23ECE282

Analog Electronics Laboratory

Group Id: C-02

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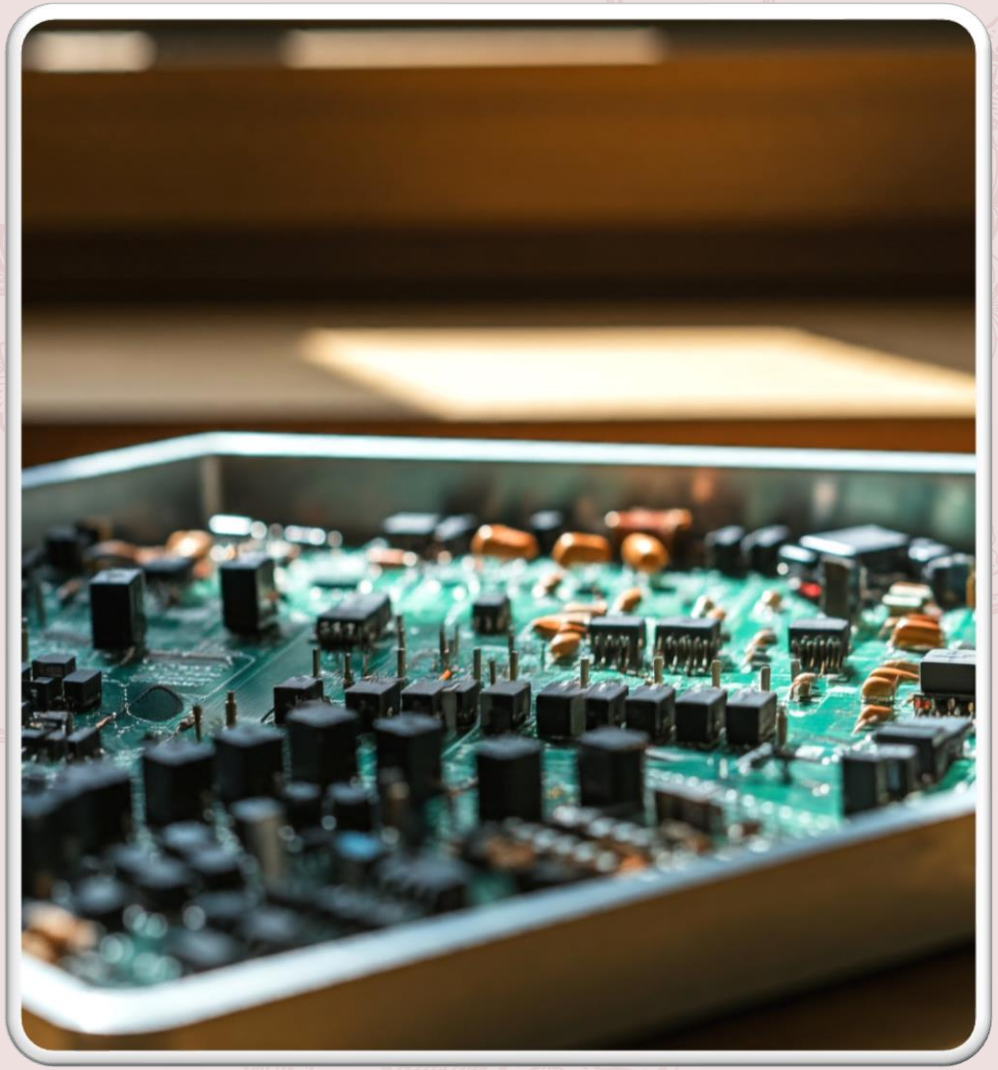
AM Radio Receiver Using Bipolar Junction Transistor (BJTs)

Introduction

This presentation covers the design and implementation of an AM radio receiver using Bipolar Junction Transistors (BJTs). We will explore the fundamental principles, circuit design , and practical considerations involved in creating a functional AM receiver .



