DESIGN AND CONSTRUCTION OF AUTOMATIC REMOTE CONTROLLED ENERGY SAVING RECHARGEABLE LAMP

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2005/23560EE

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

DECEMBER 2009

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SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE, NIGERIA

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF BACHELOR OF ENGINEERING (B-ENGR) ELECTRICAL AND COMPUTER ENGINEERING

DECEMBER 2009

DEDICATION

This project is dedicated to the Glory and Mercy of the Almighty ALLAH.

DECLARATION

I MUHAMMED ABDULRASAK, declares that this project was done by me and has never been presented elsewhere for the award of degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.
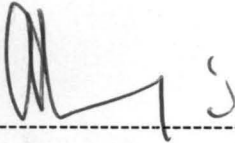

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ABSTRACT

This project deals with the design and construction of an Automatic Remote Controlled Energy Saving Rechargeable Lamp. It is aimed at overcoming darkness due to instant blackout. This project becomes active anytime there is a power failure from the local supply. The project consist of three major units, which are: The power supply unit, charging unit and the infrared unit.

This project is carried out using commonly available component and the result obtained was satisfactory.

TABLE OF CONTENT

CHAPTER ONE
GENERAL INTRODUCTION

1.1 Introduction

In case there is an emergency power failure, the design and construction of emergency lighting system will serve as a backup lighting system for a considerable period of time to avoid the danger of instant blackout. So inline with this the project "Design and Construction of Automatic Remote Controlled Rechargeable Lamp" to illuminate the areas of source sensitivity and danger when main power supply goes off. Its design is quite simple, economical and easy to use due to the incorporation of a remote controlled unit.

The lamp is made as simple as possible by the use of limited number of components. The design allows the battery to light up the involved Light Emitting Diodes (LEDs) which can serve longer hours due to low power consumption. The lighting system is suitable in places such as Libraries, Homes, Schools, Bank vault, Public corridors, Exit ways etc. Hence, the importance of this project is evident with the deteriorating electric power supply in the country.

1.2 Aim and Objectives

The main objectives of this project are:

1. To design and construct a remote controlled automatic rechargeable lighting system for sensitive places like libraries, hotels, hospitals, public corridors etc.

2. To incorporate the use of Energy Saving Lamp (LED) Light Emitting Diode to increase the battery's life span and provide greater illumination.

3. Portable handheld remote controlled unit for convenience.

1

1.3 Methodology

As stated earlier, the design involves lighting using light emitting diode of a low energy consumption that requires a 220V AC power supply with a 12volt rechargeable battery. A fact is clear about the design, a rectifier circuit allows the conversion of AC voltage to DC voltage required to power the light emitting diode at a greater illumination. A battery charging unit is included in the circuit to restore the used voltage back into the battery.

1.4 Scope

In case there is an emergency power failure, the design and construction of emergency lighting system is been carried out to serve as back up lighting system. It is dedicated and specifically designed to serve as lighting system for some sensitive areas for considerable amount of time to remove the danger of instant blackout at emergence of power failure.

1.5 Limitations

This system should not be put in to use as a complete alternative for power failure for a very long time, for this does not fit into its design and usage. Therefore, operating this device beyond its specification will affect its life span and may lead to low reliability and efficiency of the project.

CHAPTER TWO
LITERATURE REVIEW

2.1 Historical Development of Light

In the history of mankind, lighting has become the most valuable and most needed energy, it has evolved from the primitive form to the sophisticated form in the present time. Naturally, the lighting system consists of moonlight, sun and fire. Sun is the heavenly body producing light energy to the earth. The early man first produced light by striking two stones together. However, the advent of electricity seems to be the end for the quest of light energy.

As the source of the light energy (i.e. electricity) is becoming less reliable most especially in developing countries then the quest for providing alternative illumination to some sensitive area or environment in case of power failure gained momentum. It was this quest that led to the advent of emergency lighting system. It is of interest to mention here that that emergency lighting system had also evolved from different forms till now.

Russian Oleg Vladimirovich Loser independently created the first LED, his research was distributed in Russian, German and British scientific journals, but no practical use was made of the discovery for several decades.

Rubin Braun stein of the radio corporation of America reported on infrared emission from Gallium Arsenide (GaAs) and other semiconductor alloys. Braun stein observed infrared emission generated by simple diode structures using Gallium Antimode (GaSb), GaAs, Indium phosphate (InP) and Silicon Germanium (SiGe) alloys at room temperature and at 77 Kelvin[8].

Experimenters Robert Biard and Gary Piltman working at Texas instruments found that GaAs[7] emitted infrared radiation when electric current was applied and received the patent for the infrared LED.

Holonyak is seen as the "father of the LED" M. George Craford a former graduate student of Holonyak invented the first yellow LED and improved the brightness of red and red-orange LED's[5]. T.P Pearsall created the first high-brightness, high efficiency LEDs for optical fiber telecommunications by inventing new semiconductor materials specifically adapted to optical fiber transmission wavelength.

Alberto Barbieri at the Cardiff University Laboratory England investigated the efficiency and reliability of high brightness LEDs demonstrated a very impressive result by using a transparent contact made of Indiumtin Oxide (ITo) on (AlGaInP/GaAs) LED. The existence of blue LEDs and high efficiency LEDs quickly led to the development of the first white LED which employed a phosphor coating[5] to yellow (down converted) light with blue to produce light that appears white.

The development of LED technology has caused their efficiency and light output to increase exponentially, with a doubling occurring about every 36 months since the 1960s.

A new type of blue LED was demonstrated by the company Cru, incorporated to provide 24mW at 20mA. This produced a commercially packaged white light giving 65lumen/W at 20mA, becoming the brightest white LED commercially available at the time, and more than four times as efficient as standard incandescent[12].

An LED will begin to emit light when the on voltage is exceeded. Typical on voltages are 2-3 volt. Current flow from the P-side (anode) to the N-side (cathode) but not in the reverse direction. LEDs are to operate with not more than 30-60 mW of electrical power[4].

One of the key advantages of LED based lighting is its high efficiency, as measured by its light output per unit power input. White LEDs quickly matched and overtook the efficiency of standard incandescent lighting system.

