DESIGN AND CONTRUCTION OF FOUR INPUT AUDIO MIXER

BY

HALIRU K. MAIMUNA
98-6981EE

DEPARTMENTOF ELECTRICAL & COMPUTER ENGINEERING
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOVEMBER, 2004

A PROJECT REPORT

ON

DESIGN AND CONTRUCTION OF FOUR INPUT AUDIO MIXER

BY

HALIRU K. MAIMUNA

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

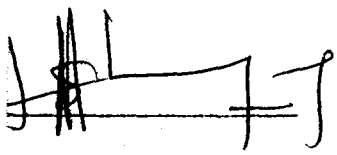
A PROJECT SUBMITTED FOR THE AWARD OF BACHELOR OF ENGINEERING (B. ENG) IN ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT.

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

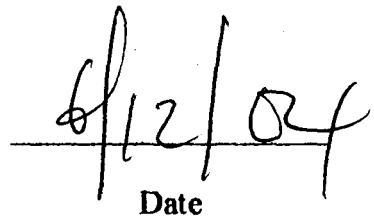
NOVEMBER, 2004

CERTIFICATION

is is to certify that this project titled "Design and Construction of four input Audio xer" was carried out by Haliru k. Maimuna (98/6981EE) for the award of bachelor of gineering in Electrical and Computer Engineering Department of Federal University of chnology, Minna, Niger State.

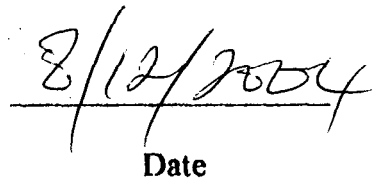


upervisor
ngineer M .S. Ahmed



Date

lead of Department
ngr. Musa D Abdullahi



Date

External Examiner

Date

DECLARATION

I do hereby declare that this report was presented in respect to the completion of a project work on Design and Construction of Four input Audio Mixer, that this report was prepared by me, Haliru k. Maimuna and that report has not been presented either wholly or partially for any other programme elsewhere. Information derived from published and unpublished work of others has been acknowledged in the test.

_____

Date/Sign

DEDICATION

This is dedicated to the Almighty Allah (S.W.T) who has seen me through out my programme and always, and also my dear parents for their total support in prayers and Love for me in all aspects of life.

ACKNOWLEDGEMENT

My thanks and praise goes especially to my creator, Almighty Allah who has given me life and good health to complete my course in the University and has seen me through the successful completion of this project.

My profound gratitude goes to my supervisor, Engineer M.S.Amed for his fatherly assistance and encouragement. I am also thankful to my lecturers: Engineer Abdullahi, Mallam Mohammed, Mallam Bashir, Mr Attah, Mr Asula and all other Lecturers of the Department.

I am highly indebted to my parents Alhaji k. Haliru and Hajiya Maimuna Ibrahim for their love, financial and moral support. Also, I appreciate the entire Haliru Family for their contributions to my Education especially Engr. Abubakar Haliru, Fatima Haliru and Engr.Sulaiman Haliru.

I am thankful to my friends: and colleagues in school, Habibullah Danjumma, Hussaina Abdul, Mrs Grace Yahaya, Joy Ayere,Aisha Yakubu, Bukky Bawallah, Amina Mustapha, Hauwa Bako and others, thank you all.

My heartfelt thanks go to Abdullahi B. Musa for his love, financial and moral support. Special thanks goes to Mr & Mrs Dada Paiko for their Parental guidance.

Once again, I am grateful to Almighty Allah, without whom nothing is possible and who has spared my life till date.

ABSTRACT

This project is concerned with the construction and testing of a 4-input mixer. It is a general purpose mixer project that can be modified to meet future requirements.

The Audio Mixer is a device or equipment that is used to mix two or more audio simultaneously without the distortion of the other.

The project aim is to provide a device whereby a mixed music can be recorded either for home consumption or FM Stations etc. Therefore, this equipment can provide the artist a means of adding many audio of his choice during the process of recording.

The project deals essentially with the design and construction of FOUR input audio mixer. Discrete components are used through out the design and construction process. Both the design, construction and testing were carried out successfully by me.

The four-input audio mixer consists of four identical source follower circuits (pre-amplifier stage), summing amplifier and the power supply unit.

TABLE OF CONTENTS

CHAPTER ONE

GENERAL INTRODUCTION

1.1 INTRODUCTION

The Audio Mixer is an equipment that is used to mix two or more audio at the same time without anyone been distorted. The initial type of mixer was one channel and audio was reproduced many times at different times.

This system was produced of extremely high standard, the harmonic distortion has been out to less than one percent the frequency response extended well beyond the performance.

However, the promotion of the operation of sound location sense was still lacking; and as a result of this perspective of sound being listened to is lost. The reason for this is that both ears of a listener collect the sounds coming from the sources at various angles and the brain being a natural computer, try to compare sound collected by the ears and extract the information from the sound source. But it was very difficult, because single channel cannot promote the operation of sound location sense very well. It should be noted that even if two or more loudspeakers are used, this sound coming will not be obviated but will only help in spreading the sound over a large area due to attention given to their phasing.

There are cases where a simple unit is required to mix four or more audio perhaps for home recording and for disco use and the unit described here designed to fill such a function.

The mixer is fed via different potentiometer inputs which permits anyone or a combination of any two or all the inputs to be fed at the same time or simultaneously.

To achieve this objective, the design of the pre-amplifier stage is done due to the following reasons:

i. Since the output level of a magnetic pick up is not duly low but varies with frequency. At the top end of the audio, spectrum i.e. 15 – 20 KHz, the signal output gain is expected to be about 40dB (100 times) that of the lowest end, i.e. the input signal range. I also followed the RIAA (Record Industry Association of American) rules for the frequency response curve so that when designing such a pre-amplifier stage, we do not only calculate suitable feedback loop components but also we should be aiming at a design that has a response which diminishes with increasing frequency over a range of 40dB.

ii. This pre-amplifier is expected to operate over a wide range of supply voltage (9 – 40V dc) hence a reduction in complexity of power supply design.

iii. The pre-amplifier is built on field effect transistor n-channel, apart from being a dual pre-amplifier, it features two noise, high gain and required frequency response with just a few components. The essential feature of this mixer is that the fading of one input has no effect on the others. The virtual earth acts as an isolating barrier

between the input of the operational amplifier (adder) and this provides independent operation. The overall output of the mixer is a well blended stereo sound.

