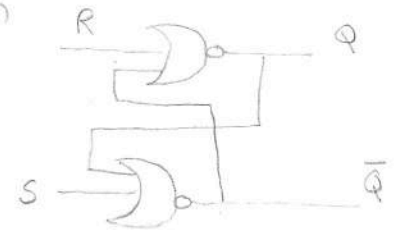
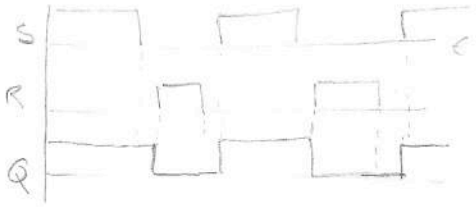
## Ex 1

1)

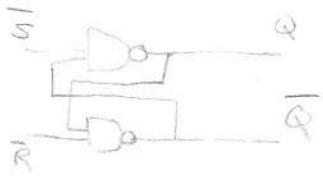



| S | R | Q |
|---|---|---|
| 0 | 0 | mémoire |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | interdit |

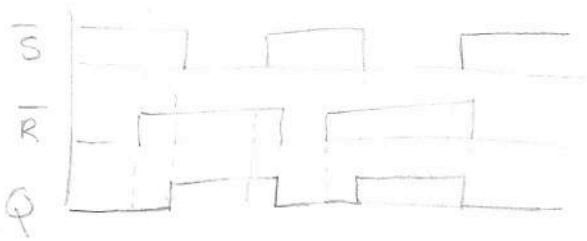
2) quand $R = S = 1$ → interdit car $Q = \bar{Q} = 0$ contradictoire
le circuit entre dans un état métastable = sorties prennent des valeurs inconnues

3) bascule $\bar{R}\bar{S}$



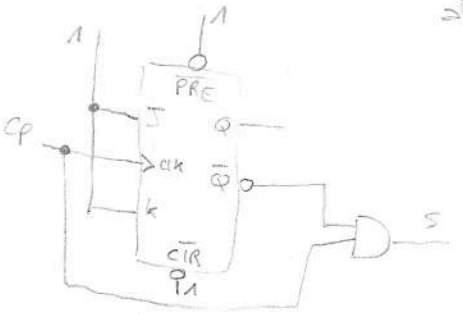

| $\bar{R}$ | $\bar{S}$ | Q |
|---|---|---|
| 0 | 0 | interdit |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | mémoire |

4)

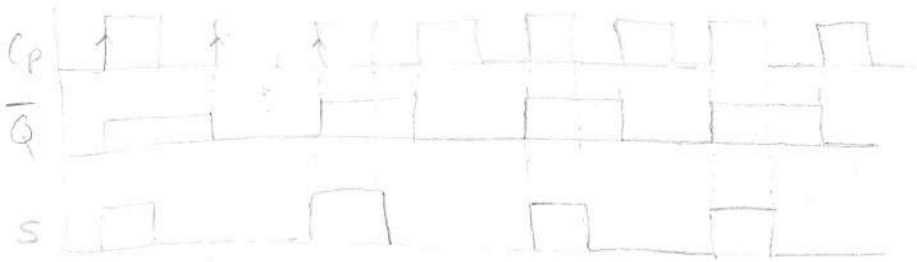



5) $\bar{R} = \bar{S} = 0$ → interdit
car $Q = \bar{Q} = 1$

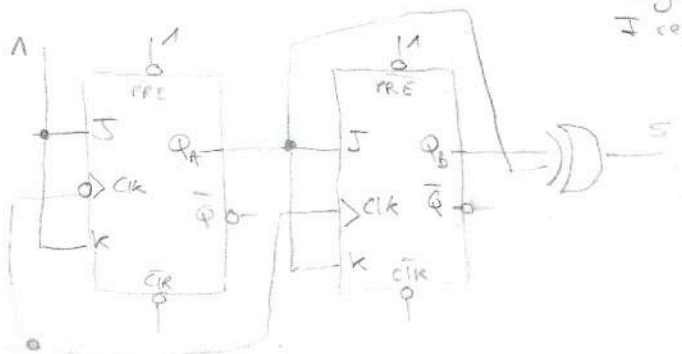
## Ex 2



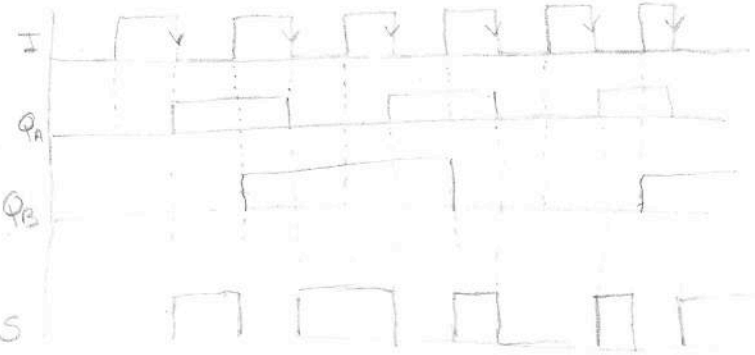

allure du signal en S quand Cp reçoit 8 impulsions
→ $\epsilon = 0$ $Q = 1$




## Ex 3




signal en S
I reçoit 6 impulsions → $\epsilon = 0$ $Q_A = Q_B = 0$



fonctionnement?

