Audio Power Amplifier

by

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A comprehensive project report has been submitted in partial fulfillment of
The requirements for the degree of

Bachelor of Technology
in
ELECTRONICS & COMMUNICATION ENGINEERING

Under the supervision of

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May, 2018

CERTIFICATE OF APPROVAL

This is to certify that the project titled "**Audio Power Amplifier**" carried out by

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for the partial fulfillment of the requirements for B.Tech degree in **Electronics and Communication Engineering** from **Maulana Abul Kalam Azad University of Technology, West Bengal**is absolutely based on his own work under the supervision of **Mr. Arpan Deyasi.** The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

.....

Dr. Abhishek Basu
Head of the Department (ECE)
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DECLARATION

"We Do hereby declare that this submission is our own work conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute and that, to the best of our knowledge and belief, it contains no material previously written by another neither person nor material (data, theoretical analysis, figures, and text) which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text."

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Place: RCCIIT, Kolkata

CERTIFICATE of ACCEPTANCE

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Name of the Examiner Signature with Date

1. ……

2.……..…….

3.……

4. ……..……

Acknowledgement

Patience and preservation is the part & parcel to make fulfill any desired motto successful. Not only this two indispensable characters but also kind operation and zestful help are always required with which one can be able to reach his ultimate goal after passing through a series of several incidents.

Likewise we do have the pleaser to expose that we have completed our job training project on *"AUDIO POWER AMPLIFIER"*. So, at the very outset we deeply feel like expressing my indebtedness and gratitude to all concerned, unless who's help, valued suggestions, guidance and moral boosting, the presence of the work of ours would not have been possible.

In the beginning, we do express our heartfelt gratitude in deep humility to MR.ARPAN DEYASI (PROJECT Supervisor) who has provided us with the facilities in achieving the objective to prepare the project work.

We also express our sincere thanks from bottom of the heart to MR.SUJOY MONDAL (PROJECT Coordinator) who's valuable and priceless suggestions helped us at various stages of the project.

Date: -

[Signature of Project Supervisor]

ABSTRACT

The aim of this project was to design and develop a audio power amplifier. The amplifier is mainly for the CD, DVD players which are most common audio player today.

In this Project, we study the audio amplifier circuits. Moreover study the flow of the whole system from a music player to the loudspeakers. Each functions of the components in the amplifier.

Then the whole single ended audio power amplifier is built. After finish the whole have some different test and measurement to define the performance of the amplifier.

Finally, the most important thing was use the amplifier to listen music and feels the different of transistor amplifier.

CONTENTS

LIST OF SYMBOLS

Ω - Ohm

μ – Micro

A_v- Voltage Amplification

A_i- Current Amplification

A_p- Power Amplification

LIST OF ABBREVIATIONS

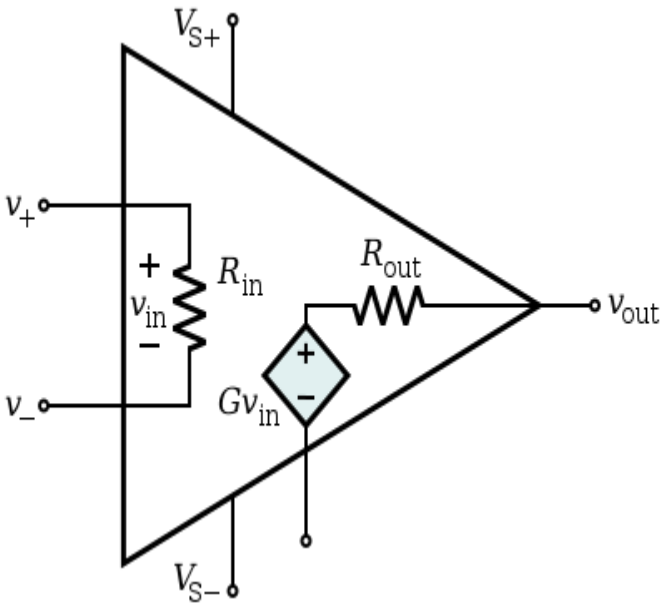
PCB	**Printed Circuit Board**
RMS	**Root Mean Square**
K-Ohm	**Kilo-Ohm**
dB	**Decibel**
Amp	**Ampere**
V	**Voltage**
R	**Resistance**

LIST OF FIGURES

Introduction

1.1 Amplifier:-

An amplifier is an electronic device that increases 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*.



An amplifier is one of the most commonly used electronic devices in the world. It's a basic building block of a vast number of circuits, and comes in various forms. Amplifiers can be defined simply as an electronic device that increases the power of a signal. In other words, it increases the amplitude of a signal, and makes it stronger than the given input. Although this sounds simple in theory, amplifiers have a lot of parameters and conditions in the real world. Amplification is never perfectly efficient; there are always losses, distortion and noise to deal with.

Thus, there are a whole load of amplifiers created, that work best in different situations. Not all amplifiers provide optimal output in all situations, and there's always cost factors to consider. So here's all the types of amplifiers and all you need to know about them!

What is an Audio Power Amplifier?

The power amplifier receives the audio signal from the mixing board or signal processor and magnifies it, giving it the power it needs to drive your speakers and entertain your audience. In this article, we'll discuss the things you need to know when choosing an amplifier for your pro audio system.

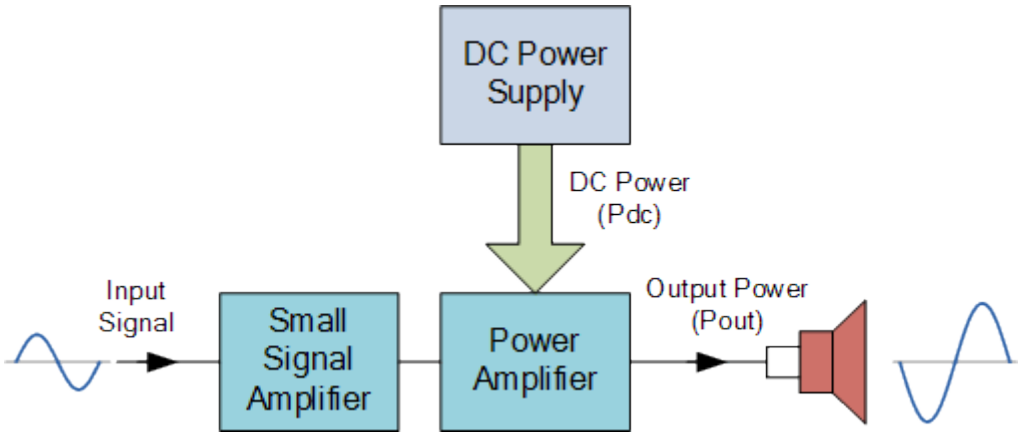


Fig 1.1

1.2 What to look for in an amplifier

Most amplifiers have similar features. The differences come in the amount power it produces, the number of channels it has, the types of connections it offers, how the controls are set up, and whether it has any built-in processing or effects.

