DESIGN AND CONSTRUCTION OF A WIRELESS ALERTING DEVICE

BY

ALAKE ADEKANMI MOSES

98/6864EE

A PROJECT SUBMITTED

TO

ELECTRICAL AND COMPUTER ENGINEERING
DEPARTMENT

SCHOOL OF ENGINEERING AND ENGINEERING
TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
NIGER STATE, NIGERIA.

IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR
THE AWARD OF BACHELOR OF ENGINEERING [B. ENG.]
DEGREE IN ELECTRICAL ELECTRONICS AND COMPUTER
ENGINEERING.

OCTOBER 2004

CERTIFICATION

This is to certify that this Project work was carried out by Alake Adekanmi Moses with registration number 98/6864EE under the supervision of Engr. M.D. Abdullahi and submitted to the Electrical and Computer Engineering Department, Federal University of Technology, Minna.

Engr. M. D. Abdullahi
(Project Supervisor)

21/12/2004
Signature and Date

Engr. M. D. Abdullahi
(Head of Department)

21/12/2004
Signature and Date

(External Examiner)

....
Signature and Date

DEDICATION

This project is dedicated to the Almighty God for guiding me through this academic exercise and for His loving kindness upon my life.

I also dedicate this project to the Deeper Life Campus Fellowship F.U.T Minna chapter for extending their hands of fellowship towards me.

ACKNOWLEDGEMENT

I am most grateful to the Almighty God for His Goodness, Faithfulness, and Mercy upon my life and for giving me life and wisdom to complete this academic exercise

My profound gratitude goes to my supervisor Engr., M. D. Abdullahi for his dexterous and fatherly supervision throughout the period of this project work and for taking his time to read through the report at various stages of the write-up.

My heartfelt appreciations goes to my beloved parents Mr. and Mrs. Alake for their all round support. I would forever remain grateful for your continuous benevolence.

My thanks to the entire staff and lecturers of the Electrical/computer Engineering Dept for the knowledge imparted into me.

My sincere gratitude to Mr. and Mrs. Orji for their material support and for granting me an open door to their home during most of my semesterial breaks.

I remain grateful to my precious friends and companions among whom are Folaranmi M. David M., Afolabi M., Ajaguna B., Adex K., Isah Aminu, Alli B.S., others are Ndagi N., Adisa A., Joseph O., and Kenneth O., for their priceless encouragement and friendly support.

TABLE OF CONTENTS

CONTENTS **PAGE**

LISTS OF SYMBOLS AND ABBREVIATIONS

WAD	Wireless Alerting Device
AGC	Automatic Gain Control
AF	Audio Frequency
IF	Intermediate Frequency
RF	Radio Frequency
FM	Frequency Modulation
AM	Amplitude Modulation
PM	Phase Modulation
IC	Integrated Circuit
H	Henry
Hz	Hertz
V	Volt
R	Resistance
C	Capacitance
F	Farad
I	Current
Ω	Ohms
μ	Micro (10^{-6})
p	Pico (10^{-9})

LIST OF FIGURES

ABSTRACT

This project is on the design and constriction of a Wireless Alerting Device that can be used by hospital patients to alert Doctors and Nurses in the event of medical emergency occurrence without leaving their beds or wards.

The project uses an astable multi-vibrator to generate 7.2 kHz signal. The signal is used to modulate a carrier wave of 60-70 MHz generated by an oscillator. The transmitted signal, is then demodulated by a receiving unit to obtain the original audio frequency signal, which is then amplified to the required power level to trigger an audio alarm.

CHAPTER ONE

GENERAL INTRODUCTION

1.1 INTRODUCTION

It is extremely difficult, if not impossible for one to make an exact prediction as to when emergency situations, that will require urgent response may arise. However an Alerting Device would help to notify necessary authorities whenever they occur within the shortest possible time.

1.2 DEFINATION OF AN ALERTING DEVICE

An Alerting Device is an equipment that can be used to notify a person or a group of people that, emergency exist, call for attention, or to signal the presence of a hazard, and they are classified into two major types, namely AUDIBLE ALERTING DEVICES and VISUAL ALERTING DEVICES

1.2.1 AUDIBLE ALERTING DEVICES

Audible Alerting Devices include Bells, Horns, Sirens, Voice announcement Systems and other Devices that can be distinguish above and apart from the normal sound level within the located environment or work place. [1]

(a) BELLS: These are the most common alerting devices generally in use, though their usage is universal, their significance and symbol varies from place to place and from culture to culture. They are used to alert people of danger or to call for attention.

(b) HORNS: These alerting devices produce a very loud distinctive sound, which immediately attracts attention. They are very useful alerting devices used to call for attention to critical emergency situations. [1]

(c) SIRENS: These are alerting devices that continuously produce a loud piercing wail that is ideally suitable for alerting emergency situations.

(d) PUBLIC ANNOUNCEMENT SYSTEMS: Speakers can also be used to play live or recorded messages. They are often ideally suited for large working environment. [1]

1.3 VISUAL ALERTING DEVICE

These are steady, flashing, or strobe light used to alert workers to emergency situations in areas where noise level is high, especially where ear protection must be worn, and audible signal may not be heard or may be miss-understood.

Visual signals also provide an effective way to alert individuals with hearing loss about an emergency. Visual alerting devices may either be flashing, steady or strobe light. [1]

(a) FLASHING STEADY LIGHT: The light is well suited for areas or locations where ambient noise makes audible signals difficult to hear. This type of light comes with different colored covers for increase attentions. [1]

(b) STROBE LIGHT: Strobe light uses high intensity flash tubes that are ideally suited for areas where high ambient light levels make flashing light difficult to distinguish or where ambient noise makes audible signal difficult to be heard. [1]

For alerting devices to produce adequate notification in the event of emergency, they must be: Appropriate for the location in consideration, capable of being heard, seen or otherwise perceive by everyone in the workplace, distinctive and easily identified by concerned authorities as a signal to perform certain actions in response to an emergency and provide notification to assigned personnel whenever a deficiency exists. [1]

1.3 MOTIVATION

The aim of this project work is to design and construct an alerting device that may be used to alert any emergency situation that would require urgent response.

Particularly to aid hospital patients with an alerting device that may be used to alert nurses or doctors in the event of any medical emergency without necessarily leaving their wards.

1.4 AIMS AND OBJECTIVES

- To design and construct an alerting device that immediately alerts emergency situations.
- To design and construct an alerting device that will incorporate both visual and audible alarm signals to accommodate the hearing and visually impaired.
- To design and construct both a transmitter and a receiver to achieve its wireless nature.
- To design and construct an alerting device whose blinking rate would be, below five blinks per second (5bps). Because blinks above this rate can trigger seizures in people with certain form of epilepsy.

1.5 WORKING PRINCIPLE OF THE ALERTING DEVICE

The alerting device consists basically of a hand held transmitter and a centrally installed radio receiver capable of responding to alarm signals from a given location.

When an individual with the hand held transmitter needs an urgent attention in the event of emergency occurrence. The transmitter is being operated and this in turn transmits signals. Immediately the centrally installed alarm signal receiver detects the signals the centrally installed radio receiver begins to give an alarm sound which now gets the attention of the concerned personnel or necessary authorities.

1.6 PROJECT OUTLINE

This Project Report covers five chapters in all. The first chapter gives a general introduction on what the project is all about, reasons why the project was carried out and how it was carried out.

Chapter two is on literature review, an insight was given on previous work already carried out on the project.

Chapter three of the report discussed in detail the circuit design and analysis of the project work

.In Chapter four of the Report, the construction steps followed in carrying out the project work was fully discussed, difficulties encountered and results obtained were fully stated.

The final Chapter of the Report is chapter five, In this chapter, quite a number of conclusions on the project work were drawn and necessary proffered recommendations were given for further work.

CHAPTER TWO

LITERATURE REVIEW

2.1 HISTORY OF ALERTING DEVICES

Since ancient times, several alerting devices were used by man to signal the presence of emergency. These devices range from bells, whistles, horns, sirens etc. Each of these devices has its strength and limitations.

In those early days, they were used to call for the attention of village residents, to notify community residents that a curfew is in effect, alert people of danger such as the presence of marauders or approaching storms among others.

2.1.1 WHISTLES

In 1876, the popular alarm system was to use whistles, which were located on structures in the various parts of town Three whistles were used in Adams. The northern whistle was located on the -Gingham Mill, the southern on the Stone Mill, and the central on the Adams Paper Mill.

Fortunately, an alarm system was installed in 1893. The system had 21 boxes divided between the town's five districts. Each box had its own signal. Adams was the first to use this type of system and other communities soon adapted it. In 1969, the "Group Alerting Telephone System" was installed and operated by the Adams Police Department.

This system allowed the company's members to receive the exact location of the fire over the phone. This technology later gave way to the present system of wireless communication via pagers. [2]

2.1.2 BELLS

Since ancient times, bells have been used to alert people of danger such as marauders or approaching storms. Bells have been used to call for the attention of village residents. In 1945, many bells tolled to announce the end of World War II.

Bells are regularly used in every country from Russia to South Africa to china and in the United States. Though the use of bells as an alerting device is universal, their significance and symbolism varies from continent to continent and from culture to culture. For example in America the liberty bell is viewed as a symbol of freedom and independence and the school bell symbolizes freedom from stuffy classrooms.[3]

2.1.3 HORNS

Another important alerting device is the horn, which are generally adapted as warning horns. Although Northey Horns were either single tone or dual tone, these horns were and still are used at different locations to alert concerned authorities that an emergency exist. In the early days, they were used by certain communities to alert their people that a curfew is in effect.

