

Operational Amplifiers (Op-Amps)

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1. Introduction

- An operational amplifier is a high-gain DC-coupled voltage amplifier with two inputs and one output.
- Op-amps are versatile building blocks for amplification, filtering, and signal conditioning.

2. Key Characteristics

- **Inverting and non-inverting inputs:** the output responds to the difference between these inputs.
- **Ideal properties:** infinite open-loop gain, infinite input impedance, and zero output impedance.
- Real devices like the 741 approximate these ideals closely enough for most uses.

3. Feedback and Gain

- **Negative feedback:** routing output back to the inverting input sets a stable, predictable gain.
- **Virtual short:** with feedback, the two input voltages are nearly equal, simplifying analysis.

4. Common Configurations

- **Inverting amplifier:** gain set by the ratio of feedback to input resistor, with phase inversion.
- **Non-inverting amplifier:** gives a gain of one plus the resistor ratio without inversion.
- Other circuits include voltage followers, summers, integrators, and comparators.

5. Applications

- Used in instrumentation, active filters, oscillators, and analog computation.
- Comparators sense thresholds in control and alarm systems.

6. Summary

- Op-amps are high-gain differential amplifiers whose behaviour is controlled by external feedback components to perform amplification and signal processing.