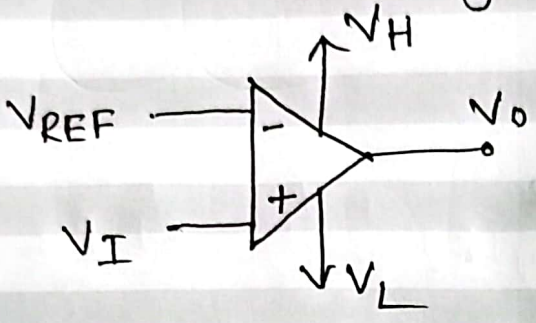
Comparators:

(a) Non inverting



Here, $V_+ = V_I$, $V_- = V_{REF}$

For $V_o = V_H$,

$V_+ > V_-$

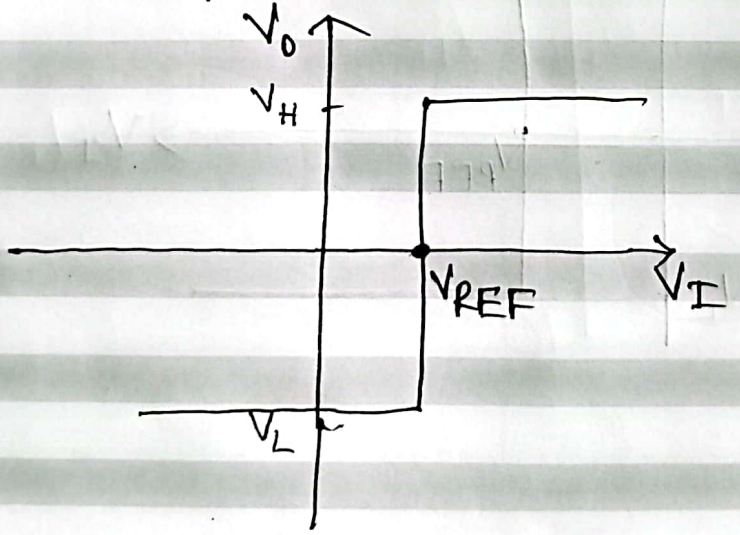
$\Rightarrow V_I > V_{REF}$

For $V_o = V_L$

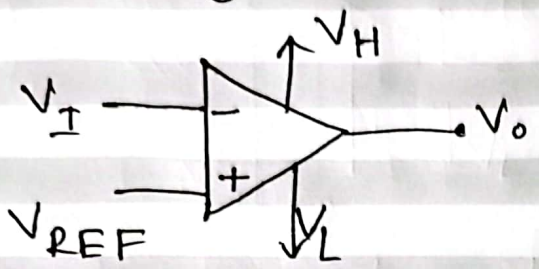
$V_+ < V_-$

$V_I < V_{REF}$

V_o vs V_I plot,



(b) Inverting



Here, $V_+ = V_{REF}$, $V_- = V_I$

For $V_o = V_H$

$V_+ > V_-$

$\Rightarrow V_{REF} > V_I$

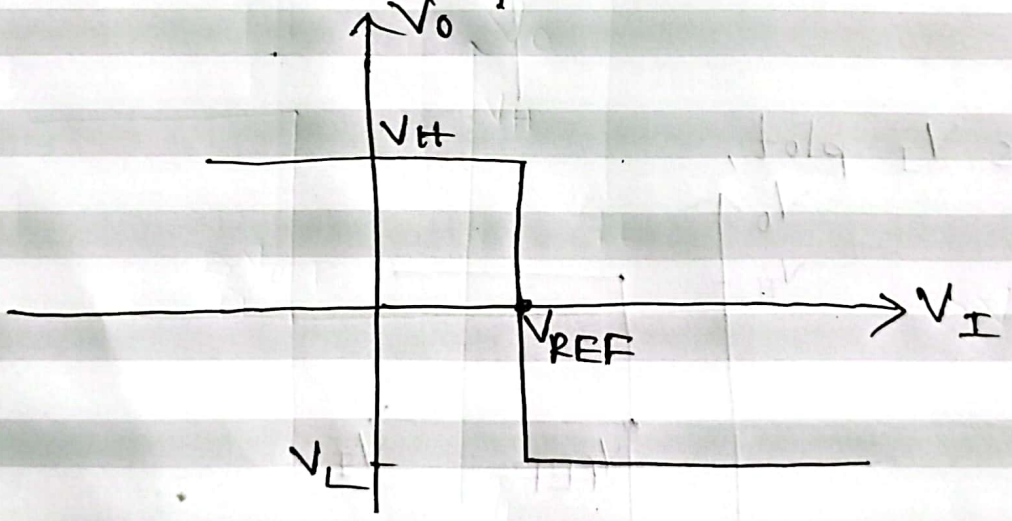
$\Rightarrow V_I < V_{REF}$

For, $V_o = V_L$

