DESIGN AND CONSTRUCTION OF A REMOTE CONTROLLED POWER SUPPLY UNIT

BY

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2000/9815EE

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE, NIGERIA.

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DEDICATION

This project is especially dedicated to God Almighty and to my beloved parents, Mr. and Mrs. Anthony Danbaki, my siblings Tagwai, Esther, Jerusha, Abigail and to my colleagues in the federal university of technology minna, too numerous to mention.

CERTIFICATION

This is to certify that this project design and construction of a remote controlled power supply unit was carried out by Danbaki Anthony Bulus (2000/9815EE) under the supervision of Eng'r. M.S. Ahmed for the award of bachelor of engineering (B.Eng) degree in electrical/computer engineering federal university of technology MINNA Niger State

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Name of External Examiner	Signature and Date

ACKNOWLEDGEMENT

All praises is due to the Almighty God, the creator of the whole earth for this divine protection over me through the period of undergoing this programme. My special thanks goes to my parents, Mr. and Mrs. Anthony Danbaki for their patience, sacrifice and understanding throughout my stay in the university.

I would also like to express my indebtedness to the lecturers of the department of Electrical/Computer Engineering, Federal University of Technology Minna, for the knowledge they have impacted on me as a student, which was the key to the successful implementation of this work.

This work will not be complete without mentioning the tremendous support and encouragement from my sisters, brothers; Esther, Cynthia, Linda, Jenifer, Hassan and Daniel and my friends and colleagues too many to mention.

My special appreciation goes to my able project supervisor, Engr. M.S. Ahmed for his attention, understanding and indispensable assistance throughout the course of this project.

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

With advancement in engineering technology over the years 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 constructions to his protection and convenience. 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 officers, these problem continues to eat deep in most cases, like cases of over current or over voltage which to is 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 system, 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, 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.

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 30 KHz and 60 KHz 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.

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 highs 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. [9]

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) .

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.

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.

Commander McDonald loved the concepts proven by pulley's flashmetic 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.

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 – ½ 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. [9].

2.2 THEORETICAL BACKGROUND

The remote controlled power supply switch has five (5) functional blocks namely.

A - The transmitter stage

B - The detector (phototransistor)

C - The NAND Schmitt trigger stage

D - The flip flop stage

E - The relay stage

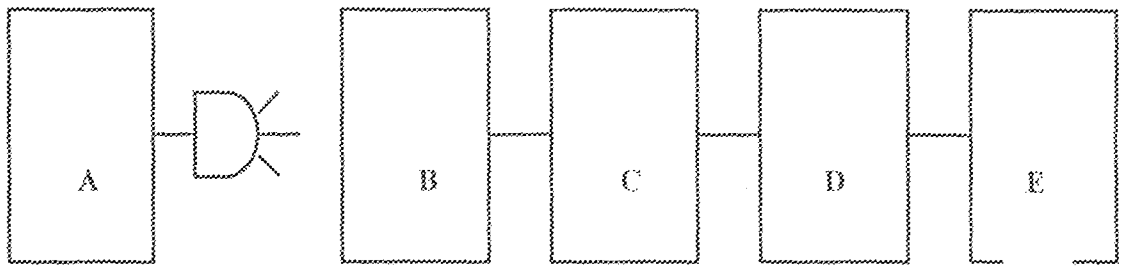


Figure 2.3.1 A block diagram of the design.

The circuit comprises of a transmitter which is designed to generate an average frequency from 30 KHz to 60 KHz. [7]. The frequency rate of the output pulse is determined by the values of two resistors "R1 and R2" and the timing capacitor "C of the 555 timer [8]. The signal generated by the timer is picked up by the IR detector unit which goes low on receiving the signal [1], [5] and [6]. The detector unit (photodiode) is set by different values of "R1" and "C1", the values for the resistor "R1" may to be as high as 10Kohms and the capacitor C1 40μF. This will prevent the photodiode unit from turning on under normal lighting conditions [7]. The output to the photodiode which is at low level is then inverted by the NAND Schmitt trigger, (the NAND gate is a NOT -AND, or an inverted AND function)[2]. The NAND gate I used for this project is the CB 4093 BCN, the output of the NAND gate (a high) is now fed to into the flip flop which is a D – type of flip flop and it stores the information it receives which is a high (i.e.1), until it receives a contrary command or information which may be a low (i.e.0) when the transmitter button is pressed again[3]. The flip flop receives data or information which is a single bit and stores it, the data may be a low or high depending on the input. The output of the flip flop now turns on or triggers the relay which supplies power to the AC supply line. The flip flop I used for this project is the TC 4013 BP. 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.

CHAPTER THREE

3.0 SYSEM 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 defector (phototransistor)
- The NAND submit trigger stage
- The flip – flop stage
- The relay stage

