DESIGN AND CONSTRUCTION OF AN AUTOMATED INTERCOM SYSTEM

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DEDICATION

This project is solely dedicated to Almighty God, the author and the finisher of my faith.

And

Also to my parents, Mr. & Mrs. M.A. Ogunkoya whose earth great treasure and desire is to see me educated in all aspects, I will forever appreciate you.

DECLARATION

I, Ogunkoya Lawrence Adebola declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna

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This report is dedicated to Almighty God and to my love for Electrical/Computer Engineering, it is a dream I have had since childhood and also it's a bus stop to making me achieve my dream as one of the best aspiring Electrical/Computer Engineering ever. My sincere appreciation goes to my wonderful Supervisor Engr. Eronu .E. who has decided to assist me in making my graduation fro this department a success. Also to my H.O.D., Engr. M.D. Abdullahi for his fatherly care to the entire student's of the department. Special thanks goes to my family; Mr. M.A. Ogunkoya and his wife (S.I), my brothers, sisters and friends; Adeyemi, Mayowa, Adedayo, Aderonke, Adebusola, Adebusayo, Ademola, Oyin, Paul, Juliet, Zinat, Ramoni, Law, Tolu, Yakubu, Damola, Adebambo(Mr.), Yinka, Olamide, Olabisi e.t.c for their morally, financial and spiritually support throughout my academic era. I love you all....

ABSTRACT

Telecommunications has come to stay because of its immense contributions to the betterment of life for mankind. Its importance cannot be overemphasized because without it, life will not worth living. To this end, an Automatic Intercom system has been developed to help improve on the communication need of man.

The system makes use of a microcontroller as the basic Control Unit that does the switching of the caller and the called. Also, the system makes use of μA741, LM386 amplifier, which is primarily responsible for the amplification of the sent Audio signal so that it can be received clearly at the other end. Relays were also used at the exchange to achieve/realize the aim of the design implementation. Channels were linked via the use of a keypad (button) switches through an auto exchange in accordance with the program-line microcontroller.

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CHAPTER ONE: INTRODUCTION

1.1 INTRODUCTION TO COMMUNICATION

In light of the fact that communication is a process that allows beings – in particular humans to exchange information by several methods; Communication in Electrical Engineering term can therefore be define simply as " the sending, processing and receiving of signals, ideas, information and messages [1]. The information to be sent takes either of written message, voice message or an electrical signal e.t.c.

A Communication System can be defined as a system of sending, transmitting, processing and receiving of signals. The means of communicating can be of a radio link, optical fiber, satellite and telephone network. Telecommunication is therefore the transfer of information from one point to a distance point. It is the key of today's civilization. The prefix "Tele" is from the ancient Greek word meaning "Far". One can now imagine a world without ready access to reliable, economical and efficient means of communication.

Therefore, in the world of constant competition, communication is very important to the biological survival of all living creatures. Efficient means of communication and quick access to requisite information are great needs of a fast developing world which even explorers beyond its horizon. Scientists and Engineers have been able to so far provide for the communication need of our world, thereby actualizing the concept of "One big Family" [2].

1.2 COMMUNICATION AS INFORMATION TRANSMISSION

Communication can be seen as processes of information transmission governed by three levels of Semiotic rules: Syntactic (formal properties of signs and symbols), Pragmatic [3] (concerned with the relations between signs and their users) and Semantic (study of relationships between signs and symbols and what they represent). Therefore, Communication is a kind social interaction where at least two interacting agents share a common set of semiotic rules. In a simplistic model, information or content (e.g. a message in natural language) is sent in some form (as spoken language) from a source/sender/encoder to a destination/receiver/decoder. In a slightly more complex form, a sender and a receiver are linked reciprocally.

A particular instance of communication is called Speech act. A speech act typically follows a variation of logical means of delivery. The most common of these and perhaps the best, is the dialogue. The dialogue is a form of communication where both the parties are involved in sending information. There are many other forms of communication but the reason the dialogue is good is because the dialogue lends itself to clearer communication due to feedback. Feedback being encoded information, either verbal or nonverbal is sent back to the original sender (now the receiver) and then decoded.

1.3 INTERNAL COMMUNICATION

An Internal Communication "INTERCOM" as it is called is a device which allows conservation between people in a miniaturized environment say about 500m radius. The intercom is a cheap and efficient means of communicating within and office block, organization or a parastatal. The design of an Intercom is made to suit the need of the environment in which it is to be utilized with adequate considerations for future expansion.

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 transmission employed in intercoms, (the wires interconnecting the various systems of an intercom system must not transverse any public place, they must be confined within the boundary of the premises using the system). Various classifications are used for intercom systems. One method is based on the control of the stations and is classified as:

i. Principal Subsidiary or master-Slave system.

ii. Independent Station System.

In the principal subsidiary system, control is vested on one system called the "MASTER STATION". The Master Station controls the setting up of connections and flows of conversations in the system. It also monitors conversations with the other stations. The master station initiates calls and go on – air at will. The system usually has two stations; the master and the slave stations. The independent station system has station system has station with independent and equal access to other stations and also privacy of discussion between two parties is guaranteed. Some Intercom systems have separate mouth – piece and ear – piece, while others use only one transducer which serves both for talking and listening. This is made possible using a mechanical switch commonly called press – to – talk switch.

Another classification based on transmission system is:

i. Wired Intercom System

ii. Wireless Intercom System

The Wired Intercom is more popularly used because the circuit and transmission using cables is relatively cheap and easily achievable. It doesn't require modulation and demodulation as well as privacy of discussion is achieved or else there is a deliberate "tapping" of the wires physically.

Disadvantages of Wired Intercom System include:

i. There is high cost of installation, infrastructure, and at times maintenance.

ii. Non – Optimum usage of transmission lines.

iii. The Intercom system is limited to only where cable would be used.

iv. There are also problems of "cross-talk" interference.

On the other hand, no form of wring or dedicated cables is required for the operation of the wireless intercom. Hence the signal is propagated through AC (alternating current) means or modulated and propagated through space at very high frequency (VHF). This type of intercom transmits and receives signal through the existing AC mains and is used to power the system. The voice frequency is modulated at transmitting station and picked up at the other station after demodulation.

Advantages of this type of Intercom are as follows:

i. Elimination of difficulties associated with cable installation.

ii. It can be used in any area where there are AC mains lines of the same phase.

iii. It saves the cost of providing dedicated intercom lines which are difficult to maintain.

The disadvantages include:

i. Increase complexity of circuitry.

ii. It's cost is high when implementing.

iii. Limitations of communications to only stations connected to the phase of the AC mains.

Wireless Intercom could therefore be summarily put as an important aspect of Intercom that involves the frequency or amplitude modulation of a carrier signal with instantaneous values of the modulating signal, and the voice frequency signal. Generally, an intercom system would consist of the following:

i. Ear-piece and mouth-piece (transducer).

ii. Audio circuit (speech path)

iii. Signaling circuit

iv. Switching circuit

v. Decoding and conditioning circuit

1.4 OBJECTIVE OF STUDY

This project was carried out in order to develop a cheap, affordable and efficient means of communication for local industries, organizations or even in a large establishment like the department of electrical/computer engineering where the head of department needs to communicate with his members of staff comfortably without wasting energy and time in sending for them, he can conveniently discuss through this affordable intercom system. Past research has being studied with a view, to improve on them by replacing the Light Emitting Diodes (LED) at the handed set with tone generator circuits to notify the called. Digital exchange has also replaced the manual connectors at the Control Unit.

1.5 SCOPE OF STUDY

The scope of this project is to design an electrical circuit that will enable the sending and retrieval of information within a short distance or within an establishment where time is very precious to waste in walking from one office to the other just to deliver a message. The study carried out in this project has been limited to wired Intercom with provision for only three terminal stations which will automatically operate from one handset to the other without any interference in conversations.

1.6 PROJECT METHODOLOGY

This design operates on the method of direct current (dc) flowing through the exchange circuit when one person at each terminal stations lifts his handset, this current operates the combinational logic circuit of the exchange which triggers the relays connected to each handsets, immediately the tone generator circuits sounds at any terminal. the called person picks up his earpiece and sound begin to flow through the amplifiers due to the establishment of communication between the caller and the called.

1.7 JUSTIFICATION

As it is a known fact, that time is precious for profit oriented establishments, it would save many establishment time and energy to move from one office to the other for search and retrieval of information, in other words, having a cheap, reliable and effective means of communication which is totally automatic eliminating the manned – operator at the exchange would be a welcomed development of our time, hence this justifies the design of this project.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL BACKGROUND

2.1 HISTORICAL BACKGROUND OF TELECOMMUNICATIONS

In light of communication, Man has sought a means of more efficient and effective means of transmitting information at faster speeds. As noted, drum beats, fire, smoke signals and ram's horn were methods used in early times and more so, during the middle Ages, homing pigeons were used to transmit messages.

It was in the 17th century that significant steps were taken in the area of telecommunications development. An English physicist in 1667, Robert Hooke invented a string telephone that can convey sound over an extended wire by means of mechanical vibrations.

Hence, "Sporadic" developments/inventions have been experienced. It was however in 1876, that Alexander Graham Bell was granted the patent for electric speaking telephone, discovering that only a steady electric current could be used to transmit human voice. In 1877, he produced the first telephone to transmit and receive the human voice with all quality and sophistication.

2.2 LITERATURE REVIEW

It is now taken for granted in developed countries/ nations that by pressing few buttons, people can talk to families, friends or business associates across the world. The technology that has led to one of the most complex creations of the 20th century, the telephone network has evolved over the past hundred years or so.

The first electrical means of communication was not the telephone, however, but the telegraph which allowed message to be sent in codes (usually Morse codes) to be received and printed at a distant location. The age of commercial telegraph dawned in

1839 by William Fothergil Cooke and Charles Wheatstone in London. In 1889, Almon Stronger developed an automatic switching system that could set up a telephone call without intervention by a human operator. In 1901, Gulgliolimo Marconi demonstrated that, rapid waves could be used to transmit information over a long distance when he sent a radio message across the Atlantic Ocean.

In 1947, William Shocey, John Bardenan and Walter Brattain invented transistors. These enable the electronic revolution to take place and provide the basis for a computerized rather than a mechanical, telecommunication network. In 1965, Charles Kuo put forward the theory that information could be carried using optical fibers. Optical fibers form the backbone of the global transmission network, because of its speed. The modern telephone network can be viewed as a globally distributed machine that operates as a single resource. Much of it, uses interconnected computers, the network that most people use to carry voice traffic can also be used to transfer data in the form of pictures, texts and images.

2.3 THE TELEPHONE SYSTEM

Usually the telephone system comprises of the transmitter, receiver, channel, cable, exchange and other several components such as switches, alarm, power source e.t.c. The telephone system operates on the principle of electromagnetism brought about by varying air pressure. When a person speaks into a microphone, he sends sound as air from the mouth into the microphone; which is then converted into an electrical energy by the microphone at the receiving end. This electrical energy is converted back into sound by the loudspeaker in the earpiece; this is now heard as message. The following is a simplified block diagram of a communication system.

