DESIGN AND CONSTRUCTION OF A TOUCH SENSITIVE ALARM SYSTEM

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING.

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FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BARCHELOR OF ENGINEERING (B. ENG.) DEGREE IN THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

OCTOBER, 2006.

DEDICATION

This project work is dedicated to God almighty for his constant love, guidance, protection and inspiration.

DECLARATION

I Achukwu Ekainu with matriculation number 2000/9776EE declare that this work was done by me under the supervision of Mr.S.N Rumala 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.

Achukwu Ekainu	Mr.S.N Rumala
(Name of student)	*(Name of Supervisor)*
………………… 10/10/06	………………………
(Signature and date)	*(Signature and date)*
Engr. M.D Abdullahi	………………………………
(Name of H.O.D)	*(Name of External Examiner)*
………………………	………………………………
(Signature and date)	*(Signature and date)*

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Credit goes to my friends, colleagues and neighbours for their advice and concern for the successful realization of this project work. To mention but a few, Lanre, Andrew, Gabriel, Godwin, Agada, Philip, Mercy and Margaret.

ABSTRACT

The design presented by this project work is an integrated, multi purpose alarm system which can be connected to metallic gates, door handles, and window protectors.

The design and construction was implemented in three units which were integrated to function as a single electronic alarm system. These units are the power supply unit, trigger unit and the alarm/amplifier unit. This integrated system uses a capacitive sensor which detects changes in electrostatic field and triggers the alarm unit to produce a large audible sound whenever there is an intrusion. Sensitivity of the sensor was limited to human touch by alteratering the value of R2 in order to avoid cases of false alarm. The touch sensor can be connected to metallic door handles, gates, window protectors e. t. c. and the main alarm system kept in a strategic location.

A unique feature this alarm system is incorporation of an automatic change over switch in to the power supply unit to check the problem of unexpected power failure and thereby increasing the reliability of the alarm system.

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CHAPTER ONE

INTRODUCTION

1.1GENERAL INTRODUCTION

One of the major problem in our society today is the issue of insecurity. Much time and resources have been devoted to projects that will make life easier and more comfortable for man while little is been done to make the world safer.

Homes, offices and industries are still under the threat of burglars, vandals, and thieves. These gave rise to the need for an increasing development in the technology of alarm systems of varying complexities. Even with the introduction of alarm systems, there is also a problem of false alarm which has to be minimized [1]. These are some of the reasons that prompted the design and construction of the touch sensitive alarm system presented in this project work.

The circuit design presented by this project work consists of four units. These units are:

(a). The power supply unit which employs the use of both battery and mains supply to ensure constant power supply to the circuit.

(b). The trigger unit which is responsible for activating the alarm unit, It was designed to have a low time out period and moderate sensitivity in order to reduce the rate of false alarm.

(c). The alarm/amplifier unit which produces an amplified siren sound when activated by the trigger unit with the aim of producing a large audible sound that can alert the entire neighborhood or scare an intruder away.

All these three units were integrated into the circuit design to form a cost effective, power efficient and reliable electronic alarm system with reduced rate of false alarm.

The problem of frequent power outages in our country today gave rise to introduction of an automatic power changeover switch which has the ability to switch between mains supply and battery supply using a relay (RLY1) .This provides cold redundancy for the alarm system thereby increasing its reliability of the entire alarm system.

Also, the possibility of internal intrusion was envisaged and this was the reason why the main alarm system was separated from the alarm speaker. This was done so that main alarm unit can be kept in a place only accessible to the operator.

The entire construction was manually done using tools and equipment available within the immediate environment and tested with available measuring instruments. The circuit design and implementation was accomplished using ideas from the textbooks, internet, lecturers and colleagues.

1.2 AIMS AND OBJECTIVES

1. To develop an alarm system that will check the increasing activities of burglars and vandals thereby reducing crime rate in the society.
2. To develop a cheap and reliable means for raising alert in the event of unauthorized intrusion to residential and commercial buildings.
3. To develop a portable alarm system that has multiple applications.
4. To develop an alarm system with reduced rate of false alarm.
5. To develop an electronic system that is power efficient, reliable and has the ability to use two independent sources of power supply with one acting as backup.
6. To experiment the use of relays as automatic power changeover switch in portable electronic devices as a means of providing redundancy in power supply .

CHAPTER TWO

LITERATURE REVIEW

2.1 EVOLUTION OF ALARM SYSTEMS

An alarm can be defined as a loud noise or signal that warns people of danger or a problem. An alarm system therefore means a device that warns people of a particular danger [2]. The development of alarm system started with the creation of man. Man required a way of giving alert information which was inform of signals and exclamation or shouting, later this was replaced by clapping of hands and beating of gongs by town criers to alert the community in order to disseminate information in the early African society. All these methods of raising alert or warning were crude and unreliable.

With the advancement in science and technology, these crude methods of alarm gave way for electronic alarm systems in the late 18^{th} [4] These electronic alarm systems operated without any human effort. Once it senses a particular signal, depending on its design it gives an indication in form of loud sound or noise [12].

On 28 April 1852, the first electronic fire alarm system was invented by Dr. William F. Channing, and was assisted by Mr. Moses G. Farmer, an electrical engineer in its development and construction [3]. This system used call boxes with automated signaling to indicate the location of fire and was first put into operation in Boston (U.S.A). The system was highly successful in reducing property loss and deaths due to fire and subsequently adopted throughout U.S.A and Canada [3].

After the invention of the first fire alarm system in 1852, there have been evolutions of fire and burglar alarm technologies of varying complexities and sophistications which are too numerous to mention. Notable among these technologies is the remote signaling intruder alarm system which was invented in 1970[4]. This provided a rapid and full response to alarm calls.

The security industry is constantly evolving to come up with new and innovative techniques to keep off burglar and vandals [13]. Today we have the new generation of electronic alarm system which comes in various levels of complexities and sophistication [2]. They are usually called the modern electronic alarm systems.

2.2 MODERN ELECTRONIC ALARM SYSTEMS

In these times of increasing crime rates, it has become imperative to safeguard our buildings and properties with adequate safety devices with increased level of sophistication[13]. The cost of these safety devices depend on the equipment and technology being used, the layout of the building and wiring required. These safety devices are called the modern electronic alarm systems [5].

Some of the modern alarm systems commonly used these days are burglar alarms, duress alarms, industrial alarms, speed limit alarms, and anti-theft car alarms.

- **Burglar Alarm Systems**

Most burglar alarm systems involve a circuit loop system that rings a bell or activates a siren when set off. A central control box monitors several motion detectors and perimeter guards and sound an alarm when any of them are triggered.

Some burglar alarm work on the concept of magnetic contacts and others on the concept of sensitivity. Some times, sensors are placed in the hallways or large rooms, which activate an alarm when the beam of light is interrupted by a person walking across it [5] .Motion detection is also carried out by ultrasonic means. Point detector burglar alarm brings to notice any intrusion at a specific point such as doors or windows. Area detection for intruders is done within a protected area with the help of ultrasonic transducers and passive infrared detectors. These sensors can be used individually or in combination depending on the kind of burglar alarm sophistication desired [5]. (The alarm system designed in this project work is an example of point detector burglar alarm).

These days, closed circuit television (cctv) are incorporated to burglar alarms to detect the presence of unauthorized persons.

The output of the modern burglar alarm systems can range from siren or loud alarms to telephone automatic dialers and flashing out door lights. This serves the function of alerting the neighbours of possible intrusion and also serves as a signal to the police [6]. Auto dialers attached to burglar alarms are programmed to dial the police and play a pre recorded message that informs the police of the address of the house being burgled; most burglar alarm systems have battery back up that function in times of temporary electrical blackouts.

- **Duress Alarm Systems**

Modern duress alarms are generally electronic devices that vary widely in capabilities. They are used when under threat to send alarm signals to a specific location, there are three general overlapping categories of duress alarms that can send one or more levels of distress signals to a particular location [7].

They are:

a) A panic button alarm- a push button mounted in a fixed location

b) An identification alarm- a portable device that identifies the owner of the device.

c) An identification/location alarm- a portable device that identifies locates and tracks the person who activated the duress alarm

The panic button is by far the most common type of duress alarm. It is found in schools, banks, offices e.t.c. The simplest application is a strategically located button that when initiated, would engage a dedicated phone line. A pre recorded message specifying the location and urgency is sent to several locations such as police department or other security agencies [7].

The second type of duress alarm incorporates a pager-like device that has a panic button built in and is either worn by the user or installed within a foot switched located under a desk. When the panic button is pushed, a wireless alarm signal is sent to the closest installed wireless unit (a type of repeater) which sends the signal to an alarm console. The personnel at the console would receive a coded number and this number would correspond to the user. This system does not give specific locations other than the general pre programmed zone of repeater. This type of alarm also incorporates a two way radio built into the pager that would allow communication between the console operator and the person under duress [7].

The third type of duress alarm is a smarter version of the second type. I t can identify, locate and track the person who activated the duress alarm of his or her pager. The electronics and software of such a system produces a positioning symbol on a console panel or map like display. Some advance duress alarm systems use hybrid design that tracks the user (e.g. soldier, cars, pets e.t.c) with global positioning satellite (GPS) technology and radio frequency or infrared system [7].

- **Industrial Alarm Systems**

These alarms come in three versions. The 12v de Grey bell is affordable and suitable for home security. It complies with the requirements of BS4737 intruder alarm system in buildings. The unit is mounted within a bell enclosure when used in external environments for fire detection.

