Multivibratori

Retroazione positiva: multivibratori e generatori di funzione

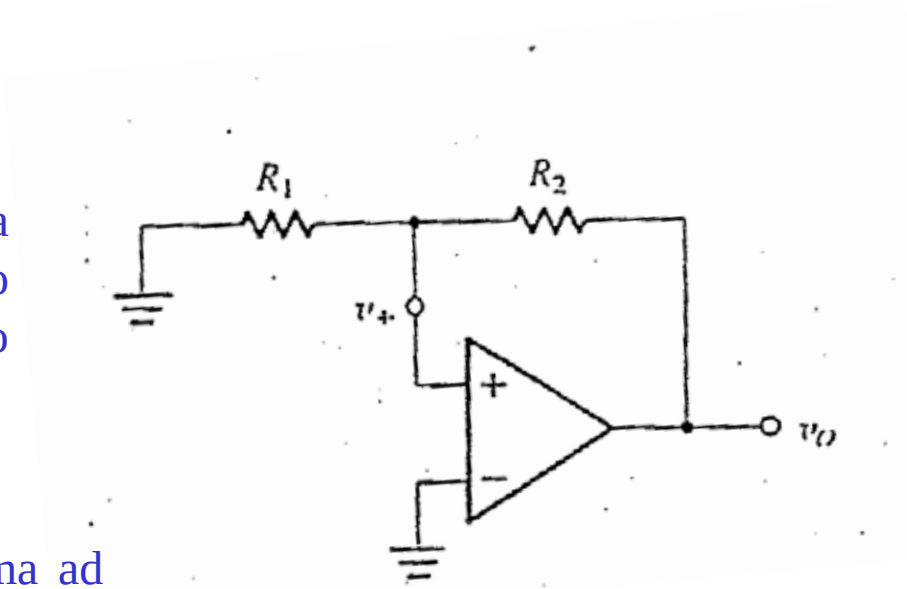
Oscillatori non lineari o generatori di funzione servono per generare delle forme d'onda sfruttando la retroazione positiva e fanno uso di una classe di circuiti detti **multivibratori**.

Esistono tre tipi di multivibratori:

- Bistabili (comparatori)
- Astabili (generatori di forme d'onda quadre e triangolari)
- Monostabili (generatori di impulsi)

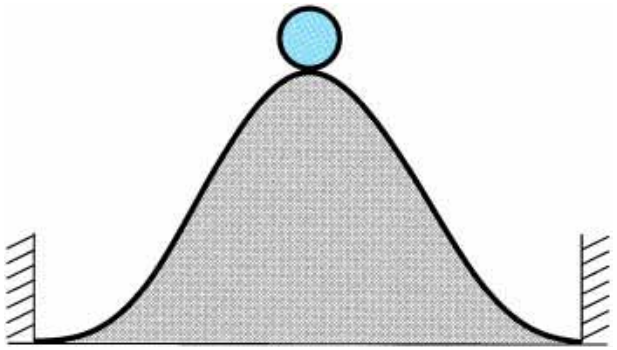
Trigger di Schmitt o multivibratore bistabile

multivibratore bistabile in quanto presenta due stati stabili, e si muove da uno stato stabile all'altro solo quando viene applicato un opportuno trigger.



Analogia fisica è quella di una palla in cima ad una collina che rappresenta uno stato di equilibrio instabile. L'inevitabile presenza di disturbi faranno sì che la palla cada in uno dei due stati stabili da un lato o dall'altro.

Il trigger di Schmitt può essere invertente o non invertente.

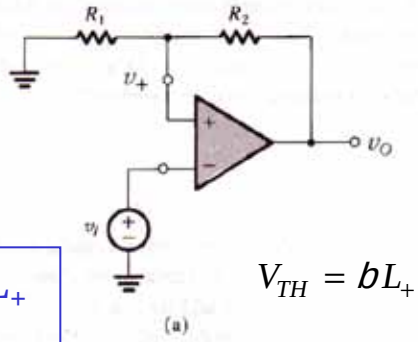


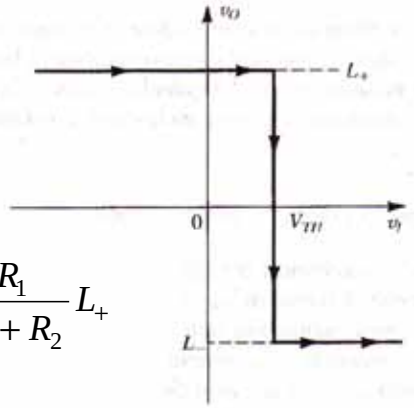
Trigger di Schmitt invertente

v_I crescente, $v_o = L_+$ (fig. b)