Block Diagram of Four Input Audio Mixer

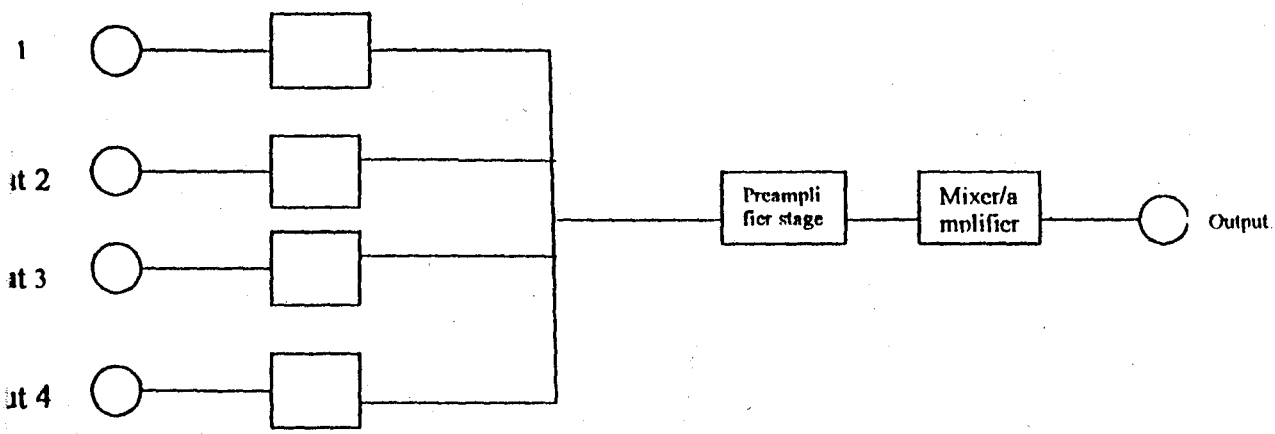


Fig. 1.0: The Block Diagram Of Four Input Audio Mixer

DESIGN SPECIFICATION

Input Voltage	:	220 Vac mains
Supply Voltage	:	±12Vdc
Inputs (Audio)	:	Signal generator
Output (Audio)	:	Oscilloscope

1.2 LITERATURE REVIEW

The application of electronics to the world around us is nearly limited. In the past 50 years, the world has seen electronics become a major influence in every aspect of daily life.

It is impossible to think of doing daily tasks without relying on electronics. However, these devices would not have come into being without the discovery of some basic components which could be passive such as capacitor, resistors, inductor, etc. and the active components include diode, transistor, op amp, etc. The combination of the components and others makes up what is known as electronic device i.e. amplifier, radio, electronic clock, mixer , etc.

Electronic processes involve inputs in various forms and output such as voltage variations on a microphone, complex radio signals and the output could be the amplification of such signals. But for the case of an audio mixer, the area of interest is the blending of several input signals while the output is just through a single channels.

The variations from each signal input such as one or more microphones, record player could have the energy level increased via a power boosting amplifier so that a speaker is taking a different dimension as the use of transistors is now being replaced with the use of operational ICs and it has reduced the bulky electronic circuits.

These mixing amplifiers are designed to amplify signals at around the frequencies which human ears are sensitive to but fall between 20Hz to 20KHz. Area of application include F.M. A. M. stations, music/recording studio, social gathering, churches, etc.

1.3 AIMS AND OBJECTIVES

Since the title of this project is design and construction of a four input audio mixer, the following are the aims and objectives;

- Ability to identify the various components necessary and their alternatives for the design.
- To take low level energy inputs and boost their energy level sufficiently to a high energy output.
- To mix various input-signals while amplifying the output.
- To eliminate as possible the unwanted signal distortion.
- To relate various electronic components' function.

1.4 PROJECT OUTLINE

The stages that aid the design and construction are dealt with as arranged in the chapters. Chapter 1 is the introduction of the project Four-Input Audio Mixer, generalised block diagram, and design specification and literature review, Aims and Objective and then the literature layout. Chapter 2 is system designs and

analysis, where the stages of the design are explained. That is the preamplifier stage, the use of op-amp in this project, the mixer stage and the power supply unit. Chapter 3 is the construction and testing of the project, where the circuit was generally describe. Chapter 4 is recommendation, conclusion and references.

CHAPTER TWO

SYSTEM DESIGN AND ANALYSIS

The audio mixer consists of three stages. These stages are:

i. The Preamplifier Stage.

ii. The Mixer Stage.

iii The Power Supply Unit.

2.1 THE PREAMPLIFIER STAGE

The circuit of the preamplifier is shown below:

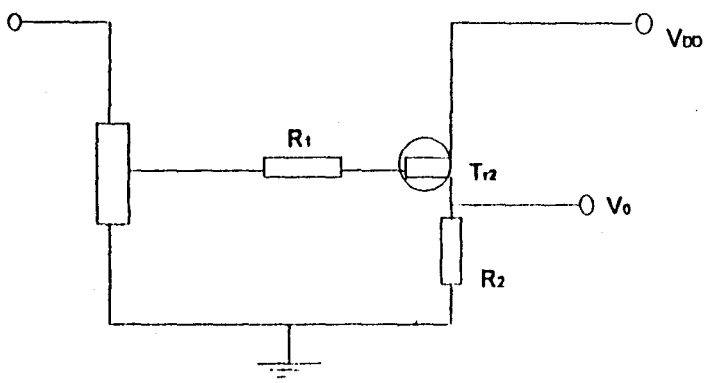


Fig: 2.0 Pre-amplifier circuit.

Since the preamplifiers are identical and are four, therefore all the components are the same. The transistor is a field effect transistor n-channel with number 2N3819.

In addition to the parameter values, the following assumptions were made-

Ic =1.2uA where V_{gs} = 12mv

Is $= 0.9mA$ where $V_{dd} = 9v$

Also the desired input voltage $V = 3.2mV$ and the voltage gain 10.

