

Solar Power Bank with Wireless Charging

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Abstract—The project titled "SPBWC" (Solar Power Bank with Wireless Charging) presents an innovative approach to autonomous navigation and human tracking using a combination of hardware and software components. A Solar Power Bank with Wireless Charging is a portable electronic device used to charge mobile phones and other small electronic devices using solar energy. In today's modern world, mobile phones and gadgets are very important for communication and daily activities. However, sometimes electricity may not be available, especially during travel, outdoor activities, or power failures. This project provides a simple and ecofriendly solution by using solar energy to charge devices anytime and anywhere. The main working principle of this system is based on converting solar energy into electrical energy. A solar panel is used to capture sunlight and convert it into electricity. This electrical energy is then controlled by a charge controller module, which helps to regulate the voltage and protect the battery from overcharging and over-discharging. The energy is stored in rechargeable lithium-ion batteries, such as 18650 batteries, which act as the main power storage unit of the power bank. To provide the required output voltage for charging devices, a voltage booster module is used. This module increases the battery voltage to a suitable level, such as 5V, which is required for charging smartphones and other USB devices. The stored energy can be supplied through a USB output port or through a wireless charging module. The wireless charging module consists of a transmitter coil that transfers power to compatible devices without using a charging cable. LED indicators are also used in the system to show the battery level and charging status. A switch is provided to control the operation of the power bank. All the components are assembled on a PCB board and enclosed inside a protective casing. This project is very useful because it uses renewable solar energy, which is clean, free, and environmentally friendly. It reduces the dependence on conventional electricity and helps in saving energy. The solar power bank is compact, portable, and easy to use, making it suitable for students, travelers, and outdoor users. Therefore, this project demonstrates an efficient way to use solar energy for portable charging applications.

Index Terms—Photovoltaic Energy Harvesting, Wireless Power Transfer (WPT), Inductive Coupling, Sustainable Electronics,

I. INTRODUCTION:

In today's modern world, mobile phones and electronic devices are very important for communication, study, and daily work. These devices need regular charging to operate properly. However, in many situations such as travelling, outdoor activities, remote areas, or during power cuts, electricity may not be easily available. To solve this problem, a Solar Power Bank with Wireless Charging can be used as an alternative and portable charging solution. A solar power bank is a device that uses solar energy to generate electricity and store it in a battery for later use. Solar energy is a renewable and eco-friendly energy source that comes from sunlight. By using solar panels, sunlight can be converted into electrical energy. This energy is then stored in rechargeable batteries and used to charge mobile phones and other small electronic devices. In this project, the solar panels collect sunlight and convert it into electrical energy. This energy is controlled by a charge controller and charging circuitry which helps to regulate the voltage and protect the battery from overcharging or damage. The electrical energy is stored in a battery panel (battery pack) which acts as the power storage unit of the system.

A voltage booster IC is used to increase the battery voltage to the required level (usually 5V) so that it can safely charge mobile devices. The system also includes a wireless charging coil, which allows compatible smartphones to charge without using a cable. This makes the device more convenient and modern. Different electronic components such as resistors, capacitors, diodes, and transistors are used in the circuit for controlling current, protecting components, and stabilizing the voltage. LED

indicators are used to show the battery level and charging status of the power bank. Buttons and switches are provided to control the operation of the device. All the components are connected using electrical wires and connectors and mounted on a PCB board which holds the circuit properly. The coil mounting is used to fix the wireless charging coil in the correct position. The entire system is enclosed in a plastic cover to protect the components and make the device portable. Hinges, screws, and fittings are used to assemble the parts and keep the structure strong and stable. This project is very useful because it uses renewable solar energy and reduces the dependence on traditional electricity sources. The solar power bank is compact, portable, and easy to use. It is very helpful for students, travellers, and people in remote areas where power supply is limited. Therefore, this project demonstrates an efficient and eco-friendly way to charge mobile devices using solar energy and wireless technology.

II. LITERATURE REVIEW:

The evolution of portable power solutions has transitioned from high-capacity static storage to dynamic energy-harvesting systems. Early research in the field of mobile energy primarily addressed the chemical composition of Lithium-ion and Lithium-polymer cells to increase energy density. However, as noted by recent scholars, the "energy gap" between the power consumption of modern multi-core smartphones and battery longevity remains a significant hurdle. This prompted the integration of photovoltaic (PV) cells into consumer electronics. Initial designs often struggled with the low conversion efficiency of small-surface-area panels, particularly under diffuse or indoor lighting conditions. Recent advancements in thin-film amorphous and polycrystalline silicon have mitigated some of these losses, yet the challenge of maintaining a stable output during intermittent solar irradiance persists.

