DESIGN AND CONSTRUCTION OF TWO WAY INTERCOM

BY

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2000/9872EE

DEPARTMENT OF ELECTRICAL AND
COMPUTER ENGINEERING

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OCTOBER 2006

DEDICATION

This project is especially dedicated to Almighty ALLAH and to my beloved mother MALLAMA AISHA GOGOWODU MOHAMMED for her love and tender care.

DECLARATION

I, MOHAMMED G. YAHAYA, declare that this work was done by me and therefore presented for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

MOHAMMED G. YAHAYA	MR. ADAMU M.B. ZUNGERU
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H.O.D	EXTERNAL EXAMINER
Signature and Date	Signature and Date

ACKNOWLEDGEMENT

I give ALLAH (SWT) 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 acknowledge the effort of my supervisor MR. ADAMU M.B. ZUNGERU for his sound advise leading to the completion of this project work and also my H.O.D ENG'R M.D ABDULLAHI, for his guidance in our academic work.

My appreciation goes to my parents ALH. ADAM MOH'D and MALLAMA AISHA G. MOH'D for their love and tender care. Also to ENGR B.K and family, MALLAM ABDULLAHI WAZIRI and family,ENGR.Y.YISA, NDABAKO,AGBA ,my friends and the entire manzwakwa compound and descendents peace be unto you all Amin.

ABSTRACT

The development of telecommunications has been growing with new methods that are effective and intelligent

However, the primary needs of a man as regards to communication with his environment are of paramount importance. The two-way intercommunication system has been developed with the purpose of providing a cheap but yet efficient means of communication in a relatively small society or establishment.

The system makes use of UA741 and TDA2822 amplifier, which is primarily responsible for the amplification of the sent signal "acoustic signal". And ICs CD4060 and CD4061 for generation of ringing tone

Channels were linked via the use of button switches.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 THE NEED FOR COMMUNICATION

Communication and expressiveness are vitals to the biological survival of all living creatures. Recent studies dealt with the range of animals Communication, have that these creatures communicate by body movement or making sounds to indicate danger, discovery or desire [7]. Primitive man developed methods of communicating with his immediate society and even longer distances. An early method includes drumbeats, fire, instruments such as horn etc.

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

1.2 DEFINITIONS AND CONCEPT OF COMMUNICATION.

In electrical engineering terms, communication refers to the sending, processing and reception of information using electrical means. The information or message to be sent, processed and received (i.e. to be communicated) may take different forms. It may be voice, picture, written message, electrical signals etc.

A communication system is, therefore, a technique or equipment that is used to send process and receive messages. This may take the form of telephone network, radio links, satellite and optical fiber, amongst others [1].

Telecommunication is the transfer of information from one point to another distant one. The prefix "Tele" is from Ancient Greek word meaning "far". In modern.

terms, telecommunication is the electronic transmission of sound, data, facsimiles, pictures, voice, video, and other information between systems using either analogue or digital signaling techniques. It is the bedrock of modern civilization. Without it commerce and industry as we know it today would not have existed. Certainly, man's probing into space would be impossible. It is difficult to imagine what the effect on our lives would be without reliable, economical and efficient means of communication.

Therefore communication is not just concerned with technology but it is primarily concerned with people and in the best analysis, any communication administration must be judged not by its equipment, but by how well it meets the need and aspiration of the people it serves. A feel of the advancement in the communication world can be felt when you make a call to a friend who is overseas, and the response sounds like he or she is next door thereby reducing the need for distant journeys, which involve high risk and cost. But in the technological field, the continual research by communication engineers have been able to so far provide for the communication needs of our world with the use of optical fiber, coaxial-
cables, Power Line Carrier Communication (PLCC), radio link, and satellite transmission thereby actualizing the concept the world as a global village.

1.3 INTERNAL COMMUNICATION

An intercom is a device, which allows normal conversation between people in a specified area. The intercom is a cheap and effective means of communicating within an office block, an 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; within an organization with its

name derived from the role it plays as a good means of internal communication. However, with the rapid development of telecommunication in recent years, it has become one of the most interesting subjects of study in the world. 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 intercoms.

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 its port of call. However, the automatically operated one does not need 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 study was carried out in order to develop a cheap, affordable and efficient means of communication for our local industries/organizations. Past works were studied and their defects such as manual connection between the caller and the called subscriber at the master station were corrected by replacing it with a digital exchange.

1.5 SCOPE OF STUDY

This project focuses on transmission of information or messages within a short 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 METHODOLOGY

This intercom is powered by a.c and an alternative supply of 9volt battery. The system works on the basis of voice communication over bounded medium (wired). This method of communication (duplex) allows both connected parties to simultaneously listen and talk at the same time, unlike the simplex mode of intercom link in which there can be only one at any point in time. Thus, conversation is not too effective with respect to time, although it does allow the use of simpler communication arrangement. The intercom system is self-contained and also A.C-driven with a network of the two power sources maintaining uninterrupted audio link in the event of a dead battery or power outage.

1.7 JUSTIFICATION

It is generally an accepted fact that traveling a 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 establishments with a tight budget will be a most 'welcome development. The fact that it needs no master station to operate it eliminates the need for second operator. All this provides good justification for which this project is to be achieved.

CHAPTER TWO

2.0 THEORY

2.1. THEORITICAL BACKGROUND

Basically, the telephone comprises of transmitter, receiver and other several components such as gravity switches, the buzzer "alarm" induction coil, alternating current a.c source. The principles that govern the concept of the telephone are those of sound (varying air pressure) electricity and magnetism.

When a person speaks, sound is produced by puff of air from the vocal chord 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.

2.2. LITERATURE REVIEW

As stated earlier, drumbeats, fire, smoke signals and the ram's horn were methods used in the early times. During the middle ages, homing pigeons were used to transmit messages.

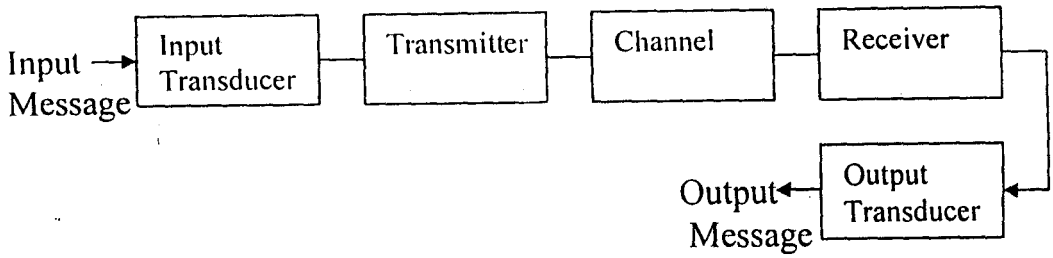
During the 17^{th} century, a significant step was taken in the area of telecommunications development when in 1667 the English physics Robert Hooke invented a strong telephone that conveyed sound over an extended wire by means of mechanical vibrations [8].

