DESIGN AND CONSTRUCTION

OF A

TWO-WAY INTERCOM TELEPHONE

SYSTEM

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CERTIFICATION

This is to certify that this project was done by Abubakar Baba (97/5891EE), of the department of the electrical and computer engineering, under the supervision of Engr. M.D Abdullahi, and has been prepared in accordance with specifications governing the presentation of a B.Eng. degree in Electrical and Computer Engineering, Federal University of Technology, Minna.

SIGN & DATE 28/10/03

Engr. M.D Abdullahi
SUPERVISOR

SIGN & DATE 22/10/04

ENGR. M.N NWOHU
H.O.D OF DEPARTMENT

DECLARATION

I do hereby declare that this project work was wholly presented by me. Under the close supervision of Engr. M.D Abdullahi during the 2001/2002 academic session, and to the best of my knowledge it has never been presented elsewhere before now.

ABUBAKAR BABA
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23/10/2003

DATE

DEDICATION

This project work is thankfully dedicated to the Allah (S.W.T) for the greatest influence upon my life, who bestowed upon me strength and direction to carry out this project work.

And also to my dad, mum Hajiya Fatima Baba whose were unflinching efforts and desire to see me educated and knowledgeable I will forever live to remember and appreciate.

ACKNOWLEDGEMENT

I give Allah (S.W.T) all the glory for his love grace and favor upon my life who saw me through all my happy and trying moments, the omnipotent creature who has predestinated me unto good works here on earth and whose favor are looked upon in the hereafter. I also thankfully acknowledged the efforts of my supervisor Engr. M.D Abdullahi, for his sound advice leading to the completion of this project work and also to my H.O.D (Dr) Engr. Y.A Adediran for his guidance in our academic work also special thanks goes to all my friends and well-wishers who are out there with good will towards me.

Peace upon you all.

ABSTRACT

Over the years telecommunications has witnessed tremendous and mind-boggling development with more effective and cost saving methods being discovered.

However, the primary needs of man as regards communications, to communicate with his immediate environment are of vital importance.

The design and construction of a three-way intercom system is aptly described in this project. The project is intended to provide a cheap but yet effective means of communication within a house or an establishment.

The system makes use of $\propto$A 741, LM 386 amplifier is primarily responsible for the sent signal so that it will be received clearly at the channel where it is sent.

Relays were used at the exchange to achieve/realize the aim of the design.

Channels were linked via the use of button switches through an auto exchange.

The expected result is discussed in chapter five and this chapter terminates with the conclusion and recommendation.

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CHAPTER ONE

INTRODUCTION

1.1 THE NEED FOR COMMUNICATION

In a word of constant predation and competition, communication and expressiveness are vital to the biological survival of all living creature. Recent studies which have dealt with the range of animal's communication have revealed that these creatures communicate by body movement or by making sounds to indicate danger, discovery or desire.

Humans, being creatures of higher intelligence were not left behind in this 'revolution'. Primitive man developed methods of communicating with his immediate society and even longer distance. Early methods include drumbeats, fire, smoke signals and instruments such as the rem`s horn etc.

As man increased in wisdom and knowledge, his methods and needs of communication have also become more sophisticated and efficient. Communication continues to the backbone of social development and hence its development is necessary.

1.2 CONCEPT AND DEFINITION OF COMMUNICATION

In the light of the fact that all living creatures communicates with each other and also with their environment, communication in electrical Engineering term; can

therefore be define as **"the sending, processing and reception of signal using electrical means. A communication system can be defined as a system of sending, transmitting, processing and receiving signals. The means of communication can be in the form of a radio link, optical fibred, satellite and telephone network.**

Telecommunication is therefore the transfer of information from one point to a distance one. It is the life-blood of modern civilization. Without it commerce and industry as we know it today could not exist. Certainly man's probing into space would be impossible. It is even difficult to imagine what the effect on our lives would be without reliable economical and efficient means of communication.

In the technological field, communication development focuses on researching more efficient ant faster means of transmitting information and messages over any distance.

Efficient means of communication and quick access to requisite information are great needs of a fast developing world which even explorers beyond its horizons.

Scientists and engineers have been able to so far provide for the communication need of our world, thereby actualizing the concept of the world as being a "one big family".

1.3 THE INTERCOM IN COMMUNICATIONS.

The intercom is a simple development utilizing telephone for the purpose of communicating with a specified area. It is adequately suited to cater for the

communication within an area which is consanguine, eliminating all the unnecessary excesses and ensuring quick access to the desired port of call.

The intercom is a cheap and effective means of communication within an office block or a complex, an organization or even a parastatal. The design of the intercom system is made to suit the specified needs of the environment in which it is to be utilized with adequate consideration for future expansion.

The intercom, therefore, plays the role of being the most efficient as well as the cheapest mode of internal communication within an organization. (the name is derived) from the role it plays as a good means of internal communication.

The intercom can either be manually or automatically operated, the manually operated intercom requires the presence of an operator at the master station to connect a caller to it port of call. The automatically operated intercom however, does not require a master station or an operator to connect a caller to its port, as calls are passed through the digital exchange with automatic operated switches.

1.4 OBJECTIVE OF STUDY

This project was embarked upon so as to develop a cheap and efficient means of communication for our local establishments/organizations.

Improvements were made on previous works carried out as manual connection between the caller and the called subscriber at the other end were improved upon by replacing it with an auto-exchange.

More sophisticated intercom design were also analyzed and the excesses in were expunged from this project.

An intercom which specifically suits the needs of a small organization/ Establishment without being too expensive is the focus of this study.

1.5 SCOPE OF STUDY

This project focuses on short distance of information and messages within an establishment or small organization.

The study only wired telephone transmission is outlined in this project with provision for 2-CHANNEL system which will automatically operate from one caller to the other is discussed in this project. There is however the need for grater communication needs for which a wireless communication system will be more desirable, but the scope of this project specifies the design and construction of a 3-way AY intercom telephone system.