Finché $v_I < V_{TH} = \beta L_+$ Þ $v_d > 0$, $v_o = L_+$, $v_+ = \beta L_+$

Quando $v_I > V_{TH} = \beta L_+$ Þ $v_d < 0$, $v_o = L_-$, $v_+ = \beta L_-$





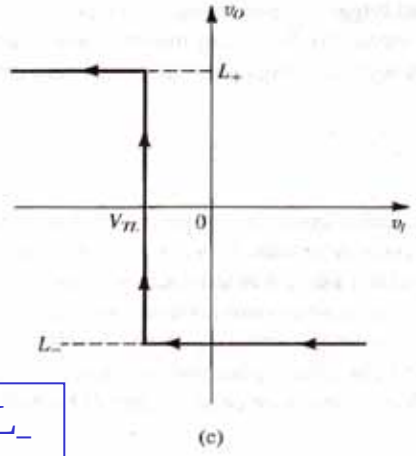
$$V_{TH} = \beta L_+ = \frac{R_1}{R_1 + R_2} L_+$$

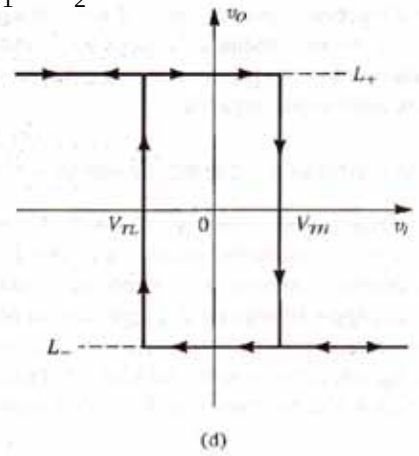
$$V_{TL} = \beta L_- = \frac{R_1}{R_1 + R_2} L_-$$

v_I decrescente, $v_o = L_-$ (fig. c)

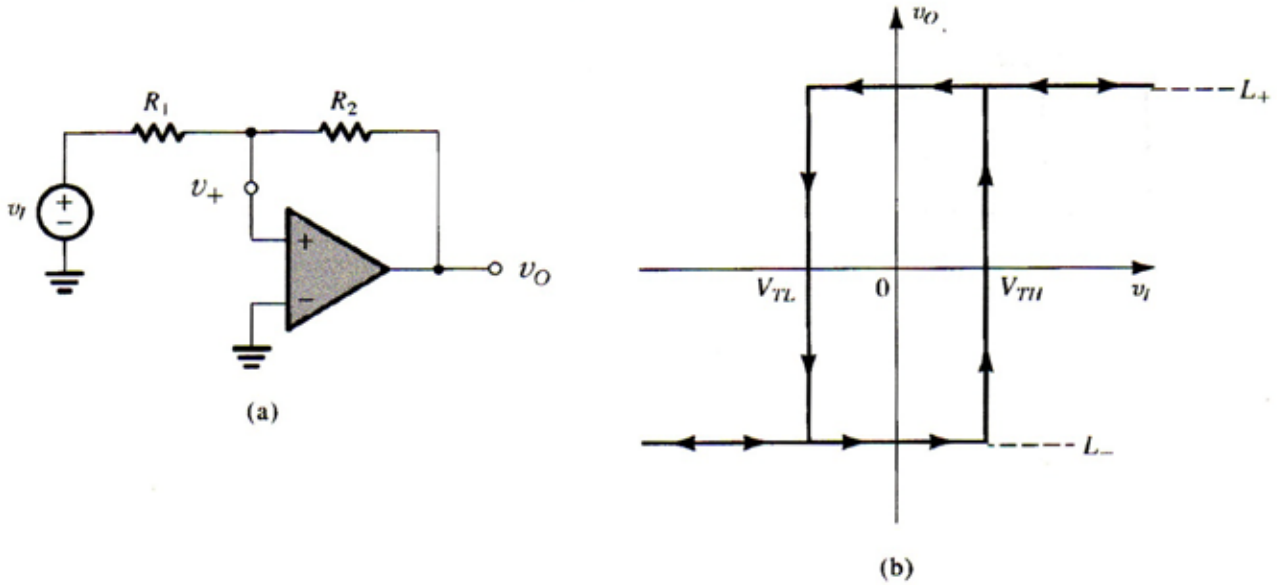
Finché $v_I > V_{TL} = \beta L_-$ Þ $v_d < 0$, $v_o = L_-$, $v_+ = \beta L_-$