2.1.1 Block diagram

```
┌──────────────┐      ┌──────────────┐      ┌──────────────┐
│    POWER     │      │   CHARGING   │      │    OUTPUT    │
│ SUPPLY UNIT  │─────▶│     UNIT     │─────▶│     UNIT     │
└──────────────┘      └──────────────┘      └──────────────┘
                             ▲
                             │
                      ┌──────────────┐
                      │    REMOTE    │
                      │   CONTROL    │
                      │     UNIT     │
                      └──────────────┘
```
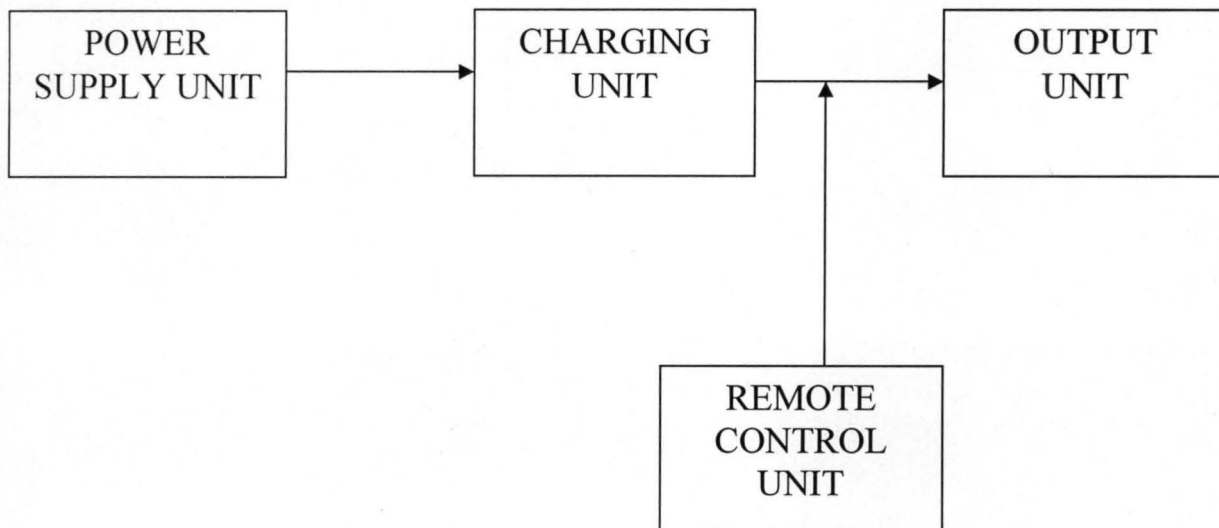
Figure 2.1.1 Block Diagram of an Automatic Emergency Rechargeable Lighting System.

2.2 Power Supply Unit

Most electronic equipment requires DC voltages for its operation.[10] These can be provided by batteries or by internal power supply that convert alternating current as available at the home electric outlet, into regulated DC voltages. The first element in an internal DC power supply is a transformer, which steps up or down the input voltage to a level suitable for the operation of the equipment. A secondary function of the transformer is to provide electrical ground insulation of the device from the power line to reduce potential shock hazards. The transformer is then followed by a rectifier, normally a diode. In the past, vacuum sulfide was employed in the low-power rectifiers used in electronic equipment. Today silicon rectifiers are used almost exclusively because of their low cost and their high reliability.

Fluctuations and ripples superimposed on the rectified DC voltage (noticeable as hum in a malfunctioning audio amplifier) can be filtered out by a capacitor; the lager the

capacitor, the smaller is the amount of ripple in the voltage. More precise control over voltages level and ripples can be achieved by a voltage regulator, which also makes the internal voltages independent of fluctuations that may be encountered at an outlet. A simple often used regulator is the zener diode. It consist of a solid state pn-junction diode[7], which acts as an insulator up to a predetermined voltage; above that voltage it becomes a conductor that bypasses excess voltages. More sophisticated voltage regulators are usually constructed as integrated circuits.

2.3 Charging Unit

This is where the battery is charged. A battery charger is a device used to put energy into a secondary cell or chargeable battery by forcing an electric current through it[11]. The charge current depends upon the technology and capacity of the battery being charged for example, the current that should be applied to charge a 12 volt car battery will be very different from the current for a mobile phone battery.

The charge rate of battery is often denoted as 'C' and signifies a charge or discharge rate equal to the capacity of a battery divided by 1 hour. For example 'C' for a 4500mAhogany battery would be 4500mA or 4.5 amps.

2.4 Remote Controlled Unit

Provided is a remote control unit for remotely controlling an external device. The remote control unit includes a key input part having plurality of keys. Basically, a remote control operates in this manner. A button is pressed; this completes a specific connection which produces a morse code line signal specific to that button[6]. 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. The infrared remote control is made up of a transmitter and a receiver (photo detector). The transmitter transmits within the frequencies of 30khz and 60khz having a wavelength of about 950nm.

6

Today, remote control is a standard feature on some consumer electronic products including; VCRs, cable satellite boxes, digital video disc players and home audio receivers. More than 99% of all TV sets and 100% of all VCRs and DVD players sold in the U.S.A were equipped with remote control. The average individual these days probably picks up a remote control at least once or twice in an hour.

2.4.1 Infrared

The cheapest way to remotely control a device within a visible range is via Infra-Red light. Almost all audio and video equipment can be controlled this way.

Infrared light actually is normal light with a particular colour. We humans can't see this colour because its wavelength of 950nm is below the visible spectrum.[6] That's one of the reasons why infrared is chosen for remote control purposes.

There are many sources of infrared light. The sun is the brightest source of all, but there are many others, like light bulbs, candles, central heating system and even our body radiates infrared light. Therefore we have to take some precautions to guarantee that our infrared message gets across to the receiver without errors.

2.5 Light Emitting Diode (LED)

Light Emitting Diodes are semiconductors that produce light when current passes through them. All early devices emitted low-intensity red light, but modern LEDs are available across the visible, ultraviolet and infrared wavelengths, with very high brightness[6]. LEDs are based on the semiconductor diode. When the diode is forward biased (switched on), electrons are able to recombine with holes and energy is released in the form of light. LEDs present many advantages over traditional light sources including lower energy consumption, longer life-time, improved robustness, smaller size and faster switching. However, they are relatively expensive and require more precise current and heat management than traditional light sources.

7

Applications of LEDs are diverse. They are used as low-energy indicators but also for replacements for traditional light sources in general lighting and automotive lighting.

2.5.1 Types of LED

The main types of LEDs are:

- Miniature and
- High power

Miniature LEDs. These are mostly single -die LEDs used as indicators and they come in various sizes from 2mm to 8mm, through hole and surface mount packages.

