DECLARATION

I, Iliyasu Umar, 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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DEDICATION

DESIGN AND CONSTRUCTION OF INFRARED REMOTE CONTROL POWER SUPPLY UNIT OF HOME APPLIANCES

BY

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2001/12006EE

A THESIS SUBMITTED TO THE DEPARTMENT OF
ELECTRICAL/COMPUTER ENGINEERING
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

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My special and sincere thanks go to my father Alhaji Iliyasu Masanawa and My brother Alhaji Dahiru Mangal that help me both financially and morally to complete my degree successfully. May Allah who blessed them with these resources, with which they took care of me and ensured my successful University education, continue to bless them all the days of their lives.

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My utmost appreciation goes to all my friends both in school and at home for being there all through my struggles, I thank them all, may Allah in his infinite mercy reward them abundantly.

ABSTRACT

The project is the design and construction of an infrared remote controlled power supply switching unit, which is a device that enables the user to operate or control the mains power supplied to a room from approximately 5 to 10 meters away. The use of the remote, to control the mains power supply was borne out of the need to make life simple for the handicaps and the average individuals alike.

The remote transmits a beam of light using an infrared light emitting diode, which cannot be seen by the human eye. This light is picked and decoded by the receiver unit (Photodiode). Since the receiver only activates when it receives the beam of light, there are no accidental activations.

The top-down design approach was used in the design and implementation of this project, whereby the system was broken down into simpler functional blocks. The successful implementation of this project involved the careful plan and layout of the circuit components so that troubleshooting and repairs could be carried out with much ease.

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CHAPTER ONE

1.0 Introduction

The past few decades has witnessed tremendous advancement in the field of science and technology anchored on the development in the electronics and computer world. In all of this, it is the duty of the engineer to ensure that this advancement are undertaken and maintained with the available minimum resources. Micro electronics is a form not far fetched. It entails the ability to miniaturize very complex electronic circuits to small chips. These chips are interconnected with other chips and discrete electronic component via the tracks of a printed circuit board. PCB is not a very expensive material; the cost comes from the chips placed on them.

With advancement in engineering technology over the year's life has been made easier as engineering has and is always devising new ways (methods) of identifying and solving problems. These problems could be mechanical, structural, environmental chemical or electrical.

Electrical engineering can now be imperiously said to be the finding of electrical solutions various human needs and problems. This can be achieved using electrical components and circuits.

Engineering's greatest goal is to satisfy all of man's needs found within its fields and current capabilities, because man has always had needs and desires which are numerous.

Man's need may spread from easier ways of production and construction to his protection and convenience to protection from natural disasters, his fellow man etc. One major problem faced by man is protection against electrical disaster or faults in our homes offices etc. In spite of the various complex measures and means employed to

combat this problem of protection against electrical faults, circuit breakers etc in our homes and offices, these problems continue to eat deep in most cases, like cases of over current or over voltage which is as a result of a phase to phase fault on the distribution cables. With the advancement in technology new electrical protective devices with various levels of complexity have been designed for this purpose. Even with this, different failures from these systems have been recorded. These systems also have a disadvantage when it comes to their cost of production and installation, taking into consideration the economical state of some part of the world these system are deemed unaffordable. This motivated the design and construction of a reliable cost effective protective device, "the remotely controlled power supply switching unit" to be used in collaboration with some other forms of protective devices (circuits breakers and fuses). The primary aim of this project is to give a sample cost effective and reliable circuit (protective system) which will aid in protecting electrical and electronic devices in our homes and offices with ease.

1.1 Scope of the project

The remote control functions as soon as a key or button is pressed, and the information is translated into infrared light signal that is received by the receiving appliances.

Usually, the transmitter part is constructed so that the transmitter oscillator which is driving the infrared transmitter LED can be turned ON/OFF by applying a CMOS (Complementary metal oxide semi conductors) voltage on the input control. On the receiver side a photodiode takes up the signal amplifies it, and then it operates the device connected to it.

Basically a remote control operates in the following manner. A button is pressed; this completes a specific connection which produces a Morse code line signal specific to that button. The transistors amplify the signal and send them to the LED which translates the signal into infrared light the sensor on the appliance detects the infrared light and response appropriately to the received signal or command.

1.2 Project objectives and motivation

The aim of the project is to facilitate the protection of electrical and electronic devices from electrical faults in the home. And also to facilitate the control of mains supply to a room from a distance easily.

My motivation for the design and construction of this project was the need to make life a little easier and convenient for both the physically handicapped and the normal human being and most of all for protection against electrical faults.

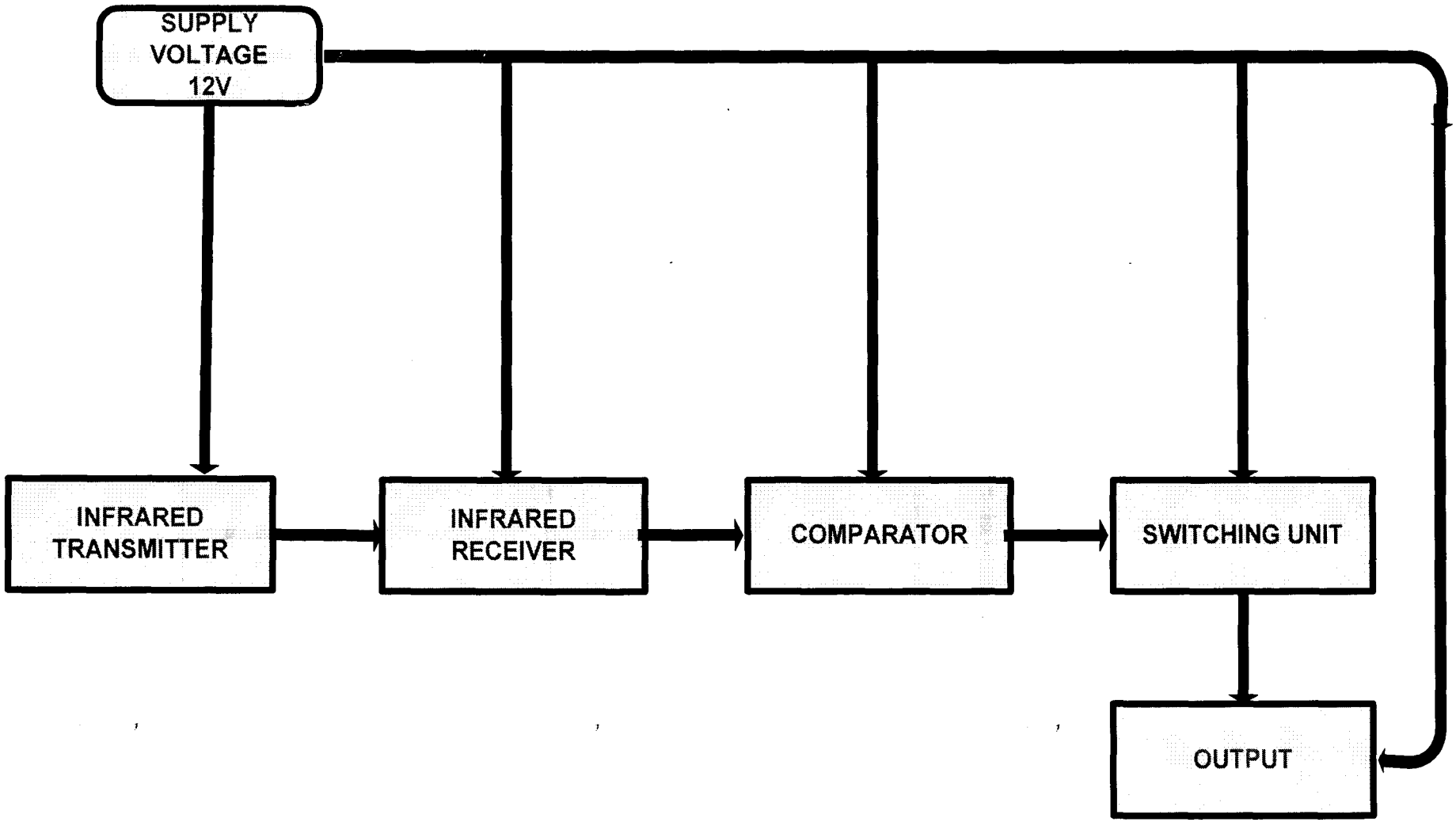


Fig 1.0 General Block Diagram of the Remote Control Power Supply System

CHAPTER TWO

LITERATURE REVIEW/THEORETICAL BACKGROUND

2.0 Introduction

The infrared remote control is made up of a transmitter and a receiver (Photo detector). The transmitter transmits light with a particular colour within the frequencies of 30KHz and 60KHz having a wave length of about 950nm. This is just below the red part of the visible light spectrum, and cannot be seen by the human eye.

The control works by pressing a button on the transmitter, which sends signals by a binary code, a series of logical zeros and ones having different combinations to tell the receiver what to do [14].

