FORM 2

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PROVISIONAL SPECIFICATION

[See section 10 and rule 13]

"SMART OUTAGE-GUARD BULB"

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The following specification describes the invention.

FIELD OF THE INVENTION

Embodiments of the present invention generally relate to lighting bulb, and more particularly relates to a modular LED bulb with improved power backup.

BACKGROUND OF THE INVENTION

In today's modern world, our daily lives depend on electrical power supply. From lighting our homes to powering essential appliances and devices, electricity has become an integral part of our daily lives. The problem of power outages remains a significant concern, disrupting our daily routines. It even affects basic lighting, which is crucial for essential activities like studying in schools, working in offices, and delivering critical services in hospitals. Traditionally, inverters have been widely adopted to tackle lighting challenges during power outages. Although, the high initial cost of these inverters and their limited efficiency pose significant barriers for many individuals and organizations. Moreover, they rely on lead-acid batteries for power backup. These batteries are heavy and bulky. To fit in small devices and apparatus like bulb size of these batteries are reduced. Usually, the small lead-acid batteries in bulbs like devices don't last for more than three hours. They have slower charging-discharging rates and a lower energy density, resulting in a shorter backup duration and a short lifespan. Additionally, they present a potential environmental risk due to hazardous materials like lead and acids. As technology advances, alternative battery technologies are emerging.

Existing solutions for lighting during power outages do not consider factors such as the charge available in the battery, the available light in the room, the target area, the region, user preferences, or preset profiles. While inverters have long been used as a backup solution, they often come with high initial costs and limited efficiency. Similarly, bulbs equipped with lead-acid batteries provide backup for less than three hours, making them inadequate for longer outages. These limitations have paved the way for a new invention that addresses these problems: the smart outage-guard Bulb with improved power backup.

Therefore, there is a need in the art for a lighting solution that incorporates new technologies such as lossless pulse width modulation techniques and lithium-ion batteries. These technologies offer higher energy density, faster charging, and longer lifespan, providing an improved and more efficient lighting solution.

OBJECT OF THE INVENTION

An object of the present invention is to provide a lighting solution during power outage.

Another object of the present invention is to provide an efficient and environmentally friendly lighting solution.

Yet another object of the present invention is to provide an adaptive lighting solution with brightness and colour control.

EXAMPLES

The present invention is described hereinafter by various embodiments with reference to the accompanying drawing, wherein reference numerals used in the accompanying drawing correspond to the like elements throughout the description.

While the present invention is described herein by way of example using embodiments and, those skilled in the art will recognize that the invention is not limited to the embodiments of described and are not intended to represent the scale of the various components. Further, some components that may form a part of the invention may not be illustrated, for ease of illustration, and such omissions do not limit the embodiments outlined in any way. It should be understood that and description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the invention is to cover all modifications, equivalents, and alternatives falling within the scope of the present invention. As used throughout this description, the word "may" is used in a permissive sense (i.e. meaning having the potential to), rather than the mandatory sense, (i.e. meaning must). Further, the words "a" or "an" mean "at least one” and the word “plurality” means “one or more” unless otherwise mentioned. Furthermore, the terminology and phraseology used herein is solely used for descriptive purposes and should not be construed as limiting in scope. Language such as "including," "comprising," "having," "containing," or "involving," and variations thereof, is intended to be broad and encompass the subject matter listed thereafter, equivalents, and additional subject matter not recited, and is not intended to exclude other additives, components, integers or steps. Likewise, the term "comprising" is considered synonymous with the terms "including" or "containing" for applicable legal purposes.

Embodiments of the present invention provide an outage-guard bulb device. The device comprises a LED circuit with covering, one or more sensors, a Li-ion battery module, one or more resistors, one or more switches, one or more opto couplers, one or more heat sinks, one or more converter circuit, a pulse generator circuit, one or more filter circuits, one or more indicator LEDs, one or more protection circuits and a processing module.