High Power LEDs. This can be driven at hundreds of mA (Vs. tons of mA for other LEDs). Some with more than one ampere of current, and gives out large amounts of light.

2.6 Timing Circuit (555 Timer)

The 555 timer is an integrated circuit that is capable of implementing a variety of timer and multivibrator applications. The IC was designed and invented by Hans R. Camenzind and introduced in by Signetics. The original name was the SE555 and was called the "IC Time Machine".[13] As of 2003, 1 billion units are manufactured every year. The IC depending on the producer, it contains over 20 transistors, 2 diodes and 15 resistors on a single chip (8-pin mini dual-in-line package). The 555 timer is one of the most popular and versatile integrated circuits ever produced.
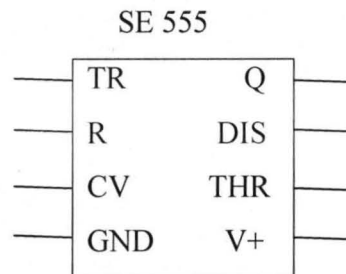
SE 555

TR	Q
R	DIS
CV	THR
GND	V+

Fig. 2.1 The schematic diagram of 555 Timer

The pin connection is illustrated in the table below:

Pin Number	Name	Purpose
1	Ground	Low level
2	Trigger	A short pulse high, low on the trigger starts the timer.
3	Output	During a timing interval, the output stays at Vcc
4	Reset	A timing interval can be interrupted by applying a reset pulse to low voltage
5	Control voltage	It allows access to the internal voltage divider
6	Threshold	The threshold at which the interval ends
7	Discharge	Connected to a capacitor whose discharge time will influence the timing interval
8	Vcc	The positive supply voltage which must be between 3 and 15V

The 555 timer has three operating modes which are the monostable mode, the astable mode and the bistable mode[14]. For the purpose of this project the astable mode was used. Therefore an Astable multivibrator is a timing circuit whose low and high states are both unstable. As such the output of an astable multivibrator toggles between low and high continuously, in effect generating a train of pulses.

2.7 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.

When an electric current is passed through the coil, the resulting magnetic field attracts the armature and the consequent movement of the movable contact or contacts either makes or breaks a connection with a fixed contact.[8] When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Most relays are manufactured to operate quickly.

The relay's switch connections are usually labelled 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**.

2.8 D-Flip-flop (4013)

A D-type flip-flop, also called a D-type bistable, is a subsystem with two stable states. Using appropriate input signals, you can trigger the flip-flop from one state to the other. The diagram of fig 2.2 below shows the input and output connections of a single D-type bistable:
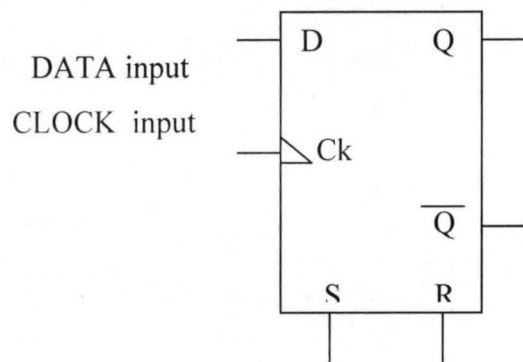
DATA input

CLOCK input

D   Q

Ck

$\overline{Q}$

S   R

Fig 2.7 Single D-type bistable

Q and **Q** are the output of the bistable. The logic states of the outputs are always opposite. The D-type has four inputs.[3] These are:

- Data Input: This is connected either to a low voltage, logic 0 or to a high voltage logic 1.

- Clock Input: The triangle next to the clock input shows that it is edge triggered, that is it responds to sudden changes in voltage.

- Set Input: The set input is normally held low. When it is pulsed high. The outputs of the bistable are forced immediately to the set state.

- Reset Input: The reset input is normally held low. When it is pulsed high, the outputs of the bistable are forced immediately to the reset state[14].

CHAPTER THREE

Design and Implementation

The project automatic remote controlled rechargeable light is designed to boost and increase the efficiency of light by providing higher illumination through the use of LEDs. The project is made up of different unit consisting of different components performing certain specified task.

- Power Supply Unit
- Charging Unit
- Infrared Unit
- Output Unit

3.1 The Power Supply Unit

Almost all electronic circuit or system requires DC for their operation. One way of obtaining DC power is primarily by the use of a transformer, a 15 volt transformer was used in the cause of this project, in other to adequately convert 230 V AC to a 15 VDC (step down transformer).

3.1.1 Rectification

The transformer is then followed by a rectifier normally diode, an IN4007 diode was used to achieve a full wave rectification. Rectification is the conversion of alternating current (AC) to direct current (DC).[2] The full wave Rectification consist of four IN4007 diodes connected as shown in figure 3.1
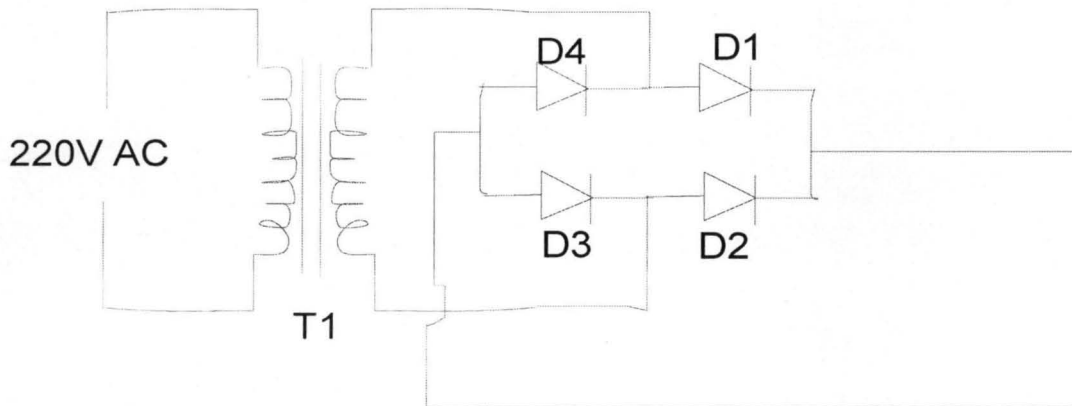
Figure 3.1 Rectification circuit