1.6 PROJECT METHODOLOGY

This device operates with direct current when the line is not locked on. Basically, when one person lift his handset and call the other, direct current flow

flows through to the exchange with no power conversion. As the called subscriber picks his handset, circuit current automatically seizes with A.C flowing through the amplifier due to the establishment of communication link between the two.

1.7 JUSTIFICATION

Since it is generally agreed fact that traveling long distance to deliver just a simple message which might not be that important as an unnecessary waste of time, considering the time span, a simple communication system, cheap, affordable and easy to maintain which caters for the needs of small establishment with a tight budget will be a most welcome development.

An organization must maintain a high efficiency level and also try to keep over-head cots as low as possible and so this project which is simple in nature can come in profitably.

The fact that it needs no master station to operate it eliminates the need for second operator. All this beyond reasonable doubt has provide justification to the reason(s) for which this project has been carried out.

CHAPTER TWO

THEORY

2.1.0 HISTORICAL BACKGROUND OF TELECOMMUNICATIONS

Man has always sought for a means of more efficient means of transmitting information at faster speed. As noted earlier, drumbeats, fire, smoke signal and the ram's horn were methods used in early times. During the middle ages, homing pigeons were used to transmit messages.

It was in the 17^{th} century that a significant step was taken in the area of telecommunications development when in 1667, the English physicist, Robert Hooke invented a string telephone that conveyed sound over an extended wire by means of mechanical vibrations.

Ever since, "sporadic" developments/inventions have been witnessed. It was however in 1876 that Alexander Graham bell was granted the patent for electric speaker telephone; he had discovered that, only a steady electric current could be used to tranamit the human voice.

In 1977, he produced the first telephone to transmit and receive the human voice with all quality and sophistication.

2.1.1 BELL'S MAGNETIC TELEPHONE

The basic unit of Bell's invention consisted of a transmitter, receiver and a single connecting wire.

The transmitter and the receiver were identical, each containing a flexible metallic diaphragm and a horse-shoe magnetic with a wire coil.

Sound waves striking the diaphragm caused it to vibrate in the field of the magnet. This vibration generated an electric current in the coil that varied in proportion to vibrations of the diaphragm.

The current traveled through the wire to the receiving station where changes in the strength of the magnetic field were produced.

This variation in strength caused the receiving diaphragm to vibrate reproducing the original sound.

2.1.2 MODERN COMMUNICATION SYSTEM

The modern communications system was developed through research and by identifying the needs of a fast-developing world.

The block diaphragm of a modern communication system is shown below;

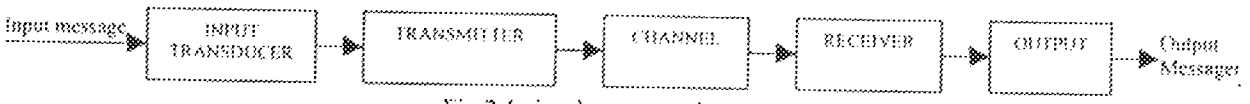


Fig 2.1 simple communication system

2.2.1 INPUT TRANSDUCER

A transducer is a device that converts energy from one system into energy in another system; the converted energy usually being in a different form.

The input message, being in the form of sound waves in the frequency range of 300Hz is sent into the input transducer by a person speaking into the sound waves are then converted to voltage variations by the microphone and sent the wires on to the transmitter.

2.2.2 TRANSMITTER

The transmitter essentially couples the message (which has been converted into electrical signals by the input transducer) to the channel. It is at the transmitter that the sound waves are modulated (if necessary). It is necessary that sound waves are passed through the transmitter for the following reasons:

- For channel assignment; each message signal is transmitted at a unique frequency band to avoid mix-up with other signals.
- To reduce noise and interference, especially at low frequencies.
- For multiplexing
- To overcome equipment limitations e.g size and weight.

2.2.3 THE CHANNEL

This is the medium through which the transmitted signals gets into the receiver.

There are different forms in which channels can be found, ranging from the ground (earth) to wires in the sky or space. The transmitter could therefore, be hard-wired or wireless.

The signal passing through the channels undergo degradation which may result from noise or interference, fading or filtering and therefore the use of the best available channel for specified need is great importance in telecommunications development.

2.2.3 THE RECEIVER

The receiver extracts and process the desired signal from various signals received at the output of the channel.

The desired signal is converted into a suitable form for the output transducer stage. This includes amplification of the received signal if the signal level is low. An important factor in receiver designs is that it should be able to select the desired signal "well" and reject any unwanted signal "well".

2.2.4 THE OUTPUT TRANSDUCER

This is a device that converts the electrical output signal of the receiver into the form desired by the user.

A loud speaker converts electrical signals into the sound waves. The output transducer has the same operational functions as the input transducer, except that it converts the electrical signal into audible sound. The device used for the input transducer.

2.3 THE INTERCOM

With the rapid development of telecommunications, making it possible to link areas which are miles away from a station, telecommunications has become the most interesting subject of study in the world. As much as it is important to communicate with one's own immediate environment is still of great importance.

The intercom therefore still plays a great role in telecommunications.

The simple design and implementation of the intercom makes it desirable as it is also very effective.

The intercom has the same operating principles as the telephone network system, the distinguishing factor being the type of transmitter employed in intercoms. An intercom is desirable mainly for the expandability feature i.e it is design simply, so that more channels can be easily added to the system. An intercom system can therefore comprise as few as two channels or as many as desired by the users.

The intercom system can either be manually operated or operated automatically. The manually operated intercom required the presence of a person at master station connected to the caller to his port of call. The automatically operated intercom does not need a master station as calls are passed through to their switches operated automatically which could be digital system or analogue system.