The LEDs or light emitting diodes have gained popularity as a replacement for traditional incandescent lamps, compact fluorescent lamps (CFLs), and mercury lamps due to several advantages. They are Energy Efficient, Durable and Environmentally Friendly. They are typically connected in a forward bias configuration. They operate on low voltage and low current levels, making them suitable for various applications, from small indicator lights to large-scale lighting installations. The one or more LEDs connected in a circuit to form a LED circuit. It can be made of various semiconductor compounds. The LED material can be selected from but not limited to Gallium Arsenide (GaAs), Gallium Nitride (GaN), and Indium Gallium Nitride (InGaN). The LED material selection broadly depends on the desired colour of light emission, efficiency, cost, and other factors. The different combinations of materials are used to achieve specific colours of light emission. For example, Gallium Phosphide (GaP) is used to create red LEDs, while Aluminum Gallium Arsenide (AlGaAs) is used for creating red and infrared LEDs. In recent years, the development of Indium Gallium Nitride (InGaN) LEDs has been significant. InGaN LEDs are widely used to produce high-brightness blue, green, and white light. By combining blue InGaN LEDs with phosphors, white light can be generated.

The LED circuit is covered with a covering in the present invention. The covering may be selected from, but not limited to, a translucent type, one or more transparent type or lens type. The lens type covering concentrates light from the LEDs. The translucent type covering or covering with multiple reflecting or refracting surface provides almost uniform diffusion of light in the surrounding areas.

The one or more converter circuits may be selected from but not limited to, DC-DC type of converters, inverter circuits or rectifier circuits. The inverter circuit used in the device converts direct current or DC supply from the Li-ion batteries module to AC supply. The processing module is configured to generate control signals according to parameters such as desired output frequency and voltage. The pulse generator connect to the processing module is configured to generate pulses according to the control signal. The pulse generator is further connected to each of high frequency switches through its gate terminal. The rectifier circuit is configured to charges the one or more Li-ion batteries. A rectifier circuit converts AC power into DC power. It utilizing power switching devices, optional high-frequency transformers, protection circuitry, and filter circuits, same as in inverter circuit. It is commonly used in various applications, including power supplies, battery charging systems, and motor control. The one or more filter circuits improves supply characteristics. It can be present at the inverter side and the rectifier side of the circuit.

In some embodiments of the present invention, other varieties of converters are employed to fulfill these kinds of functions. In general, buck converters step down the input voltage to a level suitable for LEDs to convert it into voltage. The buck converters efficiently reduce the voltage while maintaining a regulated output. Conversely, boost converters are utilized when the input voltage needs to be increased to a higher level for LED operation. They provide voltage step-up capability, ensuring that the LEDs receive the necessary voltage. A buck-boost converter is used when both step-down and step-up voltage conversion is required. These converters can regulate the output voltage regardless of whether the input voltage is higher or lower than the desired LED voltage.

The plurality of high frequency switches used in the device are integral components in inverter and rectifier circuits, which can be controlled by a processing module through a pulse generator. The pulse generator is configured to generate precise pulses with specific timing and frequency.

These pulses or pulse signals control one or more high-frequency switches, which turn on and off rapidly.

Among the commonly used high frequency switches are the Insulated Gate Bipolar Transistor or IGBT and the Metal-Oxide-Semiconductor Field-Effect Transistor or MOSFET. Both IGBTs and MOSFETs provide efficient and accurate power control in inverter and rectifier circuits. The choice between the two depends on various factors, including specific voltage and current requirements, desired switching frequency, cost considerations, and thermal management requirements. Ongoing advancements in semiconductor technologies and designs continuously enhance the performance and capabilities of these high frequency switches, further expanding their applications and improving overall circuit efficiency.

