DESIGN AND CONSTRUCTION OF A MOTION DETECTOR MAKING USE OF INFRA-RED AS A SECURITY SYSTEM.

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AUGUST ,2003.

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA
ELECTRICAL AND ELECTRONICS ENGINEERING

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A PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE
EQUIREMENT FOR THE DEGREE OF BACHELOROF ENGINEERING[B.ENG.]

AT

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA
AUGUST, 2003

CERTIFICATION

This is to certify that this project was carried out by **OKOYE BRIA OBY** of the Department of Electrical & Computer Engineering of the Federal University of Technology Minna under the supervision of Engr. Kolo, for the award of Bachelor of engineering

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ENGR. KOLO
Project Supervisor

DATE

_______________________________ 6/4/84

ENGR. NWOHU
Head of Department

DATE

_______________________________ _______________________

External Examiner

DATE

DEDICATION

This project is dedicated to my beloved family
Engr.[sir] and lady w.c okoye ,billiet, billyandre,
Bella, jasiel,Brenda and the chukkas

ACKNOWLEDGEMENT:

ly first and sincere gratitude goes to God Almighty without whose love, guidance and protection this work vould have not been accomplished.

am also greatly indebted to my project supervisor Engr.Kolo whose care for his students has left a strong npression in my life.

My special thanks also goes to the head of department Dr. Adediran for providing a conducive atmosphere n the department of electronic Engineering and being a father and a very good one at that.

My sincere gratitude goes to Mr. kolo in physics department for his guidance and protection.To some vonderful students who were always ready to give a helping hand, Chantal Chukkas,My dearest Chimere huta,Bashir Saleh ,Emeka Umeh, Jummai,Noho, Mustapha Umar,Yakubu Mohammed , Onize awodu,Chi Enya, Sophie,Enata and a whole lot.

To my friends Nene Ajiduku,Temi Engr. Ifeanyi Akosionu,Funmi,Kingson Momah,Alvin Unuane, Tonye raham Douglas,Dr.Ibrahim kuta,Mr Bala Bonnet,Mr.Obi Okpe,Chris,Segun Olorunfemi,Mebaka,Zainab lohammed,Jemila Mohammed and a whole lot I cant remember.To the staff of INTELS OIL SERVICES a ig thank you.

Finally I would like to thank my best friend Chantal Chukkas once again for being there all through my truggles in this school that I shall be forever grateful.

ABSTRACT

This thesis covers the design and construction of a motion detector making use of an infrared beam, which helps in detecting an Intruder.

The detector is first powered using a 12volts dc supply, which is being filtered and is used to charge up the battery. The battery is a substitute incase of power supply failure. The timing unit is the next stage, which creates a time delay. Then comes the alarm unit, which alerts on detection of an intruder.

The infrared unit detects the motion and the transmitter is triggered which reflects on the receiver unit.

A maximum output voltage of about 11 volts is ensured this is because of the operational amplifiers, which are active devices of the infrared receiver unit. This test was carried out and the result was close for practical application.

CHAPTER ONE

) INTRODUCTION:

Our contributions to the society are most times fueled by personal experiences complemented by the owledge of a particular field of study. Though I personally have not come in contact with armed obbers or burglars, but I must say that stories told on the loss of properties and life is enough to gear e towards formulating a means of improving our security system.

Today, as was in the past, the means derived in order to bring nefarious activities of burglars to the arest minimum, borders on the resources and managerial know-how available to us. In the past, nches were dug around storage houses for unsuspecting intruders to fall into. With time these odlums though I wouldn't want to credit them with so much intelligence derived better ways of going out their business. It is also true that the only tool available to these spineless fellows is the element r surprise (for instance entering when the inhabitants of the premises are least expecting it).

This work becomes important in this regard as it serves as an alerting system thereby taking away the rprise element and making the intruders psychologically handicapped who normally would run away r fear of being caught on detection.

The major or functions of the motion detector which are to detect and alert could therefore not be ver emphasized.

.1 LITERATURE REVIEW

rom research and sampled opinion it could be regarded as statement of fact to say that on quite a umber of occasions the loss of life and property could be avoided if the presence of burglars or armed obbers could be ascertained at the breaking in stage. To this, the development in the field of electronics t has contributed one of the greatest success stories of this century has the no-sentiments-attached tion detector as a contribution to make to the society. As an introductory time it should not escape us at alarm systems are either open loop or closed loop [feedback]. Systems. A typical example of an rm system which implement s the requirements of an open loop system is the bell system used in the st where the disturbance of the rope tied to a bell by an intruder for instance causes the bell to ring. A sed loop system [alarm] which by the way is the subject of this write up engages the operation of ctronic equipment like comparators [a typical closed loop tool] .To compare the intensity of the rared beam [for this particular design] the output or after a disturbance and the specified intensity. e infrared is the basic feature of this design and so are the sensors which senses the infra red intensity d also the actuator which is based on the result from the sensor gives an output. The infra red was first scovered by w.Herschel. At this stage it seems obvious that this work is basically based on the operties of the infrared, which includes the following.

Infrared is a wave and thus follows the properties like refraction, reflection, diffraction interference etc

Infrared is detected by its heating effect, which takes place when it is incident on a black body. [The eating effect of the sun is mainly due to infra red.]

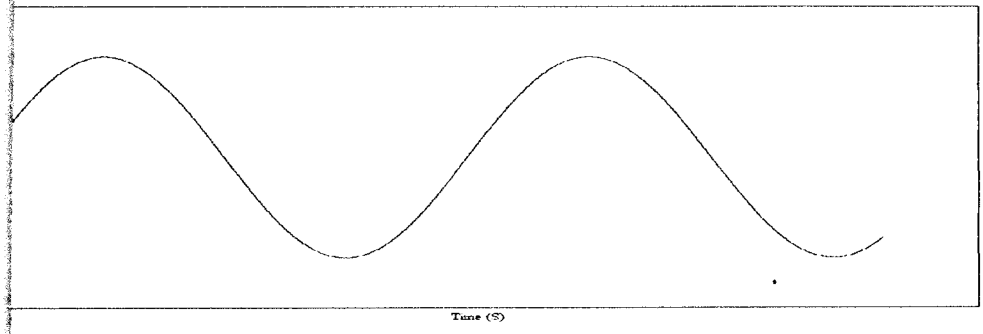
The long wavelength of the infrared makes it suitable for long range propagation than the visible light.

e encounter little problems due to some factors

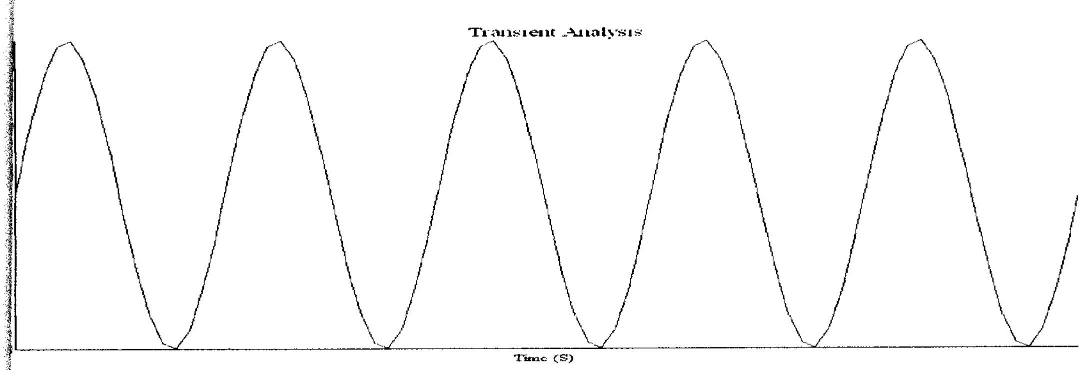
he first one is the effect of visible light on infrared due to the fact that they are not of the same avelength and so there is an interference which is destructive from a little knowledge of physics. We

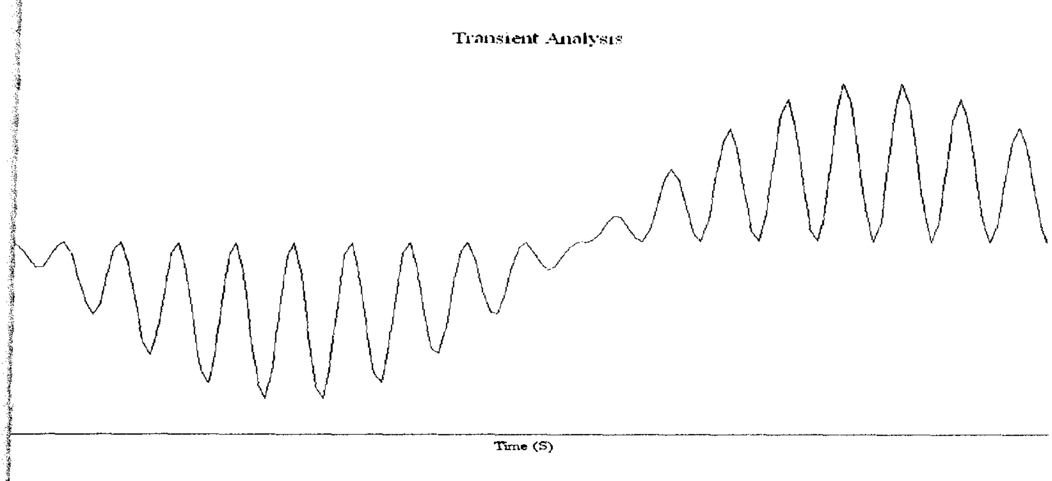
an recall that destructive interference reduces the amplitude, which in this design is related to the sitivity of the beam and thus the effect of the parent wave. From the figure below, one can notice that interference at the output is destructive because of the difference in the amplitude of the parent and ble wave.