In most cases, in the usage of the horns, Coded "honks "or blasts are sent out. The number of horns indicates what kinds of emergency exist and quite often were the incident is located. [4]

2.1.4 SIRENS

Preparing for a disaster before it occurs is an integral part of surviving and responding to any disaster that might impact our community. The City of San Leandro has stepped up response capabilities for emergencies with the launching of an alerting and warning device that will alert and inform the community in the event of a disaster.

San Leandro's alerting and warning System consists of 8 sirens strategically placed throughout the city to cover all portions of San Leandro, any of which may be activated during a localized or citywide emergency. The goal is to train residents and businesses to tune into1610 AM, Radio San Leandro, once a siren is heard to obtain information about the emergency and what to do

The Alerting and Warning Siren is an essential Response tool in an emergency and are maintained and activated by the San Leandro Police Department and the Alameda country Fire Department. Sirens will be sounded. In the event of danger resulting from earthquakes, Chemical spills, flooding, fires, Storms, power outages, transportation accidents, and other public Safety incidents. [5]

2.2 HISTORICAL BACKGROUND OF WIRELESS COMMUNICATION

The working principle of this project work is based on wireless communication operating basically on the principle of radio waves. Concerning the history of wireless communication, several brilliant men contributed to its development and advancement. The very possibility of wireless communication was founded on the research work of the British physicist James Clark Maxwell. [6]

In 1867 Maxwell developed his theory on electromagnetism and predicted the existence of radio waves, which travel through space at a constant velocity. However, Heinrich Rudolf Hertz later demonstrated the validity of the self-propagating electromagnetic waves suggestion in an experiment in 1888. He demonstrated the existence of electromagnetic waves, and proved that electric signals can travel through open air and this was fundamental to the invention of radio.

In 1894 the British Physicist Sir Oliver Lodge went further to detect the presence of radio waves in space as predicted by Maxwell.

It will be interesting to note that the most successful of all the radio pioneers was Gugliemo Marconi who was generally known as the father of radio communication. He became interested in wireless communication thereby studying the earlier works of Maxwell, Hertz, and others. In 1895 he developed apparatus for the purpose of transmitting a wireless signal and in 1896, Marconi was successful in transmitting signals for over one mile. Before long in 1899 he has succeeded in establishing communication across the English Channel between

England and France. Two years later, he used synchronized transmitters and receivers in sending signals across the Atlantic Ocean a distance of 2800 km. His system was soon adopted by the British and Italian navies. [7]

As time progress, Lee Deforest developed an improved wireless receiver in 1902. He modified the work of other inventors and created an audium, a vacuum tube containing some gas. It was a triode incorporating a filament and a plate like ordinary vacuum tubes. This strengthened the current through the tube hence amplifying weak radio signals.

A year later Paulsen discovered the transmission of a continuous waves with an electric arc. The thermionic valve was later used as radio generator, which produces a carrier wave capable of being modulated.

The efforts of the above great men enhance the possibility of wireless communication, consequently, making space exploration possible.

CHAPTER THREE

SYSTEM DESIGN AND ANALYSIS

3.1 GENERAL INTRODUCTION

Design is the art of engineering, good design evolves out of considerable circuit analysis. [8]. in this chapter detail consideration of the building blocks that is incorporated in the design is properly considered and analysed.

The basic building blocks that make up the wireless alerting system can be divided into the following sub-units: Control Switch Unit, Signal Generator, Signal Transmitter, Signal Receiver, Output Latch, Reset Control, Audio Alarm and Visual Display Unit. The block diagram of the wireless alerting device is shown in figure 3.1 below.

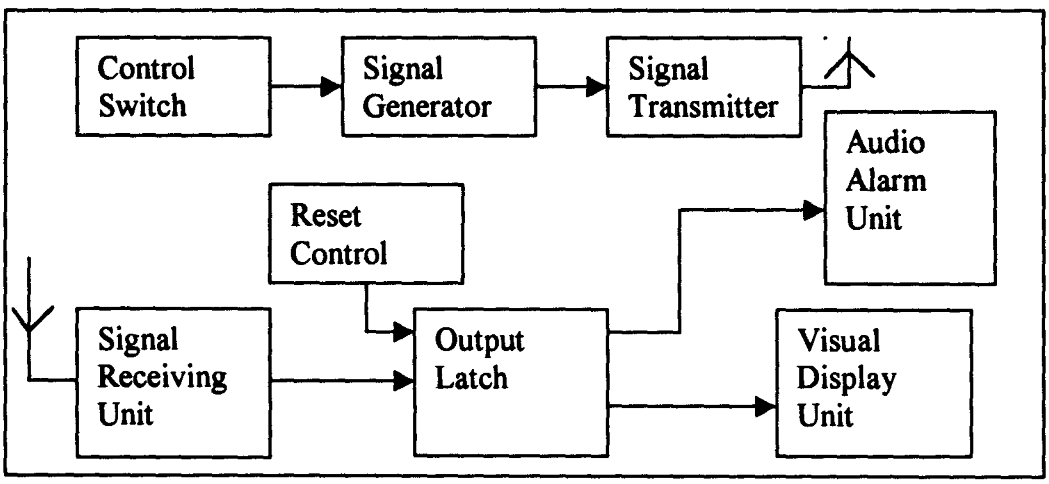


Fig. 3.1 Block diagram of the Wireless Alerting Device

3.2 POWER SUPPLY UNIT

Most electronic devices and circuit requires a dc source for their operation. The most convenient and economical source of power is the domestic ac supply, it is therefore necessary to convert the ac mains supply to the required dc voltage. The process of converting ac into dc voltage is illustrated in figure 3.2.

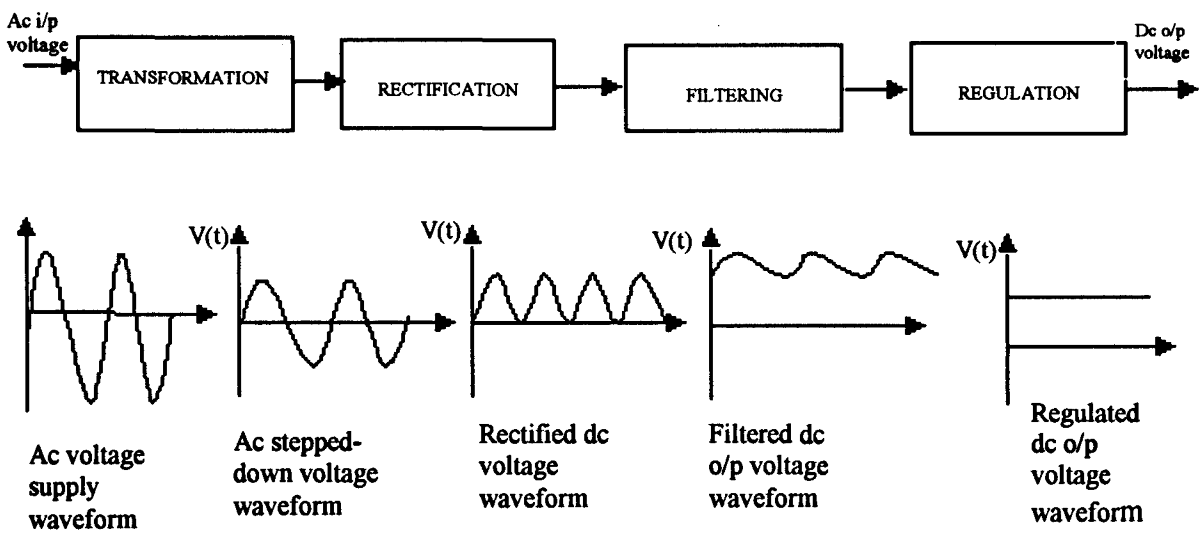


Fig. 3.2a: Block Diagram of the Power Supply Unit with Corresponding Waveform

3.2.1 TRANSFORMATION STAGE

The first stage of the power supply unit involves the stepping down of the 240 V ac supply from the mains to 12 V, the stepping down of the voltage level is achieved with the aid of a transformer. In its simplest form it consists of two inductive coils which are electrically separated but magnetically linked. The first

3.2 POWER SUPPLY UNIT

Most electronic devices and circuit requires a dc source for their operation. The most convenient and economical source of power is the domestic ac supply, it is therefore necessary to convert the ac mains supply to the required dc voltage. The process of converting ac into dc voltage is illustrated in figure 3.2.

