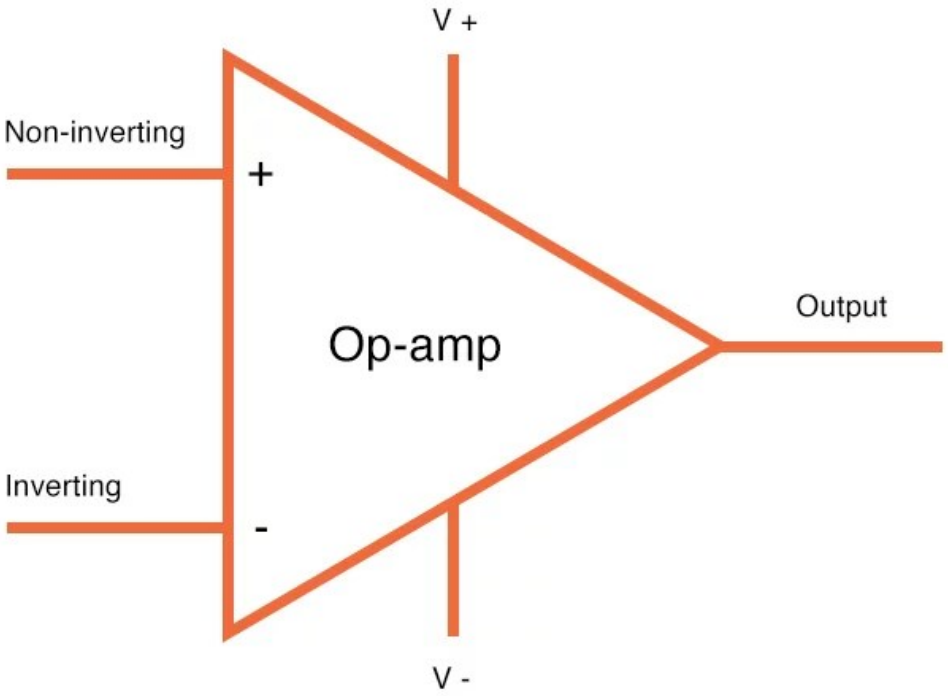
Operational Amplifier or Op-amp



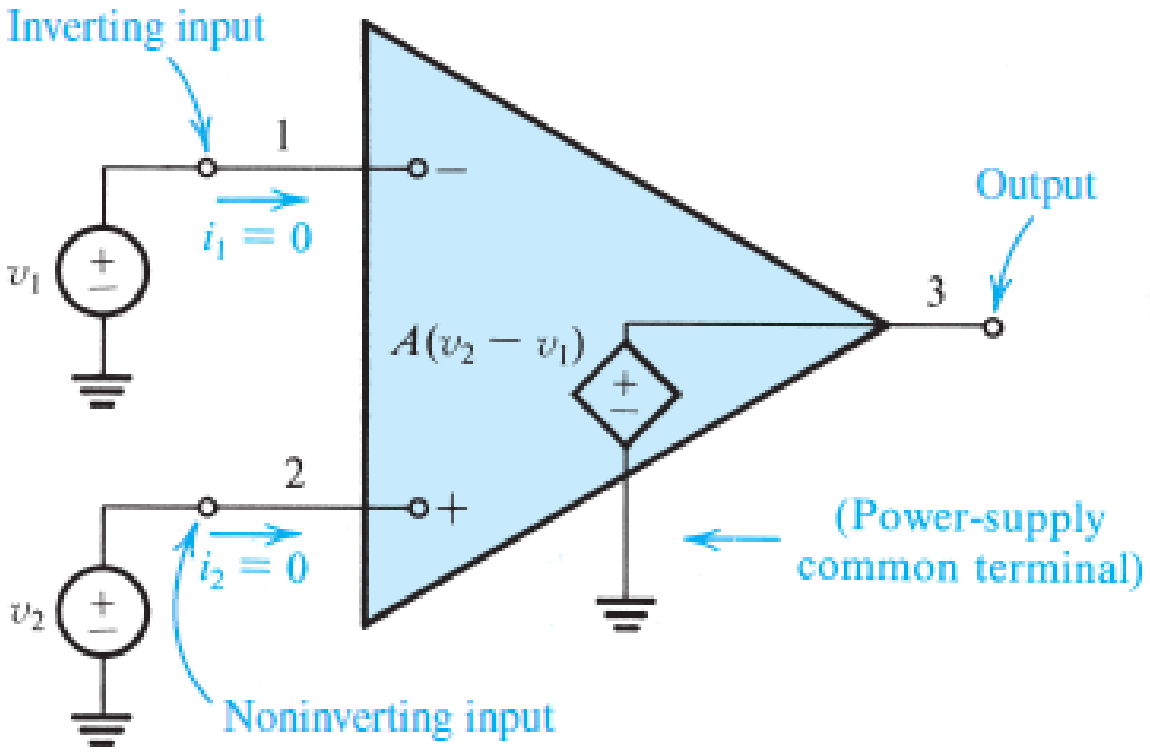
Introduction

An Operational Amplifier, or op-amp for short, is fundamentally a voltage amplifying device designed to be used with external feedback components such as resistors and capacitors between its output and input terminals. These feedback components determine the resulting function or “operation” of the amplifier and by virtue of the different feedback configurations whether resistive, capacitive or both, the amplifier can perform a variety of different operations, giving rise to its name of “Operational Amplifier”.

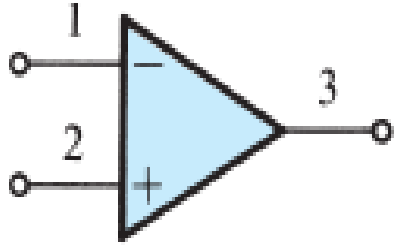
- ***Open Loop Gain***, (Avo) of an operational amplifier can be very high, as much as 1,000,000 (120dB) or more.This very high gain is of no real use to us as it makes the amplifier both unstable and hard to control as the smallest of input signals.
- The open loop DC gain of an operational amplifier is extremely high we can therefore afford to lose some of this high gain by connecting a suitable resistor across the amplifier from the output terminal back to the inverting input terminal to both reduce and control the overall gain of the amplifier. This then produces and effect known commonly as Negative Feedback, and thus produces a very stable Operational Amplifier based system.

- Op amps are used in a wide variety of applications in electronics. Some of the more common applications are: as a **voltage follower, selective inversion circuit, a current-to-voltage converter, active rectifier, integrator, a whole wide variety of filters, and a voltage comparator.**

