DESIGN AND CONSTRUCTION OF 300 WATTS STEREO AMPLIFIER

BY

OKUNNUGA SAMSON O.
98/7886EE

A PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING DEGREE (B. ENG.) IN THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, SCHOOL OF ENGINNERING AND ENGINNERING TECHNOLOGY, MINNA, NIGER STATE, NIGERIA.

SEPTEMBER, 2003.

DEDICATION

This project work is affectionately and wholly dedicated to Almighty God, who saw me through in the execution of this project and throughout the duration of this course.

Also, it is dedicated to my beloved parent, CHIEF and Mrs. E. Okunnuga who had contributed right from the beginning up to this very moment, towards my educational success and to my loving brothers, sisters and other well wishers.

DECLARATION

I, Okunnuga Samson O. (Reg. No 98/7886EE) declare that this project work "design and construction of 300watts stereo amplifier", was solely carried out by me under the able supervision of Engr. M. Abdullahi, Department of Electrical and Computer Engineering and has never been presented before for a degree in any University. All authors from whose books vital information were gotten have been duely acknowledged.

15/10/03

(Signature of student) Date

Okunnaga Samson O.

98/7886EE

CERTIFICATION

This is to certify that this project work titled "Design and Construction of 300 watts Stereo Amplifier" was carried out by Okunnuga Samson O. (98/7886EE) under the supervision of Engr. Abdullahi submitted to the Department of Electrical and Computer Engineering, Federal University of Technology, Minna, in partial fulfillment of the requirements for the award of Bachelor of Engineering (B.ENG). Degree in Electrical and Computer Engineering.

Engr. Abdullahi **Project Supervisor**	28/10/03 **Sign. and Date**
Engr. M.N. Nwohu **Head of Department**	13/4/04 **Sign and Date**
External Examiner	**Sign. and Date**

ACKNOWLEDGEMENT

Glory be to God in the highest for the power and courage given to me through the course of my programme at the Federal University of Technology, Minna. When kindness cannot be returned, it should be appreciated and passed on to others. In the course of the project, quite a lot of people have been kind to me and their kindness deserved to be acknowledged.

My sincere appreciation goes to my honourable supervisor, Engr. M. Abdullahi for his intensive supervision, useful suggestions and advice given to me during the course of this project.

I also acknowledge the head of department, Electrical and Computer Engineering, Engr. M.N. Nwohu, Engr. (Dr.) Y. Adediran and other lecturers in the department: Engr. Rumala, Engr. Attah, Engr Kolo, Engr Shehu who have been a source of inspiration to me through impacting knowledge, and through which this project has been written.

Equally important is my parent, CHIEF EZEKIEL OKUNNUGA and Mrs. Modupe Okunnuga and likewise Mr. Samuel Okunnuga, Mr. Segun Okunnuga, Mrs. Ranti Akinyele, Mrs. Abiodun Arowolo, Miss. Bukky Okunnuga, Master Wale and Owolabi Okunnuga. I must not forget to appreciate my friends, Femi Ola Joseph, Dare, Olisa, Dayo Fakorede, Dayo Akinye, Odunola Sunkanmi, Rasheed Azeez, Bayo Asaju, Feyi Adeyemi and Taiwo Ogunsowo, Tunde Olaleke, Ajagbe Ajibola, Johnson Opadare, Kunle Oyinloye, Yemi Adesanya and a host of others too numerous to mention.

ABSTRACT

This project titled "Design and Construction of 300Watts Stereo Amplifier" is designed to produce a greatly amplified output audio signal irrespective of how small or low the audio input signal may be. It allows the use of auxiliary (CD and Cassette player) and microphone input sources at the same time. Equalization of audio output stream is also provided through the active tone control (treble/bass control unit).

To accomplish the aim and objective of this project, BC147, 2N1893, BF337, BD712, 2N3055, MJ2955 transistors, 4558D, 741 Op Amp ICs and other associated components were used.

In order to facilitate a better understanding of the thesis, clear and precise drawings, illustrations and references are incorporated in the thesis. This makes it to a vast extent self explanatory.

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CHAPTER ONE

1.0 INTRODUCTION

At a point in time, it became imperative that small signals which are transmitted from one point be received at a distant point without the intelligent signal disappearing.

Besides, signals which are as a result of experimental purposes are required to be eligible enough for experimental analysis.

Furthermore, to all aspects of life most especially audio and video devices, the need that small signals be amplified is inevitable.

For some decades, there have been amplifiers which can amplify small signals to a higher level. However, their output power is not enough for industrial purposes. It is in view of this that we have decided to come out with a design which is capable of delivering a maximum power of 300 watts, and a nominal power of about 250 watts.

Besides, this design features a four inputs and an auxiliary which can be switched to suit mic functions.

In addition, it incorporates bar graphic display which indicates the level of output signal of the system.

The system also encompasses an automatic protective device which switches off the system if for any reason the temperature of the heat sink exceeds the normal operating value.

LITERATURE REVIEW

During the period 1904-1947 vacuum tube was undoubtedly the electronic device of interest and development. In 1904, the vacuum-tube diode was introduced by J.A.Fleming. Shortly thereafter, in 1906, Lee De Forest added a third element, called the control grid to the vacuum tube resulting in the first amplifier, the triode. In the following years radio and television provide great stimulation to the tube industry. Production rose from about 1million tubes in 1922 to about 100 million in 1937. In the early 1930s, the four-element tetrode and five-element pentode gained prominence in the electron-tube industry. In the years to follow, the industry become one of primary importance and rapid advances were made in design, manufacturing techniques, high-power and high-frequency applications, and miniaturization.

On December 23, 1947 however, the electronics industry was to experience the advent of a completely new direction of interest and development. It was on the afternoon of this day that walter it. Brattain and john Bardeen demonstrated the amplifying action of the first transistor at the Bell Telephone Laboratories. The advantages of this three-terminal solid-state device over the tube were immediately obvious. It was smaller and light weight; had no heater requirement or heater loss; had rugged construction; and was more efficient since less power was absorbed by the device itself; it was instantly available for use, requiring no warm-up period; and lower operating voltages were possible. It will be formed that all amplifiers (devices that increase voltage, current or power level) have at least three terminate with one controlling the flow between two other terminals. In a transistor amplifier, small variation in the base-to-emitter voltage produces greater changes in the emitter current and the collector current, and high amplification is possible.

AIMS AND OBJECTIVES

The main aim of carrying out this project work is to relate the theoretical knowledge acquired in Electrical / Electronics Engineering to practical work. That is, the design and construction of a stereo amplifier that has a power output of 300 watts, which will be of immeasurable significance for industrial and public functions.

This project work is carried out to prove that amplifiers of large power output can be constructed locally rather than depending on those being manufactured by foreign companies.