2.3.1 THE OPERATIONAL AMPLIFIER

The amplifier is the basic building block of electronic system. The components constituting an amplifier have been changed over the years and will continue to

change, but it is important to know how one amplifier load another when they are connected in series (cascaded).

Usually the voltage amplification or power gain or frequency response obtain with a single stage amplifier is not sufficient to meet the needs of a composite electronic circuit or a load device. Hence two or more single stage of amplification are used to achieved greater voltage or amplification. The output of one stage serves as the input of the next stage as shown in figure 2

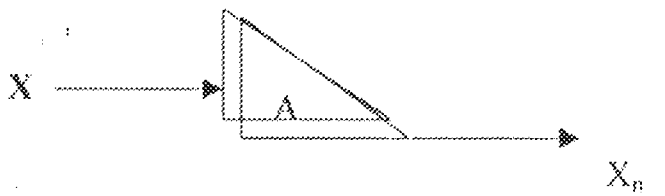


Fig 2.2 Amplifier symbols.

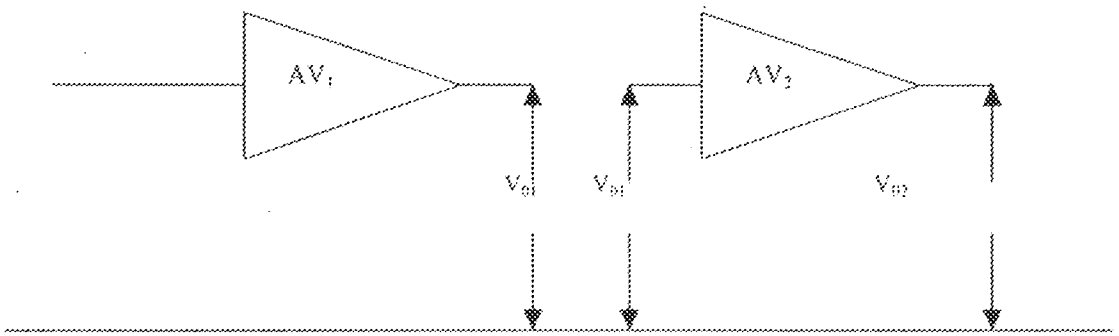


Fig. 2.3 Amplifier in series

From the fig 2(a) the input X_i is related, to the output X_0 by a constant. The stage is said to have a gain A, which is given by.

$$A = \frac{\text{amplifier output}}{\text{Amplifier input}} = \frac{X_0}{X_i}$$

As the output X_i is increased, there will come a time when X_0 cannot rise anymore due to limitations of the supply. Thus, every amplifier will be non-linear for very large output demands. Also amplifiers will be non-linear to some extent, even for small signals; X_{01}/X_{i1} and X_{02}/X_{i2} may be different for two amplifiers connected in series. There will however be a restricted working of the amplifier where the rations are nearly constants (within a few percent of each other).

2.3.2 PROPERTIES OF REAL AND IDEAL AMPLIFIERS

One of the most important properties required of the basic internal amplifier to be used as the heart of an operational amplifier is that it must have a very high gain.

For analysis and design purposed gain is considered high enough to be considered as infinite. Ideally, it is assumed that an operational amplifier has infinitely high input impedance. There should be a specified operating frequency (or frequency range) at which these properties will be maintained.

Specifications are also made as to the immunity to change in the environment of the amplifier's performance such as temperature changes.

Real linear amplifiers cannot meet the specifications of an ideal amplifier, hence properties governing the selection of an amplifier are:

- High gain
- Direct current connection

- Wide bandwidth
- High input impedance
- Low output impedance
- High degree of stability against temperature and other environment changes.
- Minimum of adjustment to set the dc conditions.

2.4.0 THE INVERTING OPERATIONAL AMPLIFIER

This type of amplifier has the input signal being fed into the (-) terminal. The (+) terminal of this amplifier is connected to the common rail or ground

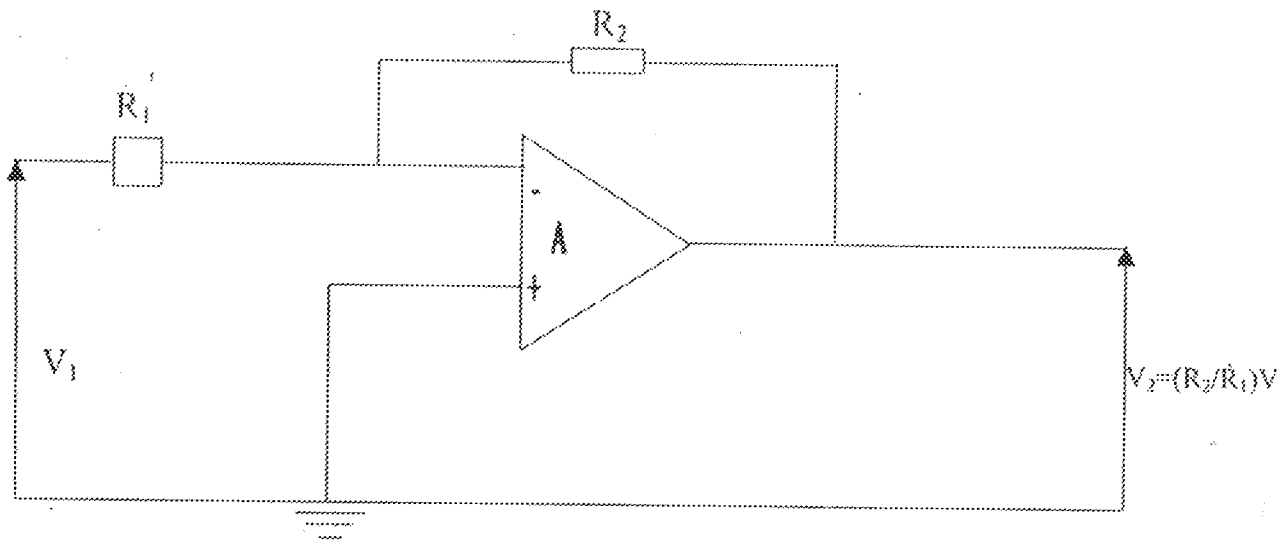


Fig 2 4 Inverting operational Amplifier

2.4.1 GAIN OF THE INVERTING AMPLIFIER

To calculate the overall gain, G. for amplifiers, were assume that:

- The internal gain A is large
- The input resistance of the internal amplifier is infinite
- The output resistance is zero

If the amplifier gain A is very large, then for a given output signal, the signal at the (-) terminal is very small, and the terminal said to be at virtual earth.