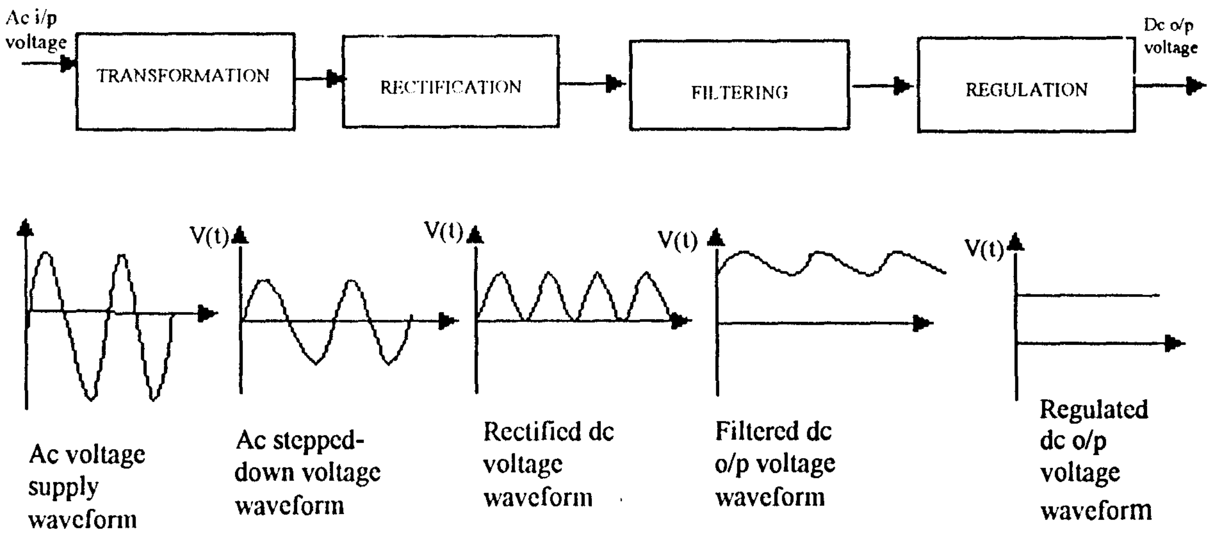


Fig. 3.2a: Block Diagram of the Power Supply Unit with Corresponding Waveform

3.2.1 TRANSFORMATION STAGE

The first stage of the power supply unit involves the stepping down of the 240 V ac supply from the mains to 12 V, the stepping down of the voltage level is achieved with the aid of a transformer. In its simplest form it consists of two inductive coils which are electrically separated but magnetically linked. The first coil, through which electrical energy is fed is called the primary winding and the other from which energy is drawn out, is called the secondary winding. [9]

3.2.2 RECTIFICATION STAGE

Rectification is the process of converting the ac voltage into one that is limited to one polarity. The diode is useful for this function because of its non-linear characteristics, i.e. current exist for one voltage polarity but is essentially zero for the opposite polarity.

A dc power supply is required to bias all electronic circuit, therefore a rectifier employs the usage of one or more diodes to convert the ac voltage into pulsating dc voltage. [8]

3.2.3 FILTERING STAGE

The function of the filtering stage is to remove the fluctuations or pulsations called ripples, present in the output voltage supplied by the rectifier. Certainly, no filter can, in practice, give an output voltage as ripple- free as that of a dc battery, but it approaches it so closely that the power supply performs well. [9]

3.2.4 REGULATION STAGE

Regulated power supply can be obtained by using a voltage regulator circuit. A regulator is an electronic control circuit capable of providing a nearly constant dc output voltage even when there are variations in load or input voltage. All electronic devices require regulated dc power, for their operation. At the regulation stage, a relatively constant dc voltage from an ac signal source is established. [9]

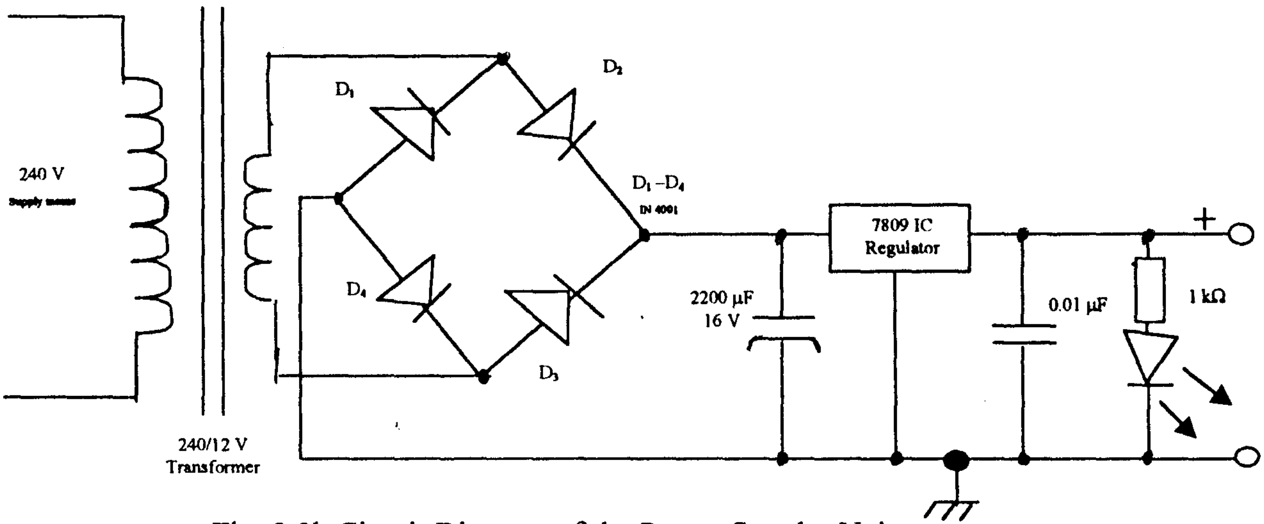


Fig. 3.2b Circuit Diagram of the Power Supply Unit

3.3 SIGNAL GENERATOR

The multi-vibrator, as its name implies, is very rich in harmonics of the fundamental frequency of oscillation, the square-wave output if in the audio range is very pleasant to the human ear as such the multi-vibrator is used in electronic circuit as tone or signal generators.[10]

Multi-vibrators are found everywhere in electronics, either as individual circuit or as part of larger circuit and systems. Multi-vibrator is an old fashion term referring to a circuit that vibrates or oscillates.

The astable multi-vibrator is one of the three multi-vibrators in existence. It was the first of the multi-vibrator family to be investigated, as a relaxation circuit it works on the basis of charging a capacitor within a short period followed by discharging through a resistor. The discharging period is dependent on the RC combination.

The output of a relaxation circuit is not a sine-wave; it is a saw tooth or a rectangular wave. It is a two-stage capacitor coupled common-emitter amplifier with the whole of its output feedback to the input. [10].

Figure 3.3 and 3.4 shows the circuit diagram of the astable multi-vibrator, and the output waveform respectively.