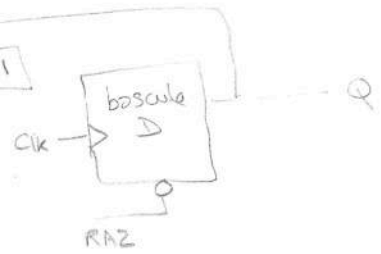
si RAZ = 0 → Q = 0

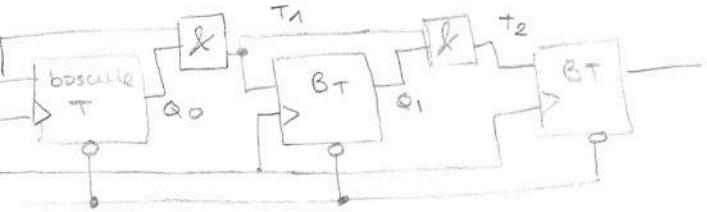
sinon dépend de Clk

→ si Clk = ↑, $Q_{t+1} = \bar{T} Q_t + T \bar{Q}_t$

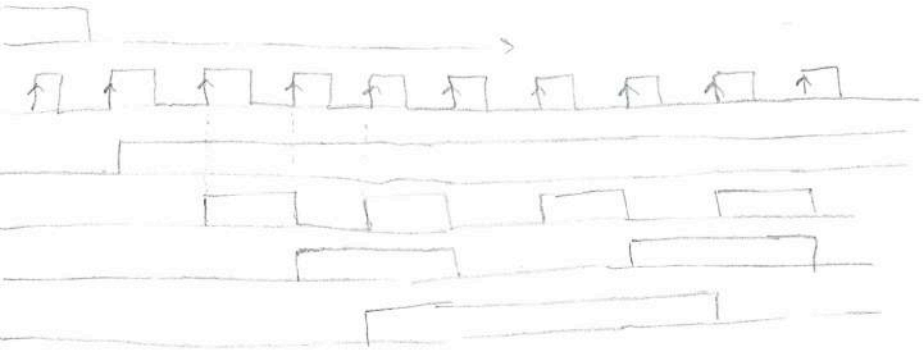
si $t=0$ ⇒ $Q_{t+1} = Q_t$

si $t=1$ ⇒ $Q_{t+1} = \bar{Q}_t$

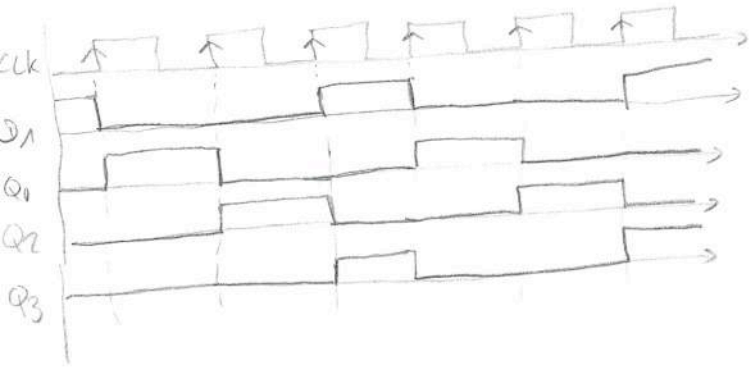



fonctionnement ? en f° de $T_0$



TD2




| Clk | Q |
|---|---|
| ↑ | D |
| ↓ | $Q_{t-1}$ |

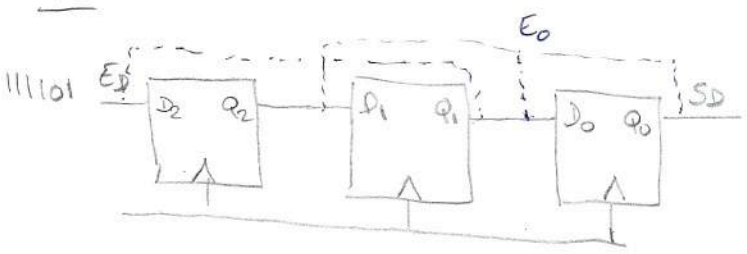
$D_1 = \bar{Q}_1 \cdot \bar{Q}_2 = \overline{Q_1 + Q_2}$

