

Class-AB Push-Pull Amplifier for Low-Distortion Audio Signal Amplification

Abhijeet M. Rajmane

Department of Electrical Engineering (Third Year)

Shri Guru Gobind Singhji Institute of Engineering and Technology (SGGSIE&T)

Vishnupuri, Nanded, Maharashtra, India

1. Abstract

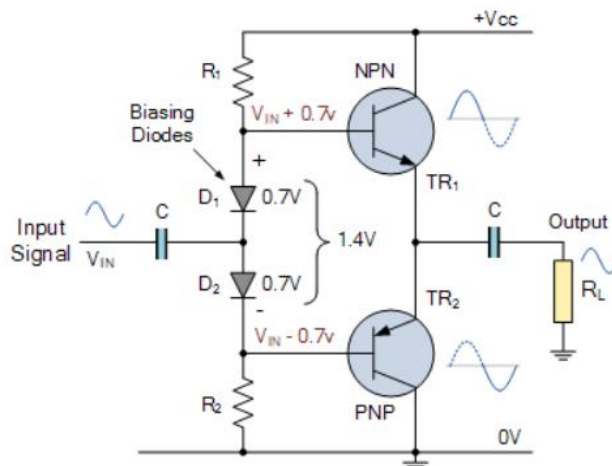
This work presents the simulation and analysis of a Class-AB push-pull amplifier using complementary transistors (BC547 and BC557) in eSim. The circuit employs diode biasing to reduce crossover distortion while maintaining good efficiency. Simulation results show proper amplification of a sinusoidal input signal with improved waveform linearity. The study validates theoretical concepts of Class-AB operation and demonstrates its suitability for low-distortion audio amplification.

2. Working Principle

The Class-AB amplifier operates using a push-pull configuration of complementary transistors (BC547 – NPN and BC557 – PNP) biased with two silicon diodes. The diodes establish a bias voltage of approximately 1.4 V, ensuring both transistors remain slightly forward-biased and operate in the active region, thereby minimizing crossover distortion.

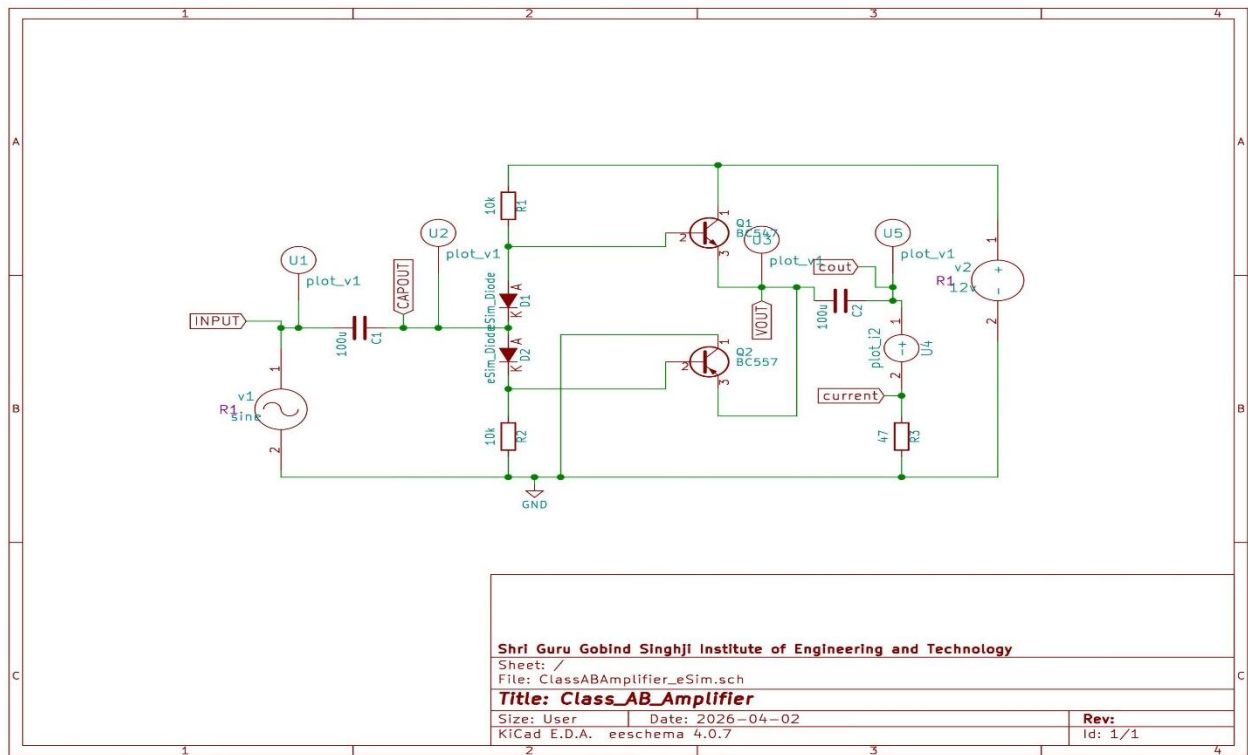
The input AC signal is applied through the coupling capacitor (C1), which blocks DC components while allowing the AC signal to pass. The diode bias network sets the quiescent operating point of the transistors. During the positive half-cycle of the input signal, the NPN transistor conducts and amplifies the signal, while the PNP transistor remains less active. During the negative half-cycle, the PNP transistor conducts and amplifies the signal, while the NPN transistor turns off. The output signals from both transistors combine at the output node, producing a complete amplified waveform. The output coupling capacitor (C2) blocks DC components and passes only the amplified AC signal to the load. This results in an output with improved linearity and significantly reduced crossover distortion compared to Class-B operation.

