National Institute of Technology Meghalaya

Department of Electronics and Communication Engineering

A Report on

Design and Fabrication of *Class AB* Audio amplifier

Author:
Raman Kumar Gupta
Sixth Semester
Roll No:-B15EC032

Mentors:
Mr. Aaditya Chaudhary
Mr. Swaroop R S
Soil Agritech Pvt. Ltd
NSRCEL, IIM Bangalore

July 25, 2018

Abstract

This report is on audio amplifier, In this report we had discussed about the different types of audio amplifier and its classes. In chapter one includes the design and stimmulation of *class A and class B* audio amplifier. After that we moved to *class AB* audio amplifier, in compare to *class A and class B* amplifier it provide the optimum result in terms of the sound quality. The whole chapter two involves the discussion about the *class AB* audio amplifier and its working. In chapter three it includes the stimulation results of it while playing the different johner and stimulation shows the different waveforms with voltage. Refer the stimulation picture. In Hardware design pcb design is build by using kicad software and etching is done by chemical processf. Chapter four includes the *references*.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

In this chapter, you will read about the audio amplifiers and its differrent classes of it. specifically, *class A, class B* and *class AB* is discussed in this chapter.

1.1 Overview

Amplifier:- An amplifier is an electronic device that enhance the voltage, current, or power of a signal. Amplifiers are used in wireless communications and broadcasting, and in audio equipment of all kinds. They can be categorized as either weak-signal amplifiers or power amplifiers.

Audio Amplifier:-An audio amplifier is an electronic amplifier that amplifies low-power audiosignals (signals composed primarily of frequencies between 20 - 20 000 Hz, the human range of hearing) to a level suitable for driving loudspeakers and is the final stage in a typical audio playback chain.

While the input signal to an audio power amplifier may measure only a few hundred microwatts, its output may be tens, hundreds, or thousands of watts.

1.2 Classes of Audio Amplifier

Amplifiers are classified into classes according to their construction and operating characteristics.Not all amplifiers are the same and there is a clear distinction made between the way their output stages are configured and operate. The main operating characteristics of an ideal amplifier are linearity, signal gain, efficiency and power output but in real world amplifiers there is always a trade off between these different characteristics.

Amplifier Classes represent the amount of the output signal which varies within the amplifier circuit over one cycle of operation when excited by a sinusoidal input signal. The classification of amplifiers range from entirely linear operation (for use in high-fidelity signal amplification) with very low efficiency, to entirely non-linear (where a faithful signal reproduction is not so important) operation but with a much higher efficiency, while others are a compromise between the two.

Amplifier classes are mainly lumped into two basic groups. The first are the classically controlled conduction angle amplifiers forming the more common amplifier classes of A, B, AB and C, which are defined by the length of their conduction state over some portion of the output waveform, such that the output stage transistor operation lies somewhere between being ”fully-ON” and ”fully-OFF”.

The second set of amplifiers are the newer so-called ”switching” amplifier classes of D, E, F, G, S, T etc, which use digital circuits and pulse width modulation (PWM) to constantly switch the signal between ”fully-ON” and ”fully-OFF” driving the output hard into the transistors saturation and cut-off regions.

The most commonly constructed amplifier classes are those that are used as audio amplifiers, mainly class A, B, AB and C and to keep things simple, it is these types of amplifier classes we will look at here in more detail.

1.2.1 *Class A* Amplifier

Class A Amplifiers are the most common type of amplifier class due mainly to their simple design. *Class A*, literally means ”the best class” of amplifier due mainly to their low signal distortion levels and are probably the best sounding of all the amplifier classes mentioned here. The *Class A* amplifier has the highest linearity over the other amplifier classes and as such operates in the linear portion of the characteristics curve.

Generally class A amplifiers use the same single transistor (Bipolar, FET, IGBT, etc) connected in a common emitter configuration for both halves of the waveform with the transistor always having current flowing through it, even if it has no base signal. This means that the output stage whether using a Bipolar, MOSFET or IGBT device, is never driven fully into its cut-off or saturation regions but instead has a base biasing Q-point in the middle of its load line.

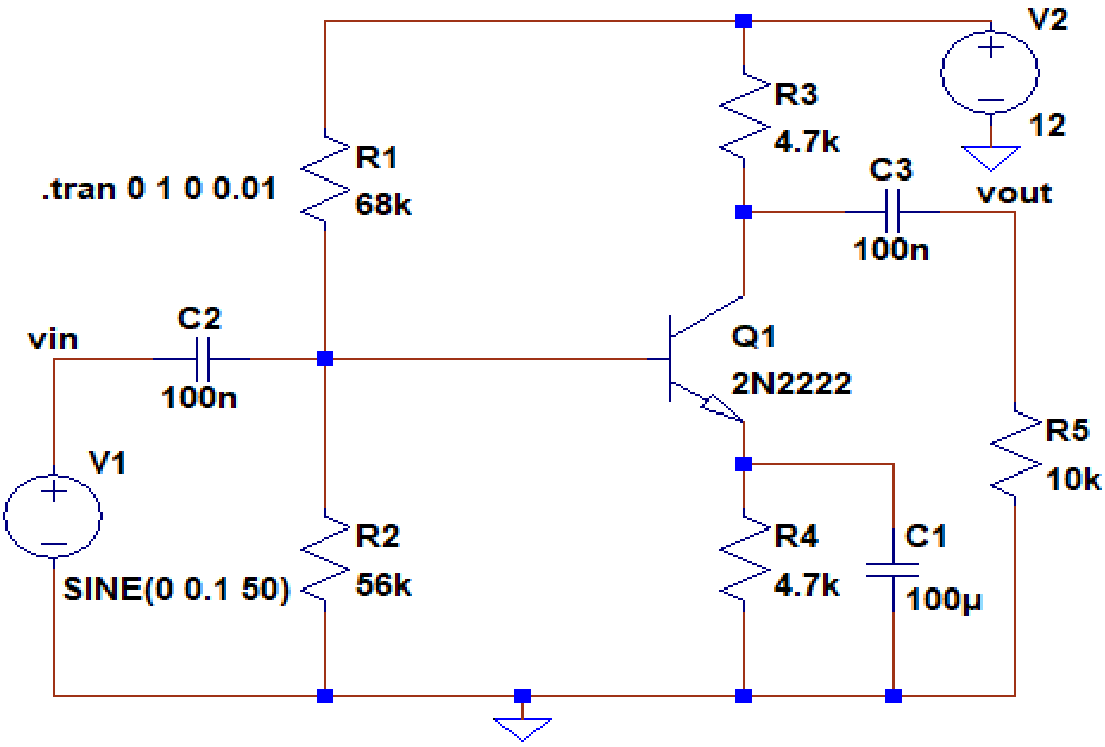

Fig 1.1: Circuit diagram of *Class A* amplifier

Then the transistor never turns "OFF" which is one of its main disadvantages. To achieve high linearity and gain, the output stage of a class A amplifier is biased "ON" (conducting) all the time. Then for an amplifier to be classified as "*Class A*" the zero signal idle current in the output stage must be equal to or greater than the maximum load current (usually a loudspeaker) required to produce the largest output signal.

