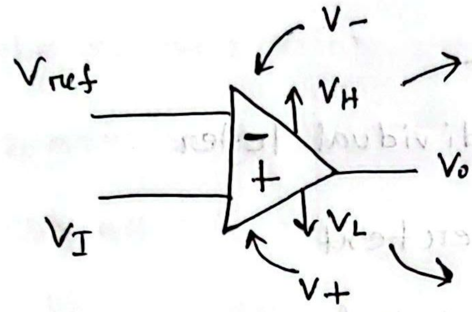
Final

## Schmitt Trigger

Comparator



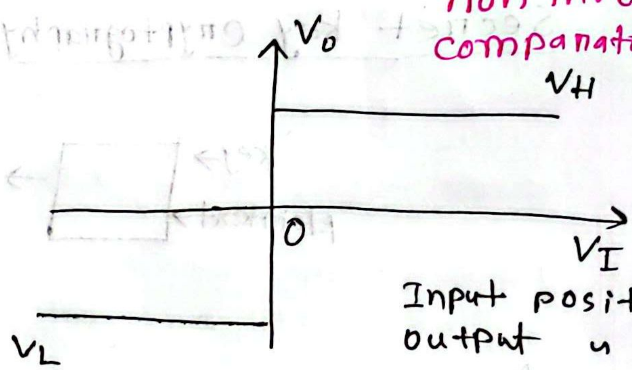

→ +12V positive saturation voltage

→ −12V negative saturation voltage

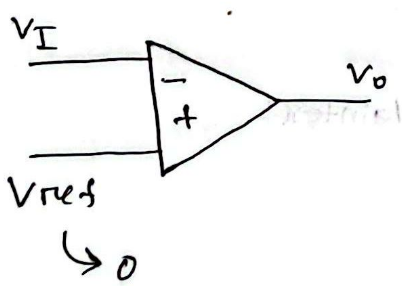
$V_+ > V_- \rightarrow V_0 = V_H$

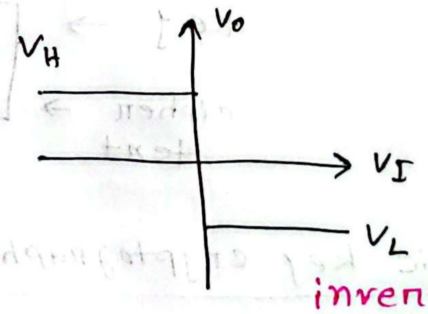
$V_+ < V_- \rightarrow V_0 = V_L$

non inverting comparator

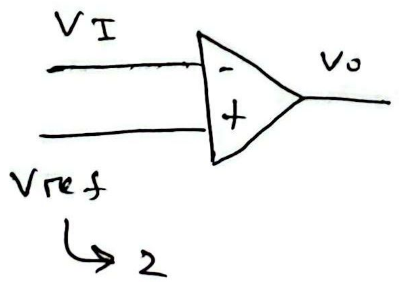


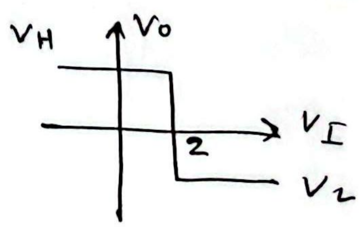

Input positive
output "




inverting comparator



Comparator

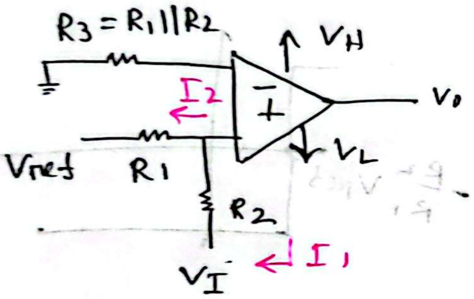
1. Inverting
   - → with applied reference voltage
   - → Ground reference

2. Non-inverting
   - → with applied reference voltage
   - → Ground reference

non inverting:

→ $I = 0$

$R_3 = R_1 \| R_2$




$V_- = 0$

$V_+ = ?$

$I_1 + I_2 = 0$

$$\Rightarrow \frac{V_+ - V_I}{R_2} + \frac{V_+ - V_{ref}}{R_1} = 0$$

$$\Rightarrow R_1(V_+ - V_I) + R_2(V_+ - V_{ref}) = 0$$

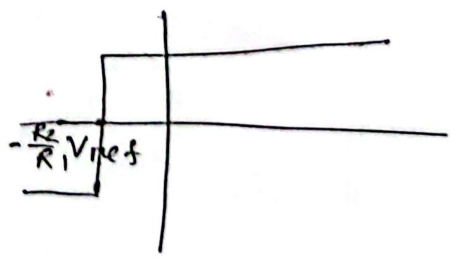
$$\Rightarrow V_+(R_1 + R_2) - R_1 V_I - R_2 V_{ref} = 0$$

$$\Rightarrow \boxed{V_+ = \frac{R_1 V_I}{R_1 + R_2} + \frac{R_2}{R_1 + R_2} V_{ref}}$$

