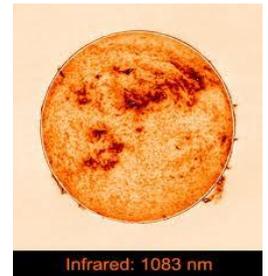
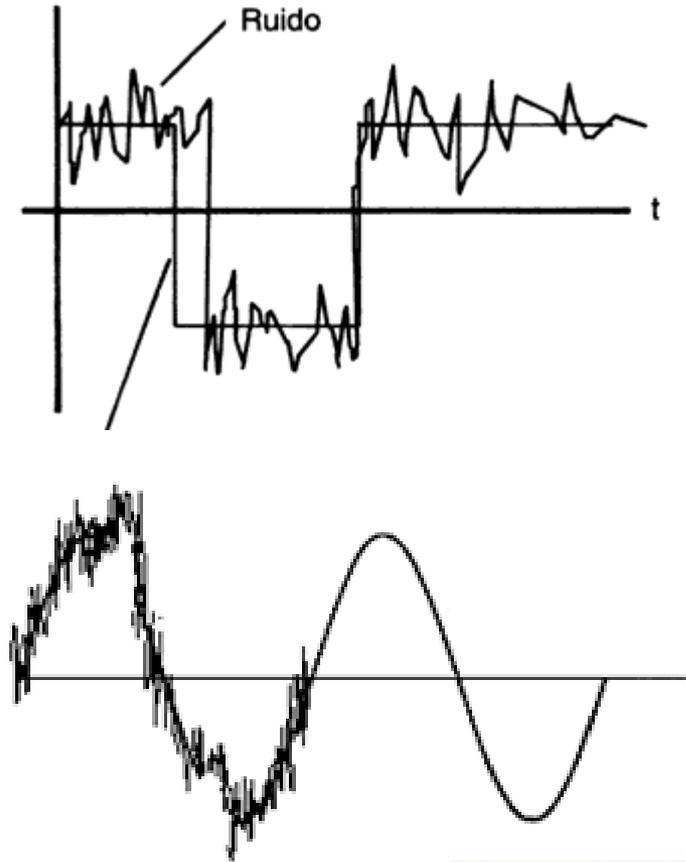