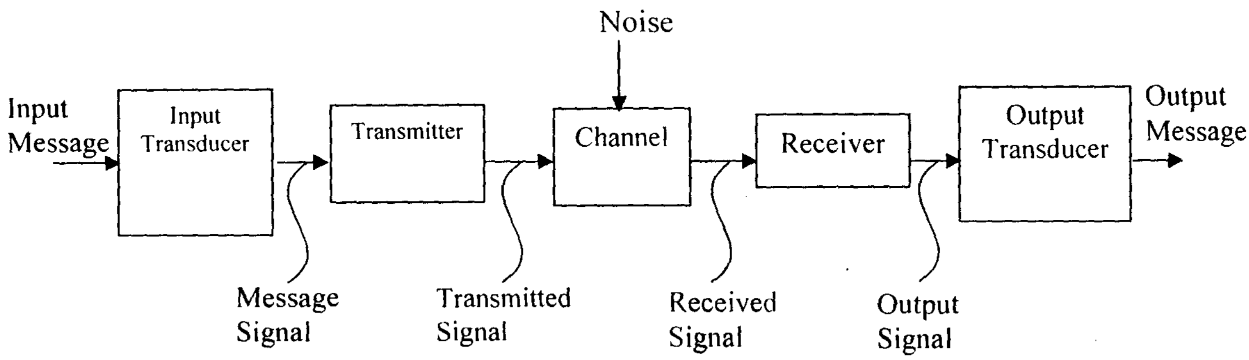

Fig 2.1: Simple block diagram of a Communication System

2.4 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 transducer converts sound waves in the frequency range of 0.3kHz – 3.4kHz to electrical signal which is fed by wires to the transmitter. Hence, a microphone acts as the input transducer.

2.5 TRANSMITTER

The transmitter usually couples the message to the terminal. It is the transmitter that if necessary, will modulate, but in this design, I avoided modulation because of the use of wired intercom system. The telephone transmitter contains tiny particles of carbon called Carbon granules.

They are closely held in small compartment between a piece of carbon which is cup-shaped and another piece which is dome-shaped with the aid of moving front electrode, which moves only when the diaphragm converges as a result of changes in air pressure, the carbon granules compresses, thereby increasing their contact area which causes the resistance of the circuit to reduce thereby giving rise to a high flow of current.

2.6 CHANNEL

This is the medium through which the transmitted signals get to the receiver. It may have many different forms ranging from the ground, underground or overhead cables, to sky and space. It could be wired or non – wired channel. 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 a specified need is of great importance in telecommunication development.

2.7 RECEIVER

The receiver extracts and processes the desired signal from the received signal at the output of the channel. Amplification of poor signals is performed; delaying of the received signal is also performed. In fact a good receiver should be able to select "well" the desired signal and reject "well" any unwanted.

2.8 OUTPUT TRANSDUCER

The Output transducer is a device that converts the received electrical output signal into the desired form by the user, hence sound. The output transducer hence is the loudspeaker, which converts electrical signal to sound waves; other examples are Cathode ray tube (CRT), meters and Oscilloscopes.

2.9 OPERATIONAL AMPLIFIER

An Operational Amplifier usually referred to as an Op-Amp for brevity, is a DC-coupled high-gain electronic voltage amplifier with Differential inputs and usually, a single output. In its ordinary usage, the output of the Op-Amp is controlled by Negative Feedback. The basic amplifier is represented below in Fig. 2.2. The amplifier has two inputs, which are denoted by V_{i+} and V_{i-}, and a signal output, V_0. Positive and negative power supplies of equal magnitude are normally used (although single supply operation is possible) and are shown as +Vs and –Vs (for simplicity these connectors are not normally shown on circuit diagrams).

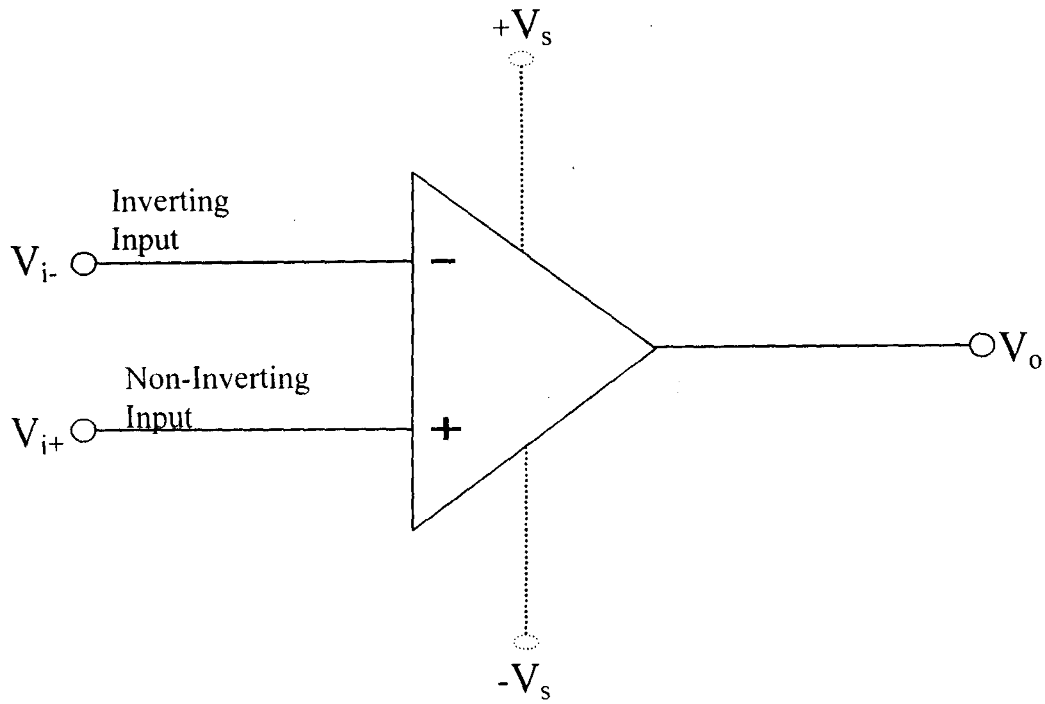

Fig.2.2: Basic Operational Amplifier Symbol

Considering an ideal operation of the Amplifier, this is shown in the transfer characteristics of Fig. 2.3:

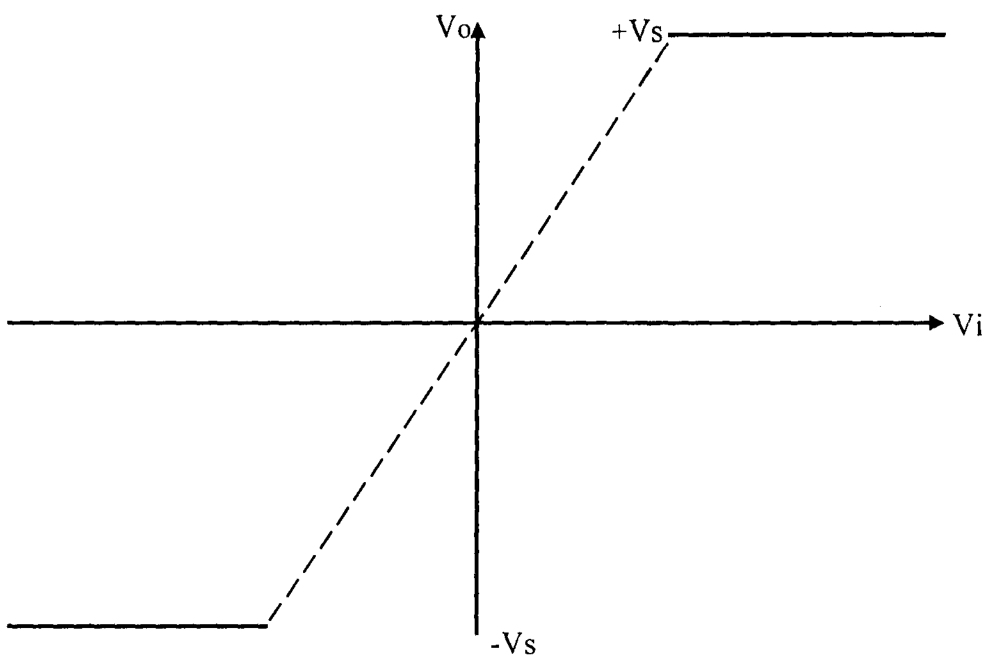

Fig.2.3: Ideal transfer Characteristics (Solid line)

Here, Vi represents the difference the voltage supplied to the two inputs (V_{i+} and V_{i-}). It can be seen that if Vi is positive, even by only a small amount the output Vo is positive and constant, having a magnitude slightly less than that of the supply voltage (the output saturation voltage). Similarly, negative values of V_i produce a constant output.

In practice, a finite change in Vi will be needed in order to change Vo from one level to the other as shown by the dotted line. Also, the change over will occur for a value of Vi that is not precisely equal to zero. For a characteristic having a finite slope, the input/output relationship is written as;

$$Vo = A(V_{i+} - Vi-) \quad .... \quad 1.1$$

Where A is the gain of the Amplifier in the region between the two output saturation voltages. The value of "A" is large for practical amplifiers (typically more than 50, 000) and theoretically infinite for ideal ones. "A", may be the Open Loop gain i.e. gain without feedback.

2.9.1 Inverting Mode of an Amplifier

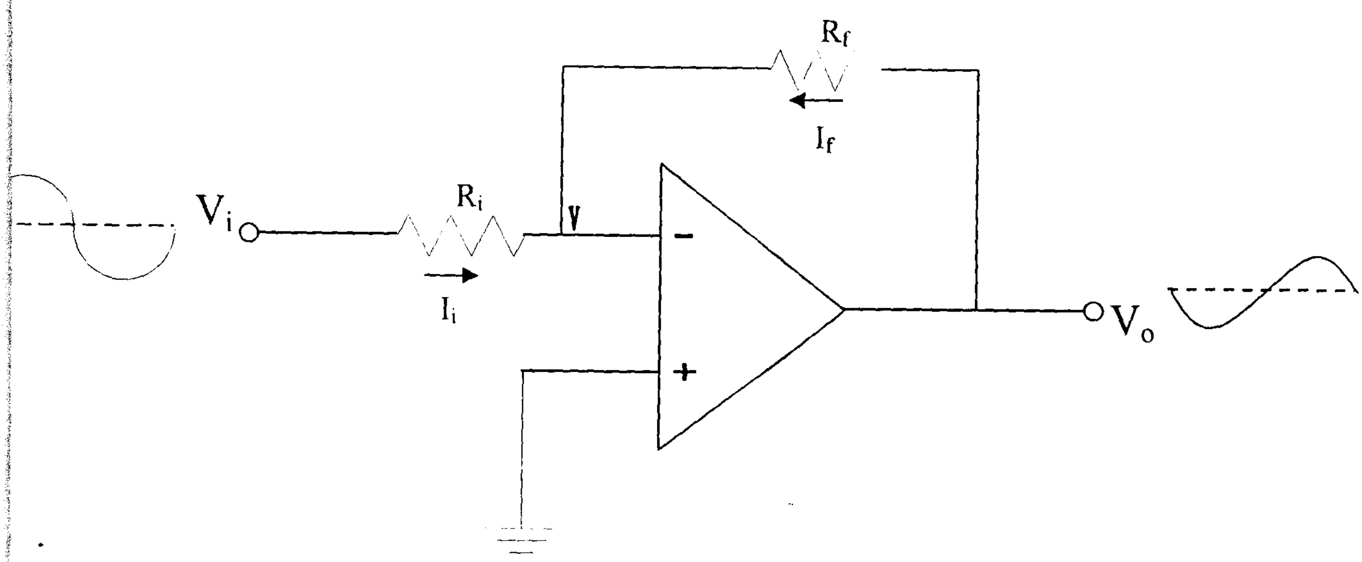

Fig 2.4: Operational Amplifier Configuration

This basic configuration is shown above where the resistors Ri and R_f are the input and feedback resistors respectively. Let the currents in the input and feedback resistor be Ii and I_f; if the input resistance of the amplifier is so high that the current flowing into the inverting input may be neglected then;

$$I_i + I_f = 0 \quad \ldots\ldots\ldots\ldots \quad 1.2$$

Applying Ohm's law to each resistor, thus

$$\frac{V_i - V}{R_i} + \frac{V_o - V}{R_f} = 0 \quad \ldots\ldots\ldots\ldots \quad 1.3$$