As a *Class A* amplifier operates in the linear portion of its characteristic curves, the single output device conducts through a full 360 degrees of the output waveform. Then the class A amplifier is equivalent to a current source.

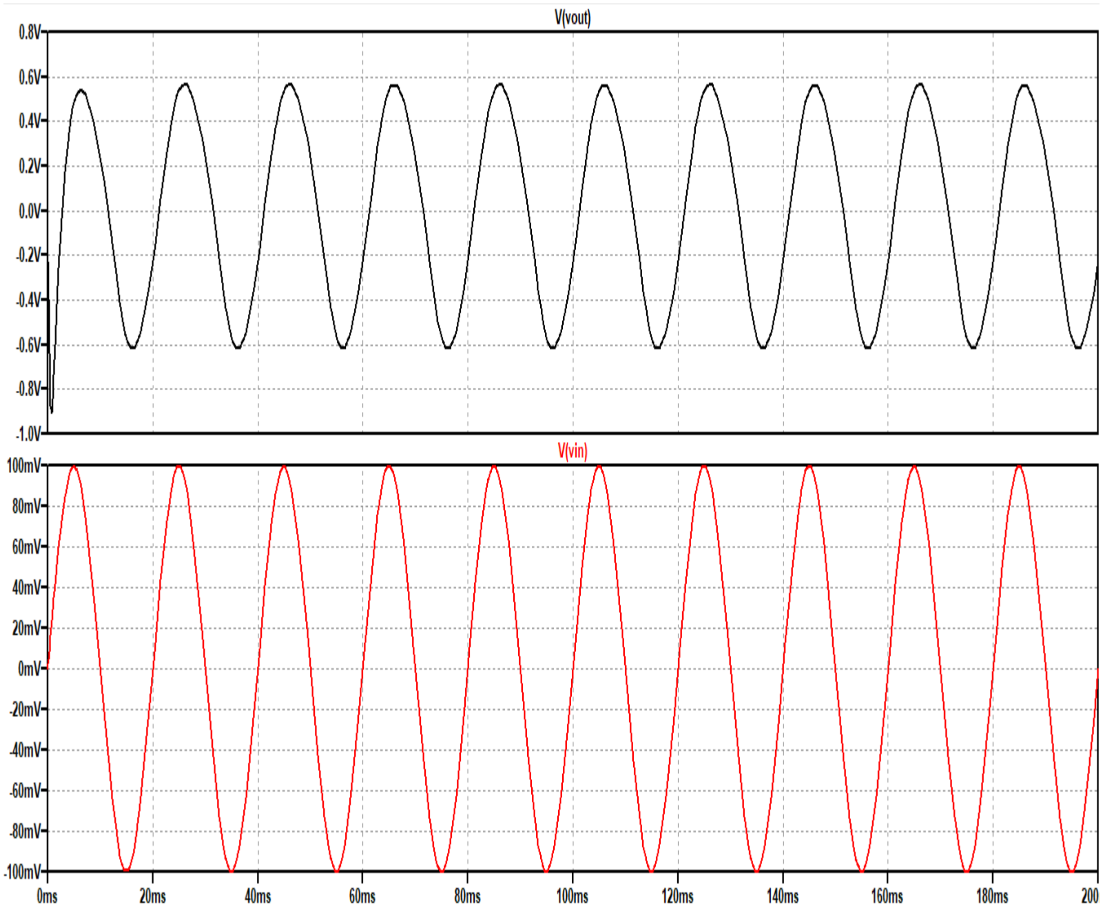

Fig 1.2: Simulation result of *Class A* amplifier

Since a *Class A* amplifier operates in the linear region, the transistors base (or gate) DC biasing voltage should by chosen properly to ensure correct operation and low distortion. However, as the output device is "ON" at all times, it is constantly carrying current, which represents a continuous loss of power in the amplifier.

Due to this continuous loss of power *Class A* amplifiers create tremendous amounts of heat adding to their very **low efficiency at around 30%**, making them impractical for high-power amplifications. Also due to the high idling current of the amplifier, the power supply must be sized accordingly and be well filtered to avoid any amplifier hum and noise.Therefore, due to the low efficiency and over heating problems of *Class A* amplifiers, more efficient amplifier classes have been developed.

1.2.2 *Class B* Amplifier

Class B amplifiers were invented as a solution to the efficiency and heating problems associated with the previous *Class A* amplifier. The basic class B amplifier uses two complimentary transistors either bipolar of FET for each half of the waveform with its output stage configured in a "*push-pull*" type arrangement, so that each transistor device amplifies only half of the output waveform.

In the *class B* amplifier, there is no DC base bias current as its quiescent current is zero, so that the dc power is small and therefore its efficiency is much higher than that of the *class A* amplifier. However, the price paid for the improvement in the efficiency is in the linearity of the switching device.