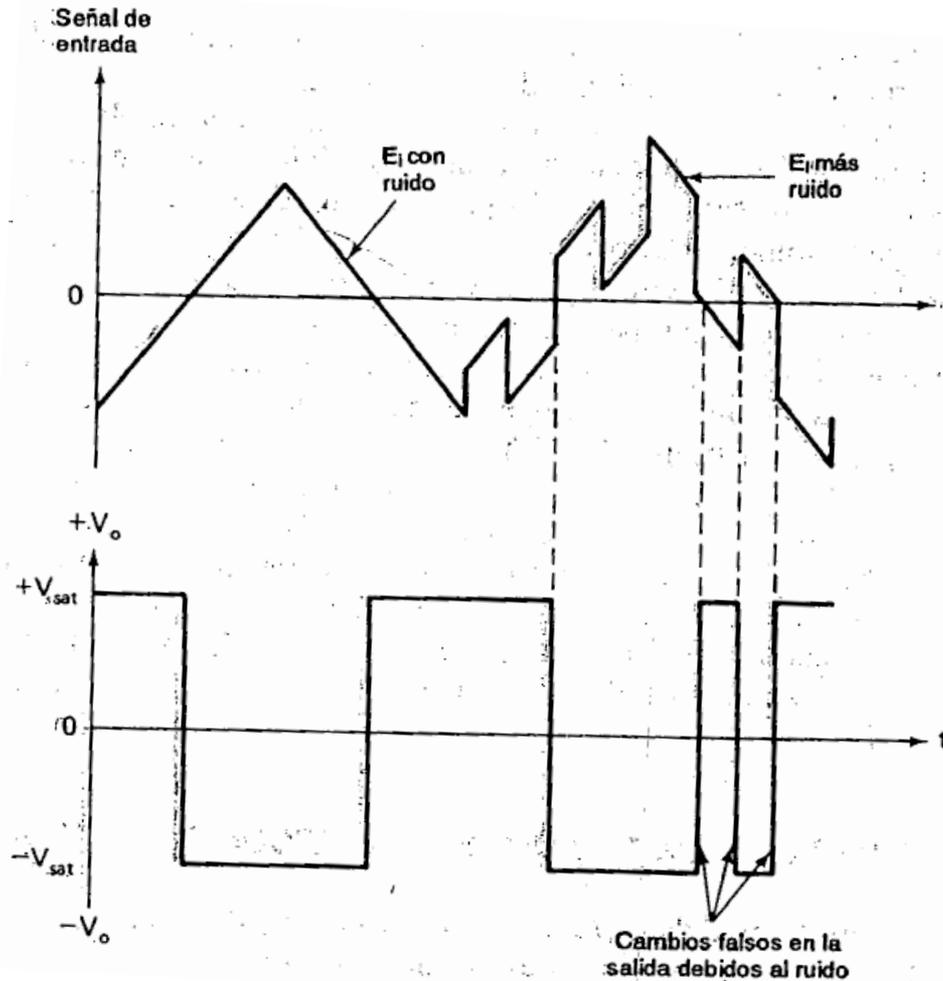
# COMPARADORES DE VOLTAJE

RUIDO EN COMPARADORES,  
COMPARADORES CON HISTÉRESIS,  
DETECTORES DE VENTANA

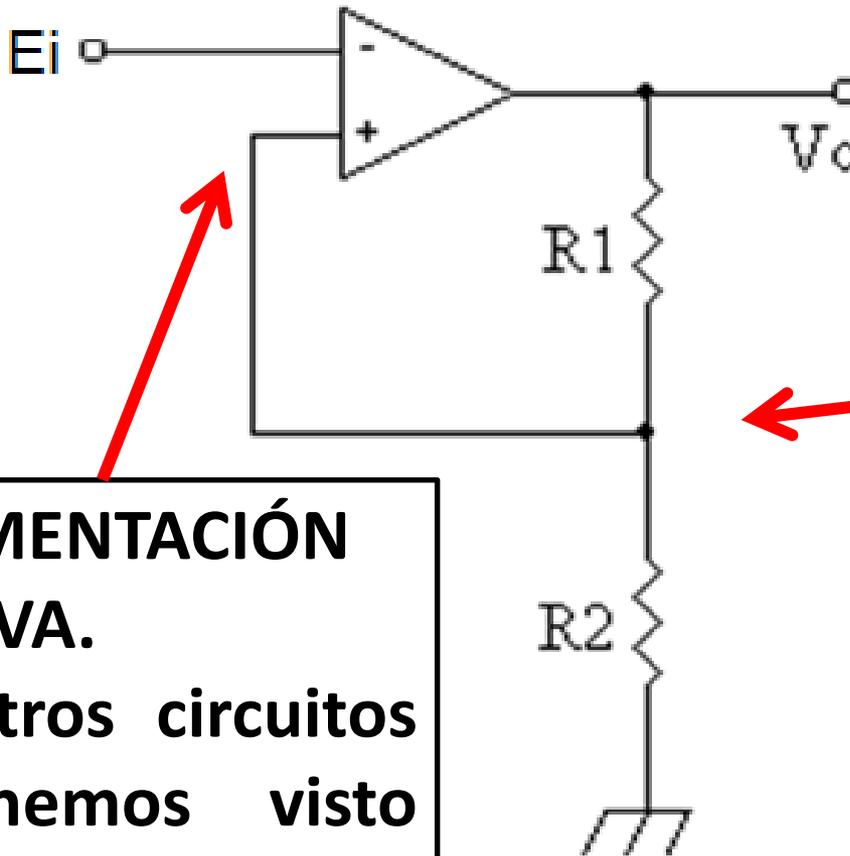
# RUIDO



# EFEECTO DEL RUIDO EN LOS COMPARADORES



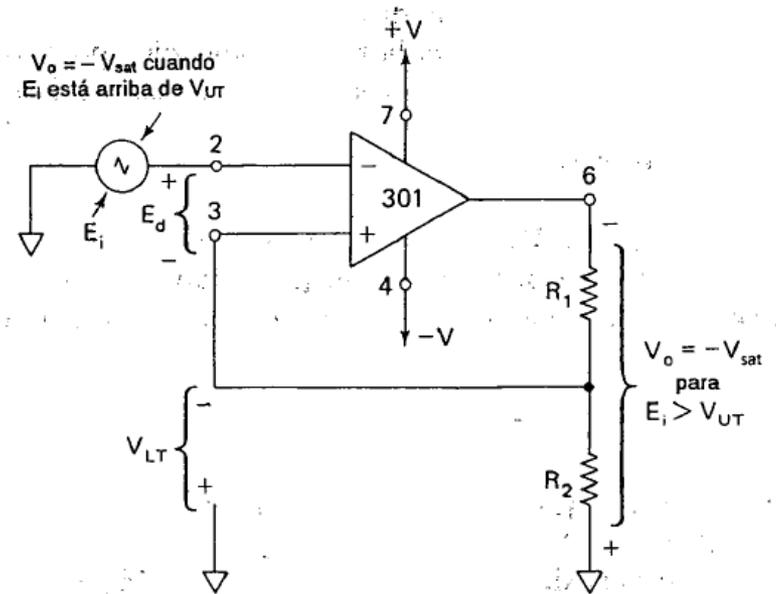
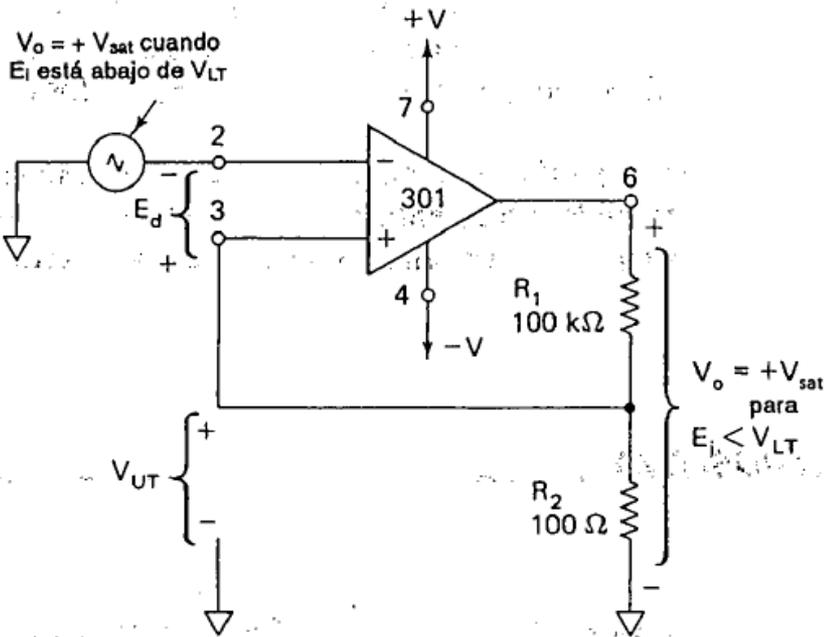
# AGREGANDO REALIMENTACIÓN POSITIVA



**EL VOLTAJE DE REFERENCIA DEPENDE DE LA SALIDA**

**REALIMENTACIÓN POSITIVA.**  
(Los otros circuitos que hemos visto son con negativa)

# VOLTAJES DE UMBRAL SUPERIOR E INFERIOR

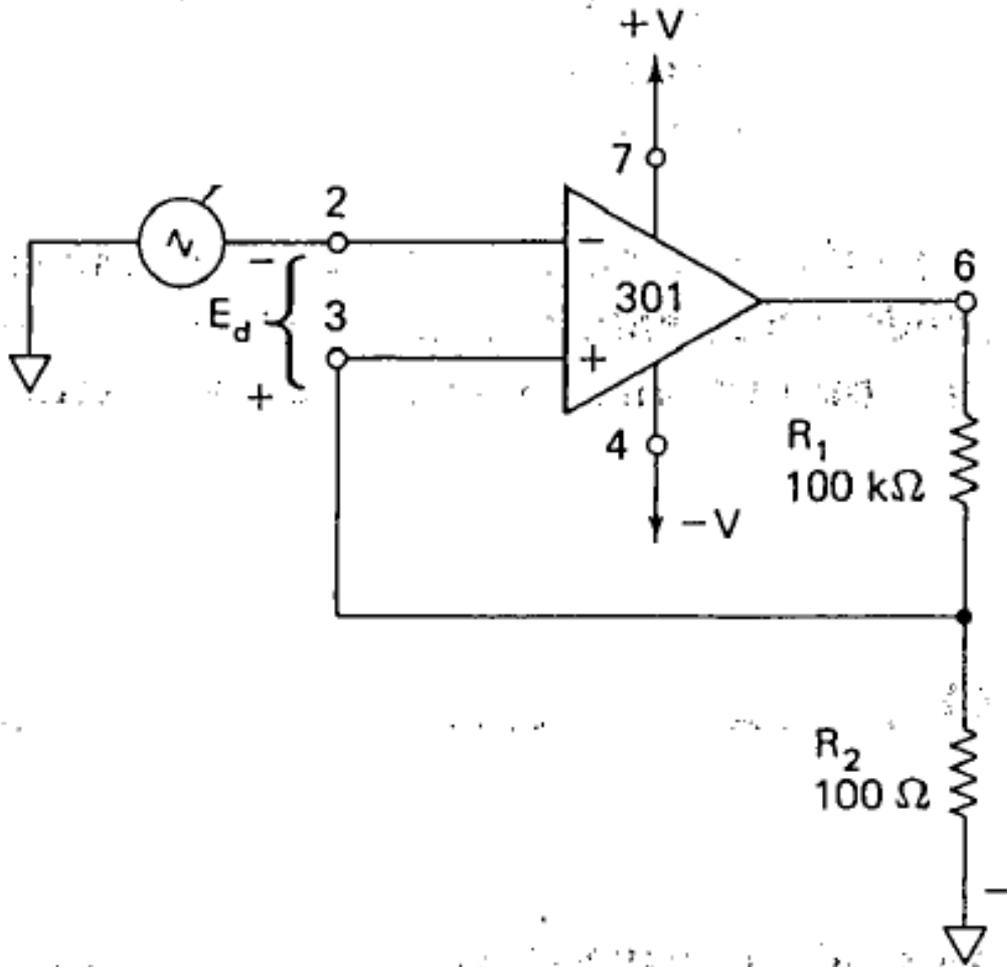


Ya no tenemos un solo voltaje de umbral (de referencia) si no que este va cambiando entre un umbral superior y uno inferior.

