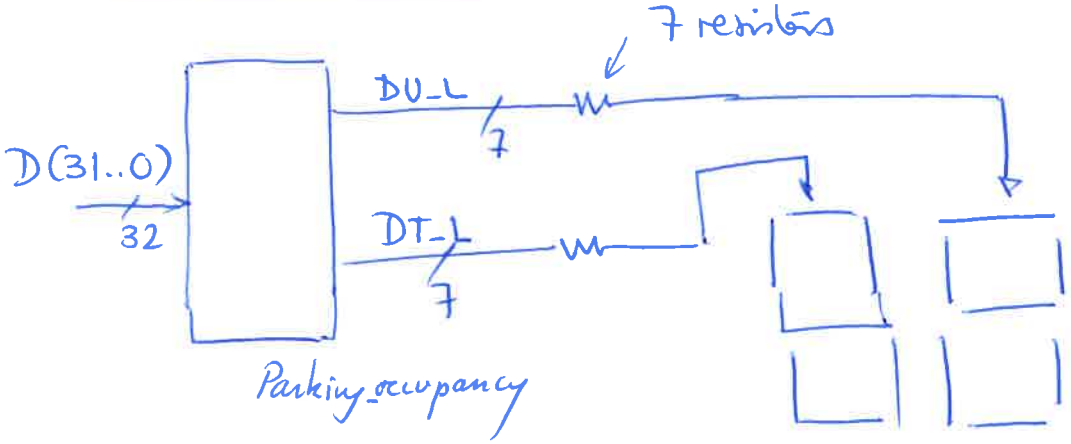
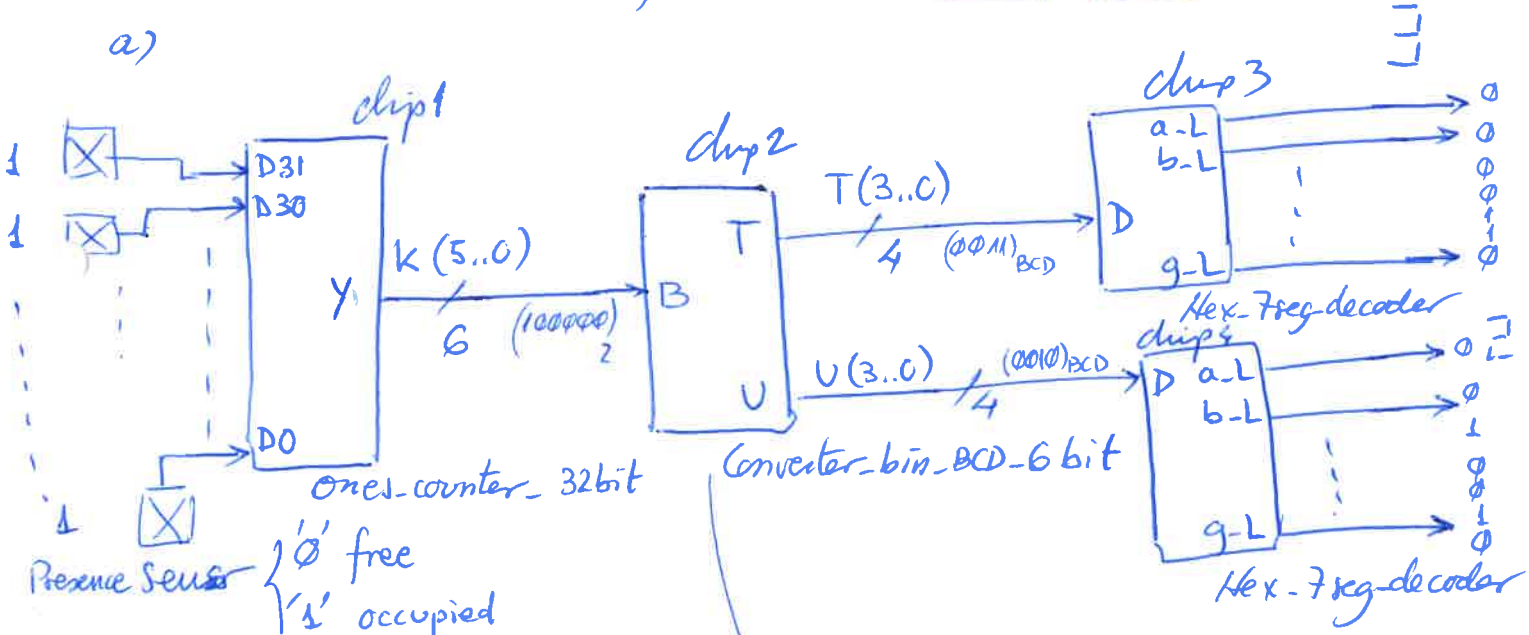
Problem 2 discussion



