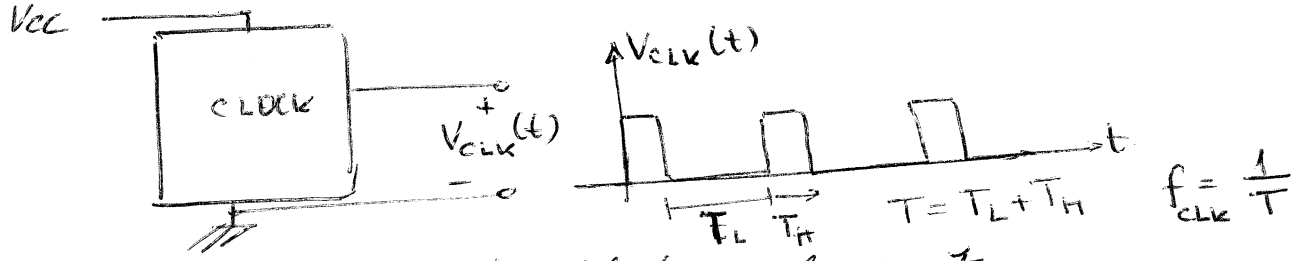
22.3.2.- Circuits de rellotge (astable)

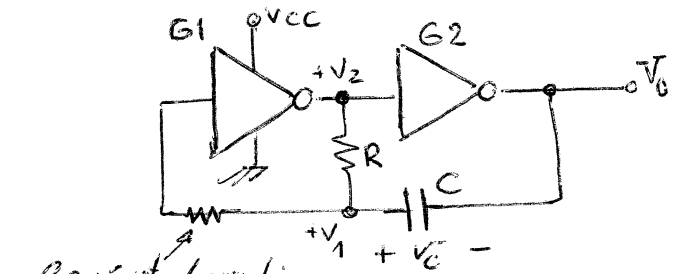
Rellotge amb portes lògiques i RC.

És tracta del bloc que genera el sincronisme CLK per al funcionament dels sistemes seqüencials síncrons.

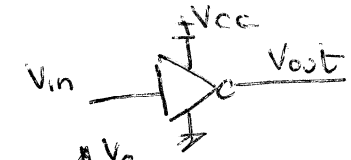


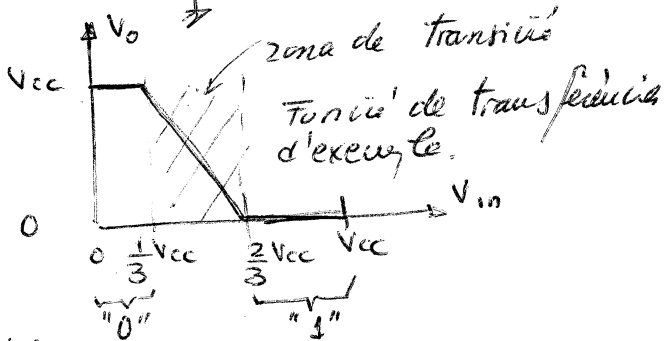
La forma d'ona depèn del tipus de circuit.

Exemple de circuit astable

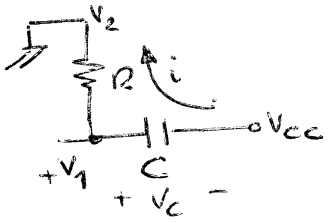


Aquí pot haver-hi una $R \simeq 1M\Omega$





- Suposem $\left.\begin{matrix} V_C(0^-) = 0V \text{ (condensador descarregat)} \\ V_0(0^+) = V_{cc} \;;\; V_2(0^+) = 0V \end{matrix}\right\}$



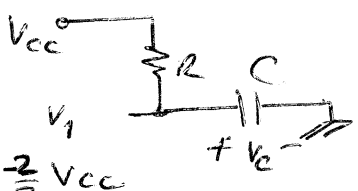
$$\left.\begin{matrix} V_C(\infty) = -V_{cc} \\ V_C(0^+) = 0 \end{matrix}\right\} V_C(t) = -V_{cc}\left(1 - e^{-t/\tau}\right)$$

$$V_1(t) = V_C(t) + V_0 = V_{cc}\, e^{-t/\tau}$$

Quan $t = t_1$; $V_1(t_1) \geq \frac{1}{3}V_{cc}$ G1 deixarà d'interpretar un "0" a l'entrada

$$\frac{1}{3}V_{cc} = V_{cc}\, e^{-t_1/\tau} \Rightarrow t_1 = (\ln 3)\cdot RC$$

- Ara per $\underline{t > t_1}$ el circuit equivalent és



$V_2 = V_{cc}$
$V_0 = 0$

$$V_C(t_1) = -V_{cc}\left(1 - e^{-t_1/\tau}\right) = \frac{2}{3}V_{cc}$$

$V_C(\infty) = V_{cc}$

$$V_C(t - t_1) = V_{cc} - \left(V_{cc} - \left(-\frac{2}{3}V_{cc}\right)\right) e^{-(t-t_1)/\tau} = V_{cc}\left(1 - \frac{5}{3}e^{\frac{-(t-t_1)}{\tau}}\right)$$

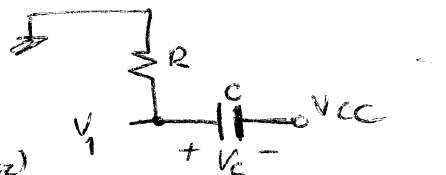
$$\Rightarrow V_1(t - t_1) = V_C(t - t_1) + 0V = V_{cc}\left(1 - \frac{5}{3}e^{-\frac{(t-t_1)}{\tau}}\right)$$

