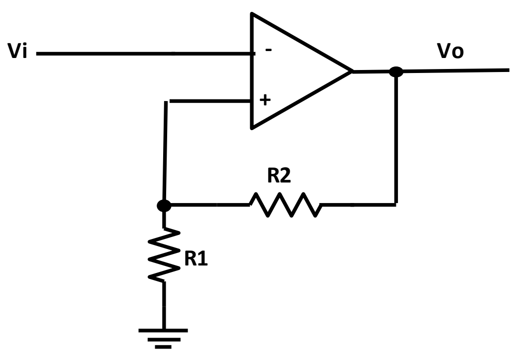
TEMA 6: EL TEMPORIZADOR INTEGRADO 555

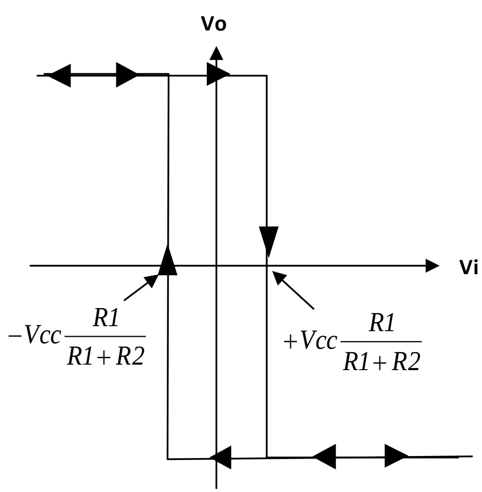
Introducción: Multivibrador monoestable

(Generación de pulsos de tensión con señal externa de disparo)

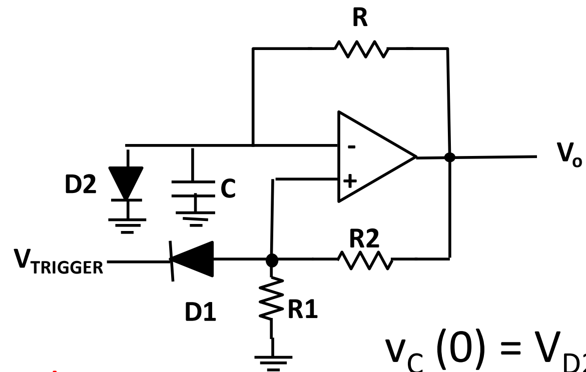
Disparador Schmitt



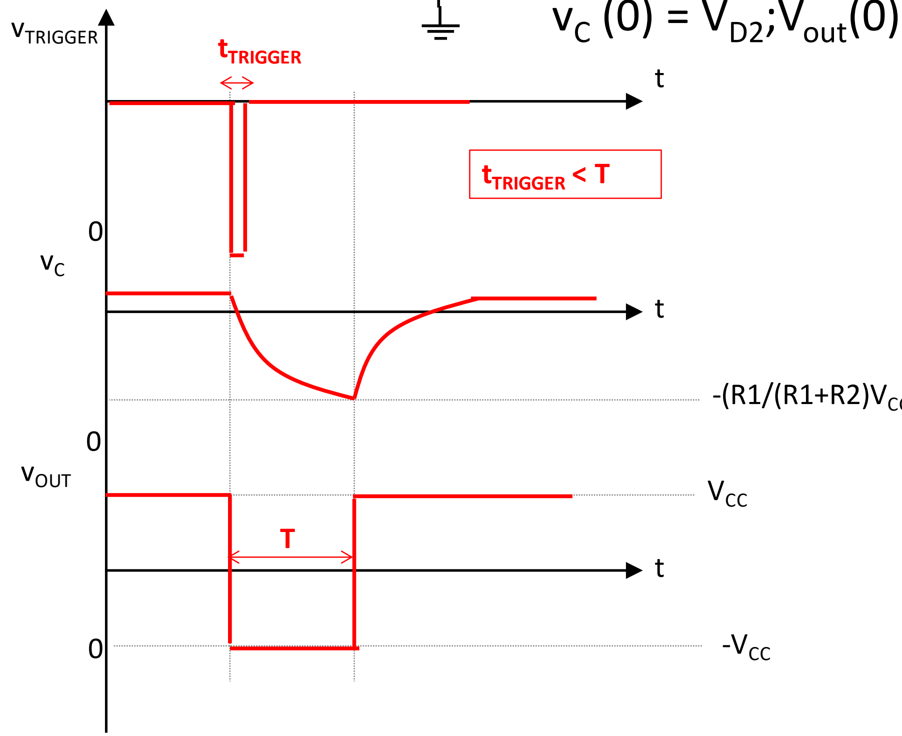
Función de transferencia



Multivibrador monoestable



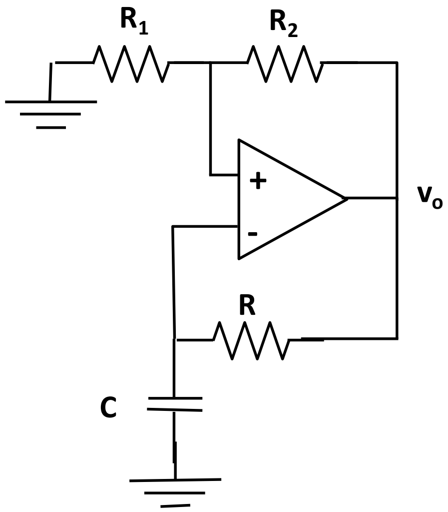
$v_C(0) = V_{D2}; V_{out}(0) = +V_{CC}$



Introducción: Multivibrador astable

(Autodisparado: generación continua pulsos de tensión)

