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# Design and development of smart emergency light

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**ABSTRACT**

The demand for electricity is increasing day-by-day and frequent power cuts is causing many problems in various areas such as household, domestic, farms, etc. Due to limited amount of power generation at power station and due to shortage of non-renewable sources, uninterruptible power supply being a biggest challenge in the entire world. In this paper, a smart emergency light is designed, developed and tested for use it in various applications such as home, industries, agricultural sector and shops, etc. The developed energy lamp has no running cost and has low initial cost. The main objective of this work is to provide the smart emergency light with solar power to the farmers. This work will help the farmers in many ways such as protecting the fields from yield animals. It can also be used as emergency light and entertainment, etc. The main applications of this work is that it can used as FM radio, USB charging, music by memory card, mini fan, torch light, etc. This can also be controlled by remote. The battery can be used for all these applications. This battery can be charged by two ways using solar energy and AC mains supply. The developed lamp is tested in the real time environment.



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## 1. INTRODUCTION

In today's world, a considerable portion of consumed energy in electrical network is changed to artificial lighting. With the increase in energy consumption by various segments in relation to difficulty of generation, the importance of efficient ways of lighting can be investigated. Light emitting diodes (LEDs) are widely used in low-light-level applications. Use of LEDs for signalization has been well known for more than a decade and for many different applications. In most activities, the lighting is needed. Therefore, the emergency lighting systems have become important. They have been considered as safety item and are required in many environments. They are installed in halls, ladders, garages, elevators, restaurants and other public environments ensuring lighting in the absence of electricity. Emergency lights are considered as extremely important for workplaces because they may be the only means of light available for the farmers or workers during emergency situations. The battery powered lights ensure that the workers can easily find an exit with relative ease. This is why installation of these lights is considered a legal requirement within the remote areas. Sung W. T., et. all., [1] develops a smart LED lighting system, which is remotely controlled by Android apps via handheld devices, e.g., smart phones, tablets, etc. A new emergency ballast for fluorescent lamps is presented, Alonso J. M., et. all., [2]. An emergency lighting system integrated into a compact lamp using high-brightness LEDs is proposed in [3]. These devices have high luminous efficacy, long useful life and small size. Besides, they work with low voltage and current values and they do not need ignition process. These features make these devices attractive to use in emergency lighting. Secades M. R., et. all., [4] presents an alternative solution based on high-efficiency LEDs. The long operation life of high-efficiency LEDs with a very simple electronics circuitry implies an interesting solution for these types of applications. An emergency lighting system integrated into a compact lamp using high-brightness LEDs is proposed in [5].

A distributed emergency lighting system by using LEDs and a converter applied to supply this network consists of the integration of two flyback converters is proposed, Oliviera A. M. M., et. all., [6]. Pinto R. A., et. all., [7] proposes a circuit which supplies the LEDs in two ways. First, by mains (220 V, ac) using a circuit called voltage regulator in DC. Another way, in the emergency mode, the circuit supplies the LED using a Ni-MH battery without the need of converter. The objective of [8] is to develop a compact and low-cost electronic circuit to drive and control the current of LEDs arranged in a single enclosure. The system proposed, Lohote R., et. all., [9] overcomes all the drawbacks of conventional system and provides energy saving, smart alerting solutions. An efficient and compact emergency lighting system using high intensity LEDs is proposed in [10]. The objective of this work is to design and develop a smart emergency light which is mainly useful for the farmers in remote areas as they face some problems during late nights in the fields from low lighting and facing field loss from wild animals and birds. The main objective of this paper is to provide the smart emergency light using solar power to the farmers. In many countries, most of the farmers are stick around to their remote areas. The main applications of this work are FM radio, USB charging, music by memory card, mini fan, torch light, etc. This can also be controlled by remote control. The battery can be used for all these applications. This battery can be charged by two ways using solar energy and AC mains supply [11]. These are designed, implemented and tested in the real time environment. The objectives of this work are as follows:

- To design and develop a smart emergency light in real time environment.
- To provide supply to loads using battery.
- To charge the battery using both solar energy source and ac mains supply.
- The design should be simple and easily operated.