Since then, some speedy developments/inventions have been witnessed. It was however in 1876 that Alexander Graham Bell was granted the patent for electric speaking telephone; he had discovered that only a steady current could be used to transmit the human voice [8].In 1877, he produced the first telephone to transmit and receive the human voice with all quality and sophistication.

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 state, Japan, Holland and France [1]. With further developments in electronics and computer technology, more barriers are expected to be broken or surmounted through the development of better, faster and more efficient communication system [1].

2.3 BLOCK DIAGRAM OF A COMMUNICATION SYSTEM

Figure 2.30 shows a simplified block diagram of a typical communication.



2.3.1 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 to 3400Hz is sent into the input transducer by a person speaking into the sound waves are the converted to voltage variations by the microphone and sent through the wires on the transmitter [1].

2.3.2 TRANSMITTER

Essentially, the transmitter couples the message to the channel. It is at the transmitter that, if necessary, a carrier wave is modulated by the message signal. Modulation is the modification of one of the parameters (amplitude, frequency, phase etc.) of the carrier wave, usually of much higher frequency than that of the message

signal. The parameter to be modified or modulated varies from one system to another, depending on the system requirements [1].

Modulation is employed in communication systems for the following reasons.

1.For channel assignment: Each message signal is transmitted at a unique frequency band to avoid mix-up with other signals.

2. To reduce noise and interference, particularly at low frequencies.

3. To overcome equipment limitations, e.g. size and weight.

4. For easy radiation and reception of signals by using practically realizable antenna sizes.

5. For multiplexing so that several messages can be transmitted through the same single channel [1].

2.3.3 CHANNEL

This is the medium through which signal gets to the receiver. It may have many, different forms ranging from the ground, through underground or overhead cables, to sky and space. Therefore, the transmitter can be either hard-wired or non-wired (wireless or radio) to the receiver [1].

2.3.4 RECEIVER

The receiver in a communication system processes the desired signal from the 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 reduced signal if the signal level is low (voltage or power). Demodulations occur at the receiver and a good characteristic of a good receiver is its ability to select the desired signal and reject any unwanted signal [1].

2.3.5 OUTPUT TRANSDUCER

This is a device that converts the electrical output signal of the receiver into the form desired by the user. For example, a loudspeaker convert electrical signal to sound waves for the listener to hear, the cathode ray tube (CRT), meters and oscilloscopes are also examples of output transducer [1].

2.4.0 CATEGORIZATION OF TELEPHONE SYSTEM

Telephone system may be categorized by the nature of transmission used.

1. SIMPLEX SYSTEM:- The system allows transmission in one direction at a time. It provides communication in either direction alternatively in instances where transmission is unidirectional [4].

Figure 2.40 illustrates the simplex communication system.

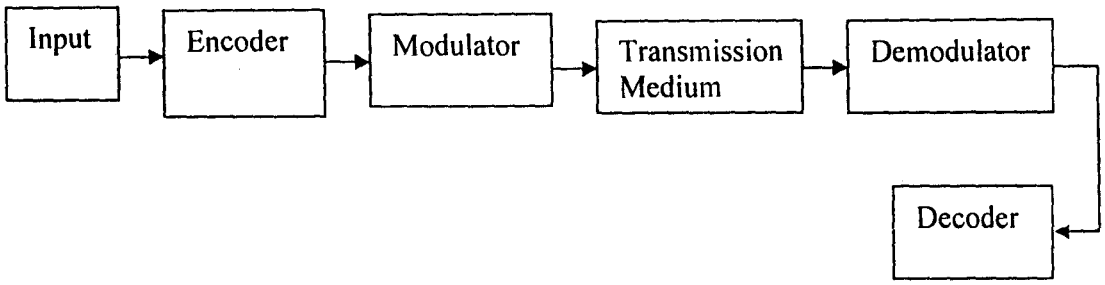


Fig. 2.4Diagram of a Simplex Telephone System

2. DUPLEX: - This allows simultaneous transmission in both directions; this is normally accomplished by using two separate circuits. One circuit for each direction although it is not economical because of duplication of facilities [4].

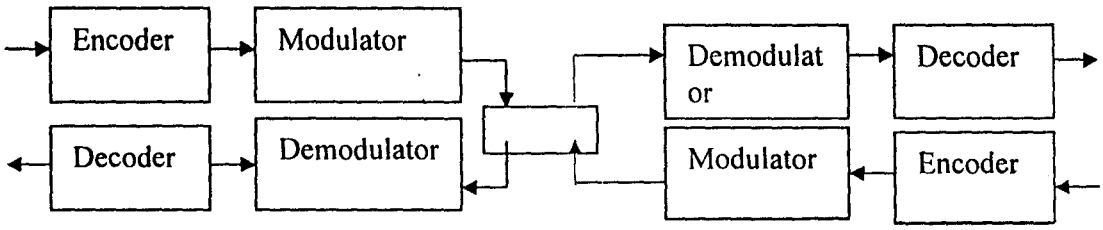


Fig 2.4.2 Diagram of a Duplex Telephone System

Fig 2.4.2 Diagram of a Duplex Telephone System

2.5.0 BASIC TELEPHONE SYSTEM

A simple two points telephone circuit uses a single pair of wires (or one wire with ground return) and two telephone sets of self-contained type. Each set is self-contained and does not use any control office equipment. This arrangement is illustrated in fig 2.50 with all the hand sets hanging on the hook switches, the signaling circuit is complete and putting the switch on at one set will cause the bell at the other set to ring, when the handsets are picked up, the exchange (sequential circuit) automatically triggers up to provide +Vcc voltage to the two amplifiers thus giving rise to establishment of conversation between the people.

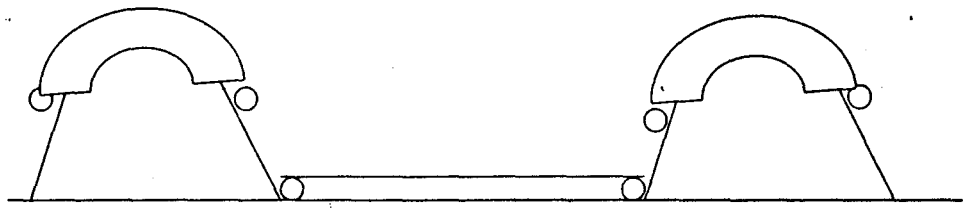


Fig. 2.5 Diagram of a basic telephone system

From fig 2.5 above, it will be difficult in the arrangement above to connect a subscriber to several other subscribers say hundreds or thousands. This fully interconnected system has a limit both in terms of number of subscribers and in the geographical location that can be covered. To overcome this problem, a central point to which all subscribers are connected is provided. Thus this central point is called switching center or exchange.