Oscilador de relajación



Formas de onda

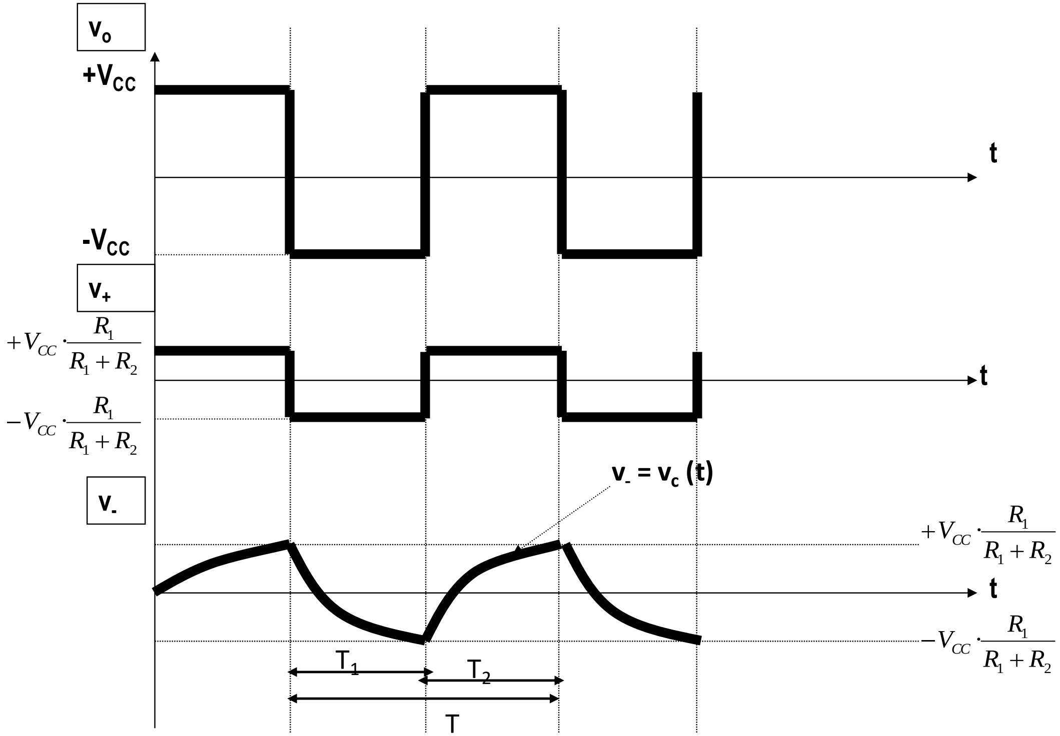
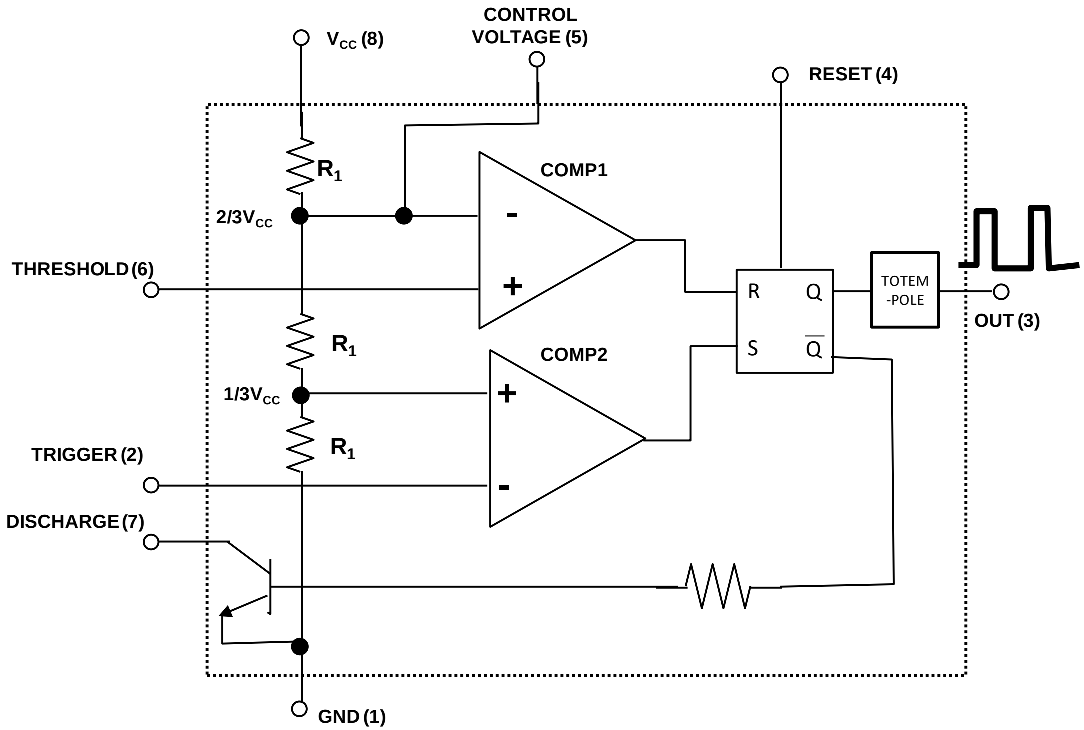
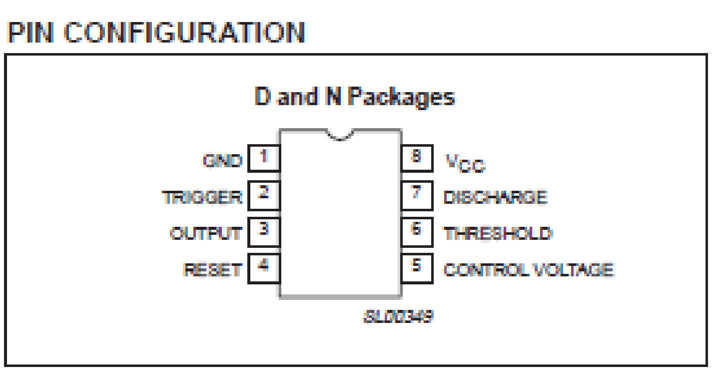


Diagrama de bloques





Modos de funcionamiento:

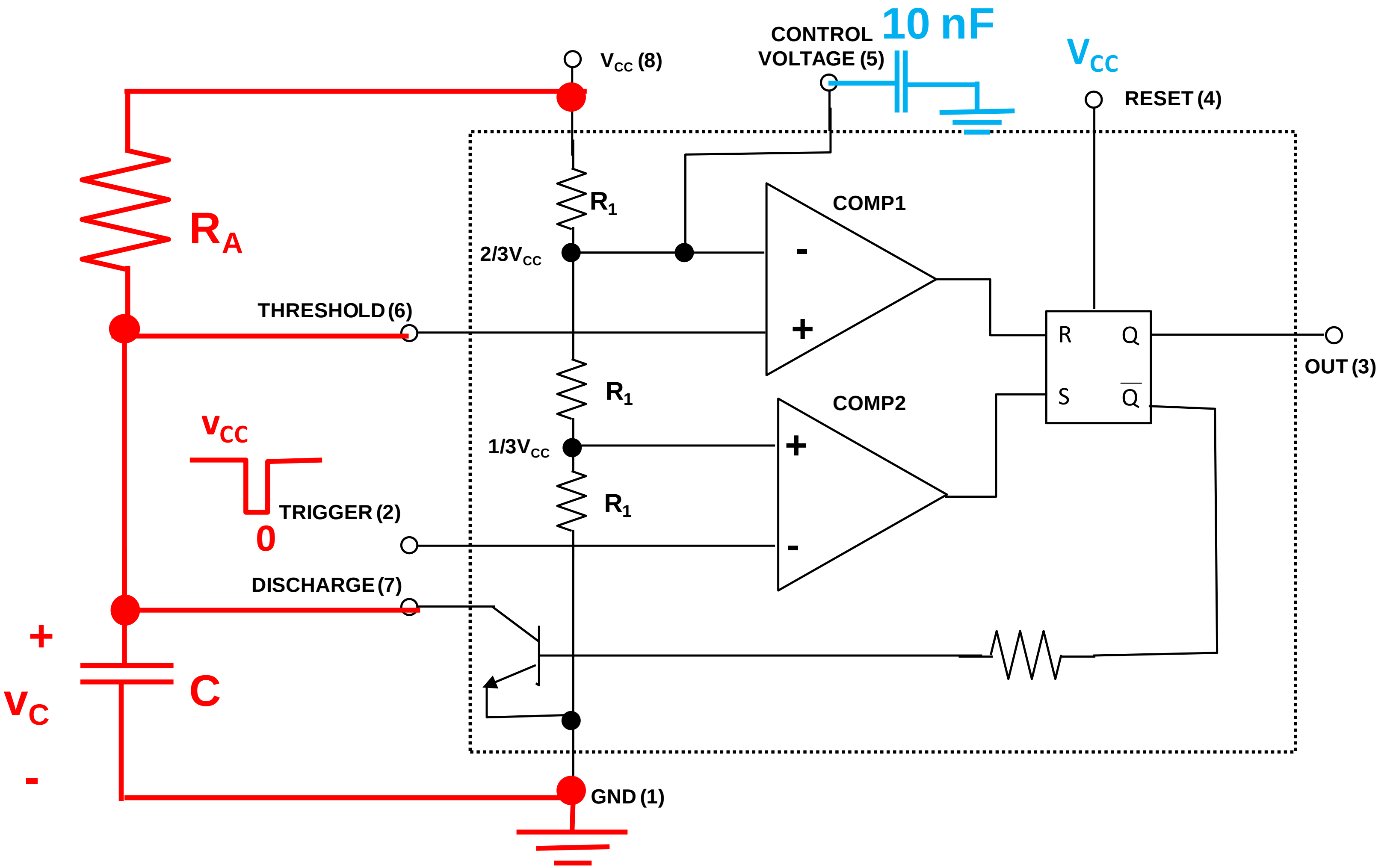
- Modo monoestable: Señal externa disparo (TRIGGER)
- Modo astable: Autodisparo (TRIGGER = THRESHOLD)