The remainder of this paper is organized as follows: section 2 describes about the smart emergency light. Design and analysis of smart emergency light is presented in section 3. Testing, results and discussion is presented in section 4. Finally, various contributions of this paper are presented in section 5.

## 2. SMART EMERGENCY LIGHT

Figure 1 depicts the block diagram of smart emergency light. From this Figure, it can be observed that the battery can be charged by two ways using solar energy through charge controller and AC mains supply through battery charger [12]. This battery can be fed to different loads, and they are main light, FM receiver, torch light, USB fan and USB light, mobile charging. The components of smart emergency light are described next:

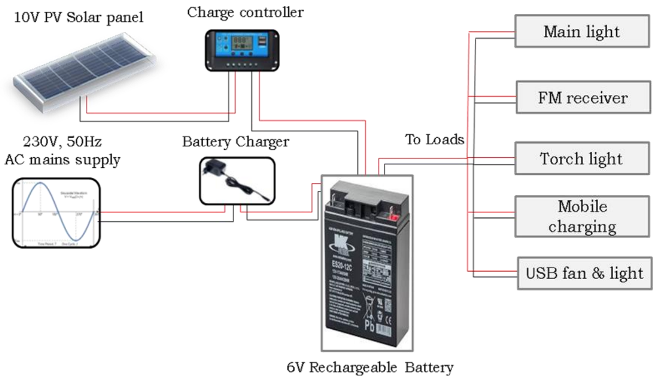


Figure 1. Block diagram of smart emergency light

### 2.1. Solar panel

The essential component in solar energy system is photovoltaic or solar cell, by which sun light energy is converted into electric current based on the principle of photo electric effect [13]. Electrical energy is stored in the battery using solar energy through the charge controller circuit. The specifications of solar panel used in this work are: model number is 0603-1824, solar maximum power ($P_{max}$) is 5 W, voltage at $P_{max}$ is 8.60 V, current at $P_{max}$ is 0.58 A, open circuit voltage is 10.5 V, short circuit current is 0.67 A, operating temperature is -40 °C to 85 °C, and number of cells are 18 [14].

**2.2. Solar charge controller**

It is fundamentally a voltage or current controller to charge the battery and keep electric cells from overcharging. It directs the voltage and current hailing from the solar panels setting off to the electric cell. Generally, 12 V boards/panels put out in the ballpark of 16 to 20 V, so if there is no regulation the electric cells will damaged from overcharging. Generally, electric storage devices require around 14 to 14.5 V to get completely charged. The range of charge controllers are from 4.5 A and up to 60 to 80 A [15]. There are three different types of solar charge controllers are available, and they are: simple 1 or 2 stage controls, pulse width modulated (PWM) and maximum power point tracking (MPPT) [16].

**2.3. Battery and battery charger**

The specifications of this battery are: voltage is 6 V, capacity is 2.8 Ah. The battery charging through AC mains by using charger. The battery charger circuit diagram is presented in Figure 2. Mainly, this circuit consists of one step-down transformer, rectifier bridge, filter, etc [17, 18].

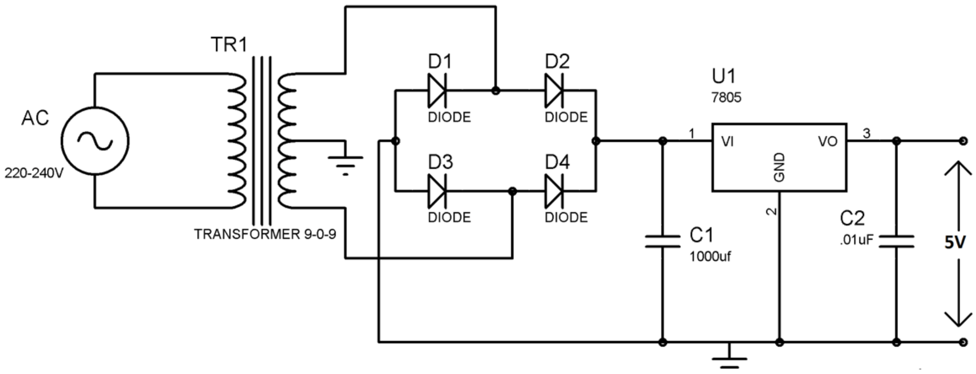


Figure 2. Battery charger circuit

**2.4. FM receiver**

FM receiver is an electronic device that receives radio waves and converts the information carried by them to a usable form [19]. An antenna is used to catch the desired frequency waves. The receiver uses electronic filters to separate the desired radio frequency signal from all other signals picked up by the antenna [20].