The 24v ac Grey bell is an extremely effective signaling unit for use in industrial environments. The design avoids the need for mechanical contacts resulting in greater reliability and efficiency. The units may be ceiling or wall mounted with flush or surface wiring and requires no final setting up adjustment [8].

- **Speed Limit Alarm Systems**

These are wireless portable devices or units adaptable with most internal combustion engines. The circuit is designed to alert the vehicle driver when he has reached the maximum speed limit. It eliminates the needs to look at the speedometer thereby reducing the risk of accident while driving. This system works on the basis of the relationship that exists between the revolution per minutes (RPM) and speed of vehicle. It monitors the RPM and starts giving a beep when the maximum speed is attained [9].

- **Anti Theft Car Alarm System**

This type of alarm system is mounted somewhere in the car where it will be difficult to locate and remove. The switch can be located under the dash board or under the driver's seat. When the switch is activated or turned on, the electrical system of the car seizes to function or fuel supply is cut off [10].

2.3 ADVANCEMENT IN ALARM SENSOR TECHNOLOGY

The increasing developments in science and technology have given rise to a tremendous improvement in the technology of Alarm sensors. These sensors act as inputs which triggers the alarm [9]

Some of the alarm sensor technologies that have evolved over the years are:

(a) ***Photo electric beam sensor***: These sensors transmit a beam of infrared light to a remote receiver thereby creating an electronic fence. These sensors are often used to cover openings such as door ways or hall ways acting essentially as trip wire. Once the beam is broken or interrupted, an alarm signal is generated [9].

(b) ***Microwave sensors***: These are motion detection devices that flood a designated area or zone with an electronic field. A movement in the zone or area disturbs the speed and sets off the alarm [9].

(c) ***Vibration sensors***. These sensors are designed to be mounted on walls, ceiling and floor with the intention of detecting mechanical vibrations caused by chopping, sawing, drilling or any type of physical intrusion on which it is mounted [9].

(d) ***Passive ultrasonic sensor***: These are motion detection of the sensors that listens for ultrasonic sound energy in a protected area and reacts to high frequencies associated with intrusion attempts.

(e) ***Active infrared sensor:*** These sensors generate a certain pattern of modulated infrared energy and reacts to a change in the modulation of the frequency or an interruption in the received energy. Both of these occurrences happen when an intruder passes through the protection zone [9].

(f) ***Electrical field sensors:*** These sensors generate an electrostatic field between and around an array of wire conductors and an electrical ground. These sensors detect changes or distortion in the field. This can be caused by anyone approaching or touching the sensor.[9]

(g) ***Audio sensors***. These sensors listen for noise generated by an intruder's entry into a protected area and are generally used but exclusive for internal application.[9]

(h) ***Capacitance sensors:*** These sensors detect changes in electrostatic field. A signal is generated when an intruder changes the capacitance of the field by approaching or contacting the sensor's wires [9].

The Alarm sensor technology employed in this project work is the capacitance sensor. The sensor's wire is usually attached to metallic door handles, metallic protectors, existing fence fabric e.t.c. and normally require touch or close proximity to trigger the alarm. This alarm sensor technology was used in this project work because it reduces the rate of false alarm. This is due to the fact that weather, electromagnetic and radio frequency interference has no effect on the sensor's detection ability.

CHAPTER THREE

DESIGN AND IMPLEMENTATION

3.1 STAGES OF IMPLEMENTATION

The system design was implemented in three units as shown in fig. 3.1. These units are:

(a) The power supply unit

(b) The trigger unit

(c) The alarm/amplifier units

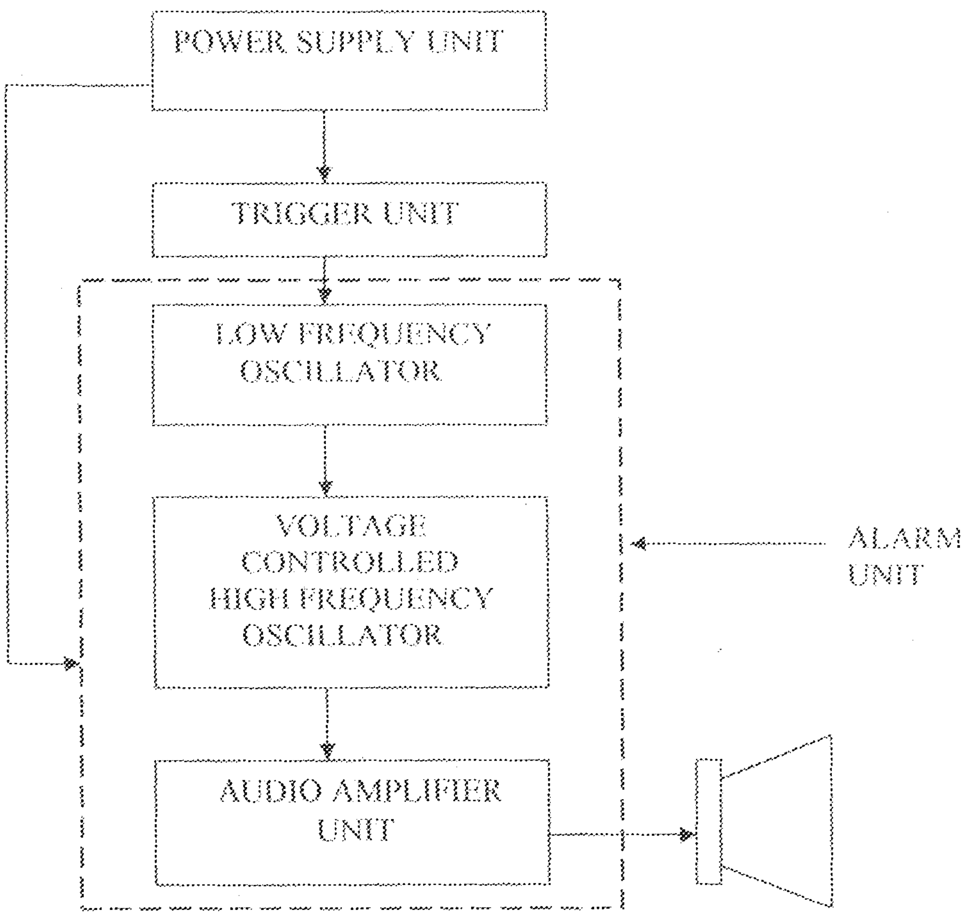


Fig.3.1. Block diagram of a touch sensitive alarm system

3.2 POWER SUPPLY UNIT

The power supply unit is a 2-way automatic power supply system. It gets input from both mains supply and battery supply. The two independent supply systems are connected to a relay switch which acts as an automatic change over switch to switch on any of the available input supply to the main circuit. The power supply unit provides power supply for the other two units of the circuit.

The schematic diagram of the power supply unit is shown below:

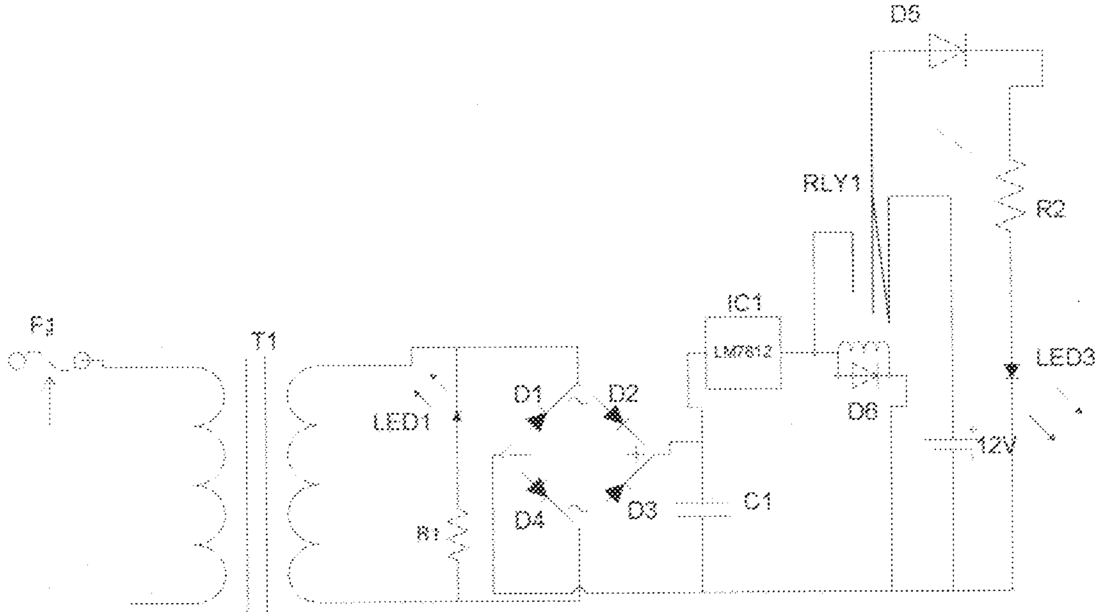


Fig.3.2. Schematic diagram of the power supply unit.

The schematic diagram of the power supply unit consists of two supply input sources (i.e. mains supply and 9V d.c supply from battery). F1 is a protective fuse used to prevent excess current from entering the circuit. T1 is a step down transformer. D1, D2, D3, and D4 are rectifier diodes. C1 is a filter capacitor. IC1 is a regulator IC. Rly1 is a relay switch. R1 and R2 are current limiting resistors protecting LED1 and LED2 respectively.