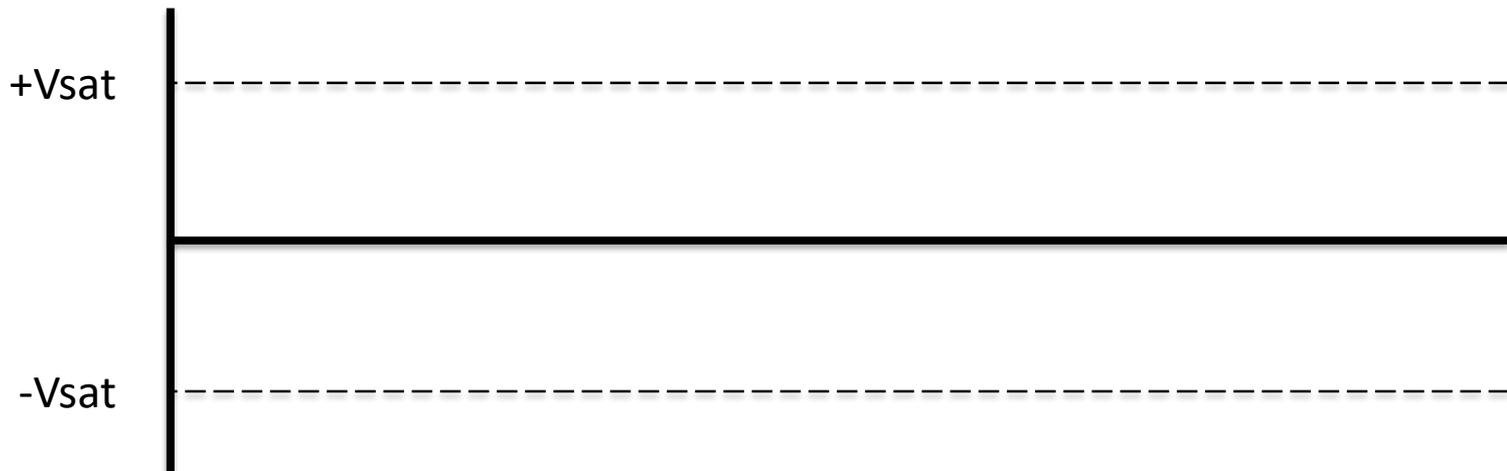
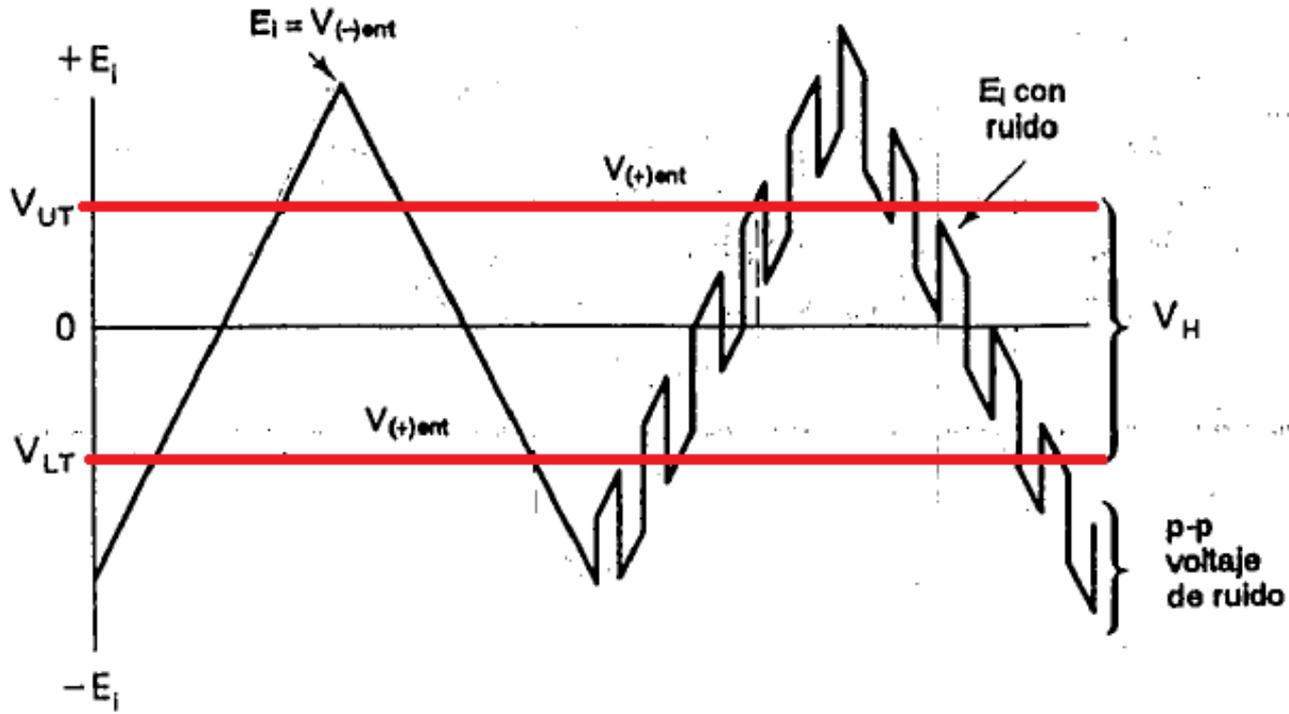
$$V_{UT} = +V_{SAT} \frac{R_2}{R_1 + R_2}$$

$$V_{LT} = -V_{SAT} \frac{R_2}{R_1 + R_2}$$

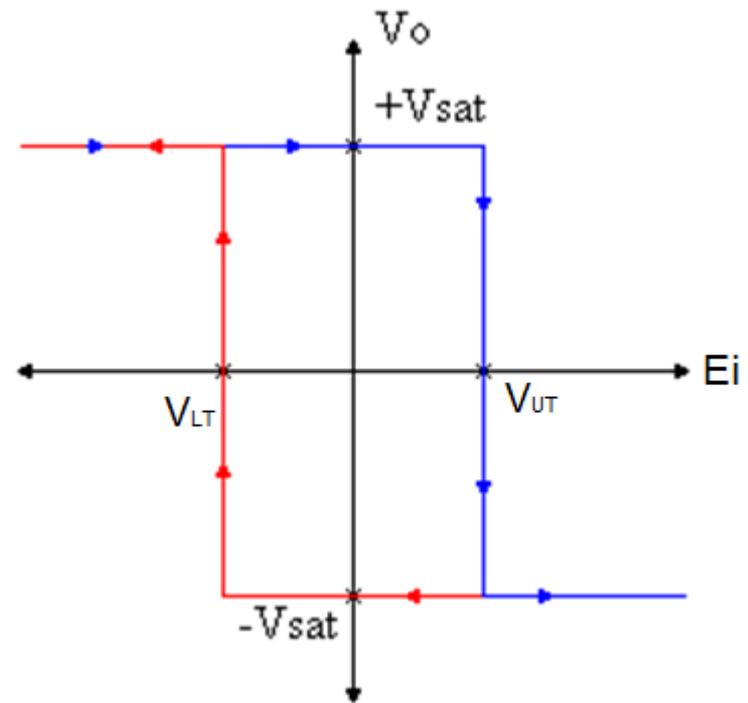
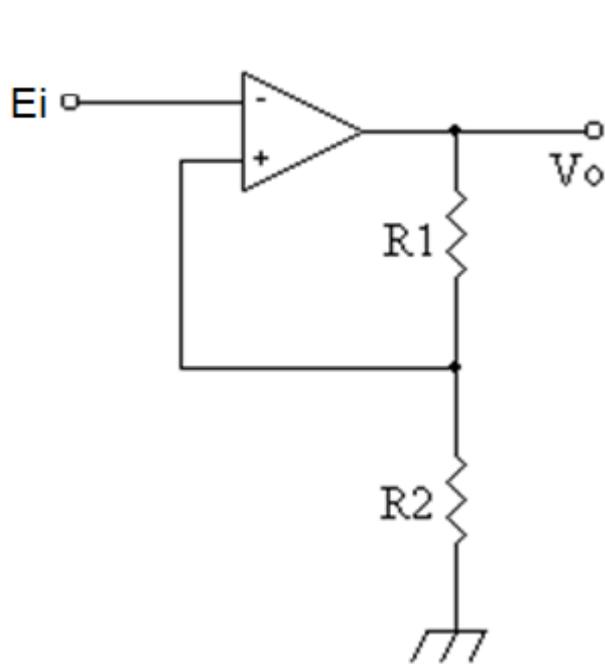
# EJEMPLO



Veamos como se comporta con estos valores específicos de resistencias. Supongamos una entrada triangular con ruido.