Resistive dimming control is a commonly used method for adjusting the brightness of lighting bulbs. It operates by altering the amount of current flowing through the bulb, thus regulating its light output. Let's explore the working principle of resistive dimming control in lighting bulbs. In a resistive dimming circuit, a dimmer switch or controller is connected in series with the lighting bulb. The dimmer switch includes a variable resistor, typically a potentiometer or a rheostat, which can be adjusted to change the resistance in the circuit. As the resistance is increased or decreased, the amount of current flowing through the bulb is correspondingly reduced or increased, resulting in a dimmer or brighter light output.

The resistive dimming control operates based on Ohm's Law, which states that the current passing through a resistor is directly proportional to the voltage across it and inversely proportional to its resistance. By adjusting the resistance in the circuit, the current passing through the lighting bulb is regulated, thereby controlling its brightness.

It's important to note that resistive dimming control is typically compatible with incandescent bulbs and some halogen bulbs. While it offers a simple and cost-effective dimming solution, it is important to consider its limitations and ensure compatibility with the rest of the electrical circuit to achieve the desired dimming effect. However, it may not be suitable for use with LED bulbs and certain types of energy-saving bulbs, such as CFLs, without additional considerations or specialized dimming circuits designed for those bulb types.

In some embodiments of the present invention, PWM or Pulse-Width Modulation dimming control is used technique for adjusting the brightness of LED bulbs. The working principle of PWM dimming involves rapidly turning the LED on and off at a high frequency while varying the duty cycle. The duty cycle represents the ratio of the time the LED is on state or high state to the total period of the PWM signal. These dimmers use pulse-width modulation techniques to adjust the average current supplied to the LEDs, allowing for precise dimming and brightness control.

In PWM dimming, a PWM generator is utilized. This generator produces a continuous sinusoidal wave signal with a fixed frequency. The duty cycle of the signal determines the brightness of the LED. A high duty cycle means the LED receives power for a longer duration during each cycle, resulting in a brighter light. Conversely, a low duty cycle means less power is provided, resulting in a dimmer light. To control the brightness, the duty cycle is adjusted by varying the ON and OFF times of the sinusoidal square wave.

To integrate ambient light sensing into the dimming process, a photodiode, photo transistors or other light sensors can be employed. The photodiode detects the level of surrounding light. If the surrounding light is low, indicating a darker environment, the sensors senses this and sends a signal to the PWM generator. The generator then increases the duty cycle, supplying more power to the LED, and thereby increasing its brightness. Conversely, if the ambient light is high, indicating a brighter environment, the photodiode detects this and sends a signal to decrease the duty cycle, reducing the LED's brightness.

Hence, to incorporate ambient light sensing, a similar mechanism with a photodiode can be employed. If the surrounding light is low, photodiode, photo transistors or other light sensors detects this and increases the resistance of the variable resistor. This effectively reduces the current flowing through the LED, resulting in a dimmer light. Conversely, if the ambient light is high, the photodiode senses this and decreases the resistance of the variable resistor, allowing more current to flow and increasing the LED's brightness.

Both PWM and resistive control techniques offer flexible options for adjusting the brightness of an LED bulb. By incorporating ambient light sensing, these methods can adapt the bulb's brightness to match the requirements of the surrounding lighting conditions, providing a comfortable and energy-efficient lighting experience.

In accordance with an embodiment of the present invention, for power efficiency enhancement converter switching is used. It utilizes isolated, non-isolated or mixed converters, such as buck, boost or flyback converters. These converters employ high-frequency switching techniques to efficiently convert power, minimizing power losses and maximizing energy utilization. Integrated drivers combine various functionalities, including voltage conversion, current regulation, dimming control, and protection features, into a single integrated circuit or IC. This integration enables compact designs and simplifies the installation of LED lighting systems.

In accordance with an embodiment of the present invention, the high-frequency transformer is configured to step up or step down the voltage circuit as required in the device. It also provides isolation between the DC input and AC output. A High-frequency transformers typically employ ferrite cores as the core material instead of traditional laminated iron cores. The ferrite core exhibits lower core losses at higher frequencies. It allows for efficient energy transfer and reduced power losses in the transformer. The output from the high-frequency transformer is passed through the one or more filter circuits, which smooths out the waveform and reduces harmonic distortion.