Recall from Equation 1.1

$$V_o = -AV$$

And

$$V = \frac{-V_o}{A} \quad \ldots\ldots\ldots\ldots \quad 1.4$$

Substituting 1.4 in 1.3

$$\frac{V_i - V_o/A}{R_i} + \frac{V_o - V_o/A}{R_f} = 0 \quad \ldots\ldots\ldots\ldots \quad 1.5$$

For large value of A, V tends to 0, and Equation 1.3 reduces to

$$\frac{V_i}{R_i} + \frac{V_o}{R_f} = 0 \quad \ldots\ldots\ldots\ldots \quad 1.6$$

Therefore,

$$V_o = -(R_f/R_i)\ V_i \quad \ldots\ldots\ldots\ldots \quad 1.7$$

2.9.2 NON INVERTING MODE OF AN AMPLIFIER

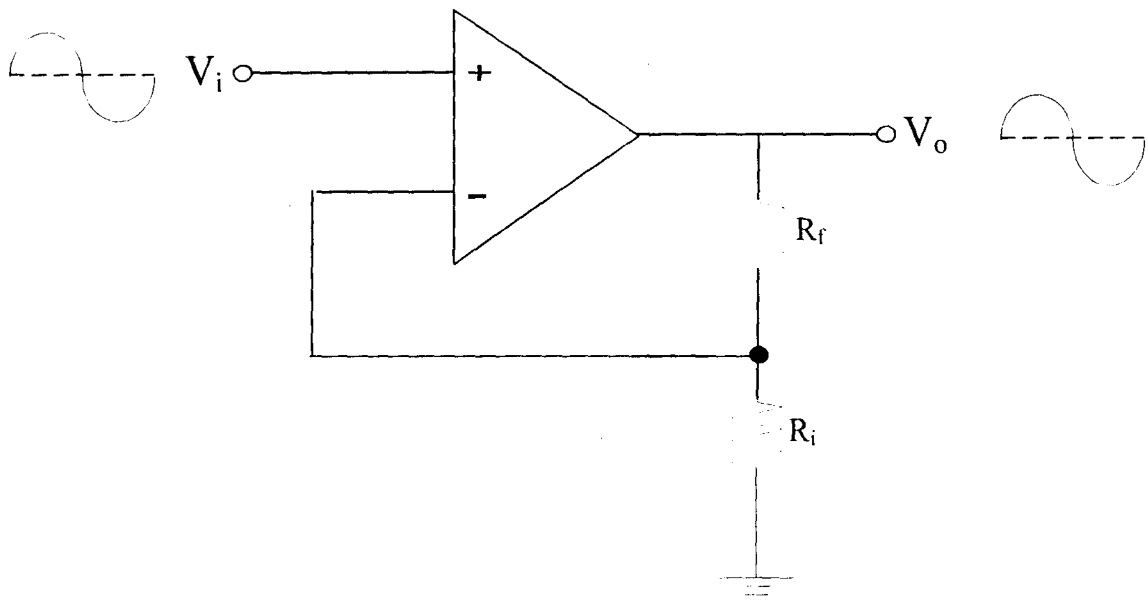

Fig 2.5: Non Inverting Feedback Amplifier Circuit

Considering the circuit shown above, in some applications, the sign change associated with the inverting mode of operation is not required. The potential V. at the inverting input mat be derived from V_o since R_i and R_f from a potential divided;

$$V_- = \frac{V_o R_i}{R_i + R_f} \quad \ldots\ldots\ldots\ldots \quad 1.8$$

As before, currents flowing into amplifier are assumed to be negligible;

From equation 1.1,

$$Vo = A(V_i - V_-)$$

Therefore,

$$V_i - V_- = \frac{V_o}{A} \quad \ldots\ldots\ldots\ldots \quad 1.9$$

As A tends to ∞, $V_i = V_-$ and then

$$V_i = \frac{V_o R_i}{R_i + R_f} \quad \ldots\ldots\ldots\ldots \quad 2.0$$

$$V_i = \frac{V_i(R_i + R_f)}{R_i} = V_i\left(1 + \frac{R_f}{R_i}\right) \quad \ldots\ldots\ldots\ldots\ldots \quad 2.1$$

2.9.3 FREQUENCY RESPONSE

Open Loop Behaviour Compensation

The circuits discussed earlier all depend on the assumption that the Open Loop gain remain very large (ideally infinite) under all operating conditions. In practices, this cannot be true for all frequencies. For stable operation with feedback configuration used, the high gain must be preserved for low frequencies including DC. However, for stable operation under all conditions, the gain must to fall or "roll off" at high frequencies this will occur in any case due to stray capacitance, but additional capacitance is also needed in order to define the frequency at which roll-off starts to occur.

Roll – off is desirable not only to ensure stability but also to avoid amplification of signals outside, the required range of frequencies, since this would increase the noise content. This additional capacitance may be internal to the IC amplifier or external (external compensation). Internal Compensation has the advantage that stability guaranteed under all operating conditions and an external capacitor is not required. The disadvantage is that Open Loop bandwidth by the manufacture cannot be change by the user. The widely used μA741 Amplifier is of this type.

External compensation gives greater flexibility; but care should be taken as unsuitable choice of compensating capacitor can cause instability. The simplest way of modeling this effect is by a single low pass filter as shown below:

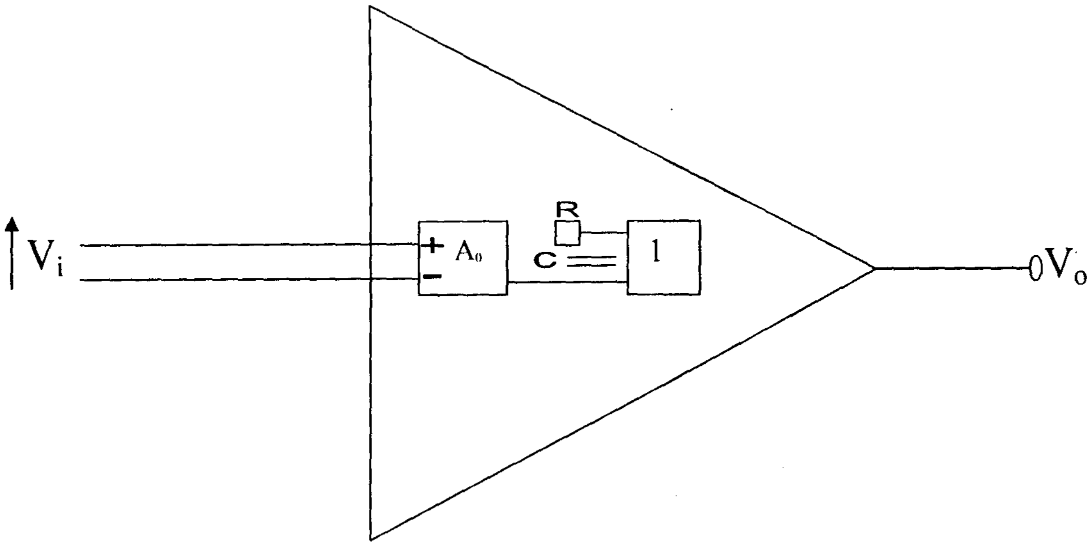

Fig 2.6: First – Order Model of Amplifier behaviour at High Frequency

From the diagram above, C is the total effect of all stray capacitance plus the compensating capacitor.

A_o = Low frequency (dc) gain

| 1 | = Ideal buffer Amplifier whose gain is Unity

Then $V_o = \dfrac{A_o V(1/jwc)}{R + 1/jwc} = A_o V(1/(1 + jwCR))$ ----------- 2.2

Where $\omega = 2\pi f$

When $\omega \rightarrow \infty$, gain tends to 0

From equation 2.2,

$$A = \frac{V_0}{V} \quad A_0 \left(\frac{1}{(1 + jwCR)} \right) \qquad \text{.................................} \quad 2.3$$

$$A = \frac{A_0}{j(w/w_0)} \qquad \text{................................} \quad 2.4$$

where $W_0 = 1/CR$

In decibels, gains (db) = $20 \log_{10}/A/ = 20\log_{10} A_0 / \sqrt{1 + (w/w_0)^2}$ 2.5

It is useful to consider these cases;

1. $W << W_0$, the gain tends to $20\log_{10}A$, where A is the dc gain.

2. $W >> W_0$, this implies that w/w_0 is much longer than unity, so equation 2.5 becomes;

$$\text{Gain (db)} + 20\log_{10} A_0 + 20\log_{10} w_0 - 20\log_{10} w \quad \ldots\ldots\ldots\ldots\ldots \quad 2.6$$

Hence, the frequency response of a μA741 Amplifier is shown below: -

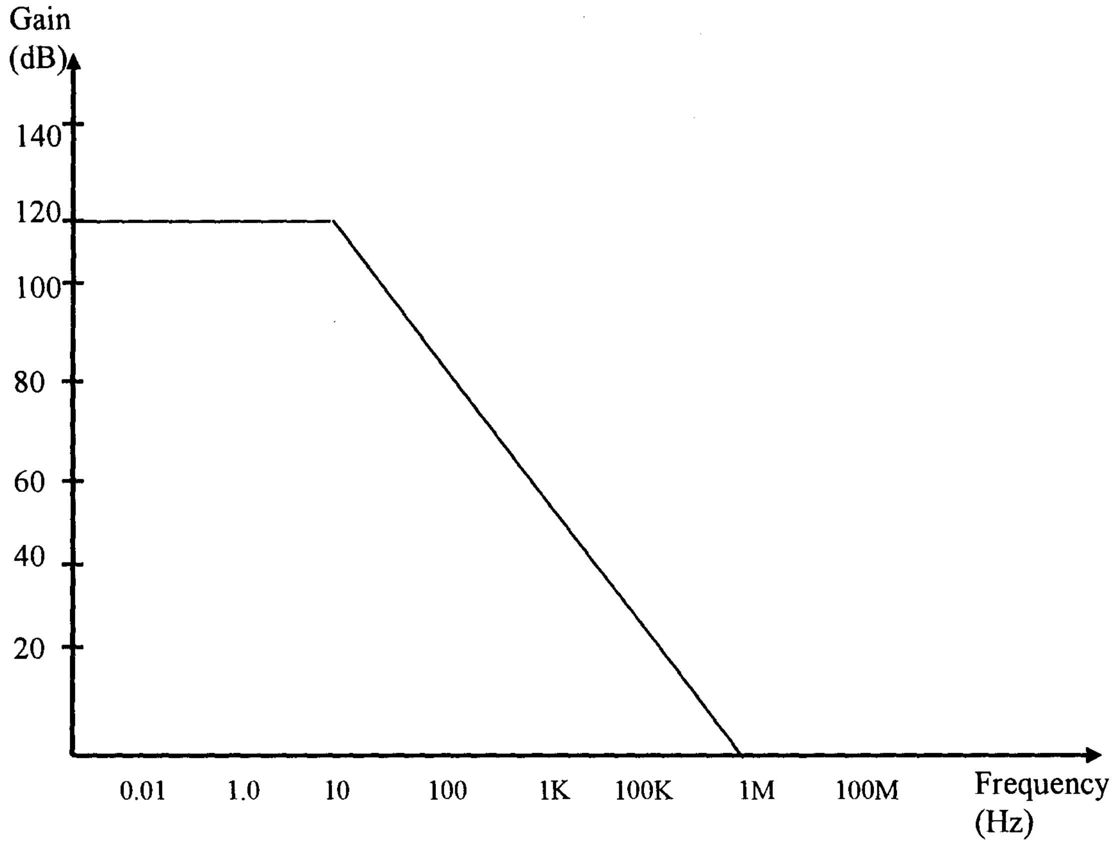

Fig 2.7: Frequency Response of the μA741 Amplifier (f_0 = 5kHz)

