DESIGN AND CONSTRUCTION OF

INFRA – RED ALARM SYSTEM

BY

OLARINRE JIMOH GBOLAGADE

(93/4121)

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA.

MARCH, 2000.

DESIGN AND CONSTRUCTION OF

INFRAED ALARM SYSTEM

BY

OLARINRE JIMOH GBOLAGADE

93/4121

A PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS OF THE AWARD OF BACHELOR

OF ENGINEERING (B.ENG) DEGREE

IN THE

DEPARTMENT OF ELECTRICAL AND COMPUTER

ENGINEERING

SCHOOL OF ENGINEERING AND ENGINEERING

TECHNOLOGY,

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA.

MARCH, 2000

DECLARATION

I hereby declare that this project is the result of my handwork and research which has never been presented anywhere by anybody. It was under the supervision of Mr. Paul Attah in the department of Electrical and Computer Engineering of Federal University of Technology, Minna Niger State

Student
OLARINRE JIMOH

24/03/2000

Date

CERTIFICATION

This is to certify that this project titled Design and Construction of Infrared Alarm system was carried out by Olarinre Jimoh G. (93/4121) under the supervision of Mr. Paul Attah and submitted to Electrical and Computer Engineering Department, Federal University of Technology, Minna in partial fulfillment of the requirements for the award of Bachelor of Engineering (B. ENG.) degree in Electrical and Computer Engineering.

.... 24/03/2000

MR. Paul Attah

Sign & Date

(Project Supervisor)

....

Dr. Y. A Adediran

(Head of Department)

Sign & Date

.... 6/4

Dr. J. O. Oni

External Examiner

Sign & Date

DEDICATION

This project work is dedicated to the Almighty Godfor His mercy, guidance and Blessings over me.

ACKNOWLEDGEMENTS

I am grateful to the Almighty God who has been giving me comfort in all my lie endearvours.

I will like to express my profound gratitude to my uncle in person of DR. K .A. Adeleke for his financial and moral support since the beginning of my academic pursuit .

I also appreciate the untiring support of my father, Mr Tijani Olarinre and my mother, late Mrs Olarinre Sariyu.

My thanks goes to my supervisor, Mr. Attah for sacrificing most of his time in advising and assisting me whenever I have problem on this project.

I am also indebted to my friends on the Campus and outside the Campus who are too numerous to mention here for they see my comfort as their pleasure.

I would also like to seize this opportunity to pray for those who have assisted me in one way or the other for successful completion of my programme at FUT Minna. May God Almighty be with everybody in all their future endearvours, amen.

LIST OF ABBREVIATION/SYMBOLS

Vrms/Irms	Instantaneous values of voltage/current
Vm/Im	Maximum voltage/current
Vdc/Idc	Dc output voltage/current
Vcc	Based voltage supply
Vbe	Base-emitter voltage
Vin/Vout	Input/output voltage
Bdv	Breakdown voltage
PIV	peak - inverse voltage
Δv	peak - to - peak ripple voltage
Il/Id	Load current/diode current
Ic(sat)	saturation collector current
hFE	D.C Current gain
hFE(sat)	Forward, current, transfer ratio at saturation
Po	Power output
Rl	Load resistor
C	Capacitor
f	Frequency
γ	Overdrive factor
μF	Micro farad
NC/NO	Normally closed/Normally opened
LED	Light Emitting Diode
T_1	Transformer 1
IC	Integrated circuit
Tr	Transistor
UJT	Unjunction transistor
SPKR	Speaker

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

CHAPTER ONE

GENERAL INTRODUCTION

1.1 INTRODUCTION

Whereas other building systems contribute to the comfort and convenience of the building's occupants, the alarm system protects a building, its equipments and its occupants from impending disaster and as such may well be the most important system in the building. They serve as round – the – clock "watch dogs" against fire, smoke, holdups and burglar as well as monitors for various process pressures, temperature, liquid levels flows etc. For safety sake, serious consideration should be given to alarm systems in the early design stages of a building.

Infrared detection system is one of the various alarm systems. This is a detection system comprising of source of infrared radiation used as a transmitter and a receiver consisting of a sensor sensitive to infrared, an amplifier and a relay. The infrared beam between the transmitter and the receiver is invisible. If the beam is interrupted, an alarm signal is produced.

Some current applications of infrared systems are:

MILITARY: Military fire control at night or during the day when vision isdiminished due to fog, smoke or haze. Detection and tracking of ships, aircraft, missiles, surface vehicles and personnel, submarine detection and range finding.

MEDICAL: Early detection and identification of cancer, obstacle detection for the blind, location of blockage in a vein and early diagnosis of incipient stroke.

SCIENTIFIC: Satellite and space communication. Environmental survey

and control, detection of life and vegetation on other planets and measurement of lunar and planetary temperature.

INDUSTRIAL: Aircraft landing aid and traffic counting, forest fire detection and natural resource detection.

1.2 AIMS AND OBJECTIVES

The aim of this project is to design and construct a multipurpose movement detector which will be able to form the basis of all sorts of burglar alarms and automatic controllers.

It will work either as a single interrupted beam alarm over substantial distances or will directly detect moving objects or persons by measuring changes in the level of reflected infrared over shorter distances. It is intended that the project will be insensitive to ordinary visible light.

1.3 METHODOLOGY

Each of the stages was designed separately (i.e. modular approach method, fig.1). Discrete components as well as IC were used to realize the project.

The project is composed of four stages. These are: emitter, receiver, timer and alarm stages

The circuit diagram of the transmitter is a standard 555 astable circuit having the values of the timing components (R_3, R_4, And C_3) chosen to give a suitable operating frequency. The output waveform of the 555 astable was connected to the emitter diode, connected between the output of IC1 and the positive supply rail fig. 3.a.

The next is the circuit diagram of the receiver (detector). The detector diode (D_5) is coupled to receive transmitted signal filtered by R_5 and C_4. At the receiver circuit is the amplifier which is a simple two – stage common emitter type capacitively coupled. The output of the amplifier was rectified and smoothened by D_6, D_7,C_9 and R_{12}. The Schmitt trigger is based on IC_2. R_{14} was incorporated to provide hysteresis and to obtain desired sensitivity (a compromise between these two qualities being maintained)

The output of the comparator (IC_2) was coupled to the timer circuit. The timer circuit employed is a 555 timer IC which has a monostable operation. The timing components are R_{16} and C_{12}. Fig. 8 a The relay is a 12V, 400Ω relay (RLA $_2$). The making of the relay depends on the timer circuit.

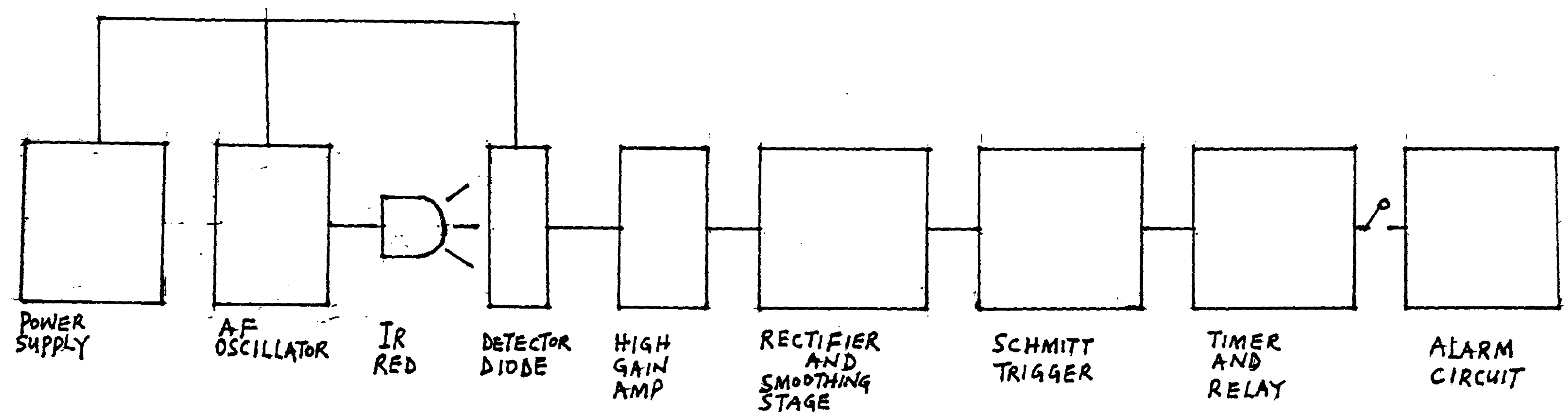


FIG 1: BLOCK DIAGRAM OF INFRARED ALARM SYSTEM.

The normally open, NO terminal of the relay feeds the alarm circuit. Two oscillator were used at the alarm circuit. The unijunction oscillator and the astable multivibrator. The output of the unijunction oscillator was coupled to the base of one of the transistor of the astable multivibrator. The output of the two oscillators was coupled to a speaker through an impedance matching transistor.

1.4 LITERATURE REVIEW

Infrared radiation is an electromagnetic radiation generated by vibration and rotation of the atoms and molecules within any material at temperatures above absolute Zero – that is 0^{o} k or - 273^{o}c.

In recent years there has been an increasing emphasis on the research, design, development and deployment of various infrared devices and systems for military applications at night or during the day when vision is diminished by fog, haze, smoke or dust.

In 1900 Sir William Herschel discovered infrared radiation. Then he referred to it as "invisible rays", "radiant Heat", dark heat" and "the ray that occasion heat". Sir William Herschel found that the heating effect increased as he moved the thermometer towards the red from the blue end of the spectrum.

