IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Microelectronics: Devices to Circuits

Ideal Operation Amplifier and its Terminals

SUDEB DASGUPTA

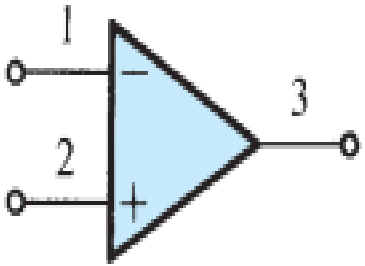
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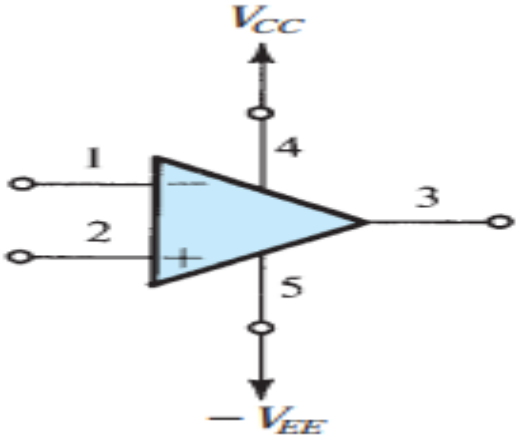


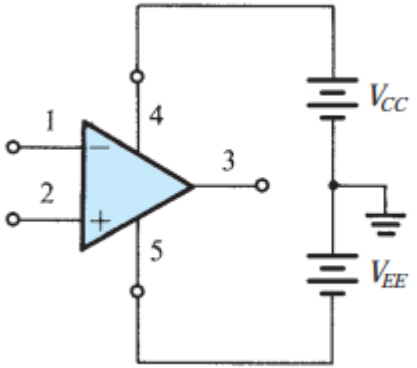
Outline

- Ideal Op-amp
- Function and Characteristics of the Ideal Op Amp
- Differential and Common-Mode Signals
- Recapitulation

Ideal Op-amp

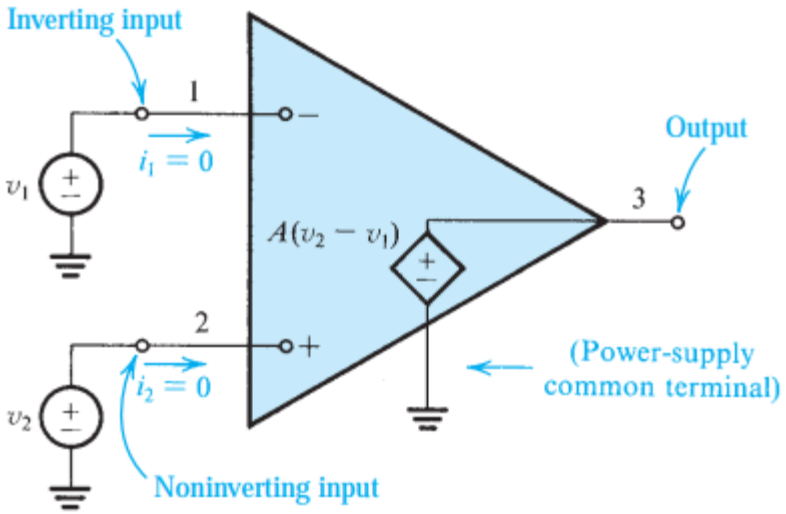






Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

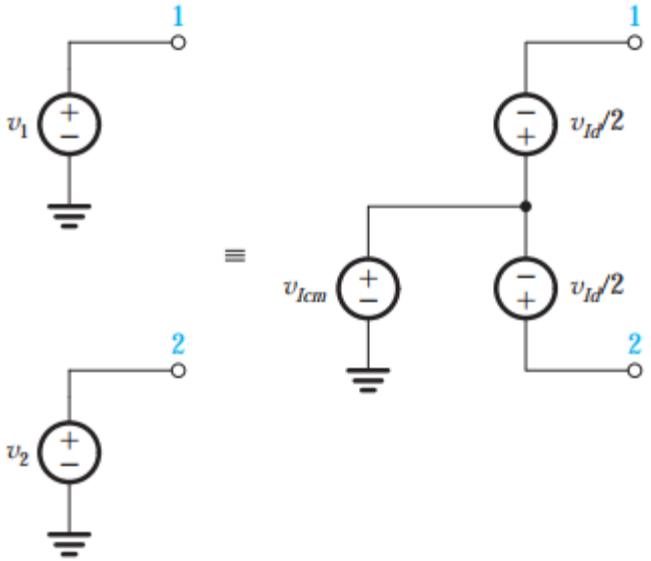
Function and Characteristics of the Ideal Op Amp



- Infinite input impedance.
- Zero output impedance.
- Zero common-mode gain or, equivalently, infinite common-mode rejection.
- Infinite open-loop gain *A*.
- Infinite bandwidth.