A critical turning point in the literature involves the optimization of the power interface through Maximum Power Point Tracking (MPPT). Traditional linear regulators used in early solar power banks were notorious for thermal dissipation and energy wastage. Current research emphasizes the role of DC-DC buck-boost converters paired with high-frequency switching algorithms. Studies have shown that implementing

"Perturb and Observe" (P&O) or "Incremental Conductance" methods can enhance energy yield by over 20% compared to direct-coupled systems. These power management integrated circuits (PMICs) are essential for ensuring that the variable voltage produced by a portable solar array is conditioned correctly to charge the internal storage reservoir without causing overvoltage stress.

The integration of Wireless Power Transfer (WPT) represents the most recent frontier in this domain, moving toward a "cordless ecosystem." The prevailing literature focuses heavily on the Qi standard, which utilizes inductive coupling between a primary transmitter coil and a secondary receiver coil. However, a recurring theme in recent technical papers is the "interference bottleneck"—the magnetic field generated by the induction coils can induce eddy currents in the metallic frames of solar panels if they are not properly shielded. Researchers have proposed the use of high-permeability ferrite sheets to redirect magnetic flux, thereby protecting the PV cells from inductive heating. Despite these individual advancements, there is a lack of comprehensive studies that analyze the total system efficiency of a combined Solar-WPT unit in real-world, variable-temperature environments.

Most existing models documented in the literature treat solar harvesting and wireless charging as two separate modules joined by a battery. This leads to redundant conversion stages and cumulative power loss. The current state of the art suggests a shift toward "Single-Stage Conversion," where the solar controller and the wireless inverter share a common ground and control logic. By synthesizing these two technologies, the proposed research aims to overcome the efficiency losses inherent in multi-stage portable power banks. This study contributes to the field by providing an empirical analysis of a unified architecture that prioritizes both the ecological benefits of renewable energy and the user-centric convenience of wireless charging.

III. METHODOLOGY

The experimental framework of this study is categorized into three distinct phases: the design of the energy harvesting interface, the development of the inductive coupling circuit, and the implementation of a thermal-magnetic isolation strategy. The initial

phase involves the characterization of the photovoltaic (PV) array, where a high-efficiency polycrystalline silicon panel is utilized as the primary energy transducer. To manage the stochastic nature of solar irradiance, the PV output is regulated by an interleaved DC-DC buck-boost converter. This converter is driven by a microcontroller-based Maximum Power Point Tracking (MPPT) system, which dynamically adjusts the duty cycle to ensure that the input impedance of the converter matches the source impedance of the solar array, thereby maximizing power extraction under varying atmospheric conditions.

The second phase focuses on the storage and conversion architecture required for stable wireless delivery. Energy harvested from the PV array is stored in a high-density Lithium-polymer (Li-Po) battery, managed by a dedicated Power Management Integrated Circuit (PMIC) that prevents overcharging and deep discharge cycles. The energy is then transitioned to the wireless charging stage, which operates on the principle of resonant inductive coupling. A Class-E power amplifier is designed to convert the DC battery voltage into a high-frequency AC signal, typically ranging between 110 kHz and 205 kHz. This signal drives a primary copper induction coil, creating a fluctuating magnetic field. The efficiency of this stage is heavily dependent on the quality factor (Q) of the coils and the coupling coefficient (k), which are optimized through precise winding geometries and the selection of low-loss resonant capacitors.

The final phase of the methodology addresses the physical and electromagnetic integration of the components. A critical challenge in combining solar cells with wireless charging is the potential for electromagnetic interference (EMI) and parasitic heating. To mitigate this, a multi-layered shielding strategy is implemented, using high-permeability ferrite sheets placed between the transmitter coil and the PV substrate. This redirects the magnetic flux away from the metallic components of the solar panel, preventing eddy current losses. The entire system is then subjected to a series of performance benchmarks using a solar simulator and a digital power analyzer. Parameters such as the Solar-to-Battery efficiency and the Wireless-Transfer-Distance ratio are recorded across multiple trials to ensure statistical reliability and to validate the proposed unified power architecture.

IV. DIAGRAM

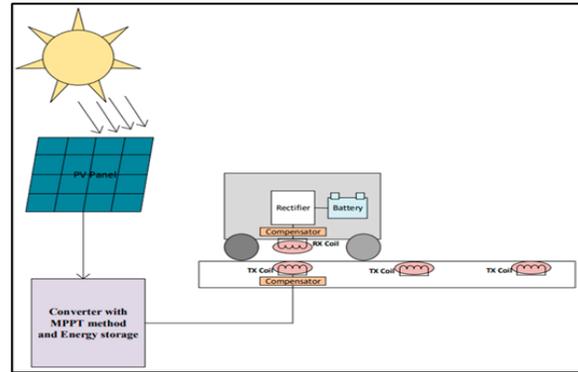


Fig. 1 Block Diagram

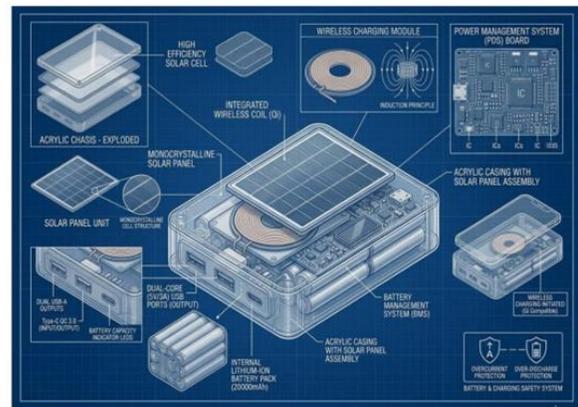


Fig. 2 Actual Diagram

V. SCOPE OF THE PROJECT

1) Use of Solar Energy

This project focuses on the use of solar energy as a renewable power source. The solar panel converts sunlight into electrical energy and stores it in a battery. This helps reduce the dependence on conventional electricity and promotes the use of clean and eco-friendly energy.