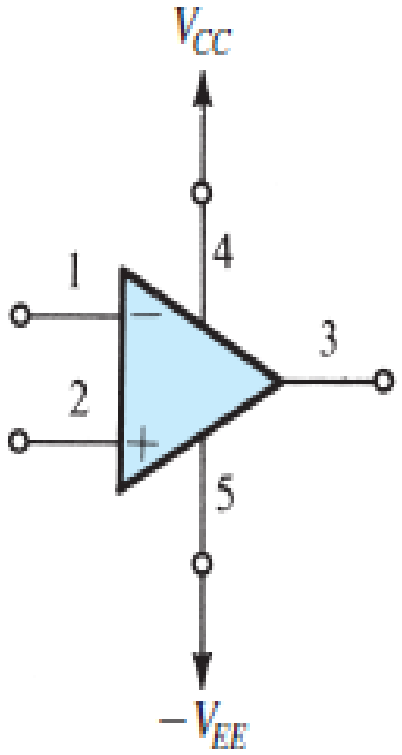
Equivalent circuit of ideal op-amp

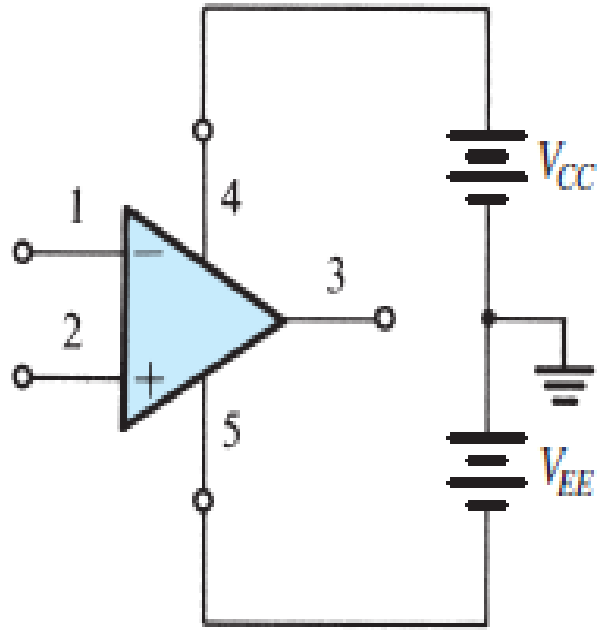


Circuit symbol for the op amp.



The op amp shown connected to dc power supplies.





Characteristic of the ideal op-amp

- ***Ideal Characteristic***

- ***1. Infinite input impedance***

  The ideal op amp is not supposed to draw any input current

- ***2. Zero output impedance***

  Output voltage independent of the current.

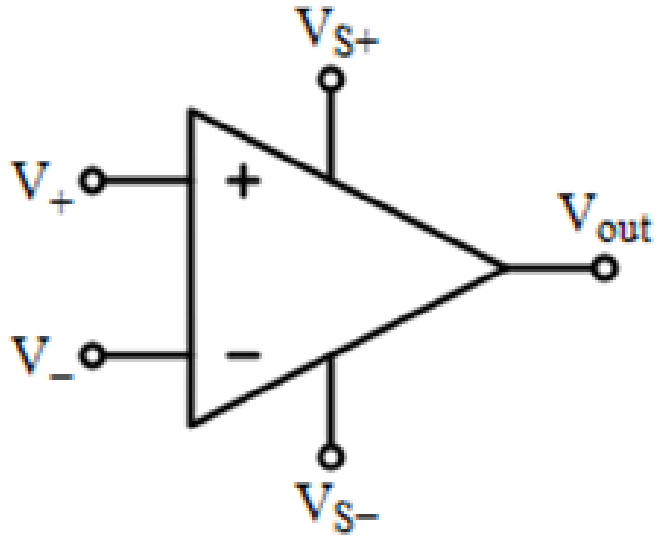
- ***3. Zero common-mode gain***

  if v1 = v2 = 1 V, then the output will (ideally) be zero.