From fig. 2.4 at node X, $I_1 = - I_2$ and input impedance of the amplifier is infinite, $I_1' = o$ (no current into the amplifier).

The terminal X is at a virtual earth and the current equation becomes;

$$\frac{V_1}{R_1} = - \frac{V_2}{R_2}$$

And the overall gain becomes, $G = V_2/V_1 = -R_2/R_1$

By the assumption made, the overall gain of the operational amplifier has been shown to be independent of the internal amplifier gain A and determined entirely by the ratios of the external resistors.

The gain of the overall inverting amplifier can be adjusted by various means. It is possible to male either R_1 or R_2 variable, however, R_1 effectively determines the input resistance of the inverting amplifier, and thus its adjustment to control the gain causes the input resistance to vary.

Variation of R_2 may be achieved either by means of a potentiometer or by switching in different resistors. The input resistance is undisturbed, but caution must be taken in the connection to the very sensitive (-) input of the amplifier, where spurious signals can produce a large undesirable output.

An alternative method is to vary the gain by using the circuit below.

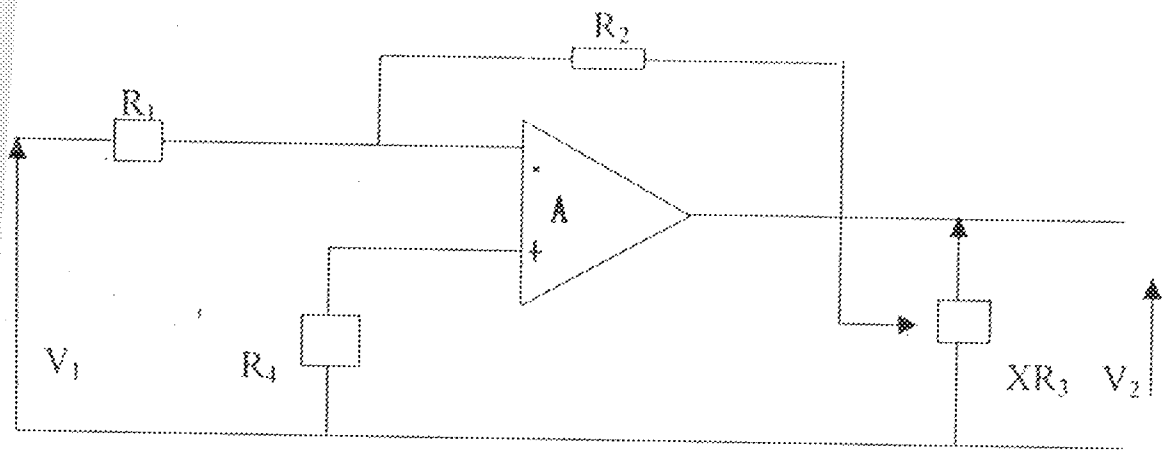


Fig. 2.5 Gain of the inverting Amplifier

The potentiometer is across the low impedance output of the amplifier and connected to the (-) terminal through the relatively large resistance R_2, therefore, spurious signals affect the amplifier very much less.

The gain in this arrangement is given by:

$$G = \frac{-1}{X\,(R_2/R_1)}$$

Where X is the fraction of the output voltage V_2 to which R_2 is connected.

2.4.2 AND OUTPUT IMPEDANCE OF THE INVERTING AMPLIFIER

From the idealized amplifier of fig. 2.4 with very large gain A and an extremely small signal at X (which is virtual earth), R_1 is connected between the input and 'earth', so that the input resistance; $V_1/R_i = R_1$

When gain A and input resistance R_i of the internal amplifier are considered to be finite, the input current is:

$$i_1 = \frac{V_1 - V}{R_1} \quad \text{---------- (i)}$$

With $V' = \frac{-V_2}{A}$, $\quad i_1 = \frac{V_1}{R_1} + \frac{V_2}{AR_1}$ ---------- (ii)

But $\frac{V_2}{V_1} = \frac{-R_2}{R_1}\left[\frac{1}{1 + \frac{1}{A}\left[\frac{1}{R_1} + \frac{R_2}{R_1} + \frac{R_2}{R_1}\right]}\right]$ ---------- (iii)

therefore $V2 = -V1\,\frac{R_2}{R_1}\left[\frac{1}{1 + \frac{1}{A}\left[\frac{1}{R_1} + \frac{R_2}{R_1} + \frac{R_2}{R_1}\right]}\right]$ ---------- (iV)

And $i_1 = V_1\left[\frac{1}{R_1} + \frac{R_2}{Ri}\left[\frac{1}{A + 1 + \frac{R_2}{R_1} + \frac{R_2}{R_1}}\right]\right]$ ---------- (V)

This gives $\frac{V_1}{i_1} = R_{in} = R_1\left[1 + \frac{R_2\,Ri}{R_1\,(R_1 + AR_1 + R_2)}\right]$ ---------- (Vi)

The output impedance is derived for the circuit of fig. 2.6 below,

Which assumes that R_1 is very large. The currents at notes X and Y are given as:

$\frac{V_1 - V_1}{R_1} = \frac{V' - V_2}{R_2}$ ---------- (Vii)