Biestable RS

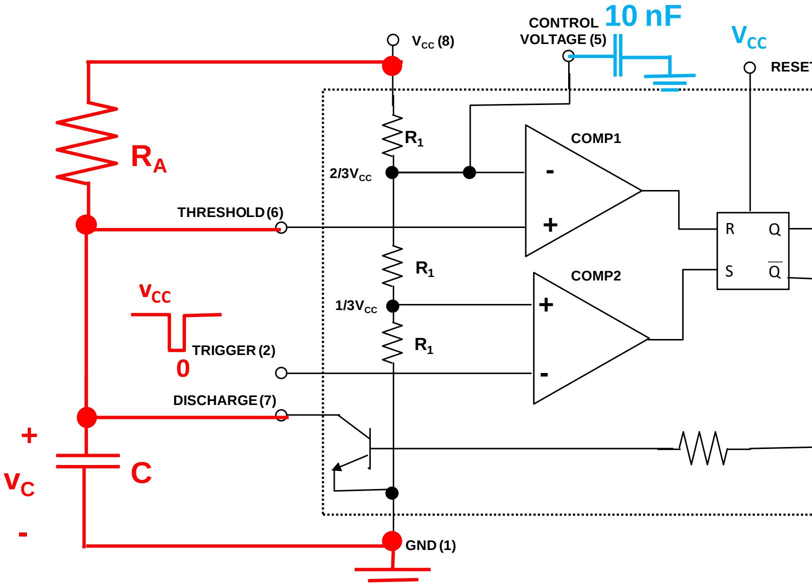
R	S	Q_t
0	0	Q_{t-1}
0	1	1
1	0	0
1	1	X

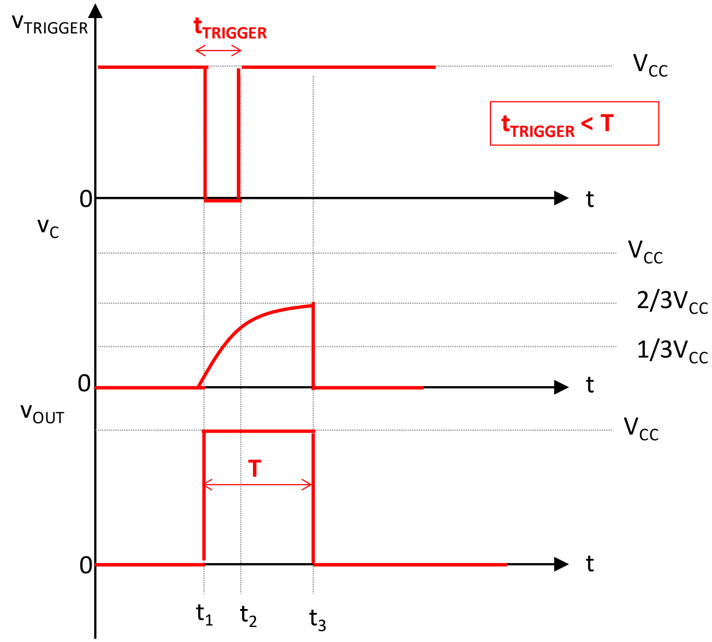
"1" → V_{CC}
"0" → GND (0V)

Modo monoestable



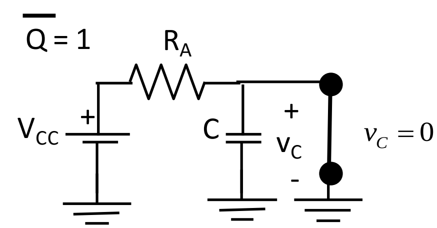
Modo monoestable

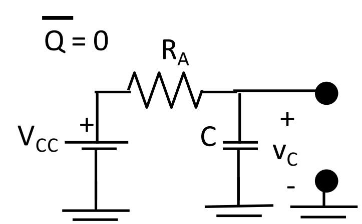




$v_C(0) = 0; V_{out}(0) = 0$

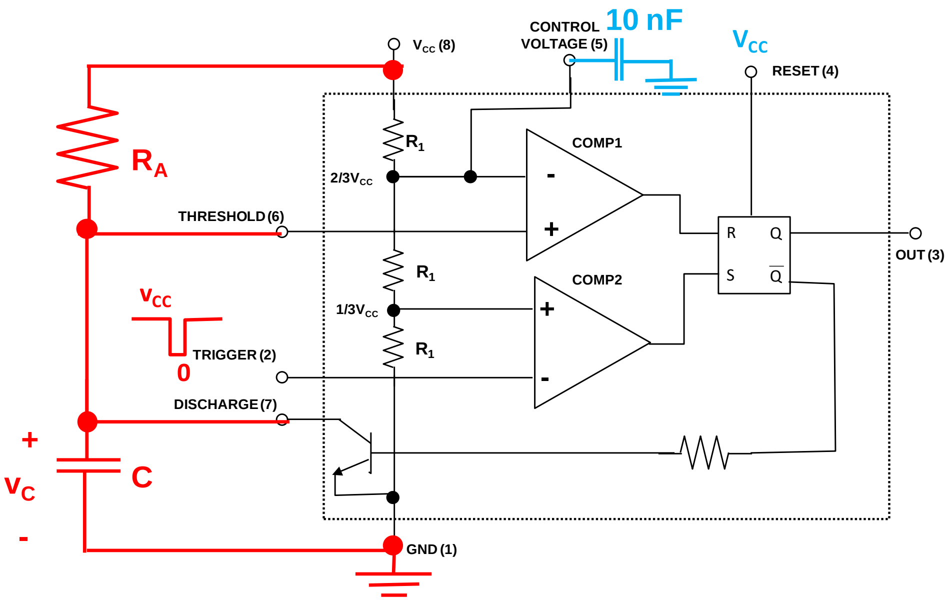
	COMP1			COMP2					
t	V_+	V_-	R	V_+	V_-	S	V_{OUT}	$\overline{Q}$	v_C
[0-t$_1$)	**0**	**2/3V$_{CC}$**	**0**	**1/3V$_{CC}$**	**V$_{CC}$**	**0**	**0**	**1**	**0**
t$_1$	**0**	**2/3V$_{CC}$**	**0**	**1/3V$_{CC}$**	**0**	**1**	**1**	**0**	**v$_C$ (t)**
(t$_1$-t$_2$)	v$_C$ **(t)**	**2/3V$_{CC}$**	**0**	**1/3V$_{CC}$**	**0**	**1**	**1**	**0**	**v$_C$ (t)**
[t$_2$-t$_3$)	v$_C$ **(t)**	**2/3V$_{CC}$**	**0**	**1/3V$_{CC}$**	**V$_{CC}$**	**0**	**1**	**0**	**v$_C$ (t)**
t$_3$	**↑2/3V$_{CC}$**	**2/3V$_{CC}$**	**1**	**1/3V$_{CC}$**	**V$_{CC}$**	**0**	**0**	**1**	0
>t$_3$	**0**	**2/3V$_{CC}$**	**0**	**1/3V$_{CC}$**	**V$_{CC}$**	**0**	**0**	**1**	**0**