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

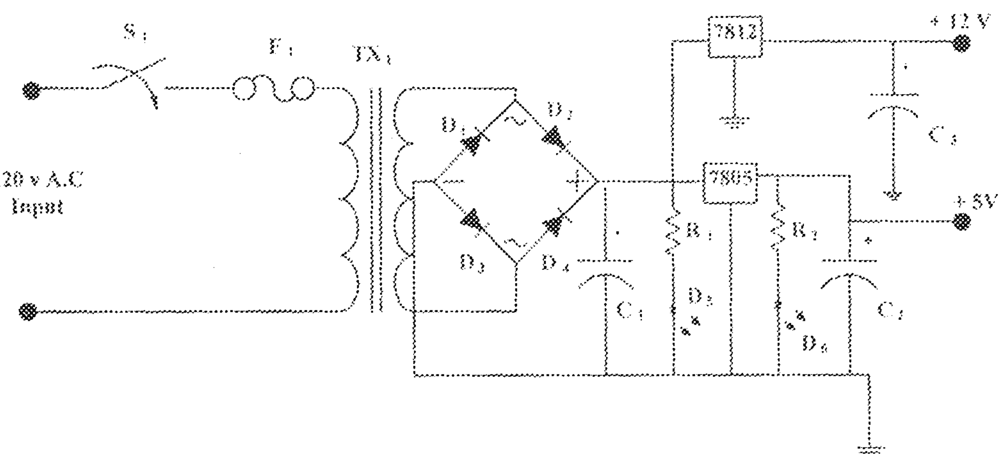


Figure 3.1 Power supply unit

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 transformer
	Ns	=	Secondary windings of transformer
	Np	=	Primary windings of transformer
	Vp	=	Primary winding of 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 is the secondary coil.

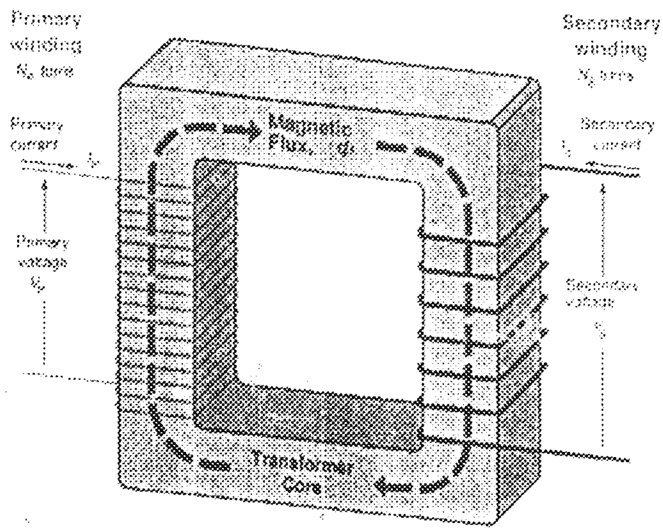


Figure 3.1.1 Schematic diagram of a transformer

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

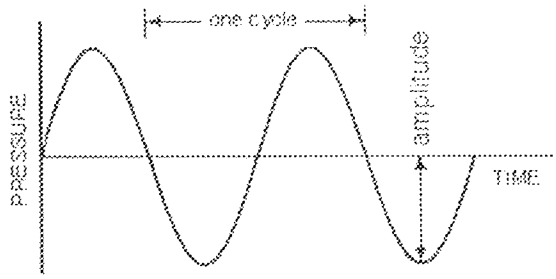


Figure 3.1.2 Graph of the transformer

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.

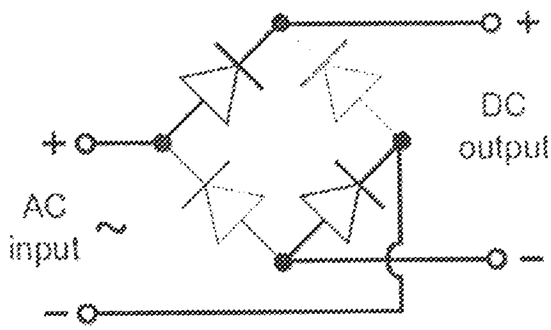


Figure 3.1.3 The Bridge Rectifier Circuit

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.

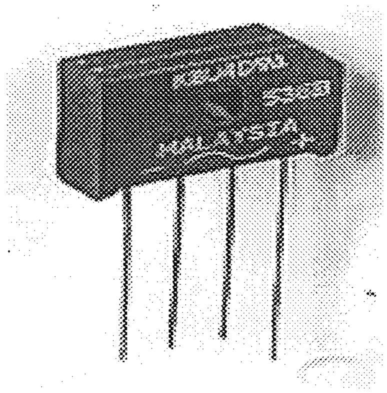


Figure 3.1.4 Rectifiers I.C.

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

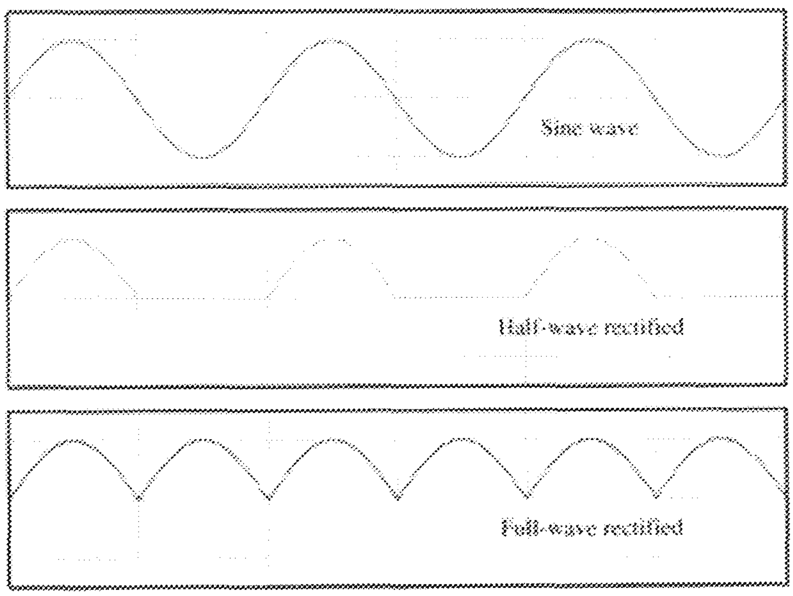


Figure 3.1.5 Transformer waveforms

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.