Quando $v_I < V_{TL} = \beta L_-$ Þ $v_d > 0$, $v_o = L_+$, $v_+ = \beta L_+$





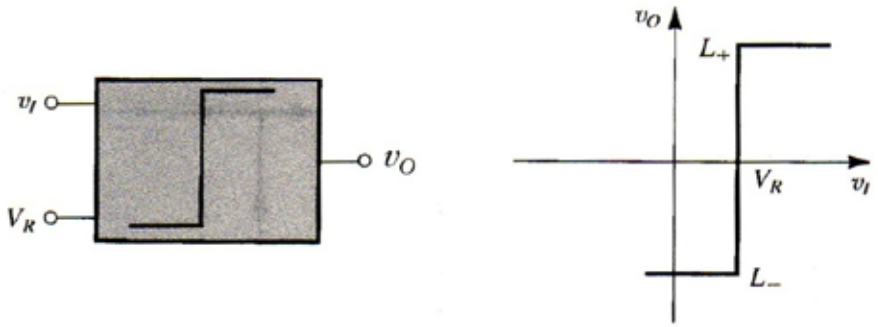
Trigger di Schmitt non invertente



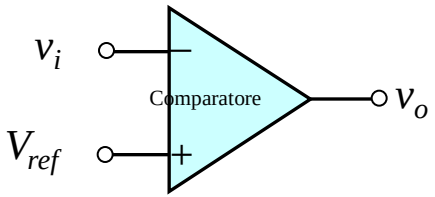
$$v_+ = v_I \frac{R_2}{R_2 + R_1} + v_O \frac{R_1}{R_2 + R_1}$$

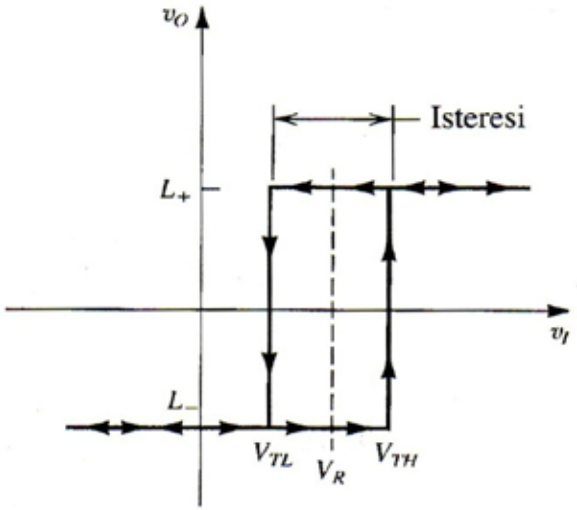
$$V_{TL} = -\frac{R_1}{R_2} L_+ \; V_{TH} = -\frac{R_1}{R_2} L_- ,$$

