DESIGN AND CONSRUCTION OF AN INFRARED SECURITY ALERT SYSTEM

BY

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF ENGINEERING DEGREE (B.ENG) IN THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

SEPTEMBER, 2006

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DEDICATION

This work is dedicated to the Almighty ALLAH for His mercies, grace, guidance and protection over my life.

Also this work is dedicated to my parents, Mall. Aliyu Tanko Beji and Malama Salamatu Tanko who gave me this wonderful opportunity and urged me on when the odds seemed insurmountable. They made me believe that I could if I tried.

To my siblings, Aliyu, Hapsat, Adama, and Hamzat whose emotional support was invaluable.

And to my entire friends, especially Murtala Abdullahi, Mohammed Sani Alhassan, Mall. Umar Shaba and my dear princess Zuwaira, I owe it all to you.

DECLARATION

I Tanko Sulaiman, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Department of Electrical and Computer Engineering, Federal University of Technology, Minna.

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TANKO SULAIMAN

9TH oct. 2006
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DATE

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MR. MICHAEL DAVID
SUPERVISOR

9/10/06
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DATE

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H.O.D

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EXTERNAL EXAMINER

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AKNOWLEDGEMENT

In the name ALLAH, the Beneficent, the Merciful, Praise be to ALLAH, Lord of the Worlds. I give thanks to Him for his protection, guidance, love, provision and the gift of life. I owe all gratitude and praises to him.

I wish to acknowledge the assistance of all those who helped to make this project work a bit success.

My warmest gratitude goes to my supervisor, Mr. Michael David, who took time out to look at the ideas I came up with and made corrections and suggestions that greatly improved the quality of the work.

My sincere gratitude goes to my friends and colleagues who were ever present and always ready to help and give useful suggestions.

And to my parents and siblings, I could not have asked for a better family, you are the best.

Thank you all, I appreciate and love you all.

ABSTRACT

The project is a design and construction of an infra red security alert system. The infra red beam intrusion detection system is a security device capable of detecting the motionof an intruder within its area of coverage. The system is distinctively divided into two parts:- The transmitter and the reciever design. The itrusion detection system is of volumetric(space) detection type capable of detecting motion in (three dimensional) space. The transmitting and the receiving circuits are powered by 9V battery. The transmitter, build around an astable 555 timer IC, provides a pulse signal which is used to power infra red LEDs which serve as the source of the transmitted infrared beams.

The receiver module detects the transmitted beamss using photodiodes. This recieved signal is then passed through a monostable 555 timer IC circuits. The latch circuits latches onto the difference signal passed through by the monostable 555 timer IC, so that even when the source of the disturbance is removed, the signal is retained when the system is RESET, using the RESET button. This signal is then used to trigger an alarm, using the audio sounder as the output device.

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CHAPTER ONE

1.1 INTRODUCTION

The word "security" in general usage is synonymous with "safety," but as a technical term "security" means that something not only is secure, but that it has been secured. For example, in telecommunications, the term security has the following meanings:

- A condition that results from the establishment and maintenance of protective measures that ensures a state of inviolability from hostile acts or influences.
- With respect to classified matter, the condition that prevents unauthorized persons from having access to official information that is safeguarded in the interests of national security.
- Measures taken by a military unit, an activity or installation to protect itself against all acts designed to, or which may, impair its effectiveness.[1]

Intrusion detection

A whole series of detectors and devices are used for monitoring purposes. They detect either the offender himself (noises, radiated heat, movement) or the changes he causes to the targeted object (vibration, heat, positional change). Broadly speaking, monitoring consists of three different disciplines: Outer-shell monitoring: Monitors the outer shell (walls, windows/doors) of a building or building wing. Detectors: alarm glass, break-glass detectors, pneumatic screens, vibration and seismic detectors, magnetic and bolt contacts. Room monitoring: This involves the use of motion detectors that operate according to either ultrasonic, microwave or infrared principles. The choice of detector depends in each case on potential environmental influences and disturbance variables. Outdoor monitoring: In the case of high-level security requirements the intruder has to be detected the moment he trespasses onto the property. Detectors installed outdoor include: microwave directional lines, infrared light barriers, fence and ground sensors, video monitoring. [2]

1.2 OBJECTIVES

The basic function of a security system is to detect as fast as possible an unauthorized entry of a person into a defined area. Furthermore, an ideal security system should also be difficult to bypass or override; it must be highly reliable and operates under adverse conditions e.g. should not be subjected to false alarming. Security is something that concerns us all. A good security concept must therefore include measures in the following areas:

- Mechanical: to delay attempted burglaries (secured windows, doors)
- Technical: to detect intruders (monitoring, alarming)
- Organisation: to apprehend intruders (alarm/operations plan, intervention)

A professionally installed security system can bring many benefits to your home. With one of our monitored alarms you can enjoy peace of mind 24 hours a day, 365 days a year. At work a security system will aid in ensuring that your stock, valuable data and equipment is adequately protected. Insurance does not cover the aggravation of being burgled or loss of time should trading be interrupted through crime against your premises.

"One of the most feared crimes is burglary. The threat of being a victim of crime in the home is bad enough, but to be subjected to crime a second or even more times increases the fear of the victim and other householders in the area."

One study shows that once a house has been burgled the chance of repeat victimization was four times the rate of houses that had not been burgled before. Make a burglar think twice; don't give him an easy ride.

Many homes are more prone to burglary as they have access points which are sheltered from public view; for example, a back door in a garden. You may have valuable jewelers or TV and Hi-fi equipment in a particular room. You may live in a shared apartment complex where breaches in access can occur or you may be worried about the crime rate in your area.

"Criminals pick a house that looks unoccupied, has little or no obvious security and where they think they won't be seen." Simply having a professional alarm box present on your property will reduce the chance of it being targeted. If a break in occurs an intruder alarm will significantly reduce the amount of time a burglar is in your premises. An intruder alarm system can also tell you if a burglary was attempted and which area of the property. Their job is to delay the intruder until the police - automatically notified by the alarm system - arrive on site and arrest the criminal. In cases where assets or the safety of people are considerably at risk (banks, jewellers, museums, embassies, military installations), more comprehensive "obstacles" such as fences,walls, gates are still required. This means that long before the intruder reaches the building, he has already unwittingly triggered off an alarm (outdoor monitoring).[3]

1.3 METHODOLOGY

The topic of this project is the design and construction of infrared security alarm system. Infra-red waves are just below visible red light in the electromagnetic spectrum ("Infra" means "below"). You probably think of Infrared waves as heat, because they are given off by hot objects, and you can feel them as warmth on your skin. Infrared waves are also given off by stars, lamps, flames and anything else that's warm - including you.

Infrared waves are called "IR" for short. Because every object gives off IR waves, we can use them to "see in the dark". Night sights for weapons sometimes use a sensitive IR detector. the design has the unique advantage of using an invisble infrared rays to detect intruders. the infra-red source is a semiconductor diode made from gallium arsenide, which is a strong infrared transmitter in the 9000 angstron region. in addition to emmitting infrared energy, the gallium arsenide diode can actually be pulsed. another unique aspectof the design is the synchronization of emmitted and the recieved infrared beam,thus was achieved using the synchronous detector, the synchronous detector converts the pulse level into a steady voltage which represent the recieved pulselevel, with this it detects changes in the recived beam level.[4]

1.4 SCOPE OF WORK

This work will contain the following sourced information as relevant to the subject of discussion:

1. Theoretical background of similar type of projects.
2. Historical background
3. Application of infra red radiation
4. Detailed analysis and mode of operation of circuit components.
5. Relevant issue arising from design modification.
6. Recommendations and conclusion.

The sources of the material used were basically in Minna and Lagos. The constraint to achievable performance is basically problems posed by the non availability of new components as well as the scarcity of some of the major components.

CHAPTER TWO

LITERATURE REVIEW

2.1 THEORETICAL BACKGROUND

Intruder detectors are system that detect the presence of an intruder in a define area. An infrared inruder detector system uses an infrared beam projected onto a photoele ctric cell either by direct projection of the beams or by means of mirrors. If an intruder interrupts the invisible infrared beam, the break is detected; thus trigerring an alarm. A wide area can be covered when the beam is deflected by mirrors[5]. Infrared Radiation, emission of energy as electromagnetic waves in the portion of the spectrum just beyond the wavelength limit of the red portion of visible radiation. The wavelengths of infrared radiation are shorter than those of radio waves and longer than those of light waves. They range between approximately 10^{-6} and 10^{-3} metres (about 0.00004 and 0.04 in). Infrared radiation can heat up objects, and instruments such as bolometers are used to detect it.