Therefore, the objectives or purposes of this project are:

To serve as a model for those who wish to design and construct an amplifier for industrial purpose.

To enlighten students that designs are not static but keep on changing.

To provide self reliance on ones product or field of study as long as one is very productive.

To harness the creature attribute in the design so as to contribute to the solution of the nations economy.

Also, to encourage the young electronics engineer to breathe so as to make models of Electronic devices and apparatus with little supervision.

PROJECT OUTLINE

The project has to do with the design and construction of a 300 watts stereo amplifier. Chapter one deals with introduction, history of the amplifier as well as aims and objectives for carrying out this project work.

Chapter two includes operation of amplifier and also the modules contained in the amplifier as a system unit included the mic inputs, mixer, treble / bass control, splitter unit, 150W power amplifier (mono) and the speakers (8-2-16-2).

Furthermore, chapter three contains construction, testing and results obtained after tests.

Lastly, chapter four focuses on the factors considered before embarking on the construction. It was included recommendations and references.

CHAPTER TWO

SYSTEM DESIGN AND ANALYSIS

INTRODUCTION TO DESIGN OPERATION

The design process is one where a current and/ a voltage may be specified and the elements required to establish the designated levels must be determined. This synthesis process requires a clear understanding of the characteristics of the device, the basic equations for the network, and a firm understanding of the basic laws of circuit analysis, such as Ohm's law, Kirchoff's voltage law, and so on. In most situations the thinking process is challenged to a higher degree in the design process than in the analysis sequence. The path toward a solution is less defined and may in fact may require a number of basic assumptions.

The design sequence is obviously sensitive to the components that are already specified and the elements to be determined. If the transistor and supplies are specified, the design process will simply determine the required resistors for a particular design. once theoretical values of the resistors are determined, the nearest standard commercial values are normally chosen and any variations due to not using the exact resistance values are accepted as part of the design. This is certainly a valid approximation considering the tolerances normally associated with resistive elements and the transistor parameters.

If resistive values are to be determined, one of the most powerful equations is simply Ohm's law in the following form:

$$R_{unk} = V_R/I_R$$

that can accept more than one signal at a time and allows one to listen to each signal simultaneously without suppressing one for another. The output of the signal is sent into the treble / bass control unit which is also called the tone control unit. This unit allows for the adjustment of the bass or treble or both to ones desire. The splitter units function as its name implies is to split its input signal into two with each of its output signal containing the intelligent signals at all outputs and in all levels.

Each of the output signals of the splitter unit is incorporated into each of the 150 watt power amplifying circuits (mono). It is in this circuit that major amplification of input signals are done with a very high output power of approximately 150w each.

At the output of each of the 150w power amplifier, a speaker is attached. It is made sure that the impedance and power rating of the speakers used matches that of the 150W power amplifying circuits.

2.3 MIC INPUT

The mic input circuit is one whose input voltage ranges from 0-100mv. The circuit is a common-emitter based amplifier which has a moderately low input resistance with output resistance moderately large. It current gain, ß, is high and also a very high voltage gain. The circuitry is shown below:

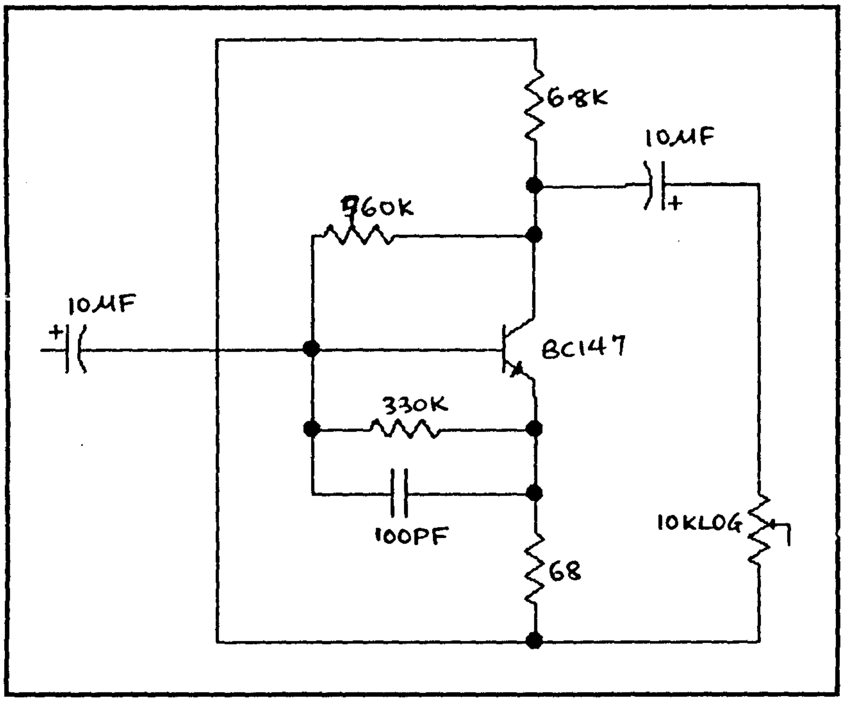


Fig. 2: Mic input

The input signal from the microphone is coupled into the common-emitter amplifier configuration via the coupling capacitor C3. The main function of the common-emitter amplifier configuration circuit is to amplify the voltage of the microphone which has a range of 0-100mv to a moderately larger value. Hence voltage amplification by the circuit. The input signal to the circuit is coupled in through the base-emitter terminal and output amplified signal through the collector-emitter terminal. The variable resistor, VR1, is the output load of the circuit which can be varied in order to adjust the audio output of the microphone. This unit is a pre-amplification stage.

$R_{in} = R_b || \beta r_e$ where $R_e = 26/I_E$, $Re = 26mV/I_B$

$= \beta r_e$ Where $R_B > \beta r_e$

Output resistance: $r_0 = Rc$

However, because of the variable load RV1 (i.e. R_L)

Then $r_o=R_c //R_L=r_L$

This is called output resistance of the stage current gain: $A_i= ß$

Voltage gain: $A_v=ßr_o/r_{in}=ßr_O/ßr_e=r_O/r_e$ of $R_B>ßr_e$

Power gain: $A_p=A_v.A_i=ßr_o/r_e$; $G_p=10\ \log10\ A_p dB$

Design Calculation:

The input of the pre-amp. consists of a voltage amplifier which have different components connected to it.