Comparatore

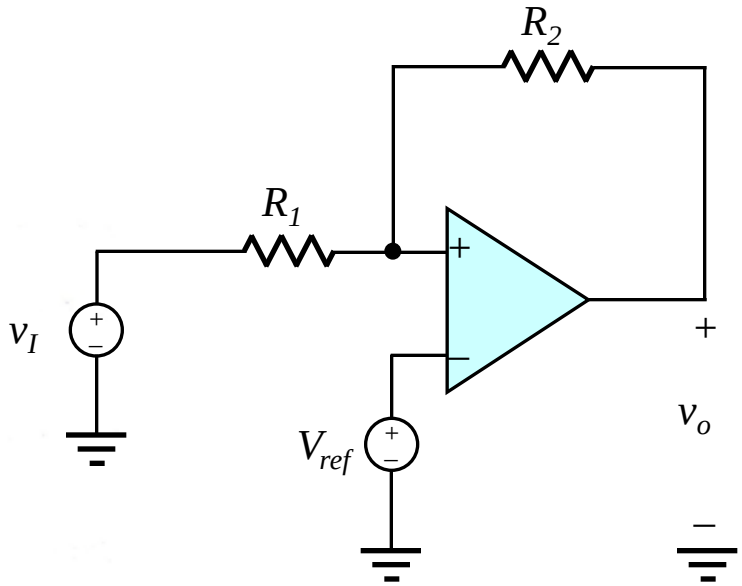


(a) ***Comparatore***

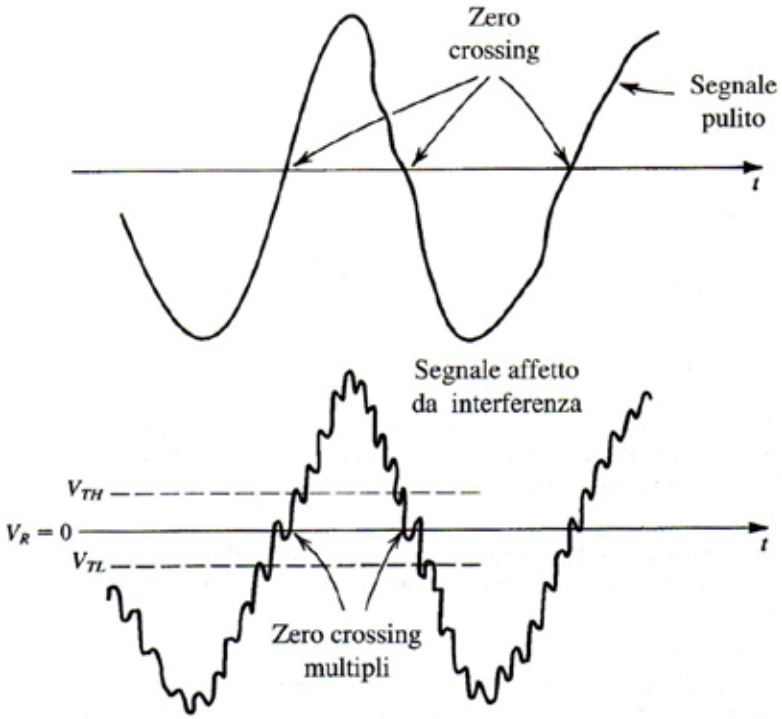


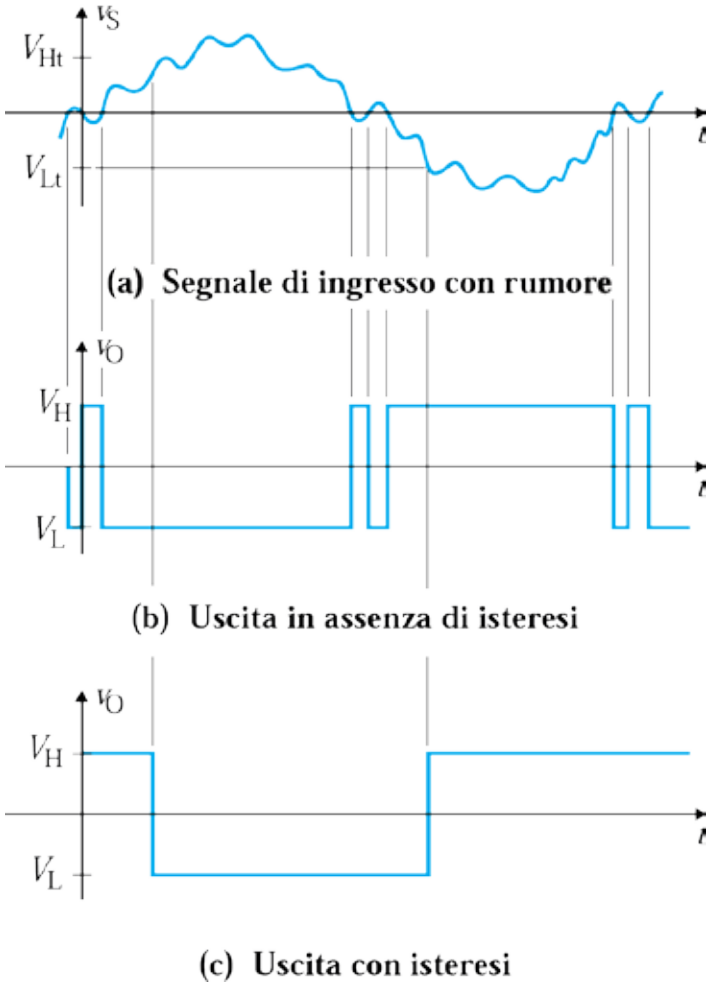


(b) ***Comparatore con isteresi***

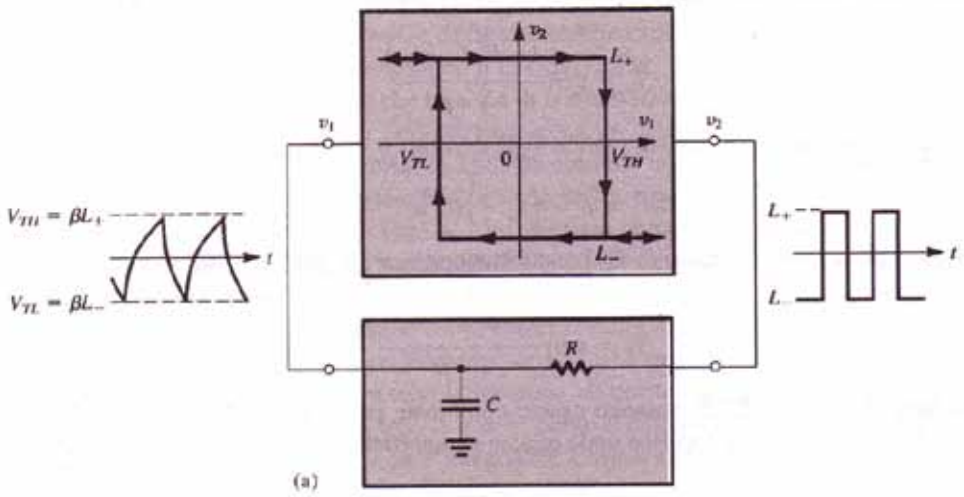