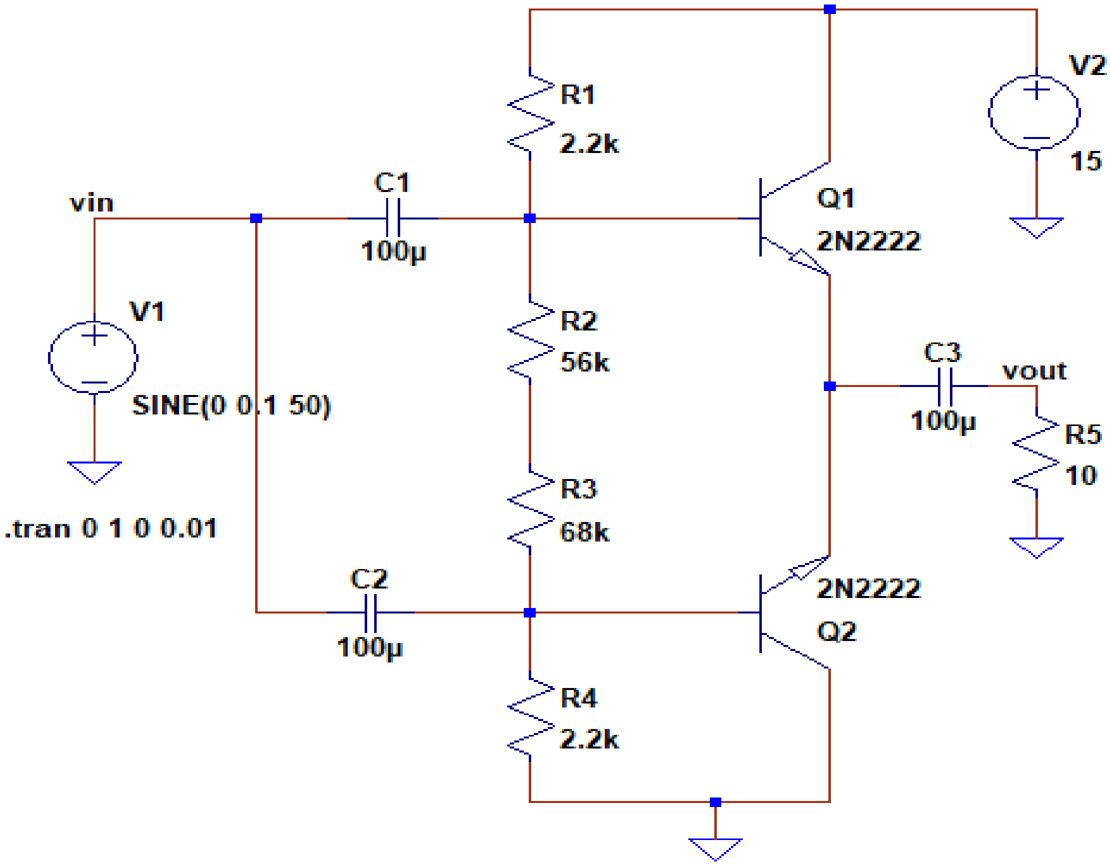

Fig 1.3: Circuit diagarm of *Class B* amplifier

When the input signal goes positive, the positive biased transistor conducts while the negative transistor is switched "OFF". Likewise, when the input signal goes negative, the positive transistor switches "OFF" while the negative biased transistor turns "ON" and conducts the negative portion of the signal. Thus the transistor conducts only half of the time, either on positive or negative half cycle of the input signal.

Then we can see that each transistor device of the *class B* amplifier only conducts through one half or 180 degrees of the output waveform in strict time alternation, but as the output stage has devices for both halves of the signal waveform the two halves are combined together to produce the full linear output waveform.

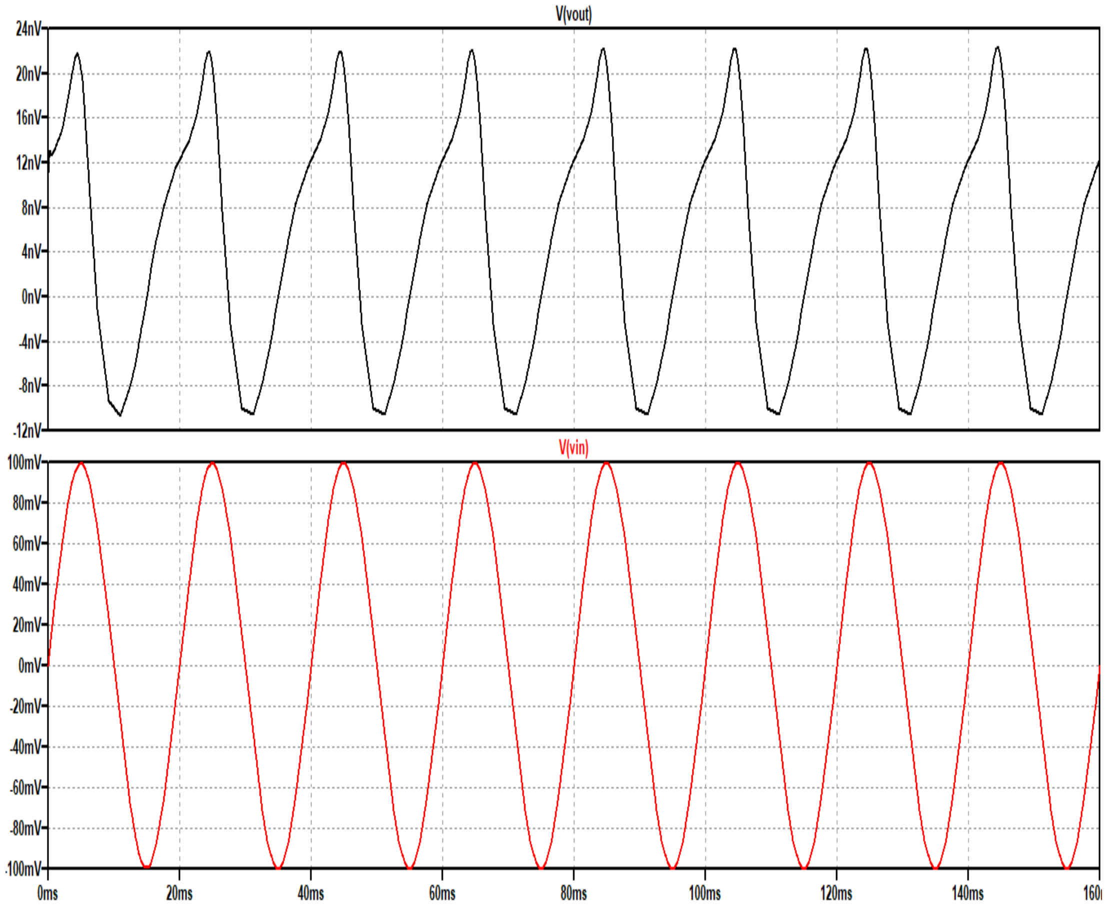

Fig 1.4: Simulation result of *Class B* amplifier

This push-pull design of amplifier is obviously more efficient than *Class A*, at about 50%, but the problem with the class B amplifier design is that it can create distortion at the zero-crossing point of the waveform due to the transistors dead band of input base voltages from *-0.7v to +0.7v*.

We remember from the Transistor tutorial that it takes a base-emitter voltage of about 0.7 volts to get a bipolar transistor to start conducting. Then in a *class B* amplifier, the output transistor is not "biased" to an "ON" state of operation until this voltage is exceeded.

