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"CLASS AB AMPLIFIER"

A MINI PROJECT REPORT

Submitted by

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In partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING
IN
ELECTRONICS AND COMMUNICATION

NEW HORIZON COLLEGE OF ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

Certified that the mini project work entitled "**CLASS AB AMPLIFIER**" carried out by **K Sai Swathi (1NH18EC060),** bonafide student of Electronics and Communication Department, New Horizon College of Engineering, Bangalore.

The mini project report has been approved as it satisfies the academic requirements in respect of mini project work prescribed for the said degree.

Project Guide HOD ECE

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External Viva

Name of Examiner Signature with Date

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ABSTRACT

Audio amplifiers are typically large and inefficient when it comes to powering high power speakers and loads. Audio drivers demand efficient heat dissipation to cool down the active components resulting in a huge casing and heat sinking. The aim of this project is to create a compact class AB amplifier that can drive a large speaker while keeping the size under acceptable limits. The design used consists of a water cooling block and three transistor design to create the amplifying circuitry. As there is an ever increasing demand for miniaturization, this project aims to apply the same principle to power electronic components such as high power audio drivers .The Class AB amplifier is biased so that output current flows for less than one full-cycle of the input waveform but more than a half cycle. The implementation of Class AB amplifiers is very similar to the standard Class B configurations in that it uses two switching transistors as part of a complementary output stage with each transistor conducting on opposite half-cycles of the input waveform before being combined at the load.

CHAPTER 1:

INTRODUCTION

In class-AB operation, each device operates the same way as in class B but also conducts a small amount on the other half. As a result, the region where both devices simultaneously are nearly off is reduced.

When the waveforms from devices are combined, the crossover is greatly minimised altogether. The exact choice of quiescent current (the standing current through both devices when there is no signal) makes a large difference to the level of distortion. Often, bias voltage applied to set this quiescent current must be adjusted with the temperature of the output transistors. For example, in the circuit shown in fig 1.A, the diodes would be mounted physically close to the output transistors, and specified to have a matched temperature coefficient. Another approach (often used with thermally pursuit bias voltages) is to incorporate tiny worth resistors asynchronous with the emitters.

Class AB sacrifices some potency over category B in favour of one-dimensionality, therefore is a smaller amount economical (below 78.5% for full-amplitude sin waves in semiconductor device amplifiers, typically; a lot of less is common in class-AB vacuum-tube amplifiers).

It's generally way more economical than category A. The purpose of amplifier is to supply an output that follows the characteristics of the input however is sufficiently massive enough to provide the requirements of the load connected to that.
We have seen that the facility output of associate amplifier is that the product of the voltage and current, (P = V*I) applied to the load, whereas the facility input is that the product of the DC voltage and current taken from the facility offer.

In a class-AB amplifier, the angle of conduction is an intermediate between class A and B. The active elements conduct more than half of the cycle. Class AB is widely considered to be a good acceptable balance of linearity and efficiency for amplifiers, since much of the time the music signal is low that the signal stays in the "class-A" region, where it is amplified with higher linearity, and by definition if passing out of this region, is large enough that the distortion products typical of class B are relatively small. The crossover distortion is by using negative feedback.

Thus by allowing both switching transistors to conduct current at the same time for a very short period, the output waveform during the zero crossover period can be substantially smoothed reducing the crossover distortion associated with the Class B amplifier design. Then the conduction angle is greater than 180^o but much smaller than 360^o.We have also seen that a Class AB amplifier configuration is more efficient than a Class A amplifier but slightly less efficient than that of a Class B because of the small quiescent current needed to bias the transistors just above cut-off. However, the use of incorrect biasing can cause crossover distortion spikes producing a worse condition.