And $\frac{-AV' - V_2}{Ro} + \frac{V' - V_2}{R_2} = I$ ---------- (Viii)

$$V' = \frac{R_1 R_2}{R_1 + R2}\left[\frac{V_1}{R_1} + \frac{V_2}{R_2}\right]$$

Eliminating V' from equation (viii)

$$V_2 = \frac{-V_1 (AR_2 - R_0)}{Ro + R_1 + R_2 + AR_1} \frac{-i \quad Ro\,(R_1 + R_2)}{Ro + R_1 + AR_1 + R_2} \text{ ---------- (ix)}$$

This is equivalent to

$V_2 = V_1$ (no-load voltage gain) – i (amplifier output resistance)

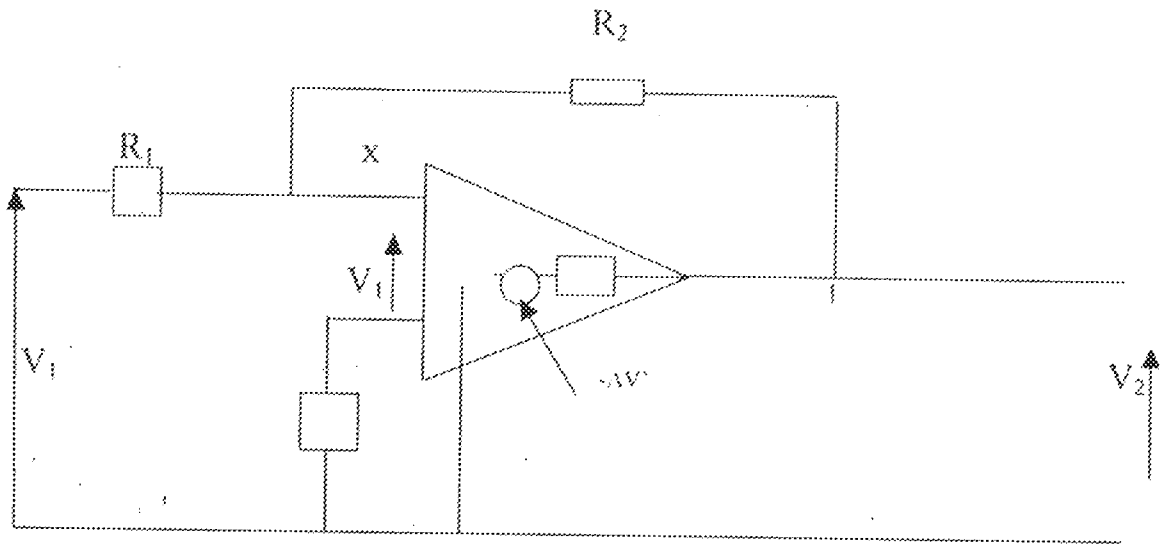


Fig. 2.6 Input and output Impedance of the inverting Amplifier

When A is large, the 'no- load voltage gain' becomes $-R_2/R_1$ the output resistance Ro of the overall amplifier is

$$\frac{R_0 (R_1 + R2)}{R_0 + R2 + R1 \quad (1 + A)} \text{ ---------- (ix)}$$

2.4.3 THE NON-INVERTING OPERATIONAL AMPLIFIER

Here, the signal is applies to the (+) terminal, but the circuit connections using R_2 and R_1 are still made (-) terminal. One end of R_1 is joined to the earth.

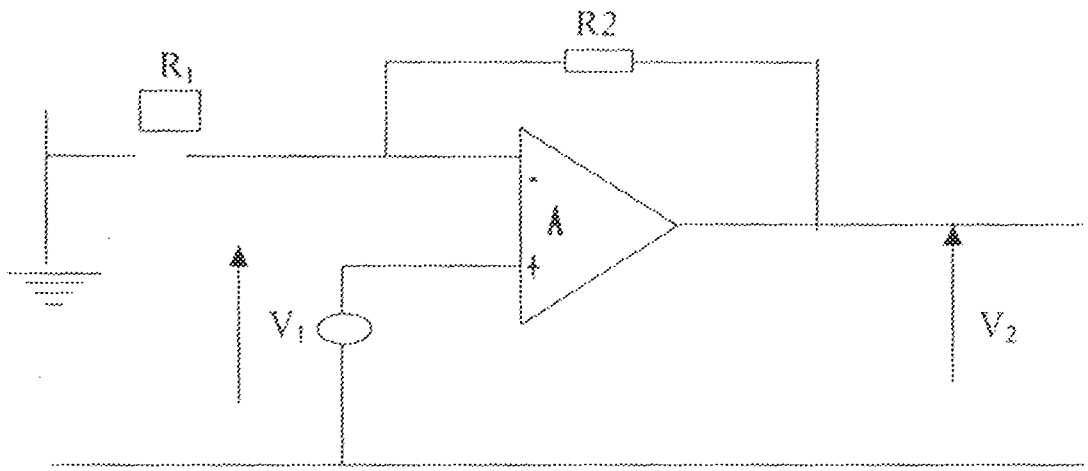


Fig. 2.7 the non-inverting operational Amplifier

2.4.4 GAIN OF THE NON-INVERTING OPERATIONAL AMPLIFIER

We first consider the case where input resistance R_i tends to infinity and output resistance R_0 tends to zero. The output voltage at the inverting input.

$$V' = \frac{V_2}{R_1 + R2} V_2$$

$$\frac{V_2}{V_1} = \frac{A}{1 + AR_1/(R_1 + R_2)}$$

When A is large

$$\frac{V_2}{V_1} \cong 1 + \frac{R_2}{R_1}$$

2.4.5 REDUCTION OF THE EFFECT OF INTERNAL DISTURBANCES IN THE AMPLIFIER

Disturbance can be taken to mean unwanted signal in the signal. It can be due to various reasons as poorly fitted supplies, thermal e.m.f's in the circuit and non-linearity in the amplifier when the output is no longer directly related to the input.

