DESIGN AND CONSTRUCTION OF A GENERATOR REMOTE CONTROL DEVICE

BY

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DEDICATION

This project is dedicated to the King of kings for his unfathomable love and protection throughout my course of study in the university. Also to my parents, Elder Timothy and Mrs Comfort Obashe.

DECLARATION

I, Obashe Emmanuel Bayode 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 Federal University of Technology, Minna.

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ABSTRACT

The function of this project is to control a generator from a distance; to switch a generator on or off and to time the generator operations. This is achieved by using an infrared transmitter and receiver combination to couple the remote to the generator. The transmitter has a button that controls its operations. The infrared transmitter sends an infrared signal to the receiver. When the infrared detector in the receiver receives the infrared signal, it will transfer it to the base of a transistor in emitter-follower configuration, which will feed the signal into a decade counter. The decade counter serves as the controlling module. Two transistors are coupled to the outputs of the decade counter. These transistors will serve as the switching module which powers the generators on or off. The infrared rays are delivered in pulses which are generated by a 555 timer. The duration of these pulses depend on the RC circuit of the 555 timer. These provide the timing action of the remote.

ACKNOWLEDGEMENT

Without the effort and contribution of some people, this project would not have been brought to completion, but first and foremost, I give thanks to the Almighty God for his mercies and for seeing me through all the storms.

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CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION TO GENERATOR REMOTE CONTROL

As the world moves into an age where control is invaluable, mans desire for control is becoming increasingly insatiabe.Virtually everything from radios to rockets, and even missiles are being remotely controlled. At the present time,a remote control can be devised for multiple purposes.

Generator Remote Control Device, which is the title of this project, had been a mirage in time past, but now it can be achieved with a number of integrated circuits. These remote control devices are very small and handy, hence eliminating stress previously experienced in controlling generators.

Infrared remote control refers to the use of an of an infrared link, usually over short line – of – sight distances for the purpose of controlling the operation of electronic equipment [1].

However, the term infrared refers to electromagnetic energy in a band whose wavelength is longer than that of visible light, but shorter than that of microwave energy [1].

The infrared remote control is used to control devices electronics at a distance or as intermediate circuits; examples of this include devices used to control cars, televisions, satellites, submarines and so on.

Remote control devices have gained such a major foothold in human activities, that to do without them would be a recipe for retrogression. Their uses range from complex control systems, like radar control, space exploration to even domestic systems such as household appliances [2].

In this modern day world, the need for a remote controlled generator cannot be overemphasized, especially considering the fact that some setups may require using a number of generators and switching over from one to another rapidly. In addition, generators which previously needed manual pulling or cranking to start up can also be remotely controlled.

Innovations in Remote Control Technology have put to an end, the days of slow, stressful and risky generator operation.

1.2 Aims and objectives

The aim of the project design is to be able to provide power control for the user of the remote, so as to control more than one generator at a time and also to make such generators tamper- proof by assigning a specific time frame.This design is flexible because it gives the user of the remote the opportunity of timing the generator operation.

1.3 Methodology

This project is made up of five modules.

The modules are:

- Power source modules
- Transmitter module
- Reciever module
- Controlling module
- Switching module

The function of both ac and dc power source module is to power the entire system. When the system is on and the transmitter is as well powered with a dc source, any other function can carry on.

1.4 Scope of work

The project is designed with the intention of implementing a circuit capable of sending signals to control a generator. It involves the use of electronic components like 555 timers, decade counters, operational amplifiers, infrared transmitters, receivers etc. The use of integrated circuits makes the circuit economical.

1.5 Limitations of the project

(i) Because the project is a prototype.the controlling capacity of the remote is limited to just two generators and the range of the remote control is just more than a metre because it uses infrared signals.

(ii) The infrared signal generated by the transmitter is susceptible to interference.

CHAPTER TWO

LITERATURE REVIEW / THEORETICAL BACKGROUND

2.1.1 History of the Infrared Remote Control

.The first machines to be operated by remote control were used mainly for military purposes. Radio controlled motorboats, developed by the German navy, were used to ram enemy ships in World War I. Radio controlled bombs and other remote control weapons were used in World War II [3].

Once the wars were over, United State scientists experimented to find non – military uses for the remote control. In the late 1940s, automatic garage door openers were invented, and in the 1950s, the first TV remote controls were used [3].

2.1.2 History of the TV Remote Control

Zenith began playing around with the idea of a TV remote control in the early 1950s. They developed one in 1952 called " Lazy bones" which was a long cable that was attached to the TV set. Pushing buttons on the remote activated a motor that would rotate a tuner in the set. This type of remote was not popular for long considering that at the time there were very few channels to choose from [4].

In 1955, the Flash- O – Matic was invented; A flashlight was aimed at light sensitive cells in each of the four corners of the TV.Each corner had a different function. They turned the TV on and off, changed the channel, and controlled the volume. However, people often forgot which corner of the TV operated which control. Also, if the set was in sunlight, the suns rays would affect the operations of the TV [4].

On the infrared control, each button has its own command, and is sent to the TV in a series of signals. There is a digital code for each button, and in the TV there is a tiny sensor called a photodetector that identifies the infrared beam and translates the code into a command [5].

Manufacturers used to only make remote controls that operated one TV set. However,they've recently begun making universal remote controls that can operate any TV set [5].

In 1800, an astronomer, Sir Fredrick Williams Herschel (1738-1822) made an important discovery. He built his own telescope and therefore was familiar with lenses and mirrors. With this knowledge, he knew sunlight was made up of all colours and it's also a source of heat [6].

He was interested in knowing how much heat was passed through different colours of filters. He noticed that filters of different colours seemed to pass different levels of heat. He devised a better experiment to investigate his hypothesis, since he felt the colours might contain different levels of heat. So he directed sunlight through a glass prism to create spectrum (the rainbow-created when light is divided into its colours) and he measured the temperatures of each colour using thermometer with blackened bulbs (for better absorption).he noticed that the colours had temperatures which increased from violet to the red part of the spectrum [6].

On this account, he decided to measure the temperature beyond the red portion of the spectrum in a region apparently devoid of sunlight. He discovered this region had the highest temperature of all. The radiation causing the heat was not visible, so he called the invisible radiation "calorific rays", later known as infrared ray. He found that the calorific ray which exists beyond the red part of the spectrum could be reflected. refracted, absorbed and transmitted just like visible light [6].

His discovery was a form of electromagnetic radiation with wave length greater than that of red light (a form of light beyond red light) called infrared rays or infrared radiation. The experiment he carried out not only led to the discovery of infrared (IR) but also showed that there are forms of light that cannot be seen with the ordinary human eyes [6].

