Volume 10, Issue 12, December – 2025 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec061

Power Management System For Highway Using Radio Frequency Identification

Namburi Nireekshana[1]; Ch. Rajkumar[2]; Ch. Sathvik[3]; K. Chandrajay[4]; B. Satish[5]; Md. Farhan[6]; K. Pavan[7]

[1]Assistant Professor, Department of Electrical and Electronics Engineering,
Methodist College of Engineering and Technology (Autonomous), Hyderabad, India
[2,3,4,5,6]BE, IV Year, Department of Electrical and Electronics Engineering,
Methodist College of Engineering and Technology (Autonomous), Hyderabad, India

Publication Date: 2025/12/15

Abstract: This article presents a Power Management System for Highway Lighting Using RFID (Radio Frequency Identification) to improve energy efficiency and reduce operational costs. The primary goal of this project is to develop an intelligent street lighting system for highways that conserves power by controlling streetlights based on vehicle movement. This is achieved by utilizing Radio Frequency Identification (RFID) technology. Each vehicle on the highway is equipped with an RFID tag carrying a unique identification number. As the vehicle passes by, an RFID reader detects this tag and signals a microcontroller to activate the corresponding streetlights. Once the vehicle has passed, the lights can be automatically turned Offor dimmed, thereby significantly reducing unnecessary power consumption unit that communicates with RFID readers gathers data on the status of each light and energy consumption.

Keywords: *Electrical Power Systems, Micro Controller, Radio Frequency Identification.*

How to Cite: Namburi Nireekshana; Ch. Rajkumar; Ch. Sathvik; K. Chandrajay; B. Satish; Md. Farhan; K. Pavan (2025) Power Management System For Highway Using Radio Frequency Identification. *International Journal of Innovative Science and Research Technology*, 10(12), 701-707. https://doi.org/10.38124/ijisrt/25dec061

I. INTRODUCTION

The rapid growth of urbanization, industrialization, and vehicular transportation has created an unprecedented rise in energy consumption along road networks, particularly on highways equipped with illumination, surveillance, toll-collection, and traffic-management infrastructures. Continuous operation of streetlights, signboards, cameras, and monitoring systems results in significant wastage of electrical energy, especially during periods of low vehicular density or daylight hours. This situation has compelled engineers and researchers to develop intelligent systems capable of optimizing power usage without compromising safety and reliability. In this context, the Power Management System for Highways using Radio Frequency Identification (RFID) represents an innovative and technologically advanced approach that integrates communication, automation, and energy-control principles to ensure efficient utilization of electrical power in highway infrastructure. The proposed system combines the versatility of RFID technology with embedded controllers, sensors, and communication modules to achieve real-time monitoring and dynamic control of highway electrical loads, especially lighting systems. The ultimate goal is to create a self-regulating, energy-efficient, and cost-effective power-management solution that aligns with the objectives of smart-transportation and smart-city initiatives[1], [2].

The demand for electricity along highways is primarily driven by illumination systems installed to ensure visibility and safety during nighttime operation. Conventional lighting systems are typically controlled by timers or manual switches, which fail to account for the fluctuating traffic density and varying environmental conditions. As a result, large amounts of energy are wasted by operating all lights continuously, even when only a few vehicles traverse the highway at certain times. To address this inefficiency, intelligent lighting systems have evolved, employing technologies such as motion sensors, light-dependent resistors (LDRs), infrared sensors, and more recently, RFID-based identification and control[3], [4]. Among these, RFID stands out for its reliability, non-contact operation, and ability to uniquely identify vehicles without requiring line-of-sight communication. In the proposed system, RFID technology forms the backbone of vehicle detection and communication, enabling the power-management controller to regulate electrical loads dynamically based on real-time traffic movement. By identifying vehicle entry and exit through RFID tags mounted on vehicles, the system can activate or deactivate lighting zones sequentially, ensuring that lights operate only in regions where vehicles are present, thus minimizing unnecessary power consumption[5], [6].