From $Av = \frac{-vo}{vi} =$

$$10 = \frac{-v0}{3.2}$$

$$vo = 3.2 \times 10 = 32mv$$

Since $Rl = \frac{V_{Gs}}{I}$

Putting the values into the above expression

$R_1 = \frac{1.2\times10^{-2}}{1.2\times10^{-6}} = 10K$

Considering when $V_{DD} = 9v$ and is$= 0.9mA$

$R_2 = \frac{V_{DD}}{Is}$

Substituting the value into the above equation

$R_2 = \frac{9}{0.9\times10\text{-}3} = 10K$

2.2 THE OPERATIONAL AMPLIFIER STAGE

The op-amp used in LM 301 and the desired gain of the amplifier is 200.

The input voltage 32mA when the current is 3μA . By the formula $R_1 = \frac{V}{I}$

Substituting the value in the above expression we have

$R_1 = \frac{32 \times 10^{-3}}{3 \times 10^{-6}} = 10666.67$

Preferred value 10K

To calculate the value of R_f, the output current If was assumed to be 8μA and the output voltage is 0.8v from characteristic.

Using ohm's law

$R_f = \frac{v}{I_f}$

$= \frac{0.8}{8 \times 10^{-6}}$ 100000 =100K

Below is the diagram of the op-amp

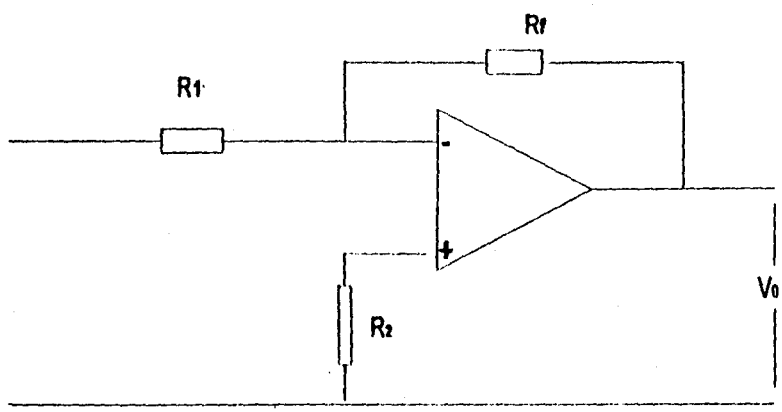


Fig: 2.1 Operational amplifier circuit.

From the figure 2.15 above, $R_2 = \frac{R_f R_1}{R_f + R_1}$

Hence using the above expression R_2 was calculated

. Thus:

$$R_2 = \frac{100 \times 103 \times 10 \times 103}{100 \times 103 \times 10 \times 103}$$

=9090.09091 =9.1K

Preferred value 10K

2.3 THE POWER SUPPLY UNIT

The power supply unit has been discussed in chapter four and the general circuit diagram is as shown below.

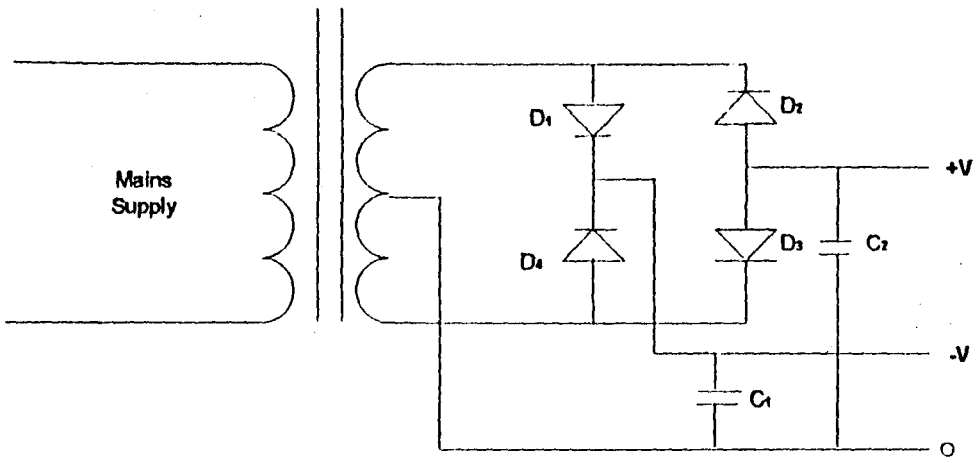


Fig: 2.2 Schematic diagram of power supply unit

The power supplied unit is made up of 9 volt centre tapped transformer because the op-amp use in the mixer is a dual type; hence need positive and negative supply to bias it.

The transformer steps down the voltage from 240 volts to 12 volts before rectification. This method of rectification uses four diodes connected in bridge form. The IN4002 diodes are used for the purpose of this design, because they are capable of withstanding at least 500mA of current and 100 volts of peak inverse voltage.