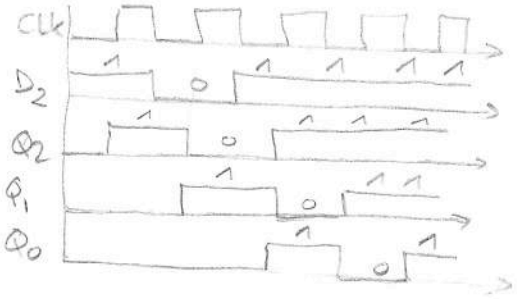
| $Q_3$ | $Q_2$ | $Q_1$ | |
|---|---|---|---|
| 0 | 0 | 1 | |
| 0 | 1 | 0 | |
| 1 | 0 | 0 | |
| 0 | 0 | 1 | |
| 0 | 1 | 0 | |
| 1 | 0 | 0 | |

etats 1 → 2 → 4

cycle

Ex 3




2) Decalage à droite

$S = 1 \Rightarrow D_2 = E_D$ , $D_1 = Q_2$ , $D_0 = Q_1$ , $S_D = Q_0$

Décalage à gauche

$S = 0 \Rightarrow D_0 = E_D$ , $D_1 = Q_0$

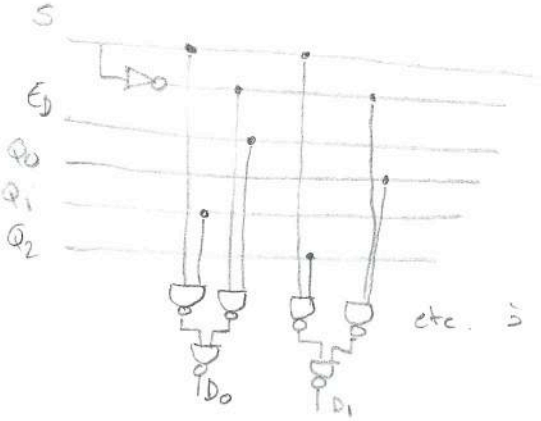
$D_2 = Q_1$ , $S_D = Q_2$

$D_0 = \overline{SQ_1 + \bar{S}E_D} = \overline{SQ_1} \cdot \overline{\bar{S}E_D}$

$D_1 = SQ_2 + \bar{S}Q_0 = \overline{SQ_2} \cdot \overline{\bar{S}Q_0}$

$D_2 = SE_D + \bar{S}Q_1 = \overline{SE_D} \cdot \overline{\bar{S}Q_1}$

$S_D = Q_0S + \bar{S}Q_2 = \overline{SQ_0} \cdot \overline{\bar{S}Q_2}$




etc. à brancher sur le circuit précédent

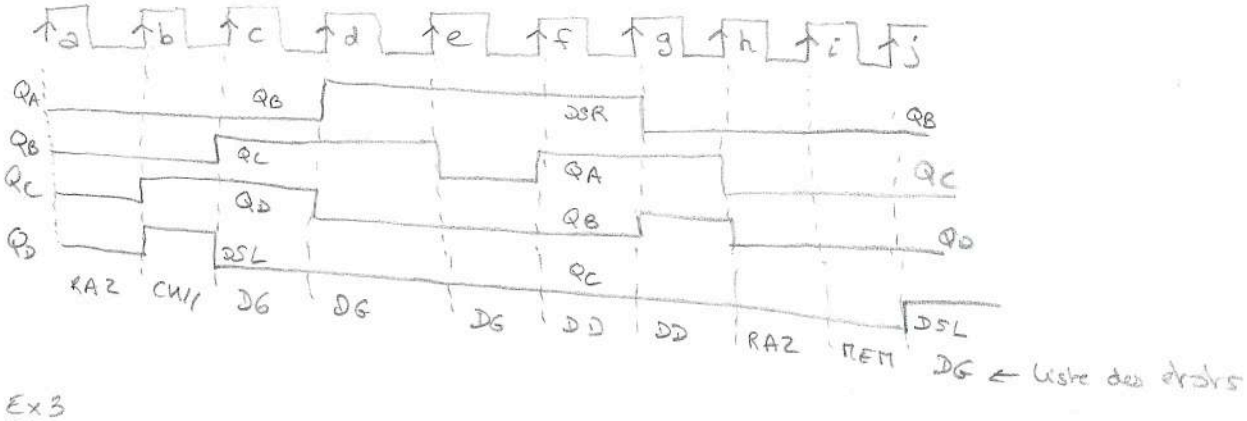
Ex 4

$(76)_{10} = {}^{Q_7}1\,0\,0\,1\,1\,0\,0^{Q_0}$

| D/G | $E_D$ | $Q_7$ | $Q_6$ | $Q_5$ | $Q_4$ | $Q_3$ | $Q_2$ | $Q_1$ | $Q_0$ | $S_D$ |
|---|---|---|---|---|---|---|---|---|---|---|
| G | 0 → | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| D | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| D | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| D | etc | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| G | | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | |
| G | | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| D | | | | | | | | | | |
| G | | | | | | | | | | |
| D | | | | | | | | | | |
| G | | | | | | | | | | 1 |
| G | | | | | | | | | | 0 |

