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The Implementation and Design of an Automatic LED Emergency Light System for Power Outages

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Abstract: *Growing demand for electricity savings has led to the development of an automatic LED emergency light system. It is based on providing light when the power is cut off. Once fully charged, the battery ceases charging, and in the event of a power failure, the LEDs are automatically powered by the battery. The project focuses on two primary functions: it automatically activates during power outages to give illumination, eliminating the need to search for the switch, and the battery rapidly begins recharging as the main power is restored. The emergency light is crucial due to the inconsistent voltage distribution and frequent power outages in operational regions of communities and diverse enterprises. The system includes a power supply that converts 230V AC to 12V DC, a relay that uses a control pulse to alternate between connecting the battery to the LEDs and isolating it, and a rechargeable Li-ion battery that supplies power to the LEDs during blackouts. The parallel-connected LEDs light up during a power outage in the circuits. The circuit architecture shown here serves to mitigate the entire discharge of the battery, hence enhancing the battery's longevity. Key components of the system include a step-down transformer, a bridge circuit to convert AC to DC, a Zener diode to maintain voltage stability, capacitors for energy storage, and various diodes to control current flow. The project highlights the advantages of LED emergency lights, such as efficiency, longevity, and minimal energy waste, though it acknowledges the higher initial cost and temperature sensitivity as disadvantages. The automatic LED emergency light is suitable for use in homes, offices, retail shops, and other commercial settings. The project demonstrates a cost-effective and compact solution that enhances daily life by providing reliable lighting during power failures.*

Keywords*: Power outages, Automatic LED emergency light, energy efficiency, Rechargeable battery, Voltage regulation*

INTRODUCTION

The need to reduce power use is on the rise. The idea is to keep the lights on even when the power goes off. An automated charger, which charges itself whenever there is an electrical source, makes this possible. The charging process terminates after the battery is completely charged. The fully charged battery will automatically turn on the LED in the event of a power outage. There are two main processes that this project is focusing on: [1]

1. Once the mains power goes off, it turns on automatically, so there's no need to hunt it out in the dark.
2. Its battery begins charging the moment the power goes back on. Due to the absence of power, this emergency light is mostly used inside the community.

Whenever there is a regular occurrence of a voltage distribution that is not uniform, an emergency light is used, both in commercial and residential settings. Rechargeable torches and systems like generators are only two of the many options for emergency lighting that are now on the market. When there is a regular power outage, you'll need a switch to turn them all on and off. This one focuses on a model that can detect when it is daytime and connected

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to the mains in order to activate the emergency light. Because it turns itself on and off automatically, you won't have to worry about finding it in the dark. This one just has one switch, and the emergency light will turn on when you turn it on. The majority of emergency lights have one negative aspect. The battery's discharge level is not being maintained at a safe level. The battery life is drastically reduced when it becomes fully depleted. A minimal discharge level guarantees the batter's extended life, which is an important part of overcoming this cut-off. Assuming the primary power goes out, the study aims to assist individuals.

Functional Block Diagram

The LEDs will be turned off if the power source is shut off, since it is linked to the Relay. The power source constantly charges the battery while it is turned on. The following is an explanation of the Block diagram in action.

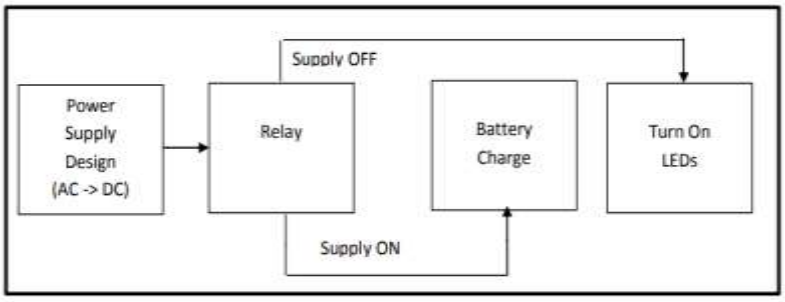

Figure (1) Functional Block Diagram of Economic LED emergency light

Flow Diagram of Economic LED emergency light:

The flow shows that the battery is charging when the air conditioner is turned on. In the absence of air conditioning, the flow diagram reveals the lights are illuminated.(1) A flow diagram of an economical LED emergency light is shown in Figure 2.