CHAPTER THREE: DESIGN AND IMPLEMENTATION

3.1 CIRCUIT DESIGN AND ANALYSIS

In order to meet the set objectives of this project, the operation of the entire system design is divided into five basic unit, the Keypad Unit, the Control Unit, the Amplifier Unit, the Ringer Unit, and the Power Supply Unit. The block diagram for the design Analysis is shown below:

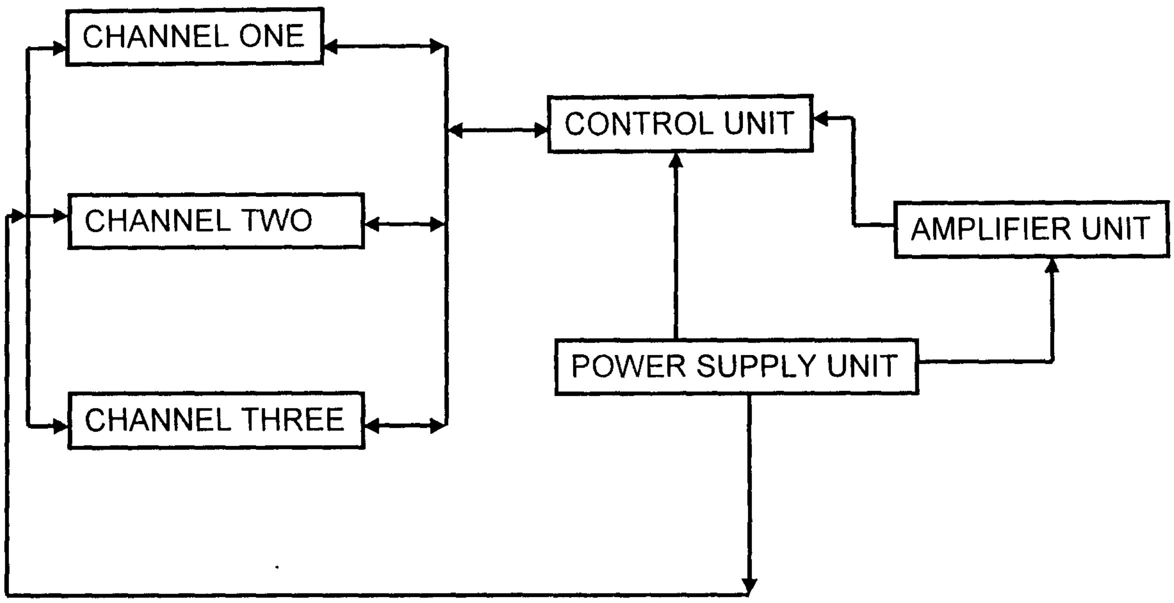

Fig 3.1: Block diagram of the Entire System

3.2 THE KEYPAD UNIT

This unit is made up of three 3 x 4 push button, arranged in matrix form. Each of the 3 x 4 push button is for one channel. The unit consists of 12 push button (normally open) arranged in rows and columns as shown in the figure below.

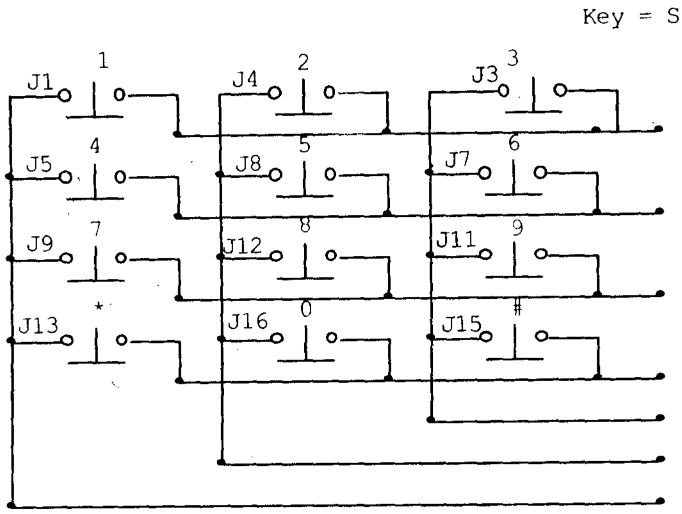

Fig 3.2: Circuit diagram of a 3x4 keypad

Key Rows: There consist of four rows; Row1 consist of three push buttons, which are 1, 2 and 3 respectively Row2 consist of three push buttons which are 4,5, and 6 respectively. Row3 consist of three push buttons which are 7, 8 and 9 respectively. And row 4 consist of three push button which are *, 0, and #. One terminal of a switch in each push button in a particular row is connected together, while the other terminal is left for the column connection.

Key Columns: Just like the key rows consist of four columns. Column 1 consist of four push button, which are 1, 4, 7 and *. Column 2 consists of four push buttons, which are 2, 5, 8 and 0 respectively; Column 3 consists of four push buttons which are 3, 6, 9 and # respectively. Remember that one terminal is left for column connection; these terminals are connected together in a particular column.

3.3 THE CONTROL UNIT

This unit is responsible for controlling the system through software written in Assembly Language. This unit consists of a Microcontroller (MCU), a Reset Circuitry, Clock Pulse Circuitry, Relay Circuitry and the Software Development for the design.

3.3.1 Microcontroller Circuitry

There are no modern Electrical systems in the world today that is complete without the use of a Microcontroller or Microprocessor. In the scope of this project a Microcontroller is used to capture, manipulate and save the digital data. The Microcontroller used in this project is the AT89C52 from Atmel 8051 Series of Microcontrollers.

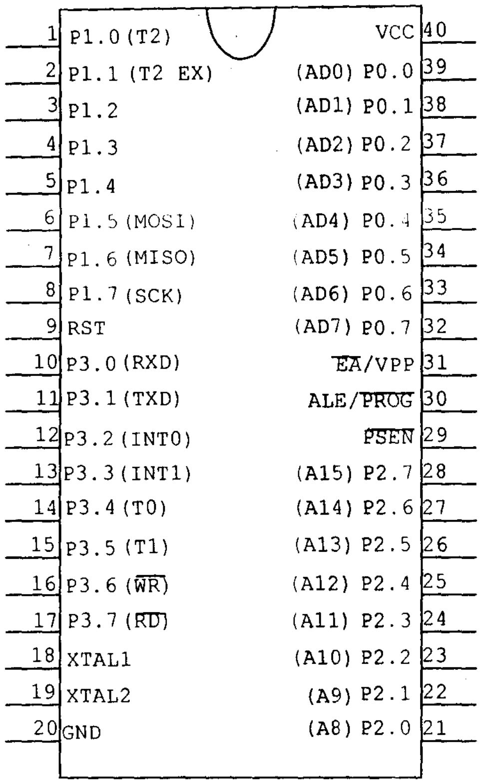

Fig 3.3: The Microcontroller Circuitry

AT89C52 is a low power- high performance CMOS 8-bit microcomputer with the following features.

→ Compactable with MCS-51 products.

→ 8K bytes of In-system Reprogrammable flash memory.

→ Endurance: 1000 write\ Erase cycles.

→ Full static Operation: 0 Hz to 33 MHz.

→ Three level program memory lock.

→ 256 x 8 bit Internal RAM

→ 32 programmable I\O (Input \ Output) lines

→ Three 16-bit Timer\Counters

→ Eight Interrupt sources

→ Programmable serial channels

→ Low – power Idle and Power-down Mode

→ 4.0V to 5.5V Operating Range

→ Interrupt Recovering from Power-down Mode

→ Watchdog Timer

→ Dual Data Pointer

→ Fast Programming Time

3.3.2 Reset Circuitry

This Circuitry is needed by the microcontroller. This prevent the unusual resetting of the microcontroller, which could be as a result of electric spark , relay switching etc, the circuitry also provided a way of manually resetting of the microcontroller through a push button connected to VCC.

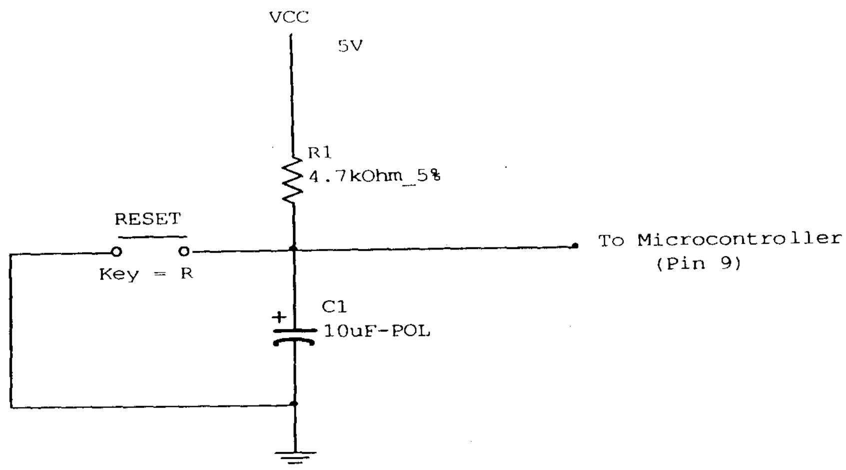

Fig 3.4: The Reset Circuitry

3.3.3 Clock Pulse Circuitry

The clock source circuitry is made up of two basic components (two capacitors and a crystal). This unit generates the clock pulse for the microcontroller to execute its instruction. The interface between the clock source unit and the microcontroller is shown below:

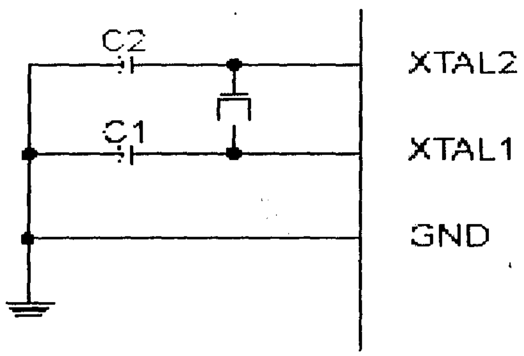

Fig 3.5: Interface between the clock source unit and the Microcontroller.

