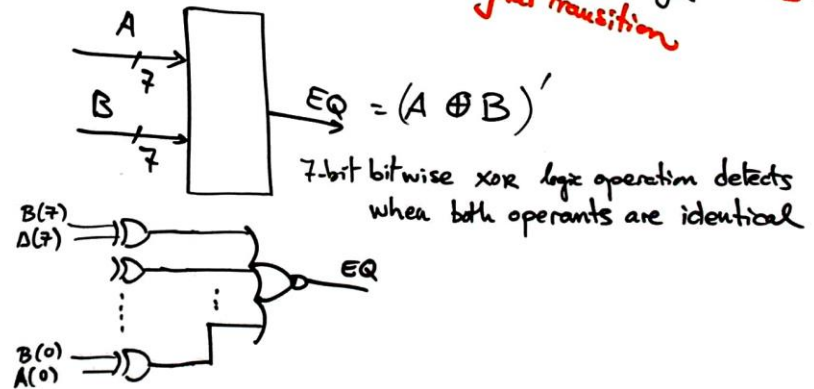
4) Running all the test requires $2^{15} * \text{Min. Pulse} = 344 \text{ms}$
Example of timing diagram



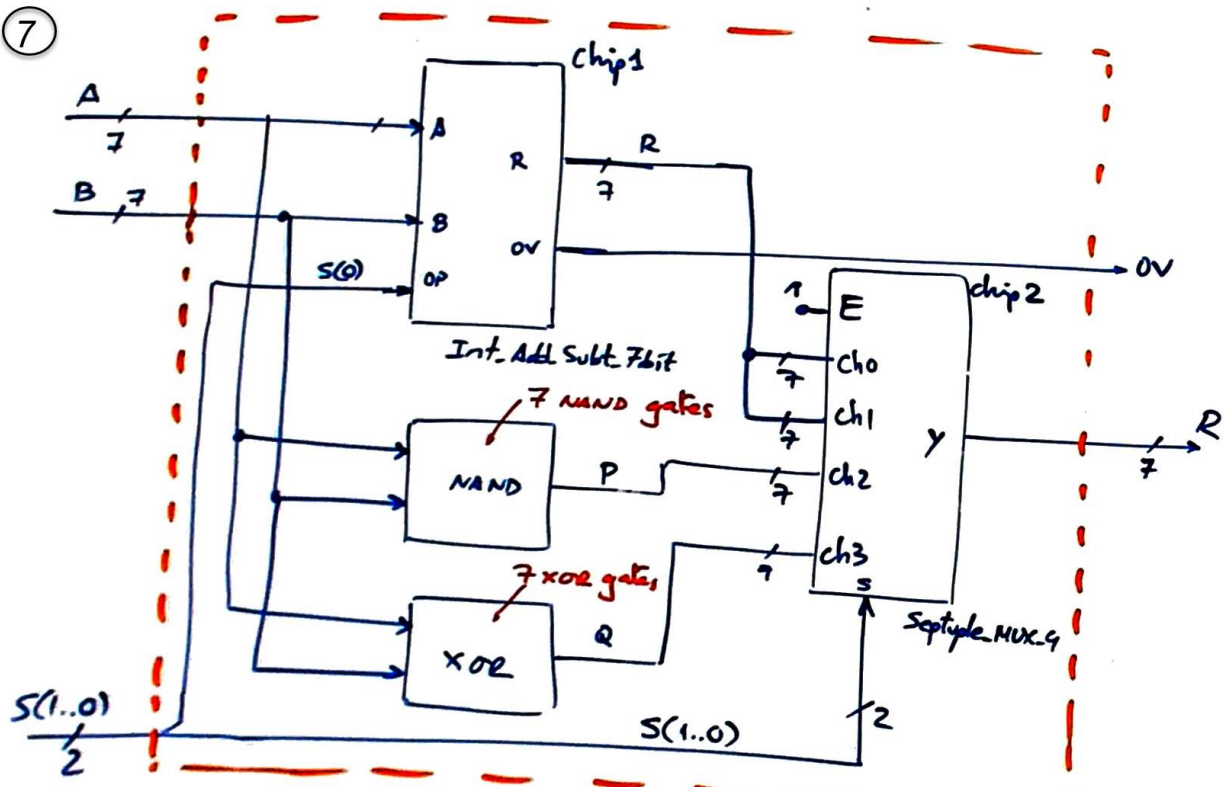
5) Circuit's speed of computing



6) $t_p = (2 + 7 \cdot 3) \cdot t_{p, \text{gate}} = 46 \text{ns}$
example in a signal transition



7



ALU-7bit

when $S=00 \rightarrow R = A+B$
 $S=01 \rightarrow R = A-B$
 $S=10 \rightarrow R = A \text{ NAND } B$ (or = x)
 $S=11 \rightarrow R = A \text{ XOR } B$ (or = x)