1.3 How much power do I need?

This can feel like a bit of a minefield since amplifiers and speakers will often come with multiple power ratings. For best results, pay attention to the amplifier's **RMS power rating**. That's a measure of how much power it puts out consistently.

Speakers, on the other hand, tend to list a **program power rating** for their handling capabilities. This is the amount of power a speaker needs in real-world situations.

Compare the amplifier's RMS power rating (how much power it puts out consistently) to the speakers' program power handling (how much power the speakers need to sound good).

- As a general rule, the amplifier should be able to provide up to twice the speaker's program power rating.
- Also important to note is that it's generally better to overpower a speaker a little than to under power it. It is much easier to damage a speaker by giving it too little power than by giving too much.

For example, for a speaker with a program rating of 200 watts, you want an amplifier that'll deliver between 200-400 watts RMS. The closer you get to the higher number, the better the speaker will sound.

Other power ratings

The **peak power rating** gives you an idea of the maximum, instantaneous short-term power an amplifier can deliver or that a speaker can handle, typically for intervals lasting less than a second. It's good to know, but not very helpful when planning a system.

1.4 Amplifier power and resistance

The amount of power an amplifier generates depends on the impedance (or resistance) load of the speakers it's driving. It'll put out different amounts of power to different impedance loads. So you might see something like an amp that's rated 1,000 watts at 8 ohms, but 1,500 watts at 4 ohms.

Problems arise when the amp's output meets very little resistance (low impedance) and it tries to put out more power than it was designed to produce. This leads to the amplifier overheating and shutting down — not good in the middle of a performance. In most cases, power amplifiers are rated to work best against 4- or 8-ohm loads.

Just remember that the amplifier you choose must be able to provide an adequate amount of power to your speakers at the impedance they present to the amp's output. For example, connecting two 8-ohm speakers to one channel presents the amp with a 4-ohm load. Make

sure the amplifier can handle that load before adding the second speaker. In this case, there's no problem.

Using our example above, our amp puts out 1,500 watts at 4 ohms. This power is divided among the two speakers, so each will get 750 watts. If that's enough power for the speakers, then this amp will be a good match for them.

1.5 How many channels do I need?

Power amplifiers are categorized by the number of channels they offer: mono (single-channel), stereo (2-channel), and multi-channel (usually 4). The vast majority of amps are 2-channel. They're the most popular because of their flexibility. You can use one as a 2-channel stereo amp, two single-channel amps, or a more powerful, single-output amp.

How many channels you need depends on how many speakers you need to power. A simple system with two speakers (left and right) is perfect for a 2-channel amp. If the amp has enough power, you can add more speakers on each channel, so long as the impedance load we talked about doesn't drop too low.

Different classes of an audio amplifier

Now, the most well known types of amplifiers aren't the ones described above, but power amplifier types. Often confused as the only categories of amplifiers, they are actually types of power amplifiers and are classified on the basis of the proportion of the input cycle during which the amplifier is giving an output. The proportion of the active input cycle is also known as conduction angle. For example, a 360 degrees conduction angle means that the device is always on, a conduction angle of 180 degrees means that the device is on only for half of each cycle. Now, the different types of power amplifiers are described below

Class AB Power Amplifier

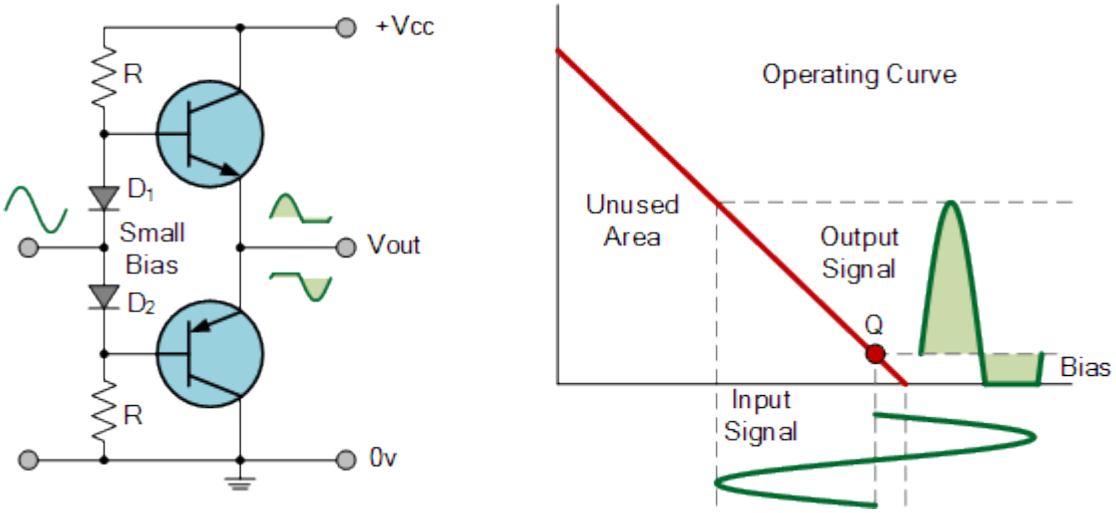


Fig 1.2

A Class AB Power Amplifier is, as the name suggests, a mix of Class A and Class B power amplifiers. Like the Class B amplifier, it also uses 2 conducting elements (transistors), but they both run at the same time. This eliminates the 'dead zone' from -0.7 V to + 0.7 V seen in the Class B power amplifier. But in this case, while each transistor conducts for more than a half cycle, they conduct less than a full cycle completely. So the conduction angle is somewhere around 180 degrees and 360 degrees, commonly shown as 270 degrees in some cases. Here are it's characteristics:

- Uses 2 transistors that work together
- Each transistor is active for slightly less than a full cycle but more than a half cycle
- Combines Class A and Class B characteristics
- No crossover distortion
- Fairly efficient, at around 50-60%
- Most common audio amplifier design

Characteristics of Power Amplifier

The quality of an amplifier is measured by a series of specifications called figures of merit. They are as follows:

- **Bandwidth:** The frequency range at which the amplifier can operate.
- **Noise:** The amount of unwanted extra information included in the output.
- **Skew Rate:** The maximum rate of change of output.
- **Gain:** Perhaps the most important, the ratio between the magnitudes of input and output signals.
- **Stability:** The ability to provide constant and reliable output.
- **Linearity**: The degree of proportionality between input and output signals.
- **Efficiency:** Another very important characteristic, it is the ratio between the output power and power consumed.
- **Output Dynamic Range:** Ratio between the largest and smallest useful output levels.