In 1829 Nobili made the first thermocouple, which was an improved thermometer based on the thermo electric effects discovered by Seebeck in 1821.

During World War I, an infrared search system could detect aircraft at a distance 1.6km and a person at a distance of 300m. Many sensitive infrared detector such as photon detectors and image converters were developed during the World War II.

Furthermore, infrared techniques became applicable to the altitude stabilization of space vehicles measurement of planetary temperatures earth mapping and the early detection of cancer.

1.5 PROJECT OUTLINE

This project is divided into four chapters:

Chapter one discusses general introduction of the project, some of the current applications of infrared systems, the aims and objectives of the project, the methodology employed in carrying out the project and literature review.

Chapter two was on system design. Here, calculations leading to the choice of components used were shown. Experiments were carried out to determine the choice of components in some cases e.g biasing a transistor at the Q-point, selecting timing resistor and capacitor of a 555 timer and threshold voltage in the schmitt trigger.

Chapter three was assigned with construction, testing and results. The method of construction and the construction of the boxes containing the circuits were discussed here. Also, testing of the modules were carried out and the results tabulated.

Chapter four was left for conclusion and Recommendations. The results got from experiment and testing were compared with established facts. Recommendations wee also made under this chapter.

CHAPTER TWO

SYSTEM DESIGN

2.1 POWER SUPPLY

i. METHOD OF RECTIFIATION:

A full-wave rectifier network with center tap transformer was employed to:

- obtain a higher dc voltage output since

$$Vdc = 2Vm/\pi \quad \text{and } Idc = 2Im./\pi$$

Compared to a half – wave rectification where $Vdc = Vm/\pi$

- Increase the peak inverse voltage (PIV).

PIV is the maximum voltage that can be applied in the reverse direction without breakdown (through the rectifying diodes)

$PIV = 2Vm$, ($PIV = Vm$ for half – wave)

ii Transformer selection

$$Po = Vdc \times Idc$$

$$= 2Vm/\pi \times 2Im/\pi$$

$$= 2\sqrt{2}\,Vrms/\pi \times 2\sqrt{2}\,Irms/\pi$$

$$= 2\sqrt{2}\,Vrms/\pi \times 2\sqrt{2}/\pi \times Vrms/R$$

$$= 8Vrms^2/\pi^2 R$$

therefore Vrms = $\sqrt{Po\pi^2 R/8}$

for this project,

Po is 15W, RL 8Ω

Vrms = $\sqrt{15x\pi^2 8/8}$

≈ 12.167V

≏12V

therefore a transformer of 240V : 12V was chosen

iii **diodes rating**

Voltage rating: the maximum voltage, which occurs across the diode in the reverse direction, peak inverse voltage (PIV) must be less than the breakdown voltage of the diode if it is not to conduct appreciably in the reverse direction.

for a full-wave,

PIV = 2 Vm

Vm = $\sqrt{2}$ Vrms

= $\sqrt{2}$ x 12

= 16.197V

Vm ≈17V

Therefore PIV = 2 x 17

= 34V

the breakdown voltage must be greater than PIV (Bdv > PIV)

Therefore diodes of breakdown voltage of 50V (>34) are desirable.

Current rating:

Idc $= 2Im/\pi$

$= 2\sqrt{2}/\pi \times Vrms/R$

$= 2\sqrt{2} \times 12/8\pi$

$= 1.35A$

Idc = the mean load current

Therefore a diode of current rating of 1.5A was chosen.

From the E.C.G. data book IN5391 diode satisfy the requirements.

iv. **CAPACITOR SELECTION**

voltage rating:

capacitor voltage, Vc rating $\geqslant \sqrt{2}$ Vrms

$\sqrt{2} \times 12 = 16.97V$ ($\sqrt{2}$ Vrms)

$Vc \geq \sqrt{2}\ 2\ Vrms$

$Vc \geq 16.97V$

Therefore a capacitor of voltage rating of 25V was chosen.

Capacitance rating:

$\Delta V \approx Vm/2fRC$

$\Delta V \propto 1/C$

If a peak – to – peak ripple voltage of not more than 10V is to be tolerated

$10 = 12\sqrt{2}/(50 \times 8 \times C)$

$C = 12\sqrt{2}/8000$

$= 2121\ \mu F$

therefore a capacitor of 2200μF capacitance was chosen

v ZENER DIODE AND LIMITING RESISTOR, RS

a varying load: fixed supply voltage

$$Rs = (Vin - Vout)/ (Idmax + Ilmin) \quad \text{.....................(1)}$$

$$Rs = (Vin - Vout)/(Idmin + Ilmax) \quad \text{.....................(2)}$$

b. varying supply voltage, fixed load

$$Rs = (Vin\ min - Vout) /(Idmin - Il) \quad \text{..................(3)}$$

$$Rs = (Vin\ max - Vout)/(Idmax + IL) \quad \text{....................(4)}$$

Using equation (1) above,

Vin = 14.7V

Vout = 12V

Id = 6 mA

Therefore Rs = (14.7 – 12)/0.006

= 450Ω

the preferred value of Rs = 470Ω

vi Protective fuse

current rating:

current rating of fuse should be higher than the mean load current (I dc)

Idc = 0.63Im

= 1.35A

therefore a fuse of 1.5A was used. (See fig. 2)

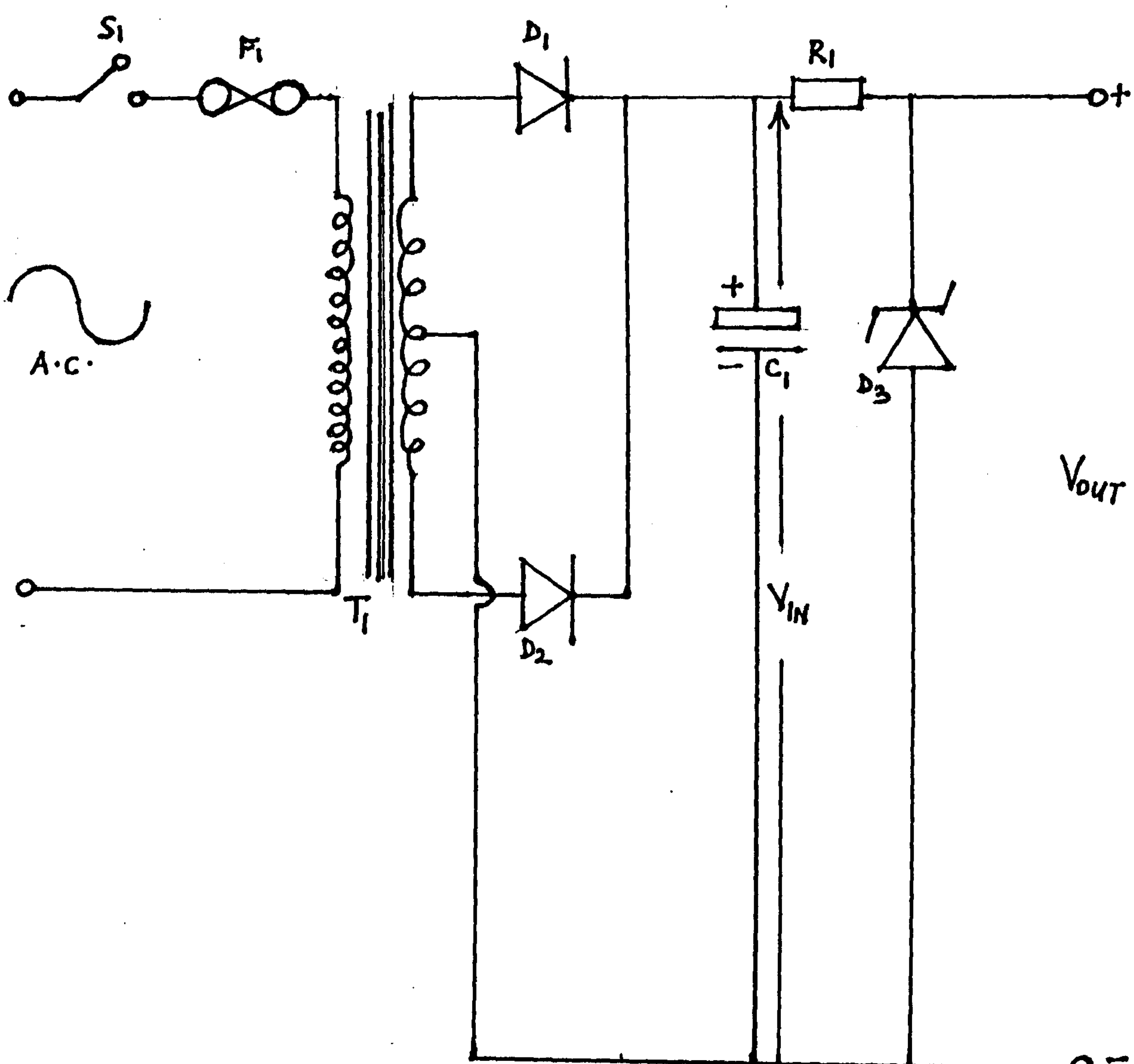


FIG 2 : POWER SUPPLY CIRCUIT

LEGEND :

S_1	:	TOGGLE SWITCH
F_1	:	1·5A FUSE
T_1	:	240V/12V TRANSFORMER [CENTRE TAP]
$D_1 = D_2$	:	IN 5391 [50V; 1·5A]
C_1	:	ELECTROLYTIC CAPACITOR (2200μF; 25V)

2.2 THE TRANSMITTER STAGE.

The pulse generator is a standard 555 astable circuit having the values of the

timing components (R3, R4, and C4) chosen to give a suitable operating frequency.