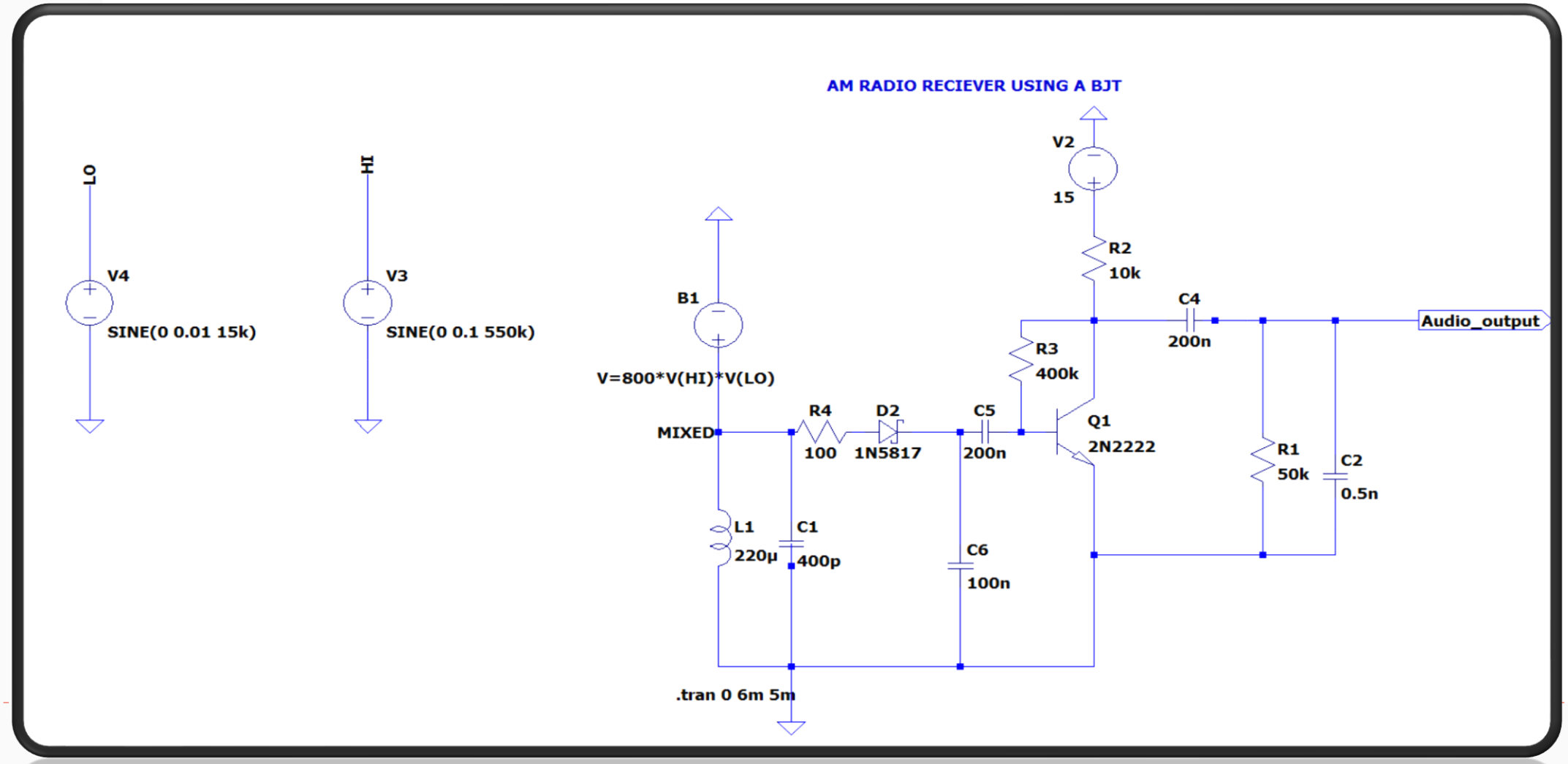
Understanding AM Radio

Amplitude Modulation (AM): The amplitude of the carrier wave is varied according to the audio signal, while the frequency remains constant.

