DESIGN AND CONTRUCTION OF 100W HIGH FIDELITY AUDIO AMPLIFIER

BY

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DEDICATION

I dedicate this project report to my lovely and caring mother late Mrs. Tani L. Sambo. Whom I lost during the progress of this project work. She was so dear to me and she had been my "backbone" in my academics. May her soul rest in peace.

DECLARATION

I Sambo Kurutsi hereby declare that this project titled "DESIGN AND CONSTRUCTION OF 100W HIGH FIDELITY AUDIO AMPLIFIER" was done by me and has never be presented as a final year project in any university. I therefore relinquish the copy write permission to Federal University of Technology Minna.

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ACKNOWLEDGEMENT

All gratitude to Almighty God, my creator and the sustainer of my life for giving the health, knowledge and strength to successfully carry out this project.

I want to say a big thank you first to those who have contributed financially and otherwise to make my academic career a reality. I would love to especially appreciate my parent Mr. and late Mrs. Luka Sambo for their priceless contribution and for dedication towards the actualization of my academic dream. I also appreciate my supervisor Mr. A.M.B Zungeru for his numerous contributions towards the implementation of this project.

ABSTRACT

The project is on the "Design and Construction of a 100W High Fidelity Audio Amplifier" The method used in the design of this project is the modular approach, whereby the design is sub-divided into different modules, each of the modules co-operating with other to achieve the objective of the project. The working principles of various models such as the power supply unit, pre-amplification/driver unit, audio tone control and the power amplifier gives the desired harmonic in the output audio.

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CHAPTER ONE

INTRODUCTION

1.1 APLICATION IN COMMUNICATION

An amplifier is an electronic circuit which accepts signal input and produces an electrical output such that there is a prescribed relationship between the input and output signals whether they be voltage or current. While amplification is the process whereby the power of a signal is increased without altering its basic information carrying characteristics.

Amplification in communication has found itself in virtually all human endeavors for example public address system (indoor and outdoor), radios, phonographs television receivers, telephone receivers, industrial control equipment, etc. these make use of transistors and operational amplifier to amplify tiny electrical voltages to a level at which they can operate loudspeaker.

There is no doubt that without amplification, communication in engineering would have been impossible.

1.2 AUDIO AMPLIFICATION

High fidelity (HIFI) audio amplifier has the ability to deliver high and accurate audio with less or limited distortion. Audio amplifier is designed to amplify the power of electrical signals in the audio range of frequencies that is the range of frequencies that can be detected by a normal human ear (20Hz- 20 kHz).

An audio amplifier sends its enlarged electrical signals directly into loudspeakers which convert the signals to sound waves; it is the most common type to amplifier found in the home today.

In audio amplification, the first stage are small-signal voltage (or current) amplifier designed to amplify the output (i.e. a few milli-volts up to a signal of several volts). The final stage is a large-signal or power amplifier that suppress sufficient power several watts, to drive the load (loudspeaker in the case of audio amplifier).

The loudness of sound produced by a loudspeaker varies with the output power of the amplifier driving it. The greater the amplifier power, the louder the sound. An electronic device called a pre-amplifier is sometimes necessary to make a very weak signal strong enough to be handled by an audio amplifier i.e. power amplifier stage.

The purpose of this project is to design and construct unit of 100w audio amplifier.

1.3 AIMS AND OBJECTIVE

1. To design and construct a multi-stage audio amplifier
2. To demonstrate the amplification capacity of complementary pair of transistor
3. To enjoy high quality audio output from a low input.

4 METHODOLOGY

The method used in the design of this project is the modular approach, whereby the design is sub-divided into different modules, each of the modules co-operating with each other to achieve the objective of the project

1.5 NEED FOR STUDY

In order to compare the standard of living between the early age with the present days or modern days. The effect of communication cannot be over emphasized; communication has contributed immensely to the growth, development and improvement of standard of living in the world today.

One cannot just imagine what the whole world would have looked like, if there is no means of communication. Information would have been very easy to pass from one part of the world to another.

Today news about things happening in Gaza is received here in Nigeria with few seconds. One is able to communicate with his family in Jalingo from Minna and exchange words through cell phones. Equally, electronic conference is possible in internet through modern computer communication system. These and many others are example of good work of communication system. In communication, both electrical and electric wave and radio wave are used in transmitting messages from one point (source) to the other (destination) by the user through certain medium.

In electrical communication system, the information to be transmitted such as music of computer date, must be transformed into a charging current or voltage, this can be achieved by using transducers such as microphone at the sending end and loudspeaker at the receiving end.