**2.5. Main light**

Main light contains three sets and each set consists of six LED lights as shown in Figure 3. Each LED light rating is 4 V DC, these LEDs are connected in parallel. Illumination level can be varied as required by using control variable [21]. LED is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. This effect is called electro luminescence [22].

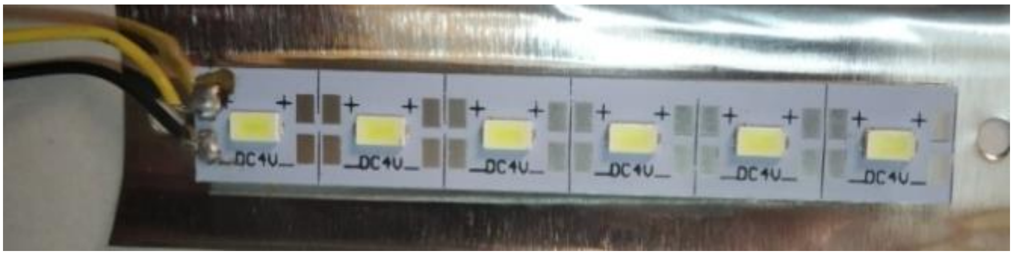


Figure 3. Main light

## 3. DESIGN AND ANALYSIS

The instruments used to design the smart emergency light are wood parts, screws, flex gum, connecting wires, solar panel, charge controller, battery, volume adjuster, light intensity variac and charging port [23]. Smart emergency light can be designed by wooden plates as follows: height of the plate is 25 cm, width of top and bottom side 15 cm, area of the bottom and top plates is (15*15 cm), area of four sides plates is (25*15 cm), area of three sides of main light is (8.5*2 cm), area of FM dimensions is (8.5*2 cm), area of torch light is $\pi r^2 = \pi(1.5)^2$, area of switch cutting is (2*1 cm), area of main light variac and volume adjuster is $\pi r^2 = \pi(0.4)^2$, area of charging port is $\pi r^2 = \pi(0.4)^2$, area of solar adapter port is $\pi r^2 = \pi(0.5)^2$, number of screws are 18 with area of $\pi r^2 = \pi(0.2)^2$, charge controller indicator area is (4*1 cm), and area of designed handle is (36*3 cm) [24]. Figure 4 shows the front and top views of developed smart emergency light. Front side has FM receiver, USB port, FM channel adjuster and main light second side view. Top view has solar panel and handle.

Figure 4. Front and top views of smart emergency light

## 4. TESTING AND RESULT ANALYSIS

This section presets the testing and results of working of real time emergency light. Here, various loads like main light, FM receiver, torch light, etc., gets supply from battery [25]. The battery can be rechargeable. This battery can be charged by various sources, such as solar energy and AC mains supply. In this paper, 5 different tests are performed and they are discussed as follows:

### 4.1. Test 1: illumination test

Figure 5 depicts the pictures illumination test on main light. Here, it provides the results of emergency illumination test [26]. The illumination test was conducted in the most conservative test configuration possible, i.e., with onetime lights ON and another time lights OFF. We believe the emergency lighting levels on the control room bench board to be adequate. However, we are continuing to investigate possible options for improving the lighting levels under this scenario. The number of LED sources tested in this case are 6 LEDs in three parallel sets. LEDs brightness can be varied by controlling light intensity adjuster or illumination level variac with five resistors connected in series, and this variac circuit is shown in Figure 6. The brightness of LED light can be increased by removing the resistors one by one, by changing the variac. LEDs are supplied through battery source.