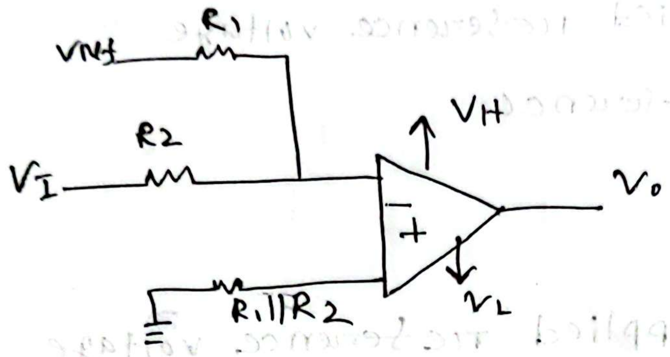
$V_+ > V_- \Rightarrow V_0 = V_H$

$$\frac{R_1}{R_1 + R_2} V_I + \frac{R_2}{R_1 + R_2} V_{ref} > 0$$

$$\Rightarrow V_I > \cancel{\neq} - \frac{R_2}{R_1} V_{ref}$$



inverting comparator :



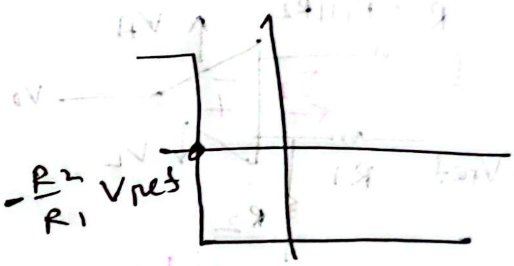

$V_+ = 0$

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

$V_+ > V_- \rightarrow V_o = V_H$

$\Rightarrow 0 > V_I \frac{R_1}{R_1+R_2} + V_{ref} \frac{R_2}{R_1+R_2}$

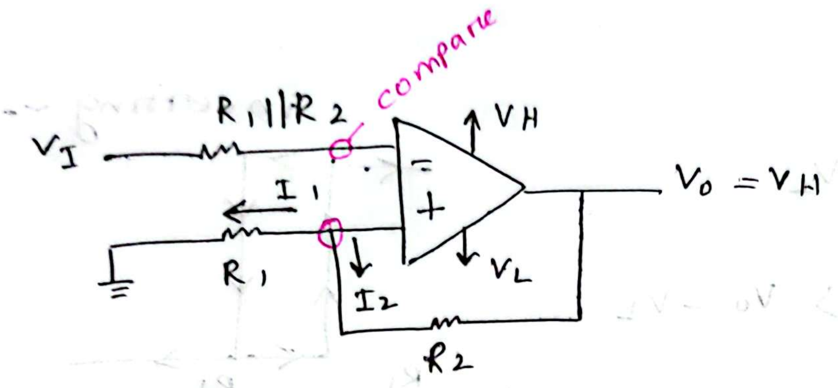
$\Rightarrow V_I < -\frac{R_2}{R_1} V_{ref}$

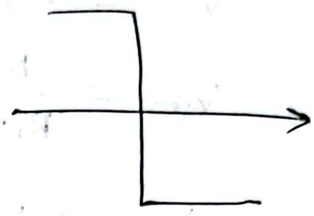



$V_+ < V_- \rightarrow V_o = V_L$

$V_I = -\frac{R_2}{R_1} V_{ref}$

# Schimitt Trigger → transition point ২টা



# suppose, $V_I$ is a large negative voltage.

$$V_- = V_I$$

$$I_1 + I_2 = 0$$

$$\Rightarrow \frac{V_+ + 0}{R_1} + \frac{V_+ - V_o}{R_2} = 0$$

$$\Rightarrow V_+ (R_2 + R_1) = R_1 V_o$$

$$\Rightarrow V_+ = \frac{R_1}{R_1 + R_2} V_o$$

+ve ও 0 হয়
output আসে, output
এর max VH এর সমান।
so negative voltage < VH(12V)
V+>V-, that's why Vo = VH

$$V_+ > V_- \Rightarrow V_o = V_H$$

$$\frac{R_1}{R_1 + R_2} V_o > V_-$$

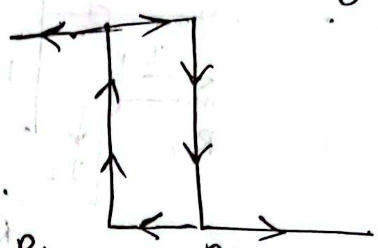
$$\Rightarrow V_- < \frac{R_1}{R_1 + R_2} V_H$$

