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Design and Implementation of Solar Power Wireless Battery Charger

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Declaration

We hereby declare that this thesis is based on the results found by ourselves. Materials of work found by other researcher are mentioned by reference. This thesis, neither in whole nor in part, has been previously submitted for any degree.

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Abstract

In the pursuit of sustainable energy solutions, this project focuses on the design and implementation of a solar-powered wireless battery charger. The increasing reliance on portable electronic devices necessitates efficient and environmentally friendly charging technologies. This project integrates solar energy harvesting with wireless charging technology to create a self-sustaining, portable, and efficient charging solution.

The system utilizes photovoltaic (PV) panels to convert solar energy into electrical energy, which is then stored in a battery. A wireless power transfer (WPT) system is employed to charge devices without the need for physical connectors. The design process involves optimizing the PV system for maximum energy capture, ensuring efficient power management, and implementing a resonant inductive coupling for effective wireless energy transfer. Testing and analysis are conducted to evaluate the system's efficiency, charging speed, and reliability under various environmental conditions. The results demonstrate the feasibility of a solar-powered wireless charging system, offering a promising solution for remote and off-grid applications, as well as reducing dependency on traditional power sources.

This project contributes to the growing field of renewable energy technologies, providing insights into the potential of integrating solar energy with wireless charging to support sustainable development goals.

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1 INTRODUCTION

1.1 Introduction

The rapid advancement of portable electronic devices has led to an increased demand for convenient and sustainable charging solutions. Traditional charging methods, which often rely on wired connections and grid-based electricity, present limitations in terms of mobility and environmental impact. This project explores the innovative integration of solar energy with wireless charging technology to develop a solar-powered wireless battery charger. By harnessing the abundant and renewable energy of the sun, this system offers an eco-friendly alternative to conventional charging methods. The project focuses on designing an efficient photovoltaic (PV) system to capture solar energy, which is then converted into electrical power and stored in a battery. This stored energy is subsequently used to wirelessly charge electronic devices through a resonant inductive coupling method. The design and implementation of this system aim to provide a reliable, portable, and sustainable charging solution, particularly beneficial for remote or off-grid locations. This introduction sets the stage for a comprehensive exploration of how solar power and wireless charging can be effectively combined to create a self-sustaining energy system.

1.2 Objective

The primary objectives of Design and Implementation of Solar Power Wireless Battery Charger & the project aims to achieve the following key goals:

- Design and develop a solar-powered charging system capable of capturing and storing solar energy efficiently.
- Implement a wireless power transfer mechanism using resonant inductive coupling to enable contactless charging of electronic devices.
- Optimize the photovoltaic (PV) system to maximize energy conversion efficiency under various environmental conditions.
- Integrate power management circuits to ensure stable and consistent energy supply from the solar panel to the wireless charger.
- Evaluate the system's performance in terms of charging efficiency, speed, and reliability through experimental testing.

- Ensure portability and ease of use by designing a compact and user-friendly system suitable for remote and off-grid applications.
- Analyze the environmental impact and sustainability benefits of the system compared to conventional charging methods.
- Document and present the design, implementation process, and findings to contribute to the field of renewable energy technologies.

1.3 Problem Statement

The widespread use of portable electronic devices, such as smartphones and tablets, has led to an increased demand for accessible and efficient charging solutions. Traditional charging methods, which rely heavily on wired connections and grid electricity, pose significant limitations, particularly in remote or off-grid areas where access to electrical power is scarce. Additionally, the reliance on non-renewable energy sources for charging contributes to environmental degradation and increased carbon emissions.

