Problem 1

①

	E_L	X3	X2	X1	X0	Y15_L	Y14_L	Y13_L	----	Y2_L	Y1_L	Y0_L
disable	1	x	x	x	x	1	1	1	----	1	1	1
	0	0	0	0	0	1	1	1	----	1	1	0
	0	0	0	0	1	1	1	1	----	1	0	1
			⋮									
	0	1	1	1	0	1	0	1	----	1	1	1
	0	1	1	1	1	0	1	1	----	1	1	1

$$Y7\_L = f(E\_L, X) = (E\_L + X_3 + X_2' + X_1' + X_0') = M_7$$

$$Y14\_L = M_{14} = (E\_L + X_3' + X_2' + X_1' + X_0)$$

The functions in this chip have 31 minterms and only one maxterm

② Redraw the truth table in order to make it easier

	A3	A2	A1	A0	B3	B2	B1	B0
0	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	1
2	0	0	1	0	0	0	1	1
3	0	0	1	1	0	0	1	0
4	0	1	0	0	0	1	1	1
5	0	1	0	1	0	1	1	0
6	0	1	1	0	0	1	0	0
7	0	1	1	1	0	1	0	1
8	1	0	0	0	1	1	1	1
9	1	0	0	1	1	1	1	0
10	1	0	1	0	1	1	0	0
11	1	0	1	1	1	1	0	1
12	1	1	0	0	1	0	0	0
13	1	1	0	1	1	0	0	1
14	1	1	1	0	1	0	1	1
15	1	1	1	1	1	0	1	0