The frequency, f, of the pulses produced by the astable is given by

$f = 1/(t1 + t2)$ HZ.

With the mark period three times longer than the space timer so that the emitter diode is only pulsed on for 25% of the time fig 3(b). This was done to keep the average current consumption of the circuit down to a reasonable level. Fig 3(a) and 3 (b)

From the above:

LED on = R4 C3

LED off = (R3 + R4) C3

LED off : Led on = 3:1

(R3 + R4) C3 : R4 C3 = 3:1

(R3 + R4)/R4 = 3/1

R3 = 2R4

From $f = 1/(t1 + t2)$ Hz

And $t = R4\ C3$, $t2 = (R3 + R4)\ C3$

$f = 1/\{R4\ C3 + (R3 + R4)C3\}$ Hz

$= 1/(R3 + 2R4)C3$ Hz

but R 3 = 2R4

therefore $f = 1/\{2R4 + 2R4)C3\}$

$= 1/(4R4\ C2)$ Hz

$f \propto 1/R4$ (with 1/4C3 constant)

with a frequency of 10KHz and a capacitance of 10n F

$10 \times 10^3 = 1/(4R4 \times 10 \times 10^{-9})$

therefore R4 = 2.5K

The preferred value of R4 is 10K (for maximum adjustment)

Since R3 = 2R4,

R3 = 2(2.5) K

= 5K

preferred valued of R3 is 20K .

D4 is an LED (TIL 38) with the following parameters:

Maximum forward voltage VF = 1.5V

Dc forward current, IF = 150mA

Therefore R2 = (Vcc – VF)/IF

$= (12 - 1.5)/150 \times 10^{-3}$

= 70 Ω

the preferred value is 56Ω

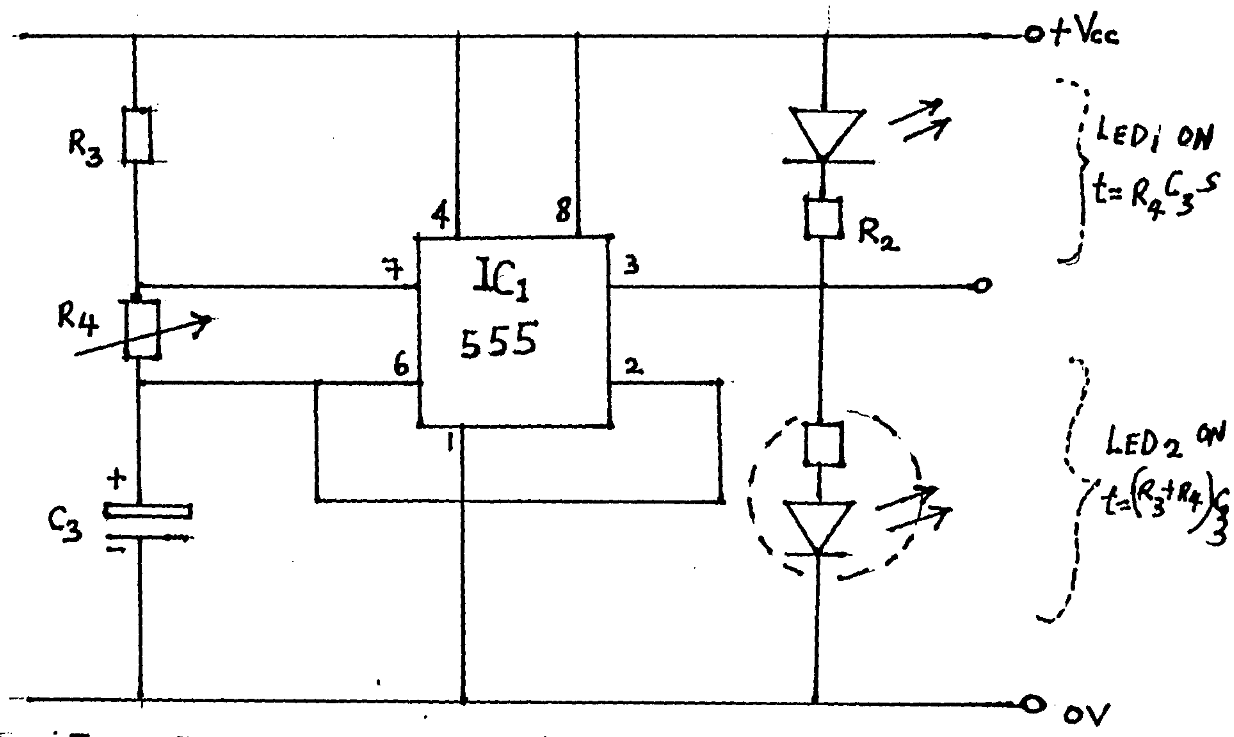


FIG. 3(a) THE TRANSMITTER CIRCUIT (ASTABLE OPERATION).

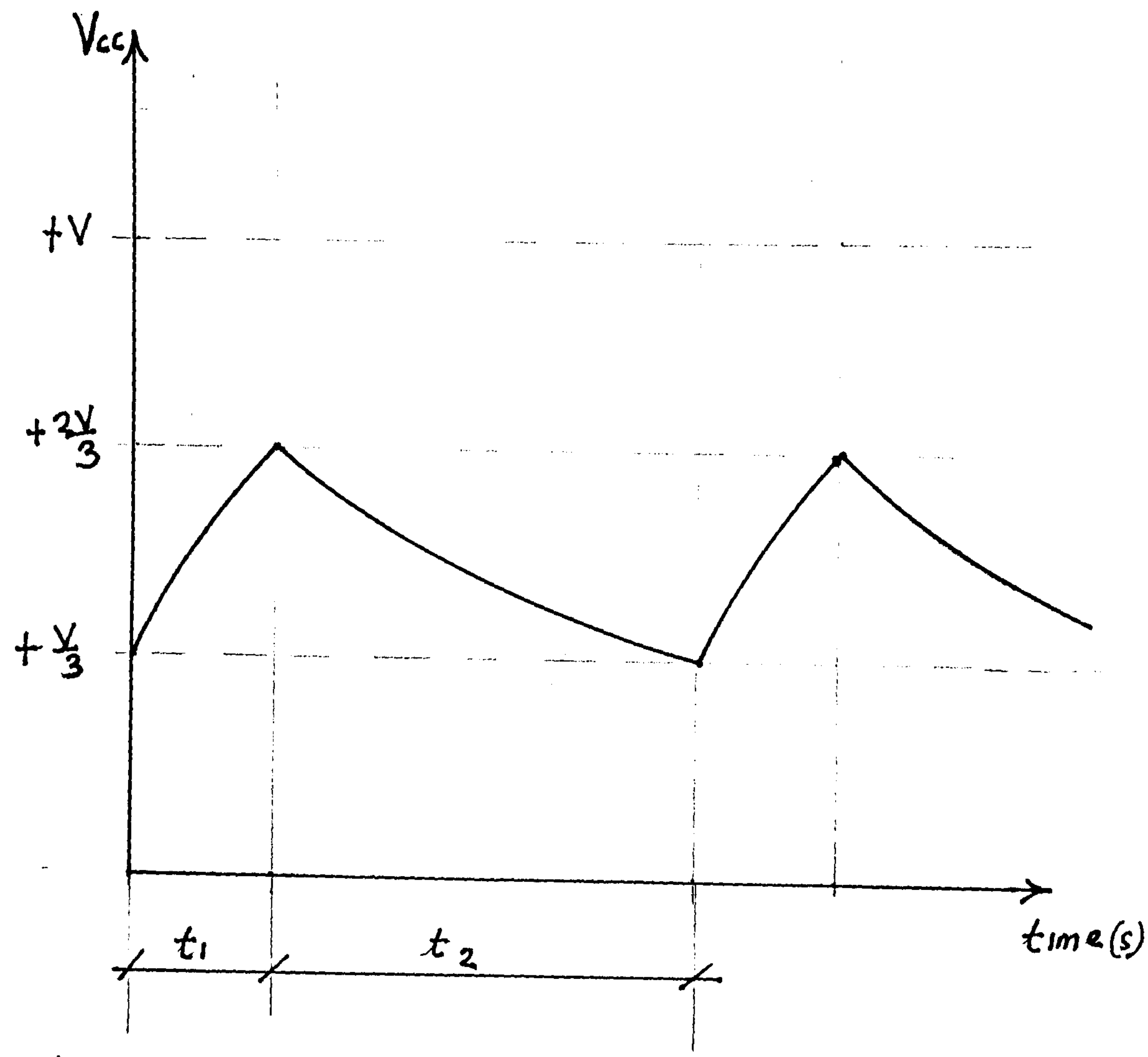


FIG. 3(b). CAPACITOR CHARGE AND DISCHARGE CURVE FOR THE 555 ASTABLE FUNCTION.

2.3 AMPLIFIER STAGE

For the transistor to be used as amplifier, the following were done.

- Bias at the mid-point of transistor operation
- Collector resistor, Rc and base resistor, Rb were included
- A transistor of high gain, hFE were chosen
- Base resistor value used was very high

Since high input resistance implies small base current and this together with high hFE increases the sensitivity of the transistor.

Capacitor C5 was included to the block d.c (component of the signal into the transistor.