This means that the the part of the waveform which falls within this 0.7 volt window will not be reproduced accurately making the *class B* amplifier unsuitable for precision audio amplifier applications.

To overcome this zero-crossing distortion (also known as Crossover Distortion) *class AB* amplifiers hs been developed.

1.2.3 Conclusion

So, till now we discussed about the *class A* and *class B* audio amplifier. We saw that *class A* and *class B* is not so efficient means the amplification results were poor in *class B*, power dissipation and distortion were high in *class A* audio amplifier due to the continuous power supply. Now, we will furher discuss about the *class AB* amplifier.

Chapter 2

Class AB amplifier

In a class-AB amplifier, the conduction angle is intermediate between class A and B, efficiency of this amplifier lies between both of it.The crossover distortion can be reduced further by using negative feedback. It is used in low cost device.

2.1 Design parameters

Key design parameters for audio amplifiers are frequency response, gain, noise, and distortion. These are interdependent; increasing gain often leads to undesirable increases in noise and distortion. While negative feedback actually reduces the gain, it also reduces distortion. Most audio amplifiers are linear amplifiers operating in *class AB*.

2.2 *Class AB amplifier with transistors*

Before, the making of *class ab amplifier* with *tda2030a* ic, I had tried to make it with transistors but during simulation of it, the gain was very less and noise is too high.The circuit is given below:

2.2.1 Circuit Description

Usually, the audio output from a device's built-in speakers is low. A power amplifier is required to get a high volume. Here is a simple circuit to amplify the audio output. The circuit is built around power amplifier *IC TDA2030A* and a few other components. The *TDA2030A* provides high output current and has very low harmonic and cross-over distortion.It's intended for use as low frequency *class AB* amplifier. For audio one 8 ohm speaker has been used. so Assemble the circuit on a general-purpose PCB and enclose in a suitable cabinet.The circuit works off regulated 12V power supply. It is recommended to use audio input socket in the circuit board. Use a proper heat-sink for heat dissipation. By varying the potentiometer which is at the input side of circuit, the volume of the amplifier can be varied.

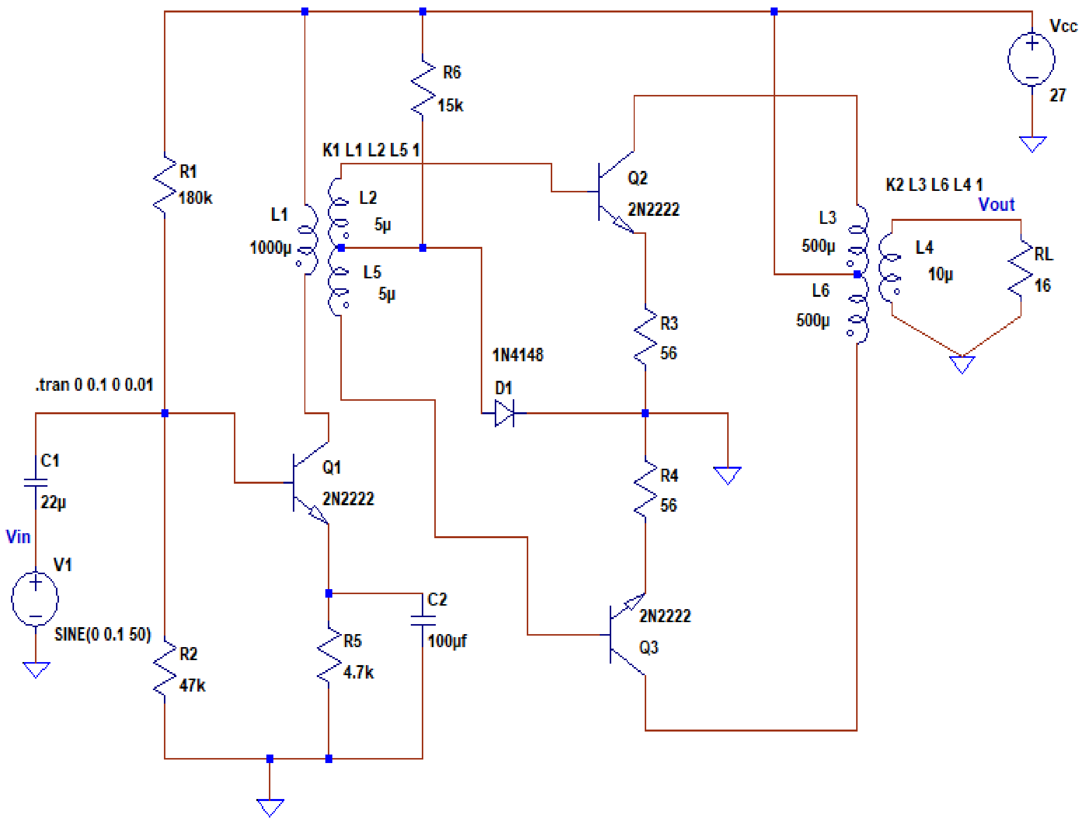

Fig 1.5: Circuit diagarm of *Class AB* amplifier with transistors

SI No.	Name of Component	Quantity	Specification
1	IC TDA2030A	1	18 watt
2	Potentiometer	1	50 kΩ, pot
3	Audiojack	1	3.5mm
4	Speaker	1	8 ohm, 0.5 watt
5	Diode	1	IN4007
6	Heat sink	1	-
7	Resistor	1	4.7 kΩ, 1/2 watt
8	Resistor	1	10 Ω, 1/2 watt
9	Resistor	4	100 kΩ, 1/2 watt
10	Ceramic Capaitor	1	0.1 uF, 104
11	Electrolytic Capaitor	1	1 uF, 50 volt
12	Electrolytic Capaitor	1	2.2 uF, 63 volt
13	Electrolytic Capaitor	2	22 uF, 50 volt
14	Electrolytic Capaitor	1	100 uF, 25 volt
15	Electrolytic Capaitor	1	2200 uF, 25 volt
16	2-pin Screw Terminal Block	3	5 mm pitch, 250 V, 16 A