The crystal used is an 8MHz crystal, that is, it will generate 8,000,000 pulses in one second. Normally an 8051 compactable microcontroller executes one instruction in 12 clock pulses, therefore the microcontroller will be able to perform 8,000,000 divided by 12 instructions in one second (1 MIPS i.e. million instruction per second).

3.3.4 The Relay Circuitry

This circuitry is responsible for selecting or switching the speakers and the microphones in the amplifier circuitry. It consists of seven 24V relays cascaded in such a way that the caller's speakers and microphone are connected to the amplifier as well as the called. The figure below shows the interface between the relays, the microcontroller and the amplifier.

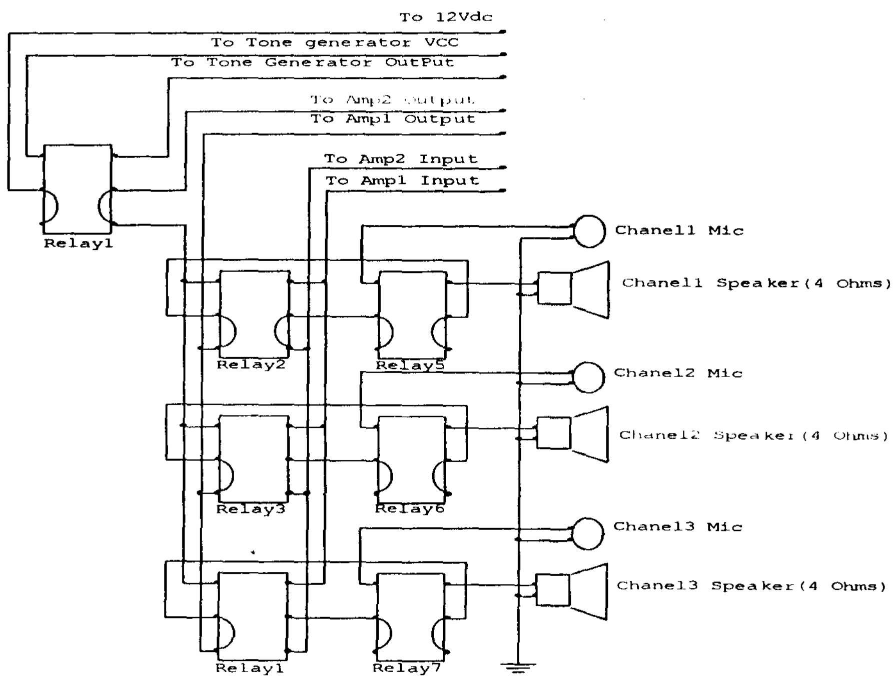

Fig3.6: The Relay Circuitry

3.3.5 Software Development

The software for the system is written in assembly language utilizing the input/output ports of the microcontroller for interface with hardware for input and output purposes. The functionality of the system and the necessary conditions to be implemented were first developed in flowchart in order to ease the development of the assemble codes.

The flowchart was then transformed into the assembly code (See appendix II) which was burnt into microcontrollers using an EPRON programmer and the software for this project was developed in AVR Studio4. The program was written in assembly language using the instruction set for an ATmega8515 provided by Atmel Corporation.

The Flowchart

The symbolic representation for the program to be developed is shown in the flowchart. (See Appendix I)

3.4 THE AMPLIFIER UNIT

This unit consists of two similar amplifiers, but the analysis of one will be given. The amplifier used is given below.

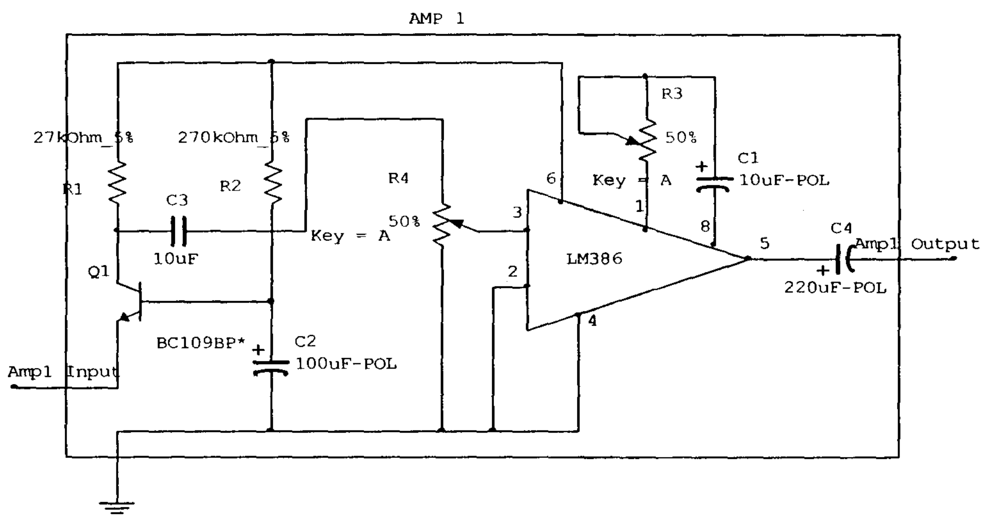

Fig 3.7: The Amplifier Circuitry

The BC109C stage amplifier is in the common base mode, giving good voltage gain, whilst providing a low impedance input to match the speaker. Self DC bias is used allowing for variations in transistor current gain. The LM386 is used in non-inverting mode as a power amplifier to boost voltage gain and drive the 8 ohm speaker. The 10k potentiometer acts as the volume control, and overall gain may be adjusted using the 5k preset.

3.5 THE RINGER UNIT

This unit uses two (2) 555 timers together to create a two-note tone. The frequency of operation of the circuit is dependent upon the values of R1, R2, and C. The frequency can be calculated thus with the formula:

$$f = 1/(.693 \times C \times (R_1 + 2 \times R_2))$$

The Frequency f is in Hz, R_1 and R_2 are in ohms and C in farads. The time duration between pulses is known as the 'period', and usually designated with a 't'. The pulse is on for t_1 seconds, then off for t_2 seconds. The total period (t) is $t_1 + t_2$. That time interval is related to the frequency by the familiar relationship:

$$f = 1/t \quad \text{or} \quad t = 1/f$$

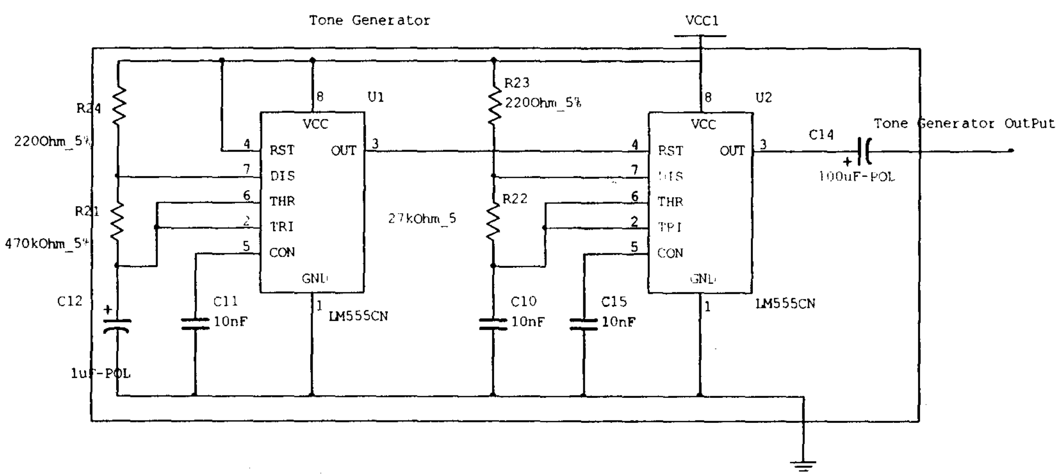

Fig3.8: The Ringer Circuitry

From the circuit above, the frequency of the first oscillator is F_1

$$F_1 = 1/(0.69 \times 0.000001 \times (220 + (2 \times 470)))$$

$$= 1.5 \text{ Hz}$$

The period is given by $T_1 = 1 / F_1$

$T_1 = 1 / 1.5 = 0.66$ sec

While the frequency of the second oscillator is F2

$F_2 = 1 / (0.69 \times 0.000000001 \times (220 + (2 \times 270)))$

$= 268.28$ Hz

The period is given by $T_2 = 1 / F_2$

$T_2 = 1 / 268.28 = 0.0037$ sec

3.6 THE POWER SUPPLY UNIT

Virtually every electronic circuit requires some form of power supply. The power unit has two outputs of 12V dc and 5V dc. It was designed using LM7812 and LM7805 voltage regulators to produce 12V dc and 5V dc respectively.

This normally means that it requires one or more *Power Rails* – lines held at specific steady d.c. voltages – from which the required current and hence power may be drawn. This unit is sub divided into Voltage transformation, Voltage rectification, Voltage regulation and Filters.

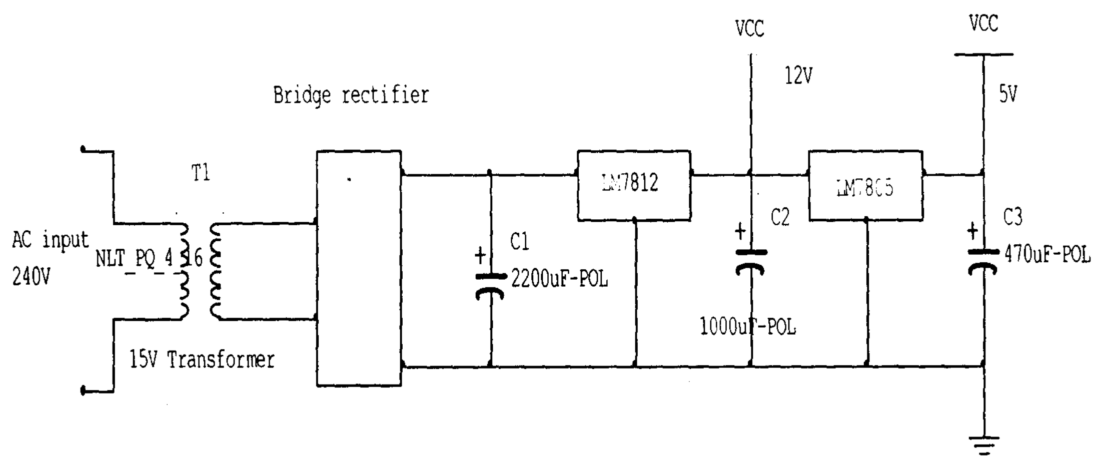

Fig 3.9: The Power Supply Unit

3.6.1 Voltage Transformation

The Voltage transformation was achieved using a step-down transformer with specification given below:

Primary Voltage	V_p,	-	-	240 V_{rms}
Secondary Voltage	V_s,	-	-	15 V_{rms}
Secondary Current	I_s,	-	-	1.5 A

Using the transformer equation;

$(V_P/V_S) = (I_S/I_P)$ - - - - - 3.1

$I_P = (V_S * I_S)/ V_P$

$= (15 * 1.5)/ 240 = 93.75 * 10^{-3}$ A = 94mA

Also,

$V_{peak} = \sqrt{2} * V_{rms}$ - - - - - 3.2

$= \sqrt{2} * 15 = 21.21$ V

$I_{peak} = \sqrt{2} * I_{rms}$ - - - - - 3.3

$= \sqrt{2} * 1.5 = 2.12A \approx 2$ A

3.6.2 Voltage Rectification

A bridge rectifier with 2A rating was used in the design for the rectification of the AC mains. It converts an AC voltage level to a DC voltage level. It consists of four diodes connected in a bridge circuit. The DC voltage is calculated from the equation below:

$V_{dc} = (\sqrt{2} * V_{peak})/ \pi$

$= (\sqrt{2} * 21.21)/ \pi = 9.55$ V

3.6.3 Voltage Regulation

The system needs two different voltage levels, 5V for the microcontroller chip and 12V for the amplifier and the ringer unit. A 12V regulator (LM7812) was used to regulate the output voltage from the bridge rectifier to 12V, and then a 5V regulator for the microcontroller chip.