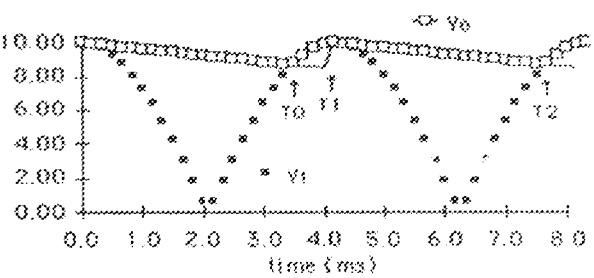


Figure 3.1.6 Output waveform of capacitor

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 R_1, R_2, and C_1 form the timing network that sets the frequency of oscillation.

When the switch S_1 is closed, power is turned on, and the capacitor "C_1" 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_1 LOW and keeping the transistor off. Now, C_1 begins charging through R_1 and R_2 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 Q_1 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 $^1/3$ Vcc, comparator B switches HIGH; this SETS the latch, which makes the base Q_1 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 R_1 and R_2. The transmitter circuit can be seen below.

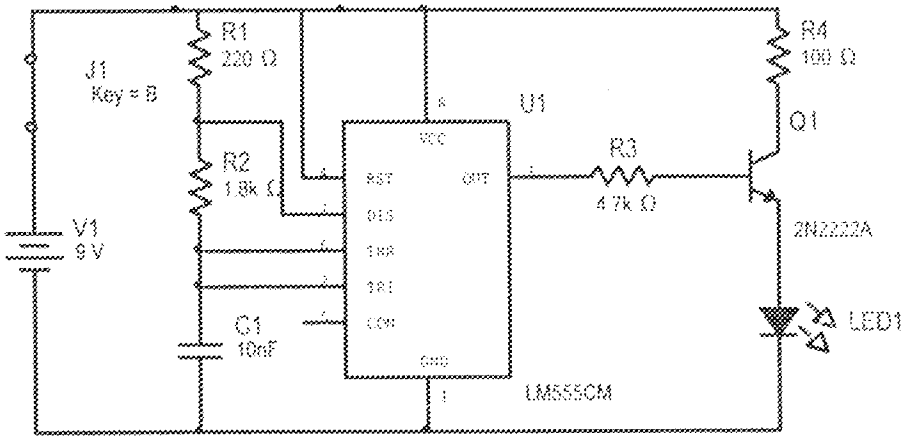


Figure 3.2.1 Transmitter circuit

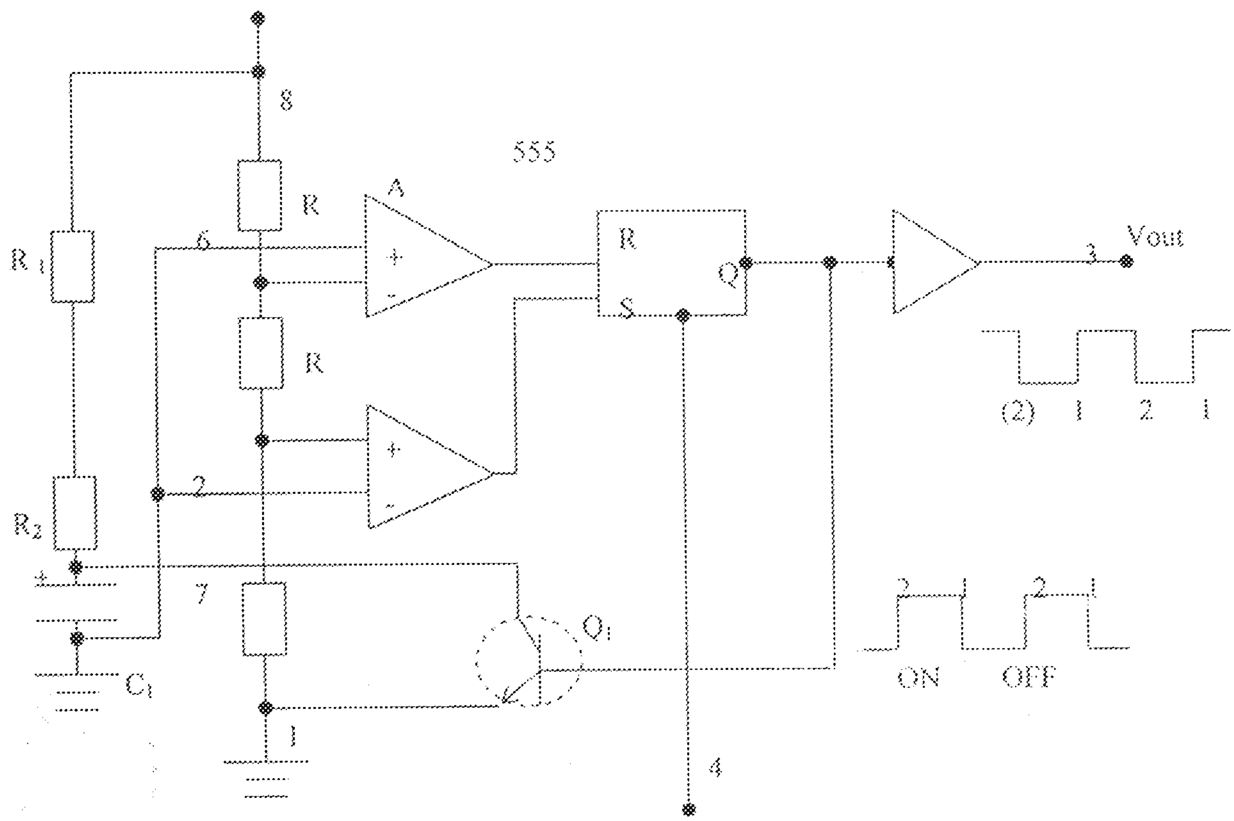


Figure 3.2.2 Operation of the 555 timer in the astable mode.