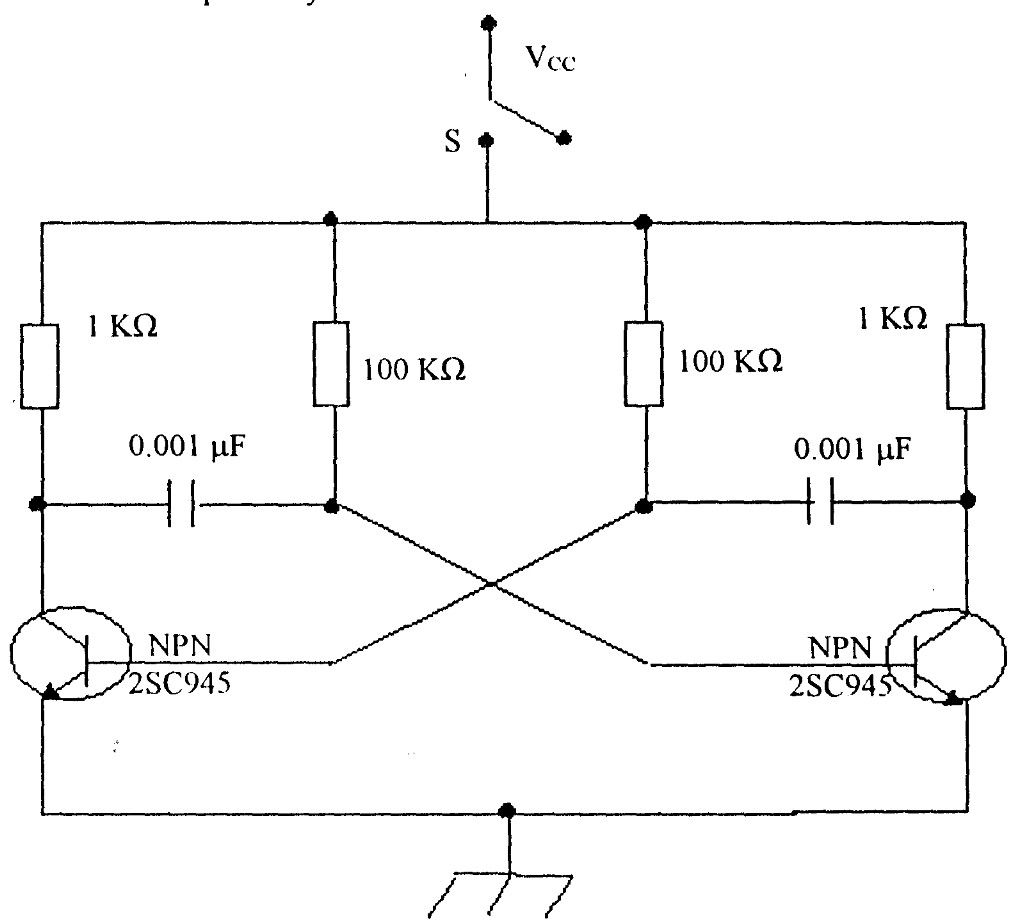


Fig. 3.3 Circuit Diagram of an Astable Multi-Vibrator

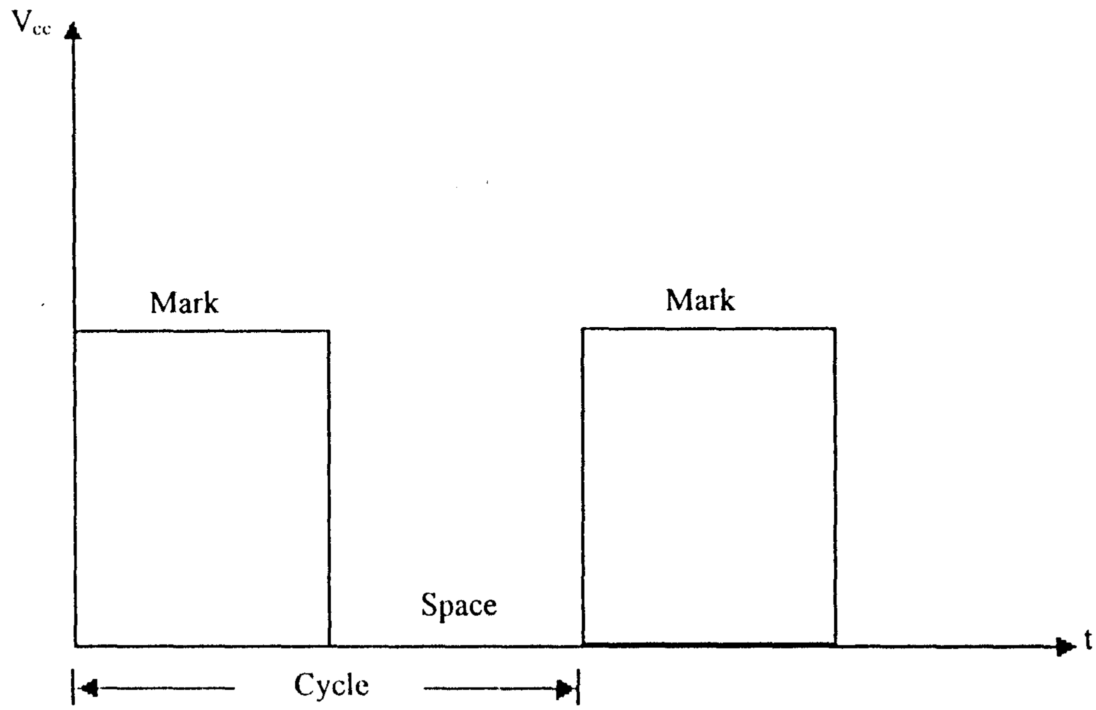


Fig 3.4 Output Waveform of the Astable Multi-Vibrator

3.3.1 CIRCUIT OPERATION OF THE SIGNAL GENERATOR

The circuit operation will easily be understood if it is remembered that due to feedback (i) when Q_1 is ON, Q_2 is OFF and, (ii) when Q_2 is ON, Q_1 is OFF.

When the power is switched ON by closing S, one of the transistors will start conducting before the other does or slightly faster than the other. It is so because characteristics of no two seemingly similar Transistors can be exactly alike.

Suppose that Q_1 start conducting before Q_2 does. The feedback system is such that Q_1 will be very rapidly driven to saturation and Q_2 to cut off. [9] The following sequence of event will occur; since Q_1 is in Saturation, whole of V_{cc} drops across

Q_2 is in cut off, i.e. it conducts no current; there is no drop across R_{L2}. Hence point B is at V_{cc}. Since A is at 0 V, C_2 starts to charge through R_2 towards V_{cc}.

1. When voltage across C_2 rises sufficiently (i.e. more than 0.7 V) it biases Q_2 in the forward direction so that it start conducting and is soon driven to Saturation.

2. V_{C2} decreases and becomes almost zero when Q_2 gets saturated, the potential of point B decreases from Vcc to almost zero volt. The potential decrease (negative swing) is applied to the base of Q_1 through C_1. Consequently, Q_1 is pulled out of saturation and is soon driven to Cut Off.

3. Since, now, point B is at 0 V, C_1 starts charging through R_1 towards the target voltage V_{cc}.

4. When voltage of C_1 increases sufficiently, Q_1 becomes forward biased and start conducting. In this way the whole cycle is repeated.

3.3.2 SWITCHING TIMES

It is seen that the circuit alternates between a state in which Q_1 is ON and Q_2 is OFF and a state in which Q_1 is OFF and Q_2 is ON. The time in each state depends on RC values. Since each transistor is driven alternately into Saturation and Cut Off.

The voltage waveform at either collectors (point A and B), is essentially a square wave form with a peak amplitude equal to V_{cc}. Figure 3.5 depicts the square wave form of the astable multi-vibrator. [9]

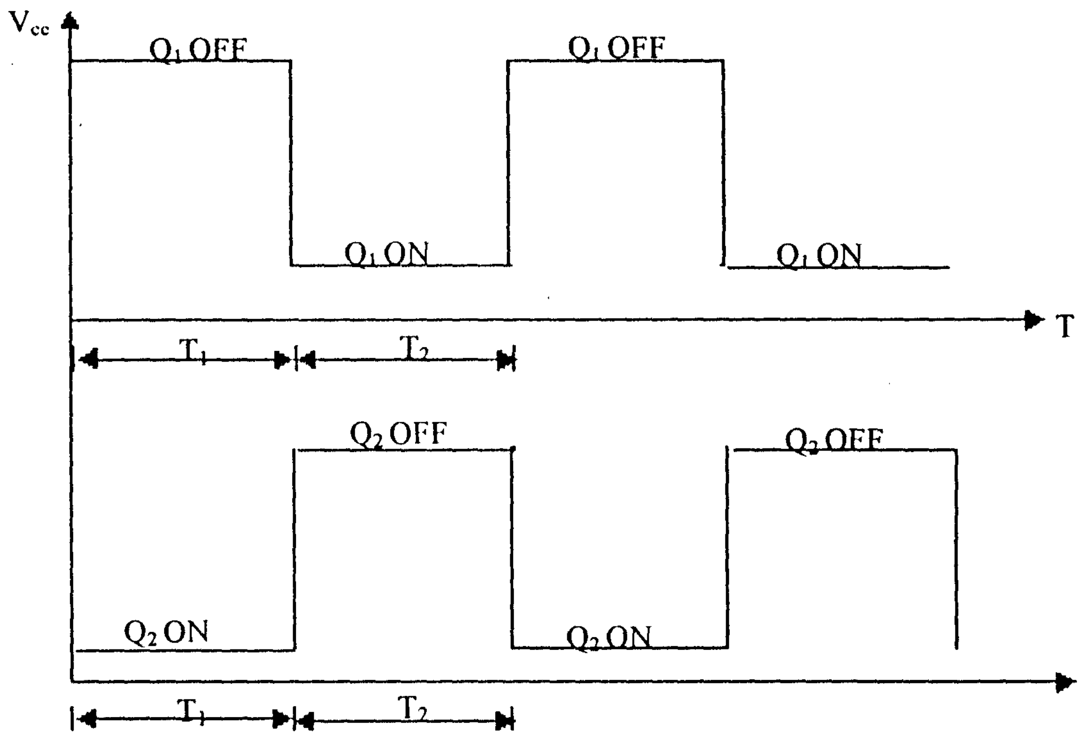


Fig 3.5 Waveform at Collector A and B of the Astable Multi-vibrator

The off time for Q_1 is $T_1 = 0.693\ R_1C_1$ and

For Q_2 is $T_2 = 0.693\ R_2C_2$.

Hence, total time period of the wave is,

$T = T_1 + T_2 = 0.693(R_1C_1 + R_2C_2)$ Since $R_1 = R_2 = R$ and

$C_1 = C_2 = C$

The two stages symmetrical, therefore

$T = 1.386RC$ but $R_1 = R_2 = R = 100\ K\Omega$ and $C_1 = C_2 = C = 0.001\mu F$

$T = 1.386 \times 100 \times 10^3 \times 0.001 \times 10^{-6} = 138.6\ \mu s$

3.3.3 FREQUENCY OF OSCILLATION

The frequency of oscillation of the signal generated by the astable multi-vibrator is given by the reciprocal of the time period

i.e. $F = 1/T$, but $T = 138.6\ \mu s$, therefore

$F = 1/\ 138.6\ \mu s = 7.215$ KHz

3.4 SIGNAL TRANSMITTING UNIT

A transmitting device aids the transmission of signals from one point to another by means of radio waves. The transmission of signals involves the modulation of an audio signal by impressing it on a suitable frequency. Radio signals are transmitted and received by means of aerials. For successful transmission and reception of intelligence, by the use of radio waves, two processes are essential, Modulation and Demodulation.

3.4.1 MODULATING UNIT

Modulation is the process of combining a low frequency signal with a very high frequency radio wave called carrier wave; the resultant wave is called modulated carrier wave. Modulation is necessary i.e. using a carrier wave to carry the low frequency signal from one point to another. Fig. 3.6 is the circuit diagram of the signal-transmitting unit.