# HISTERESIS

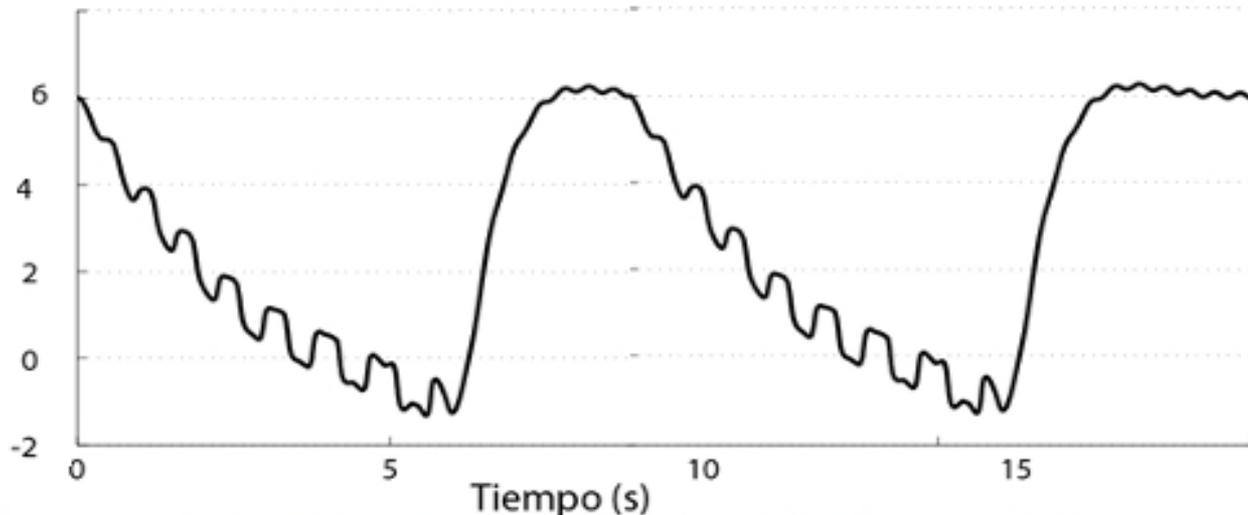


$$V_H = V_{UT} - V_{LT}$$

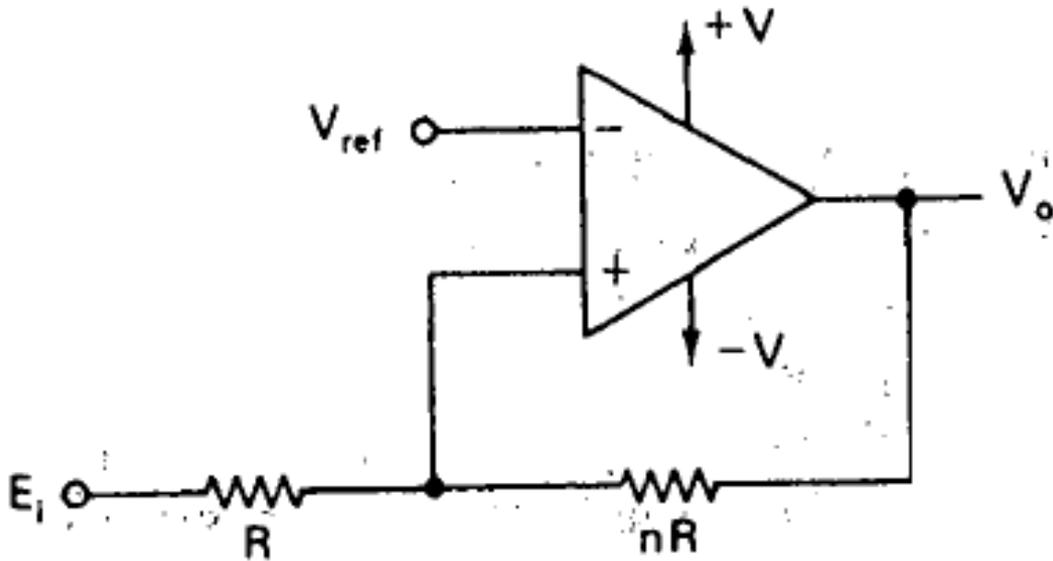
$$V_{ctr} = \frac{V_{UT} + V_{LT}}{2}$$

# EJERCICIO

Dada la siguiente forma de onda, suponga que las variaciones más pequeñas de voltaje (1v aproximadamente), son debidas al ruido. Diseñe un detector de cruce por cero con histéresis de tal forma que no se generen falsos cruces por cero debidos al ruido. Dibuje la forma de onda de salida correspondiente a dicho detector.



# DETECTOR DE VOLTAJE NO INVERSOR CON HISTÉRESIS



$$V_{UT} = V_{ref} \left( 1 + \frac{1}{n} \right) - \frac{-V_{SAT}}{n}$$

$$V_{LT} = V_{ref} \left( 1 + \frac{1}{n} \right) - \frac{+V_{SAT}}{n}$$

$$V_H = V_{UT} - V_{LT} = \frac{+V_{SAT} - (-V_{SAT})}{n}$$

$$V_{ctr} = \frac{V_{UT} + V_{LT}}{2} = V_{ref} \left( 1 + \frac{1}{n} \right)$$

# EJEMPLO

Suponga que quiere que  $V_{UT}=12$  y  $V_{LT}=8$ .

Voltaje de saturación= +/-15V

Calcule las resistencias y el voltaje de referencia.