Infrared radiation is used to obtain pictures of distant objects obscured by atmospheric haze, because visible light is scattered by haze but infrared radiation is not. The detection of infrared radiation is used by astronomers to observe stars and nebulae that are invisible in ordinary light or that emit radiation in the infrared portion of the spectrum.

An opaque filter that admits only infrared radiation is used for very precise infrared photographs, but an ordinary orange or light-red filter, which will absorb blue and violet light, is usually sufficient for most infrared pictures. Developed about 1880, infrared photography has today become an important diagnostic tool in medical science as well as in agriculture and industry. Use of infrared techniques reveals pathogenic conditions that are not visible to the eye or recorded on X-ray plates. Remote sensing by means of aerial and orbital infrared photography has been used to monitor crop conditions and insect and disease damage to large agricultural areas, and to locate mineral deposits. In industry, infrared spectroscopy forms an increasingly important part of metal and alloy research, and infrared photography is used to regulate the quality of products.

Infrared devices such as those used during World War II enable sharpshooters to see their targets in total visual darkness. These instruments consist essentially of an infrared lamp that sends out a beam of infrared radiation, often referred to as black light, and a telescope receiver that picks up returned radiation from the object and converts it to a visible image.

The Theory of infrared radiation and the related techniques of thermographs are new to many who would like to make use of Infrared Cameras and Non-contact Thermometers. The electromagnetic spectrum is divided arbitrarily into a number of wavelength regions called "bands", distinguished by the methods utilized to produce and detect the radiation. There is no fundamental difference between radiations in the different bands of the electromagnetic spectrum. Light at frequencies below red is called infrared. The human eye cannot see it, but infrared detectors and imaging devices can. All objects emit infrared energy at ordinary temperatures. The hotter the object, the more infrared energy it emits[6].

In security alarm systems, there are two basic categories. The first stage secures vulnerable perimeter access points such as doors and windows; the second stage consists of space detection such as interior motion detectors, which monitor movment inside the premise.

2.1.1 PERIMETER DETECTION DEVICE

The level of protection afforded to any given building or area is normally determined by the level of risk from intrusion or other criminal activity and ideally will comprise of several different but complimentary 'layers' of protection. In this respect Perimeter Protection, in its various forms, is the ideal 1st level of protection providing both an early warning of attempted intrusion as well as deterring / delaying entry of intruders. Perimeter Protection is applied to the boundary of the property, be it the external fabric of the building or the boundary fence line in open or border areas. Most situations would benefit from incorporating a Perimeter Protection System, in addition to any other security measures involved but for high risk and sensitive areas such as airports, military establishments, international borders, power stations, governmental establishments, nuclear power plants, oil & gas refineries, research establishments, embassies, residential establishments of individuals at risk from kidnap or assassination, banks, industrial plants etc, the installation of adequate perimeter security is vital. In addition Perimeter Security can be applied to areas posing a safety risk to unauthorized persons such as water treatment plants, building sites, firing ranges, mining areas etc. And in such cases Perimeter Protection can be used to provide an early warning of intrusion or trespass and to instigate an alarm or audible safety message warning etc.

The perimeter detection devices consist of different types of switches, which are strategically located around the perimeter of the protected premises. A classical example of the perimeter intrusio detector is the popular Magnetic Contacts, which can be mounted in doors and windows. Such a device consists of two pieces – a magnet and a reed or slide switch, which is usually supplied in the electrically closed position. When the magnet is moved away from the switch as a result of the window or door being opened, the switch opens up triggering an alarm. Most perimeter detectors work on this basic switch principle and are employed in wide variety of applications. Another type of perimeter switch is an electronic mat or ribbon, which is laid around or at the entrance point of the area to be protected. The electronic mat is constructed in such a way that any one stepping on it will close an electrical contact triggering an alarm. Another common form of perimeter detection is the Glass Break Sensors in which a conductive thin foil is glued to the glass. When the glass is broken, the foil opens up and the circuit triggering the alarm. Still another type of perimeter detector is the Vibration / Impact Sensors. This device has adjustable contact which close whenever vibration is exceeded on a wall or panel. The vibration perimeter switches are very useful in protecting roofs or walls where the intruder might employ a saw or a hammer to gain entry. Note that these perimeter detectors, though taking various forms, have one thing in common, in that they protect the circumference of an area; i.e. they do not offer protection in the three dimensional (volumetric) space. Furthermore, as most intruder detector device known as perimeter type of detector can easily be "Jumped", such jumping is accomplished merely by paralleling the electrical connection prior to breaking it. Thus, by putting a jumper wire across a normally closed magnetic switch prior to entry. The effectiveness of a magnetic switch can completely be defeated by electrically shunting it out; normally electrically open perimeter detectors are even more easily defeated by simply cutting the wires heading to them. Consequently, suchdevices offer less protection with regard to the prevention of robberyor an unauthorized entry.

2.1.2 SPACE INTRUSION DETECTORS

Space intrusion detectors are devices, which can detect an intrusion in volumetric (three dimensional) space. In operation, a space intrusion detector generates an energy field in all direction. When this energy field is disturbed, as by entry of human being or other mass, a signal is initiated which triggers the alarm. Obviously, a space intrusion detector is very difficult to "JAM" because one has to pass through its energy field to get at the device. One of the best ways of generating this energy field is through the emission of an invisible infrared rays. Due to this obvious advantage, I have chosen to design an alert system that will function using the infrared ray as the intrusion detector [1,2].

2.2 HISTORICAL BACKROUND

Sir Fredrick Williams Hershel, a German born Britsh astronomer royal, is credited with the discovery of Infra-red radiation during the spring of 1800. Hershel referred to this infra-red radiation as invisible light and speculated that its nature was the same as that of visible light.

Many of the early experiments searched similarities between infrared energy and visible light. in 1847, Armand Hippotyle, Louis Fizeau, Jean Bearnard and Leon Foucault of France showed finally that infra-red radiation exhibited interference effects in exactly the same way as visible light. It has also been revealed among other things that though, infrared radiation is reflected and refracted just like the visible light[7].

2.3 APPLICATIONS OF INFRARED RADIATION

Today infrared find use in :- Security systems, Material analysis, Thermal Imaging, Remote temperature sensing and Communication.

2.3.1 SECURITY SYSTEMS

Passive InfraRed sensors (PIRs) are electronic devices which are used in some security alarm systems to detect motion of an infrared emitting source, usually a human body. All objects, living or not, whose temperature is anything above absolute zero (-273. 15°C or -459.67°F) emit infrared radiation; see black body radiation. This radiation (energy) is invisible to the human eye but can be detected by electronic devices designed for such a purpose. The term "passive" in this instance means the PIR does not emit any energy of any type but merely sits 'passive' accepting infrared energy through the 'window' in its housing. The heart of the sensor is a solid state 'chip', approximately 1/4 inch square and often from a pyroelectric material, mounted on a printed circuit board which also contains the necessary electronics required to interpret the signals from this chip. The printed circuit board is contained in the housing which is then mounted in a location where the chip can 'see' the area to be 'protected'. The aforementioned window in the housing allows infrared energy to reach the chipThe window is covered with an infrared-transparent (but translucent to visible light) plastic sheet which may or may not have Fresnel lenses moulded into it. This plastic sheet prevents the intrusion of dust and insects while the Fresnel lenses, if present, focus the infrared energy onto the surface of the chip. Some PIRs use a plastic segmented parabolic mirror or mirrors to focus the infrared energy onto the surface of the chip. Their plastic window cover has no Fresnel lenses molded into it. In either case, the PIR can be thought of as a kind of infrared 'camera' which remembers the amount of infrared energy falling on its surface, focused there by the mirrors or the Fresnel lenses. It might help to thin of these focused points as 'hot spots' on the surface of the chip. Once power is applied to the PIR the electronics in the PIR shortly settle into a quiescent state and energize a small relay. This relay controls a set of electrical contacts which are usually connected to the detection input of an alarm control panel. The actual sensor on the chip is made from natural or artificial pyroelectric materials, usually in the form of a thin film, out of Gallium nitride (GaN), Caesium nitrate (CsNO3), Polyvinyl fluorides, derivatives of Phenylpyrazine, and Cobalt phthalocyanine. Lithium tantalate (LiTaO3) is a crystal exhibiting both piezoelectric and pyroelectric properties. An intruder entering the protected area is detected when the infrared energy emitted from his body is focused by a Fresnel lens or a mirror segment and overlaps a section on the chip which had previously been looking at some much cooler part of the protected area. That portion of the chip is now much warmer than when the intruder wasn't there. As the intruder moves, so does the hot spot on the surface of the chip. This moving hot spot causes the electronics connected to the chip to de-energize the relay, operating its contacts, thereby activating the detection input on the alarm control panel. Conversely, if an intruder were to try to defeat a PIR perhaps by holding some sort of thermal shield between himself and the PIR, a corresponding 'cold' spot moving across the face of the chip will also cause the relay to de-energize unless the thermal shield has the same temperature as the objects behind it.

