# SMART STREET LIGHT CONTROL SYSTEM USING 555 TIMER IC AND RELAY

A MINI PROJECT REPORT IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE IN BACHELORS' IN ELECTRONICS AND COMMUNICATIONS ENGINEERING

UNDER THE GUIDANCE OF Dr. BIJOY KANTHA

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# CERTIFICATE

This is to certify that this project report titled **SMART STREET LIGHT CONTROL SYSTEM USING 555 TIMER IC AND RELAY** submitted in partial fulfilment of requirements for award of the degree Bachelor of Technology (B. Tech.) in Electronics and Communication Engineering of Maulana Abul Kalam Azad University of Technology is a faithful record of the original work carried out by,

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TITLE OF THE PROJECT :

**SMART STREET LIGHT CONTROL SYSTEM USING 555 TIMER IC AND RELAY**

**PROJECT GUIDE** : Dr. BIJOY KANTHA

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**NETAJI SUBHASH ENGINEERING COLLEGE, GARIA, TECHNOCITY, KOLKATA**

| PROJECT VERSION | MEMBERS | DESCRIPTION | DATE COMPLETED ON |
|---|---|---|---|
| Mini project | Ankit Samaddar<br>Arnab Basak<br>Meheli Roy<br>Souvik Ghosh | Project Report | 18th May, 2023 |

Signature of the examiner

Date:

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Date:

# Smart Street Light Control System using 555 Timer IC and Relay

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## ABSTRACT

This project involves the use of a 555 timer IC and a relay to create an automatic street light control system. The system uses an LDR (light dependent resistor) to detect the ambient light level and turn on the street lights when it gets dark. The 555 timer IC acts as a comparator circuit, with pin 6 connected to the positive supply voltage and pin 2 connected to the LDR. When the ambient light level falls below a certain threshold, the output of the 555 timer goes high, triggering the relay to turn on the street lights. The system can be easily used to control higher AC/DC loads by adding a relay with the LED at the output of the 555 timer.

## OBJECTIVES

Objectives of the Smart Street Light Control System using 555 Timer IC and Relay:

1. To create an automatic street light control system that can detect the ambient light level and turn on the street lights when it gets dark.
2. To use a 555 timer IC as a comparator circuit with pin 6 connected to the positive supply voltage and pin 2 connected to the LDR.
3. To use a relay to control higher AC/DC loads by replacing the LED at the output of the 555 timer.
4. To design a system where there is automatic turning on and off of the light whenever needed and eliminate manual operation of the lighting system completely.
5. To provide an energy-saving solution for electrical power wastage.
6. To assist people who have a phobia of darkness by providing automatic street lights.
7. To provide an intelligent street lighting mechanism that provides light automatically during night without any human interference.
8. To use LEDs instead of incandescent lamps for energy-saving street lights.
9. To make an electronic circuit for street light control that is simple and cheap.
10. To use an LDR (light dependent resistor) whose value depends on the quantity of light falling on it to detect ambient light levels.
11. To turn on street lights in the evening before the sun sets and switch them off the next morning after there is sufficient light on the roads.
12. To make a project built around a few electronic components that can be used in lawns and Smart Home systems as well.
13. To simulate the Automatic Street Light Control System using Proteus Simulation software to test its functionality before implementation.
14. To provide an effective, simple, and low-cost solution for automatic street lighting that can be easily implemented in any area where street lights are needed.

# INTRODUCTION

The Smart Street Light project aims to develop an innovative and energy-efficient lighting system for streets using the 555 timer IC and a relay. This system utilises advanced circuitry to automate the operation of street lights, optimising energy consumption while ensuring adequate illumination.

The circuitry of the smart street light system is designed to adapt to ambient light conditions, ensuring that the street lights are active only when necessary. This not only conserves energy but also reduces the overall maintenance and operating costs associated with traditional street lighting systems.

The core of the system is the 555 timer IC, a versatile integrated circuit widely used in various timer and oscillator applications. The 555 timer IC offers precise timing capabilities and can be configured in multiple modes, making it an ideal choice for controlling the street light system. The 555 timer IC has three modes of operation: astable, monostable, and bistable.

The astable mode is the most commonly used mode for the Smart Street Light project. In astable mode, the 555 timer gives output high when input low and output low when input high. The Pin 2 (Trigger) turns on the Pin 3 (Output) when the voltage supplied to it drops below 1/3 of Vcc.

The circuit configuration consists of an 8-pin 555 timer IC, with pins assigned specific functions. Pin 5 and pin 7 are connected by a 100k resistor, forming a voltage divider circuit. This setup provides a reference voltage for the 555 timer's internal comparators. Pins 8 and 6 are connected to the power supply (Vcc), ensuring stable voltage levels for proper operation. Pin 4 is connected to the ground, establishing the common ground reference for the circuit.

To regulate the street light's brightness based on ambient light conditions, a Light-Dependent Resistor (LDR) is employed. LDR (Light Dependent Resistor) that acts as a sensor to detect the intensity of ambient light. The LDR, connected in series with a 100k resistor, forms a voltage divider circuit. This voltage divider circuit is connected to pin 2 (trigger input) of the 555 timer IC via a 2.2 M ohm resistor.

When the ambient light level falls below a certain threshold, indicating nighttime, the resistance of the LDR increases, causing an increase in the voltage at the junction of the LDR and the 100k resistor. This triggers the 555 timer IC, turning pin 3 (output pin) low, which is connected to the cathode of the red LED with its anode connected to Vcc. The red LED illuminates and activates the relay, providing the required lighting during nighttime.

Conversely, during daylight hours, when the ambient light intensity increases, the resistance of the LDR decreases. This reduces the voltage at the junction of the LDR and the 100k resistor, resulting in the deactivation of the 555 timer IC's turning the output pin 3 high. In this state, a blue LED with its anode connected to pin 3 and cathode to ground, is activated, indicating that the street lights are off.