As eelier said in the introduction part, for information to be transferred successfully from one place to another, amplification of the signal is necessary. However, amplification is the process whereby the power of a signal is increased without altering its basic information carry characteristics which is the basic objective of this project.

Communication system have many functional elements in common, because of this, it is often possible to adopt methods of analysis of implementation from one system to another. Although, continuous evolution marked the technology and practice of communication engineering, a large segment of basic theory remains unchanged and this provides the basis for evaluating new techniques and new systems.

Going by the historical perspectives of communication in the olden days slaves were sent to deliver information by trekking through foot-path of a far distance. However in these modern days, communication is executed by means of using device referred to as an audio amplifier

1.6 SCOPE AND LIMITATIONS

This project is limited to the development of very large integration circuit and the working principles of various models such as the power supply unit, pre amplifier unit, audio tune control and power amplifier.

1.7 PROJECT OUTLINE

This project outlines the steps involved in the "design and construction of 100watts HI-FI audio amplifier" and is represented in the five chapters as shown below.

Chapter one provides a general introduction which include application in communication, audio amplification, aim and objectives, methodology, need for study, scope and limitations and the sources of information that aided the design.

Chapter two present the literature review, historical and theoretical background of the related systems. Chapter three presents the design analysis, component selection and design calculations. Chapter four outlines the test and measurement of the circuit. Chapter five presents

he conclusion, recommendation for improvement on the project and problems encounter during he design.

CHAPTER TWO

LITERATURE REVIEW

2.1 LITERATURE REVIEW

Reviewing the history of audio reproduction, which started more than a century ago, there has been a steady improvement in quality. The first record player, which was a rotating drum, used only mechanical excitation of a needle to produce sound. The movement of the needle was transferred to a diagram in a hum, thus, forming a true "audio amplifier". Later, the movement of the needle was transformed into an electrical signal. This signal was amplifier by means of vacuum tube and fed to a loudspeaker [1].

Long ago, valves were used in most electronic circuits including audio amplifiers. The problem with these designed type amplifier was bulkiness and cost. Transistors, which are smaller and relatively cheaper, compared with values of those days, are currently being used therefore, making the present design more economical [2].

Before the emergence of audio amplifiers, there was high need of energy in a bit to send information across to a wider audience, it is in view of this that one could imagine this modern world without an efficient means of sending information. It is obvious therefore, that the introduction of amplifier in the communication industry can not be over-emphasized; it serves as the basic means of sending information.

The first-form of audio amplifier was mechanical in nature. It was from this that the electronic amplifier known to evolved. These early type of audio amplifier had problems of noise and clipping. With the used of the active device in our present day electronic gadgets, these

)blems can be minimized if not rule out completely. The most outstanding capability of a nsistor as an amplifier is a indication leading to the production of widely used forms of audio ıplifiers of these generation. [3]

Modern amplifiers always use transistor instead of vacuum tubes. In a vacuum tube, ıplifier undergoes similar process as the signal in a transistor amplifier. The vacuum tube can thstand electrical abuse that would leave even the most robust transistor completely blown. so, vacuum tube amplifiers use an output transformer to interface the speaker; such a device ɔvides an excellent buffer protection in the case of internal malfunction. Modern amplifiers th no output transformer occasionally fail in a way that connects the full DC supply voltage to ɜ speaker. If the amplifier does not have adequate in built protection circuitry, the result is ten a method woofer voice coil [4].

The amplifier is actually an energy converter. The input signal merely controls the rrent that flows from the power supply. Thus, the energy from the power supply is converted the amplifier to signal energy. The transistor perhaps is the most fundamental component in ır modern electronics. It was its invention that sparks off the electronic revolution and till date e transistor stands out of all elements found in any electronic circuit [5]

2 THEORETICAL BACKGROUND

The basic theories that guide the design and construction of this project are those of nplifiers and operation of operational amplifier.

2.2.1 AUDIO AMPLIFIERS

An audio amplifier is an electronic device that amplifier low-power audio signal to a level suitable for driving loudspeakers. This is the final stage in an audio play back chain [6]. The major task of an audio amplifier is to take a little signal and make it bigger without actually making any change to it. This however is not an easy task because sound contains a lot of frequency which must be amplified by the same factor as to changing of the waveform and hence the sound quality. An amplifier which multiplies the amplitudes of all frequencies by the same factor is said to be linear. Departure from linearity leads to various type of distortions.