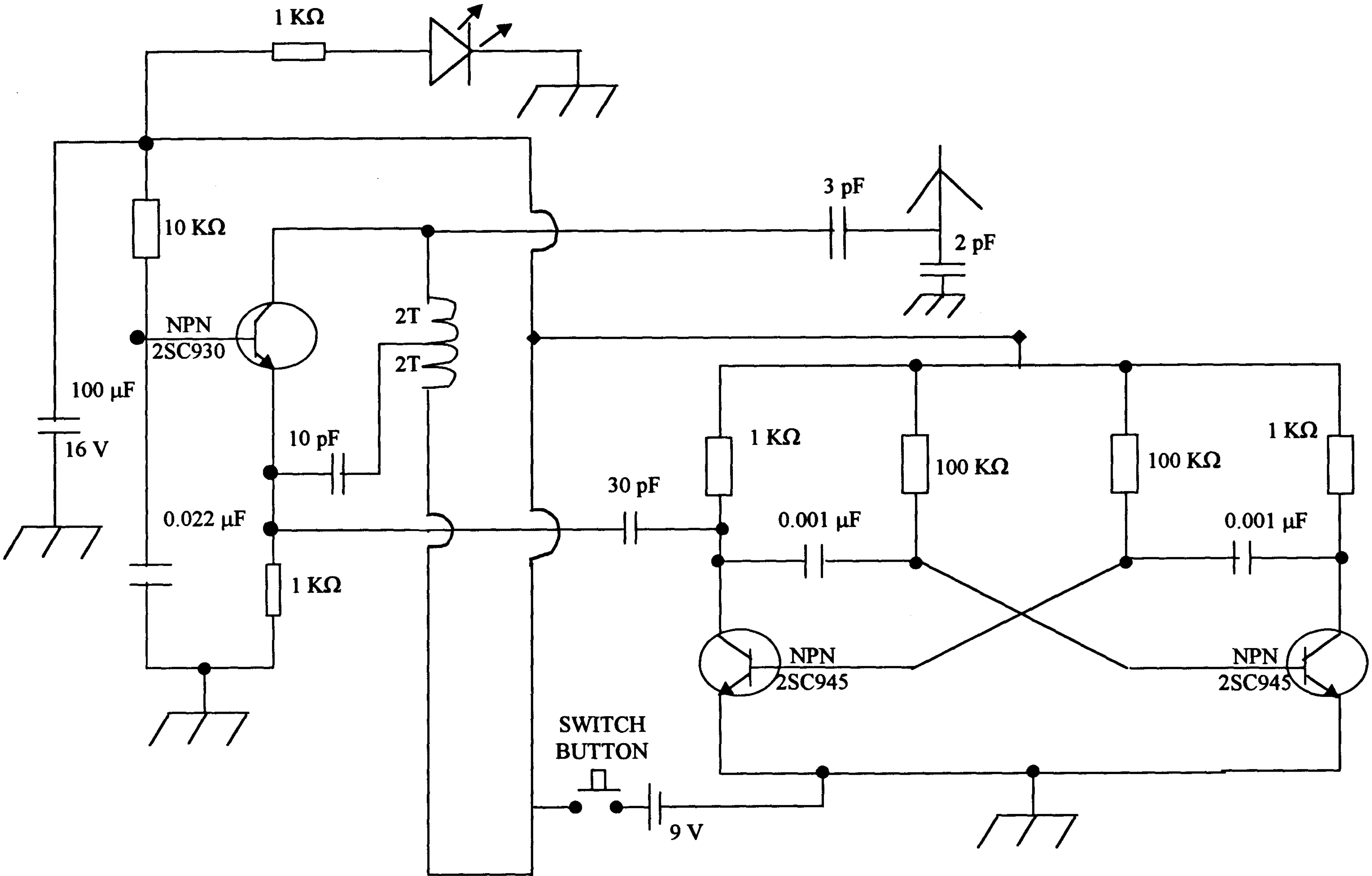


Fig. 3.6 Circuit Diagram of the Signal Transmitting Unit

Modulation enables a low frequency signal to travel large distance through space with the aid of high frequency carrier waves. These carrier waves needs reasonably sized antenna and produce no interference with other transmitting device operating in the same area. [9]

3.4.2 METHODS OF MODULATION

As earlier explained, modulation is the process of combining an audio-frequency (AF) carrier wave with a radio frequency (RF) carrier wave. The AF signal is called the modulating wave and resultant wave is called the modulated wave. [9] Basically, there are three types of modulations, they include:

(1) Amplitude Modulation (AM

2) Frequency Modulation (FM)

(3) Phase Modulation (PM)

In Amplitude Modulation, the information or audio frequency signal changes the amplitude of the carrier wave without changing its frequency or phase. In Frequency Modulation, The information signal changes the frequency of the carrier wave without changing its amplitude or phase. In Phase Modulation, the information signal changes the phase of the carrier wave without altering the other two parameters. [9] In the design of this project, Wireless Alerting Device, Frequency Modulation was the Modulation technique adopted.

3.4.3 FREQUENCY MODULATION

As the name shows, in this modulation, it is only the frequency of the carrier wave that is changed and not its amplitude. The amount of change in frequency is determined by the amplitude of the modulating signal whereas the rate of change is determined by the frequency of the modulating signal. [9]

In FM, carrier information or intelligence is carried as variations in its frequency, so the frequency of the modulated carrier wave increases as the signal amplitude increases but decreases as the signal amplitude decreases. [9]

Two important points that could be established about the nature of frequency modulation are as follows:

(1) The amount of frequency deviation (shift or variation) depends on the amplitude of the audio signal. The louder the sound, the greater the frequency deviation and vice versa.

(2) The rate of frequency deviation depends on the frequency of the signal

3.4.4 TERMS ASSOCIATED WITH FREQUENCY MODULATION

Frequency Deviation: This is defined as the maximum departure of the instantaneous frequency of the FM from the carrier frequency. It is usually Denoted by ΔF and it is directly proportional to the peak amplitude of the modulating wave, but is independent of the modulating frequency

Carrier Swing: The carrier swing of an FM wave is defined as the difference between the highest and the lowest frequency attained by the FM signal.

Modulating Index: It is given by the ratio:

M_f = frequency deviation/modulating frequency. Unlike amplitude modulation, modulation index can be greater than unity; furthermore it has the following characteristics:

(a) The greater the modulating frequency the smaller the modulation index

(b) The greater the frequency deviation the greater modulation index

(c) Modulation index is independent of the amplitude and frequency of the carrier signal.

(d) The greater the amplitude of the modulating signal, the greater the modulation index. [11]

Deviation Ratio: It is the worst-case modulation index in which maximum permitted frequency deviation and maximum permitted audio frequency are used.

$$\text{Deviation Ratio} = \frac{\Delta F_{(max)}}{F_{m\,(max)}}$$

3.5 OSCILLATOR STAGE

An oscillator is an electronic circuit that generates a repetitive ac signals at a frequency that may be of few hertz, a thousand hertz, million hertz or even in the gigahertz range used for the purpose of generating signals. [12]

An oscillator produces signals in a repetitive waveform. This repetition indicates the frequency of oscillation. They are amplifiers with positive feedbacks. Three basic sections that are common to all oscillators are an amplifier, feedback loop or connection and frequency-determining component.

For this project design, a Hartley oscillator circuit was adopted because the amplified output was connected to one end of the tuned circuit and the feed-back is taken from the other end. There is also a tap on coil to establish an ac ground nearest to the end where the feedback is connected.

3.6 ANTENNA

The final stage of any transmitting unit is the antenna. It is a structure that couples the output of a transmitter to the receiver. At the antenna, FM signals are converted to electromagnetic waves, which are radiated to the atmosphere or space.

Usually an antenna is either vertically or horizontally polarized which is determined by their relative position with the earth surface. A transmitting antenna that is horizontally polarized transmits better to a receiving antenna that is also horizontally polarized and vice versa. [11]

3.7 SIGNAL RECIEVING UNIT

The fundamental function of a receiver is to select the desired signal from all the signal picked up by the aerial, to extract information which has been modulated to the wanted signal, and then to amplify the signal to the level necessary to operate the loudspeaker or other receiving device.

At the signal-receiving unit, the desired signal frequency is converted into a constant frequency known as the intermediate frequency – at which most of the

At the signal-receiving unit, the desired signal frequency is converted into a constant frequency known as the intermediate frequency – at which most of the gain and the selectivity of the receiver is provided. The basic building block diagram of the signal-receiving unit is shown in figure 3.7

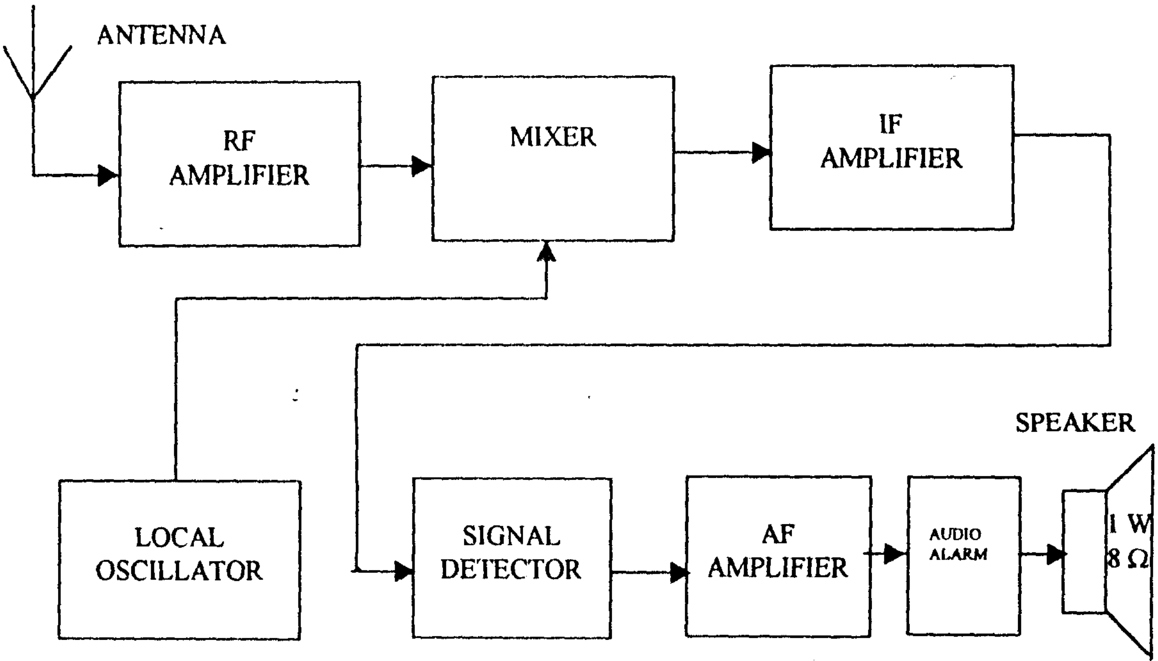


Fig. 3.7 Block Diagram of the Signal Receiving Unit

The desired signal, at frequency, F_S, is passed together with many other undesired frequencies by the radio frequency stage to the mixer (or frequency changer) the radio frequency stage is not provided to select the desired signal but chiefly to prevent certain particularly troublesome frequencies reaching the mixer stage.