As infrared technology improved, an infrared component was used to activate a transmitter controlled signal which can be coded into a receiver [7].

2.1.3 Typical Applications of Infrared Technology

- In robotics, to monitor the operation of robots.
- Domestic use, in appliances or household accessories.
- Banks, as motion detectors
- Military use, as guidance system for missiles.
- Industrial use, to remotely operate equipment under hazardous conditions.

Advancements in infrared technology have greatly enhanced the development of the remote control industry.

CHAPTER THREE

DESIGN AND IMPLEMENTATION

3.1 DESIGN BACKGROUND

The overall design was first broken into functional block diagrams. Each block has a specific function and was integrated according to design specifications. The modular design for the project is shown in fig. 3.1 below.

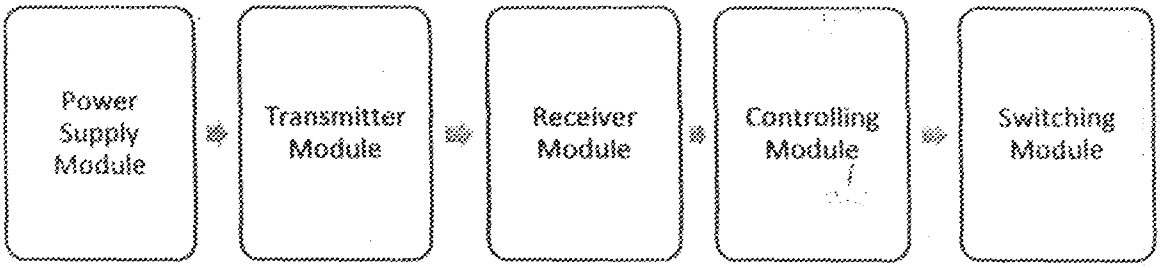

Fig. 3.1: Block diagram of Generator remote control

3.1.1. Power Supply Unit

A power supply unit increases or reduces the mains voltage and then converts it from A.C to steady D.C. So that it can be used in a range of electronic circuits. PSUs can have additional circuitry to enable them to maintain either a constant current or a constant voltage when applying a load. The basic PSU consist of a transformer, a full wave rectifier and a smoothing circuit. It may also contain a stabilized voltage circuit and/or a stabilized current circuit. Batteries are often shown on a schematic diagram as the source of DC voltage but usually the actual DC voltage source is a power supply. A more reliable method of obtaining DC power is to transform, rectify, filter and regulate an AC line voltage. Power supplies make use of simple circuits [8].

DC power supplies are often constructed using a common inexpensive three-terminal regulator. These regulators are integrated circuits consisting of several solid state devices and are designed to provide the desirable attributes of temperature stability, output current limiting and thermal overload protection [8].

In power supply applications it is common to use a transformer to isolate the power supply from the 110 V AC line. A rectifier can be connected to the transformer secondary to generate a DC voltage with little AC ripple. The object of any power supply is to reduce the ripple.

The power supply unit must be the most ubiquitous electronic circuit since every piece of electronic equipment has to be supplied with power, usually D.C at a controlled voltage. It consists of the unregulated with its transformer, rectifier and filter as well as precision [8].

An A.C to D.C power supply unit comprises of a transformer, rectifier, filter and regulator. The first three components which forms what is called an unregulated or raw D.C supply. The circuit diagram of the power supply unit is shown in fig. 3.2.

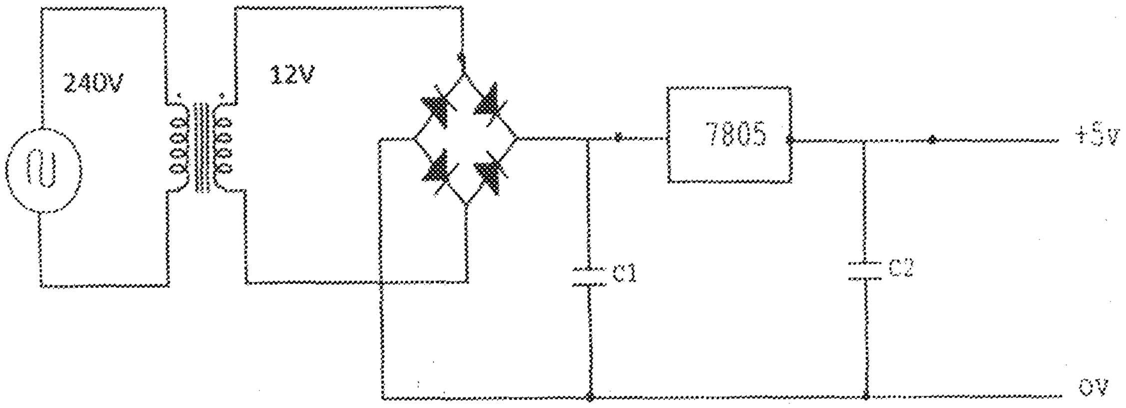

Fig. 3.2: Circuit diagram of the Power Supply Unit

The block diagram of a D.C power supply unit is shown in fig. 3.3.

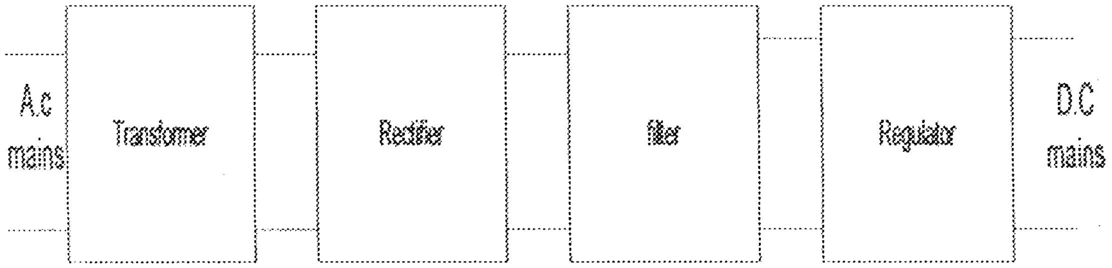

Fig. 3.3: Block diagram of a D.C Power Supply Unit

3.1.2 The Transformer

In a power supply unit, the transformer is the component which converts the a.c mains to a higher or usually a lower a.c voltage. Fundamentally, a transformer consists of two windings or coils, inductively coupled by a magnetic core. The input winding is called the primary, while the output is called the secondary. The ratio of primary to secondary voltage equals the ratio of the number of turns on each winding. Fig 3.4 shows the primary and secondary windings of primary windings.