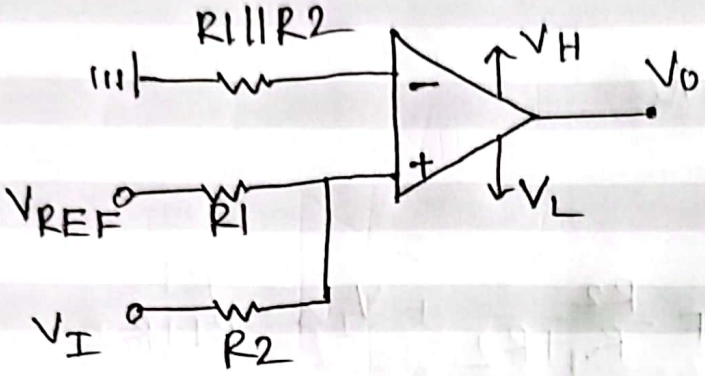
$V_+ < V_-$

$\Rightarrow V_{REF} < V_I$

$\Rightarrow V_I > V_{REF}$



(c) Non inverting (voltage division)



Here, $V_- = 0$

$$V_+ = V_{REF}\frac{R2}{R1+R2} + V_I \times \frac{R1}{R1+R2}$$

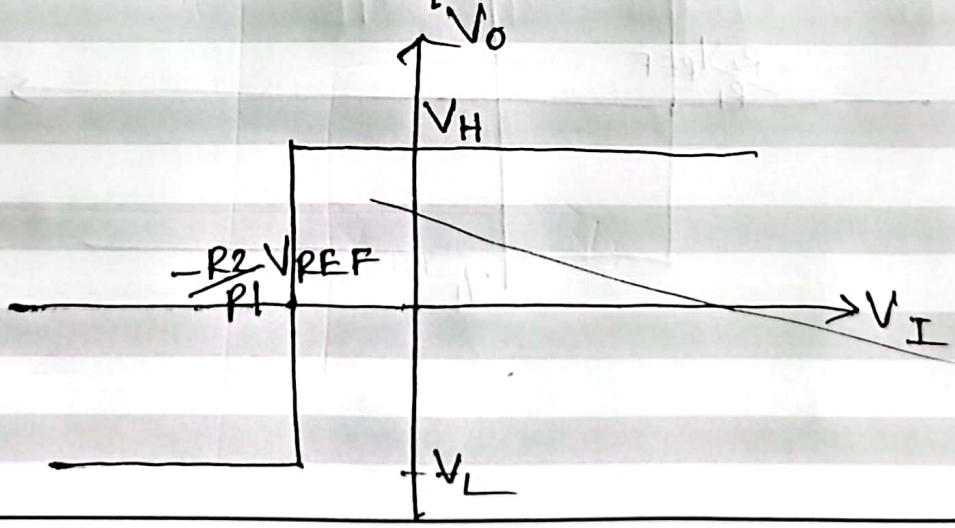
For, $V_o = V_H$

$V_+ > V_-$

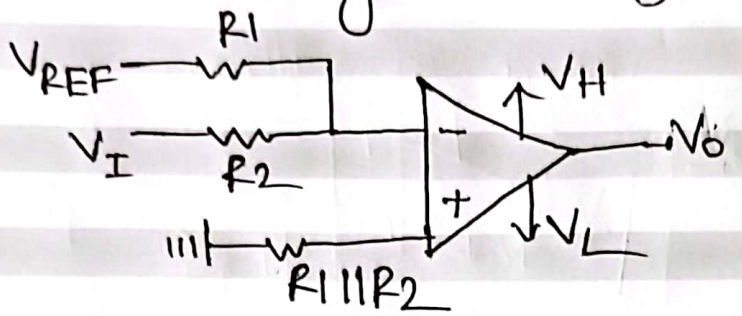
$$\Rightarrow V_{REF}\frac{R2}{R1+R2} + V_I \times \frac{R1}{R1+R2} > 0$$

$$V_I > -\frac{R2}{R1} V_{REF}$$

$$V_I < -\frac{R2}{R1} V_{REF}$$



(d) Inverting (Voltage devided)