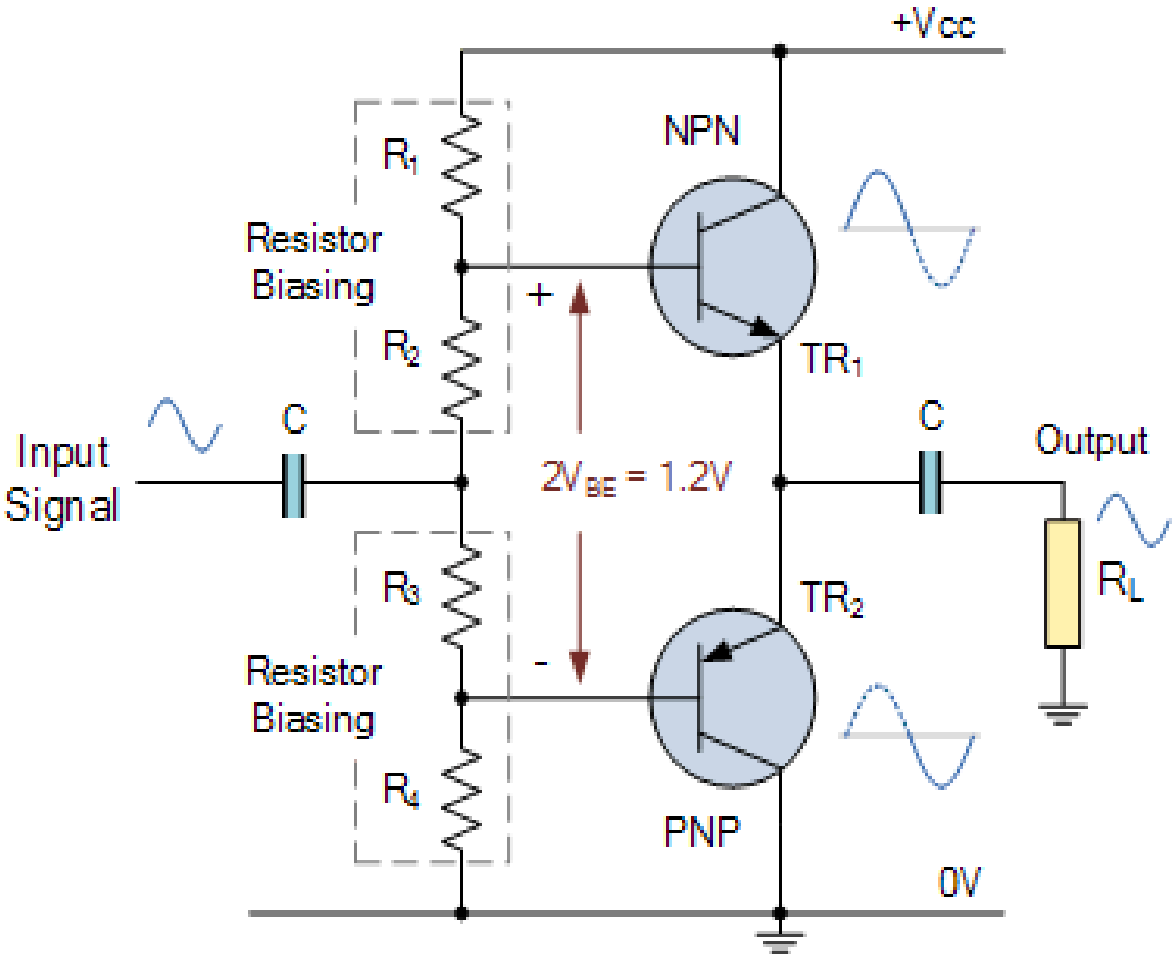


Fig 1.A) **Class AB amplifier**

The electronic amplifiers categories are outlined as follows:

- **Class A:**

The amplifiers single output semiconductor device conducts for the complete 360o of the cycle of the input undulation.

Class B:

The amplifiers 2 output transistors solely conduct for simple fraction, that is, 180o of the input undulation.

- **Class AB:**

The amplifiers 2 output transistors conduct somewhere between 180o and 360 of the input wave.

1.1) **Class A amplifier operation**

For Class A amplifier operation the change semiconductor devices Q-point is found around the middle of the output characteristic Plimsoll mark of the transistor and at intervals the linear region. This permits the semiconductor device to conduct for the whole 360o therefore the output varies over the complete cycle of the input.

1.2) **Advantages of class A amplifier:**

• Class-A circuits may be simpler than different categories in so far as category AB and B circuits need to connected devices within the circuit (push–pull output), every to handle one half the undulation whereas category A will use one device (single-ended).

• The amplifying part is biased therefore the device is usually conducting, the quiescent (small-signal) collector current is about to the foremost linear portion of its trans conductance curve.

• Because the device isn't 'off' there's no "turn on" time, no issues with charge storage, and higher high frequency performance and circuit stability (and usually fewer high-order harmonics).