TD 3

Ex 1



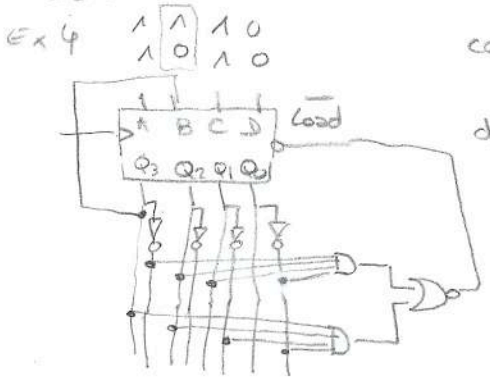

Ex 3

| $Q_D$ | $Q_C$ | $Q_B$ | $Q_A$ |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 |
| 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 |
| 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 |

| $\varphi_{110}$ | RCO |
|---|---|
| 0 | 0 |
| 1 | |
| 2 | |
| 15 | |
| 0 | 0 |
| 13 | 1 |
| 14 | 0 |
| 15 | 0 |
| 0 | 0 |
| 13 | 1 |

TD3 :

Ex 4




compteur 0 → 6

détecter $6|_{10} = (0110)_2$ ⇒ charger $(10)_{10} = (1010)_2$

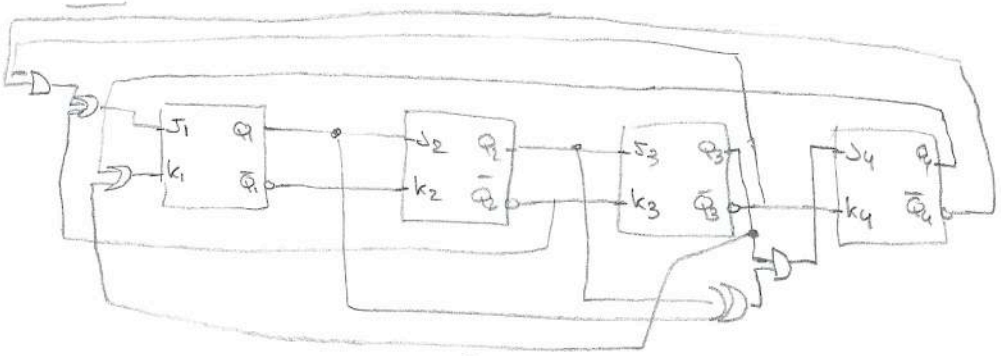
⇒ $(6) = \bar{Q}_A Q_B Q_C \bar{Q}_D$

$12|_{10} = (1100)_2$ ⇒ charger $(14)_{10} = (1110)_2$

⇒ $(12) = Q_A Q_B \bar{Q}_C \bar{Q}_D$

$\overline{Load} = \overline{\bar{Q}_A Q_B Q_C \bar{Q}_D + Q_A Q_B \bar{Q}_C \bar{Q}_D}$