Una possibile applicazione dei comparatori: rivelatore di *zero-crossing*





Multivibratore astabile: generatore d'onda quadra



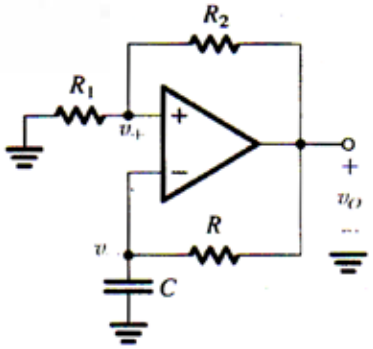
$$v_- = L_+ - (L_+ - bL_-)e^{-t/t} \quad t = CR$$

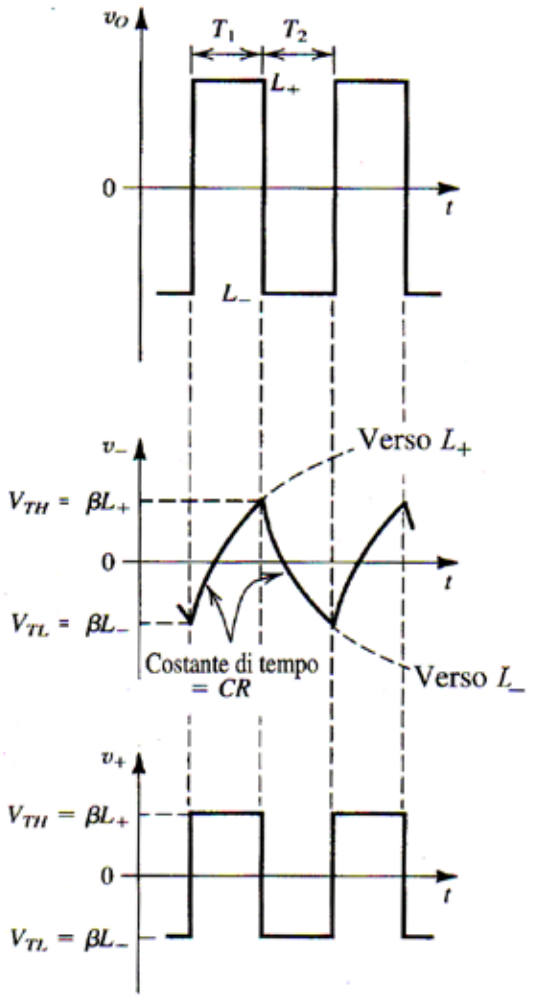
$$T_1 = t \ln \frac{1 - b(L_-/L_+)}{1 - b}$$