The resistor R2 was chosen to be one with very high resistance, because a duty cycle approaching a minimum of 50% can only be achieved if R2 >> R1 so that the charging and discharging times are approximately equal. Therefore, R2 was chosen to be 1.8kΩ and R1 to be 220Ω 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 "ι," is equivalent to KRC.

ι = KRC ------------------------------------..... 2

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.

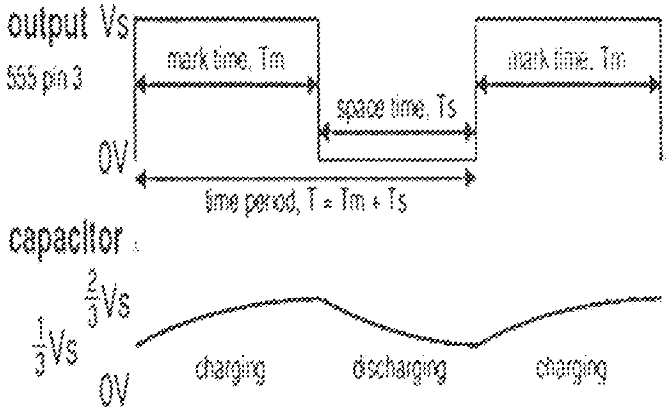


Figure 3.2.3 Waveform of an RC circuit

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 Tcharge seconds and discharges for Tdischarge seconds. Where R is a resistor, C is a capacitor, and K is a constant (0.693).

From the transmiter circuit in figure 3.2.1

$R_1 = 220\Omega$

$R_2 = 1.8k\Omega$

$C = 0.01\mu F$

$Tcharge = 0.693R_TC$ -- 3

Where R_T is $R_1 + R_2$

Therefore $Tcharge = 0.693(R_1 + R_2)\,C$ ---------------- 4

$Tcharge = 0.693(220 + 1.8k)\,0.01\times10^{-6}$

$1399.86 \times 0.01 \times 10^{-6}$

$= 14\mu s$

$Tdischarge = 0.693R_2C$

$= 1.8k\times0.693\,(0.01 \times 10^{-6})$

$= 13\mu s$

Therefore, period of oscillation

$T = tcharge + tdischarge$

$= 14 + 13 = 27\mu s$

Frequency of oscillation

$$F = \frac{1.44}{(R_1 + 2R_2)\,C} = \frac{1.44}{(220 + 3.6k) \times 0.01 \times10^{-6}}$$

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

$F = 37{,}696.34H_z$

$F = 38$ KHz

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

Duty cycle is therefore 51%

3.2.2 OSCILLATION

The oscillator in this circuit is a free running non-sinusoidal oscillator. The oscillator can be defined as a circuit which generates ac output signals without requiring any external applied input signal. Or it can be defined as an electronic source of alternating current or voltage having sine, square or saw tooth, or pulse shapes.

A non sinusoidal oscillator may be defined as a circuit in which voltage or current changes abruptly from one value to another and continues to oscillate between these two values as long as dc power to supplied to it.

3.2.3 RC RELAXATION OSCILLATORS

A very simple kind of oscillator can be made for charging a capacitor through a resistor (or a current source), then discharging it rapidly when the voltage reaches a certain threshold, beginning the cycle anew. The Oscillator used for this project is based on the RC principles, which is called the RC relaxation oscillator.

Here, it should be noted that the product RC (Resistance x capacitance) is known as the time constant, "t" and has units of time. This time constant is the characteristic time of the charging and discharging behavior of an RC circuit and represents the time it tells the current to decrease to e^{-1} of its initial value, whether the capacitor is charging or discharging.

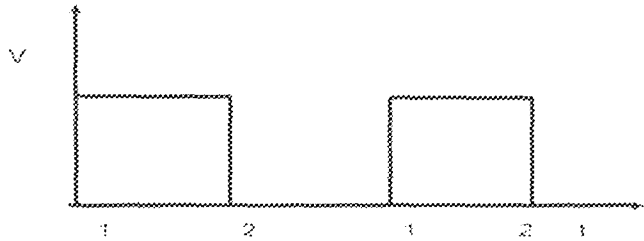


Figure 3.2.4 Square wave that drives the RC circuit

3.2.4 THE TRANSISTOR AS A SWITCH

The ON/OFF switching action of the transistor is controlled by the transistor's base-to-emitter (B-E) diode. If the B-E diode of the transistor is forward biased, the transistor will turn ON; if the B-E diode of the transistor is reverse biased, the transistor will turn OFF. See diagram below