Types of Amplifiers (on the basis of Driver device)

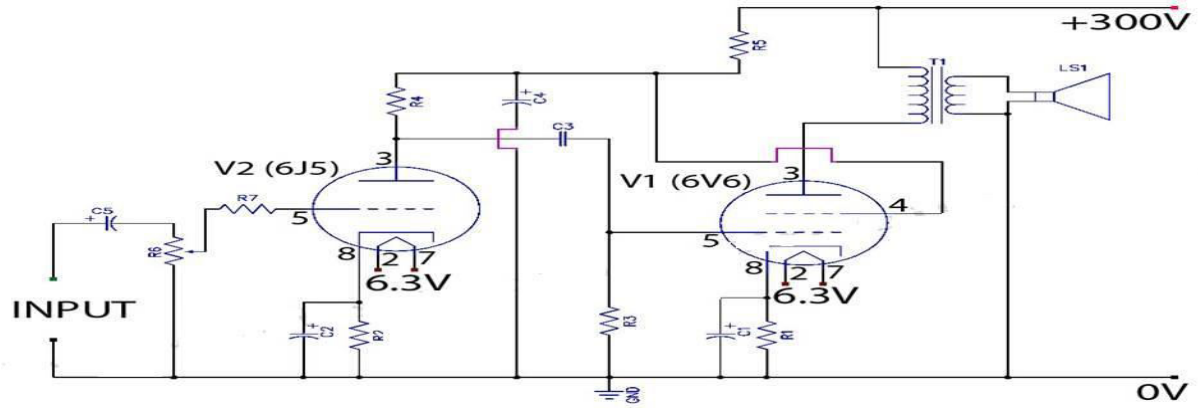


Fig 1.3

- **Valve (or) Vacuum Tube Amplifiers:** An amplifier that uses vacuum tubes to provide an increased power or voltage output is known as a valve (or) vacuum tube amplifier. As mentioned above, op-amps were originally of the valve type, but were replaced by ICs once they got cheaper, in smaller applications at least. In high power applications, they're still in use because of their cost effectiveness and output quality. They are used in radar, military, high power radio and UHF transmitter applications.

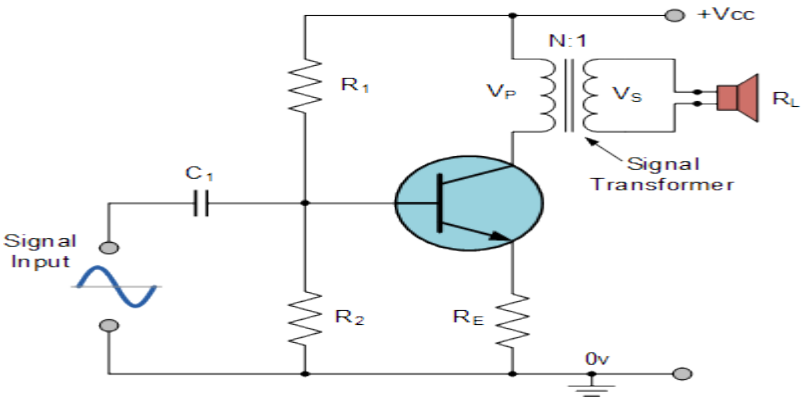


Fig 1.4

- **Transistor Amplifiers:** A well known type of amplifier, specially to engineering students, a transistor amplifier is a multi configuration high output amplifier that uses transistors as the working base. These include bipolar junction transistors (BJTs) and metal oxide semiconductor field-effect transistors (MOSFETs).

These are just a few types of amplifiers in use right now, and it's pretty obvious that each of them has an area of specialization, more or less. There are a vast number of applications in the world, and there's an amplifier for almost all of them.

100 watt RMS Class (AB) Power Amplifier

Block diagram:

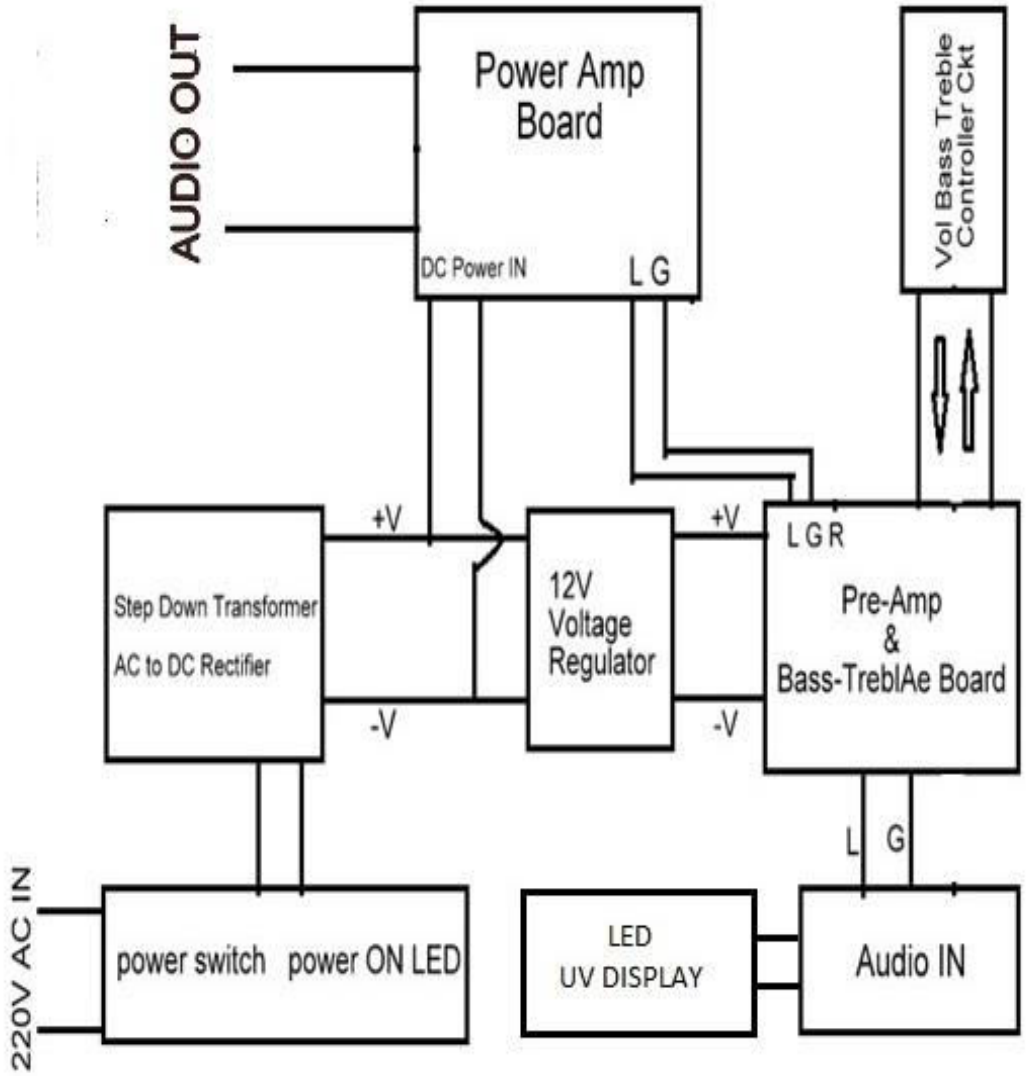


Fig 1.5

The audio signal from the source is fed into the pre-amp. In the pre-amp the signal gets boosted and gets a gain in bass and treble.