2.6.0 THE EXCHANGE

As defined above, the exchange is the switching center where a person with a, line would be able to speak to any other person with a similar connection. There have been three generations of exchanges:

i. The analogue Exchange: this is a purely mechanical, is considered as the first generation. In this type of exchange an operator makes the connection between subscribers [4].

ii. The semi Exchange: Here mechanical and electrical are combined. Example of this is the cross bar system [4].

iii. The electronic Exchange: This is purely electronic, in this digital system; the interconnections are made by the exchange central processor, which is usually with the aid of decoders, gates, PROMS. Example of this is HICOM 300 [4].

CHAPTER THREE

3.0 SYSTEM ANALYSIS AND DESIGN

3.1 OPERATING PRICIPLES OF THE TWO WIRE INTERCOM

The system operates on a dual power source i.e a.c and a 9volts battery. For communication to be initiated, both power packs must be switch ON at both stations. The ringer switch from station A would be pressed and held until the privacy switch of station B is pressed. Communication can then begin and vice-versa. To end a call the privacy switch is pressed again on both stations and this terminates the call.

3.2 DESIGN AND IMPLEMENTATION

The 2-way full duplex room intercom is build around the following subsystems;

i A linear microphone preamp

ii A digital ringing tone generator

iii A low-power audio op-amp

3.2.1 LINER MICROPHONE PREAMP

This subsystem comprises a UA741 integrated op-amp alongside Sauxiliary components. It is wired as shown below;

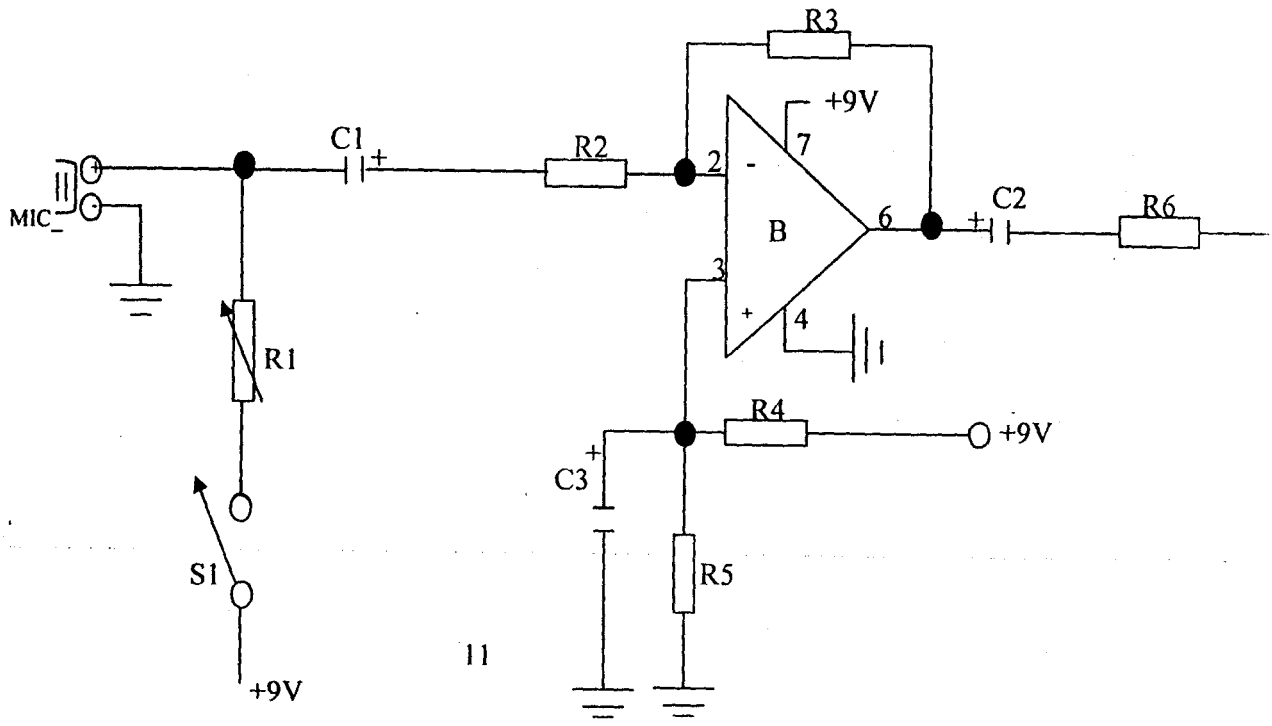


Fig 3.2.1 Diagram of a linear microphone preamp

The UA741 is wired in the inverting amplifier mode with a nominal gain given by the relation; $(-R_F/R_{in})$--------(1)

R_F= 47KΩ, R_{in}= 4.7KΩ

Using the values of the two resistances and employing (1), the gain is calculated as;

A= -47000/ 4700 = - 10.

The negative sign indicates that the amplifier is an inverting amplifier and an out-of-phase relationship between the input and the output.

Since most of the op-amps are designed for operation on dual supplies, i.e. 1Vcc relative to 0V, they have to be biased appropriately together on a single supply. The biasing arrangement is done using R4 and R5 as shown in fig 3.2.1 below.

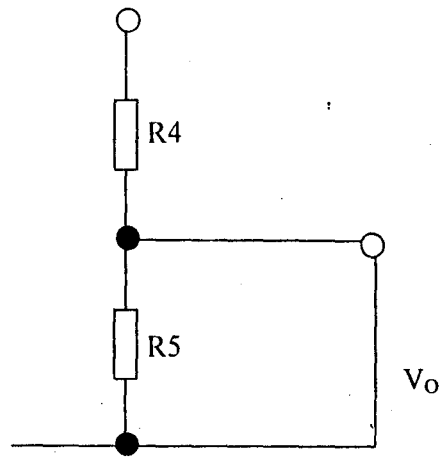


Fig 3.2.1

Using VR5=IR5 =0.00045*10,000=4.5V

The above value can also be obtained by employing the voltage divider rule;

VR5=Vcc*R5/ (R4+R5)=9*10,000/20,000=4.5V.

The 4.5V potential is stabilized by a 50V 10μF capacitor, and also connected to the (+) input of the op-amp. Thus, the dc potential at pin 6 of the op-amp is approximately 4.5V. This is the quiescent dc level on which the output AC voltage is superimposed, and around which the AC output signal symmetrically swings. The signal into the amplifier is derived from an electrets condenser microphone biased appropriately through a 50KΩ resistance. The biasing puts the capacitor in the operating region. Sound waves reaching the microphone are converted to electric signals for boosting to a higher level. A privacy switch enables/disable microphone activity when used. This prevents eavesdropping on the party after a conversation.