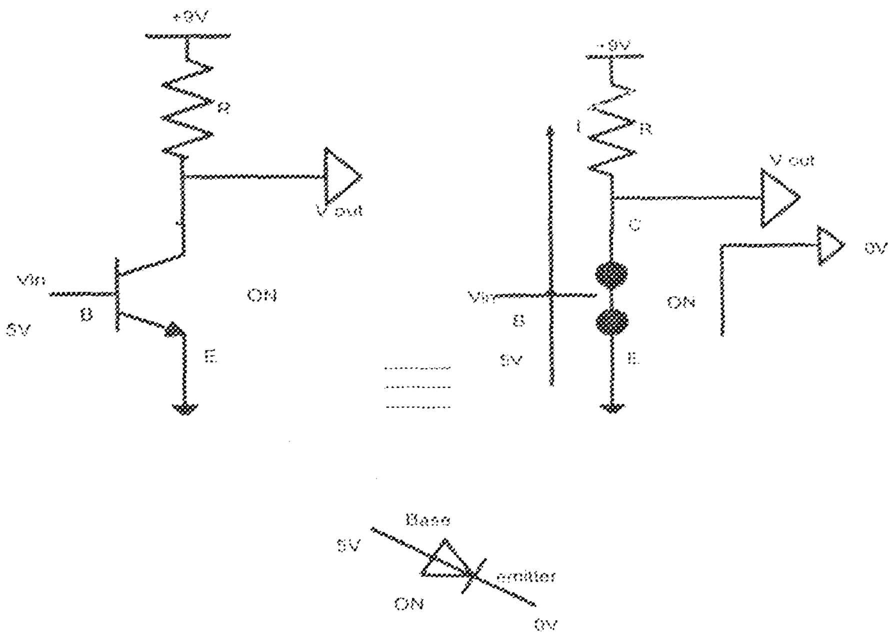


Figure 3.2.5 Bipolar transistor ON

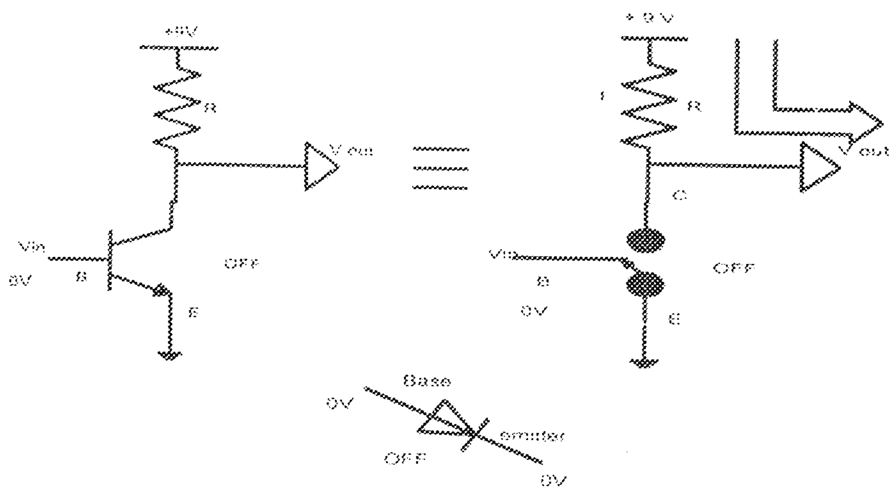


Figure 3.2.5 Bipolar transistor OFF

3.3.0 THE RECIEVER

This is a device which consists of a photodiode pre-amplifier and a signal processor, which operates at a turned frequency of about 37.9KH₃.

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 (1) is the voltage drop across the photodiode under normal light. When the photodiode, receivers 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 $30KH_3$ to $40KH_3$, 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.

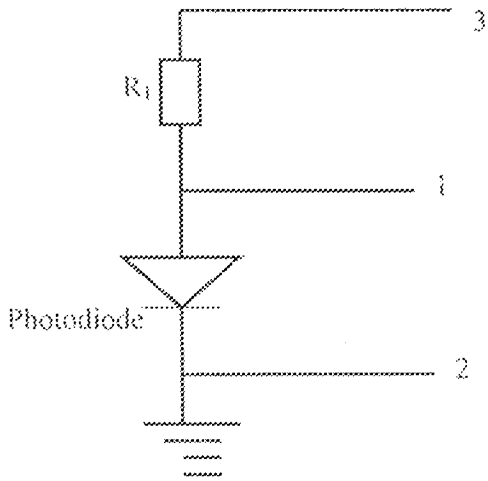


Figure 3.3.1 Receiver circuit

3.4.0 THE NAND GATE

The NAND gate is a popular logic element because it can be used as a universal gage; that is, NAND gates can be used in combination to perform the AND, OR, and inverter operates.

3.4.1 LOGICAL OPERATION OF THE NAND GATE

The nand gate produces a LOW output only when all the inputs are HIGH when any of the inputs is LOW, the output will be HIGH. For the specific case of a 2- input NAND gate (the one used for this project), with inputs labeled "A" and "B" and the output labeled "X", the operations can be stated thus:

The output "X" is LOW if input "A" and "B" are HIGH, "X" is HIGH if either "A" or "B" is LOW, or if both "A" and "B" are LOW.