2.3.2 MATERIAL ANALYSIS

Many complex molecules asorb infrared energy at specific wavelengths. This char acteristics permits rapid identification of material without the use of chemical and without distroying the materials.

2.3.3 THERMAL IMAGING

Infrared scanning instrument (or image-forming cameras) produces thermal picture of their targets. Medical application of this include remote thermal mapping of humman body temperature. Areas that exhibit abnormal high or low temperature are readily revealed and analyzed for body malfunctioning or disease. also infrared microscope permits thermal mapping of very small objects such as transistors or micro circuits. Devices that exhibit loclized and excessive high temperature are discarded as defective.

2.3.4 REMOTE TEMPERATURE SENSING

Radiation emmitted by an object is a unique function of its temperature. the Infrared radiometer or pyrometer collects and measures the radiation from a target to determine its temperature version of the infrared radiometer that has been used to detect fires, plot ocean surface temperature from air craft and detect overheated bearing on railroad vehicles as they move at high speed.

Military applications of radiometer are found in heat-sinking missiles, aircraft and missile trackers, aiming devices for locating vehicles and people in the dark and for gun fire control.

Automatically radiometers track the position of the sun, moon and stars. Meteorologists use satellite images taken in infrared light to determine the heat of areas of the atmosphere. The data is translated into a visible image, which is often enhanced, or coloured with shades representing temperatures. Long range wheather forecasting depends on infrared radiometer surveillance of the earth's cloud covering from satellites. Radiometers called "HORIZON SENSOR" detect the thermal discontinuity between the earth and space; and are used to establish a stable vertical reference for altitude control of a missile.

2.3.5 COMMUNICATIONS

Modulated sources of infrared energy provide highly directional infrared beams that can be detected only by the reciever at which they are aimed, thus providing a high degree of privacy[6,7,8].

CHAPTER THREE

DESIGN AND CONSTRUCTION

The design of infrared security alert system consist of two parts; a transmitter and a reciever,as shown below.

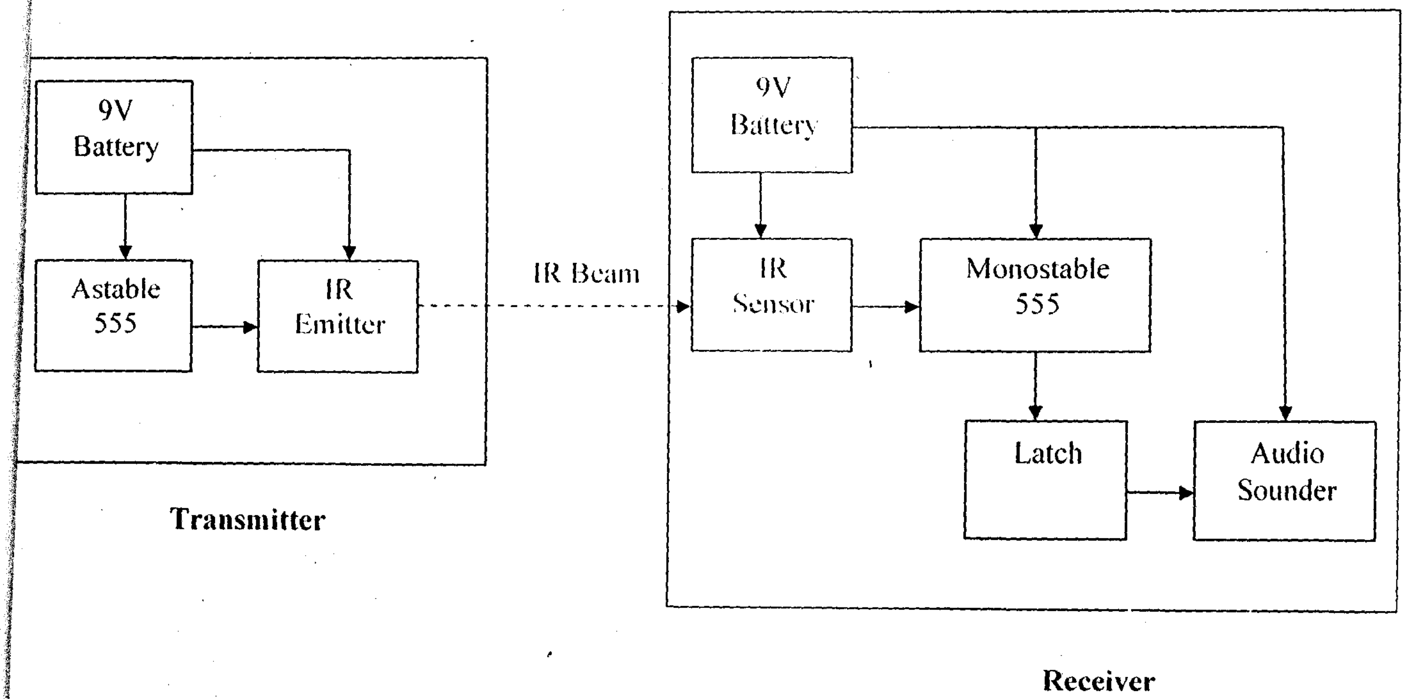

Fig. 3.1 Block diagram

The above is a block diagram of the project consisting of the transmitter and the receiver, the transmitter transmitting the IR beam to the receiver. The construction of each unit is as follows:-

3.1 THE TRANSMITTER

The transmitter is a 40kHz astable oscillator buit around a 555 timer IC, an infrared emitter, a C9014 high-freguency transistor and powered by a 9V d.c battery. The astable oscillator generates an unmodulated 40kHz high frequency square wave that drives the C9014 transistor ON and OFF with the wave form. The alternate ON-OFF state of the transistor caused the infrared emitting diode to correspondingly emit the 40kHz frequency accurately. This high frequency infrared signal is beamed across the space to be projected directly align with the sensor on the reciever. The operating frequency F was fixed at 40kHz, this being the frequency at which the commercial IR sensor used manifest greatest sensitivity.[9]

