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Solar Power Bank and Wireless Mobile Charging with Dual AC Output

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ABSTRACT

The primary objective of this study is the development of a foldable solar power bank incorporating an inverter system capable of generating a 230V AC supply. Furthermore, the system will include wireless power transfer for charging mobile phones. Efficiency will be a key consideration, aiming for a design with a reduced component count. The underlying principle for mobile charging in this design is wireless power transfer, a technique that employs electromagnetic fields to convey energy through electromagnetic induction. Recognizing the utility of power banks and their reliance on mains power, which can be limiting in mobile scenarios, this paper presents the design of an intelligent solar-powered power bank with AC output. This dual-charging system will enable users to power their mobile devices through either wireless induction or a conventional AC adapter.

KEYWORDS: *Wireless Charging Module, Buck Converter, Solar Panel, Inverter*

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1. INTRODUCTION

Wireless charging is a rapidly growing technology, also known as wireless power transfer, that allows devices to be charged without physical connections. Integrating solar charging with a high-capacity battery and wireless charging, this solar power bank offers a unique solution for portable power. The device can recharge itself during daylight hours, ensuring continuous power availability for users. This cable-free charging method, also referred to as inductive charging, reduces wear on device ports. Solar energy, encompassing light and heat from the sun, can be harnessed through various technologies like solar heating, thermal energy, architecture, and photosynthesis. As a significant renewable energy source, solar technologies are broadly classified as passive (e.g., building orientation, material selection for thermal mass, natural ventilation) and active (e.g., photovoltaics, concentrated solar power, solar water heating), depending on their method of capturing and distributing solar energy. These classifications—passive and active—also apply to how solar technology captures, converts, and distributes sunlight for energy harnessing at different scales. While "solar energy" typically refers to the direct use of solar radiation, most renewable energy sources, excluding geothermal and tidal, ultimately derive their energy from the sun, either directly or indirectly. Solar power involves converting sunlight into electricity, either directly using photovoltaics (which employ the photoelectric effect to generate electric current) or indirectly through concentrated solar power.

Solar inverters can be categorized into three main types, each designed for specific applications. **Stand-alone inverters** are used in off-grid systems. They convert DC power from batteries, typically charged by solar panels. Many of these inverters also include built-in chargers to replenish the batteries from an AC source when available. Importantly, they do not connect to the public electricity grid and therefore do not require anti-islanding protection. **Grid-tie**

inverters, on the other hand, synchronize their output with the phase of the utility-supplied AC waveform. For safety, these inverters are engineered to automatically shut down if the grid power fails and do not provide backup power during outages. Finally, **battery backup inverters** are specialized units that draw power from batteries, manage battery charging through an integrated charger, and can feed surplus energy back into the grid. These inverters are designed to supply AC power to designated loads during a power outage and are equipped with anti-islanding protection.

2. HARDWARE DESCRIPTION:

The hardware part used in this solar power bank are mentioned below.

A. Solar Panel:

Fig.1: Solar Panel

A solar panel consists of multiple interconnected solar photovoltaic modules. Individually, a photovoltaic module is a packaged unit comprising several solar cells. Solar panels serve as components within larger photovoltaic (PV) systems, enabling electricity generation and supply for both commercial and residential use. Each module has a DC power rating determined under standard test conditions, typically ranging from 10 to 320 watts. The efficiency of a module directly influences its required surface area. Given that a single solar module produces a limited amount of power, most installations incorporate multiple modules arranged in panels or arrays. A typical PV system includes these solar panels or arrays, an inverter to convert DC to AC power, and may also include batteries for energy storage, solar trackers to optimize sunlight capture, and the necessary wiring for interconnection.

