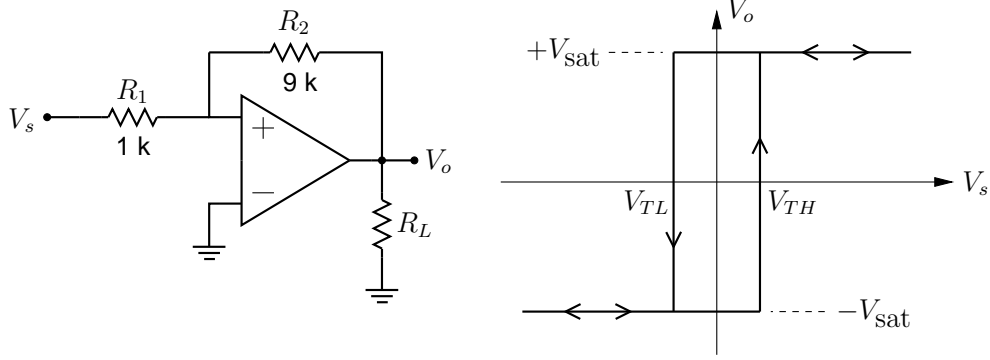


# schmitt\_741\_1.sqproj

## Description



The Schmitt trigger circuit shown in the figure works on the basis of positive feedback, which makes the gain very high. As a result of the high gain, the Op Amp operates in the saturation region, i.e.,  $V_o = \pm V_{\text{sat}}$ . Let us consider these two cases:

- (a)  $V_o = +V_{\text{sat}}$ : Since the input current of an Op Amp can be neglected (at the non-inverting terminal), we have, by voltage division,

$$V_+ = \frac{R_1}{R_1 + R_2} \times V_{\text{sat}} + \frac{R_2}{R_1 + R_2} \times V_s. \quad (1)$$

For the Op Amp output  $V_o$  to change to  $-V_{\text{sat}}$ ,  $V_+$  needs to cross  $V_-$ , i.e.,  $0\text{ V}$ , which happens when

$$V_s = -\frac{R_1}{R_2} \times V_{\text{sat}} \equiv V_{TL}. \quad (2)$$

- (b)  $V_o = -V_{\text{sat}}$ : Again, since the input current at the non-inverting terminal can be neglected, we have

$$V_+ = \frac{R_1}{R_1 + R_2} \times (-V_{\text{sat}}) + \frac{R_2}{R_1 + R_2} \times V_s. \quad (3)$$

For  $V_o$  to change to  $+V_{\text{sat}}$ ,  $V_+$  needs to cross  $0\text{ V}$ , which happens when

$$V_s = +\frac{R_1}{R_2} \times V_{\text{sat}} \equiv V_{TH}. \quad (4)$$

The above considerations give rise to the  $V_o$  versus  $V_s$  relationship shown in the figure, and the circuit is therefore called “non-inverting” Schmitt trigger.

## Exercise Set

1. For the component values shown in the figure, what are the values of  $V_{TL}$  and  $V_{TH}$ ?
2. Simulate the circuit with a sinusoidal input voltage of amplitude  $10\text{ V}$  and frequency  $50\text{ Hz}$  for, say, two cycles. Plot  $V_o$  versus  $V_s$  and check if your computed values of  $V_{TL}$ ,  $V_{TH}$  are correct. Also observe  $V_o$  and  $V_s$  versus time.
3. Plot  $V_+$  versus  $V_s$  and explain your observation.
4. If  $R_2$  is changed to  $5\text{ k}$ , how will the transfer characteristic change? Verify by simulation.
5. If the inverting input of the Op Amp is connected to a DC voltage source of  $0.5\text{ V}$ , how would the transfer characteristic change? Verify by simulation.
6. If the inverting input of the Op Amp is connected to a DC voltage source of  $-0.5\text{ V}$ , how would the transfer characteristic change? Verify by simulation.