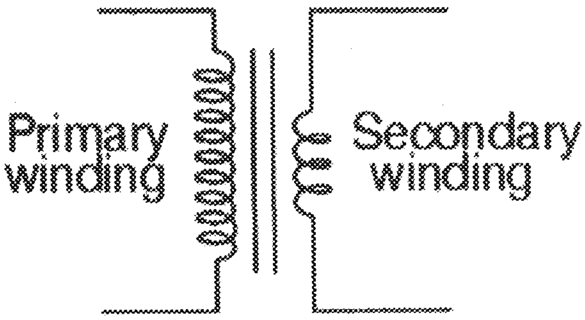

Fig. 3.4: Transformer

The secondary/primary voltage ratio is not sustained on current by a load connected across the secondary is uncreated. This is due to losses: magnetic (or iron losses arising from eddy currents in the core, and resistance (or copper losses). Transformers can be used to increase or decrease AC voltages. They are used in electrical equipment to convert the 220 Volts coming from the wall socket to lower and safer voltages for use in equipment. The schematic diagram and defining equation for a transformer are shown in fig 3.5.

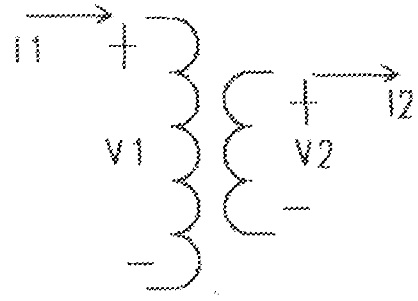

Fig. 3.5: Transformer schematic diagram

$$\frac{V_1}{V_2} = \frac{N_1}{N_2} \qquad (3.0)$$

Where input voltage V1, output voltage V_2, input current I_1 and output current I_2 are defined as shown, and N_1 and N_2 are the number of windings on the primary and secondary coils, respectively. Power transformers are usually not described in terms of N_1 and N_2, but instead are described in terms of the voltage output, and assume a 220 volt input. Also specified is the maximum current output which is limited by the size of the wire used in the transformer.

The transformer shown above is called a single tap transformer because there is only one output. It is possible to build transformers with multiple taps, and a common way of doing that is to make a connection to the middle of coil 2; this is called a center-tapped transformer.

$$\frac{V_1}{V_2} = \frac{N_1}{N_2} \qquad (3.1)$$

$$\frac{I_2}{I_1} = \frac{N_1}{N_2} \qquad (3.2)$$

For this project,the transformer used was rated from the manufacturer as 0.5A and 9V.Therefore the resistance,

$$R = \frac{V}{I} \qquad (3.3)$$

$$R = \frac{9}{0.5} = 1.8\Omega \qquad (3.4)$$

The secondary voltage = 240V AC

And the primary voltage = 12V DC

Since power efficiency = power input = power output

To determine the secondary current

$$V_2 \times I_2 = V_1 \times I_1 \qquad (3.5)$$

$$I_2 = \frac{12 \times 0.5}{240}$$

$$I_2 = 0.025A$$

$$I_2 = 25mA$$

3.1.3 Voltage Regulator

Regulated voltage supply can be obtained by using a voltage regulator circuit; a regulator is an electronic control circuit, which is capable of providing a nearly constant d.c output voltage even when there are variations in load or input voltage. The change in voltage from no-load to full load condition is called voltage regulation.

The aim of a voltage regulator circuit is to reduce these variations to zero, or at least to the minimum possible value.

The percentage regulation is given by:

$$\% \text{ regulation} = \frac{V_0 - V_{100}}{V_0} \times 100\% \qquad (3.6)$$

Where V_0 is the no –load secondary and V_{100} is the voltage under full load current. It is usual for a transformer secondary voltage to be specified at the full load current which is calculated from the quoted VA (power) rating and secondary voltage.

The wave form of the transformer secondary voltage is a directional and normally sinusoidal. To convert this a.c voltage to d.c, a device called a rectifier is used.

This is usually one or more silicon diodes selected to handle the required voltage and current. Fig. 3.6 shows the diagram of voltage regulator.

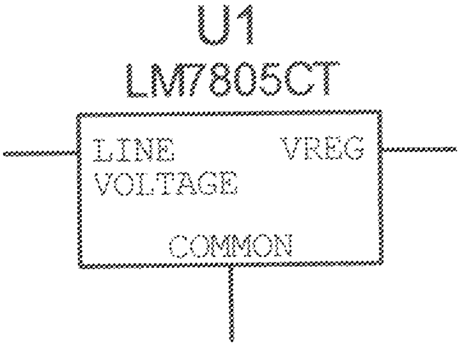

Fig. 3.6: Circuit Diagram of Voltage Regulator

3.1.4 Rectifier

A rectifier is a circuit which employs one or more diodes (in this case four)to convert a.c into pulsating d.c voltage.

V_{rms} = rms value of the total voltage for a full-wave rectifier signal.

$$V_{rms} = \frac{V_m}{\sqrt{2}} \text{ and } \quad V_{DC} = \frac{2V_m}{\pi} \qquad (3.7)$$

The load resistance, R_L, is given as;

$$R_L = \frac{V_{out}}{I_{out}} \tag{3.8}$$

Where V_{out} = output voltage = 9V

I_{out} = current output =0.5A

$$R_L = \frac{9V}{0.5A} = 18\Omega$$

The transformer's voltage input is $240V_{rms}$ which was stepped down to 12V and this means that the 240V was reduced by

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The transformer's voltage input is $240V_{rms}$ which was stepped down to 9V and this means that the 240V was reduced by

$$\frac{240\,V}{12V} = 20 \text{ times}$$

The maximum voltage, E_m, is given as;

$E_m = 12V_{rms} \times \sqrt{2} = 12V_{rms} \times 1.4142 = 13V$ peak to peak

$E_m \approx 13\ V_{pk}$

Thus the d.c voltage, $V_{d.c}$, is given as;

$$V_{d.c} = \frac{2}{\pi} \times E_m \tag{3.9}$$

$$V_{d.c} = \frac{2}{3.142} \times 13V = 0.6365 \times 13V = 8.27V$$

The d.c current, $I_{d.c}$, is given as;

$$I_{d.c} = \frac{V_{d.c}}{R_L} \qquad (3.10)$$

$$I_{d.c} = \frac{8.27V}{18\Omega} = 0.459A \approx 0.5A$$

The maximum voltage, E_m, is given as;

$E_m = 9_{rms} \times \sqrt{2} = 9_{rms} \times 1.4142 = 12.7\ V$

$E_m \approx 13\ V_{pk}$

$$I_{d.c} = \frac{8.27V}{18\Omega} = 0.459A \approx 0.5A$$

$$I_m = \frac{2}{\pi} \times I_{d.c} \qquad (3.11)$$

$I_m = 0.72A$

Since the waveform from the rectifier still contain large AC component, the voltage output terminal varies with time.