$$Vdc = \frac{Idc}{4\sqrt{3}Fc}$$

Though the desired voltage is 9v

But Vdc =0.636and Vm =12v

$$Vdc = 0.636 \times 12$$

$$= 7.6v$$

Assuming the d.c current is 0 03mA and the ripple voltage is 0.9v

From the formula

$$Vr = \frac{Idc}{4\sqrt{3}\,FC}$$

Substituting the value above into the expression

$$0.9 = \frac{0.05}{4\sqrt{3}\,FC}$$

$$C = \frac{0.05}{4\sqrt{3} \times 50 \times 0.9} = 0.0000962 = 96\mu f$$

Preferred value 100μf/10v

2.4 APPLICATION OF OP-AMPS

(i) AS AN AMPLIFIER

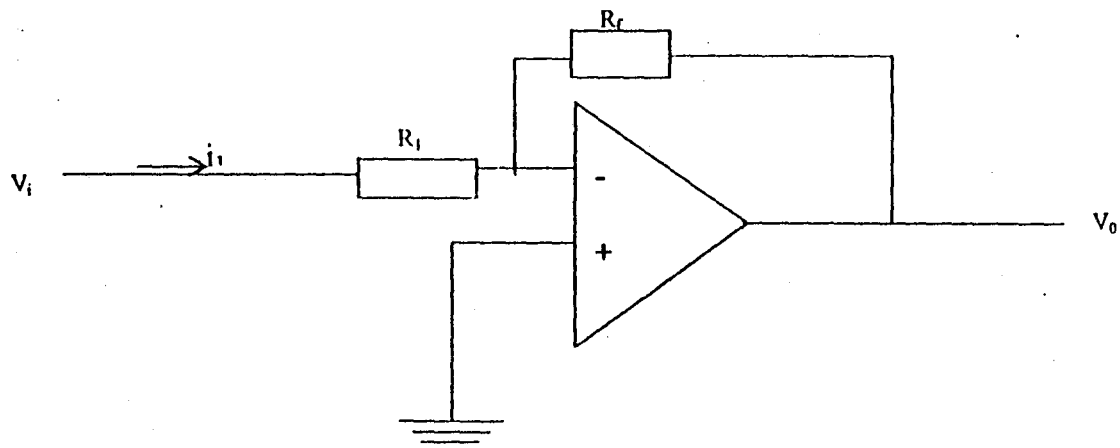


Fig. 2.3: *Op-Amp as an amplifier*

At the Summing Junction (SJ), the sum of the input and output current is zero, i.e. $i_1 + i_0 = 0$, because of the visual south.

$$i_1 = -i_0$$

But $i_1 = \frac{V_i}{R_1}$ and $i_0 = \frac{V_0}{R_f}$

$$\frac{V_i}{R_1} = \frac{-V_0}{R_f}$$

$$\frac{V_0}{V_i} = -\frac{R_f}{R_1}$$

Where $\frac{V_0}{V_i} = A_v$ = Voltage gain. Therefore $Av = -\frac{R_f}{R_1}$ = the amplification factor

(ii) AS A DIFFERENTIATOR

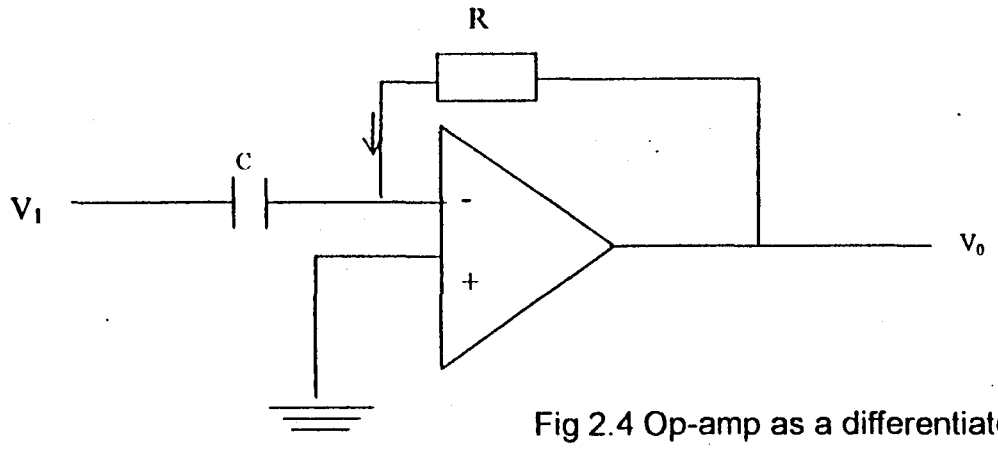


Fig 2.4 Op-amp as a differentiator

$I_1 = -I_0$

$I_1 = \frac{CdV_I}{dt}$, $-I_0 = \frac{V_0}{R}$

$\frac{CdVi}{dt} = -\frac{V_0}{R}$

$RCdV_I = -V_0dt$ Therefore $V_0 = -RC\frac{dVi}{dt}$

Iii AS A SUMMER

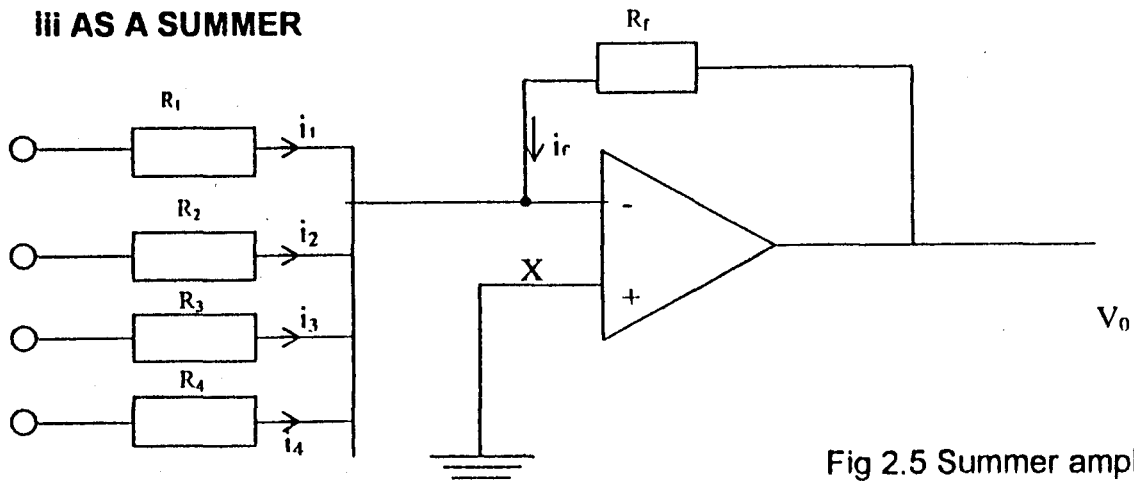


Fig 2.5 Summer amplifier

From the Figure 2.5 above assuming the corresponding current flows in each circuit; Applying KCL to node X, we have:

$$\Sigma i_m = 0$$

$$i_1 + i_2 + i_3 + i_4 = - i_f$$

But $i_1 = \frac{V_1}{R_1}$

$i_2 = \frac{V_2}{R_2}$

$i_3 = \frac{V_3}{R_3}$

$i_4 = \frac{V_4}{R_4}$

And $i_f = \frac{V_0}{R_f}$

Therefore $\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} + \frac{V_4}{R_4} = - \frac{V_0}{R_f}$

If $R1 = R_2 = R_3 = R_4 = R$, then $\frac{1}{R} (V_1 + V_2 + V_3 + V_4) = - \frac{V_0}{R_f}$

$$V_0 = - \frac{R_f}{R} (V_1 + V_2 + V_3 + V_4)$$

2.5 THE INVERTING AND NON INVERTING CIRCUITS OP-AMPS

The two simple op-amps circuit which have wide application are known as the basic inverting and non inverting op-amps. And two basic properties of op-amps which greatly simplify the analysis and design of op-amps circles are:

a. op-amps input terminals draws in current because of the high input impedance.
b. The voltage across op-amps input terminals is zero because of the high open loop gain.