RENT WAVE[INFRA-RED]



ISIBLE LIGHT





UTPUT WAVE FORM

he use of filters to keep out waves of wavelength different from that of the infra-red is one solution to kling this problem.

The second problem is the issue of external disturbances, which might not necessarily be from truders. Since the sensor is making use of a differential amplifier, anything that causes a disturbance of e infrared thereby generating a differential voltage, for instance the movement of the curtains as a sult of wind will activate the alarm. As a result of this sometimes-false calls are made. One of the medies is to keep this unit in an environment that can be kept as still as possible. Another solution could e attributed to the sensor used in this project where the sensitivity of this project is adjustable. For this oject we decided to construct an infrared motion detector. Originally we wanted to build an ultrasonic tector but that would require much time. When positioned in the entrance of a protected area, a person tering the area will interrupt the beam causing an alarm to be triggered. This therefore requires careful igning when being installed.

The choice of this project "MOTION DETECTOR USING INFRA-RED" is born out of the realization at with the use of resources and technological know-how humans should be able to play a role in eciding how and to whom his property is lost.

2 APPLICATIONS OF THE MOTION DETECTOR

here is hardly a limit to the usage of this work in terms of location once the layout of a room, house, lding, office etc. necessitates that within a particular time interval entrance is prohibited then a tion detector is the unparalleled choice.

ome areas of application with little or no modification include:

homes:

It is a well-known fact that even the highest fences and the most efficient security guards and dogs nnot make a home impenetrable. Record shows that on quite a number of occasions have our priced ssessions be given away to urchins for financial benefits or even bones for the dogs as the case may . The use of motion detector whose principle of operation is not based on sentiments is our only hope.

offices:

Our private sections of the office are kept private by the use of tamper proof motion detector.

banks:

The use of manpower for security though efficient is still not enough based on sentimental basis as entioned before. The motion detector compliments the sincere efforts of the security personnel in order keep unauthorized personnel out of places like the vault.

•

CHAPTER TWO

0 BLOCK DIAGRAM OF THE SYSTEM

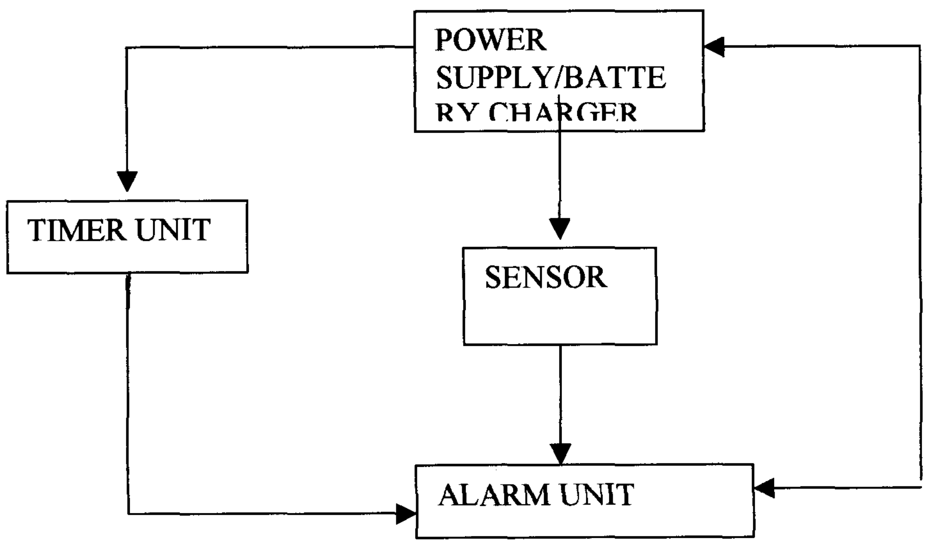
he project used of infra-red in motion detection for houses, offices, etc. is implemented on a circuit ard in three main modules which includes

Power supply unit

Timing unit

Alarm unit

The block diagram however incorporates a fourth unit, which is the circuit design.



he sensor incorporates the infra-red transmitter and receiver and in this design, the sensitivity if the am making use of a differential amplifier is adjustable.

he power supply/battery charger unit: from the block diagram, it can be seen that all the other blocks being powered by this unit.

The timer unit: provides a time delay making use of resistance and capacitors given a time constant hich keeps the alarm system inactive when the whole unit is in the READY mode.

The Alarm unit: here the given is put on when the switches are caused to open either by opening a or or cutting across the beam from the sensor.

1 CHOICE OF COMPONENTS

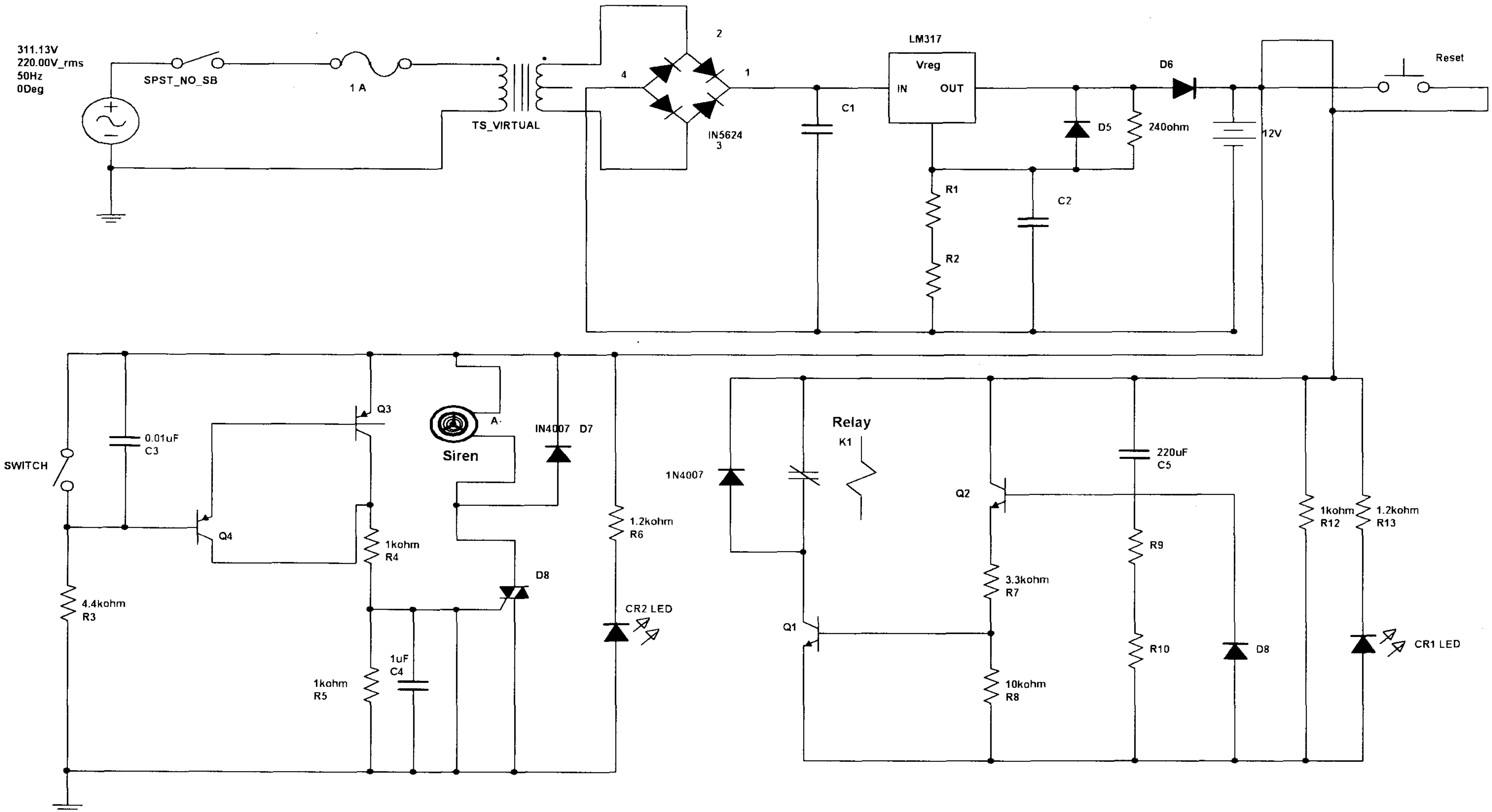
The choice of components as in many engineering designs is considered as one of the major factors in rrying out an engineering design. As a result of this, the choice of components for this project was fluenced by many factors, which include:

- Availability of components
- Types of component needed
- Cost of components
- Complexity of the system
- Maintainability of the system
- Reliability of the system
- Safety and security
- Cost effectiveness and marketability

Considering the whole factors mentioned above, this project is supposed to be a portable and ffordable one. The whole project is based on hard-wired logic due to the high cost of microprocessor ed designs or project.