a)



D31 . . . . DO	K(5.0)
1010 11 . . . 0101	001100
12 '1'	
11 1	100000
32 '1'	
00 0	000000
32 '0'	

↑ Counting the number of '1' without considering their position

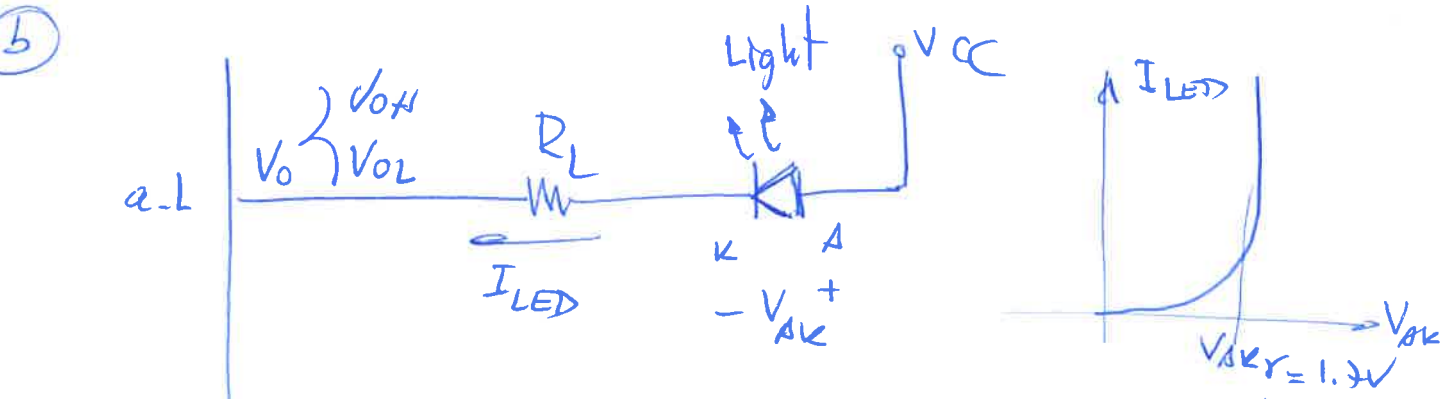
Tens B	Units T . U
001100	0001 ; 0010
011111	0011 ; 0001
100000	0011 ; 0010
000111	0000 ; 0111

Translating from binary to BCD

from Hex to 7-seg active low

D	a_L b_L . . . . g_L
0111	0 0 0 1 1 1 1
⋮	
1001	0 0 0 1 1 0 0
⋮	
0001	1 0 0 1 1 1 1

(b)