T_1 = charge period of the capacitor

T_2 = dicharging time of the capacitor

T = period of rectified voltage.

To determine the voltage ripple remaining after filtering with the 470µF capacitor.

$$V_r = \frac{V_{dc}}{RC} \times T_2 \qquad (3.12)$$

The capacitor charges from 8.8V to 13V thefore the DC voltage is equal to maximum voltage.

To determine for T_2, the discharge voltage is always 37 % of supply voltage [8].

Approximate triangular ripple for capacitor filter is shown in fig. 3.7

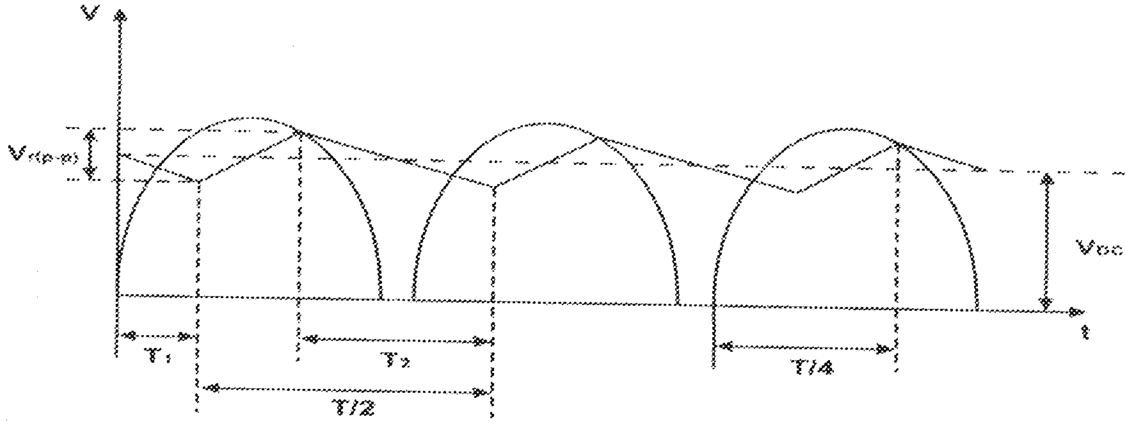

Fig. 3.7: Approximate triangular ripple for Capacitor Filter.

3.1.5 The Transmitter Module / Receiver Module

The Infrared Sensor

This is a narrow range of device that are infrared light-sensitive, in which a device parameter resistance , current or voltage is dependent on the inrfared light intensity in the device. The device is limited to specific light spectrum, that is, to a specific range of light wavelength with frequency 4MHz and the corresponding wavelength is 0.7μm. This spectral limitation clearly indicates that an important criteria for the suitability of a device is the operation on desired range, therefore the infrared sensor was used in the circuit to control the timng of the timer circuit [9].

Another important parameter is light intensity, the terms that will be used to this quality are : Irradiance (H) in mW / cm^2 , and the total incident power in mW.

The irradiance is the light power per unit area of the device, while the incident total flux or power is the total light power incident on the device [9].

Thus,Total Incident Power, $P = A \times H$ (3.13)

Where A is the effective (effective) area of the light sensitive device, the term radiant flux density is often used in place of irradiance, and the unit used for irradiance is mW/cm^2 [9].

Therefore , the active area = $4.6 \times 10^{-3}\ cm^2$

$P = A \times H$

$H = 0.5\ m/W^2$

Power = $2.3 \times 10^{-3}\ mW$

Therefore the power on the surface of the sensor is $2.3 \times 10^{-3}\ mW$.

Photon current , $I_p = P \times R_{\varnothing}$ (3.14)

Where $R_{\varnothing}$ is the responsivity.

Therefore , $I_p = 2.3 \times 10^{-3}\ mW \times 0.35$

$I_p = 8.05 \times 10^{-4}\ mA$.

Therefore the voltage output of the sensor ,

$V_o = I_p \times R_l$ (3.15)

Where R_l is the load resistor.

$V_o = 8.05 \times 10^{-4}\ mA \times 1 \times 10^{-6}\Omega$

$V_o = 0.805V$

Hence,voltage output of the infrared = 0.8V

Fig. 3[illegible] shows the circuit diagram of an infrared sensor.

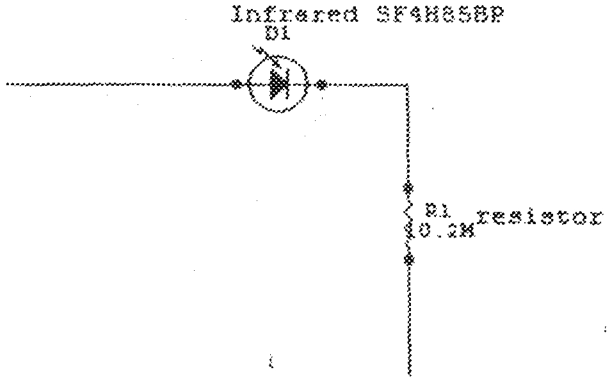

Fig. 3.8: Circuit Diagram of infrared sensor

The infrared sensor is reverse – biased to the negative supply rail line of the power supply thereby exhibiting a high resistance when darkness approaches , but when infrared light falls on it, its resistance reduces, thereby leading to leakage of current [9].

Therefore R_s = reverse biased resistor

$$R_s = (E - V_R)/ I_S \qquad (3.16)$$

$R_s = (9 - 0.8) / (8.05 \times 10^{-7})$

$R_s = 10{,}186.335$

$R_s = 10.2\text{M}\,\Omega$

Therefore as the current increases, the resistance falls

Therefore, Gain = $1\text{M}\,\Omega / 10.2\text{M}\,\Omega$

Gain = 0.09

Volt output = $0.09 \times 0.8 = 0.072\text{mV} = 72\text{mV}$

Therefore at irradiance of $10\text{mW} / \text{cm}^2$

Power = $3\text{mW} / \text{cm}^2 \times 4.6 \times 10^{-3}$

Power = 1.38×10^{-5}

$I_P = 4.38 \times 10^{-5} \times 0.35$ (responsivity)

$I_P = 4.8 \times 10^{-6}$ A

$V_O = 4.83 \times 10^{-6} \times 1 \times 10^{-6}$

$V_O = 4.83V$

$R_{S}= \frac{9-4.83}{4.8\times10^{-6}}$

$R_S = \frac{4.17}{4.8\times10^{-6}}$

$R_S = 868.8K\ \Omega$

Therefore the negative feed back of the inverted operational amplifier

Gain = $- R_f / R_i$

Gain = - 1M Ω / 868.8K Ω

Gain = 1.15

Therefore,

Voutput = - 1.15 × Vinput

Vout = - 1.15 × 4.17V

Vout = - 4.799V

The voltage output of the operational amplifier is 4.779V which was fed to the comparator.

