DECLARATION

I, Atugbokoh Akalaka Jude declare that the project work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to Federal University of Technology, Minna.

Atugbokoh Akalaka Jude	19/10/11
(Student)	Signature and Date

CERTIFICATION

This is to certify that this project titled "Design and Construction of a Two-Way Intercom" was carried out by Atugbokoh Akalaka Jude with matric. number 2005/22010EE, and submitted to the Department of Electrical and Electronics Engineering, Federal University of Technology Minna in partial fulfilment of the requirements for the award of Bachelor degree in Engineering (B.Eng).

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Signature and Date
6/3/2012

DEDICATION

I dedicate this project work to God Almighty for His divine intervention and to my ever loving parents, Mr and Mrs A. O. Atugbokoh.

DESIGN AND CONSTRUCTION OF A

TWO WAY INTERCOM

BY

ATUGBOKOH AKALAKA JUDE
(2005/22010EE)

A THESIS SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING IN PARTIAL FULFILMENT FOR THE REQUIREMENTS OF BACHELOR OF ENGINEERING (B.ENG) DEGREE FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

OCTOBER, 2011.

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ABSTRACT

The development of telecommunication has grown with new gadgets that are more efficient and intelligent in nature. However, the primary needs of man as regards communication with his environment are of paramount importance. The two-way intercommunication system has been developed with the purpose of providing cheap but efficient means of communication in a relatively small society or establishment. The hand-sets of the system were linked via a 2-pair cable which makes use of BC548 general transistor and a 2N3055 power transistor, that are primarily responsible for the amplification of the sent signal.

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CHAPTER ONE

INTRODUCTION

1.1 THE NEED FOR COMMUNICATION

Communication is the process of sharing ideas, information and messages with others in a particular time and place. Communication includes writing and talking as well as nonverbal communication (such as facial expressions, body images or gestures),visual communication (the use of image or pictures, such as painting, photography, video), and electronic communication (telephone calls, electronic mail, cable television or satellite broadcasts). Communication is a vital part of personal life and is also important in education, business, and any other situation where people interact with each other [1].

Communication has roles to play in industries and businesses, some organisations build and install communication equipment, such as fax (facsimile) machines, video cameras, personal computers and telephones. Organizational communication is important in every way, people in organizations need to coordinate their work and to inform others outside about their product and services; these kinds of communication are called advertising or public relations. In electrical engineering, communication refers to transmitting, processing and reception of information using electrical means. The information or message to be transmitted, processed and received may take different forms. It may be voice, picture, written message, or electrical signals [2].

Telecommunication is the transfer of information from one point to another (i.e. from the transmitting side to the receiving side). The prefix "Tele" is from an ancient Greek word meaning "Far". In modern terms, telecommunication is the electronic transmission of sound, data, fax, picture, voice, video and other information between systems using either analogue or digital techniques which is the bedrock of modern civilization; without it commerce and industry as we know it today would not have existed. It is difficult to imagine how less effective our lives would be without a reliable, economical and efficient means of communication [2].

Technology in communication is concerned by how well it meets the need and aspiration of the people it serves. Advancement in communication can be felt when you make a call to a friend who is somewhere else, and the response sounds like he or she is at the next door thereby reducing the need for distant journeys that involve high cost and risk. Furthermore, persistent effort in researches by communication engineers have paved way for the use of optical fiber, coaxial cable, radio link and satellite transmission thereby actualizing the concept of making the world a global village [4].

1.2 INTERNAL COMMUNICATION (INTERCOM)

An intercom (intercommunication) device is a stand-alone electronic communication system intended for limited or private conversation between people within a specified distance. The intercom is a cheap and effective means of communicating within an office block, organization or buildings. The design of the intercom system is made to suit the specific needs of the environment in which it is to be utilized with adequate consideration for future expansion. It therefore plays the role of being the most efficient as well as the cheapest mode of internal communication. The simple design and implementation of the intercom makes it desirable and effective. It has the same operating principles as the telephone network system, the distinguishing factor being the type of transmitter employed in intercom [7].

1.3 PROJECT AIM

This project is aimed at achieving a cheap and efficient intercommunication between blocks of offices to enable people within these offices communicate among themselves without stress.

1.4 MOTIVATION

In organisations, people move from one office to another to pass information which could be stressful. This movement can be avoided by having an intercom placed in offices to ease communication among them. This is what motivated the construction of this project.

1.5 SCOPE AND LIMITATIONS

The project focuses on transmission of messages between two ends within a reasonable distance. The study carried out in this project was limited to wired telephone transmission with a provision for 2-channel system, which will automatically operate from one caller to the other.

1.6 PROJECT OUTLINE

The report of this project consists of five chapters. The first chapter introduces the project and states the aims, motivation, scope of work and limitations. The second chapter gives the literature review. The third chapter is the design and implementation stage which forms the major part of this project work, it explains the steps taken to design this project work. The fourth chapter is the testing, result and discussion which analyzes the steps taken in construction of the project work and the last chapter which is the conclusion that summarizes the project work; it also contains the recommendation on how to improve on the work.

CHAPTER TWO

LITERATURE REVIEW

2.1 HISTORICAL BACKGROUND

During the 17th century, a significant step was taken in the area of telecommunication development. In 1667, the English physics, Robert Hooke invented a strong means of communication that conveyed sound over an extended wire by means of mechanical vibration.

However, in 1876 a Scottish-born American inventor, Alexander Graham Bell was granted the patent for electric speaking telephone. He discovered that only a steady current could be used to transmit the human voice. In 1877, he produced the first telephone to transmit and receive the human voice with all quality and sophistication. Early devices capable of transmitting sound vibrations and even human speech appeared in the 1850s and 1860s. Originally, Bell thought that the telephone would be used to transmit musical concerts, lectures, or sermons. According to Alexander Graham Bell when a person speaks, sound is produced by puff of air from the vocal cord of the mouth. The changes in air pressure are caused by puffs due to vibration. However, for proper transmission of such messages through a long distance, modern communication systems were developed through research. Increase use of intercom systems for communication between office blocks is made since it handles large quantities of information that requires no phone bill charges [10].