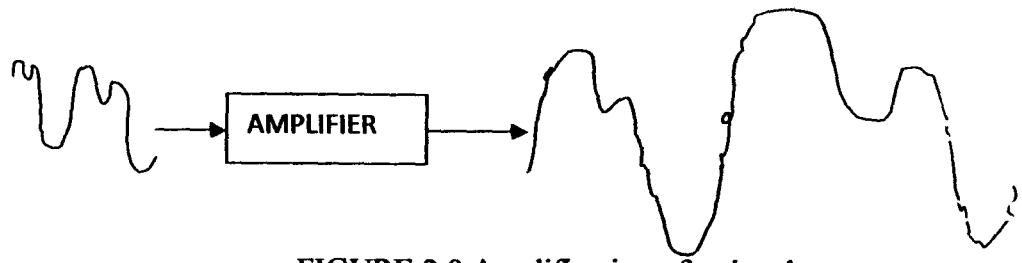


FIGURE 2.0 Amplification of a signal

2.2.2 HI-FI AUDIO

Amplifiers designed to amplify signals at around the frequencies to which the human ear is sensitive, have their own special problems, and the circuits are designed to solve these problems. The range of frequencies to be amplified is well within the capability of even simple circuits. The general accepted 'HI-FI' frequency range includes all frequencies between 20 Hz and 20 KHz [7].

The first requirement for an audio amplifier to be considered here is the power output. A typical transistor radio or portable tape-player will provide an output power of around 500mW into a small speaker. This sort of power level proves quite adequate for general listening at fairly close range; but for HI-FI, where the faithful reproduction of high-energy transient sounds is

nportant, 20W is considered a sensible minimum. The fact about high-fidelity is that the very est equipment now available is probably better than it needs to be, that is to say, the tiny amount of distortion and 'unfaithful' reproduction are almost certainly too small for even the most rained human ear to detect. The design of Hi-Fi equipment is very specialized but below are the pecification of a hi-fi system [7].

.2.3 POWER

The output power should probably be 20W or more per stereo channel (that is 20W for ach side), not because this is a sensible level at which to listen all the time (except for hard rock nd heavy metal), but because the amplifier is required to reproduce high-energy transient ounds-like the leading edge of the sound made when a rock drummer hits the crash cymbal- without distortion. Also, modern speakers tend to be inefficient, trading small size and sound quality for electrical efficiency; they require lots of power to drive them to high volumes.

The output power to the system would thus be 40W; this means r.m.s power. Manufacturers sometimes quote 'peak power', which is the amount of power an amplifier will deliver for a short period. The figure for peak power output is about twice that of r.m.s power.

In the old valve amplifiers and in the early days of transistor amplifiers, it was quite difficult to arrive at a design which successfully amplified signal across the whole of the audio spectrum. It is not a problem today, and any good amplifier can handle signals from 20 Hz to 20 kHz. 'Handle' needs defining in this context: the amplifier has a respond to say a 20 Hz signal in the same way as it does to a 2 kHz signal. Frequency limits are usually quoted to '3 dB down', meaning that the signal inside the quoted limits is no more than 3dB smaller at the limits than in

the loudest part. As a rough guide, a change of 3dB is about the least change that a human being can detect. A typical graph of frequency is shown above.

It is not a good idea to an audio amplifier that amplifies signal to a frequency much higher than 20 KHz, for ultrasonic frequencies can use up power and heat up the output stage to no audible result. Most amplifiers dip dramatically above 20 KHz. In the same way, the ability to amplify very low frequencies-sound below the ability of the speaker to produce and the listener to hear can be a liability.

2.2.4 DISTORTION

There are various measures of distortion; the most commonly used is total harmonic distortion (t.h.d). A top-quality amplifier would achieve better than 0.01 percent across the entire audio frequency range.

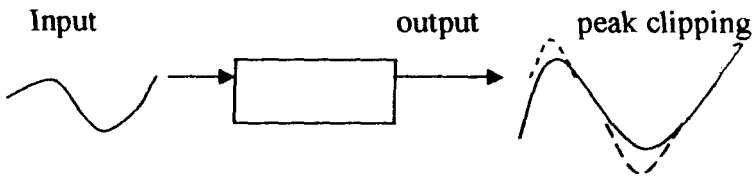


Fig.2.1 Harmonic Distortion in Amplification

In the diagram, the input is a single frequency (pure sine wave), but the output waveform is clipped by the amplifier. The result is that harmonic frequencies not present in the original signal are produced at the output (harmonic distortion). This harmonic distortion contains only odd harmonics if the clipping is symmetrical. For example, a geometrical square wave has only odd harmonics, and as a signal is clipped, it approaches a square wave rather than a sine wave.