1. Increasing reliance on portable electronic devices demands efficient and convenient charging solutions that traditional wired methods fail to provide.
2. Conventional charging methods often depend on grid-based electricity, contributing to environmental degradation and carbon emissions.
3. Limited accessibility to charging infrastructure in remote or off-grid areas restricts the usability of portable devices.
4. Physical connectors in wired charging are prone to wear and tear, reducing the lifespan of charging ports and cables.
5. Energy inefficiency in traditional charging methods leads to unnecessary power consumption, exacerbating the global energy crisis.
6. Environmental factors such as sunlight variability can affect the efficiency of solar power systems, making it challenging to maintain a consistent energy supply.
7. Current wireless charging technologies are limited in range and efficiency, necessitating advancements to improve performance and practicality.
8. The need for a sustainable and portable solution that integrates renewable energy with advanced wireless technology to address these challenges effectively.

This project aims to address these challenges by designing and implementing a solar-powered wireless battery charger. The core problem lies in the need for a sustainable, portable, and efficient charging system that can operate independently of the electrical grid. The project will focus on developing a system that not only harnesses renewable solar energy but also provides the convenience of wireless charging, thus eliminating the need for physical connectors and promoting eco-friendly practices. The solution must ensure reliable energy capture, storage, and transfer, while being adaptable to various environmental conditions and user needs.

1.4 Background

The rapid evolution of technology has led to an unprecedented increase in the use of portable electronic devices such as smartphones, tablets, and wearable gadgets. As these devices become integral to daily life, the demand for efficient and reliable charging methods has intensified. Traditional wired charging methods, while widely used, present several limitations, including dependence on grid electricity, the inconvenience of cables, and the susceptibility of charging ports to physical damage. In parallel, the growing global emphasis on sustainability and reducing carbon footprints has sparked interest in renewable energy sources, particularly solar power. Solar energy is abundant, renewable, and environmentally friendly, making it an attractive alternative to fossil fuel-based electricity. Over the past few decades, significant advancements have been made in photovoltaic (PV) technology, enhancing the efficiency and affordability of solar panels.

Wireless charging, on the other hand, has emerged as a promising technology that eliminates the need for physical connectors. Based on principles such as resonant inductive coupling, wireless power transfer (WPT) allows energy to be transmitted over short distances without direct contact, providing convenience and reducing wear and tear on devices. The integration of solar power with wireless charging represents an innovative approach to addressing the limitations of conventional charging methods. By combining these two technologies, it is possible to create a self-sustaining, portable, and efficient charging system that can be particularly beneficial in remote or off-grid locations where access to traditional power sources is limited.

This project aims to explore this integration by designing and implementing a solar-powered wireless battery charger. The system will harness solar energy to charge a battery, which in turn will power a wireless charging unit. This approach not only promotes the use of clean energy but also enhances the convenience and lifespan of portable electronic devices.

1.5 Literature Review

The integration of solar power and wireless charging technology has garnered significant attention in recent years, driven by the growing need for sustainable and efficient energy solutions. Research on photovoltaic (PV) systems has demonstrated substantial improvements in the efficiency and affordability of solar panels, making solar energy a viable alternative to conventional power sources [Kalogirou, 2014]. These advancements have paved the way for innovative applications, including the development of solar-powered devices and systems. [1]

Wireless power transfer (WPT) technology, particularly through resonant inductive coupling, has also seen considerable progress. Pioneering work by Tesla in the early 20th century laid the foundation for modern WPT systems, which are now capable of transmitting power over short distances with high efficiency [Sample et al., 2011]. The widespread adoption of wireless charging for consumer electronics, such as smartphones and electric vehicles, underscores the practicality and growing acceptance of this technology [Lu et al., 2016].

Recent studies have explored the combination of solar energy and WPT to create self-sustaining charging systems. For instance, Guo et al. (2018) proposed a hybrid solar-wind wireless charging station, highlighting the potential of renewable energy sources in powering wireless charging systems. Similarly, Mahmud et al. (2018) discussed the design of a solar-powered wireless charging system for low-power electronic devices, emphasizing the importance of optimizing both energy harvesting and power transfer efficiency.