A new entrant into the communication system development is the optical fiber, a lightweight and high-capacity transmission medium. The first experimental optical communication links were set up in 1976 in Canada, the United States, Japan, Holland and France. With further developments in electronics and computer technology, more barriers are expected through the development of better, faster and more efficient communication system.

2.2 THEORETICAL BACKGROUND

The intercom (intercommunication device) is a stand-alone electronic communication system intended for private or limited dialogue. Intercoms are generally portable and mounted permanently in a position suitable to the user, preferably, on an office table. The intercom facility is an option available where array of offices can communicate internally within office blocks [11].

Traditional intercom system are composed entirely of analogue electronics components but many new features and interfacing options can be accomplished with new intercom based signals. Digital intercom stations can be connected using Cat 5 cable which is a network of cables that converts digital signals to analogue signals and can even use existing computer networks as a means of interfacing distant parties. Most intercom systems have such in common as voice signals, power source and their push to talk capability.

The two way intercom functions in the same way a transceiver does. This type of communication system is simple to design, maintain and operate but has limited capacity and flexibility. A typical user on the system could not choose who to talk to. He would communicate with the same person or group of people where the intercom is positioned since it is mounted at a position suitable to the user [11].

In voice communications there are half-duplex and full-duplex methods of transmission and receiving. Half-duplex communication is like push-to-talk, you have to press a button to talk, let go, and then wait for a reply. The other person on the other end does the same to respond; the two-way intercom are usually half-duplex only with one pair of wires that are used for both transmission and receiving.

To construct the two-way intercom, several electronic components were used to carry out the particular operations required. These components are briefly described below [12]:

2.2.1 POWER SUPPLY MODULE

The power supply module is composed of a 9V direct current (DC) battery.

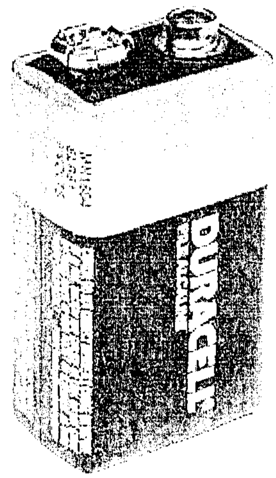

Plate 1: A 9V DC battery

2.2.2 TRANSISTOR

A bipolar junction transistor is a three layer electronic device constructed of doped semiconductor material and is used in amplifying or switching applications [4].

Bipolar transistors are so named because their operation involves both electrons and holes. Charge flow in a BJT is due to bidirectional diffusion of charge carriers across a junction between two regions of different charge concentrations. This mode of operation is contrasted with uni-polar transistors, such as field-effect transistors, in which only one carrier type is involved in charge flow due to drift. By design, most of the BJT collector current is due to the flow of charges injected from a high-concentration emitter into the base where they are minority carriers that diffuse toward the collector, and so BJTs are classified as minority-carrier devices. As a switch the transistor is ON at saturation and OFF at cut-off. For the transistor to be ON the base must be supplied with a base current and the base-emitter voltage must be greater than the forward blocking voltage of the base-emitter usually called V_{BE} [4].

Basically, in transistor circuit configuration there are three types of circuit connections for operating a transistor.

Common-base (CB)

Common-emitter (CE)

Common-collector (CC)

The term 'common' is used to denote the electrode that is common to the input and output circuits. Because the common electrode is generally grounded, these modes of operation are frequently referred to as ground-base, ground-emitter and ground-collector configuration. Since a transistor is a 3 terminal device, one of its terminals has to be common to the input and output circuits [6].

For proper working of a transistor, it is essential to apply voltages of correct polarity across its two junctions. It is worthwhile to remember that for normal operation the emitter-base junction is always forward biased and the collector-base is always reversed biased. This type of biasing is known as forward and reversed biasing. In a transistor, for normal operation, collector and base have the same polarity with respect to the emitter [6].

The four basic guideposts about all transistor circuits are:

1. Conventional current flows along the arrow whereas electrons flow against it.
2. The Emitter-Base (E/B) junction is always forward-biased.
3. The Collector-Base (C/B) junction is always reversed-biased.
4. $I_E = I_B + I_C$

where I_E is emitter current; I_B is base current and I_C is collector current

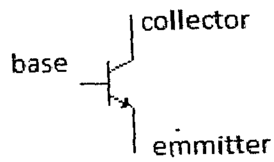

Fig. 1: Symbol of an NPN transistor

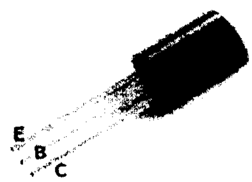

Plate II: A bipolar junction transistor

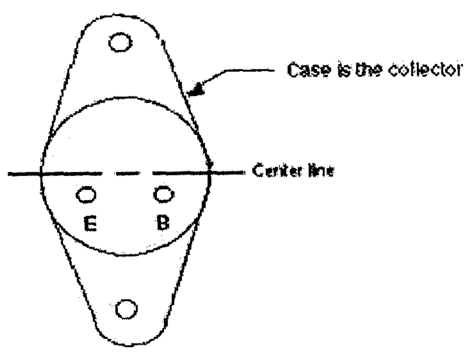

Fig. 2: A 2N3055 power transistor

2.2.3 RESISTOR

The resistor is a component of an electric circuit that resists the flow of direct or alternating electric current. Resistors can limit or divide the current, reduce the voltage, protect an electric circuit, or provide large amounts of heat or light. The amount of resistance to the flow of current that a resistor causes depends on the material it is made of as well as its size and shape. Resistors are usually placed in electric circuits.

Resistors are designed to have a specific value of resistance. Most resistors used in electric circuits are cylindrical items a few millimetres long with wires at both ends to connect them to the circuit. Resistors are often colour coded by three or four colour bands that indicate the specific value of resistance. Some resistors obey Ohm's law, which states that the current density is directly proportional to the electrical field when the temperature is constant. The resistance of a material that follows Ohm's law is constant, or independent of voltage or current, and the relationship between current and voltage is linear. Modern electronic circuits depend on many devices that deviate from Ohm's law. In devices such as diodes, the current does not increase linearly with voltage and is different for two directions of current [2].