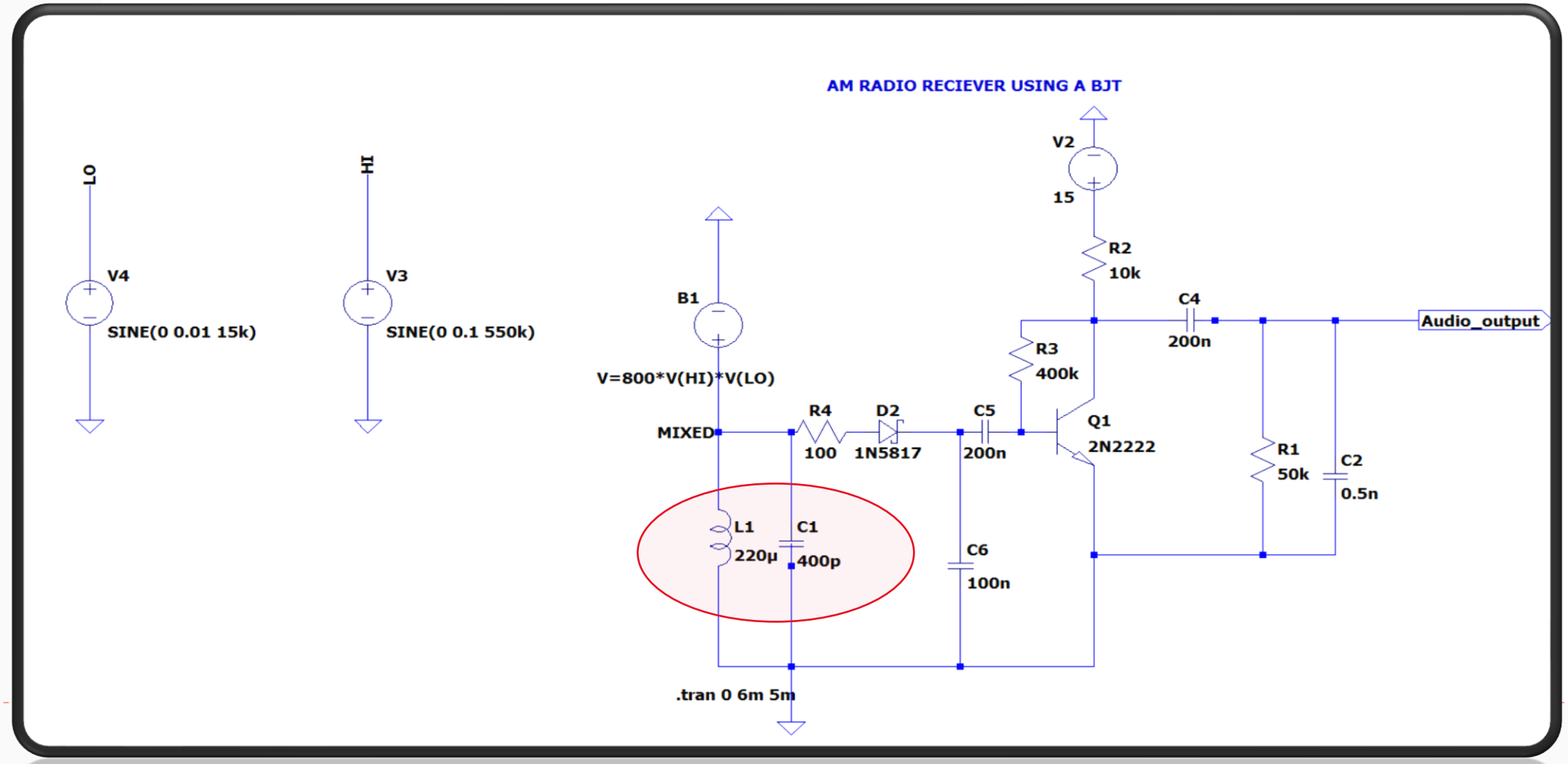
Carrier Wave: A continuous signal that is modulated with audio information and broadcasted at a specific frequency within the AM band

Demodulation: The receiver extracts the audio information from the amplitude variations of the carrier wave to reproduce sound.