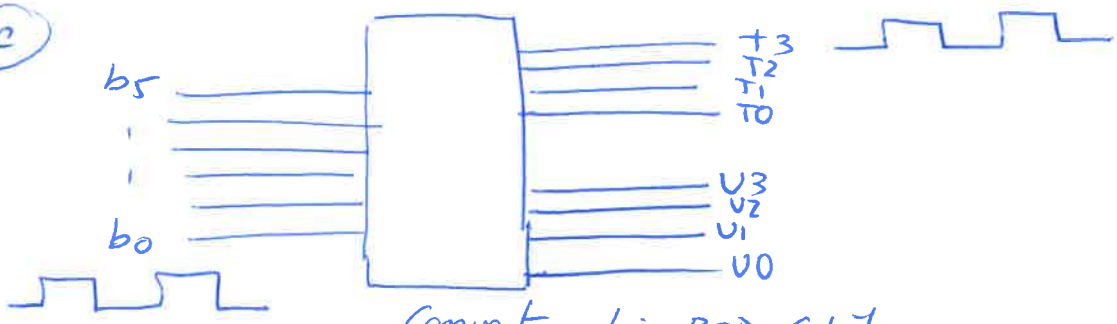
BCD outputs
Hex-7 segment

$$V_{CC} = I_{LED} \cdot R_L + V_{AK} + V_{O_L\,max}$$

$$R_L = \frac{V_{CC} - V_{AK} - V_{O_L\,max}}{I_{LED}}$$

$$R_L = \frac{5V - 1.7V - 0.4V}{15\,mA} = \underline{193\,\Omega}$$

(c)