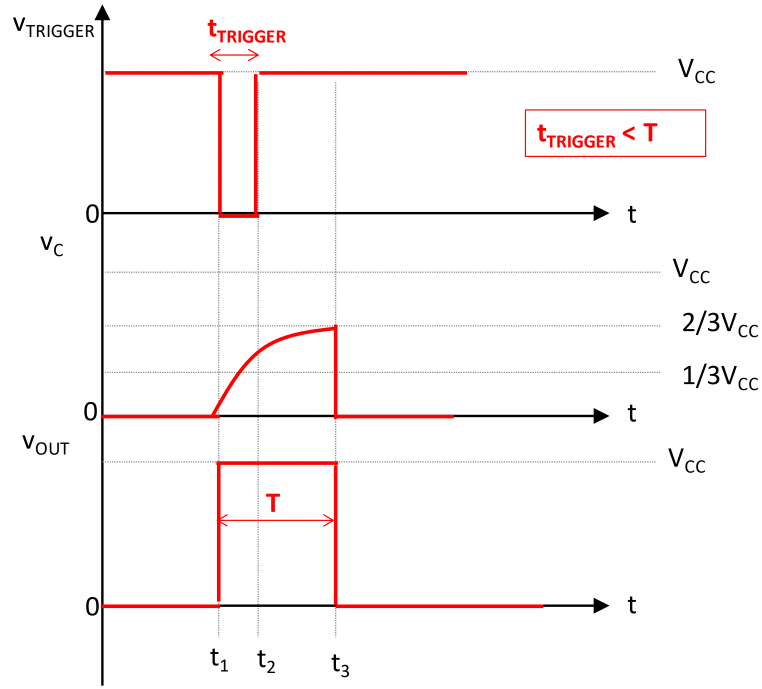




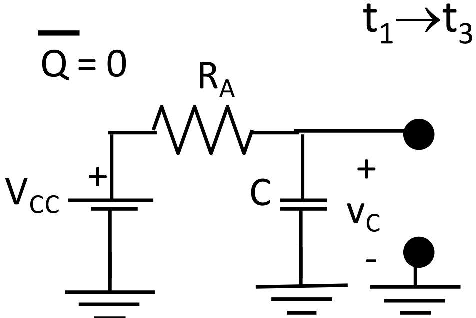
$$v_C(t) = v_{C(t\to\infty)} + \left(v_{C(t=0)} - v_{C(t\to\infty)}\right)e^{-\frac{t}{\tau}}$$

Modo monoestable





$t_1 \rightarrow t_3$: carga del condensador

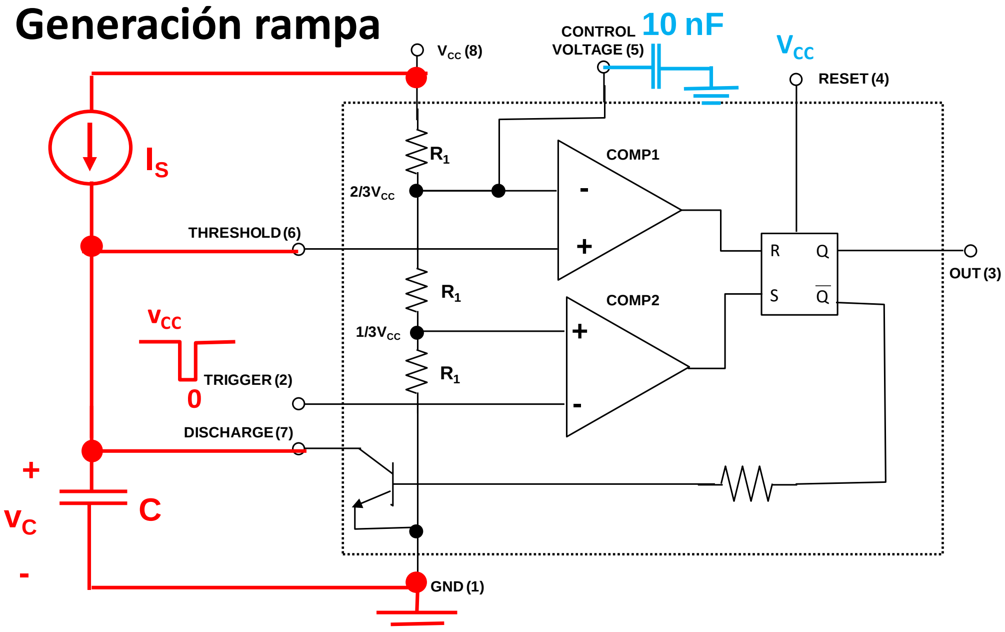


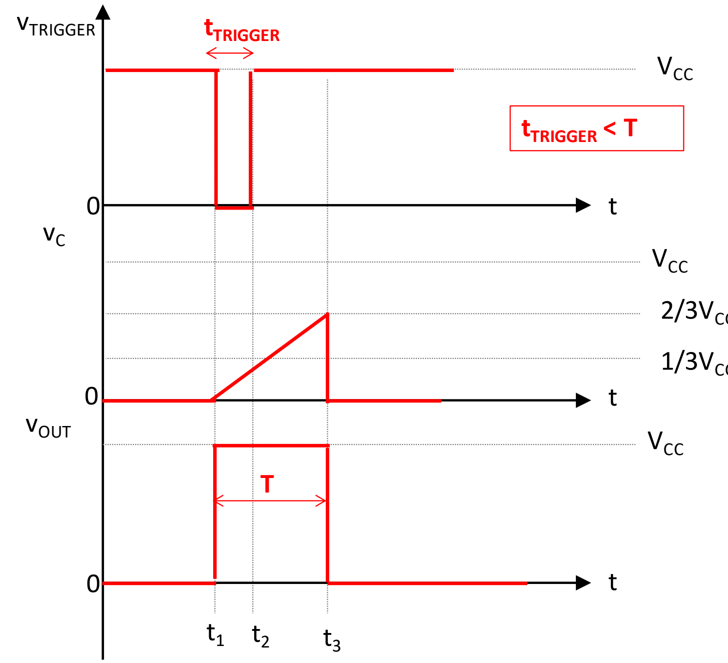
$$v_C(T) = V_{CC} + (0 - V_{CC}) \cdot e^{-\frac{T}{R_A \cdot C}} = \frac{2}{3} V_{CC}$$

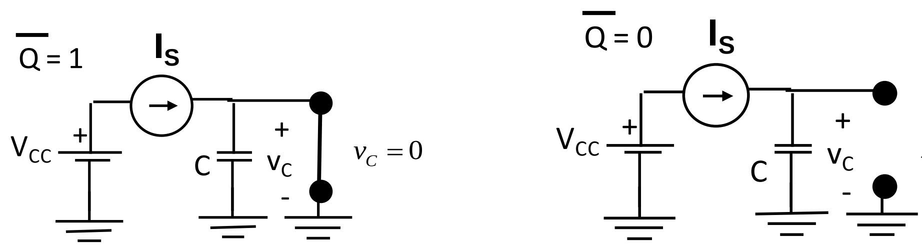
$$\Rightarrow T = -R_A \cdot C \cdot \ln\left(\frac{1}{3}\right) \Rightarrow \boxed{T = R_A \cdot C \cdot \ln(3) = 1.1 \cdot R_A \cdot C}$$

$$v_C(t) = v_{C(t\to\infty)} + \left(v_{C(t=0)} - v_{C(t\to\infty)}\right) e^{-\frac{t}{\tau}}$$