$$v_- = L_- - (L_- - bL_+)e^{-t/t}$$

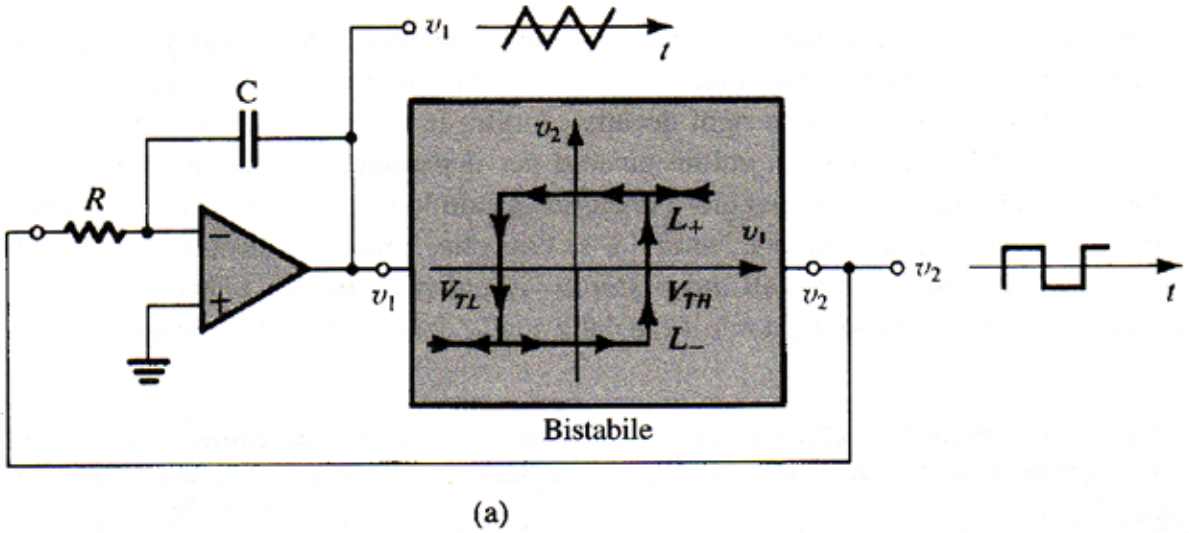
$$T_2 = t \ln \frac{1 - b(L_+/L_-)}{1 - b}$$

$$L_+ = -L_- \;\Rightarrow\; T = T_1 + T_2 = 2t \ln \frac{1+b}{1-b}$$

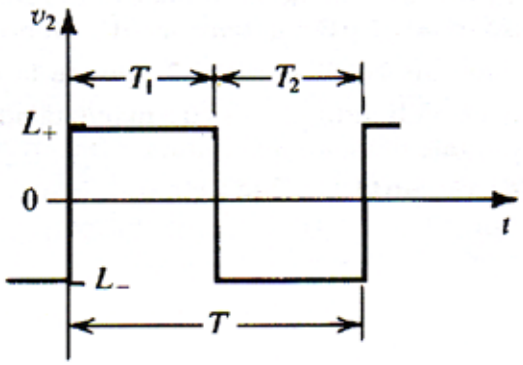




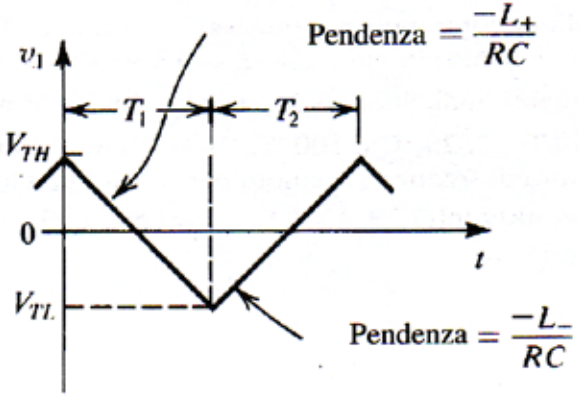
Multivibratore astabile: generatore d'onda triangolare