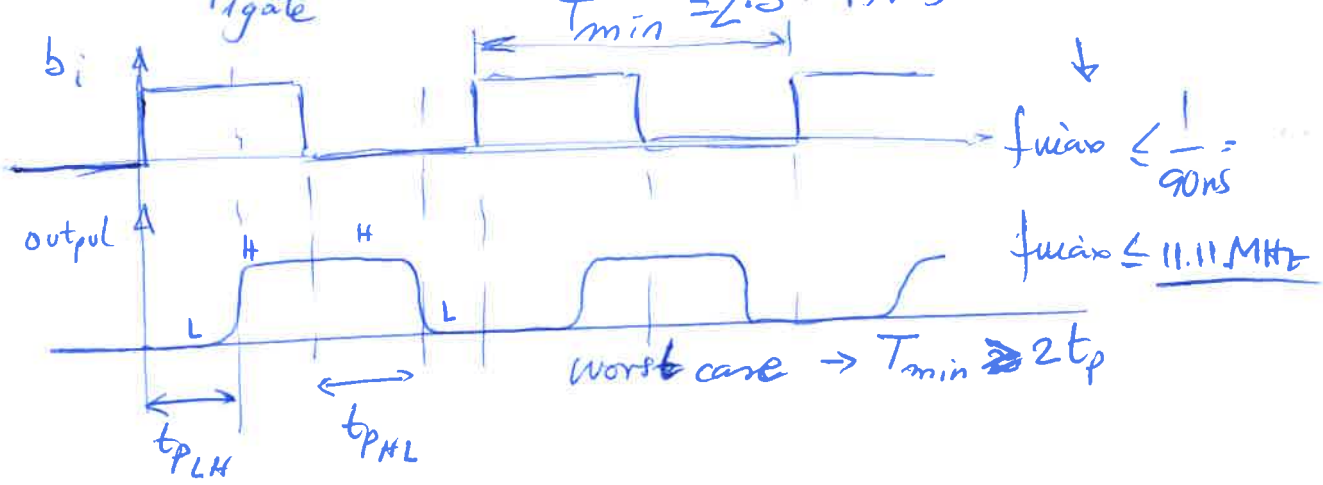
Converter_bin_BCD_6bit

↑ changing inputs means changing outputs after a delay

PoS → equations → 3-levels of gate

$t_p = 3 \cdot t_{p_{1gate}}$

$T_{min} = 2.3 \cdot 15ns = 45ns \times 2$

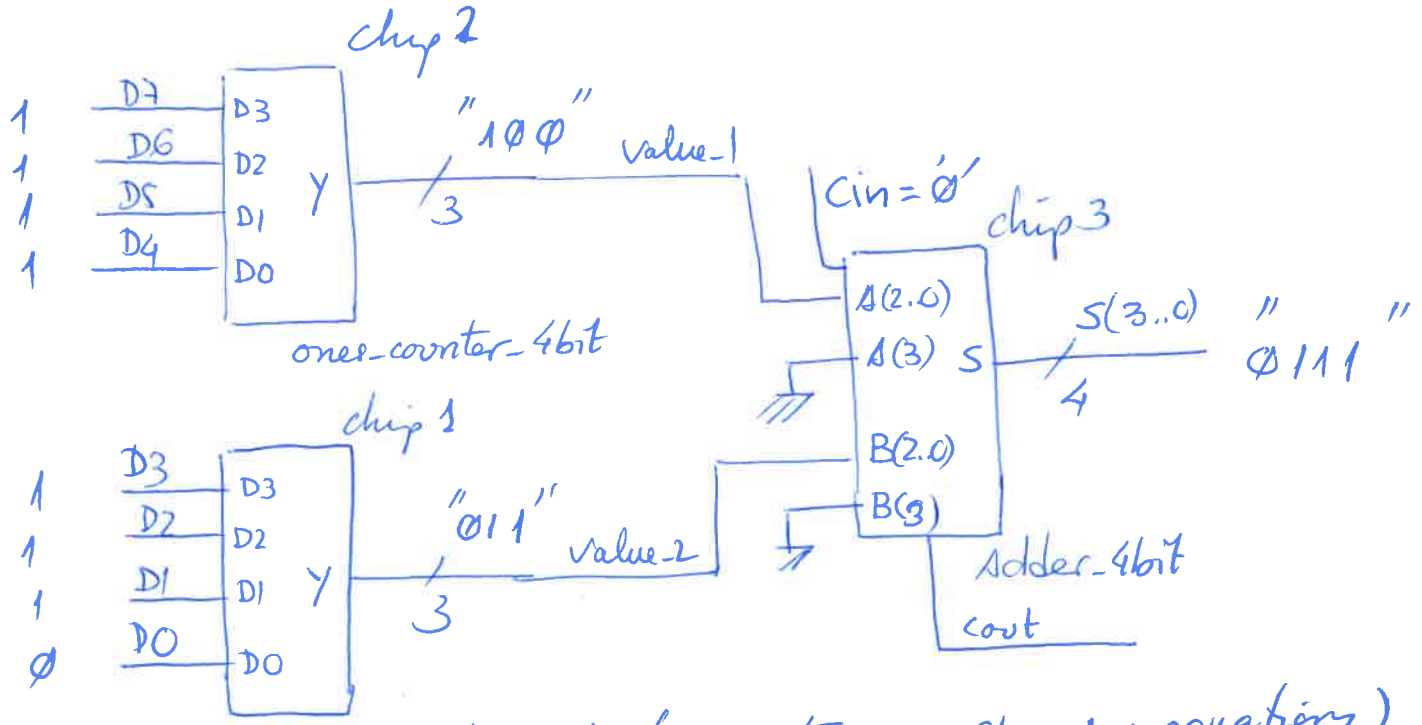