A voltage – shunt feedback technique was used. That is voltage (as output) fed back as current. Rb (R7 & R9) provide base – current bias for the two transistors. They also act as feedback elements.

Refer to figure 4

To bias to the center of the dc load line, that is, for the output voltage at the collector to be Vcc/2,

$Vcc/2 = icRc$

$Vcc = 2icRc$ ....(i)

Loop equation gives $Vcc/2 = ibRb + Vbe$

Neglecting Vbe, we have $Vcc = 2ibRb$ ....(ii)

Equating (i) and (ii)

$2icRc = 2ibRb$

$Rb = icRc/ib$

But $ic/ib = hFE$

Therefore $Rb \approx hFE\ Rc$

From $2icRc = Vcc$,

$Rc = Vcc/2ic$

for Tr1 and T2 (BC10 9C) ;

Ic max = o.1 amps

$hFE = 400$

$Rc = 12/2(0.1)$

$= 60\Omega$

the preferred value of R6 is 68Ω

power rating of Rc, PRc

$PRc = I^2\ Rc$

$= (0.^2) \times 68$

$= 0.68W$

$\approx 1W$

therefore the preferred value of Rc is 68Ω , 1W

from $Rb \approx hFERc$

$Rb = 400 \times 68$

$= 272000\Omega$

The preferred value of Rb = 30 K

Power rating = 1/4W

Therefore the value of Rb = 30K , 1/4W

The value of the capacitor, C5

$Xc \ll rin$

Xc = reactance of the capacitor

rin = input resistance

If $Xc = 10\%\ rin$

$Xc = 1/2\pi fC$

$1/2\pi fC = 10/100rin$

From the circuit: fig. 11

$Vcc = Ib(Rc + Rb) + Ic\,Rc + Vbe$

$rin \approx Rc + Rb$

$Rb \gg Rc$

$rin \approx Rb$

Therefore $rin \approx 30K$

$1/2\pi fC = 10/(100 \times 30{,}000)$

$C = 1/(100\pi \times 3000)$ $\{f = 50Hz, \quad \pi = 3.142\}$

$= 1.06 \times 10^{-6}$

The preferred value of C5 $= 1\ \mu F$

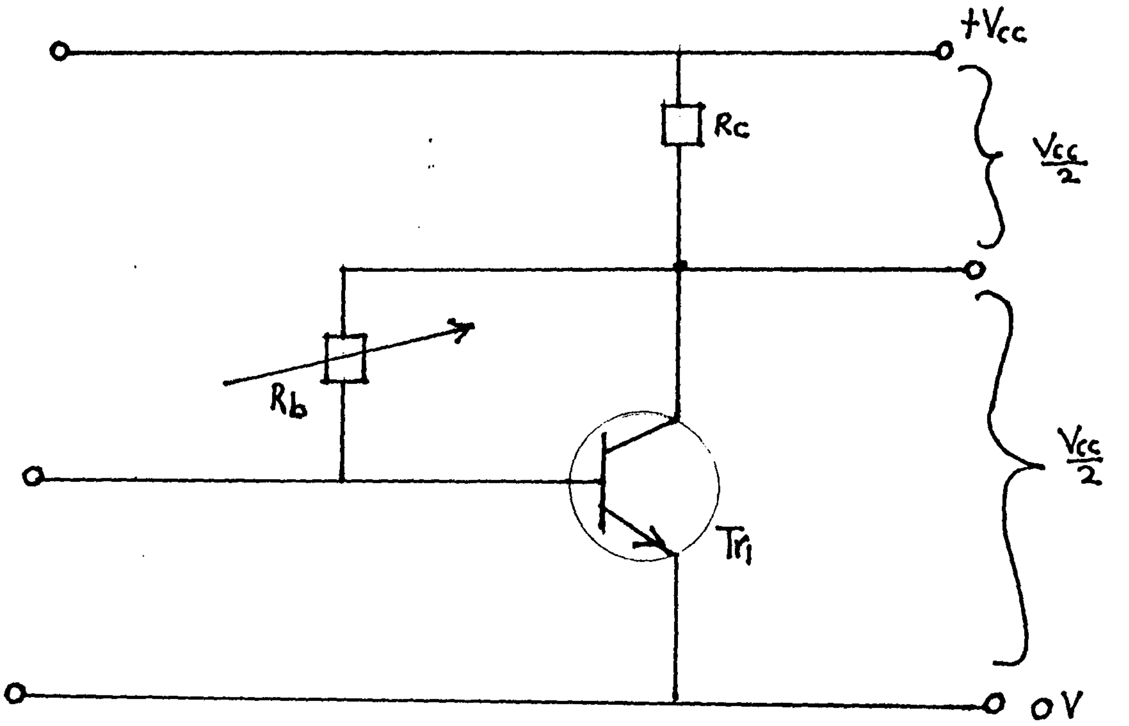


FIG 4 : BIASING A TRANSISTOR AT THE Q-POINT.

2.4 THE SCHMITT TRIGGER (COMPARATOR)

The Schmitt trigger is a circuit that will produce sharp rectangular pulses. It

is used to know which of two signals is larger, or to know when a given signal exceeds a pre – determined value. It may also be used in wave shaping applications. For example, various periodic waveforms such as sinusoid and triangular waveforms may be converted to square wave or pulse trains.

Schmitt trigger makes use of positive feedback. The effect of the feedback resistor in the circuit is to have two thresholds which eliminates multiple triggering. Also, the positive feedback ensures a rapid output transition regardless of the speed of the input waveform. The input of a Schmitt trigger depends on both the effect voltage and on its recent history.

This effect is called hysteresis fig. 7(b)

Comparators are examples of non – linear circuits. The two op – amp input voltages may have completely different values because of the absence of negative feedback.

The divider network consisting of R1 and R2 establihcs a voltage at the non – inverting input terminal proportional to the output voltage. The magnitude of the voltage across R2 in Fig 5 will be defined as threshold (triggering) voltage, VT

VT = R2 V(sat)/(R1 + R2)

By choosing an appropriate value of V_T, one can minimize the effect of noise at the transition points.

The transition points corresponds to the input voltage becoming more positive than V_T in one direction and becoming more negative than $-V_T$ in the opposite direction.

If the output lies at the positive saturation limit V positive, V_T will be positive and equal to

$V+ = R2/(R1 + R2)\ Vpos$

Applying a Vin greater than R2/(R1 +R2) V_{pos} to the negative terminal causes (V_+, -V-) to become negative, in turn forcing V_{out} to its negative saturation limit of V_{neg} If Vin is returned to Zero, however, V_{out} will remain negative at V_{neg} eg, with $V_+ = R_2/(R_1 + R_2)\ V_{neg}$.

Now, consider fig 7

With $V_2 < V_1, V_o = +V_o$

$V_1 = V_o - R_2/(R_1 + R_2)\ Vcc$ ....(1)

With $V_2 > V_1,\ V_0 = -Vo$

$V_2 = V_o + R_2/(R_1 + R_2)\ Vcc$ ....(ii)

The width of the hysteresis band $V_2 - V_1\ (V_H)$

Is easily controlled by adjusting R_2

$V_H = V_2 - V_1 = V_0 + R_2\ Vcc/(R_1 + R_2)\ -\{ (V_0 - R_2\ Vcc/(R_1 + R_2) \}$

Therefore $V_H = 2R_2\ Vcc/(R_1 + R_2)$

For a symmetrical square wave:

$V_1 = -V_2$

$= -\ R_2/(R_1 + R_2)\ Vcc$

Design Procedure

Consider fig 6

1. R* (variable resistor) was used as a resistive divider to put the threshold at approximately the right voltage. Figure 6.

2. The (positive) feedback resistor R was chosen to produce the required hysteresis figure 7.

Now with the power supply voltage at Vpos

(ie + 12V $\equiv$ Vsat)

$V_{in} = R_2/(R_1 + R_2)$ Vpos

For a faster transition, the reference voltage (or threshold) must be as small as possible.

Thus reference voltage of 0.5V was chosen.

$V_T = R_2/(R_1 + R_2)$ Vpos

$0.5 = R2/(R1 + R2) \times 12$

$R_2/(R_1 + R_2) = 0.5/12$

At R_1 = IM

$R_2/(1000 + R_2) = 0.0416$

$R_2 = 41.67K$

The preferred value of $R_2 = 47K\Omega$

($R_2 \equiv R_{13}$ in the complete circuit diagram) figure 11.

The schmitt trigger has a bistable characteristic. In other words it has two stable states. These states are the positive saturated state whereby the output drives (V+ -V-) in the positive direction and when Vout and (V+ -V-) are both negative.

Where (V+ -V-) are power supplies.