THE INVERTING OP-AMPS

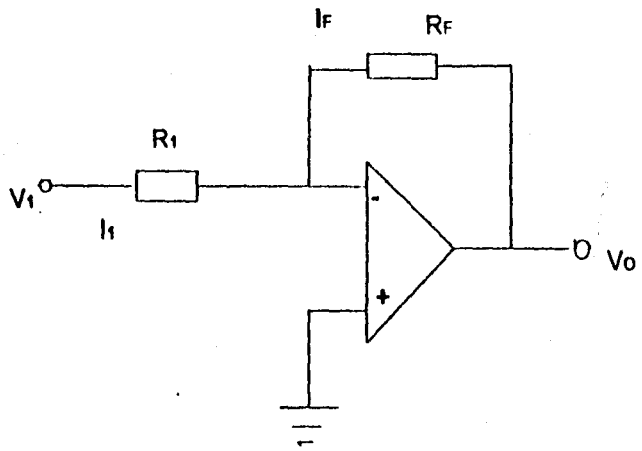


Fig: 2.6 OP-Amp connected to an inverting gain.

To obtain the gain of the inverting op-amps, a resistor R_1 is connected between the input terminal of the circuit and the negative terminal of the op-amp and another resistor R_f is connected between the negative terminal and the output terminal. The positive terminal is connected to the earth either directly or via a third resistor whose value is chosen to optimised the common rejection ratio (CMRR) of the circuit. The open loop gain of the op-amp is very high and this means that the voltage at the negative terminal must be very small. The negative terminal voltage will be at very nearly the same potential as the positive terminal and it is therefore said to be a virtual earth.

The impedance of the op-amps is very high and so very little current flows into the op-amp it self. All the input current flows via R_f and the voltage developed across R_f is equal to the output voltage Vo of the circuit hence,

$\frac{V_1}{R_1} = -\frac{V_0}{R_2}$ or $Av = \frac{V_0}{V_i} = \frac{R_f}{R_1}$

And input impedance $Z_1 = \frac{V_1}{I_1} = R1$

NON-INVERTING OP-AMP

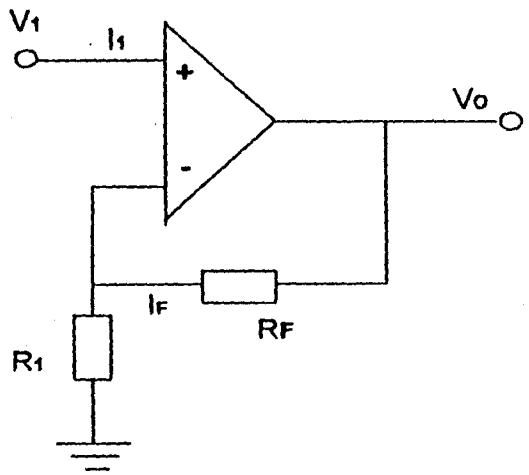


Fig: 2.7 OP-Amp connected to provide a non-inverting gain.

$V_i = V_0$

$V_0 = I_f R_f + I_f R_1$

$I_f (R_f + R_1) = V_0$

$I_f = \frac{V_0}{R_f + R_1}$

$V_i = I_i R_i$

$I_i = \frac{V_i}{R_i}$

$I_i = I_f$

$$\frac{V_i}{R_1} = \frac{V_0}{R_f + R_1}$$

$$\frac{V_0}{V_i} = \frac{R_f + R_1}{R_1} = \frac{R_f}{R_1} + \frac{R_1}{R_1}$$

$$Av = \frac{V_0}{V_i} = \frac{R_1}{R_f} + 1 \text{ (gain of non inverting amplifier)}$$

2.6 THE USE OF OP-AMP IN THIS PROJECT

In this project the op-amp used in LM301An, therefore special attention is given to it under this heading.

This summing amplifier and it is used as amplifier in which the gain of the op-amp is proportional to the ratio of effective resistance. R_f of R_{18} to the input resistance R_{10}.

Using negative series voltage feedback, the 301 function a s non-inverting amplifier in this circuit. The input is applied directly to the LM301 non-inverting input terminal, this input and feedback are in series.

As predicted by feedback theory, the input impedance of the LM301 amplifier is required which will not significantly load the signal source to which it is connected.

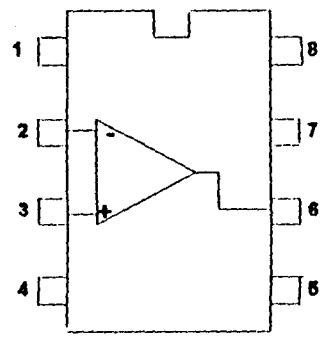


Fig: 2.8 internal connection of LM 301

2.7 THE MIXER STAGE.

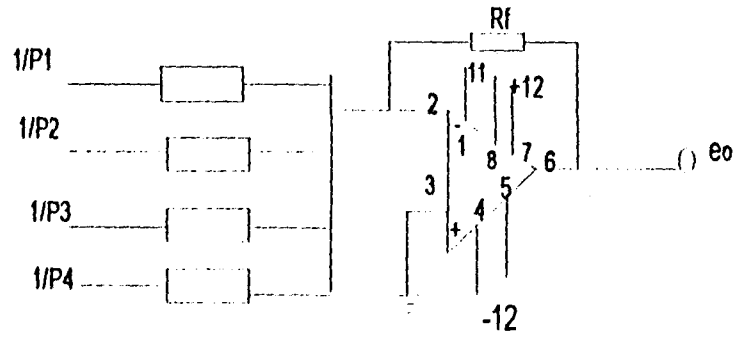


Fig: 2.9 LM 301 OP-Amp used as adder.