Fig. 3: Symbol of a resistor

Plate III: A resistor

2.2.4 CAPACITOR

Capacitor is a device for storing an electrical charge. In its simplest form a capacitor consists of two metal plates separated by a non-conducting layer called the dielectric. When one plate is charged with electricity from a direct-current or electrostatic source, the other plate will have induced in it a charge of the opposite sign; that is, positive if the original charge is negative and negative if the charge is positive. The electrical size of a capacitor is its capacitance, the amount of electric charge it can hold.

Capacitors are limited in the amount of electric charge they can absorb; they can conduct direct current for only an instant but function well as conductors in alternating-current circuits. This property makes them useful when direct current must be prevented from entering some part of an electric circuit. Fixed-capacity and variable-capacity capacitors are used in conjunction with coils as resonant circuits in radios and other electronic equipment. Large capacitors are also employed in power lines to resonate the load on the line and make it possible for the line to transmit more power. Capacitors are produced in a wide variety of forms; electrolytic, ceramics, paper are used as dielectrics, depending on the purpose for which the device is intended [3].

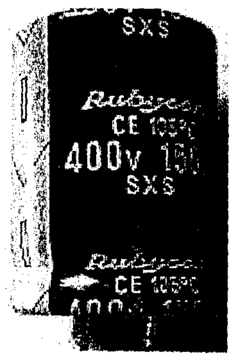

Plate IV: A capacitor

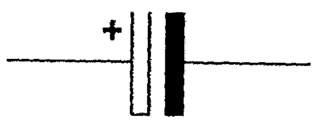

Fig. 4: Symbol of a capacitor

2.2.5 MICROPHONE

Microphone is a device used to transform sound energy into electrical energy. Microphones are important in many kinds of communication systems and in instruments that measure sound and noise. The simplest type of modern microphone is the carbon microphone, used in telephones. This microphone consists of a metallic cup filled with carbon granules and a movable metallic diaphragm mounted in contact with the granules covering the open end of the cup. Wires attached to the cup and diaphragms are connected to an electrical circuit so that a current flows through the carbon granules. Sound waves vibrate the diaphragm, varying the pressure on the carbon granules. The electrical resistance of the carbon granules changes with the varying pressure, causing the current in the circuit to change according to the vibrations of the diaphragm. The varying current may either actuate a nearby telephone receiver or may be amplified and transmitted to a distant receiver. If the current variation is suitably amplified, it may also be used to modulate a radio transmitter.

A condenser microphone is one which is used in this project work. It has two thin metallic plates placed close to each other that serve as a capacitor. The back plate of the capacitor is fixed, and the front plate serves as the diaphragm. Sound waves alter the spacing between the plates, changing the electrical capacitance between them. By placing such a microphone in a suitable circuit, these variations may be amplified, producing an electrical signal. Condenser microphones can be very small. A common type of condenser microphone, the electric condenser microphone, is used in hearing aids. Among the important characteristics of microphones are their frequency response, directionality, sensitivity, and immunity to outside disturbances such as shock or vibration [5].

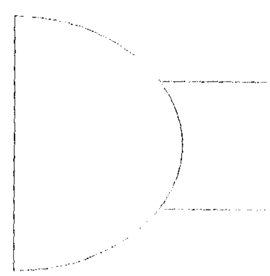

Fig. 5: Symbol of a microphone

2.2.6 SPEAKER

The speaker is an electrical device that converts a modulated electrical signal back into sound. The intercom uses a diaphragm (small membrane) connected to a microphone and a wire coil to convert sound into an analogue or electrical waveform representation of the sound. When a person speaks into the intercom's microphone, sound waves created by the voice vibrate the diaphragm, which in turn creates electrical signals that are sent along an intercom microphone. The receiver's microphone is connected to a speaker, which converts the modulated voice signal back into sound [5].

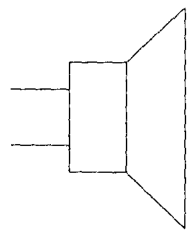

Fig. 6: Symbol of a speaker

CHAPTER THREE

DESIGN AND CONSTRUCTION

The design and construction of the two way intercom was done using various steps and procedures to actualize the efficiency and reliability of the circuit design. Proper attention was given to these design parameters in order to generate the desired output signal needed. The designed circuit was first simulated on multisim (an electronic workbench application software) to ensure that the desired output was obtained and the implementation of the work was done. The construction of the circuit is based on the availability of components which perform different operations necessary for the overall performance of the system.

A block diagram below indicates the stage by stage representation of the entire project work.

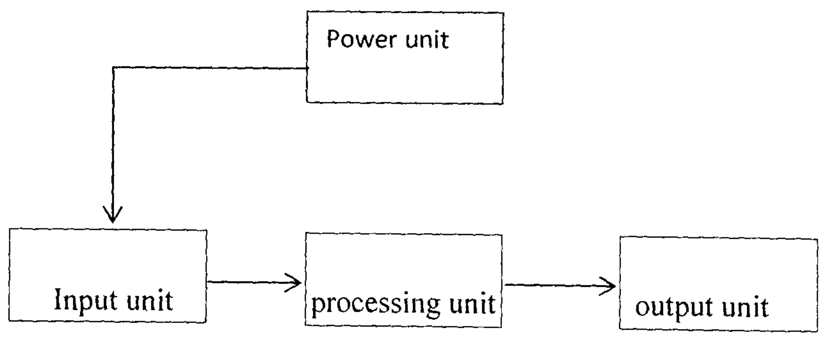

Fig. 7: Block diagram of the two-way intercom system

3.1 DESIGN ANALYSIS

In this section, the design analysis of the various modules is actualised as well as the steps taken in implementing the work. The workspace of the computer simulation is shown below:

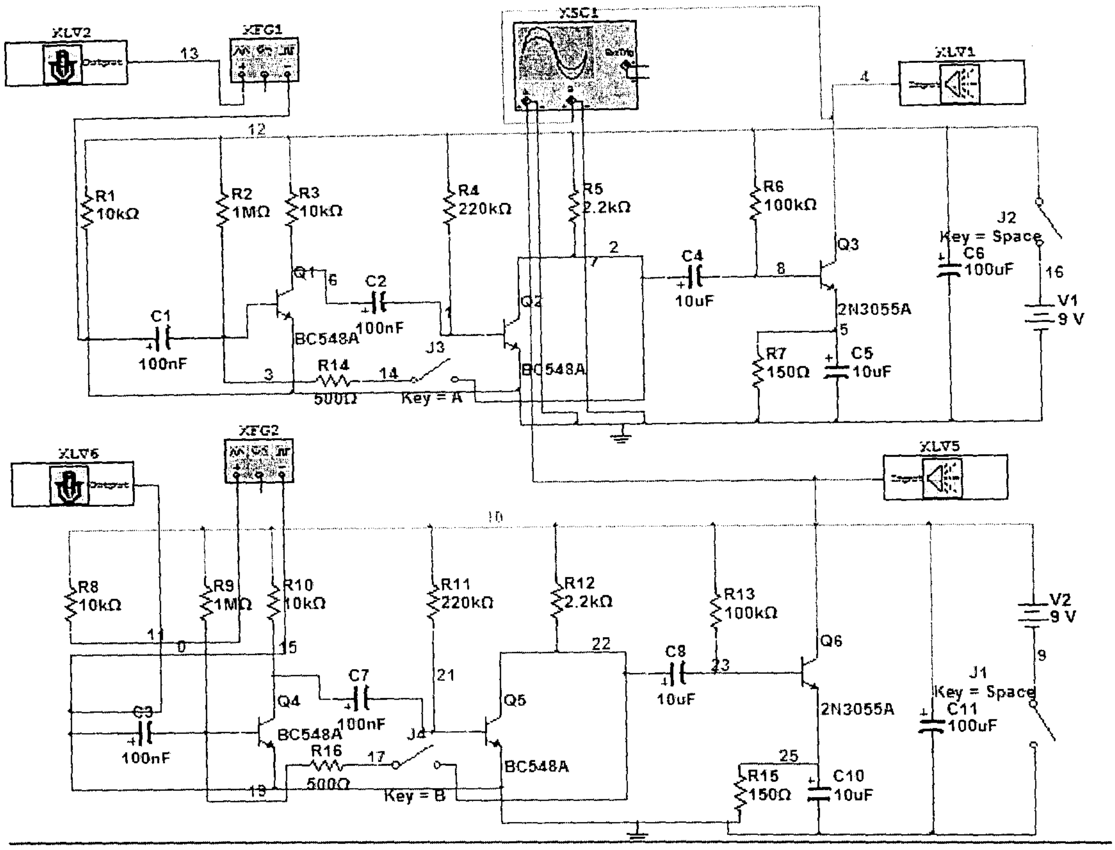

Plate V: Diagram of the simulation workspace of the two-way intercom

3.1.1 WORKING PRINCIPLE

In Plate V above, the input signal (voice) is amplified by Q_1 and Q_4 respectively. It is phase reversed (usually with the emitter-collector C_E connection). The amplified outputs of Q_1 and Q_4 appear across R_3 and R_{10} respectively. The output of the first stage across R_3 and R_{10} is coupled to the input at R_4 and R_{11} respectively by coupling capacitor C_2 and C_7. The capacitors are referred to as "blocking capacitor" because it blocks the passage of dc voltages and currents. The signal at the base of Q_2 and Q_5 is amplified and its phase is again reversed, the output across R_5 and R_{12} is coupled by C_4 and C_8 to load resistors R_7 and R_{15}. The output signal v_o is twice-amplified that of the input signal v_i because it has been reversed twice [6].

The system operates on a direct power source i.e. D.C. (9 volts battery). For communication to be initiated, both power sources must be switched ON at both stations. The ringer, key A switch from station A would be pressed until the answer switch of station B is pressed; communication can then begin and vice-versa. To end a call, the answer switch is pressed again on both stations and this terminates the call.

3.1.2 ANALYZING THE FIRST AND SECOND STAGE RC COUPLE AMPLIFIER:

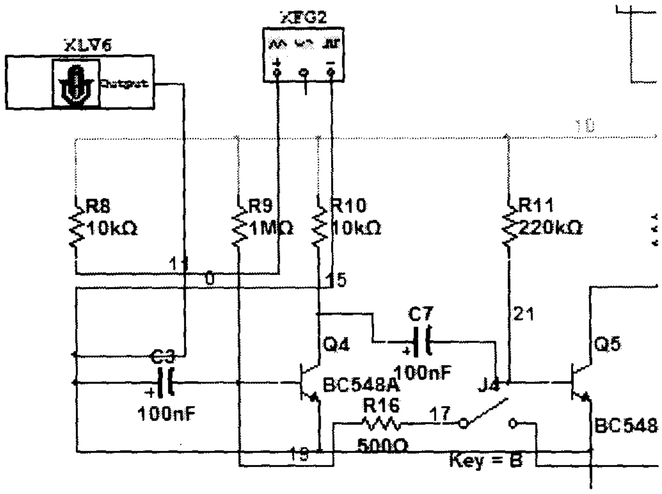

Plate VI: Diagram of the first and second stage of the RC couple amplifier

For a microphone, the maximum allowable current is 100mA while the minimum current is 5mA. Thus, calculating the current entering microphone;

$$I_{mic} = \frac{V_{EE}}{R_1} = \frac{+9v}{10\times10^3} = 90mA \qquad (1)$$

RC-couple two-stage amplifier consists of two single-stage transistor amplifier using the CE configuration.