Therefore – 4.779V was the voltage obseved when exposed to infrared rays and 72 mV in the absence of infrared rays.

3.1.6 The Amplifier

An operational amplifier, or op amp, is a specialized form of linear IC. The op amp consists of several transistors, resistors, diodes, and capacitors, interconnected so that high gain is possible over a wide range of frequencies. An op amp might comprise an entire IC or an IC might consist of two or more op amps .Examples are dual op amps or quad op amps. Some ICs have op amps in addition to various other circuits.

An op amp has two inputs, one noninverting and one inverting, and one output. When a signal goes into the noninverting input, the output is in phase with it; when a signal goes into the inverting input, the output is 180 degrees out of phase with it. An op amp has two power supply connections, one for the emitters of the transistors (V_{ee}) and one for the collectors(V_{cc}).

An amplifier is an electronic device which is a means of using an electronic device to enlarge small signal to large amplitude pulse or signal. In this design, the amplifier used is the operational amplifier [9].The operational amplifier has some characteristics which help in the full operation of the circuit:

Closed loop voltage gain; this is the ratio of output voltage to input voltage measured with feedback applied, the effect of providing negative feedback is to reduce the loop voltage gain to a value which is both predictable and manageable [9].

Practically, closed loop voltage gain ranges from 1 to 10,000.

Input resistance: this is the ratio of input voltage to input current expressed in ohms, it is often expedient to assume that the input of an operational amplifier is purely resistive, though this is not the case at high frequencies where shunt capacitive reactance may become significant, the input resistance ranges from about 2MΩ for common bipolar types to over 10^{12} for FET and CMOS device [9].

Output resistance: this is the ratio of open circuit output voltage to short circuit output current expressed in ohms.typical values range from less than 10Ω to around 100Ω depending on the configuration and the amount of feedback employed [9].

The amplifier used for the sensor is the inverting operational amplifier in which a negative feedback resistance was coupled. The negative feedaback resistor act as a resistance to yield the voltage drop as a result of the incident photon current on the resistor, the voltage drop was what the amplifier used for its amplification. Therefore to achieve the gain of the inverted operational amplifier which was coupled with a negative feedback resistor?

$$\text{Gain} = -R_f / R_1 \; [9] \tag{3.17}$$

Where R_f = is the feedback resistor

And R_1 is the resistance of the infrared diode.

To achieve the resistance of the infrared, the voltage across the diode was noted

$V = 26 \times 10^{-3}$ mV. This value is constant for diodes [9].

The circuit diagram of the amplifier is shown in fig. 3.9

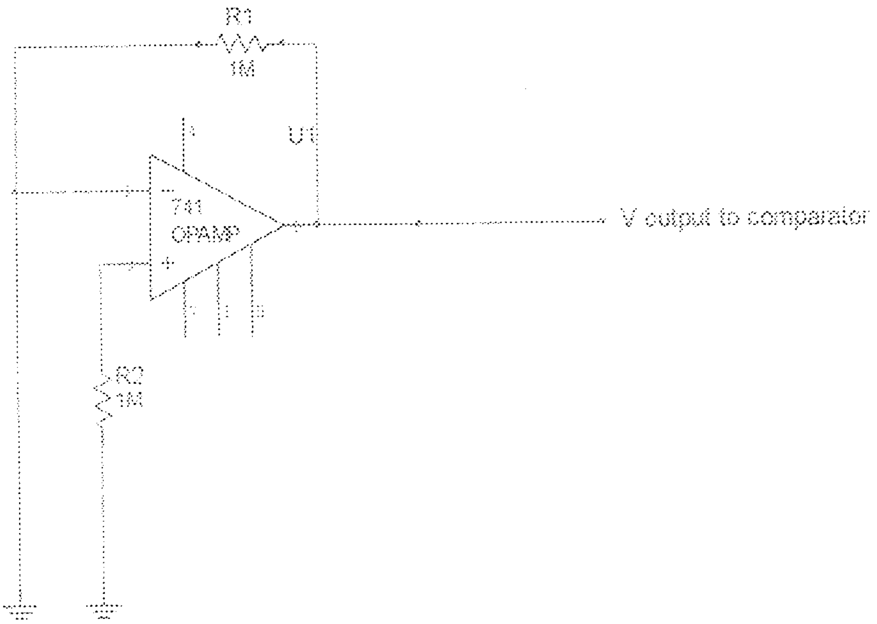

Fig. 3.9 Circuit Diagram of Amplifier

3.1.7 Comparator

The comparator of an operational amplifier involve device operating in an open loop configuration (without negative feedback applied) the output voltage can thus be in one of two state,either nearly equal to that of the negative supply or nearly equal to positive supply. at the threshold reaches 2/3 of the supply voltage,at this point, the output of upper comparator changes state and is reset, the Q input of the bistable then goes high, therefore the TR1 is driven into conducting state until another trigger pulse is received [11]

Therefore if the variable resistance varied to the left the resistance will be

= 1kΩ + 171 and 301 to the left.

Therefore

1KΩ + 170+300 + 1KΩ

Non-inverted voltage will be

= (9 × 171× 10 3)/ (171 × 10 3 + 301 × 10 3)

Non inverted voltage = - 3.2V

Comparing,

-3.2 will remain uninverted while – 4.79V will be inverted to positive 4.79V by the inverting input of the operational amplifier.

Therefore in comparison, -3.2V + 4.79

= 4.79 – 3.2 V = 1.529V

Hence , the operational amplifier will amplify it by its gain which was 10,000, but because the rail voltage is just 9V therefore it was amplified to 2V less than 9V.

Therefore , it will be 7 volt amplified.

But in darkness, or when light intensity is 0.8V, the negative voltage at the non – inverted input will superimpose the positive voltage of the inverted input.

Comparing, $72 \times 10^{-3} - 3.2V = - 3.128V$. Therefore ,the negative voltage will supersede the positive,thereby making the output of the operational amplifier negative.