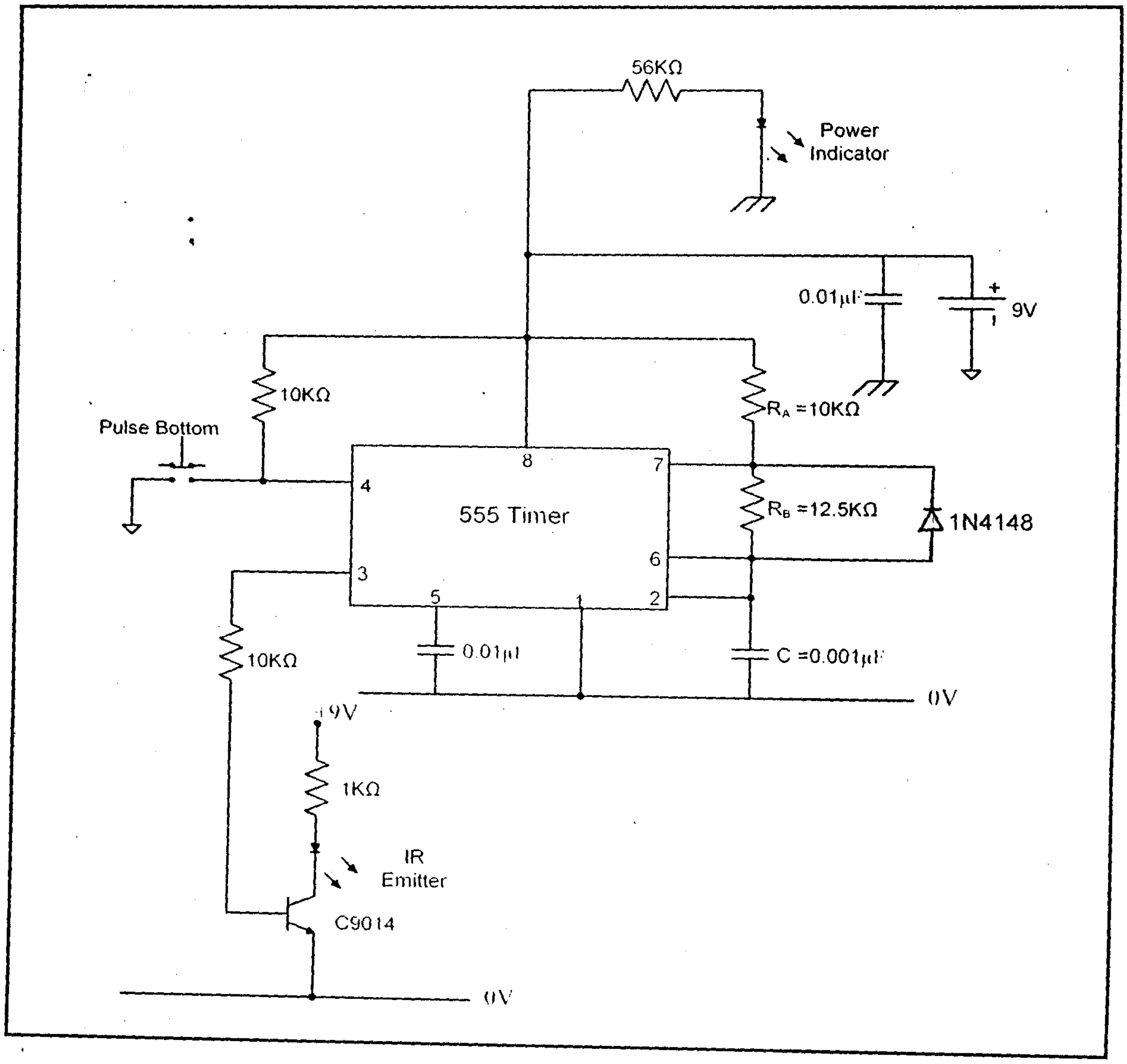

Fig. 3.2 Transmitter circuit

3.1.1 PULSE GENERATED BY THE TRASNMITTER

A PULSE button is provided on the subsystem. this pulse is to facilitate alignment of the trasnmitter and reciever . When this button is pressed, the IR generator is deactivated briefly, as depicted below.

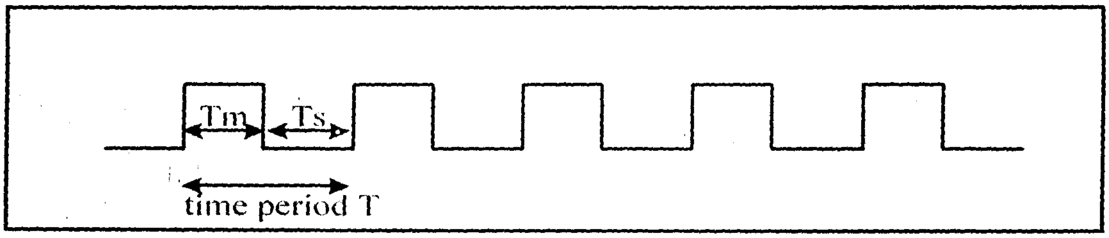

Fig. 3.3 555 astable output, a square wave
(Tm and Ts may be different)

An astable circuit produces a 'square wave' as shown above, this is a digital waveform with sharp transitions between low (0V) and high (9V). Note that the duration of the low and high states may be different. The circuit is called an astable because it is not stable in any state; the output is continually changing between 'low' and 'high'.

The time period (T) of the square wave is the time for one complete cycle, but it is the time for one complete cycle, but it is usually better to consider frequency (f) which is the number of cycles per second.

$T = 0.7 \times (R_A + 2R_B) \times C$ and

$$f = \frac{1.4}{(R_A + 2R_B) \times C}$$

where, T = time period in seconds (s)

f = frequency in hertz (Hz)

R_A = resistance in ohms (Ω)

R_B = resistance in ohms (Ω)

C = capacitance in farads (F)

The time period can be split into two parts: T = Tm + Ts

Mark time (output high): $Tm = 0.7 \times (R_A + R_B) \times C$

Space time (output low): $Ts = 0.7 \times R_B \times C$

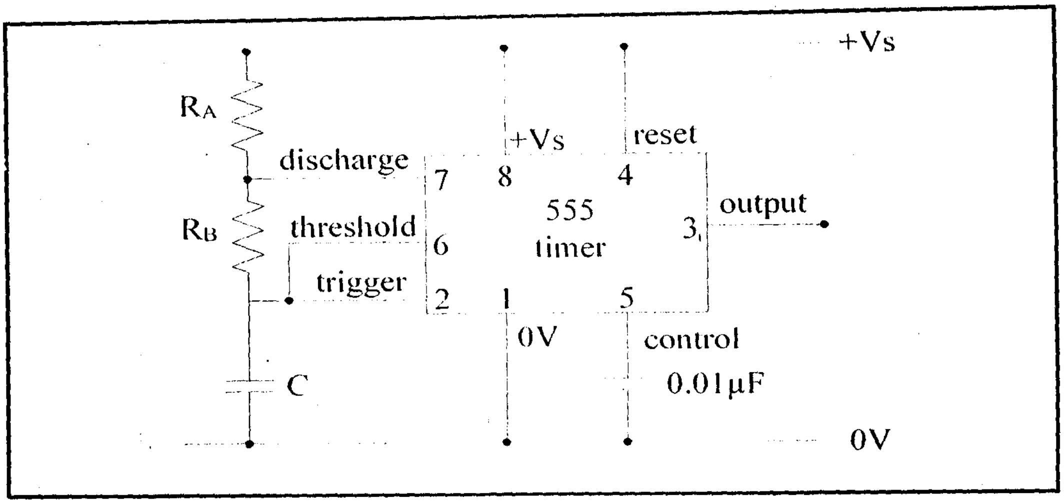

Fig. 3.4 555 astable circuit

3.1.2 ASTABLE OPERATION

With the output high (9V) the capacitor C is charged by current flowing through R_A and R_B. The threshold and trigger inputs monitor the capacitor voltage and when it reaches 2/3 Vs (threshold voltage) the output becomes low and the discharge pin is connected to 0V.

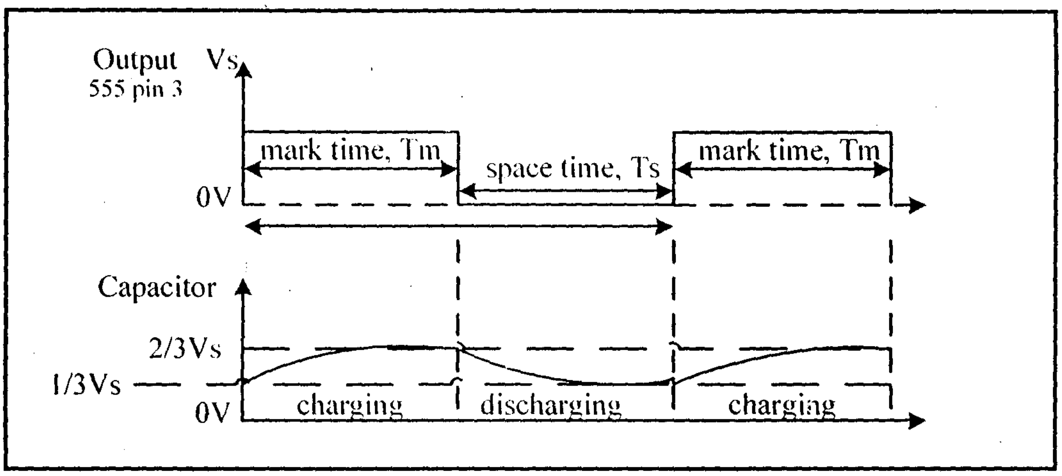

Fig. 3.5 Output wave form of astable 555 timer

The capacitor now discharges with current flowing through R_B into the discharge pin. When the voltage falls to 1/3Vs (trigger Voltage) the output becomes high again and the discharge pin is disconnected, allowing the capacitor to start charging again. This cycle repeats continously unles the reset input in connected to 0V which forces the output low while reset is 0V.

3.1.3 DUTY CYCLE

The duty cycle of an astable circuit is the proportion of the complete cycle for which the ouput is high (the mark time). It is usually given as a percentage.