Generación rampa





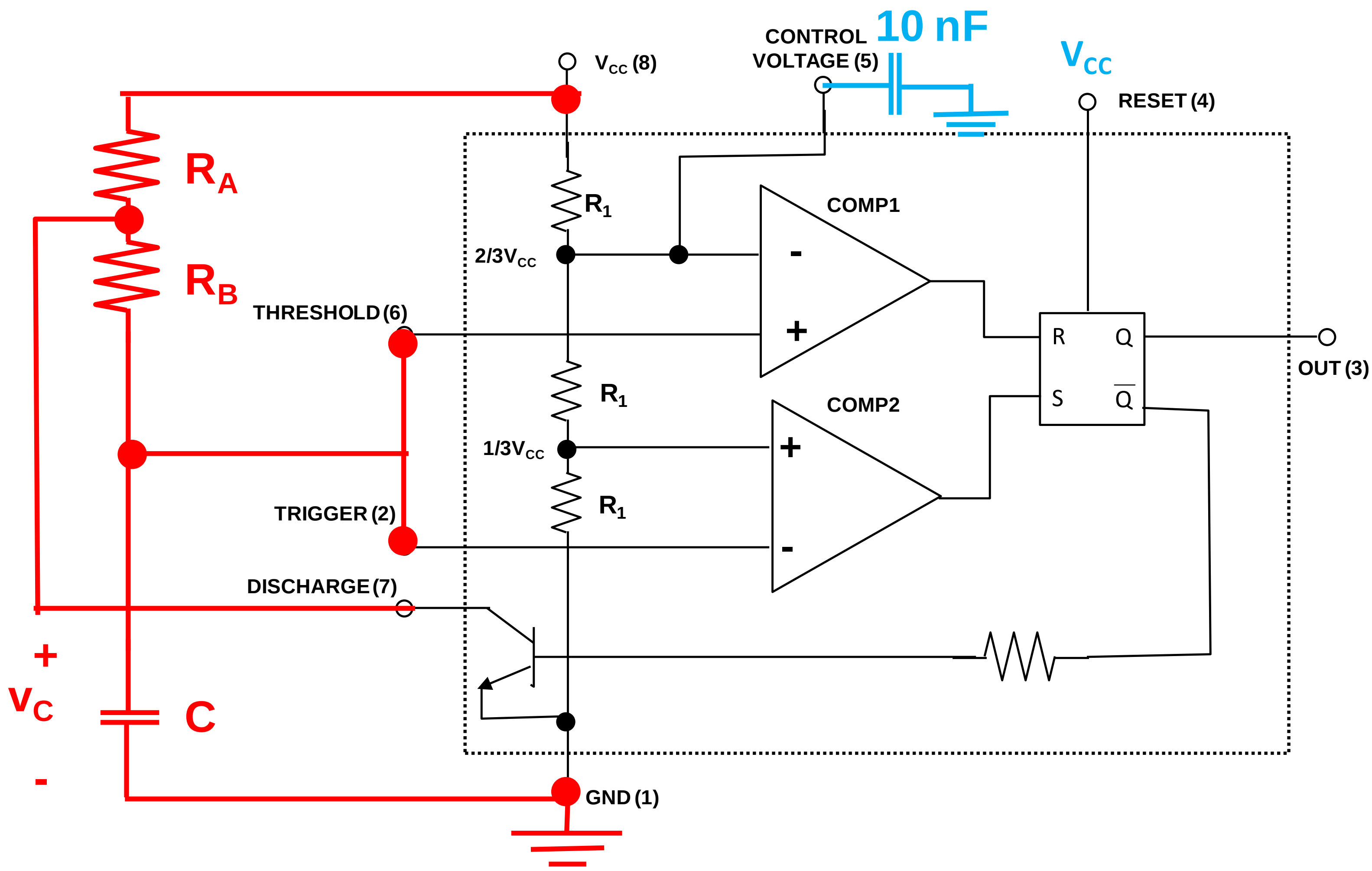


$$I_S = i_C = C\frac{dv_C}{dt} \Rightarrow v_C(t) = \frac{1}{C}\int I_S dt + v_C(0)$$

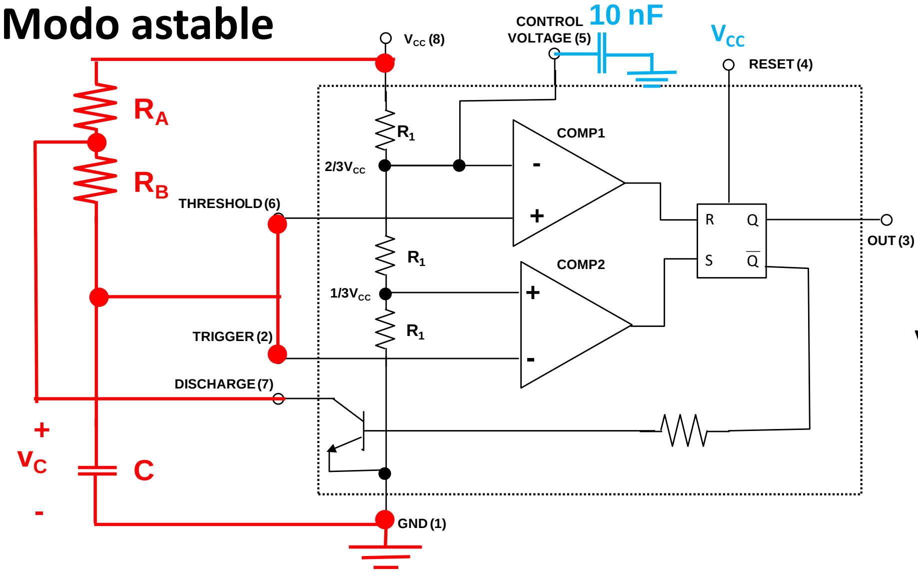
$t_1 \rightarrow t_3$: carga del condensador (corriente constante)

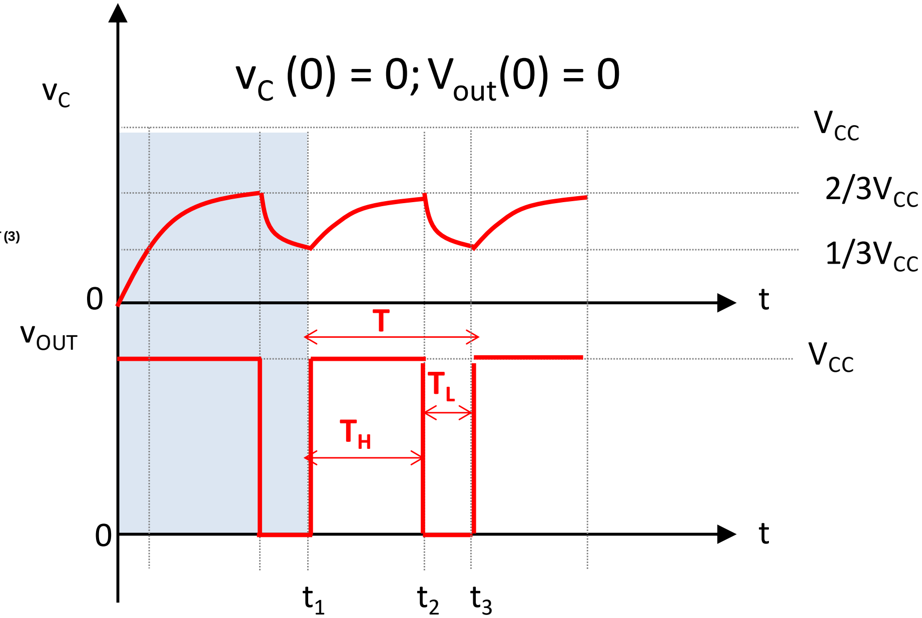
$$v_C(T) = \frac{1}{C}\cdot\int_0^T I_S dt + v_C(0) = \frac{2}{3}V_{CC} \Rightarrow \frac{T\cdot I_S}{C} = \frac{2}{3}V_{CC} \Rightarrow T = \frac{2}{3}V_{CC}\cdot\frac{C}{I_S}$$

