# Light-Dependent LED Control Using Relay & LDR

Engr. Furqan Shahid **Team Leader**
*Dept. of Mechatronics and Control Engineering*
*University of Engineering and Technology*
Lahore, Pakistan
engr.furqanshahid64@gmail.com

Noor ul Ain Amjad
*Dept. of Mechatronics and Control Engineering*
*University of Engineering and Technology*
Lahore, Pakistan
engr.noorulainamjad72@gmail.com

***Abstract*— This paper presents the design and implementation of an automatic LED control system using an LDR and relay module. The system detects ambient light using a Light Dependent Resistor and accordingly switches the LED ON or OFF through a relay interface. The aim is to develop a cost-effective and energy-efficient solution for automatic lighting control without the use of microcontrollers. The system was designed and tested using Proteus simulation software and then implemented on a PCB for real-time validation. Results show that the circuit reliably activates the LED in low-light conditions and deactivates it in bright environments.**

***Keywords*— LDR, relay, automatic lighting system, LED control, light sensor, Proteus simulation, PCB design.**

## I. Project Overview

The objective of this project is to create an automatic lighting control system that activates an LED based on the surrounding light conditions. The project uses an LDR (Light Dependent Resistor) to sense light and a transistor to drive a relay module. When the environment becomes dark, the LDR increases its resistance, triggering the transistor to energize the relay. This completes the LED circuit, turning it ON. During daylight or bright conditions, the LDR has low resistance and keeps the transistor OFF, deactivating the relay and LED.


*Figure. 1: Actual Hardware Implementation of the LED Control Circuit*

## II. Process

The project followed a systematic approach, starting from circuit design and simulation to PCB fabrication and final testing.

First, the circuit was designed in Proteus, a widely-used simulation software. The schematic included components such as an LDR, a transistor (BC547), resistors, a relay module, a diode for back EMF protection, and an LED. This schematic was tested under simulated light and dark conditions by varying the LDR resistance. The LED responded correctly by turning ON in darkness and OFF in light, validating the design logic.

After confirming the functionality in simulation, the circuit was transferred to PCB layout mode in Proteus. Component footprints were arranged neatly, and traces were routed with care to avoid overlap or short circuits. Both top and bottom copper layers were visualized to finalize the design.

Once the PCB layout was complete, the etching process was initiated. The layout was printed on glossy paper and transferred onto a copper-clad board using a heat transfer method. The board was then etched in a ferric chloride solution, which removed unwanted copper, leaving behind only the desired circuit paths. After etching, the board was cleaned, drilled, and components were soldered in place.

This hands-on process gave a complete understanding of schematic design, layout planning, PCB fabrication, and real-world circuit assembly.

### A. Simulation Results and Schematic Design

The circuit simulation was conducted in Proteus. The LDR and resistor formed a voltage divider connected to the transistor base. When light falls below a set threshold, the increased resistance of the LDR creates enough voltage to switch the transistor ON. The transistor then allows current through the relay coil, activating it and closing the circuit for the LED.

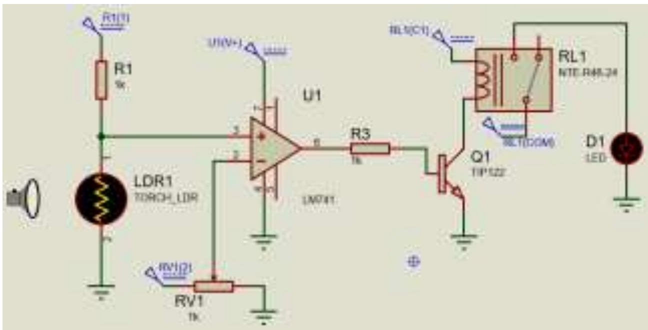


*Figure. 2: Schematic Diagram Designed in Proteus*

This configuration allowed accurate testing of circuit behavior and adjustment of resistor values before proceeding to PCB design.

### B. *PCB Layout and Design*

After successful testing in simulation, the circuit was transferred to a PCB layout in Proteus. The placement of components was optimized to ensure a compact and clean design. Tracks were routed with proper spacing, and pads were assigned for each terminal.