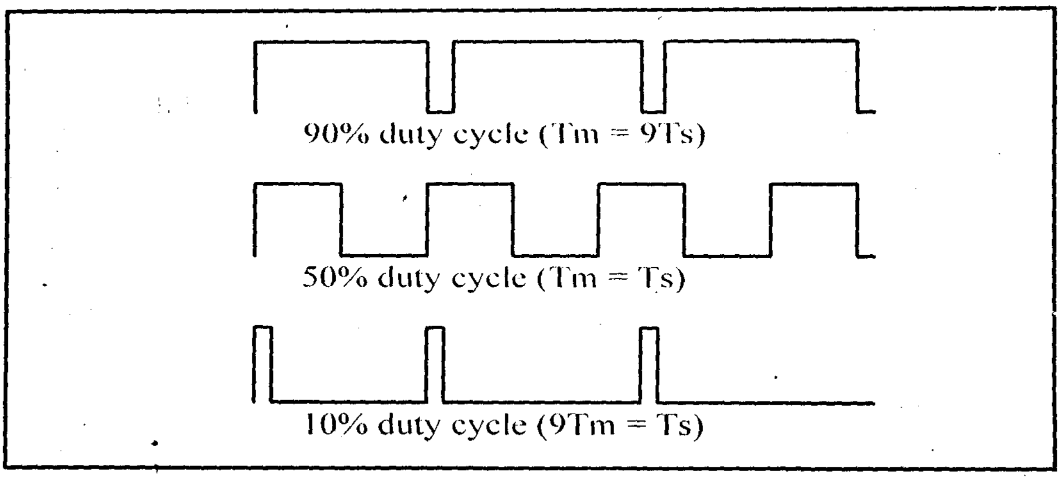

Fig. 3.6 Duty cycle output wave form

For a standard 555 astable circuit the mark time (Tm) must be greater than the space time (Ts), so the duty cycle must be at least 50%.

$$\text{Duty cycle} = \frac{Tm}{Tm + Ts} = \frac{R_A + R_B}{R_A + R_B}$$

To achieve a duty circle of less than 50% a diode (1N4148) can be added in parallel with R_B. This bypasses R_B during the charging (mark) part of the cycle so that Tm depends on R_A and C. [9, 10, 12]

3.2 THE RECIEVER

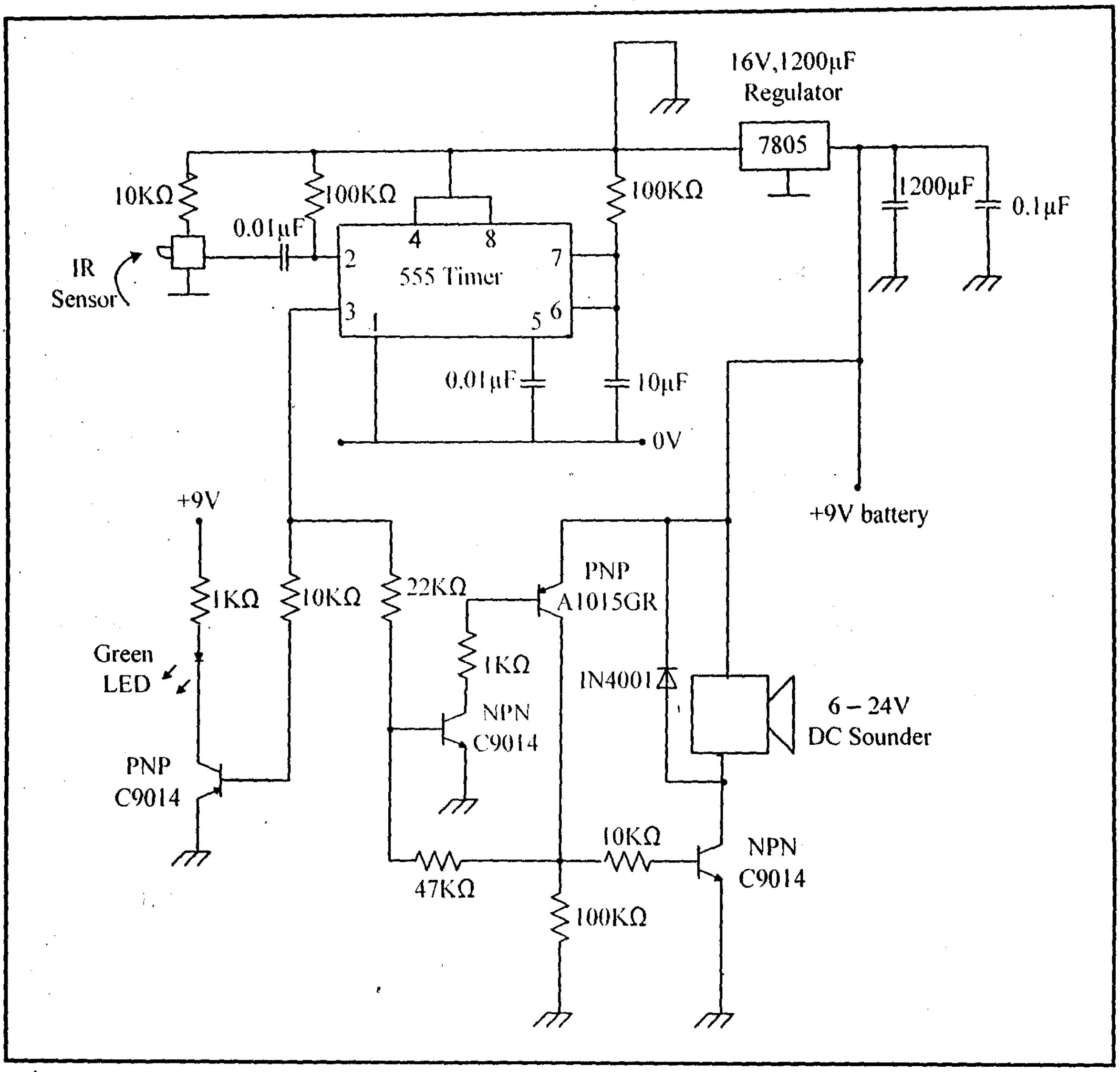

FIG. 3.7 The Receiver circuit

The reciever circuit is designed around :-

1. An infrared reciever module
2. A 555 monostable
3. A latching circuit
4. An audio sounder
5. Switches for setting up an alignment.

3.2.1 OPERATION

When the infrared sensor is fed by a continous infrared input, its output goes low only once before retiring high. The signal source has to be removed before the sensor can make another high again. The high-to-low transition of the IR sensor triggers a 1-second monostable designed from a 555 oscillator chip.

The monostable output is empolyed in:-

1. Pulsing the aligned LED ON briefly to aid alignment.
2. Setting the latch designed around Q_1 and Q_2 .

Since the monostable output is active only for a predetermined time frame before becoming inactive, a means of storing the momentary output is needed to capture the transient state lasting for only a second. Two transistors, an NPN (Q_1) and a PNP (Q_2) achieves this purpose.[9]

3.2.2 IR SENSOR

The IR sensor is a ISOP1738 designed to work for commercial remote control units with peak sensitivity at 38KHz. It is a high-sentivity 3-pin infrared diode-cum-integrated amplifier.

3.2.3 THE LATCHING CIRCUIT

The term "latch" is usually reserved for a special kind of register; one in which the outputs follow the inputs when enable, and hold the last value when disabled. The latch is connected as shown below:-