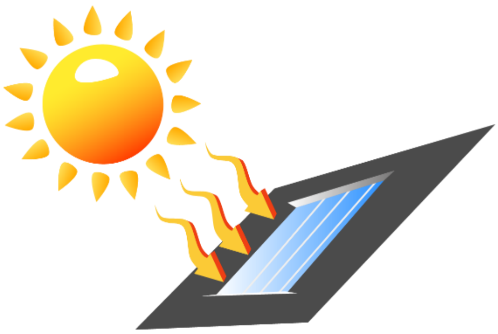
The literature also addresses challenges associated with these technologies, such as energy conversion losses in PV systems and limitations in the range and efficiency of wireless charging. Researchers have investigated various methods to overcome these challenges, including the use of maximum power point tracking (MPPT) algorithms to enhance the efficiency of solar energy conversion [Esram & Chapman, 2007] and the development of advanced materials and circuit designs to improve WPT performance [Zhang & Liu, 2017].

Despite the progress made, there remains a gap in fully integrating these technologies into a portable, efficient, and scalable solution for off-grid applications. This project aims to bridge this gap by designing and implementing a solar-powered wireless battery charger, building on the existing body of research and addressing the limitations identified in previous studies. The proposed system will focus on maximizing energy capture from solar panels, optimizing power management, and ensuring effective wireless energy transfer, contributing to the broader field of renewable energy and wireless technology.

2 THEORY

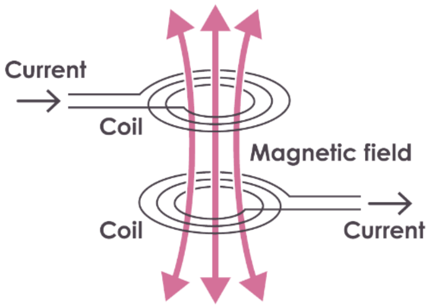
2.1 Theory

The design and implementation of a solar power wireless battery charger is rooted in the principles of photovoltaic energy conversion and wireless power transfer. The photovoltaic (PV) cells, which form the basis of solar panels, convert sunlight directly into electrical energy through the photovoltaic effect. This effect occurs when photons from sunlight strike the semiconductor material of the PV cells, causing electrons to be knocked loose and creating a flow of electricity. The generated DC power is then harnessed and regulated for the purpose of charging batteries. [2] Wireless power transfer, on the other hand, is based on electromagnetic induction, where an alternating current (AC) in a primary coil generates a magnetic field that induces a current in a secondary coil, thereby enabling wireless charging. The integration of solar power with wireless charging technology offers a sustainable and convenient solution for battery-powered devices, eliminating the need for wired connections and contributing to the advancement of green energy technologies. This project seeks to explore the feasibility, efficiency, and practicality of such a system, aiming to provide a reliable and eco-friendly alternative to conventional battery charging methods.



Solar Power Generation: Solar power generation involves converting sunlight into electricity using photovoltaic (PV) cells. PV cells are made of semiconductor materials, typically silicon, which absorb sunlight and release electrons, creating an electric current. This process, known as the photovoltaic effect, forms the foundation for solar energy systems. The efficiency of solar power generation depends on various factors, including the quality of the PV cells, the intensity of sunlight, and the angle of incidence.

Wireless Power Transfer: Wireless power transfer (WPT) technology allows the transmission of electrical energy from a power source to a load without physical connectors. The most common method used for WPT is electromagnetic induction, where an alternating current (AC) in a primary coil generates a magnetic field that induces a voltage in a secondary coil.



This induced voltage can then be used to power a device or charge a battery. Resonant inductive coupling, a variation of this method, enhances efficiency over short to medium distances by using resonant circuits at both the transmitter and receiver ends.

Battery Charging Principles: Battery charging involves replenishing the stored energy in a rechargeable battery by applying an electrical current. For efficient and safe charging, it is crucial to control the current and voltage levels, typically managed by a charge controller. Different types of batteries, such as Lithium-ion (Li-ion) and Nickel-Metal Hydride (NiMH), have specific charging characteristics and requirements. Overcharging or charging at inappropriate voltage levels can damage the battery or reduce its lifespan.