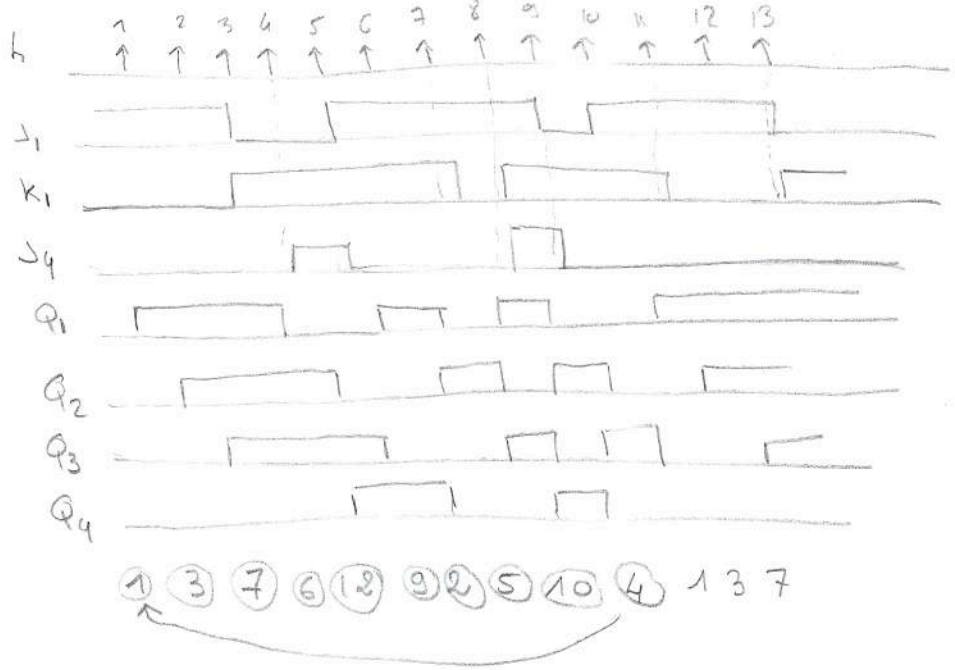
TD4




$J_4 = \bar{Q}_1 Q_2 Q_3 + Q_1 \bar{Q}_2 Q_3$

$= Q_3(\bar{Q}_1 Q_2 + Q_1 \bar{Q}_2)$

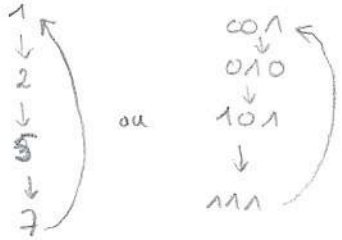
$= Q_3 \underbrace{(Q_1 \oplus Q_2)}_{\text{xor}}$




1 3 7 6 12 9 2 5 10 4 1 3 7

Ex 2

1)




2)

| Etat présent | Etat suivant |
|---|---|
| 001 | 010 |
| 010 | 101 |
| 101 | 111 |
| 111 | 001 |

3) Table de bascule JK

| Q | $Q^*$ | J | K |
|---|---|---|---|
| 0 | 0 | 0 | d |
| 0 | 1 | 1 | d |
| 1 | 0 | d | 1 |
| 1 | 1 | d | 0 |

d = don't care

4) EP

E.S

| $Q_1$ | $Q_2$ | $Q_3$ | $Q_1^*$ | $Q_2^*$ | $Q_3^*$ |
|---|---|---|---|---|---|
| 0 | 0 | 1 | $J_1k_1$ | $J_2k_2$ | $J_3k_3$ |
| 0 | 1 | 0 | 0,d | 1,d | d,1 |
| 1 | 0 | 1 | 1,d | d,1 | 1,d |
| 1 | 1 | 1 | d,0 | 1,d | d,0 |
| | | | d,1 | d,1 | 0,0 |

$J_1$

| $Q_3$ \ $Q_1Q_2$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | x | 1 | x | x |
| 1 | 0 | x | x | x |

$J_1 = Q_2$

$k_1$

| | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | x | x | x | x |
| 1 | x | x | 1 | 0 |

$Q_2 = k_1$

$J_3$

| | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | x | 1 | x | x |
| 1 | x | x | x | x |

$J_3 = 1$

$k_3$

| | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | x | x | x | x |
| 1 | 1 | x | 0 | 0 |

$k_3 = \overline{Q_1}$

$J_2$

| | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | x | 1 | x | x |
| 1 | 1 | x | x | 1 |

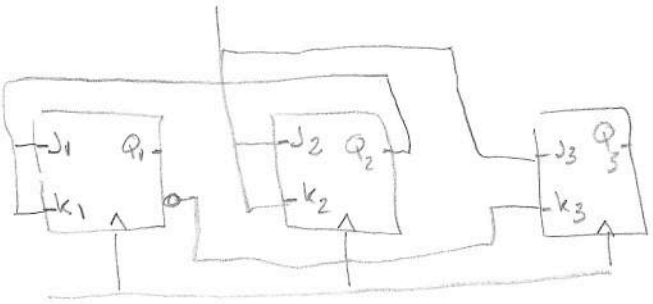
$J_2 = 1$

$k_2$

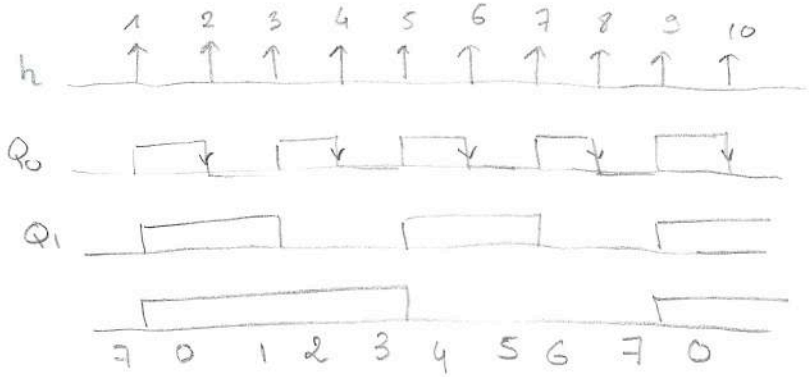
| | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | x | 1 | 1 | x |
| 1 | x | x | 1 | x |