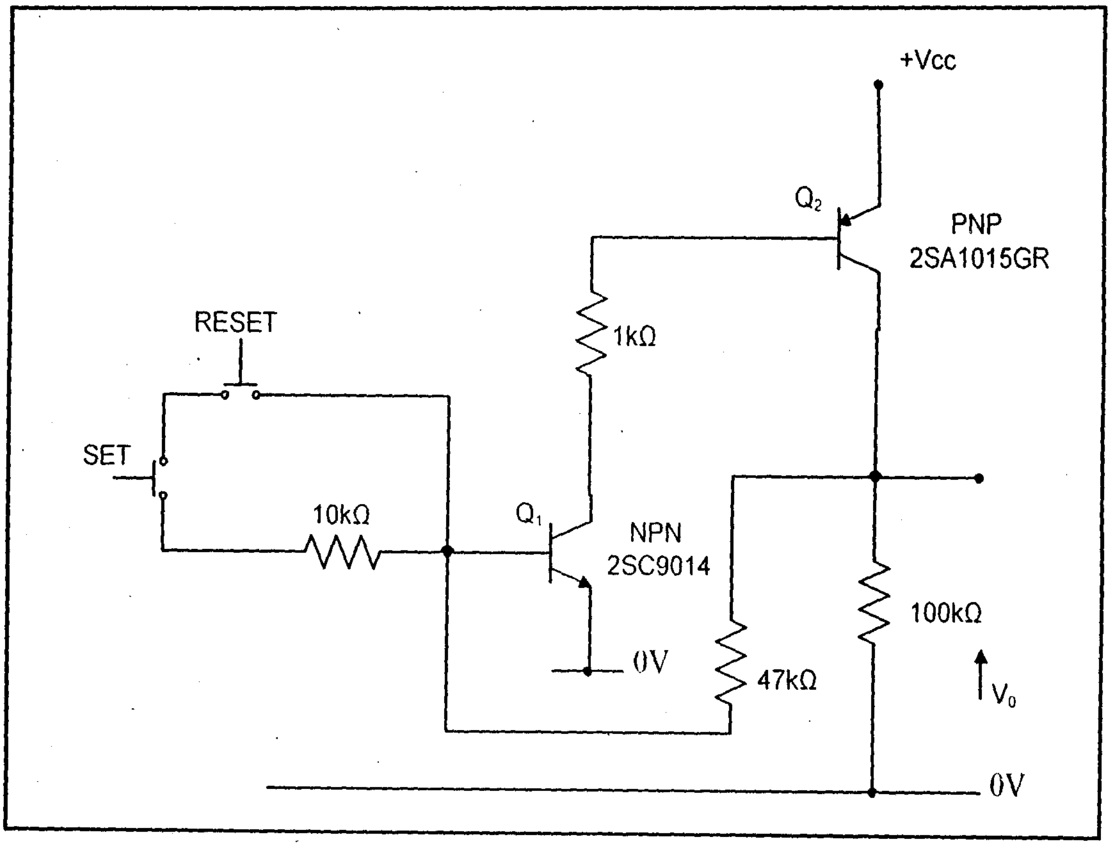

Fig. 3.8 The Latch

Assuming the SET input is at 0V, the RESET is connected to 0V, Q_1 an NPN transistor, is switched OFF corresponding to the PNP transistor whose $V_B<V_E$ to conduct has its $V_B=V_E$, this forced it OFF. Consider a $+V_{cc}$ applied to the SET input and RESET open i.e. not connected, Q1 switches ON since its $V_B>V_E$ by V_{BE}. Its collector goes low i.e.V_{CE} =0V. This pulls the base of Q_2 low to 0V through a 1kΩ resistance, forward biasing the base-emitter junction i.e $V_B<V_E$ by at least one V_{BE}. Consecutively, the PNP transistor switches ON, and a potential approximately appears at its collector developed across the 100kΩ resistor. Note that in this case, the PNP transistor is uesd as a saturated switch and not in the linear mode of an amplifier. The potential at the emitter of Q_2 is fed back through the 47kΩ resistance at the base of Q_1. This fed back "Locks" Q_1 ON and Q_2 ON by reason of connection. Hence, the potential at the collector of Q_2 remains at Vcc, until RESET is taken to 0V, i.e the latch is reset. The output at Q_2's collector drives an NPN transistor with a d.c Sounder as its collector load. this potential drives the trransistor ON, and in effect the sounder generates a continous high-pitched audible sound.

For easy alignment, an ALIGN/OPERATION switch is provided. To align the reciever with the transmitter, the switch is pressed 'ON': in this state, the latch and sounder circuits are disabled and they do not sound. Rather, the align LED on the reciever is the only output circuit.

To align the two units, the 'Pulse' switch on the transmitter is pressed and depressed. When the two units are aligned, the align LED on the reciever goes ON briefly for a second and OFF. Pressing the PULSE button repeatedly pulse the GREEN align LED on. Next, the ALIGN/OPERATE switch is depressed, i.e pushed on. The two units are now aligned, and beam continuity is achieved. Walking through the distance between the transmitter and the reciever set the alarm on the reciever ON.

Testing can be achievied by placing a papper between the transmitter and the reciever, in which the system is triggered into action.

3.2.4 555 MONOSTABLE

A monostable circuit produces a single output pulse when triggered. It is called a monostable because it is stable in just one state: 'output low'. The 'output high' state is temporary.

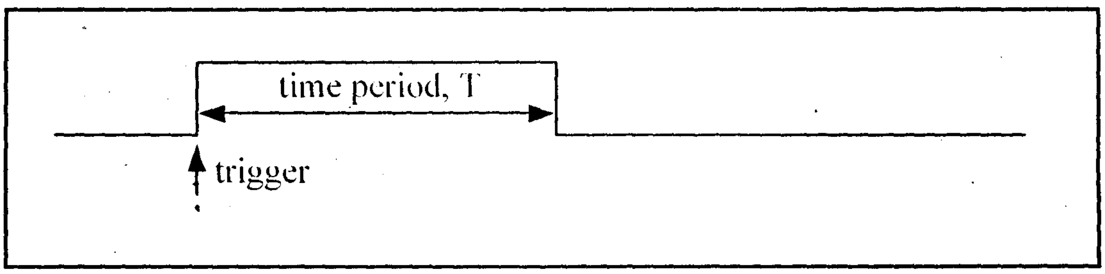

Fig. 3.9 555 monostale output, a single pulse

The duration of the pulse is called the time period (T) and this is determined by resistor R1 and Capacitor C1:

time period, $T = 1.1 \times R1 \times C1$

Where,

T = time period in seconds (s)

$R1$ = resistance in ohms (Ω)

$C1$ = capacitance in farads (F)

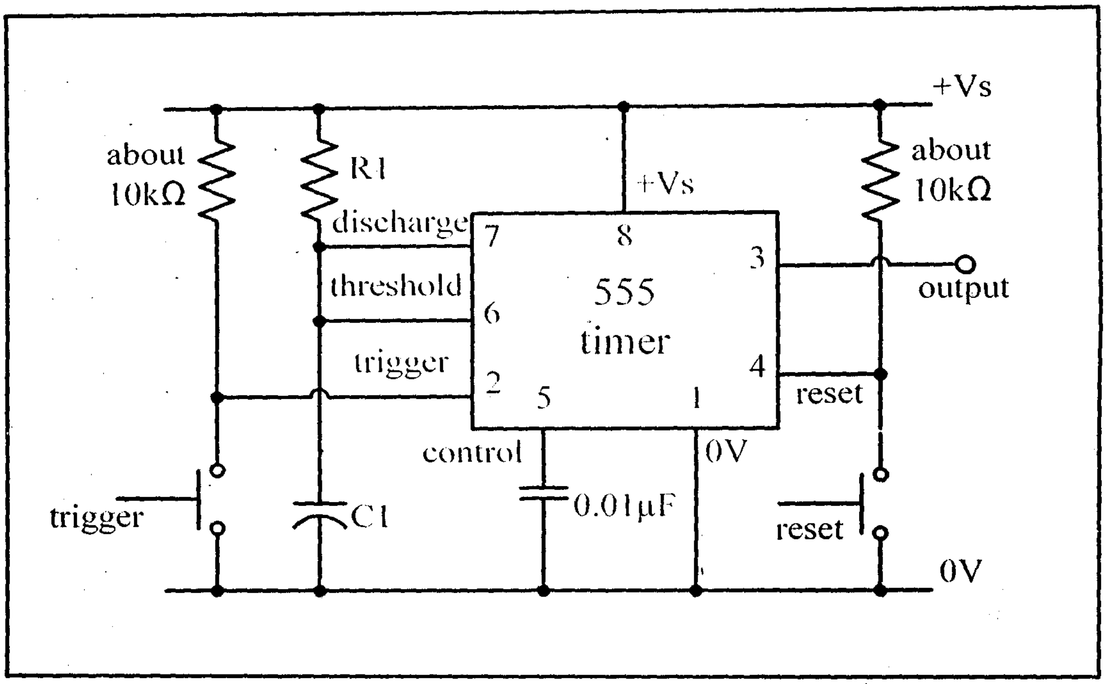

Fig. 3.10 555 monostable circuit with manual trigger

Monostable Operation

The timing period is **triggered** (started) when the trigger input (555 pin 2) is less than 1/3 Vs, this makes the **output** high (+Vs) and the capacitor C1 starts to charge through resistor R1. Once the time period has started further trigger pulses are ignored.

The **threshold** input (555 pin 6) monitors the voltage across C1 and when this reaches 2/3 Vs the time period is over and the **output** becomes low. At the same time **discharge** (555 pin 7) is to 0V, discharging the capacitor ready for the next trigger.