Integration of Solar Power and Wireless Charging: The integration of solar power generation and wireless power transfer in a battery charger system presents a unique challenge. The variability of solar energy output due to changing weather conditions and the efficiency loss during wireless transmission must be addressed to ensure reliable battery charging. A combination of power management techniques, such as Maximum Power Point Tracking (MPPT) for solar panels and resonant frequency tuning for the wireless charger, is essential to optimize the overall system performance.

System Design Considerations: Designing a solar-powered wireless battery charger requires careful consideration of several factors, including the selection of appropriate solar panels, the design of an efficient wireless power transfer system, and the implementation of a robust battery management system. Additionally, environmental conditions, such as temperature and shading, must be accounted for in the system design to ensure reliable operation. The goal is to create a system that can efficiently harvest solar energy and wirelessly charge batteries with minimal energy loss.

2.2 Methodology

The design and implementation of the solar power wireless battery charger involve several key phases. Initially, the system design begins with the selection of appropriate components. The solar panel is chosen based on its efficiency and power output, with careful consideration given to different types such as monocrystalline, polycrystalline, and thin-film panels. [3] The goal is to find a balance between efficiency, cost, and practical size constraints. Concurrently, the wireless power transfer system is designed, focusing on the method of energy transfer—typically inductive or resonant inductive coupling. This includes designing the transmitter and receiver coils for optimal alignment and resonance, and selecting suitable frequencies and power levels for efficient charging.

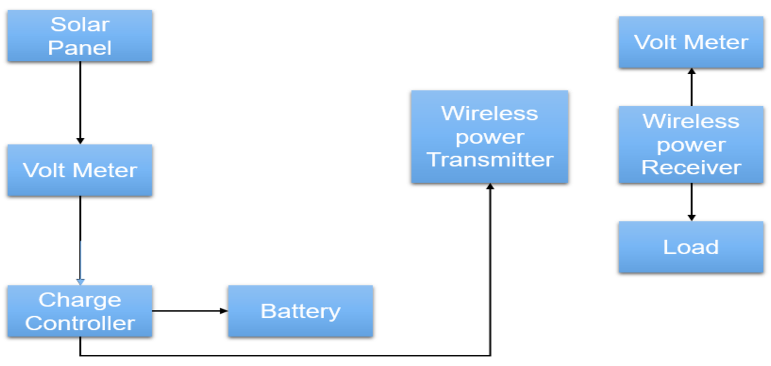


Figure 2.1 Block Diagram of the System

The next step involves choosing a compatible battery, where various chemistries like Lithium-ion and Nickel-Metal Hydride are evaluated. The selected battery must align with the solar panel's output and the wireless charger's specifications in terms of voltage and capacity. Following component selection, the circuit design phase involves developing electronic circuits to integrate the solar panel, wireless charger, and battery management system. This includes implementing a Maximum Power Point Tracking (MPPT) circuit to maximize solar power extraction and a charge controller to manage battery charging safely.