T1=Transformer

D1-D4=IN4007 Diodes

During the positive input half-cycle, diode D1 and D2 become forward biased (ON) whereas D3 and D4 are reversed biased (OFF) during the negative input half-cycle. The full wave rectification efficiency can be calculated from figure 3.2, using[2]:

$$\eta = \frac{0.812R1}{Rd + R1}$$

Where R$_1$=load resistance

R$_2$=diode resistance

After full wave rectification, the relation below gives the DC voltage with the peak amplitude.

$$Vdc = (Vrms * 0.9)V$$

Where Vrms is 15Vrms input, the peak DC voltage is therefore:

$$Vdc = (15 * 0.9) = 13.5 \approx 14\text{V}$$

13

3.1.2 Filtering

This is a way of removing ripples from the power supply, ripples are usually noticeable as hum in a malfunctioning audio amplifier, it is filtered out by the use of a capacitor, usually the lager the capacitor the smaller the ripples in the voltage, a 25V, 1000uf (C1) capacitor was used to eliminate ripples, as shown in figure 3.2 below
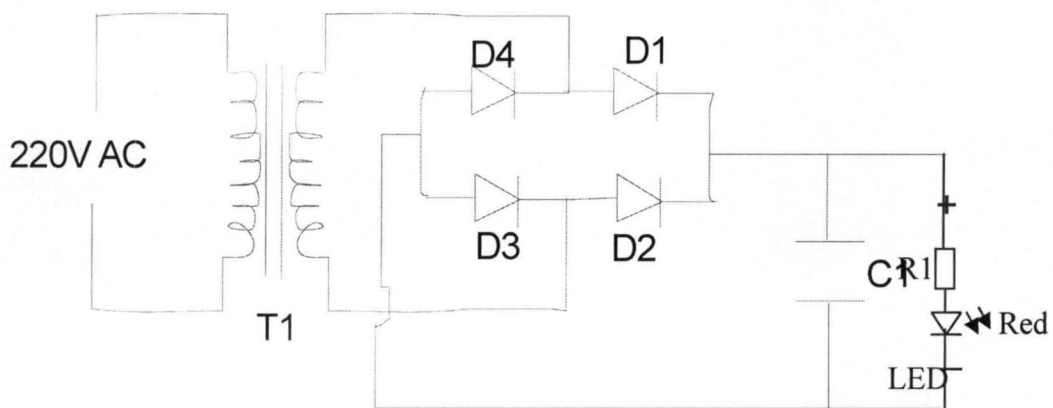

Figure 3.2 Filter circuit

An LED (red), power indicator was provided across the DC output to reflect the presence or absence of the local mains. A current limiting resistor R1 was wired in series with the LED, the value of which was evaluated using[2]:

$$R_1 = \frac{Vdc - Vled}{Iled} \quad \text{where } I_{led} \text{ is current of LED}$$

From the data sheet[3];

$V_{led} = 1.7$, $I_{led} = 10mA$

$V_{dc} = 14v$ (calculated)

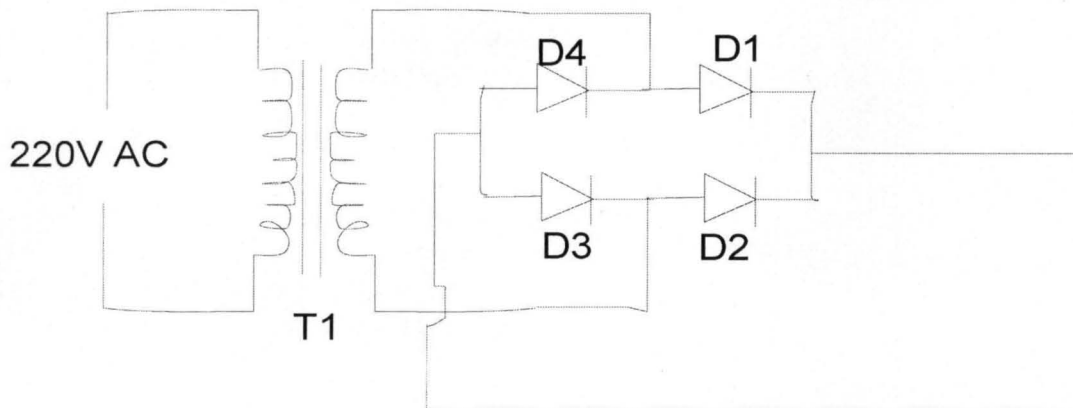$$R_1 = \frac{14 - 1.7}{0.01} = 1230\Omega = 1.23K\Omega$$

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T1=Transformer

D1-D4=IN4007 Diodes

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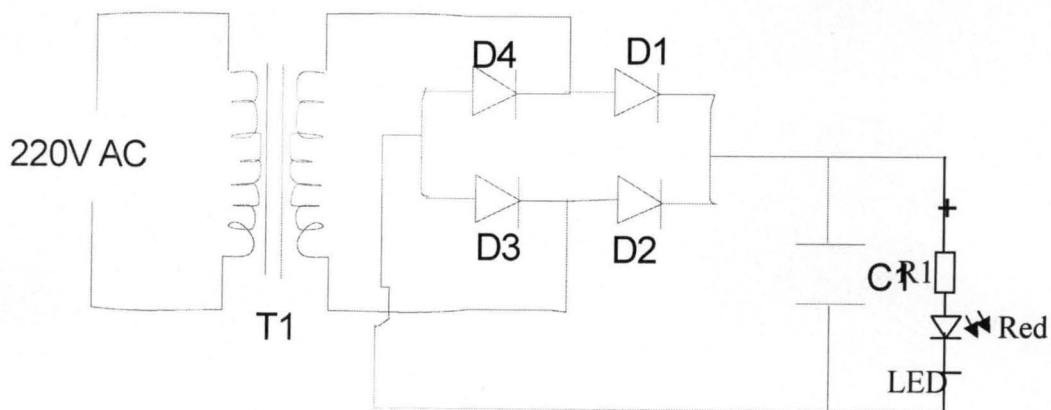

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$$R_1 = \frac{Vdc - Vled}{Iled} \quad \text{where } I_{led} \text{ is current of LED}$$

From the data sheet[3];

$V_{led} = 1.7$, $I_{led} = 10\text{mA}$

$V_{dc} = 14\text{v}$ (calculated)

$$R_1 = \frac{14 - 1.7}{0.01} = 1230\Omega = 1.23K\Omega$$

But, due to constrain in getting the exact component value, I used a 1KΩ resistor in my design.

