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EFFICIENT WIRELESS CHARGING INDUCTIVE POWER TRANSFER BY SOLAR ENERGY MOBILE DEVICES

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Abstract- This study presents a novel method for wireless charging of mobile devices, leveraging solar energy as a power source. The system integrates inductive power transfer technology to enhance efficiency by converting radio frequency signals into direct current effectively. This approach enables concurrent charging and energy harvesting, thereby maximizing power utilization. By incorporating solar energy, the system reduces dependence on conventional power outlets, promoting sustainability in device charging practices. This innovative solution represents a significant advancement in wireless charging technology, promising increased convenience and environmental friendliness for mobile device users. In summary, the proposed system offers a dual functionality of wireless charging and solar energy harvesting for mobile devices. By utilizing inductive power transfer technology, it optimizes the conversion of radio frequency signals to direct current, ensuring efficient energy utilization. This integration of solar energy not only facilitates sustainable charging but also reduces reliance on grid-based electricity, contributing to environmental preservation. Consequently, the proposed solution presents a compelling advancement in wireless charging technology, promoting convenience and eco-friendliness in powering mobile devices.

1. OBJECTIVE

- The objective of this study is to develop an efficient wireless charging system for mobile devices powered by solar energy.
- This is achieved through the integration of a dual-band inverse Doherty rectifier, enabling efficient conversion of radio frequency signals into direct current for charging.
- By leveraging solar energy, the system aims to reduce reliance on conventional power sources and promote sustainability.
- The overarching goal is to enhance convenience for users while minimizing environmental impact through innovative wireless charging technology.

2. INTRODUCTION

2.1 Wireless Power Transfer

Wireless power transfer (WPT), wireless energy transmission, or electromagnetic power transfer is the transmission of electrical energy from a power source to an electrical load, such as an electrical power grid or a consuming device, without the use of discrete human-made conductors. Wireless power is a generic term that refers to a number of different power transmission technologies that use time-varying electric, magnetic, or electromagnetic fields. In wireless power transfer, a wireless transmitter connected to a power source conveys the field energy across an intervening space to one or more receivers, where it is converted back to an electrical current and then used.

Wireless transmission is useful to power electrical devices in cases where interconnecting wires are inconvenient, hazardous, or are not possible. Wireless power techniques mainly fall into two categories, non-radiative and radiative. In near field or non- radiative techniques, power is transferred by magnetic fields using inductive coupling between coils of wire, or by electric fields using capacitive coupling between metal electrodes. Inductive coupling is the most widely used wireless technology; its applications include electric toothbrush chargers, RFID tags, smartcards, and chargers for implantable medical devices like artificial cardiac pacemakers, and inductive powering or charging of electric vehicles like trains or buses.

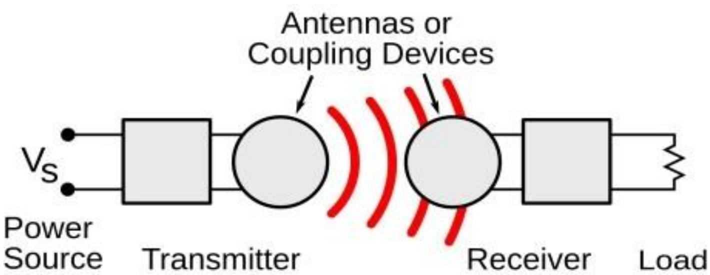

Fig. 2.1 Block Diagram of a Wireless Power System

A current focus is to develop wireless systems to charge mobile and handheld computing devices such as cellphones, digital music players and portable computers without being tethered to a wall plug. In far-field or radiative techniques, also called power beaming, power is transferred by beams of electromagnetic radiation, like microwaves or laser beams. These techniques can transport energy longer distances but must be aimed at the receiver. Proposed applications for this type are solar power satellites, and wireless powered drone aircraft.
"Wireless power transfer" is a collective tool that refers to a number of different technologies for transmitting energy by means of electromagnetic fields. The technologies, listed in the table below, differ in the distance over which they can transfer power efficiently, whether the transmitter must be aimed at the receiver, and in the type of electromagnetic energy they use: time varying electric fields, magnetic fields, radio waves, micro waves or infrared or light waves.