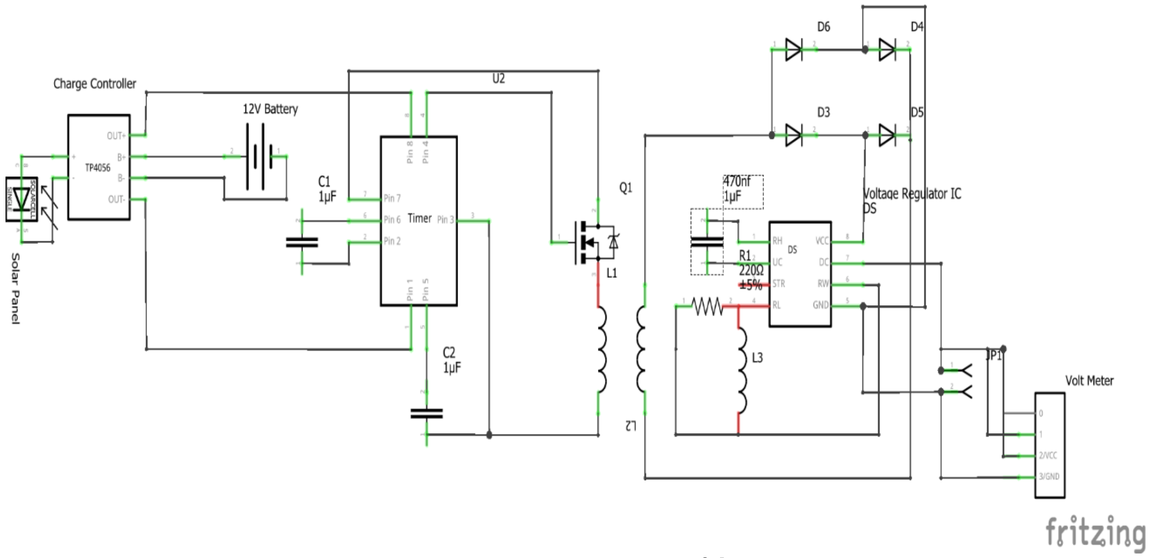


Figure 2.2 Circuit Diagram of the System

Once the circuit design is complete, a functional prototype is assembled. This includes integrating the solar panel, wireless charger, and battery into a cohesive system while ensuring mechanical stability and proper alignment of components. Safety features and enclosures are also added to protect and support the system. The prototype is then subjected to rigorous testing under various conditions to assess performance.

2.3 Required Component

To build our proposed project we need the following components:

- Volt meter
- 12V battery
- Mosfet
- Charge Controller
- Capacitor
- Solar Panel
- Diode
- 20 AWG wire coil
- Voltage regulator IC

2.3.1 Volt Meter

A voltmeter is an essential electrical instrument used to measure the potential difference, or voltage, between two points in an electrical circuit. It operates by connecting its two terminals across the component or section of the circuit where the voltage is to be measured. The voltmeter is designed to have a high internal resistance to ensure that it does not significantly alter the current flowing through the circuit, thereby providing accurate measurements without affecting the circuit's operation. Digital voltmeters (DVMs) display the measured voltage in numerical form on an LCD or LED screen, offering precise readings and ease of use. Analog voltmeters, on the other hand, use a needle and scale to indicate voltage levels, providing a visual representation of changes in voltage. The choice between digital and analog voltmeters often depends on the required accuracy, ease of reading, and the specific needs of the measurement task. Overall, a voltmeter is a crucial tool for diagnosing electrical problems, calibrating circuits, and ensuring that electrical systems operate within their designated voltage ranges. [4]

Figure. 2.4. Volt Meter.

2.3.2 12V DC Battery

A 12V DC battery is a common type of battery used in various applications, ranging from automotive systems to renewable energy storage. This battery provides a nominal voltage of 12 volts in direct current (DC), making it suitable for powering a wide array of electronic devices and systems that require a stable and reliable power source. The 12V DC battery typically consists of multiple cells connected in series, each generating approximately 2 volts. In automotive contexts, lead-acid batteries are commonly used due to their robustness and ability to provide high current for starting engines and powering accessories. In renewable energy systems, such as solar power setups, 12V DC batteries are often used to store energy collected from solar panels, ensuring a steady power supply even when sunlight is unavailable. These batteries are valued for their portability, relatively low cost, and versatility, though they require proper maintenance and charging to ensure longevity and optimal performance. Their applications include powering household electronics, backup power systems, and various portable devices.

Figure. 2.5. 12V battery.

2.3.3 Mosfet

A MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor) is a type of transistor widely used in electronic circuits for switching and amplification. It is characterized by its gate, drain, and source terminals. The MOSFET operates by controlling the flow of electrical current between the drain and source terminals through the application of a voltage to the gate terminal.

In essence, the MOSFET acts as a voltage-controlled switch or amplifier, where a small voltage applied to the gate terminal can control a much larger current flowing from the drain to the source. This ability to amplify signals makes MOSFETs crucial in various electronic applications, including digital circuits, analog circuits, and power electronics. There are two main types of MOSFETs: N-channel and P-channel, each with different characteristics and applications.