3.2.2 DIGITAL RINGING TONE GENERATOR

This subsystem is based on a CD4060 14-stage ripple counter and a CD4011 quad 2-input NAND gate.

TheCD4060 is also an oscillator; this functionality can be realized by suitable choice of components connected to pins 9,10,11 as illustrated below;

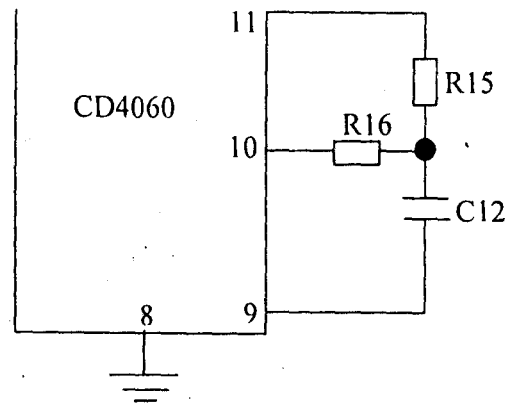
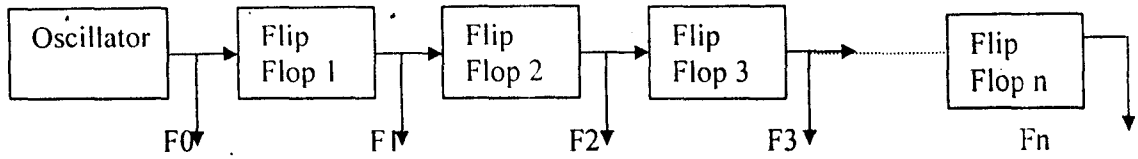


Fig 3.2.2.1 Diagram of a CD4060

The fundamental frequency of the oscillator is given by;

F=(1/ 2.3R2C1) HZ. By design resistor R1 is between (2 to 10) R2 for oscillation to occur. Oscillation occurs at the frequency given by the above expression.

The CD4060 has a 14-stage biasing counter connected to the output f the oscillator as shown below;



As each flip-flop is a divide by two elements (bistable), the output frequency at the output of each flip-flop is given by;

$Fn = F0/ 2^n$, Where n=stage number, and F0 is the input fundamental frequency.

For a counter chain of n series connected flip-flops, the output frequency is easily deduced from the above equation as $Fn = F0 / 2^n$.

A standard telephone ringer tone generator circuit was implemented using the CD4011and CD4060. The complete circuit is shown below

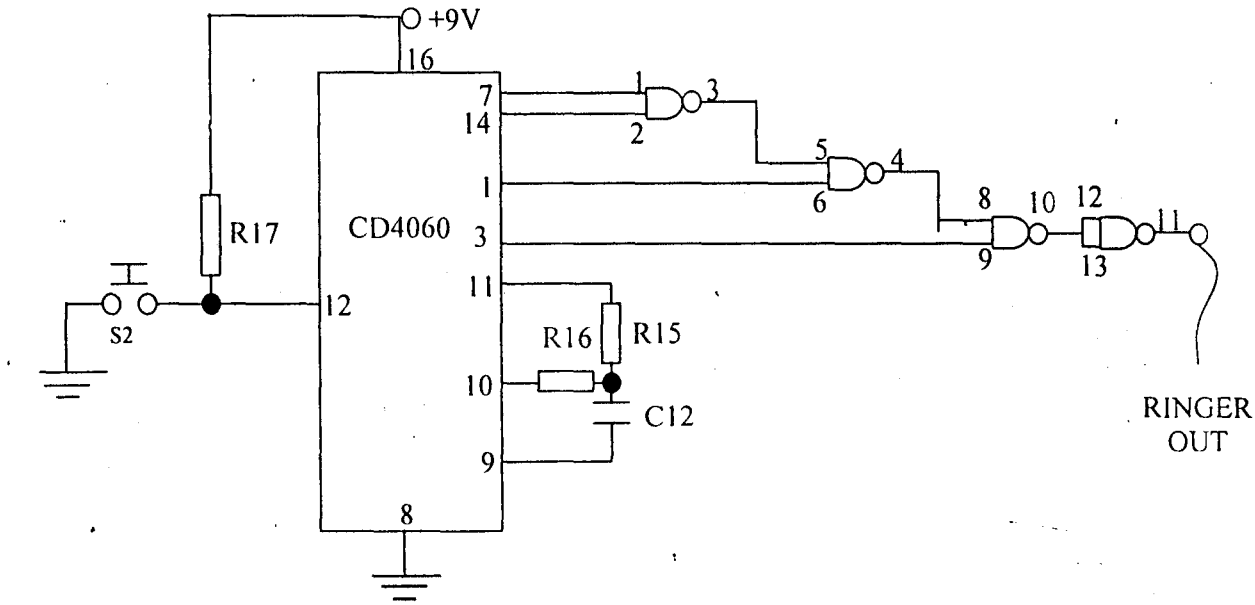


Fig 3.2.2.2 Diagram of a ringing tone generator

Four different output frequencies were generated using connections made to different outputs on the CD4060. From component values shown,

$F_{osc}=1/2.3R_TC_T=1/(2.3*10000*6.8*10^{-9})=6393HZ \approx 6400HZ$.

Applying this frequency to the 14 stages. The generated frequencies were tabulated below;

3.2.2.1 TABLE OF GENERATED FREQUENCY

STAGE NUMBER	OUTPUT FREQUENCY (HZ)
1	3200
2	1600
3	800
4	400
5	200
6	100
7	50
8	25
9	12.5
10	6.25
11	3.125
12	1.5625
13	0.78125
14	0.390625

From an adaptation of the standard ringer system; the following four frequencies were NANDed together to generate the needed complex waveform; 400HZ, 25HZ, 1.5625HZ, and 0.390625HZ. These frequencies were gotten from Q4, Q8, Q12, and Q14 respectively. They were NANDed as shown below:

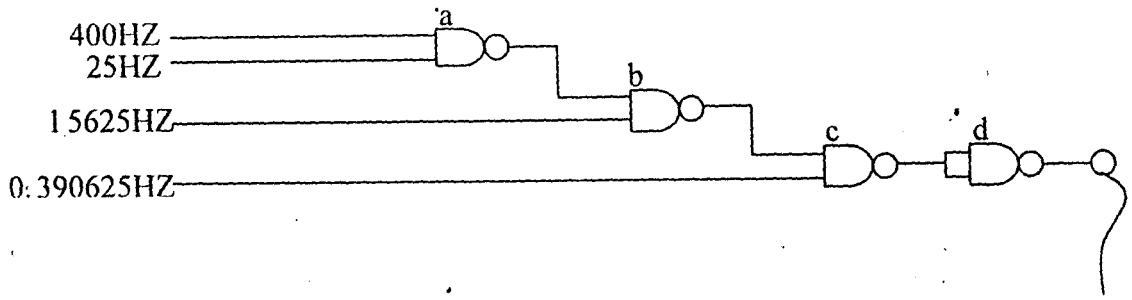


fig 3.2.2 Diagram of CD4011

The resulting ringer out waveform was summed with the amplified microphone signal before transfer over the connecting cable.