LED1 is used to indicate the presence of mains supply while LED2 is used to indicate that current is entering the trigger unit. D5 and D6 are protective diodes.

3.2.1. Operation of the power supply unit

The operation of the power supply unit can be illustrated by the bock diagram below:

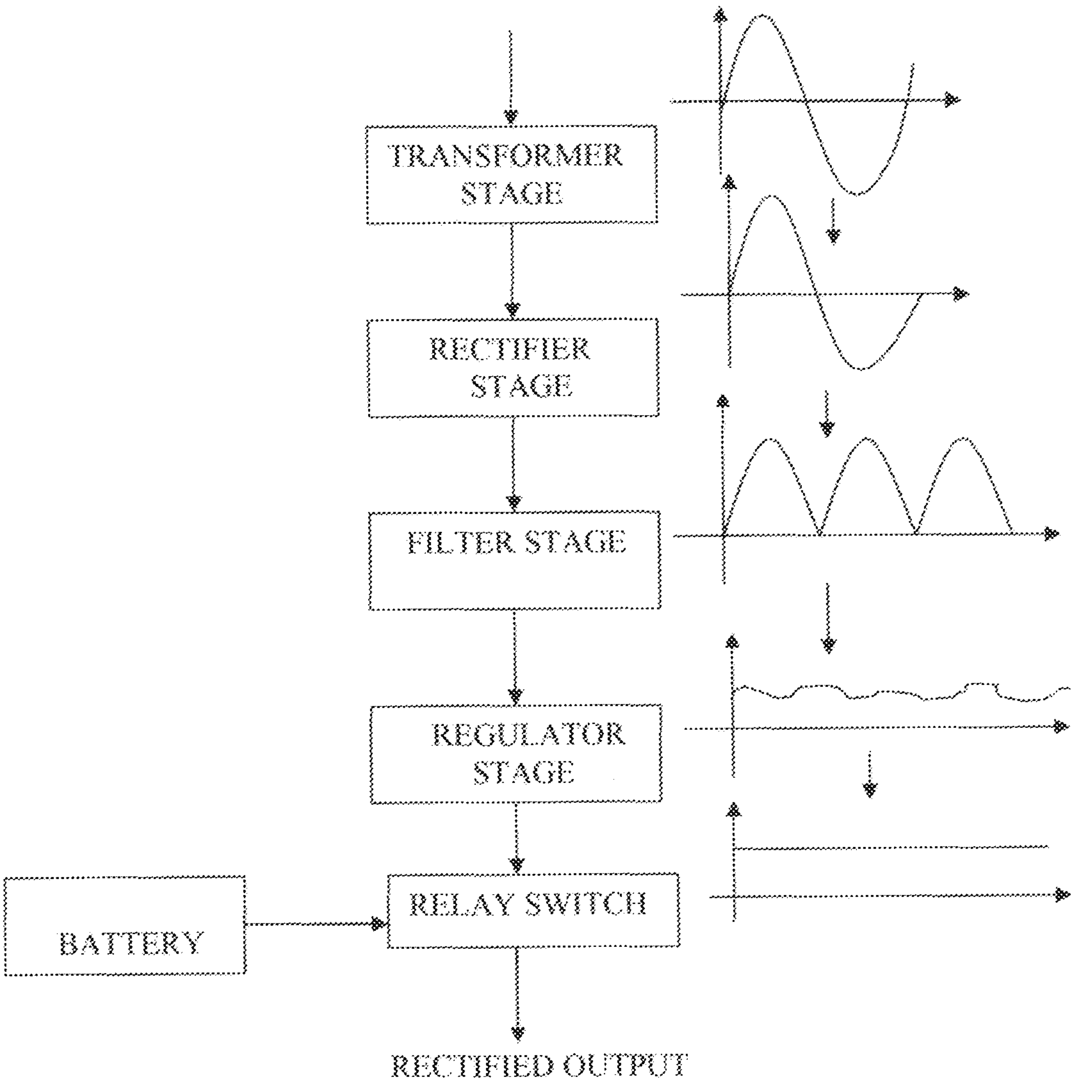


Fig.3.3. Block diagram of the power supply unit

The block diagram consist of 4 stages for rectification of 240V (A.C) mains supply to 12V (d.c), a battery supply and a relay switch. The description of each stage is given below:

(a) **TRANSFORMER STAGE:** This stage consists of a 240V/18V, step down transformer. It converts the 240V a.c voltage supply from mains to 18V a.c. A 1A fuse (F1) was incorporated at the primary side of the transformer to protect it from excess current. The 18V a.c supply is then passed to the rectifier stage. A 220V/18V step down transformer was chosen because the regulator used required more than 12V for its operation.

(b) **RECTIFIER STAGE**: In this stage, the rectifier converts the 18V a.c supply from the transformer into a pulsating d.c voltage. A full bridge rectifier was used for this purpose. It consist of four diodes (In 4001) arranged as shown in fig. 3.2. During the positive half cycles diodes D2 and D3 are forward biased and current flows through the terminals. In the negative half cycle, diodes D1 and D4 are forward biased. Since load current is in the same direction in both half cycles, full wave rectifier signal appears across the terminals[11].

(c) **THE FILTER STAGE**: The pulsating d.c voltage that comes out from the rectifier stage is converted into constant d.c voltage with the aid of a filter capacitor (C1). This capacitor is a large value electrolytic capacitor. It charges up (i.e. store energy) during the conducting half cycle and discharges (i.e. deliver energy) during the non-conducting half cycle thereby opposing any changes in voltage. The filter stage therefore filters out voltage pulsations (or ripple).

(d) **REGULATOR STAGE:** The output of the filter stage varies slightly when the load current or input voltage varies and it's a 18V d.c supply which is higher than the circuit requirement. For these reasons, an LM 7312 regulator was used to stabilize the voltage and also reduce it from 18v to a 12v steady d.c supply.

3.3 THE TRIGGER UNIT

Below is the schematic diagram of the trigger unit:

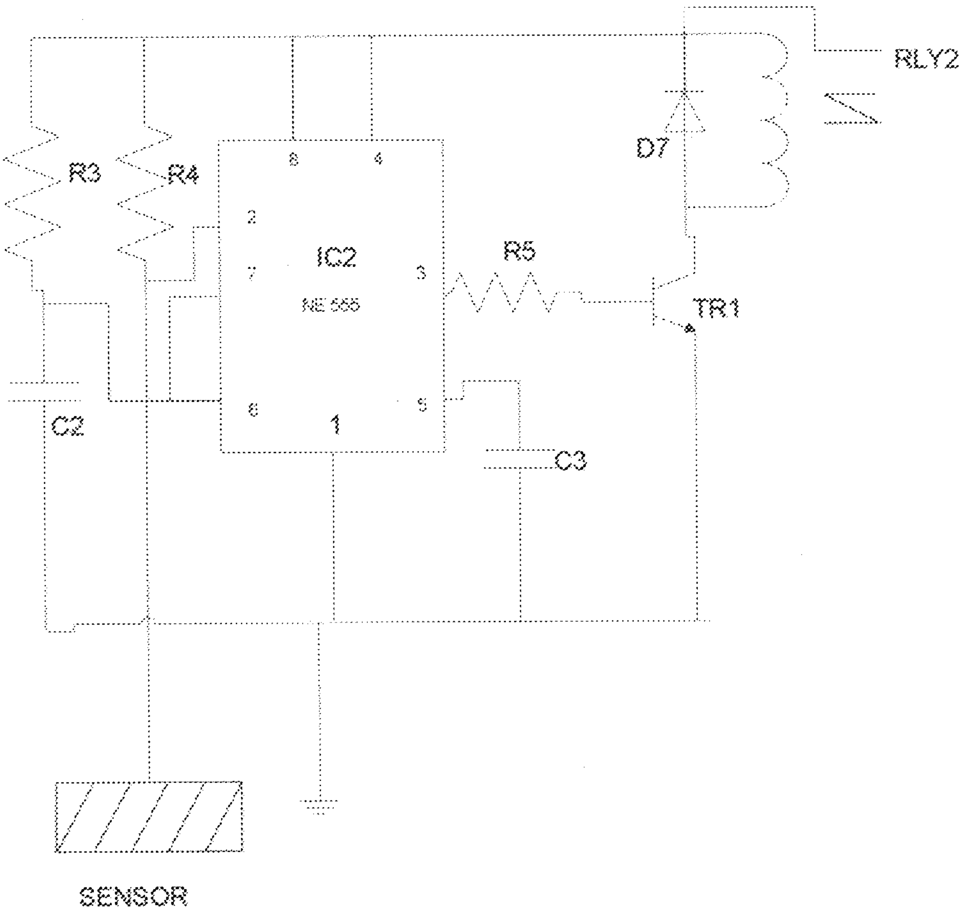


Fig. 3.4. Circuit diagram of the trigger unit

As shown in fig. 3.4, the schematic diagram of the trigger unit consist of 3 major components which are NE555 timer (IC2), transistor Tr1 and a relay (Rly2).

The 555 timer (IC2) produces a trigger current which comes out through its pin 3 whenever pin 2 is activated through the sensor. Pins 4 and 8 are connected to positive power supply while pin 1 is grounded. R3 and C2 determines the time out period of the 555 timer (i.e. the period at which the alarm sounds) while R4 determines the sensitivity of the sensor.