• The purpose wherever the device comes highest to being 'off' isn't at 'zero signal', therefore the issues of crossover distortion related to class-AB and -B circuits is avoided.

• Best for low signal levels of radio receivers thanks to low distortion.

1.3) **Disadvantage of class-A amplifiers**

• Class-A amplifiers are inefficient. A most theoretical potency of twenty fifth is get table victimisation usual configurations, however five hundred this that the most for a electrical device or inductively coupled configuration. in an exceedingly power amplifier, this not solely wastes power and limits operation with batteries, however will increase in operation prices and needs higher-rated output devices. unskillfulness comes from the standing current that has got to be roughly 0.5 the most output current, and an outsized a part of the facility offer voltage is

gift across the output device at low signal levels. If high output power is required from a class-A circuit, the facility offer and related heat becomes important. For each watt delivered to the load, the amplifier itself, at best, uses an additional watt. For top power amplifiers this implies terribly massive and expensive power provides and warmth sinks.

• Because the output devices are fully operation in any respect times, they'll not have as long a life unless the amplifier is specifically over-designed to require this into consideration, adding to the value of maintaining or coming up with the amplifier.

Class-A power amplifier circuits have mostly been outmoded by a lot of economical circuits, although their simplicity makes them popular. There's a marketplace for expensive hi-fi class-A amps thought-about a "cult item" among audiophiles in the main for his or her absence of crossover distortion and reduced odd-harmonic and high-order harmonic distortion. Category an influence amps are utilized in some "boutique" stringed instrument amplifiers thanks to their distinctive tonal quality and for reproducing vintage tones.

1.4) **Class B amplifier operation**

For Class B amplifier operation, 2 complimentary change semiconductor devices are used with the Q-point (that is its biasing purpose) of every transistor placed at its cut-off point. This allows for one semiconductor device to amplify the signal over one 1/2 the input wave, whereas the opposite semiconductor device amplifies the opposite 0.5. These 2 amplified halves are then combined along at the load to supply one full wave cycle. This NPN-PNP complimentary combine is additionally called a push-pull configuration.

Because of the cut-off biasing, the quiescent current is zero once there's no input, thus no power is dissipated or wasted once the transistors are within the quiescent condition, increasing the potency of a category B amplifier with reference to category A.

However, because the category B amplifier is biased so the output current flows through every semiconductor device for less than1/2 the input cycle, the output wave is thus not an explicit reproduction of the input wave since the output is distorted. This distortion happens at each zero-crossing of the input manufacturing what's usually known as cross-over distortion because the 2 transistors switch “ON” between themselves. This distortion drawbacks may be simply overcome by locating the biasing purpose of the semiconductor device slightly higher than cut-off. By biasing the semiconductor device slightly higher than its cut-off purpose however a lot of below the centre Q-point of the category amplifier, we are able to produce a category AB amplifier circuit. Then the essential purpose of a category AB amplifier is to preserve the essential category B configuration whereas at an equivalent time up its one-dimensionality by biasing every change semiconductor device slightly higher than threshold.

1.5) **Advantages of B amplifier:**

- As there's no would like of centre approach transformers, the burden and price are reduced.
- Equal and opposite input voltages don't seem to be needed.

1.6) **Disadvantage of class-A amplifiers**

Class-A amplifiers are inefficient. At most theoretical efficiency is 25 percent available in usual configurations, however it is for an electrical device or inductively coupled configuration. In an exceedingly power amplifier, this not solely wastes power and limits operation with batteries, however will increase operative prices and needs higher-rated output devices.

It’s issue comes from the standing current that has got to be roughly 0.5 the utmost output current, and an outsized a part of the ability provide voltage is gift across the output device at low signal levels. If high output power is required from a class-A circuit, the ability provide and attendant heat becomes important.

For each watt delivered to the load, the amplifier itself, at best, uses an additional watt. for prime power amplifiers this implies terribly giant and high-priced power provides and warmth sinks. Because the output devices are fully operation in the slightest degree times (unlike a category A/B amplifier), they'll not have as long a life unless the amplifier is specifically over-designed to require this into consideration, adding to the price of maintaining or planning the amplifier.

Class-A power amplifier circuits have mostly been outdated by additional economical circuits, though their simplicity makes them popular. There’s a marketplace for high-priced sound reproduction class-A amps thought-about a "cult item" among audiophiles principally for his or her absence of crossover distortion and reduced odd-harmonic and high-order harmonic distortion.