The resistors R_3, R_4 and capacitor C_2 form the coupling network. R_3 is the collector load of Q_1 and R_5 is that of Q_2. Capacitor C_1 couples the input signal whereas the 100nF capacitor C_3 couples the output signal to the final amplifier circuit. R_2 and R_4 provides dc base bias. The input signal is the human voice as the output is the microphone which ranges from 300Hz to 3.4 KHz for the above circuit to work well. Transistors (BC548) are used in the above circuit because their overall amplifications which are higher than that of the other coupling. C_1 *and* C_2 are the coupling capacitors otherwise known as blocking capacitor because they block the passage of dc since the input is human voice which is analogue in nature and the circuit is known to be a low level audio amplifier. The input impedance γ_i of the cascaded amplifier is given as:

$$\gamma_i = R_2 \parallel B_1 \times \gamma_{e1} \tag{2}$$

where β_1 = current gain of the first transistor.

γ_{e1} = a.c junction resistance of the first transistor.

From the technical data sheet [12].

$I_{C1} = 100mA$ and $I_{B1} = 5mA$

$$\text{Thus current gain } \beta_1 = \frac{I_{C1}}{I_{B1}} = \frac{100mA}{5mA} = 20 \tag{3}$$

To find γ_{e1} we need I_{E1} which is -100mA and $V_{CE(sat)} = 0.6V$ from the technical data sheet.

$$\text{Thus, } \gamma_{e1} = \frac{V_{CE}}{I_{E1}} = \frac{0.6V}{100mA} = 6\Omega \tag{4}$$

Hence, $\beta_1 \times \gamma_{e1} = 20 \times 6 = 120\Omega$

Thus, $\gamma_1 = R_2 \parallel \beta_1 \times \gamma_{e1} = 1\text{M} \parallel 120\Omega$

$$\frac{1\times10^6\times120}{1\times10^6+120} = 120\Omega$$

Also, the voltage gain AV_1 for the first stage is given as:

$$AV_1 = \frac{\gamma_{0,1}}{\gamma_{e1}} \tag{5}$$

where $\gamma_{o,1}$ = output impedance of the first stage

γ_{i1} = input impedance of the first stage

Now, $\gamma_{o1} = R_3 \parallel \gamma_{i2}$ (6)

where $\gamma_{i,2}$ is the input impedance of the second stage.

Therefore, $\gamma_{i2} = R_4 \parallel \beta_2 \times \gamma_{e2}$ (7)

where γ_{e2} is the a.c junction resistance of the second transistor and $R_4 = 220\text{K}\Omega$

To find γ_{e2}, we need I_{E2} which is -100mA from the technical data sheet [13].

Now, $I_{C2} = 100mA$

Therefore, $\gamma_{e2} = \dfrac{V_{CE(sat)}}{I_{E2}} = \dfrac{0.6V}{100m\text{A}} = 6\Omega$ (8)

where $V_{CE(sat)}$ = collector-emitter voltage.

Also, $\beta_2 = \dfrac{I_{C2}}{I_{B2}} = \dfrac{100m\text{A}}{5m\text{A}} = 20$ (9)

Thus, $\beta_2 \times \gamma_{e2} = 20\times6 = 120\Omega$

$$\gamma_{i2} = 220\text{K}\Omega \parallel 120\Omega = \frac{220\times10^3\times120}{220\times10^3+120} = 120\Omega$$

$$\gamma_{o1} = 10\text{K}\Omega \parallel 120\Omega = \frac{10\times10^3\times120}{10\times10^3+120} = 118.6\Omega$$

$$\text{A}V_1 = \frac{\gamma_{o1}}{\gamma_{e1}} = \frac{118.6\Omega}{6\Omega} = 20$$

The amplified signal by Q_1 is phase reversed while the voltage gain, $\text{A}V_2$ of the second stage is given as:

$$\text{A}V_2 = \frac{\gamma_{o2}}{\gamma_{e2}}$$

$$\gamma_{o2} = R_5 \parallel R_6 = 2.2\text{K}\Omega \parallel 100\text{K}\Omega$$

$$= \frac{2.2\times10^3\times100\times10^3}{2.2\times10^3+100\times10^3} = 2152.6\Omega$$

But, $I_{E2} = -100m\text{A}$ and $I_{C2} = 100m\text{A}$ *from the data book* [12].

$$\gamma_{e2} = \frac{V_{CE(sat)}}{I_{E2}} = \frac{0.6V}{100m\text{A}} = 6\Omega$$

$$\text{A}V_2 = \frac{\gamma_{o2}}{\gamma_{e2}} = \frac{2152.6}{6.0} = 359$$

The amplified signal by Q_2 is also phase reversed. Thus, the power gain, A_p of the second stage RC coupled amplifier is given as:

$$\text{A}_p = \text{A}V_1\times\text{A}V_2 = 20\times359 = 7180 \qquad (10)$$

In Decibel, it is given as;

$$G_p = 10\log_{10}\text{A}_p = 10\log_{10}7180 = 38.56dB$$

3.1.3 ANALYSING THE 3RD STAGE RC COUPLE AMPLIFIER:

The transistor in the 3rd stage serves as a voltage-shunt negative feedback amplifier, a portion of the output voltage is coupled through R_E in parallel with the input signal at the base. The feedback stabilizes the overall gain while decreasing both the input and output resistances, it can therefore be proved that $\beta = R_C / R_F$ from the data book [13].

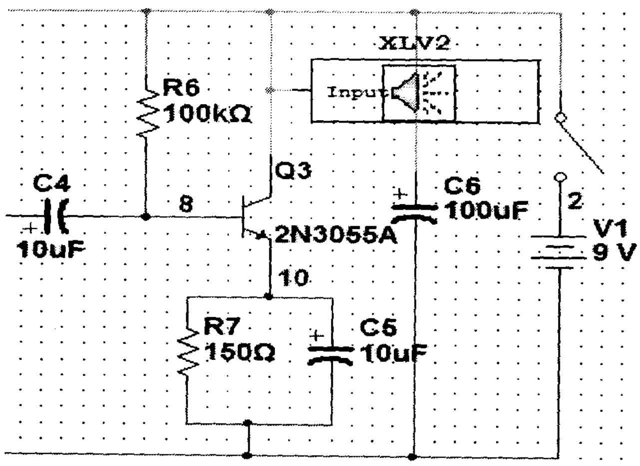

Plate VII: Diagram of the third RC couple amplifier

The voltage gain AV_3 of the 3rd and final stage of the three stage RC couple amplifier is

given as: $AV_3 = \dfrac{\gamma_{o.3}}{\gamma_{e.3}}$ (11)