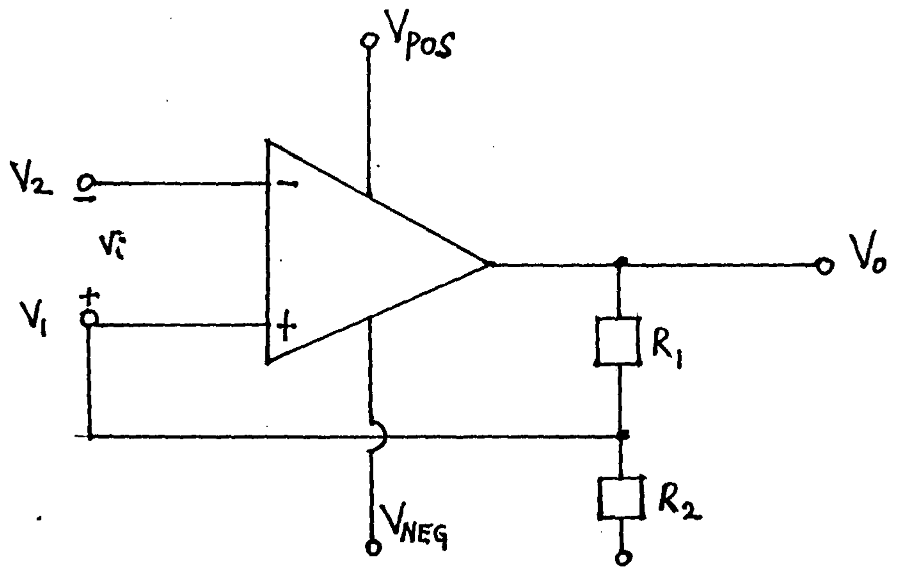


FIG 5. THE BASIC CIRCUIT OF SCHMITT TRIGGER.

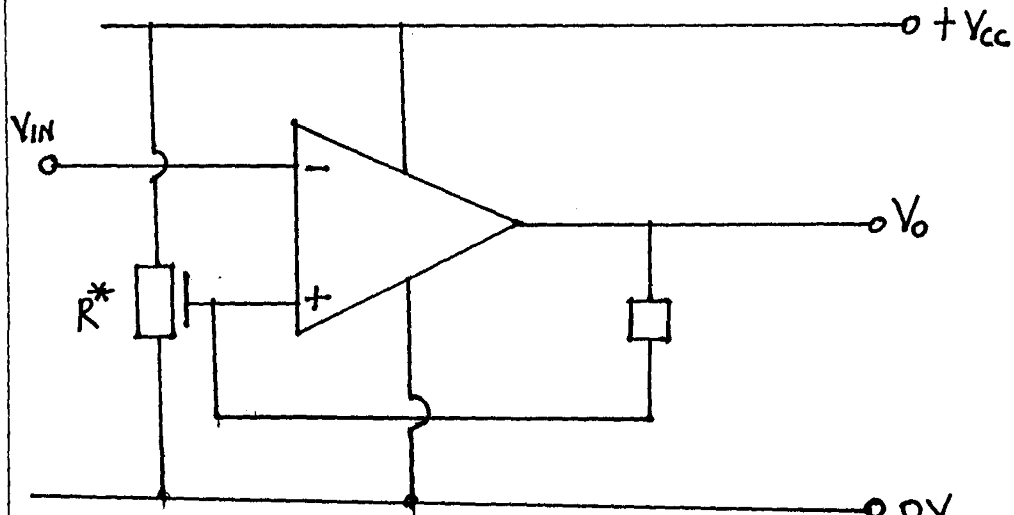


FIG 6 THE SCHMITT TRIGGER WITH VARIABLE RESISTOR TO SELECT THRESHOLD VOLTAGE.

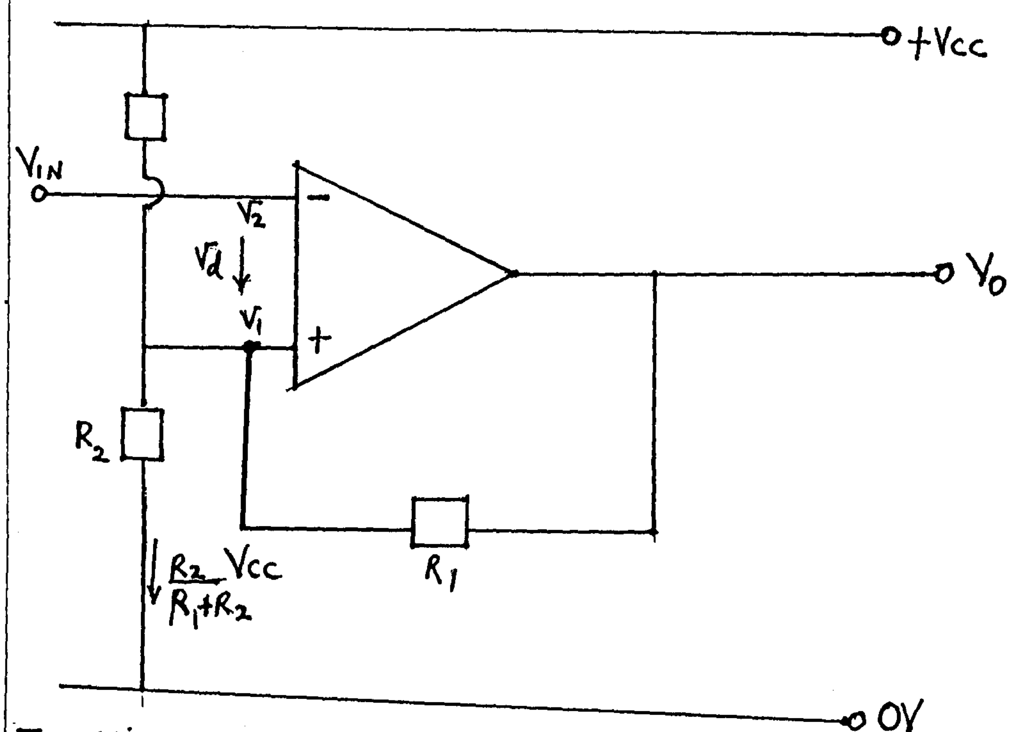


FIG. 7. THE SCHMITT TRIGGER: CIRCUIT ANALYSIS.

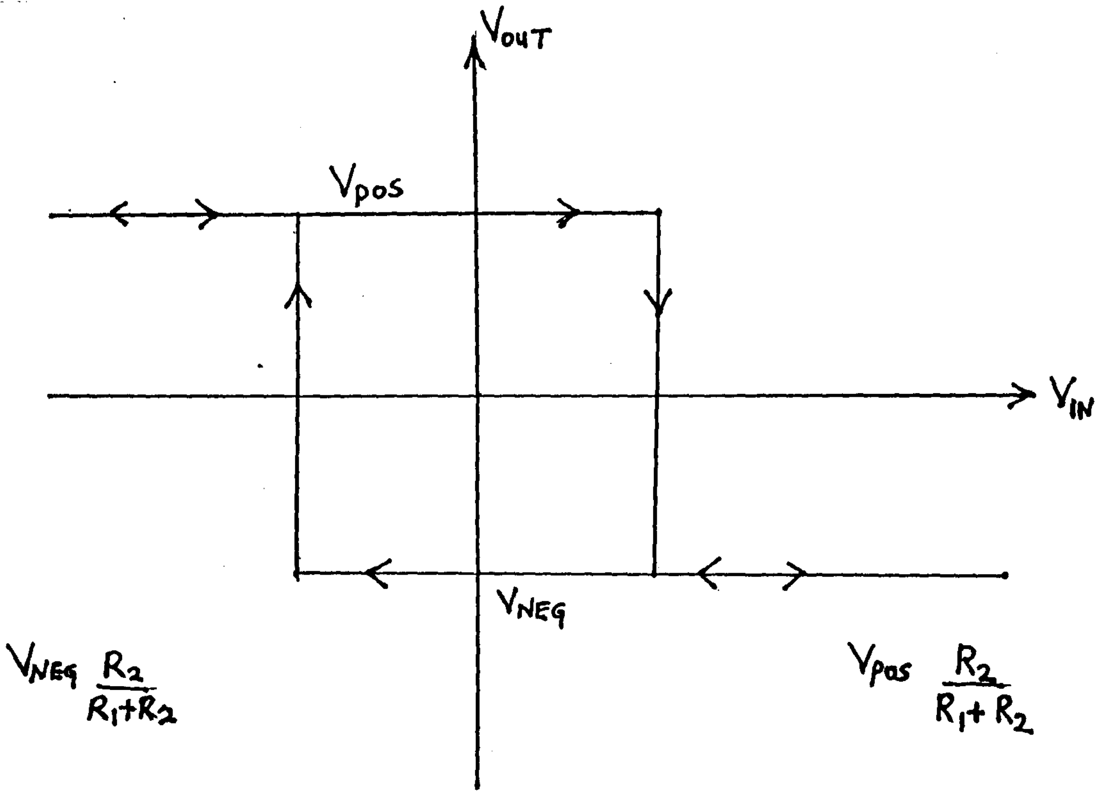


Fig.7(b). PLOT OF VOUT VERSUS VIN FOR THE SCHMITT TRIGGER.

2.5(A) TIMER CIRCUIT

The 555timer circuit is designed to switch on a device for a pre – set period of time and then switch it off..

A signal through pin 2 of the 555 timer makes pin 3 which was at 0 volts goes to $+V_{cc}$ and the relay2 energizes. The relay then remains on for the period determined by the timing components R_{16} and C_{12}.

It then turns off–that is pin 3 goes back to 0 volts. The circuit of this type has a monostable operation. Fig 8(a) and fig 8 (b).