Here, $V_+ = 0$, $V_- = V_{REF}\frac{R_2}{R_1+R_2} + V_I \times \frac{R_1}{R_1+R_2}$

For, $V_0 = V_H$

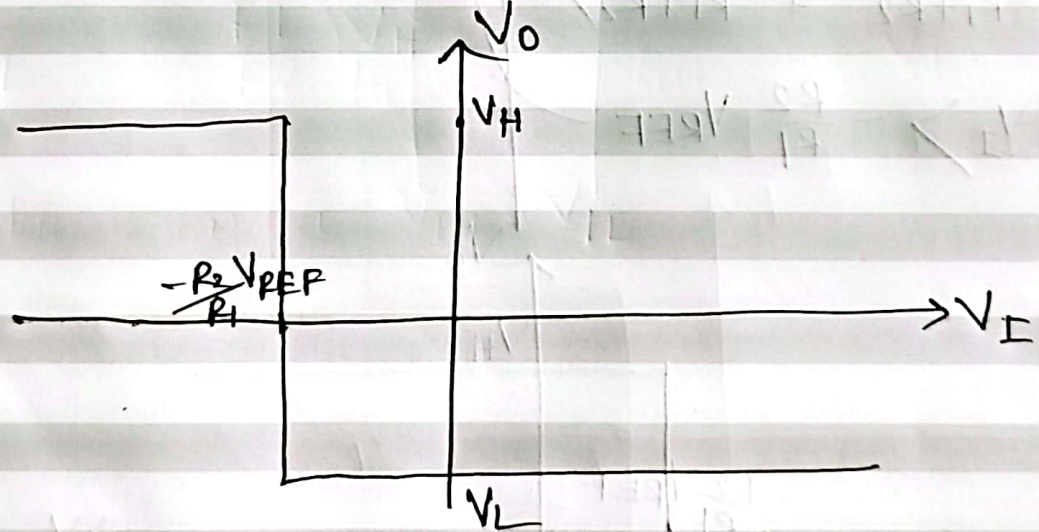
$V_+ > V_-$

$V_I < -\frac{R_2}{R_1}V_{REF}$

For $V_0 = V_L$

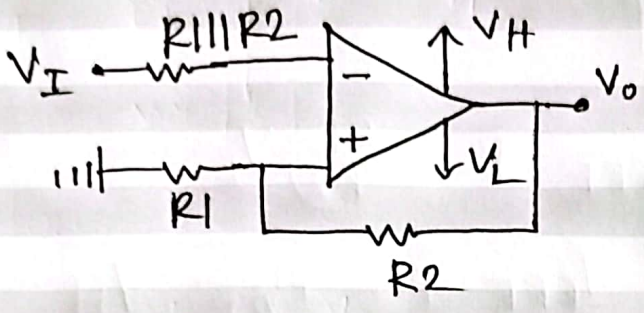
$V_+ < V_-$

$V_I > -\frac{R_2}{R_1}V_{REF}$



Schmitt Trigger

(a) Inverting ST



Here, $V_- = V_I$ ∞, $V_+ = V_o \frac{R_1}{R_1+R_2}$.