3.1.3 Regulator

A more precise control over voltages and ripples can be achieved by a voltage regulator. A voltage regulator is a device use to maintain a constant output voltage irrespective of the varying input voltage.[2] An LM317 regulator was used in the cause of this project. The LM317 is an adjustable 3-terminal positive voltage regulator capable of supplying 1.5A over a differential voltage range of 3V to 40V, as shown in figure 3.3 below:
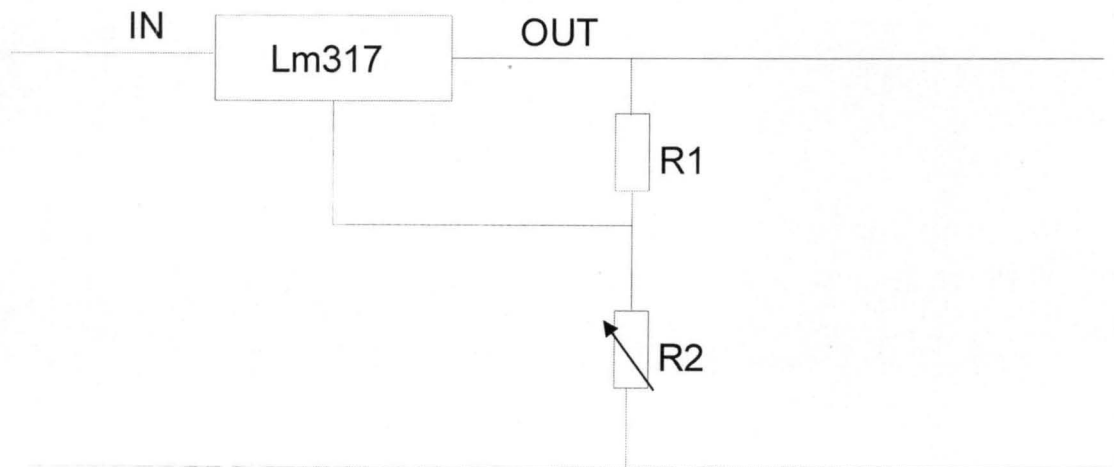

Figure 3.3 Regulating circuit

The output voltage is given by the relation;

$$V_{out} = (1.25(1 + \frac{R2}{R1}))\ V$$

Where:

$R_1 = 180\,\Omega$ (from the rated value)

$R_2 = 2.2K\,\Omega$ variable (voltage setting resistance).

Note that R_2 is normally adjustable only over a narrow range.

3.2 The Charging Unit

In other to store up energy for future use, a battery source is needed for the purpose of this project a lead acid battery of 12V 9AH was used; this is so because of their ability to charge and retain charged voltages over a period of time. The charger is built around the 3 terminal adjustable regulator (LM317). Unregulated DC voltage fed to the input of pin 3 and provides charging current through diode IN4007 and timing resistor (16ohm, 5Watts) through the normally open terminal of the relay. As shown in the figure 3.4 below :
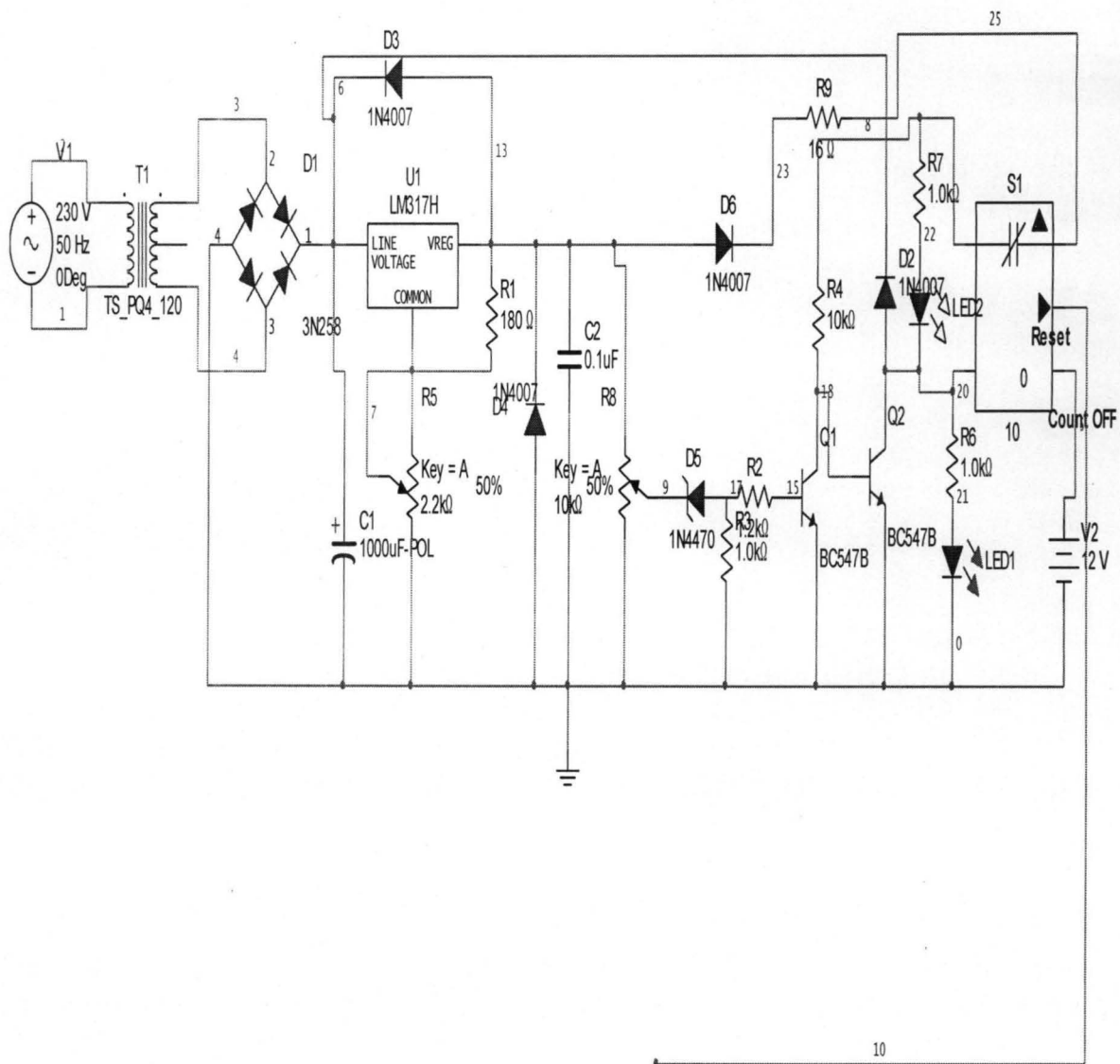

Fig 3.4 Circuit diagram for the charging unit of Emergency Rechargeable Lamp.