Delay time, t is given by

$t = 1.1\ RC\ s$

$t \propto R\ (1.1C = \text{constant})$

With $t = 5$ s, and $C = 10\ \mu F$

$5 = 1.1 \times 10 \times 10^{-6} R$

$R = 454.5\ K$

The preferred value of R16 = 470K

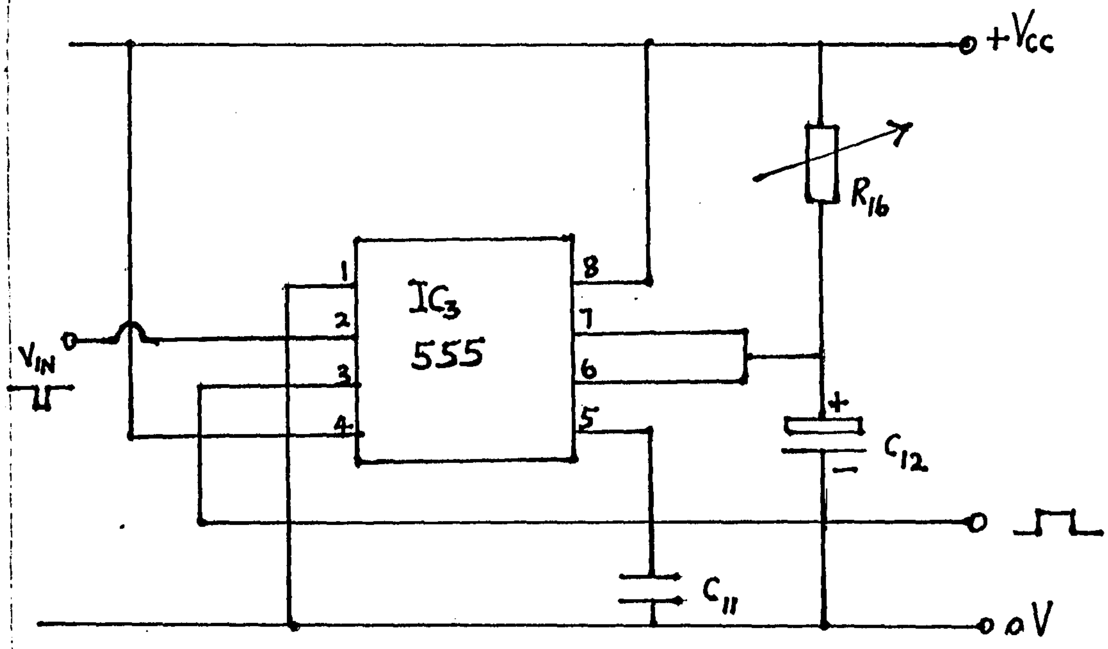


FIG. 8 (a) TIMER CIRCUIT.

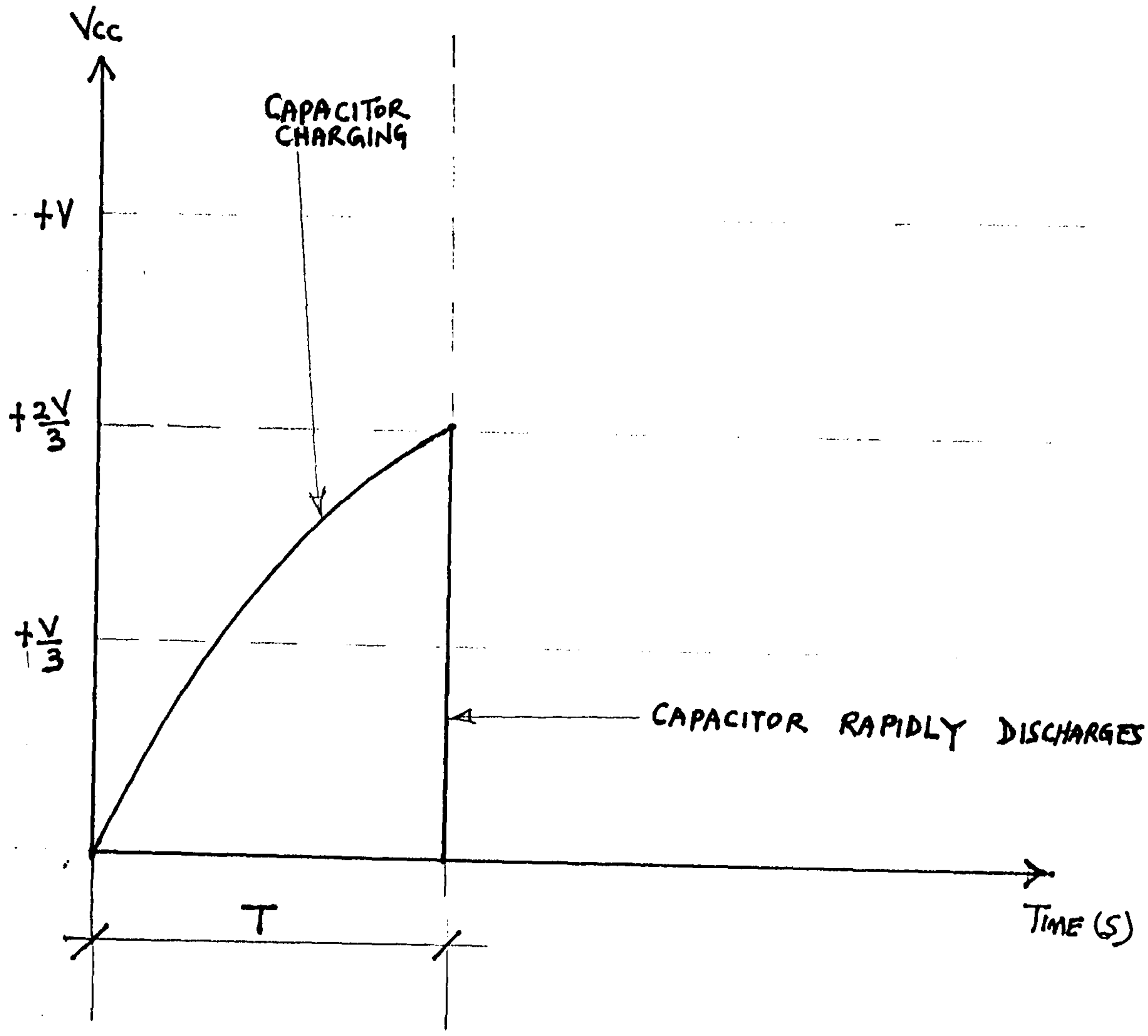


FIG 8(b) CAPACITOR CHARGE AND DISCHARGE CURVE FOR 555 MONOSTABLE FUNCTION.

2.5(B) RELAY AND THE DRIVER

The output from the 555 timer (IC_3) is not enough to switch the relay, hence the incorporation of the transistor switch .

Ib = Ic(sat)/hFE (sat)

Ib is the current just needed to switch on the transistor .

To improve the switching time and to ensure that the circuit is driven hard into saturation, an overdrive factor, γ , is normally introduced, so that Ib is given by ;

Ib = γIc(sat)/hFE(sat)

For sufficient overdrive, γ lies between 2 and 5

Rb = (Vbb – Vbe)/Ib

For Tr_3, (D400) the parameters are:

Ic (max) = 1 ampere

hFE = 120

For the relay of 12V, 400Ω ,

Relay current, Ir = 12/400

Therefore Ir = 0.03A

for effective making of the relay,

Ic = Ir (i.e collector current = relay current)

γIc = Ib/hFe

Ib = γIc/hFE

Ib = 3(0.03)/120(γ = 3)

Therefore, Ib = 0.75 mA

Vbb = voltage (output) form the 555 timer

$Vbb = 7V$

$Vb = \{Vbb - Vbe\}/Ib$

$= (7 - 0.6)/(0.75 \times 10^{-3})$

$= 8.5\ K$

preferred value of $Rb = 10K\Omega$,

power rating of Rb is $= (0.75\times10^{-3})^2 \times 10000 \approx \frac{1}{4}$ w

preferred value of $R_{17} = 10k\Omega$, $\frac{1}{4}$ w.

Refer to fig. 9.

D9 is a freewheeling diode (overswing limiting diode). When inductive loads are switched off by semi conductor devices, the inductance sweeps the collector/emitter (or anode/cathode) voltage to a greater value than the supply. This could cause avalanche breakdown which eventually leads to the failure of the device. It is usual therefore in such circuits where this problem is likely to arise to include an overswing limiting diode (Fig 9).

Current rating of D9 > load current

Breakdown voltage > $12\sqrt{2}$

Current rating of D9 = 2A (>1.3A)

Voltage rating of D9 = 100V (> $12\sqrt{2}$)