RFID technology is a form of wireless communication that uses electromagnetic fields to automatically identify and track tags attached to objects. An RFID system typically consists of three components: the RFID tag or transponder, the RFID reader or interrogator, and the backend controller or database. The tag contains a microchip that stores identification data and an antenna for transmitting the data when energized by the reader's radio waves[7], [8]. Tags may be active, passive, or semi-passive, depending on whether they contain an internal power source. For highway power management, passive tags are often preferred due to their low cost and maintenance-free operation. RFID readers are strategically placed at different points along the highway—typically at entry and exit points or specific control sections—to detect approaching vehicles. When a vehicle equipped with a valid RFID tag enters the detection zone, the reader identifies it and sends the information to a microcontroller or a central control unit. The controller then initiates a programmed response, such as turning on the lights in the upcoming section of the highway or adjusting illumination intensity through pulse-width-modulation (PWM) control. As the vehicle leaves a zone and moves to the next, the previous section is automatically dimmed or turned off, thereby ensuring sequential illumination that directly corresponds to vehicle presence. This results in significant power savings, improved component life, and enhanced automation of highway infrastructure[9], [10].

In addition to lighting control, the RFID-based power management system can also integrate with other highway utilities such as toll collection, traffic monitoring, and safety management, thereby contributing to a holistic intelligent-transportation ecosystem. For instance, by linking the same RFID tag database used for toll identification, the system can recognize different vehicle categories (e.g., heavy trucks, light vehicles, emergency services) and adjust power usage or lighting intensity accordingly. Emergency vehicles such as ambulances or police cars could trigger full illumination along their route to ensure maximum visibility, while normal traffic might activate only partial lighting.[11], [12] This adaptability introduces a layer of intelligence and safety into highway operation. Furthermore, by connecting the RFID system to a cloud-based database or SCADA (Supervisory Control and Data Acquisition) interface, real-time data on energy consumption, system status, and fault conditions can be remotely monitored by highway authorities. This feature not only improves maintenance efficiency but also supports predictive diagnostics—detecting lamp failures or power anomalies before they cause critical problems[13], [14].

The power-management architecture of the RFID-based system typically comprises several functional modules—vehicle identification, control and processing, communication, and power-switching interface. The control unit, often based on a microcontroller such as Arduino, PIC, or ARM Cortex, serves as the central brain of the system. It receives input signals from RFID readers, processes them according to pre-defined algorithms, and generates control outputs to the power drivers or relays that manage lighting circuits. Depending on system design, the lights may be conventional high-intensity discharge (HID) lamps, LED luminaires, or smart streetlights capable of brightness modulation. The communication between the RFID reader and controller can be wired or wireless (e.g., via ZigBee, Wi-Fi, or LoRaWAN) for extended coverage. In some advanced prototypes, solar panels are integrated into the system to supply renewable energy for lighting, further enhancing sustainability. By employing low-power microcontrollers, efficient switching circuits, and optimized algorithms, the system ensures minimal energy wastage and maximum operational reliability under varying environmental conditions such as rain, fog, or temperature changes[15], [16].

Another major advantage of integrating RFID into power management is the data intelligence and analytics it provides. Each vehicle passage event recorded by the RFID reader can be logged with timestamps and energy usage statistics. Over time, these datasets can be analyzed to determine traffic patterns, identify peak hours, and optimize energy-allocation strategies accordingly. For example, during peak traffic, lights may remain fully illuminated across multiple sections, whereas during off-peak hours, selective dimming may suffice. This approach allows adaptive learning and self-optimization, creating a smart power grid along the highway that responds to real-world demand. Moreover, the data collected can be shared with transportation planning authorities for traffic forecasting, road safety analysis, and infrastructure design. The synergy between power management and traffic analytics thus extends beyond mere energy savings—it contributes to the broader goals of intelligent mobility and sustainable urban development[17], [18].

From an economic perspective, the RFID-based power management system offers substantial cost benefits. Energy consumption is reduced dramatically since lights operate only when and where needed, which directly translates into lower electricity bills and reduced maintenance expenses. The use of LED lights further enhances efficiency due to their lower wattage and longer life compared to conventional lamps. Initial setup costs involving RFID readers, microcontrollers, and communication infrastructure are offset over time by energy savings and reduced manpower requirements. Moreover, the modular nature of the system allows for phased implementation, enabling highway authorities to upgrade existing networks gradually without major structural modifications. Additionally, because RFID tags are inexpensive and maintenance-free, the system is highly scalable and suitable for large-scale deployment across national or regional highway networks[19],[20].

In terms of environmental impact, the proposed system aligns strongly with global sustainability goals. By optimizing energy consumption, it reduces the carbon footprint associated with power generation, thereby contributing to cleaner and greener transportation

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec061

infrastructure. When integrated with renewable energy sources such as solar streetlights or hybrid energy systems, the benefits multiply, resulting in near-zero emission highway lighting systems. Furthermore, reduced light pollution through targeted illumination enhances ecological balance by minimizing the impact of artificial lighting on nocturnal wildlife and nearby communities. The system therefore embodies the principles of the smart-green highway concept, promoting sustainable development alongside technological advancement[21],[22].