Categories of such amps are employed in some "boutique" stringed instrument amplifiers because of their distinctive total quality and for reproducing vintage tones. Class B amplifier operation for Class B amplifier operation, 2 complimentary switch amplifier are used with the Q-point (that is its biasing purpose) of every transistor settled at its cut-off point. This allows for one amplifier to amplify the signal over one 1/2 the input wave, whereas the opposite amplifier amplifies the opposite 0.5. These 2 amplified halves are then combined along at the load to supply one full wave cycle.

This NPN-PNP complimentary try is additionally referred to as a push-pull configuration. Because of the cut-off biasing, the quiescent current is zero once there's no sign, so no power is dissipated or wasted once the transistors are within the quiescent condition, increasing the potency of a category B amplifier with regard to category A. However, because the category B amplifier is biased in order that the output current flows through every amplifier for less than 1/2 the input

cycle, the output undulation is so not a precise duplicate of the input wave since the signal is distorted.

This distortion happens at each zero-crossing of the sign manufacturing what's typically referred to as cross-over distortion because the 2 transistors switch “ON” between themselves. This distortion drawback will be simply overcome by locating the biasing purpose of the amplifier slightly on top of cut-off.

By biasing the amplifier slightly on top of its cut-off purpose however abundant below the center Q-point of the category A amplifier, we will produce a category AB amplifier circuit. Then the fundamental purpose of a category AB amplifier is to preserve the fundamental category B configuration whereas at a similar time up its dimensionality by biasing every switch amplifier slightly on top of threshold.

1.7) **Advantages of B amplifier:**

As there's no would like of center tapped transformers, the load and value are reduced.

Equal and opposite sign voltages don't seem to be needed.

1.8) **Disadvantage of class-A amplifiers the disadvantages of B amplifier are as follows.**

It is tough to urge a try of transistors (NPN and PNP) that have similar characteristics.

We need each positive and negative provide voltages.

1.9) **Category C amplifier operation**

The Class C amplifier circuits has the best potency however the poorest dimensionality of the categories of amplifiers mentioned here. The previous categories, A, B and AB are thought-about linear amplifiers, because the output signals amplitude and section are linearly associated with the input signals amplitude and section. However, the category C amplifier is heavily biased in order that the output current is zero for over one 1/2 AN input curved signal cycle with the amplifier idleness at its cut-off purpose.

In alternative words, the conductivity angle for the amplifier is considerably but a 100 and 80 degrees, and is usually round the 90 degrees space. While this manner of amplifier biasing provides a way improved potency of around eightieth to the amplifier, it introduces a awfully serious distortion of the signal. Therefore, category C amplifiers don't seem to be appropriate to be used as audio amplifiers. Due to its serious audio distortion, category C amplifiers are usually employed in high frequency wave oscillators and sure sorts of frequency amplifiers, wherever the pulses of current created at the amplifiers output will be regenerate to finish trigonometric function waves of a specific frequency by the employment of LC resonant circuits in its collector circuit.

1.10) **Other Common Amplifier Classes**

- **Class D Amplifier**

  A Class D audio amplifier is basically a non-linear switching amplifier or PWM amplifier. Class-D amplifiers theoretically can reach 100% efficiency, as there is no period during a cycle were the voltage and current waveforms overlap as current is drawn only through the transistor that is on.

- **Class F Amplifier**

  Class-F amplifiers boost both efficiency and output by using harmonic resonators in the output network to shape the output waveform into a square wave. Class-F amplifiers are capable of high efficiencies of more than 90% if infinite harmonic tuning is used.

- **Class G Amplifier**

  Class G offers enhancements to the basic class AB amplifier design. Class G uses multiple power supply rails of various voltages and automatically switches between these supply rails as the input signal changes. This constant switching reduces the average power consumption, and therefore power loss caused by wasted heat.

- **Class I Amplifier**

  The class I amplifier has two sets of complementary output switching devices arranged in a parallel push-pull configuration with both sets of switching devices sampling the same input waveform. One device switches the positive half of the waveform, while the other switches the negative half similar to a class B amplifier.

  With no input signal applied, or when a signal reaches the zero crossing point, the switching devices are both turned ON and OFF simultaneously with a 50% PWM duty cycle cancelling out any high frequency signals.