The pre-amp is attached with a controller circuit to adjust the gain in different frequency.

The output from the pre-amp is fed to the main power amplifier; here the signal is subjected to very high amplitude.

Then the high amplitude signal is fed to the Impedance matching transformer from there we can get different types of output for different speakers 16ohm, 8ohm, 4ohm.

Components Used:

1. 30-0-30volt 5 Amp step down transformer

2. Diode 1n5408 *4, 1n914* 2, ln4148*4

3. Zener Diode 20v 0.5w *2

4. Capacitor-10000µf*2, 100 µf*6, 10 µf*1, 220 µf*2, 0.04 µf*2, 0.1 µf*10, 4.7 µf*2, 0.01 µf*2, 47pf*2, 1 µf*1, 0.47 µf*1, 0.001 µf*1, 0.022 µf*1, 100 µf*1, 18pf*1 10pf*1 .

5. Resistance-47KΩ*4, 10 KΩ*3, 82 KΩ*1, 150 KΩ*1,12 KΩ, 4.7 KΩ, 220Ω*4, 100Ω*4, 22KΩ*2, 680Ω*1, 4.7KΩ*1, 0.22Ω*2, 33KΩ*2.

6. Variable potentiometer 100k *4

7. Pcb

8. Voltage regulator 7812

9. IC-Op-Amp jrc 4558, lm3915

10. Transistor -bc148, bc546, bc556, mje340, mej350

11.POWER Transistor -**2SC5200, 2SA1943**

12. Inductor coil – 6mH

Power Supply Unit:

Step Down Transformer Along With Bridge Rectifier:

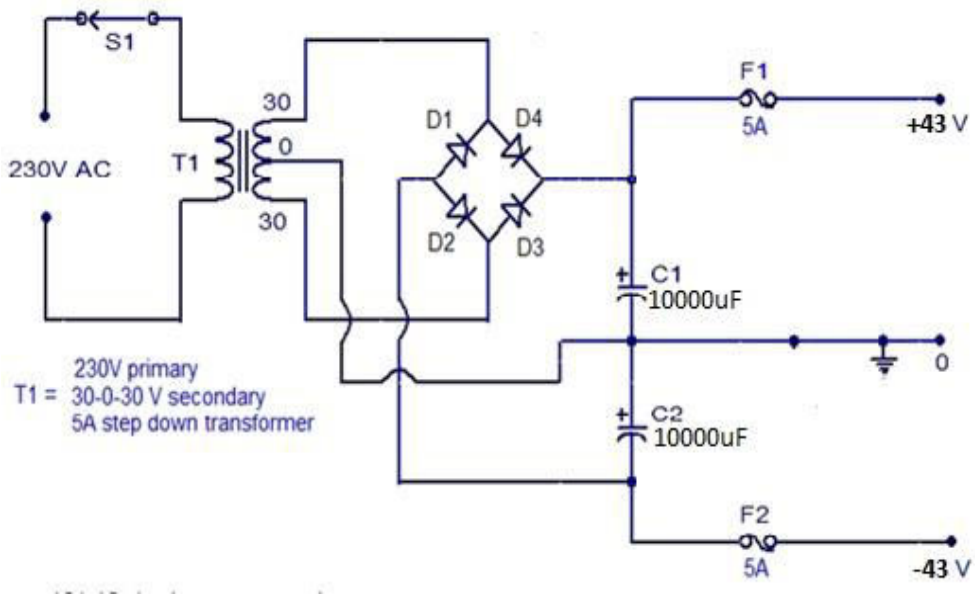
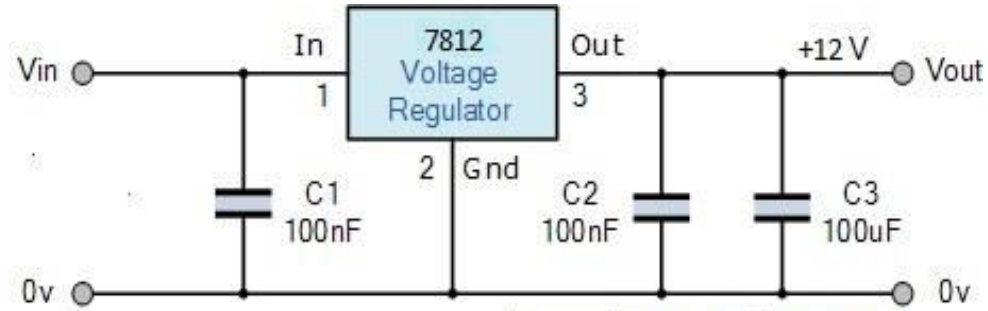
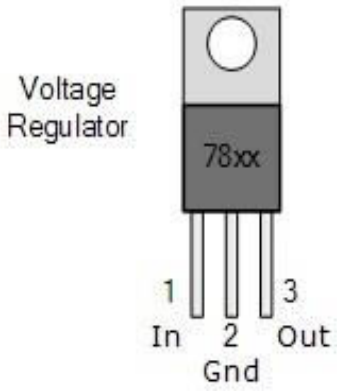


Fig.1.6

12V Voltage Regulator Circuit:





Type	Min Input Voltage	Output Voltage
7805	7V	+5V
7806	8V	+6V
7808	10V	+8V
7809	11V	+9V
7812	15V	+12V
7815	18V	+15V
7818	22V	+18V
7824	30V	+24V

Fig 1.7

UV Led Display:

Led Display Circuit:-

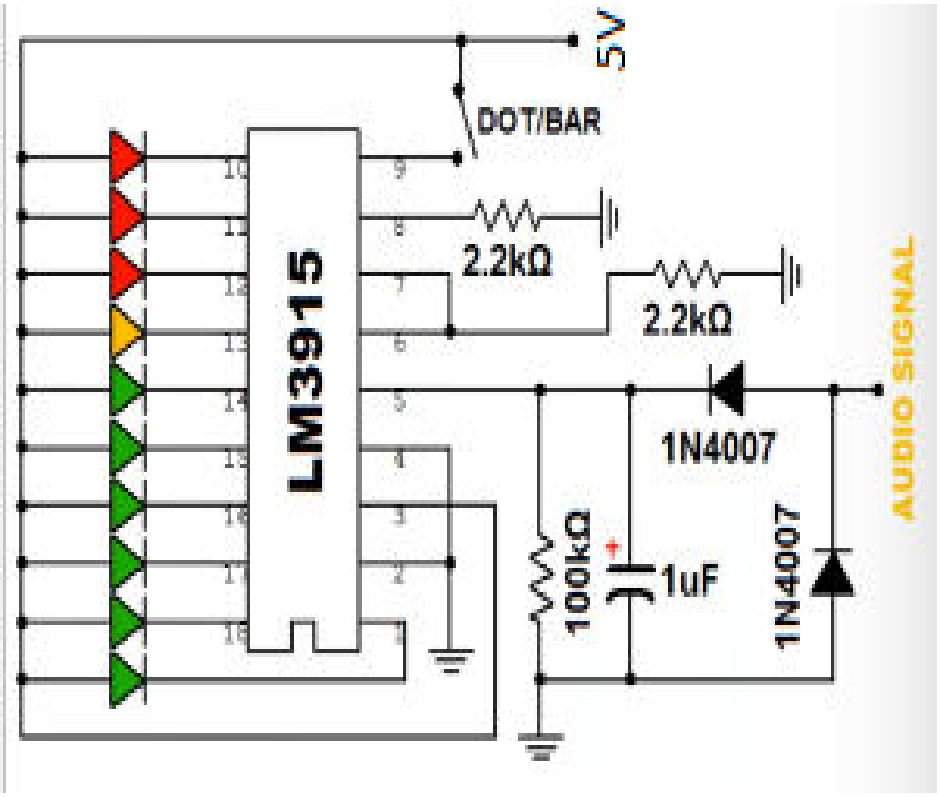


Fig 1.8

WORKING PRINCIPLE:-

The input signal from power amplifier will be entered through to Voltage Doubler circuit consists of C1, D1, D2 to convert sound signal voltage to DC voltage and have amplitude are 2 times of the input signal. Then, insert single to input pin 5 of IC.

And next IC will compare the signal amplitude, to drive LEDs display follows amplitude of input signal as above.

The Mode selection in working of circuit. to display in Dot or Bar form. The ability do with connecting a switch to pin 9 of IC. Which if indiscreetly release the switch will display is bar form. But connected the switch to pin 9 together with a positive voltage, the circuit will display in the dot form immediately.

Pre-Amp and Bass treble Gain Unit:

Pre-Amplifier:

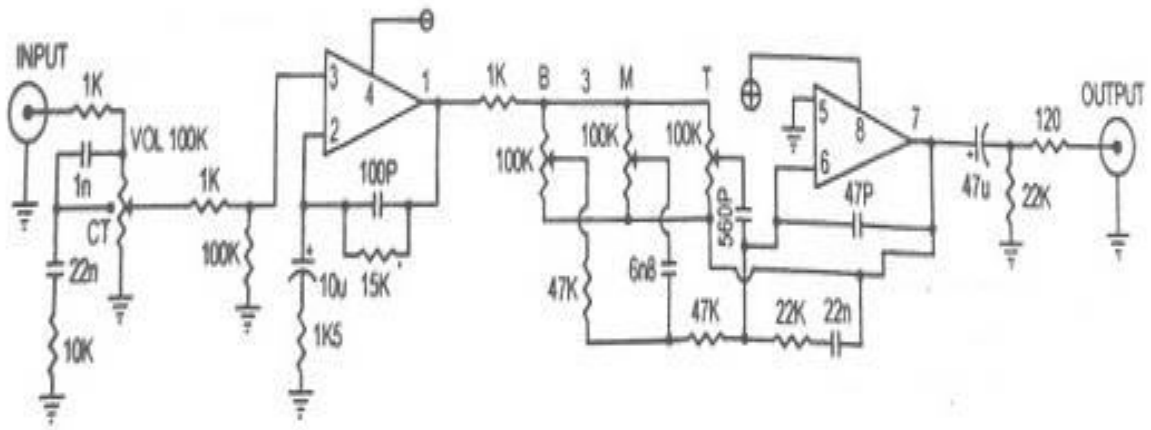


Fig 1.9

Bass (dB)

Bass is characterized by a very low-pitched sound and is the lowest tone that is registered in musical instruments and the lowest singing voice range.

The amount of gain (amplification above 0 dB or attenuation below 0 dB) to bass (low) frequencies. Set this to a positive amount to boost the bass, or to a negative amount to reduce the bass. Bass gain is applied to frequencies lower than 1000 Hz, with the most gain being applied to frequencies about 100 Hz or lower.

Treble (dB)

Treble means the highest part in a composition that has three parts which came from the Latin "triplus." It is characterized by a very high pitched sound or tone and is the higher part in a recording.

The amount of gain (amplification above 0 dB or attenuation below 0 dB) to treble (high) frequencies. Set this to a positive amount to boost the treble, or to a negative amount to reduce the treble. Treble gain is applied to frequencies higher than 1000 Hz, with the most gain being applied to frequencies above 10000 Hz

WORKING:-

Parametric Tone Control IC4558

Tone Control is an electronic circuit to set the tone or process so pleasant to hear. Tone Control is usually present only a 3 to 4 setting only, namely:

- Volume
- Bass
- Treble and
- Mid (Vocal)

Tone Control process the voice signal from the MP3, Phone output, DVD, Laptop or the other device. And then the results of the processed or the output of the Parametric Tone Control, Parametric Tone Control will be forwarded to the Power Amplifier that the processed sound Parametric Tone Control to be great.

2. Power Amplifier Unit:

Power Amplifier :