Case 1. V_I large positive

$V_o = V_L$ as $V_- > V_+$

Now, $V_- = V_I$

$V_+ = V_L \frac{R_1}{R_1+R_2}$

For sustaining, $V_o = V_L$,

$V_- > V_+$

$V_I > V_L \frac{R_1}{R_1+R_2}$

$\therefore V_{TH} = V_L \frac{R_1}{R_1+R_2}$

Case 2: V_I large Negative

$V_o = V_H$ as $V_+ > V_-$

$V_- = V_I$, $V_+ = V_H \frac{R_1}{R_1+R_2}$

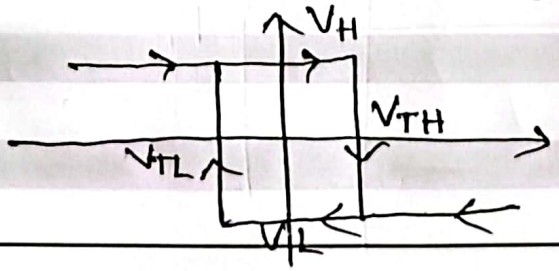
For sustaining, $V_o = V_H$

$V_+ > V_-$

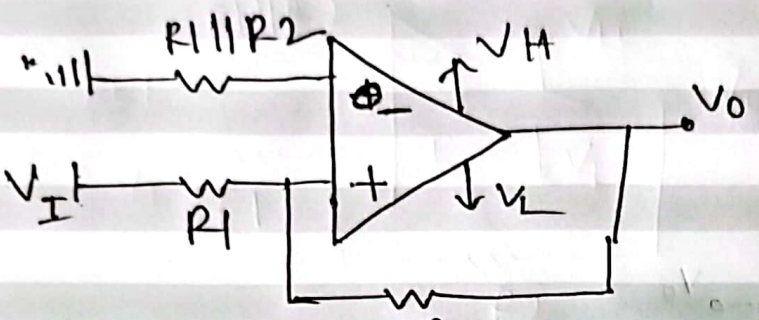
$V_I < V_H \frac{R_1}{R_1+R_2}$

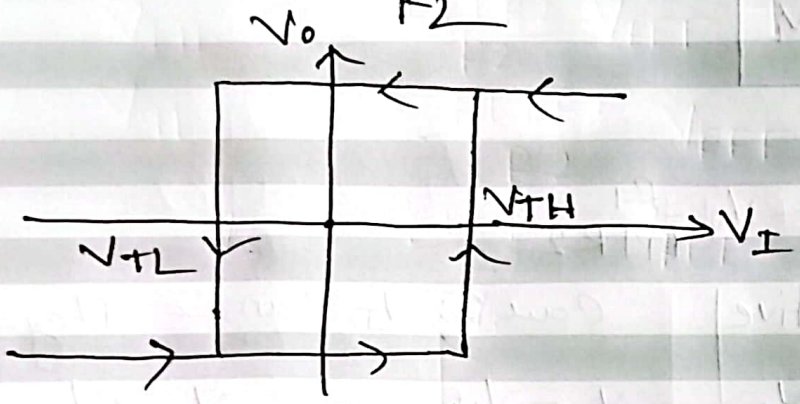
$V_{TH} = V_H \frac{R_1}{R_1+R_2}$

Hysteresis width $= V_{TH} - V_{TL}$



(b) Non inverting ST



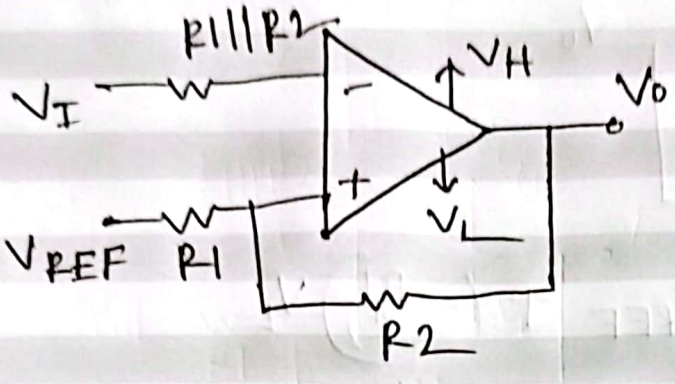


$$V_{TH} = \left(-\frac{R1}{R2}\right) V_L$$