2.2 Inductive Coupling

In inductive coupling (electromagnetic induction or inductive power transfer, IPT), power is transferred between coils of wire by a magnetic field. The transmitter and receiver coils together form a transformer. An alternating current (AC) through the transmitter coil (L1) creates an oscillating magnetic field (B) by Ampere's law. The magnetic field passes through the receiving coil (L2), where it induces an alternating EMF (voltage) by Faraday's law of induction, which creates an AC current in the receiver.

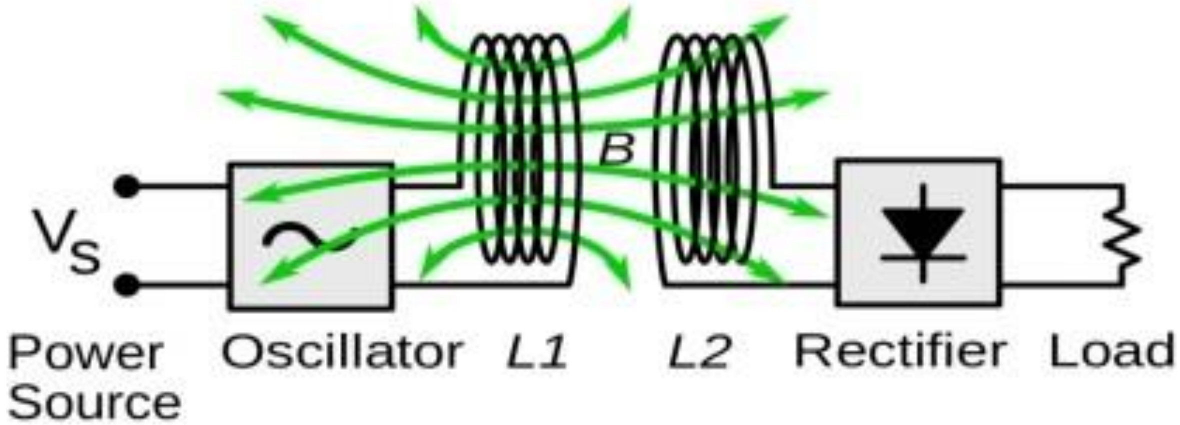

Fig. 2.2 Inductive Wireless Power System

2.2.1 Resonant Inductive Coupling

Resonant inductive coupling (electrodynamics coupling strongly coupled magnetic resonance) is a form of inductive coupling in which power is transferred by magnetic fields (B, green) between two resonant circuits (tuned circuits), one in the transmitter and one in the receiver (see diagram, right). Each resonant circuit consists of a coil of wire connected to a capacitor, or a self-resonant coil or other resonator with internal capacitance. The two are tuned to resonate at the same resonant frequency. The resonance between the coils can greatly increase coupling and power transfer, analogously to the way a vibrating tuning fork can induce sympathetic vibration in a distant fork tuned to the same pitch.
The induced alternating current may either drive the load directly, or be rectified to direct current (DC) by a rectifier in the receiver, which drives the load. A few systems, such as electric toothbrush charging stands, work at 50/60 Hz so AC mains current is applied directly to the transmitter coil, but in most systems an electronic oscillator generates a higher frequency AC current which drives the coil, because transmission efficiency improves with frequency.
In capacitive coupling (electrostatic induction), the conjugate of inductive coupling, energy is transmitted by electric fields between electrodes such as metal plates. The transmitter and receiver electrodes form a capacitor, with the intervening space as the dielectric. An alternating voltage generated by the transmitter is applied to the transmitting plate, and the oscillating electric field induces an alternating potential on the receiver plate by electrostatic induction, which causes an alternating current to flow in the load circuit. The amount of power transferred increases with the frequency the square of the voltage, and the capacitance between the plates, which are proportional to the area of the smaller plate and (for short distances) inversely proportional to the separation.