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Differential and Common-Mode Signals



$$v_{Id} = v_2 - v_1$$

$$v_{Icm} = \frac{v_1 + v_2}{2}$$

$$v_1 = v_{Icm} - \frac{v_{Id}}{2}$$

$$v_2 = v_{Icm} + \frac{v_{Id}}{2}$$

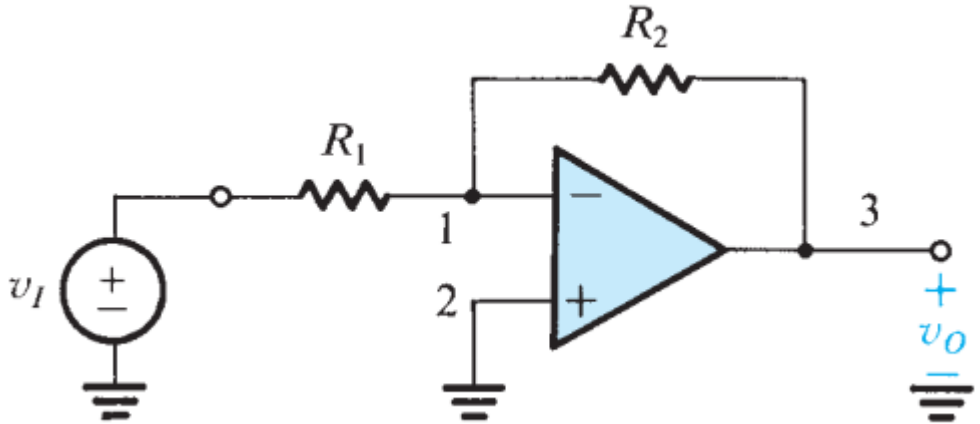
Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Recapitulation

- Ideal op amps will amplify signals of any frequency with equal gain, and are thus said to have infinite bandwidth.
- The ideal op amp should have a gain A, whose value is very large and ideally infinite.
- An important characteristic of op amps is that they are direct-coupled or dc amplifiers.
- The input impedance of an ideal op amp is supposed to be infinite.

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

The Inverting Configuration



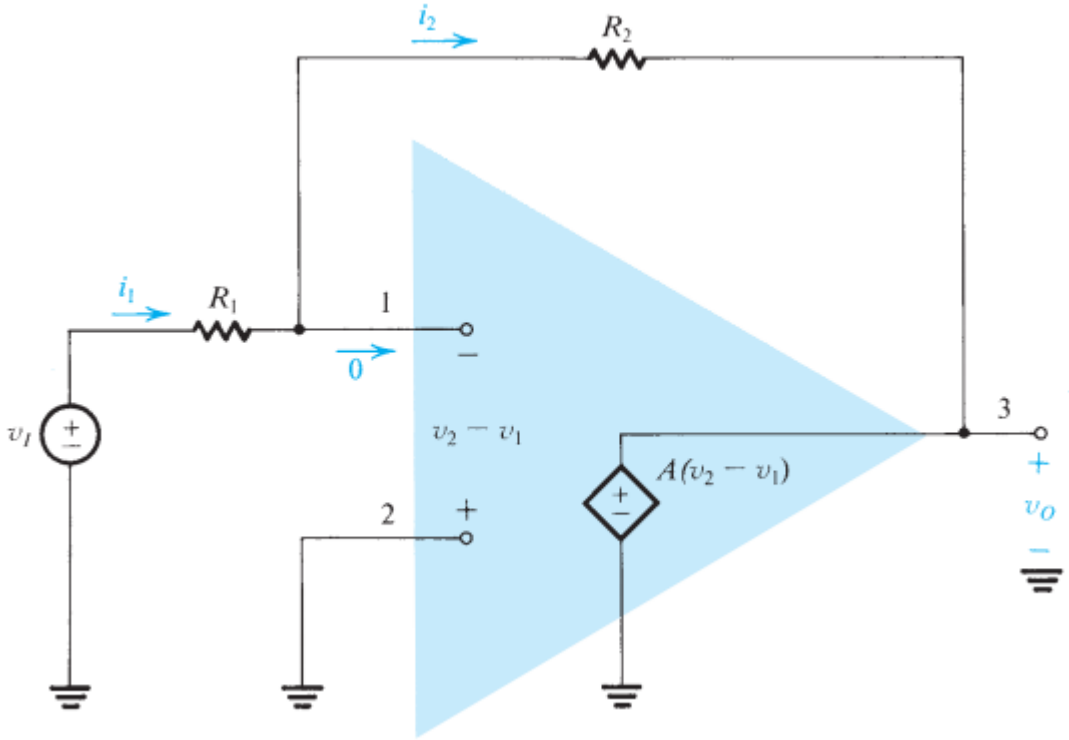
$$I_1 = \frac{v_I - v_1}{R_1} \qquad G = \frac{v_0}{v_I}$$