Specification : Supply voltage 12V; stage gain= 200 ; frequency range 100Hz to 300Hz; Input Signal 10mVr.m.s, Icmax = 0.26mA

Since the supply voltage is 12V, then the voltage drop across the emitter resistor should be 10% of supply to provide emitter stabilization.

$$Icmax = Vsupply/R_3 + R_4$$

$$R_3 + R_4 = 12/0.26mA$$

$$= 4.6K$$

Also, since $V_{EE} = 6V$, from $V_{EE} = 1/2Vcc$

$$R_4 = V_{EE}/Ic_Q$$

$$= 6V/0.12$$

$= 50\Omega$

$= 68\Omega$(nearest preferred value)

To calculate the collector resistor R_3, thus:

The total resistance obtained from the d.c load line (4.6K) minus the value of R_4 gives the collector resistance R_3

Therefore, $R_3 = 4600 - 50$

$= 4550$

$= 4.6K$

$= 4.7K$(nearest preferred value)

Calculating the value of R_1:

Current in R_1 = 11 X 0.6μA (since the current through R_1 must be at least 11 times the required base current)

$= 6.6\mu A$

$V_{R1} = 12V - (6 + 6mV)$ (i.e the voltage across R_1 is supply voltage minus base bias voltage and emitter voltage $V_{EE)}$

$= 5.99V$

from which $R_1 = 5.99/6.6 \times 10^6$

$= 757K$

$= 750K$ (nearest preferred value E24 series)

If the average $h_{fe} = 200$ for a BC147 (from the specification sheet), then knowing the quiescient collector current (0.12mA), thus

Base current, $I_B = Ic/h_{fe}$

$= 0.12/200$

$= 0.6\mu A$

To calculate the voltage across R_2, thus

Since voltage across R_4 is at least 10% of supply voltage,

Therefore, $V_{R4} = 2V$

Voltage across $R_2 = V_{R4} + V_{BE}$

$= 2 + 0.006$

$= 2.006$

$R_2 = 2.006/I_{R2}$

$= 2.006/6\mu A$

$= 334K$

$R_2 = 330K$ (nearest preferred value)

Calculating the value of the coupling capacitors C_1 and C_2

The effective a.c input resisstance is R_1 and R_2 and Rin all in parallel

R_1 and R_2 in parallel = R_1R_2/R_1+R_2

= 330 X 757/330 + 757

= 249810/1087

= 229.8K

R_1 and R_2 in parallel with Rin (hie) gives

229.8 X 2/229.8 + 2 = 459.6/231.8

= 1.98K

Therefore the capacitive reactance at the lowest frequency (100Hz from the specification sheet) must not be more than a tenth of this value i.e 198Ω or less

Therefore Xc = i1/2ΠfC ohms

Therefore, C=1/2Π x f x Xc farads = 1000000/2Π x 100 x 198 μf

= 8.04μf (10μf preferred value)

C_1 = 10μf (minimum value obtainable)

Since the output resistance is very much larger than the input resistance, this value will also be suitable for C_2.

2.5 AUXILLIARY INPUT

Auxiliary sources are those sources whose output voltages range from 100-500mV. Because some input sources may have output voltages higher than what can be accommodated by the mic input (whose input voltages are low), the auxiliary input has been incorporated in this project to take care of this.

The circuit for the auxiliary input is shown below:

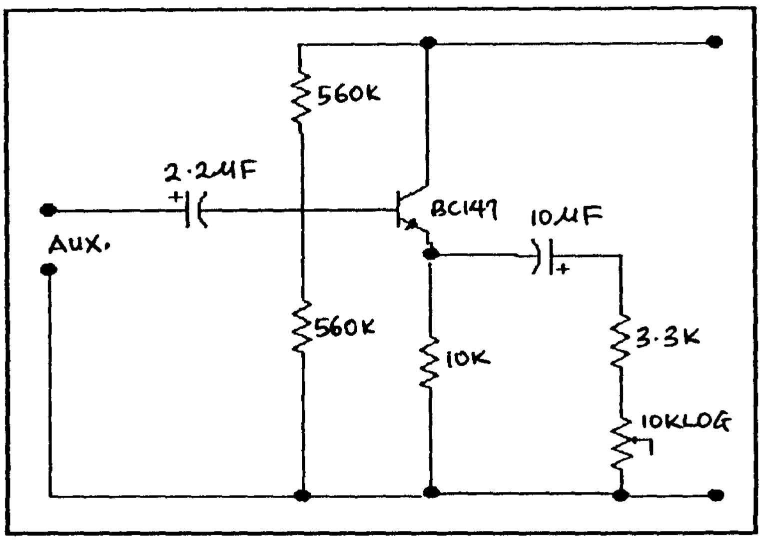


Fig 3: Auxiliary input Circuit Diagram

The high voltage output of the auxiliary source is incorporated into the system via the auxiliary input. The circuit is a common-collector amplifier configuration. It is used for impedance matching i.e. for connecting a circuit having high output impedance to one having low input impedance. It also has a high current gain. It also has a moderate power gain. The resistors R1 and R2 form a potential divider across V_{cc}. This is in order to reduce the high voltage input to a desired level.

From the voltage divider network,

$V_2=V_{cc}\,R_2/(R_1+R_2)$ where V_2 is the voltage across R_2

$I_E=V_2/R_E$

$r_E=26mV/I_E$

$r_L=R_E//R_L$

$r_{in}(base)=ß(r_e+r_L)$

$r_{in}=R_1//R_2//r_{in}(base)$

Current gain: $Ai= i_e/i_b = (1+ß) = ß$

Voltage gain: $v_{in} = i_b.r_{in}(base) = i_b.ß(r_e+r_L)$

Voltage $= i_e.r_L = ßi_L.r_L$

$A_v = V_{out}/V_{in} = ßi_b r_L/i_b.ß(r_e+r_L) = r_L/r_e+r_L= r_L/r_L=1$

If $r_e<<r_L$

Power gain:

$Ap = A_v.A_i=1(1+ß) = (1+ß) = ß$

Gp =10log10ApdB

2.6 MIXER

The mixer as the name implies is a circuit that enables one to listen to two or more sound sources (i.e. mic input and auxiliary inputs) simultaneously without suppressing one for the other.

The mixer is essentially a summing operational amplifier whose circuit configuration is given below:

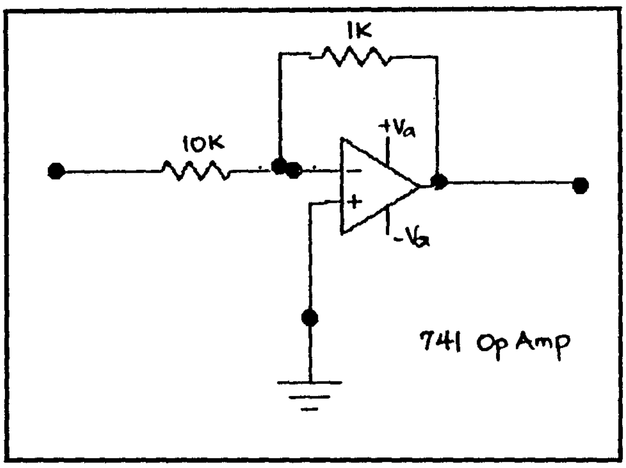


Fig. 4: Mixer Circuit Diagram

$I = V_i/R_1 = -V_o/R_f$

Therefore $V_o/V_1 = -R_f/R_1$

The mixer independently but simultaneously amplifies the two or more different signals. The summing ability of the mixer is attributed to the fact that the inverting input terminal of an operational amplifier acts as a virtual earth or a summing junction, since the sum of all the input currents is equal to the current in the feedback resistor. The mixer can take any number of input signals provided they are from high output impedance sources. These input sources must be fed into the mic/auxiliary input circuits through coupling capacitors. The output signals from the mic/auxiliary input circuits must also pass through coupling capacitors and to the loads before entering the mixer circuit. The circuit below shows a four-input summing amplifier circuit which provides a means of algebraically summing (adding) four voltages, each multiplied by a constant gain factor.