3.1.8 The Emitter Follower Transistor

The emitter follower is a common collector transistor in which the output is in the emitter direction.it has high input resistance

$$\text{Thus},\ V_{in} = (Vs \times R_{in}) / (R_s + R_{in}) \qquad (3.18)$$

The circuit diagram of the emitter follower transistor is shown in fig. 3.10

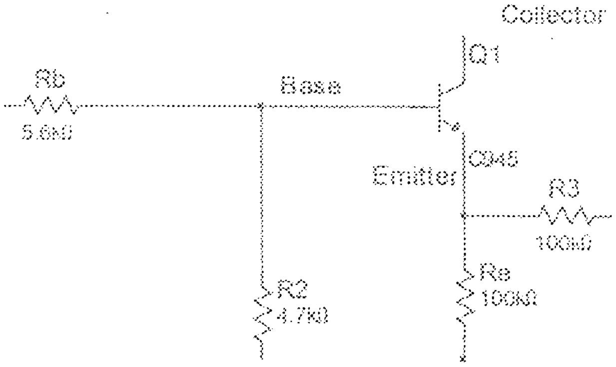

Fig. 3.10: Emitter Follower Transistor

Where,

Vs = source voltage

R_{in} = input resistance

Rs = source resistance

$R_{in} = R_{TIN} // \beta (R_e + R_{EN})$

R_{BN} = total resistance between base to ground

$R_E = (26 \times 10^{-3}\,V) / I_E$

$I_B = (7 - 0.7) / (10\ 10^{3})$

$I_B = 6.3 \times 10^{-4}\,A$

$I_C =$ gain $\times\ I_B$

$I_C = 200 \times 6.3 \times 10^{-4}$

$I_C = 0.126A$

$I_C = I_E$

$R_E = (26 \times 10^{-3}\,V) / 0.126$

$R_E = 0.206\,\Omega$

$R_{EN} = R_E \parallel r_{ce} \parallel R_L$

R_E' = emitter resistance

r_{ce} = internal resistance between collector to emmiter which was 200kΩ for silicon transistor.

R_L = load resistance

$$R_E \parallel r_{ce} = \frac{10\times10^3\times200\times10^3}{10\times10^3+200\times10^3} = 9.5K\Omega$$

$$9.5K\Omega \parallel 1K\Omega = \frac{9.5\times10^3\times1\times10^3}{9.5\times10^3+1\times10^3}$$

$R_{EN} = 902.7\Omega$

The input resistance, R_{in}

$R_{in} = (5.6 \times 10\ 3 \parallel 200\,(0.21 + 902.7)$

$r_{in} = (5.6 \times 10\ 3) \parallel (180.26 \times 10\ 3)$

$= 5.432K\Omega$

$$V_{in} = \frac{7\times5.43\times10^3}{5.6\times10^3+5.43\times10^3} =$$

$V_{in} = 3.45V$

$$r_{in} = 5.432K\Omega$$

$$V_{in} = \frac{7 \times 5.43 \times 10^{3}}{5.6 \times 10^{3} + 5.43 \times 10^{3}} =$$

$$V_{in} = \quad 3.45V$$

$$\text{Gain} = \frac{R_{EN}}{re + R_{EN}} \qquad (3.19)$$

$$Gain = \frac{902.7}{0206 + 902.7} = 0.9997$$

Gain = 0.9997

Voutput = gain × Vinput

Voutput = 0.9997 × 3.45

Voutput = 3.4492V

Therefore, 3.4492 V was delivered to the output of the emitter follower transistor which was fed to the input pin 2 of the 555 timer.

3.1.9 Timer

This is the pulse generated at a given duration; this could be generated by astable and monostable timer circuit.

Pulse characteristics are noted on this design which are:

- pulse repetitive frequency
- pulse width
- rise time
- fall time

The 555 timer in this design is a monostable device; the timing period was initiated by a high to low transition applied to the trigger input. When the trigger edge is received and the trigger input voltage falls below the supply voltage, the output of the comparator goes high, at this point, the bistable is placed in the "Set" state, the Q output of the bistable is kept low, TR1 is placed in the off state (non – conducting state) and pin 3 goes high.

The capacitor C then charges through the series resistor, the capacitor will charge until the voltage at the threshold reaches two thirds of the supply voltage, at this point, the output of the upper comparator changes state and is reset, the Q output of the bistable then goes, therefore the TR1 is driven into conducting state until another trigger pulse is received. The trigger voltage is the voltage from the operational amplifier which is varied by the regulated time light interference, this delivers each pulse to the 555 timer input at each point the light is interfered. Therefore if the time is delayed by the RC circuit, the response time to the trigger voltage will be poor at every light interfered time interval.

Time Delay = 1.1 × RC

Where R= resistor

And C = capacitor

Fig.3.11 shows the circuit diagram of the 555 timer.

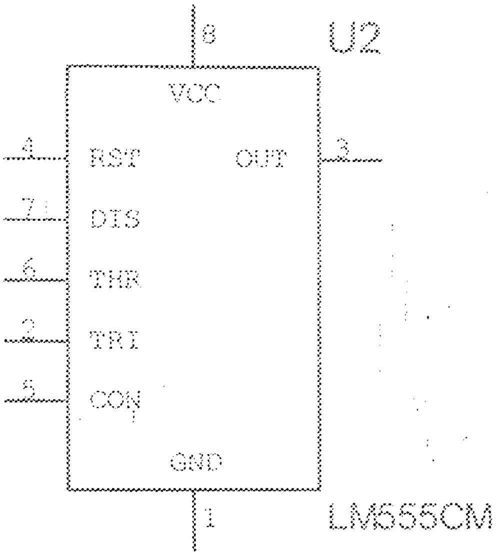

Fig.3.11 Circuit diagram of 555 timer

3.2.0 The Controlling Module

Decade Counter

A counter is a combination of flip flops and gates that can count either up or down, depending on the implementation. Counters are available in 4-bit blocks that can both increment and decrement and count to either 15 (binary counter) or 9 (decade counter) before restarting the count at 0.

The decade counter used is a CMOS decade counter, precisely the 4017 CMOS counter.It has 10 decoded outputs, inputs include a clock from the 555 timer set on varied time pulse to time the sequential pulse output of the decade counter. The decade counter drives an internal schmitt trigger circuit for pulse shaping and allows for unlimited clock rise and fall time, the clock is advanced one count at the rising edge of the clock signal, if the clock inhibit line is low, a high reset signal reset the the initial count,the circuit was configured to count less than 10 by connect reset to outpin 7 above the desired count. The outputs were sequentially changed due the varied voltage displayed by the operational amplifier controlled by the remote control. The sequential pulses diplayed were timed using the variable resistor and the capacitor of the monostable 555 timer.The duration controlled pulses were fed to the transistor. The voltage delivered by the decade counter is 7V from the 9V because of the function of the operational amplifier which amplifies any voltage 2V less than the rail voltage.