- ***4. Infinite open-loop gain A***

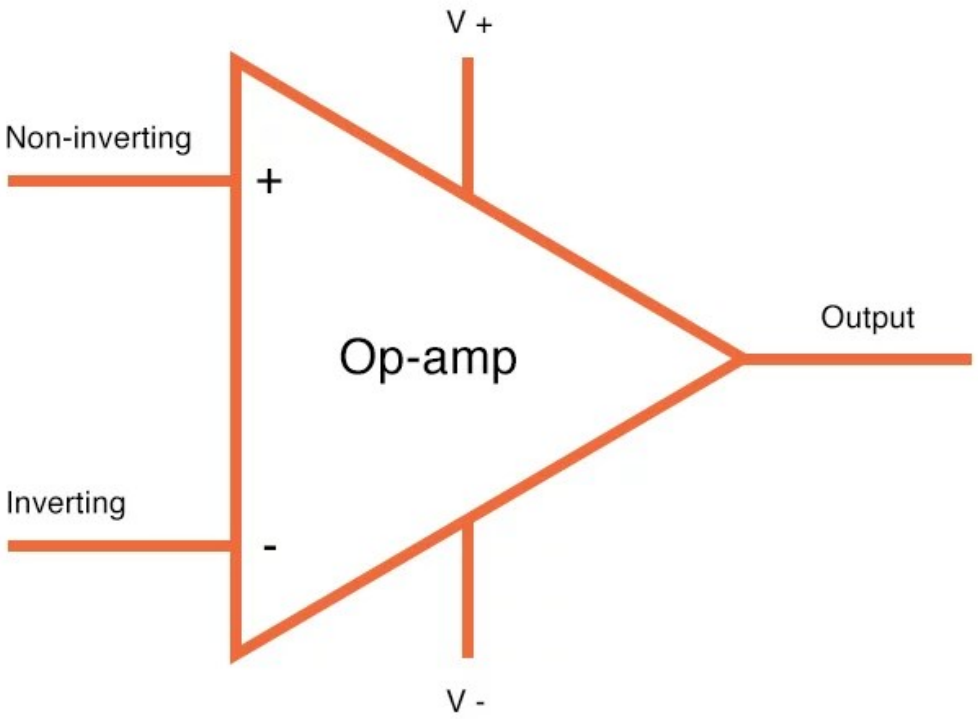
- ***5. Infinite bandwidth***

  Ideal opamp gain A is constant for all frequencies.



- V_+ : non-inverting input
- V_- : inverting input
- V_{out} : output
- V_{S+} : positive power supply
- V_{S-} : negative power supply

Op-amp : Comparator



Output voltage of openloop op-amp

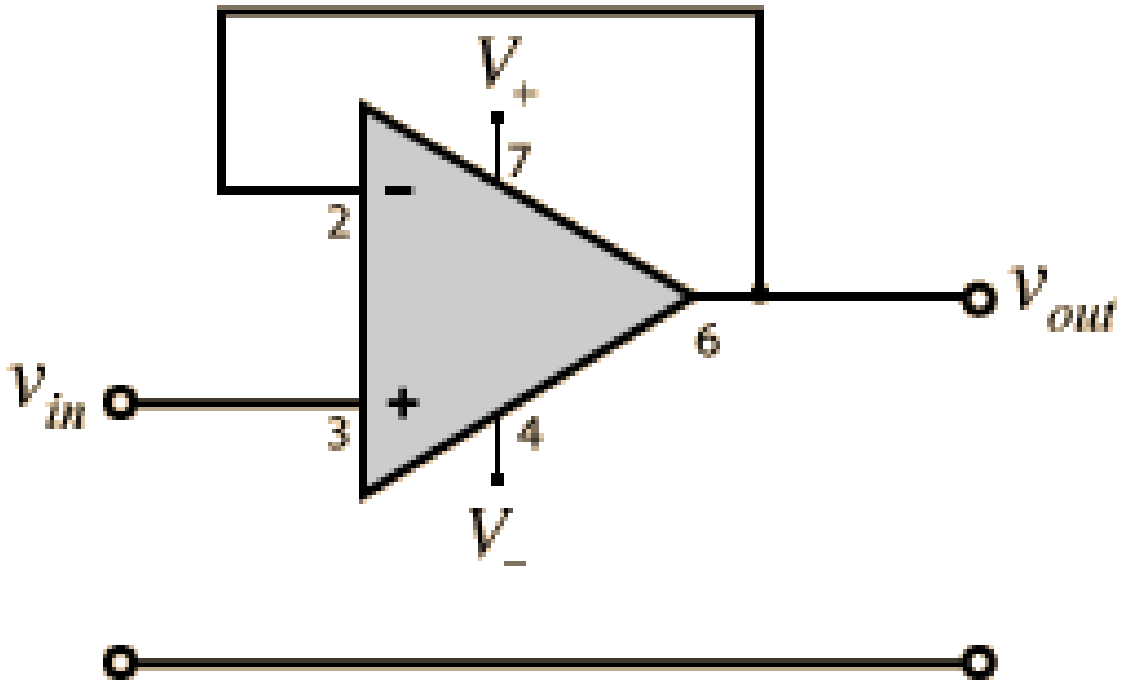
$$V_o = A * (V_{NI} - V_I)$$

A-Open loop gain of op-amp

if $V_{NI} > V_I$ - V_o= + infinite, but practically its saturate +ve supply voltage

if $V_{NI} < V_I$ - V_o= - infinite, but practically its saturate -ve supply voltage