Modo astable



Modo astable





$$t = t_1 : v_C(t) \downarrow \frac{1}{3} V_{CC}$$

$$\Rightarrow \begin{Bmatrix} R = 0 \\ S = 1 \end{Bmatrix} \Rightarrow \begin{Bmatrix} V_{OUT} = 1 \\ \overline{Q} = 0 \end{Bmatrix} \Rightarrow Carga \quad C$$

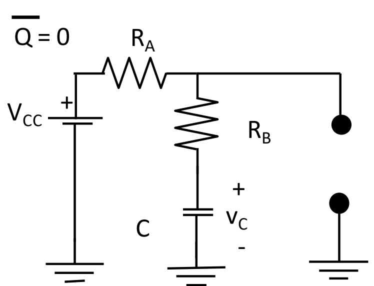
① ② ③

$$t = t_2 : v_C(t) \uparrow \frac{2}{3} V_{CC}$$

$$\Rightarrow \begin{Bmatrix} R = 1 \\ S = 0 \end{Bmatrix} \Rightarrow \begin{Bmatrix} V_{OUT} = 0 \\ \overline{Q} = 1 \end{Bmatrix} \Rightarrow Descarga \quad C$$

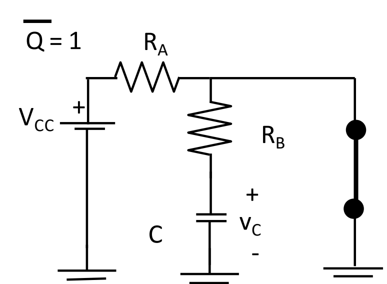
$$\begin{matrix} t_2 > t > t_1 \\ t_3 > t > t_2 \end{matrix} \Bigg\} \Rightarrow \frac{2}{3} V_{CC} > v_C(t) > \frac{1}{3} V_{CC}$$

$$\Rightarrow \begin{Bmatrix} R = 0 \\ S = 0 \end{Bmatrix} \Rightarrow \begin{Bmatrix} V_{OUT} = V_{OUT-1} \\ \overline{Q} = \overline{Q}_{-1} \end{Bmatrix}$$



Carga C

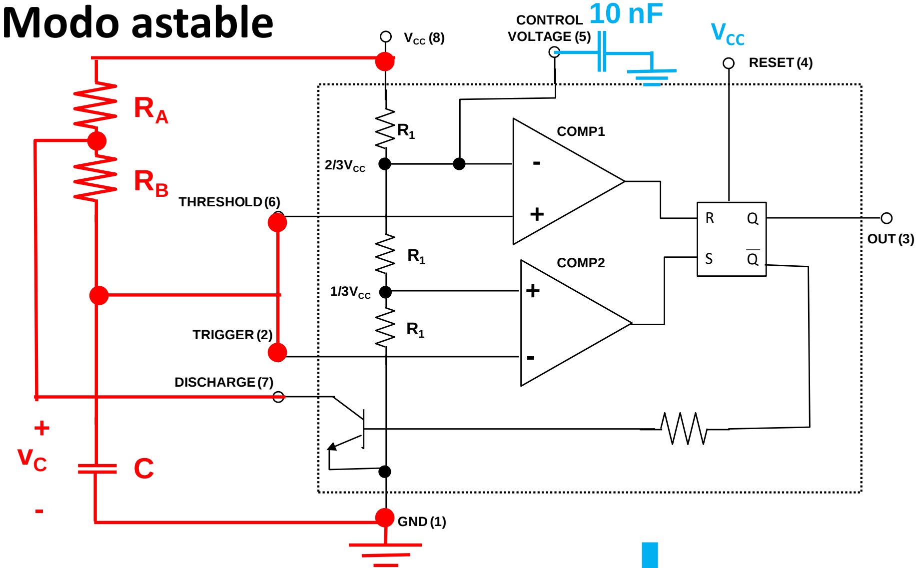
$$v_C(t) = v_{C(t\to\infty)} + \left(v_{C(t=0)} - v_{C(t\to\infty)}\right) e^{-\frac{t}{(R_A+R_B)\cdot C}}$$

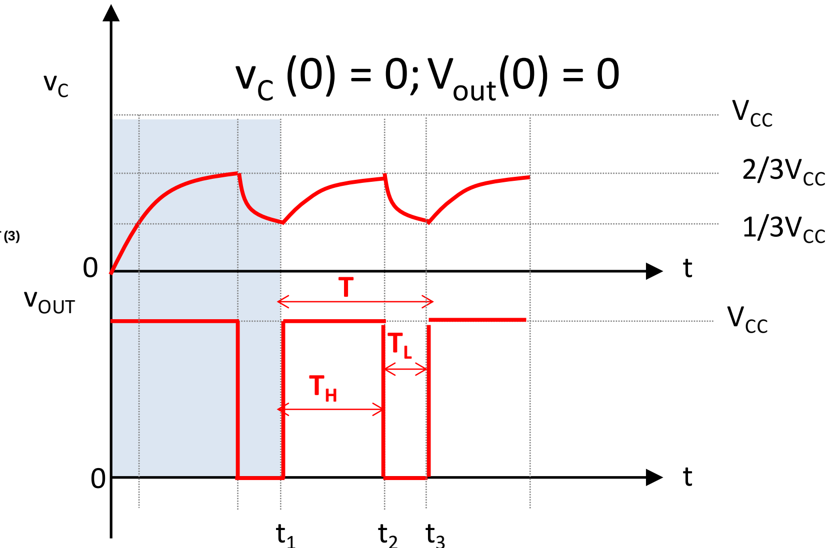


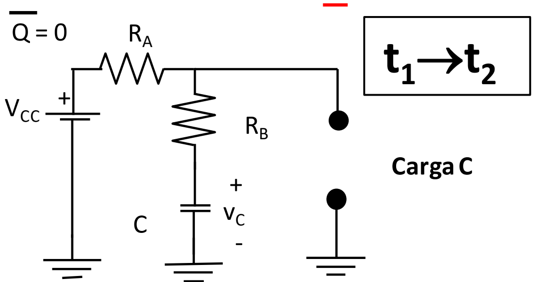
Descarga C

$$v_C(t) = v_{C(t\to\infty)} + \left(v_{C(t=0)} - v_{C(t\to\infty)}\right) e^{-\frac{t}{R_B\cdot C}}$$