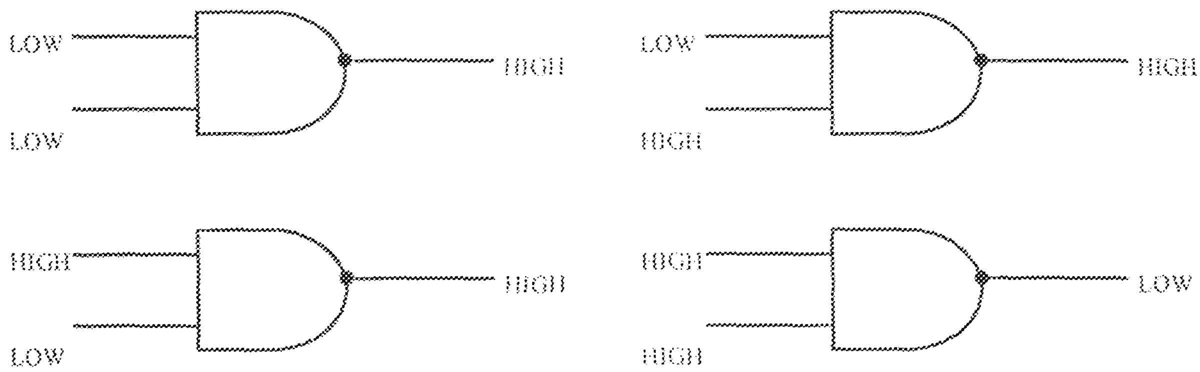


Figure 3.4.1 Logical operation of a 2- input Nand gate

Input		Output
A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

1 = HIGH, 0 = LOW

Table 1 Truth table of a two input nand gate

This operation is opposite that of the AND in terms of the output level. In a NAND gate, the LOW level (O) is the active output level, as indicated by the bubble on the output as seen above.

3.5.0 THE FLIP - FLOP

Flip – flops are synchronous bistable devices in this case the term synchronous means that the output changes state only at a specified point on a triggering input called the clock

(CLK) which is designated as a control input "C" that is, changes in the output occurs in synchronization with the clock.

An edge – trigged flip – flop changes state either at the positive edge (rising edge) or at the negative edge (falling edge) of the clock pulse and is sensitive to it's input only at this transition of the clock.

The type of flip – flop used for this project is the D – type of flip – flop which is useful when a single data but (1 or 0) is to be stored. D stands for data. The operation of D flip flop is very simple, the level present at D will be stored in the flip – flop at the instance the positive going transition occurs. See wave form in fig 3.5.2 above. Assuming Q to be initially HIGH, when the first positive going transition occurs at point "a", the "D" input is low, thus Q will go to the low state (0). Even though the D input level changes between points "a" and "b", it has no effect on "Q". Q is storing the LOW that was on D at point a. when the positive going transition at b occurs. Q goes HIGH since D is HIGH at that time. Q stores C causes Q to go LOW. Since D is LOW at that time. In a similar manner, the Q output takes on the levels present at D when the positive going transitions occur at points d, e, f and g. Note that Q stays HIGH at point e because D is still HIGH.

Again, it is important to remember that Q can change only when a positive going transition occurs. The D input has no effect between positive going transitions (PGTS).

A negative going transition D flip – flop (negative edge trigged flip flop), operates in the same way just described except that Q will take on the value of D when a negative going transition (NGT) occurs at clock. The symbol for the D – flip – flop that triggers on negative going transitions (NGTS) will have a bubble on the clock input

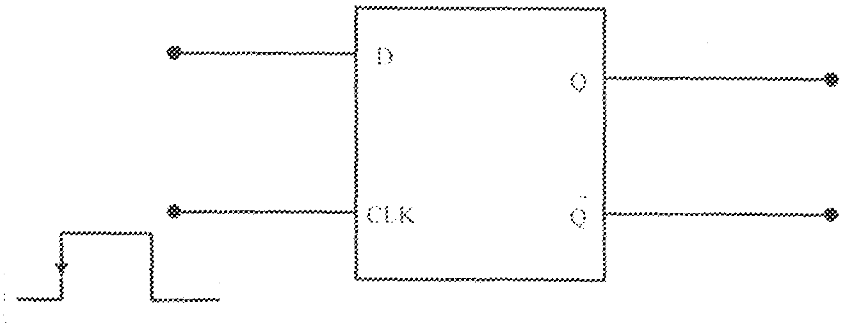


Figure 3.5.1 D flip- flop that triggers only on PGT

INPUT			OUTPUT	COMMENTS
D	CLK	Q	Q̄	
1	↑	1	0	SET (stores a 1)
0	↑	0	1	RESET (stores a 0)

Table 2 Truth table for a positive edge – triggered D – flip

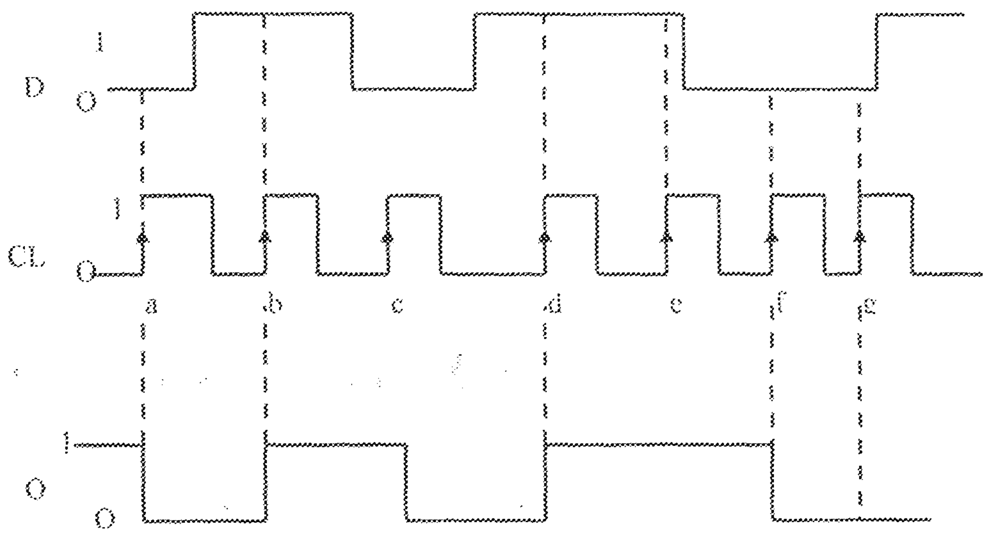


Figure 3.5.2 D flip-flop trigger pgt waveform

3.6.0 THE BUFFER CIRCUIT

The buffer used in this project is the C9014 transistor or emitter follower, it is called that because the output terminal is the emitter, which follows the input (the base), less one diode drops. For this circuit, the Vin was at the positive 0.6 volt, so that the output will remain at ground level. An emitter follower has current gain that is why it is used in this project to increase the driving current of the relay, even though it has no voltage gain. The circuit requires less power from the signal source to drive a given load (as is the case in this project), than will be the case if the signal source were to drive the load directly.