The difference frequency $F_O - F_S$ is known as the **INTERMEDIATE FREQUENCY** and is selected by the intermediate frequency amplifier. The IF is a fixed frequency and this implies that when a receiver is tuned to receive a signal at a particular frequency, the local oscillator frequency is adjusted so that the correct difference frequency is obtained. [13]

The amplified output of the IF amplifier is applied to the detector stage and it is here that the information contained in the modulated signal is recovered.

The detected signal is amplified to the required power level by the audio frequency amplifier and is then fed to the loudspeaker or other output device.

3.7.1 RADIO FREQUENCY AMPLIFIER STAGE

First of all, the receiving antenna picks up energy from the transmitter whose output passes through its intercept area. Consequently it receives and amplifies the frequencies of incoming signals.

It performs the following functions:

(a) It couples the aerial to the receiver in an efficient manner

(b) It suppress signals at or near the intermediate frequencies

(c) It operate linearly to avoid the production of cross modulation

(d) It has efficient selectivity which minimize the number of frequencies appearing at the input to the mixer that result in inter modulation products lying within the pass band of the intermediate amplifier. [13]

At very high frequencies, the noise picked up by the aerial is larger than the noise generated within the receiver. A radio frequency amplifier amplifies the aerial noise as well as the signal and produce little improvement in the output signal to noise ratio. The radio frequency amplifier also permits the use of two or more tuned circuit in cascade, with a consequent improvement in the image response ratio. [13]

3.7.2 MIXER AND LOCAL OSCILLATOR

The amplified signals enters the mixer's circuit which is so designed that it can conveniently combine two radio frequencies that are fed into by RF amplifiers and the other by local oscillator. The mixer, which is non-linear device, produce sum and difference frequencies, this time at low power levels. [13]

The local oscillator is designed so that its frequency will always be a certain fixed level different from the frequency of the incoming signals, usually the oscillator operates at an higher frequency than the incoming signals from the antenna. The difference frequency produced at the output of the mixer's circuit is referred to as the intermediate frequency.

The function of the mixer stage is to convert the wanted signal frequency into the intermediate frequency of the receiver. This process is carried out by mixing the signal frequency with the output of the local oscillator and selecting the resulting difference frequency.

The local oscillator is capable of tuning to any frequency in the band to which the receiver is tuned plus the intermediate frequency. The ability of a receiver to remain tuned to a particular frequency without drifting depends upon the frequency stability of its local oscillator. [13]

High frequency communications receivers need greater frequency stability mainly because the channel bandwidth is narrow. The frequency stability of the receiver is good enough to ensure that the receiver will not drift from its nominal value. This is necessary because any change in the local oscillator frequency will cause a corresponding shift in the frequency output of the signal.

KA2297 IC was used as the mixer's circuit. Pin 1 and 2 are connected to the antenna; Pins 3, 5, 8 are connected to the intermediate frequency amplifier. The mixed frequencies emanate from Pin 3 and filtered out to Pin 8. The Pins connected to the radio frequency input and the Frequency Modulated oscillator is 15 and 13 respectively. Pin 14 is mainly used to adjust the integrated circuit to frequency modulated mode. The demodulated signal output is outputted from pin 11. The unused Pins in the IC are 4, 5, 7, 9, 12 and 16. The connection layout is shown in fig. 3.8, which depicts the circuit diagram of the signal receiving unit.

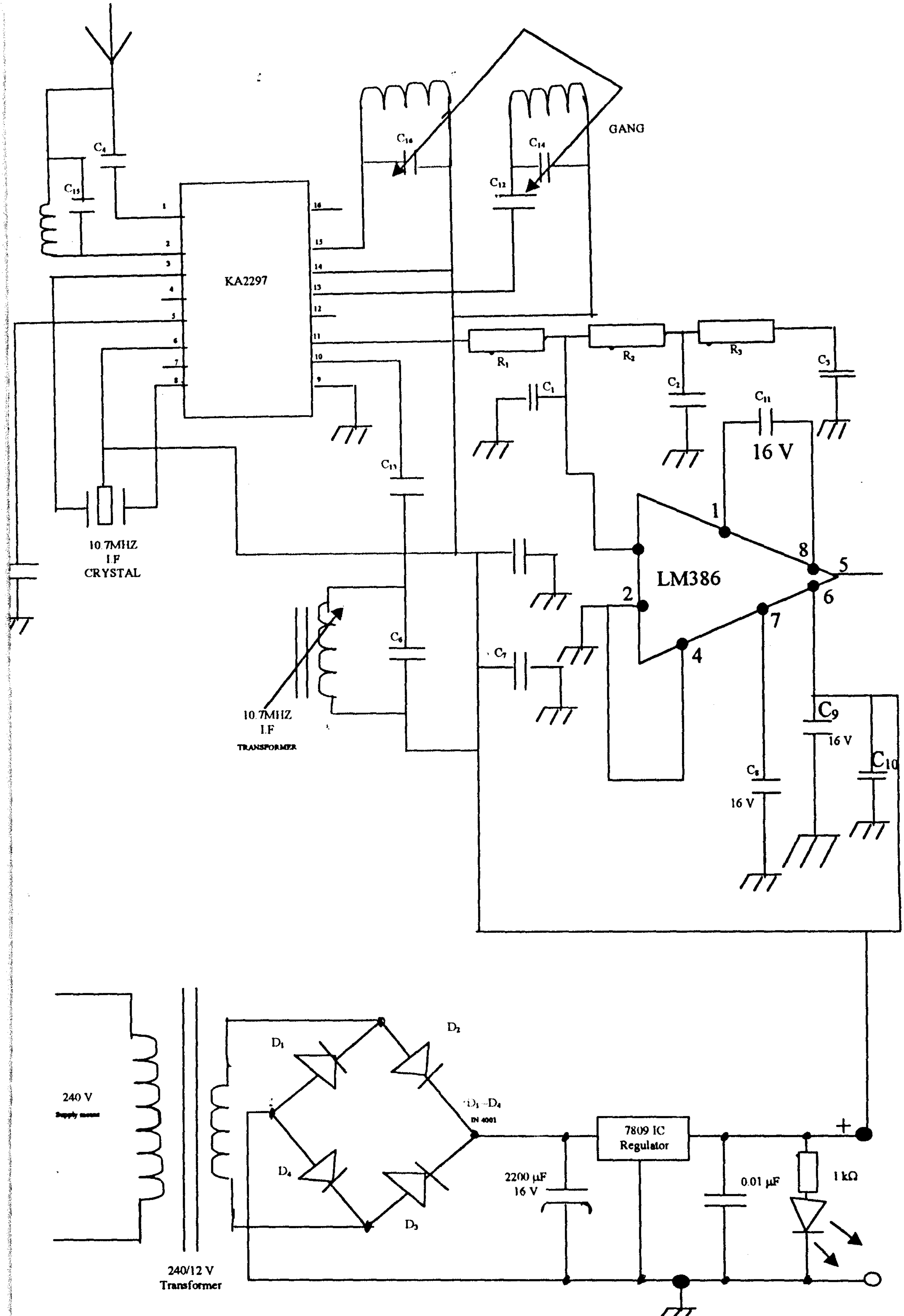


Fig. 3.8 Circuit Diagram of the Signal Receiving Unit

3.7.3 GANGING AND TUNNING

When the signal-receiving unit is tuned to receive a particular signal frequency, the resonant circuit in the radio frequency stage must be tuned to that frequency and the tuned circuit of the local oscillator must be tuned to a frequency equal to the sum of the signal and the intermediate frequencies. Clearly it is convenient if the tuning of these circuits can be carried out by a single external control. To make this possible the tuning capacitors are mounted in a common spindle so that they can be adjusted simultaneously; this practice is known as GANGING. [13]

The maintenance of the correct frequency difference (the intermediate frequency) between the radio frequency stage and local oscillator is known as Tracking.

3.7.4 INTERMEDIATE FREQUENCY AMPLIFIER STAGE

The purpose of the intermediate frequency amplifier in the receiving unit is to provide most of the gain and the selectivity of the receiver. Most receivers utilize the impedance or frequency characteristics of single or double tuned circuit to obtain the required selectivity. The selected signal and oscillator frequency is always constant. Additionally the output of the intermediate frequency amplifier is demodulated by a detector, which provides the audio signal.

The main factors considered when choosing the intermediate frequency for the signal receiver are:

(a) The required intermediate frequency bandwidth.

(b) Interference signals.

(c) The required intermediate frequency gain and

(d) The required adjacent channel selectivity.

The intermediate frequency should not lie within the tuning range of the signal receiver, so that the radio frequency stage can include an intermediate frequency trap to prevent intermediate frequency interference. However, to simplify the design and construction of the intermediate frequency amplifier, the intermediate frequency should be low as possible.

Adequate adjacent channel selectivity is easier to obtain using a low intermediate frequency, but on the other hand, image channel rejection is easier, if a high intermediate frequency is selected. The signal-receiving unit, which require an intermediate frequency bandwidth of about 20 KHZ, uses an intermediate frequency of 10.7 MHZ. [13]

3.7.4 SIGNAL DETECTOR STAGE

The function of the detector stage in the receiving unit is to recover the signal modulated on to the carrier wave appearing at the output of the intermediate frequency amplifier.

As earlier discussed, an FM carrier signal contains intelligence, to recover the signal; the FM signal was demodulated in such a way that it appears as a modulated RF voltage.