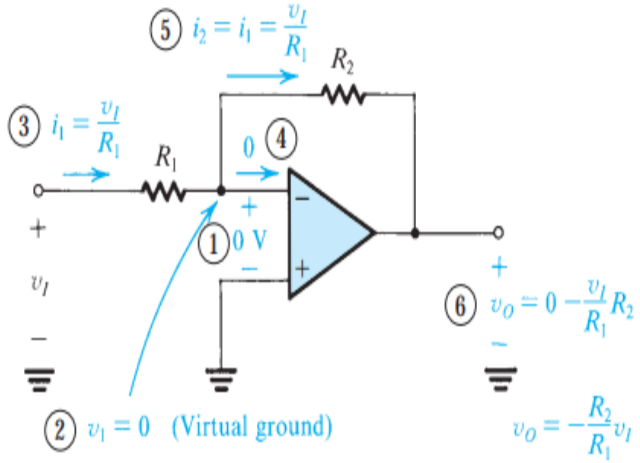
$$I_1 = \frac{v_I}{R_1} \qquad v_2 - v_1 = \frac{v_0}{A} = 0$$

$$v_0 = v_1 - i_1 R_2 \qquad v_2 = v_1$$

$$\frac{v_0}{v_I} = -\frac{R_2}{R_1}$$

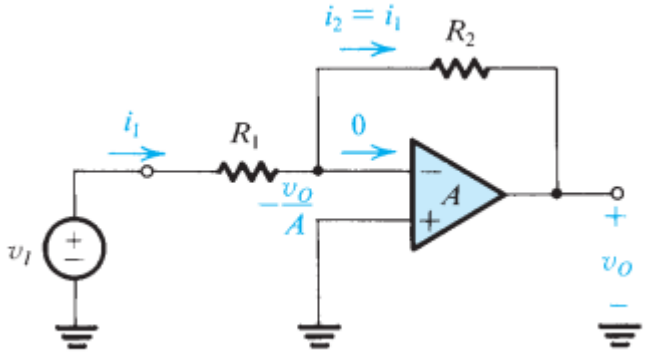
Source: Microelectronics Circuits, Sedra and Smith, Fifth edition





Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Effect of Finite Open-Loop Gain



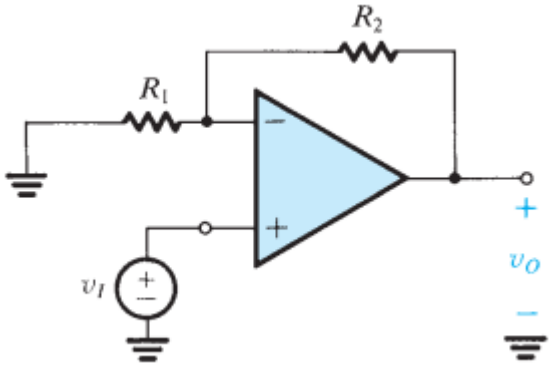
$$G = \frac{v_0}{v_I}$$

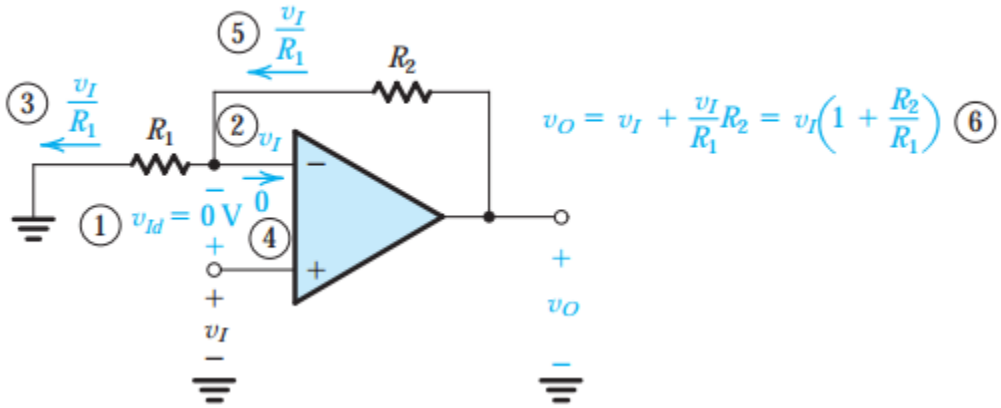
$$G = \frac{-\frac{R_2}{R_1}}{1 + \frac{\left(1 + \frac{R_2}{R_1}\right)}{A}}$$

$$R_i = R_1$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

The Non-inverting Configuration





$$v_o = v_I + \left(\frac{v_I}{R_1}\right)R_2 \qquad \frac{v_0}{v_I} = \left(1 + \frac{R_2}{R_1}\right)$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Effect of Finite Open-Loop Gain

$$G = \frac{v_0}{v_I} = \frac{\left(1 + \frac{R_2}{R_1}\right)}{1 + \frac{1 + \left(\frac{R_2}{R_1}\right)}{A}}$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Recapitulation

- To minimize the dependence of the closed-loop gain *G* on the value of the open-loop gain *A*, we should make $1+\frac{R_2}{R_1} \ll 1$.
- The inverting configuration suffers from a low input resistance.

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Thank You