Circuit Design Overview



Tuning Circuit



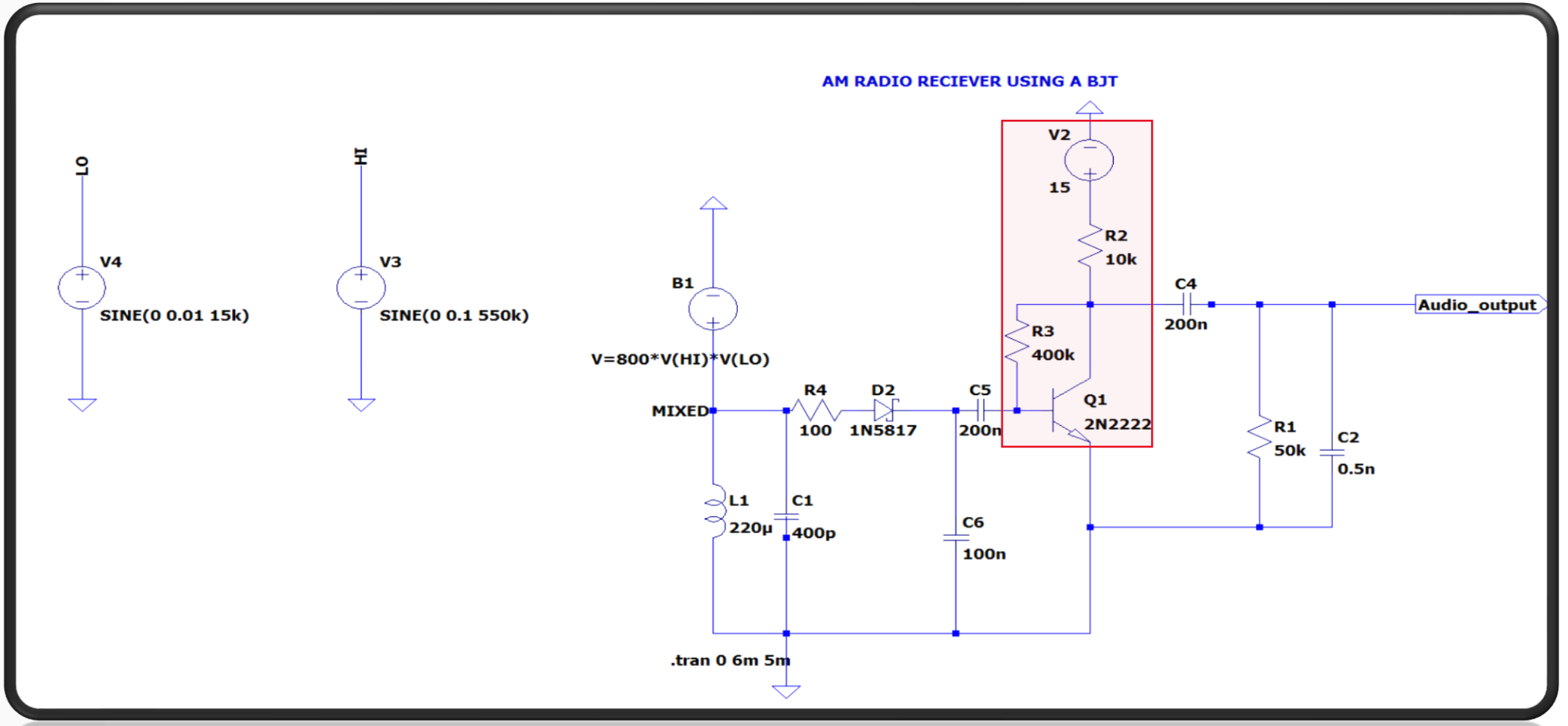
Tuning Circuit

In a radio, the LC circuit is part of the tuner. By adjusting either the inductor or the capacitor, you can change the resonant frequency of the LC circuit to match the desired carrier frequency of the AM signal.

Variable Capacitor: Most radios use a variable capacitor to adjust the capacitance of the LC circuit. As you turn the tuning knob, you change the capacitance, which shifts the resonant frequency.

Fixed Inductor: The inductor is usually fixed, so only the capacitor is adjusted during tuning. When the LC circuit's resonant frequency matches the frequency of the incoming AM signal, the circuit resonates and efficiently receives that frequency while rejecting others.