$k_2 = 1$

5)



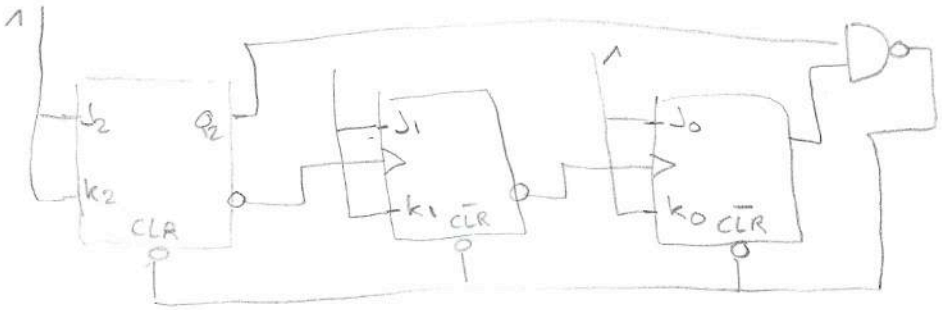
Ex 3




$t_p = 8\,ns$

Le $t_p$ le plus long → les 3 bascules changent d'état $\Rightarrow T_p = 3 \times 8 = 24\,ns$

Ex 4




$\overline{CLR} = \overline{Q_2 Q_0}$

TD 5

Ex 1 $\quad 2^2 \times 2^{12} = 4 \times FFF$ $\qquad 2^2 =$

$16k_o = 2^{14} = 4 \times 16^3 = 3FFF)_{16}$ $\quad \Rightarrow \Pi_1 = 2000 \rightarrow 5FFF$

$8k_o = 2^3 \times 2^{10} = 2 \times 16^3 = 1FFF)_{16}$ $\quad \Rightarrow \Pi_2 = 8000 \rightarrow 9FFF$

$4k_o = 2^2 \times 2^{10} = 2^{10} = FFF)_{16}$ $\quad \Rightarrow \Pi_3 = A000 \rightarrow AFFF$

$2^{12} \times 2^1 = 1FFF$

| | Adresse (16) | $A_{15}$ | $A_{14}$ | $A_{13}$ | $A_{12}$ | $A_{11}$ | ..... | $A_0$ |
|---|---|---|---|---|---|---|---|---|
| $\Pi_1$ | 2000 | 0 | 0 | 1 | 0 | 0 | | 0 |
| | 5FFF | 0 | 1 | 0 | 1 | 1 | | 1 |
| $\Pi_2$ | 8000 | 1 | 0 | 0 | 0 | 0 | | 0 |
| | 9FFF | 1 | 0 | 0 | 1 | 1 | | 1 |
| $\Pi_3$ | A000 | 1 | 0 | 1 | 0 | 0 | | 0 |
| | AFFF | 1 | 0 | 1 | 0 | 1 | | 1 |

$$\overline{S_{M_1}} = \overline{\overline{A_{15}}\,\overline{A_{14}}\,A_{13}} + \overline{A_{15}\,\overline{A_{14}}\,\overline{A_{13}}} = \overline{\overline{A_{15}}\left(\overline{A_{14}}A_{13} + A_{14}\overline{A_{13}}\right)} = \overline{\overline{A_{15}}\left(A_{14}\oplus A_{13}\right)}$$

$$\overline{S_{M_2}} = \overline{A_{15}\,\overline{A_{14}}\,\overline{A_{13}}} = \overline{A_{15}} + A_{14} + A_{13}$$

$$\overline{S_{M_3}} = \overline{A_{15}\,\overline{A_{14}}\,A_{13}\,\overline{A_{12}}} = \overline{A_{15}} + A_{14} + \overline{A_{13}} + A_{12}$$

## Ex 2

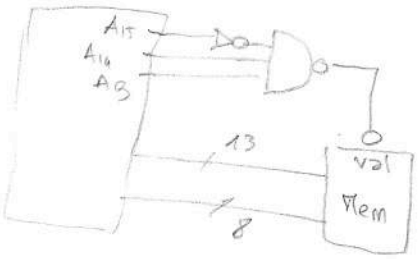
Ad 16 bits
Dom 8 bits

Mem 8ko 6000 → 7FFF

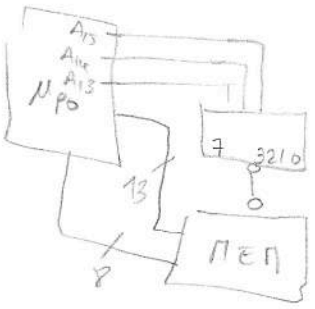
$8ko = 2^3 \times 8^{10} = 2^{13}$

| | $A_{12}$ | | | | $A_0$ |
|---|---|---|---|---|---|
| 011 | 0 | 0000 | 0000 | 0000 | |
| 011 | 1 | 1111 | 1111 | 1111 | |

$$\overline{S_M} = \overline{A_{15}}\,A_{14}\,A_{13}$$




2)