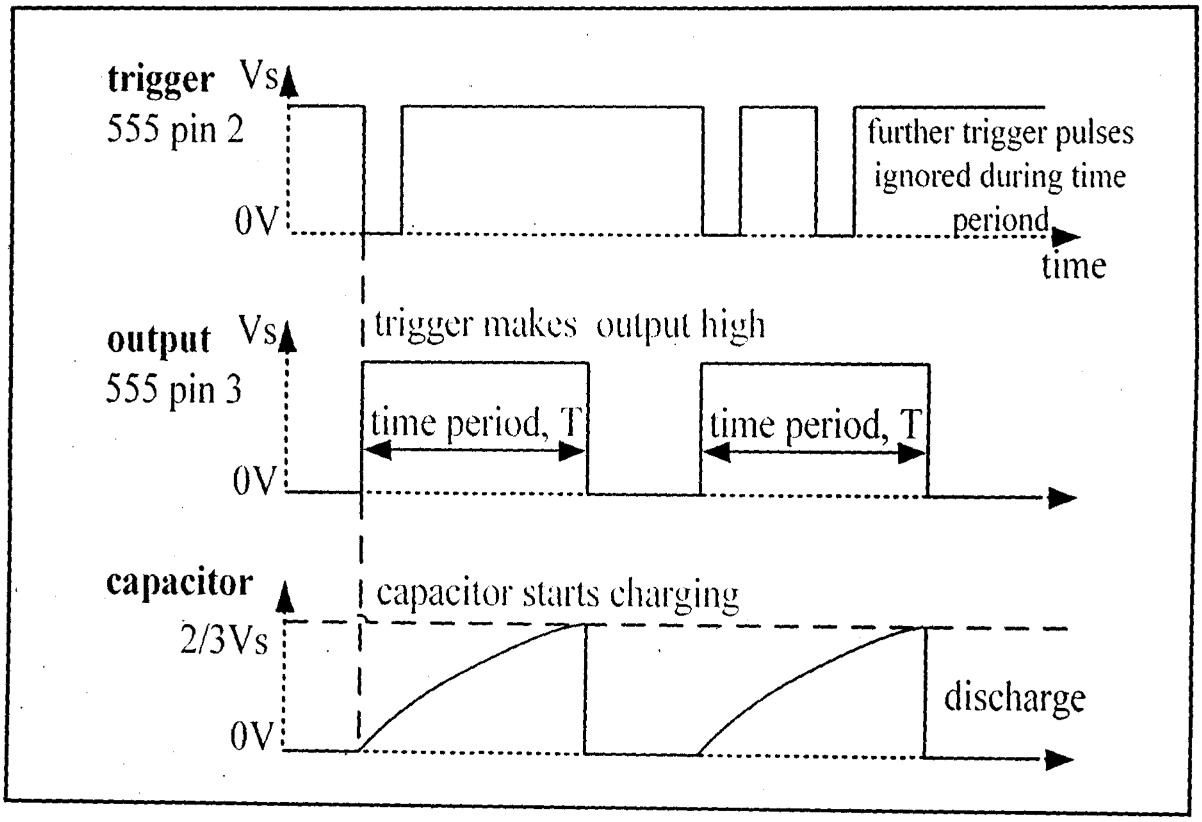

Fig. 3.11 Output wave form of the monostable 555 timer

The **reset** input (555 pin 4) overrides all other inputs and the timing may be cancelled at any time by connecting reset to 0V. this instantly makes the ouput low and discharges the capacitor. If the function is not required the reset pin should be connected to +Vs.

Power-on reset or tigger

It may be useful to ensure that a monostable circuit is reset or triggered authomatically when the power supply is connected or switch on. This is achieved by using a capacitor instead of (or in addition to) a push switch. The capacitor takes a short time to charge, breifly holding the input close to 0V when the circuit is switch on. A switch may be connected in parallel with the capacitor if manual operation is also required. [9, 10, 11, 12]

3.2.5 THE AUDIO SOUNDER

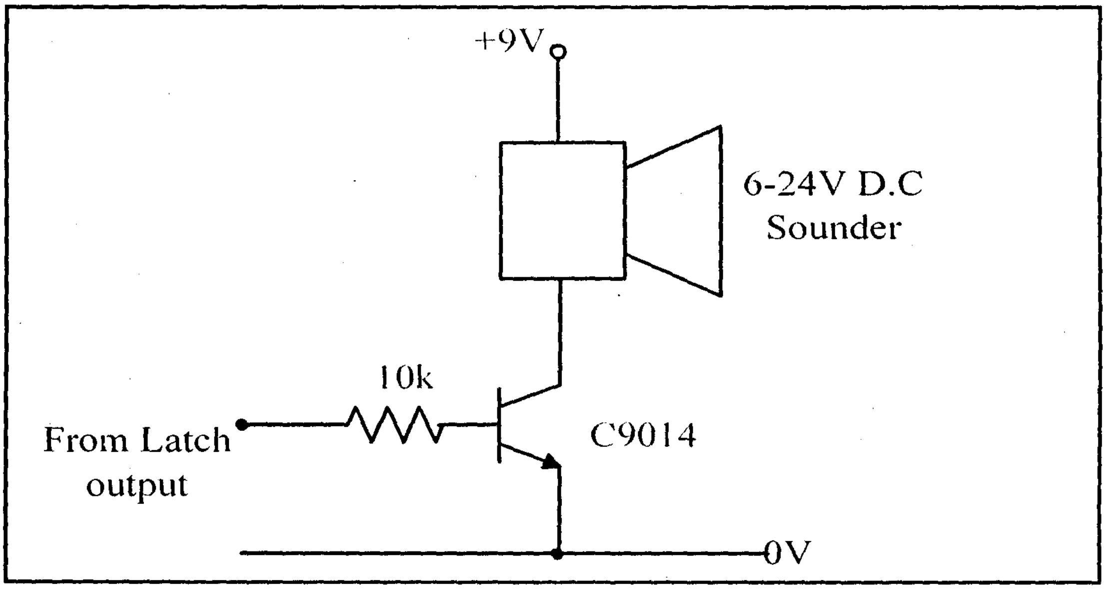

Fig. 3.12 Audio Sounder

The 6-24 d.c sounder is powered by a 9V battery which is fed by a signal from the output of a latching circuit though an NPN transistor (C9014) as shown above. [9]

3.3 THE 555 TIMER CIRCUIT

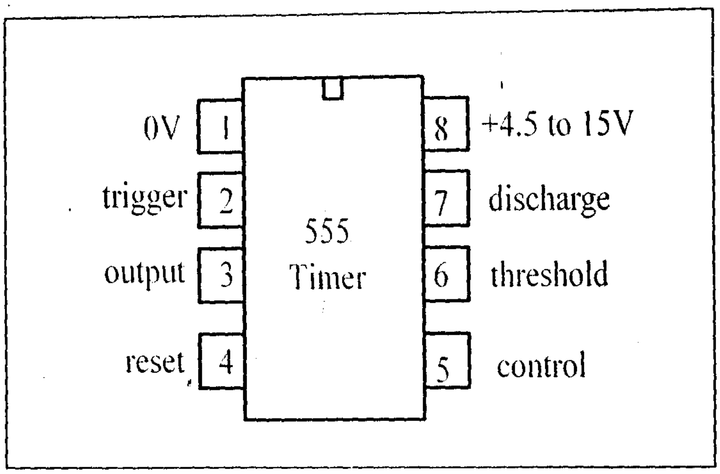

Fig. 3.13 Actual pin arrangement

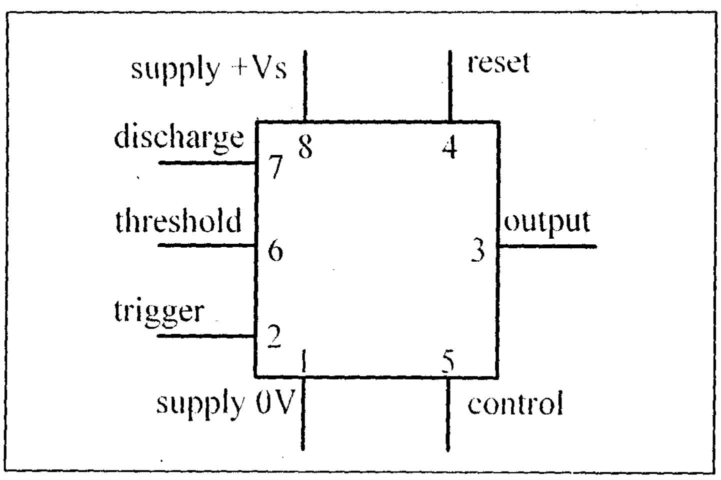

Fig 3.14 Circuit symbol

3.3.1 INPUTS OF 555 TIMER

Trigger input: when < 1/3 Vs ('active low') this makes the output high (+Vs). It monitors the discharging of the timing capacitor in an astable circuit. It has a high input impedance > 2MΩ.

Threshold input: when > 2/3 Vs ('active high') this makes the output low (0V). It monitors the charging of the timing capacitor in astable and monostable circuits. It has a high input impedance < 10MΩ.

Reset input: when less than about 0.7V ('active low') this makes the output low (0V), overriding other inputs. When not required it should be connected to +Vs. It has an input impedance of about 10kΩ.

Control input: this can be used to adjust the threshold voltage which is set internally to be 2/3 Vs. Usually this function is not required and the control input is connected to 0V with a 0.01µF capacitor to eliminate electrical noise. It can be left unconnected if noise is not a problem.

The **discharge pin** is not an input, but it is listed here for convenience. It is connected to 0V when the timer output is low and is used to discharge the timing capacitor in astable and monostable circuits.