Per $t=t_2$ la tensió $V_1(t)$ haurà arribat a $\frac{2}{3}V_{cc}$ i el comutarà

$$V_c(t_2-t_1) = V_1(t_2-t_1) = \frac{2}{3}V_{cc} = V_{cc}\left(1-\frac{5}{3}e^{-\frac{(t_2-t_1)}{\tau}}\right)$$

$$\frac{5}{3}e^{-\frac{(t_2-t_1)}{\tau}} = 1-\frac{2}{3} = \frac{1}{3} \Rightarrow T_L = t_2-t_1 = \tau\cdot(\ln 5) = \underline{RC\cdot\ln 5}$$

- Ara per $t>t_2$ el circuit equivalent és



$$V_c(\infty) = -V_{cc}$$

$$V_c(t_2) = \frac{2}{3}V_{cc}$$

$$v_c(t-t_2) = -V_{cc} - \left(-V_{cc}-\frac{2}{3}V_{cc}\right)e^{-\frac{(t-t_2)}{\tau}} = -V_{cc}\left(1-\frac{5}{3}e^{-\frac{(t-t_2)}{\tau}}\right)$$

$$V_1(t-t_2) = v_c(t-t_2) + V_0 = V_{cc}\frac{5}{3}\cdot e^{-\frac{(t-t_2)}{\tau}}$$

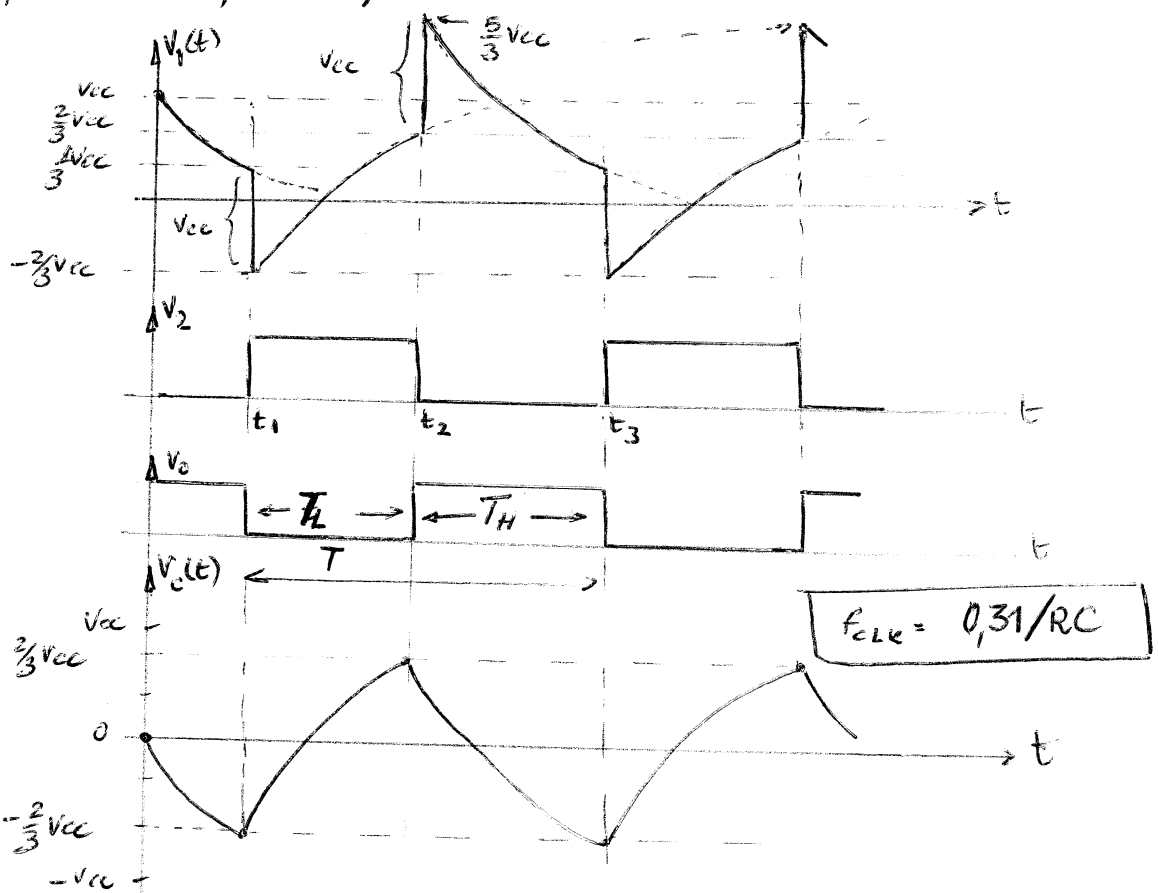
Per $t=t_3$, quan $V_1(t_3-t_2) = \frac{1}{3}V_{cc}$ torna a comutar el

$$V_1(t_3-t_2) = \frac{5}{3}V_{cc}e^{-\frac{(t_3-t_2)}{\tau}} = \frac{1}{3}V_{cc} \Rightarrow T_H = t_3-t_2 = \underline{RC\cdot\ln 5}$$

A partir d'ara, els intervals de commutació són idèntics i s'obté:

$$f_{CLK} = 1/T = \frac{1}{(T_H+T_L)} = \boxed{\frac{1}{2RC\ln 5}}$$

Ex: $f = 1MHz$; $C = 10pF \Rightarrow R = 31{,}066\ k\Omega \Rightarrow R \simeq 31\ k\Omega$



$$f_{CLK} = 0{,}31/RC$$

→ La f_{CLK} depèn de RC i de la tecnologia de les portes. És un inconvenient greu.