All the integral circuits were mounted on integrated circuit sockets for easy replacement or intainability.

CIRCUIT DIAGRAM



HAPTER THREE

0 SYSTEM BOARD

e circuitry of this alarm project is soldered on a printed circuit board.The board was made by aring a blank copper clad and carefully drawing the connecting circuit with a marker pen The ink s allowed to dry before immersing in a ferric chloride solution for etching. After etching the rked areas were cleared off and holes drilled accordingly. After drilling the components were unted and soldered.

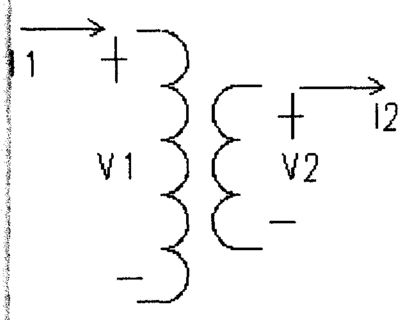
1 SYSTEM ANALYSIS

e circuit used in implementing the design of this project could be explained in the supply, timing and rm stages. With detailed explanation of each component.

1.1 THE POWER SUPPLY STAGE. *

HE TRANSFORMER

transformer is an electronic device which steps down or steps up an input primary voltage [v1] to a condary voltage [v2] . They are used in electrical equipment to convert the 240volts coming from the wall cket to lower and safer voltages for use in equipments. The schematic diagram and defining equation for a nsformers are shown below.



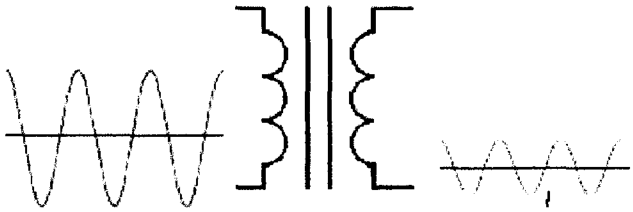
$$\frac{V_1}{V_2} = \frac{N_1}{N_2} = N$$

and

$$\frac{I_2}{I_1} = \frac{N_1}{N_2} = N$$

here N is the ratio of primary turns to the secondary turns. Where V1, V2, I1andI2 are defined as shown.

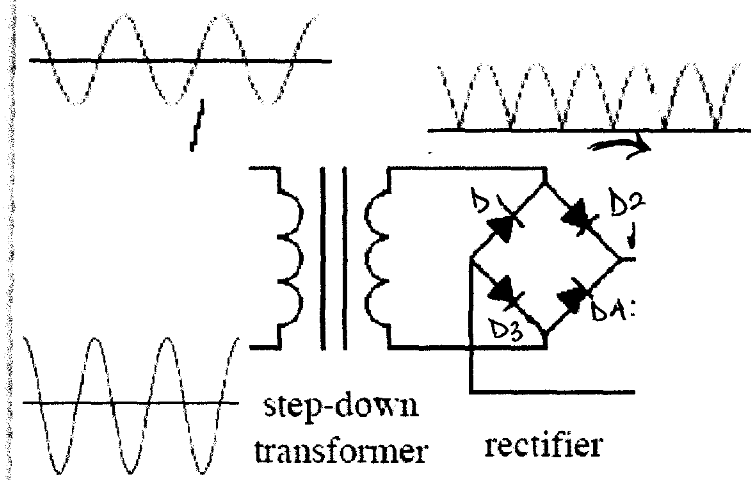
and N2 are the number of windings on the primary and secondary coils respectively. Power transformers usually not described in terms of N1 and N2 but instead are described in terms of the voltage output and ume a 220volts input. The transformer shown above is called a single tap transformer because there is ly one output. The ac input voltage from the mains is a step down in this case of study and is brought to a wer voltage usable for consumption. This is illustrated below:



rger transformers have better load regulation than smaller ones. The transformer transmits variations in e primary or line voltage directly to the secondary i.e. a 220v fluctuation +or-10%[198v to 242v] would use a 12v rated secondary to fluctuate + or-10%[10.8v to 13.2v]

ECTIFICATION

his is achieved by using a full wave rectifier. It uses four diodes to perform the rectification of an input ac ltage .Two diodes conduct during each half cycle, giving a full wave rectified output voltage. The top and ttom terminals can be used as the input terminals for the ac voltages, while the left and right terminals can used as the output dc terminals.

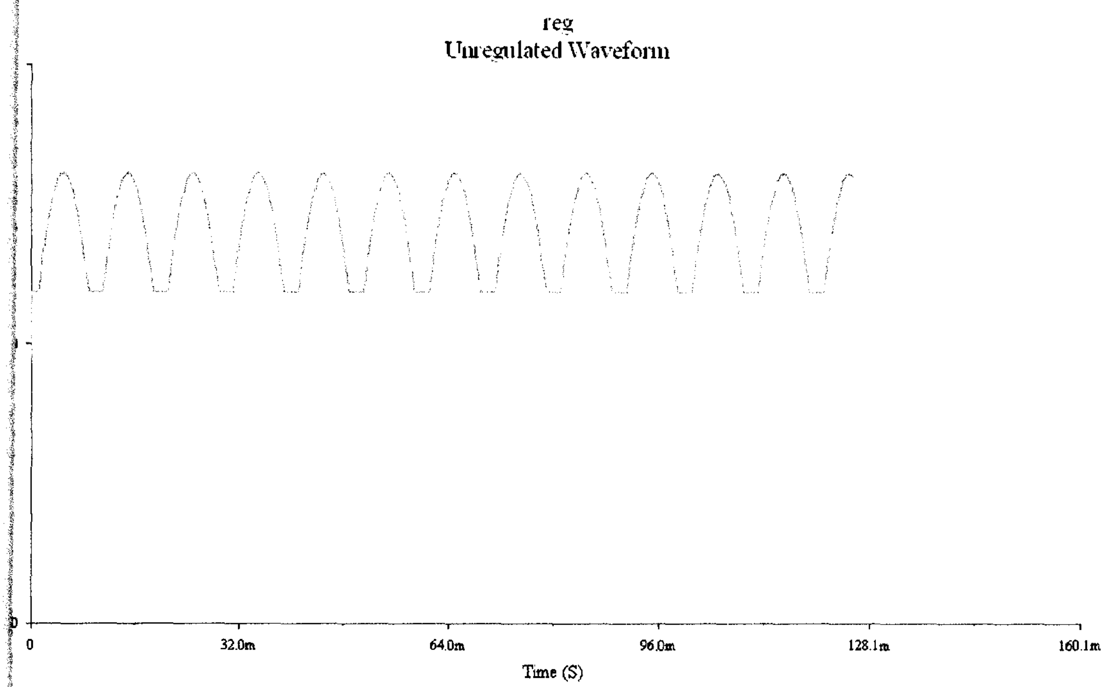


full wave rectifier consists of four diodes as shown above. When the input cycle is positive, diodes D1 and 2 are forward biased and D3 and D4 are reversed biased. D1 and D2 thus conduct current in the direction own. The voltage developed is identical to the positive half of the input sine wave the diode drops when the put cycle is negative, diodes D3and D4 become forward biased and conduct current in the direction shown. ence the current flows in the same direction for both the positive and negative halves of the input wave. This moves the negative half cycle of the sine waveform from the secondary end of the transformer. A full wave ctifier voltage appears across the load. The average output dc voltage at no load condition is approximately ven by

Vdc=0.636*[Vp-1.4]

here Vp =the peak value of the input AC voltage

i.e Vdc=0.636*[16.9-1.4]=9.858V



he secondary voltage of the transformer

sec=12V[rms]

his voltage rectified by the four diodes IN4001 diodes to dc voltage with an ac component superimposed its ripples as illustrated in the waveform above.

nstabilized voltage

rectified=Vdc+Vripple

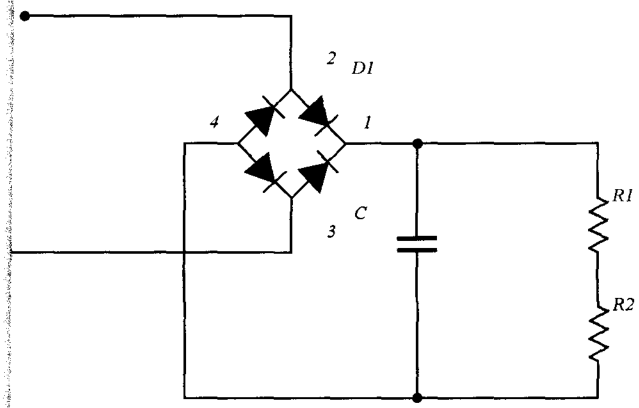
= Vpeak

=16.9v

fter the dc signal has been rectified, ripples are still significant which can be minimized by the use of a apacitor.