3.6.4 Filters

The voltage obtained from the rectifier contains some ripples. To eliminate these ripples, high value capacitor of 2200µF 35V was used. Two other capacitors of 1000µF 25V and 470uF 16V were used at the output of the regulator to ensure proper smoothing.

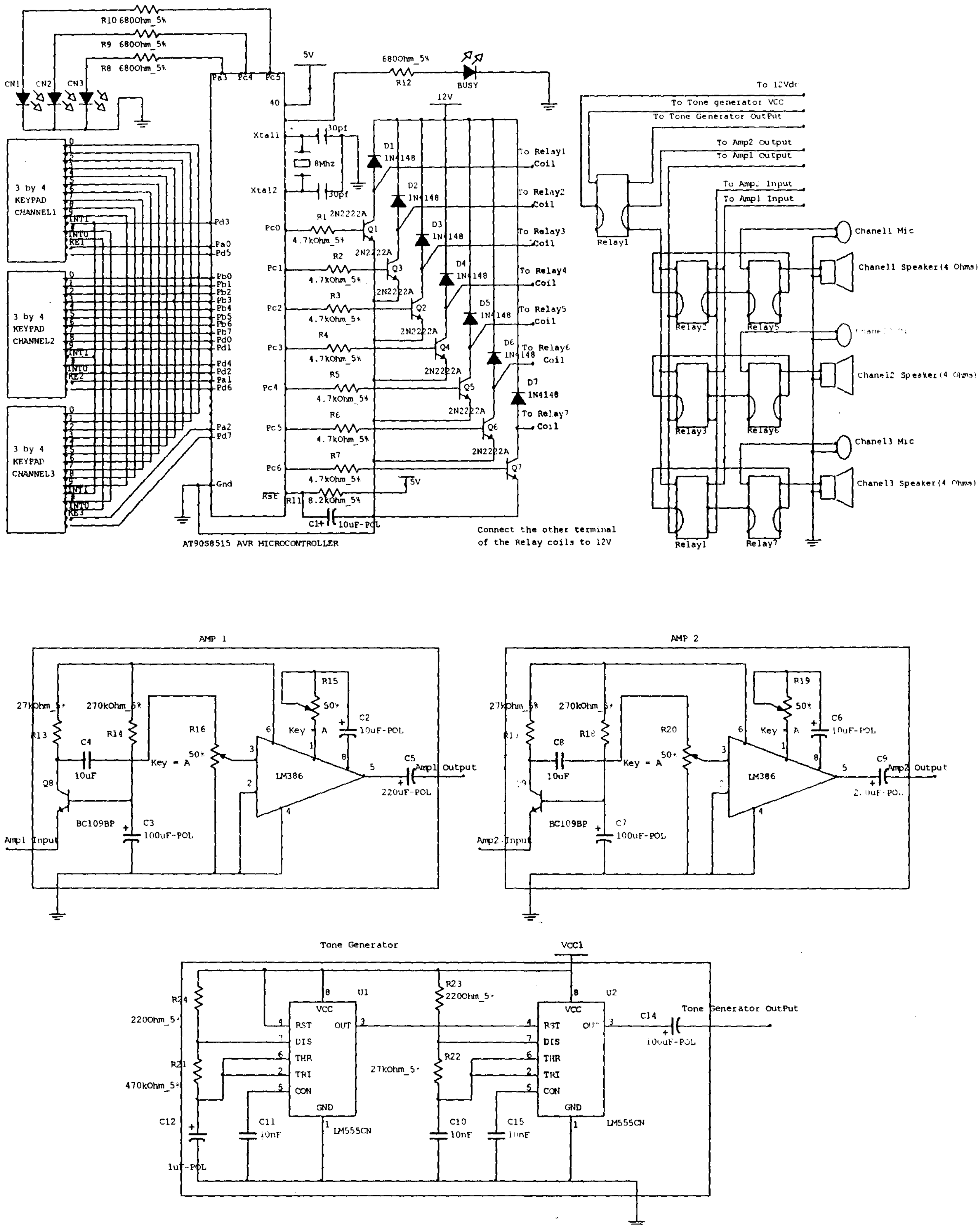

FIG. 3.10 CIRCUIT DIAGRAM OF THE ENTIRE SYSTEM

CHAPTER FOUR: TESTS, RESULTS AND DISCUSSION

4.1: CONSTRUCTION

This construction of this project is in several parts (or sub circuits), the main circuit which comprise of the Control Unit, Keypad Unit, Ringer Unit, Relay unit and Power supply unit. The construction of the design was implemented by fixing various components and units as shown in previous chapters. The central controlling unit was soldered on a 24.5 x 9.5cm Vero board using a 40W soldering iron and 60/40 flux cored soldering lead.

The Vero-board is an insulator strip comprising several parallel tracks of strips with small holes drilled along its length, giving a matrix format. It is made up of plastic, and provides adequate insulation between connected components. The components are 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 is to ensure immovability of the components; hence this stage of construction is referred to as the final circuit construction. Soldering the component 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.

Uniformity of the arrangement of components with the tested design was ensured, to eliminate the need to remove components for the purpose of correction, after the circuit would have completely soldered. Also, the concept of a conventional telephone casing was considered for the design of the project casing. The choice material was wood 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 given for any subsequent additions. The casing was first designed and implemented on paper and necessary modification was 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. The construction and testing of the units and entire system was carried out following the same broad principles of electronic circuit construction and troubleshooting.

4.2: TOOLS AND INSTRUMENTS

The tools and instruments which were used during the construction of the project work include:

→ Bread board

→ Vero board

→ Circuit components

→ Lead sucker

→ Soldering iron

→ Alloy (soldering)

→ Multi-meter

→ Connecting wires

→ Frequency meter

→ Communication cable (CAT5)

4.3: TESTS

Since a unit by unit approach was used in the construction, each of the five functional units was simulated on Electronic work bench software and tested afterwards on bread board to certify that they work independently and correctly.

Each Unit (Subsystems) was tested one after the other as the project design proceeds or progresses.

- The Switching circuits were implemented and tested on the board.
- The Bilateral switches were tested and coupled to ensure that they were able to switch the voice circuits when addressed.
- The Amplifier circuits were first tested to ensure that they worked without any noise.
- The signal circuits were also tested.
- The tone generator and power supply units were finally coupled and tested.

4.4 RESULTS AND DISCUSSION

The results obtained from the tests on each of the units (subsystems) are summarized in the table below. The steps taken to detect, rectify faults where the values obtained deviates from expected values are also discussed.

Table 4.1: Test and Obtained Results

UNIT(SUB-SYSTEMS)	PARAMETER TESTED	TESTING EQUIPMENT	RESULTS
Power Supply Unit	Workability	Power Supply and Multi-meter	Satisfactory
Complete System	Range	Communication cable	Not fully determined due to unavailability of lengthy cables.
Tone Generator	Output Frequency	Electronic Work bench simulation	190694.12Hz
Amplifier Circuit	Noise	12V DC Supply and voice input signal	Satisfactory
Signal Circuit	Pulse period	Electronic Work bench simulation	Few Hours

4.4.1: PRECAUTIONARY MEASURES

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

Some of these precautions measures include:

- All components were tested before soldering on the board.
- The circuit design was made to be easy to understand, noting methods used in previous designs, so as to save time and prevent too much experimentation with components.
- Brush was used to clean out any solder remaining on the board.
- The Vero Board and components leads were properly cleaned to remove any dust particle that could cause short circuits on the surface.

4.4.2: LIMITATIONS

The work done here would have been better than this if only some of these limitations were not there, they include:

i. Financial constraints, most of the desired features of this project were not realized because of the financial involvements attached. For instance,

- More than three terminals would have been implemented by using multiplexer switches or even cascading more than one. Better finishing would have been given to the package to promote marketability.
- Longer cables would have been used for longer distance coverage.

ii. The gain of the LM386 was very low, thus causing low amplification at the output.

CHAPTER FIVE: CONCLUSIONS

5.1 SUMMARY

The project work is designed and implemented on micro controller based Automated Intercom System. Working on this project was challenging, but it turned out to be interesting and very enlightened. It was noted that there is a difference between the theoretical (calculated results) and the practical values obtained because of the approximations made in values of the components and also due to some error which can be describe as human.

5.2 ACHIEVEMENTS

The construction of an Automated Intercom System was achieved at low cost with the best available materials. After executing this project design and construction, I know better more than ever before how important telecommunications is is in this advanced age both technological, socially and economically in the society. The system is designed to have a good quality, low noise output by taking into consideration the gain and the feedback of the amplifiers. The overall design and construction is also user friendly.

5.3 PROBLEMS ENCOUNTERED

While carrying out this project work, several constraints were encountered, amongst these difficulties encountered are:

i. Irregular power supply

ii. Lack of prior knowledge on assembly language programming and the need to develop the software for the application using the language.

iii. The difficulty encountered sourcing for components especially the integrated circuits and micro controller.

iv. Wastage of resources, time and energy resulting from damage of some components during soldering.

5.4 RECOMMENDATION

The work so far can be improved upon by using a microcontroller at each terminal (channel) so that each channel (terminal) will have its own Control Unit, Amplifying Unit and its ringer unit, instead of one microcontroller controlling the entire system.

5.5 CONCLUSION

This report covers extensively the design and construction of a three station Automated intercom system. The system was designed primarily to enhance Internal Communication within the Department of Electrical and Computer engineering, F.U.T. Minna, and also any other organization that has the similar structure. After carrying out this work, I now know better more than ever before, the importance role of Telecommunication in the technological, social and economic development of out society.

The Design and Construction of an Automated Intercom System was chosen for its stability to provide privacy of communication. The system is divided solely into three sections, the Control unit containing the Relay unit, the Channel Unit and the Power Supply unit.