TheCD4060 is held rested by a 10KΩ resistance connected between Vdd (pin 16) and RESET (pin 12) [5]. A switch, TONE, pulls RESET low when closed, thus disabling reset. With RESET disabled, the ringer circuit is activated, and thus a ringing tone is sent over the connecting cable to the intercom at the other end.

3.2.3. LOW POWER AUDIO AMPLIFIER

This is a TDA2822 dual-channel (stereo power amplifier) configured in the bridge mode [6].

The TDA2822 rms off a supply of +3V to +12V, delivering 1.5W into 4Ω (typical). It has a fixed internal gain, and was configured as shown bellows.

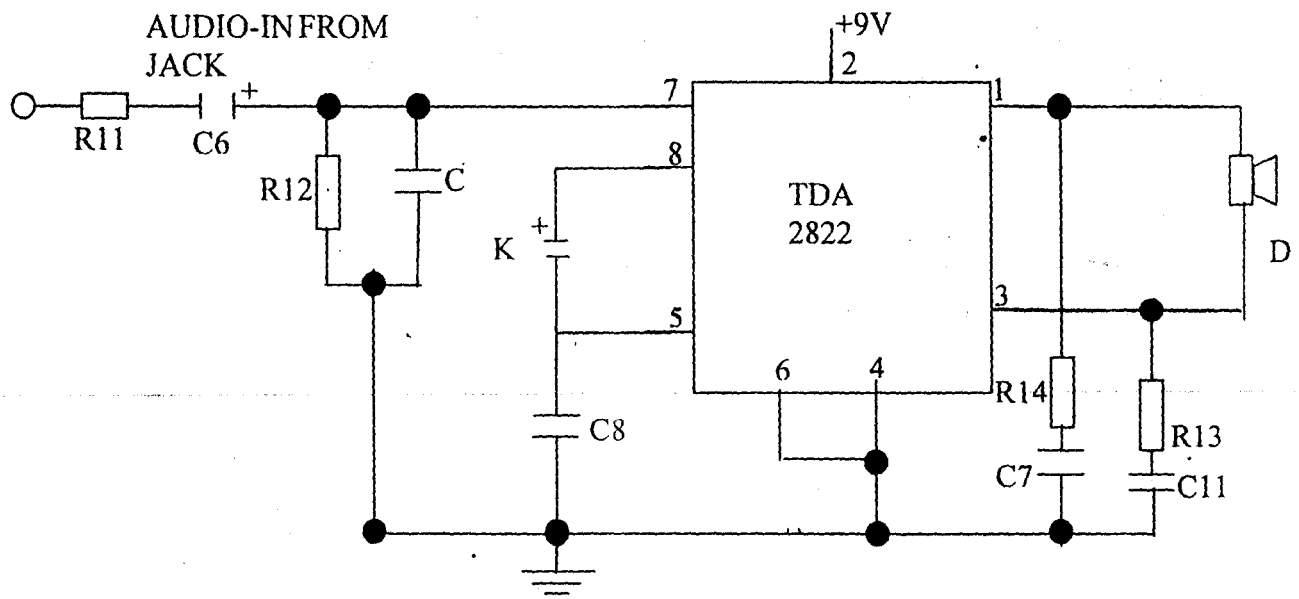


Fig 3.2.3 Diagram of a low power audio amplifier

3.3 AUDIO IN AND AUDIO OUT SOCKET

The full duplex audio link is effected using a stereo headphone jack as shown below:

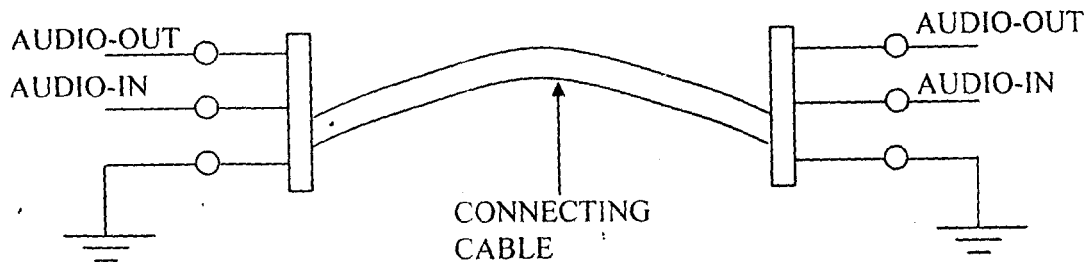


Fig 3.3 Diagram of a stereo headphone jack

A crossover cable was used to make the two units as the signal flows are in the same direction. The crossover wiring allows the audio-out of a unit to fed into the audio-in of another unit. This scheme allows multiple units to be interconnected without rewiring the connection on board the two units.

3.4 POWER SUPPLY

The power supply is gotten from two sources; a 9V regulated DC source (from rectifier) and a +9V DC battery source. The two sources were ORed as shown below

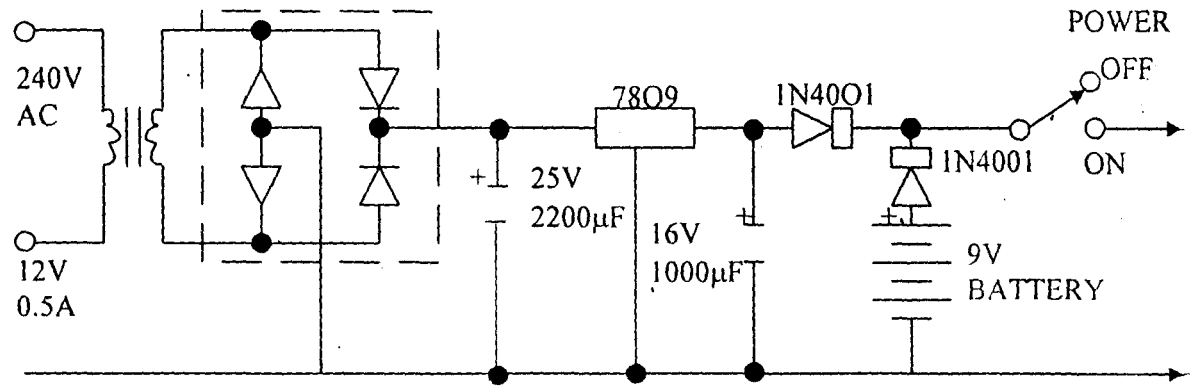


Fig 3.4 Diagram of Power Supply

The regulated 9V DC source is derived from the rectified DC output of a 12V 0.5A transformer