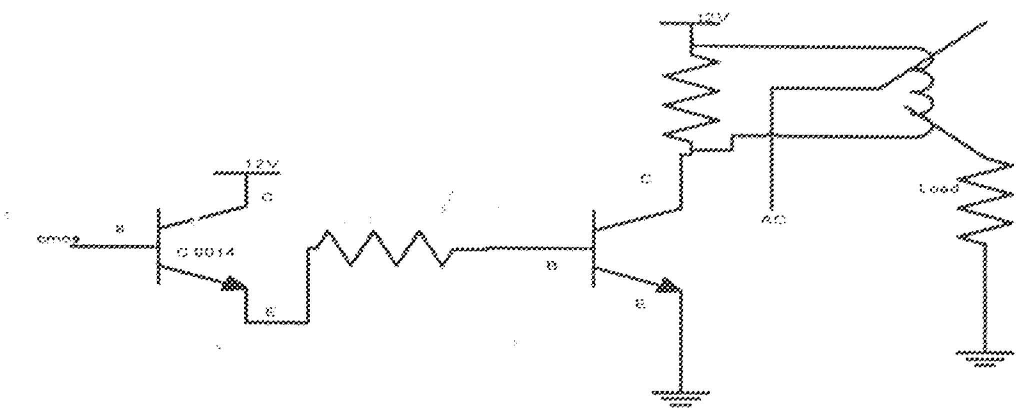


Figure 3.6.1 Buffer circuit

3.7.0 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 de energized. the spring force in the reeds pulls the contacts apart.

- Solid state relay: SSRs are 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

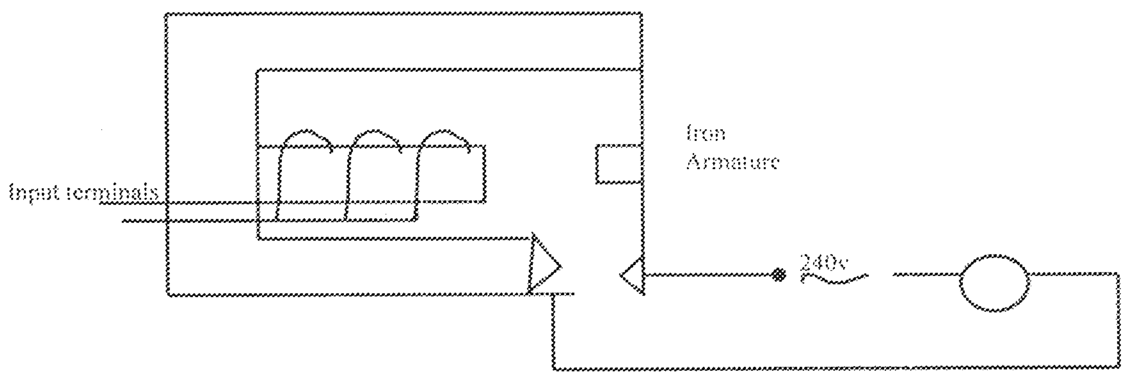


Figure 3.7.1 A circuit controlled by a relay

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.

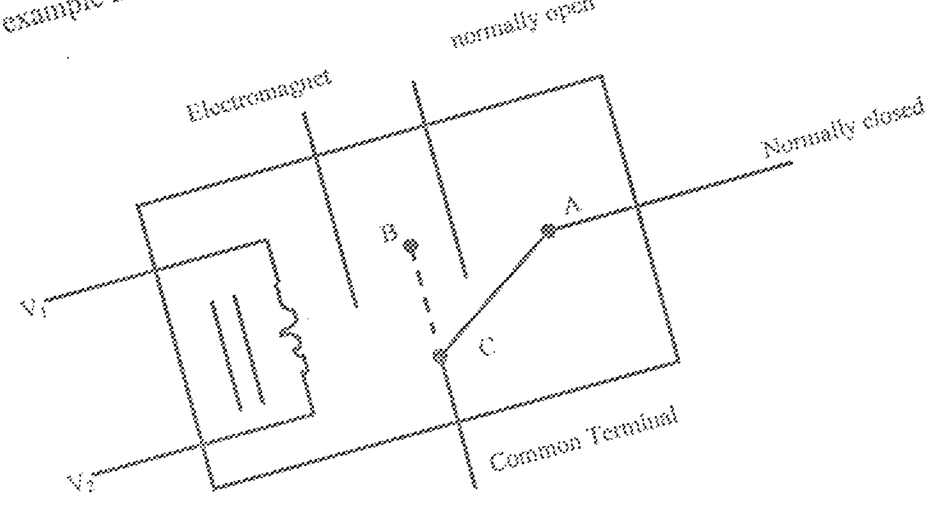


Figure 3.7.2 A single pole double throw relay

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

As is the case with many mechanical devices being replac equivalents, relays are being "phased out" by solid state relays (SS have their disadvantages when compared to on SSR.