These codes hold information, like the address to the receiver i.e. the particular receiver the information was meant for and also to the appropriate location, with commands to be executed. The first thing the transmitter sends to the receiver is called the header. The header is a burst of high that alerts all the infrared receivers in an area.

After the header comes the code which includes the address to the specific receiver that is to be operated. Then comes the command that tells the receiver what to do, this command will continue as long as a button on the transmitter is held or pressed down when the button is released a string of code as sent to the receiver telling it to stop.

2.1 Literature review

One of the earliest examples of a remote control development in 1893 by Nikola Tesla and described in his patent U.S patent 613809, named, method of and apparatus for controlling mechanisms of moving vehicle (s) [6].

The first remote controlled model airplane flew is 1932. The first remote control intended for a television was developed by Zenith Electronics Corporation (then known as Zenith Radio Corporation) in the early 1950s the remote unofficially called "lazy bones" used a wire to connect to the TV set. A motor is the TV set operated the tuner through the remote control by pushing buttons on the remote control viewers rotated the tuner clockwise or counterclockwise depending on whether they wanted to change the channels to a higher or lower number. The remote control included buttons that turned the TV set on and off [9].

Although, customers liked having remote control of their TV sets, they complained that people tripped over the unsightly cables that meandered across the floor of the living room. To improve the cumbersome setup, the first wireless remote control was created in 1955 by Zenith Engineer Eugene Polley. The remote called "Flashmatic" worked by means of four photocells, one in each corner of the TV screen. The viewer used a highly directional flashlight to activate the four-control function, which turned the pictures and sound on and off, and changes channels by turning the turner dial clockwise and counterclockwise. But the flashmatic had some limitations. It was a simple device that had no protection circuits and, if the TV set was placed in an area in which the sun shone directly on it, the turner might start rotating [3],[7].

Commander McDonald loved the concepts proven by pulley's flashmatic and directed his engineers to develop a better remote control. First thoughts pointed to radio. But, because they travel through walls, radio waves could inadvertently control a TV set in an adjacent apartment or room [11].

Using distinctive sound signals was discussed, but Zenith engineers believed people might not like hearing a certain sound that would become characteristic of operating the TV set through a remote control.

It also would be difficult to find a sound that wouldn't accidentally be duplicated by either household noises or by the sound coming from TV programming.

Regardless of the specific system chosen, Zenith sales people were against using batteries in the remote control. In those days batteries were used primarily in flashlights. If the batteries went dead, the sales staff said, the customer might think something was wrong with the TV. If the remote control didn't emit light or show any other visible sign of functioning, people would think it was broken once the batteries died.

Zenith's Dr. Robert Adler suggested using "Ultrasonic", that is, high frequency. Sound, beyond the range of human hearing. He was assigned to lead a team of engineers to work on the first use of ultrasonic technology in the home, as a new approach for a remote control.

The transmitter used no batteries, it was built around aluminum rods that were light in weight and, when struck at one end, emitted distinctive high frequency sound. The first such remote control used four rods, each approximately 2 - 1/2 inches long. One for channel up, one for channel down, one for sound on and off, and one for on and off.

They were very carefully cut to lengths that would generate four slightly different frequencies they were excited by a trigger mechanism similar to the trigger of a gun that stretched a spring and they released it so that a small hammer would strike the end of the aluminum rod.

The device was developed quickly with the design phase beginning in 1955 called Zenith Space Command the remote went into production in the fall of 1956, becoming the first practical wireless remote control device.

The original space command remote was expensive because an elaborate receiver in the TV set, using additional six vacuum tables was needed to pick up and process the signal though adding the remote control system increased the price of the TV set by about 30 percent it was a technical success and was adopted in later years by other manufacturers.

In the early 1960s solid state country (i.e. transistors) began to replace vacuum tables. Hand held battery powered control units could now be designed to generate the inaudible sound electronically.

By the early 1980s, the industry moved to infrared or IR, remote control technology. The IR remote works by using a low frequency light beam so low that the human eye cannot see it, but which can be detected by a receiver in the TV. Zenith's development of cable compatible tuning and Teletext technologies in the 1980s greatly enhanced the capabilities and uses for infrared remotes which replaced ultrasonic remote controls.

Today remote control is a standard feature on other consumer electronic products including VCRs, cable and satellite boxes, digital video disc players and home audio receivers. And the most sophisticated TV sets have remotes with as many as 50 buttons.

In year 2000, more than 99 percent of all TV sets and 100 percent of all VCRs and DVD players sold in the United States are equipped with remote control. The average individual these days probably picks up a remote control at least once or twice in an hour.

With most pieces of consumer electronics from camcorder to stereo equipment an infrared remote control is usually always included.

2.1 Component theory

2.1.1 Transistors

Transistors are active components used basically as amplifiers and switches. The two main types of transistors are. The bipolar junction transistors whose operation depends on the flow of both minority and majority carriers, and the unipolar or field effect transistors (called FETs) in which current is due to majority carriers only (either electrons or holes). The transistor as a switch operates in a class 'A' mode. In this mode of bias the circuit is designed such that current flows without any signal present. The value of bias current either increased or decreased about its mean value by input signals (if operated as an amplifier), or ON and OFF by the input signal if operated as a switch fig.2.0 shows the transistor as a switch.

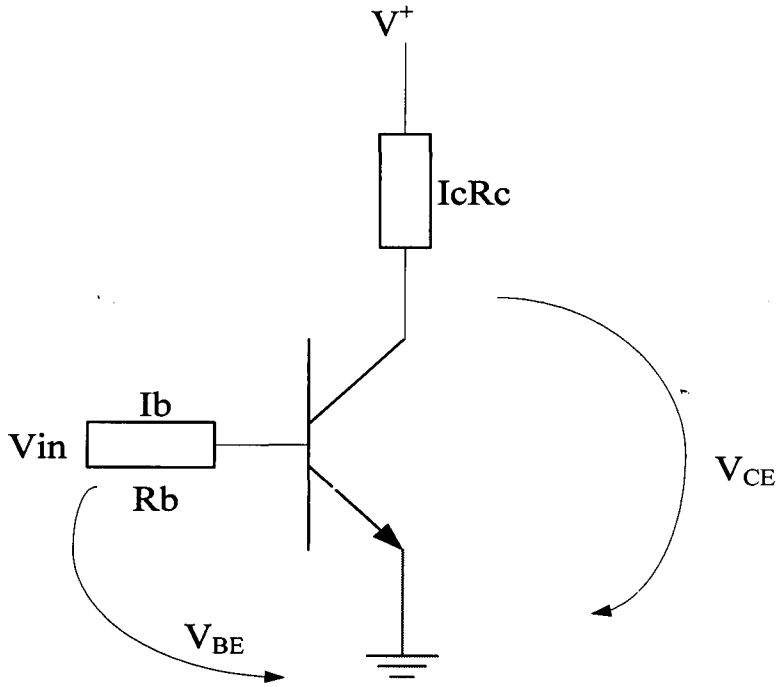


Fig. 2.0 transistor as a switch

For the transistor configuration, since the transistor is biased to saturation

$V_{CE} = 0$, when the transistor is ON,

This implies that,

$$V^+ = I_C R_C + V_{CE} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.5)$$

$$V_{in} = I_B R_B + V_{BE} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.6)$$

$$\frac{I_c}{I_b} = h_{fe} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.7)$$

$$R_b = \frac{V_{in} - V_{BE}}{I_b} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.8)$$

Where

I_c = collector current

I_b = base current

V_{in} = input voltage

V^+ = Supply voltage

V_{CE} = collector emitter voltage

H_{fe} = current gain

V_{BE} = Base emitter voltage.

2.1.2 Comparator (LM 393)

General Description

The LM393 series consists of two independent precision voltage comparators with an offset voltage specification as low as 2.0 mV max for two comparators that were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. These comparators also have a unique characteristic in that the input common-mode voltage range includes ground, even though operated from a single power supply voltage.

Features

Wide supply (Voltage range: 2.0V to 36V, Single or dual supplies: ±1.0V to ±18V), Very low supply current drain (0.4 mA) independent of supply voltage, Input common-mode voltage range includes ground, Differential input voltage range equal to the power supply voltage.

Applications

Application areas include limit comparators, simple analogue to digital converters; pulse, square wave and time delay generators; wide range V_{CO}; MOS clock timers; multivibrators and high voltage digital logic gates.