$$V_H = V_{UT} - V_{LT} = \frac{+V_{SAT} - (-V_{SAT})}{n}$$

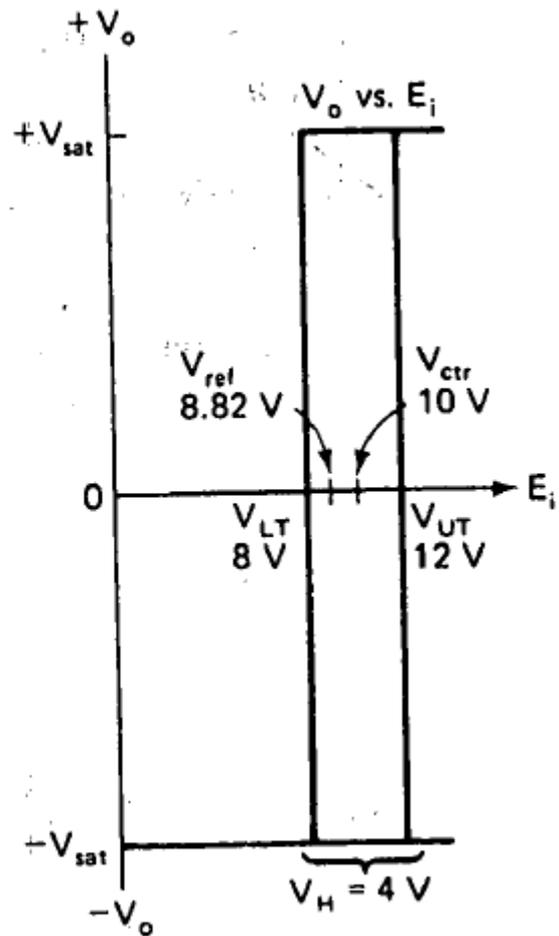
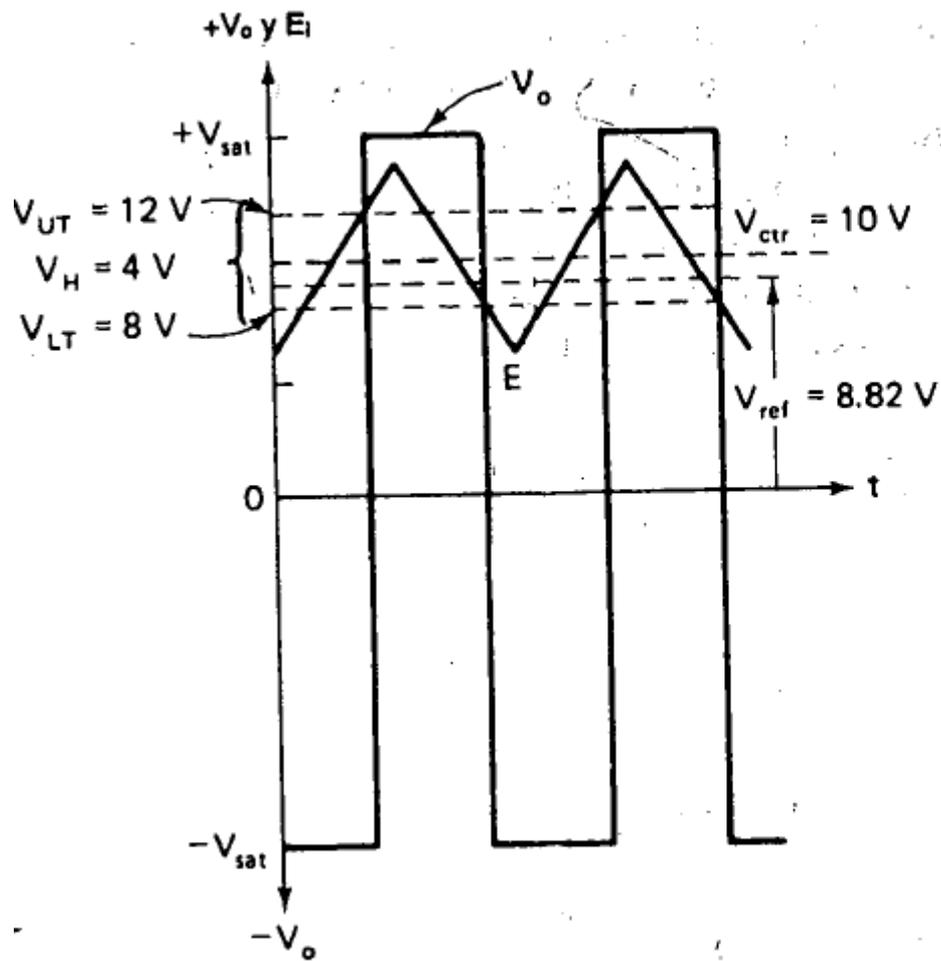
$$12 - 8 = \frac{15 - (-15)}{n}$$

$$n = \frac{30}{4} = 7,5$$

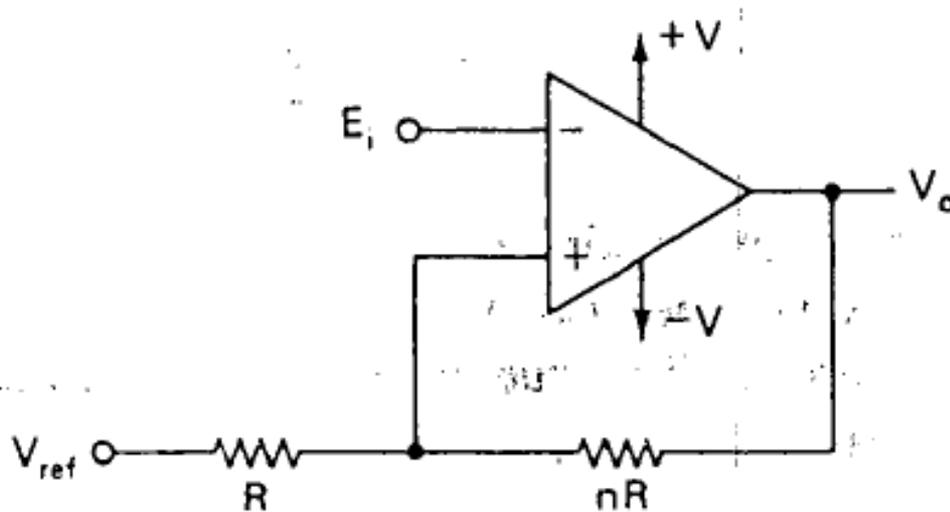
$$V_{ctr} = \frac{V_{UT} + V_{LT}}{2} = V_{ref} \left( 1 + \frac{1}{n} \right)$$

$$\frac{12 + 8}{2} = V_{ref} \left( 1 + \frac{1}{7,5} \right)$$

$$V_{ref} = \left( \frac{10}{1,13333} \right) = 8,8235$$



# DETECTOR DE VOLTAJE INVERSOR CON HISTÉRESIS



$$V_{UT} = V_{ref} \left( \frac{n}{n+1} \right) + \frac{+V_{SAT}}{n+1}$$

$$V_{LT} = V_{ref} \left( \frac{n}{n+1} \right) + \frac{-V_{SAT}}{n+1}$$

$$V_H = V_{UT} - V_{LT} = \frac{+V_{SAT} - (-V_{SAT})}{n+1}$$

$$V_{ctr} = \frac{V_{UT} + V_{LT}}{2} = V_{ref} \left( \frac{n}{n+1} \right)$$

# EJEMPLO

Suponga que quiere que  $V_{UT}=12$  y  $V_{LT}=8$ .

Voltaje de saturación= +/-15V

Calcule las resistencias y el voltaje de referencia.