APACITOR FILTERING

the diodes D1 and D2 conduct the terminals T1 becomes positive , C charges up to the peak voltage peak of the ac supply . During this time, current is also passing through the resistor RL [R1 and R2].



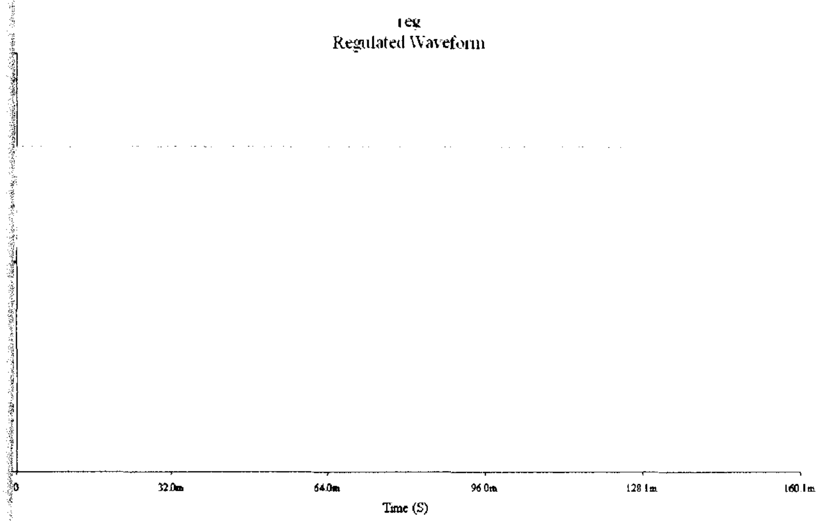
his is 5 times greater than 1/50seconds and smoothening could be efficient.

Then the voltage at T1 begins to fall, current still continues to pass through RL since C is discharging. If e time constant [CRL] is high enough then C takes some time to discharge. If the voltage on C falls a little uring the time for the voltage at T1 to fall to zero, no negative and becomes positive again, then the DC is fficiently smoothened.

or a good smoothening or filtering action [i.e. small ripple voltage Vr, C *RL must be larger than 50seconds. This is the time for the voltage on T1 to go from one positive peak to the next positive peak. If =100μF and RL=1kΩ

Then CRL =100*10^-6*10^3=1/10second

his is 5 times greater than 1/50seconds and smoothening would be efficient.



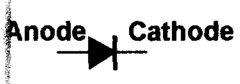
DLTAGE REGULATION

is measure of a circuit's ability to maintain a constant output voltage even when either input voltage or ad current varies. A zener diode when working in the break down region can serve as a voltage regulator. ie sample voltage is compared to a zener voltage and the error is used to modulate the base of the current niting transistor. The current is adjusted until

Vsampled=Vzener+0.6V

IODES

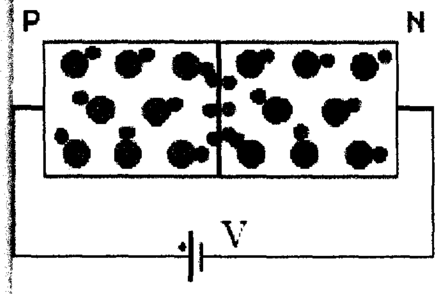
nese are pn devices, which allow current to flow in only one direction. It has two terminals known as the iode and cathode.



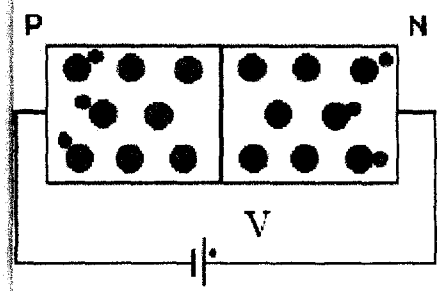
ne cathode is usually marked with a colored mark. When the diode is forward biased i.e. If the applied oltage is positive on the p side, it opposes the contact potential and then reduces the height of the potential rrier. It begins to conduct with only a small power voltage across it.When the diode is reversed biased i.e. e applied voltage makes the n side more positive as is indicated in the diagram below , the barrier is creased. Only a negligible small leakage current flows through the device until reverse breakdown voltage reached. However in normal operation, the reversed biased voltage should not reach the break down

ing.

RWARD BIASED



EVERSED BIASED



odes exhibit a number of useful characteristics such as predictable capacitance [that can be voltage ntrolled] and region of very stable voltage. They can therefore be used as switching devices. Voltage ntrolled capacitors [varactors] and voltage references [zener diodes]. Because diodes will conduct current sily in only one direction, they are used extensively as power rectifiers.

summary for this stage, the transformer steps down the voltage from the utility company, the rectification rcuit removes the negative half cycle. The output still having some ripples, is smoothened by the capacitor 1; IC1 is a voltage regulator that regulates the filtered dc voltage. This dc voltage is set to 12v by the mbination of R1 and R2.This value further brought down to 11.3v by forward biasing the diode, which ops the voltage by 0.7v. This diode labeled D6 is referred to as a blocking diode .The regulated DC ltage of value 11.3v is used to charge the battery, which makes the value drop further to a value of

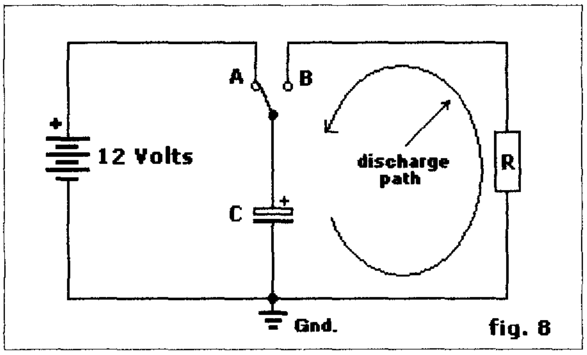
10.64V.

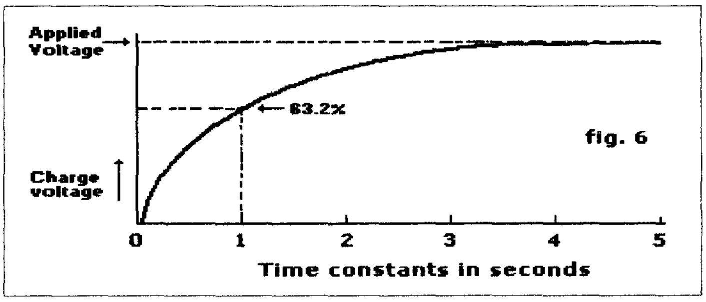
3.1.2 THE TIMING CIRCUIT.

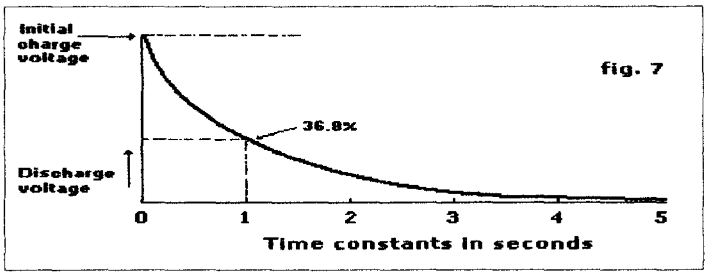
The timing unit is a very essential part of this project and therefore certain components and functions have to be explained in details to be understood properly.

3.1.2.1 CHARGING A CAPACITOR.

The circuit arrangement below shows a capacitor, which may be charged through a high resistance R from a battery of V volts. When the switch S is connected to terminal [A]C is charged but when it is connected to [B], C is short circuited through R and is thus discharged , the voltage across the capacitor n plates continually being measured by the use of a voltmeter.