## CIRCUIT DIAGRAM

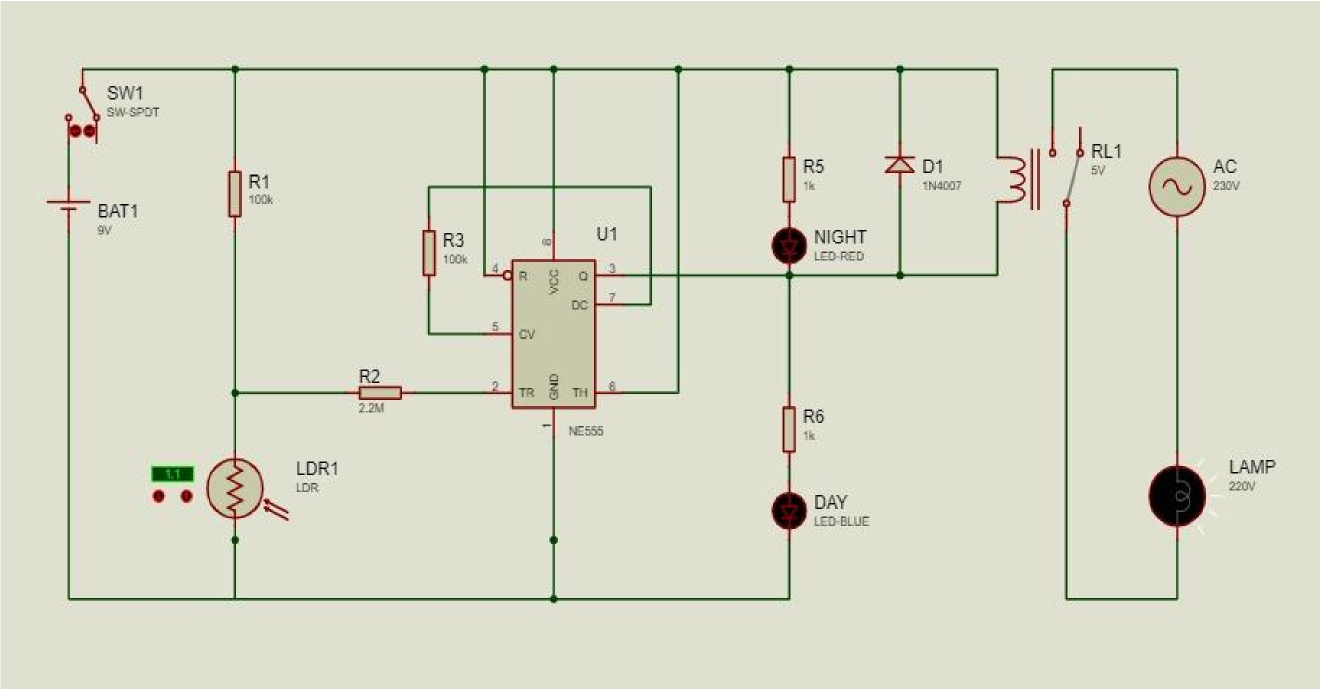



**Figure 1** : Circuit diagram of Smart Street Light Control System using 555 Timer IC and Relay

## HARDWARE REQUIRED

| Component | Value/Specs | Quantity |
|---|---|---|
| Timer IC | NE555 | 1 |
| LDR | - | 1 |
| Diode | 1N4007 | 2 |
| Resistor | 1KΩ | 2 |
| Resistor | 100KΩ | 2 |
| Resistor | 2.2MΩ | 1 |
| Relay | 5V | 1 |
| Battery | 5V-12V | 1 |

**Table 1** : Components required

## THEORETICAL BACKGROUND

### I. Working Principle Of 555 Timer IC

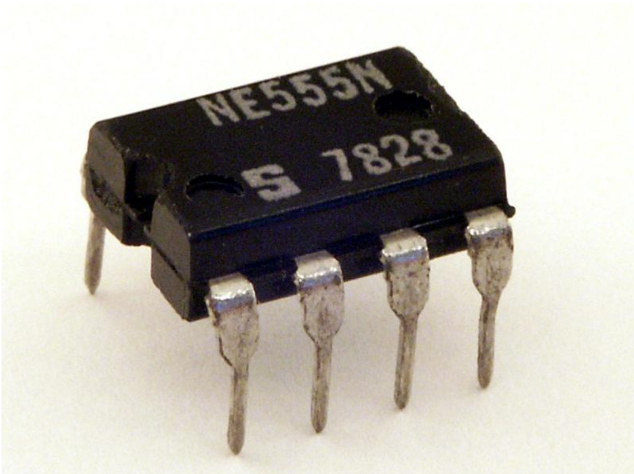



**Figure 2** : 555 Timer IC

The 555 timer is a widely used integrated circuit (IC) that functions as a versatile timing device in electronic circuits. Its working principle involves internal comparators, flip-flops, a transistor and resistors/capacitors to generate accurate timing signals.

The basic 555 timer IC consists of three functional blocks: a voltage divider network (comprising three resistors), two comparators, a flip-flop, and an output stage. It can operate in various modes, including monostable (one-shot) mode, astable (free-running oscillator) mode, and bistable (flip-flop) mode.