$$V_{TL} = \left(-\frac{R1}{R2}\right) V_H$$

Hysteresis width = $V_{TH} - V_{TL}$

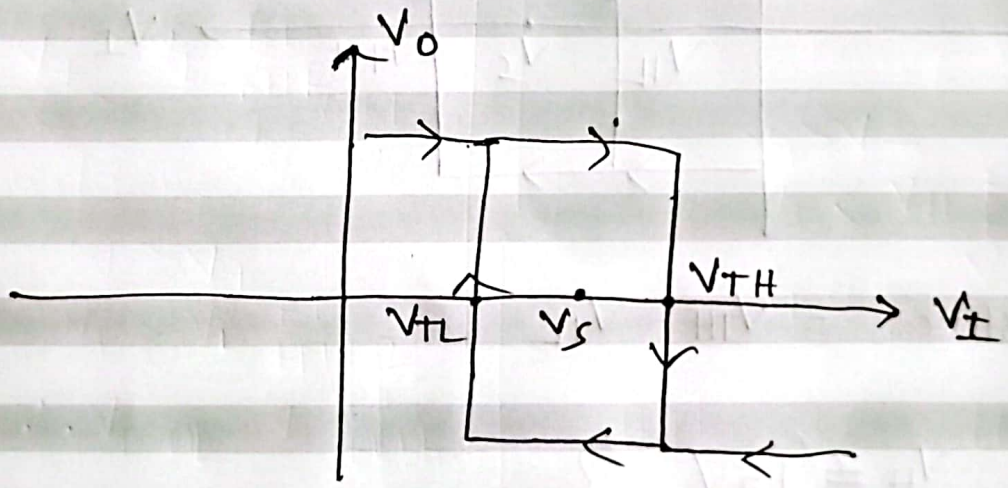
(c) Inverting ST with V_{REF}



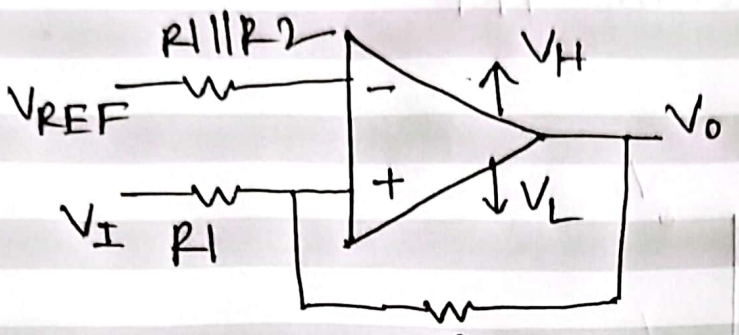
$$V_{TH} = V_{REF}\frac{R2}{R1+R2} + V_H\frac{R1}{R1+R2}$$

$$V_{TL} = V_{REF}\frac{R2}{R1+R2} + V_L\frac{R1}{R1+R2}$$

$$V_S = \frac{V_{TH}+V_{TL}}{2} = V_{REF}\frac{R2}{R1+R2}$$



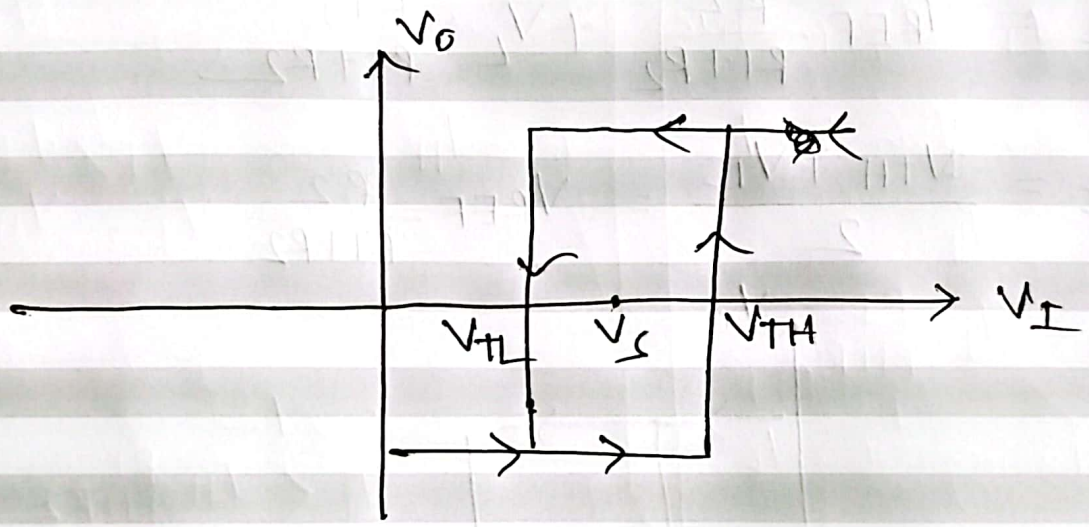
(d) Non inverting ST with V_{REF}



$$V_{TH} = \frac{R1+R2}{R2} V_{REF} + \left(-\frac{R1}{R2}\right) V_L$$

$$V_{TL} = \frac{R1+R2}{R2} V_{REF} + \left(-\frac{R1}{R2}\right) V_H$$

$$V_S = \frac{R1+R2}{R2} V_{REF}$$



$$V_{Hysteresis} = V_{TH} - V_{TL}$$

Note: $V_H = 15V$, $V_L = -15V$ } can be assumed, if data are missing