Fig 3.12 shows the diagram of the 4017 Decade counter

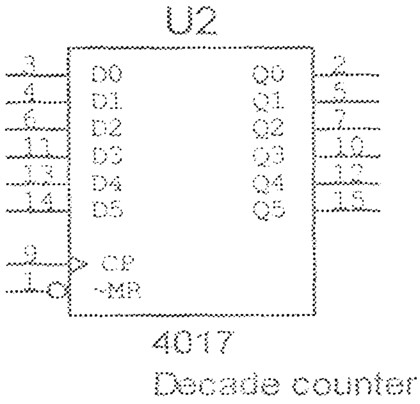

Fig. 3.12: Circuit diagram of 4017 decade counter

3.2.1 The Switching Module

The switching module comprises a bipolar junction transistor in common emitter configuration. Fig. 3.13 shows the diagram of Common emitter transistor.

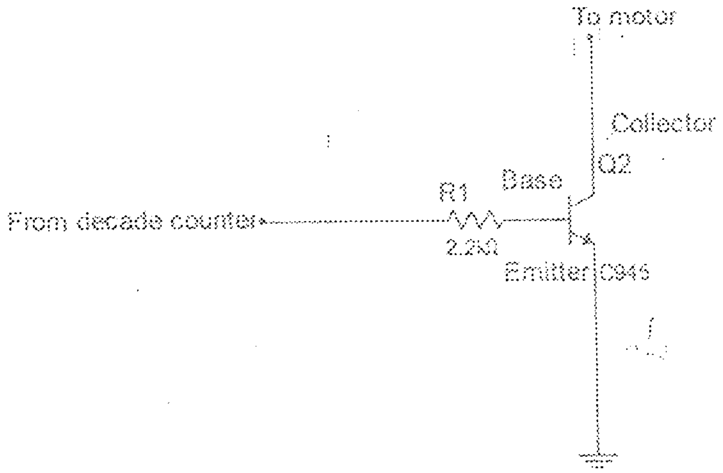

Fig 3.13 Common emitter transistor

$V_H = 7V$

$V_L = 0$

The resistance of the motor is denoted as R_L i.e the load resistance encountered by the transistor.The voltage rating of the motor is 5V and 300mA, current rating

Therefore ,

$$R_L = \frac{5}{300 \times 10^{-3}}$$

$R_L = 16.7\,\Omega$

$\therefore$ the base current, $I_B = (V_B - 0.7)/R_B$

Where R_B , the base resistance $= 2.2K\,\Omega$

$I_B = (7 - 0.7)/(2.2 \times 10^3 = 0.028A$

$\therefore$ at $V_B = 2.8 \times 10^{-3}A$

$\therefore$ $I_C = \beta \times I_B$

$I_C = 200 \times 2.8 \times 10^{-3}$

$I_C = 200 \times 2.8 \times 10^{-3}$

$I_C = 0.572A$

Therefore the voltage drop at the collector,

$$V = I_C \times R_C \quad (3.20)$$

$$V = 0.572 \times 16.7\Omega$$

$$V = 9V$$

9V was used to control the movement of the rotor which represents the turbine engine that will mobilize the generator to revolve the setup for power supply. Two or more generators could also be interchanged by the time setting of the system.

The overall circuit diagram of the generator remote control device is shown in fig. 3.14