The voltage across C does not rise to v instantaneously but builds up slowly. Charging current is maximum at the start i.e. when C is unchanged then it gradually increases and finally ceases when P.D across capacitor plates becomes equal and opposite to that of the battery.

Note: In the circuit designs of the project it could be seen that the capacitor is also connected as explained above to the battery.

3.1.2.2 STATEMENTS ON TIME CONSTANT

just at the start P.D across the capacitor is zero, hence applying kirchoffs law

$Vs=Vr+Vc$

But $Vr=IR$

Currentflowing in the circuit is related to the voltage across the capacitor by

$I=C[dv/dt]$

Simple elimination then yields

$Vs=RCdVc/dt+Vc$

Introducing the time constant CR as f

$f=CR$

if Vs is aconstant i.e independent of time, then a particular solution for Vc can be found by $Vcp=Vs$

the homogeneous solution is found by setting the source term to zero and solving the resulting homogeneous differential equation

$dVch/dt+Vch/f+0$

$Vch =Vs+C1e^{-t/f}$

$Vc=Vcp+Vch$

$=Vs+C1e^{-t/f}$

this is equivalent to showing that the voltage across the capacitor is zero initially

Vc[0]=Q[0]/C=0

This implies C1=-Vs

Therefore $Vc=V[1-e^{-t/f}]$

If this rate of rise were maintained, then the time taken to voltage v would have been CR. This time is known as the time constant of the circuit.

Statement 1

The time constant of an R-C circuit is defined as the time during which voltage across capacitor would have reached its maximum value v had it maintained its initial rate of rise.

Also from $Vc=V\ [1-e^{-t/f}]$

We find that if t=f then

$Vc=V[1-e^{-t/f}]$

$=V[1-e^{-f/f}]$

$=V[1-e^{-1}]$

=V[1-1/e]

=V[1-1/2.718]

=0.632V

Statement 2

The time constant may be defined as the time during which capacitor voltage actually rises to 0.632 of its final steady value

Also from

$I=V/Re^{-t/f}$

$=\ln e^{-t/f}$

By put t=f, we get

$I=\ln e^{-f/f}=\ln e^{-1}=\ln/2.718$

$=0.371\ln$

Statement 3

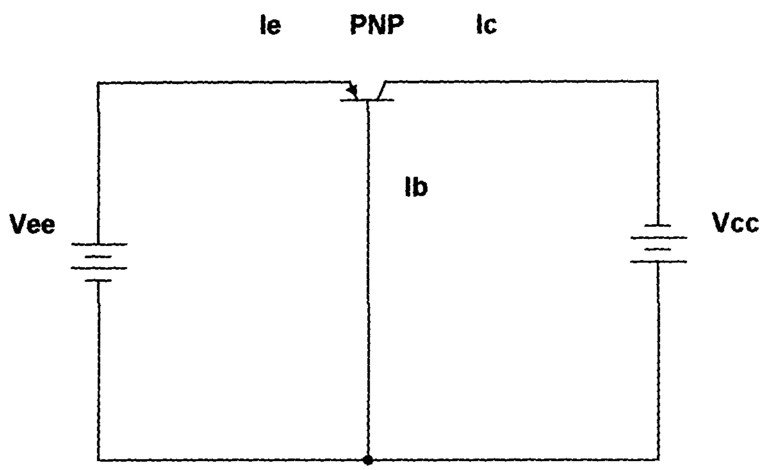
The time constant of a circuit is also the time during which the charging current falls to 0.37 of its initial maximum value.

Recall that the time constant is a deciding factor of when the base of the emitter follower Q2 is biased. The time constant in this design, is kept at five minutes after which the emitter follower of Q2 falls to such a low level that Q1 comes out of saturation and eventually turns off thus energizing the relay which transfers to the normally open switch thus taking the system to the alarm mode.

A brief discussion on transistor biasing is in this stage important in this write up.

3.1.2.3 TRANSISTOR BIASING

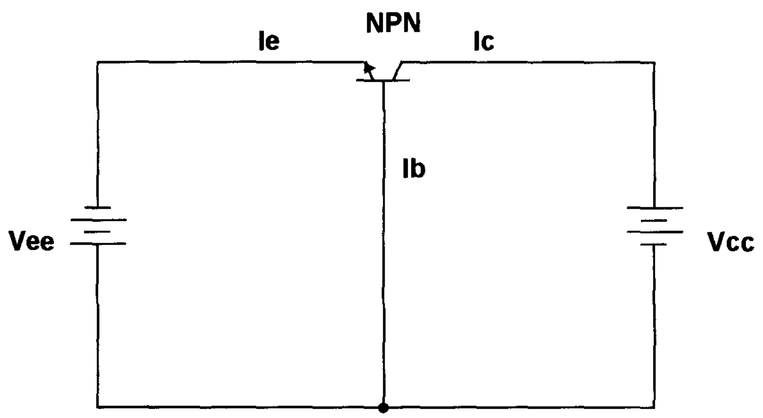
A transistor is a three terminal semiconductor device, which is made up of two pn junctions it, is available in two varieties [npn and pnp]. For proper working of a transistor it is essential to apply voltages of correct polarity across its two junctions .It is worthwhile to remember that for normal operation.



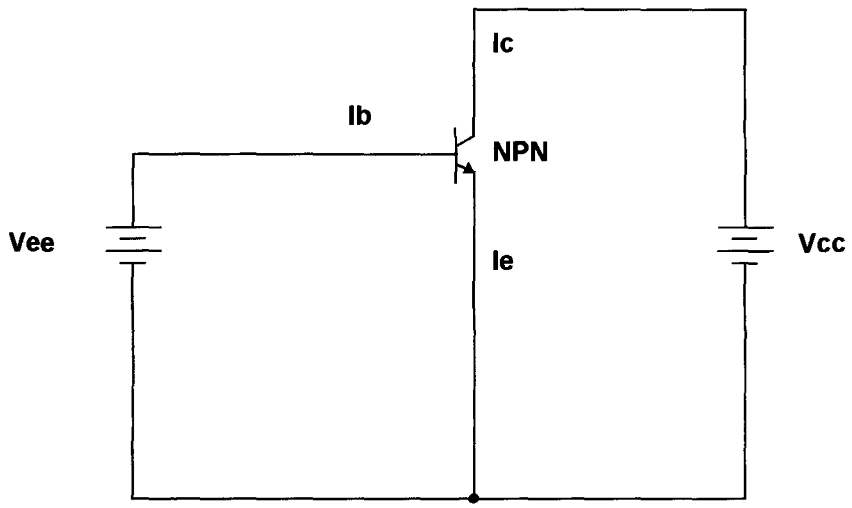
In the figure above, the two batteries respectively provide the dc emitter supply voltage Vee and collector supply voltage Vcc for properly biasing the two junctions of transistor. I n the pnp transistor positive terminal of Vee is connected to p type emitter in order to repel or push holes into the base.

The negative terminal of Vcc is connected to the collector so that it may attract or push holes through the base.

Similar conditions apply to the npn transistor. Below are transistors connected into a simple common emitter and common base circuit It is called a common emitter circuit because the emitter is common to both the input and output circuits. As a result of the forward bias on the base emitter junction, electrons from the n-type emitter easily cross into the p-type base where diffusion into the depletion layer at the base-collector junction takes place. The reverse bias on the collector facilitates electron motion through the base into the collector to establish the collector current Ic.In the common base emitter, the junction must be reverse-biased by battery Vcc while the base emitter junction is forward-biased by the battery Vee



TRANSISTOR CONNECTED INTO A COMMON EMITTER CIRCUIT



TRANSISTOR CONNECTED INTO A COMMON BASE

It must be remembered that a transistor will never conduct any current if its emitter base is forward biased. In the circuit diagram design of this project the combined effect of the transistor which is brought out of saturation after the time delay has elapsed and the relay Kd which is powered energizing by the output of the form the collector Q1 transfer the operations of the unit to alarm section by latching which is one of the functions of a relay.

3.1.2.4 RELAYS

Relays are electronically controlled switched. In the type used a coil pulls in an armature when sufficient coil current flows. This armature is what makes contact with normally open switch current flows shown in the design.

Many varieties relays including latching and stepping relays are available. Relays are available for dc and ac excitation and coil voltages from 5volts up to 110volts are common mercury wetted and reed relays are intended for high speed applications and giant relays intended to switch thousands of amps are used by power companies . Many previous relay applications are now handled with transistors or FET switches and devices known as solid-state relays and now available to handle ac switching applications.

Because it is important to keep electronic circuits electrically isolated from the ac power supply line, relays are useful to switch ac power while keeping the control signals electronically isolated.