The unwanted effects are included as disturbance D, in fig. 2.8

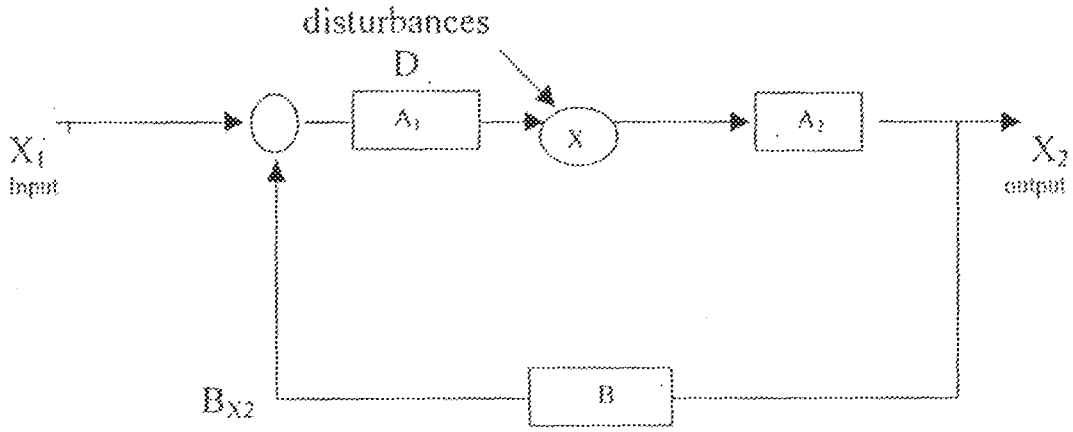


Fig. 2.8 the unwanted effects in the Amplifier

The disturbance occurs between the input and output of the amplifier. The total forward gain is now $A_1 A_2$. The output X_2 can be written as

$$X_2 = A_2 (\text{output of } A_1 + D) = A_2 [A_1 (X_1 - B X_2) + D]$$

This can be arranged to give

$$X_2 = \frac{X_1 A_1 A_2}{1 + A_1 A_2 B} + \frac{D A_2}{1 + A_1 A_2 B}$$

The second part of the equation shows that the disturbance has been reduced by a factor (1 + loop gain).

DA_2 is the disturbance that would have reach the output without feedback, and has clearly been reduced by a useful factor in a feedback amplifier where the loop is large.

When $A_1A_2B >> 1$, the above equation gives

$X_2 = X_1 (1/B) + D (1/A_1B)$

The disturbance is divided by A_1B where as the unwanted signal is only divided by B. thus the signal had been approved relative to the disturbance.

CHAPTER THREE

3.0 CIRCUIT DESIGN AND CALCULATIONS

The design consists of two LM 386 audio amplifiers for the two ways system. Each amplifier serves each way the amplifier are logically connected to serve the task the output of one amplifier is connected to the speaker of the one outside so that in that way, when a person speaks into the microphone the audio signal is amplified and link the other speaker who listens. The other listener can do the same.

The operation of the entire project depend on the circuit and hence, the design of the circuit is infact the main focus of this project.

An understanding of the operation of an intercom system, which is automatically operated, is necessary. The intercom system is sub-divided into the following sub-system:

- The amplifier circuit
- Signaling circuit
- Power supply unit

A good choice of the components will yield good result.

3.1 MODE OF OPERATION OF THE PROJECT

The main mode of operation is that a person for instance a visitor outside the house presses a button on the system which trigger on an alarm inside the house which inform the guest inside the house that somebody is at the door. But for security consciousness he has to converse with the visitor to make enquiry into his identity to avoid opening the door to a criminal. To carry out this operation the person inside the house presses a button, which displays a red light (LED) that blinks before communication takes place and henceforth a yellow light (LED) is displayed during the communication.

After the interaction the person inside presses a button to turn off the system and the yellow light (LED) goes back to standby state, which is represented by a red blinking light.

A schematic diagram of the operating principle of this project is shown in fig. 2.9 .

