

# INTEGRATED CIRCUITS



# OVERVIEW

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- Introduction
  - What are Op-Amps?
  - Circuit symbol and Pin- Configuration
  - Inverting and Non-inverting modes..
  - Gain of an Op-Amp..
  - REFERENCES..
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# Introduction

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- ✓ Amplifier is a device which senses an input and produces a larger version of it.
  - ✓ Amplifiers are used to boost electrical signals in devices (radio, televisions..)
  - ✓ Op-Amp: Class of High gain DC Amplifiers with two inputs and Single output
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# Symbol & Pin Configuration

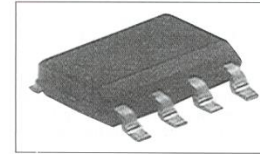
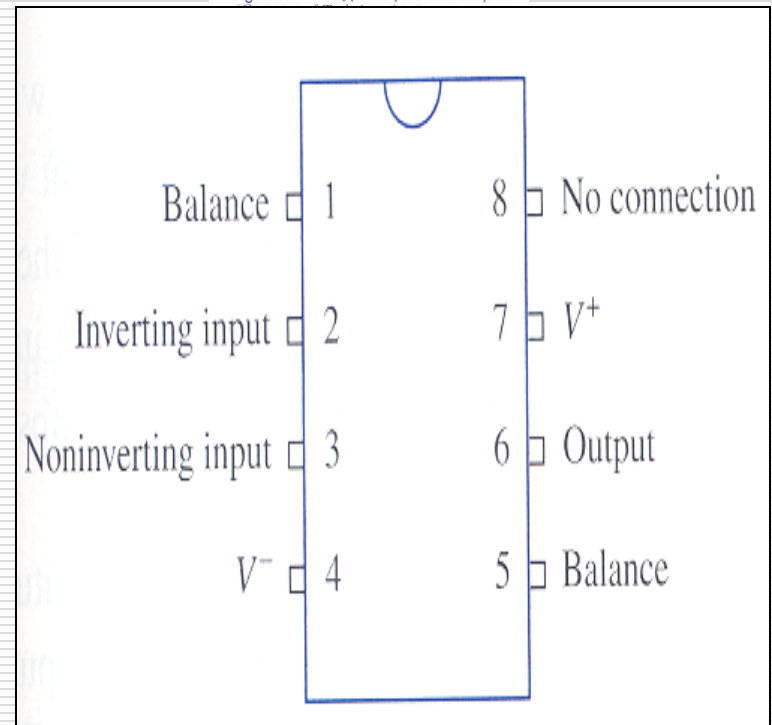
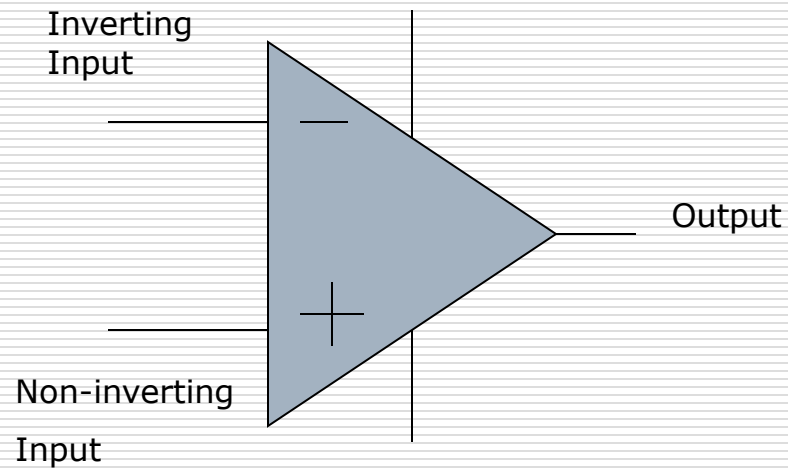


Figure 5.1 A typical operational amplifier.

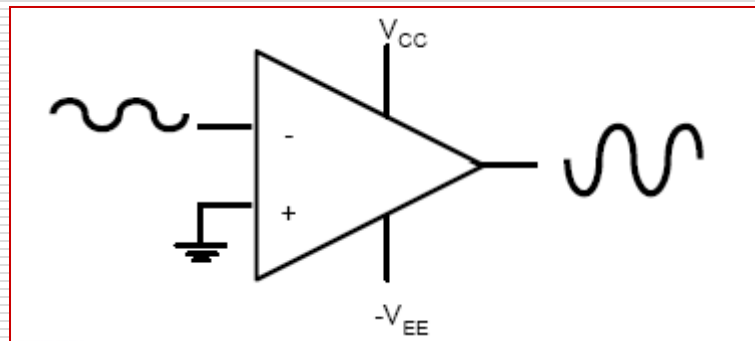


# Inverting and Non-Inverting

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## Inverting Amplifier:

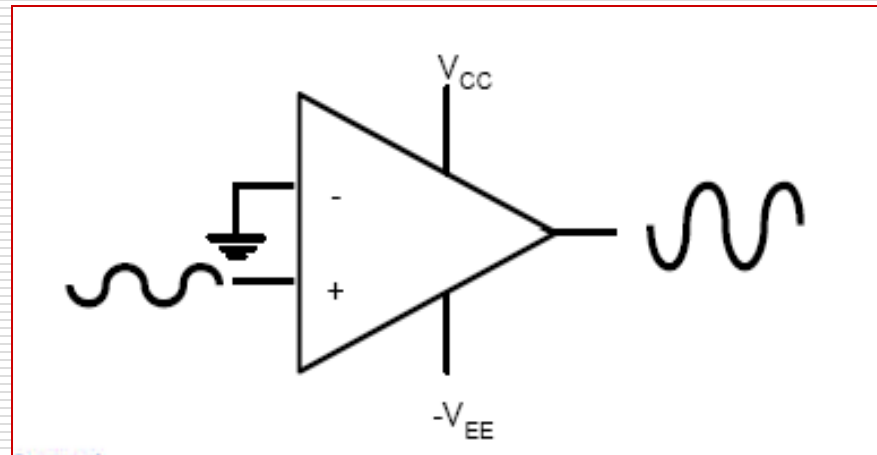
- Non- Inverting input is grounded.
- Signal is applied to the Inverting input.
- Output is  $180^\circ$  out of Phase.



# Non-Inverting Amplifier

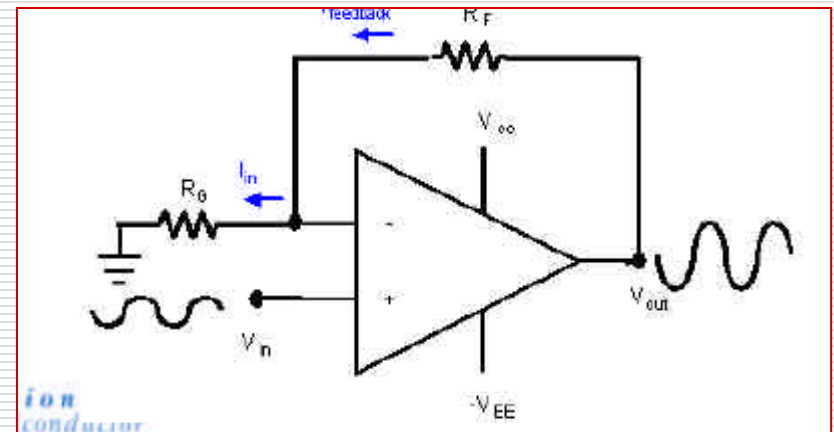
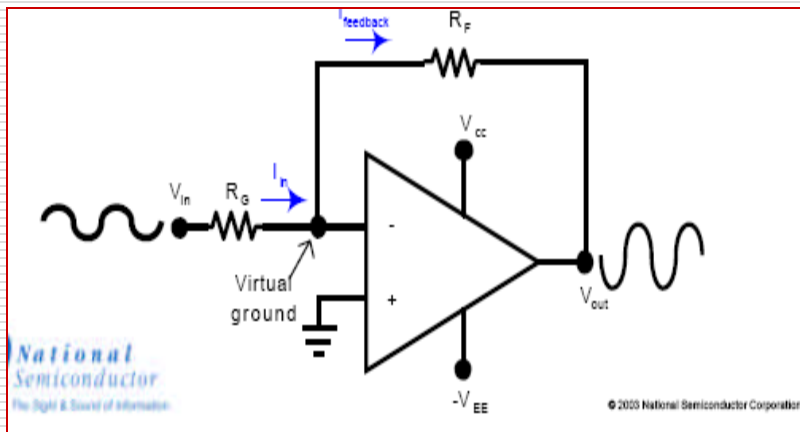
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- Inverting input is grounded.
- Signal is applied to the Non-Inverting input.
- Output is in Phase.



# Closed Loop Connection

- "Output is applied back in to the Inverting Input."
- Used in both Inverting and Non-inverting modes of Operation.