From the technical data sheet, for Q_3=2N3055, $I_C = 4.0A$ and $I_B = 0.4A$ and $I_E = I_C$

The current gain β_3 is given as:

$$\beta_3 = \frac{I_{C3}}{I_{B3}} = \frac{4.0}{0.4} = 10$$

$$\gamma_{e.3} = \frac{V_{CE}}{I_{B3}} = \frac{1.1V}{4.0\text{A}} = 0.275\Omega$$

$$\gamma_{o.3} = R_6 \| R_7 = 100\text{K}\Omega \| 150\Omega = \frac{100 \times 10^3 \times 150}{100 \times 10^3 + 150} = 150\Omega$$

$$\text{A}V_3 = \frac{\gamma_{o.3}}{\gamma_{e.3}} = \frac{150\Omega}{0.275\Omega} = 545.5$$

Overall power gain $\text{A}_p = \text{A}V_1 \times \text{A}V_2 \times \text{A}V_3$

But $\text{A}V_1 \times \text{A}V_2 = 7180$

Therefore, $\text{A}_p = 7180 \times 545.5 = 3916690$

In decibel it is given as;

$G_p = 10 \log_{10} 3916690 = 65.9d\text{B}$

3.2 CONSTRUCTION AND TESTING

The design of the two way intercom was done. The implementation of the project was temporarily done on a breadboard. Some preliminary tests were carried out to determine the state of the components to be used. Thereafter, these components were soldered on the veroboard according to the circuit lay-out. The tests carried out include:

1. Determination of the collector, base, and emitter terminals of the transistors using a digital multimeter.
2. Confirmation of the values of the resistors.
3. Determination of the values of the speaker and microphone.

3.2.1 CONSTRUCTION

The implementation was carried out in two stages, the temporary construction was done on a breadboard to confirm that the simulated circuit was realisable, then the final and permanent construction was carried out on a veroboard.

3.2.1.1 TEMPORARY CONSTRUCTION

The simulated circuit was physically implemented on a breadboard. All the components used were of the same value as those used in multisim. Those components which are the microphone and speakers that could not be attached to the breadboard directly were connected using connecting cables. Various tests were carried out during implementation to ensure that correct polarities of components were strictly adhered to and continuity maintained. The pictorial diagram of the temporal construction is shown below:

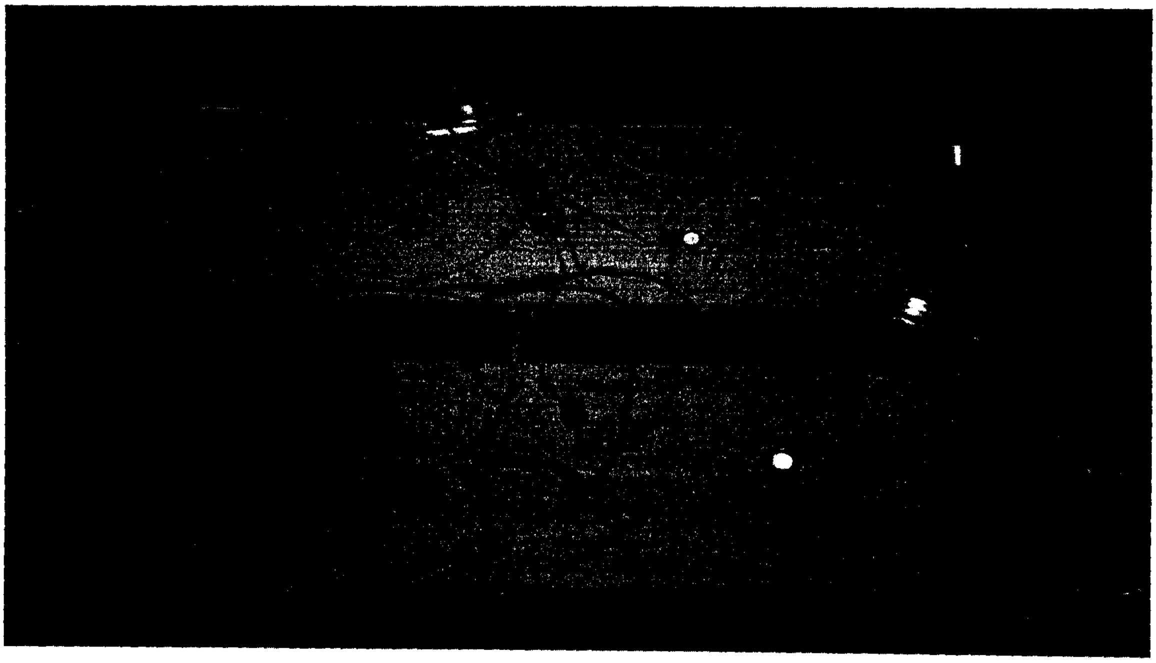

Plate VIII: Construction on a breadboard of the two-way intercom

3.2.1.2 PERMANENT CONSTRUCTION

The exact circuit on the breadboard was transferred to a veroboard which components were soldered to the circuit. Plate IX depicts diagram of the veroboard implementation.

