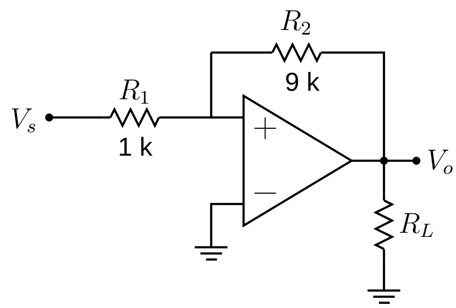
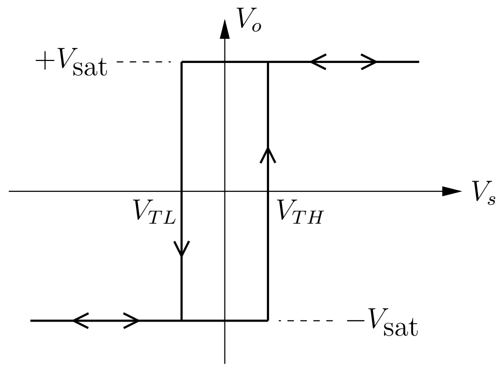
schmitt_741_1.sqproj





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,

$$V_+ = \frac{R_1}{R_1 + R_2} \times V_{\text{sat}} + \frac{R_2}{R_1 + R_2} \times V_s \,. \tag{1}$$

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

$$V_s = -\frac{R_1}{R_2} \times V_{\text{sat}} \equiv V_{TL} \,. \tag{2}$$

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

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

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

$$V_s = +\frac{R_1}{R_2} \times V_{\text{sat}} \equiv V_{TH} \,. \tag{4}$$

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 $10\,V$ and frequency $50\,\mathrm{Hz}$ 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 $5\,\mathrm{k}$, 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 $0.5\,V$, 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 $-0.5\,V$, how would the transfer characteristic change? Verify by simulation.

References

1. S. Franco, *Design with Operation Amplifiers and Analog Integrated Circuits,* McGraw-Hill, 1998.
2. J. Millman and A. Grabel, *Microelectronics,* McGraw-Hill, 1988.
3. A. S. Sedra, K. C. Smith, and A. .N. Chandorkar, *Microelectronic Circuits*, Oxford University Press, 2004.