  To produce the positive half of the output signal, the output of the positive switching device is increased in duty cycle while the negative switching device is decreased by the same and vice versa.

The two switching signal currents are said to be interleaved at the output, giving the class I amplifier the named of: “interleaved PWM amplifier” operating at switching frequencies in excess of 250 kHz.

- **Class S Amplifier**

A class S power amplifier is a non-linear switching mode amplifier similar in operation to the class D amplifier. The class S amplifier converts analogue input signals into digital square wave pulses by a delta-sigma modulator, and amplifies them to increases the output power before finally being demodulated by a band pass filter. As the digital signal of this switching amplifier is always either fully “ON” or “OFF” (theoretically zero power dissipation), efficiencies reaching 100% are possible.

- **Class T Amplifier** –

The class T amplifier is another type of digital switching amplifier design. Class T amplifiers are starting to become more popular these days as an audio amplifier design due to the existence of digital signal processing (DSP) chips and multi-channel surround sound amplifiers as it converts analogue signals into digital pulse width modulated (PWM) signals for amplification increasing the amplifiers efficiency. Class T amplifier designs combine both the low distortion signal levels of class AB amplifier and the power efficiency of a class D amplifier.

CHAPTER 2:

LITERATURE SURVEY

2.1) **LITERATURE SURVEY TABLE**

Paper No	Title	Author & Year of Publication	Outcome	Limitation
1.	Electronic principles	Albert Malvino	Biasing explained	Not detailed
2.	Class AB amplifier with a reduced crossover distortion for real time video application	Dr.R.K.Baghel	Increased Efficiency	Reduced Linearity
3.	Audio Power Amplifier	O'Riely	Increased Quality	Limited Applications
4.	Class AB Amplifier Design	Electronic Tutorials	Eliminate Outcome Distortion	Fails to explain characteristics.

CHAPTER 03

PROPOSED METHODOLOGY

The purpose of any amplifier is to produce an output which follows the characteristics of the input signal but is sufficiently large enough to supply the needs of the load connected to it.

Class AB Amplifier is mainly used in audio amplifiers. The circuit consists of a three transistor audio amplifier that can deliver around 10W power to a 125 Ohm speaker. The diodes D1 and D2 provides a constant bias voltage for the transistors Q1 and Q2.The transistor Q1 works as a preamplifier. Transistors Q2 and Q3 drives the speaker. You can use NPN transistor for Q1, Q3 and PNP transistor for Q2. Any way the minimum collector current capacity of the transistors must not be less than 100mA. The circuit will work well with an 8 ohm speaker too, but the volume will be a little less.

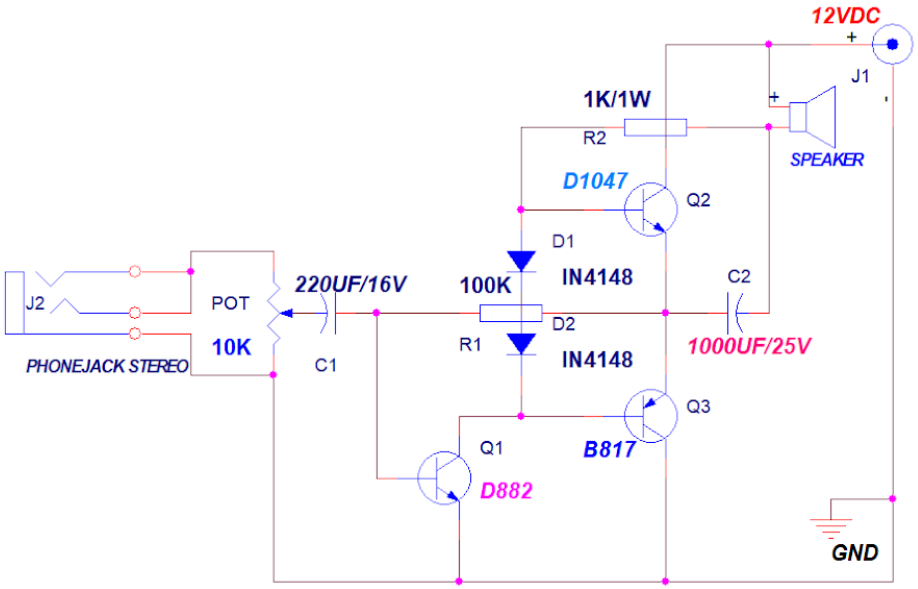


FIG 3.1)**Circuit diagram of the amplifier used**

Transistor Q1 acts as a current source that sets up the required DC biasing current flowing through the diodes. This sets the quiescent output voltage as Vcc/2. As the input signal drives the

base of Q1, it acts as an amplifier stage driving the bases of Q2 and Q3 with the positive half of the input cycle driving Q2 while Q3 is off and the negative half of the input cycle driving Q2 while Q1 is off, the same as before.