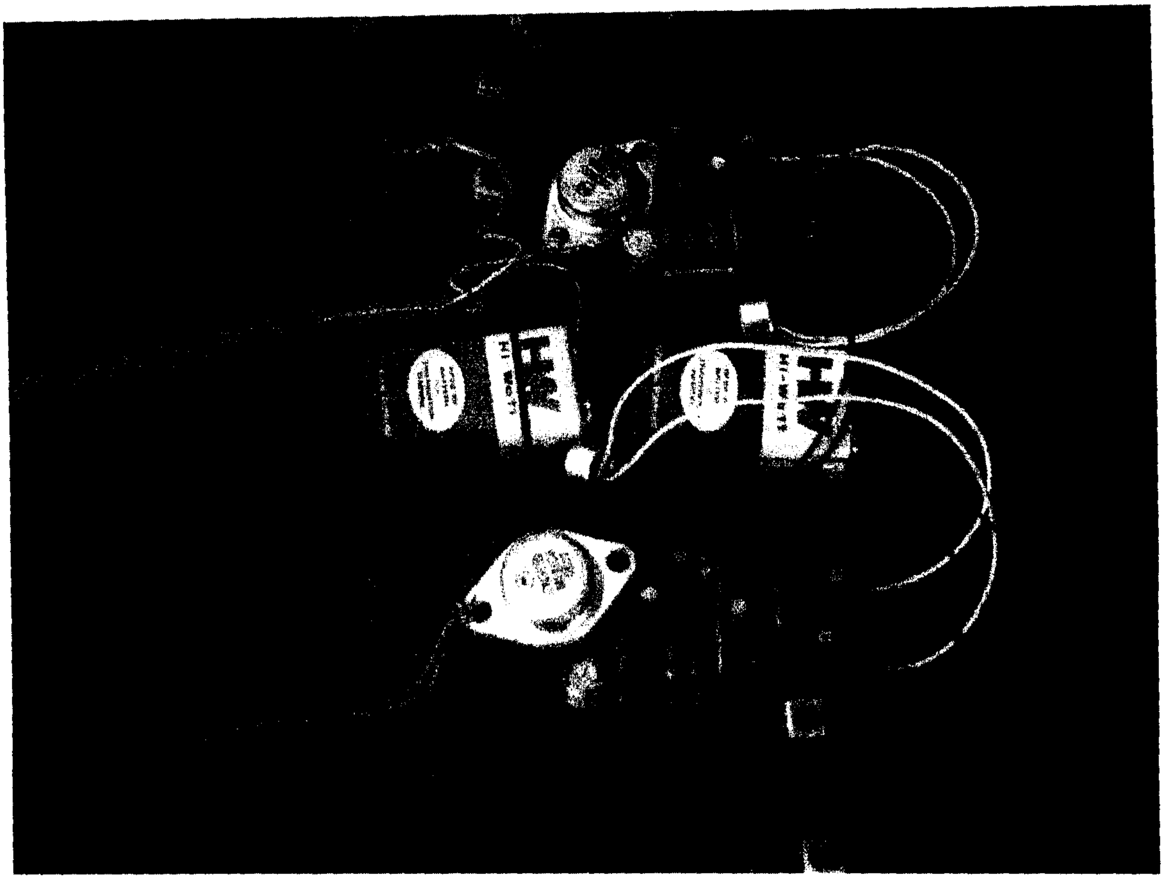

Plate IX: A permanent construction on a veroboard of the two-way intercom

For protection and aesthetic purposes, the veroboard was enclosed in a case. The case is made of wood and plastic sheet. The cased work is represented in Plate X below:

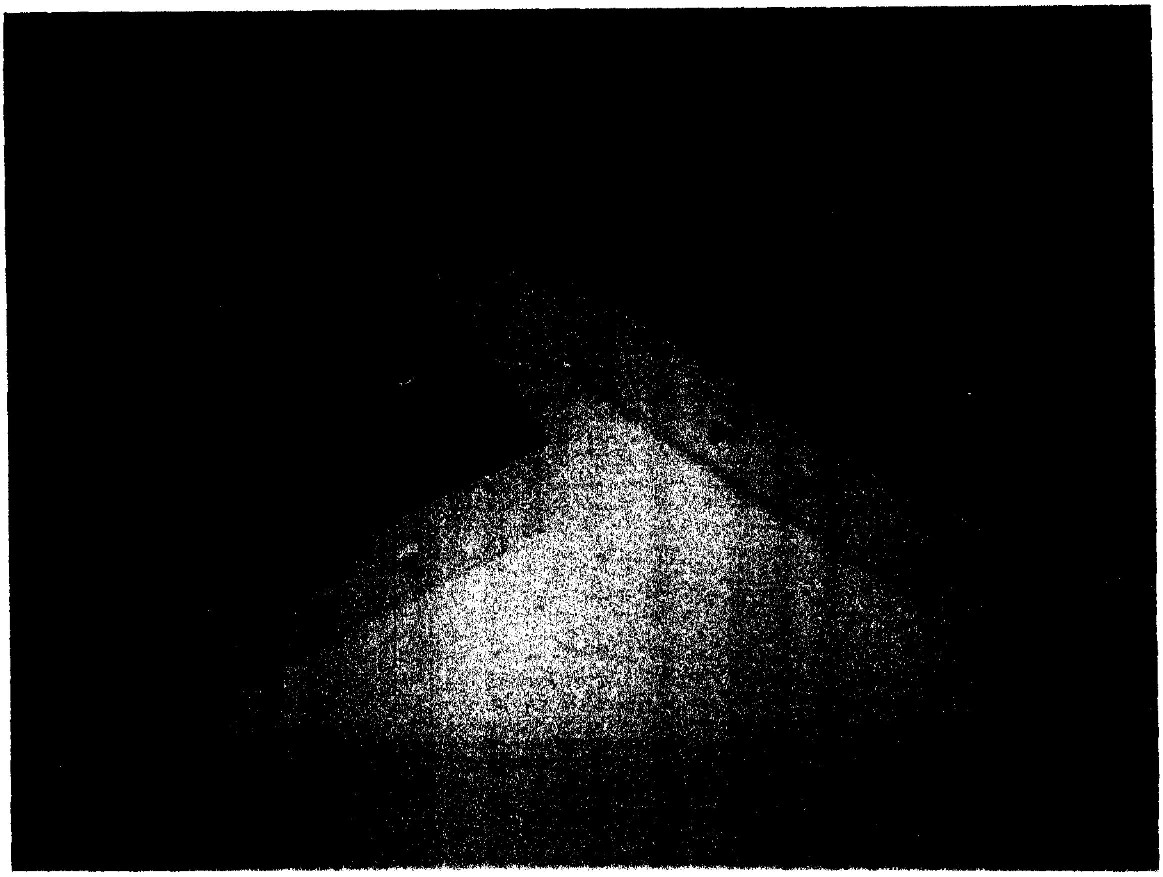

Plate X: Picture of the cased Two-way intercom system

3.2.1.3 CONSTRUCTION OF CASING

During case construction, allowance was made for easy maintenance. The subscriber units were two in number constituting the channel system. Spaces were also provided for the switches, cables and sound outlet.