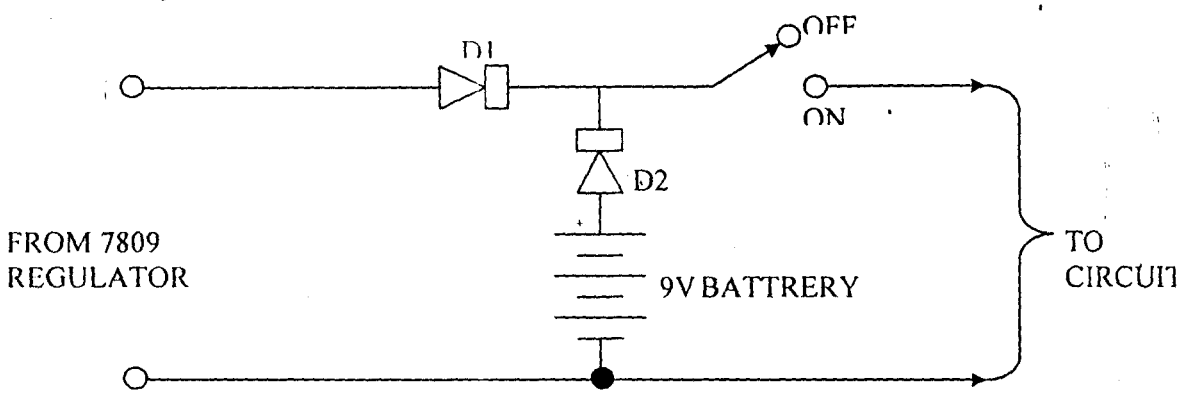
3.4.1 CALCULATIONS

Vrms=12V

Vsm=(12(2)^0.5

Vpeak (rectified)=(12(2)^0.5 – 1.4) V [2].

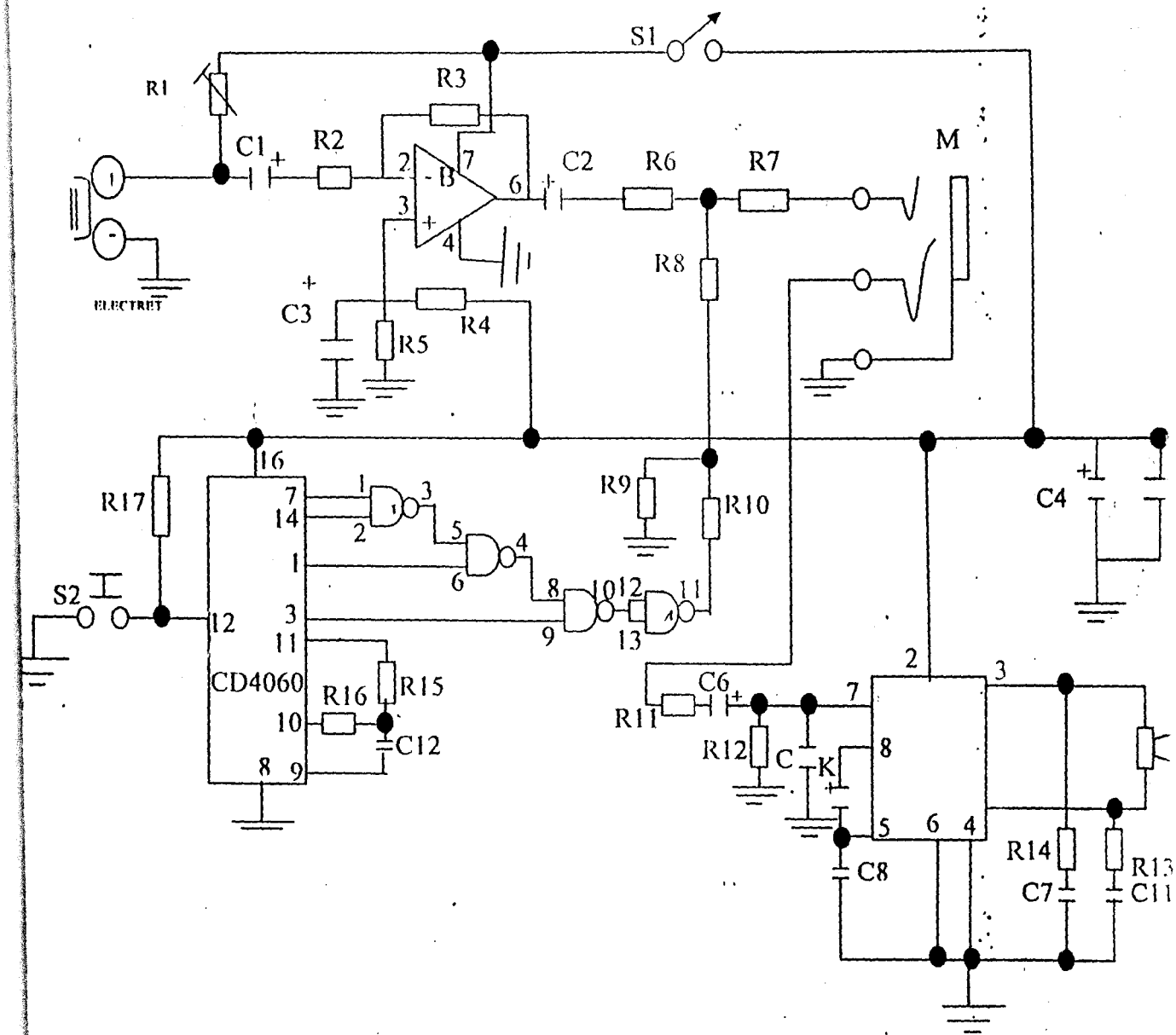
This voltage is applied in to the input of a 7809 9V fixed –voltage regulator to produce a ripple-free 9V output. This 9V output is ORed with the battery supply as indicated below;



When the 9V supply from the regulator is present, D1 is forward-biased and since the battery terminal potential difference will be slightly lesser than 9V, D2 is reverse-biased. Thus, the circuit receives power from the regulator. When AC supply fails, D2 switches on, supplying power t the load from the battery.

This arrangement ensures maximum battery life, as it will not be utilized when AC mains voltage is present, and the power pack is connected.