The frequency spectrum at the right is measured the output of a particular amplifier driven above its power rating. The spectrum has a larger amount of odd harmonic than even harmonic output, but the fact that even harmonics are present suggests that the distortion was not symmetrical with respect to the wave form

An amplifier can be said to be linear if the output voltage is strictly proportional to the input signal. Any nonlinearity, such as that arising from the semi-conductor devices themselves, will give rise to harmonic distortion. Such defects in the performance of the devices can be minimized by using negative feedback in the circuit so long as the output is not over overdriven to the point of clipping.

2.2.5 NOISE

All amplifiers produce some background noise, although modern systems are so good you may have to put your ear to the speaker to hear it; the noise is inherent in the way transistors work and can in all probability never be eliminated entirely. However, it is possible to reduce the noise level to 'practical inaudibility', at -70dB (that is 70dB – more than 300 times – lower than the output signal).hum generally at mains frequency, and if not arising from problems with interconnection between hi-fi units, is always due to poor/cheap design. A hi-fi amplifier should have no discernible hum, even with the volume control turned right up.

In common use, the word noise means unwanted sound or noise pollution. In electronics, noise can be referred to as the electronic signal corresponding to acoustic noise in an audio system. Signal processing or computing can be considered as data without meaning; that is data that is not being used to transmit a signal, but is simply produced an unwanted by-product of

other activities. In information theory, however, noise is still considered to be information. In a broader sense, film grain or even advertisements in web pages can be considered as noise [8].

2.3 AMPLIFIER DESIGN THEORY

The major aim of all design techniques used in the design of audio amplifier is to produce an output that is directly proportional to the input power as shown in the equation below

$$P_o = AP_i$$

Where Po = output

Pi = input power and A = constant known as amplification factor or gain of the amplifier circuit.

2.3.1 MULTISTAGE AMPLIFIER

In multistage audio amplification very low frequency performance is required. In such cases the effect of any offset may be eliminated by means of a capacitor called a blocking capacitor that could be connected directly in series with the amplifier output. Without the blocking capacitor, the offset of the early stages is amplified by the gain of all subsequent stages. This can clearly lead to saturation of the later stages when high gain is used, blocking capacitors avoid this problem by restricting the effect of offset to individual stages [9].

Two precautions must be observed in designing amplifiers of this kind

1. The offset even within a single stage must be so great that saturation can occur with the peak values if the anticipated alternating signals.

2. The blocking capacitor must have sufficient high value that the lowest required signal frequency is not attenuated excessively.

2.3.2 MATCHING

When two single stage amplifiers are connected together in tandem to obtain maximum gain then the output resistance of the first amplifier must be matched to the input resistance of the second amplifier. If they are matched then the total gain is the product of the two individual gains. If the two stages are not matched then the second amplifier can load up the second amplifier and lower its gain [10].

2.3.2 AMPLIFIER COUPLING.

Coupling refers to the method used to transfer signal from one stage to the next. Capacitive coupling is useful when the signals are alternating current. Coupling capacitors are selected to have allowed reactance at the lowest signal frequency. This gives good performance over the frequency range of the amplifier. Any DC component will be blocked by a coupling capacitor.

Coupling capacitors used in transistor circuits are often of the electrolytic type. This is especially true in low frequency amplifiers. High values of capacitance are needed to pass the signal with little loss. Polarity is an important factor when working with an electrolytic capacitor. Capacitive coupling is widely applied in electrolytic amplifiers process AC [11]

3.3 OTHER CONFIGURATION

Amplifier has many characteristic; among these is input impedance. The input impedance of ı amplifier is the loading effect it will present to a signal source. That is, when a signal source connected to an amplifier, the amplifier sees a load, not an amplifier. The load seen by the ɔurce is the input impedance of the amplifier and every signal has characteristic impedance. For ıe best power transfer, the source impedance should be equal to the amplifier input impedance 11].

.3.5 CLASSIFICATION OF AMPLIFIER

Classification according to operating conditions includes:

1. Class A: class A amplifier have very low distortion (lowest distortion occur when the volume is low). However they are very inefficient and they are rarely used for high power requirement.
2. Class B: class B amplifiers are used in low cost design or on design where sound quality is not important. Class B amplifier are significantly more sufficient than class S amplifiers; however, they suffer from bad distortion than when the signal level is low.
3. Class AB: class AB is probably the most common amplification class currently used in homes stereo and similar amplifiers. Class AB amplifiers combined the good point of class A and class B amplifiers. They have the improved efficiency of class B amplifier and distortion performance of class B amplifier and distortion performance that is a lot closer to that of class S amplifiers. Class AB amplifier (like class B) use pair or transistors, both of them is being biased slightly ON so that the crossover distortion (associated unit class B is largely eliminated). Other classes include C, D, and E .