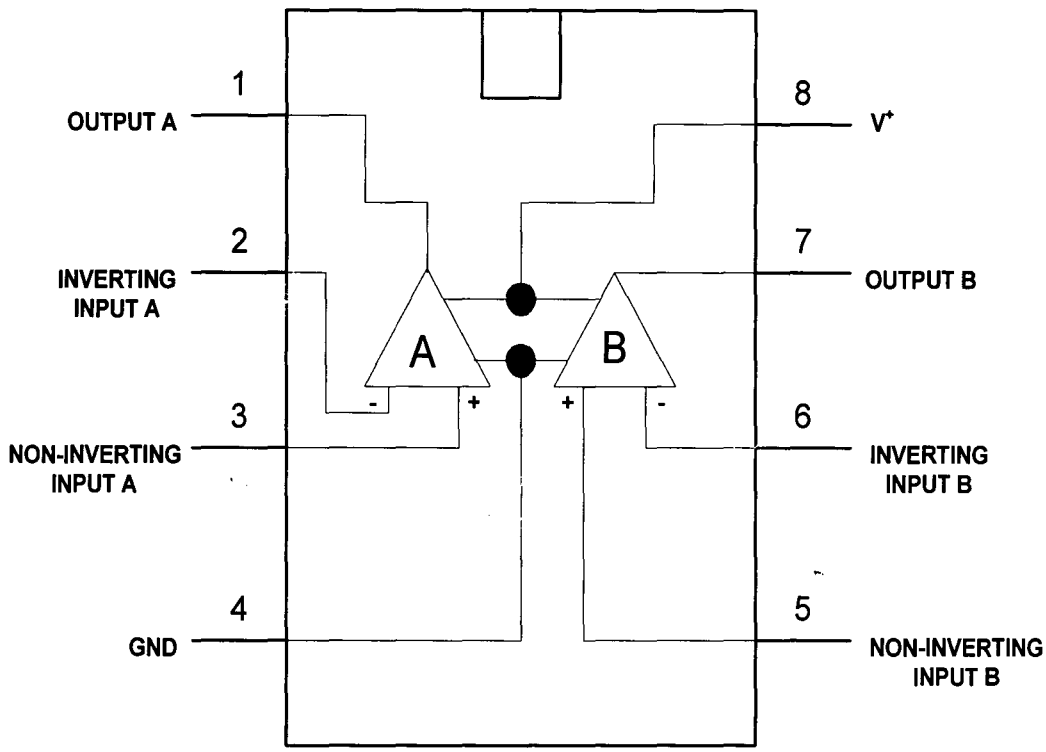


Fig.2.1 top view of LM393

2.1.3 Relay

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field, which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches.

Relays allow one circuit to switch a second circuit, which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current; typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timers IC is 200mA so these devices can supply relay coils directly without amplification.

Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available. Most relays are designed for PCB mounting but you can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay.

The supplier's catalogue should show you the relay's connections. The coil will be obvious and it may be connected either way round. Relay coils produce brief high voltage 'spikes' when they are switched off and this can destroy transistors and ICs in the circuit. To prevent damage you must connect a protective diode across the relay coil.

The animated picture shows a working relay with its coil and switch contacts. You can see a lever on the left being attracted by magnetism when the coil is switched on. This lever moves the switch contacts. There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT.

The relay's switch connections are usually labeled COM, NC and NO:

- COM = Common, always connect to this; it is the moving part of the switch.
- NC = Normally Closed, COM is connected to this when the relay coil is off.

- NO = Normally Open, COM is connected to this when the relay coil is on.
- Connect to COM and NO if you want the switched circuit to be on when the relay coil is on.
- Connect to COM and NC if you want the switched circuit to be on when the relay coil is off.

A relay is a switch operated by an electromagnet; it is useful if we want a small current in one circuit to control another circuit containing a device such as lamp or electric motor which requires a large current, or if we wish several different switch contacts to be operated simultaneously. In this project, a relay was used to control the switching effect of the bulbs used. Fig below shows the symbol of a relay. The current needed to operate a relay is called the pull-in current and the dropout current is the current in the coil when relay just stops working

If the coil resistance of a relay R and its operating voltage is V, then the pull-in current

$I = V/R$

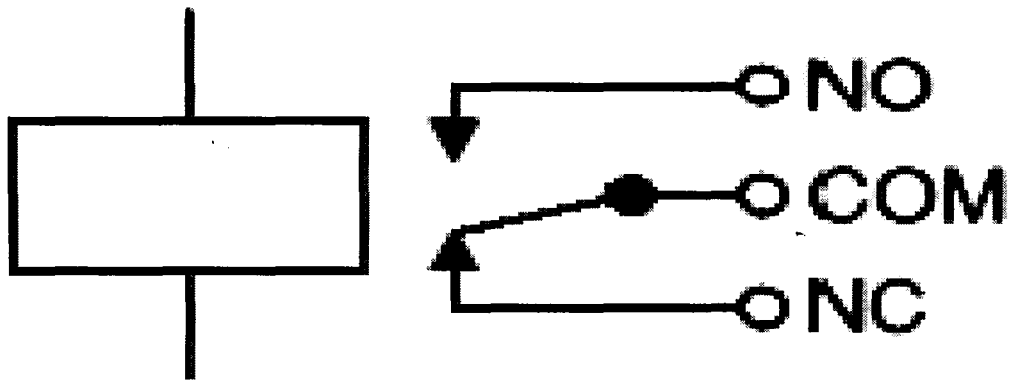
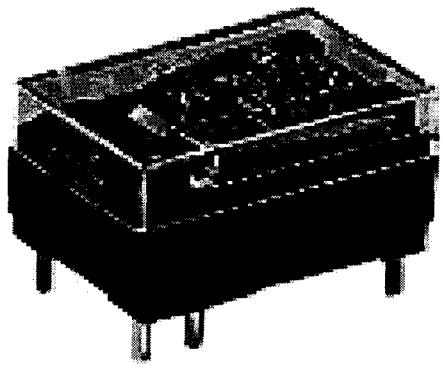


Fig 2.2a circuit symbol of a relay



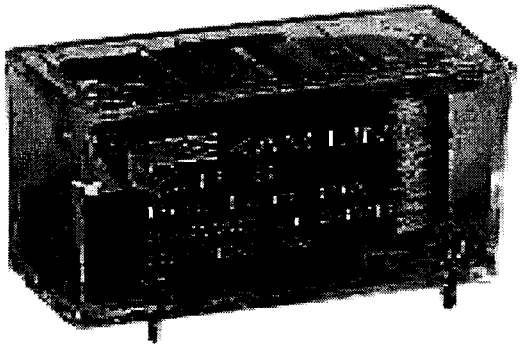


Fig 2.2a and b showing Relays pictures

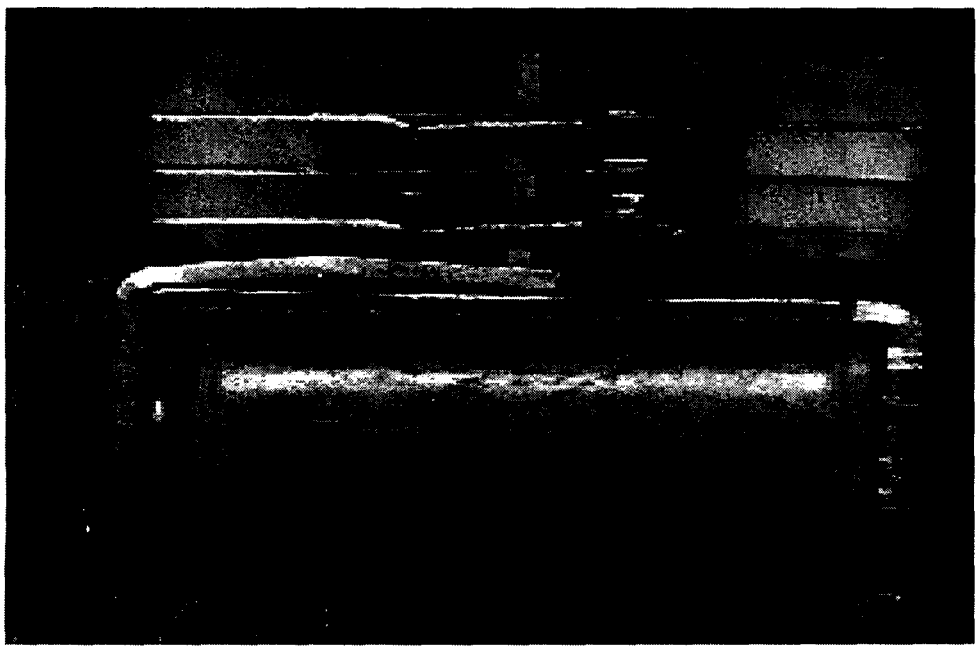


Fig 2.2d Relay showing coil and switch contacts

2.1.4 Protection diodes for relays

Transistors and ICs (chips) must be protected from the brief high voltage 'spike' produced when the relay coil is switched off. The diagram shows how a signal diode (eg 1N4148) is connected across the relay coil to provide this protection. Note that the diode is connected 'backwards' so that it will normally not conduct. Conduction only occurs when the relay coil is switched off, at this moment current tries to continue flowing through the coil and it is harmlessly diverted through the diode. Without the diode no current could flow and the coil would produce a damaging high voltage 'spike' in its attempt to keep the current flowing.

