Introduction To Amplifiers

Course Number: EE-02-120

PDH: 5

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Module 1: Amplifiers

Learning Objectives

By the end of this section, you will be able to:

- **Define** amplification and identify its common industrial applications.
- **Classify** amplifiers based on their function (voltage vs. power) and frequency response.
- **Evaluate** the four classes of amplifier operation and their trade-offs between efficiency and fidelity.
- **Select** appropriate coupling methods and transistor configurations to meet specific impedance and gain requirements.
- **Analyze** the effects of positive and negative feedback on circuit performance.

Executive Summary: Amplifiers are fundamental electronic circuits that allow a small input signal to control a larger output signal. For the Professional Engineer, understanding the nuances of amplifier classification, class of operation, and coupling methods is essential for designing systems that balance fidelity, efficiency, and power transfer. Key design considerations include matching impedances for maximum power transfer and utilizing negative feedback to stabilize gain and improve signal reproduction.

Introduction to Amplification

Amplification is the process of increasing the **amplitude**—the size of a voltage or current signal. An amplifier acts as a control device where the input signal dictates the characteristics of the output signal, which is generally larger in terms of voltage, current, or power.

Uses of Amplification

Most electronic devices require amplifiers because original signals (e.g., from a turntable needle or a radio antenna) are often too weak to drive output devices like speakers or transmitters. Each step in this process is referred to as a **stage** of amplification.

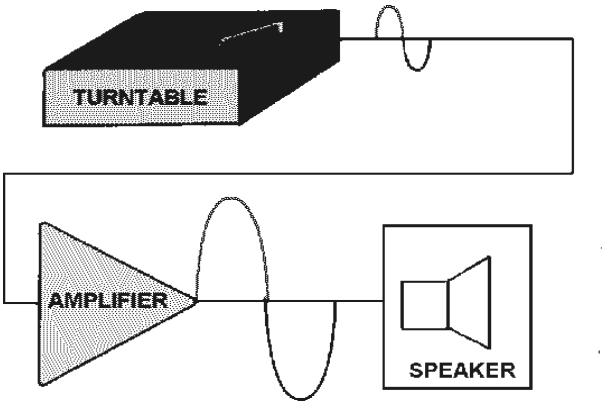

Figure 1-1. Amplifier as used with turntable and speaker.

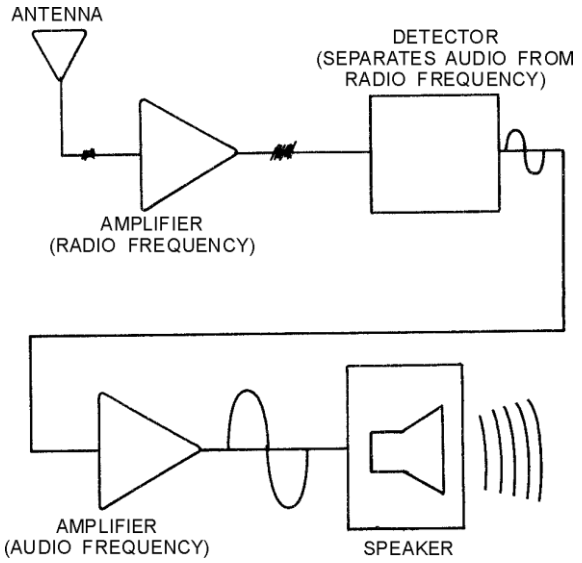

Figure 1-2. Amplifiers as used in radio receiver.

Classification of Amplifiers

Amplifiers are primarily classified in two ways: by their **function** and by their **frequency response**.

Voltage vs. Power Amplifiers

All amplifiers are current-control devices. Their specific circuitry determines their classification:

- **Voltage Amplifiers:** Designed so that the output signal voltage is larger than the input signal voltage.
- **Power Amplifiers:** Designed so that the output signal power is greater than the input signal power. These often serve as the final stage to drive high-load output devices.

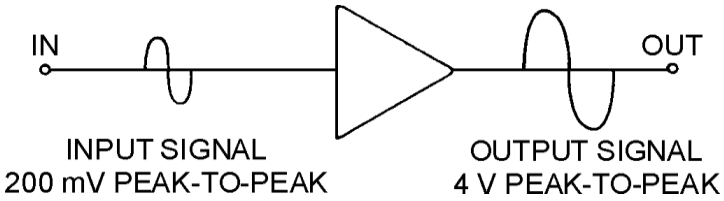

Figure 1-3A. Block diagram of voltage and power amplifiers.