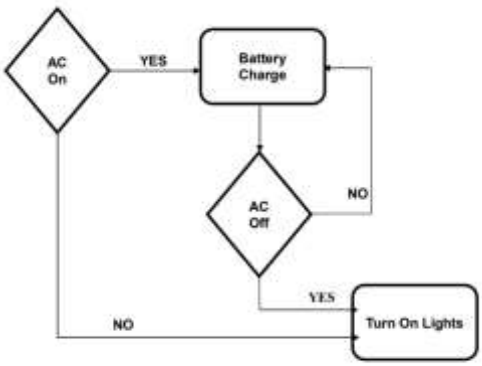

Figure (2) Flow Diagram of Economic LED emergency light

Explanation Of Each Block:

Power Supply:

Utilizing a 12-0-12V Transformer, the 230V AC power may be reduced to 12V AC. It converts 230 volts AC to 12 volts AC. A Bridge Circuit is used to convert 12V AC into 12V DC. The 12V DC output is achieved by means of four 1N4007 Diodes. The power supply's job is to do just that: change the current from AC to DC[2] .

Relay:

Imagine a relay acting as a switch. Common, Normally Open, and Normally Close are the three possible terminals. We link here. The rechargeable battery is attached to the NC terminal, while the LEDs are linked to the common terminal. At this point, it charges the battery by connecting to the NO terminal when the power source is turned on. The LEDs will be turned on when there is no power source, and the NC connection is connected to the battery.[3] .

Rechargeable Battery:

The output voltage of a Li-ION battery is 3.7V, while the maximum voltage that the battery can produce is 4.7V. To get 4.5V as an input, a 4.5V Zener Diode is used. In order to see how long it takes to charge the battery[4] .

LEDs:

Ten LEDs linked in parallel will charge the batteries when the power is off. When the electricity goes off, it turns on by itself.[5] .

Transformer:

A step-down transformer, which takes 230 V on the main side and puts out 12 V, is used in this circuit. A step-down transformer with 230 volts main and 12 volts secondary is what this is.[6] .

Relay circuit:

Imagine a relay acting as a switch. The DC supply may be fed into the 9V input of the relay, and then we can test its functionality by connecting a bulb to its output; this will cause the light to turn on and off, just as in the figure.3 [7]

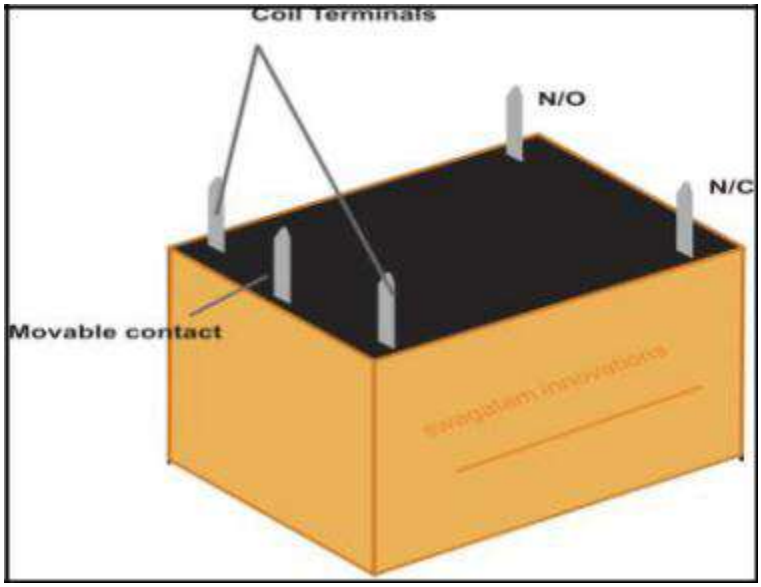

Figure (3) Relay

Simulated circuit for Relay as shown below:

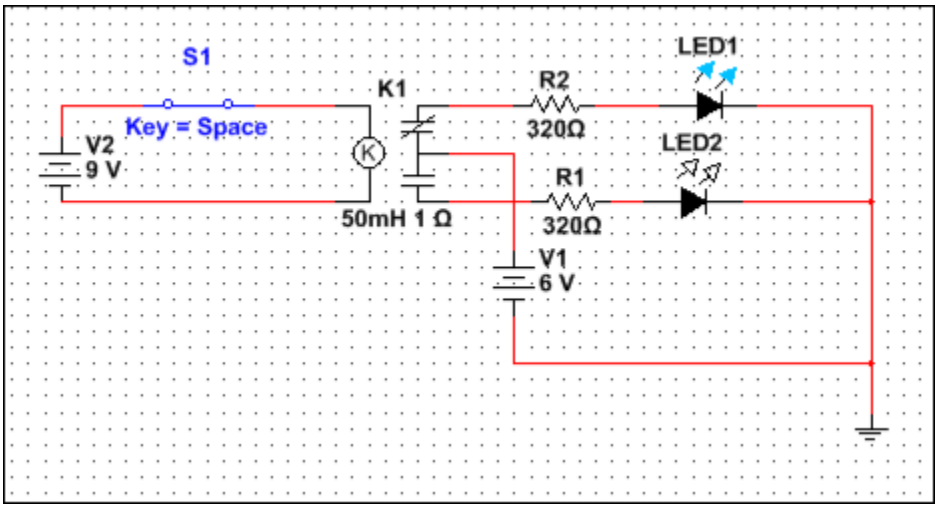

Figure (4) Relay Simulation Circuit

Zener Diode:

In a typical configuration, it allows current to flow forward. However, the reverse flow of current opens at a breakdown voltage (also called the Zener voltage). In order to prevent voltage breakdown at a certain voltage, the Zener diode is custom-made. [7] For instance, A diode with a Zener breakdown voltage of 4.2 V will show a voltage drop of roughly 4.2 V for a variety of reverse currents[8].

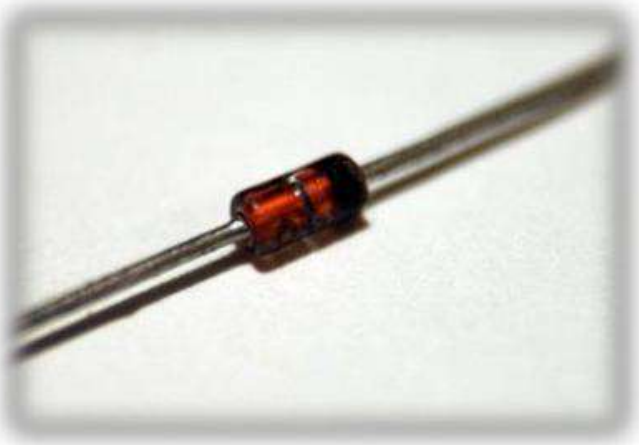

Figure (5) ZENER DIODE

Capacitor:

A capacitor is an electrical component with two terminals that passively stores electrostatic energy in an electric field. Capacitors come in many shapes and sizes, but they always have two plates—the electrical conductors—separated by a dielectric—the insulator—between them. The capacitance of a perfect capacitor has just one constant value. A capacitor is defined as the electric charge per unit area of potential difference (Q/V) between two conductors. A farad (F) is equivalent to one coulomb per volt (1 C/V), the standard SI unit of capacitance. Capacitance levels typically fall between the range of around 1 pF (10−12 F) to 1 mF (10−3 F). [9]

Figure (6) Capacitor

Diode:

In electronics, a diode has two terminals and an asymmetric conductance, meaning that current flows through it with little to no resistance in one direction and an unlimited amount in the other. [10]

Figure (7) Diode

LED:

A semiconductor light source, a light-emitting diode (LED), has two leads. When turned on, this simple PN-junction diode produces light. The device's ability to recombine electrons with electron holes allows it to release energy in the form of photons when a suitable voltage is supplied to the leads. Here, a rechargeable battery powers ten LEDs linked in parallel so that they continue to glow even after the power goes off. In addition, it has an automatic on feature that activates when the power is turned off. the eleventh

Figure (8) LED

Rechargeable Battery:

An output voltage of 3.7V may be generated by a Li-ION battery with a maximum voltage rating of 4.7V. To get 4.5V as an input, a 4.5V Zener Diode is used. So that the amount of time needed to charge the battery can be seen. [12]

Figure (9) Rechargeable Battery

Bridge Circuit:

One kind of electrical circuit is called a bridge circuit. It consists of two branches that run parallel to one other and are "bridged" by a third branch that connects the first two branches somewhere in the middle.

The automated emergency light circuit's bridge circuit converts 12VAC into 12VDC [13].

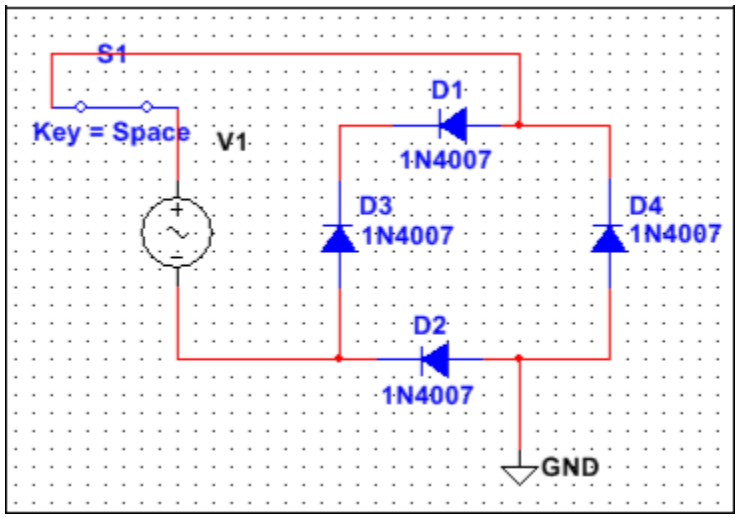

Figure (10**)** Bridge Simulation

Advantages of Economic LED Emergency Light[14]

- LEDs have several advantages over incandescent bulbs, including:
- They produce less heat than other light sources;
- They are easy to switch on and off
- They light up rapidly.
- LEDs last longer and are less likely to break.
- They are safer to use as they are free of mercury.

Disadvantages of Economic LED Emergency Light[15]

While conventional emergency lights are less expensive, energy-efficient LED options are more expensive. Sensitivity to temperature — A diode's illumination efficiency is quite sensitive to its operational temperature.

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Uses of Economic LED Emergency Light

Commercial spaces such as offices, stores, movie theaters, restaurants, healthcare facilities, educational institutions, and buildings with several stories may all benefit from its use.

Circuit Diagram

The circuit diagram of the Automatic LED Emergency light is as follows:

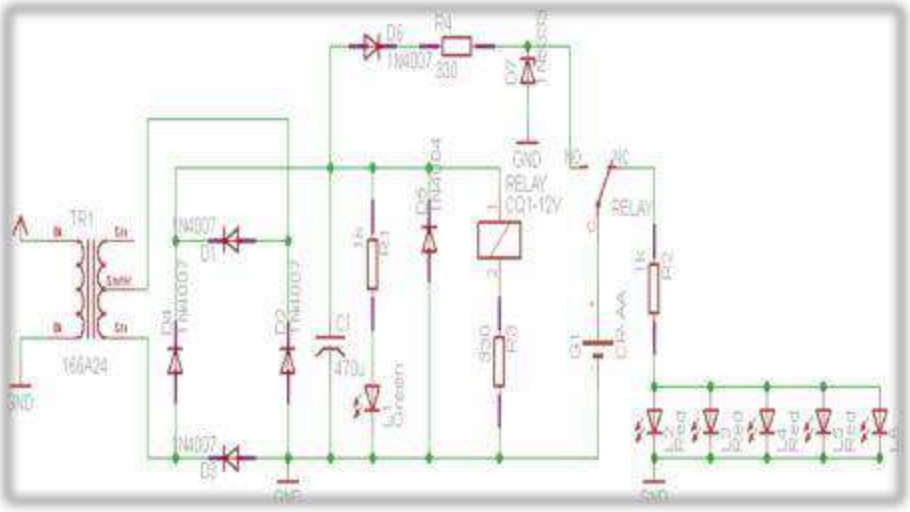

Figure (11**)** Circuit Diagram

Operation of circuit Diagram

The diode bridge rectifier and step-down transformer reduce the high alternating current (AC) voltage, which may be anywhere from 110 to 230 volts, to a low direct current

(12 volts). As a freewheeling diode, diode D5 stops the flow of charge backwards from the battery. The relay's NO (Normally Open) connection contacts the battery when power is applied. Consequently, this is when the battery gets a charge. To keep track of when your emergency light battery needs charging, use a green LED. The Normally Closed (NC) terminal of the relay is linked to the battery in the event of a supply failure. By virtue of their connection to the NC connector, the LED arrays draw power from the battery to illuminate.

Circuit Diagram With Operational Details

Transformer:

We used a 12-0-12V Transformer to transform high AC voltage into low AC voltage.

Bridge Circuit:

Our 12 V DC power source is a four-diode 1N4007. Its low forward voltage drop and high current capability are notable features. The capacitor has a capacitance of 470µF. Our output is corrected as a result.

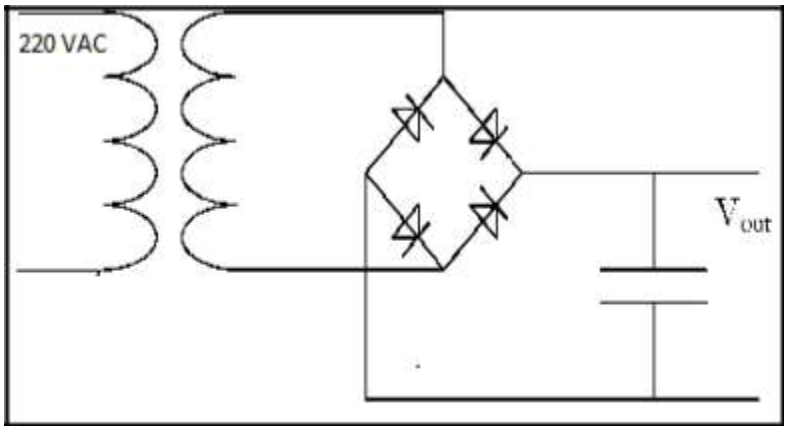

Figure (12) Bridge Circuit

Relay:

Imagine a relay acting as a switch. The Relay requires a direct current (12V DC) source, which is why a 12V transformer is in use.

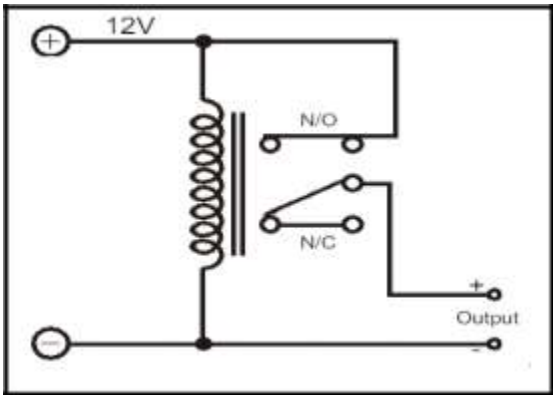

Figure (13) Relay

Rechargeable Battery:

The nominal voltage of a lithium-ion battery, which is used for rechargeable batteries, is 3.7 volts. The typical amount of power stored is 1950mAh. At 4.2V, it may be charged. Current constant: 0.2C5A.