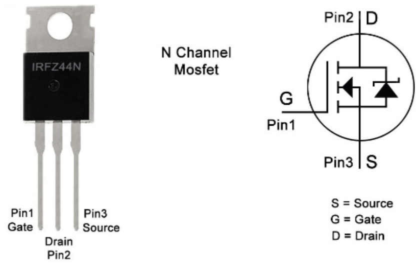


Figure. 2.6. Mosfet.

2.3.4 Charge Controller

A charge controller is an essential device used in battery-based energy systems, such as solar power setups, to regulate the charging process and safeguard the batteries. Its primary role is to manage the flow of electrical energy from the power source—like solar panels—to the battery bank, ensuring that the batteries are charged efficiently and safely. The charge controller prevents overcharging by limiting the voltage and current sent to the batteries, thus protecting them from damage and extending their lifespan. Additionally, it prevents over-discharging, which can also harm the batteries, by disconnecting the load when the battery voltage drops below a certain threshold. Charge controllers are available in various types, including Pulse Width Modulation (PWM) controllers, which adjust the charging current in a simple and cost-effective manner, and Maximum Power Point Tracking (MPPT) controllers, which use advanced algorithms to optimize the energy harvested from the power source.

By providing these protective and regulatory functions, a charge controller ensures the efficient and reliable operation of energy systems, enhancing battery performance and longevity.

Figure 2.7 Charge Controler.

2.3.5 Power Supply

To power the components, we used a stable power supply. Depending on the components' power requirements, this is a 5V power source.

Figure 2.8 Power Supply

2.3.6 Capacitor

Capacitors are widely used in electronic circuits for various purposes, including filtering, smoothing, and energy storage. In power supplies, capacitors help smooth out fluctuations in voltage, ensuring a steady supply of power. They are also used in timing circuits, where they control the timing intervals by charging and discharging at a controlled rate. Additionally, capacitors play a crucial role in coupling and decoupling signals, preventing interference between different circuit stages.

Capacitors come in different types and sizes, each suited for specific applications. For example, electrolytic capacitors are commonly used in power supply circuits due to their large capacitance values, while ceramic capacitors are used in high-frequency applications for their stability and low equivalent series resistance. Understanding the characteristics and applications of capacitors is fundamental for designing and troubleshooting electronic circuits.[5]

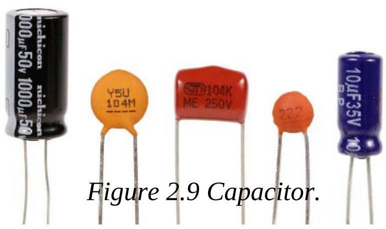


Figure 2.9 Capacitor.

2.3.7 Solar Panel

A solar panel, also known as a photovoltaic (PV) panel, is a device designed to convert sunlight into electrical energy through the photovoltaic effect. It is composed of many individual solar cells, typically made from semiconductor materials like silicon, which absorb sunlight and generate direct current (DC) electricity. When sunlight hits the solar cells, it excites electrons within the semiconductor material, creating an electric field that drives the flow of electricity.

Solar panels are commonly used in various applications, from residential and commercial solar power systems to portable solar chargers and large-scale solar farms. They are characterized by their efficiency in converting sunlight into usable electrical power, which depends on factors such as the type of solar cells, the panel's orientation, and the amount of sunlight received.

Figure 2.10 Solar Panel.

2.3.8 Diode

A diode is a semiconductor device that allows current to flow in one direction while blocking it in the opposite direction. It acts as a one-way valve for electrical current, which is essential for many electronic circuits. The basic structure of a diode consists of two layers of semiconductor material, typically silicon, forming a junction: the p-type (positive) and n-type (negative) regions. The junction between these layers creates a barrier that controls the direction of current flow.