A simple method is to make use of the principle that reactance (coil or capacitor) flowing through it var:es with amplitude according to the changes in frequency of the FM signal, which depends of the amplitude of the modulating signal.

3.7.4 AUTOMATIC GAIN CONTROL

The field strength of the desired signal at the aerial is not constant but fluctuates widely because of changes in propagations conditions. Automatic gain control was applied to the receiver to maintain the carrier level at the input to the detector at a more or less constant value even though the level at the aerial may vary considerably.

Automatic Gain Control ensures that the audio output of the receiver varies only as a function of the modulation of the carrier and not with the carrier level itself. The use of A.G.C also ensures that the audio output of the receiver gain can be made available for the reception of weak signals without causing the overloading of the radio frequency amplifier stage, with consequent distortion.

3.7.5 AUDIO FREQUENCY AMPLIFIER STAGE

The function of the audio frequency stage of a radio receiver is to develop sufficient audio frequency power to operate the loud speaker. A sensitive receiver will produce a considerable output noise level when there is no input signal because their will then be no A. G. C voltage developed to limit the gain of the receiver.

The AF signal generated at the output of the mixer is amplified further in the audio frequency amplifier. This further amplification helps to increase the signal power and gain of the AF signal before its passage into the audio alarm unit.

In the design of this project, LM386 was used as an audio signal amplifier. The IC is a low voltage power amplifier designed for used in low voltage consumer application. The gain is increased by connecting a capacitor between pins 1 and 8. The connection layout is illustrated in shown in figure 3.9 and the Pin Configuration is shown in Fig. 3.10

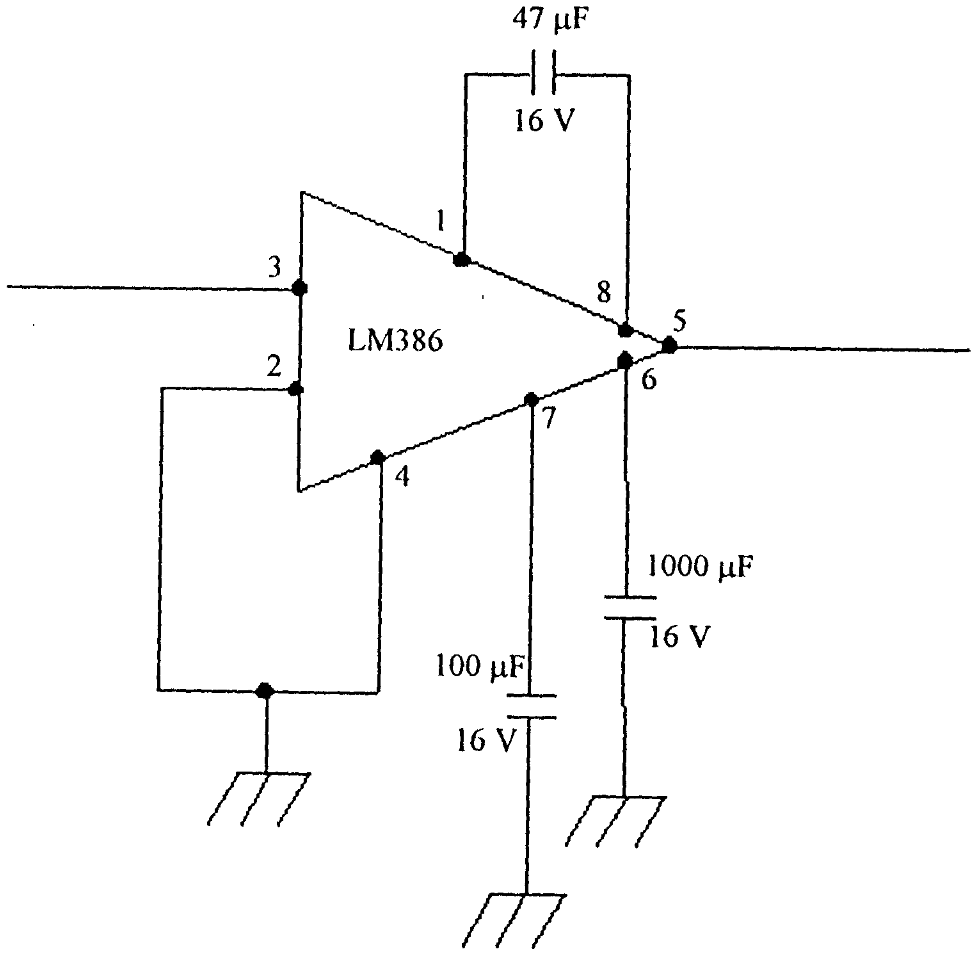


Fig. 3.9 Connection Layout of LM 386

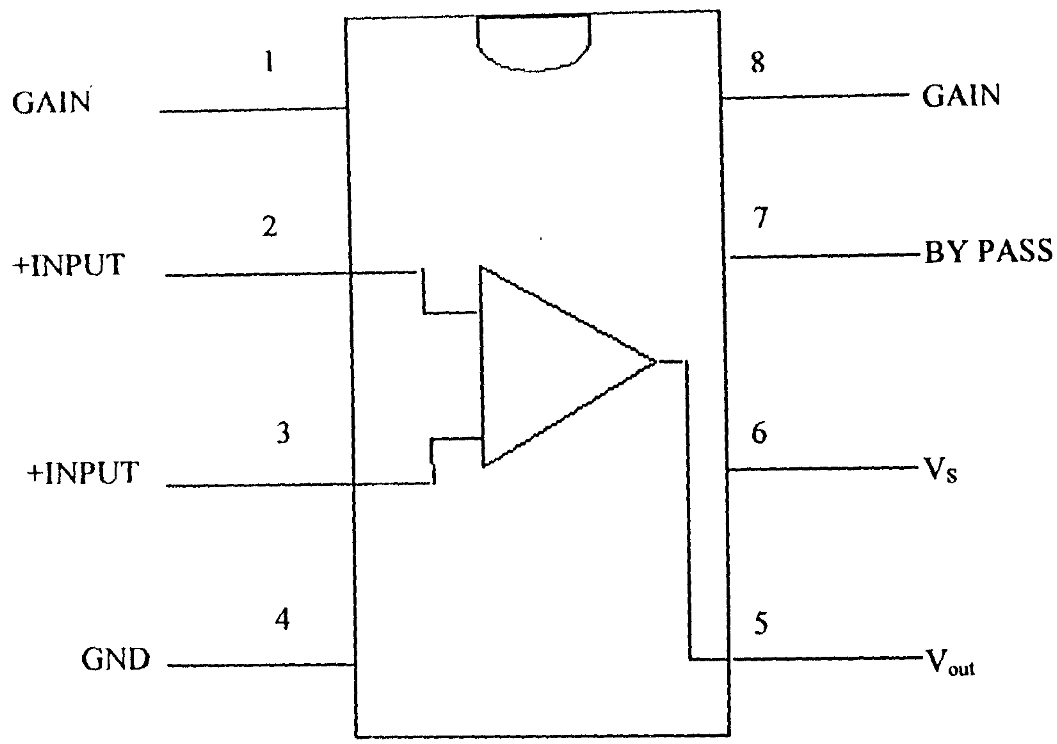


Fig. 3.10 Pin Configuration of LM 386

3.7.6 LOUD SPEAKER

As a transducer, it aids the conversion of electrical signals into acoustical energy. Hence in the circuit it brings out the amplified signal sound waves. The fundamental function of the loudspeaker is to convert the audio signal into sound similar to the one transmitted by the transmitting device.

CHAPTER FOUR

CONSTRUCTION, TESTING AND RESULTS

4.1 INTRODUCTION

This chapter focuses on the construction procedure followed in the implementation of the design. Detailed test that were carried out on the final circuit design and the result obtained were briefly discussed. The construction of the design was successfully completed and the result obtained was fairly adequate.

4.2 CONSTRUTION PROCEDURE

Simply put, design construction involves the practical aspect of coupling together the various components contained in the design. The project design in consideration consists mainly of the electronics design aspect and the casing. The design aspect of the electronics consists mainly of the control switch, signal generators and oscillator all at the transmitting end. While the signal-receiving end consist of the radio amplifier, local oscillator, mixer, intermediate frequency amplifier, frequency modulation detector, audio frequency amplifier and the loudspeaker acting as a transducer.

Each of the sub-unit was constructed in a sequential order as pre designed and analysed in the design aspect of this Project Report in Chapter three. With the necessary design calculations done, the components with corresponding values were bought and in a situation were the required components were not available, components with the approximate values were obtained. With the entire component in place, they were all properly soldered on the Vero board directly; this is because frequency related Project might not be easily arranged on a breadboard. The soldering of the various components on the Vero board started with the power supply unit, which is the first stage down to the antenna stage, where the generated signals are launched into space. In the same way, the sub-units of the signal receiving section were also properly soldered in a sequential order.

After the successful soldering on the Vero board, the design was tested and the obtained results were satisfactory. The design was then cased using wooden materials i.e. plywood to be precise. The choice of this is to allow for cost effectiveness and portability for easy handling. The design casing was then perforated for proper passage of audio signals emanating from the loud speaker and the antenna hole was drilled on the wooden casing box.

4.3 CONSTRUCTION TOOLS

In order to obtain the expected result, proper tools were used in the construction of the design. They are listed and briefly explained below.

Digital Multi-meter: This was used for quite a number of functions. It was used to test the continuity of electronics links, to measure resistance, capacitance and voltage in various part of the circuit.

Vero Board: This allows permanent prototyping of an electronic design. The Vero was pre-etched; therefore the various electronic components were simply soldered in place, using connecting wires and blade to make continuity respectively between them, wherever necessary.

Soldering Iron: This was used to solder the various components on Vero board.