Simulated Circuit

At the time of simulation, the circuit is simulated, and the diagram is as shown below:

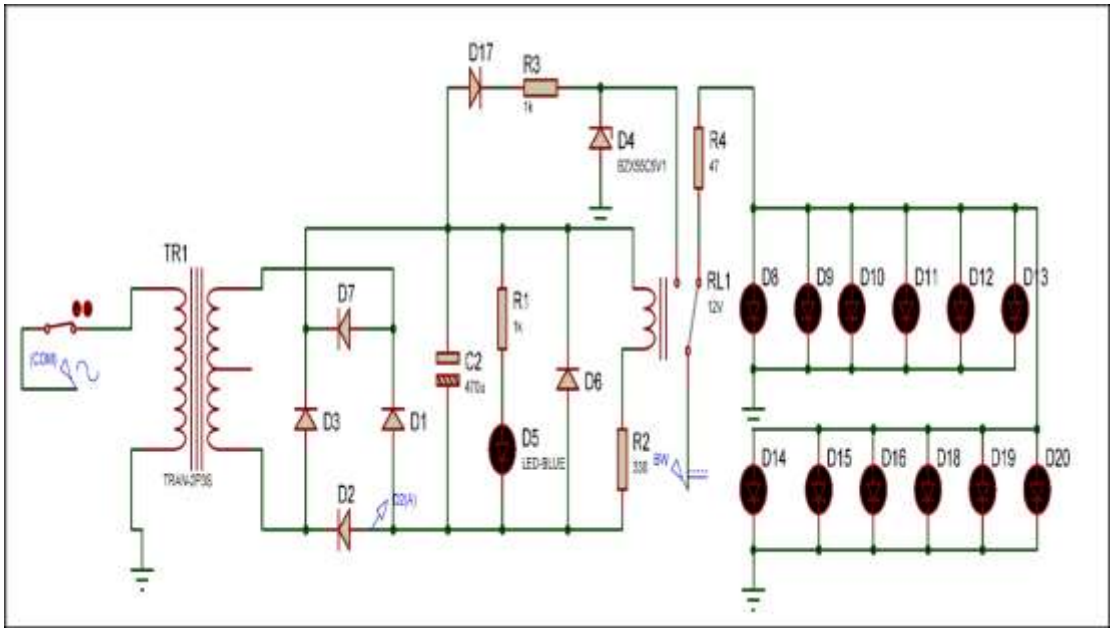

Figure (14) Simulated Circuit

Scope of Economic LED emergency light

Here is what the Automatic LED Emergency Light can do: The battery life is extended to around 8 hours. The LEDs (light) are immediately turned off as soon as it detects that power is available. Simple to operate.

Ideal for use as a workroom, meeting room, or exhibit hall illumination Instructional Uses Bathroom Arrow Board ()

Advantages of Economic LED emergency light

Among its many benefits are its inexpensive price, high energy savings, ease of installation, and ease of usage.

Higher light output per watt compared to incandescent lights; efficiency.

Color: may provide the desired hue even when no color filters are present. Dimensions: minuscule.

Time of illumination: turns on and off rapidly. Long and fruitful life span

Disadvantages of Economic LED emergency light

Cost: currently more expensive.

Health hazard: cool white LEDs can cause problems to the eyes

Application

In the event of a power outage, it serves as a backup supply.