The figure 2.9 above shows a typical op-amp constructed with LM 301, and used as an audio mixer. Since it is the summing of four inputs, resistors 13-16 are connected to lower, to some extent, the input level. If the input level A.C. is not the highest signals, this can be achieved by increasing the value of R_{13}-R_{16}.

R_{13}-R_{16} has a minimum value of 10k and should not go below this value as it will affect the sensitivity of the mixer.

With the arrangement of fig.2.10 above, all the inputs are connected to the inverting terminal via a volume control or fader which is regarded as the master volume, which enables us to select inputs required for mixing and so this provision we can listen to any one of the inputs individually, swinging from one to another at will.

The input impedance at any input is practically the value of the input resistor (10k). The overall gain of the mixer stage is controlled by Rv which also provides the feedback.

C_5 is included in the op-amp to effect frequency compensation .

2.8 POWER SUPPLY

Every equipment needs a stabilized power supply unit for its normal operation. Some portable electronics equipment such as transistor radio receivers are battery operated, but the majority of equipment employs an electronic power supply. It is therefore, important to study the power supply unit which is capable of producing a (stabilized) d.c voltage which every electronic circuit needs. The correct operation of many equipment demand that, the direct power supply voltage is maintained at a constant value, within fairly fine limits, even though the input mains voltage and the current taken from the power supply may vary hence the need for voltage stabilizer whose function is to maintain a constant voltage across the load as the input voltage and the load current vary within specified limit.

A block diagram containing the parts of a typical power supply and voltage at various points in the unit is shown below in figure 2.10

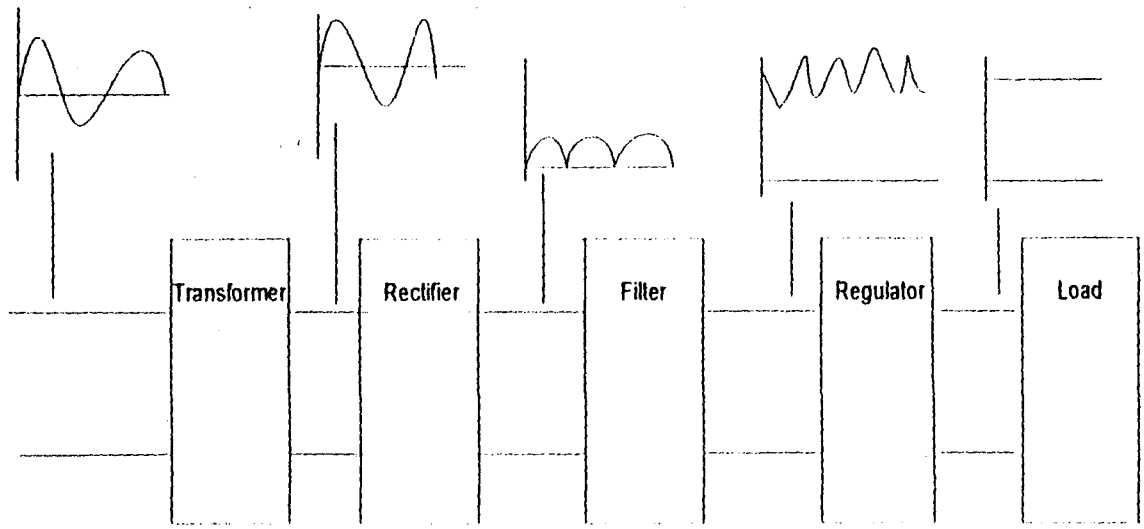


Fig: 2.10 Block diagram showing parts of a power supply.

Therefore, after the step down of the voltage, necessary rectification and filtering is done to achieve a smooth perfect required d.c voltage for the electronic components and requirement for use. In this regard, I wish to design and calculate for +9v and -9v d.c supply for audio mixer by the use of 9v centre tapped transformer.

CHAPTER THREE

CONSTRUCTION AND TESTING

3.1 CIRCUIT DESCRIPTION

The four input music mixer consist of four identical source follower circuits and a summing amplifier. The source followers circuits are connected in parallel and their output are tied together and fed to a summing amplifier. The source follower circuit is intended to match the input impedance of the inverting input of the summing amplifier to that if the desired source.

The source follower presents a higher input impedance in a way to avoid losing most of the voltage across the audio source. In this application, the input impedance of the mixer is that of the alternator, the one mega ohm pots, since the input impedance of a FET very high. The alternator is also for controlling the input signal for each audio input.

Also a FET source follower has a relatively wider frequency response compared with a mixer using a matching impedance.

The summing amplifier is the LM 301 AN Op-Amp. This Op-Amp has max. open loop gain of about 100,000dB

And an approximate cut-off frequency of 10MHZ. The amplifier gain can be varied through pot R_{18} which acts as a feed back resistor and a master gain control. The gain of the op-amp is proportional to the ratio of the effective resistance R_f of R_{18} to the input resistance R_{in}. Resistors R_{13},

R_{14}, R_{15}, R_{16} are fixed resistances that prevents unstable high gain value that could occur if their resistance is almost zero. Each resistor also acts as the load resistance of each source follower.

Resistors R_{17} is connected across the non-inverting input (Pni3) of the IC (LM301) and ground, compensates for any bias current that cause a voltage drop across the feed-back and input resistance and having no corresponding voltage applied to the non-inverting input capacitor. C_5 is for balance compensation. Capacitor C_6 and C_7 are provided for maintaining stability even under varying supply voltage. While capacitor C_1, C_2, C_3, and C_4 are coupling capacitors between the source follower and than 100. Ohms, short circuit proof with excess load resulting only to distortion of the output signal, direct coupling of the o/p to the amplifier and a small D.C offset voltage, usually 2mv.

3.2 CONSTRUCTION

The construction of a 4-input Audio mixer was carried on a Vero board. First of all the suitable optimum size of the Vero board was fixed according to the space available in the case, then the component layout was planned according to the size of the Vero board.

The Vero board is of the size 16 x 13cm, which is housed in a cabinet. The enclosure is made form rectangular shaped pieces of wood with metal pieces as front cover.

