OPAMP

• Dual in Line Packaging (DIP)
OPAMP PACKAGING

• Pinouts
OPAMP CIRCUITRY

• The linearity of OPAMP is due to the elaborate circuitry.
Fig. 2.4 The inverting closed-loop configuration.

OPAMPS

• Common and Differential Mode Inputs
OPAMP Circuit Model

- The linear models for OpAmps include dependent sources
Find Currents

- Inv and non-inv inputs are at same voltage

\[ i_1 = \frac{v_I}{R_1} \]
\[ i_2 = i_1 = \frac{v_I}{R_1} \]

\[ v_1 = 0 \quad \text{(Virtual ground)} \]

\[ v_O = 0 - \frac{v_I}{R_1} R_2 \]
\[ v_O = -\frac{R_2}{R_1} v_I \]
OPAMP Circuit Model

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Amplification Using Opamp

- Difference amplifier
- Use Kirchoff’s Current Law
- Use Superposition

**IDEAL OP-AMP CONDITIONS**

\[ i_+ = i_- = 0, \quad v_+ = v_- \]
Opamp Circuit using KCL

KCL @ INVERTING TERMINAL

\[
\frac{v_1 - v_-}{R_1} + \frac{v_o - v_-}{R_2} = i_-
\]

KCL @ NON INVERTING TERMINAL

\[
\frac{v_2 - v_+}{R_3} = \frac{v_+}{R_4} + i_+
\]

\[
i_+ = 0 \Rightarrow v_+ = \frac{R_4}{R_3 + R_4} v_2 \Rightarrow v_- = \frac{R_4}{R_3 + R_4} v_2
\]

\[
v_o = \left(1 + \frac{R_2}{R_1}\right) v_- - \frac{R_2}{R_1} v_1 = \frac{R_2}{R_1} \left(1 + \frac{R_1}{R_2}\right) v_- - \frac{R_2}{R_1} v_1
\]
Opamp Circuit using Superposition

Remove Sources

Superimpose

\[ v_o = v_{o1} + v_{o2} \]

\[ v_{o1} = -\frac{R_2}{R_1} v_1 \]
Input Impedance of Opamp

\[ v_o = R_2 \times \frac{v_+ - v_-}{R_1} \]

\[ R_{\text{in}} = \frac{R_1}{R_1 + R_2} \]

\[ |Z_{\text{in}}| = \frac{1}{R_{\text{in}}} \]

\[ |Z_{\text{in}}| = \frac{1}{\frac{R_1}{R_1 + R_2}} \]

\[ |Z_{\text{in}}| = \frac{R_1 + R_2}{R_1} \]