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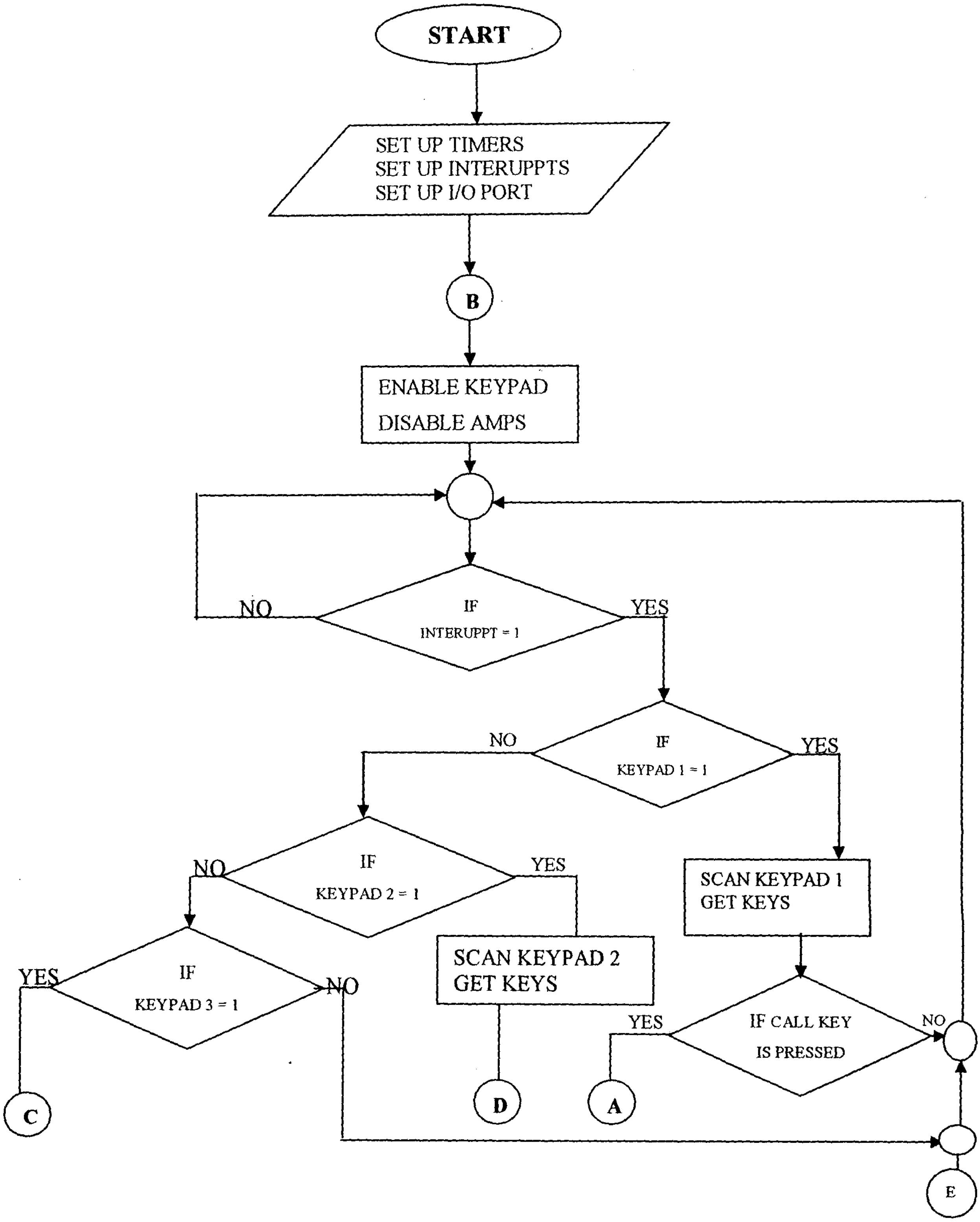
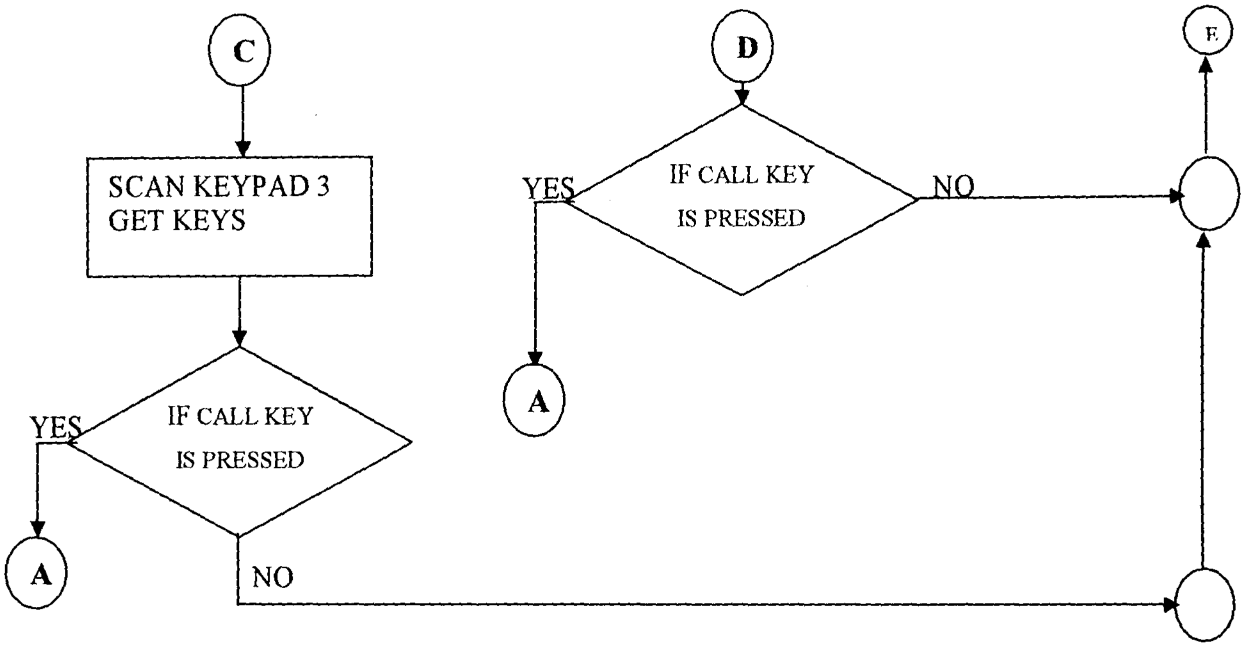
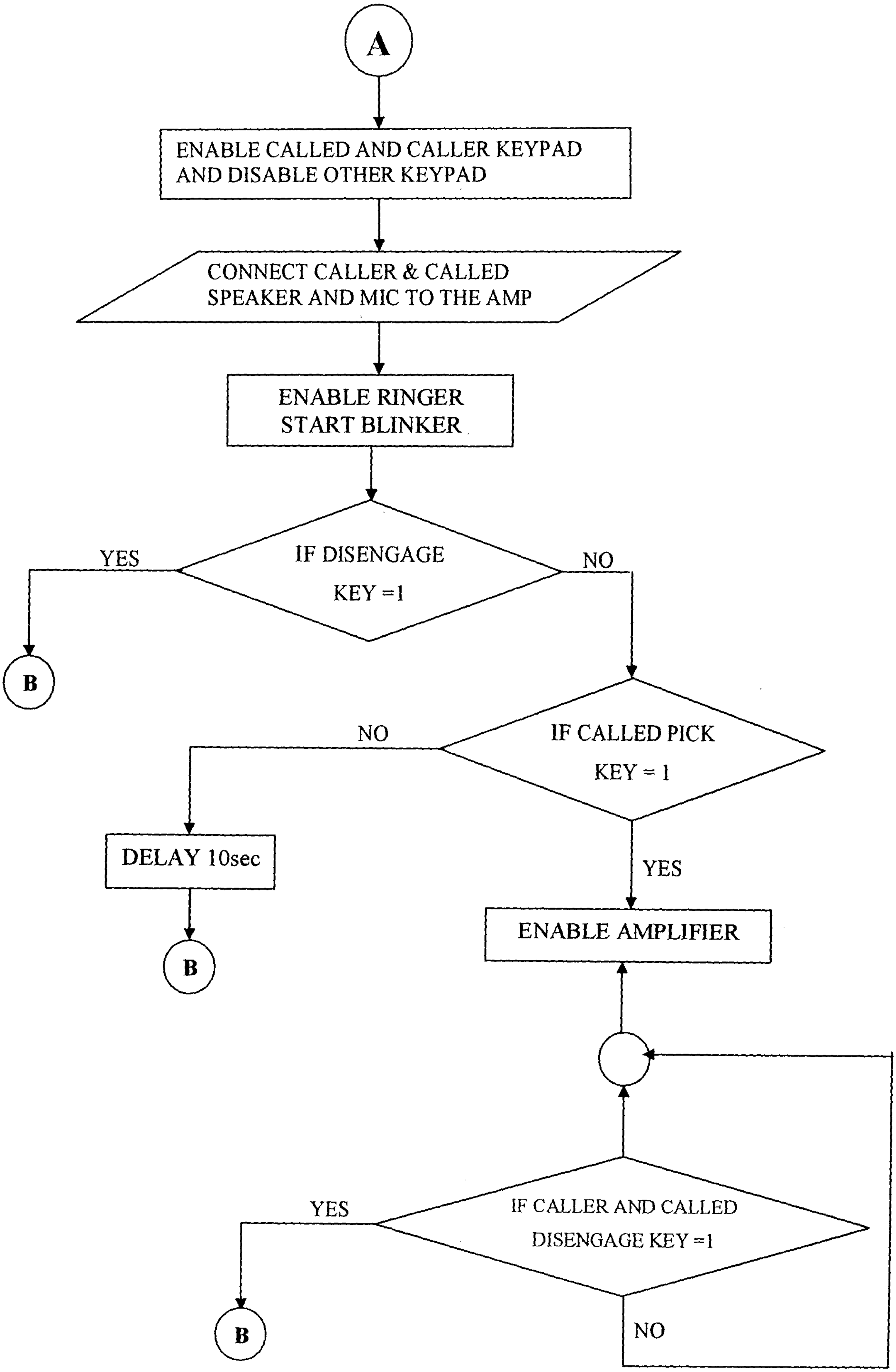
[12] www.8052.com

APPENDIX I


START
SET UP TIMERS
SET UP INTERUPPTS
SET UP I/O PORT
B
ENABLE KEYPAD
DISABLE AMPS
NO
IF
INTERUPPT = 1
YES
NO
IF
KEYPAD 1 = 1
YES
NO
IF
KEYPAD 2 = 1
YES
SCAN KEYPAD 1
GET KEYS
YES
IF
KEYPAD 3 = 1
NO
SCAN KEYPAD 2
GET KEYS
YES
IF CALL KEY
IS PRESSED
NO
C
D
A
E


C
SCAN KEYPAD 3
GET KEYS
IF CALL KEY
IS PRESSED
YES
A
NO
D
IF CALL KEY
IS PRESSED
YES
NO
A
E


A
ENABLE CALLED AND CALLER KEYPAD AND DISABLE OTHER KEYPAD
CONNECT CALLER & CALLED SPEAKER AND MIC TO THE AMP
ENABLE RINGER START BLINKER
IF DISENGAGE KEY =1
YES
NO
B
IF CALLED PICK KEY = 1
NO
YES
DELAY 10sec
B
ENABLE AMPLIFIER
IF CALLER AND CALLED DISENGAGE KEY =1
YES
NO
B