The protection circuits, incorporate features such as overcurrent protection, overvoltage protection, short-circuit protection, and temperature monitoring. These protection mechanisms ensure the safety and longevity of the LED bulbs. It may have components, but not limited to, Diodes, Zener Diodes, Resistors, Snubber Circuits, Capacitors. The arrangement of these components in the LED bulb circuit may vary depending on the specific design and requirements. However, generally, they are connected in parallel or series with the LED or power supply to provide the desired protection. It's important to note that the specific values and configurations of these components would be determined based on the electrical characteristics of the LED and the desired level of protection required.

The converters such as buck converters, boost converters, buck-boost converters, constant current drivers, mixed converters or non-isolated converters like fly-back converters are commonly used in lighting bulb applications. Each type of converter serves a specific purpose related to voltage conversion, current regulation, power efficiency enhancement, dimming control, protection, and compact integration within LED lighting systems.

A heat sink is attached to each switch for dissipating heat during the switch operation. Heat sinks are commonly used for high-frequency switches like MOSFETs to dissipate heat generated during operation. MOSFETs are semiconductor devices that can switch high currents and voltages rapidly. However, they also produce heat due to their internal resistance and switching losses. At high frequencies, MOSFETs can experience increased power dissipation, which can lead to a temperature rise. Excessive heat can degrade the MOSFET's performance, reduce its lifespan, and even cause it to fail. To mitigate these issues, a heat sink is employed to enhance heat dissipation. The heat sink serves as a passive cooling solution that helps transfer heat away from the MOSFET to the surrounding air more efficiently. It typically consists of a thermally conductive material, such as aluminium or copper, with fins or other structures that increase the surface area. The increased surface area facilitates better heat transfer by allowing more contact with the ambient air. When the MOSFET is mounted onto the heat sink, the heat generated by the device flows into the heat sink through thermal conduction. The larger surface area of the heat sink exposes more area to the air, promoting convective heat transfer. The air circulating around the heat sink absorbs the heat, carrying it away and keeping the MOSFET at a lower temperature.

The one or more optocouplers are connected in between the pulse generator and the one or more switches. They provide isolation to the pulse generator and the other circuit by reducing noise towards the gate circuit. It in turn improves the switching of the one or more high frequency switch. The optocoupler, also known as an opto-isolator, is an electronic device that combines an optical transmitter or LED and a receiver, usually a phototransistor or a photodiode in a single Integrate circuit package. It provides electrical isolation between two circuits while allowing them to communicate optically. The basic structure of an optocoupler consists of an LED on one side and a photosensitive component on the other side, with a transparent isolating barrier in between. When current flows through the LED, it emits light. This light is then detected by the photosensitive component, which generates an electrical signal proportional to the intensity of the received light. The primary purpose of an optocoupler is to transfer signals or electrical power between two circuits while maintaining electrical isolation. It achieves this by using light as the communication medium, which effectively separates the input and output sides of the device.

The AC output from the transformer is passed through the filter circuit, which smooths out the waveform and reduces harmonic distortion. The filter configuration can be selected on the basis of the frequency range of interest, the level of harmonic distortion to be eliminated, and the desired output quality. It can be active or passive or combination thereof. The passive filters utilize passive components such as capacitors, resistors, and inductors to filter out unwanted harmonics and high-frequency noise from the output waveform. While the active filters employ active components such as operational amplifiers or op-amps along with passive components to achieve better filtering performance. The active filters are capable of providing greater control and flexibility in shaping the frequency response. By utilizing passive and active filters, the inverter circuit can deliver a smoother AC output waveform with reduced harmonic content and improved overall performance. The filtered AC power is then available at the output terminals of the inverter for utilization in connected devices or applications.