$$V_H = V_{UT} - V_{LT} = \frac{+V_{SAT} - (-V_{SAT})}{n + 1}$$

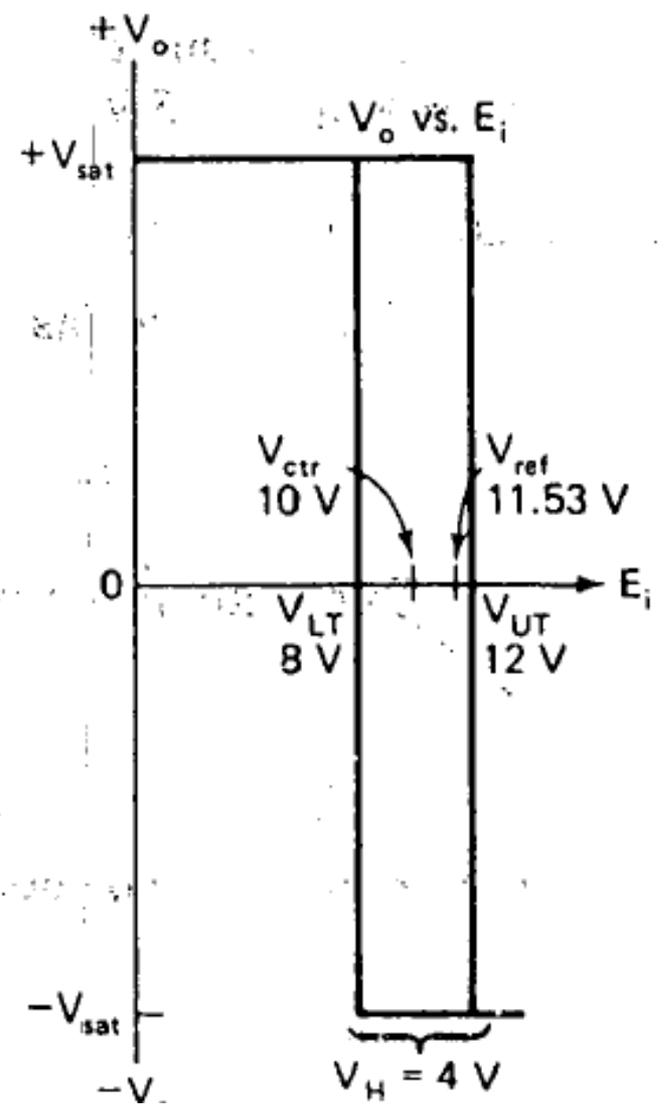
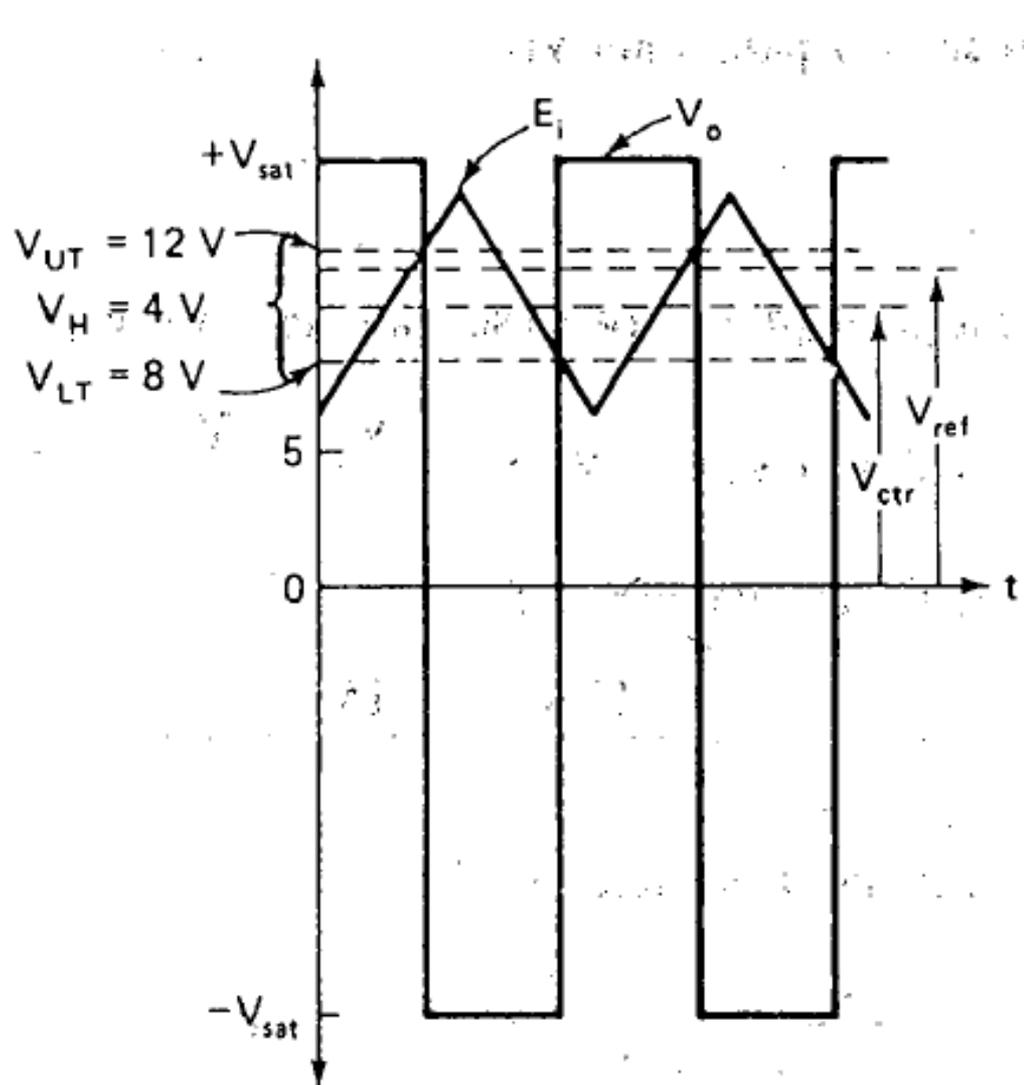
$$12 - 8 = \frac{15 - (-15)}{n + 1}$$

$$n = \frac{30}{4} - 1 = 6,5$$

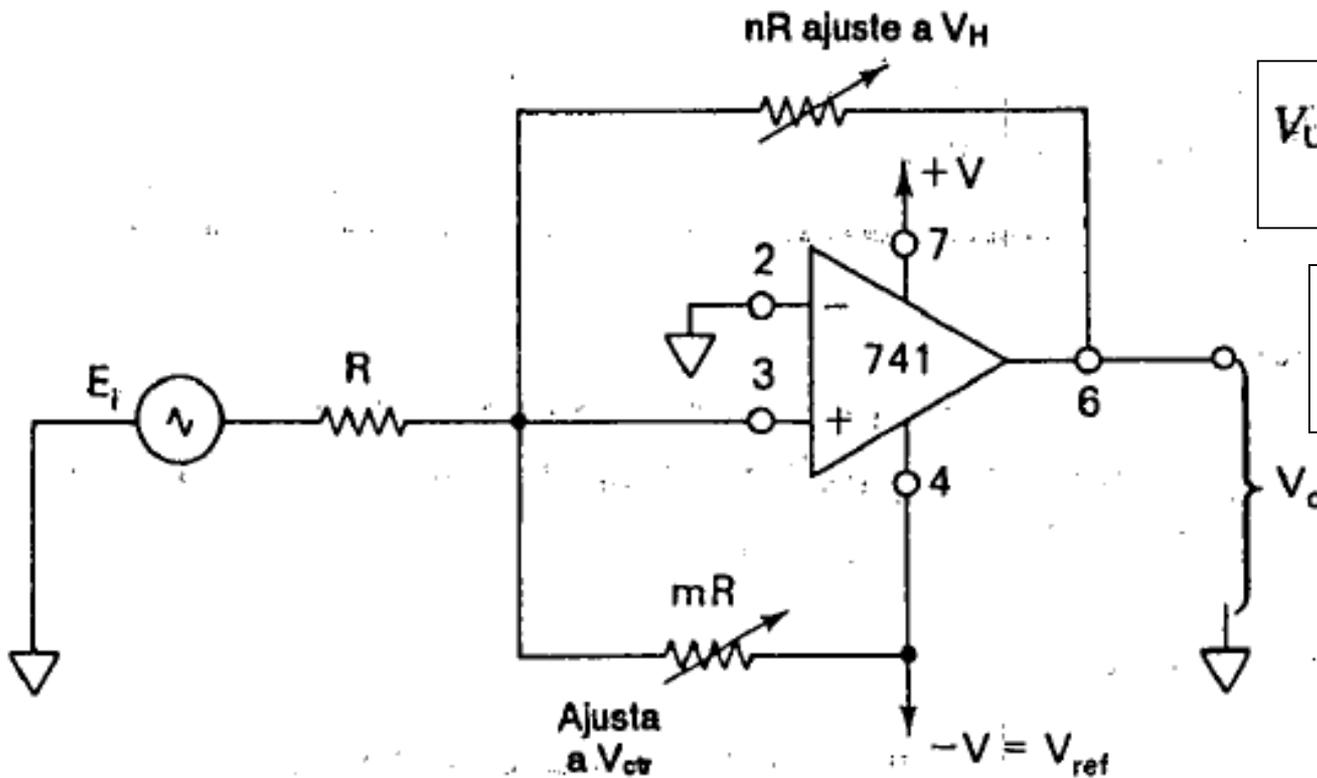
$$V_{ctr} = \frac{V_{UT} + V_{LT}}{2} = V_{ref} \left( \frac{n}{n + 1} \right)$$