From a technological standpoint, RFID offers several advantages that make it particularly suitable for highway applications. It is contactless, unaffected by environmental obstacles such as dust or fog, and capable of functioning in all weather conditions. Unlike infrared or ultrasonic sensors, RFID does not require line-of-sight, making it ideal for detecting high-speed vehicles under variable environmental conditions. Its ability to operate at different frequency bands—low frequency (125 kHz), high frequency (13.56 MHz), and ultra-high frequency (860–960 MHz) provides design flexibility for both short-range and long-range detection. The use of secure tag encoding ensures that only authorized vehicles trigger the system, preventing false activations. In future implementations, RFID can also be integrated with other identification technologies such as the Internet of Things (IoT), Vehicle-to-Infrastructure (V2I) communication, or Global Positioning System (GPS) tracking for even more robust power management and traffic coordination[23].

The Power Management System for Highway Using RFID represents a convergence of power electronics, automation, and wireless communication, offering a sustainable and intelligent solution to one of the most pressing challenges in modern infrastructure—efficient energy utilization. By harnessing the identification and communication capabilities of RFID, the system ensures that electrical energy is used judiciously, responsively, and intelligently. Beyond energy conservation, it enhances safety, reduces maintenance, and integrates seamlessly with emerging smart-transportation technologies. As the world moves toward fully automated, data-driven infrastructure systems, RFID-based power management stands as a pivotal innovation—bridging traditional electrical engineering with the digital era of connected highways and smart cities[24],[25].

II. OBJECTIVES

- To design a reliable and automated power-management system that reduces energy wastage along highways using RFID technology.
- To achieve real-time detection of vehicle movement for dynamic illumination control.
- To implement a microcontroller-based logic that switches lighting sections ON or OFF based on vehicle position.
- To collect data for monitoring power consumption and vehicle flow for future analytics.
- To enhance road safety and visibility while reducing operating costs and environmental impact.

The successful implementation of this system is expected to result in at least 30–50 % reduction in power consumption along highways, depending on traffic density and system configuration.