Figure 5. Illumination test on main light

Figure 6. Illumination level of variac circuit

### 4.2. Test 2: torch light test

The circuit of torch light test is shown in Figure 7 and it is conducted by choosing the suitable rating of LED light to bare the 4 V battery capacity. Torch light 4.5 V rating LED is chosen, and it can be connected to battery through switch series with it. Here, the features are verified and tested successfully [27].

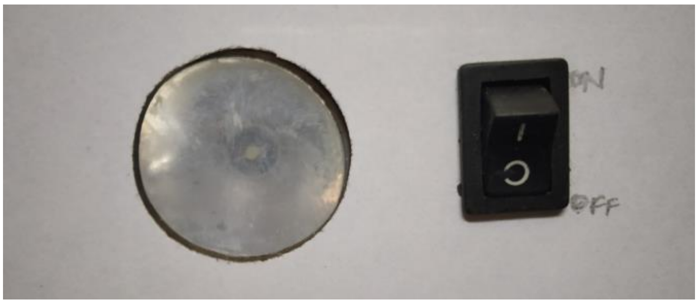


Figure 7. Torch light test

### 4.3. Test 3: FM receiver test

In this case, four different tests are conducted, and they are: volume test, channel varying test, remote control test and signal receiving test (antenna) [28]. The circuit of FM receiver test is presented in Figure 8. Earlier two tests are conducted by connecting audio amplifier along with speaker to battery with FM receiver module, and absorbed the volume clearance and station changing. The frequency range observed is from (88-108) MHz [29]. Volume and station changed by station adjustor and remote control. Signal receiving test can be tested by 40 cm small antenna wire, connected to signal port of receiver module and it is shown in Figure 9.

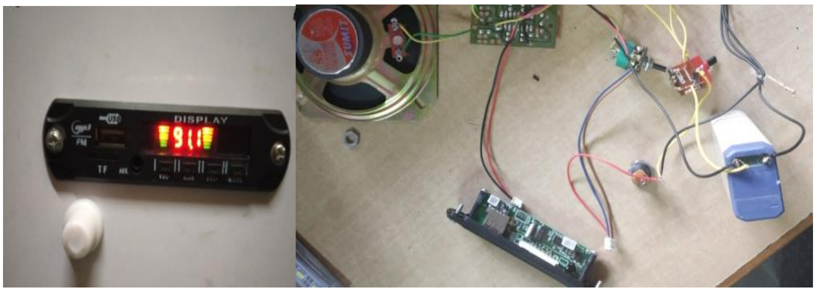


Figure 8. FM receiver test

Figure 9. Antenna test

### 4.4. Test 4: battery charging test

Battery charging can be done by using two ways, i.e., adapter and solar panel. One by connecting AC mains charging port to charge indicating light with small resistance and to battery and another by solar panel through charge controller to battery [30]. Charging of battery through AC mains indicated by charge indicating LED light as shown in Figure 10.

### 4.5. Test 5: USB test

USB testing is shown in Figure 11, and this test includes the following:
- It can be tested to produce sounds by inserting pen drive.
- It can be tested for mobile charging through cable.
- It can be tested to drive the USB fan and USB light.
- Above the USB port have micro SD slot and earphone cable port. Working of these ports are also tested.