$$\frac{12 + 8}{2} = V_{ref} \left( \frac{6,5}{6,5 + 1} \right)$$

$$V_{ref} = \left( \frac{10}{0,8666} \right) = 11,538$$



# AJUSTE INDEPENDIENTE DE HISTÉRESIS Y VOLTAJE CENTRAL

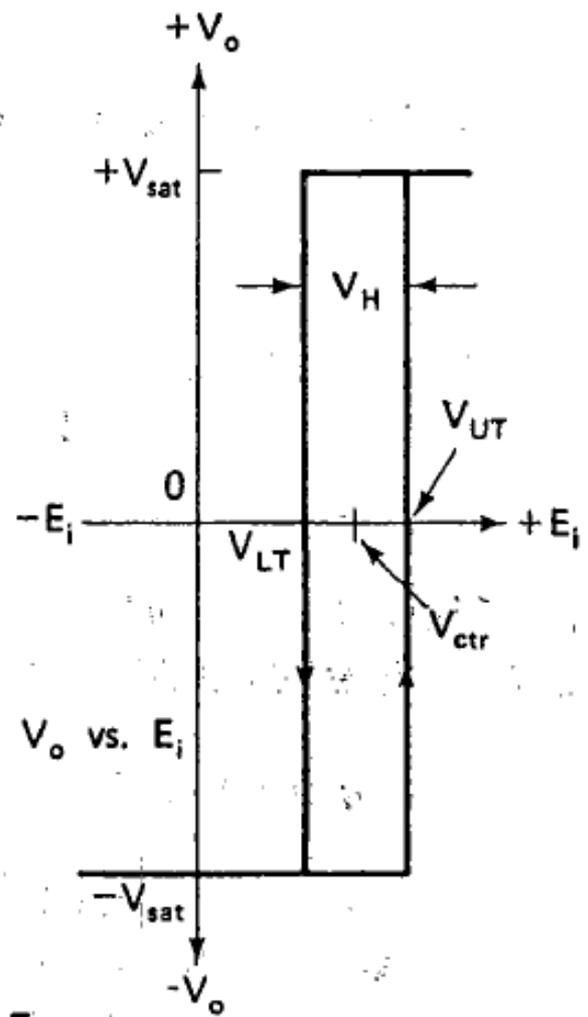
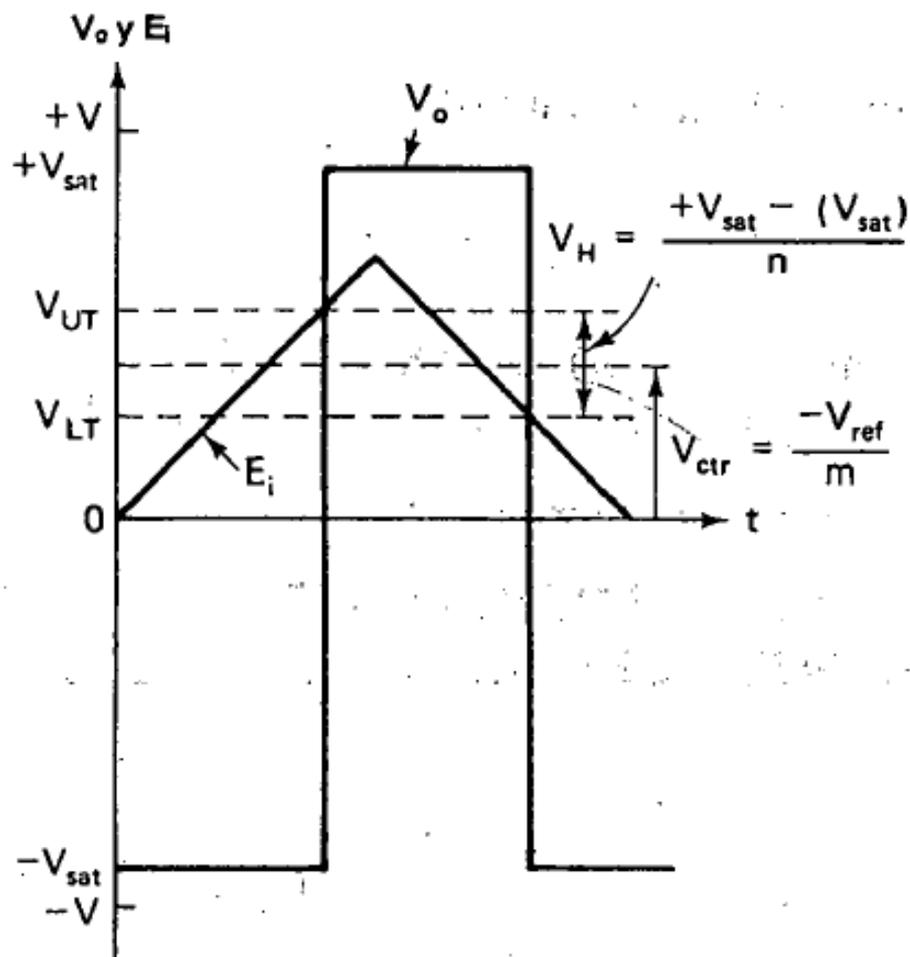