# What is Gain??

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Gain = Output / Input

Gain of Op-Amp (Inverting Mode) =  $-R_f/R_1$

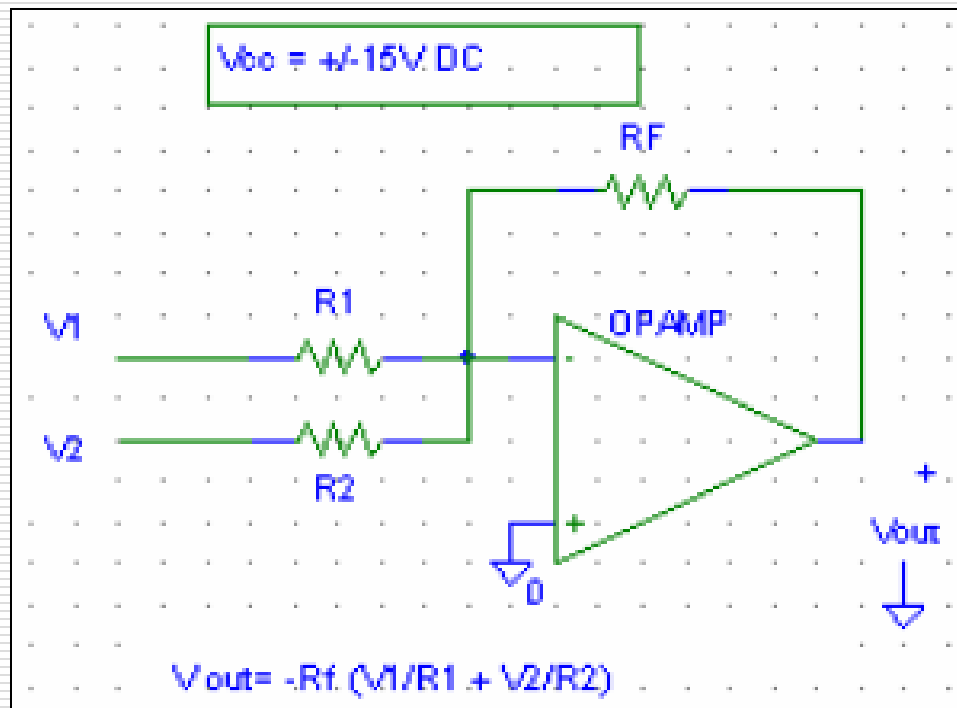
Gain of Op-Amp (Non-inverting Mode) =  $1 + R_f/R_1$

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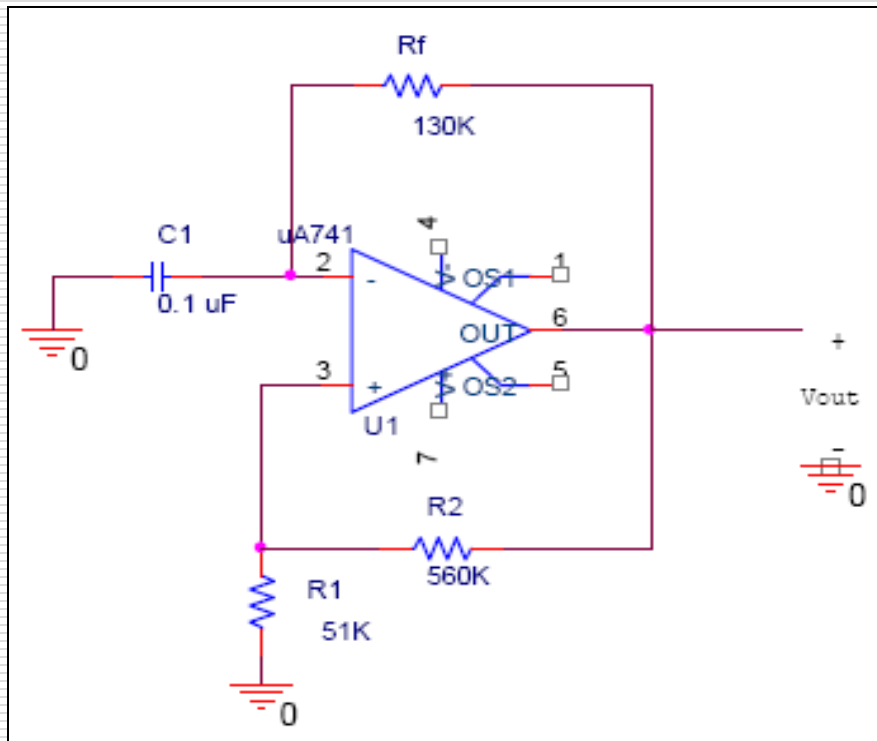
# Inverting Summing Amplifier

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$$V_{OUT} = V_1 + V_2$$

# Op-amp as Oscillator



$$f_0 = \frac{1}{2R_f C \ln\left(\frac{2R_1}{R_2} + 1\right)}$$

# Differential and Common mode

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- ❑ Common Mode: When both inputs of the signal have the same common voltage..
  - ❑ Output will be zero in the common mode.
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