#### I.I Pinout of 555 Timer IC:

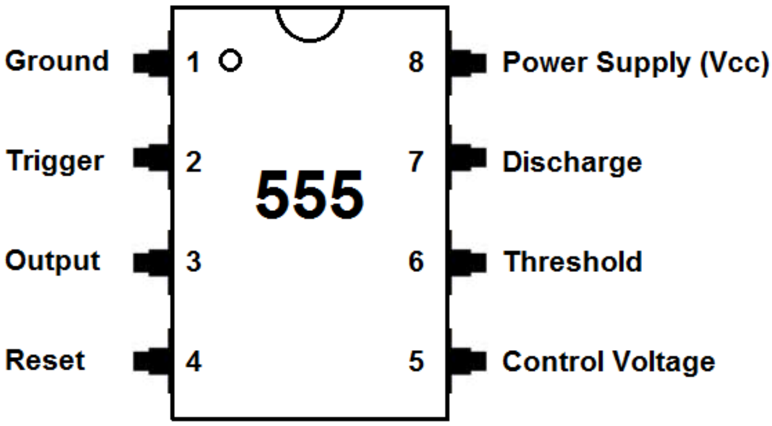



**Figure 3** : Pin -Diagram of 555 single-Timer IC

**Pin 1**: *Ground*. All voltages are measured w.r.t this terminal.

**Pin 2:** *Trigger*. The output of the timer depends on the amplitude of the external trigger pulse applied to this pin. The output is low if the voltage at this pin is greater than 2/3 VCC. When a negative going pulse of amplitude greater than 1/3 VCC is applied to this pin, comparator 2 output goes low, which in turn switches the output of the timer high. The output remains high as long as the trigger terminal is held at a low voltage.

**Pin 3:** *Output*. There are two ways by which a load can be connected to the output terminal: either between pin 3 and ground or between pin3 and supply voltage +VCC. When the output is low the load current flows through the load connected between pin3 and +VCC into the output terminal and is called sink current. The current through the grounded load is zero when the output is low. For this reason the load connected between pin 3 and +VCC is called the normally on load and that connected between pin 3 and ground is called normally off-load. On the other hand, when the output is high the current through the load connected between pin 3 and +VCC is zero. The output terminal supplies current to the normally off load. This current is called source current.

**Pin 4:** *Reset*. The 555 timer can be reset (disabled) by applying a negative pulse to this pin. When the reset function is not in use, the reset terminal should be connected to +VCC to avoid any possibility of false triggering.

**Pin 5:** *Control Voltage*. An external voltage applied to this terminal changes the threshold as well as trigger voltage. Thus by imposing a voltage on this pin or by connecting a pot between this pin and ground, the pulse width of the output waveform can be varied.

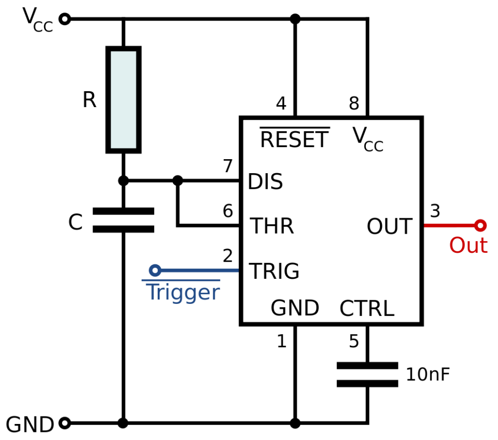
**Pin 6:** *Threshold*. This is the non-inverting input of comparator 1, which monitors the voltage across the external capacitor. When the voltage at this pin is greater than or equal to the threshold voltage 2/3 VCC, the output of comparator 1 goes high, which in turn switches the output of the timer low.

**Pin 7:** *Discharge*. This pin is connected internally to the collector of transistor Q1. When the output is high Q1 is OFF and acts as an open circuit to external capacitor C connected across it. On the other hand, when the output is low, saturated and acts as a short circuit, shorting out the external capacitor C to ground.

**Pin 8:** *+VCC*. The supply voltage of +5V to + 18V is applied to this pin with respect to ground.

## I.II Modes of 555 Timer IC

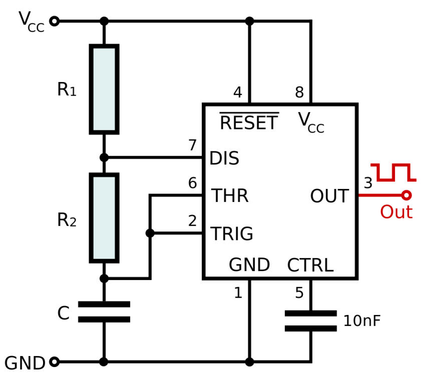
### I.II.I Monostable Mode




In the monostable mode, the 555 timer produces a single pulse of a fixed duration when triggered. The timing of the pulse is determined by the values of an external resistor (R) and capacitor (C) connected to the IC. When a trigger signal (typically a low voltage) is applied to the trigger pin (pin 2), it initiates the timing process. The internal flip-flop is set, and the output pin (pin 3) goes high for the duration determined by the RC time constant. At the end of the specified time, the output pin returns to its low state.

**Figure 4** : Schematic of a 555 in monostable mode.

### I.II.II Astable Mode




In the astable mode, the 555 timer operates as a free-running oscillator, continuously generating a square wave signal. This mode requires an external resistor and capacitor to determine the timing parameters. The capacitor charges and discharges through the external resistors, creating a time-dependent oscillation. The duty cycle (the ratio of ON time to the total period) and frequency of the output signal can be adjusted by varying the values of the external components.