3.1.2.5 THE LIGHT EMITTING DIODE (LED)


LED

The LED is a pn junction device that emits light when biased in a forward direction. They are frequently used as pilot lights in electronic appliances to indicate whether the circuit is closed or not .The light emitted can either be invisible [infrared] or can be light in he visible spectrum. The flat side of the bulb or the shorter of the two wires extending from the LED is the negative end and should be connected to the negative side of the battery. LED's operate at relatively low voltages between 1to 5 volts and draws current of about 10 to 50 milliamperes. Voltages and currents substantially above these values can melt a LED clip. From our cause of study of divides, the LED has two region separated by a function. The p region is dominated by the charges and the n region by negative elective charges. When a voltage is applied and the current starts to flow, electron in the n region have sufficient energy to move access the function into the p region. Once in the p-region the electron are immediately attracted to the charges due to the mutual coulomb forces of attraction between opposite elective charges. Each time an electron recombines with a positive charge, elective potential energy is converted into electromagnetic energy. A quantum of electromagnetic energy is emitted in the form of a photon of light. Different coloured LED's emit predominantly light. Different colored LED's emit predominantly light of a single colour. The energy (E) of the light emitted by an LED is given as:

$E = qv$

Where q = electric charge of an electron

$= -1.6 \times 10^{-19}C$

v = voltage required to light the LED

Therefore to find the energy required to light the red LED

$E_R = 1.6 * 10^{-19} *$ voltage across red LED

$=-1.6*10^{-19}*1.99$

$=-3.18*10^{-19}$joules

Energy required to light the green LED

$E_G = -1.6 * 10^{-19}*0.23$

$=-3.68*10^{-20}$joules

The frequency of light is related to wavelength of light. A spectrometer is used to examine the light from the LED and to estimate the peak wavelength of the LED.

$F = c/a$

Where c =speed of light= $3* 10^8$m/s

A =wavelength of light read from the spectrometer[in units of nanometer]

The wavelength of the red light as read from the spectrometer is a=660nM

Therefore $Fr=3*10^8$ ms-1/$660*10^{-9}$ m=$4.55*10^{14}$Hz

Where Fr is frequency of the red light

The function of the timing circuit is to provide a time delay for the user to exit the building before arranging the limit. Upon pressing the used button power is sent to the LED, which lights up to show that the system is the ready mode.

C5, R9, and R10 as shown in the circuit diagram for a time potential divider that is connected to the base of the emitter follower Q2. The emitter amplifier Q2 feeds into the base of the common emitter amplifier Q1 which uses k1relay as it's collector load. C5 acts as a simple filter network that provides smooth DC, to the C5, R9 and R10 timing network.

When power is first applied to the circuit the relay evil self latch thereby applying power to the alarm circuit arming the limit. Pressing the reset button again will transfer power to the timing circuit. The timing circuit will aim the units after a time interval of five minutes.

Understanding the concept of time constant, which provides a time delay by the combination of C5, R9 and R10 in the circuit is enhanced by the explanations of the capacitor characteristics.

3.1.3 THE ALARM UNIT

As soon as power is applied to the circuit c5 starts o charge exponentially via R9 and R10 and the voltage on the base and emitter of Q2 starts to decay slowly towards zero. Eventually, after a period of five minutes, the emitter current of Q2 falls to such a low level that Q1 comes out of saturation and starts conducting. If any of the alarm switches are opened at or after this time, the SCR circuit and the alarm will turn on and self latch, thus sounding the alarm. The infrared motion detector and the contact switch are in series. Thus opening any of these censors will activate the alarm.

When the normally open switch is closed, power is transferred to the alarm units and the LED (CR2) upon passing current, lights up as an indication that the unit is armed.The diode across the siren is to avoid it from drawing excessive current.

CHAPTER FOUR

4.0 THE INTRUDER DETECTOR

In this work two switches or motion detectors are made use of one is the contact switch could be kept at the door with one part of the switch permanently mounted on the door such that closing and opening the switch respectively.

The second motion detector is the sensor which incorporate the infra-red transmitter and receiver is the basis of this write-up.

4.1 PRINCIPLE OF OPERATION OF THE INFRARED MOTION DETECTOR

The infrared motion detector works on the basis of transmitter and receiver. The transmitter sends a signal into the space in such a way that it could be picked up by the receiver and subsequently will be implemented by the main control unit.

Here the infrared radiated is used to send the signals. The aim is to bias the infrared diode so as to radiate energy. The radiated ray of the infrared is used as a carrier for the common signals.

There are various ways of modulating the infrared ray. Increasing the forward current increases the radiations because more electron hole pairs are created, but practical diode places a limit to the forward current to less the 100MA.

Which thus a break in the regular pattern of the infrared beam caused by an intruder or any other form of disturbance then the receiver would no longer have the required amount of rays to keep the circuit close reaching it. This open circuit condition triggers off the alarm.

Recall that the infrared beam is invisible to the human eye and thus the intruder is unable to see the pattern of the beam. An experienced intruder may try to inactivate the receiver by shining bring light on it. This particular project is equipped to accept only a pulse beam of fixed frequency. Also destructive interference as a result of the light may also lead to the alarm been sounded.

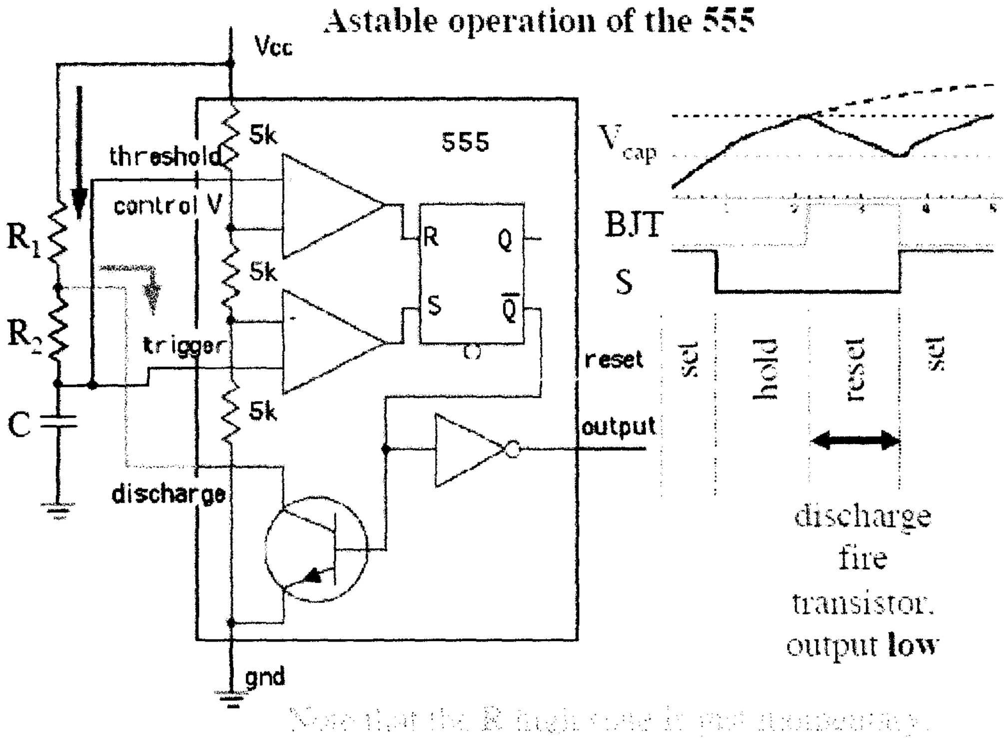
Trying also to cut the sensor wires would cause an open circuit condition and subsequent sounding of the alarm.

An infra-red beam of the same frequency may however be able to deactivate the sensor if pointed directly in the "eye" of the receiver.

Though the transmitter and receiver of infrared are incorporated in a sensor unit, below is an outline of the design of the basic transmitter and receiver unit.