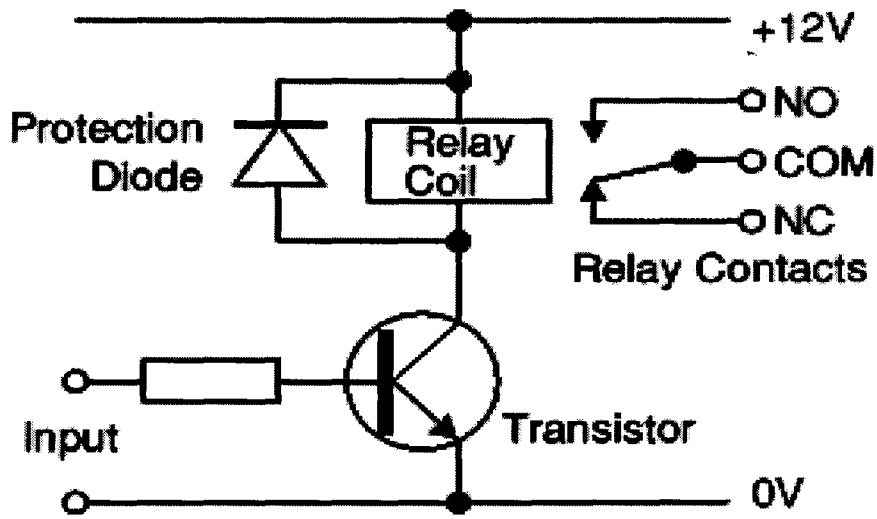


Fig 2.3 Relay connected in a protective mode

The relay acts as a switch and as an isolator in this project because it was used to isolate the main circuit from the AC supply line, and it switches the power supply of a given room ON or OFF as the case may be.

2.5 IC Timers

The emanation of IC timers eliminated a wide range of mechanical and electromechanical timing devices. It also helped in the generation of clock and oscillator circuits.

Timing circuits are those, which will provide an output change after a predetermined time interval. This is of course, the action of the monostable multivibrator which will give time delay after a fraction of a second to several minutes quite accurately. The most popular of the present IC, which is available in an eight-pin dual inline package in both bipolar and CMOS form is 555 timer.. The 555 timers is a relatively stable IC capable of being operated as an accurate bi-stable, monostable or astable multivibrator. The timer comprises of 23 transistors, 2 diodes and 16 resistors in its internal circuitry. Its functional diagram is shown in fig. 2.3 below.

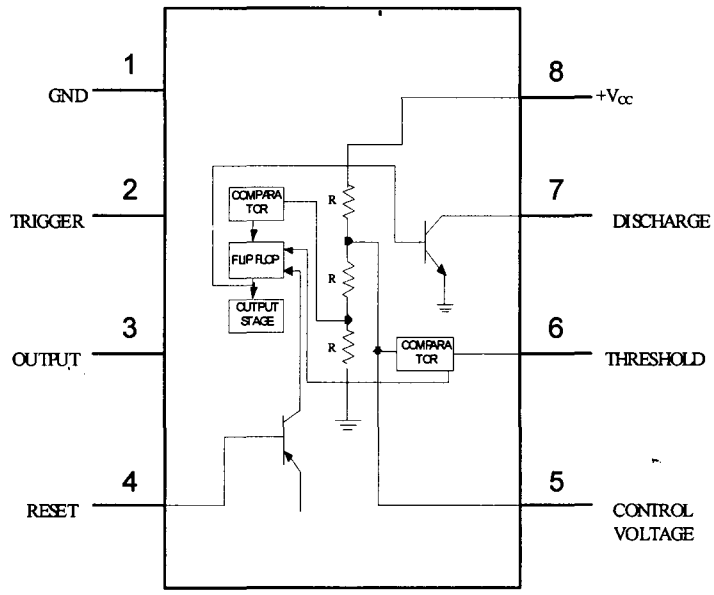


Fig.2.3 functional diagram of 555 timer

The functional diagram consists of two comparators, a flip-flop, two control transistors and a high current output stage. Two comparators are actually operational amplifiers that compare input voltage to internal reference voltage which are generated by internal voltage divider of three 5K resistors.

The reference voltages provided are one third and two third of Vcc. When the input voltage to either of the comparators is higher than the reference voltage for the comparator, the amplifier goes to saturation and produces an output signal to trigger the flip-flop. The output of the flip-flop controls the output stage of the timer. The 555 timer chip works from a D.C supply between 3-15V and can source or sink up to 200mA at its output.

The operation of the 555 timers is further defining the functions of all pins. The details regarding connection to be made to pins are as follows.

Pin 1: This is ground pin and should be connected to the negative side of the power supply voltage.

Pin 2: This is the trigger input. A negative going voltage pulse applied to this pin when falling below 1/3 V_{CC} causes the comparator output to change state. The output level then switches from LOW to HIGH. The trigger pulse must be of shorter duration than the time interval set by the external CR network other wise the output remains high until trigger input is driven high again.

Pin 3: This is the output pin and is capable of sinking or sourcing a load requiring up to 200mV and can drive TTL circuits. The output voltage available is approximately -1.7V

Pin 4: This is the rest pin and is used to reset the flip-flop that controls the state of output pin3. Reset is activated with a voltage level of between 0V and 0.4V and forces the

output to go low regardless of the state of the other flip-flop inputs. If reset is not required, then pin 4 should be connected to same point as pin 8 to prevent resetting.

Pin 5: This is the control voltage input. A voltage applied to this point to this pin allows the timing variations independently of the external timing network. Control voltage may be varied from between 45 to 90 of the Vcc value in monostable mode. In astable mode the variation is from 1.7 to the full value of supply voltage. This pin is connected to the internal voltage divider so that the voltage measurement from here to ground should read 2/3 of the voltage applied to pin 8. If this pin is not used it should be bypassed to ground, typically use a 10nF capacitor. This helps to maintain immunity from noise. The CMOS ICs for most applications will require the controlled voltage to be decoupled and it should be left unconnected.

Pin 6: This is the threshold input. It resets the flip-flop and hence drives the output low if the applied voltage rises above two-third of the voltage applied to pin 8. Additionally a current of minimum value 0.1 A must be supplied to this pin since this determines the maximum value of resistance that can be connected between the positive side of the supply and this pin. For a 15V supply the maximum value of resistance is 20M.

Pin 7: This is the discharge pin. It is connected to the collector of an NPN transistor while the emitter is grounded. Thus the transistor is turned on and pin 7 is effectively grounded. Usually the external timing capacitor is connected between pin 7 and ground and is thus discharged when the transistor goes on.

Pin 8: This is the power supply pin and is connected to the positive end of the supply voltage. The voltage applied may vary from 4.5V to 16V. Although devices, which operate up to 18V, are available.

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 output low and discharges the capacitor. If the reset function is not required the reset pin should he connected to +Vs.

- **Power-on reset or trigger**

It may be useful to ensure that a monostable circuit is reset or triggered automatically when the power supply is connected or switched on. This is achieved by using a capacitor instead of (or in addition to) a push switch as shown in the diagram.

The capacitor takes *a* short time to charge, briefly holding the input close to OV when the circuit is switched on. A switch may be connected in parallel with the capacitor if manual operation is also required.

- **Edge-triggering**

If the trigger input is still less than 1/3 Vs at the end of the time period the output will remain high until the trigger is greater than 1/3 Vs. This situation can occur if the input signal is from an on-off switch or sensor.

The monostable can be made edge triggered, responding only to changes of an input signal, by connecting the trigger signal through a capacitor to the trigger input. The capacitor passes sudden changes (AC) but blocks a constant (DC) signal. The circuit is 'negative edge triggered' because it responds to a sudden fall in the input signal. The resistor between the trigger (555 pin 2) and +Vs ensures that the trigger is normally high (+Vs).

- **Bistable Operation**

The circuit is called a bistable because it is stable in two states: output high and output low, this also known as a 'flip-flop'.

It has two inputs:

- Trigger (555 pin 2) makes the output high.

  Trigger is 'active low', it functions when <1/3 Vs.

- Reset (555 pin 4) makes the output low.

  Reset is 'active low', it resets when < 0.7V.

CHAPTER THREE

3.0 system design and implementation

The remote controlled power supply switching unit was designed using six (6) functional blocks, namely:

- Power/Regulator stage
- The transmitter stage
- The detector (photo diode)
- Comparator stage
- The relay stage
- Output unit

3.1 Power / Regulator

The power supply used in this project is a linear power supply type which comprises of a step down transformer, filter capacitors, rectifier and voltage. The two regulators were used to give the various voltage levels used in this project. The power supply circuit diagram is shown below.