3. Circuit Description



The circuit consists of a sinusoidal input source, a diode biasing network, and a push-pull amplifier stage using complementary transistors (BC547 and BC557). The input signal is applied through a coupling capacitor, while two diodes provide the required bias voltage to minimize crossover distortion. The push-pull stage amplifies the signal, and the output is obtained across the resistive load.

Schematic Diagram of Class-AB Push-Pull Amplifier



4. Simulation and Results

The input to the circuit is a sinusoidal AC signal with a peak amplitude of approximately ± 3 V and a frequency of 1 kHz. The waveform is symmetrical about zero, indicating no DC offset. In the second observation (with circuit connected), the input waveform remains sinusoidal with the same amplitude and frequency, confirming that the coupling capacitor does not distort the input signal but only blocks DC components.

Input:

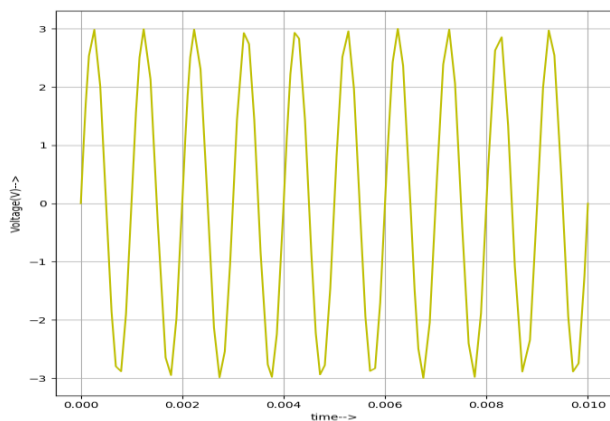


Fig. (a) Input Signal

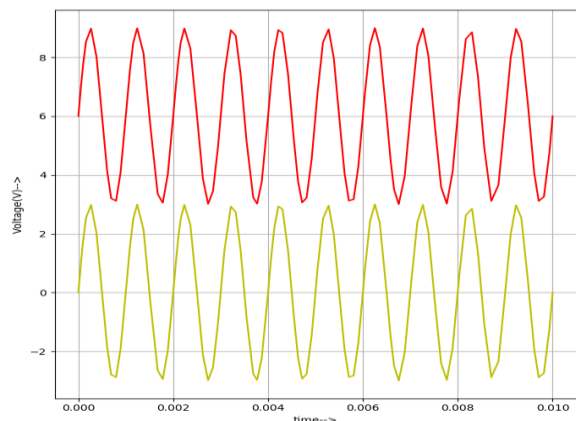


Fig. (b) Input under Loaded Condition

Output:

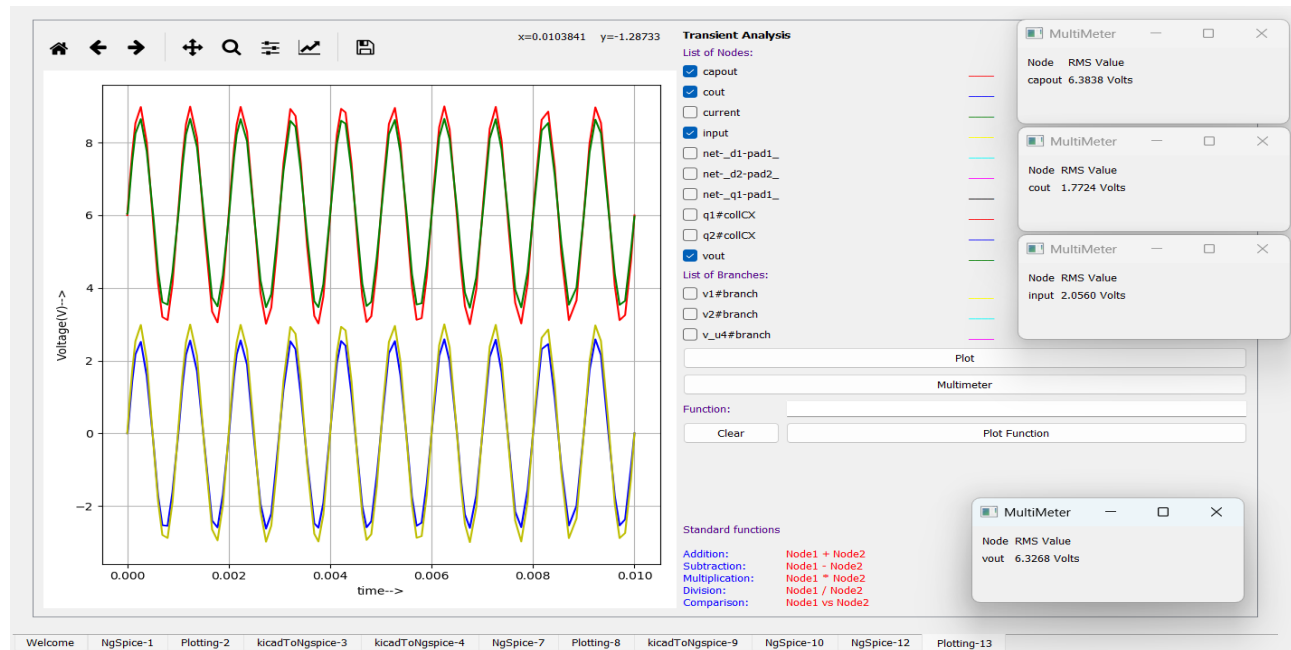


Fig. (c) Output Waveforms of Class-AB Amplifier

Red line (capout):

Output before coupling capacitor → highest amplitude (~8–9 V peak), includes DC offset

Green line (vout):

Amplified output waveform (push-pull stage) → similar to red but slightly smoother

Blue line (input):

Input signal → sinusoidal (~±3 V peak)

Yellow line (cout / load):

Output across load after capacitor → reduced amplitude (~2.5 V peak), DC removed

The output of the Class-AB amplifier is an amplified version of the input sinusoidal signal. At the push-pull stage (before the coupling capacitor), the signal reaches a higher amplitude (~8–9 V peak) and includes a DC offset due to biasing. After passing through the output coupling capacitor, the DC component is removed, and the signal across the load becomes a pure AC waveform with reduced amplitude (~2.5 V peak).

The waveform remains smooth near the zero-crossing region, indicating effective reduction of crossover distortion. The reduction in amplitude across the load is due to the effect of the coupling capacitor and load resistance, which limits the effective output voltage.

5. Conclusion

The Class-AB amplifier was successfully simulated in eSim, demonstrating proper push-pull operation with complementary transistors. The output waveform shows effective amplification with reduced crossover distortion due to diode biasing. The results closely match theoretical expectations, confirming the circuit's suitability for low-distortion audio amplification.

References

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