**Figure 5** : Schematic of a 555 timer in astable mode

### I.II.III Bistable Mode

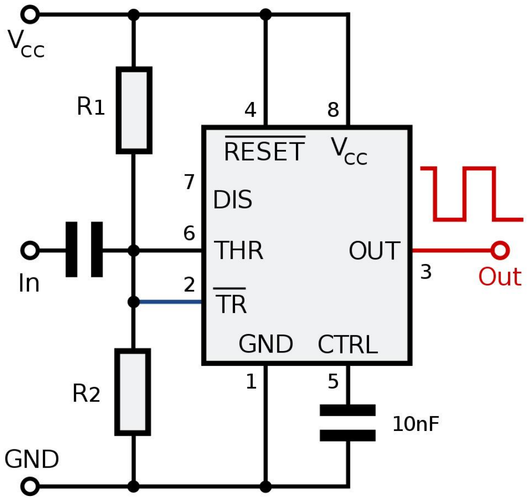



**Figure 6** : Schematic of a 555 in bistable Schmitt triggers inverter mode.

In the bistable mode (also known as flip-flop mode or Schmitt trigger), the 555 timer functions as a basic flip-flop circuit. The circuit has two stable states, and it toggles between these states in response to trigger signals. The output remains in one state until a trigger signal is applied to the trigger pin, causing the output to switch to the other state.

The timing functions of the 555 timer are controlled by internal comparators that compare the voltage levels of the external components with internal reference voltages. These comparators determine the transitions between high and low states, driving the internal flip-flops and controlling the output.

In summary, the working principle of the 555 timer involves utilising internal comparators, flip-flops, and external resistors/capacitors to generate precise timing signals. Depending on the mode of operation and the external components, the 555 timer can function as a monostable, astable, or bistable device, providing timing and control functions in electronic circuits.

### I.III Design :

Depending on the manufacturer, the standard 555 package incorporated the equivalent of 25 transistors, 2 diodes, and 15 resistors on a silicon chip packaged into an 8-pin dual in-line package (DIP-8).Variants available included the 556 (a DIP-14 combining two complete 555s on one chip), and 558 / 559 (both variants were a DIP-16 combining four reduced-functionality timers on one chip).

The NE555 parts were in the commercial temperature range, 0 °C to +70 °C, and the SE555 part number designated the military temperature range, −55 °C to +125 °C. These chips were available in both high-reliability metal can (T package) and inexpensive epoxy plastic (V package) form factors. Thus, the full part numbers were NE555V, NE555T, SE555V, and SE555T.

Low-power CMOS versions of the 555 are now available, such as the Intersil ICM7555 and Texas Instruments LMC555, TLC555, TLC551.

## II. Working Principle Of LDR

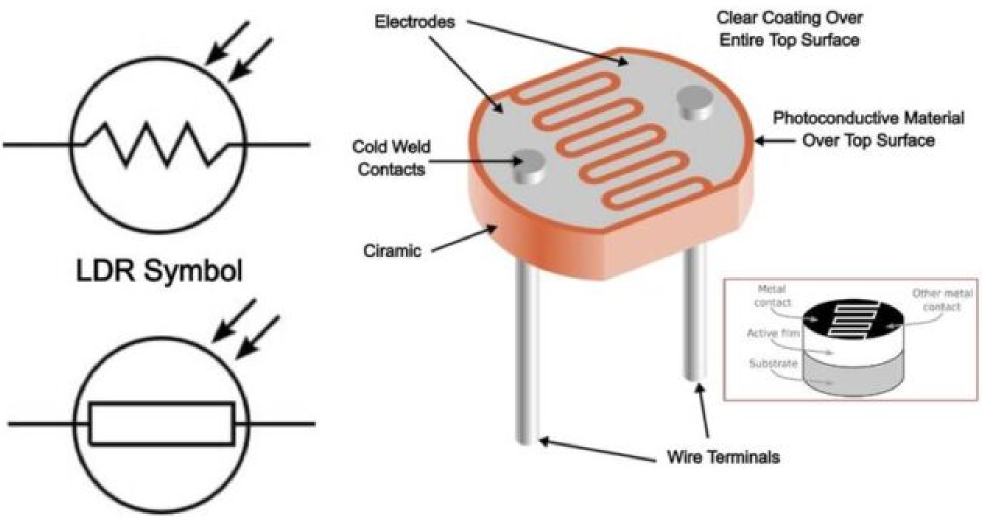



**Figure 7** : Schematic diagram of LDR

The working principle of an LDR (Light Dependent Resistor), also known as a photoresistor, is based on its light-sensitive properties. LDRs are passive electronic components whose resistance changes in response to the amount of light falling on them.

The basic construction of an LDR consists of a semiconductor material with high resistance. This material is typically cadmium sulphide (CdS) or lead sulphide (PbS) coated on a substrate. When light photons strike the semiconductor material, they excite the electrons in the material, causing the resistance to decrease.

The behaviour of an LDR can be understood using the band theory of solids. In the absence of light, the valence electrons in the semiconductor material are bound to their atoms and form a valence band. There is a forbidden energy gap between the valence band and the conduction band, where the electrons are free to move and conduct electricity.

When light illuminates the LDR, photons with sufficient energy are absorbed by the semiconductor material, promoting the electrons from the valence band to the conduction band. This process creates free charge carriers (electrons and holes) that contribute to the conduction of electricity. As a result, the resistance of the LDR decreases.

The resistance of an LDR can vary over a wide range, from several megaohms in darkness to just a few hundred ohms or less in bright light conditions. This variation in resistance allows LDRs to be used as light sensors in various applications.

By connecting the LDR in a circuit, such as a voltage divider or a wheatstone bridge configuration, changes in its resistance can be measured. The output voltage or current of the circuit will vary as the resistance of the LDR changes in response to the amount of light falling on it. This variation can be further processed and utilised in applications such as automatic lighting control, solar panels, and light intensity measurement.

Overall, the working principle of an LDR involves the modulation of its resistance by the incidence of light, making it a useful component for light sensing and control applications.