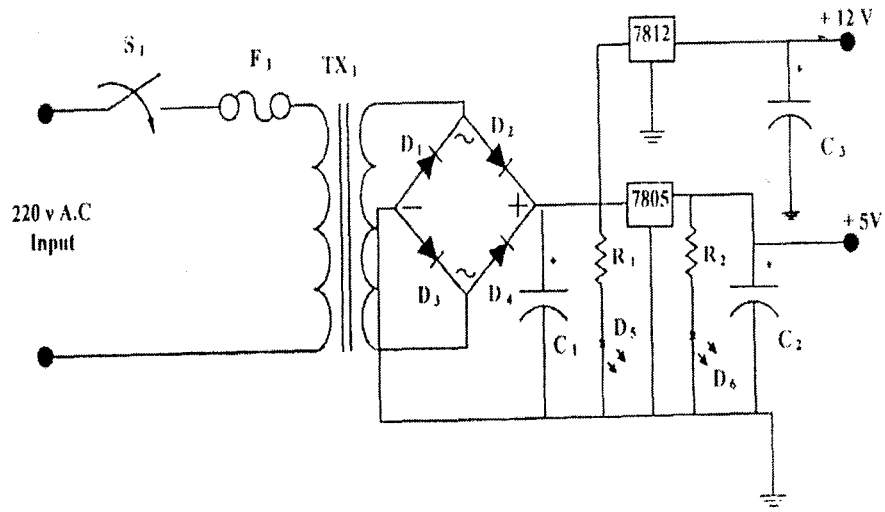


Figure 3.1 Power supply unit

3.1.1 The Transformer

The turn's ratio of a transformer in a d.c power supply can be selected to either increase or decrease the 220V ac input. With most electronic equipment, a supply voltage of less than 220V is required, and therefore, a step down transformer is used. The secondary output voltage (Vs} from the transformer can be calculated with the formula below.

$$Vs. = \frac{Ns \times Vp}{Np}$$

Where Vs = Secondary voltage of a transformer

Ns = Secondary windings of a transformer

Np = Primary windings of a transformer

Vp = Primary voltage of a transformer

Below is the simplest form of a single phase transformer which has two coils wound and a ferrous core. Usually, the coil is connected to the load

The two electrical conductors called the primary and the secondary windings are

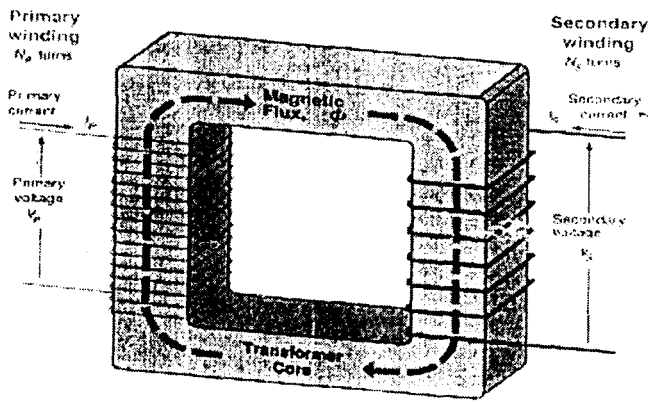


Figure 3.1.1 Schematic diagram of a transformer

mutually coupled. Energy is coupled between the windings by the time varying magnetic

flux that passes through both the primary and the secondary windings. Thereby supplying a certain voltage at the output of the transformer. Below is the graph of the transformer output.

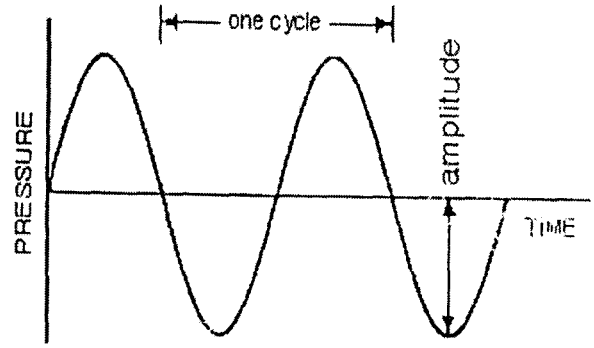


Figure 3.1.2 Graph of the transformer

3.1.2 The rectifier

The rectifying unit is used to change or convert the AC voltage from the transformer's output to d.c voltage used by the circuit. There are two types of rectification: the half wave rectification and the full wave rectification. The full Wave rectification was used for this project. The full wave rectifier consists of four diodes which only allow current flow in one direction. The full wave rectifier was chosen for this project because its output can easily be filtered to a smooth d.c. level as against the half wave rectifier unit. See bride rectifier below.

Rectifiers are now available in IC forms for easy construction work, a typical rectifier IC like the one used for this project can be seen below.

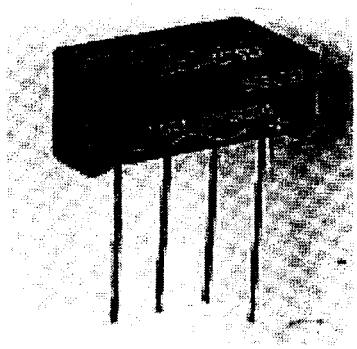


Figure 3.1.4 Rectifiers I.C.

The output of the transformer after rectification gives a waveform output which is the full wave rectification output waveform

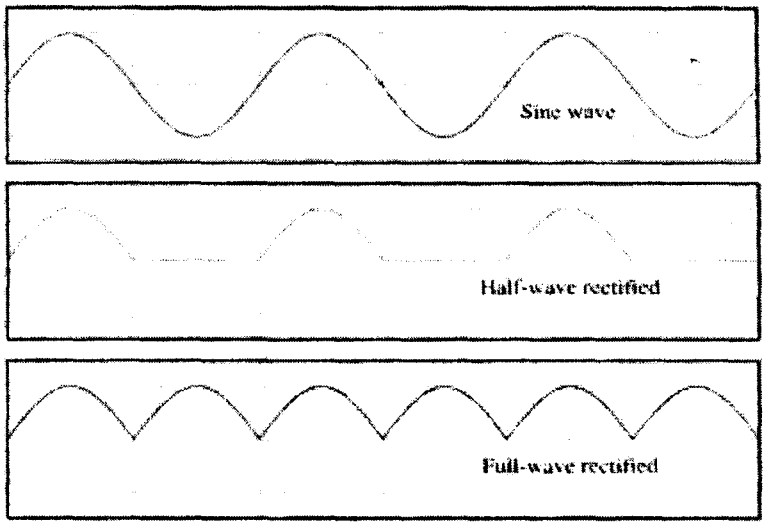


Figure 3.1.5 Transformer waveforms

3.1.3 Capacitor filtering

Filters in a dc power supply convert the pulsating d.c. output from the full wave rectifier into an unvarying d.c. voltage. When the a.c. input swings positive, the diode is

turned ON and the capacitor charges, but the charge time constant will be small because no resistance exists in the charge path except for that of the resistance of the connecting wires. When the a.c. input begins to fall from it's positive peak (at 90°) the diode is turned OFF by the large positive potential on the diode's cathode being supplied by the charge capacitors, and the decreasing positive potential on the diode's anode being supplied by the input. With the diode OFF, the capacitor begins to discharge. The discharge time is a lot longer than the charge time because of the load resistance. As the a.c. input and the rectifier's pulsating d.c. cycle repeat, the output (Vout) is an almost constant d.c. output with a slight variation or ripple above and below the average value.

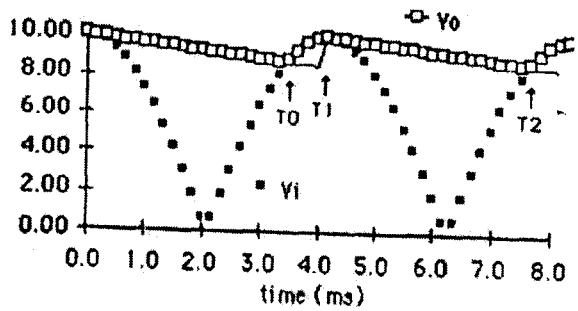


Figure 3.1.6 Output waveform of capacitor

3.1.4 Regulators

The voltage regulators in a d.c. power supply maintains the d.c. output voltage constant despite variations in the a.c. input voltage and the output load resistance. The regulators used for this project are:

The LM 7805

The LM 7812

The regulators were used to supply 5 and 12 volts respectively, used to supply voltages to main circuit.

3.2.0 Transmitter

The transmitter usually is powered by a battery. It should consume as little power as possible and the IR signal should also be as strong as possible to achieve an acceptable control distance.

For this project, a 9 volts battery was used. A 555 timer was used to generate signal and the 555 timer was configured in Astable mode. The threshold input pin (6) six is connected to the trigger input pin (2) two. The external components RI, RI, and C_I form the timing network that sets the frequency of oscillation.