III. WORKING

➢ *Block Diagram*

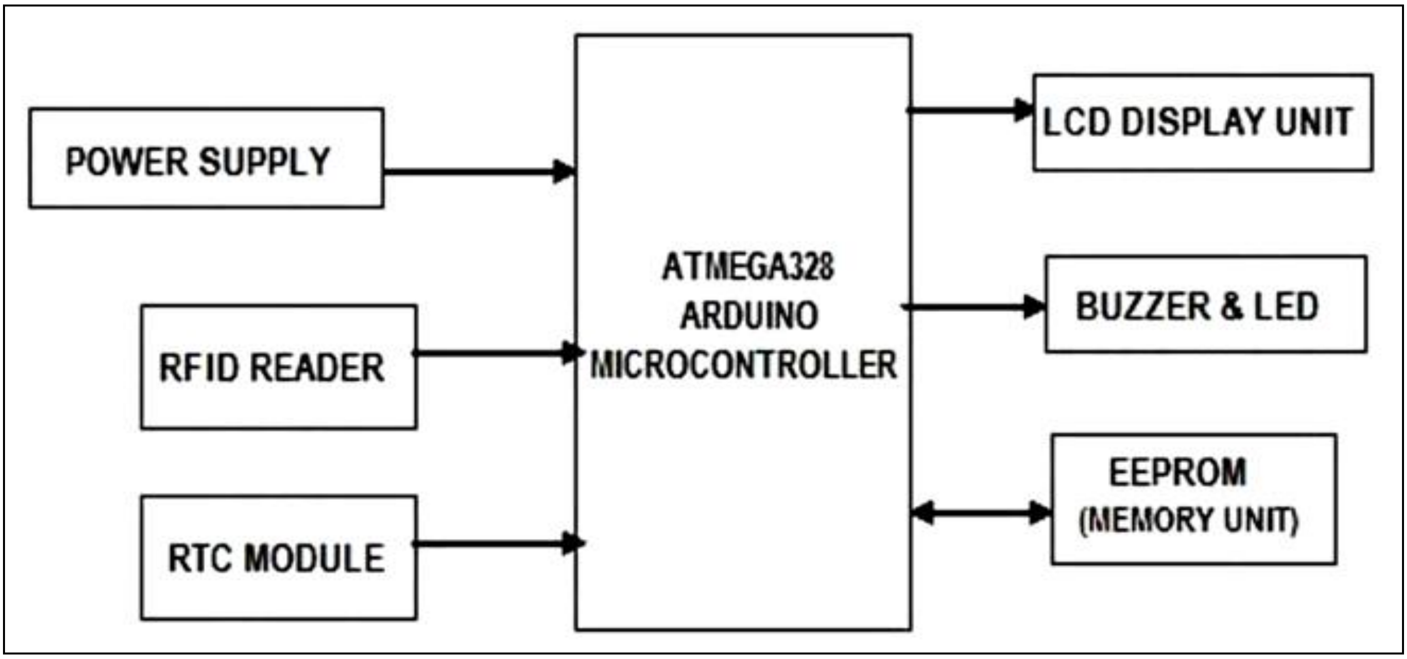

Fig 1 Block Diagram

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec061

- *From the Figure 1, the Main Components are*

- ✓ EM18 Reader module
- ✓ Regulated power supply
- ✓ PIC microcontroller
- ✓ RFID Tag
- ✓ Crystal oscillator
- ✓ Voltage regulator
- ✓ Bridge rectifier
- ✓ LED'S

- Regulated power supply: Every embedded system requires a DC voltage, and that will be a 5V supply. We are getting 230V, 50Hz in our household applications. We can use it to operate home appliances like TV, cooler, fan, light's Digital electronic devices need a digital supply, and we can get a supply from a regulated power supply block. Stable Voltage for Microcontroller and RFID Module.

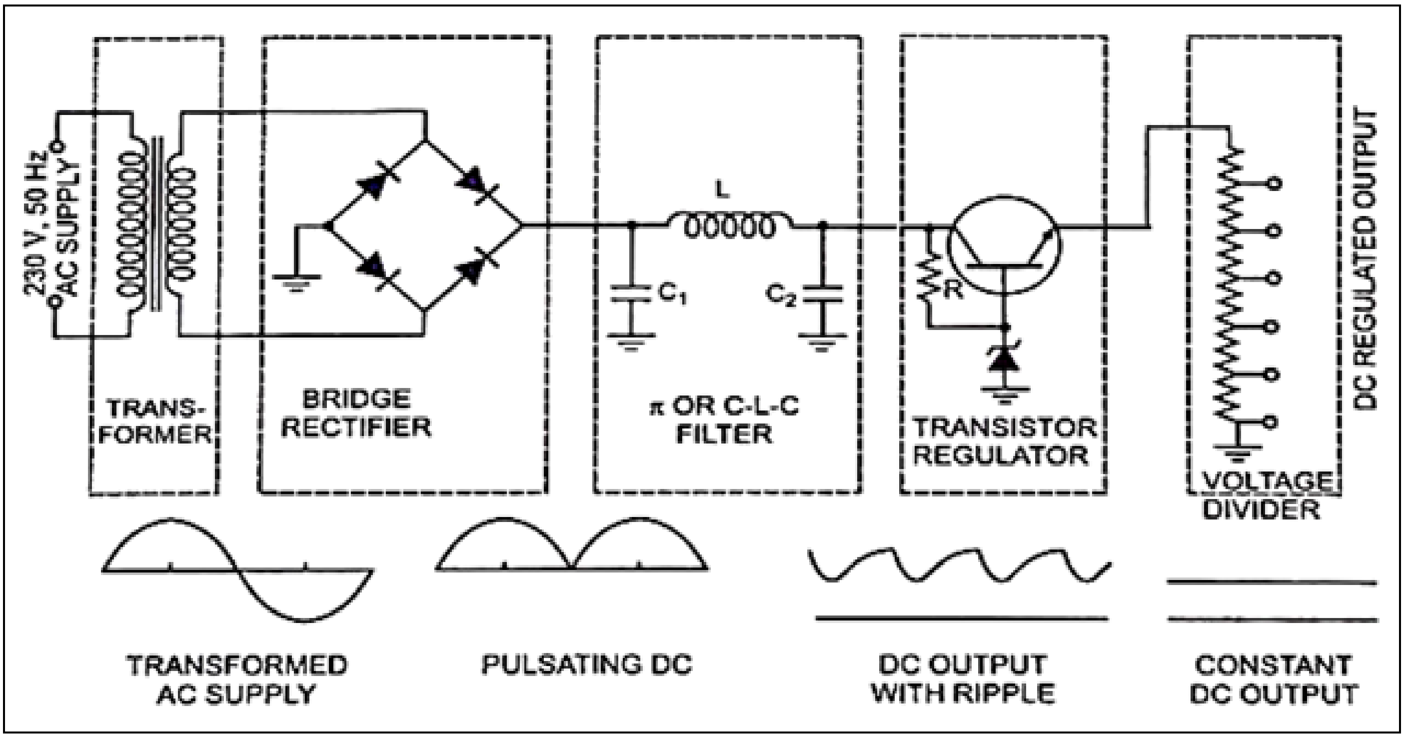

Fig 2 Regulated Power Supply

- Microcontroller: Processes input from the RFID reader and controls LED lights based on the tag detection.