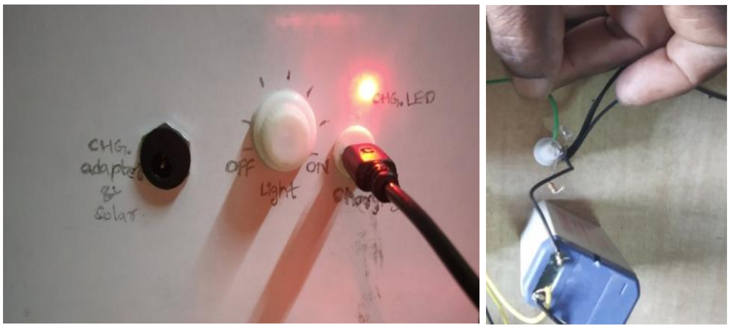


Figure 10. Battery charging test

Figure 11. USB test

## 5. CONCLUSIONS

In this work, a smart emergency light is designed and developed, and it is tested successfully, and verified all the features of it. Smart emergency light is designed successfully and tested in real time environment with different features like battery charging by solar panel and AC mains, main LED light, FM radio, USB charging, music by memory card, torch light, mini USB fan and USB light, etc. The developed smart emergency light is suitable in many areas such as home applications, industries, agricultural sector and shops, etc. Mainly, it can be used for the farmers, who can spend time in remote areas, night time workers and protect the fields from yield animals like peacocks. The advantage of this smart emergency lamp is that it has no running cost and has low initial cost.

## ACKNOWLEDGEMENTS

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## REFERENCES

[1] Sung W. T., Lin. J. S., "Design and Implementation of a Smart LED Lighting System Using a Self Adaptive Weighted Data Fusion Algorithm," *Sensors*, vol. 13, no. 12, pp. 16915-16939, 2013.
[2] Alonso J. M., Diaz J., Blanco C., and Rico M. A., "Smart-Lighting Emergency Ballast for Fluorescent Lamps Based on Microcontroller," *Proceedings Eighth Annual Applied Power Electronics Conference and Exposition*, San Diego, CA, USA, pp. 549-555, 1993.
[3] Pinto R. A., *et al.*, "Compact Emergency Lighting System using High-Brightness LED Lamp," *9th IEEE/IAS International Conference on Industry Applications*, Sao Paulo, vol. 10, pp. 1-6, 2010.
[4] Secades M. R., Calleja A. J., Ribas J., Corominas. E. L., "Evaluation of a Low-Cost Permanent Emergency Lighting System Based on High-Efficiency LEDs," *IEEE Transactions on Industry Applications*, vol. 41, no. 5, pp. 1386-1390, 2005.
[5] Pinto R. A., *et al*,. "Emergency Lamp using High-Brightness LED," *IEEE International Symposium on Industrial Electronics*, Gdansk, pp. 257-262, 2011.
[6] Oliveira A. A. M., Marchesan T. B., Prado R. N., Campos A., "Distributed Emergency Lighting System LEDs Driven by Two Integrated Flyback Converters," *IEEE Industry Applications Annual Meeting. New Orleans*, LA, pp. 1141-1146, 2007.
[7] Pinto R. A., *et al.*, "Emergency Lighting System Integrated into a Compact High-Brightness LED lamp," *Brazilian Power Electronics Conference*, Bonito-Mato Grosso do Sul, pp. 593-597, 2009.
[8] Pinto R. A., *et al.*, "Compact Emergency Lamp Using Power LEDs," *IEEE Transactions on Industrial Electronics*, vol. 59, no. 4, pp. 1728-1738, 2012.
[9] Lohote R., Bhogle T., Patel V., Shelke V., "Smart Street Light Lamps," *International Conference on Smart City and Emerging Technology*, Mumbai, pp. 1-5, 2018.

[10] Pinto R. A., *et al.*, "LED Lamp with a Compact Emergency Lighting System," *IEEE Industry Applications Society Annual Meeting,* Houston, TX, pp. 1-6, 2009.

[11] Pinto R. A., *et al.*, "Compact Emergency Lamp Using Power LEDs," *35th Annual Conference of IEEE Industrial Electronics, Porto,* pp. 3494-3499, 2009.

[12] Rudrawar O., Daga S., Chadha J. R., Kulkami P. S., "Smart Street Lighting System with Light Intensity Control Using Power Electronics," *Technologies for Smart-City Energy Security and Power,* Bhubaneswar, pp. 1-5, 2018.

[13] Hussin W. M. H. B. W., Rosli M. M., Nordin R., "Review of Traffic Control Techniques for Emergency Vehicles," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 13, no. 3, pp. 1243-1251, 2019.