For the case construction, the materials used were wood and plastic. The veroboard containing the circuit was then placed in the constructed casing. It was fixed firmly at appropriate points on the casing.

3.3 TESTING

Most of the testing had been performed before construction i.e. appropriate placement of components on the breadboard, measurement of the components during construction, the output of each stage was monitored and the final stage of testing was done when the project had finally been completed.

3.4 PRECAUTIONS

Several precautions were taken in putting this project work together; this was done to ensure the system works according to specifications without damaging its components in the process of construction. The precautions are as follows:

1. The circuit diagram was followed carefully during the breadboard and veroboard stages of the construction.
2. During soldering of the components on a circuit, care was taken to prevent accidental bridging of the veroboard copper strips.
3. Utmost care was taken while assembling the constructed work within the case in order not to cause any damage to the work.
4. Some components were separated via a connecting cable so as not to allow them touch each other during the temporary breadboard implementation to prevent accidental short circuits.
5. Continuous test for continuity was carried out during the implementation stages of both the temporary and permanent construction to prevent open circuits.

CHAPTER FOUR

TESTS, RESULTS AND DISCUSSIONS

The tests carried out and results obtained in the course of the design and implementation of the work is divided into two broad categories namely:

1. Simulation and results
2. Construction, tests and results

4.1 Simulation and results

After the circuit has been simulated, the following tests were carried out and the results were obtained using an oscilloscope to view the output waveform.

4.1.1 Input Waveform

The measured input frequency using a microphone was 300Hz. Using an oscilloscope, the wave form of the input frequency was obtained as shown below:

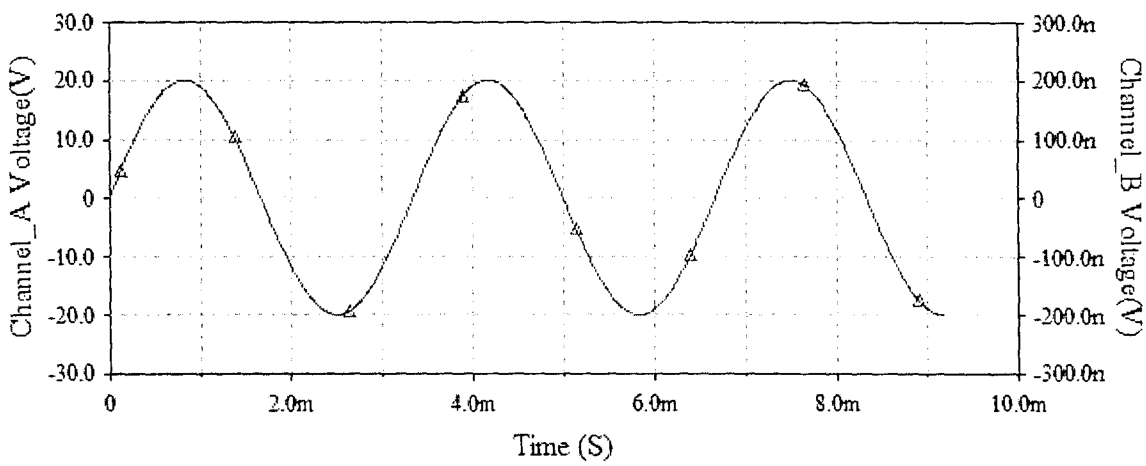

Fig. 8: Waveform of the input frequency

4.1.2 Output Waveform of the circuit

The final waveform of the 3rd oscilloscope which is the general output using an oscilloscope is shown below:

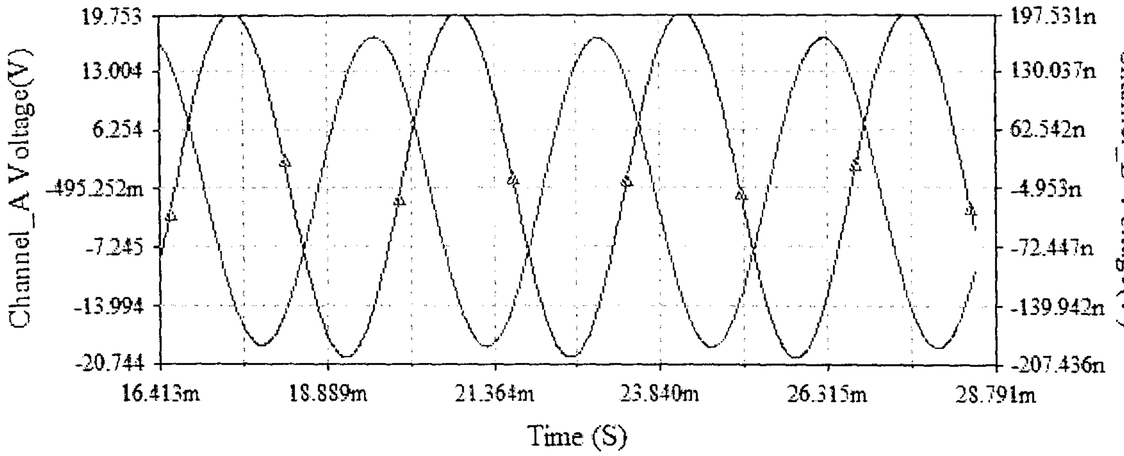

Fig. 9: Output Waveform of the circuit

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The two way intercom has been designed, constructed and tested. The results are in conformity with all results obtained in other literatures of some researchers that did significant work on two way intercom. Important precautions were also taken to ensure that results were obtained.

Computer simulation was performed using an electronic workbench application known as multisim. It provided a deep insight into the project work as it allows extensive testing. The circuit was designed and constructed such that its efficiency is very high, the mode of operation was made easy with the total cost of this project and the components used were relatively cheap and readily available.

5.2 RECOMMENDATION

The two way intercom is used in the case of two links but can be increased in the case of more links which could be four-way or six-way depending on specification of the user and where it is required.

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