Table 1.1: List of Components

Class AB amplifier

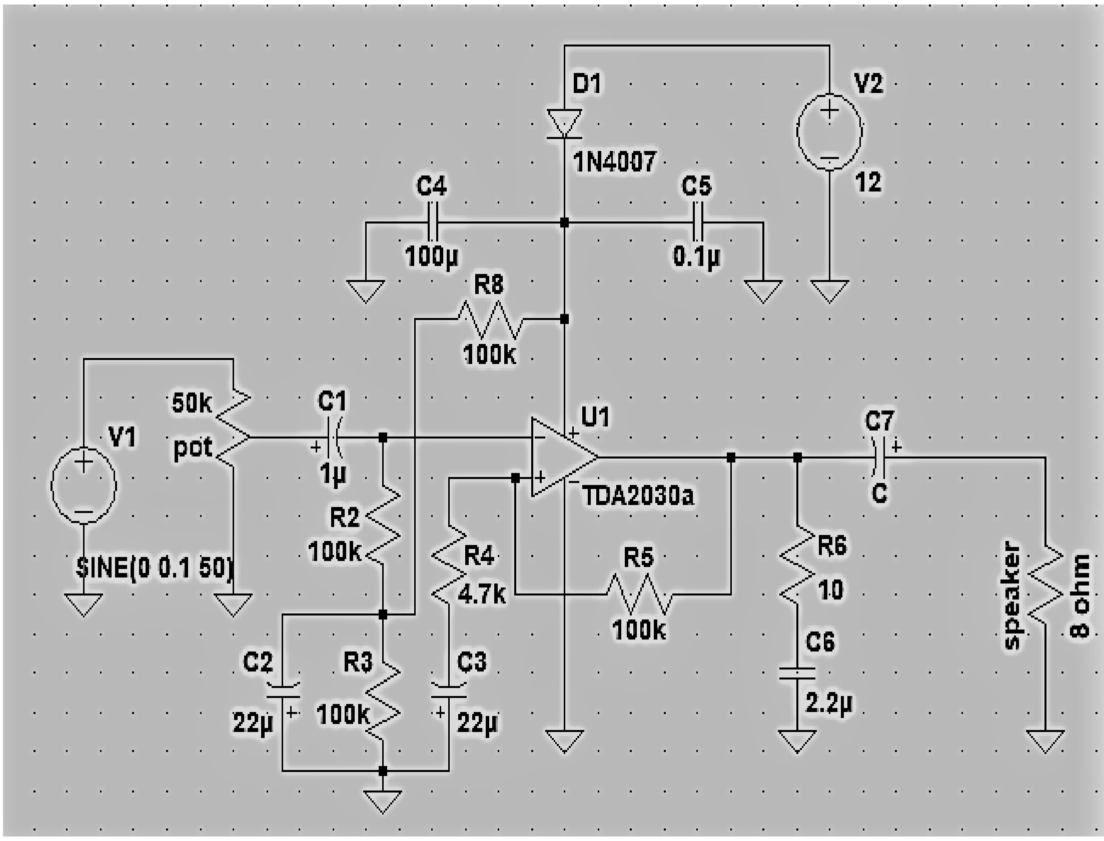

Fig 1.6: Circuit diagarm of *Class AB* amplifier

2.3 Working of *Class AB* amplifier

As its name suggests, the *Class AB* Amplifier is a combination of the "*Class A*" and the "*Class B*" type amplifiers we have looked at above. The AB classification of amplifier is currently one of the most common used types of audio power amplifier design. The *class AB* amplifier is a variation of a *class B* amplifier as described above, except that both devices are allowed to conduct at the same time around the waveforms crossover point eliminating the crossover distortion problems of the previous *class B* amplifier.

The two transistors have a very small bias voltage, typically at 5 to 10% of the quiescent current to bias the transistors just above its cut-off point. Then the conducting device, either bipolar of FET, will be "*ON*" for more than one half cycle, but much less than one full cycle of the input signal. Therefore, in a *class AB* amplifier design each of the push-pull transistors is conducting for slightly more than the half cycle of conduction in *class B*, but much less than the full cycle of conduction of *class A*.

The advantage of this small bias voltage, provided by series diodes or resistors, is that the crossover distortion created by the *class B* amplifier characteristics is overcome, without the inefficiencies of the *class A* amplifier design. So the *class AB* amplifier is a good compromise between *class A* and *class B* in terms of efficiency and linearity, with conversion **efficiencies reaching about 50% to 60%**.

Chapter 3

Simulation & Results

This chapter deals with the simulation and results of *class AB* amplifier, hardware is build successfully. Different types of instrument were used while making and testing of the hardware such as CRO(cathode ray oscilloscope), SMPS(switch mode power supply) of 350 watt, DMM(digital multi meter) and LTSpice software for stimulation purpose of different amplifier.