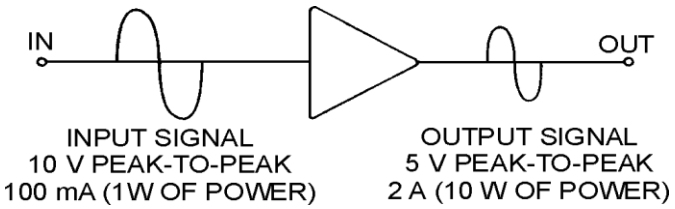

Figure 1-3B. Block diagram of voltage and power amplifiers.

Frequency Response Categories

Frequency response refers to the range of frequencies the amplifier is designed to handle:

- **Audio Amplifiers:** 15 Hz to 20 kHz.
- **RF (Radio Frequency) Amplifiers:** 10 kHz to 100,000 MHz.
- **Video (Wide-Band) Amplifiers:** 10 Hz to 6 MHz. These provide a wide range but lower gain per stage.

Transistor Amplifier Principles

Transistor and vacuum-tube amplifiers are both **current-control devices**. In a transistor, the base current controls the collector current. This fundamental control allows the circuit to provide either voltage or power gain.

Amplifier Classes of Operation

The class of operation is determined by the **bias** applied to the device, which dictates the percentage of the input signal cycle during which current flows in the output circuit.

- **Class A:** Current flows for 100% (360º) of the signal. Provides high **fidelity** (low distortion) but low **efficiency**.
- **Class AB:** Current flows for 51% to 99% of the signal. Better efficiency than Class A but introduces some distortion.
- **Class B:** Current flows for exactly 50% (180º) of the signal. High efficiency; often used in pairs.
- **Class C:** Current flows for less than 50% of the signal. Most efficient class, but has the poorest fidelity.

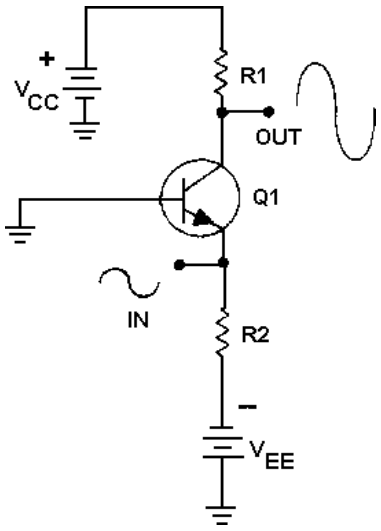

Figure 1-4. A simple class A transistor amplifier.

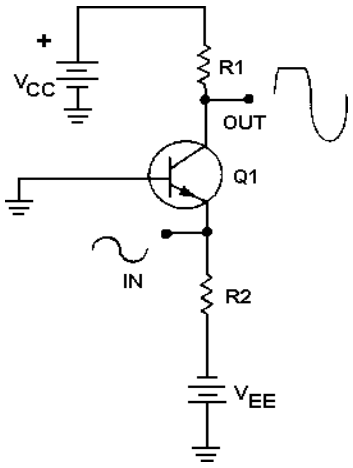

Figure 1-5. A simple class AB transistor amplifier.

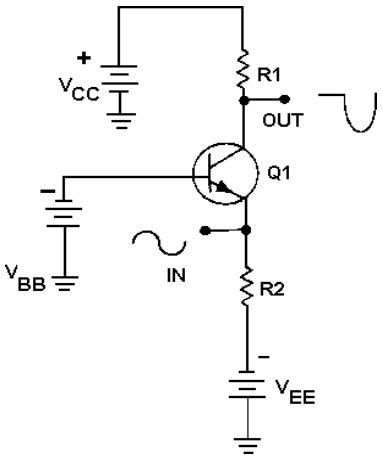

Figure 1-6. A simple class B transistor amplifier.

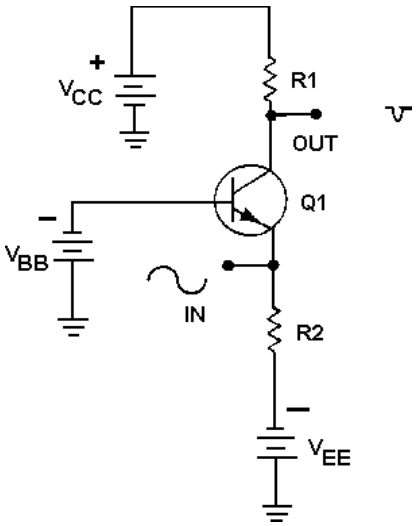

Figure 1-7. Simple class C transistor amplifier.