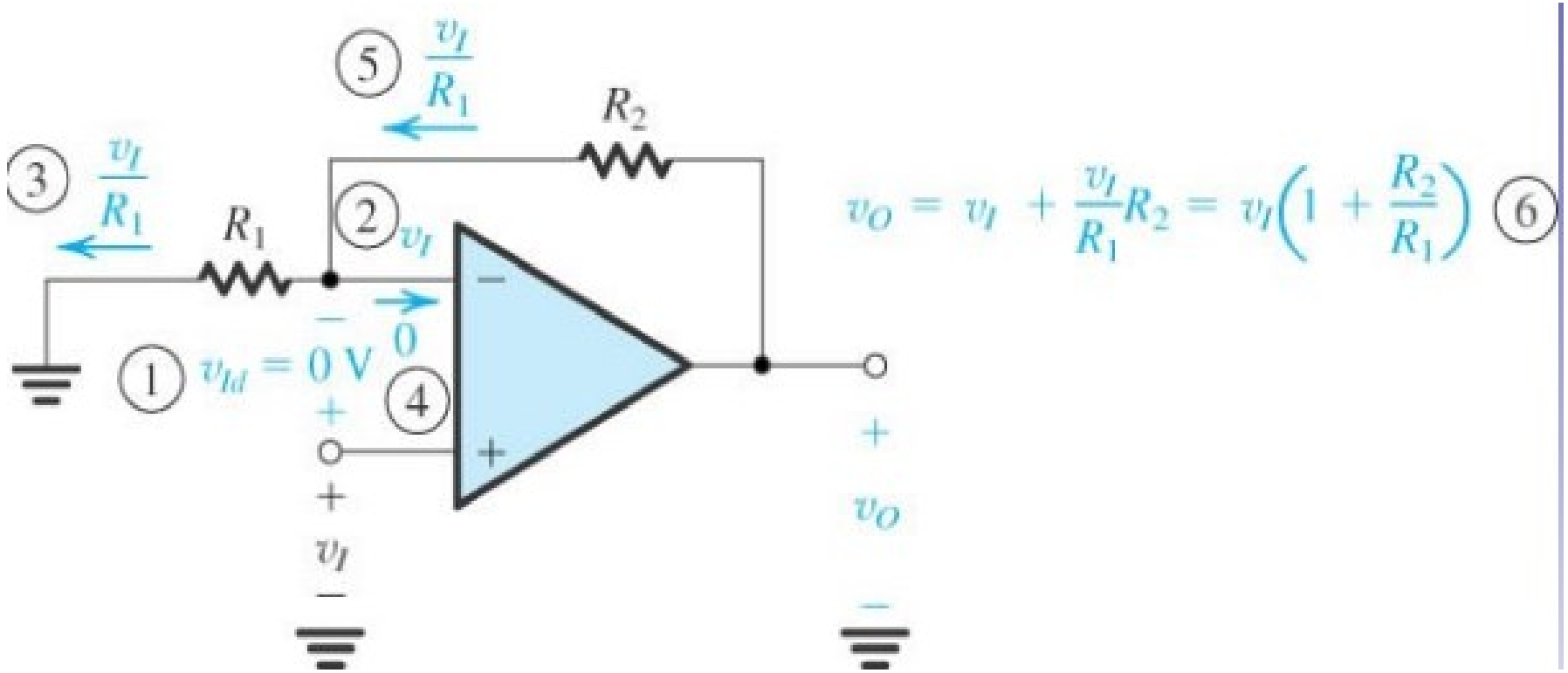
Op-amp : Voltage follower



$$V_{out} = V_{in}$$

This is called as ***unity buffer or volatge follower circuit***

Non-Inverting Op-amp



$$v_O = v_I + \frac{v_I}{R_1}R_2 = v_I\left(1 + \frac{R_2}{R_1}\right) \quad (6)$$