2.2.2 Magneto Dynamic Coupling

In this method, power is transmitted between two rotating armatures, one in the transmitter and one in the receiver, which rotate synchronously, coupled together by a magnetic field generated by permanent magnets on the armatures. The transmitter armature is turned either by or as the rotor of an electric motor, and its magnetic field exerts torque on the receiver armature, turning it. The magnetic field acts like a mechanical coupling between the armatures.

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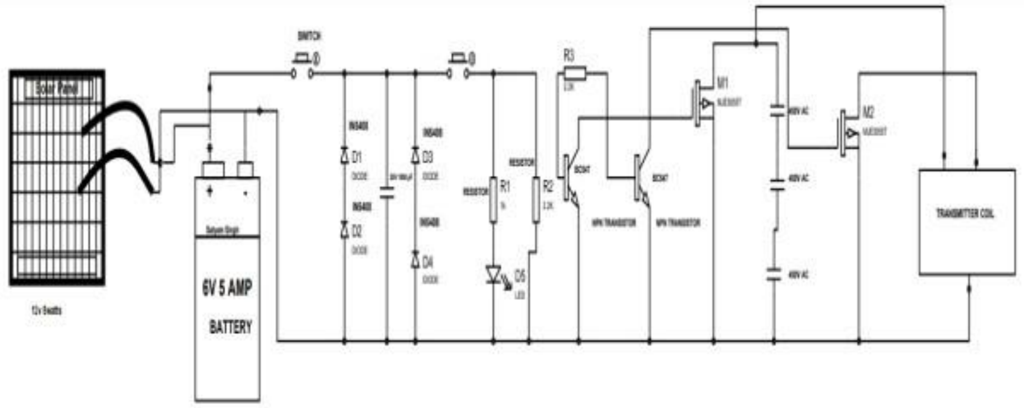
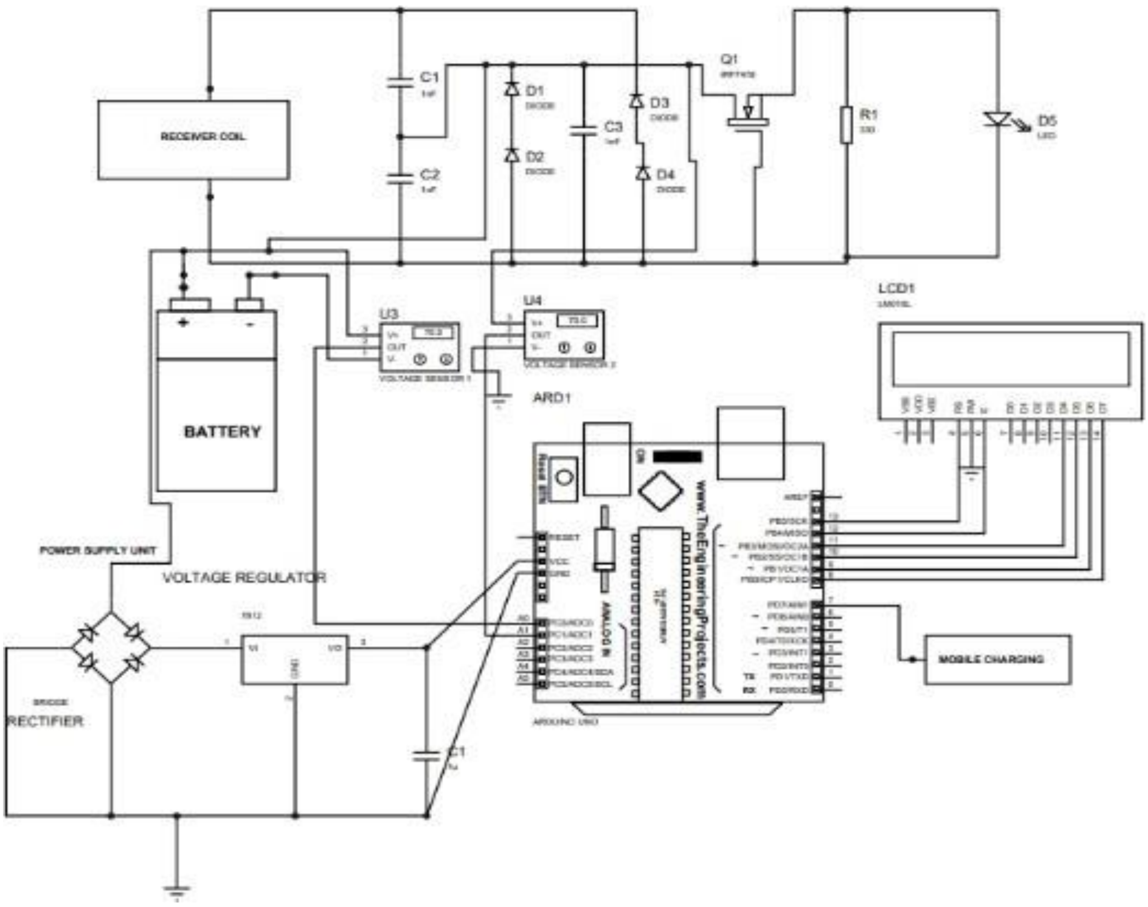