Modo astable





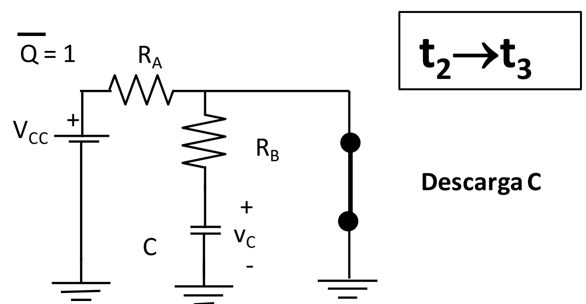


$$v_C(t) = v_{C(t\to\infty)} + \left(v_{C(t=0)} - v_{C(t\to\infty)}\right) e^{-\frac{t}{(R_A+R_B)\cdot C}}$$

$$v_C(T_H) = V_{CC} + \left(\frac{1}{3}V_{CC} - V_{CC}\right) \cdot e^{-\frac{T_H}{(R_A+R_B)\cdot C}} = \frac{2}{3}V_{CC}$$

$$\Rightarrow T_H = -(R_A + R_B) C \cdot \ln\left(\frac{1}{2}\right) \Rightarrow$$

$$T_H = (R_A + R_B) C \cdot \ln(2) = 0.7 \cdot (R_A + R_B) C$$



$$v_C(t) = v_{C(t\to\infty)} + \left(v_{C(t=0)} - v_{C(t\to\infty)}\right) e^{-\frac{t}{R_B\cdot C}}$$

$$v_C(T_L) = 0 + \left(\frac{2}{3}V_{CC} - 0\right) \cdot e^{-\frac{T_L}{(R_B)\cdot C}} = \frac{1}{3}V_{CC}$$

$$\Rightarrow T_L = -(R_B) C \cdot \ln\left(\frac{1}{2}\right) \Rightarrow T_L = (R_B) C \cdot \ln(2) = 0.7 \cdot R_B \cdot C$$

$$T = T_H + T_L = \ln(2) \cdot C \cdot (R_A + 2R_B)$$

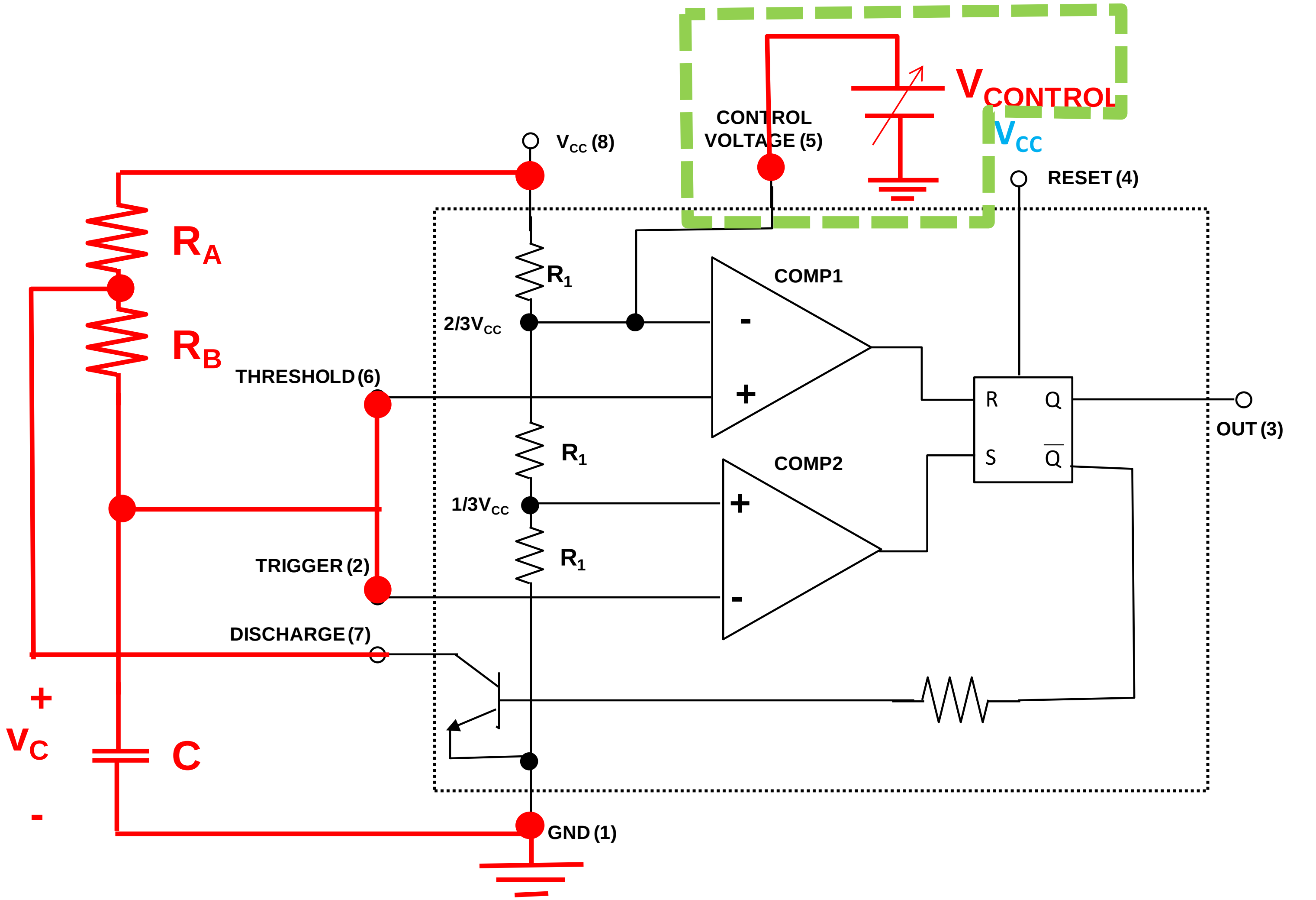
$$CT(\%) = \frac{T_H}{T} \cdot 100$$

$$CT(\%) = \frac{\ln(2) \cdot C \cdot (R_A + R_B)}{\ln(2) \cdot C \cdot (R_A + 2R_B)} \cdot 100$$

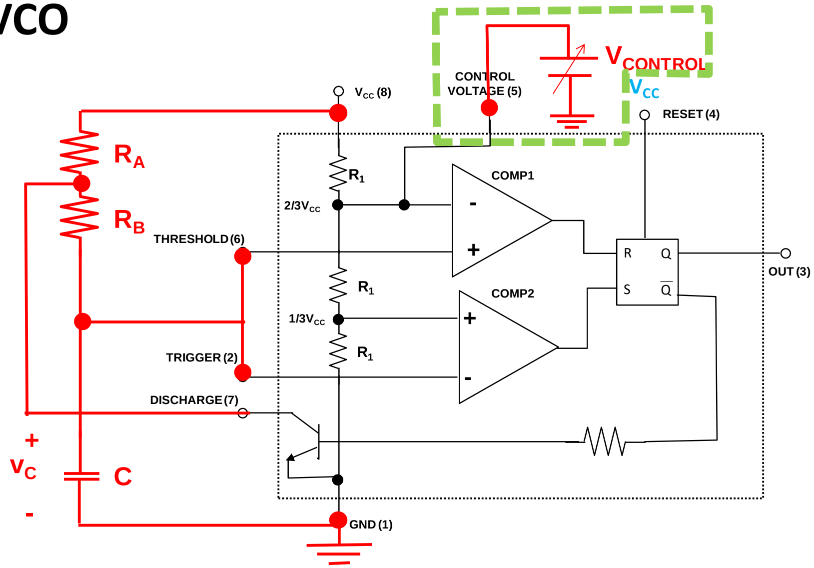
$$CT(\%) = \frac{R_A + R_B}{R_A + 2R_B} \cdot 100 > 50\%$$