When the switch Si is closed, power is turned on, and the capacitor "Ci" uncharged, thus the trigger voltage (pin 2) is at 0 volt. This causes the output of the comparator "B" to the HIGH and output of comparator "A" to be LOW, Forcing the output of the latch, and thus the base of Q] LOW and keeping the transistor off. Now, C_1 begins charging through RI and R2 as seen in Fig. 3.2.2 when the capacitor voltage reaches $^1/3$ Vcc, comparator B switch to its LOW output state, and when the capacitor voltage reaches $^2/3$Vcc, comparator A switches to it's HIGH output state. This RESETS the latch, causing the base of Qi to HIGH, and turns on the transistor. This sequence creates a discharge path for the capacitor through R_2 and the transistor. The capacitor now begins to discharge, causing comparator A to go LOW. At the point where the capacitor discharges down to '/3 Vcc, comparator B switches HIGH; this SETS the latch, which makes the base Qi LOW and turns off the transistor. Another charging cycle

begins and the entire process repeats. The result is a rectangular wave output whose duty cycle depends on the values of RI and R2- The transmitter' circuit ran be seen below.

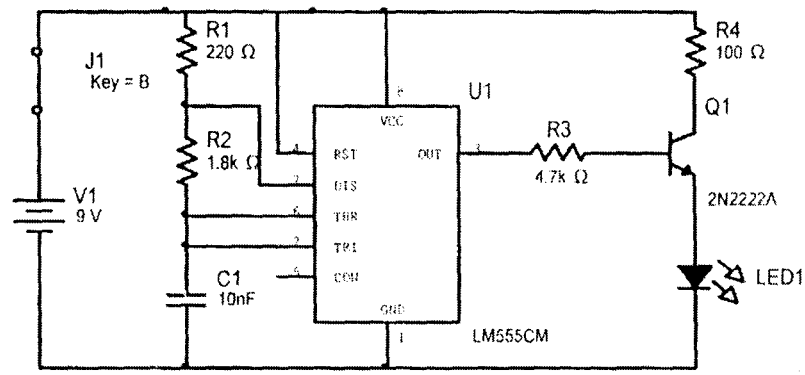


Figure 3.2.1 Transmitter circuit

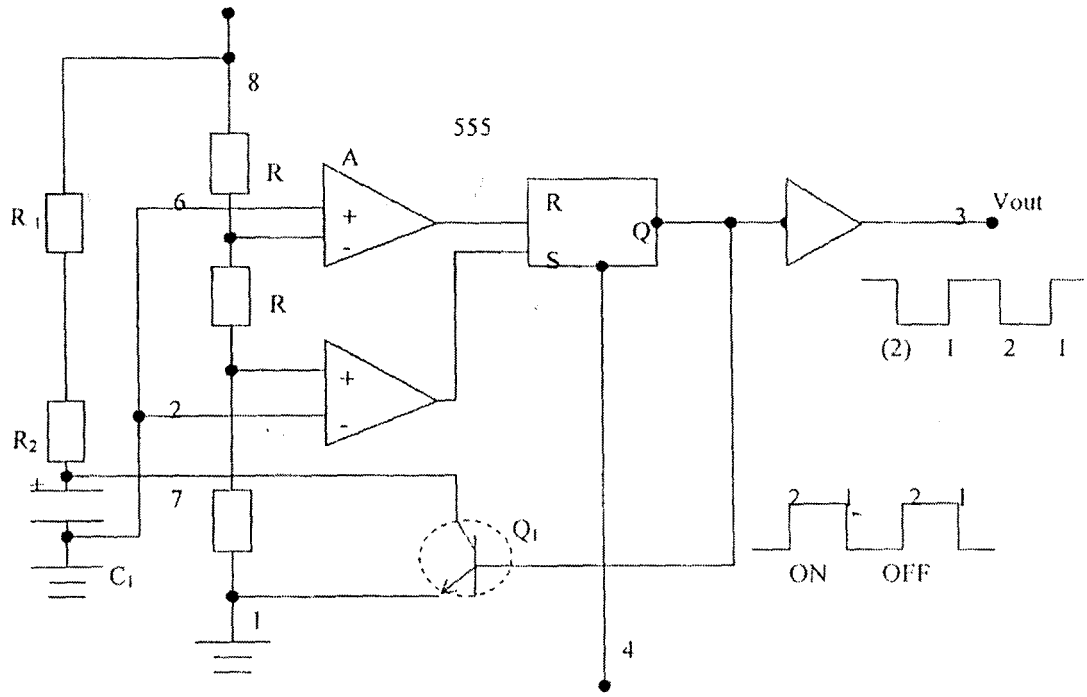


Figure 3.2.2 Operation of the 555 timer in the astable mode.

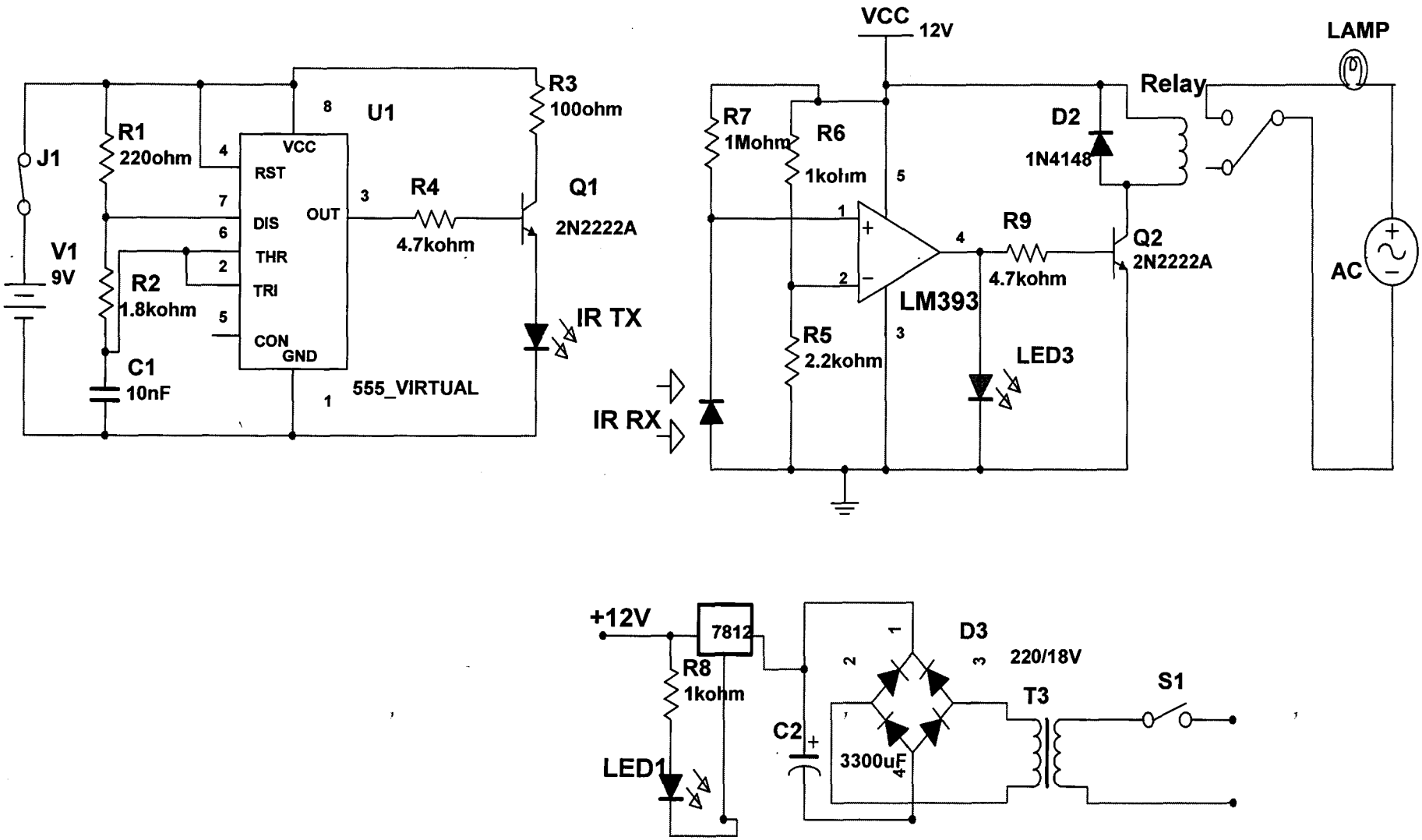


Fig 3.8 COMPLETE CIRCUIT DIAGRAM OF THE REMOTE CONTROL HOME APPLIANCES

The resistor R2 was chosen to be one with very high resistance, because a duty cycle approaching a minimum of 50% can only bo achieved if R2 » Rl so that the charging and discharging times are approximately equal. Therefore, R2 was chosen to be 1.8RQ and Rl to be 220U for this project design.

