# Design and Construction of Low Power Amplifier

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***Abstract***- This paper describes the design and construction of low power audio amplifier. In the construction of this amplifier, microphone preamplifier, tone preamplifier and output power amplifier. The output power amplifier is constructed by using class AB push pull amplifier. The input can come directly from the microphone or similar device and typical 4Ω/5W speakers are output. The signal output is clean with no distortion up to certain audio levels, but some distortion occurs at higher levels. The Multisim Software is used for the construction of audio amplifier.

***Index Terms***- audio amplifier, class A, class AB push pull amplifier, Multisim Software

## I. INTRODUCTION

The push pull amplifier drives the current using with two identical BJTs or MOSFETs. One is used as a source and the other is used as a sink and then through the load. The signal is amplified into 180° out of phase by preamplifier. The advantages of push pull amplifier are low distortion, cancellation of power supply ripples and absence of magnetic saturation in the coupling transformer core [3].

In this paper, BJTs Class AB push pull amplifier is used. This amplifier has an efficiency rating between that of Class A and Class B but poorer signal reproduction than Class A amplifiers. BJT is controlled by the input base current. The cost and the losses of the BJT is much lower cost than FET. BJT can give low current and low voltage supply. BJT is good in amplification. But when FET is used, it can give high current and high voltage supply. FET is not good in amplification. To get the high power, FET can be used [1].

## II. OPERATION PRINCIPLE

The circuit is constructed of four distinct components: the power supply, the volume control, preamplifier Stage and tone preamplifier stage which functions to amplify the voltage signal, a Class AB Power Amplifier Stage which increases the current output stage. See figure1 for a block diagram.

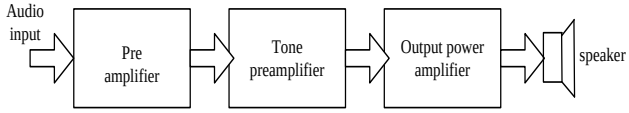



Figure 1: Block Diagram of Audio Amplifier

Microphone Preamplifier is to pre amplifies the audio signals from the microphone device. Tone Preamplifier is to lift and cut the low frequency and high frequency of the signal. Output Amplifier is to get the better sound force to the output power amplifier from the audio signals. Output Power Amplifier is to amplify the audio signals and to produce the necessary amount of watts. Sound signal Indicator is to indicate the volume of sounds. Three BC 547 transistors Q6, Q1 and Q2 are wired as pre-amplifier and Q4TIP 41C and Q3TIP 42C together for driving the speaker.

The pre-amplifier section of this circuit is based around transistor Q6, Q1 and Q2 which forms a class A amplifier reduces the noise performance of the circuit is improved. A complementary class AB push pull stage is built around the Q3and Q4 speaker. Diodes D1 and D2 bias the complementary pair and ensure the proper operation o Q2 drives the push pull pair and its base is directly coupled to the collector of transistor. Other essential features include the use of two diodes to provide thermal stability, and some bias adjustments to give minimum distortion. The advantages of Class AB amplifier are no cross over distortion, high fidelity and low harmonic distortion. These amplifiers are most suitable for low power applications.

Transistor Q6, Q1 and Q2 driver transistor is a class A voltage amplifier fed with a variable amplitude audio signal from the input via the volume control VR1. Bias for Q1 is provided via the potential divider R4, Vr1 & R11 from the transistor of Q3 and Q4 emitters, which will be at half of the supply voltage.

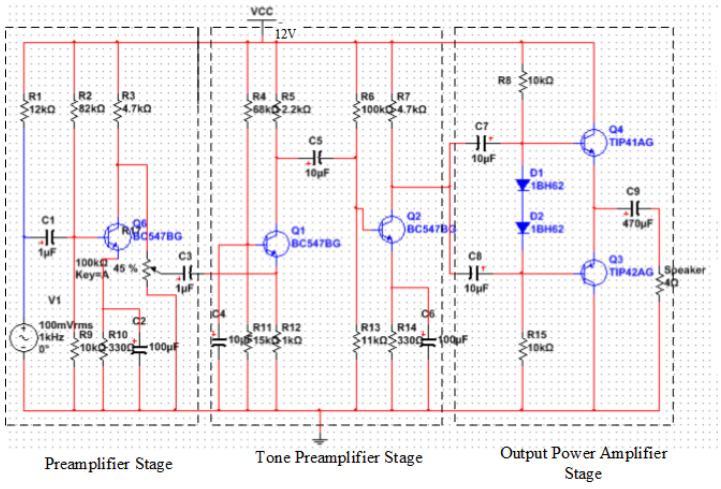



Figure .2: Overall Circuit Diagram of Audio Amplifier

## III. System Design

### *A. Preamplifier Stage*

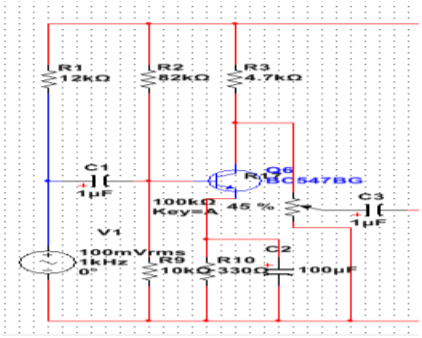



Figure 3: Circuit diagram of preamplifier Stage

In preamplifier stage, we select BC547 transistor. The required bias resistors are needed to select. So the calculation steps are follows.