3.6 TRANSISTOR AMPLIFIER

There are two terms one should be familiar when discussing transistor amplifier: MPLIFICATION and AMPLIFIER SIGNAL. Amplification is the process of increasing the rength of a signal. A signal is just a general term used to refer to any particular current, voltage power in a circuit. An amplifier is the device that provides amplification (the increase in urrent, voltage or power of a signal) without appreciable altering the original signal.

Transistors are frequently used as amplifiers. Some transistor circuits are CURRENT mplifiers with a small load resistance; others circuit are designed for VOLTAGE amplification nd have a high load resistance; other amplify POWER. The amplification factor for a single ansistor amplifier is usually approximately equal to the gain (h_{fe}) of the transistor. The output urrent from the single stage amplifier is equal to the product of the input current and the mplifier gain.

.3.7 TRANSISTOR CONFIGURATION

A transistor may be connected in any one of three basic configurations that is: common mitter (CE), common base (CB), and common collector (CC). The term common is used to enote the element that is common to both input and output circuits. Because the common lement is often grounded, these configurations are frequently referred to as ground emitter, ground base and ground collector.

CHAPTER THREE

SYSTEM DESIGN AND ANALYSIS

3.1 BLOCK DIAGRAM.

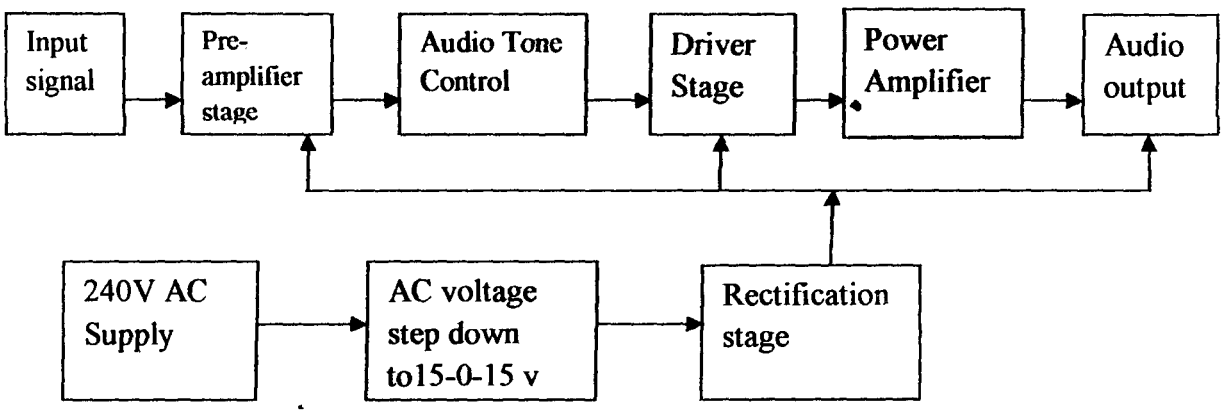


FIG.3.1 block diagram of 100W HIFI Audio Amplifier.

3.2 POWER SUPPLY UNIT.

The power supply unit for the system comprises of the following stages:

I. Stepping down of 230v by a transformer.

II. Rectification of the voltage by a full wave rectifier.

III. Smoothen by a capacitor network.

The power supply unit can be represented in the block diagram as shown below:

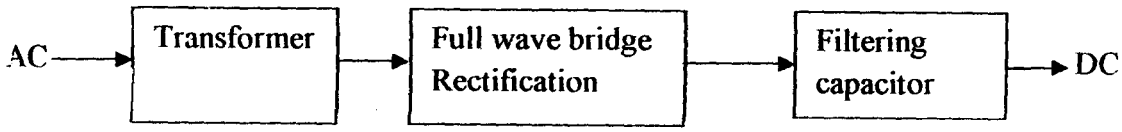


FIG.3.2 block diagram of power supply unit.

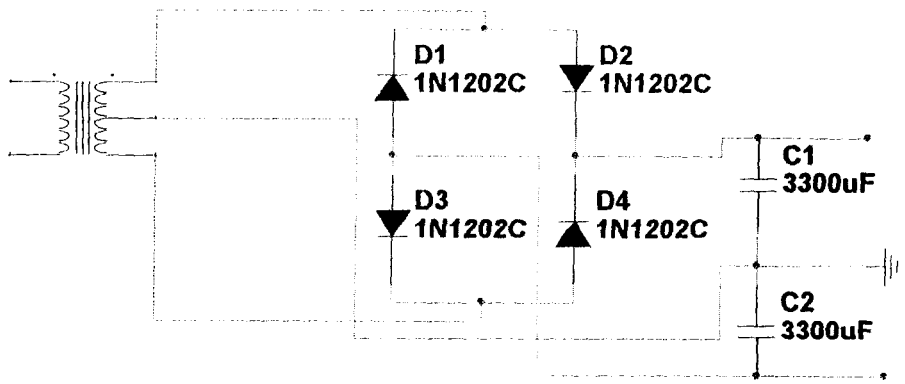


FIG.3.3 Circuit diagram of power supply unit.