Like with most electronic circuits, there are many different ways to design a power amplifiers output stage as many variations and modifications can be made to a basic amplifier output circuit. The job of a power amplifier is to deliver an appreciable level of output power (both current as well as voltage) to the connected load with a reasonable degree of efficiency.

This can be achieved by operating the transistor(s) in one of two basic operating modes, Class A or Class B.

One way of operating an amplifier with a reasonable level of efficiency is to use a symmetrical Class B output stage based on complementary NPN and PNP transistors. With a suitable level of forward biasing its possible to reduce any crossover distortion as a result of the two transistors being both cut-off for a brief period of each cycle, and as we have seen above, such a circuit is known as a Class AB amplifier.

Then putting it all together, we can now design a simple Class AB power amplifier circuit as shown, producing about 10 watt into 125 ohms with a frequency response of about 20Hz to 20kHz.

CHAPTER 04

PROJECT DESCRIPTION

In this we make use of a heat sink to dissipate heat.

The components are mounted on the heat sink.

The components required are as follows:

SL NO:	COMPONENTS	NUMBER OF COMPONENTS
1)	D1047 Transistor	1
2)	B718 Transistor	1
3)	D882 Transistor	1
4)	100K 1/4 W Resistors	1
5)	1K 1W Resistors	1
6)	10K volume	1
7)	220uf Capacitors	1
8)	1000uf Capacitors	1
9)	4148 Diode	2

- **D1047 Transistor -1**

  Function:

  NPN Triple Diffused Planar Silicon Transistors

- **B718 Transistor -1**

  Function:

  NPN Triple Diffused Planar Silicon Transistors

- **D882 Transistor -1**

  Function:

  PNP Triple Diffused Planar Silicon Transistors

- **4148 Diode -2**

Function:

A **diode** is defined as a two-terminal electronic component that only conducts current in one direction. An ideal diode will have zero resistance in one direction, and infinite resistance in the reverse direction. A diode conducts current in the forward direction, blocking it in the reverse direction. Its ability to conduct current is limited by its size and construction. A circuit that puts too much current through a diode will burn it up.

- **100K 1/4 W Resistors -1**

Function:

The resistor is a passive electrical component to create resistance in the flow of electric current. Resistance is a measure of the opposition to current flow in an electrical circuit. Resistors are used for many purposes. A few examples include delimit electric current, voltage division, heat generation, matching and loading circuits, control gain, and fix time constants.

They are commercially available with resistance values over a range of more than nine orders of magnitude. They can be used to as electric brakes to dissipate kinetic energy from trains, or be smaller than a square millimeter for electronics. A resistor controls the flow of current.

- **1K 1W Resistors-1**

Function:

The resistor is a passive electrical component to create resistance in the flow of electric current. Resistance is a measure of the opposition to current flow in an electrical circuit. Resistors are used for many purposes. A few examples include delimit electric current, voltage division, heat generation, matching and loading circuits, control gain, and fix time constants.

They are commercially available with resistance values over a range of more than nine orders of magnitude. They can be used to as electric brakes to dissipate kinetic energy from trains, or be smaller than a square millimeter for electronics. A resistor controls the flow of current.

- **10K volume-1**

  Function:

  A **potentiometer** is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider.[1] If only two terminals are used, one end and the wiper, it acts as a **variable resistor** or **rheostat**.The measuring instrument called a potentiometer is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name.

  Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducers, for example, in a joystick. Potentiometers are rarely used to directly control

significant power (more than a watt), since the power dissipated in the potentiometer would be comparable to the power in the controlled load.

- **220uf Capacitors-1**

Function:

Capacitors are components which have the ability or the capacity to store energy in the form of an electrical charge producing a potential difference (*static voltage*) across its plates, much like a small rechargeable battery. There are many different kinds of capacitors available in the market. From very small capacitor beads used in resonance circuits, to large power factor correction capacitors, but they all serve the same purpose, that is, they store charge.