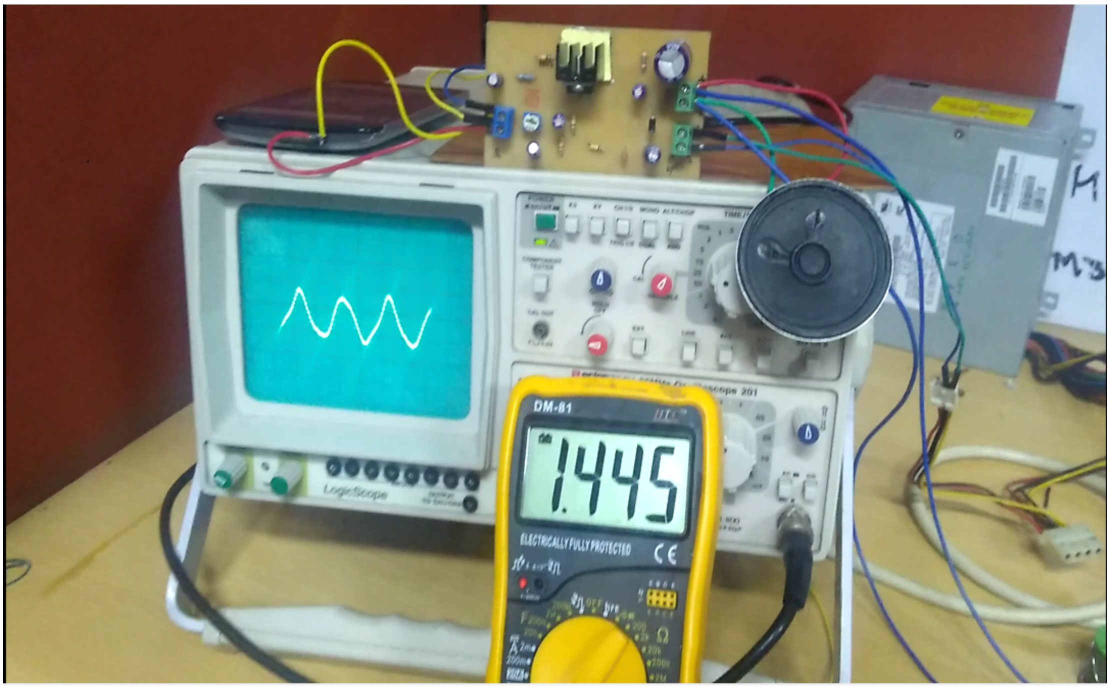

Fig 1.7: Output of johner 1

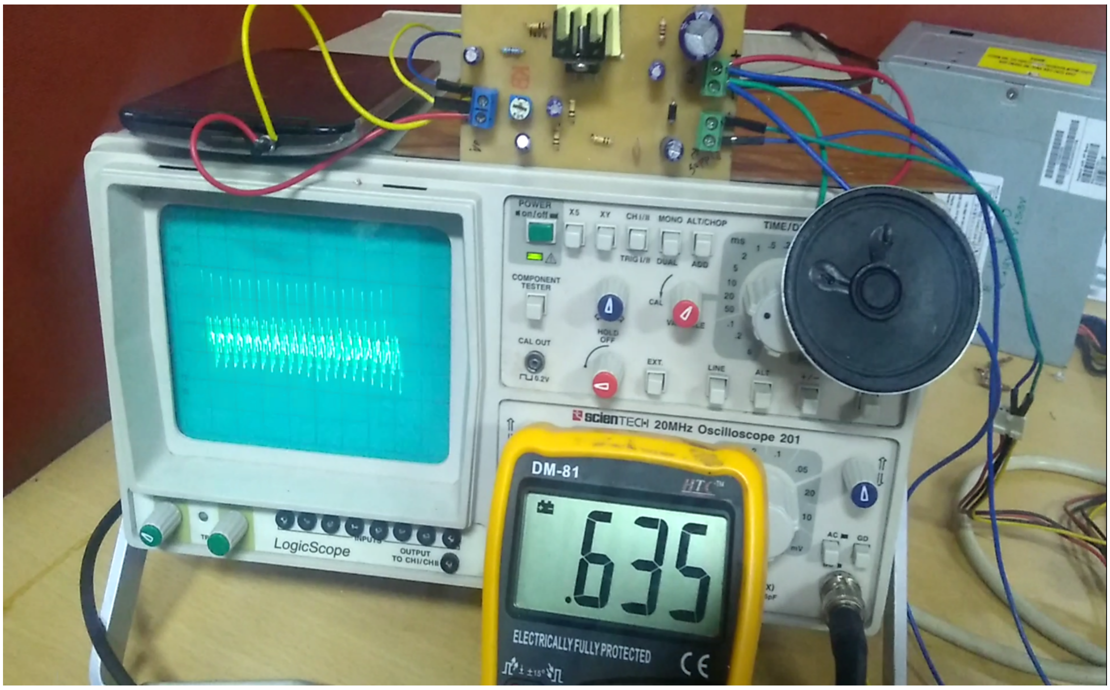

Fig 1.8: Output of johner 2

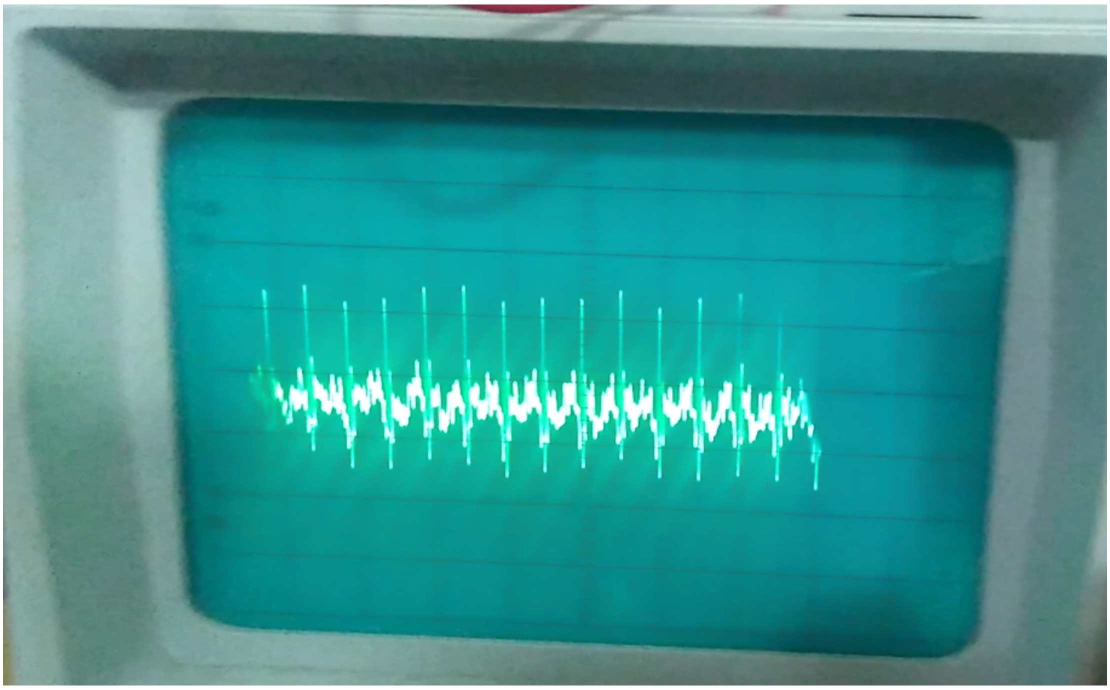

Fig 1.9: waveform of johner 2