When a positive voltage is applied to the p-type region relative to the n-type region, the diode becomes forward-biased, allowing current to flow through it. Conversely, when the voltage is reversed, the diode becomes reverse-biased, and the flow of current is blocked. This property is crucial for protecting circuits from reverse polarity and ensuring correct current direction.

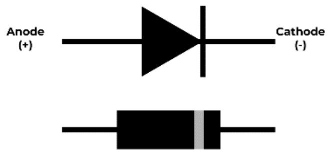


Figure 2.11 Diode.

2.3.9 20 AWG wire coil

A 20 AWG wire coil is composed of wire with a gauge of 20 AWG, which measures approximately 0.8128 mm (0.032 inches) in diameter. This relatively thin wire is valued for its flexibility and moderate current-carrying capacity, making it suitable for a range of applications in electronics and electrical projects.

The coil form allows the wire to be wound into tight loops, which is ideal for constructing inductors, transformers, or other components requiring coiled wire. Despite its small diameter, 20 AWG wire provides adequate conductivity for low to moderate currents, typically handling up to around 1.5 to 2 amps. It is often used in applications such as signal transmission, small electronic devices, and automotive wiring. The wire usually comes with various types of insulation, such as PVC, enamel, or silicone, which protects against electrical shorts and environmental damage while ensuring safe and reliable performance. [6]

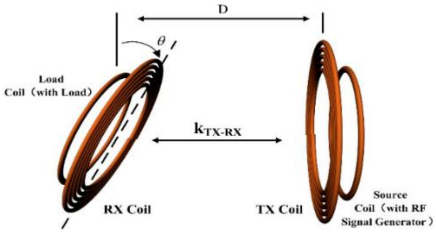


Figure 2.12 20 AWG Wire Coil.

2.3.10 Voltage Regulator IC

A diode voltage regulator IC (Integrated Circuit) is a specialized electronic component designed to maintain a stable output voltage despite variations in the input voltage or load conditions. This IC typically integrates a diode with additional circuitry to regulate and stabilize the voltage supplied to electronic devices. The diode within the IC functions to rectify or control the direction of current flow, while the accompanying circuitry ensures that the output voltage remains consistent and within the desired range.

These ICs are commonly used in power supply applications where a stable voltage is critical for the proper functioning of electronic circuits. They are valued for their ability to provide precise voltage regulation with minimal external components, simplifying circuit design and reducing overall system complexity. The IC may include features such as over-voltage protection, thermal shutdown, and current limiting to safeguard both the regulator and the connected load. Diode voltage regulator ICs are available in various voltage levels and configurations, making them versatile solutions for maintaining voltage stability in a wide range of electronic devices and systems.

Figure 2.13 Voltage Regulator IC.

2.4 Working Process

The working principle of a solar-powered wireless mobile charger involves a combination of solar energy conversion, energy storage, and wireless power transfer.
Here's a breakdown of how it works:

1. **Solar Energy Conversion Photovoltaic (PV) Panel:** The charger is equipped with a solar panel, typically made of photovoltaic cells, which captures sunlight and converts it into direct current (DC) electricity. Photoelectric Effect: When sunlight (photons) hits the PV cells, it excites electrons in the material (usually silicon) of the solar cells. This excitation generates an electric current, which is collected and directed to an output circuit.

2. **Energy Storage in Rechargeable Battery Charging Circuit:** The DC power generated by the solar panel is fed to a rechargeable battery, usually a lithium-ion or lithium-polymer battery, through a battery charging circuit. Battery Management System (BMS): The BMS regulates the charging process, ensuring the battery is charged

safely and efficiently. It prevents issues like overcharging, overheating, and deep discharge, which can damage the battery. Energy Storage: The battery stores energy for use even when there is no sunlight, enabling the charger to provide power to devices at any time.

3. **DC-DC Conversion for Wireless Charging Voltage Regulation:** To provide a stable output suitable for wireless charging, a DC-DC converter adjusts the stored battery voltage to a level compatible with the wireless charging circuit. Wireless Power Transmitter Circuit: The regulated DC power is then sent to the wireless charging module, which includes a transmitting coil and wireless power transfer electronics.