1- Switching is much slower
2- The contacts wear out
3- They make noise when they switch
4- Their magnetic field can cause problem

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

3.7.1 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.

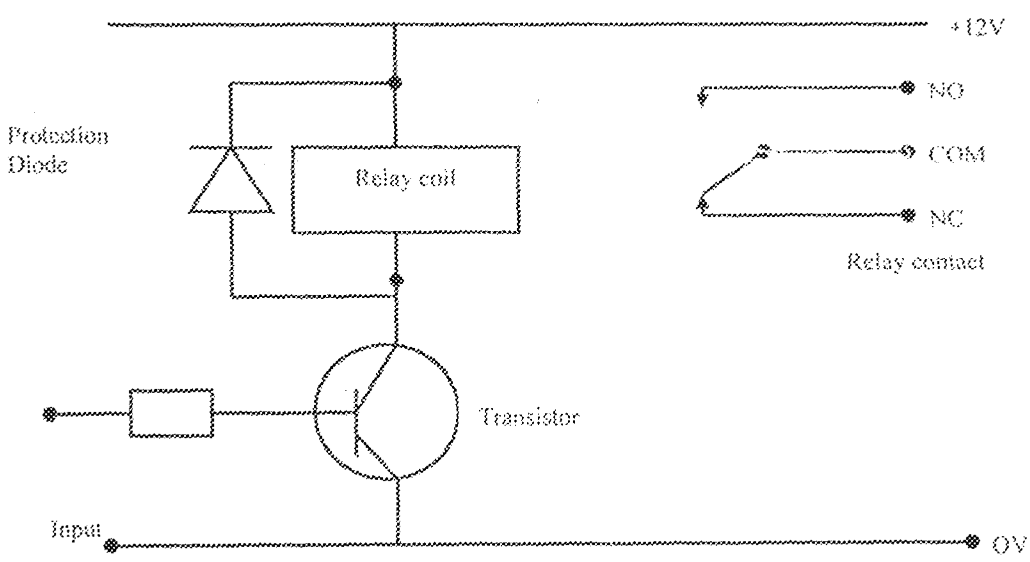
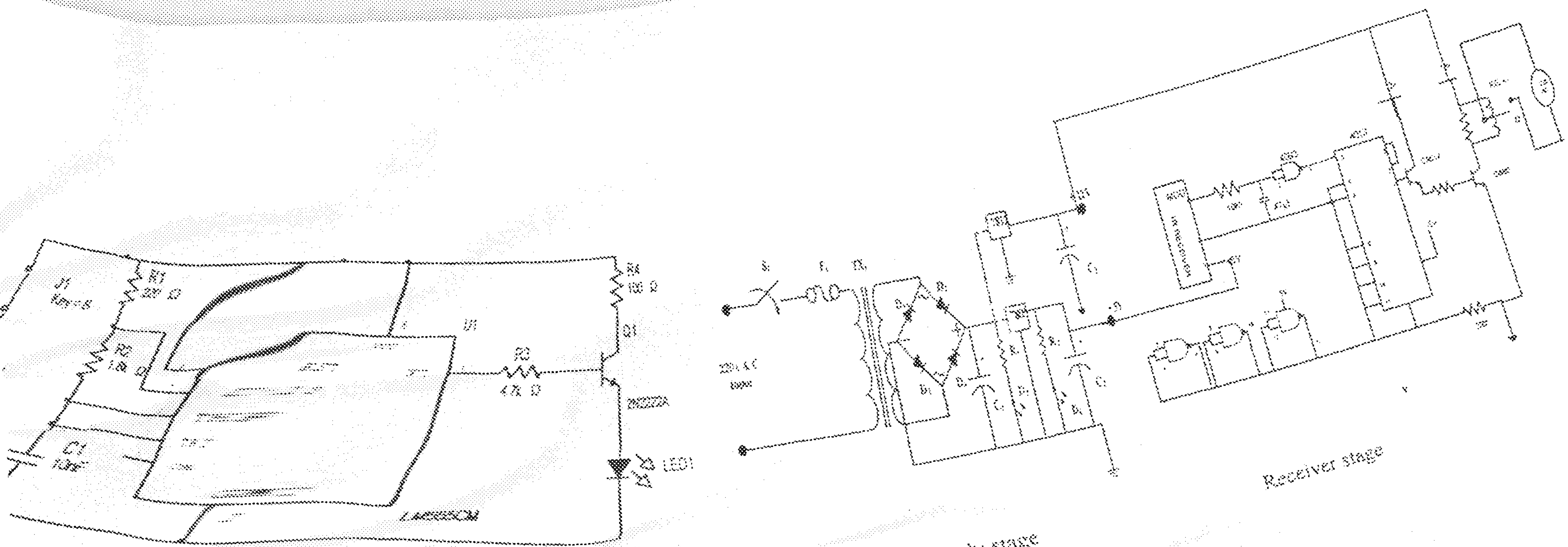


Figure 3.7.3 A relay protected by a diode



Receiver stage

Power supply stage

Complete Circuit diagram of an infrared remote control unit

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.

(i) 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.

(ii) 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 breadboarded, 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 DISCUSSION 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 38 kHz.

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 of 38 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 5m 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 transmition 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 IC (opto isolator) gotten from the market did not work. So the option of a relay came into play, but with modifications because cmos 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 RECOMMENDATION

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.

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