For use around the house, it works well. Employed in outlying residential regions.()

Comparison of LED Lamps with other Lighting Technologies:

The comparison between LED, Florescent Lamps and incandescent lamps is shown() :

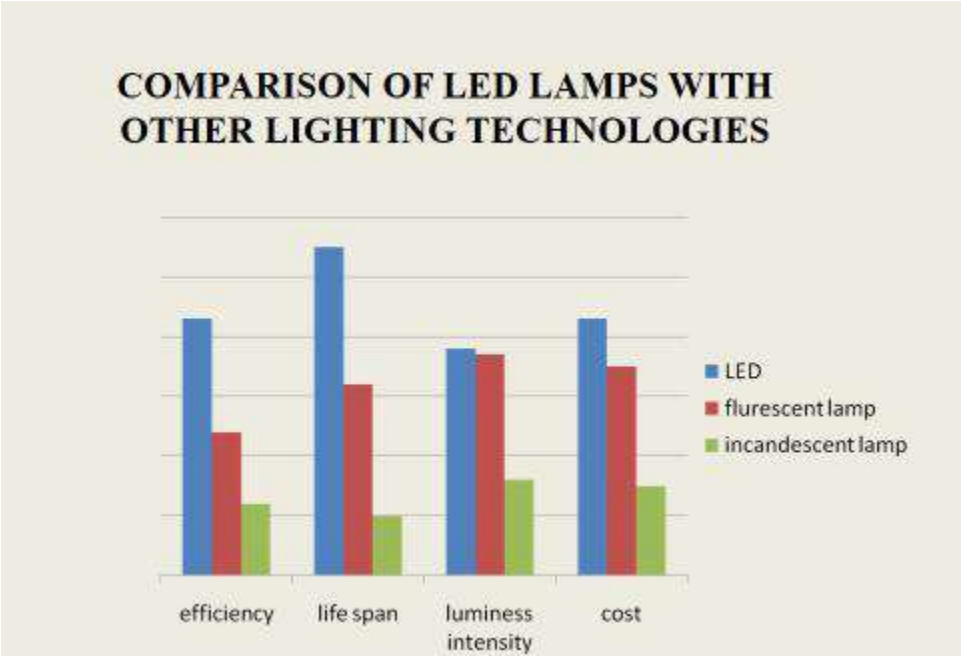

Figure (15) Comparison of LED with other Technologies

Eagle PCB Layout

With the use of a circuit diagram, the PCB layout is as follows:

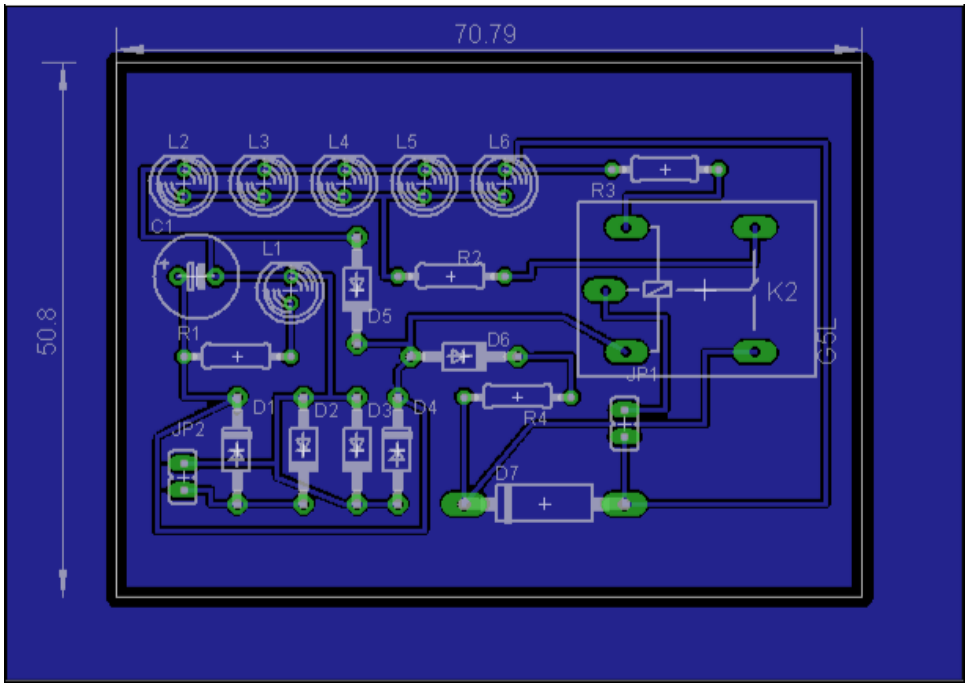

Figure (16) PCB Layout

Part list

Part Value Package Library Position (inch) Orientation

Table 1 Part List

Part	Value	Package	Library	Position (inch)	Orientation
C1	470u	E3, 5-8	rcl	(0.3 1.1)	R0
D1	1N4007	DO41-10	diode	(0.45 0.45)	R270
D2	1N4007	DO41-10	diode	(0.7 0.45)	R90
D3	1N4007	DO41-10	diode	(0.9 0.45)	R90
D4	1N4007	DO41-10	diode	(1.05 0.45)	R270
D5	1N4004	DO41-10	diode	(0.9 1.05)	R90
D6	1N4007	DO41-10	diode	(1.3 0.8)	R180
D7	1N5333	C1702-15	diode	(1.6 0.25)	R0
JP1	3.7V	JP1	jumper	(1.9 0.55)	R0
JP2	230V	JP1	jumper	(0.25 0.35)	R18
K2	G5L	G5LE	relay	(2.2 1.05)	R0
L1	Green	LED5MM	led	(0.65 1.05)	R90
L2	Red	LED5MM	led	(0.25 1.45)	R90

L3	Red	LED5MM	led	(0.55 1.45)	R90
L4	Red	LED5MM	led	(0.85 1.45)	R90
L5	Red	LED5MM	led	(1.15 1.45)	R90
L6	Red	LED5MM	led	(1.45 1.45)	R90
R1	1k	0207/10 resistor		(0.45 0.8)	R0
R2	1k	0207/10 resistor		(1.25 1.1)	
R180					
R3	330	0207/10 resistor		2.05 1.5)	
R180					
R4	330	0207/10 resistor		1.5 0.65)	
R180					

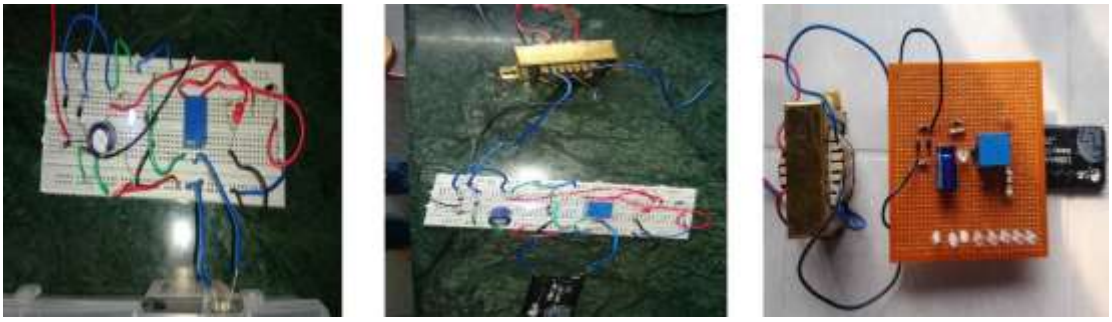

Figure (17) Circuit Diagram in Working Condition

CONCLUSION

The initiative was found to be creative in its approach to bettering people's daily lives. The gadget also gives the old-fashioned light bulbs a fresh appearance. An additional benefit of this circuit is its inexpensive implementation cost. In today's age of shrinking technology, automated LED emergency lights are a space-saving and economical solution. Since more and more innovative applications are being built using LEDs, promoting them will improve future advancements.

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