CIRCUIT DIAGRAM

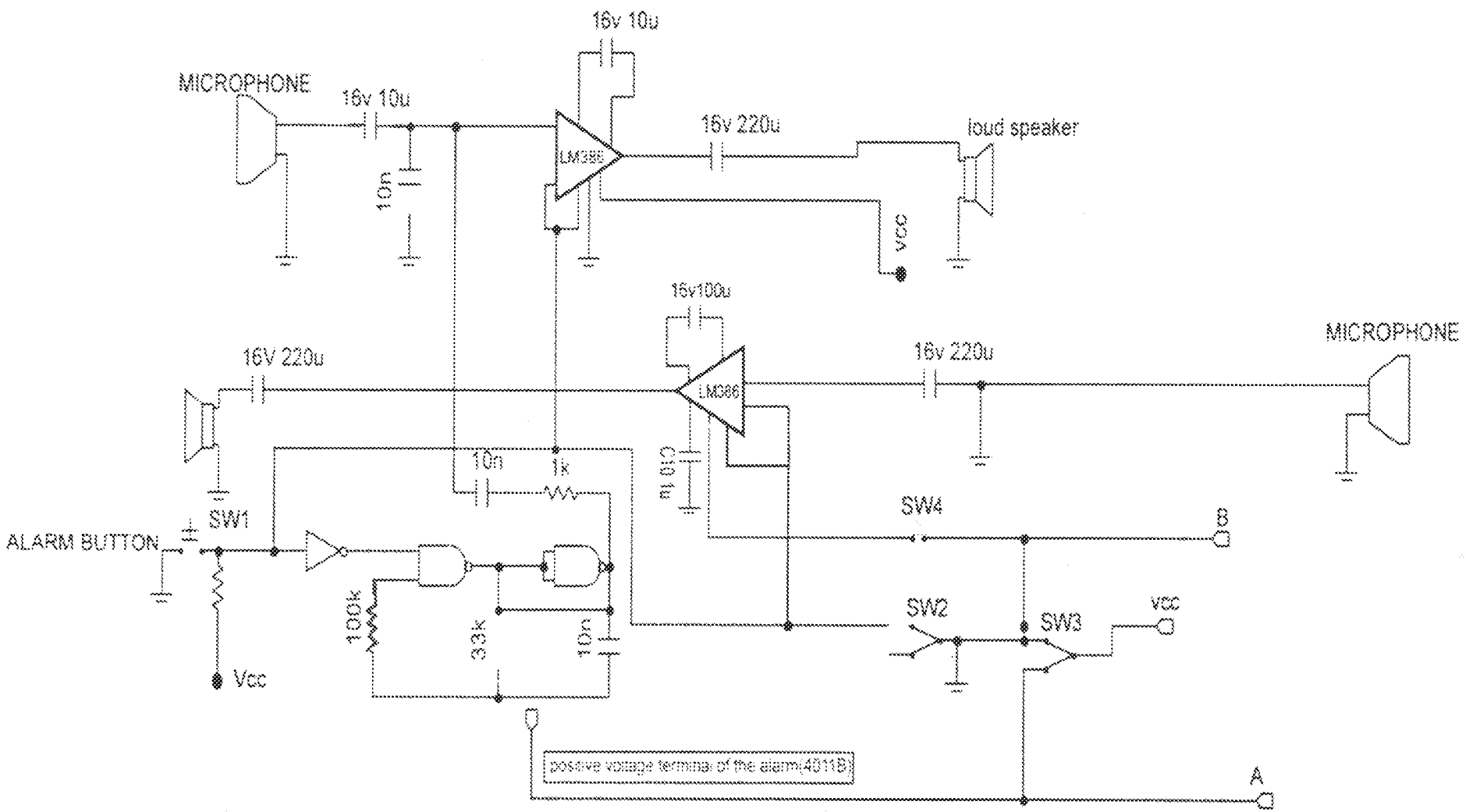


Fig. 3.0

3.2 CHOICE OF RESISTORS

Resistors are truly ubiquitous. They are almost as many types as there applications. Resistors are in many circuit i.e as feed back in this project and in combination with capacitors; they establish time constants and act as filters. The resistors used in this project were carefully selected and checked for durability their values includes:

1KΩ , 33KΩ , 100KΩ and 1KΩ , variable resistors were used.