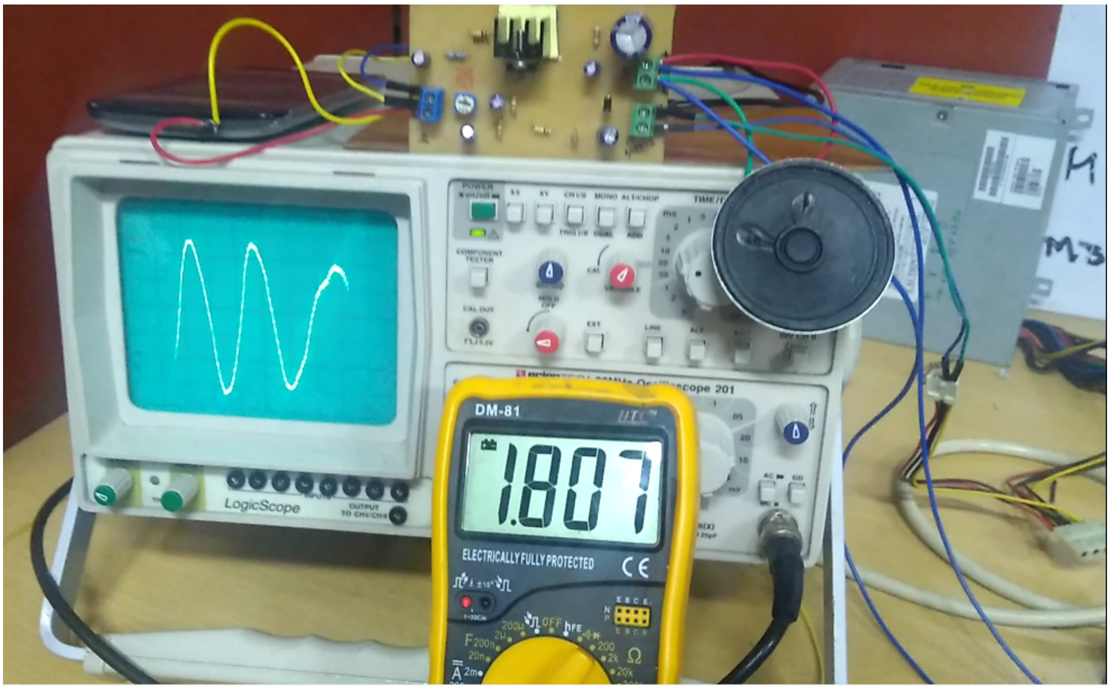

Fig 1.10: Output of johner 3

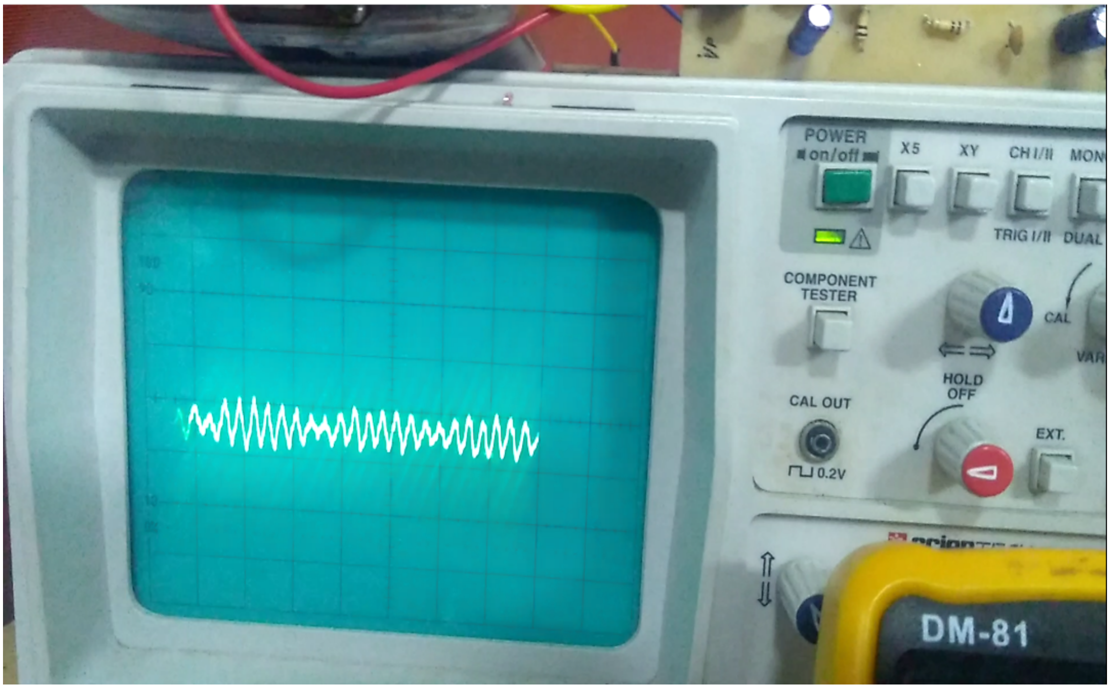

Fig 1.11: Output of johner 4

.

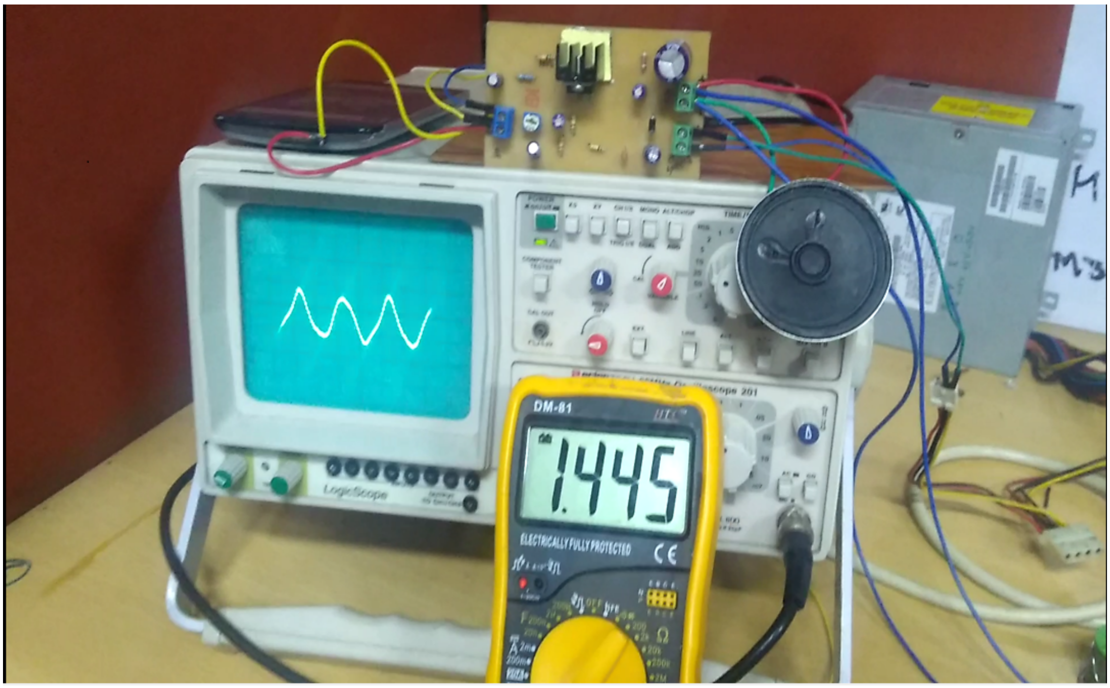

Fig 1.12: Output of johner 5

.