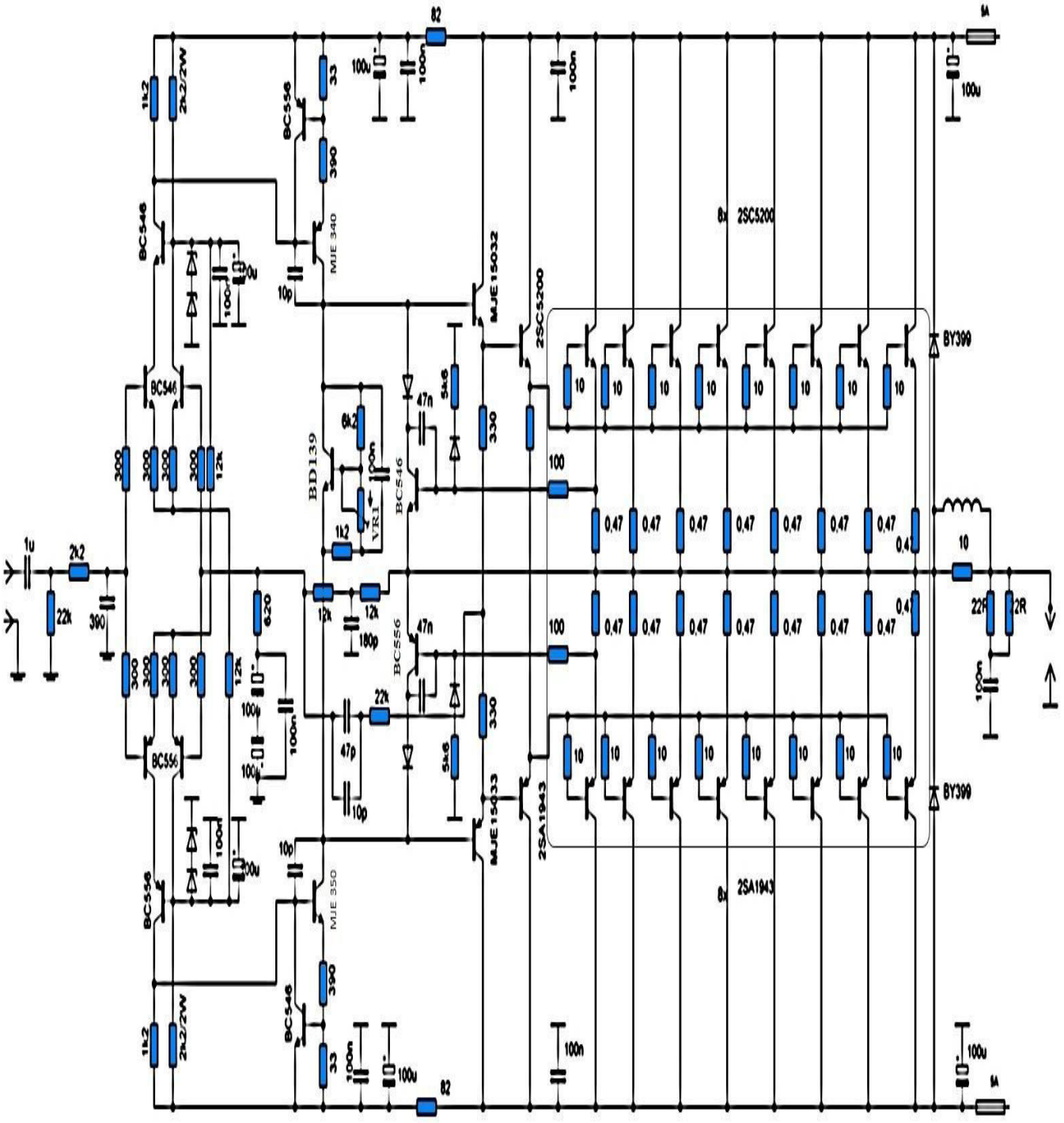


Fig 2.1

2.1 How the circuit works:

Based on the circuit, it can be seen that is determined in the All complementary input form will consist of the differential circuit of two set, the separate independent, responsible for driving directly both the positive and negative side output circuit.

As it can be seen that the positive side signal will be entered pass through the 300ohm resistor to the differential amplifier circuit with two bc546 transistors and bc556 acts as the constant current source.

The signal is amplified by the driver circuit consist of the MJE 340, MJE 15032 and 2SC5200until the signal voltage is high enough to drive the output transistors(2SC5200 *8) for amplifying the positive signal to the speaker. (Transistor 2SA1943 *8 for the negative signal)

The 0.47ohm resistors that is at the emitter pin to help the average current through the transistor be equal in the circuit and provide more stability. These are basically used to collect the output.

The diodes BY399 acts as protection to the output transistor. It allow the voltage or current to
Exceed beyond a certain level.

The transistor bd139 is setting a bias voltage value of circuit. By adjusting the idle current on VR1 for this circuit we should adjust the Idle current about 80-120 mA.

The22ohm resistors and 100n capacitors are used to protect oscillator in high frequency since connecting the speaker wiring and speaker