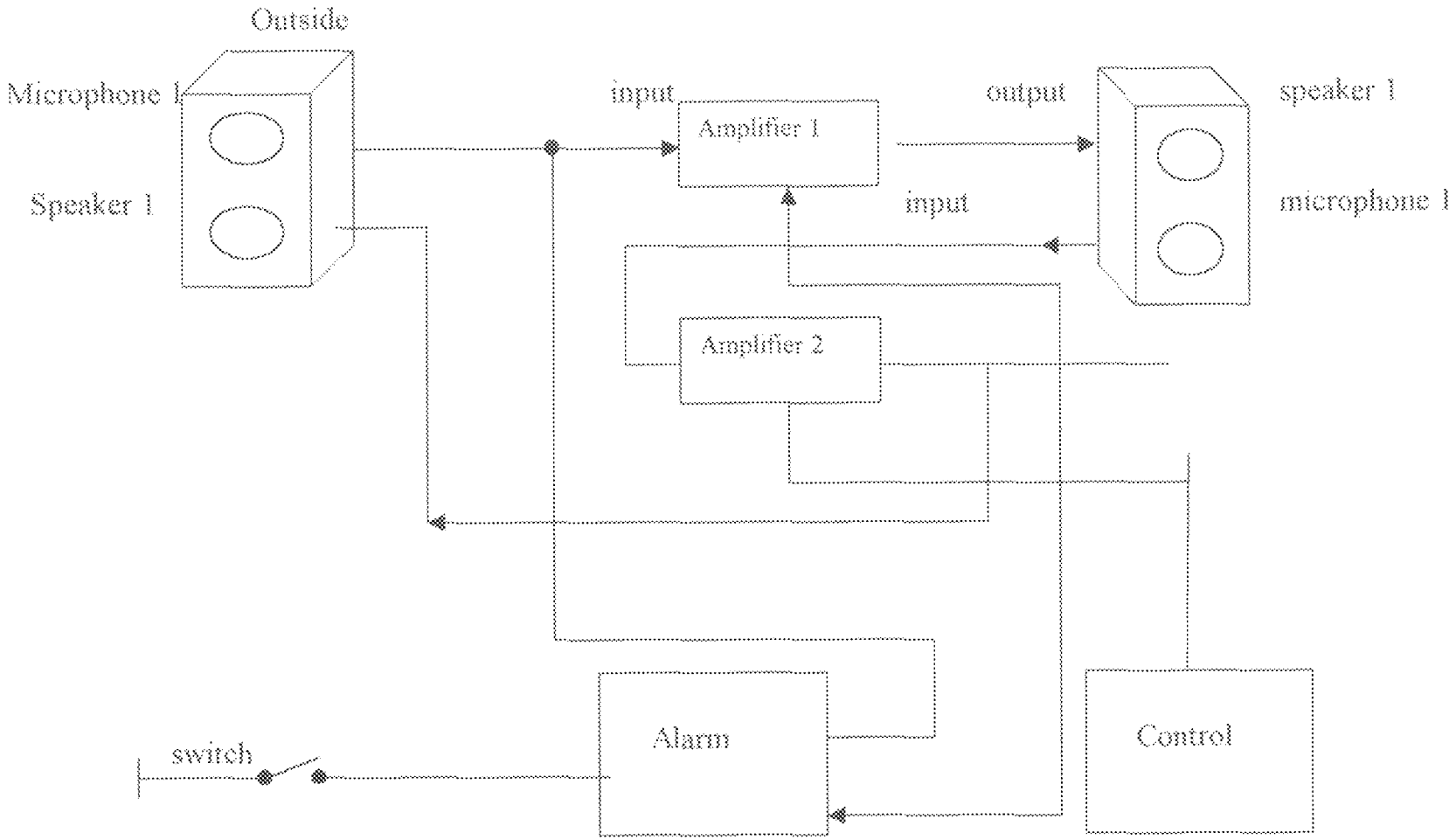
3.3 CHOICE OF CAPACITORS

The capacitor is passive element, which is very essential in every circuit design. They combine with resistors to form the basis of nearly all the component in the circuit. They are used for wave form generation, blocking and as a filtering element capacitors are in amazing variety of shapes and sizes. The basic construction is simply by placing two conductors near each other (but not touching that in parallel.

The type of capacitors used in this project is the electrolytic capacitor. It was chosen because of its flexibility and low cost compared to the ceramic type. The values used in this project include:

1μ F, 10μ F and 220μ F.

BLOCK DIAGRAM



CHAPTER FOUR

4.0 LAYOUT AND CONSTRUCTION

In this chapter, an overview of the types of materials used in the construction and general layout of the project design is seen. The complete assembly is also outlined.

4:1 CONSTRUCTION OF THE AMPLIFIER CIRCUIT.

The design of the various circuits comprising the intercom system was tested using the specified components, and testing them on a breadboard, to ensure full workability of the design. When the system was certified to be working, the components were then permanently fixed by soldering on a vero-board.

Bread boards are prototype boards, which are modules containing well arranged pin-socket for fixing-in components. The bread board is ideal for testing full working of systems and components, as it serves as a temporary construction board. For this project, all the components used in the work were laid-out on the bread board, according to the specifications of the project design. All the adjustments were made using the bread board, and the effect of interchanging components was observed and noted.

The bread board proved to be very convenient, and played an integral role in circuit design of this project, as theoretical designs were realized with

ease and components were easily experimented with. It was however noted that the bread board should not be used for circuit with operating frequencies exceeding 10MHz.

The vero-board in an insulated strip, comprising several parallel tracks of strips with small holes drilled along its length, giving a matrix format. It is made of hard plastic, and provides adequate insulation between connected components.

The components were fixed to the vero-board by placing each pin of the component in a separate hole, and then the pin will be soldered into the circuit, in accordance with the specified design. This ensures immovability of the components, hence this stage of construction is referred to as the final circuit construction. Soldering the components was done with great care to prevent damage to the components. The tip of the soldering iron was cleaned and sharpened with a chisel, and high grade soldering lead was used. The temperature of the solder was regulated to stall over-heating, and soldering techniques were applied uniformity of the arrangement of component with the tested design was ensured, to eliminate the need to remove component for the purpose of correction, after the circuit would have been completely soldered.

4.2 CONSTRUCTION OF THE CASING

The concept of a conventional telephone casing was considered for the design of the project casing, to allow for familiarity for the user. Wood was chosen as the material of the casing because of its light weight and relative cheapness.

The dimensions of the casing were considered with respect to the size of the components, and space was giving for any subsequent addition the casing was first designed on paper, and modification were made before the actual construction was made to ensure that the finished work closely resembled what was conceived.

The various components comprising the whole intercom system were put together by fixing them in their appropriate places on the constructed wooden casing. Screws were used to hold down the circuit board in the casing and also to coupled the sides of the casing. This was to allow for ease of maintenance and modifications.

4.3 PROBLEMS ENCOUNTERED

The problem of radio interference was experienced, but this was solved by making adjustment to the value of the variable resistance used to set the gain at the pre-amplification stage.

4.4 PRECAUTIONS

Quite a number of precautions were observed in the design and construction of this project work this was done to ensure the system worked well, and component were not damaged in the process of construction so as to maintain a low cost of construction.

Some of these precautions include:

- Proper soldering techniques were applied. Stray solders were carefully removed to avoid short-circuits and bridging. High grade soldering lead was used, and heat of the soldering was regulated, to avoid damage to the components.
- The circuit design was made to be easy to understand, noting the methods used in previous designed so as to save time and prevent too much experimentation with components,
- The values of circuit components were ensured to be very closed to their calculated values.
- Proper identification of component and their parts and values was made, both at the time of purchase, and during the circuit construction.

CHAPTER FIVE

5.0 CONCLUSION

The design and construction of the two-way intercom telephone system has carried out in this project exercise has given adequate information/explanation on the operation of a two-way intercom system.

After carrying out this work, I now know better more than ever before the important roles of telecommunication in the technological, social and economic development of our society. I have also been able to know to some degree the working principles, applications and short coming of the industries,

5.1 ACHIEVEMENTS

The construction of an intercom system was achieved at low cost with the best available materials.

The system is designed to have a good quality, low noise output by taking into consideration the gain and the feed back on the amplifiers. The overall design and construction is also very user- friendly.

5.2 RECOMMENDATIONS

I will suggest that the work as presented in this project should be improved upon by those who will carry out similar work in subsequent

projects so as to make the system more efficient. This improvements include:

- The analogue exchange should be replaced by a more sophisticated digital exchange.
- Extra care should be taken when mounting the components on vero-board to avoid breaking of IC leg or simply put, IC bases should be used so as to avoid sudden damage of ICs.

In conclusion, for future project works, the department should as a matter of fact make the project titles available and if possible the components available to students on time so that the problem associated with late arrival and unavailability of components could be solved earnest.

5.3 SUMMARY

Working on this project was challenging, but it turned out to be interesting and enlightening. It was noted that there is a difference between the theoretical (calculated result) and the practical values obtained because of the approximations made in values of components and also due to some errors which can be described as human.

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