B. DC DC Buck Converter LM2596 :

Fig 2 : DC-DC Buck Converter

The LM2596 power supply module is a step-down switching regulator designed to efficiently drive loads up to 3 Amps while maintaining excellent line and load regulation. This series offers fixed output voltages of 3.3V, 5V, and 12V, as well as an adjustable output option. Operating at a switching frequency of 150kHz, the LM2596 series allows for the use of smaller filter components compared to regulators with lower switching frequencies. This particular LM2596 DC-DC buck converter module incorporates a high-precision potentiometer and can deliver up to 3A with high efficiency. For output currents exceeding 2.5A, the device features internal compensation, minimizing the need for external components and simplifying power supply design.

C. Wireless Charging Module :

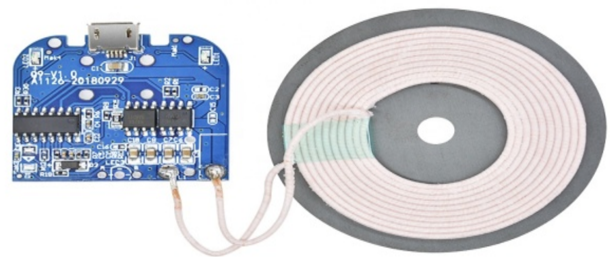

Fig 3: Wireless Charging Module

This portable digital wireless charging module operates on a 5V DC input, which can be supplied via its Micro USB port. Users can power the module using a standard smartphone charger or a PC USB port. The circuit includes LED indicators to display its operational status. A green LED illuminates to indicate that the module is receiving power. Additionally, a blue LED shows when a phone is detected and during the charging process.

D. Wireless Power Tx/Rx Module :

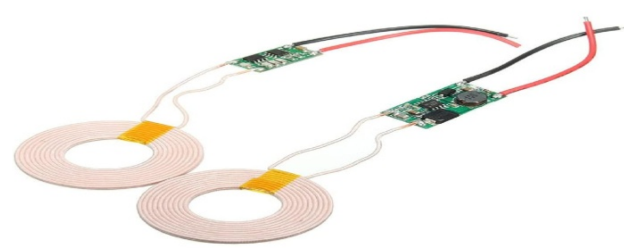

Fig 4: Wireless Power Tx/Rx Module

This Wireless Power Transfer and Charging Module facilitates short-range wireless power delivery and charging for various common electronic devices. Comprising a transmitter, receiver, and associated coils, it can function as a stable 5V wireless power supply with a maximum output current of 600mA, potentially replacing traditional wired power connections. Its compact dimensions and insulated coil design make it well-suited for integration into wireless projects. The module operates by utilizing an electromagnetic field to transfer electrical energy between its transmitter and receiver circuits. A transmitting coil, powered by a 12V input, generates an alternating electromagnetic field. A receiving coil then harvests energy from this field and converts it back into an electrical current, providing a 5V output at up to 600mA to the receiver circuit.

E. Battery Level Indicator :

Fig 5: Battery Level Indicator

This battery capacity indicator module provides a clear and visually appealing display of battery charge levels. It boasts a wide range of compatibility, including nickel-metal hydride batteries, 18650 and polymer lithium battery packs, lead-acid batteries, electric vehicle batteries, and various other electrical equipment. A key feature of this display is its reverse polarity protection, preventing damage even if the positive and negative connections are accidentally reversed. To operate the display, simply connect its positive and negative terminals to the corresponding terminals of the battery being tested. The digital display will then show the battery's real-time power level.

3. BLOCK DIGRAMOF BLACK BOX:

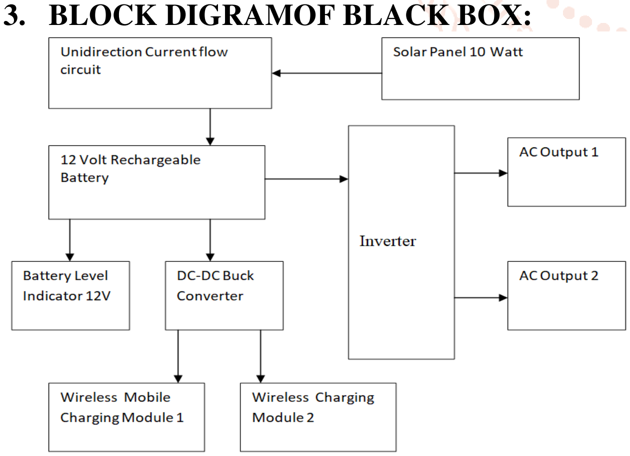

Fig 6: Block Diagram

Working :

