

CSD laboratory P\_Ch1: 9-bit arithmetic and logic unit

Operations. Let us apply an example input vector, and determine the ALU\_9bit outputs as if we were applying circuit's truth table. This kind of outputs have to be checked using a VHDL testbench.

Example of calculations

A = 101100110

B = 011011110

1) sel = 0 (00) 9-bit radix-2 addition

A = (358)<sub>10</sub> = (101100110)<sub>2</sub> = (166)<sub>16</sub>  
 B = (222)<sub>10</sub> = (011011110)<sub>2</sub> = (DE)<sub>16</sub>

= (580)<sub>10</sub> = (1001000100)<sub>2</sub>  
 (Red bracket under 001000100 labeled 'R', and 'Out' below it)  
 OV = 'x' Z = '0'

2) sel = 1 (01) 9-bit radix-2 comparison

A = (358)<sub>10</sub>  
 B = (222)<sub>10</sub>

R = 100000000  
 (Red boxes around 1, 0, 0, 0)  
 GT (A > B) EQ LT

Cout = 'x'; OV = 'x'; Z = '0'  
 always 0 when comparator

3) sel = 2 (10) 9-bit 2C addition

A = 101100110 = (-154)  
 B = 011011110 = (+222)

fsb  
 A + B

(+68) =

Cout = X  
 OV = 0  
 Z = 0

(Red bracket under 01000100 labeled 'R', and '9B' above it)

Example of calculations

$$A = 101100110$$

$$B = 011011110$$

4) Sel = 3 (11) 9-bit 2C subtraction

$$A = \boxed{1}01100110 = (-154)$$

$$B = \boxed{0}11011110 = (+222)$$

↑ SB

A - B

$$\underline{\hspace{10em}} (-376)$$

Operation range  $-2^8 \leq A, B, R \leq 2^8 - 1$   
 $-256 \leq R \leq 255$

overflow

↳ OUT of RANGE → OV = 1  
 Z = X  
 Cout = X

$$\begin{array}{r} + \boxed{1}01100110 \\ + \boxed{1}00100010 \\ \hline 1\boxed{0}10001000 \\ \text{↑ SB} \end{array}$$

→ error

R → 9-bit 2C wrong result

The calculator generates (+136) that is wrong