- **1000uf Capacitors-1**

Function:

Capacitors are components which have the ability or the capacity to store energy in the form of an electrical charge producing a potential difference (*static voltage*) across its plates, much like a small rechargeable battery. There are many different kinds of capacitors available in the market. From very small capacitor beads used in resonance circuits, to large power factor correction capacitors, but they all serve the same purpose, that is, they store charge.

CHAPTER 05

RESULT AND DISCUSSION

Connect the head phone jack to a phone and switch on the 12V power supply. Amplified audio is delivered. A typical power amplifier requires a huge heat sink but this particular design achieves the same amplification with a smaller size due to more efficient heat sink.

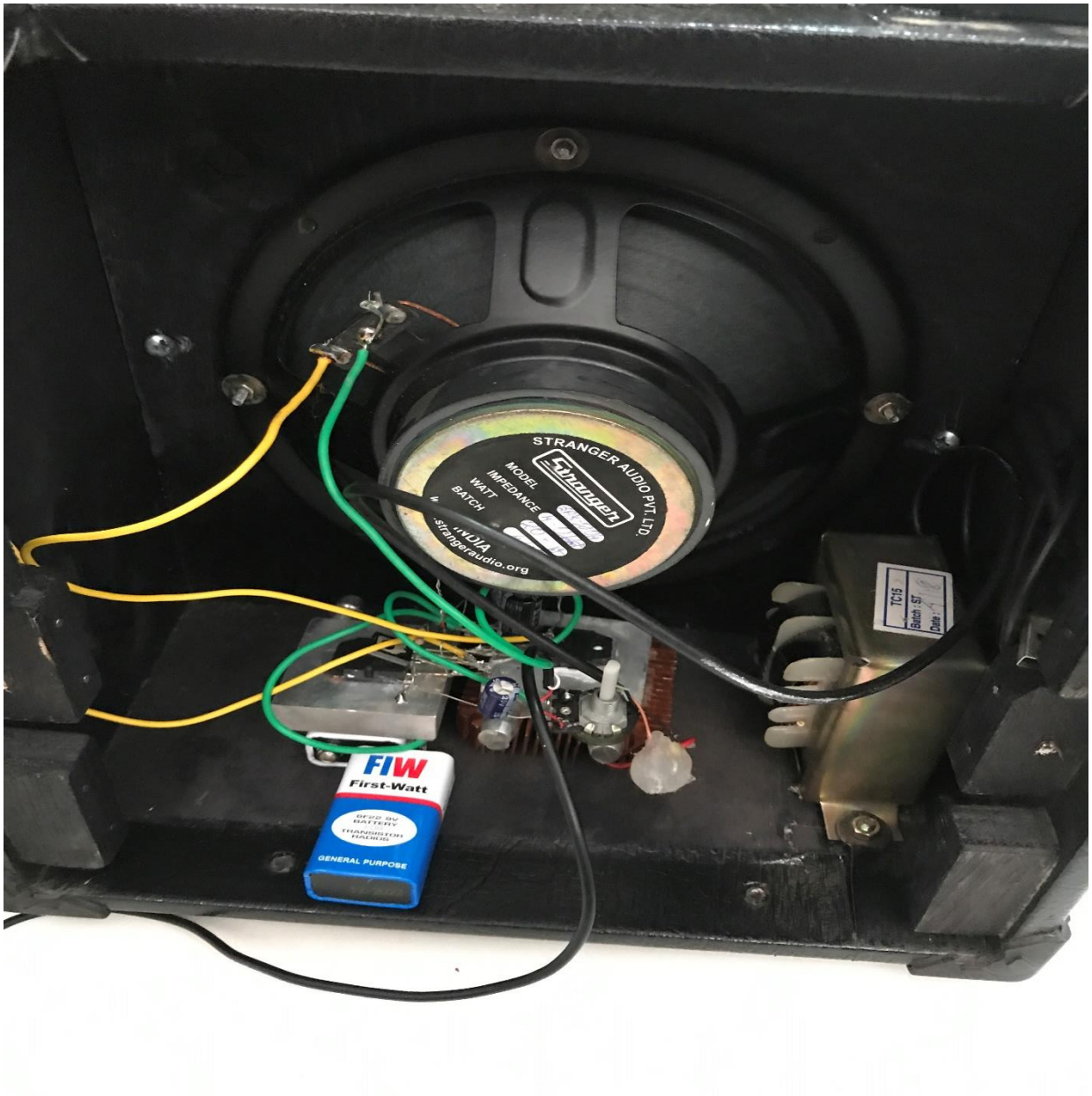
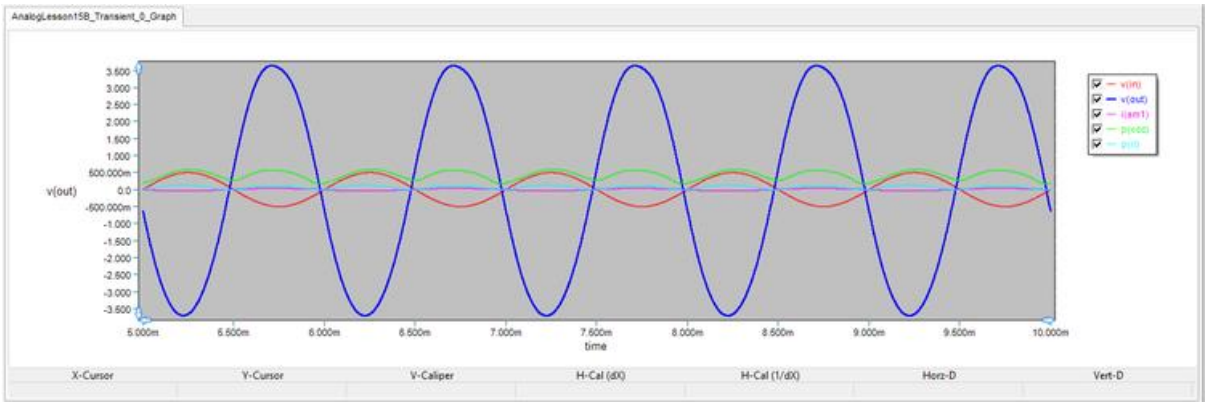