The Li-ion batteries module may have one or more Li-ion batteries connected in series or parallel configuration according to the power requirement. These are a rechargeable battery that use lithium ions to transport and store energy. The module and batteries are replaceable in nature i.e., each of the batteries can be replaced with new ones as and when required. Li-ion batteries offer benefits like High energy density, long cycle life, fast charging and more environment friendly. The battery module in the present invention offers lighting backup for up to 8 hours during power cuts. The Li-ion batteries can have an auxiliary solar PV module with converter circuit connected in parallel with the rectifier circuit or even can replace the rectifier circuit to recharge the Li-ion batteries.

In some embodiment of the device, the Li-ion batteries can be replaced capacitor bank, the capacitor can be selected from but not limited to electrolytic capacitors, super capacitors, double-layer capacitors ultra-capacitor, or capacitors with polyester (mylar), polypropylene, and polycarbonate film. These capacitors store the electrical power in the form of charge. The charge can be used as DC power to the circuit in place of the battery which can be either used directly or rectified to AC supply as per the device requirement.

The one or more protection circuits connected with the one or more Li-ion batteries, at the inverter side and the rectifier side of the circuit. The protection circuits play a critical role in ensuring the safe and reliable operation of the device. These circuits incorporate various components schemes to detect and respond to abnormal conditions, safeguarding the bulb from potential damage. These components commonly used in protection circuits for LED bulbs include overcurrent protection, overvoltage protection, short-circuit protection, temperature monitoring, surge protection, and EMI/RFI filtering. The overcurrent protection is essential to prevent excessive current flow through the LED bulb, which can lead to overheating and damage. This protection is achieved through components such as current-sensing resistors, current-limiting devices like fuses or PTC thermistors, and control circuitry that monitors the current and activates protective measures if it exceeds a predefined threshold. It is implemented to prevent the LED bulb from being exposed to excessively high voltages, which can be damaging. Components such as metal oxide varistors (MOVs), transient voltage suppressors (TVS diodes), or voltage clamping devices are used to divert or limit excessive voltages, ensuring that the LED operates within a safe voltage range.

While, the short-circuit protection is crucial for protecting the LED bulb in the event of a short circuit, which can result in excessive current flow and potential damage. Protection components like fuses, resettable fuses or PTC thermistors, or electronic current limiters are employed to interrupt the circuit or limit the current in case of a short circuit. Moreover, the device in the present invention temperature monitoring is an important aspect to prevent overheating of the LED bulb. The excessive heat can degrade its performance and lifespan. Temperature sensors, such as thermistors or integrated temperature monitoring circuits, are used to measure the bulb's temperature. The protection circuitry can respond by reducing the current, activating a thermal shutdown, or generating an alarm signal to ensure safe operation. Surge protection components, such as transient voltage suppressors or TVS diodes or gas discharge tubes, are employed to safeguard the LED bulb against voltage surges caused by lightning strikes or power grid fluctuations. These components divert excessive voltage spikes, preventing them from reaching the LED and causing damage. EMI/RFI filtering components, including capacitors, inductors, and ferrite beads, are used to suppress high-frequency noise and minimize electromagnetic emissions. This ensures that the LED bulb complies with electromagnetic compatibility or EMC standards and operates without interference from external sources. By incorporating these protection circuit components, LED bulb circuits can effectively detect and respond to abnormal conditions, ensuring the safe and reliable operation of the device. These protection mechanisms enhance the lifespan of the LED bulbs and contribute to the overall safety and performance of the lighting system.

The processing module connected with the LED circuit, a pulse generator circuit, one or more sensors, one or more Li-ion batteries. The processing module is configured to generate voltage pulse through the pulse generator. The pulse controls the gate of each switch for power conversion through rectifier circuit and inverter circuit. The processing module through one or more sensors can sense the need of brightness and colours adjustment. The one or more sensors may include photodiodes, photo transistors, and other light or colour sensors.