[14] Hashim N., Idris F., Kadmin A. F., Sidek S. S. J., "Automatic Traffic Light Controller for Emergency Vehicle using Peripheral Interface Controller," *International Journal of Electrical and Computer Engineering (IJECE),* vol. 9, no. 3, pp. 1788-1794, 2009.

[15] Jisheng C., "Evaluation on Light Sources for Electric Power Emergency Recovery System Based on Grille Method and Maximum Information Coefficient Method," *Energy Procedia,* vol. 145, pp. 181-186, 2018.

[16] Hussin R., Ismail R. C., Murrali E., Kamarudin A., "Wireless Traffic Light Controller for Emergency Vehicle through XBee and Basic Stamp Microcontroller," *Procedia Engineering,* vol. 41, pp. 636-642, 2012.

[17] Budisusila E. N., Hapsari P., "An Analysis of Intelligent LED Emergency Lamp with Voltage and Resistance Activated Sensor," *IOP Conf. Series : Materials Science and Engineering,* vol. 403, pp. 1-5, 2018.

[18] Advanced, The Advanced Emergency Lighting Test System. Technical Report, [Online], Available: https://www.luxintelligent.com/media/991216/SSD638-Lux-Intelligent-Brochure-v8FINALLR.pdf

[19] Brock K., et al,. "Light the Way for Smart Cities : Lessons from Philips Lighting," *Technological Forecasting and Social Change,* vol. 142, no. 194-209, 2019.

[20] Park S., Kang B., Choi M., Jeon S., Park S., "A Micro-Distributed ESS-Based Smart LED Streetlight System for Intelligent Demand Management of the Micro Grid," *Sustainable Cities and Society,* vol. 39, pp. 801-813, 2018.

[21] Ngatilah. Y., et al, "Design for Manufacture and Assembly for Product Development (Case study : Emergency Lamp)," *IOP Conf. Series: Journal of Physics,* vol. 218, no. 953, pp. 1-6, 2018.

[22] Lee C. K., Li S., Hui S. Y., "A Design Methodology for Smart LED Lighting Systems Powered By Weakly Regulated Renewable Power Grids," *IEEE Transactions on Smart Grid*, vol. 2, no. 3, pp. 548-554, 2011.

[23] Ranjan P., Kumar S., Sujit K., Naregalkar P. R., "Smart Solar Emergency Lamp with Motion Detector," *International Research Journal of Engineering and Technology,* vol. 3, no. 5, pp. 2246-2252, 2016.

[24] Narasimha S., Surender R. S., "Design and Implementation of Smart Uninterruptable Power Supply using Battery Storage and Photovoltaic Arrays," *International Journal of Engineering & Technology,* vol. 7, no. 3, pp. 960-965, 2018.

[25] Watson I. A., Omoregie A., Oshomah A. B., "Design and Construction of an Automatic Emergency lighting System with Battery Over-Charge Protection Circuit," *Greener Journal of Science Engineering and Technological Research,* vol. 5, no. 1, pp. 1-10, 2015.

[26] Almuraykhi K. M., Akhlaq M., "STLS: Smart Traffic Lights System for Emergency Response Vehicles," *International Conference on Computer and Information Sciences (ICCIS),* Sakaka, Saudi Arabia, pp. 1-6, 2019.

[27] Narasimha S., Surender R. S., "Dynamic and Hybrid Phase Shift Controller for Dual Active Bridge Converter," *International Journal of Engineering & Technology,* vol. 7. no. 4, pp. 4795-4800, 2018.

[28] Lohote R., Bhogle T., Patel V., Shelke V., "Smart Street Light Lamps," *International Conference on Smart City and Emerging Technology,* Mumbai, pp. 1-5, 2018.

[29] Rudrawar O., Daga S., Chadha J. R., Kulkami PS., "Smart Street Lighting System with Light Intensity Control using Power Electronics," *Technologies for Smart-City Energy Security and Power,* Bhubaneswar, pp. 1-5, 2018.

[30] Xu W., et al., "The Design, Implementation, and Deployment of a Smart Lighting System for Smart Buildings," *IEEE Internet of Things Journal,* vol. 6, no. 4, pp. 7266-7281, 2019.