Fig. 2.3 Circuit Diagram Transmitter Side

3. EXPLANATION

The solar panel is the primary power source for the transmitter. It converts sunlight into electrical energy. The battery is used to store the energy generated by the solar panel. This helps ensure a continuous power supply even when sunlight is not available. The diode bridge rectifier is used to convert the alternating current (AC) produced by the solar panel and battery into direct current (DC). This ensures a consistent and unidirectional flow of electrical energy. The capacitor is often used to smooth out voltage fluctuations and provide a stable DC output. It helps store and release electrical energy as needed, contributing to a more constant power supply. BC547 transistors are commonly used as amplifiers or switches in electronic circuits. In this context, they may be part of the control circuitry for managing the power transfer process. The exact role of these transistors depends on the specific circuit design. Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFETs) are used as switches in electronic circuits. They can control the flow of electrical current between the transmitter coil and the power source. The MOSFETs might be used to modulate the power transfer or control the on/off states of the transmitter coil. This coil is a crucial part of the wireless power transfer system. When an alternating current flows through it, it generates a magnetic field. This magnetic field, in turn, induces a voltage in the receiver coil located in the electric vehicle.

3.1 Receiver Side



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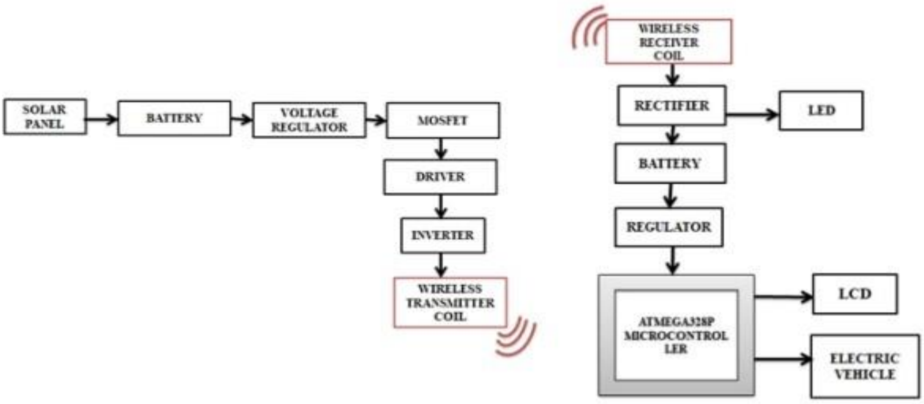