The output from pin 3 (trigger current) is amplified by transistor (Tr1). R5 acts as base resistor to Tr1 which is operating in common emitter mode. The output current from transistor (Tr1) causes the relay (Rly2) to operate thereby switching on the alarm/amplifier unit to positive power supply for duration of time determined by the time out period of the 555 timer (IC2). D7 acts as a commutation diode protecting the transistor (Tr1) from back emf generated by the relay coils. The 555 timer in this unit operates in a mono stable mode.

3.4 THE ALARM UNIT

The schematic diagram of the alarm unit is shown in the figure below:

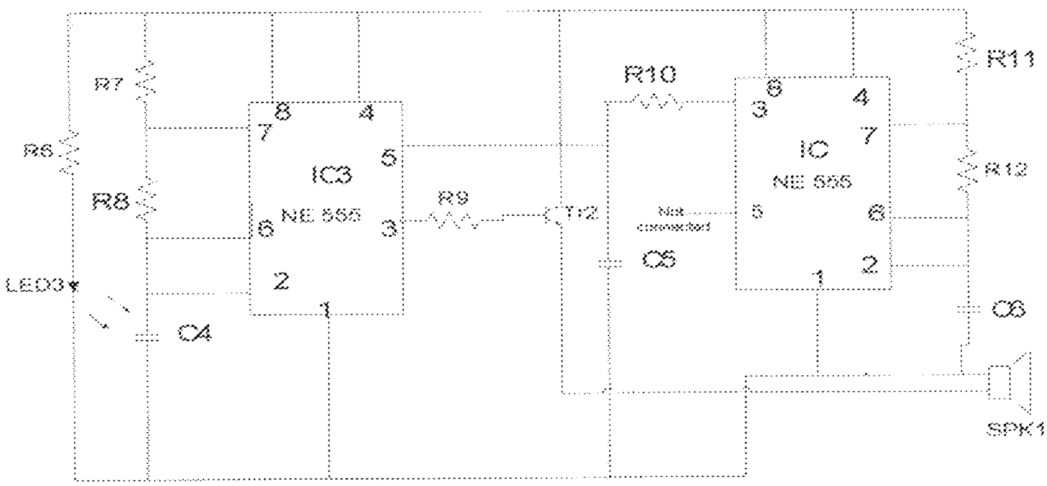


Fig.3.5. circuit diagram of the alarm unit

The alarm unit, as shown in the fig. 3.5 above consists of 3 basic components which:

(a). Two 555 timer (IC3 and IC4) operating in a stable mode to produce a siren sound.

(b). A power transistor (Tr2) used for further amplification of the audio output.

IC3 operates as high frequency oscillator (voltage controlled oscillator) operating at a normal frequency of about 481Hz and producing a square wave. This forms the basic tone of the siren sound system. IC4 produces another square wave of much lower frequency of about 0.5Hz. This lower frequency alters the rhythm of the steady tone from IC3 to the desired siren sound. The output of IC4 (i.e. its pin3) is actually coupled through R9 to control the voltage terminal of IC3. The low frequency (0.5 Hz) output from IC4 is used to modulate the high frequency (481Hz) produced by IC3 thereby alternating the frequency of operation of IC3 to produce a siren sound instead of a continuous 481Hz tone.

The final siren note is available at pin3 of IC3 but its maximum current (as calculated on page 32) is 0.038A. This current is not sufficient for 5w, 8ohms speaker. The pin3 output of IC3 is therefore fed to the transistor Tr2 for further amplification enabling it to power the speaker thereby producing a very loud audible siren sound.

3.5 CIRCUIT OPERATION

The complete circuit diagram of the alarm system is shown in fig.3.6.The 555 timer in the trigger unit gets activated whenever pin2 senses a smaller potential that is less than 1/3 the supply voltage. When activated it sounds for duration of time determined by R3 and C2.this also determines how long the alarm will sound before going off.

In reality the sensor wire is usually connected to metallic door handles, protectors (for windows and doors) or even metallic gates. Whenever the human body comes in contact with such materials the trigger unit gets activated and the alarm sounds. A detailed explanation of this action is given by the following points.

Pin 2 actually acts as a capacitance sensor and detects changes in electrostatic fields. The human body and most conductors in nature generates electrostatic charges which alters the capacitance of the field thereby inducing a small signal on the sensor wire.[8].This signal is less than 1/3 the supply voltage thereby causing the trigger unit to operate for a period of time determined by C2 and R3.

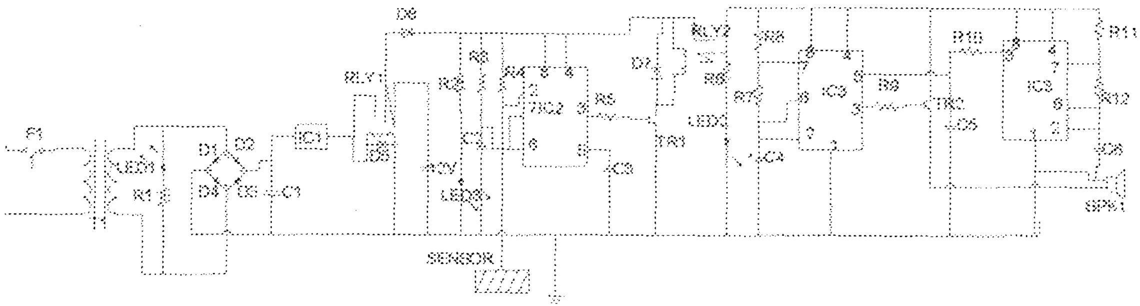


Fig 3.8 Circuit Diagram of a Touch Sensitive Alarm

Table3.1 Key to circuit diagrams

SYMBOLS	COMPONENTS	RATINGS
T1	Transformer	240/18V,9VA
F1	Fuse	1A
SPK1	Speaker	5 Watts,8Ω
IC1	Linear power regulator	LM7812
IC2,IC3,IC4	555 Timer IC	NE 555
LED1,LED2,LED 3	Light emitting diode	NTE 3010
RLY1,RLY2	Relay switch	12V,400Ω
D1,D2,D3,D4,D5,D6,D7	Diodes	ln4001
C1	Capacitor	2200 μF
C2,C5,C6	"	47 μF,25V
C3 , C4	"	0.01 μF
Tr1	Transistor	SC1815
Tr2	"	TIP31
R1	Resistor	470Ω
R2	"	980Ω
R3	"	220KΩ
R4	"	10.8MΩ
R5	"	4.7kΩ
R6,R12	"	1kΩ
R7,R8	"	100KΩ
R9	"	300KΩ
R10	"	2.2KΩ
R11	"	22KΩ

3.6 OPERATION OF A 555 TIMER IC

The 555 timer is an IC which consists of upper and lower comparators, control flip flop, discharge transistors and power output stage. It can be used as an oscillator as well as a timer. It has two basic mode of operation which are monostable mode which has only one stable state and astable mode which has no stable state. The diagram below shows an 8 pin T –package and V-package 555 timer IC with its waveform and the internal circuitry.