Soldering Stand: This was used for keeping the soldering iron in a safe, upright position. The stand used is made up of metal and is constructed so that the bit of the soldering iron does not touch any metallic or plastic parts.

Lead: Flux-core solder type was used for the soldering of the various electronic components.

Sponge: This was used for occasional cleaning of the soldering bit during use. The sponge was always kept damp and used to wipe the soldering unit.

Lead suckers: This was used for sucking up molten solder. It also served to a greater extent in removing bad components out of Vero board.

Wire cutters: Cutters were used to cut wires to required length and to rip off the excess leg of electronic components after soldering.

Strippers: Wire strippers were used to strip off the insulation from solid or stranded hookup wires.

Wire and Connectors: Wire is the link that connects all the parts of the circuit together. For this project, solid wire was used because it is easily soldered and

Unsoldered.

4.4 LIST OF COMPONENTS USED

As earlier stated, components with the corresponding calculated values were bought from the market. These components are itemized below. Basically the design incorporates a transmitter and a receiver, therefore components used for the transmitter and receiver are listed below:

4.4.1 LIST OF SIGNAL TRANSMITTING UNIT COMPONENTS

COMPONENTS	VALUES
R_1 R_3 R_6 R_7	1 KΩ
R_2 - R_4	100 KΩ
R_5	10 KΩ
$C_1 = C_2$	0.001 μF
C_3	30 pF
C_4	3 pF
C_5	2 pF
C_6 - C_8	100 pF
C_7	0.022 μF
$Q_1 = Q_2 = Q_3$	NPN Silicon (2SC945)
L_1	2 mH

4.4.2 LIST OF SIGNAL RECEIVING UNIT COMPONENT

COMPONENTS	VALUES
R_1	17 KΩ
$R_2 = R_3$	100 KΩ
$C_1 = C_8 = C_{13}$	0.01 μF
C_2	0.02 μF
C_3	0.047 μF
$C_4 = C_{15}$	30 pF
C_5	33 pF
C_6	10 pF
$C_7 = C_8$	100 μF
C_{10}	1000 μF
C_{11}	47 μF
$C_{12} = C_{16}$	15 pF
C_{13}	45 pF
L1 = L2 = L3	4 T
LM 386	
KA2297	
Crystal 10.7 MHZ	

4.5 RESULT

The construction of the design was successful .When tested the expected coverage distance was not as far as expected. However, the aim of project design, which is to notify concerned personals or individuals in the event of any emergency occurrence, was achieved.

4.6 DISCUSSION OF RESULT

The little disparity in the expected coverage distance may likely be traceable to the fact that some components used were not exact values rather approximate values were used due to the non-availability of the exact ones.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

This project design titled Design and Construction of a Wireless a Alerting Device is essentially a design implementation, during the course of implementing the design, acquired knowledge on communication principles was helpful. Quite a number of difficulties were encountered during construction; nothwistanding, the aim of the project was achieved.

To ensure that the alerting device provide adequate notification in the event of emergence occurrence, the following guidelines should be followed:

- Mount the device 80 inches above the highest floor level or 6 inches below the ceiling.
- The device should be securely mounted to a solid surface, such as secured to a junction box with a mounting plate that prevent them from putting pressures or stress on internal attached wires.
- If the device is installed outdoor, it must be shielded from the weather preferably it should be protected with a canopy or other suitable shielding device.
- Position the device away from or out of contact with materials or equipment which may cause physical damage
- A visual check should be done from time to time to ensure that the device alarm or visual unit is not obstructed by any object

- Restore the device to a normal operating condition after every response.

5.2 RECOMMENDATIONS

The following recommendations are proffered for any one interested in carrying out further work on the Wireless Alerting Device.

- The device could be made a multi-channel design so as to enhance the possibility of alerting emergency situations from more than one location.
- A wireless device should be used to reset the device rather than the manually operated reset button.
- Internal circuitry may be incorporated in the design to provide notification whenever a deficiency exist with in the Device

REFERENCES

1. U. S. DEPARTMENT OF LABOUR *Occupational Safety and Health Administration* **http://www.gov.osha.com**

2. DAVID J. LEANON JN, **Alert** *Hose .Co* 1998 http://www.adam *alerts.com/History.htm*

3. PEACE CENTRE ***For Whom DOES the Bells Toll*** **http://www.salsa.net/Peace/Article** 32.html

4. DAVID MORGAN ***Morgan Communications 1998*** http://wwwdiaphones.morgancomm.com/main htm

5. SHELTER IN PLACE EDUCATION DAY INFORMATION ***San Leandros Alerting and Warning Systems*** http://www.ci.san-leandro.co.us/slemeralert.html

6. MARCONI FOUNDATION U. S. *Marconi Museum http://www.marconiusa.org/.*

7. CAMPBELL LEWIS, THE LIFE OF JAMES CLERK MAXWELL http://www en. Wikipedia .org/wiki/James_Clerk_Maxwell

8. DONALD A. NEAMAN, *Electronic Circuit Design and Analysis,* Tata McGraw-Hill, 2002. pp. 7.

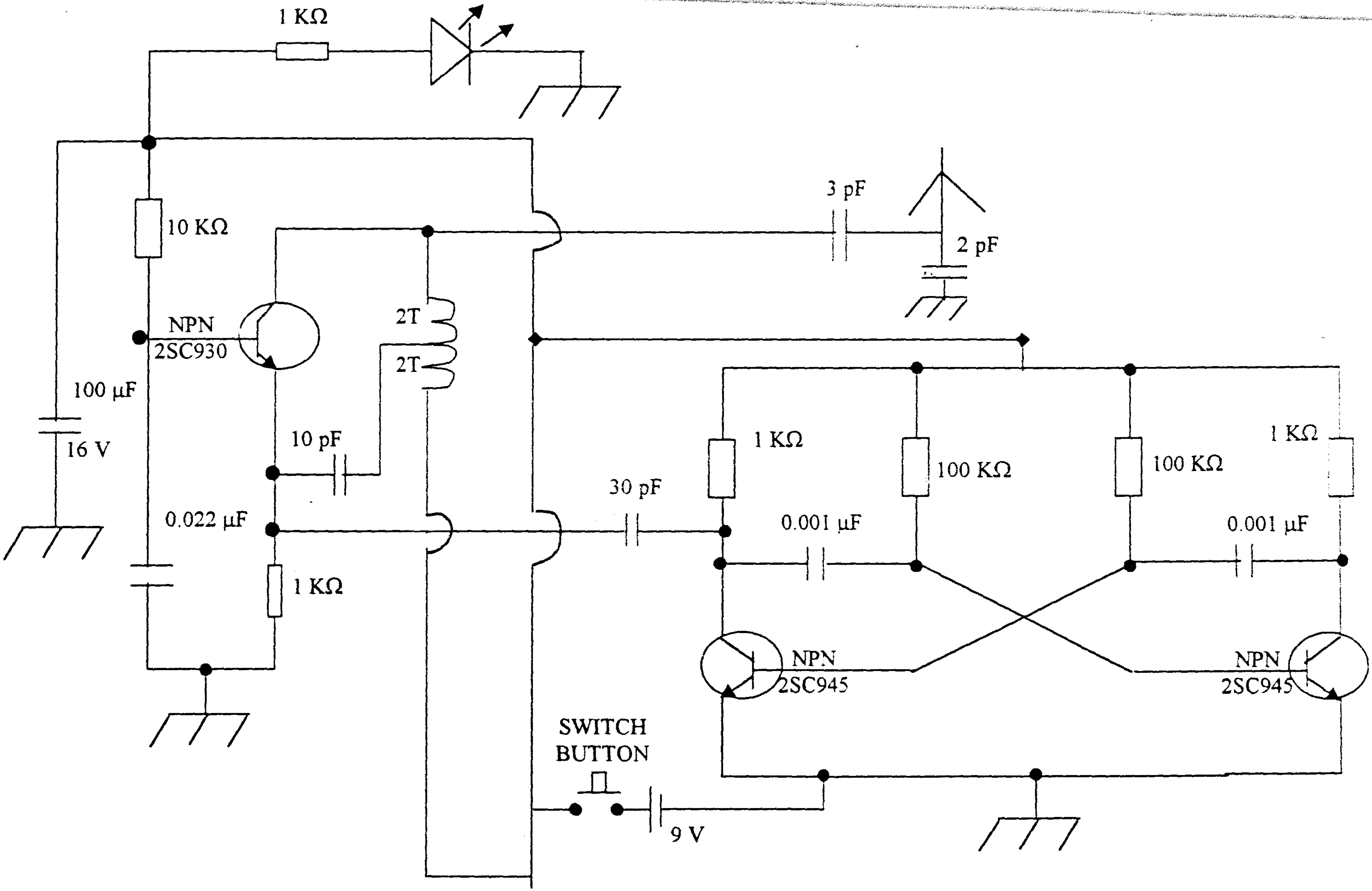
9. B.L THERAJA and A.K. THERAJA, *Text Book on Electrical Technology,* S. Chand and Company Ltd, 1999, pp.71-74, 1699-1720, 1970-1971.

10. ENGR. M.D., ABDULLAHI, *Lecture Notes on Analogue Electronics,* ECE 325 (Unpublished).

11. ADEDIRAN, Y.A., *Telecommunications: Principles and Systems,* Finom Associates, Minna-Nigeria, 1997, pp. 115, 44-45.

12. MIKE SEWELL, *Electronic Circuit,* Health Company, 1978, pp 5.

13. FERRELCN STREAMER *Introduction to Communications Systems*, Wesley Publishing Company, 1982, pp. 156,165-178



Circuit Diagram of the Signal Transmitting Unit