PCB Design

- **Software used: - EAGLE 7.2.0**

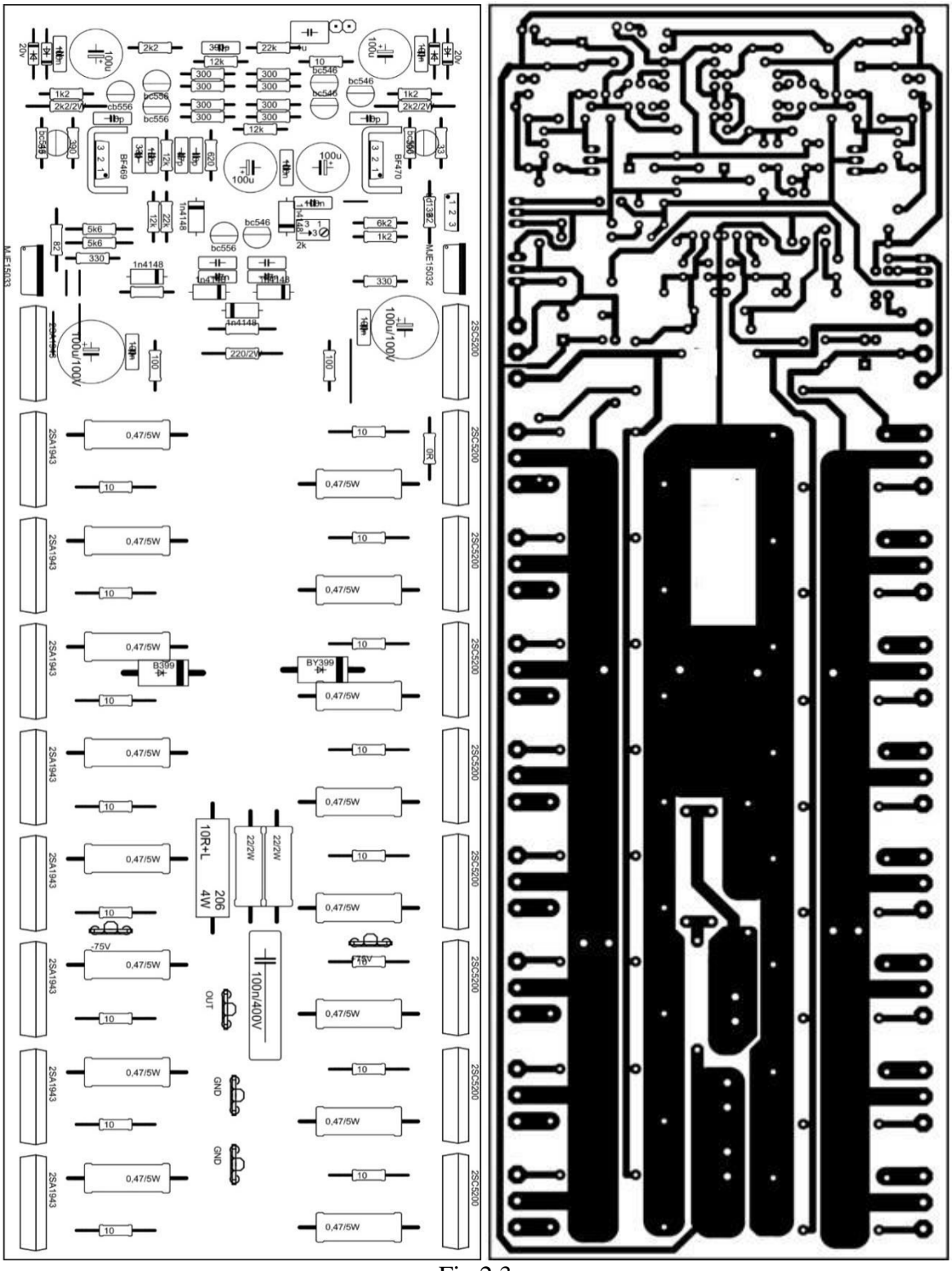
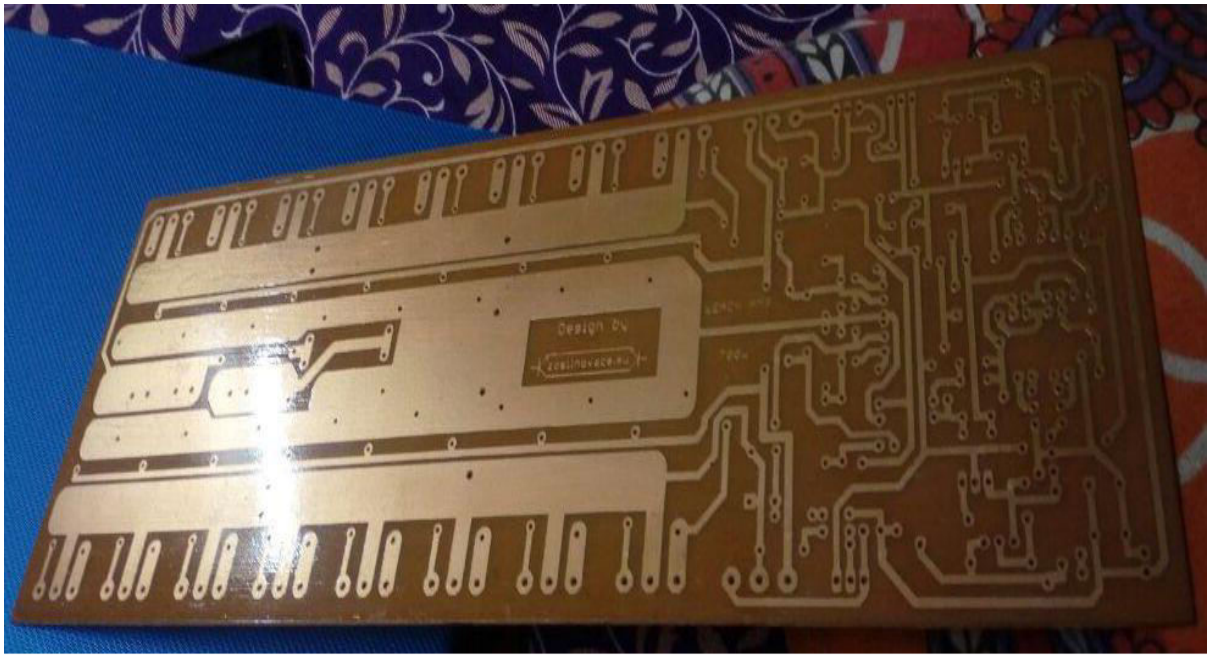
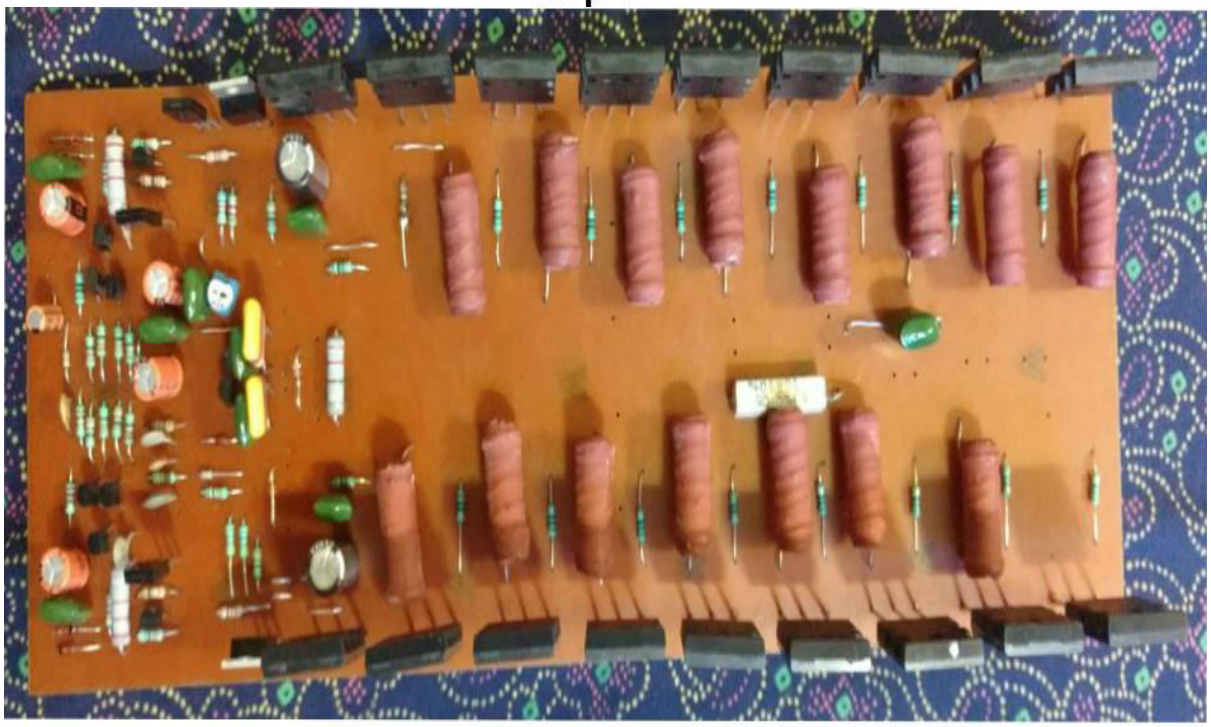