Fig 3 Microcontroller

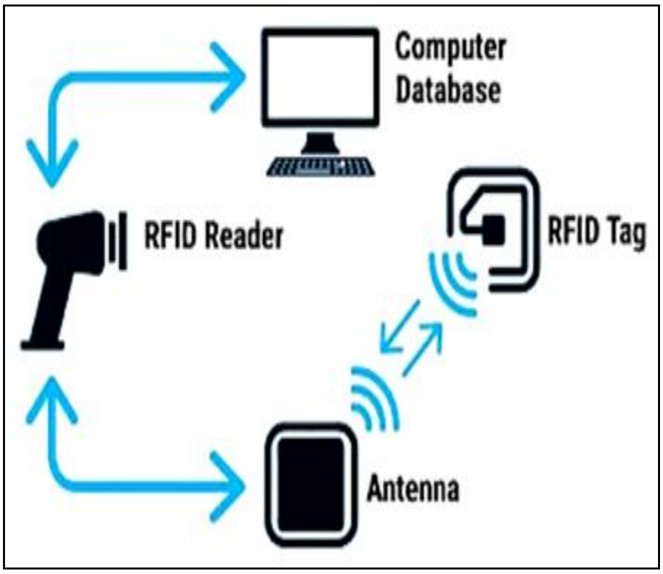

Fig 4 RFID Process

- RFID Tag: Sends a unique ID wirelessly when in range of the RFID reader. Represents each vehicle in the system.

- Crystal Oscillator: Provides a clock signal to the microcontroller. Ensures correct timing and operation of the microcontroller.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec061