The 4-input Jack, Composite output Jack and their volume control are mounted at the front side of the amplifier while the power Jack is mounted at the back side of the mixer. Also a volume metal is connected at the front panel to indicate the level of the output signal.

Once a suitable Circuit has been designed for a speech amplifier, the next thing is to get the materials and the components necessary for the construction. The construction problem resolves into avoiding two difficulties.

(i) Excessive hum and

(ii) Unwanted feed back

High impedance leads were kept as short as possible and all ground returns were made to a common point. A ground is therefore made between the circuit board and the metal classes.

3.3 PERFORMANCE TEST

The measurements that were carried out include;

(i) Gain

(ii) Frequency response and

(iii) Band width.

In addition the input and output impedance can also be measured.

To make simple test on amplifier the following equipment are needed:

(a) A d.c power supply unit

(b) A low frequency signal generator

(c) A double-beam or a single-beam oscilloscope.

(d) Digital multimeter.

A number of d.c. voltage measurements were carried out around out around the circuit, and hence, using ohm's law, the various currents and voltages were calculated and verified that the voltages and current that exist agree to some extent, with the predicted values.

The block diagram of an amplifier test circuit is as shown in Fig. 2.9. To carry out the a.c signal tests, the amplifier need to be connected as in the arrangement the op-amp.

The composite output signal is taken form the op-amps output terminal (Pin6) itself. The mixer has lower output impedance, typically less

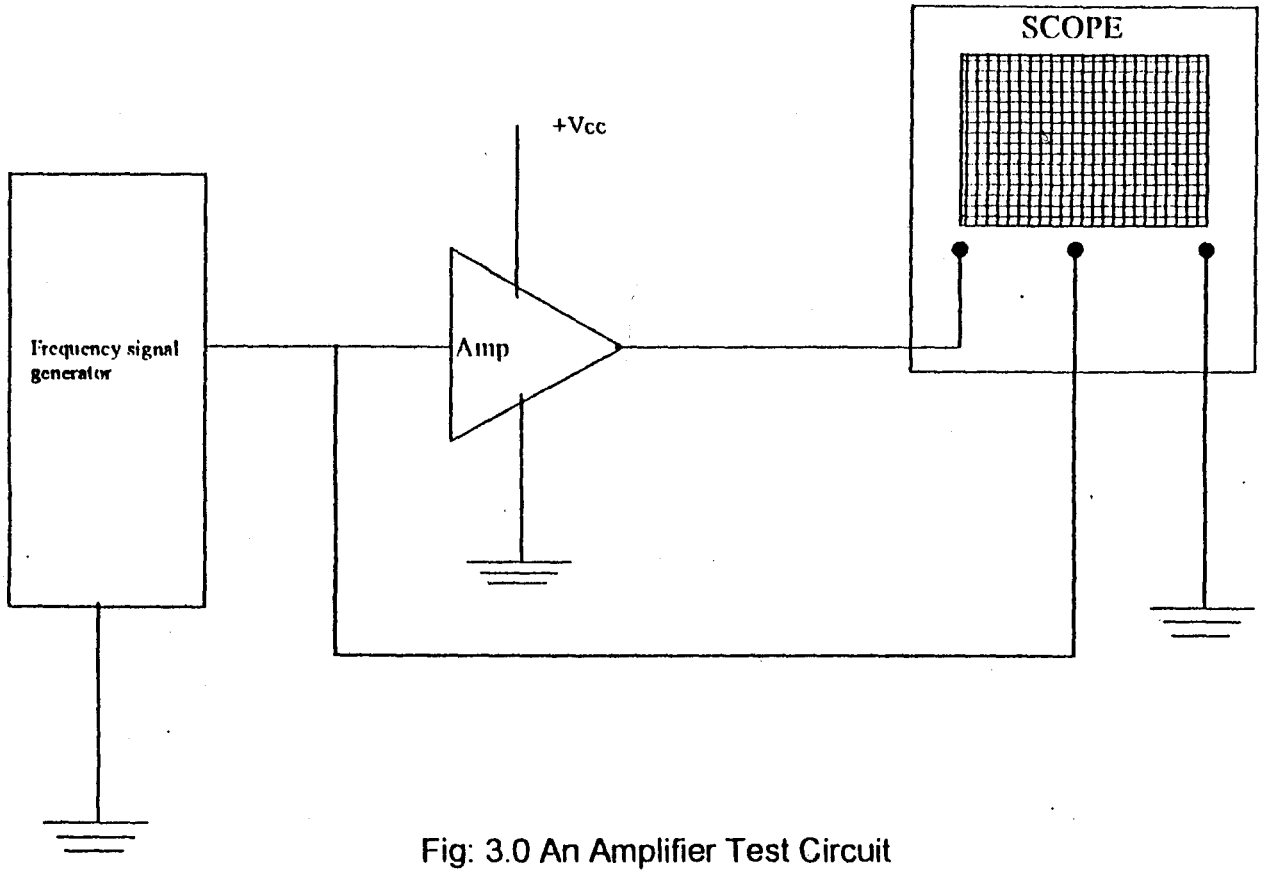


Fig: 3.0 An Amplifier Test Circuit

3.4 MEASUREMENT OF FREQUENCY RESPONSE

The following is a very simple basic test, but it will give an indication of the amplifier gain and the change through the amplifier.

The first test was that of the fixed stage which was carried out as shown in Fig. 2.9 as that of the fixed stage. The principle of testing is based on comparing the input and output of the circuit under test over a wide range of frequencies when subjected to a given amplitude of the sinusoidal input signal.

The signal generator is set to give a sinusoidal signal of 60mv (p-p) as input to first stage and the frequency was varied.

Input and output signal of the circuit are applied to V_1 and V_2 input of the oscilloscope respectively and their wave form displayed on the screen of the scope while reading were displayed on the screen of the scope while reading were taken for various frequencies.