3.3.2 OUTPUT OF 555 TIMER

The output of a standard 555 can sink and source up to 200mA. This is more than most chips and it is sufficient to supply many output transducers directly, including LEDs (with a supply resistor in series), low current laps, piezo transducers, loudspeakers (with a capacitor in series), relay coils (with diode protection) and some motors (with diode protection). The output voltage does not quite reach 0V and +Vs, especially if a large current is flowing. "The ability of both sink and source means that two devices can be connected to the output so that one is on when the output is low and the other is on when the output is high."[12]

CHAPTER FOUR

TEST, RESULTS AND DISCUSSION

This project is in two parts, the infrared transmitter unit and the infrared receiver unit. Besides the constraint placed as a result of the difference in the design of the units, the constrution and testing of both units was carried out following the same general or broad principles as outline below.

4.1 CONSTRUCTION OF THE CIRCUITS

At the end of the design stage, a prototype of the two units was constructed on a bread board. This was done to ensure that the designed circuit worked according to the design specification before final construction of the circuit. This option was chosen and used because it would be easier to make modifications and adjustments to the design where necessary on the bread board than it would be on the vero board.

Before transfering the designed circuit to the vero board that is before making the final construction the circuit diagram was drafted on vero board layout. This was done to ensure that while constructing, misttakes would not be made regarding the placement of the circuit components. a drafted circuit is usually much easier to transfer. In transfering the circuit to the vero board, a unit by unit construction method was used.

The vero board is electrically continous horizontally but certain connections were required to be made vertically. This made it necessary to use connecting wires and where they were used, it was ensured that they were neatly placed. ICs are heat sensitive devices as such IC sockets were first soldered onto the board and the ICs plugged into the sockets This was done to prevent damage to the ICs that might result as a result of heat if they were directly soldered.

While the circuit was being soldered, care was taken to aviod bridging of the conducting lines. The components were mounted such that they were a few millimeters above the board especially the lowest height components with polarity such as capacitor and diodes.

4.2 TESTING OF THE CONSTRUCTED CIRCUITS

Since a unit by unit construction method was used while constructing each of the functional units was tested after construction to ensure that it operated correctedly before the succeeding units were constructed and tested.

Furthermore, all resisitors, capacitors, LEDs used were tested using the multimeter to ensure that they were in good/perfect working condition. This makes troubleshooting easier while constructing.

Upon completion of construction, the receiver and the transmitter units were placed apart and powered. they were then aligned by moving the receiver board around until the green LED on the receiver lits showing that the beam from the transmitter unit was being sensed or detected.

The infrared beam was then broken by placing an object between the receiver and transmitter boards. When this was done, the alarm was trigerred ON showing that the circuit operates as per design specifications. To test the speed of operation, the beam was blocked momentarily. The same effect as in above was observed.

4.3 RESULTS

When the transmitter and receiver units are aligned, an indicator LED (Green) on the reveiver board lights up showing that the transmitted IR beam is being detected. When the beam is obstructed, the alarm circuit is triggered indicating that the beam is no longer being sensed.

The reciever module will only detect pulsed signal at 40kHz not a continous signal of 40kHz. The transmitted IR beam covers a distance 5.1meters from the transmitter to receiver.

4.4 INSTALLATION

The receiver unit should be aligned with the transmitter unit. This is achieved by moving the transmitter unit around and pressing the aligned button, until the green LED on the reveiver flash ON and OFF indicating the reception of the transmiitted beam.

CHAPTER FIVE

CONSTRAINTS, RECOMMENDATION AND COCLUSION

5.1 CONSTRAINTS

While carrying out this project work, several constraints where encountered. Amongst these constraints is the difficulty encountered sourcing for components as well as the fact that most components were used leading to wastage of resources as well as time and energy.

5.2 RECOMMENDATION

A lot of thought and reasoning has been masterly put to realize this prototype project. I recommend that there should be a stronger link between the theories taught and practical carried out in the department. This is because from my personal experience while caryng out this project work, the practical implementation of a circuit design is a coplex undertaking that requires some tact and in-dept understanding of the practical characteristics of circuit components.

There is yet a large room for improvement in the distance to be covered and this can be achieved by the use of mirrors to reflect the beams.

Also with an operational amplifier adopted for very high frequency-hundreds of kilohartz, a carrier frequency much higher than 40kHz can be used and a wider distance can then be covered.

And also, the audio output signal can be modernize in such a way that instead of a pitch sound, a melody or music can be incorporated to be the output sound; so that it does not scare the intruder away.

5.3 CONCLUSION

Hitting one's target can be gratifying and meeting ones aim; and objective can be fulfilling. With this design, any given area of a few meters can be secured from buglars and unwanted intruders. The use of siren, horn or buzzer can be used to deter them instantly or signal message can be used to send to the security post or police stationclose by, to apprehend them or get an ellectrically operated gate/door close-up at a prearranged time.

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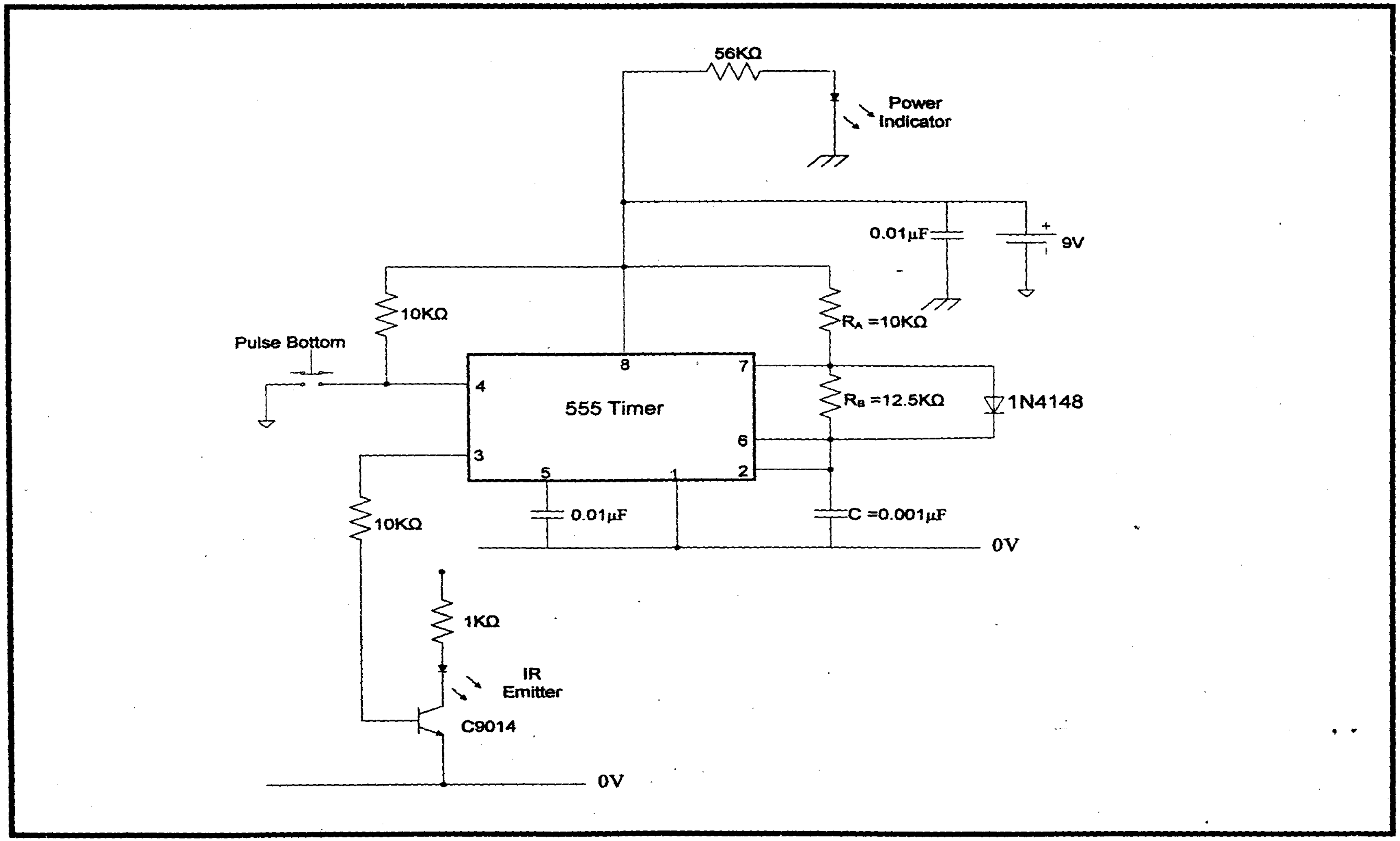
APPENDIX I

THE TRANSMITTER CIRCUIT



APPENDIX II

THE RECEIVER CIRCUIT