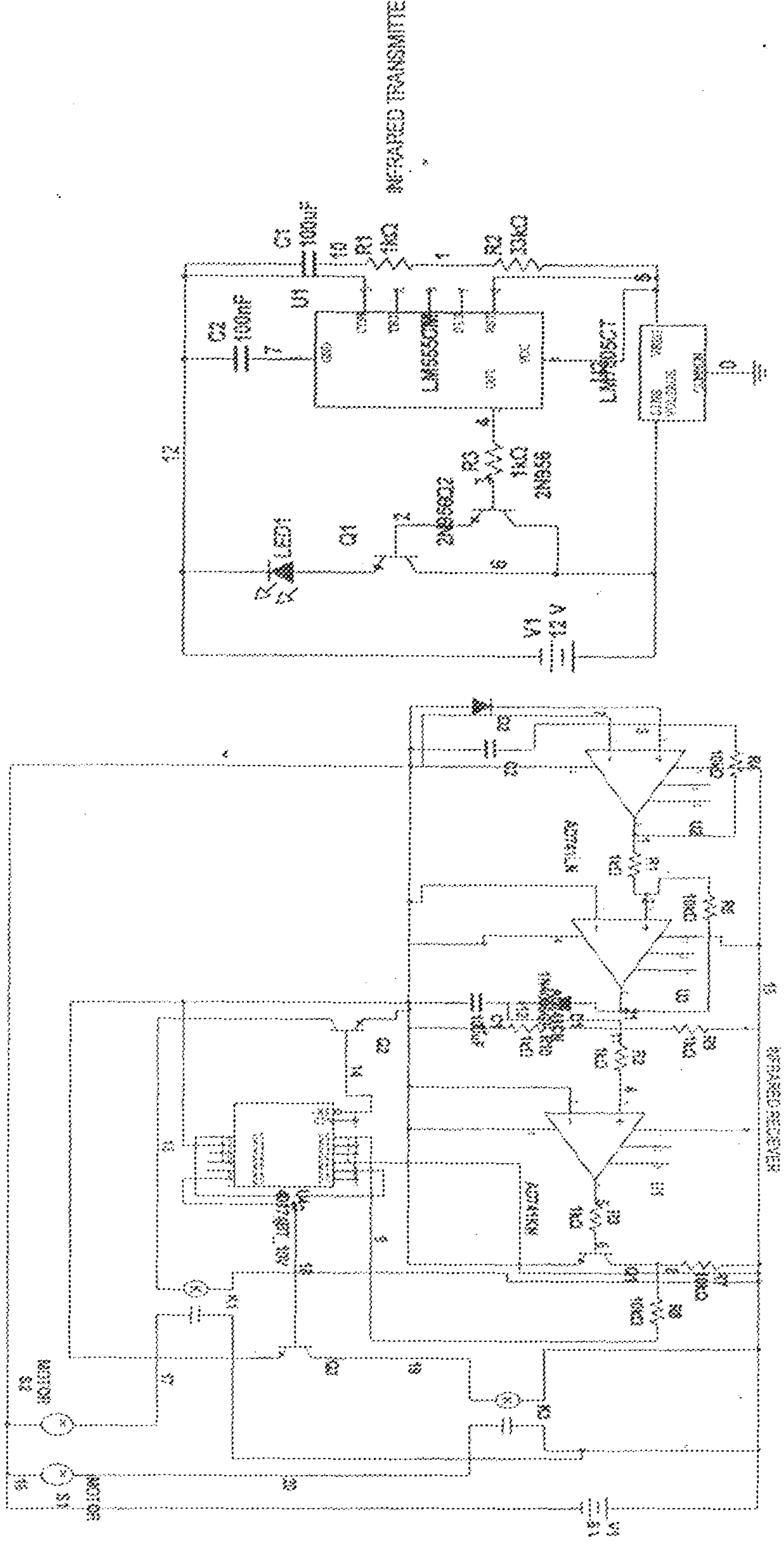

Fig 3.1.4: Generator remote control device

CHAPTER FOUR
TESTS, RESULTS AND DISCUSSION

4.1 Circuit Construction

The circuit's construction involves making the circuit diagram on paper a reality. The first step involved mounting the circuit on the bread board as temporary connection. The aim was to check the workability of the circuit's design before the permanent soldering of components on the veroboard. The bread board construction involved a close study of the circuit diagram. The circuit was divided into modules as shown in the circuit's design. Each module was constructed independently before they were joined together as one.

The success of the bread board construction made it possible to start the construction on the veroboard. It was a permanent connection of the components in accordance with the circuit diagram. The connection was achieved through soldering.

The veroboard was cut to suit the size of the circuit and it was further divided into regions consisting of the circuit modules. Each module was completed independently and then connected together as a complete circuit.

The power circuit which was quite sensitive was constructed with great care. Proper checks were carried out to prevent or remove short circuits and power bridges.

4.2 Casing Construction

The casing was made of plastic material. The full material was cut into size to fit the circuit. The plastic casing was chosen to enable ease of handling while making holes and to serve as insulation for the circuit. The plastic case as shown in fig. 4.1 was constructed with a space provided for the infrared receiving and transmitting components above. This was done so as to provide a reasonable distance range for good reception. Also, a provision was made on the casing for power supply input.

Fig. 4.1 shows the casing of the project design.

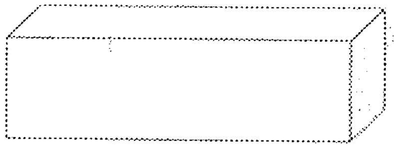

Fig 4.1 Casing

4.3 Continuity Test

Sequel to the completion of all neccesary connections, various tests were then carried out on the project without the power supply.

Before the system was powered, it was thoroughly checked to ensure that the wiring of the circuit was correctly done. This is the continuity test .After the tests, corrections were made to the few errors detected.

After the continuity test, all the modules were then mounted on their respective bases,module after module. The circuit was then activated by connecting it to the regulated 12V DC supply, with the power indicator on, an avometer was connected between the positive and negative power supply line to ensure that the correct supply level was obtained.

When the transmitter module was powered, it was discovered that it was not transmitting as expected, the unit was closely inspected and it was discovered that one of the leads of the infrared LED had broken loose, it was soldered back and the unit began to perform .

After the tests, the circuit was integrated since all the units were performing to expectation.

4.4 System Testing

The whole system functionality was tested after incorporating all the modules. The test was carried out by pressing the transmitter button. This action switched on the motors and the LEDs, pressing the button again switched off the first motor – LED combination, and powered on another set. This proved that the system was functioning.

The timing operation of the remote was tested by varying the value of the resistor in the RC circuit of the 555 timer in the remote. The various values and the corresponding time delays are tabulated in table 4.1.

The time duration of the pulses was calculated by the formula; $T = 1.1 \times RC$

4.5 Results

Table 4.1 : The table showing the resistor- capacitor combination for timing.

Capacitor(µF)	Resistor (Ω)	Time (s)
100	10K	1.1
100	20K	2.2
100	20K	3
100	47K	5

Therefore, the timing of the generator operation was thus achieved.

CHAPTER FIVE

CONCLUSION, PRECAUTIONS AND RECOMMENDATIONS

5.1 Conclusion

This project entails the design, contruction ansd testing of a generator remote control and it is achieved using infrared components and integrated circuits. The project involves using an infrared remote control to switch on a generator model. Cost implicaton, economic relevance and accessibility of components were considered. The project construction performed to expectation.

5.2 Problems encountered

While carrying out this project work, several problems were encountered. Some of them are:

I. The difficulty encountered sourcing for some components

II. Irregular power supply

III. Wastage of resources time and energy resulting from damage of some components during soldering.

IV. The susceptibility of the infrared rays to obstruction.

5.3 Precautions

I. The remote control was used within line of sight.

II. Soldering of components was carefully done to avoid short-circuit problems.

III. Components were sourced from reliable outlets.

5.2 Recommendation

I. The range of the remote control can be increased by further amplification

II. Radio frequency signals can also be used.

III. A microcontroller can be used to enhance the timing circuits.

REFERENCE

[1] S, Gibilisco, The Illustrated Dictionary Of Electronic, McGraw Hill Publishers, New York, 2001.

[2] Retrieved from http://www.infrared.com / histo.html (accessed on 16-7-2008)

[3] Retrieved from http://www.modelbahnott.com/remote/history.html (accessed on 19-7-2008)

[4] Retrieved from http://www.enwikipedia.org/wiki/infrared_systems.html (accessed on 13-7-2008)

[5] Retrieved from http://www.irda.com/devices.com (accessed on 20-7-2008)

[6] Retrieved from http:// www.flirthermography.com/about/ir_history.asp (accessed on 2-8-2008)

[7] Retrieved from http://www.datasheet4u.com/html/P/I/R/PIR324_Glolabpdf.html (accessed on 23-8-2008)

[8] B.L. Theraja and A.K. Theraja, Electrical Technology, 2002 edition. S.Chand and Company Ltd. India, 2002, pp 1922 – 1939.

[9] Henry Zanger, Semiconductor Device and Circuits, John Wiley and Sons Inc, Published in United States of America,2003, pp 80-87, 120-130, 167-169, 202-216, 220-222. 455-458, 497-505, 534-545, 539.

[10] Tarmo Anttalainen, Introduction to Telecommunications Network Engineering, 2nd edition, New York, Artech House, 2003, pp 160 -161.