Fig 2.3

Building the Amplifier



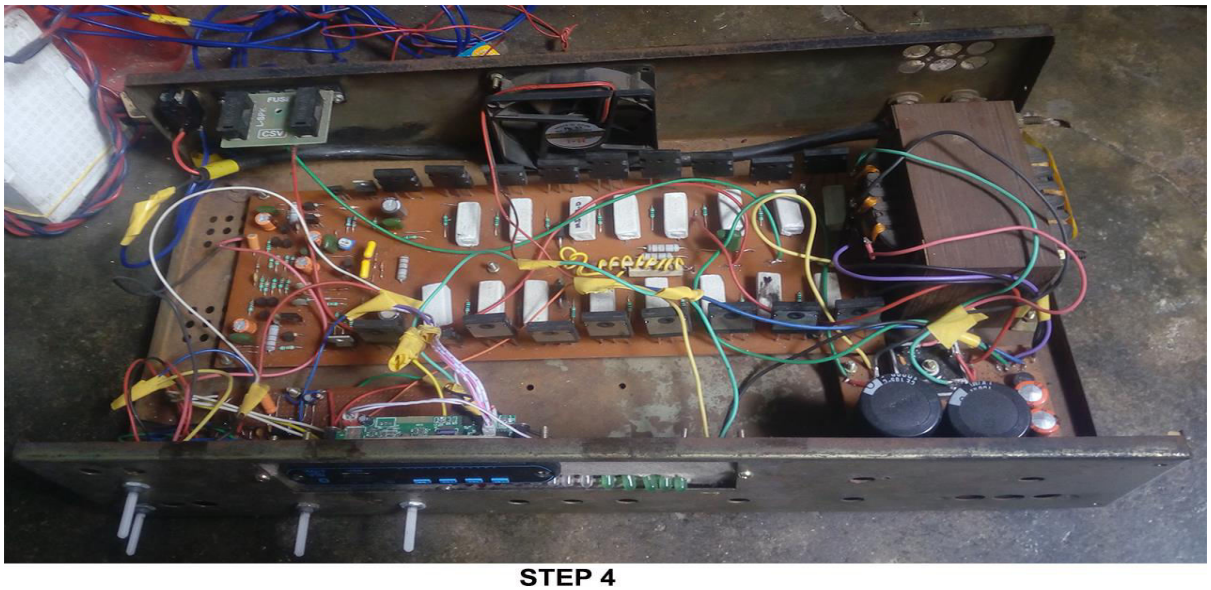
step 1



STEP 2

Fig 2.2

STEP 3



STEP 4

STEP 6

OBSERVATION TABLE:

Parameters	IN	OUT
Voltage	0.1v	8.4v
Current	2*10^-6 A	0.24 A
Power	2*10^-7 W	2.016 W

Voltage Amplification:

$$A_v = \frac{output\ voltage}{input\ voltage}$$

$$A_v = \frac{8.4}{0.1} = 84 \Rightarrow 20\log(84) = 38.48\ dB$$

Current Amplification:

$$A_i = \frac{output\ power}{input\ power}$$

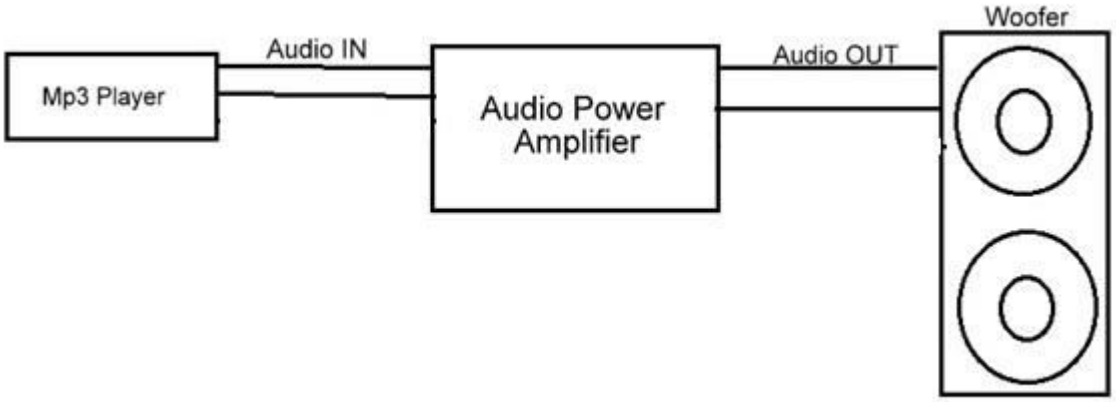
$$A_i = \frac{0.24}{2*10\text{^}-6} = 120000 \Rightarrow 20\log(120000) = 10158\ dB$$

Power Amplification:

$$A_p = \frac{output\ power}{input\ power}$$

$$A_p = \frac{2.016}{2*10\text{^}-7} \Rightarrow 10080000 \Rightarrow 20\log(10080000) = 140.07\ dB$$

Application of Audio Power Amplifier :-



Basic Application of An Audio AMP

Fig 2.3

An audio amplifier is required in all the devices that deal with sound.

To generate a sound output out of any device we need a audio amplifier. Devices that generally using audio amplifier is:-

1) **Television Set**: The basic speakers built into televisions are generally too small and inadequate to deliver the kind of good sound you deserve. If we have spent all that time selecting a large-screen television and setting up the perfect viewing environment, the audio should properly complement the experience.

2) **Smart Phone:** Consumer demand for louder ring tones, MP3 capabilities and 3D sound effects has impacted the importance of amplifier in cellular phone designs. Thus, understanding audio amplifier technology (Class-AB and Class-D) is crucial when integrating features such as hands-free mode. These features directly influence battery life when listening to voice or playing music in our Smart phones.

3) **Music System:** An Audio amplifier or power amplifier used in home audio systems and musical instrument amplifiers like guitar amplifiers. Power amplifiers make the signal—whether it is recorded music, a live speech, live singing, an electric guitar or the mixed audio of an entire band through a sound reinforcement system—audible to listeners. It is the final electronic stage in a typical audio playback chain before the signal is sent to the loudspeakers and speaker enclosures.

Conclusion

This is a compact audio powerhouse ideal for guitar or PA work or for use as a general-purpose subwoofer or hifi amplifier. Most of the people prefer MOSFET because of their legendary ruggedness. This MOSFET amplifier module which produces 200W into a 4 Ohm load. It has a rated power output of 140W into 8W and 200W into 4 Ohm. Frequency response is within 1dB from 20Hz to 80kHz. Total harmonic distortion is rated at less than 0.1% up to full power and signal-to-noise ratio is better than other forms of Amplifier.

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