SI No.	Johner	Quality of sound	Voltage
1	Johner 1	good	1.445 volt
2	Johner 2	average	0.635 volt
3	Johner 3	good	1.807 volt
4	Johner 4	nice	1.124 volt
5	Johner 5	good	1.445 volt

Table 1.2: Sound Quality

3.1 Description of *IC TDA2030A*

- The *TDA2030A* is a monolithic IC in Pentawatt package intended for use as low frequency class AB amplifier.
- It provides high output current and has very low harmonic and cross-over distortion.
- The device incorporates a short circuit pro- tection system comprising an arrangement for automatically limiting the dissipated power so as to keep the working point of the output transistors within their safe operating area.
- A conventional thermal shut-down system is also included.

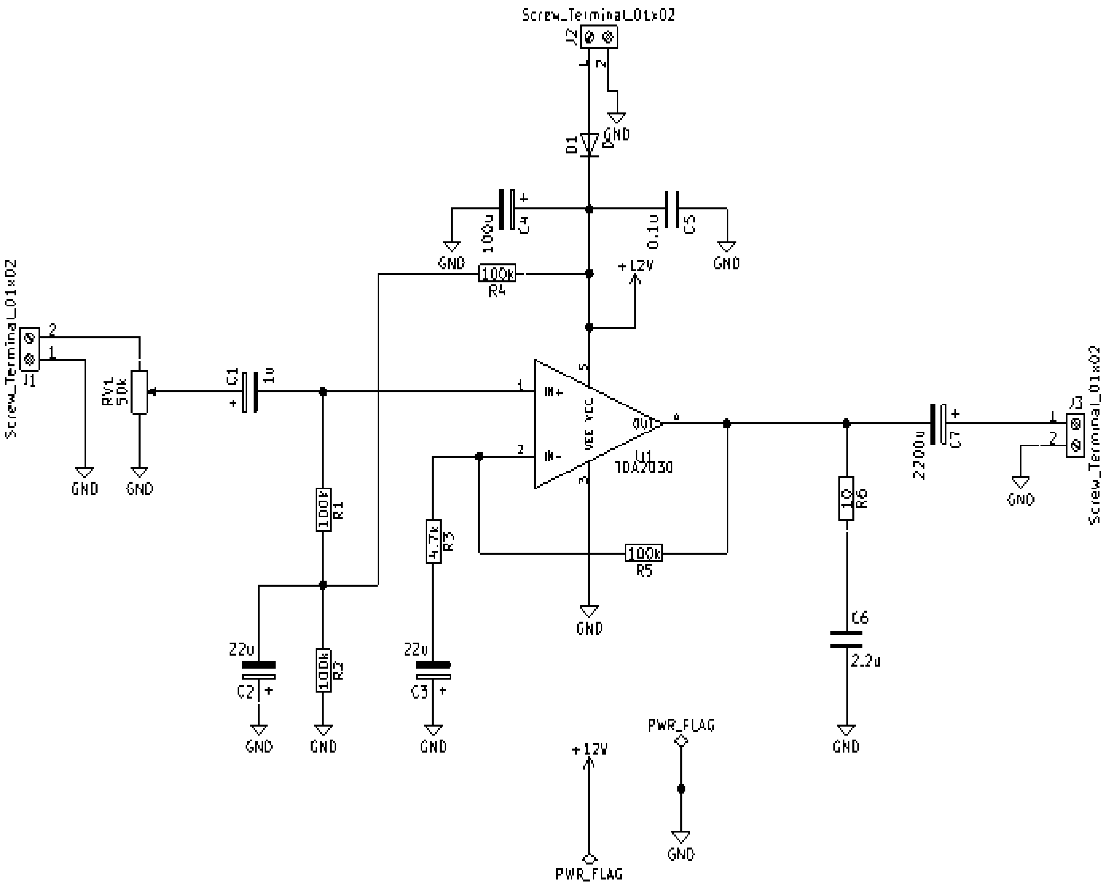

Fig 1.13: *S*chematic of Class AB amplifier

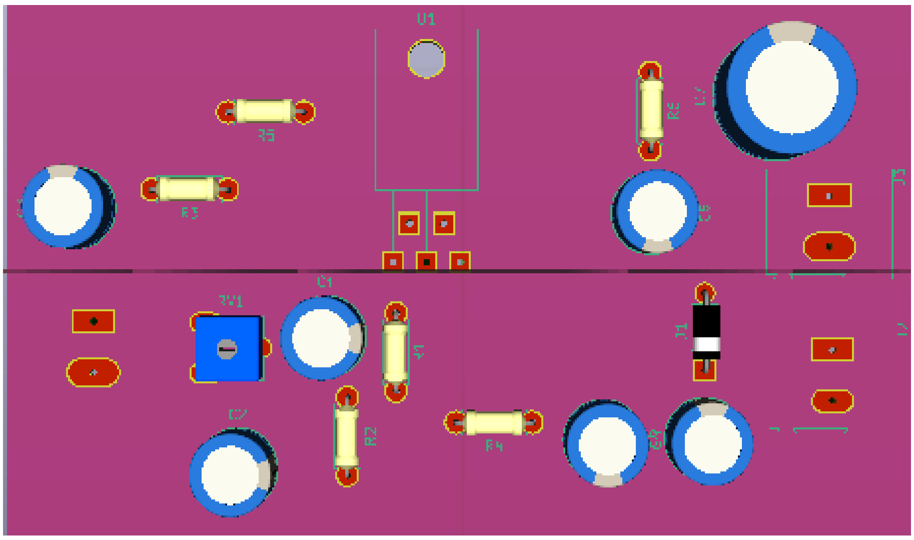

Fig 1.14: 3D PCB design of *Class AB* amplifier

Chapter 4

Result & Conclusion

The output of this amplifier is 6 watts with single channel which is loud enough to be heard clearly.Thus TDA2030A provides a good amplification of audio signal from mobile,laptop or any electronics device etc which is in milliwatts and outputsc6 watts power of signal.

So, *class ab* amplifier is easier to design and construct it, the volume can also be varied directly by varying volume control potentiometer which is given the device, is easily portable and compatible with almost device.

References

[1] David A. Bell. *Electronic Devices and Circuits* Lambton College of Applied Arts and Technology Sarnia, Ontario, Canada. Oxford University press.

[2] $https://en.wikipedia.org/wiki/Power_amplifier_classes$

[3] https://www.tutorialspoint.com/amplifiers/