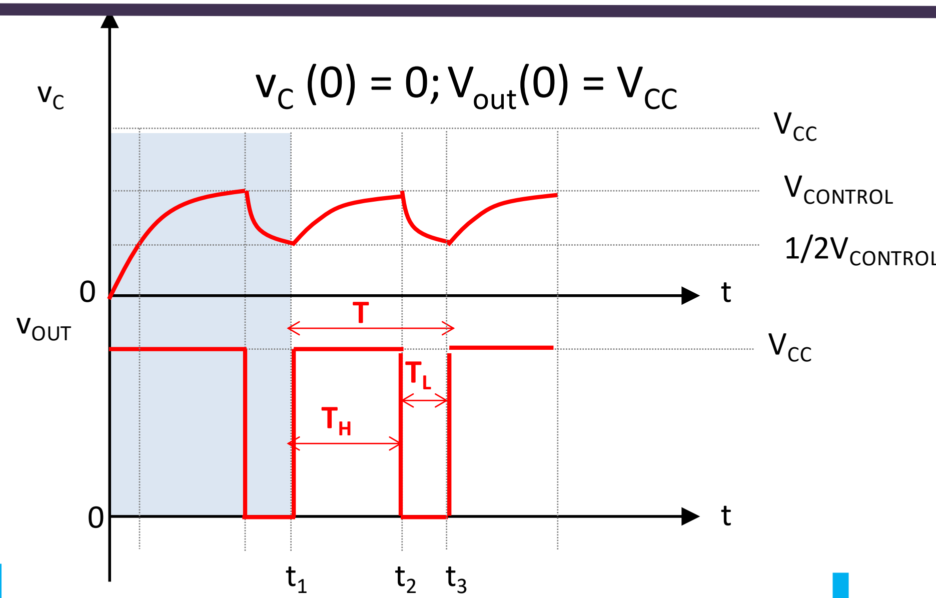
$$CT(\%) \approx 50\% \Rightarrow R_A << R_B$$

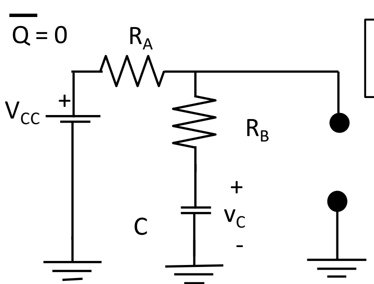
VCO


V CONTROL
CONTROL VOLTAGE (5)
Vcc
Vcc (8)
RESET (4)
RA
RB
R1
2/3Vcc
COMP1
THRESHOLD (6)
R
Q
S
Q
OUT (3)
COMP2
1/3Vcc
TRIGGER (2)
DISCHARGE (7)
+
Vc
-
C
GND (1)

VCO







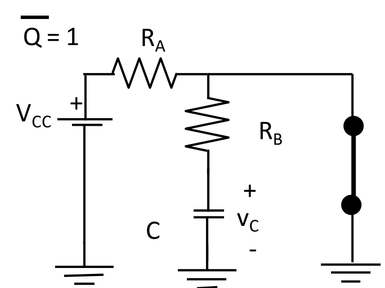
$t_1 \rightarrow t_2$

Carga C

$$v_C(t) = v_{C(t\rightarrow\infty)} + \left(v_{C(t=0)} - v_{C(t\rightarrow\infty)}\right) e^{-\frac{t}{(R_A+R_B)\cdot C}}$$

$$v_C(T_H) = V_{CC} + \left(\frac{1}{2}V_{CONTROL} - V_{CC}\right)\cdot e^{-\frac{T_H}{(R_A+R_B)\cdot C}} = V_{CONTROL}$$

$$\Rightarrow T_H = (R_A + R_B)\cdot C \cdot \ln\left(\frac{V_{CONTROL} - 2V_{CC}}{2V_{CONTROL} - 2V_{CC}}\right)$$



$t_2 \rightarrow t_3$

Descarga C

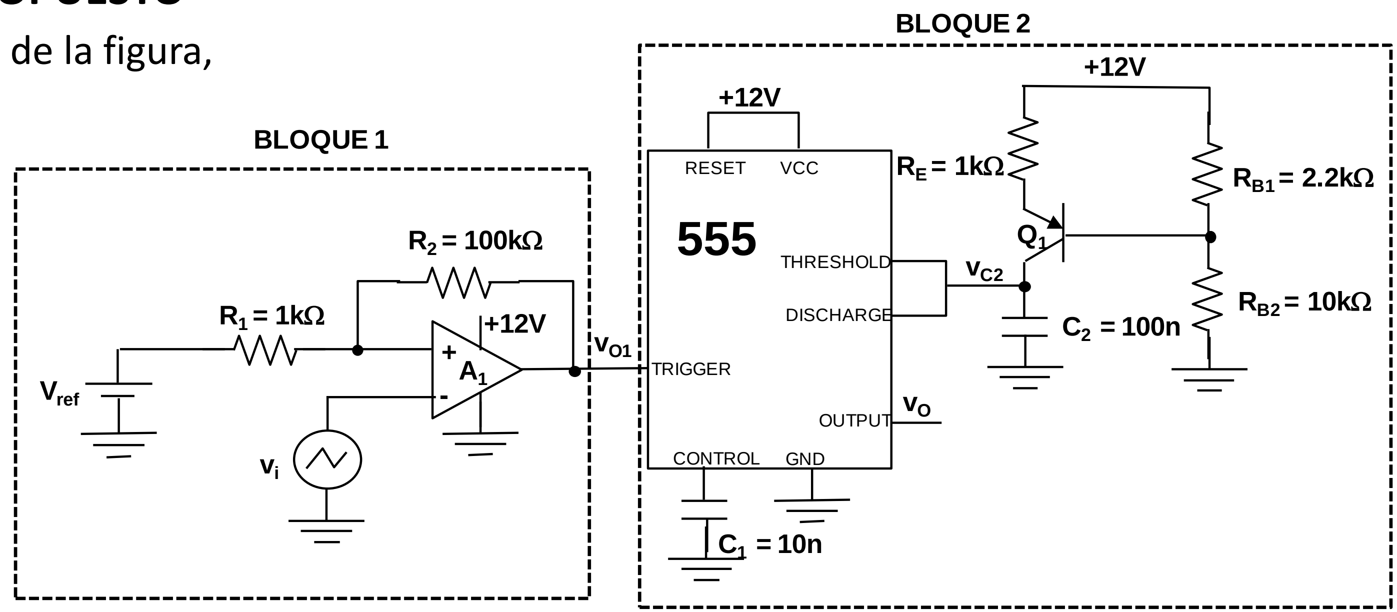
$$v_C(t) = v_{C(t\rightarrow\infty)} + \left(v_{C(t=0)} - v_{C(t\rightarrow\infty)}\right) e^{-\frac{t}{R_B\cdot C}}$$

$$v_C(T_L) = 0 + \left(V_{CONTROL} - 0\right) e^{-\frac{T_L}{(R_B)\cdot C}} = \frac{1}{2}V_{CONTROL}$$

$$\Rightarrow T_L = (R_B)\cdot C \cdot \ln(2) = 0.69\cdot R_B \cdot C$$

EJERCICIO PROPUESTO

Dado el circuito de la figura,



<u>Datos:</u> **A_1**: Amplificador operacional ideal

v_i: Señal triangular de 1kHz, 2.5V de amplitud y 2.5V de offset

Q_1: $V_{BEactiva}$ = 0.6V, V_{CEsat} =0.2V, β = 250

Se pide:

•Obtenga y represente la función de transferencia del primer bloque (v_{o1} en función de v_i).

•Deduzca el valor de la fuente de tensión continua, V_{ref}, para que el ciclo de trabajo de la tensión v_{o1} sea del 80%

•Describa el funcionamiento del segundo bloque y represente las señales v_{o1}, v_{c2} y v_o en función del tiempo, acotando los valores significativos en los ejes de tensión y tiempo e incluyendo todos los cálculos para la determinación de dichos valores.