$$B0 = f(A3, A2, A1, A0) =$$

$$= \sum_4 m\,(1, 2, 4, 7, 8, 11, 13, 14)$$

$$m_2 = A_3' \cdot A_2' \cdot A_1 \cdot A_0'$$ AND

0 0 1 0

OR

sum of minterms

$B1 = f(A3, A2, A1, A0) = \prod_{4} M(0,1,6,7,10,11,12,13)$

$(A3 + A2' + A1' + A0')$

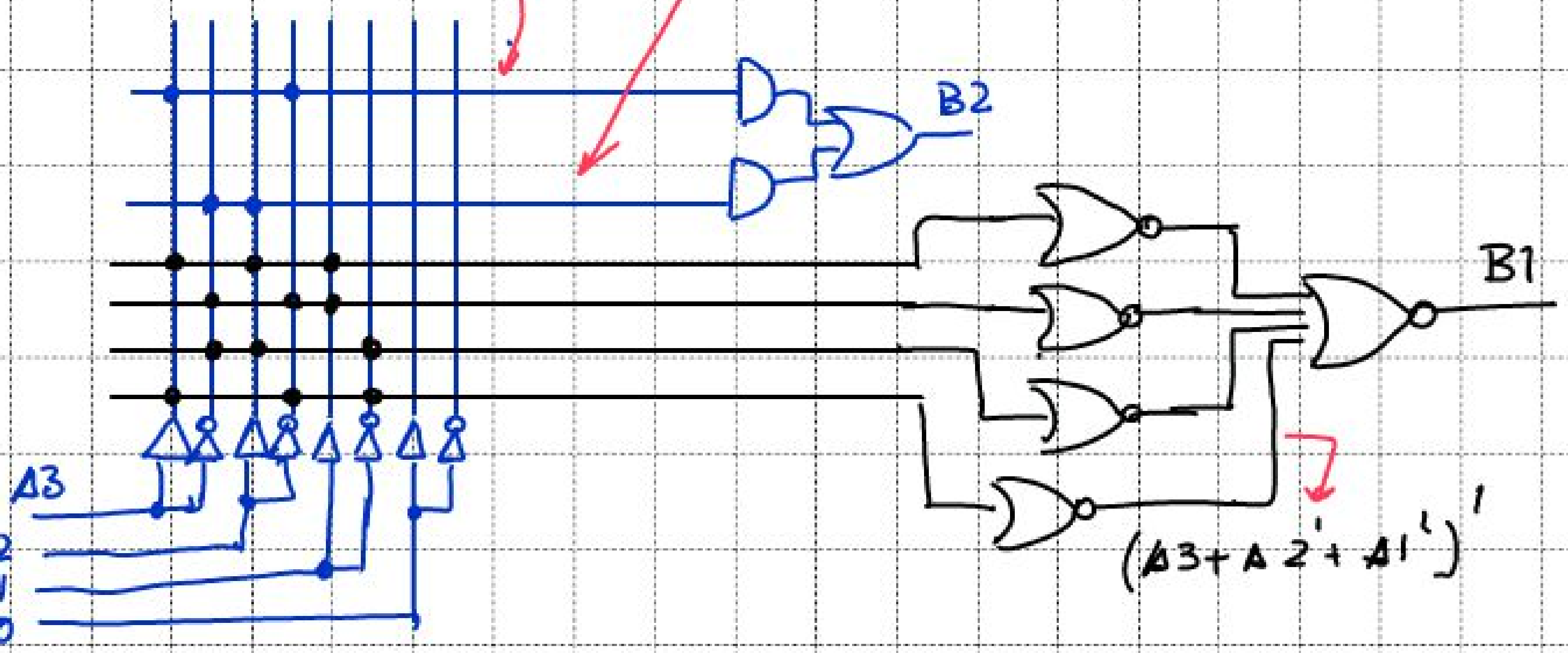
$0 \quad 1 \quad 1 \quad 1$

AND

product of maxterms (OR)

③ B2 as a sum of products (SoP)

$B2 = A3 \cdot A2' + A3' A2$