When Vcc = 12 V, Vc = Vcc/2 = 6V
From BC547 datasheet, Ic = 2 mA, $h_{FE}$ = 110 ,

$$R_3 = \frac{Vcc-Vc}{Ic}, \ 4.7k\Omega \qquad \text{Eq (1)}$$

$$V_E = V_C - V_{CE}, \ 1V \qquad \text{Eq (2)}$$

$$I_B = \frac{IC}{hFE}, \ 0.018mA \qquad \text{Eq (3)}$$

$$R_E = \frac{VE}{IB+IC}, \ 330\ \Omega \qquad \text{Eq (4)}$$

$$R_9 = \frac{VB}{nIB}, \ 10k\ \Omega \qquad \text{Eq (5)}$$

$$V_B = \frac{R9}{R2+R9} \times V_{CC}, \ R_2 = 60k\ \Omega \qquad \text{Eq (6)}$$

### *B. Tone Preamplifier Stage*

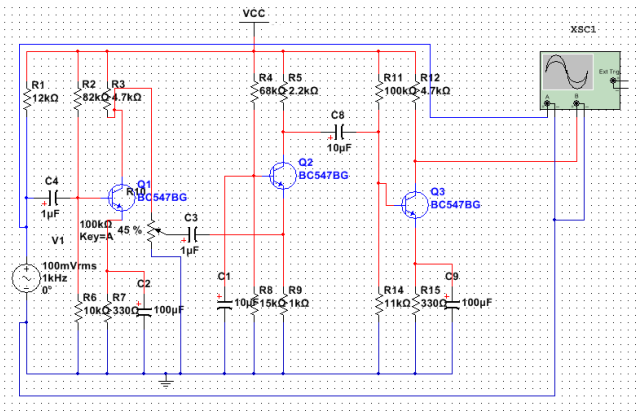



Figure 4: Circuit diagram of tone preamplifier Stage

In tone preamplifier stage, we select BC547 transistor. The required bias resistors are needed to select. So the calculation steps are follows.
When Vcc = 12 V, Vc = Vcc/2 = 6V
From BC547 datasheet, Ic = 2 mA, $h_{FE}$ = 110 ,

$$R_7 = \frac{Vcc-Vc}{Ic}, \ 4.7k\Omega$$

$$V_E = V_C - V_{CE}, \ 1V$$

$$I_B = \frac{IC}{hFE}, \ 0.018mA$$

$$R_{14} = \frac{VE}{IB+IC}, \ 330\ \Omega$$

$$R_{13} = \frac{VB}{nIB}, \ 11k\ \Omega$$

$$V_B = \frac{R9}{R2+R9} \times V_{CC}$$

$$R_6 = 100k\ \Omega$$

### *C. Output Power Amplifier*

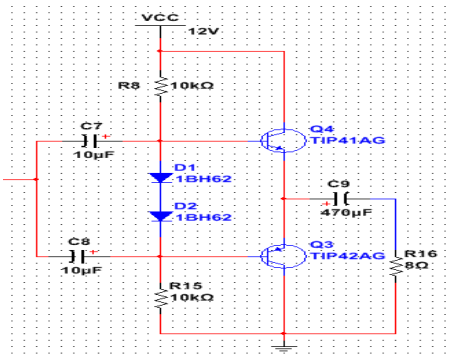



Figure 5: Output Power Amplifiers

In power amplifier stage, we select TIP41C and TIP42C transistors. So the calculation of output voltage and current are follows.

$$V_{Out\ (peak)} = \frac{Vcc}{2}, \quad 6V \qquad \text{Eq (7)}$$

$$I_{out(peak)} = \frac{Vout(peak)}{RL}, \ 1.5A \qquad \text{Eq (8)}$$

$$P_{out\ (max)} = 0.5\ V_{Out(peak)}\ I_{out(peak)} \qquad \text{Eq (9)}$$

$$= 5W$$

The efficiency of class AB push pull power amplifier is follows:

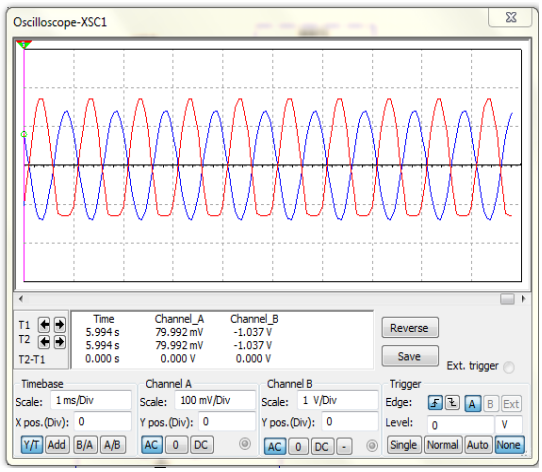
$$\eta = \frac{P_{out}}{P_{DC}} \qquad \text{Eq(10)}$$

$$P_{DC} = \frac{Iout(peak) \times V_{CC}}{\pi}, \ 5.7V$$

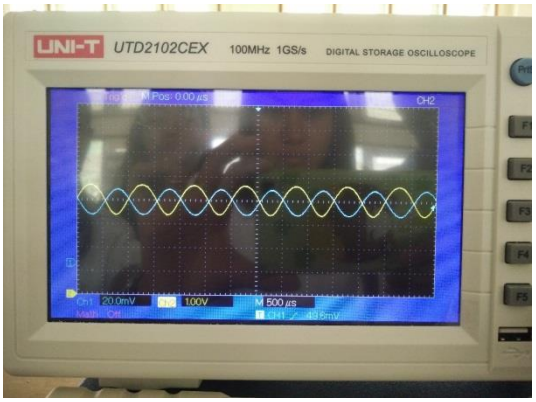
$$\eta = \frac{5}{5,7}, 87\%$$

## IV. TEST AND RESULT OF LOW POWER AUDIO AMPLIFIER

In this section, the testing results of step by step are shown. In Figure 6, the simulation and hardware results of preamplifier stage input and output waveforms are 180 degree out of phase. In Figure 7, the input and output waveforms are also 180 degree out of phase.

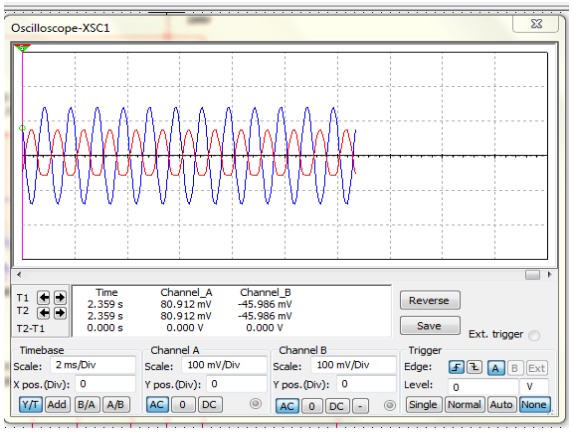



(a) Simulation result of preamplifier Stage

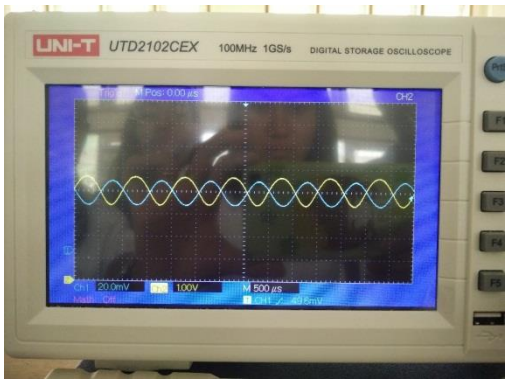



(b) Hardware result of preamplifier Stage

Figure 6: Simulation and Hardware result of preamplifier Stage




(a)Simulation result of tone preamplifier

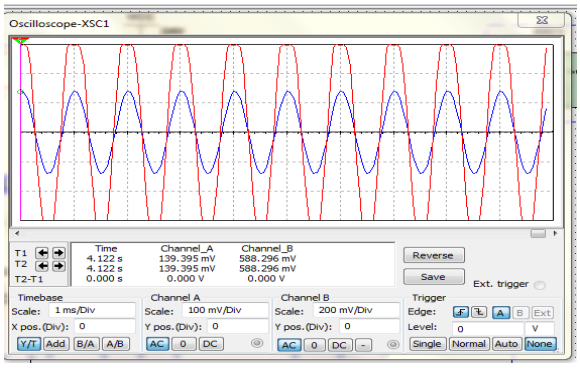



(b) Hardware result of tone preamplifier

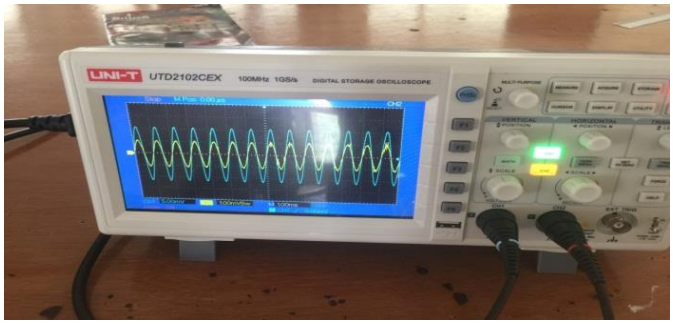
Figure 7: Simulation and Hardware result of tone preamplifier