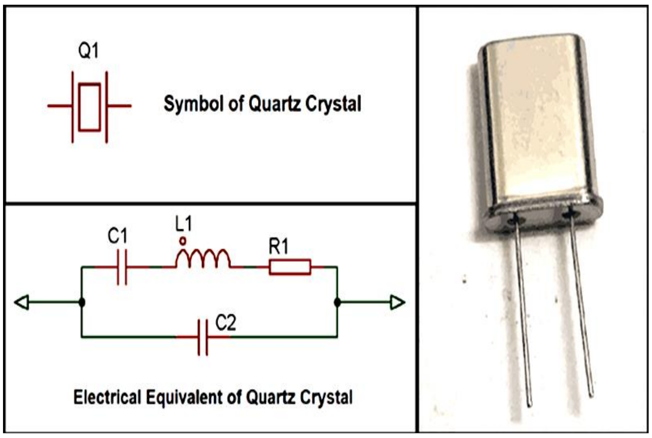

Fig 5 Crystal Oscillator

The working of the Power Management System for Highway Using Radio Frequency Identification (RFID) is based on intelligent detection of vehicle movement and dynamic control of roadway electrical loads, mainly streetlights, to achieve maximum energy efficiency and safety on highways. The system uses an ATmega328 Arduino microcontroller as the central processing unit, supported by an RFID reader, Real-Time Clock (RTC) module, LCD display, EEPROM memory unit, and alerting devices such as buzzer and LED indicators. When the system is powered ON, the power supply unit provides regulated DC voltage to all the components, ensuring stable and uninterrupted operation even in outdoor highway environments. The RFID reader is strategically installed along the roadside or embedded in the pavement, and every vehicle is equipped with an RFID tag. As a vehicle approaches a section of the highway, the reader detects the unique identification number of the RFID tag and immediately forwards this digital information to the microcontroller for processing. Upon receiving the tag data, the microcontroller verifies the ID, confirms vehicle presence, and simultaneously accesses the RTC module to retrieve the exact date and time of detection. This timestamping process ensures accurate logging of traffic movement, enabling intelligent power scheduling based on real-time traffic density. The microcontroller then performs decision-making operations according to the pre-programmed energy-saving algorithm; for instance, when a vehicle is detected, nearby streetlights are automatically switched ON or brightened to ensure driver visibility and roadway safety. When no vehicles are sensed for a predefined duration, the same lights are dimmed or switched OFF to conserve energy, thus drastically reducing wastage of electrical power on highways during low-traffic periods. Throughout this process, the EEPROM memory unit stores essential information such as vehicle ID, time of passage, and energy-related data, enabling future analysis, auditing, and performance evaluation of the system. The LCD display unit continuously provides a visual interface showing details such as the detected RFID tag number, system status, time, light control actions, and any alerts or errors, making monitoring simpler for maintenance personnel. In addition to visual feedback, the buzzer and LED indicators provide audio and visual signals whenever a vehicle is detected or when an unauthorized tag is encountered, thereby adding an extra layer of system communication and security. This automated mechanism ensures that streetlights operate only when needed, significantly reducing the operational cost of highway illumination systems. By integrating RFID technology with microcontroller-based control logic, the system intelligently adapts to real-time vehicle movement rather than relying on fixed-timing mechanisms traditionally used in streetlight control. The use of RTC ensures that the system can also follow time-based patterns, such as increasing intensity during peak traffic hours or reducing brightness during late-night low traffic zones. This combination of RFID detection and time-based optimization offers a more robust solution for modern smart highways. Moreover, the overall design supports scalability additional sensors, solar power units, or wireless communication modules can be integrated later to build a complete smart highway infrastructure. In summary, the system works by automatically detecting vehicles using RFID, processing sensor inputs through a microcontroller, dynamically controlling streetlights based on real-time traffic, storing operational data in EEPROM for future reference, and displaying system status through LCD, thereby achieving efficient, reliable, and intelligent power management on highways.

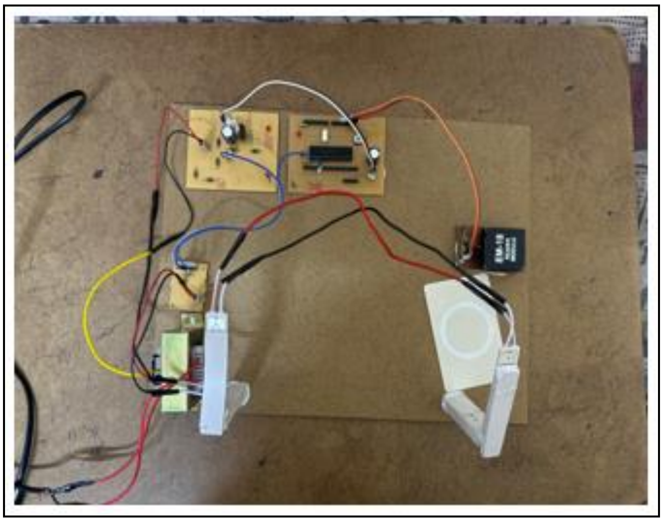
Fig 6 Proposed Work

IV. ADVANTAGES

- Significant Energy Savings – Streetlights operate only when vehicles are detected, reducing unnecessary power consumption during low-traffic hours.
- Automated Operation – The system eliminates manual switching and works intelligently based on real-time traffic movement using RFID detection.
- Improved Highway Safety – Lights turn ON automatically when a vehicle enters a specific zone, ensuring safe visibility for drivers especially at night.
- Accurate Time-Based Monitoring – The RTC module provides precise timestamps, which help in analyzing traffic flow and optimizing power usage.
- Reliable Data Storage – EEPROM memory ensures that vehicle logs, timings, and energy data remain secure even during power failures.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec061

- Low Maintenance & Cost-Effective – Once installed, the system needs minimal maintenance, making it more economical than traditional lighting systems.
- Scalable & Flexible Design – Additional sensors, extended lighting zones, or solar power units can be integrated without major modifications.
- Reduces Carbon Footprint – By lowering electricity use, the system indirectly reduces greenhouse gas emissions, supporting sustainable development.

V. APPLICATIONS

- National Highways & Expressways – To automatically manage streetlighting based on actual vehicle presence.
- Rural and Low-Traffic Roads – Ideal for areas where continuous lighting is unnecessary and wasteful.
- Smart City Intelligent Transportation Systems – Can be integrated into smart city infrastructure for efficient power management.
- Tunnels and Underpasses – For automatically illuminating selective zones when a vehicle enters.
- Campus and Industrial Roadways – Helps large university campuses, industrial zones, or IT parks manage roadway lighting smartly.
- Automated Toll Booth Systems – RFID-based vehicle detection can assist in lighting or gate control around toll plazas.
- Solar-powered Highway Lighting Systems – Can be combined with solar streetlights to further enhance energy saving.
- Parking Lots and Garages – Automatically activates lights when vehicles enter parking areas.