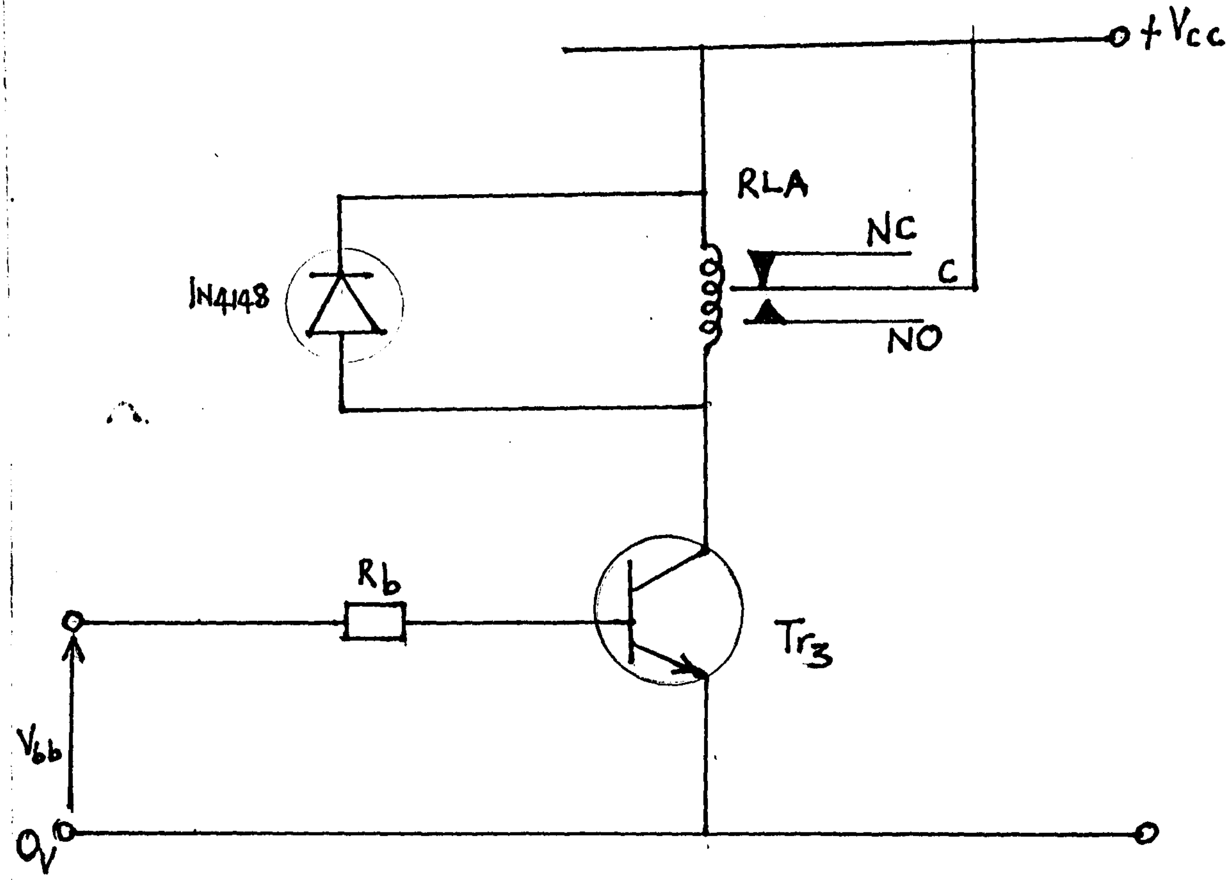


FIG. 9: RELAY AND THE DRIVER.

2.6 ALARM CIRCUIT

The circuit bonded by ABCDE is the circuit (fig 1.0(a)) is a unijunction oscillator. It modulates the basic oscillator circuit. The UJT adds and subtracts base current from Tr4. The current modulation causes the frequency of the multivibrator to shift from a low to a high frequency then turns off momentarily and repeats the cycle over and over again.

The output of the multivibrator is direct –coupled through R24 to the base of the power transistor Tr6. The current pulse at the base of Tr6 is sufficient to drive the collector to saturation, thereby connecting the supply voltage across the speaker.

The frequency of the UJT is given by

$f \approx 1/(RT\ CT\ In\ (1/1-\eta)\ \}$ HZ

Where $\eta = R1/(R1 + R2)$ Vcc

For symmetry of pulse, $R1 = R2$

$\eta = R1/2R1$

$= 1/2$

therefore $f = 1/(RT\ CT\ In\ 2)$

with $CT = 4.7\mu f$, 25V

$f \;\alpha\; 1/RT\ CT$

with $RT = 33K$

$f = 0.1075$ Hz

Refer to fig 10(b)

Transistor Tr4 and Tr5 perform as a free – running multivibrator otherwise called an astable multivribrator.

$Ic\ (sat) = \{Vcc - Vce(sat)\}/Rc$

$Rc = \{Vcc - Vce(sat)\}/Ic(sat)$

Tr 4 = Tr5 = 2N3638 PNP transistor

hFE = 180

For switching circuit, the transistors must operate in the saturation region (i.e fully ON). Required value of base current, Ib is given by

Ib = Ic (Unloaded) + fan – out current.

Fan – out current is the current that must be available to drive ~~eternal~~ external loads.

Choosing an over drive factor of 3 to ensure that the current is driven hard into saturation .

$Ib = \gamma\, Ic\,(sat)/hFE(sat)$

$Ic(sat) = 30$ mA

$= 3(30 \times 10^{-3})/180$

therefore Ib = 0.5mA

from the circuit fig 10c), the loop equation gives:

$Vcc = Vbe + IbRb$

$IbRb = Vcc - Vbe$

$Rb = (12 - 0.6)/(0.5 \times 10^{-3})$

Therefore Rb = 22.8 K

Therefore Rb = 22K

The frequency of operation is given by

$1/f = (C1\ R1 + C2\ R2) \log_e 2$

$f = 1/\{0.693(C1\ R1 + C2\ R2)\}$

$= 1/(0.7C1\ R1 + 0.7C2\ R2)$

$f = 1/(t1 + t2)$ Hz $t1 = 0.7C1\ R1$

$t2 = 0.7C2\ R2$

If R1 C1 = R2 C2, then

$f = 1/1.4R1\ C1$ or $1/1.4R2\ C2$

$C1 = 1/1.4R1f$ $R1 = R2 = Rb$

$C1 = C2 = C$

$C = 1/1.4Rbf$

$f = 1/1.4C\ Rb$

$f \alpha \quad 1/CRb$

Fixing the value of C at 0.1 μF

$f\alpha \quad 1/Rb$ $C = 0.1 \times 10^{-6}F$

$Rb = 22k$

Therefore $f = 1/(1.4 \times 0.1 \times 10^{-6} \times 22 \times 10^{3})$

Therefore f = 324.5.68.Hz

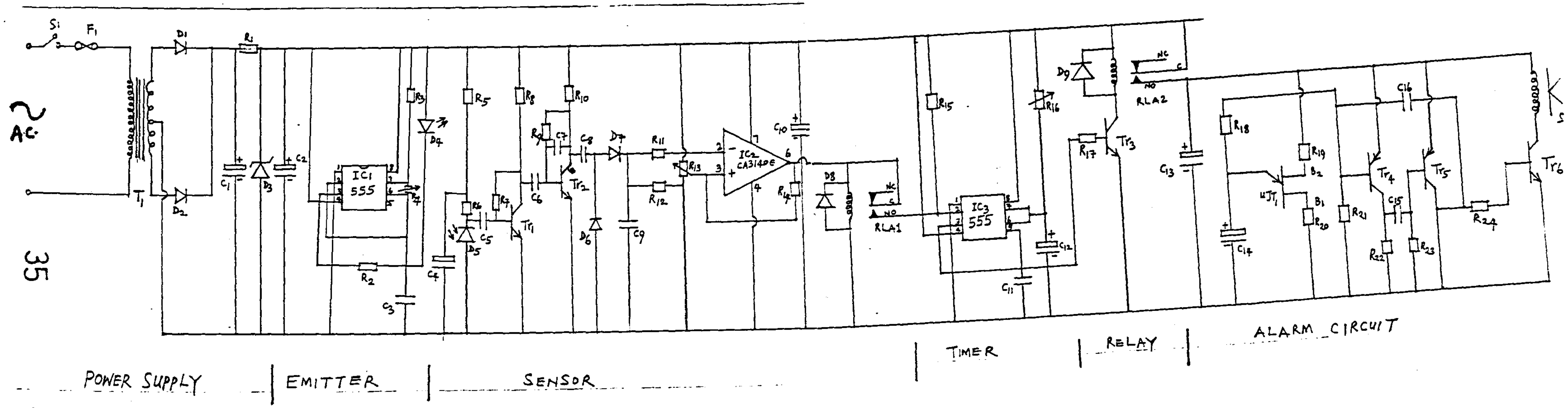


FIG 11. THE COMPLETE CIRCUIT OF INFRARED ALARM SYSTEM.