In accordance with an embodiment of the present invention, the dimming can be connected with a communication module or with one or more input buttons or switches. The communication module can enable a user to connect one or more devices like mobile for dimming or colour adjustments. Alternately the dimming or colour adjustments can be made with one or more input buttons or switches. The one or more input switches may be selected from, but to limited to push buttons, toggle switch, slide switch, rotary knob.

In some embodiment of the device, one or more indicator LEDs are used. It depicts the status of AC power supply and charge status of the Li-ion batteries module.

The device is enclosed in an enclosure. The enclosure covers the one or more sensors, the Li-ion battery module, the one or more high frequency switches, the one or more switches, one or more opto couplers, one or more heat sinks, an inverter circuit, a rectifier circuit, a pulse generator circuit, one or more filter circuits, one or more indicator LEDs, one or more protection circuits and a processing module. The material of the enclosure may be selected from any of the, but not limited to, plastic, PVC, metal, rubber alloys and combination thereof. The enclosure can adopt various industrial standard designs like A, B, C, CA, E, F, G, H, P, PS, S, T, R, BR, ER or PAR. It helps the device to easily replaced the existing solutions. The modular device arrangement with replaceable inverter circuit, rectifier circuit, batteries, LED circuit with covering makes it more user friendly.

The different implementations provided above are not limiting and are only illustrative examples of the different scope of the present subject matter. Other implementations apparent to a person skilled in the art are also included within the scope of the present subject matter.

The device may further comprise artificial intelligence and machine learning based technologies, but not limited to, for data analysis, identifying smell, collating data, presentation of data in real-time in more meaningful manner. The analyzed or raw data can be transmitted to one or more connected computing device through one or more communication modules (not shown) through communication network may be wired or wireless communication network selected from one of, but not limited to, Bluetooth, radio frequency, WIFI network or satellite communication network providing maximum coverage.

In general, the word “module,” as used herein, refers to logic embodied in hardware or firmware, or to a collection of software instructions, written in a programming language, such as, for example, Java, C, or assembly. One or more software instructions in the modules may be embedded in firmware, such as an EPROM. It will be appreciated that modules may comprised connected logic units, such as gates and flip-flops, and may comprise programmable units, such as programmable gate arrays or processors. The modules described herein may be implemented as either software and/or hardware modules and may be stored in any type of computer-readable medium or other computer storage device.

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Further, while one or more operations have been described as being performed by or otherwise related to certain modules, devices or entities, the operations may be performed by or otherwise related to any module, device or entity. As such, any function or operation that has been described as being performed by a module could alternatively be performed by a different server, by the cloud computing platform, or a combination thereof. It should be understood that the techniques of the present disclosure might be implemented using a variety of technologies. For example, the methods described herein may be implemented by a series of computer executable instructions residing on a suitable computer readable medium. Suitable computer readable media may include volatile (e.g., RAM) and/or non-volatile (e.g., ROM, disk) memory, carrier waves and transmission media. Exemplary carrier waves may take the form of electrical, electromagnetic or optical signals conveying digital data steams along a local network or a publicly accessible network such as the Internet.

It should also be understood that, unless specifically stated otherwise as apparent from the following discussion, it is appreciated that throughout the description, discussions utilizing terms such as "controlling" or "obtaining" or "computing" or "storing" or "receiving" or "determining" or the like, refer to the action and processes of a computer system, or similar electronic computing device, that processes and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission or display devices.

Various modifications to these embodiments are apparent to those skilled in the art from the description and the accompanying drawings. The principles associated with the various embodiments described herein may be applied to other embodiments. Therefore, the description is not intended to be limited to the embodiments shown along with the accompanying drawings but is to be providing broadest scope of consistent with the principles and the novel and inventive features disclosed or suggested herein. Accordingly, the invention is anticipated to hold on to all other such alternatives, modifications, and variations that fall within the scope of the present invention.