VI. CONCLUSION

The Power Management System for Highway Using Radio Frequency Identification (RFID) provides a smart and efficient approach to controlling highway lighting by integrating vehicle detection, microcontroller-based decision making, and real-time data logging. By activating lights only when vehicles are present, the system significantly reduces energy wastage and operational costs without compromising safety. The use of an RTC module and EEPROM ensures accurate time-based monitoring and secure storage of essential traffic data, making the system reliable for long-term operation. The microcontroller coordinates all units seamlessly, while the LCD, buzzer, and LEDs provide user-friendly monitoring and alerts. This technology supports the development of intelligent transportation systems and contributes toward sustainable energy usage and modern smart highway infrastructure. Overall, the system demonstrates how RFID technology can be effectively applied to achieve automated, eco-friendly, and cost-efficient power management on highways.

REFERENCES

[1]. N. Nireekshana, A. Archana, and K. Pullareddy, “A Classical H6 Topology for Modern PV Inverter Design,” in Power Energy and Secure Smart Technologies, CRC Press, 2025, pp. 1–7. Accessed: Dec. 02, 2025. [Online]. Available: https://www.taylorfrancis.com/chapters/edit/10.1201/9781003661917-1/classical-h6-topology-modern-pv-inverter-design-namburi-nireekshana-archana-pullareddy-kanth-rajini

[2]. C. P. Prasad and N. Nireekshan, “A Higher Voltage Multilevel Inverter with Reduced Switches for Industrial Drive,” Int. J. Sci. Eng. Technol. Res. IJSETR, vol. 5, no. 1, 2016, Accessed: Dec. 02, 2025. [Online]. Available: https://methodist.edu.in/web/uploads/naac/2019-11-19%2012_24_22pm%2092.pdf

[3]. N. Namburi Nireekshana and K. R. Kumar, “A Modern Distribution Power Flow Controller With A PID-Fuzzy Approach: Improves The Power Quality”, Accessed: Dec. 02, 2025. [Online]. Available: https://www.academia.edu/download/112956747/ijeer_120124.pdf

[4]. N. Nireekshana, N. Ravi, and K. R. Kumar, “A Modern Distribution Power Flow Controller With A PID-Fuzzy Approach: Improves The Power Quality,” Int. J. Electr. Electron. Res., vol. 12, no. 1, pp. 167–171, 2024.

[5]. N. Nireekshana, R. Ramachandran, and G. V. Narayana, “A New Soft Computing Fuzzy Logic Frequency Regulation Scheme for Two Area Hybrid Power Systems,” Int. J. Electr. Electron. Res., vol. 11, no. 3, pp. 705–710, 2023.

[6]. N. Nireekshana, R. Ramachandran, and G. Narayana, “A Novel Swarm Approach for Regulating Load Frequency in Two-Area Energy Systems,” Int J Electr Electron Res, vol. 11, pp. 371–377, 2023.

[7]. N. Nireekshana, R. Ramachandran, and G. V. Narayana, “A Peer Survey on Load Frequency Contol in Isolated Power System with Novel Topologies,” Int J Eng Adv Technol IJEAT, vol. 11, no. 1, pp. 82–88, 2021.

[8]. N. Nireekshana, “A POD Modulation Technique Based Transformer less HERIC Topology for PV Grid Tied-Inverter,” in E3S Web of Conferences, EDP Sciences, 2025, p. 01001. Accessed: Dec. 02, 2025. [Online]. Available: https://www.e3s-conferences.org/articles/e3sconf/abs/2025/16/e3sconf_icregcsd2025_01001/e3sconf_icregcsd2025_01001.html

[9]. N. Nireekshana, R. Ramachandran, and G. V. Narayana, “An innovative fuzzy logic frequency regulation strategy for two-area power systems,” Int. J. Power Electron. Drive Syst. IJPEDS, vol. 15, no. 1, pp. 603–610, 2024.

[10]. N. Nireekshana, T. H. Nerlekar, P. N. Kumar, and M. M. Bajaber, “An Innovative Solar Based Robotic Floor Cleaner,” Int. J. Innov. Sci. Res. Technol. IJISRT, vol. 8, no. 4, pp. 1880–1885, 2023.

[11]. N. Nireekshana, R. R. Chandran, and G. V. Narayana, “Frequency Regulation in Two Area System with PSO Driven PID Technique,” J Power Electron Power Syst, vol. 12, no. 2, pp. 8–20, 2022.

