I. Etude du capteur.

1.1. $C_0 = 200\,pF$

$C = 300\,pF$ pour $H_R = 1$

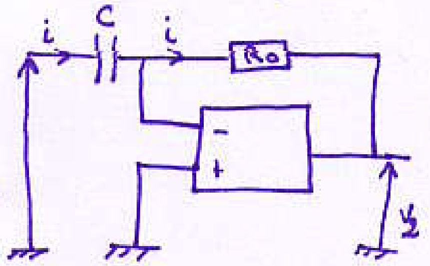
$C = C_0(1 + \alpha H_R)$

$$\frac{C}{C_0} = 1 + \alpha H_R$$

$$\alpha = \frac{C}{C_0 H_R} - \frac{1}{H_R} = \frac{1}{H_R}\left(\frac{C}{C_0} - 1\right)$$

$$\alpha = \frac{300}{200} - 1 = \frac{3}{2} - 1 = 1{,}5 - 1 = 0{,}5$$

1.2.



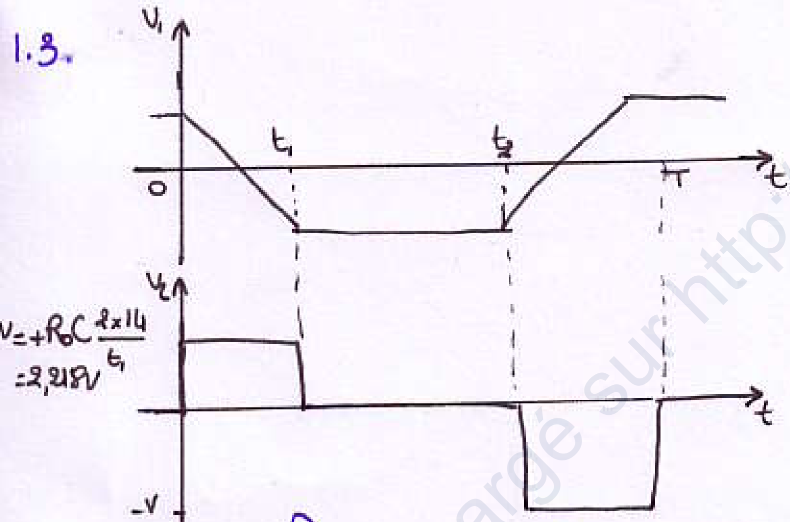
$i^+ = i^- = 0\,A$ idéal

$V^+ = V^- = 0\,V$ AOP linéaire

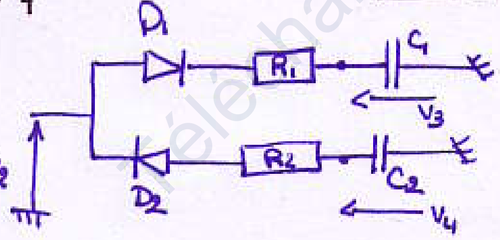
$v_2 = -R_0 i$ or $i = \frac{dq}{dt} = C\frac{du_C}{dt} = C\frac{dv_1}{dt}$

donc $v_2 = -R_0 C \frac{dv_1}{dt}$

1.3.

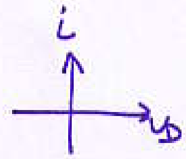


1.4

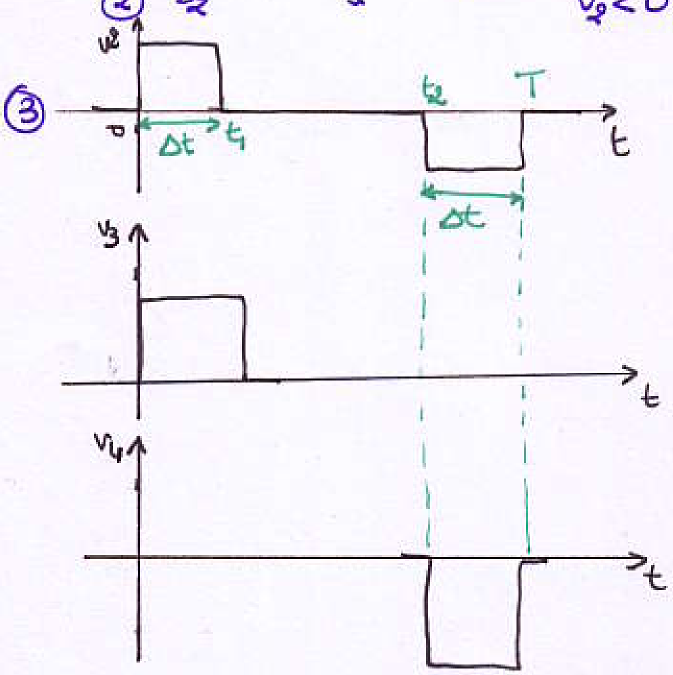


① D_1 est passante pour $v_2 > 0$

② D_2 " $v_2 < 0$



③

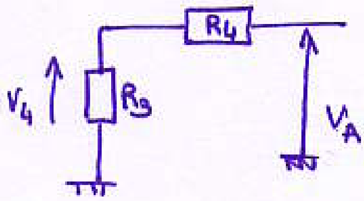


τ est très petit, la charge et la décharge sont quasi instantanées

II. Mise en forme des signaux

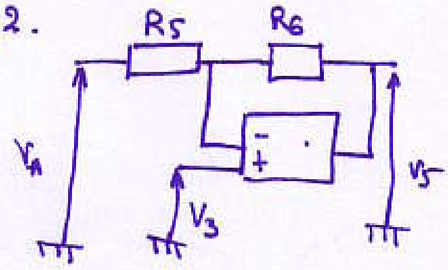
$V_S = f(V_3, V_4)$

2.1. $V^+ = V^- = V_4$



$$V_4 = \frac{R_3}{R_3+R_4} V_A$$

2.2.