(a)



(b)



(c)

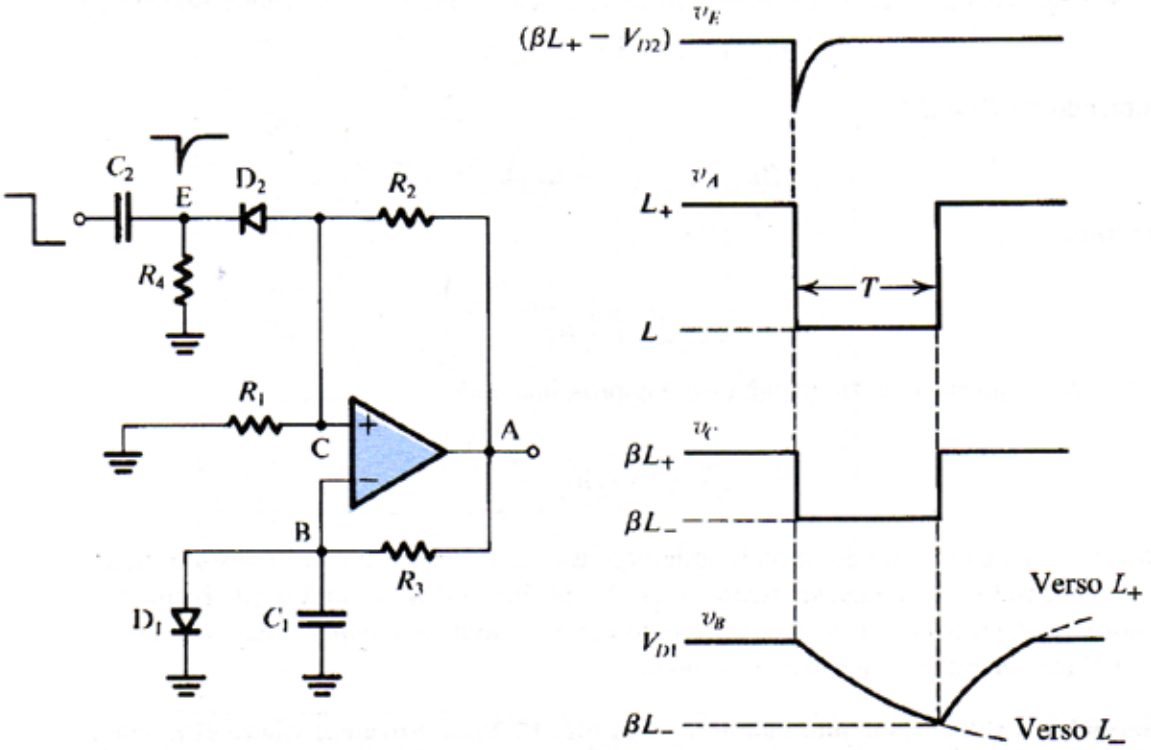
$$\frac{V_{TH} - V_{TL}}{T_1} = \frac{L_+}{CR}$$

$$T_1 = CR\frac{V_{TH} - V_{TL}}{L_+}$$

$$\frac{V_{TH} - V_{TL}}{T_2} = \frac{-L_-}{CR}$$

$$T_2 = CR\frac{V_{TH} - V_{TL}}{-L_-}$$

Multivibratore monostabile: generatore di impulsi di durata controllata



$$v_B(t) = L_- - (L_- - V_{D1})e^{-t/C_1R_3}$$

$$\beta L_- = L_- - (L_- - V_{D1})e^{-T/C_1R_3}$$

$$T = C_1R_3 \ln\left(\frac{V_{D1} - L_-}{\beta L_- - L_-}\right) \gg C_1R_3 \ln\left(\frac{1}{1-\beta}\right)$$