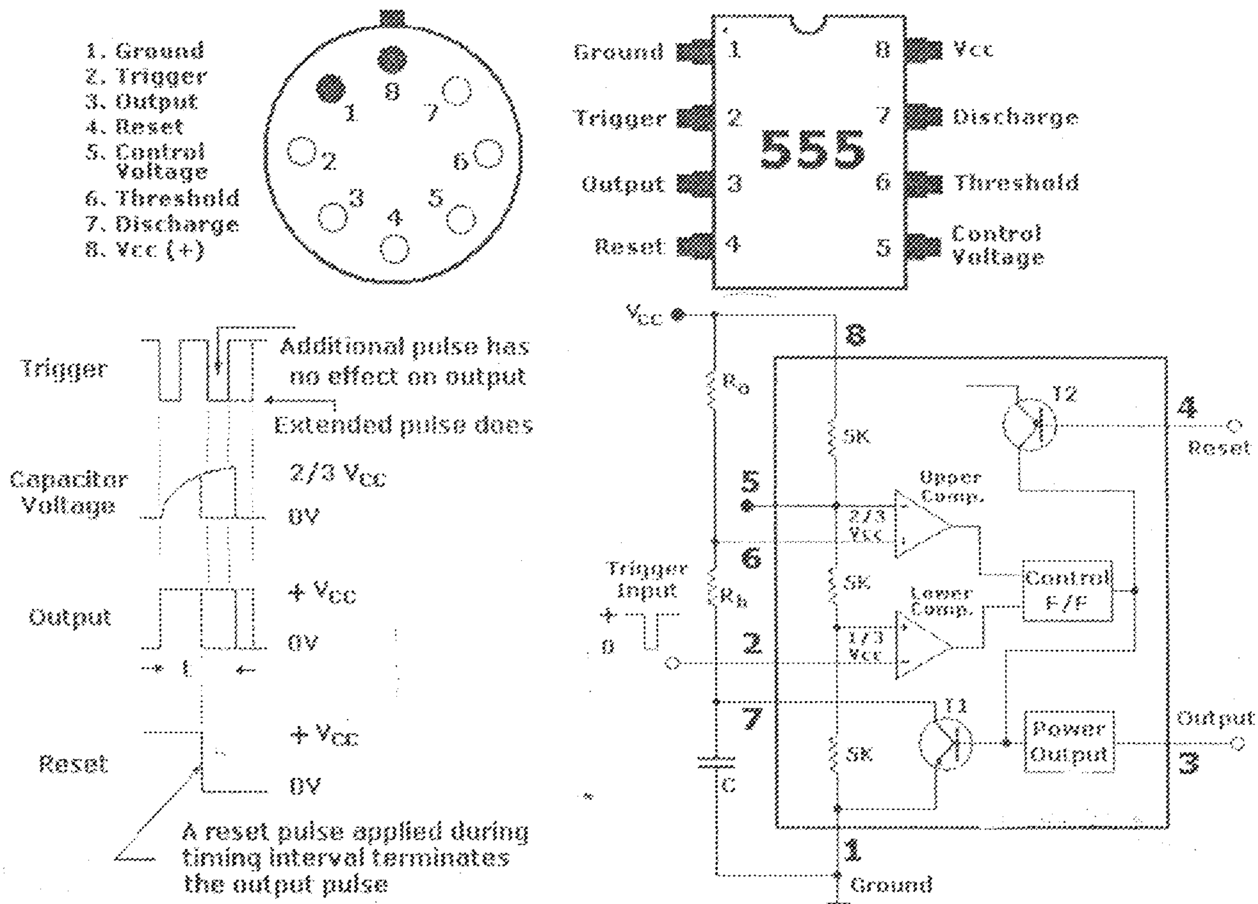


Fig 3.7 Diagrams of a T-package and V-package 555 timer IC showing its waveforms and internal circuitry.

3.6.1 Pin Definition

(a)Pin 1*(Ground):* This is the most negative supply potential of the 555 timer IC which is normally connected to the circuit ground when operated from positive voltage.

(b) Pin 2*(Trigger):* This pin is the input to the lowest comparator and is used to set the latch which in turn causes the output to go high.

(c) Pin 3 *(Output):* This pin is set to high condition when ever pin2 is momentarily taken from a high to a low level. The output voltage available at this pin is approximately equal to the supply voltage applied to pin 8 minus the 1.7V.

(d) Pin 4 *(Reset):* This pin is used to reset latch and return the output to a low state.

(e) Pin 5 *(Control Voltage):* This pin allows direct access to the 2/3Vcc voltage divider point, the reference level for the upper comparator

(f) Pin 6 *(Threshold):* This is one of the input to the upper comparator and is used to reset the latch which causes the output to go low .

(g) Pin 7 *(Discharge):*This pin act as the discharge for the 555 timer IC.A timing capacitor is usually connected between this pin and the ground and is discharged whenever the internal transistor of the 555 timer turns on.

(H) Pin 8 *(+Vcc):* This is the positive supply voltage of the 555 timer IC The operating range of the IC voltage supply is 4.5V (minimum) to 16V (maximum).

3.6.2 Monostable Operation

In monostable mode due to the internal latching mechanism of the 555, the timer will always time-out once triggered, regardless of any subsequent pulses on the input trigger

2) when the trigger input is initially high (about 1/3 of +Vcc). When a negative-going ger pulse is applied to the trigger input, the threshold on the lower comparator is eeded. The lower comparator, therefore, sets the flip-flop. That causes T1 to cut off, ing as an open circuit. The setting of the flip-flop also causes a positive-going output level ich is the beginning of the output timing pulse. The capacitor (C) connected to pin 6 now gins to charge through the external resistor (R). As soon as the charge on the capacitor qual 2/3 of the supply voltage, the upper comparator triggers and resets the control flip-flop. hat terminates the output pulse which switches back to zero. At this time, T1 again conducts thereby discharging the capacitor. If a negative-going pulse is applied to the reset input while the output pulse is high, it will be terminated immediately as that pulse will reset the flip-flop.

Whenever a trigger pulse is applied to the input, the 555 will generate its single-duration output pulse. Depending upon the values of external resistance and capacitance used, the output timing pulse may be adjusted from approximately one millisecond to as high as on hundred seconds. The duration of the output pulse in seconds is approximately equal to:

$$T = 1.1 \times R \times C \text{ (in seconds)}$$

3.6.3 Astable operation

In astable mode both the trigger and threshold inputs (pins 2 and 6) to the two comparators are connected together and to the external capacitor. The capacitor charges toward the supply voltage through the two resistors, R_a and R_b. The discharge pin (7) connected to the internal transistor is connected to the junction of those two resistors. When power is first applied to the circuit, the capacitor will be uncharged; therefore, both the rigger and threshold inputs will be near zero volts. The lower comparator sets the control flip-flop causing the output to switch high. That also turns off transistor T1. That allows the capacitor to begin charging through R_a and R_b. As soon as the charge on the capacitor reaches 2/3 of the supply voltage, the upper comparator will trigger causing the flip-flop to reset. That causes the output to switch low. Transistor T1 also conducts. The effect of T1 conducting causes resistor R_b to be connected across the external capacitor. Resistor R_b is effectively connected to ground through internal transistor T1. The result of that is that the capacitor now begins to discharge through R_b.

As soon as the voltage across the capacitor reaches 1/3 of the supply voltage, the lower comparator is triggered. That again causes the control flip-flop to set and the output to go high. Transistor T1 cuts off and again the capacitor begins to charge. That cycle continues to repeat with the capacitor alternately charging and discharging, as the comparators cause the flip-flop to be repeatedly set and reset. The resulting output is a continuous stream of rectangular pulses.

. The frequency of operation of the astable circuit is dependent upon the values of R_a, R_b, and C. The period can be calculated with the formula

$$T = 0.693 \times C \times (R1 + 2 \times R2)$$

The time intervals for the on and off portions of the output depend upon the values of R_a and R_b The ratio of the time duration when the output pulse is high to the total period is known as the duty-cycle. The duty-cycle can be calculated with the formula [13]:

$$D = t1/t = (R_a + R_b) / (R_a + 2R_b$$

$$t1 = .693(R_a+R_b)\ C$$

$$t2 = .693 \times R_b \times C$$

3.7 DESIGN CALCULATION AND COMPONENT SELECTION

3.7.1 The Power Stage

A 240/18v transformer was chosen because its rating is capable of meeting the current demand of the circuit and it is protected by the 1A fuse against excess current. The limiting resistor (R1) for the LED1 was calculated as shown below:

$$R1 = \frac{\text{Voltage drop}}{\text{LED current}}$$

$$R1 = \frac{\text{Vcc} - v(LED)}{I(LED)}$$

Where: Vcc = supply voltage = 18V

V (LED) = supply voltage = 2.2 *(see appendix II)*

I (LED) = maximum allowable current across the LED = 35mA *(see appendix II)*

$$R1 = \frac{(18 - 2.2)V}{35mA}$$

$$= \frac{15.8V}{0.035A}$$

R1 = 451.43 Ω

The preferred resistor value closest to 451.43 Ω is 470 Ω. Therefore 470 Ω was Voltage drop adopted in the design.

Current drawn by LED1 = $\frac{18V}{470\Omega}$

= 0.038mA

The peak inverse voltage (PIV) obtainable at the secondary terminal transformer is twice the terminal voltage Vs [10]

I.e. PIV = 2 × Vs = 2×18 = 36V

At the full bridge rectifier circuit IN4001 diode was used because its PIV which is 50V is greater than the PIV of the secondary of the secondary terminal which is 36V[11].This was done to avoid damage to the diodes in case reverse operation occurs.

The value o f the filter capacitor C1 was obtained as shown below.

$$C = \frac{1}{4\sqrt{3}f\gamma R} \text{(for full wave rectifier circuits)[10]}$$

Where: f = frequency of ripple voltage = 50Hz

γ = ripple factor = 5% =0.05

R = resistance of the regulator = $\frac{V}{I}$

V = Constant output voltage from the regulator = 12v

I = Constant output current from the regulator = 500mA = 0.5A

$$R = \frac{12}{0.5} = 24\Omega$$

$$C = \frac{1}{4 \times \sqrt{3} \times 24 \times 50 \times 0.05}$$

$$C = \frac{1}{415.692}$$

C = 2.4056 $\times 10^{-3}$ LED current

C = 2405.6 μF

A 2200 μF was used in the design because it is the closest value of a standard capacitor to 2405.6 μF.

The current limiting resistor for LED2 is calculated as shown below:

$$R2 = \frac{\text{Voltage drop}}{\text{LED current}}$$

$$R2 = \frac{\text{Vcc} - v(LED)}{I(LED)}$$

Where V_{cc} = supply voltage = 12V

V (LED) = supply voltage = 2.2 *(see appendix II)*

I (LED) = 0.01A (Chosen to limit the amount of current consumed by the LED)

$$R2 = \frac{(12 - 2.2)V}{0.01A}$$

$$R2 = \frac{9.8V}{0.01A}$$

R2 = 980 Ω

The preferred resistor value closest to 980Ω is 1K Ω. Therefore 1K Ω resistor was adopted as R2 in the design.

$$\text{Current drawn by LED 2} = \frac{12V}{1000\Omega}$$

= 0.012A

= 12mA

3.7.2 The Trigger Stage

The timeout period (T) and the frequency (f) were determined by the values of R4 and C2 as follows:

$T = 1.1(R3 \times C2)$

But $R3 = 220K\Omega = 220 \times 10^3\Omega$

$C2 = 47\mu F = 47 \times 10^{-6}F$

$T = 1.1(220 \times 10^3 220 \times 47 \times 10^{-6})$ secs

$= (1.1 \times 10.34)$ secs

$= 11.374 secs \approx 11 secs$

$$f = \frac{1}{T}$$

$$= \frac{1}{11.374}$$

$=0.09Hz$

The values of R4 and C2 were chosen in such a way that they can produce a approximate period of 11secs delay.