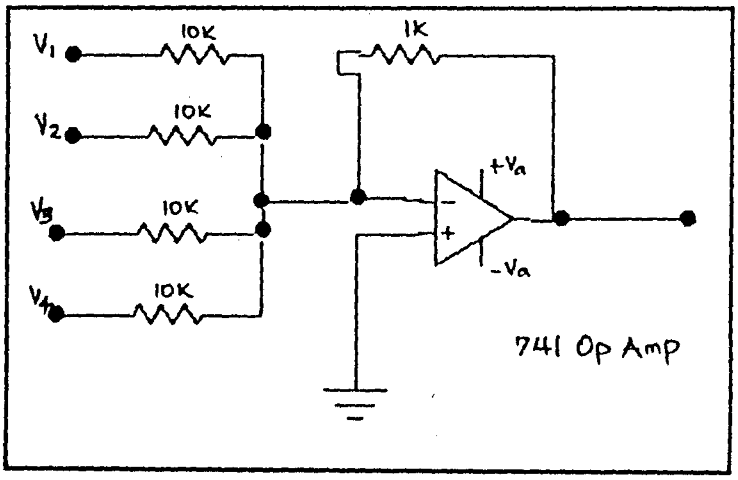


Fig. 5 Mixer Circuit Diagram

From kirchoff's law,

$i_1 + i_2 + i_3 + \text{---------} + i_n = I$

But $i_1 = V_1/R_1$, $i_2 = V_2/R_2$, $i_3 = V_3/R_3$ ------------ $i_n = V_n/R_n$

$I = V_1/R_1 + V_2/R_2 + V_3/R_3 + \text{----------------------} i_n = V_n/R_n$

$I = 1/R\,(V_1 + V_2 + V_3 + \text{----------------------} V_n)$ for $R_1 = R_2 = R_3 = \_\_\_\_ = .R7 = R$

Also, $V_o/V_i = -R_f/R$

$$V_o = -R_f/R \,.\, V_i$$

Where $V_i = IR = 1/R\,(V_1 + V_2 + V_3 + \text{-------------} V_n)R$

$$V_o = -R_f/R(\,V_1 + V_2 + V_3 + \text{---------------} V_n)$$

$$V_o = -R_f/R\,(V_1 + V_2 + V_3 + \text{-----------------} V_n)$$

Therefore, for different values of R, we have

$$V_o = (\,R_f/R_1 \,.\, V_1 + R_f/R_2 .\, V_2 + R_f/R_3 .\, V_3 + \_\_\_\_ + R_f/R_n .\, V_n)$$

In other words, each input adds a voltage to the output multiplied by bits separate constant-gain multiplier. If more inputs are used, they each add an additional component to the output.

From the above equation, it will be observed that the output voltage is the sum of all the input voltages/ current multiplied with their constant-gain multiplier.

2.7 TREBLE / BASS CONTROL UNIT

This unit is also referred to as the tone control unit. The passive tone used in most music system and playback amplifiers does not allow fine blending of music/ sound. High frequency signals are usually accentuated while low frequency signals are attenuated. To nullify this from the signal of the op-amp (mixer), it is usual to attenuate high frequency signals and accentuate signals of low frequencies. This process is called equalization.

The circuit below is that of an active tone control that offers a bass boost/ cut of 15db at 20Hz and treble boost/cut of 15db at 20KHz. This circuit is based on the common LM 741 op-amp. The controls are provided by VR1 and VR2.

Diagram

2.8 SPLITTER UNIT

The splitter unit is basically a subtracting op-amp whose circuit configuration is shown below:

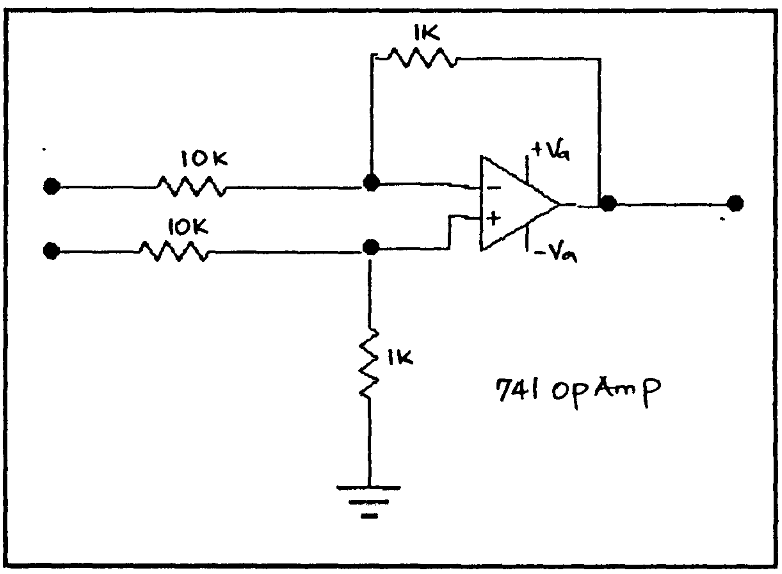


Fig. 7 Splitter Unit Circuit Diagram

From the diagram above,

$E_1 - e_3/R_1 = e_3 - e_o/R_2$ ----------------- (i)

$E_1/R_1 - e_3/R_1 = e_3/R_2 - e_o/R_2$

$E_1/R_1 + e_o/R_2 = e_3/R_2 + e_3/R_1 = e_3(1/R_2 + 1/R_1)$

$E_3(1/R_1 + 1/R_2) = e_1/R_1 + e_o/R_2$ ---------- (ii)

From the diagram,

$E_2 - e_3/R_1 = e_3/R_2$ ------------------------------ (iii)

$E_2/R_1 - e_3/R_1 = e_3/R_2$; $e_2/R_1 = e_3/R_2 + e_3/R_1$

$E_2/R_1 = e_3(1/R_2 + 1/R_1) = e_3(R_1 + R_2/R_1R_2)$

$E_3 = e_2/R_1 \times R_1R_2/R_1 + R_2$ ---------------------- (iv)

Substituting value of e3 from equation (iv) into (ii)

$E_2R_2/R_1 + R_2 \times (1/R_1 + 1/R_2) = e1/R1 + e0/R2$

$E2R2/R1 + R2 \times (R1 + R2/R1R2) = e1/R1 + e0/R2$

$E2/R1 = e1/R1 + e0/R2$

$Eo/R2 = e2/R1 - e1/R1 = 1/R1\ (e2 - e1)$

It is observed that the output voltage e_o is the difference between the two input voltages e1 and e2. This makes it a subtractor.