The circuit consists of 15-0-15v transformer, a full wave rectifier circuit and smoothening capacitors. The 15-0-15v AC voltage was rectified using a full wave bridge rectifier and smoothened by two 35/3300μf capacitors from the expression below:

$$Q = Cdv = it \longrightarrow 3.1$$

$$T = \frac{1}{2f} \longrightarrow 3.2$$

Where C=value of smoothening capacitor

Dv=Maximum AC ripple voltage

I=Current rating of the transformer

t=time required for the capacitor to charge

f=mains frequency

$$t = \frac{1}{2\times50}$$

$$=0.01s$$

$$Vp = Vrms \times \sqrt{2}$$

$$=\pm15\times\sqrt{2}$$

$$=\pm21.213$$

$$=\pm21v$$

The ripple voltage of 42% of Vp was choose to prevent audible humming on the audio output.

$$dv = \frac{42\times21.21}{100}$$

$$=8.9=9v$$

$$c = \frac{it}{dv}$$

$$= \frac{3\times0.01}{9}$$

$$= \frac{0.03}{9} = 3333\mu f.$$

Since it is hard to get such a value of a capacitor, two of 3300μf capacitor was chosen for filtering of the rectified dc signal from the positive and negative side of the diodes.

3.3 THE PRE-AMPLIFIER/DRIVER UNIT.

This unit comprises of two auxiliary, two microphones and an operational amplifier wired to operate as a linear combination. The linear combination of the input voltages from the microphones and the auxiliary constitutes the mixing and the amplification. This amplification is provided by the gain of the two amplifiers embedded in a chip which form the basis of the pre-amplifier and the driver unit.

TL072 is a dual operational amplifier which is used for the pre-amplification and for driving of signal to the power amplifier unit. It has a current rating of 6mA and a voltage rating of ±18v. The input pin takes a voltage of ±15v. It's operating at free air temperature range.

The maximum gain on the input is given as:

$$\frac{Vout}{Vin} = 1 + \frac{Rf}{Rin}$$

$$A = \frac{Vout}{Vin}$$

$$A = \frac{Rf}{Rin} + 1$$

Assuming $Rf = 22k\Omega$

A=100

Then, $100 = 1 + \frac{22\times100^3}{R1}$

$$R1 = \frac{22 \times 100^3}{99}$$

$$R1 = 222.2$$

R1=R5=R6=R10=220Ω

The available resistor is 220Ω.

The value of the coupling capacitors is obtained using the formula below:

$$C \geq \frac{1}{2\pi f R1}$$

C1=C2=C3=Coupling capacitor.

R2=1kΩ

F=20Hz (the lowest audio frequency amplifier).

$$C = \frac{1}{2\pi \times 20 \times 1000}$$

=8.00μf.

The value greater than the one obtained above can be used. Therefore, 10μf was used for the design. This implies that C1=C2=C3=10μf.

3.4 POWER AMPLIFIER.

The main task of a power amplifier is to boost its input signal. The power amplifier is the final stage of amplification where the amplified signal is matched to the load. This stage is the last output stage of the amplifying unit system and is designed to deliver a large amount of

power to the load. However, a power amplifier must supply an appreciable current and voltage swing and the amount of power that can be handled safely by an amplifier is usually determined by the active device in the output stage.

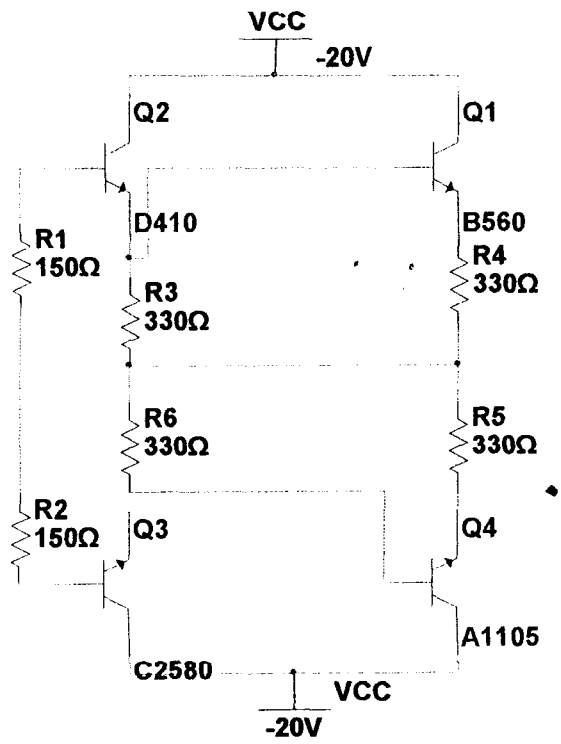


FIG.3.6 Power amplifier.