The capacitor alternately charges towards Vo and discharges towards zero according to the input voltage shown in fig. 3.2.3 below. Here, the frequency (and therefore period) of the input square wave voltage is exactly such that the capacitor is allowed to fully charge and discharge. The time constant "t," is equivalent to KRC.

t = KRC

Assume a square wave voltage, like the one in the figure above, is applied across an RC circuit, if one were to continually monitor the voltage across the capacitor, the waveform would resemble that of figure 3.2.3 shown below.

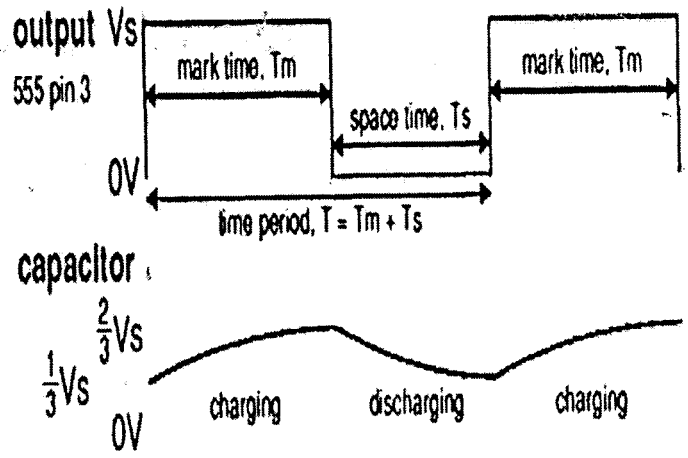


Figure 3.2.3 Waveform of an RC circuit

3.2.1 Frequency circuit calculation

Considering equation (2) above, the time constant t = KRC and from the figure above, it can be deduced that for 1 (one) period of oscillation of the RC circuit the capacitor charges for say T charge seconds and discharges For T discharge seconds. Where R is a resistor, C is a capacitor, and K is a constant (0.693).

From the transmitter circuit in figure 3.2.1

R_1 = 220ohms

R_2 = 1.8kohms

C = 0.01uF

T charge = $0.693R_TC$ ———————————— 3

Where R_T is $R_1 + R_2$

Therefore T charge = $0.693(R_1 + R_2)$ C ———— 4

T charge = $0.693(220 + 1.8k) \times 0.01 \times 10^{-6}$

= 14us

T discharge = $0.693R_2C$

= 1.8k x Q.693(0.01 x 10^{-6})

= 13us

Therefore, period of oscillation

T = t-charge + t-discharge

= 14+ 13 = 27us

Frequency of oscillation

$$F = \frac{1.44}{(R_1+2R_2)C} = \frac{1.44}{(220+3.6)\times 0.01\times 10^{-6}}$$

$$F = \frac{1.44}{3820\times 0.01\times 10^{-6}} = \frac{1.44}{3.82\times 10^{-5}}$$

F = 37,696,34Hz

F = 38KHz

$$\text{Duty cycle} = \frac{T_{charge}}{\textit{Pulse period time}}\times 100 = \frac{14\mu}{27\mu} = 0.5185\times 100$$

Duty cycle is therefore 51 %

3.3.0 The receiver

This is a device which consists of a photodiode pre-amplifier and a signal processor, which operates at a turned frequency of about 37.9KHz.

When the pin 3 of the receiver is powered, R_1 limits the current into the photodiode The output of the Receiver at pin one (I) is the voltage drop across the photodiode under normal light. When the photodiode, receives any signal from the transmitter, the

resistance of the photodiode will drop and consequently drop the voltage across it. With a considerable signal received by the receiver of about 30KHz to 40KHz. the resistance may fall to a negligible value and thus the drop across the photodiode is approximately zero volts, thus making the output of the receiver low. But when no signal is received, the resistance increases and thus the voltage drop across the photodiodes increases. See circuit below.

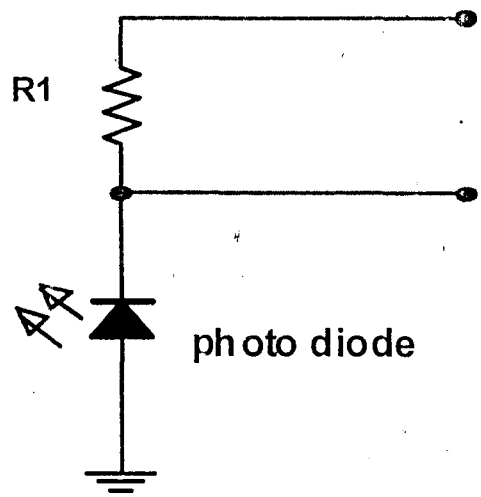


Fig 3.3.1 Receiver Circuit

3.4.0 Relays

A relay is an electromagnetic device or a solid state device operated by varying the input, which in turn is used to control other devices connected to its output.

There are four common types of relay namely:

- Reed Relay: Dry reed relays are made of coils wrapped around reed switches. The reed switch is composed of two overlapping ferromagnetic blades (allied reeds) hermetically sealed within a glass capsule that is filled with an inert gas. The reed have contacts on their overlapping ends when the coil is energized, the two reeds

are drawn together such that their contacts complete a path through the relay. When the coil is dc energized, the spring force in the reeds pulls the contacts apart.

- Solid state relay: SSRs arc constructed using a photo-sensitive MOSFET device with an LED to activate the device.
- FET switches: FET switches use a series of CMOS transistor s to implement the switching. Unlike SSRs, the control circuitry drives the gates of the transistor directly instead of driving on LED. Direct drive of the transistor gate allows for much faster switching speeds because the power-on power-off time of the LED is not an issue. In general, FET switches are the fastest of all the switches.
- Electromechanical Relays: Relays are electrically operated switches. Current following through the coil of the relay generates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches A relay is a mechanical switch used to switch other circuit ON and OFF. it enables small currents in one circuit to control a much larger current in another circuit or the simultaneous switching of more than one circuit. Fig 3.7.1 shows the diagram of a relay

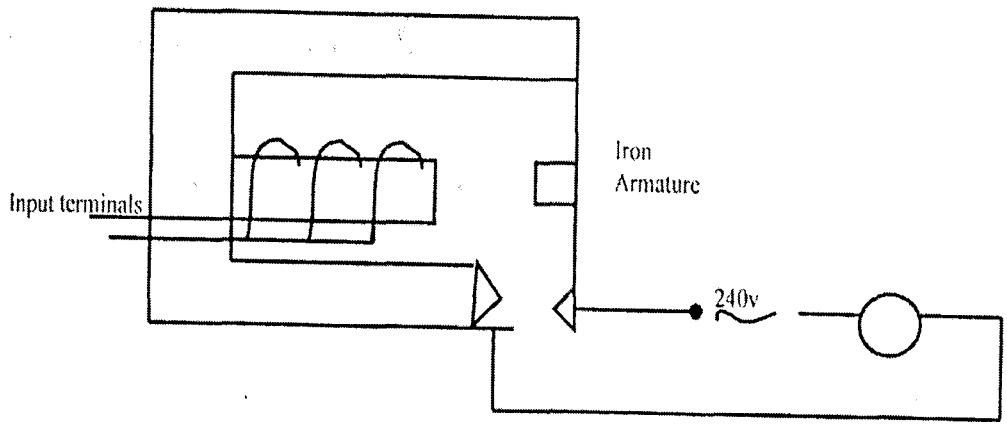


Figure 3.7.1 A circuit controlled by a relay

A small voltage applied to the input terminal e.g. 6v applied to the input terminals, which activates the electromagnet and close the contacts. These contacts can then switch on a larger amount of current and voltage safely.

It can be used to enable transistors or IC circuits to switch on higher voltage or current components, for example an automatic porch lamp.

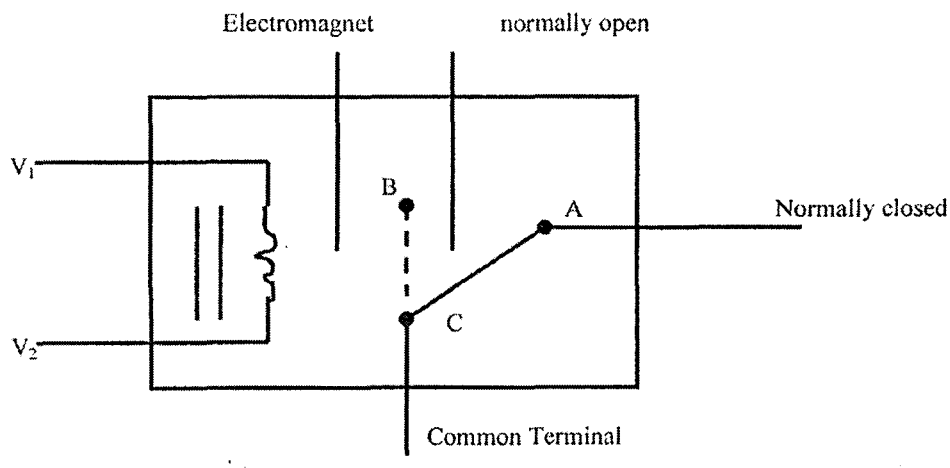


Figure 3.7.2 A single pole double throw relay

Another practical use of relays is for switching one circuit "ON" when another circuit is been switched "OFF" or broken.