Diode D6 prevent discharge of battery when the input charging voltage is removed. R2 and R3 are biasing element for Transistor BC547 which provides a shutdown of the LM 317 at a maximum battery terminal voltage set by the zener diode. The maximum battery terminal voltage was evaluated using the relation [11]:

$$V_{baH} = 0.7 + V_z$$

Where,

$0.7 = V_{bc}$ (forward voltage drop in the silicon transistor)

V_z = zener voltage = 12.6V

Therefore,

$V_{baH} = 0.7 + 12.6 = 13.3V$ (maximum charging voltage)

At 13.3V, the regulator was directed into the power down mode, occasionally coming up to charge the battery if the terminal voltage falls below 13.3V.

3.3 Infrared

Infrared actually is a normal light with a particular colour. We humans can't see this colour because it is below the visible spectrum. A button is pressed which completes a specific connection, the transmitter amplifies the signal and sends them to the LED which translate the signal into infrared light. The sensor on the appliance detects the signal (infrared light) and responds appropriately to the received signal.

The infrared remote control is made up of a transmitter and a receiver for the purpose of this project, an infrared module was used for the receiver and a 555 timer was used to

generate signal for the transmitter. The layout of the 555 timer is illustrated below in the circuit diagram of figure 3.5.
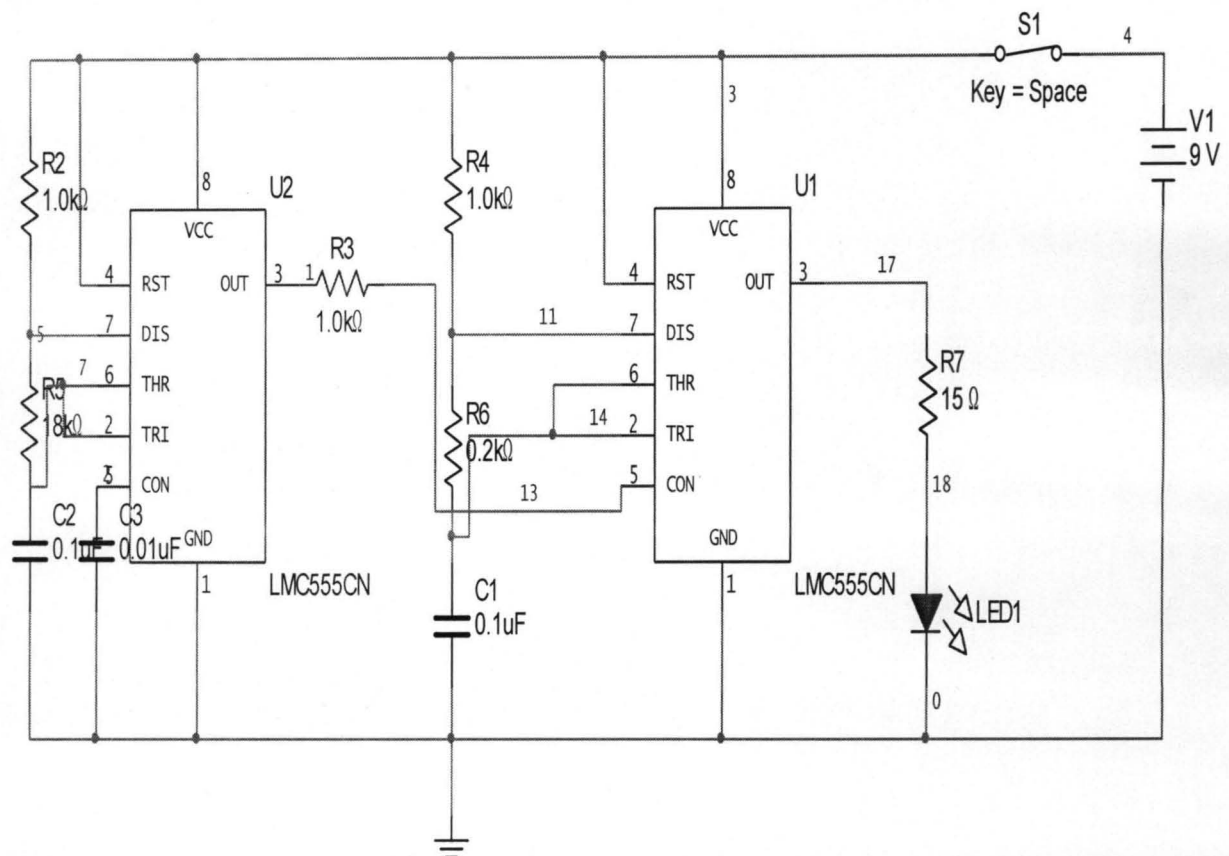

Fig 3.5 Circuit diagram of Infrared Transmitter Unit

The 555 timers are each operating in 500Hz and 38 KHz respectively, with these frequencies the values of R_2, Ton and Toff can be computed.

Computation for the 500Hz frequency, $C_1 = 0.1\mu f$ and $1k\Omega$ given.

$$F = \frac{1}{T}, \ T = \frac{1}{F} = \frac{1}{500} = 0.002 \text{ secs.}$$

$$T = 1.1 * RC, \ R = \frac{T}{1.1 * C1},$$

$R_2 = \dfrac{0.002}{1.1 * 0.1 * 10^\wedge-6} \approx 18.K\Omega$

$T_{on} = 0.693*C_1(R_1+R_2)$

$T_{on} = 0.693*0.0000001(1000+18000)$

$T_{on} = 1.3167 mSecs.$

$T_{off} = 0.693*C_1*R_2$

$T_{off} = 0.693*0.0000001*18000$

$T_{off} = 1.247 mSecs.$

Computation for the 38 KHz frequency, $C_1 = 0.1\mu f$ and $1k\Omega$ given.