④ B1 as a product of terms (PoS)

$B1 = (A3 + A2 + A1)(A3' + A2' + A1)(A3' + A2 + A1')(A3 + A2' + A1')$

$(x \cdot y \cdot z \cdot w)'' = (x' + y' + z' + w')'$

$B1 = \left((A3 + A2 + A1)' + (A3' + A2' + A1)' + (A3' + A2 + A1')' + (A3 + A2' + A1')'\right)'$

Let's check, for instance A = "1010"

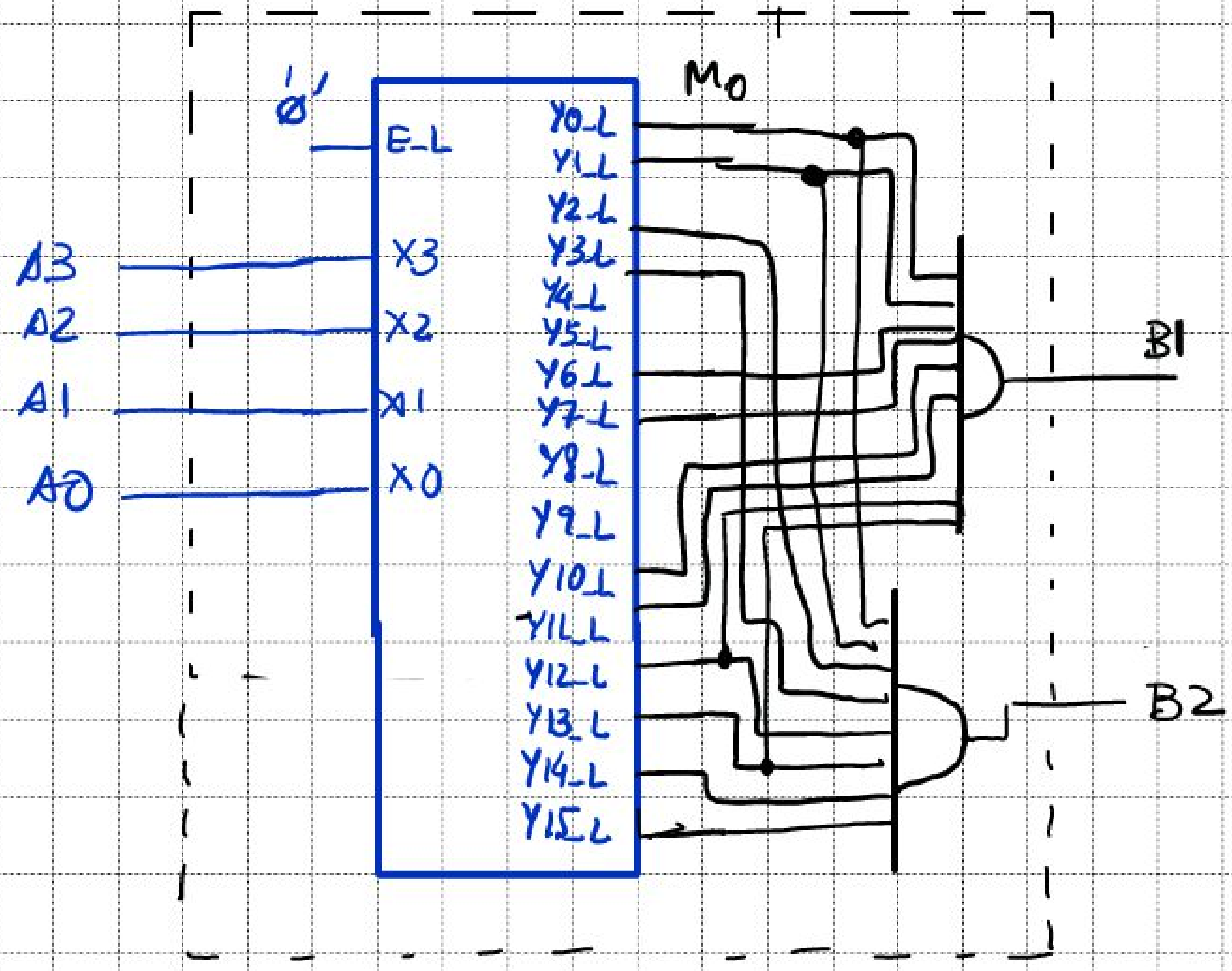
$B1 = \left((1 + 0 + 1)' + (1' + 0' + 1)' + (1' + 0 + 1')' + (1 + 0' + 1')'\right)'$