The base resistor R5 for transistor Tr1 was chosen as a result of the following calculations.

$$R6 = \frac{V_{CC} - V_{BE}}{I_B}$$

Where: V_{cc} = supply voltage =12V

V_{be} =Base emitter voltage = 0.6*(see appendix III)*

I_b = Base current

$I_b = I_c$ /gain Supply voltage

gain = 25 *(see AppendixIII)*

I_c = collector current = maximum Relay current $= \frac{\text{Supply voltage}}{\text{Coil resistance}} = \frac{12}{400} = 0.03A$

$$\Rightarrow I_b = \frac{0.03}{25} = 0.0012A$$

To ensure that the current is sufficient to drive the transistor into saturation, the quantity of the current is doubled i.e

$I_b = 0.0012 \times 2 = 0.024A$

$$R5 = \frac{12 - 0.6}{0.0024} = \frac{11.4}{0.0024}$$

$= 47050\Omega \approx 4.7\ \Omega K$

A $4.7\Omega K$ resistor was chosen to serve as the base resistor (R6) to the transistor because it is the closest value of standard resistor value to 47050Ω.

3.7.3 The Alarm/Amplifier Stage

Design calculation for this unit was done in three stages.

- ***Stage 1:*** This is the high frequency oscillator stage. The period (T_H) and frequency (f_H) for this stage were calculated as follows:

$T_H = t1 + t2$

$t1 = 0.693 \times C4\ (R7 + R8)$

But $C4 = 0.01\,\mu F = 0.01 \times 10^{-6} F$

$R7 = R8 = 100K\Omega = 100 \times 10^{3}\,\Omega$

$t1 = 0.693 \times 0.01 \times 10^{-6}\ (100 \times 10^{3} + 100 \times 10^{3})$

$= .693\ \times 0.01 \times 10^{-6}\ \times 200 \times 10^{3}$

$= 1.386\ \times 10^{-3}$ secs

$t2 = 0.693\ \times\ C4\ \times R8$

$t2 = 0.693\ \times 100 \times 10^{3} \times 0.01 \times 10^{-6}$

$t2 = 0.693\ \times\ 10^{-3}$

$\therefore T_H = t1 + t2 = 1.386\ \times 10^{-3} + 0.693\ \times 10^{-3}$

$= 2.079\ \times\ 10^{-3}$secs = 2.079mSecs

$$F_H = \frac{1}{T_H} = \frac{1}{2.097 \times 10^{-3}}$$

= 481Hz

$$\text{Duty cycle} = \frac{t1}{T_H} = \frac{1.38 \times 10^{-3}}{2.07 \times 10^{-3}} \times 100\%$$

= 66.95%

The values of C4, R7 and R9 were manipulated in order to get the desired frequency that will modulate the low frequency (IC3) to give the desired tone.

- **Stage2:** This is the low frequency oscillator stage. The period (T_l) and frequency (f_l) for this were calculated as follows:

$T_l = t1 + t2$

$t1 = 0.693 \times C6\,(R11 + R12)$

But $C6 = 47\,\mu F = 47 \times 10^{-6} F$

$R11 = 1K\Omega = 1 \times 10^{3}\Omega$

$R12 = 22K\Omega = 22 \times 10^{3}\Omega$

$t1 = 0.693 \times 47 \times 10^{-6}\ (1 \times 10^{3} + 22 \times 10^{3})$

$= .693 \times 47 \times 10^{-6} \times 23 \times 10^{3}$

$= 1041.003 \times 10^{-3}$ secs

$= 1.041$secs

$t2 = 0.693 \times C6 \times R12$

$t2 = 0.693 \times 47 \times 10^{-6} \times 22 \times 10^{3}$

$t2 = 995.74 \times 10^{-3}$

$= 0.0996$ secs

$\therefore T_1 = t1 + t2$

$= 1.041 + 0.996$

$= 2.037$Secs

$$F_1 = \frac{1}{T_i} = \frac{1}{2.037}$$

$= 0.491$Hz

$$\text{Duty cycle} = \frac{t1}{T_i} = \frac{1.0411}{2.037} \times 100\%$$

$= 51.1\%$

The values of C6, R11 and R12 were manipulated in order to get the desired frequency that will modulate the high frequency oscillator (IC3) to give the desired tone.

- *Stage 3:* This is the audio amplifier stage. It is this stage that gives the final power output to the speaker. The actual power output by the transistor (T r2) was calculated as follows:

Power output = $I_E \times V_{cc}$

Where: V_{cc} = supply voltage = 12v

I_E = Emitter current

But $I_E = (1 + \text{Gain})\, I_B$

Gain = 100 *(see appendix III)*

$$I_B = \frac{V_{CC} - V_{BE}}{R_B}$$

$V_{CC} = 12V$, $V_{BE} = 0.6$

R_B = R9 = base resistor =300 Ω

$$I_B = \frac{12 - 0.6}{300} = \frac{11.4}{300} = 0.038A$$

$I_E = (1 + 100)\, 0\,038 = 0.418A$

Substituting back into to the first equation:

$\Rightarrow P_{out} = 0.418 \times 12$

$= 5.016$ Watts

≈ 5Watts

This means that the amplifier stage of the of the alarm unit (Tr2) gives an output of 5Watts.Therefore a 5Watts, 8 Ω speaker was chosen at the output stage for maximum power transfer.

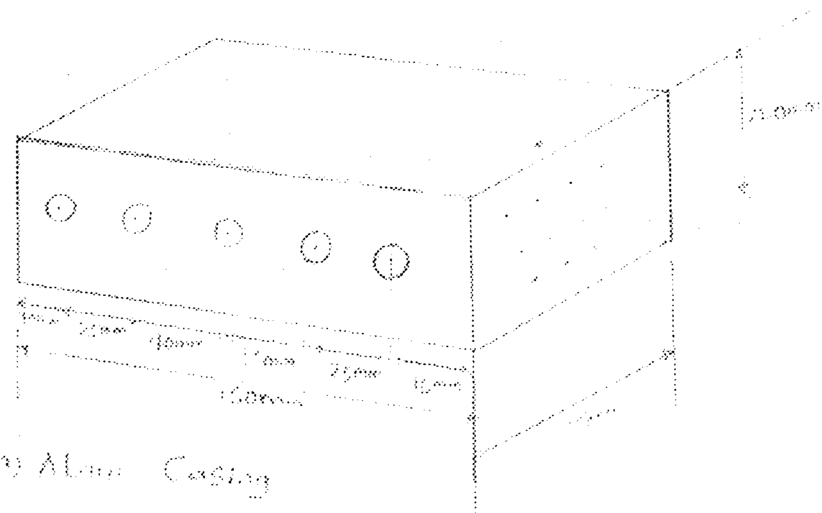
CHAPTER FOUR

CONSTRUCTION AND TESTING

4.1 CASE CONSTRUCTION

The material used for the project casing was a sheet metal. The desired dimensions were properly marked out on the material with pencil ant cut to the desired shape using chisels, hammer and hacksaw. The holes for screws, LEDs, and the various outlets were drilled using manual drilling machines and smoothened with file and painted with black paint.

The final casing that obtained at end of the construction is shown below:



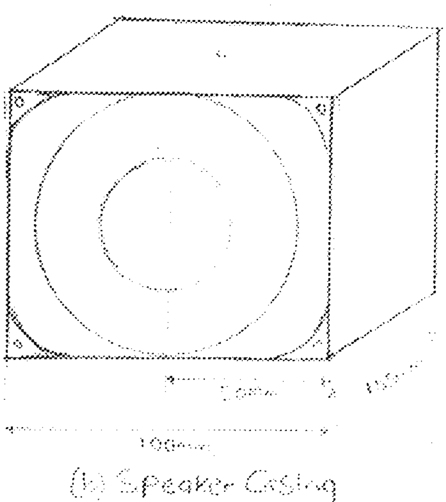


Fig.4.1 Project Casing

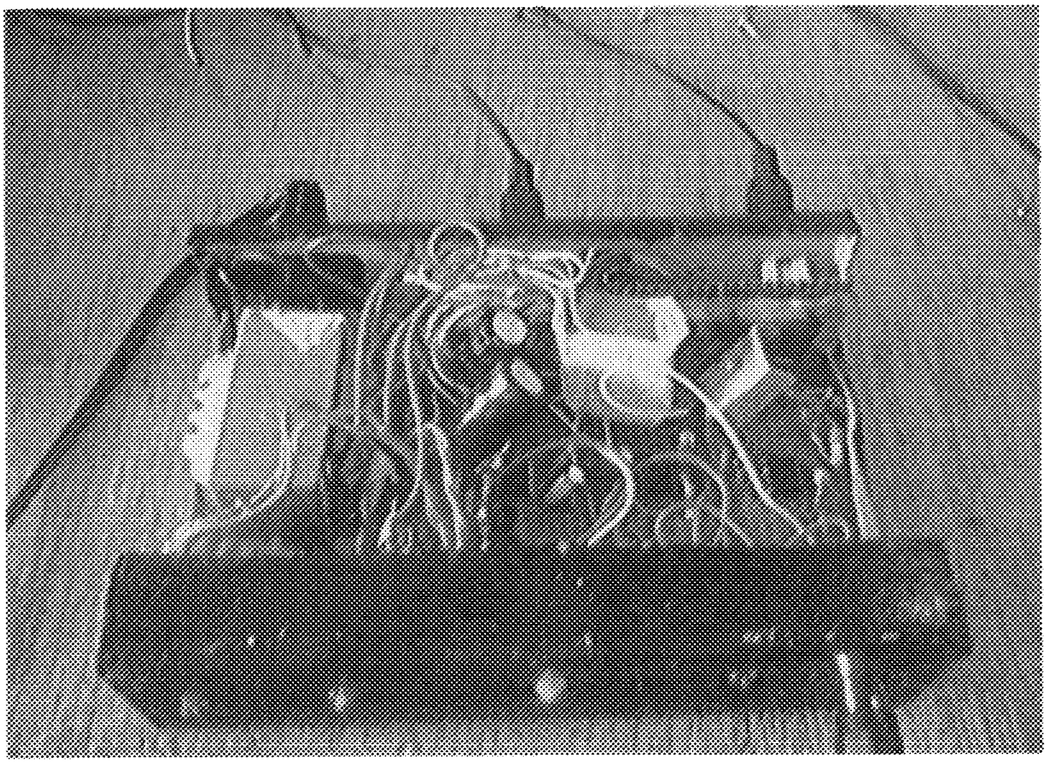


Fig.4.2 Internal circuitry of the touch sensitive alarm system.

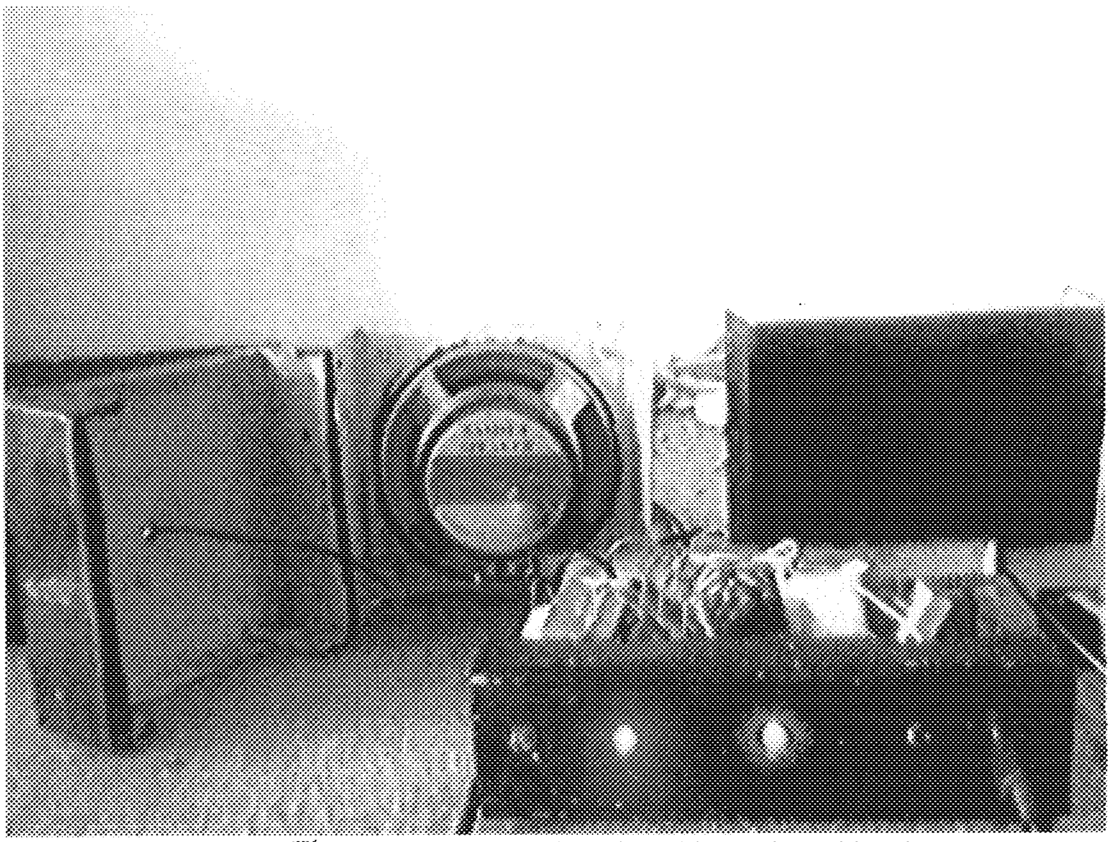


Fig 4.3 Speaker and main casing of the touch sensitive alarm

4.2 TESTING AND RESULTS

The following steps were taken to test the work:

1) All the components were tested with a digital multi meter to ensure that they were working before they were finally soldered to the veroboard.Those components that failed were replaced immediately.

2) After soldering, the entire circuit path on the Vero board was tested for continuity using digital multimeter.At the end of this test no breakage was detected in the circuit path.

3) After testing for conductivity the various sections of the circuit were simulated using circuit maker 6, student edition. The result from the simulation corresponds to the result gotten from the design calculation with slight variation in the values.

4) The time out period (i.e. duration for which the alarm sounds) was tested manually by using digital stop watch and found to be 10.60 seconds. This value agrees with result obtained in the design calculation which was 11.37 seconds.

4.3 DISCUSSION OF RESULTS

The aim of testing of testing each component before soldering was to avoid the trouble of desoldering faulty components. The continuity test carried out along the circuit path recorded no breakage along the path which implies that the circuit was in perfect working condition.

The aim of simulating the various sectors of the circuit design was to compare the results obtained from the design calculation with that of the simulation. It was observed that both results corresponded though with slight variation in values.

Also, the 10.60 seconds obtained using the stop watch is approximately equal to the 11.37 seconds obtained from the design calculation.

4.4 PROBLEMS ENCOUNTERED

(a). Advanced measuring instruments such as oscilloscope and transistor tester were not available for a detailed analysis of the circuit. The alternative was to use simulation software for the circuit analysis.

(b). some component needed for the project work were not available within the town. Equivalent components were used in place of such components with the aid of data books.

(c)Another problem encountered during the implementation stage was the fact that circuit was triggering itself even without touch. This problem was solved by reducing the sensitivity of the circuit (i.e. by reducing R2)

4.5 TROUBLE SHOOTING GUIDE

1. If the device does not come on when powered, check the relay switch (RLY1) and fuse (F1). Replace if faulty.
2. If A.C power does not come on, check the power plug, the fuse and the rectifier circuit. Replace if faulty.
3. If the D.C power does not come on, check the battery jack and the battery itself ensure proper connection to the battery jack and replace weak or dead battery.
4. If alarm does not sound when triggered, check the sensor jack, the reset button and the speaker.
5. If the alarm sounds continuously without stopping, check the sensor jack and ensure that it is not earthed.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The major aim of this project work is to develop a cheap, affordable, reliable and efficient security system which was successfully realized at the end of the project work. The cheapness of the product was attained by the choice components used as only readily available and replaceable components were used in implementing the circuit. The incorporation of automatic changeover switch into the power supply unit increased the reliability of the entire alarm system as the mains supply and the battery are cold redundancy thereby ensuring constant supply of power to the main circuit. .Also the choice of components and the use of transistor in common collector mode to couple circuit output to the speaker further increased the efficiency of the system. In summary a cheap and reliable means of checking the activities of burglars was successfully developed at the of this project work.

Finally the system was tested and found to be working to specification and safe for use in residential and commercial and commercial buildings.

5.2 RECOMMENDATION / IMPROVEMENT

To increase the efficacy of the system, further improvement can be made on the alarm system by interfacing its output to a micro computer system or incorporating a digital door lock.

Also by increasing the sensitivity of the capacitive sensor and checking the effects of ground, the alarm may also be used for oil pipelines protection and car alarm.

REFERENCES

[1] "False alarm.", http//www.alarm.org/false/tips/dealer tip/dealer tip.html.

[2].Crime and violence prevention center. California, "Home Security Handbook". Page 9-12.

[3]. "History Of Security Alarms", http://www.ieee.org/organization/history center/fire alarm.html.

[4]. British Security Industry Association (BSIA), "Journal on security systems section strategy for intruder alarm system", April 2005. Page 1-3.

[5]. "Intrusion Detection". http//www.targetwoman.com/articles/burglar system.html.

[6]. Nick A. Tim. "Technical leaflet on introduction to fire detection and Alarm", http//www.neddc.org/alarm.html.

[7]. "Duress Alarm system".http//www.ncjrs.gov/school/ch5.html.

[8]. Tijani Semiu Olarinre. "Design and construction of touch security Alarm system"FUT Minna, November 2005 page 9 -11.

[9]. Mr. J.A. Koenig and Mr. L. Taylor, "Perimeter Security Sensor Technology hand book", Electronic Security Systems Engineering Division. North Charleston. U. S. A, Page 67-86. (www.nleitc.org/perimeter/full2.htm).

[10]. B.L Theraja and A.k Theraja, "A Textbook of Electrical Technology", S.Chand and Company Ltd.1996 Reprint. Pages 1930-1933, 1969-1970.

[11] J. Shepherd. A.H Morton and L.F. Spence, "Basic Electrical Engineering", Pitman Publishing. Reprinted 1973. Page 274 -278.