# III. Working Principle Of 1N4007

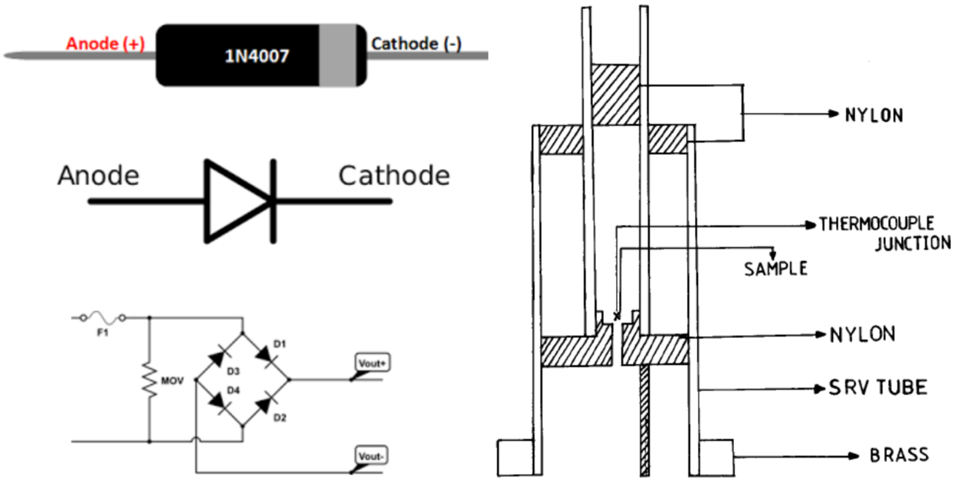



**Figure 8** : Animation,Symbolic and Real-Picture 1N4007 Diode

The 1N4007 diode is a popular and widely used rectifier diode in electronic circuits. Its working principle is based on the concept of rectification, which involves converting alternating current (AC) into direct current (DC).

The 1N4007 diode is a silicon-based semiconductor diode with a specific configuration. It consists of a P-N junction, formed by connecting a P-type semiconductor region (anode) to an N-type semiconductor region (cathode). This arrangement allows current to flow through the diode in one direction, while blocking it in the opposite direction.

When a positive voltage (higher potential) is applied to the anode terminal of the diode and a negative voltage (lower potential) is applied to the cathode terminal, the diode is said to be forward-biased. In this condition, the P-N junction conducts current easily, and the diode acts as a low-resistance path.

During forward biasing, the P-region becomes positively charged and the N-region becomes negatively charged. As a result, the free electrons from the N-region move towards the P-region, and the holes from the P-region move towards the N-region. This movement of charge carriers allows current to flow through the diode.

On the other hand, when a negative voltage is applied to the anode and a positive voltage to the cathode, the diode is reverse-biased. In this condition, the P-N junction acts as a barrier to the flow of current, and the diode has a high resistance to the reverse current.

The 1N4007 diode is specifically designed to withstand a reverse voltage of up to 1000 volts, making it suitable for rectification purposes in high-voltage applications.

The primary function of the 1N4007 diode is rectification, converting AC voltage to DC voltage. When an AC signal is applied across the diode in a circuit, it allows current to flow only during the positive half-cycle of the AC waveform, effectively blocking the negative half-cycle. This process rectifies the AC signal into a pulsating DC signal.

The rectified output can be further filtered using capacitors or other components to smoothen the pulsations and obtain a more stable DC voltage.

In summary, the working principle of the 1N4007 diode involves allowing current flow in one direction (forward bias) while blocking it in the opposite direction (reverse bias). This property makes it suitable for rectification applications, converting AC to DC voltage in electronic circuits.

# IV. Working Principle Of Resistor

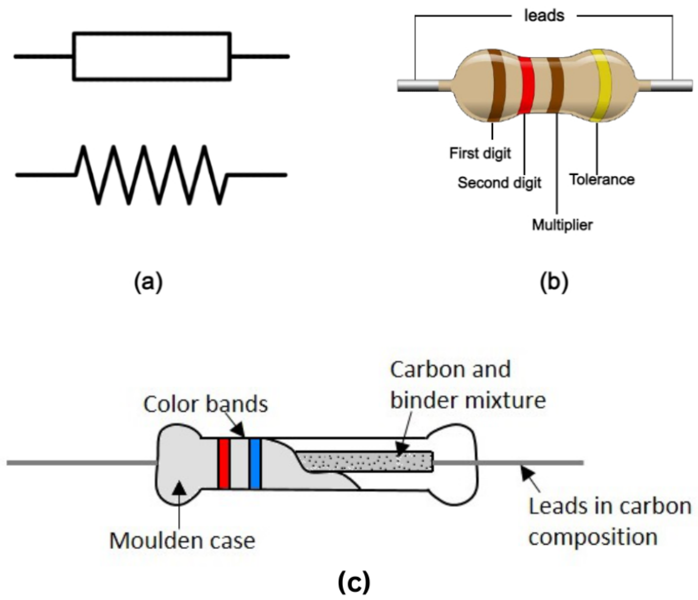



**Figure 9** : (a) Representation of resistor in circuit diagram ,

(b)Resistor with colour strips, (c) Image of a carbon composition resistor

The working principle of a resistor is based on the concept of electrical resistance. A resistor is an electronic component designed to impede the flow of electric current in a circuit.

Resistors are typically made of materials that have a high resistance, such as carbon, metal alloys, or ceramics. The resistance value of a resistor is measured in ohms (Ω) and is denoted by a specific resistance value, such as 10Ω or 1kΩ (kilo-ohm).

When a voltage is applied across a resistor, according to Ohm's law, the current flowing through the resistor is directly proportional to the voltage and inversely proportional to the resistance. The relationship can be described by the equation:

$$\boxed{\mathbf{I = V / R}}$$

Where:

**I** represents the current flowing through the resistor (in amperes)

**V** represents the voltage applied across the resistor (in volts)

**R** represents the resistance of the resistor (in ohms)

The resistor limits the flow of current by converting electrical energy into heat energy. As the current passes through the resistor, the resistance causes a voltage drop across it, dissipating energy in the form of heat. This heat generated is a result of the collisions between the moving electrons and the atoms in the resistor's material.