$= (0 + 0 + 1 + 0)' = 0$ ok ✓

(5) $B1 = \prod_4 M(0,1,6,7,12,13,10,11)$

When $E\_L = '0'$ $\quad B2 = \prod_4 M(0,1,3,2,12,13,15,14)$

↳ the outputs of the decoder are the maxterms



(6) Because every output of the decoder is a single maxterm

$Y_{10}\_L = (E\_L + X3' + X2 + X1' + X0)$

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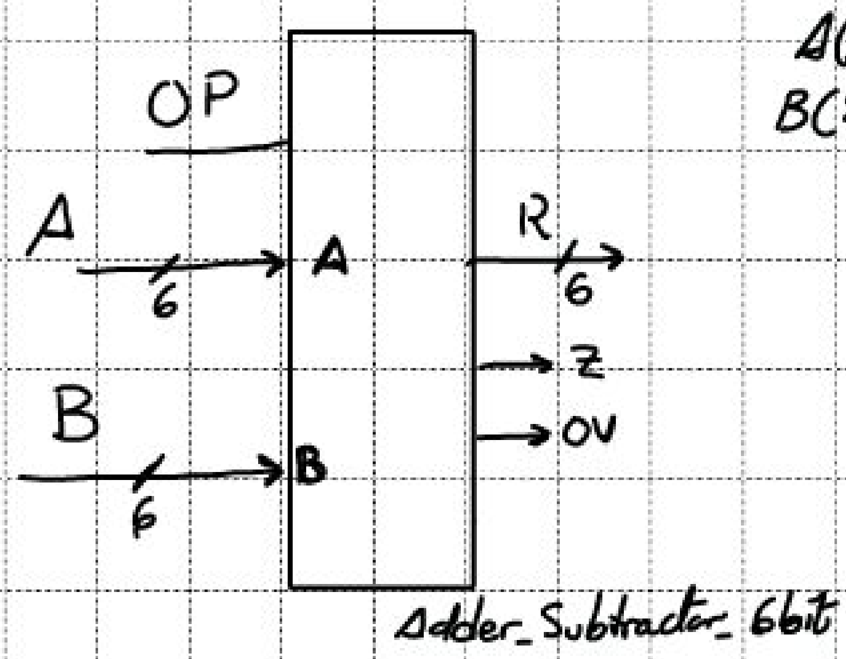
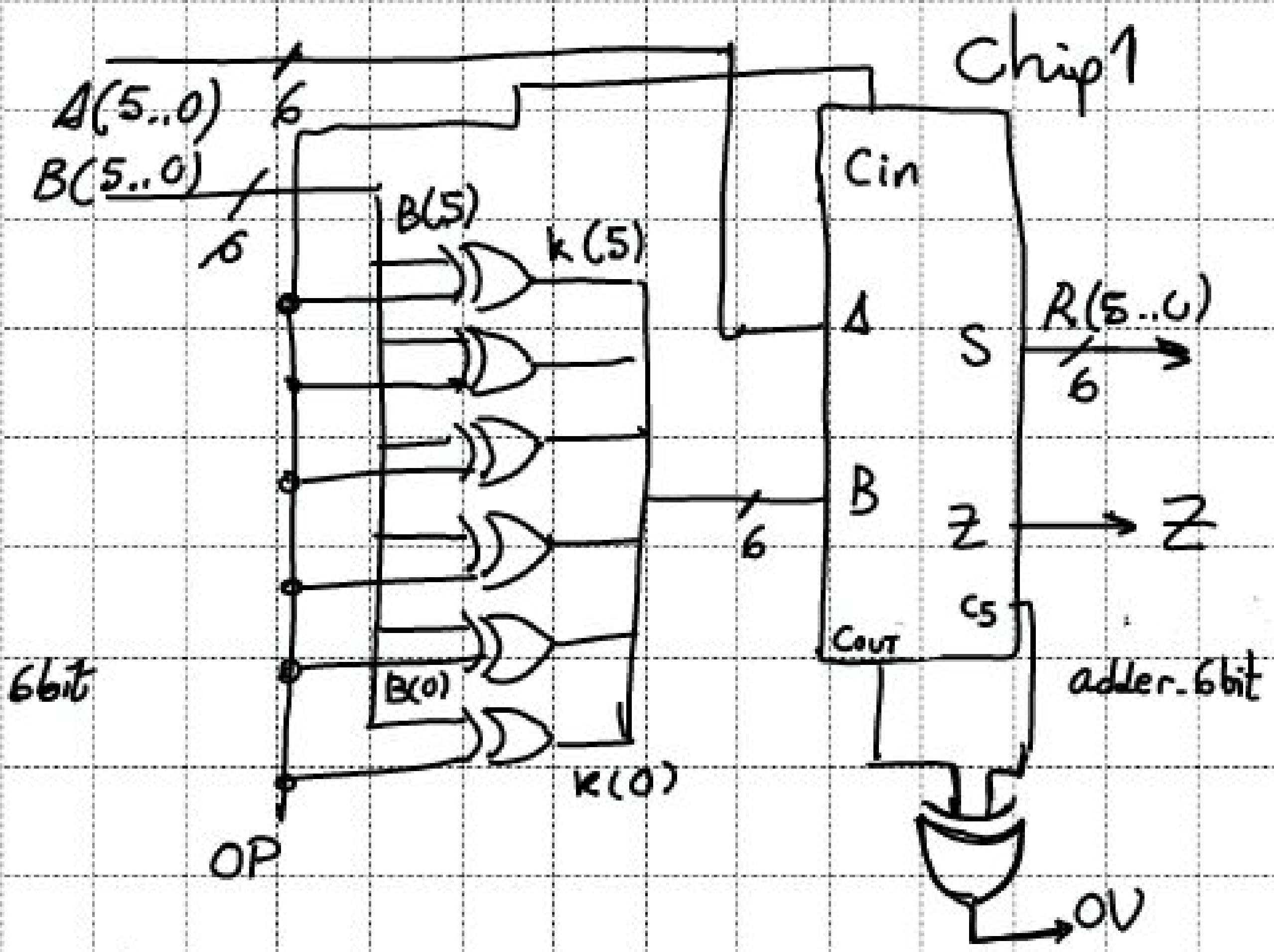
Y10_L <= E_L or not(X3) or X2 or not(X1) or X0;
```

and so the other 15 equations

⑦ It is like the P_Ch1





$$Z = \left(R(5) + R(4) + R(3) + R(2) + R(1) + R(0)\right)'$$

only when the $R = 0 \rightarrow Z = '1'$

$OV = C5 \oplus C_{OUT}$ when the carry of the two last sections is different $\rightarrow OV = '1'$

$N = 6$ bit $\rightarrow -2^5 \leq A, B, R \leq 2^5 - 1$

This is the integer range $\quad -32 \leq A, B, R \leq +31$

⑧ a) $+26 = 011010$

OP = '0' $\quad$ B = 101010

$1 \leftarrow 000100$

+4

$26 + (-22) = +4$

101010

010101

+1

010110 → +22

Z = 0

OV = 0

b) A = −22

B = −21

OP = 1

101010

+ 010101

111111

↓ −1

000000

+1

000001 → 1

010101

+1

010110 → 22

$-22 - (-21) = -1$

Z = 0

OV = 0

010101 → +21

101010

1

101011

c)

```
   010010    A = +18
+  101110    B = -18
 1 000000
```

OP = 0

→ R = 0, Z = '1', OV = '0'