3.5 COMPLETE CIRCUIT DIAGRAM OF TWO WAY INTERCOM



3.7 TABLE OF COMPONENT VALUE

R1 50KΩ	C1 50V0.22μF	A MIC
R2 4.7KΩ	C2 16V10μF	M SOCKET
R3 47KΩ	C3 50V10μF	S1 PRIVACY SWITCH
R4=R5=R6=R7=R8=10KΩ	C4 35V2200μF	S2 RINGER SWITCH
R9 2.2KΩ	C5 0.1μF	S POWER SWITCH
R10 10KΩ	C6 25V0.33μF	D SPEAKER (8Ω)
R 11KΩ	C7=C8 0.1μF	Y SUPPLY (+9V)
R12KΩ	K 1.0μF	B UA741
R13=R14 4.7KΩ	C 0.001μF	
R15 100KΩ	C11 0.1μF	
R16	C12 6.8nF	

CHAPTER FOUR

4.0 LAYOUTS TESTING AND CONSTRUCTON

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 workability of the design the system was certified to be working, the components were then permanently fixed by soldering on a Vero board.

The breadboard 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 breadboard, according to the specifications of the project design. All the adjustments were made using the breadboard, and the effect of interchanging components was observed and noted [3].

The breadboard 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.

The Vero-board is an insulator strip, comprising several parallel tracks of strips with small holes drilled along its length, giving a matrix format. The components were fixed to the Vero board by placing each of the pins of the components in a separate hole with the pin soldered into the hole in accordance with the circuit design. This ensures rigidity of the components. Uniformity of the arrangement of components with the tested design was ensured which eliminates the removal of components for the purpose of correction.

4.2 CONTRUCTION OF CASING

Allowance was made for operating the sets to the system accessible for easy maintenance. The subscribers units are two in number, which made it a channel system. Spaces were also provided for the switches, cables and sound outlet.

Lastly, floor flex tiles were chosen for the casing because of its lightweight, availability and easy to work with it. The Vero board was then inserted into the constructed casing so as to avoid short-circuiting. The switches were firmly fixed at appropriate points on the casing.

4.3 PRECAUTIONS

Several precautions were taken in putting together this project. This was done to ensure the system working well with components not damaged in the process of construction so as to maintain a low cost of construction. Below are some of the precautions;

i. The circuit diagram was followed during the breadboard and Vero board stages of the construction.

ii. The values of the circuit components were ensured to be very closed to their calculated values.

iii. The correct polarity of the components "Ics" used were correctly ascertained before soldering so as to prevent internal damages that may be caused to them

iv. Screw drives or any conduction substances that could bridge the legs of the IC's were kept away from the immediate working table during soldering.

v. Proper soldering techniques were applied – stray solders were carefully removed to avoid short-circuits. High grade soldering lead was used with IC sockets so as to reduce ICs damage when heat of the soldering was high.

4.4 TESTING

Most of the testing had been performing before construction i.e. bread boarding, measurement of the compoyents value such as capacitor, resistors etc. During, construction, the output of each stage was monitored and the final stage of testing was done when the project had finally been completed. This was achieved by making use of the two channels with the exchange. The switching system was well tested and everything was found to be in perfect shape.

4.5 BLOCK DIAGRAM

The block diagram below shows the typical process of two wire intercoms works.