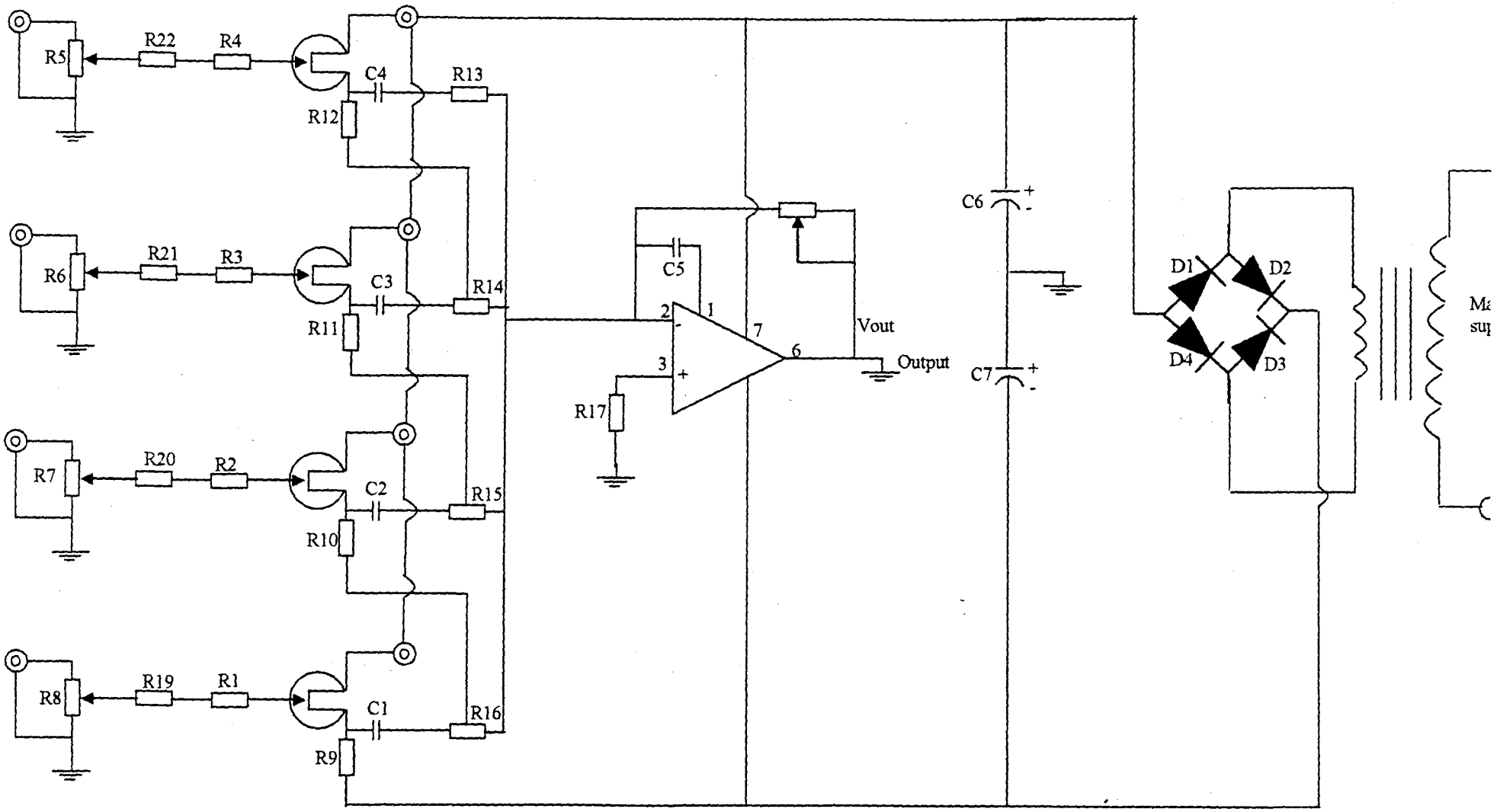


Fig 3.1 Schematic Diagram of 4 –Input – Audio Mixer

CHAPTER FOUR

CONCLUSION AND RECOMMENDATION

4.1 CONCLUSION

In designing a 4-input Audio mixer, assumptions where made were necessary to simplify calculations. This project has been carefully carried out, with soldered ends secured to the vero board.

The whole circuit is mainly made of four field effect transistors, one integrated circuit, a number of capacitors, registered circuit a number of capacitors, resistors and wire jumpers.

The project could be well used as a public address device. There are often cases when a simple unit is required to mix two or more inputs perhaps for home recordings or disco use and the unit is designed to fill the functions of mixing the signals. It is worthy to note that, unit is mostly used by musicians where different input of their choice are mixed to bring out a composite output.

Further section of this project may include tone control stage and inclusion of further amplifying stage these addition will make the project more versatile.

Care must be taken not to over drive the pre-amplifier as doing that will cause oscillation. Use of microphone with an impedance of 600ohms for proper matching would give a better output. The project could have been easily carried out if I can obtain 1 mega-ohm variable resistor

been easily carried out if I can obtain 1 mega-ohm variable resistor (potentiometer). Instead I used two of 500kohm by potentiometer with 220k and 230k in series on 1mega ohms as substitute.

If these are obtained the circuit can be improved and the number of connecting wire reduced, this will help greatly in hum reduction.

4.2 RECOMMENDATION

For the onward improvement on this project special attention should be on the following for better performance;

1. Filtering circuit as the ideal circuit has been used here.
2. Provision should be made for switch control of each of the channel.
3. Amplifying circuit especially, the biasing mode.
4. provision should be made for Mic-input.
5. LED indicator could be included to show power ON/OFF.

REFERENCE

1. COMMER, DAVID J.: Electronic Design with Integrated circuit, Harkwich Broderick Inc. 1990.

2. GREEN D.C. Electronic Tec.III Pitman Education Limited London, 2nd Edition 1984

3. GREEN D.C. Electronic Tec.IV Pitman Education Limited London 3rd Edition, 1983

4. HEUDECK HAYT. Electronics Circuit Analysis and Design.2nd Edition, 1990

5.MILLMAN-HALKIAS Integrated electronics Analog And Digital Circuits And System. International student Edition Mcgraw-Hill, U.S.A

6. OROGE, C.O. Handbook Power Supply Unit 1994.

7. PAUL CHAPELL Electronics Today September 1980

8. ENGR. M. S. AHMED Advanced Circuit 1 Techniques Five Hundred Level Notebook, F.U.T Minna (Unpublished) 2004