Solar panels generate electricity by converting solar energy through the photoelectric effect, which involves the emission of electrons when light strikes the panel's surface. These panels are constructed from silicon cells, with silicon having an atomic number of 14. When light photons hit a silicon cell, they energize the outermost two electrons of the silicon atoms, causing them to move and initiate an electric current. Silicon solar cells come in two main structural types: monocrystalline and polycrystalline. Monocrystalline panels are made from a single, large silicon ingot that is sliced into wafers. Polycrystalline cells, also made of silicon, are produced by melting and fusing multiple silicon crystals together. While monocrystalline cells exhibit higher efficiency, they are generally more expensive than their polycrystalline counterparts. The electrical energy produced by the solar panels is then stored in a lead-acid battery, which subsequently powers the wireless charging module and the inverter circuit.

Wireless Battery Charger Circuit Principle:

The fundamental operating principle of this circuit is mutual inductance. Wireless power transfer from the transmitter to the receiver is achieved through "inductive coupling." Inductance itself is a property of a conductor where the flow of current generates a voltage or electromotive force within the conductor or in a nearby one. There are two types of inductance: self-inductance and mutual inductance. "Mutual inductance" is the phenomenon where a voltage is induced in a conductor when it is placed near another current-carrying conductor. This occurs because the current in the first conductor creates a magnetic flux, which then links with the second conductor, inducing a voltage within it. Consequently, the two conductors are considered inductively coupled, enabling power transfer between them.

4. RESULT:

The outcome of this work is a functional prototype of a solar-powered power bank and inverter system featuring dual AC outputs. The developed system successfully operates as intended, effectively charging mobile phones both wirelessly and through the inverter's AC outlets

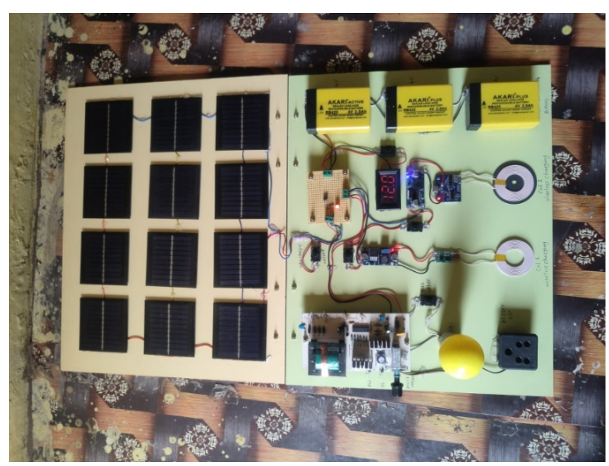

Fig 7: Final Project Model

5. CONCLUSION:

In conclusion, this project has successfully resulted in the development of a functional solar power bank with an integrated inverter. The system operates by charging its battery using solar panel input, and subsequently supplying power to a buck converter, a wireless charging module, and an inverter circuit. The inverter effectively converts the 12V DC from the battery to 230V AC, demonstrated by powering a 5-watt bulb as a load. The increasing adoption of wireless charging technology is progressively reducing reliance on wired connections, offering a more convenient and user-friendly charging method. This technique also minimizes wear on device hardware ports and significantly enhances portability for users. The appeal of wireless charging is evident in its integration into numerous mobile devices, including the iPhone 7 (Apple), Galaxy S5 (Samsung), Lumia 930 (Microsoft), and Xperia Z3 (Sony), all of which utilize the principle of inductive charging.

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