$f_{max} \leq \frac{1}{90ns} =$

$f_{max} \leq \underline{11.11\,MHz}$

worst case → $T_{min} \geq 2t_p$

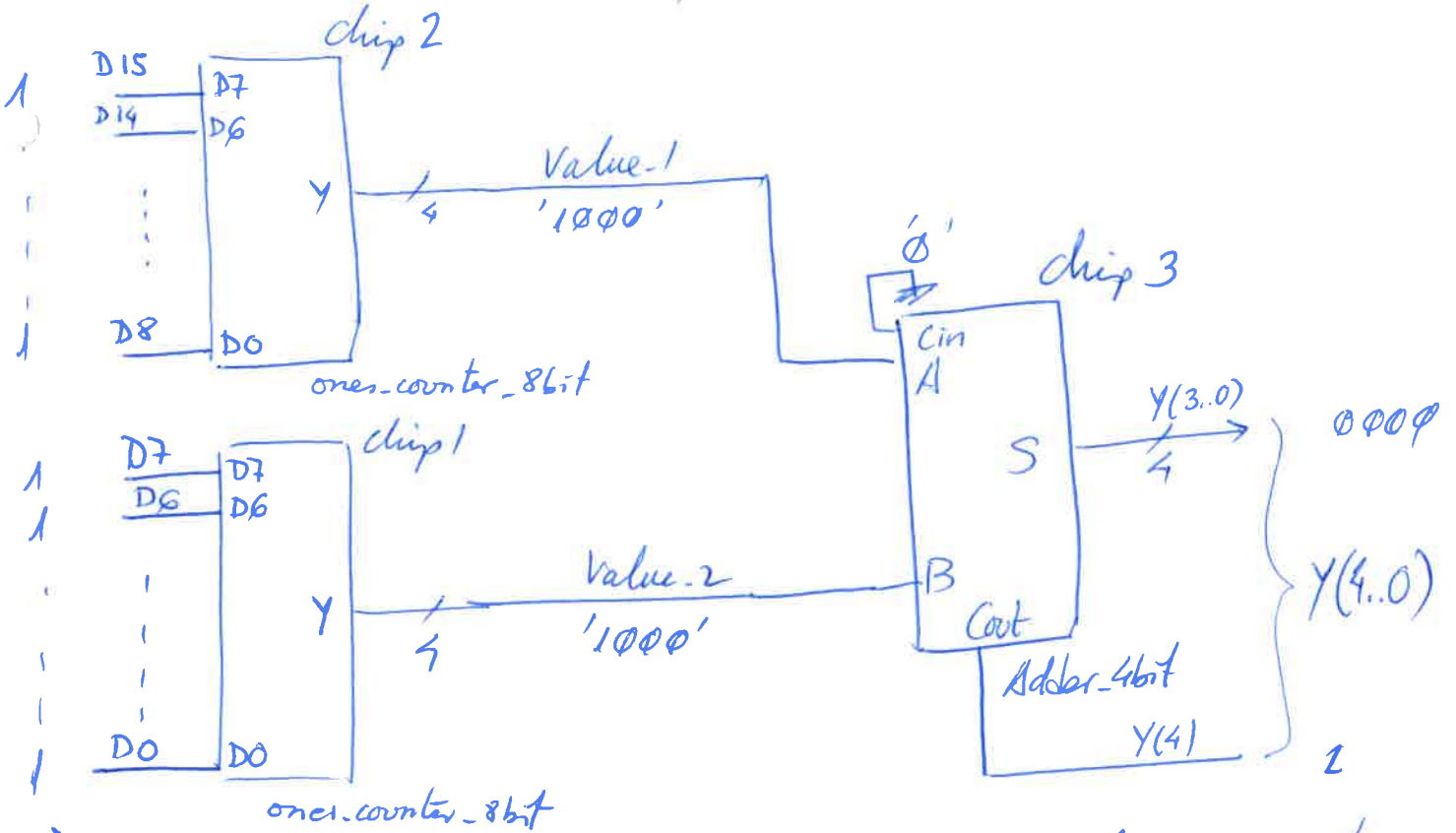
d) Let's learn about the way the ones_counter_8bit is build



When counting up to 8 bit 1111 + 1111 → "1000"