$V^+ = V^- = V_3$

$$V_3 = \frac{R_5 V_5 + R_6 V_A}{R_5+R_6}$$

$$R_5 V_5 = V_3 (R_5+R_6) - R_6 V_A$$

$$V_5 = \frac{R_5+R_6}{R_5} V_3 - \frac{R_6}{R_5} V_A$$

2.3. $$V_5 = \left(\frac{R_5}{R_5} + \frac{R_6}{R_5}\right) V_3 - \frac{R_6}{R_5}\left(1 + \frac{R_4}{R_3}\right) V_4$$

$$V_5 = \left(1 + \frac{R_6}{R_5}\right) V_3 - \frac{R_6}{R_5}\left(1 + \frac{R_4}{R_3}\right) V_4$$

2.4. $V_5 = A_D (V_3 - V_4) + A_{nc} (V_3 + V_4)/2$

2.4.1 si $V_3 = V_4$ $\quad V_5 = \frac{A_{nc}}{2}(V_3 + V_4) = A_{nc} V_4$.

$V_5 = A_{nc} V_3$ $\quad V_5 = \left[1 + \frac{R_6}{R_5} - \frac{R_6}{R_5}\left(1 + \frac{R_4}{R_3}\right)\right] V_3$.

donc $A_{nc} = 1 - \frac{R_6}{R_5} \times \frac{R_4}{R_3}$.

2.4.2 si $V_3 = -V_4$ $\quad V_5 = 2 A_D V_3$

$$V_5 = \left[1 + \frac{R_6}{R_5} + \frac{R_6}{R_5}\left(1 + \frac{R_4}{R_3}\right)\right] V_3 .$$

donc $2A_D = 1 + \frac{2R_6}{R_5} + \frac{R_6 R_4}{R_5 R_3}$

2.5. $A_{nc} = 1 - \frac{R_6 R_4}{R_5 R_3} = 0 \Rightarrow \frac{R_6 R_4}{R_5 R_3} = 1$

Soit $R_6 R_4 = R_5 R_3$. Soit $A_D = \frac{1}{2}\left(2 + \frac{2R_6}{R_5}\right) = 1 + \frac{R_6}{R_5}$

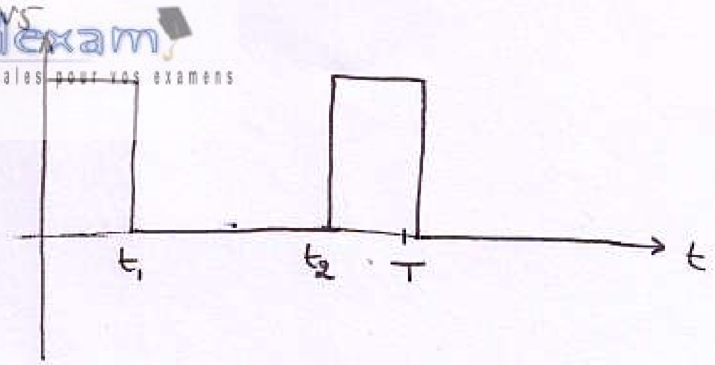
2.6. $R_5 = R_4 = 20\ k\Omega = R$.

$$\begin{cases} R_6 R_4 = R_5 R_3 \\ 1 + \frac{R_6}{R_5} = 1{,}5 \end{cases} \Rightarrow \begin{cases} R_6 = R_3 \\ 1 + \frac{R_6}{R_5} = 1{,}5 \end{cases} \qquad \frac{R_6}{R_5} = 0{,}5 \Rightarrow R_6 = R_5 \times 0{,}5 = 10\ k\Omega$$

Donc $R_5 = R_4 = 20\ k\Omega$

$R_6 = R_3 = 10\ k\Omega$.

2.7



III. Choix d'un CAN

3.1. $v_S = 5{,}54\,(1 + 0{,}5\,H_R)$

$0 < H_R < 1$.

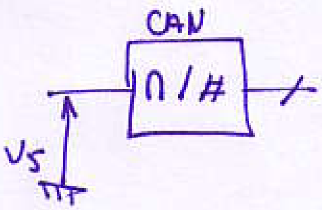
$5{,}54 < 5{,}54\,(1 + 0{,}5\,H_R) < 8{,}31$.

3.2. $\Delta v_S = \dfrac{\partial v_S}{\partial H_R}\,\Delta H_R$.

$\Delta v_S = 0{,}5 \times 5{,}54\,\Delta H_R = 2{,}77\,\Delta H_R$ si $\Delta H_R = 0{,}005$

$\Delta v_S = 0{,}01385\,V$.

3.3.



entre $5{,}54 < v_S < 8{,}31$.

On veut un $q = 0{,}0139$ or $q = \dfrac{U_{max}}{\text{nd (bit)}}$

$(5\% = 0{,}005 = \Delta H_R)$

si $N_{bit} = 8 \Rightarrow 255$

$N_{bit} = 12 \Rightarrow 4095$

ici $U_{max} = 10$.

$q_1 = \dfrac{10}{255} = 0{,}0392 > q$

$q_2 = \dfrac{10}{4095} = 0{,}00244 < q$ donc ok

$\boxed{\text{CAN4}}$