In other words, the output voltage containing the intelligent signals can be made so as to split the output voltage to give various output maintaining the intelligent signals at all outputs and in all levels. The difference between the output and the input is the gain $(-R_2/R_1)$.

2.9 AUDIO LEVEL INDICATOR

This is a unit which shows (indicates) the intensity of the audio output stream/signal of the power amplifier. It does this through the use of the AN6884 IC having limiting resistors connected across its legs. The principle of operation is thus:

The output signal (voltage) from each of the power amplifying unit (mono) is connected to the AN6884 IC .This output signal (current) comes out in streams (pulses) depending on its frequency and period of duration. Due to the configuration of the IC with limiting resistors connected to the IC, as the signal (voltage) traverses the IC through R_1, voltage is being drawn by the first limiting resistor R_2 thereby making LED 1 glow momentarily. The rest of the voltage is passed across the next limiting resistor R_3 and then turns on its LED 2. The voltage passes across each of the limiting resistors and their respective LEDs glows depending on the input voltage (intensity of the output signal from the power amplifying units).`

Therefore LEDs glow in sequence as input voltage rises. If the intensity of the output is so high that all the LEDs glow, then the rest of the voltage goes to ground.

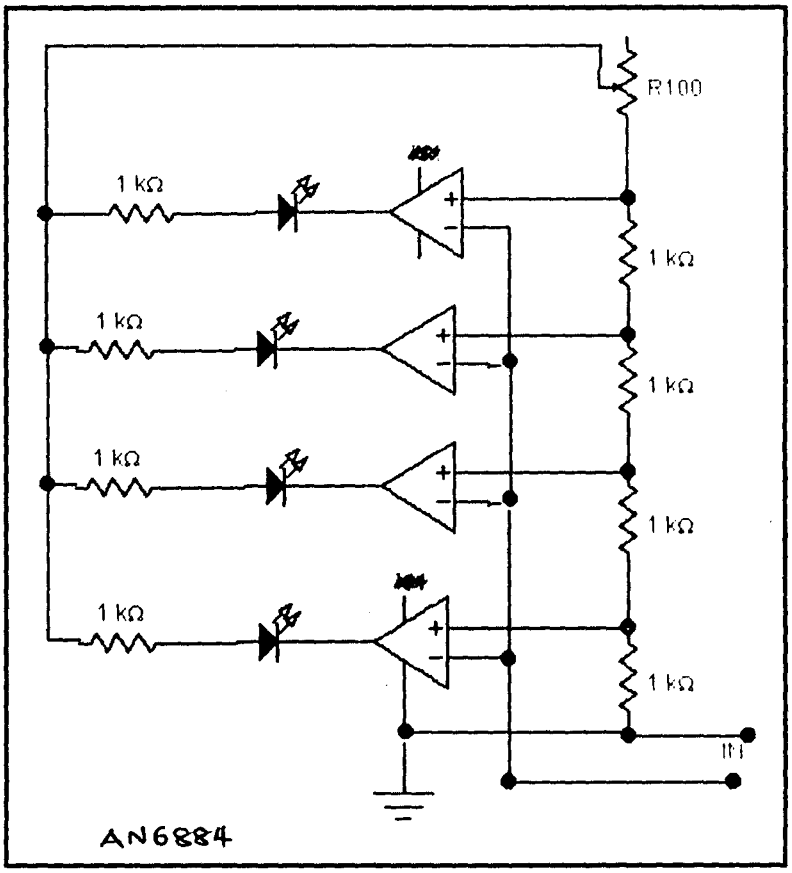


Fig 8: Audio Level Indicator Circuit Diagram

2.10 150 WATTS POWER AMPLIFIER

These power amplifying circuits deliver a crystal clear and undistorted output of about 150Watts per channel each into 8-16 ohm load (speakers) respectively. The power amplifier is built around discrete units of transistors . (power type inclusive) which are ZTX541, 2N1893, BF337, BD711 2N3055 and MJ2955. The amplifier is provided with volume control.

The output of the preamplifier, after being blended by the tone control is fed to the power amplifier circuits through the splitter unit.

The circuit is shown below:

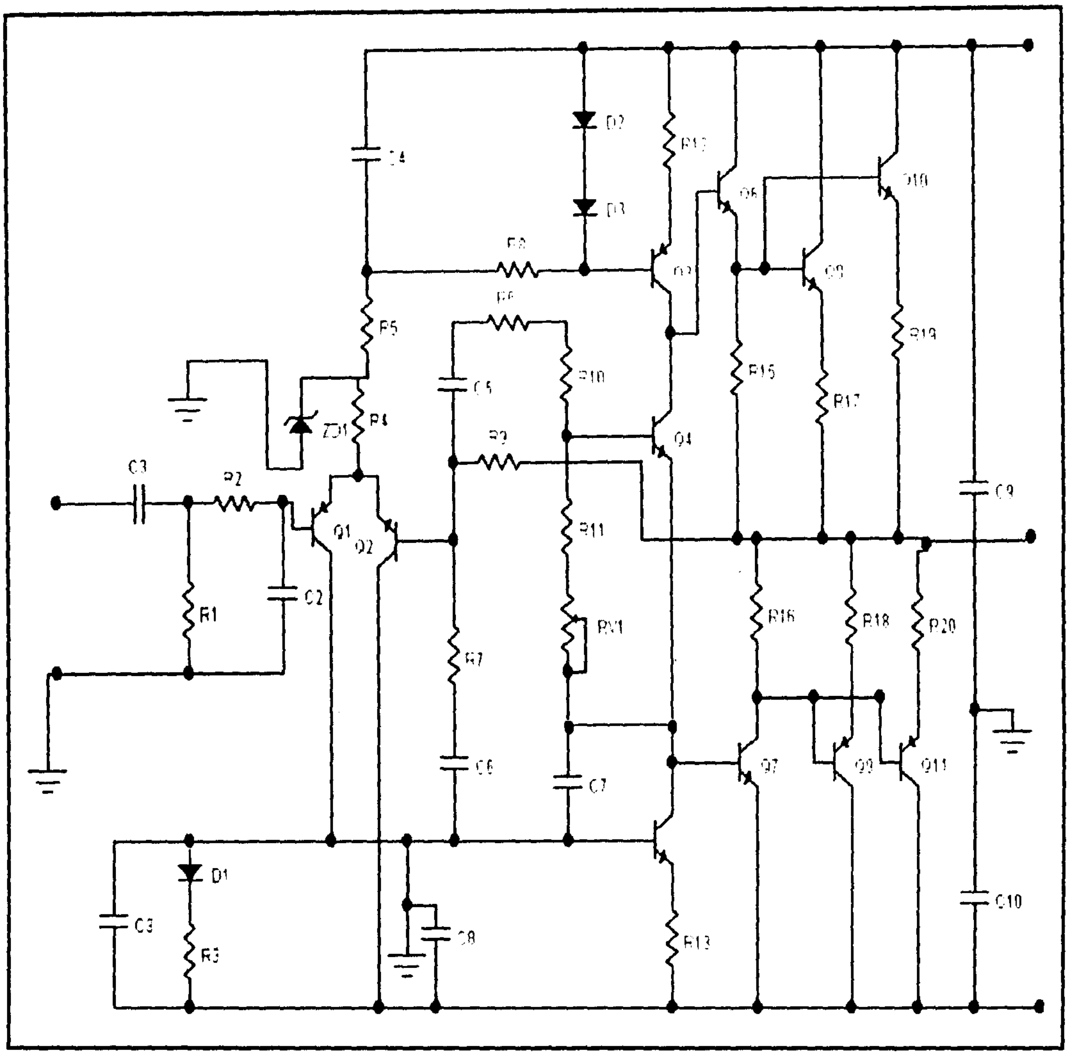


Fig 9: 150 Watts Power Amplifier Circuit Diagram

To achieve a high power output of about 150 Watts (mono), the output transistors Q_8 and Q_{10} then Q_9 and Q_{11} were paralleled. This was done with the use of wire of wire-wound resistors R_{17}, R_{18}, R_{19} and R_{20} which are high power types.

Transistors Q_3 and Q_6 are configured to form a complementary darlington emitter follower. This gives a high output current that will drive the paralleled transistors Q_8 and Q_{10}. Likewise, transistors Q_5 and Q_7 form a complementary darlington emitter follower to drive paralleled transistors Q_9 and Q_{11}.

It can be observed that the output stage of the power amplifier is arranged as class AB complementary push-pull amplifier.

Capacitor C_1 is a coupling capacitor.

In the design of any power amplifier, it is demanded that one bear in mind the output power, the load value and also the supply voltage. The supply of the power amplifier is given as +45V and -45V. This determines the maximum possible audio power that can be delivered into the load which is an 8Ω load speaker.

$Po = V^2rms/8 = (45/\sqrt{2})^2/8 = 126$watts

In practice, the available audio power is less because of the 0.5Ω series resistor for overload safety purposes and the impossibility of perfect biasing of transistors. To reduce stand-by power and to improve efficiency, the output stage is arranged as class AB complementary push-pull.

The current flow in the load at the maximum power is given by:

$Power = I^2R_L$

Therefore $I^2 = power/R_L$

$I = \sqrt{Po/R_L}$

$= \sqrt{126/8}$

$= 4A$

$I_{peak} = I_{rms}/\sqrt{2} = 2.8A$

With the above current, the complementary push-pull output transistors give the required output (each of the transistors will deliver Ipeak of 2.8A in each half cycle).

2.11 SPEAKERS

In order to know the impedance of the output speakers to be connected to the 150w power amplifiers, some calculations have to be done. This is known as impedance matching.

The supply of the power amplifier is give as v_{in} .This determines the maximum possible audio power that can be delivered into the loads which are the speakers. Also the output current I_o which flows into the speaker is determined

Then $P_o = I_o R_L$

$P_o = I_0 V_{in}$

$R_L = P_o / I_o^2$

With I_o in rms and V_{in} also in rms.

Speakers of between 8 and 16 ohms are required as load for this 300W stereo power amplifier.

2.12 POWER SUPPLY UNIT

Most of the electronic devices and circuits require a d.c source for their operation. Since the most convenient and economical source of power is the domestic a.c supply, it is advantageous to convert this alternating voltage (usually, 220Vrms) to dc voltage (usually smaller in value). The process of converting ac voltage into dc voltage is called rectification and is accomplished with the help of:

(1) Rectifier;

(2) Filter;

(3) Voltage regulator circuit.

These elements put together constitute the d.c. power supply.

2.13 REGULATED POWER SUPPLY

A typical dc power supply consists of four stages as shown below

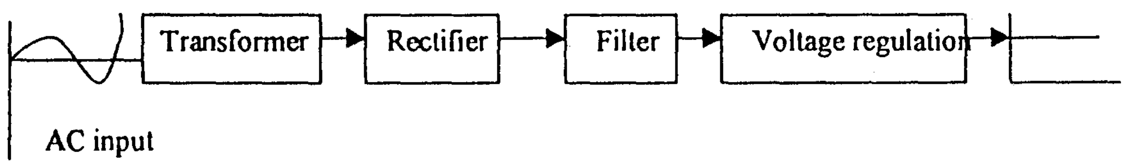
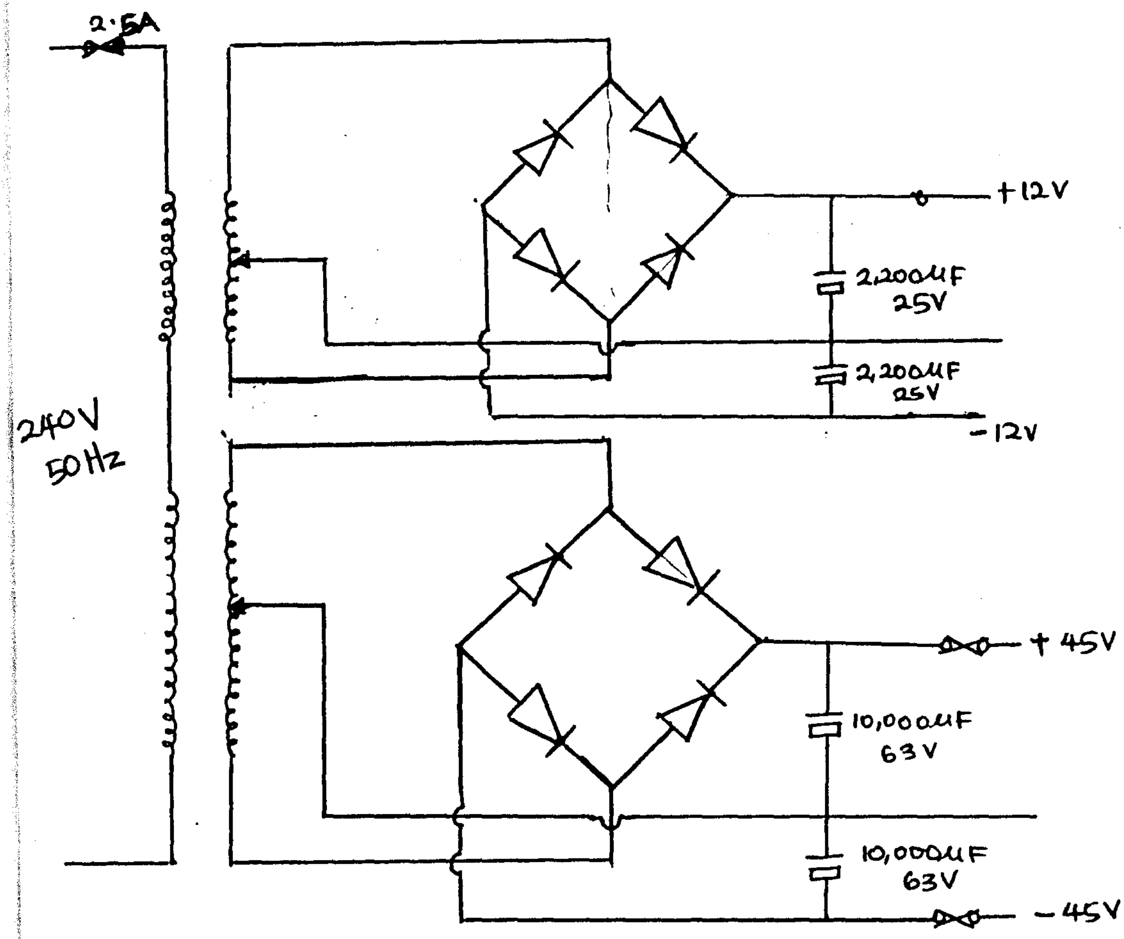