Amplifier Coupling Methods

When a single stage provides insufficient gain, stages are linked via **coupling**.

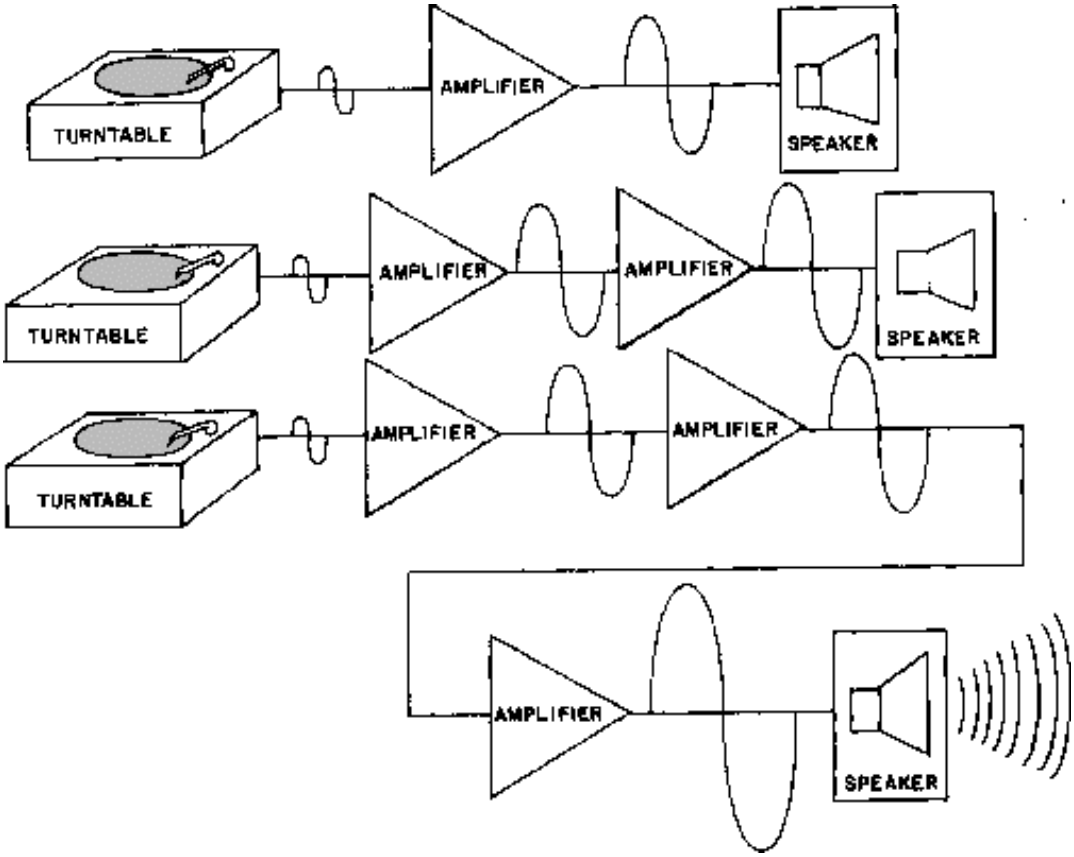

Figure 1-8. Adding stages of amplification.

- **Direct Coupling:** Connects the collector of one stage directly to the base of the next. It offers excellent frequency response but is plagued by complex biasing and power supply requirements.

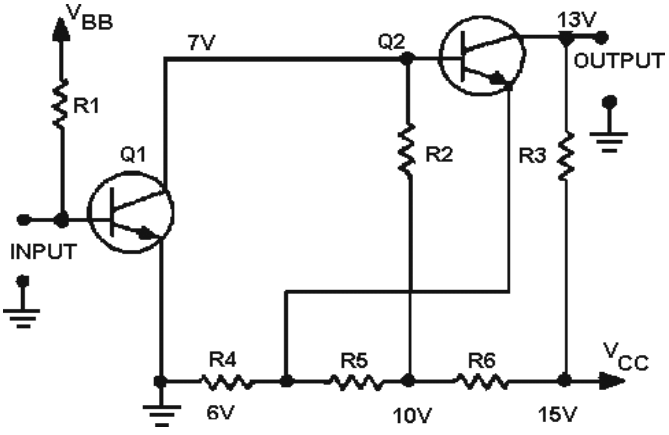

Figure 1-9. Direct-coupled transistor amplifiers.

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