As is the case with many mechanical devices being replaced by their electronic equivalents, relays are being "phased out" by solid state relays (SSRs). Mechanical relays do have their disadvantages when compared to SSR.

1- Switching is much slower

2- The contacts wear out

3- They make noise when they switch

4- Their magnetic field can cause problems for nearby components.

Presently, their one advantage is the ability to switch high voltage and high current circuits.

Relay coils produced brief high voltage "spikes" when switches "off, which can destroy transistors and ICs in the circuit. To prevent damage, a protection diode must be connected across the relay coil.

3.4.1 Protection diodes for relays

Signal diodes are also used with relays to protect transistors and integrated circuits from the brief high voltage produced when the relay coil is switched off. The diagram shows how a protection diode is connected across the relay coil, note that the diode in connected "backwards" so that it will normally "NOT conduct. Conduction only occurs when the relay coil is switched off, at this moment current tires to continue flowing through the coil and it is harmlessly divested through the diode. Without the diode, no current could flow and the coil would produce a damaging high voltage spike in its attempt to keep the current flowing.

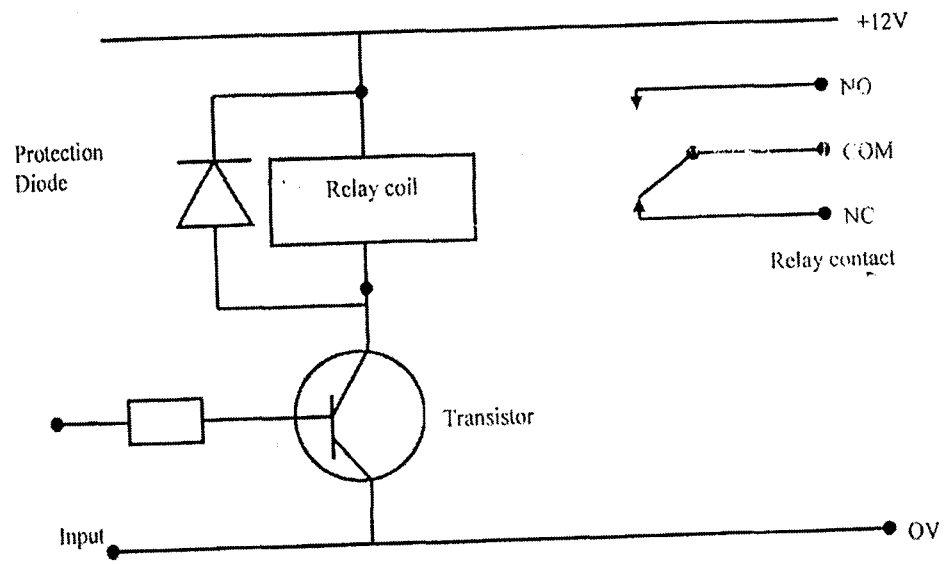


Figure 3.7.3 A relay protected by a diode

CHAPTER FOUR

4.0 Construction, testing and results

Construction is one of the most interesting aspects of the project work, where the project work is realized physically. The designer sees his or her work as a finished product not just on paper. After the whole paper work and analysis, the project was simulated using the electronic bench work software, constructed on the breadboard, before finally constructed on Vero board using the desired specifications. At various stages, the project was tested using the equipments listed below to ensure its working ability.

1) **Electronic workbench:** this is software used to test and ensure the working ability of the circuit before the breadboard stage and finally the Vero board construction.

2) **Digital multimeter:** the multimeter basically was used to measure continuity, resistance, voltage, current and the working condition of transistors and diodes, while constructing project. The multimeter was also used to measure the different voltage levels of the power supply unit. The construction was majorly divided into three stages namely, the power supply, the transmitter, and the receiver stages. At these stages the project was simulated bread-boarded, before permanently transferring to the Vero board to ease the task of troubleshooting, and eliminate the ugly task of de soldering components for amendments.

4.1 Soldering

Soldering is a process by which electrical connection is made between two or more components through the printed copper conductors on the Vero board. Before

soldering, proper checking of the connections was done, polarized components like electrolytic capacitors were checked to ensure proper fixing of the terminals. IC sockets were used to secure the ICS from damage as a result of heat from the soldering iron.

4.2 Casing

A little problem was encountered about the appropriate material to use, that could also be locally sourced for. Then the choice of pile wood which was based on:

The cost factor

- The physical lookout and workability
- Ability to prevent against electric shock
- Mechanical strength and weight of component

4.3 Discussions of results

It is quite obvious that each time a button passed on the remote control; the supply is either triggered on or off. The frequency at which the signal travels was calculated to be approximately 38kHz.

The charging time (T on) was calculated to be a little higher than the discharging (T off), which is still within experimental error. A percentage error of 0.001 was recorded, because from the design the RC network was adjusted so that a minimum duty cycle of 50% could be achieved, so that the charge and discharge time will be approximately equal. And this was achieved with a calculated duty cycle of 51%.

The output of the astable 38 kHz was now used to drives the infrared L.E.D s, the transmitter was tested by bringing an AM radio receiver near the circuit, it was found disturbing the reception of the radio indicating that the transmitter is working. The theory

bind this is that any working infrared circuit at frequency of38 kHz should create a noise when brought near radio receiver in AM band.

CHAPTER FIVE

5.0 Conclusion and Recommendation

The transmitter will transmit signals to the receiver from a distance of 5in and above when functioning at its best. It was observed that the transmitting intensity depends on the strength of the battery because it was observed that when the battery went low, the transmitter will have to be brought closer to the receiver before it (receiver) picks the signal, but reverse is the case with a stronger batteries. Another factor that determines the frequency of transmission was discovered to be the values of the resistor and capacitor used at the transmitter stage. The AC was connected to the relay output, and it performed its normal operation of switching either "on" or "off, once the transmitter button was pressed.

5.1 Problems Encountered

Actually not many problems were encountered during the construction of this project, there was less expenses and no component was either destroyed or burn. The very challenge was inability to make used of the Opto isolator in the initial design, because a good number of the 1C (Opto isolator) gotten from the market did not work. So the option of a relay came into play, but with modifications because current could not trigger the relay, until a buffer circuit was used. At the end of these modification the desire results were obtained

5.2 Conclusion

The main objective of this project being the design and construction of a remote controlled power supply unit has been achieved, with both theoretical and practical

knowledge in terms of exposure and experience were provided. And finally the transformation of the designed circuit diagram to reality (actual construction).

The project was not only able to switch the mains power supply unit but, it could also be use to control (switch) the lighting unit of a room, and also to control any electronic or electrical device connected to its output.

The result obtained from the test carried out has justified the appropriateness of the desired modifications constructional details and improvisation carried out in this project. Though the project was so how challenging and tasking, it has however been a success. Much more, the project was also a useful exposure to the basics of electronic design.

5.3 Recommendations

Though the main objective of this project was achieved, the following can be made to improve on the performance and rating.

i. A digital display may be included so as to show the voltage level coming into a given room.

ii. An automatic regulator unit could be included so that it regulate the incoming voltage or switch off an abnormal voltage,

iii. A solid state relay (Opto coupler) and other digital integrated circuits could be used to increase the rate of switching,

iv. Incorporating a unique sound alarm unit, that will come on once there is an unusual voltage.

On a final note, to improve the performance of the device, the output of the device should be regulated to properly handle variations in the power supply line.

REFERENCES

[1] http://www/appliance111.com/info/

[2] http://www.kpsec.Freeuk.com/docs/simplet.pdf.

[3] B. I. Theraja, A.K. Theraja. The Textbook of Electrical Technology S. chand and Ltd New Delhi, 1999, pp; 283, 2080

[4] Edward Hughes, Electrical Technology, Addison Wesley Longman Limited, England. 1995.pp 131,744,776,777.

[5] www.uoguelph.ca/antoon/cire/latchingcontiunitytestr,html.

[6] www.sulations.com3m.com/wps/portal3m/en-EU/Telecommus Access.html

[7] www.tecratools.com/page/fiber/35535.html.

[8] Giorgio hill, principle of Electrical Engineering. McCraw Hill higher Education, -Ohio pp 2088, 17.4

[9] www.datasheetcatalog.com

[10] www.datasheetarchive.com

[11] www.greatquates.com.

[12] www.sqatester.com/glossary/

[13] www.nd.edu/manufact/Development in the History of Automation of Manufacturing Processes.htm

[14] www.st.com/stonline/press/news/glossary/glossary.htm

[15] www.oasismanagement.com/frames/TECHNOLOGY/GLOSSARY/a.html

[16] broadway.sfn.saskatoon.sk.ca/business/sdlc/ab.html

[17] www.switches.htm