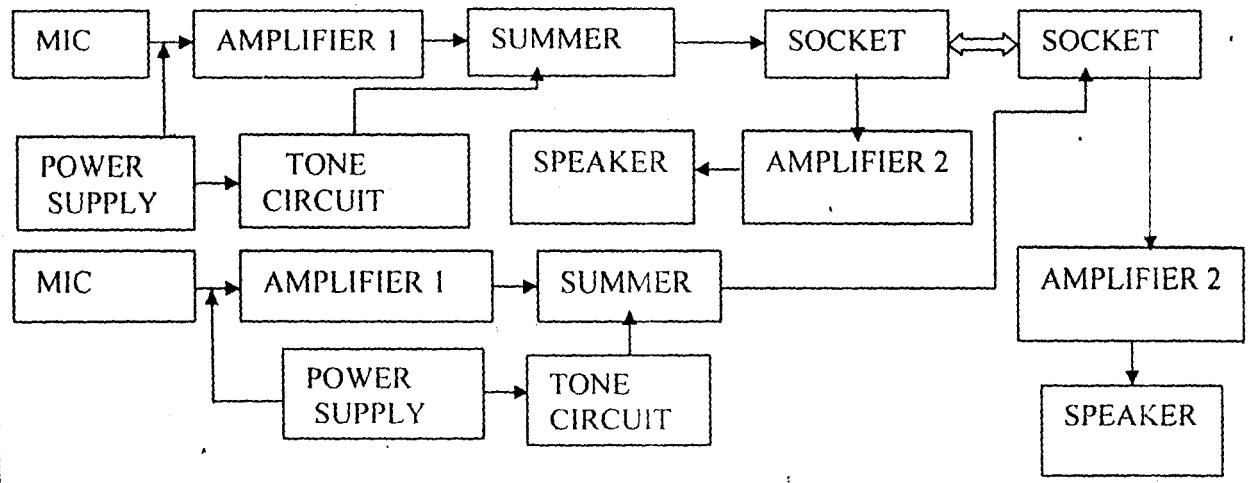


Fig 4.5 Block diagram of a two-wire intercom

4.6 PHOTOGRAPHS OF THE CONSTRUCTED WORK

Below shows the top and side views of the constructed work of two-wire intercom

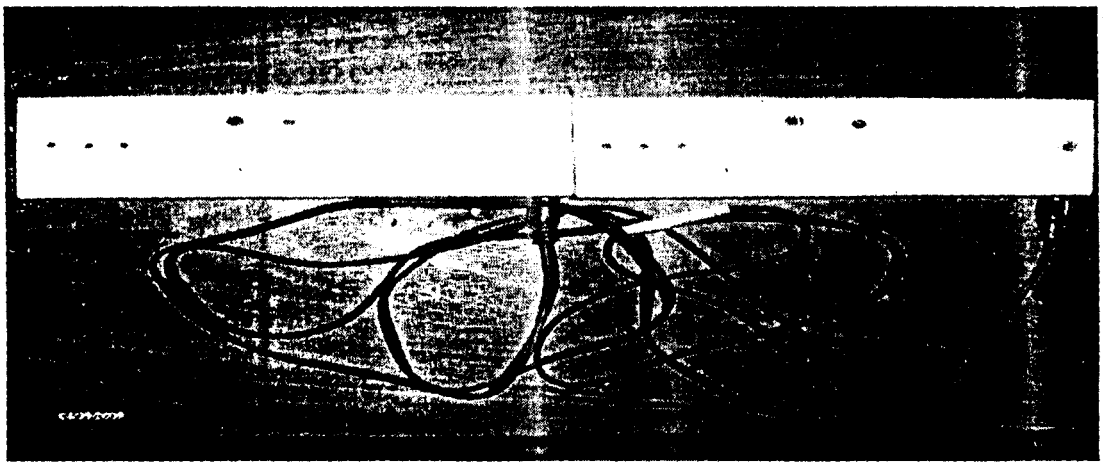


Figure 4.6.0 Top view

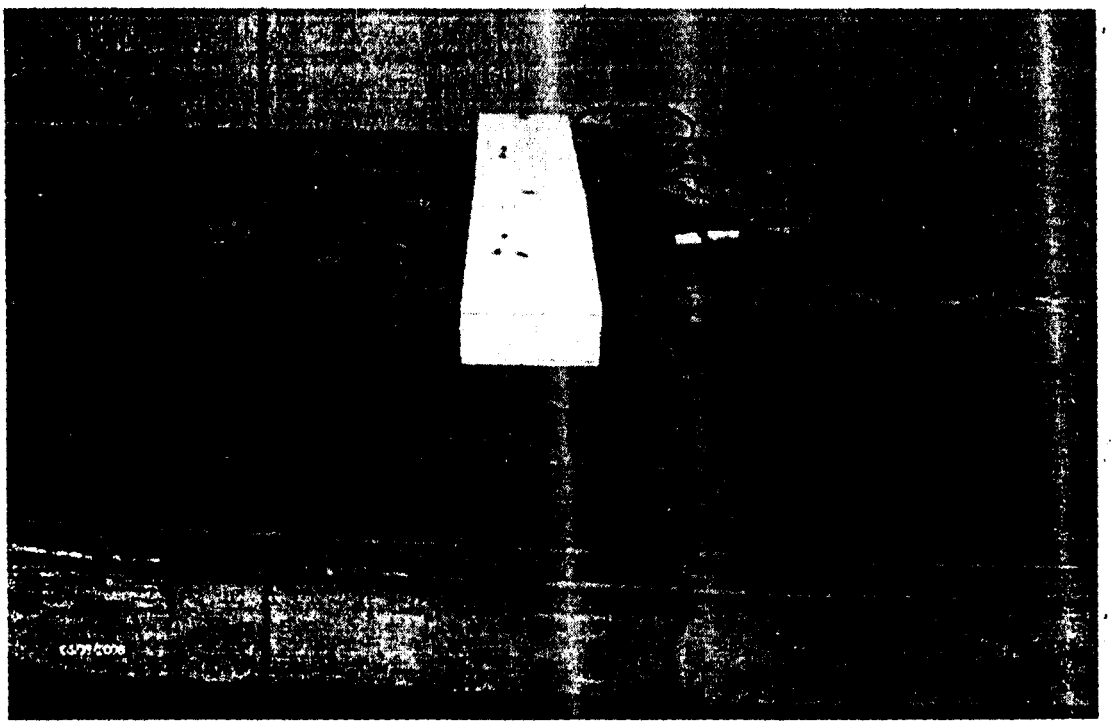


Figure 4.6.1 Side view

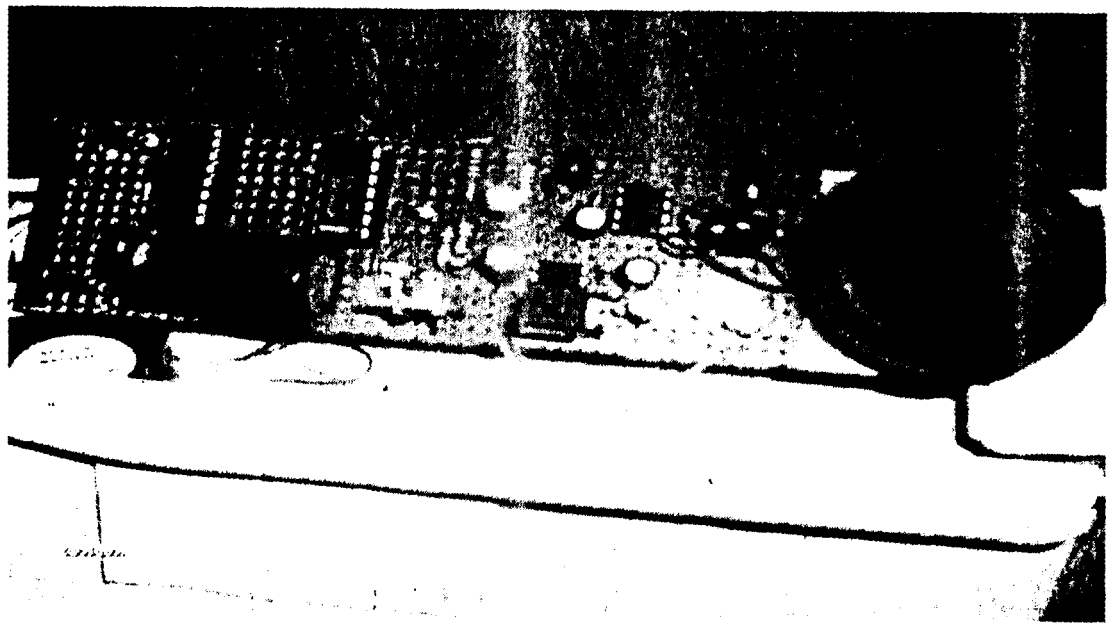


Figure 4.6.2 The Vero board

CHAPTER FIVE

CONCLUSION AND RECOMENDATIONS

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-wire intercom system.

This work has accorded me the opportunity of knowing the great extent to which telecommunication has been developed, and became familiar with the components used, their working principles and applications.

5.1 ACHIEVEMENTS

The construction of an intercom system was fully achieved at low cost with the best materials. It was also able to incorporate tone generator. The system was designed to have a good quality, low noise output by taking into consideration the gain and the feed back of the amplifier.

5.2 RECOMMENDATION

The work that has been done here can still be worked upon again and improved on so as to make the system more efficient and compatible in line with modern trends. The improvement can be in such away that the manually operated turn ON and turn OFF switch should be replaced with a thyristor switch such that you only turn ON the switch but the OFF state comes when there is a communication link which triggers the exchange automatically from Zero state to high state.

5.3 PROBLEMS ENCOUTERED

A major set back in the design of the circuit came up in the use of the UA741 amplifier at the pre- amplifier stage. A lot of noise was received at the output of the circuit but this was reduced to a considerable level by the use of capacitor to filter the noise or ripples generated.

5.4 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.

REFRENCES

1 Y.A Adediran Telecommunication principles and systems, Finom Asssociate, Minna Nigeria, January 2005, pp 1- 4.

2 B.L Theraja and A.K Theraja A textbook of Electrical Technology, S. Chand and Company Ltd, Ram Nagar, New Delhi,2001, pp 1699,1710

3 Paul Horowitz and Winfield Hil The art of Electronics Cambridge University press low price editions 1995 pp44-49, 510, and 827.

4 http//www.telcoexchange.com

5 Online datasheet; http//www.semiconductordevice.com/cd4o60

6 Online datasheet; http//www.semiconductordevice.com/tda2822

7 http://www.linktionary.com/telecommunication

8 Tom Sheldon Encyclopedia of Networking and Telecommunications, pp1224