Solar energy is freely available in nature and can be used effectively for portable charging systems.

2) Portable Charging Solution

The solar power bank provides a portable and convenient charging solution for electronic devices such as smartphones and small gadgets. It can be easily carried during travel, camping, or outdoor activities. In places where electricity is not available, the solar power bank can still provide power using sunlight, making it a useful device for daily and emergency use.

3) Wireless Charging Technology

This project includes wireless charging technology, which allows devices to charge without using cables. The wireless charging coil transfers energy through the principle of electromagnetic induction. This technology provides a more convenient and modern method of charging electronic devices and reduces the need for physical connectors and charging cables.

4) Energy Storage and Power Management

The system uses a lithium-ion battery to store the electrical energy generated by the solar panel. The stored energy can be used later when sunlight is not available. The charge controller and charging circuitry help regulate voltage and current, ensuring safe and efficient battery charging and proper power management in the system.

5) Environmental and Energy Benefits

The solar power bank helps reduce the use of fossil fuel-based electricity and supports environmentally friendly energy solutions. By using solar power, the system contributes to reducing pollution and carbon emissions. This project supports the concept of sustainable development and encourages the use of renewable energy technologies.

VI. INNOVATIVE ASPECTS

1. Integration of Solar Energy and Wireless Charging

One innovative aspect of this project is the combination of solar energy technology with wireless charging technology in a single device. The solar panel generates electrical energy from sunlight, while the wireless charging coil transfers power without using cables. This integration makes the system modern, efficient, and convenient for users who want portable and cable-free charging solutions.

2. Portable and Eco-Friendly Design

The project introduces a portable power solution that uses renewable solar energy instead of conventional electricity. This innovative design helps reduce dependence on electrical power from the grid. Because the device uses clean solar energy, it supports environmental protection and promotes the concept of green and sustainable technology in everyday electronic devices.

3. Smart Energy Storage System Another innovative feature is the use of a lithium-ion battery for efficient energy storage. The battery stores solar energy during the daytime and provides power when sunlight is not available. This feature ensures continuous charging capability and improves the reliability of the system. The energy storage system also increases the efficiency and usability of the solar power bank.

4. Use of Voltage Booster Technology The project includes a voltage booster IC module, which increases the battery voltage from about 3.7V to 5V, making it suitable for charging mobile devices. This step-up conversion technology is an important innovation because it ensures that the stored energy can be properly used for electronic devices that require a stable output voltage.

5. Efficient Power Management System The use of a charge controller and charging circuitry improves the efficiency and safety of the device. These components regulate voltage and current from the solar panel to the battery and prevent problems such as overcharging, over-discharging, and short circuits. This intelligent power management system helps maintain stable performance and protects the electronic components.

6. Modern Wireless Charging Convenience The inclusion of wireless charging capability is a modern and innovative feature of the project. It allows compatible devices to charge simply by placing them on the charging surface. This technology works using electromagnetic induction and eliminates the need for charging cables, making the device more user-friendly and suitable for modern smartphones and gadgets.

VII. CONCLUSION

The solar power bank with wireless charging is a useful and innovative project that uses solar energy to charge electronic devices. The main aim of this project is to convert sunlight into electrical energy using a solar panel and store that energy in a lithium-ion battery. This stored energy can later be used to charge mobile phones and other small electronic devices. The system also includes important components such as a charge controller, voltage booster IC module, charging circuitry, wireless charging coil, and PCB board which help the system work properly. In this project, the solar

panel generates electrical energy when sunlight falls on it. This energy is then sent to the charge controller, which controls the voltage and current and protects the battery from overcharging and over-discharging. The lithium battery stores the electrical energy so that it can be used when sunlight is not available. The voltage booster IC module increases the battery voltage to around 5V, which is suitable for charging mobile devices. The wireless charging coil allows the device to transfer energy without using cables by using the principle of electromagnetic induction. Overall, the solar power bank with wireless charging is an eco-friendly and portable charging solution. It reduces the use of conventional electricity and promotes the use of renewable solar energy. The device can be very helpful during travel, outdoor activities, and emergency situations where electricity is not available. This project also helps students understand the practical use of solar energy systems, battery storage, and wireless charging technology, making it a valuable learning project in engineering and technology.

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