Fig. 9: Regulated Power Supply Block Diagram

The transformer used for this particular project is a 220V to 35V 50Hz step- down transformer with centre-tap. The transformer also has a filament output at it secondary with voltage output of 18v. The ac output voltage of the transformer was rectifier which is made up of four discrete diodes. The centre tap wire being used as ground (0V) .



POWER SUPPLY UNIT

CHAPTER THREE

CONSTRUCTION, TESTING AND RESULTS

3.0 CONSTRUCTION

The entire project work was divided into seven modules. The modules are stated below:

1. mic/ auxiliary input
2. mixer
3. treble/ bass control unit
4. splitter unit
5. audio level indicator
6. power amplifier (2 units)
7. Power supply unit.

Following the circuit designs of each of the modules, the component layout was first sited, taking good note of component spacing, direction and proximity. The components layouts for each of the modules were first done on a paper before being set up on a breadboard then transferred to PCB and soldered. Extreme care was taken while soldering components. First the resistors and then the capacitors and last of all the transistors were soldered on the PCB. All soldering were done using 60/40 type core and a 25watt soldering rod. Care was taken about the polarity of the semiconductors while soldering.

In constructing the casing, the various modules on PCBs were put into consideration because the size and spacing of the casing matters. Front and back panels of mild steel material was chosen. The mic/auxiliary input, mixer, tone control unit, splitter, audio level indicator modules were attached to the front panel with their corresponding holes first drilled on the chassis. On the front panel also are the power switch, balance and volume control knob. The amplifier circuits were placed inside a wooden box which encloses the other modules. The jacks for the speakers are fixed onto the back panel. The power transistors Q_{10}(2) and Q_{11}(2) of the power amplifier circuits were directly screwed to the back chassis which acts as a massive heat sink. Ventilation too was provided for transformer cooling.

3.2 TESTING

With the entire circuit design put on test by feeding in signal, voltage and current readings of each module's output were taken in order to know the magnitude of amplification. This was done using a digital multimeter.

3.3 RESULTS

Module	Input Signal		Output Signal	
	Voltage	current	voltage	current
Mic/ Input	60mV	100mA	27V	320mA
Auxilliary Input	400mV	100mA	27V	320mA
Power Amplifier	24V	300mA	45V	43A(Ipeak)

3.4 DISCUSSION OF RESULTS

From the result, it is observed that preamplifier (mic/aux input) actually amplified voltage to a high level with little amplification of current. It is power amplifier module (150W) that actually amplified current to a high level in order to achieve a very high power output of signal. Hence the input signal is greatly amplified.

CHAPTER FOUR

4.1 CONCLUSION

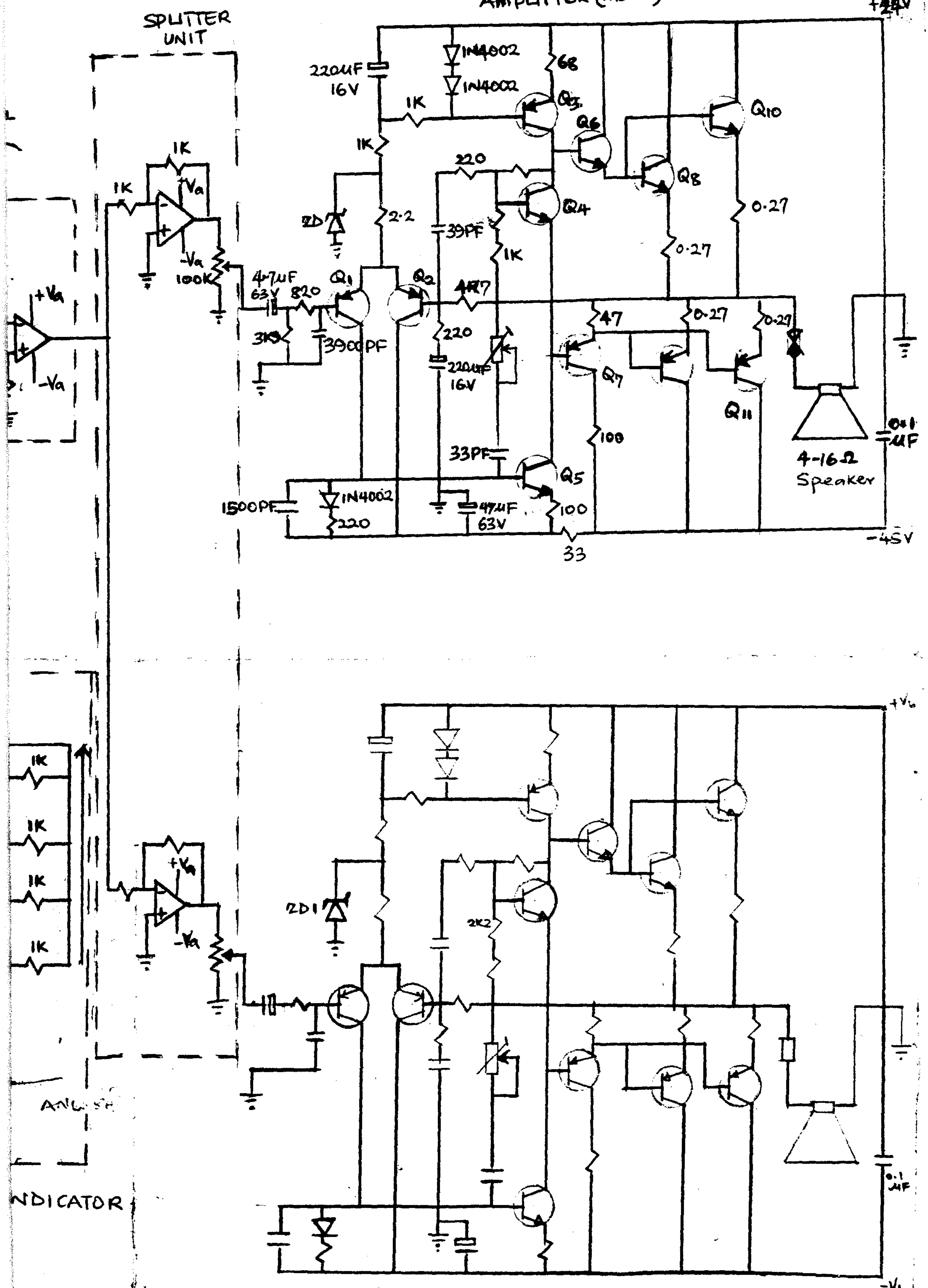
Going by the scope of this project, the set objectives have been fairly achieved; high power output and undistorted amplified output signal. However because of the use of discrete electronic components, the output efficiency of the system is limited too.