[12] Thomas petruzzelis. "The alarm, sensor and security circuit book", TAB Books. Imprint Of McGraw-hill San Francisco. U.S.A.Reprinted 1994. Page 5 – 7.

[13] Rana Sampson, "Burglar Alarms", U.S. Dept. of Justice, Pages 2-6, 13-14.

APPENDIX I: Electrical characteristics of NE 555

(TA = 25°C, VCC = 5 ~ 15V, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	VCC	-	4.5	-	16	V
Supply Current (Low Stable) (Note1)	ICC	VCC = 5V, RL = ∞	-	3	6	mA
		VCC = 15V, RL = ∞	-	7.5	15	mA
Timing Error (Monostable) Initial Accuracy (Note2) Drift with Temperature (Note4) Drift with Supply Voltage (Note4)	ACCUR Δt/ΔT Δt/ΔVCC	RA = 1kΩ to100kΩ C = 0.1μF	-	1.0 50 0.1	3.0 0.5	% ppm/°C %/V
Timing Error (Astable) Initial Accuracy (Note2) Drift with Temperature (Note4) Drift with Supply Voltage (Note4)	ACCUR Δt/ΔT Δt/ΔVCC	RA = 1kΩ to 100kΩ C = 0.1μF	-	2.25 150 0.3	-	% ppm/°C %/V
Control Voltage	VC	VCC = 15V	9.0	10.0	11.0	V
		VCC = 5V	2.6	3.33	4.0	V
Threshold Voltage	VTH	VCC = 15V	-	10.0	-	V
		VCC = 5V	-	3.33	-	V
Threshold Current (Note3)	ITH	-	-	0.1	0.25	μA
Trigger Voltage	VTR	VCC = 5V	1.1	1.67	2.2	V
		VCC = 15V	4.5	5	5.6	V
Trigger Current	ITR	VTR = 0V		0.01	2.0	μA
Reset Voltage	VRST	-	0.4	0.7	1.0	V
Reset Current	IRST	-		0.1	0.4	mA
Low Output Voltage	VOL	VCC = 15V ISINK = 10mA ISINK = 50mA	-	0.06 0.3	0.25 0.75	V V
		VCC = 5V ISINK = 5mA	-	0.05	0.35	V
High Output Voltage	VOH	VCC = 15V ISOURCE = 200mA ISOURCE = 100mA	12.75	12.5 13.3	-	V V
		VCC = 5V ISOURCE = 100mA	2.75	3.3	-	V
Rise Time of Output (Note4)	tR	-	-	100	-	ns
Fall Time of Output (Note4)	tF	-	-	100	-	ns
Discharge Leakage Current	ILKG	-	-	20	100	nA

Notes:

1. When the output is high, the supply current is typically 1mA less than at V_{CC} = 5V.
2. Tested at V_{CC} = 5.0V and V_{CC} = 15V.
3. This will determine the maximum value of $R_A + R_B$ for 15V operation, the max. total R = 20MΩ, and for 5V operation, the max. total R = 6.7MΩ.

APPENDIX II: LED Specifications

		viewing angle		intensity	forward voltage drop	reverse break-down	max DC current	max power
LED	type	degrees	color	MCD	V	V	mA	mW
NTE3000	indicator	80	red	1.4	1.65	5	40	80
NTE3010	indicator	90	green	1	2.2	5	35	105
NTE3026	tristate	50	red/green	1.5/0.5	1.65/2.2		70/35	200
NTE3130	blinker	30	yellow	3	5.25	0.4	20	
NTE3017			infrared		1.28	6	100	175

Notice that the forward voltage drop is not the 0.6 V we associate with a silicon diode, and that the reverse breakdown voltage is quite small.

APPENDIX III: Transistor Datasheet

Part Number	NPN or PNP	Maximum Ratings BVCBO (V)	BVCEO (V)	IC (mA)	PD Ta=25°C (mW)	Electrical Characteristics (Ta=25°C) hFE Min	hFE Max	hFE IC (mA)	hFE VCE (V)	VCE(sat) Max (V)	VCE(sat) IC (mA)	VCE(sat) IB (mA)	fT MHz	Pin
TO-92 (P.31)														
SB764	PNP	-60	-50	-1000	900	60	320	-50	-2	-0.7	-500	-50	150	ECB
SB772S	PNP	-40	-30	-3000	750	100	400	-1000	-2	-0.3	-2000	-200	80	ECB
SC1815	NPN	60	50	150	400	120	700	2	6	0.25	100	10	80	ECB
SC1959	NPN	35	30	500	500	120	240	100	1	0.25	100	10	300	ECB
SC2228Y	NPN	160	160	50	500	60	320	10	10	0.4	20	2	80	ECB
SC2240	NPN	150	150	100	625	120	400	2	5	0.3	10	1	100	ECB
SC2853S	NPN	120	120	200	900	60	320	10	10	1	30	3	400	ECB
SC945	NPN	60	50	100	250	135	600	1	6	0.3	100	10	150	ECB
SD1609S	NPN	160	160	100	800	60	320	10	5	2	30	3	140	ECB
SD1616A	NPN	120	60	1000	750	135	600	100	2	0.3	1000	50	100	ECB
SD468	NPN	25	20	1000	900	85	240	500	2	0.5	800	80	180	ECB
SD471A	NPN	40	30	1000	800	70	400	100	1	0.5	1000	100	130	ECB
SD667A	NPN	120	100	1000	900	60	200	150	5	1	500	50	140	ECB
SD676	NPN	30	10	3000	750	140	400	3000	2	0.3	3000	60	200	ECB
SD882S	NPN	40	30	3000	750	100	500	1000	2	0.5	2000	200	90	ECB
SD965	NPN	40	20	5000	750	230	800	500	2	0.35	3000	100	150	ECB
T606	NPN	75	40	500	625	100	300	150	10	0.3	150	15	100	ECB
TL145	NPN	500	500	300	1000	65	300	20	10	0.5	20	2	10	EBC
TL194	PNP	-400	-400	-300	1000	55	300	-20	-10	-0.7	-20	-2	10	ECB
TL195	PNP	-500	-500	-300	1000	50	300	-20	-10	-0.5	-20	-2	10	ECB
TO-220 (P.30)														
H2584	PNP	-30	-35	-10	65	1K	60K	-10	-1.7	-1.5	-10	-10		BCE
H2585	PNP	-20	-15	-6	40	1K	60K	-6	-1.2	-1.5	-6	-6		BCE
2N6388	NPN	80	80	10	65	1K	20K	5	3	2	5	10		BCE
2N6668	PNP	-80	-80	-10	65	1K	20K	-3	-3	-2	-5	-10		BCE
BU406	NPN	400	200	7	60	30	125	2	5	1	5	500		BCE
BU407	NPN	330	150	7	60	30	200	2	5	1	5	500	10	BCE
D44H11	NPN	80	80	10	50	60	-	2	1	1	8	400	50	BCE
D45H11	PNP	-80	-80	-10	50	60	-	-2	-1	-1	-8	-800	40	BCE
LB124B	NPN	900	400	2	35	10	40	0.3	5	0.3	0.1	10	15	BCE
LB125E	NPN	800	400	5	40	10	-	0.01	5	0.5	1	200		BCE
MJE13005	NPN	700	400	4	75	10	60	1	5	0.5	1	200		BCE
MJE13007	NPN	700	400	8	80	10	40	2	5	1	2	400		BCE
MJE13009	NPN	700	400	12	100	10	30	0.5	5	1	5	1000	4	BCE
MJE2955T	PNP	-70	-60	-10	75	20	100	-4	-4	-1.1	-4	-400	2	BCE
MJE3055T	NPN	70	60	10	75	20	100	4	4	1.1	4	400	2	BCE
SB507	PNP	-80	-40	-3	30	40	320	-1	-2	-1	-2	-200	8	BCE
SB857	PNP	-70	-50	-4	40	60	320	-1	-4	-1	-2	-200	15	BCE
SC4242	NPN	450	400	7	40	10	-	4	5	0.8	4	800		BCE
SD1150	NPN	300	60	4.5	40	30	100	1	5	1	4	400	10	BCE
SD313	NPN	60	60	3	30	40	320	1	2	1	2	200	8	BCE
SD880	NPN	60	60	3	30	60	300	0.5	5	1	3	300	3	BCE
TIP102	NPN	100	100	8	80	1K	20K	3	4	2	3	6		BCE
TIP105	PNP	-60	-60	-8	80	1K	20K	-3	-4	-2	-3	-6		BCE
TIP107	PNP	-100	-100	-8	80	1K	20K	3	-4	-2	-3	-6		BCE
TIP112	NPN	100	100	2	50	1K	-	1	4	2.5	2	8		BCE
TIP117	PNP	-100	-100	-2	50	1K	-	-1	-4	-2.5	-2	-8		BCE
TIP122	NPN	100	100	5	65	1K	-	0.5	3	2	3	12		BCE
TIP125	PNP	-60	-60	-5	65	1K	-	-0.5	-3	-2	-3	-12		BCE
TIP127	PNP	-100	-100	-5	65	1K	-	0.5	3	-2	-3	-12		BCE
TIP29C	NPN	100	100	1	30	15	75	1	4	0.7	1	125	3	BCE
TIP31C	NPN	100	100	3	40	10	50	3	4	1.2	3	375	3	BCE
TIP32C	PNP	-100	-100	-3	40	10	50	-3	-4	-1.2	-3	-375	3	BCE