The higher the resistance value of a resistor, the more it restricts the flow of current. Conversely, lower resistance values allow more current to flow through the circuit.

Resistors are commonly used in electronic circuits for various purposes, including voltage division, current limiting, signal conditioning, and impedance matching. They help control the flow of current, protect components from excessive currents, and shape the characteristics of signals in a circuit.

By choosing resistors with specific resistance values, engineers and circuit designers can manipulate and control the behaviour of electrical circuits, ensuring proper operation and preventing damage to sensitive components.

| Sr. No. | Colour | Colour code for Resistance Value | | | |
|---|---|---|---|---|---|
| | | Band A | Band B | Band C | Band D |
| | | (In specific value) | | | (Tolerance in %) |
| 0 | Black | 0 | 0 | ×1 | |
| 1 | Brown | 1 | 1 | ×10 | |
| 2 | Red | 2 | 2 | ×100 | |
| 3 | Orange | 3 | 3 | ×1000 | |
| 4 | Yellow | 4 | 4 | ×10000 | |
| 5 | Green | 5 | 5 | ×100000 | |
| 6 | Blue | 6 | 6 | ×1000000 | |
| 7 | Violet | 7 | 7 | ×10000000 | |
| 8 | Grey | 8 | 8 | ×100000000 | |
| 9 | White | 9 | 9 | ×1000000000 | |
| 10 | Gold | - | - | - | 5% |
| 11 | Silver | - | - | - | 10% |

**Table 2** : Colour Code for Resistance value

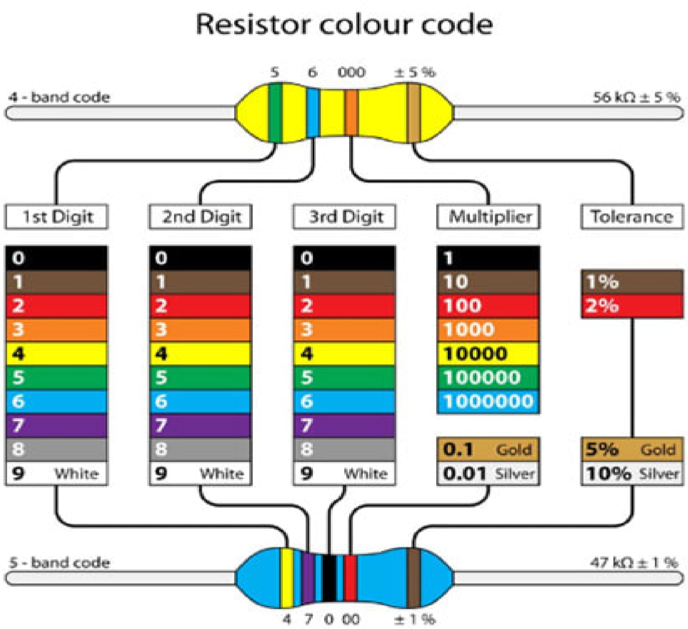



**Figure 10** : Resistor colour code

## V. Working Principle Of Relay

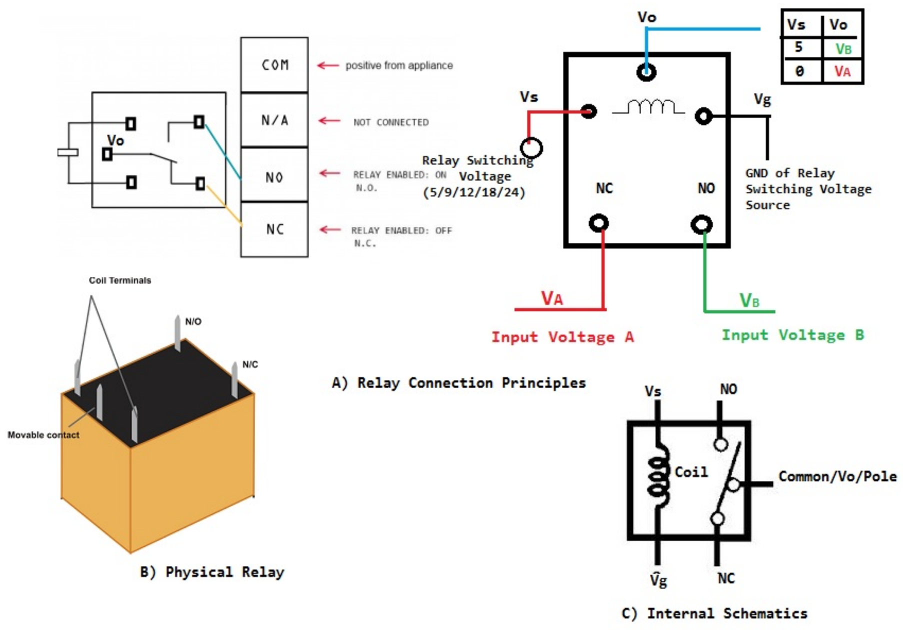



**Figure 11**: Relay Connection Principle, Schematic and Pinout of Relay

A relay is an electromagnetic switch commonly used in electronic circuits to control the flow of current to various devices or components. It works based on the principle of electromagnetism.

The basic working principle of a relay involves two circuits: the control circuit and the load circuit. The control circuit, also known as the input circuit, consists of a coil, while the load circuit, also known as the output circuit, consists of contacts.

When a current flows through the coil of the relay, it creates a magnetic field around it. This magnetic field attracts a movable iron armature or a plunger, which is mechanically linked to a set of contacts in the load circuit. The contacts consist of a normally open (NO) contact and a normally closed (NC) contact.