## Ex 3

1) $A_0 \rightarrow A_{10}$ : entrée → $2^{11}$ mots $= 2^{10} \times 2^1 = 2$ k mots $= 2$ k mots $\times$ 16 bits/mot
= 32 k bits

1 mot = 16 bits

→ signal R/$\overline{W}$ → RAM

2) μp. adresse → 16 bits

$A_{15}\,\overline{A_{14}}\,A_{13} = 101$ $\quad A_{12} = 1$ $\quad A_{11} = 0$ $\quad$ 000 7FF

Zone adressée par μP { B000 B7FF

3) Ad $53)_{10} = 48 + 5 = 35|_{16}$

$$\begin{array}{r} B000 \\ +\ \ 35 \\ \hline B035 \end{array}$$

4) $72|_{10} = 64 + 8 = 48|_{16}$ ⇒ ad = B048

$44|_{10} = 32 + 12 = 2C|_{16}$ ⇒ 002C

TD 5

Ex 4

1) 1k mot  1 mot = 8 bits

capacité  1 kmot × $\frac{8 \text{ bits}}{\text{mot}}$ = 8k bit

2) $(06A3)_{16}$  $A_{15} \rightarrow A_0$ ⇒ 16 bits d'@

$A_{15}A_{14}A_{13}A_{12} = 0000$ ⇒ C = 0 ← poids du fort

$A_{11} = 0 \Rightarrow B = 0$ } module 1  octet $(675)_{10}$

$A_{10} = 1 \Rightarrow A = 1$ }

00000 | 1010100011

module | octet

$(2A3)_{16} = 2 \times 16^2 + 10 \times 16^1 + 3 \times 16^0 = 512 + 160 + 3 = (675)_{16}$

$1k_0 = 2^{10}$ ⇒ 000 → 3FF

$M_0$ @ 0000 → 03FF

$M_1$ @ 0400 → 07FF

$M_2$ @ 0800 → 0BFF

$M_3$ @ 0C00 → 0FF

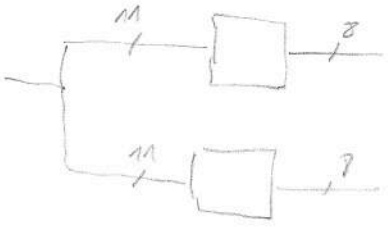
TD 6

Ex 1

1) boitier 2ko

2ko × $\frac{8 \text{ bits}}{\text{mot}}$ = 16 kbit

$2k_0 = 2^1 \times 2^{10} = 2^{11}$ octets ⇒ bus d'@ de 11 bits




1 mot = 16 bits

2k mots × 16 $\frac{\text{bits}}{\text{mot}}$ = 32 k bits

2) 8ko ⇒ 1 mot = 8 bits

$8k_0 = 2^3 \times 2^{10} = 2^{13}$ octets

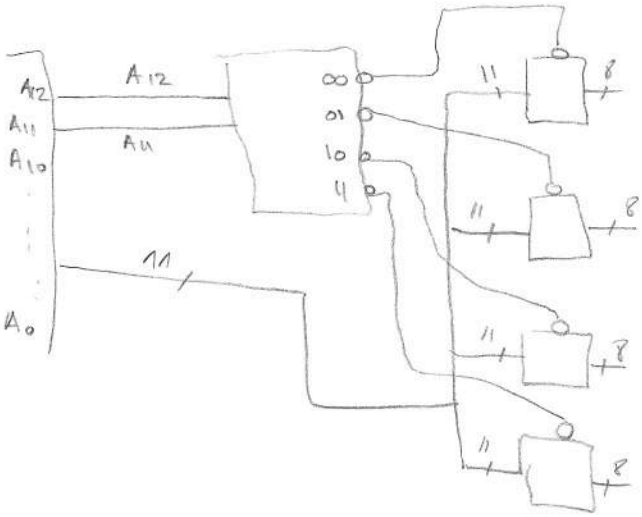
$\frac{2 \text{ ko}}{\text{boitier}}$ × 4 boitiers = 8ko