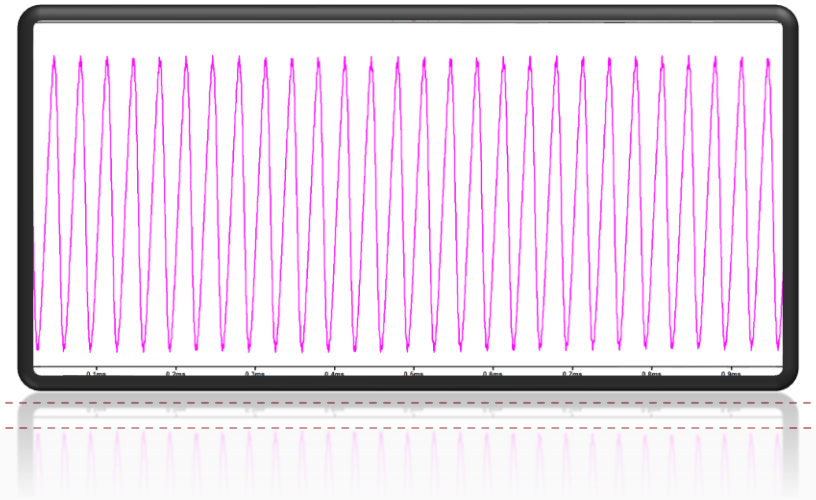
Amplification Stage



Amplification stage

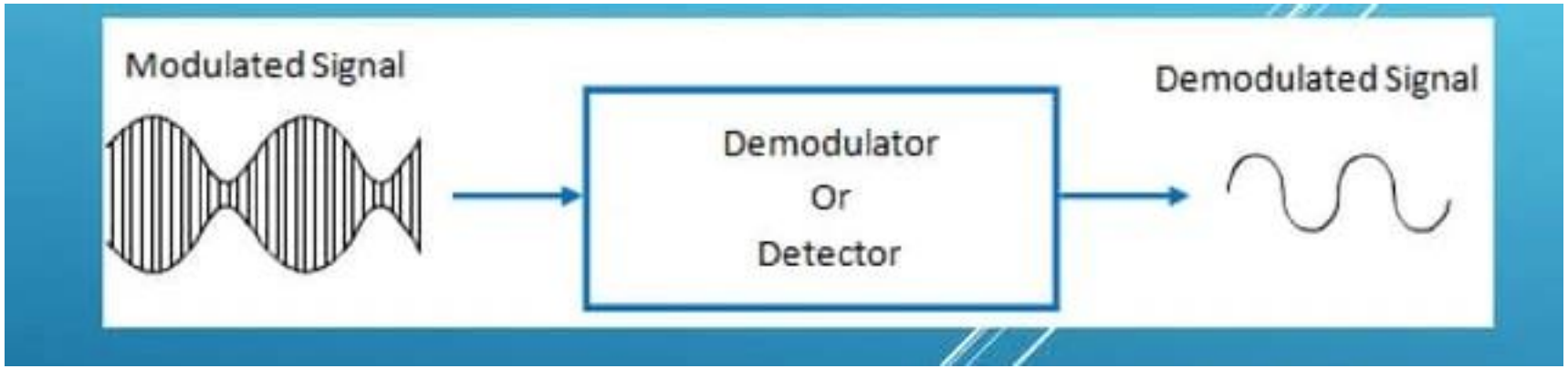
The npn transistor (2N2222) acts as amplifier in this circuit. The load resistor connected to the collector of Q1 namely R2 is equal to $10k\Omega$ helps up in setting the voltage gain. This load resistor R2 is useful in determining the gain.

The resistor R3 is equal to $400k\Omega$ is connected to emitter of Q1. Both these resistors R2 and R3 plays a vital role in determining the gain. The gain A_v of this amplifier circuit is given by $\frac{v_o}{v_i}$ which is equals to 1.491 .



Demodulation Technique

Demodulation is the process of extracting the audio signal from the modulated carrier wave.



Working Principle

1. Signal Sources (V3 and V4):
V3 (SINE 0.1 550k): Represents the **AM carrier signal** at 550 kHz. This high-frequency sine wave serves as the carrier for the audio information.
V4 (SINE 0.01 15k): A **modulating audio signal** with a frequency of 15 kHz. This signal modulates the carrier (V3), encoding audio information onto the carrier for transmission.

2. Mixer Stage (B1, L1, C1, D2):
•**B1**: Likely represents the product of mixing the high-frequency carrier and low-frequency audio signals, creating a modulated AM signal.
•**L1 (220 µH) and C1 (400 pF)**: Form a **tuned LC circuit** that resonates at the desired frequency (550 kHz). This selects the AM signal from the environment or from an input signal.
•**D2 (1N5817)**: A **diode detector** that demodulates the AM signal. It rectifies the AM waveform, effectively extracting the audio information by removing the carrier and leaving behind the modulated audio.