In the resting state, without any current flowing through the coil, the movable armature is held in place by a spring, and the NC contact is closed, while the NO contact is open. This means that the load circuit is disconnected, and the current cannot flow through it.

When a current is applied to the coil, it energises the electromagnetic field, which pulls the armature towards it. As a result, the NC contact opens, breaking the circuit, and the NO contact closes, completing the circuit in the load circuit. This allows the current to flow through the load circuit, activating the connected device or component.

Relays are often used for various purposes, such as amplification, isolation, switching high currents or voltages, and providing electrical protection. They are commonly employed in applications like home automation systems, industrial control systems, automotive electronics, and more.

Relays are versatile components that offer electrical isolation between the control circuit and the load circuit, allowing for the safe control of higher voltage or current devices using lower voltage signals. Their working principle makes them reliable and widely used in electronic circuits for switching and control purposes.

# PCB DESIGN

Designing a circuit from a breadboard and transferring it to a veroboard involves the following steps:

- Prototype the circuit on a breadboard to test and debug the design
- Draw the circuit layout on a piece of graph paper, with pin one at the top left
- Use a stripboard or veroboard to create a permanent version of the circuit. Cut and bend the board as needed, and solder the components onto it
- Test the circuit to ensure it works as expected.

When designing the circuit, it is important to plan for space and reduce rework by testing and prototyping the design before transferring it to the veroboard. There is no one "best" way to lay out components on a veroboard, but general strategies include cramming everything as small as possible or laying out components in a logical order.. Tools needed for circuit construction on veroboard include a soldering iron, wire cutters, pliers, and a multimeter.

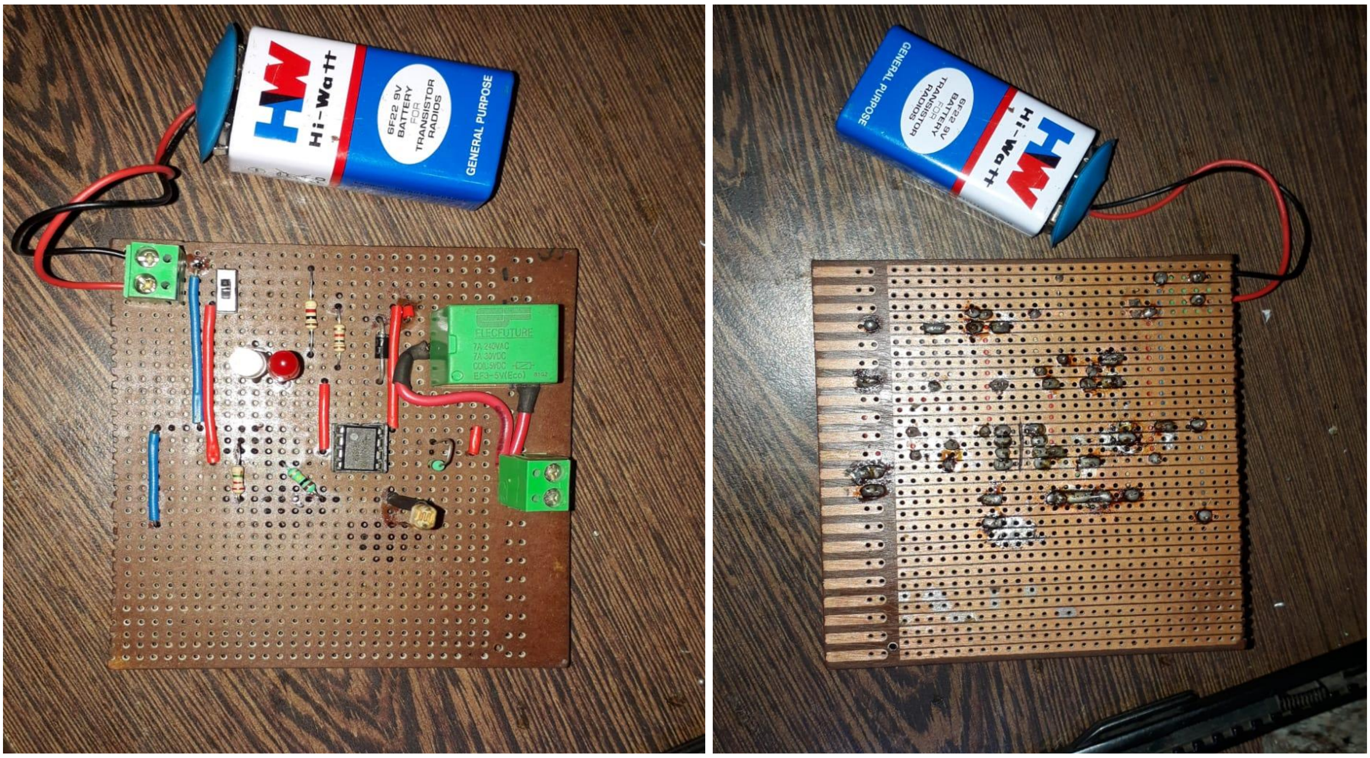



**Figure 12**: Circuit fabricated in VERO Board

## EXPERIMENTAL RESULTS

When the LDR sensor detects some light intensity the LDR is ON and bulb 1(**BLUE LED in ON**) glows, hence it signifies that it is **daytime.**

When the LDR sensor does not detect any light intensity(in dark) the LDR id OFF bulb 1(**RED LED is ON**) glows, hence it signifies **night-time**.

| CONDITION | LDR | LED 1(RED LED) | LED 2(BLUE LED) |
|---|---|---|---|
| Daytime | **ON** | **OFF** | **ON** |
| Night-time | **OFF** | **ON** | **OFF** |