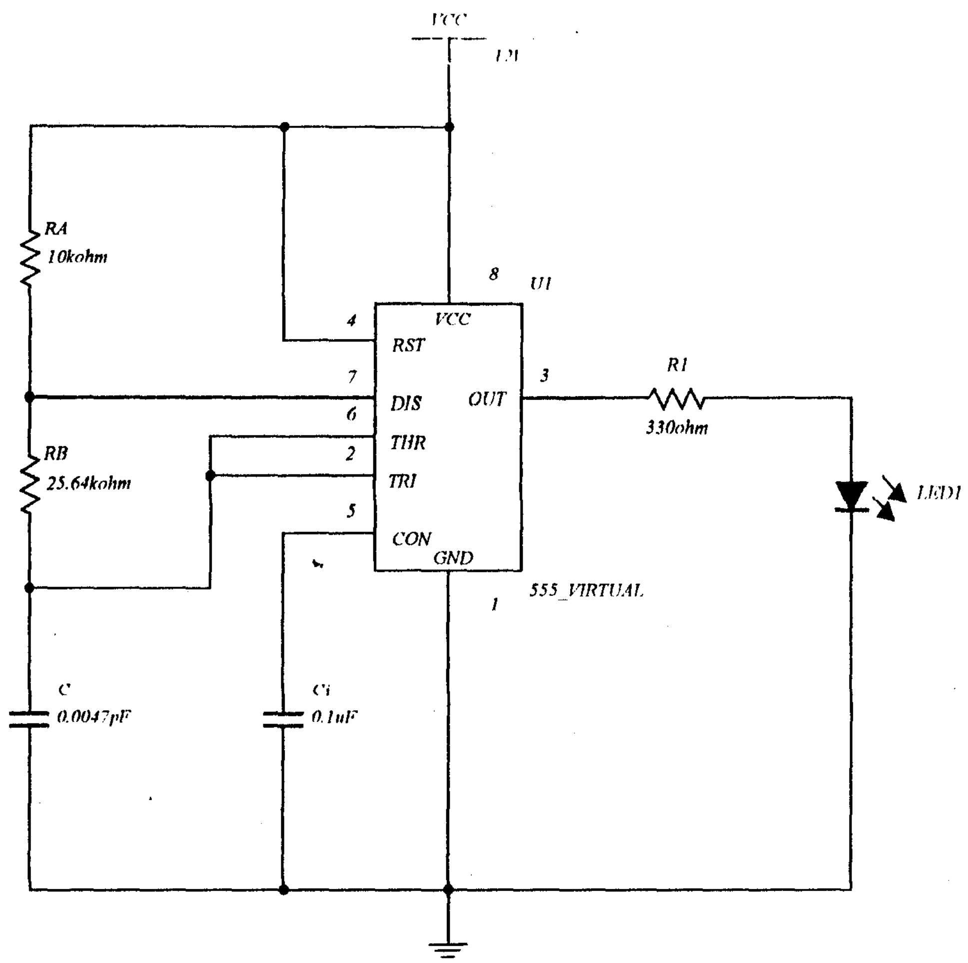
4.2 DESIGN OF INFRARED TRANSMITTER UNIT

The compounds include a 555timer, a transistor and a few biasing elements (Capacitors and resistors). The 555 timer is used in astable mode. The essence of the 555 timer is to generate the voltage wave form of particular frequency to switch on the transistor which consequently allows passage of current through the IR emitter it does this as explains below. A brief explanation on how the 555timer operates is important at this junction.



The use of the 555 as a oscillator (an astable) requires hooking up an external capacitor and a couple of resistors to have a pathway for charging and discharging. Notice how the op amps are connected, the S op amp is connected to be high when the capacitor voltage is less than 1/3 Vcc, the R op amp is connected to be high when the capacitor voltage is greater than 2/3 Vcc. In between 1/3 and 2/3 Vcc both R and S are low, so the flip flop holds the last outputs. The capacitor charges through R1 and R2 until it reaches 2/3 Vcc, then the flip flop resets, sending the inverting output high. This turns on the BJT which discharges the capacitor through R2 (note, R1 is out of the circuit). As the capacitor discharges R goes back low, and the flip flop is set again when it reaches 1/3 Vcc. The output is an inverted version of the digital signal

that drives the discharging transistor.The transmitter unit which produces a frequency of about 5khz is shown below.



the frequency of the generated wave form is given as

F=1/0.69[RA+2RB] C

Given values of RA and RB as

RA=1OKΩ

RB=25.64KΩ

C=0.0047PF

Substituting this in the above equation,

$F=1/0.69[10{,}000+\{2*25640\}]\ 0.0047*10^{-6}$

$=1/0.69[10{,}000+51280]\ 0.0047*10^{-6}$

$=1/0.69*61280*0.0047*10^{-6}$

$=1/198.73104*10^{-6}$

=5.03khz

F=5.03khz

Another important factor of the 555timer is the duty cycle which is the ratio of the pulse width to the total pulse repetition time [p.r.t] and is given by

Duty cyle=Ton/Ton+Toff

=Ton/T

Where Ton=0.693[RA+RB] C

Toff=0.693[RB] C

T=Ton+Toff

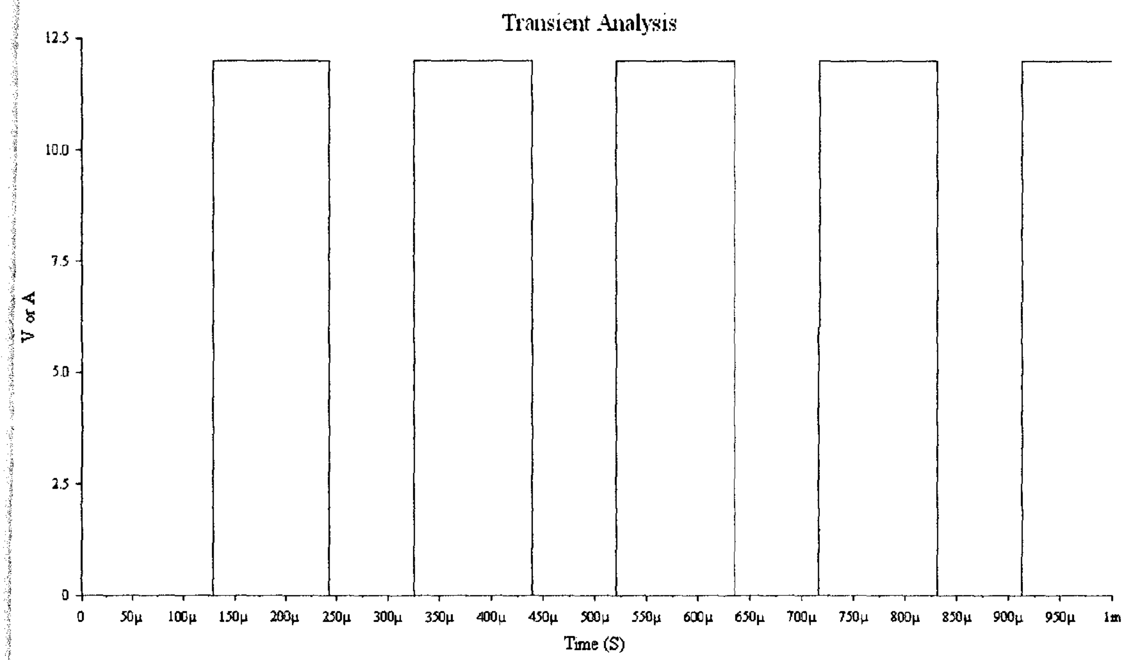
Ton=0.693[10000+25640] $0.0047*10^{-6}$

=0.000116seconds

Toff=0.693[25640] $0.0047*10^{-6}$

=0.000084seconds

Toff is the time with zero current flowing through the diode. The duty cycle determines the portion of the total current, which must flow into the diode. The duty cycle is a fraction of the time the output is high.Output response of the frequency is as shown in the diagram below



from the graph , considering one period we have

T= $[350-150]*10^{-6}=200*10^{-6}$

Therefore 1/T=F

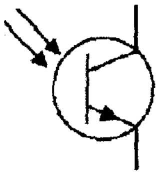
$F=1/200*10^{-6}$=5khz

This therefore confirms of our equation above

4.3 DESIGN OF THE INFRA RED RECEIVER UNIT

This unit consists of the infrared detector,amplifiers,filters and other components. The principal set-up is for the transmitted signal to be incident on the detector [phototransistor] and then amplified b an amplifier to reach a reasonable level. A better understanding of this unit can be achieved by first taking a brief insight of some components such as:

PHOTOTRANSMITTER:



A phototransistor can be an npn bipolar transistor with a large base that does not have a lead. When photons hit the base they create electron/hole pairs, the electrons are drawn to the collector and the holes are filled with electrons from the emitter. Thus there is a current from the collector to emitter.