During testing, little distortions in output signal due to instability of the system was noticed which might have resulted from the quality of the electronic component used for the design.

4.2 RECOMMENDATIONS

However, for further works on similar project, integrated circuits (ICs) and highly quality components should be used to improve the quality of amplified output signal of the system.

150W POWER AMPLIFIER (MONO)



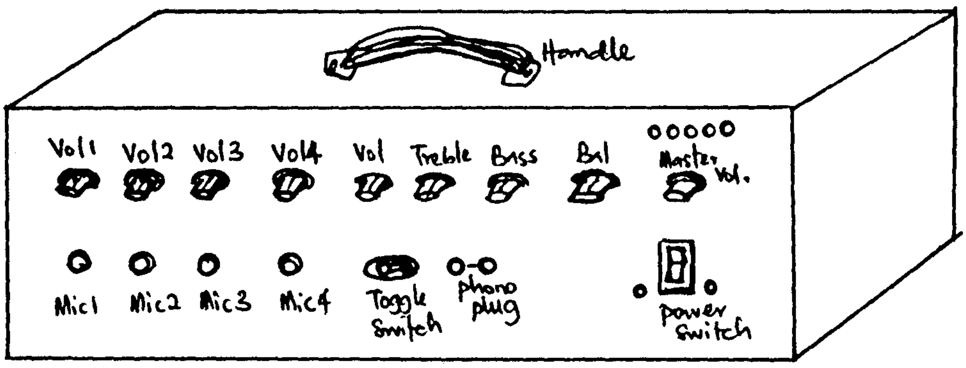
APPENDIX B

TRANSISTORS DATA SHEET

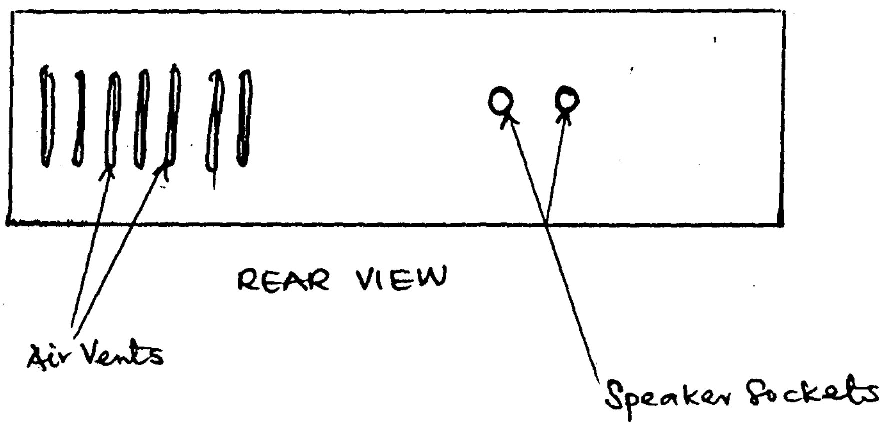
Transistor	Coll-base (volts) BV_{CBO}	Coll-emitter (volts) BV_{CEO}	Base-emitter (volts) BV_{EBO}	Max collector current I_C Amps	Max. device diss. P_D watts	Freq. Mhz	Current gain h_{FE}
2N1893	300	300	7	.5	1.0 T_A=25°C 7.0 T_C=25°C	40	60 typ.
BF337	300	300	7	.5	1.0 T_A=25°C 7.0 T_C=25°C	40	60 typ
BD711	100	100	5	15	90	30min	40typ
BD712	100	100	5	15	90	30min	40typ
2N3055	100	60	7	15	115	.800	40typ
MJ2955	100	70	7	15	150	4min	20min
ZTX541							

APPENDIX C

CASING DIAGRAM



FRONT VIEW



REAR VIEW

APPENDIX D

LIST OF COMPONENTS USED

Name of Component	Abb	Type	Qty	Values
Diodes	D	Rectifier	14	IN4002 Prv 600V
	ZD1	Zener	2	BZX61C15V
Capacitor	C	Ceramic	14	100pF,3900pF, 1500PF, 39pF
	C	Electrolytic	18	10µF,4.7µF 63V, 220 220µf 16V,47µf 63V
Transformer	XF1	Step down	1	3A, 240V/45V
Transistor	Q	NPN(Si)	5	BC147
			2	2N1893
			2	BF337
			2	BD711
			4	2N3055
		PNP(Si)	2	BD712
			4	MJ2955

			6	ZTX541
Resistor	R	Metallic	74	
	RP	W/wound	4	
Variable Resistor	VR	presets	2	100K
		Potentiometer	9	100K
Fuse	F	Wire Fuse	3	
Veroboard	VB	Stripe bus	6	
Casing	CS	metal steel	pack	
Switch	SW	Toggle	1	
		SPST Switch	1	
Integrated Circuit	IC	Op-amp	3	LM339, LM741
Plug	Plug	2pin-type	1	240V, 13A
Cable	Cable	2Core-type	1yrd	
Jack Plug	J/plug			
Speaker	Spk		2	
LED	LD			
Phono plug			1	

APPENDIX E

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