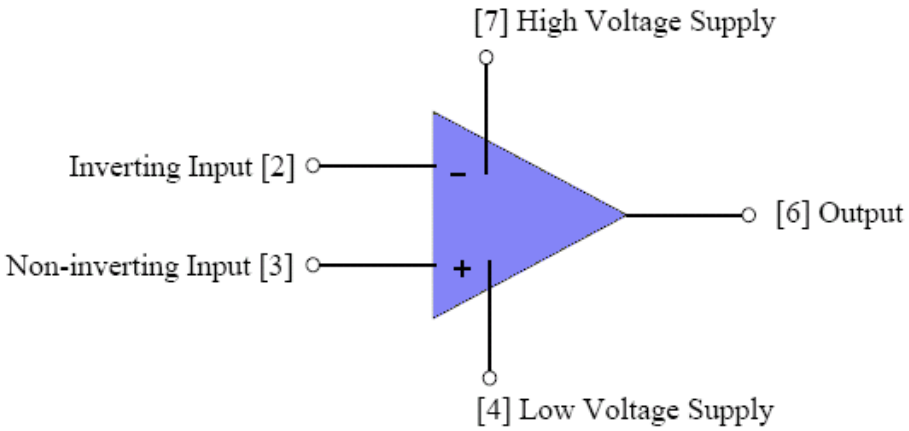
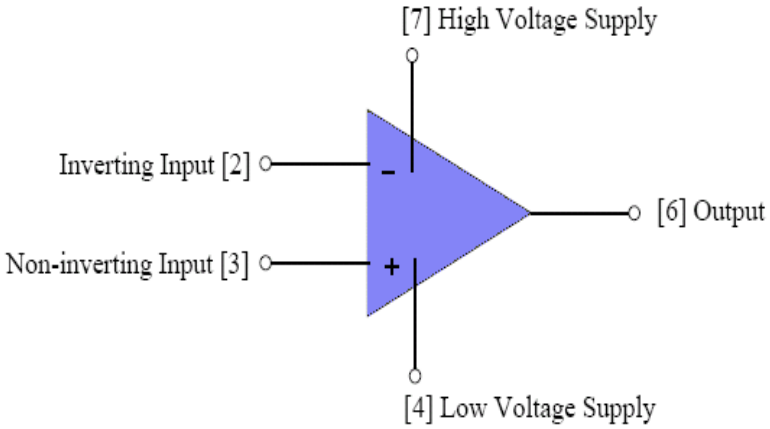
Introduction

- Operational Amplifiers are represented both schematically and realistically below:
  - Active component!



Operational Amplifier

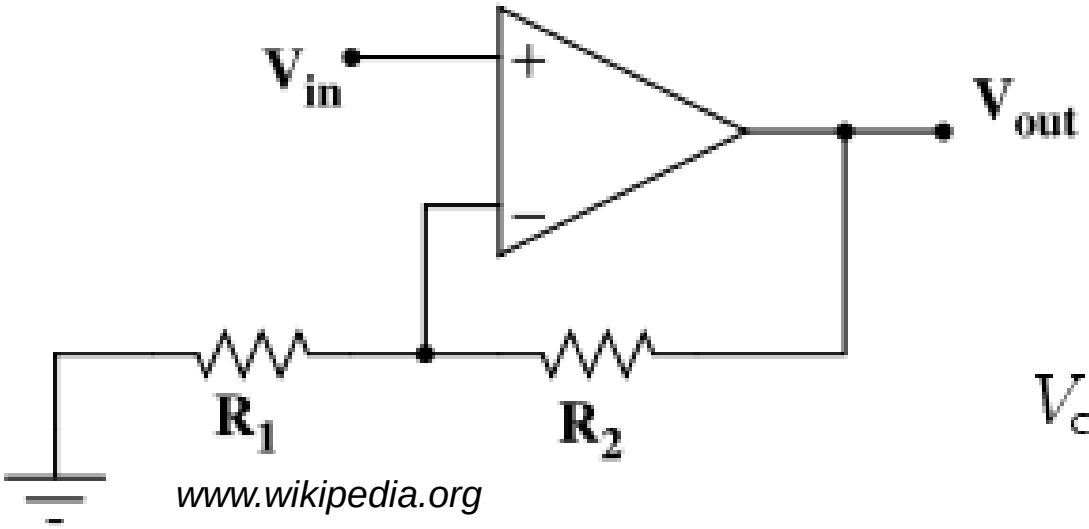


- Output gain high
  - A ~= 10^6
- Tiny difference in the input voltages result in a very large output voltage
  - Output limited by supply voltages
- Comparator
  - If $V_+ > V_-$, V_{out} = HVS
  - If $V_+ < V_-$, V_{out} = LVS
  - If $V_+ = V_-$, V_{out} = 0V

Ideal Op Amp

- Z_{in} is infinite
- Z_{out} is zero
- Amplification (Gain) $V_{out} / V_{in} = \infty$
- Unlimited bandwidth
- $V_{out} = 0$ when Voltage inputs = 0

Non-inverting Op-Amp

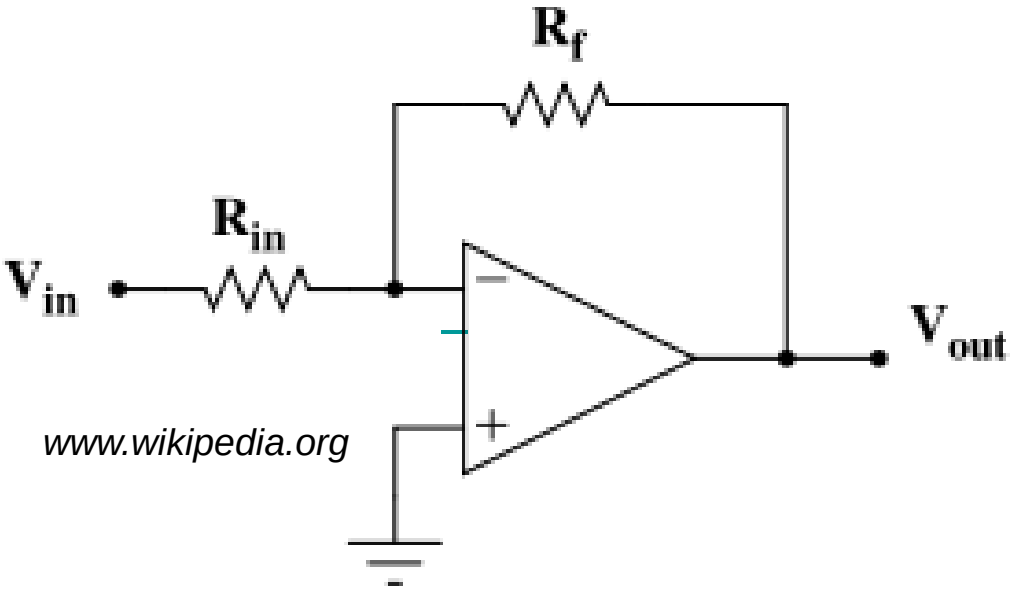


www.wikipedia.org

$$V_{\text{out}} = V_{\text{in}} \left(1 + \frac{R_2}{R_1}\right)$$

Uses: Amplify…straight up

Inverting Op-Amp



$$V_{\text{out}} = -V_{\text{in}}(R_{\text{f}}/R_{\text{in}})$$

Uses: Analog inverter