$$V_{UT} = -\frac{-V_{sat}}{n} - \frac{V_{ref}}{m}$$

$$V_{LT} = \frac{-V_{ref}}{m} - \frac{+V_{sat}}{n}$$

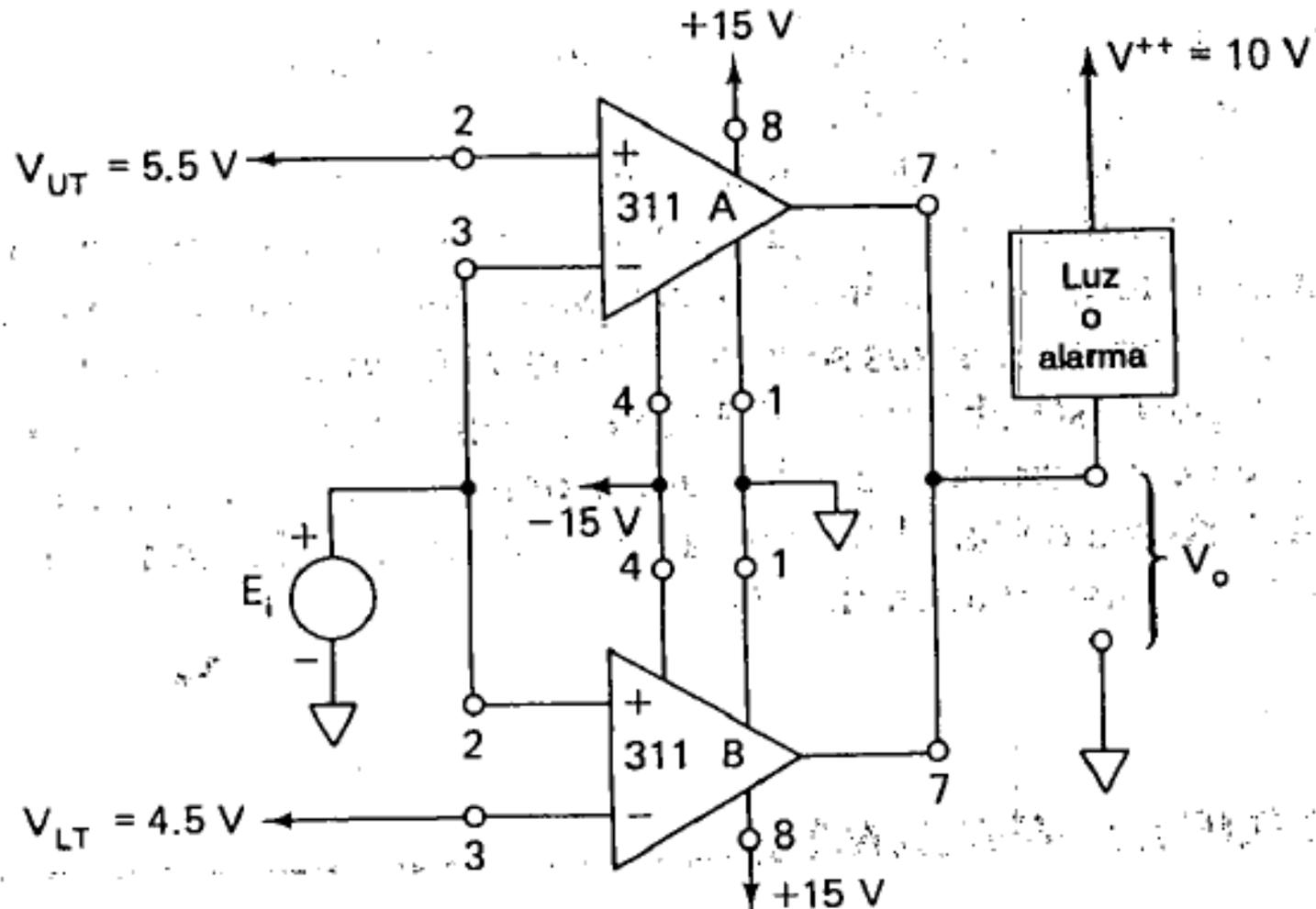
$$V_H = V_{UT} - V_{LT} = \frac{(+V_{sat}) - (-V_{sat})}{n}$$

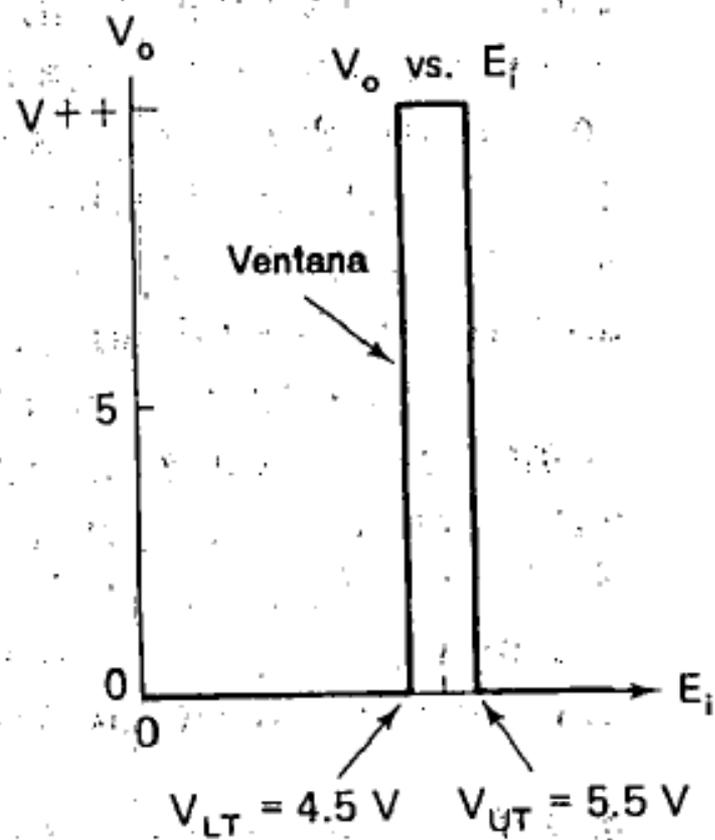
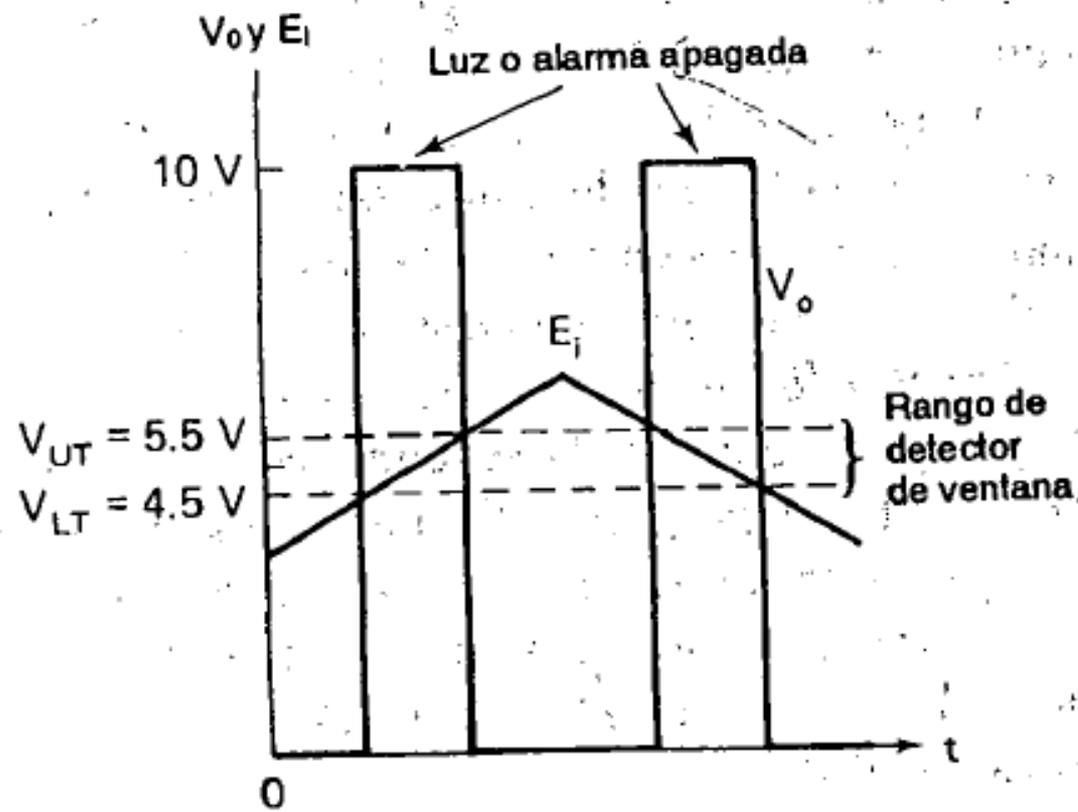
$$V_{ctr} = -\frac{V_{ref}}{m}$$



(b) Ejemplos de curvas de  $V_o$  vs.  $E_i$

# DETECTOR DE VENTANA





# EJERCICIO

Suponga que tiene un LM 35 para medir temperatura y que desea garantizar que la temperatura esté entre 20 °C y 30 °C, lo cual se indicará mediante el encendido de un led.

Diseñe un circuito para tal fin.