[12]. N. NIREEKSHANA, R. Ramachandran, and G. V. Narayana, “An intelligent technique for load

frequency control in hybrid power system," 2023, Accessed: Dec. 02, 2025. [Online]. Available: https://www.academia.edu/download/107660997/latest.pdf
[13]. R. Jatoth and N. Nireekshana, "Improvement of Power Quality in Grid Connected Non Coventional Energy Sources at Distribution Loads," Grenze Int J Eng Technol GIJET, vol. 4, no. 3, 2018, Accessed: Dec. 02, 2025. [Online]. Available: https://methodist.edu.in/web/uploads/naac/2019-11-19%2012_58_06pm%20201.pdf
[14]. N. Nireekshana, R. Ramachandran, and G. V. Narayana, "Novel Intelligence ANFIS Technique for Two-Area Hybrid Power System's Load Frequency Regulation," in E3S Web of Conferences, EDP Sciences, 2024, p. 02005. Accessed: Dec. 02, 2025. [Online]. Available: https://www.e3s-conferences.org/articles/e3sconf/abs/2024/02/e3sconf_icregcsd2023_02005/e3sconf_icregcsd2023_02005.html
[15]. N. Nireekshana, "Reactive Power Compensation in High Power Applications by Bidirectionalcasceded H-Bridge Based Statcom", Accessed: Dec. 02, 2025. [Online]. Available: https://methodist.edu.in/web/uploads/naac/2019-11-19%2012_45_47pm%20152.pdf
[16]. N. NIREEKSHANA, K. RAHUL, A. ARCHANA, B. GOUTHAM, K. M. AKSHAY, and N. REDDY, "REACTIVE POWER MANAGEMENT THROUGH INTER PHASE POWER CONTROLLER," Int. J., pp. 2772–2781, 2024.
[17]. N. NIREEKSHANA, A. SHIVA, A. FURKHAN, M. SRIDHAR, A. OMPRAKASH, and K. K. SHIVA, "SIX PULSE TYPE SEGMENTED THYRISTOR CONTROLLED REACTOR WITH FIXED CAPACITOR FOR REACTIVE POWER COMPENSATION," Int. J., pp. 3153–3159, 2024.
[18]. N. Nireekshana, M. A. Goud, R. B. Shankar, and G. N. S. Chandra, "Solar Powered Multipurpose Agriculture Robot," Int. J. Innov. Sci. Res. Technol., vol. 8, no. 5, p. 299, 2023.
[19]. N. Nireekshana, K. P. Reddy, A. Archana, and P. R. Kanth, "Solar-Assisted Smart Driving System for Sustainable Transportation," Int. J. Innov. Sci. Res. Technol., vol. 10, no. 8, pp. 168–173, 2025.
[20]. Namburi Nireekshana, A. Archana, Setla Manvitha, Mohammed Saad Ahmed, Nisar Ahmed Khan, and Akellu George Muller, "Unique Facts Device for Power Quality Mitigation," Feb. 2024, doi: 10.5281/ZENODO.10652911.
[21]. N. Nireekshana, S. Unissa, B. R. Jaleja, C. Mukta Tejaswi, P. Mangathayaru Mahitha, and P. Vaishnavi, "FACTS: Present and Future," Int. J. Innov. Sci. Res. Technol. IJISRT, pp. 2350–2358, Oct. 2024, doi: 10.38124/ijisrt/IJISRT24SEP1424.
[22]. Namburi Nireekshana, Manmarry Vaibhav Murali, Makka Harinath, Ch. Vishal, and Ankam Sandeep Kumar, "Power Quality Improvement by Thyristor Controlled Series Capacitor," Feb. 2024, doi: 10.5281/ZENODO.10669448.
[23]. Namburi Nireekshana, Onteru Divya, Mohammed Abdul Saquib Adil, Rathod Rahul, and Mohammed Shoaib Mohiuddin, "An Innovative SSSC Device for Power Quality Enhancement," Feb. 2024, doi: 10.5281/ZENODO.10670526.
[24]. N. Nireekshana, "Control of a Bidirectional Converter to Interface Electrochemical double layer capacitors with Renewable Energy Sources", Accessed: Feb. 18, 2025. [Online]. Available: https://methodist.edu.in/web/uploads/naac/2019-11-19%2012_45_38pm%20151.pdf
[25]. Namburi Nireekshana, K. Pulla Reddy, Reyya Bose Babu, Bonda Sunder, G. Sumanth Kumar, and P. Vivekananda Raj, "Static Var Compensator for Reactive Power Control," Feb. 2024, doi: 10.5281/ZENODO.10638477.