Fig. 3.1 Solar Panel Receiver Side

This receiver coil is the counterpart to the transmitter coil. Placed in the mobile charging, it captures the magnetic field generated by the transmitter coil and converts it back into an alternating current. A diode is often used in the receiver section to rectify the alternating current induced in the receiver coil. This rectification process converts AC to DC, making it suitable for charging the battery and powering the vehicle. A capacitor may be used in the receiver section to stabilize and smooth the DC output. This helps in maintaining a consistent voltage for charging the battery. Voltage sensors are employed to monitor the voltage levels in the system. A battery voltage sensor is likely used to measure the state of charge of the electric vehicle's battery. The bridge rectifier is also mentioned, which may play a role in rectifying any additional AC signals. The Arduino Uno serves as the microcontroller for the receiver section. It is likely responsible for processing signals from the voltage sensors, controlling the charging process, and managing the overall operation of the wireless power transfer system. The power generated and regulated by the receiver section, after rectification and stabilization, is used to charge on the mobile. This power is likely directed to the vehicle's battery or other power management systems.

4. BLOCK DIAGRAM

4.1 Peripheral Features

Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode – One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode – Real Time Counter with Separate Oscillator – Six PWM Channels – 8-channel 10-bit ADC in TQFP and QFN/MLF package.

4.2 Temperature Measurement

6-channel 10-bit ADC in PDIP Package Temperature Measurement – Programmable Serial USART – Master/Slave SPI Serial Interface – Byte- oriented 2-wire Serial Interface (Philips I2 C compatible) – Programmable Watchdog Timer with Separate On-chip Oscillator – On-chip Analog Comparator – Interrupt and Wake-up on Pin Change.

4.3 Special Microcontroller Features

Power-on Reset and Programmable Brown-out Detection – Internal Calibrated Oscillator – External and Internal Interrupt Sources – Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby.

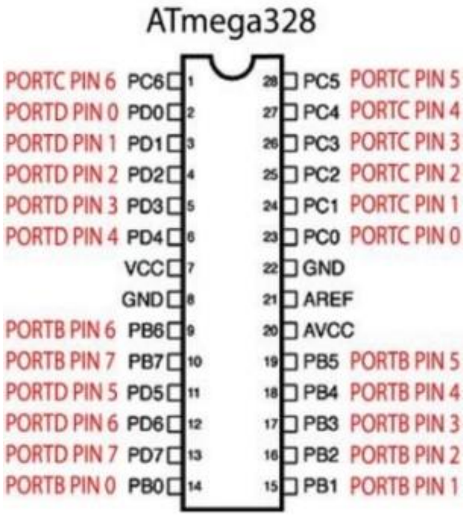

Fig. 4.1 Pin Diagram

4.4 I/O and Packages

23 Programmable I/O Lines – 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF • Operating Voltage: – 1.8 - 5.5V for ATmega48PA/88PA/168PA/328P • Temperature Range: – -40°C to 85°C • Speed Grade: – 0 - 20 MHz @ 1.8 - 5.5V. Low Power Consumption at 1 MHz, 1.8V, 25°C for ATmega48PA/88PA/168PA/328P: Active Mode: 0.2 mA – Power-down Mode: 0.1 µA – Power-save Mode: 0.75 µA (Including 32 kHz RTC).

Table-4.1 Liquid Crystal Display

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	VEE
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight VCC (5V)	Led+
16	Backlight Ground (0V)	Led-

CONCLUSION

In conclusion, the advent of an efficient wireless charging system driven by solar energy and employing inductive power transfer represents a significant step forward in sustainable technology solutions. This innovative approach harnesses renewable energy sources like solar power, providing a viable alternative to conventional charging methods that rely heavily on fossil fuels. By leveraging these clean energy sources, the system helps to mitigate environmental impact, reducing carbon emissions and lessening dependence on non- renewable resources. Moreover, the utilization of inductive power transfer enhances efficiency, ensuring that energy is utilized effectively and contributing to a more sustainable energy ecosystem. The successful deployment of this technology not only improves the convenience and accessibility of charging for mobile devices but also aligns with global initiatives aimed at fostering a greener and more sustainable future. As society grapples with the challenges of climate change and environmental degradation, solutions like this offer tangible pathways towards reducing our carbon footprint and transitioning to cleaner energy alternatives. By embracing innovations that merge convenience with environmental responsibility, we can pave the way for a more sustainable tomorrow, where technology serves as a catalyst for positive change.

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