FIG 5.A) **Class ab Power Amplifier(Model)**



Output simulation

FIG 5.1

The amplifiers two output transistors conduct somewhere between 180o and 360o of the input waveform.

SL NO:	QUANTITIES	FORMULA
1)	Quiescent Current	$I_Q \approx \frac{V_d}{R_E}$
2)	Rms voltage	$V'_{rms} \approx \frac{\sqrt{2}\,V_d R_L}{R_E}$
3)	Output power	$P_L' \approx \frac{2V_d^2 R_L}{R_E^2}$

CHAPTER 06

CONCLUSION AND FUTURE SCOPE

We have seen here that a Class AB amplifier is biased so that output current flows for less than one full-cycle of the input waveform but more than a half cycle. The implementation of Class AB amplifiers is very similar to the standard Class B configurations in that it uses two switching transistors as part of a complementary output stage with each transistor conducting on opposite half-cycles of the input waveform before being combined at the load.

Thus by allowing both switching transistors to conduct current at the same time for a very short period, the output waveform during the zero crossover period can be substantially smoothed reducing the crossover distortion associated with the Class B amplifier design. Then the conduction angle is greater than 180^o but much smaller than 360^o.We have also seen that a Class AB amplifier configuration is more efficient than a Class A amplifier but slightly less efficient than that of a Class B because of the small quiescent current needed to bias the transistors just above cut-off. However, the use of incorrect biasing can cause crossover distortion spikes producing a worse condition.

Having said that, Class AB amplifiers are one of the most preferred audio power amplifier designs due to their combination of reasonably good efficiency and high-quality output as they have low crossover distortion and a high linearity similar to the Class A amplifier design.Important applications include public address systems, theatrical and concert sound reinforcement systems, and domestic systems such as a stereo or home-theatre system.

Instrument amplifiers including guitar amplifiers and electric keyboard amplifiers also use audio power amplifiers. In some cases, the power amplifier for an instrument amplifier is integrated into a single amplifier "head" which contains a preamplifier, tone controls, and electronic effects. These components may be mounted in a wooden speaker cabinet to create a "combo amplifier". Musicians with unique performance needs and/or a need for very powerful amplification may create a custom setup with separate rackmount preamplifiers, equalizers.

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- **Electronic Tutorials/Class AB Amplifier Design/Eliminate Outcome Distortion/Fails to explain characteristics.**