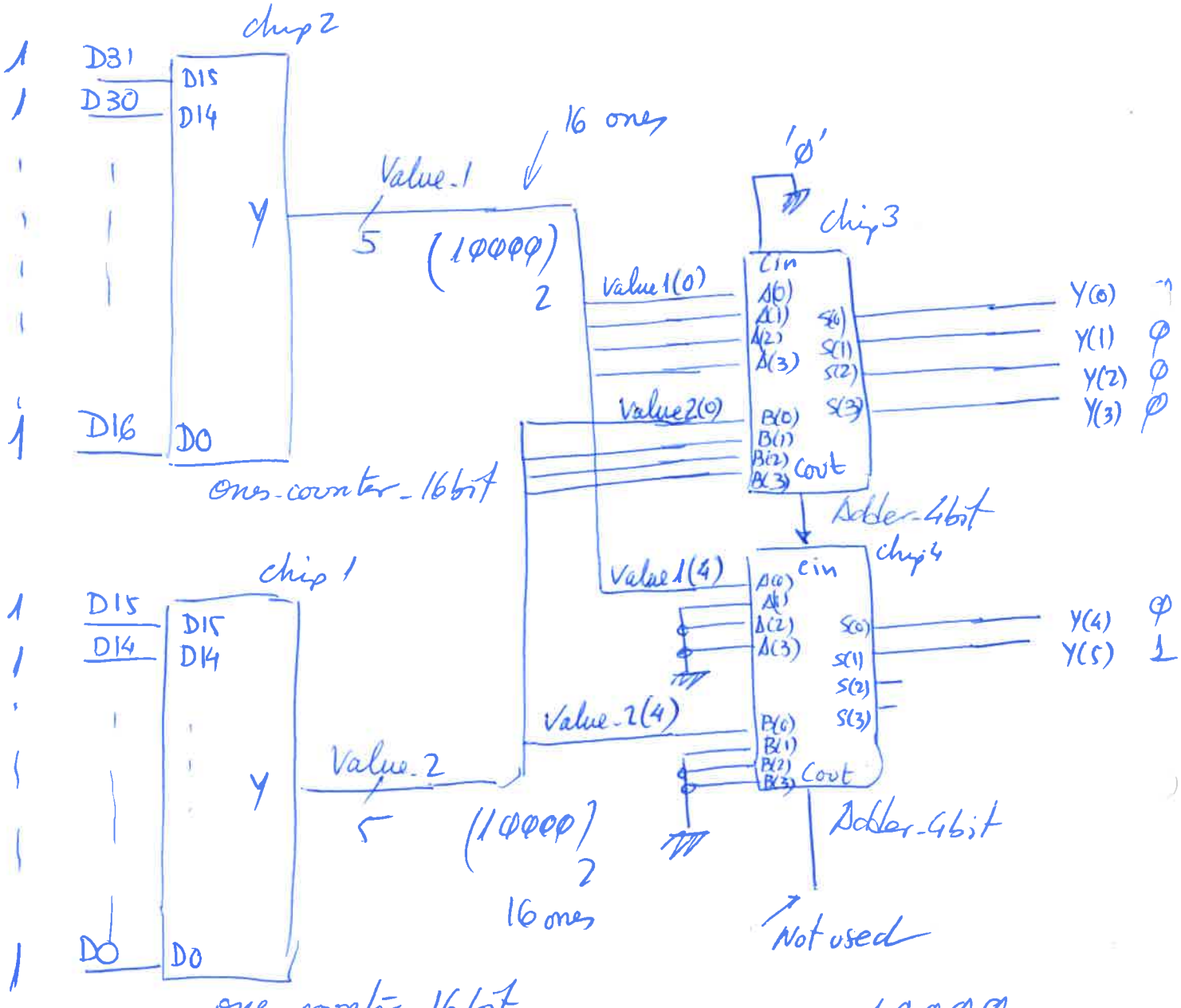
4 bits are required

Thus, in the same way; we can dismiss the ones_counter_16bit:



↑ 16 ones means that we need 5 bits "10000"

So, finally, if the range of the count is 32 bit, we need to use an Adder_5bit, for instance using two Adder_4bit.



The project will include (assuming that the adder_4bit is ripple_carry based on Adder_1bit → 6 VHDL files (adder_1bit, adder_4bit, ones_counter_4bit, ones_counter_8bit, ones_counter_16bit and ones_counter_16bit