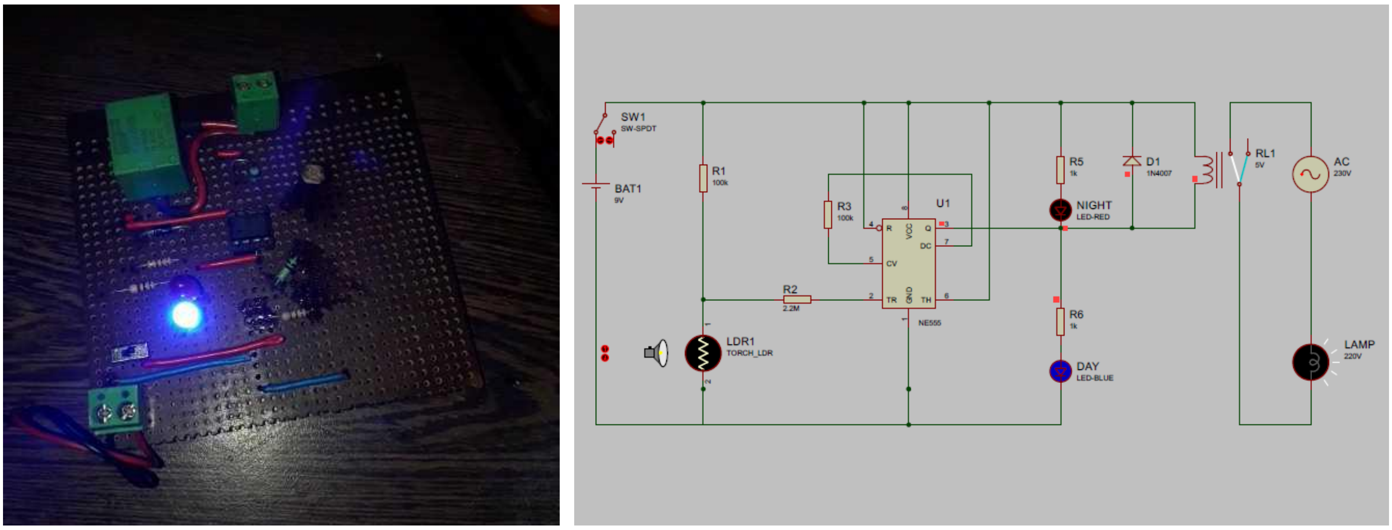



**Figure 13** : **BLUE** LED indicating DAY-TIME

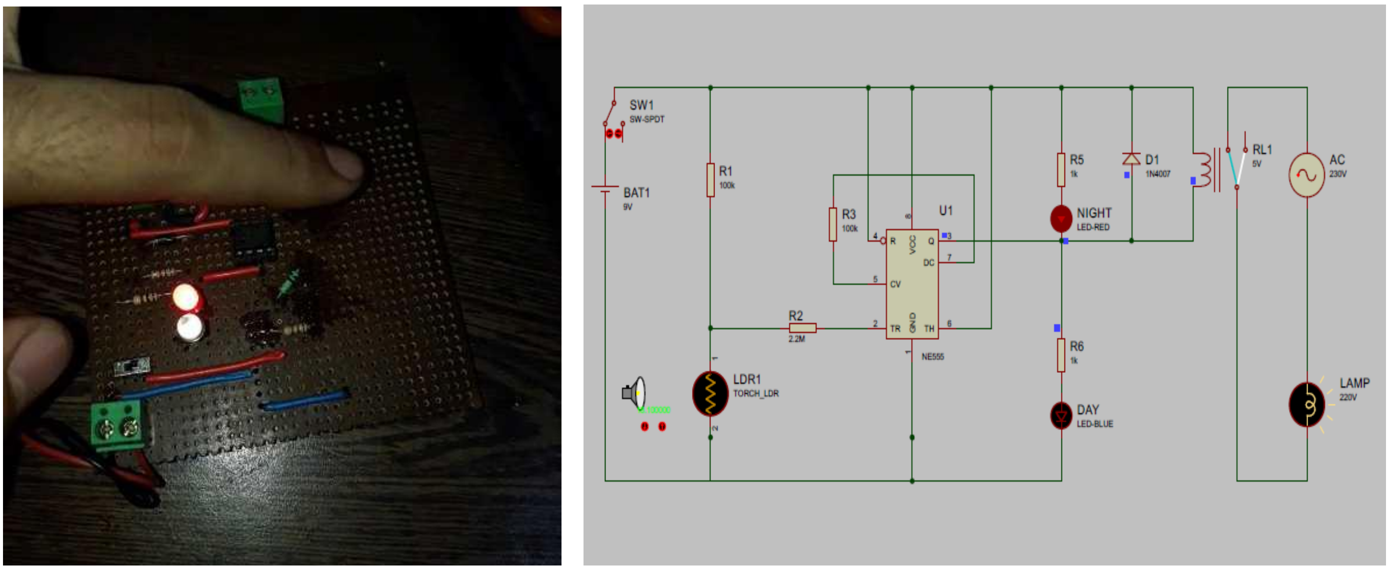



**Figure 14** : **RED** LED indicating NIGHT-TIME

# CONCLUSION

The Smart Street Light system offers several advantages over traditional lighting systems. It reduces energy consumption by activating the lights only when required, based on the ambient light conditions. This helps to conserve electricity and lower operational costs. Additionally, the system enhances safety and security by providing adequate illumination during nighttime hours.

The successful completion of this project demonstrates the effectiveness and viability of utilising the 555 timer IC and relay in a smart street light system. By providing energy efficiency, and low-cost solution, this project serves as a foundation for future developments in smart city infrastructure.

In conclusion, the Smart Street Light project presents an innovative approach to street lighting using the 555 timer IC and relay. By incorporating intelligent control mechanisms and precise timing capabilities, the system offers energy efficiency, cost-effectiveness, and improved safety, making it a valuable solution for modern urban infrastructure.

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