$F = \dfrac{1}{T}, \; T = \dfrac{1}{F} = \dfrac{1}{38000} = 0.000026 \, secs.$

$T = 1.1*RC, \; R = \dfrac{T}{1.1*C1},$

$R_2 = \dfrac{0.000026}{1.1 * 0.1 * 10^\wedge-6} \approx 0.2 K\Omega$

$T_{on} = 0.693*C_1(R_1+R_2)$

$T_{on} = 0.693*0.0000001(1000+200)$

$T_{on} = 83.2\mu Secs.$

$T_{off} = 0.693*C1*R2$

$T_{off} = 0.693*0.0000001*200$

$T_{off} = 13.9\mu Secs.$

3.4 Output Unit

The output unit of this project consist of16 (10mm Light Emitting Diodes) connected in series with 100Ω resistors. The connection of the output unit is illustrated in the circuit diagram of figure 3.6
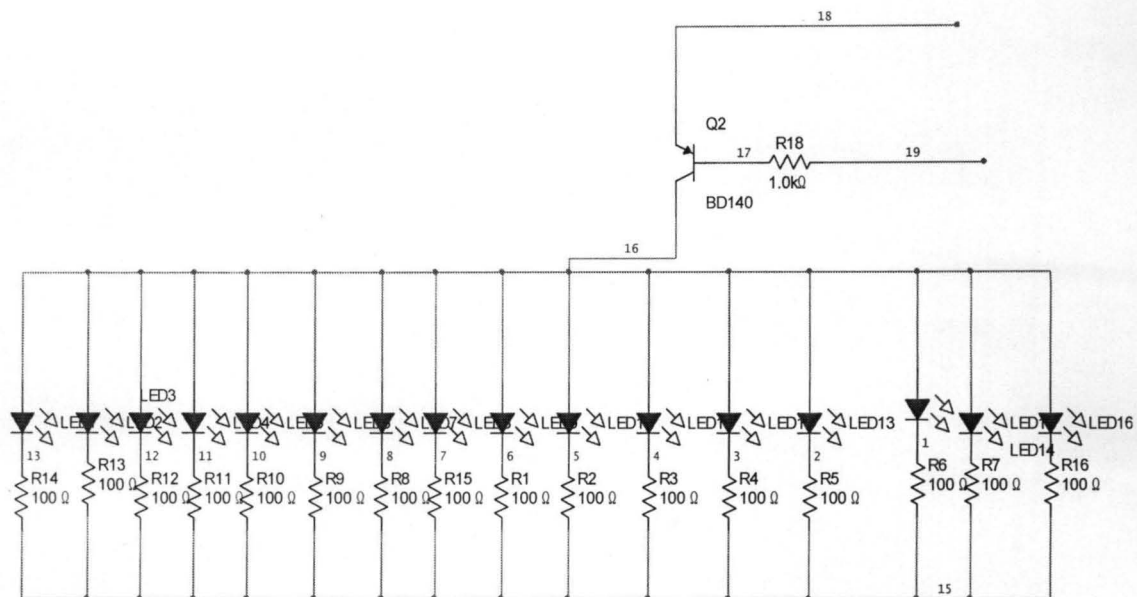

Fig 3.6 Circuit diagram of the output unit (Light Emitting Diodes)

Each of the 10mm LED from the data sheet[14] has:

- Emitted Color: White
- Size (mm): 10mm
- Lens Color: Water Clear
- Luminous: 65 lumen/watt
- Forward Current: 20mA
- Power: 50mW
- Forward Voltage: 3.6V

From the above parameters from the data sheet, the luminous intensity[9] of each LED is calculated using the following:

$$I = \frac{\phi}{4\Pi} \quad where:$$

I=Luminous Intensity

ϕ=Luminous

$$I = \frac{65}{4\Pi} = 5.17candela$$

Therefore, the total luminous intensity for the 16 LED is:

$$16 * 5.17 = 82.72candela$$

Where; 16=total number of LED, 5.17=luminous intensity per LED.

3.5 Circuit Construction

Prototyping of the project is necessary to allow measurement to be made. In the initial stage of the project, implementation of the hardware circuit was done on the bread board otherwise known as the project board. The function of this board is solely used for prototyping purposes as it allows components to be added and removed easily without soldering.

The circuit comprises: charger power supply and LED driver. The charger power supply section is built around three terminal adjustable regulator LM317, while the LED driver section is built around transistor BD140. In the charger power supply section, input AC mains are stepped down by transformer to deliver 15V, to the bridge rectifier, which comprises diodes (IN4007*4). Filter capacitor (25V/1000uf) eliminates ripples. Unregulated DC voltage is fed to the input pin 3 of LM317 and provides charging current

through diode IN4007 and limiting resistor (16ohm, 5watts). By adjusting preset 2.2K variable resistor, the output voltage can be adjusted to deliver the required charging current. When the battery gets charged to 13.3V, zener diode conducts and charging current from regulator finds a path through transistor BC547 to ground and it stops charging of the battery.