```
  010001
      +1
  010010
```

→ +18

d) A = -31, B = +22, OP = 1

```
   100001
+  101010
   0 001011
```

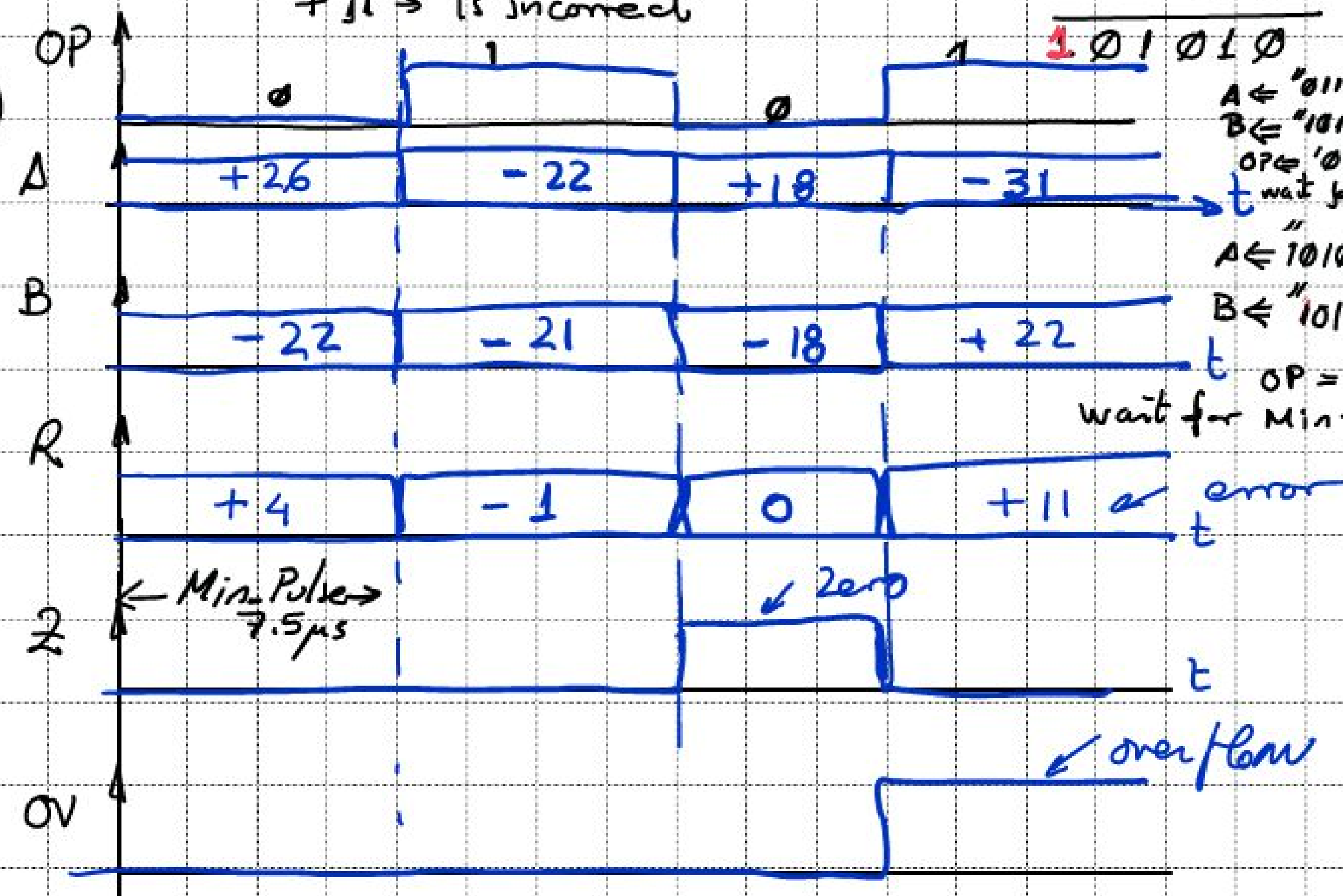
1 0 → XOR → OV = '1'

+11 → is incorrect

```
+31 → 011111
      100000
          +1
      100001
```

```
+22   010110
      101001
          +1
      101010
```

(9)



A ⇐ "011010";
B ⇐ "101010";
OP ⇐ '0';
wait for Min-Pulse;

A ⇐ "101010";
B ⇐ "101011";
OP = '1';
wait for Min-Pulse;

(10) one way to calculate the speed of the circuit is supposing that the Adder_6bit is a flat structure of 3 level of gates

BUFFER	XOR	ADDER_6BIT	(XOR or NOR)	
6ns	6ns	18ns	6ns	→ $P_d = 36ns$

⇒ $f_{max} < 27.8$ MHz