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

# suppose, input $V_I$ is a large positive voltage

$V_- = V_I$

inverting



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

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

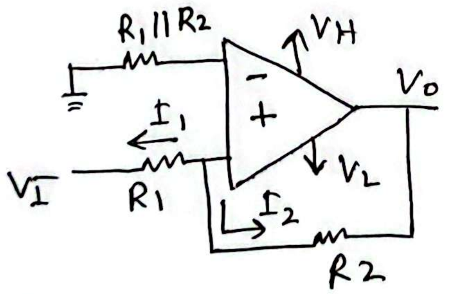
$V_+ < V_- \Rightarrow V_0 = V_L$

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

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

$$\boxed{\text{Hysteresis width} = V_{TH} - V_{TL} = \frac{R_1}{R_1+R_2}(V_H - V_L)}$$

non inverting




$-V_H \frac{R_1}{R_2}$

$V_- = 0$

$I_1 + I_2 = 0$

$\Rightarrow \frac{V_+ - V_I}{R_1} + \frac{V_+ - V_0}{R_2} = 0$

$\Rightarrow V_+ (R_1 + R_2) = R_2 V_I + R_1 V_0$

CamScanner

$$\Rightarrow V_+ = V_I \frac{R_2}{R_1+R_2} + V_o \frac{R_1}{R_1+R_2}$$

\# suppose, $V_I$ large positive $\Rightarrow V_o = V_H$

$$V_+ > V_-$$

$$\Rightarrow V_I \frac{R_2}{R_1+R_2} + V_o \frac{R_1}{R_1+R_2} > 0$$

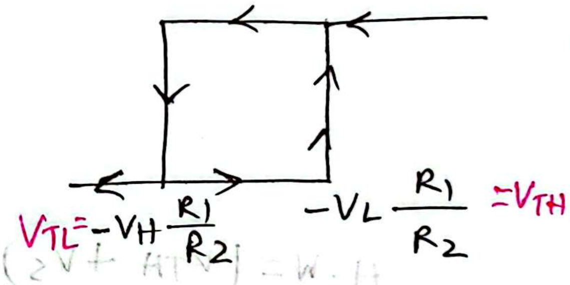
$$\Rightarrow V_I > -V_H \frac{R_1}{R_2}$$

$V_o$

\# suppose, $V_I$ large negative $\Rightarrow V_o = V_L$

$$V_+ < V_-$$

$$V_I < -V_L \frac{R_1}{R_2}$$




\# suppose, $V_I$ large negative $\Rightarrow V_o = V_L$

$$V_+ < V_-$$

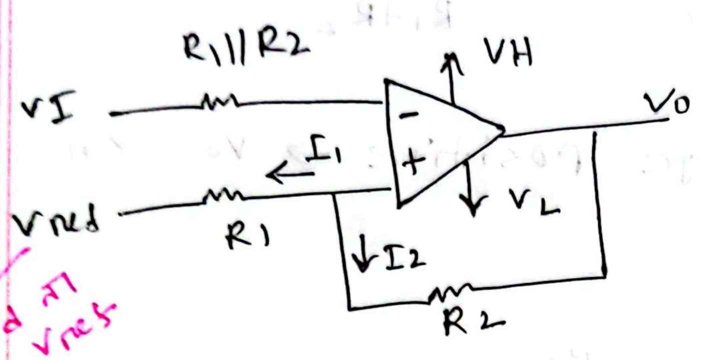
$$V_I < -V_L \frac{R_1}{R_2}$$

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

$$= \left(-V_L \frac{R_1}{R_2}\right) - \left(V_H \frac{R_1}{R_2}\right)$$

$$= \frac{R_1}{R_2}(V_H - V_L)$$

non inverting



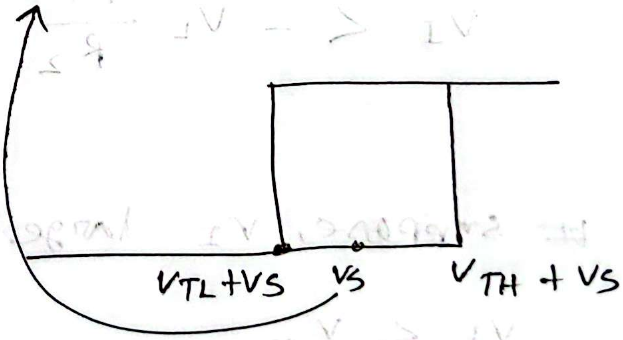

ground না দিয়ে Vref

$$V_- = V_I$$

$$\Rightarrow V_+ \rightarrow I_1 + I_2 = 0$$

$$\Rightarrow \frac{V_+ - V_{ref}}{R_1} + \frac{V_+ - V_o}{R_2} = 0$$

$$\Rightarrow V_+ = \underbrace{V_{ref}\,\frac{R_2}{R_1+R_2}}_{\text{shifting voltage}} + v_o\,\frac{R_1}{R_1+R_2}$$




$$H.W = (V_{TH} + V_S) - (V_{TL} + V_S)$$

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

(same)