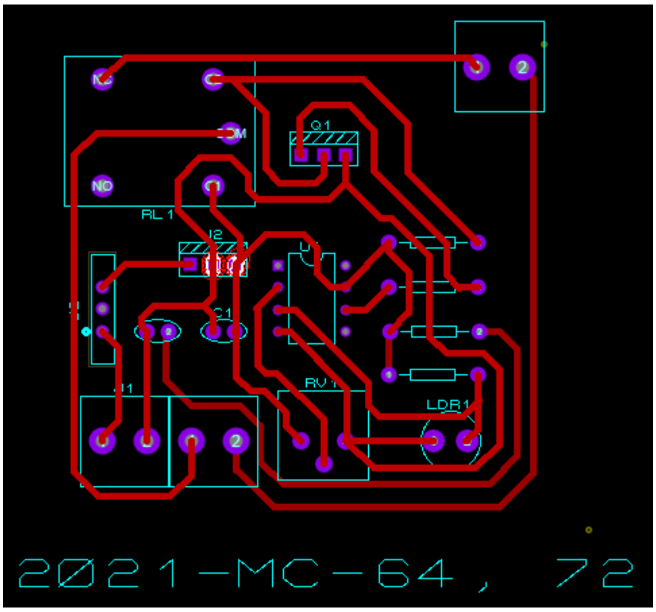


*Figure. 3: PCB Layout Created in Proteus*

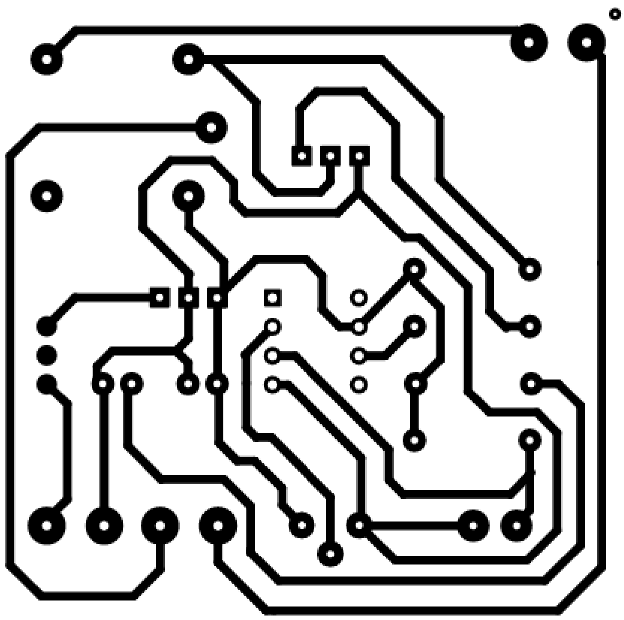

*Figure. 4: PCB Layout Created in Proteus pdf*

## III. APPLICATIONS

This light-controlled LED system can be used in various real-world scenarios, such as:

- Automatic street lights that turn on at night.
- Garden or driveway lighting systems.
- Night lamps that switch ON in darkness.
- Energy-efficient lighting in corridors or staircases.

It is also suitable for educational kits to demonstrate sensor-based automation.

## IV. CONCLUSION

The project successfully demonstrates how a basic electronic system can automate lighting control using an LDR and a relay without any microcontroller. It provides an energy-saving solution by activating lighting only when required. The use of simulation tools like Proteus and practical fabrication through PCB etching made the development process both efficient and educational. This system serves as a foundation for more advanced automation projects involving sensors and relays.

## V. FUTURE WORKS

While the system works well in its current form, future versions could include:

- Adjustable light sensitivity using a potentiometer.
- Integration with a microcontroller (e.g., Arduino) for more control and automation.
- Wireless control using Bluetooth or Wi-Fi modules.
- Solar-powered lighting integration for outdoor applications.

## VI. REFERENCES


[1] **Advanced Photonix**, "NSL-19M51 LDR Datasheet," *Advanced Photonix*, Jun. 2016. [Online]. Available: https://www.mouser.com/datasheet/2/1418/DS_NSL_19M51-2935293.pdf proteus.no+15youtube.com+15linkedin.com+15alldatasheet.com+11mouser.com+11mouser.com+11

[2] **Luna Optoelectronics**, "NSL-19M51 Data Sheet," *Luna Optoelectronics*, Apr. 2016. [Online]. Available: https://labcenter.s3.amazonaws.com/downloads/NSL-19M51_rev01-04-16.pdf labcenter.s3.amazonaws.com+2media.digikey.com+2datasheetarchive.com+2

[3] **Labcenter Electronics Ltd**, "Proteus Design Suite," *Labcenter Electronics*, 2025. [Online]. Available: https://www.labcenter.com/ electronicsmedia.info+8proteus.no+8en.wikipedia.org+8

[4] **Electronics Media**, "Proteus v8.12 for PCB Design supports Multi-Board Design," *Electronics Media*, Apr. 8, 2021. [Online]. Available: https://www.electronicsmedia.info/2021/04/08/proteus-v8-12-for-pcb-design-supports-multi-board-project-support/ electronicsmedia.info+1embeddedcomputing.com+1