$A_{12} \rightarrow A_0$

$A_{12}A_{11}$ utilisés pour sélectionner un boitier

$A_{10} \rightarrow A_0$ " " un octet

8 k octet × $\frac{8 \text{ bits}}{\text{octet}}$ = 64 kbit




3) 8k mot  1 mot = 16 bits

$8k = 2^3 \times 2^{10} = 2^{13}$ bits d'@

$2k_o = 2^{11}$ bits d'@

$8\,k\,mot \times \frac{2\,octets}{mot} = 16\,k_o \rightarrow 8$ boîtiers

Ex 2

1) 2ko/boîtier

$2k_o = 2^1 \times 2^{10} = 2^{11}$ octets

=> 000 → 7FF

@ 4000 → 47FF $PROM_1$

@ 4800 → 4FFF $PROM_2$

@ 5000 → 57FF $PROM_3$

@ D800 → DFFF $RAM_1$

@ E000 → E7FF $RAM_2$

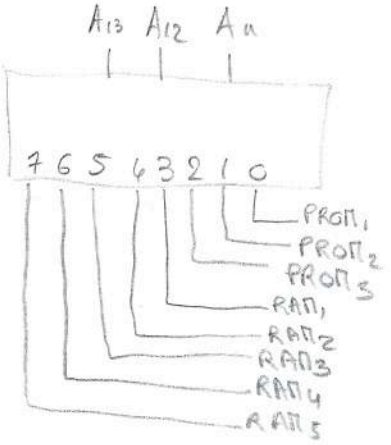
@ E800 → EFFF $RAM_3$

@ F000 → F7FF $RAM_4$

@ F800 → FFFF $RAM_5$

$\frac{6k_o}{2k_o/boîtier}$ = 3 boîtiers PROM

$\frac{10k_o}{2k_o/boîtier}$ = 5 boîtiers RAM




| | | |
|---|---|---|
| 4000 | 01 000 | PROM |
| 4800 | 01 001 | |
| 5000 | 01 010 | |
| D800 | 11 011 | RAM |
| | 11 100 | |
| | 11 101 | |
| | 11 110 | |
| | 11 111 | |

## Ex 3

1) PROM : $A_{11} \to A_0$ $\Rightarrow$ 12 bits d'@ $\Rightarrow$ $2^{12}$ données $= 2^2 \times 2^{10} = 4$ Kmots
000 → FFF

RAM : $A_{10} \to A_0$ → 11 bits d'@ $\Rightarrow$ $2^{11} = 2^{10} \times 2 = 2$ kmot
000 → 7FF

Contrôleur $A_1 A_0$ $\Rightarrow$ $2^2$ → 0 → 3

2) Processeur génère $A_{15} \to A_0$

PROM

| $A_{15}$ | $A_{14}$ | $A_{13}$ | $A_{12}$ | $A_{11}$ | ... | $A_0$ |
|---|---|---|---|---|---|---|
| 1 | 1 | 1 | x | 0 | | 0 |
| | | | | 1 | ... | 1 |

Selon $A_{12}$ on a 2 possibilités
Si $A_{12} = 0$ $\Rightarrow$ E000 → EFFF
Si $A_{12} = 1$ $\Rightarrow$ F000 → FFFF

RAM

| $A_{15}$ | $A_{14}$ | $A_{13}$ | $A_{12}$ | $A_{11}$ | $A_{10}$ | ... | $A_0$ |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | x | x | 0 | | 0 |
| | | | | | 1 | ... | 1 |

Selon $A_{11}$ et $A_{12}$ on a 4 possibilités
Si $A_{12}A_{11} = 00$ $\Rightarrow$ 0000 → 07FF
01 $\Rightarrow$ 0800 → 0FFF
10 $\Rightarrow$ 1000 → 17FF
11 $\Rightarrow$ 1800 → 1FFF

contrôleur

| $A_{15}$ | $A_{14}$ | $A_{13}$ | $A_{12}$ | $A_{11}$ | $A_{10}$ | $A_9$ | $A_8$ | $A_7$ | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | x | x | x | x | x | x | x | x | x | x | x | 0 | 0 |

Selon $A_{12} \to A_2$ on a $2^{11}$ possibilités = 2048
8000 → 9FFF

## Ex 4

77|8 1 élément = 16 bits
$2\Pi_o = 2^1 \times 2^{10} \times 2^{10} = 2^{21}$ octet adresses $\Rightarrow$ adresse 6e élément = $77|_8 + 10|_{10}$

@ $0|_{10}$ 1e élément
$2|_{10}$ 2e element
⋮
$10$ 6e element donc @ 6e élément = ad(i+10)

$10|_{10} = 12|_8 = A|_{16}$
$77|_8 = 3F|_{16} = 7 \times 8^1 + 7 \times 8^0 = 63|_{10}$

| 77 | |
|---|---|
| 12 | |
| 111 | $\|_8$ |

↑ 63 octet précédent

3) $2\Pi_o = 1\Pi mot \times \frac{2 \text{ oct}}{1\Pi mot} = 2\Pi mot \times \frac{1 \text{ octet}}{\text{mot}} = \frac{1}{2}\Pi mot \times \frac{4 \text{ oct}}{\text{mot}}$

1 Πmot de 16 bits — 2Πmot de 8bits — 1/2 5124 32bits