T1and T3 are PNP transistors used for low frequency power amplification and having a temperature characteristics at 25°c ,a DC current gain (hfe) of Ic=1A and Vce=2v and5v respectively.

T2 and T4 are NPN transistors paired with T1and T3 behaving as a current gain of ß=ß1ß2. By combining an NPN with a PNP transistor as shown above gives an effective Vbe=0.7v.

Darlington-pair configuration is very suitable for use in power amplifiers since only relatively driving power is required to obtain a large current. This configuration is employed at the output of this design to reduce cross over distortion at the output of the power amplifier unit.

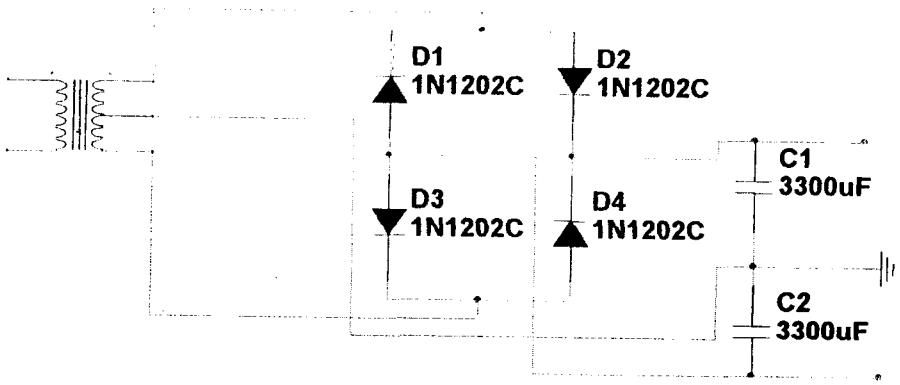
3.5 TONE CONTROL.

The tone control of an audio amplifier circuit had the high and low frequency level of the sound output according to the listener's taste, this is accomplished by changing the gain of certain frequencies or by filtering certain frequencies to ground. When a sound system amplifies all of these frequencies, it has a 20Hz to 20 kHz HiFi frequency response rating.

In the design of this project, bass tone control (low frequency response) filters out the unwanted high frequencies while treble (high frequencies response) is desired to filter out the unwanted low frequencies.

3.6 HEAT SINK.

The best design amplifier with minimum loss will have some current flowing in the transistor when it is operating. This implies that heat will be generated. An amplifier delivering power to a load will dissipate some power to them. For the device to remain stable, they must be kept cool. Therefore, power amplifier uses power transistors capable of handling the current and to keep the internal temperature to a safe level which a heat sink is used to remove the excess heat. Modern heat sinks are made from aluminum with a matt black finish; they are bolted or clipped to the transistor and remove the heat by conducting and radiation. This design incorporates a heat sink which facilitates the cooling of the power transistor.



power supply unit.