APPENDIX II

```
;TITLE:          AUTOMATED INTERCOM SYSTEM
;DEVICE:         AT89C52
;LANGUAGE:       ASSEMBLY
;COMPILER:       KEIL uVISION3
;DESIGNED BY:    OGUNKOYA ADEBOLA

;==========================================================
;==========================================================
;  DEFINITIONS
;==========================================================
;==========================================================

;==========================================================
;Registers

;==========================================================
;Memories
Caller      equ 08h
Called      equ 09h
Caller1     equ 0Ah
Called1     equ 0Ch
Caller2     equ 0Dh
Called2     equ 0Eh
Caller3     equ 0Fh
Called3     equ 10h

RingerTimer  equ 1Bh
SecCtr       equ 1Ch
LEDStatus    equ 1Dh
Ctr0         equ 1Eh
Ctr1         equ 1Fh
;==========================================================
;Bit Memories
PhoneFLag    equ 20h
;==========================================================
;Ports
LEDPort      equ P0
KPPort0      equ P1
RelayPort    equ P2
KPPort1      equ P3

;==========================================================
;Bits
KP1LED       equ P0.0
KP2LED       equ P0.2
KP3LED       equ P0.4

KP1Button2   equ P1.0
```

```
KP1Button3   equ P1.1
KP1AnsCall   equ P1.2
KP1DisCall   equ P1.3

KP2Button1   equ P1.4
KP2Button3   equ P1.5
KP2AnsCall   equ P1.6
KP2DisCall   equ P1.7

KP3Button1   equ P3.4
KP3Button2   equ P3.5
KP3AnsCall   equ P3.6
KP3DisCall   equ P3.7

CHN3Select   equ P2.0
CHN3AmpSelect equ P2.1

CHN2Select   equ P2.2
CHN2AmpSelect equ P2.3

CHN1Select   equ P2.4
CHN1AmpSelect equ P2.5

nRinger      equ P2.6
nAmp         equ P2.7


Ring0        equ 00h
Ring1        equ 01h
Ring2        equ 02h
Ring3        equ 03h
nReset       equ 04h
Blinker      equ 05h

Phone1       equ 1
Phone2       equ 2
Phone3       equ 3


;==================================================================

;==================================================================
;==================================================================
;  VECTOR ADDRESSES
;==================================================================
;==================================================================

;==================================================================
   Org 0000h       ;RESET VECTOR ADDRESS
   ljmp Start      ;Jump to start of program
;==================================================================
```

```
   Org 0003h      ;EXTERNAL INTERRUPT0 VECTOR ADDRESS
   push acc
        acall ScanKP

        acall nDelay
        pop acc
        reti
;==================================================================
   Org 000Bh      ;TIMER0 INTERRUPT VECTOR ADDRESS
   push acc
        acall nTimer
        pop acc
        reti                   ;Not used
;==================================================================
   Org 0013h      ;EXTERNAL INTERRUPT1 VECTOR ADDRESS
   reti                  ;Not used
;==================================================================
   Org 001Bh      ;TIMER1 INTERRUPT VECTOR ADDRESS
   reti                  ;Not used
;==================================================================
   Org 0023h      ;SERIAL INTERRUPT VECTOR ADDRESS
   reti          ;Not used
;==================================================================
   Org 002Bh      ;TIMER2 INTERRUPT VECTOR ADDRESS
   reti          ;Not used
;==================================================================
   Org 0038h      ;Program starts here
Start:
   mov SP,#40h     ;Stack Pointer initialized

        clr RS0        ;Bank0 selected
   clr RS1
        acall ChipSetup
        setb EA                ;Enable Global Interrupt
Idle:
   jb nReset,Start
        ajmp  Idle

;==================================================================


;==================================================================
;==================================================================
;  INTERRUPT CALLS
;==================================================================
;==================================================================
ScanKP:

        jnb KP1Button2,nCLP1CDP2
        jnb KP1Button3,nCLP1CDP3
   jnb KP2Button1,nCLP2CDP1
        jnb KP2Button3,nCLP2CDP3
```

```
   jnb KP3Button1,nCLP3CDP1
        jnb KP3Button2,nCLP3CDP2

        jnb KP1AnsCall,rPhone1AnsCall
        jnb KP2AnsCall,rPhone2AnsCall
        jnb KP3AnsCall,rPhone3AnsCall

        jnb KP1DisCall,rPhone1DisCall
        jnb KP2DisCall,rPhone2DisCall
        jnb KP3DisCall,rPhone3DisCall
   ret

rPhone1DisCall:
        ljmp nPhone1DisCall
rPhone2DisCall:
        ljmp nPhone2DisCall
rPhone3DisCall:
        ljmp nPhone3DisCall

rPhone1AnsCall:
        ljmp nPhone1AnsCall
rPhone2AnsCall:
        ljmp nPhone2AnsCall
rPhone3AnsCall:
        ljmp nPhone3AnsCall


nCLP1CDP2:
   jb Ring0,EndC
   mov Caller1,#Phone1
        mov Called1,#Phone2
        ret
nCLP1CDP3:
        jb Ring0,EndC
        mov Caller1,#Phone1
        mov Called1,#Phone3
        ret
nCLP2CDP1:
        jb Ring0,EndC
        mov Caller2,#Phone2
        mov Called2,#Phone1
        ret
nCLP2CDP3:
        jb Ring0,EndC
        mov Caller2,#Phone2
        mov Called2,#Phone3
        ret
nCLP3CDP1:
        jb Ring0,EndC
        mov Caller3,#Phone3
        mov Called3,#Phone1
        ret
```

```
nCLP3CDP2:
        jb Ring0,EndC
        mov Caller3,#Phone3
        mov Called3,#Phone2
EndC:
        ret
;========================================
nPhone1AnsCall:
        mov A,Called
        cjne A,#Phone1,P1ACProceed
        clr Blinker
        mov LEDPort,LEDStatus
        acall DiactvateRinger
        ret
P1ACProceed:
    jb Ring1,EndP1AC
        mov A,Caller1
        cjne A,#255,P1Proceed
        ajmp EndP1AC
P1Proceed:
        mov Caller,Caller1
        mov Called,Called1
        setb Ring1
        setb Ring0
        acall ActivateLED
        acall ActivateRinger
EndP1AC:
    ret

nPhone2AnsCall:
    mov A,Called
        cjne A,#Phone2,P2ACProceed
        clr Blinker
        mov LEDPort,LEDStatus
        acall DiactvateRinger
        ret
P2ACProceed:
    jb Ring2,EndP2AC
        mov A,Caller2
        cjne A,#255,P2Proceed
        ajmp EndP2AC
P2Proceed:
        mov Caller,Caller2
        mov Called,Called2
        setb Ring2
        setb Ring0
        acall ActivateLED
        acall ActivateRinger
EndP2AC:
    ret

nPhone3AnsCall:
```

```
    mov A,Called
        cjne A,#Phone3,P3ACProceed
        clr Blinker
        mov LEDPort,LEDStatus
        acall DiactvateRinger
        ret
P3ACProceed:
    jb Ring3,EndP3AC
         mov A,Caller3
        cjne A,#255,P3Proceed
        ajmp EndP1AC
P3Proceed:
        mov Caller,Caller3
        mov Called,Called3
        setb Ring3
        setb Ring0
        acall ActivateLED
        acall ActivateRinger
EndP3AC:
    ret
;====================================

nPhone1DisCall:
        mov A,#Phone1
        cjne A,Caller,nP1DC
        setb nReset
nP1DC:
    cjne A,Called,ENDP1DC
    setb nReset
ENDP1DC:
        ret

nPhone2DisCall:
        mov A,#Phone2
        cjne A,Caller,nP2DC
        setb nReset
nP2DC:
    cjne A,Called,ENDP2DC
        setb nReset
ENDP2DC:
        ret

nPhone3DisCall:
        mov A,#Phone3
        cjne A,Caller,nP3DC
        setb nReset
nP3DC:
    cjne A,Called,ENDP3DC
        setb nReset
ENDP3DC:
        ret
;====================================================
```

```
nTimer:

;=============================
nBlinker:
        jnb Blinker,nTProceed
        djnz SecCtr,nTProceed
        mov SecCtr,#7
        djnz RingerTimer,BProceed
        setb nReset
BProceed:
        mov A,Caller
        cjne A,#Phone1,BProceed0
        cpl KP1LED
BProceed0:
        cjne A,#Phone2,BProceed1
        cpl KP2LED
BProceed1:
        cjne A,#Phone3,BProceed2
        cpl KP3LED
BProceed2:
        mov A,Called
        cjne A,#Phone1,BProceed3
        cpl KP1LED
BProceed3:
        cjne A,#Phone2,BProceed4
        cpl KP2LED
BProceed4:
        cjne A,#Phone3,BProceed5
        cpl KP3LED
BProceed5:
;=============================


nTProceed:
   ret
;=========================================================
;=========================================================
;  SUBROUTINE CALLS
;=========================================================
;=========================================================

ChipSetup:

   setb EX0      ;External Interrupt0 enabled
   clr IT0       ;Externa0 Interrupt on 1-0 transition

        mov TMOD,#17   ;Timer0 and Timer1 (16bit Timers)
        setb ET0       ;Timer0 Interrupt enabled
        setb TR0       ;Start Timer0

   mov LEDPort,#255
        mov KPPort0,#255
```

```
        mov KPPort1,#255
        mov RelayPort,#0
        mov Caller,#0
        mov Called,#0

        mov Caller1,#255
        mov Caller2,#255
        mov Caller3,#255

        mov PhoneFlag,#0
        mov SecCtr,#7
    mov RingerTimer,#50

    ;mov TH1,#11     ;Timer1 reload value= 3035
    ;mov TL1,#219
        ;setb ET1       ;Timer1 Interrupt enabled
        ;setb TR1       ;Start Timer1

    ret
;======================================================
ActivateLED:
    mov A,Caller
        cjne A,#Phone1,ALProceed0
        clr KP1LED

ALProceed0:
        cjne A,#Phone2,ALProceed1
        clr KP2LED
ALProceed1:
    cjne A,#Phone3,ALProceed2
        clr KP3LED

ALProceed2:
    mov A,Called
        cjne A,#Phone1,ALProceed3
        setb CHN1AmpSelect
        acall Settle
        setb CHN1Select
        clr KP1LED
ALProceed3:
        cjne A,#Phone2,ALProceed4
        setb CHN2AmpSelect
        acall Settle
        setb CHN2Select
        clr KP2LED
ALProceed4:
    cjne A,#Phone3,ALProceed5
        setb CHN3AmpSelect
        acall Settle
        setb CHN3Select
        clr KP3LED
ALProceed5:
```

```
    mov LEDStatus,LEDPort
          setb Blinker
    ret
;=========================================================================
DiactvateRinger:
          clr nRinger
          mov A,Caller
          cjne A,#Phone1,DRProceed1
          setb CHN1Select
          ret
 DRProceed1:
    cjne A,#Phone2,DRProceed2
          setb CHN2Select
          ret
 DRProceed2:
    cjne A,#Phone3,DRProceed3
          setb CHN3Select
 DRProceed3:
          ret

;=========================================================================
 ActivateRinger:
          Setb nRinger
          ret
;=========================================================================
 nDelay:
    acall Delay
          acall Delay

          ret

;=========================================================================

 Delay:
     mov Ctr0,#255
 Delay1:
     mov Ctr1,#255
     djnz Ctr1,$
     djnz Ctr0,delay1
     ret

Settle:
          mov Ctr1,#255
     djnz Ctr1,$
          ret
;=========================================================================
;=========================================================================
     end
```