CHAPTER THREE

CONSTRUCTION; TESTING AND RESULTS

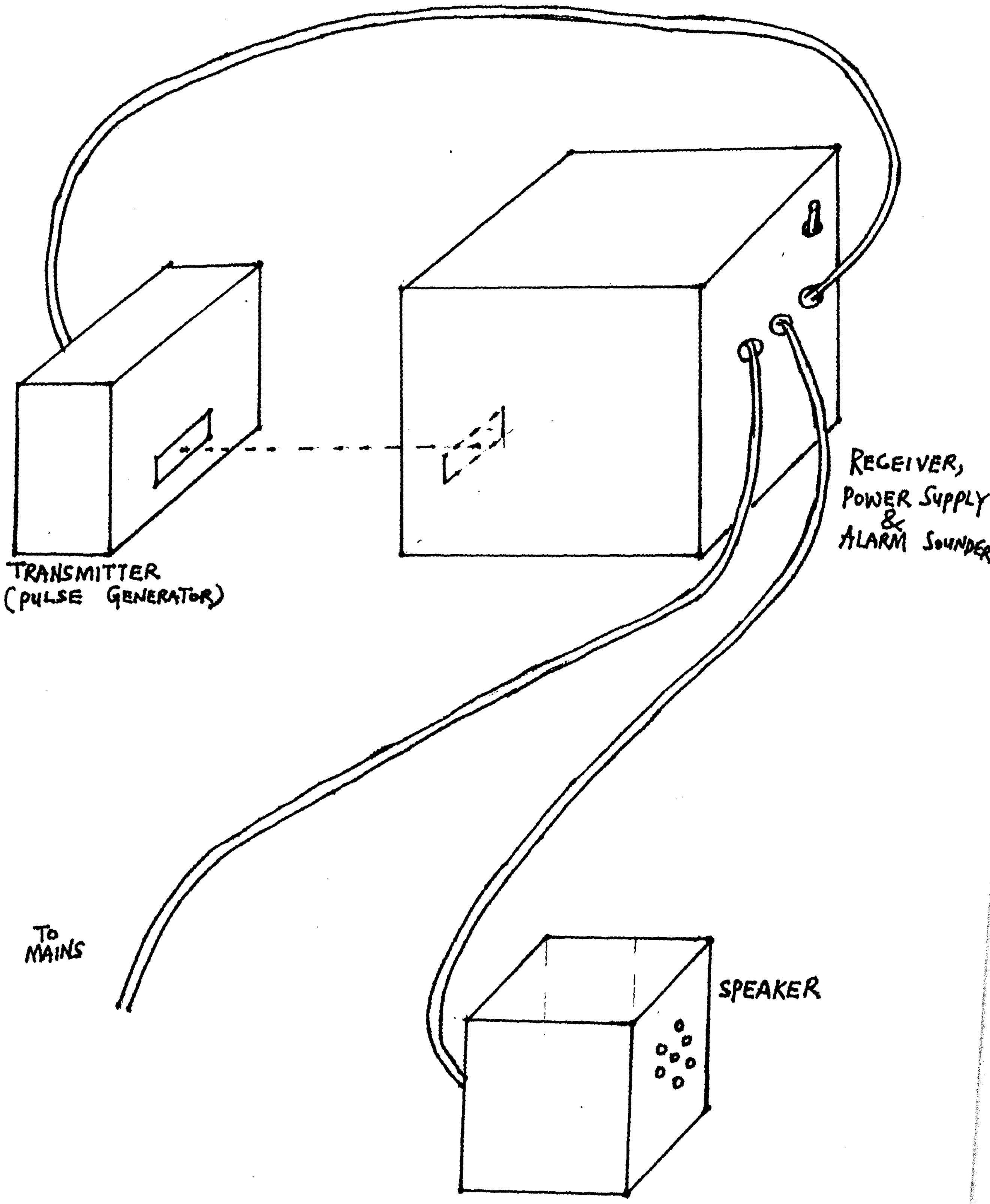
3.1 CONSTRUCTION

The construction of the project was based on the design procedures. Each of the stages was first connected on a bread – board (project board) tested separately and transferred to the vero – board and soldered permanently (with alloy lead). Screen cables were used in the connection to link some of the stages which are not so close to one another.

The steps, the methods and the components as stated in the design stage, were followed. The transformer was mounted on the vero – board some distance away from other components to prevent them from being damaged by the heat that may be generated form the power supply unit. The transmitter (emitter) was housed in a separate cabinet. The power supply unit, the sensor (receiver) and the alarm sounder were housed in the same cabinet. The speaker was housed in another separated cabinet. There are three cabinets in all (made of plywood). Figure 12.

Since the speaker was not housed in the same cabinet with the main circuit, the leads from the circuit to the speaker was made short. This was done because if the speaker leads are too long, the output level will be reduced due to high frequency losses.

The emitter and the receiver surfaces were covered with light filter so that their performances may not be affected by ambient light.



FIG·12: CONSTRUCTION OF INFRARED ALARM SYSTEM·

3.2 TESTING OF THE ALARM CIRCUIT

Values of frequencies were obtained for corresponding values of the base resistor, Rb . Table 1.1 below .

TABLE 1.1 Result of alarm circuit

Base Resistor, Rb (K)	Frequency Of Operation (In Hz)
10	700
15	475
20	350
25	280
30	230
35	200

The value of capacitance, C was fixed at 0.1 μF

Frequency of operation is inversely proportional to the base resistor, Rb

$f = 1/1.4 \times C \times Rb$

3.3 TESTING OF TIMER CIRCUIT

Various values of time in seconds were obtained for corresponding values of the timing resistor with the value of capacitor fixed at C = 10μ F

Table 1.2 result for timer circuit

Timing Resistor (K)	Time Of Operation (Seconds)
100	1
150	1.5
200	2
250	2.5
300	3
350	3.5
400	4

$t \alpha$ R (i.e time of operation is directly proportional to the timing resistor)

t = 1.1. CR

3.4 TESTING OF THE INFRARED ALARM SYSTEM

The circuit was tested in broad day light and the performance was satisfactory.

It was also discovered that total darkness does not favour the performance of the circuit

Table 1..3 **Sensitivity of the infrared alarm system**

Nature of object	range
Large object	150 – 300mm
Small object	25 mm
Very small object	Not detected
Large and highly	
Reflective object	150 – 500mm

3.5 LIST OF COMPONENTS USED

RESISTORS (¼ W)

R1 =	470 Ω
R2 =	56 Ω
R3 =	20 K
R4 =	10 K (variable)
R5 =	68 Ω
R6 =	12 K
R7 =	30 K
R8 =	68 Ω
R9 =	30 K
R10=	68 Ω
R11=	12 K
R12=	39 K
R13=	47 K (variable)
R14=	1 M
R15=	10 K
R16=	470 K (variable)
R17=	10 K
R18=	33 K
R19=	100 Ω
R20=	100 Ω
R21=	22 K
R22=	22 K
R23=	22 K
R24=	47 Ω

TRANSISTORS

Tr1=	BC 109 C
Tr2=	BC 109 C
Tr3=	D400
Tr4=	2N 3638
Tr5=	2N 3638
Tr6=	mJE 3055
UJT1=	2N 2646

CAPACITORS

C1	= 2200 μF electrolytic,25v
C2	= 2,2μF,50v electrolytic
C3	= 10 nF Ceramic
C4	= 2.2 μF,50v electrolytic
C5	= 1 μF ceramic
C6	= 1 μF ceramic
C7	= 22 PF ceramic
C8	= 1 μF
C9	= 1 μF
C10	= 100 μF, 16v electrolytic
C11	= 10 nF
C12	= 10 μF
C13	= 50 μF, 25v electrolytic
C14	= 4.7 μF, 25v electrolytic
C15	= 0.1 μF ceramic
C16	= 0.1 μF ceramic

DIODES

D1	= IN 5391
D2	= IN 5391
D3	= 12 V Zener diode
D4	= TIL 38
D5	= TIL 100
D6	= 0 A 91
D7	= 0 A 91
D8	= IN 4148
D9	= IN 4148

I C S

ICI	=	555 timer
IC2	=	CA 3140 E
IC3	=	555 timer

RELAYS.

RLA I	=	6V, 4088 Ω
RLA2	=	12V, 400 Ω

S1	=	Toggle switch
F1	=	Fuse 1.5 A
T1	=	240/12 V centre tapped transformer.
SPKR	=	Speaker, 15 W, 8 Ω

CHAPTER FOUR

CONCLUSION AND RECOMMENDATION

4.1 CONCLUSION

Form the table of results for alarm circuit, it could be seen that the frequency of operation of the alarm circuit, f α 1/.Rb.

Also, from the table of result for the timer circuit, timing operation, t α R, where R is the value of timing resistor. That is the time of operation is directly proportional to the timing resistor.

From the general outcome of the testing of the infrared alarm system, it could be seen that the amount of the infrared energy emitted depends on the nature of the body and the wavelenght of the radiation. This agrees with planck's law.

Planck's Law:

$$W(\lambda) = C1\ \lambda^{-5}\left[C_1\lambda^{-5}(e^{c2/\lambda T} - 1\right]^{-1} W/cm^2/\mu m$$

W(λ) =energy of radiation, it shows that the Electron emerge with a kinetic energy increases directly with the frequency of the light .

Where C1 = 2 π hc^2 = 3.7415 x 10^4 W. (μm)^4 /cm^2

h = 6.6256 x 10^{-34} W. s^2 is Planck's constant .

c = 3 x10^{10} cm/s is the velocity of light in vacuum

$C2 = ch/k = 1.4388 \times 10^4\ \mu m.^{\circ}K$

$K = 1.38 \times 10^{-23}$ W.S/ K is boltz mann's constant .

λ = wavelength in micrometers .

T = absolute temperature in degree Kelvin .

Therefore, the objectives of the project were achieved.

4.2 RECOMMENDATIONS

Regular power supply may not be guaranteed in Nigeria, therefore it is recommended that this project should be powered by a separate d.c power supply (e.g. a 12 V battery).

If the project is to be developed for commercial purposes, provision must be made for it at the beginning of the construction of the building to ensure the cable connection are well concealed.

Now that we are in the computer age, anybody who may want to proceed further on this project, may make the output to be a computer monitor which should describe the nature of the intruder.

4.3 REFERENCES

1. Edward Hughes, (1995), Electrical Technology, 7th edition, published by ELBS and longman Group Limited, (pg. 378-388)

2. G. J. Ritchie, (1993), Transistor Circuit Techniques, 3rd edition, published by chapman & Hall, (pg. 26-42)

3. Jacob Millan & Arivin Grabed, (1997), Micro Electronics, 2nd edition, published by Mc Graw-Hill Book Company, (pg. 679-686)

4. Mark N. Horentein, (1996), Micro electronic Circuits and devices, 2nd edition; Published by Alan Apt (pg 66-70)

5. R.L. Havill & A. K. Walton, (1978), Elements of Electronics for physical scientists, 1st edition, published by English Language Book Society and Macmillan, (pg. 145 - 162)

6. Smuel Y. Liao, (1989), Micro wave Devices and circuits, 2ndedition, published by prentice-Hall of India private Limited, (pg. 436-465).

7. W. Shepherd & L. N. Hulley (1987), Power Electronics and Motor control, 1st edition, published by cambridge University Press, (Pg. - 64-75)