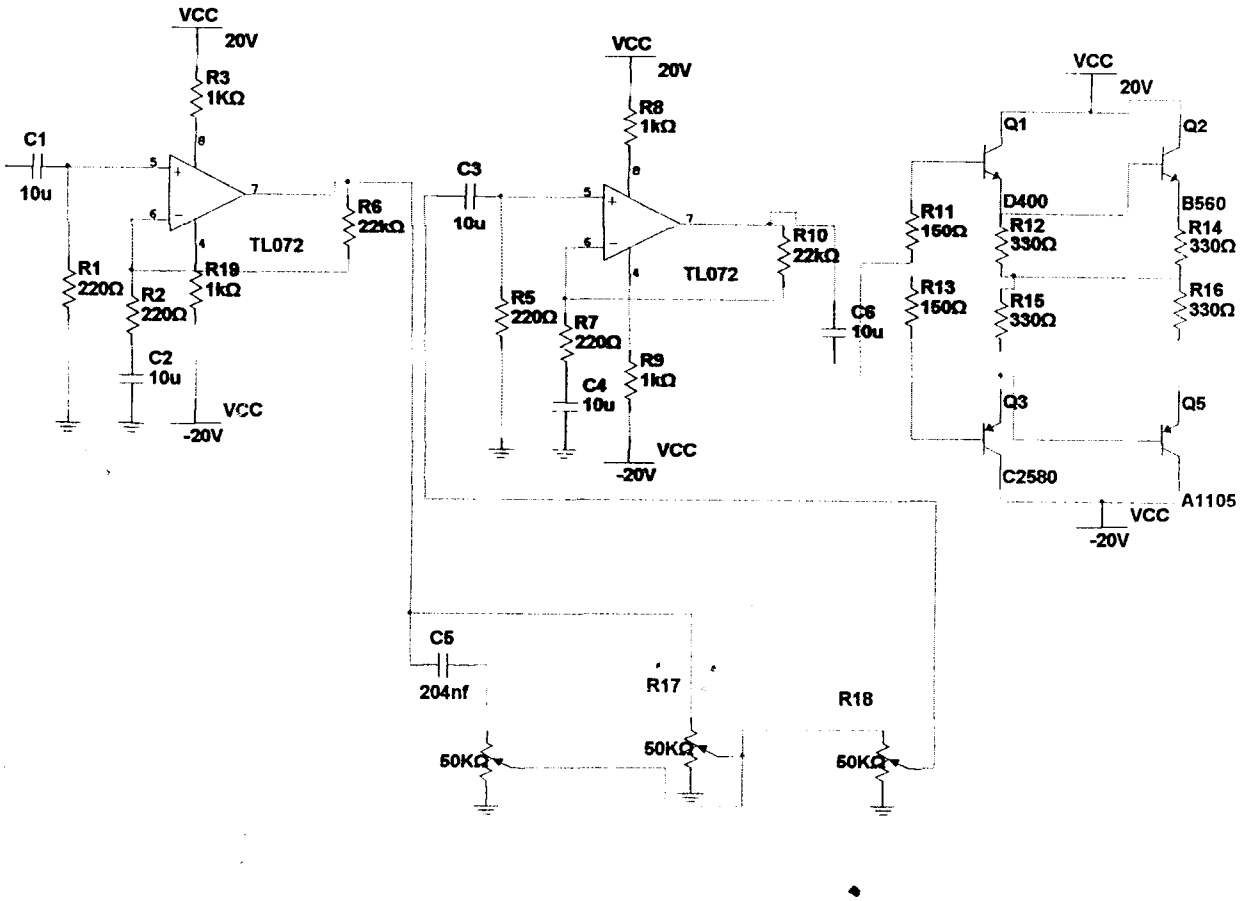


FIG 3.7 100W HIFI AUDIO AMPLIFIER CIRCUIT DIAGRAM

CHAPTER FOUR

TEST AND RESULT.

4.1 CONTRUCTION.

This project was constructed in four parts or unit; the power supply unit, the pre-amplifier and driver unit which constitute the audio mixer, the tone control for signal switching and balancing and the power amplifier unit.

The construction and testing of the four units and the entire system was carried out following the same broad principles of electronics circuit construction and trouble-shooting. When the circuit has been completely designed, the entire sub-system was simulated using the electronic work-bench. Each sub-system prototype was built on a temporary circuit board (the bread board) one after the other. This was done to ensure that the design specifications before being transferred to the Vero board where it is being made permanent by soldering.

4.2 TESTING.

The physical realization of the project is very vital. This is where the realization of the project is put in play, after all the paper work and analysis. The project is test to ensure its workability, and was finally constructed tc meet desired specification. The process of testing and implementation involves the use of the equipment below:

1) DC POWER SUPPLY- This was to supply voltage to the various stages of the circuit during the bread board test before the power supply circuit was build. Also, during the soldering of the project, the dc power was still used to test various stages before the supply used in the project was finally constructed.

CHAPTER FIVE

CONCLUSION

5.1 CONCLUSION.

The project 'Design and Construction of 100w HiFi audio amplifier' enables the amplification of voice/sound signals to a power level of 100watts.the circuit reduces the effect of cross over distortion to a barest minimum. Hence, it is a cost effective, reliable and efficient audio power system with its multiple output channels which allow both the use of microphone and auxiliary input.

The results obtained from the testing shows that the amplifier can efficiently work in any sound system where applicable.

5.2 PROBLES ENCOUNTERED.

In the course of the project I encountered certain problems which widened my experience. The problems are as follows:

I. During the design, it was difficult to select the appropriate values of the components for the expected outcome.

II. Short circuiting of components during soldering as a result of constrain in space.

III. Difficulties in sourcing for equivalent component for the project since some materials are not readily available within my immediate environment.

5.3 RECOMMENDATION.

From the result obtained, it become necessary to minimize the distortion level so as to improve the sensitivity of the amplifier, this can be achieved through a more optional biasing of the circuit and further improvement on the application of power to reduce the humming sound in the design.

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