OPERATIONAL AMPLIFIERS / FILTERS

An amplifier is a device that uses a small amount of power to control a larger amount of power. In electronics, amplifiers are composed of devices called transistors, resistors, and capacitors. The number of these components used and the way they are assembled determines the characteristics of the amplifier. An amplifier that can perform many mathematical operations such as adding, subtracting, or multiplying voltages is called and Operational Amplifier or Op-Amp. The characteristics of an ideal op-amp are the following:

A. Infinite voltage gain (no voltage at all on the input controls, large voltage on the output).

B. Infinite bandwidth (no matter how fast the input changes, the output will change just as fast).

C. Infinite input impedance (no power required at input to change output).

D. Zero output impedance (the output can deliver an infinite amount of power).

Obviously, in the real world these conditions can never be met, but for mathematical purposes they are assumed in designing electronic circuits with op-amps. The op-amp has two input terminals, inverting input (--) and non-inverting input (+), and one output terminal. Figure 6 shows the standard op-amp symbol. The two input terminals are labeled 2 and 3, and the output is 1.Most op-amps

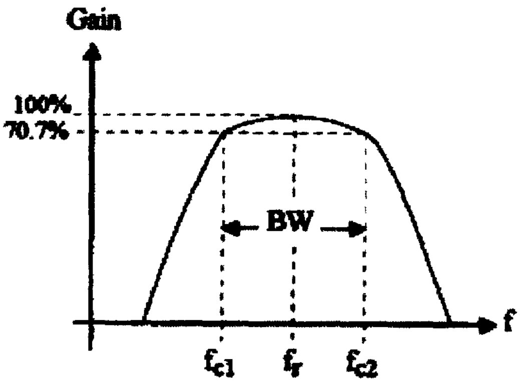


FIG 13

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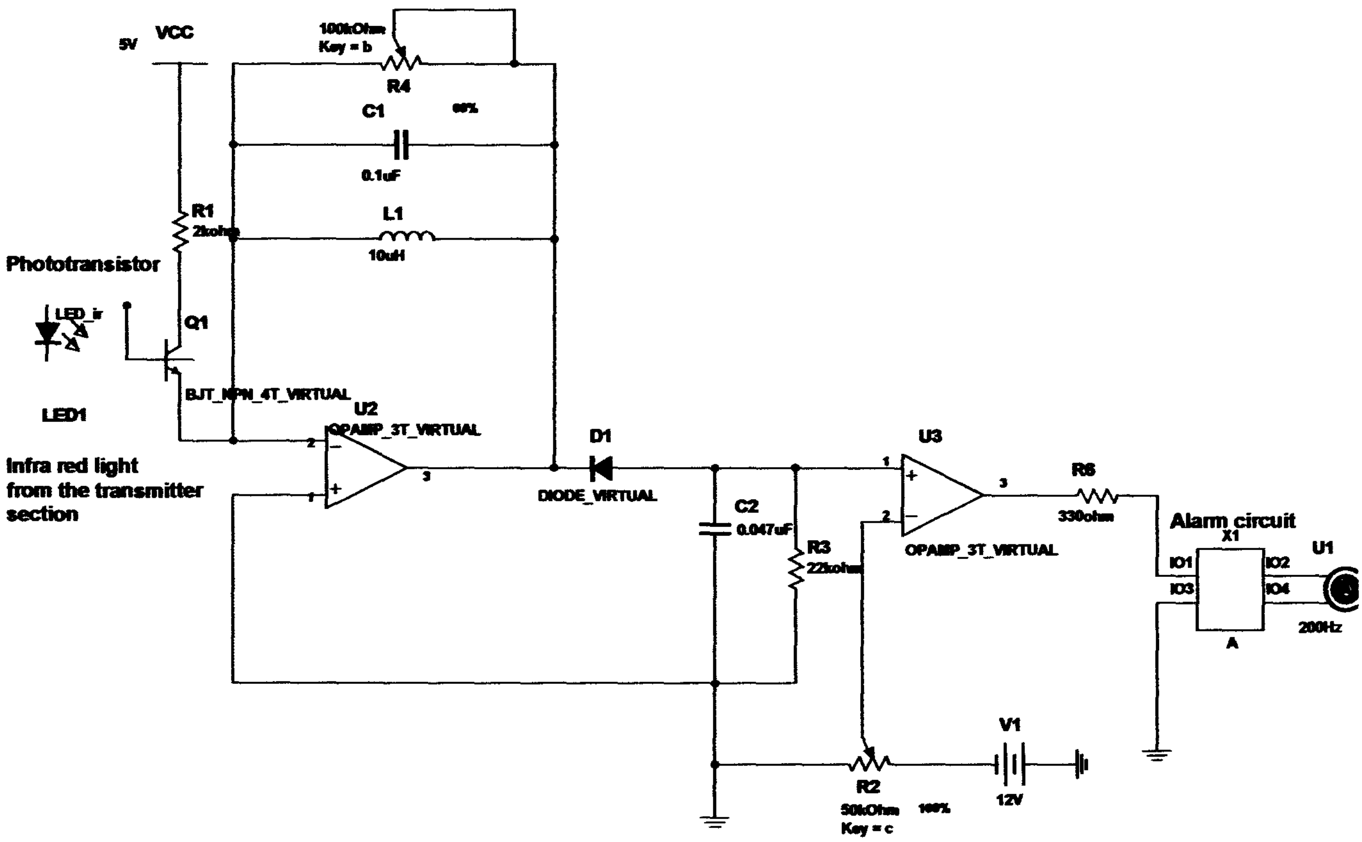


The circuit above receives 5KHz modulated infrared beam established by the transmitter unit.

operate with two DC power supplies, +VCC and --VEE connect to pins 11 and 4 respectively. Since a single power supply is used in the kit, --VEE (pin 4) is tied to ground. The op-amp multiplies the difference between the voltage signals applied at its two input terminals (V3-V2) times the gain of the amplifier (A). A x (V3-V2) appears at the output terminal as shown in Figure 7.

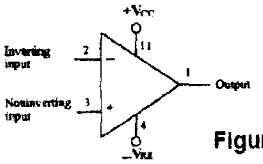


Figure 6

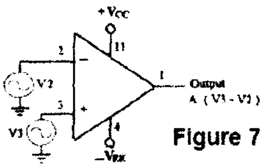
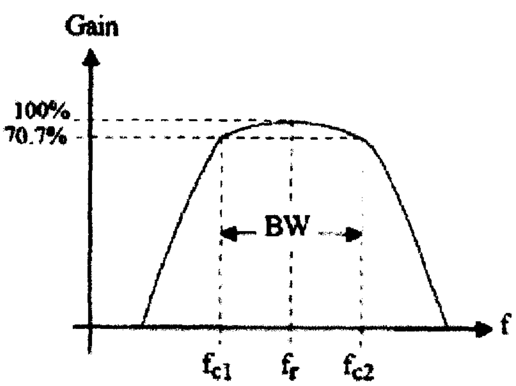


Figure 7

BAND PASS FILTER

The combination of a low and high pass filter create what is called a Band Pass Filter. The frequencies passed by each filter overlap and create a bandwidth (range), passing all signals within the bandwidth and reducing all others. Figure 13 illustrates the general band-pass response curve. A critical frequency is defined as the point where the voltage is reduced to .707 (the square root of ½ is used because it represents the point where power has been reduced to ½). The bandwidth can be defined as the difference between the upper critical frequency (fC2) and the lower critical frequency fC1 (BW = fC2 - fC1). The selectivity (or Quality) of a band-pass filter is expressed as the "Q" of the filter. It is the ratio of the center (or Resonant) frequency to the bandwidth (Q = fr/BW). A filter with a higher value of Q has a narrower bandwidth, thus passing fewer frequencies than one with a lower value. Bandpass filters can be classified as either a narrow-band (Q > 10) or a wide-band (Q < 10).



4.4 INSTALLATION

The circuit board is enclosed in a metal casing and screwed tightly shut. The casing has holes for the power supply leads and connection wires to the sensor, the siren and the contact switch.

The unit is mounted where there is only one entrance and exit. This means that there is only one way of entering and exiting the building. Although too much importance is not normally attached to the placement of the casing but care must be taken to make the sensor unit and contact switch as inconspicuous as possible.

The sensor is preferably kept above the doorframe on the inside wall such that an intruder is unable to try deactivating the unit before cutting the beam.

One part of the contact switch could be made stationary by mounting firmly on the immovable doorframe while the other part is mounted on the door such that shutting the door implements a complete circuit while opening the door leads to an open circuit and thus sounding the alarm.

These locations of the sensor unit and the contact switch complement each other. Recall that the sensor unit and the contact switch are connected in series such that opening anyone of them sounds the alarm.

CHAPTER FIVE

5.0 RECOMMENDATION FOR FURTHER WORK:

The system design although implemented using hardwired logic could also be implemented using programmed logic. In a situation where programmed logic is used a variety of concepts may be introduced.

For instance in an organized society like in the developed country similar units are directly linked to the main frame computer of the police such that the police station is instantly alerted once the alarm is sounded i.e. when there is a break in.

Also in an office complex like in high rises where there are different units at different locations of the building, the use of programmed logic provides a means of monitoring the different zones from a central monitor by the use of multiplexing techniques.

Even in the hardwired design circuitry could be implemented to power high light intensity bulbs to throw light when the alarm is sounded. This would enable the patrolling security team to know the precise location of the unit and to see the subject of intrusion at a glance.

Also for portability instead of passive components used the overall circuitry could be integrated with a very large scale integration (VLS1) chip. Miniaturization of cause would lead to better system binding.

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