Working Principle

3. Amplification Stage (Q1 - Transistor Amplifier):
•**Q1 (2N2222)**: A **common-emitter transistor amplifier** that amplifies the demodulated audio signal to a usable level.
•**R2 (10 kΩ)**: A **collector resistor** that helps set the amplifier's gain.
•**R3 (400 kΩ)**: An **emitter resistor** providing **negative feedback**, stabilizing and controlling the amplifier's gain.
•**C4 (200 nF)**: A **coupling capacitor** that passes the AC audio signal to the output while blocking any DC component from the transistor amplifier.

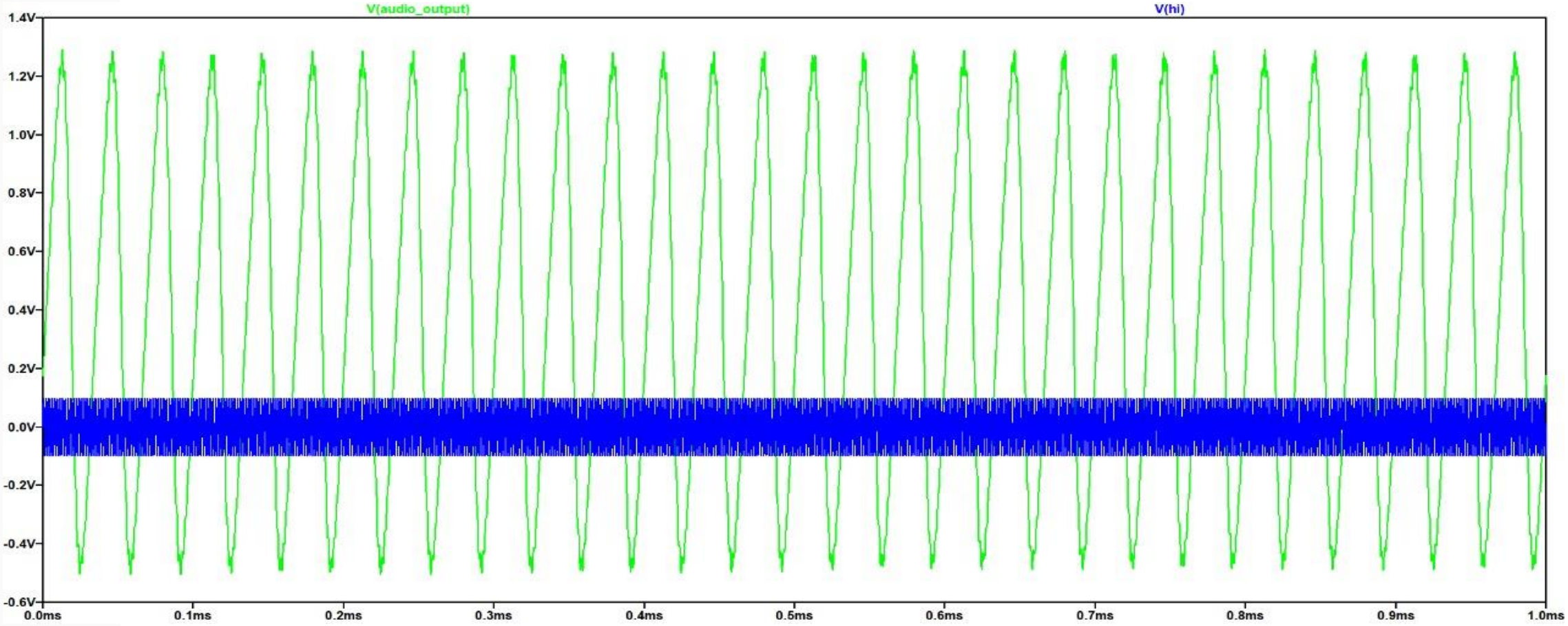
4. Decoupling and Filtering:
•**C5 (200 nF) and C6 (100 nF)**: Act as **decoupling capacitors**, filtering out noise and stabilizing the circuit by preventing unwanted high-frequency signals from interfering.
•**R1 (50 kΩ) and C2 (0.5 nF)**: Form an **RC filter** that smooths the demodulated audio signal, ensuring clean audio is delivered to the output.

Working Principle

5. Audio Output:

•The processed signal at the output is a **demodulated and amplified audio signal**, suitable for driving speakers or headphones.

Input and Output Waveforms



Thank You