The LED driver section are connected in parallel with a 100ohm resistor in series with each. The common anode junction of all the LEDs is connected to the collector of PNP transistor and the emitter is directly connected to the normally open terminal of relay. The unregulated DC voltage produced at the cathode junction of bridge diode is fed to the base of transistor BD140 through a 1K resistor. When mains power is available, the base of the transistor remains high and it doesn't conduct. Thus LEDs are off. On the other hand, when mains fails, the base of the transistor becomes low and it conducts. This makes all the LEDs to glow. The mains power supply, when available, charges the battery and keeps the LEDs off as the transistor remains cut-off. During mains failure, the charging section stops working and the battery supply makes the LEDs glow. This is illustrated in the circuit diagram of figure 3.7.
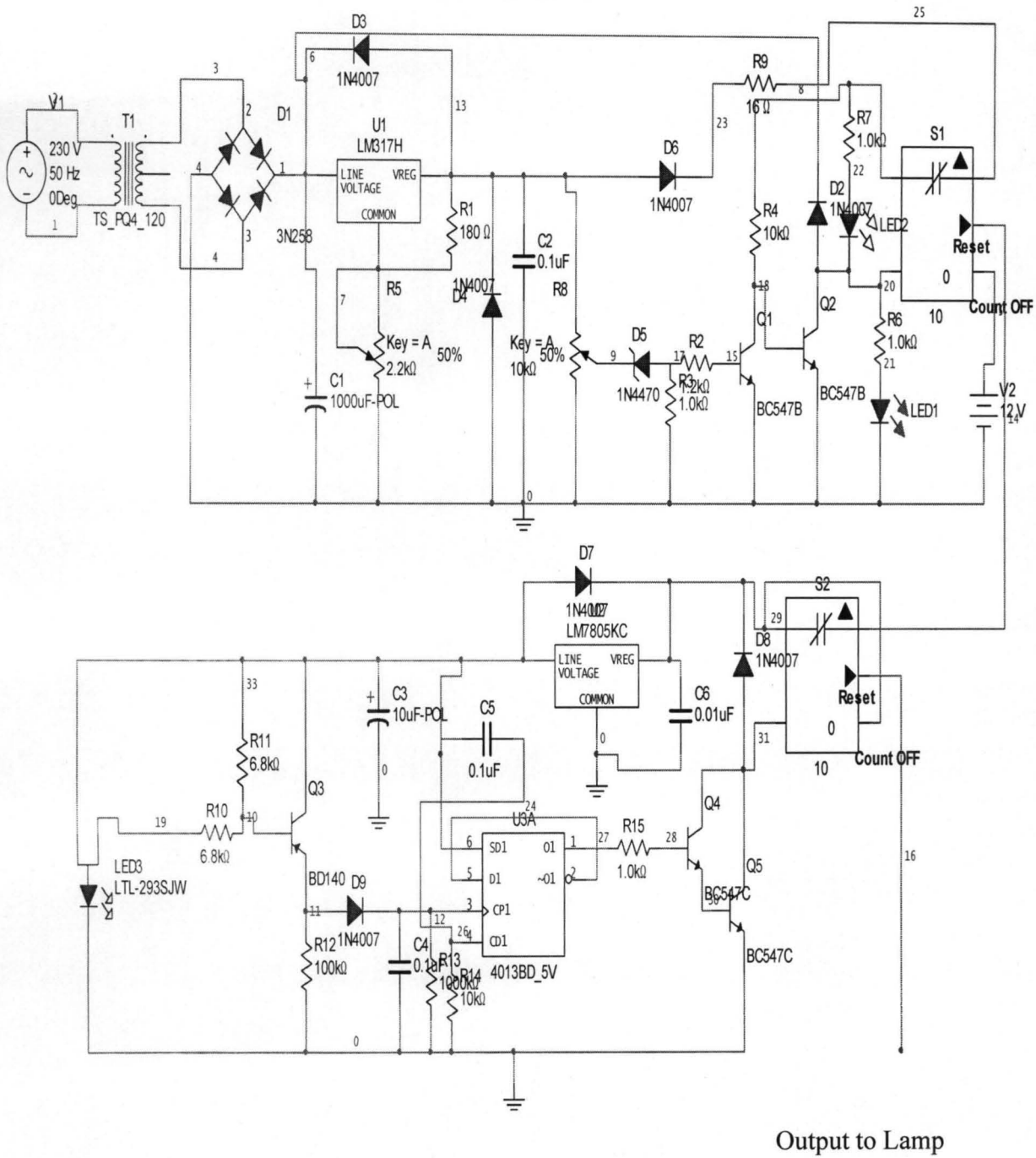
Fig 3.7 Circuit diagram of Emergency Rechargeable Lamp.

Output to Lamp

23

3.6 Casing Construction

The casing was made from unbreakable plastic material, the material was carefully dimensioned in order to get the proposed shape. Thereafter the material was cut into bits. After the cutting was made the resulting bits were joined using an adhesive of a low heat, which allows proper setting and steady drying. Then the various modules of circuit were fixed and properly screwed together with the appropriate screws.

CHAPTER FOUR

Test, Result and Discussion of result

4.1 Test

After ensuring proper connection of all components, the system was plug to main AC power supply, the LED came ON which indicated the presence of the main and battery charging operation.

4.2 Results

The maximum battery terminal voltage: i.e. $V_{baH} = 13.3V$

The luminous intensity LED was 5.17 candela, while the total luminous intensity of the total LED was 82.72 candela.

The power consumed by one LED was 0.05W from the data sheet, and a total of 0.8W was consumed by the whole 16 LEDs. However circuit power was calculated using:

$\dfrac{E1}{E2} = \dfrac{I2}{I1}$ Where E_1=230v, E_2=15v, I_1=0.5A (transformer rated values), I_2=?

$I_2 = \dfrac{230 * 0.5}{15} = 7.67A$

The circuit total power is:

$P = IV$, were $I=I_2$=7.67A and $V=V_{dc}$=14v(calculated)

P=7.67*14=107.38W

However, total unused power was (107.38-0.8=106.58W)

The resulting lighting of the LED's when the power from the mains was OFF; indicated the successful result of the project and the circuit functioning well throughout the duration of the test.

4.3 Discussion of result

The result was overwhelming due to the fact that the lamp lasted for about six hours after which the light's illumination was reduced. Also the fact that the lamp is an energy saving was proved because the total power of the circuit was 107.38W but only 0.8W of the total lamp power output was consumed, leaving 106.58W unused power.

4.3.1 Problems associated with the construction.

The following were some of the problems encountered during the cause of this project;

i Wrong choice of frequency configuration

ii Few inferior components

iii Shock from a bad soldering iron

iv Inadequate information about the components

v Bridge soldering which led to burning of some components.

4.3.2 Precautions taken during construction

The following precautions were taken during construction;

i The circuit diagram was strictly adhered to while constructing.

ii Proper soldering was ensured

iii Continuity was used in detection of error

iv The voltage coming from the power supply was measured to ensure conformity with the voltage stored by the battery.

v In order to prevent spike a decoupling capacitor was connected across the power supply.

vi I ensured that transistors and IC's were protected from the brief high voltage produced when a relay coil is switched off.

CHAPTER FIVE

Conclusion and Recommendation

5.1 Conclusion

The various tests carried out and the result obtained demonstrated that the remote controlled automatic rechargeable light achieved its design and construction aims. The system worked according to specification and quite satisfactory.

The lighting system is relatively affordable and reliable. It is easy to operate and provide greater illumination.

5.2 Recommendation

i Light dependent resistor can be used for full automatic control.

ii A much longer operation time could be achieved with further research.

iii A full automatic overcharged and undercharged indicator could be added to the circuit.

iv Silicon control rectifier should be used instead of a relay to minimize power consumption.

v More LEDs can be added to the circuit for a better luminous intensity of the lamp.

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