In Figure 7, the simulation and hardware results of tone preamplifier stage input and output waveforms are 180 degree out of phase. In this circuit, volume control VR1 functions is gain control for varying its gain

In Figure 8, the simulation and hardware results of output power stage input and output waveforms are 180 degree in phase




(a) Simulation result of push-pull class AB amplifier




(b) Hardware result of push-pull class AB amplifier

Figure 8: Simulation and Hardware result of push-pull class AB amplifier

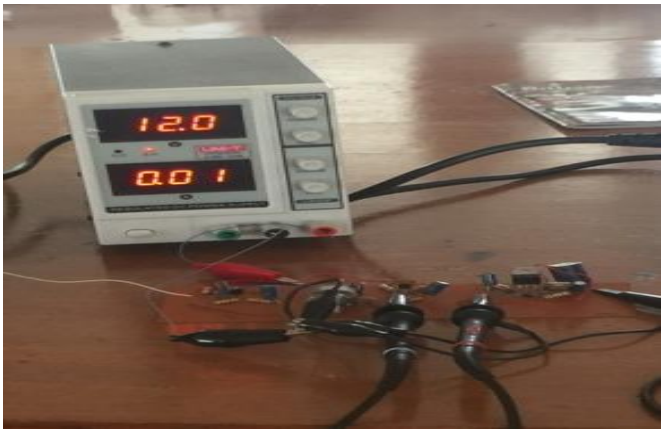



Figure 9: Test Output of Power amplifier and Power Supply Circuit on Universal Card

The circuit materials are correctly setup on Universal Card. The power supply is giving by 12V single supply to get the output power 5W. After the circuits are correctly setup, the output signal is needed to be check at the output.

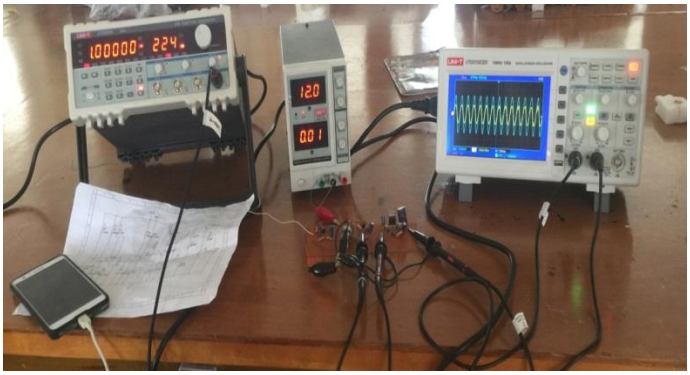


Figure 10: Test Output of Power amplifier and Power Supply Generator on Universal Card


Figure 11: Testing Power Amplifier

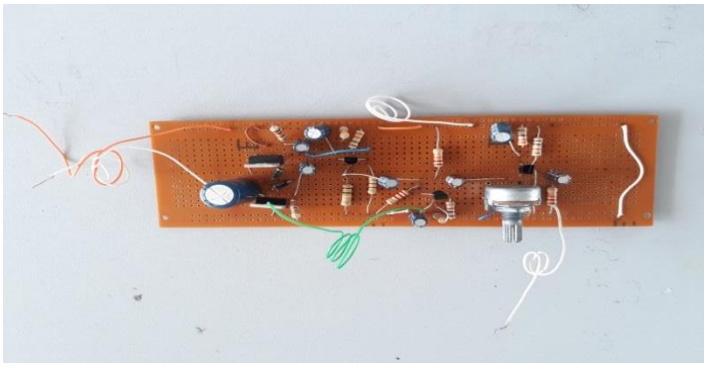


Figure 12: Constructed the Power Amplifier

## V. CONCLUSION

This paper of all circuit is designed according to the circuit diagram of class AB push pull amplifier. Then the elements are added to counter the distortion effect. A load is also connected at junction of class A across which output voltage is measured and its corresponding waveform is also drawn. Therefore we can design and analyze the hardware implementation of a high performance class AB push pull amplifier. All though a class AB power amplifier was build and functioned well, more improvements can be made to the circuit to make it better. Use heat sinks with wider surface area to increase the power dissipation. If use of PCB is tidy the circuit path and less noise. Power amplifiers with higher output power could be built by connecting more output power transistors in parallel.

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