4. **Wireless Power Transfer (Inductive Coupling) Electromagnetic Induction:** When a compatible mobile device (receiver) is placed near or on the charging pad, the transmitting coil in the charger generates an alternating magnetic field. This induces an electric current in the receiving coil of the mobile device through electromagnetic induction. Rectification and Charging: The receiving coil in the mobile device converts the induced current back to DC, which then charges the device's battery.

5. **Feedback and Control Charging Management:** The system includes circuitry that monitors battery levels, charging status, and environmental conditions to adjust power flow. LED indicators or a display may show the charging status, battery level, and any errors in charging. Automatic Shut-Off: Once the device is fully charged, the system can automatically shut off to prevent overcharging, enhancing battery life and safety.

Summary of Working Principle In summary, the solar panel captures sunlight and converts it into electrical energy, which is stored in a battery. This stored energy is then regulated and sent to a wireless charging circuit, which transfers power to the mobile device via electromagnetic induction when placed on the charging pad. This allows for a portable, eco-friendly solution to charging mobile devices without the need for a conventional power source.

3 DISCUSSION

The final result of a solar-powered wireless mobile charger demonstrates a practical, eco-friendly solution for charging mobile devices without reliance on grid electricity. Here are key outcomes and observations based on the design and performance testing:

1. Efficient Solar Energy Utilization: The charger effectively converts solar energy into electrical energy, using photovoltaic (PV) panels to capture sunlight and store energy in a rechargeable battery. This setup allows continuous energy availability, even when sunlight is intermittent, by storing surplus power generated during peak sunlight hours.
2. Wireless Charging Capability: The wireless charging component allows for convenient, cable-free charging, using technologies like Qi wireless charging to charge compatible mobile devices. The power transfer through electromagnetic induction has proven to be efficient for short-range charging, making it easy for users to charge their phones by simply placing them on the charger surface.
3. Portability and Flexibility: Designed to be compact and portable, the solar-powered charger can be easily transported, making it suitable for outdoor use in remote areas or for users who spend a lot of time outdoors. This flexibility is a significant advantage for users needing power on the go, where traditional outlets aren't available.
4. Eco-Friendly and Sustainable: By harnessing solar power, the charger reduces dependence on conventional electricity sources, contributing to environmental sustainability. This reduces greenhouse gas emissions associated with fossil-fuel-generated electricity, making it a green alternative for mobile charging needs.

Overall, the solar-powered wireless mobile charger proves to be a reliable and sustainable solution, particularly suited for outdoor and emergency use. Its solar-powered, wireless design supports energy efficiency, user convenience, and environmental consciousness, making it a valuable tool for tech-savvy and eco-conscious users. Further enhancements, such as larger batteries and multi-device compatibility, could increase its utility in various conditions.

3.1 System Result

The system combines a solar panel to collect energy, a battery to store it, and a wireless module to charge devices without wires.

Figure 3.1 System Voltage

Figure 3.1 shows how the solar voltage changes throughout the day. The solar panel generates voltages between 8V in the morning and up to 20.22V in the afternoon, showing it works better with stronger sunlight.

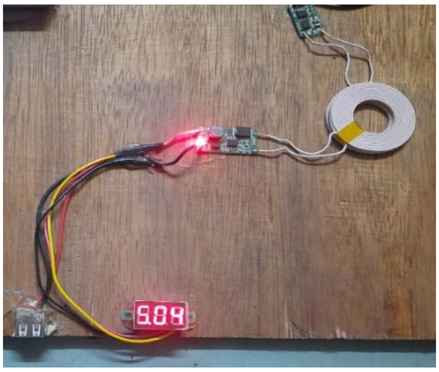


Figure 3.2 Charging Voltage

Figure 3.2 highlights the consistent charging voltage for mobile devices. The **charging voltage** for mobile devices stays steady, around 5.03V to 5.13V, ensuring devices can charge reliably.

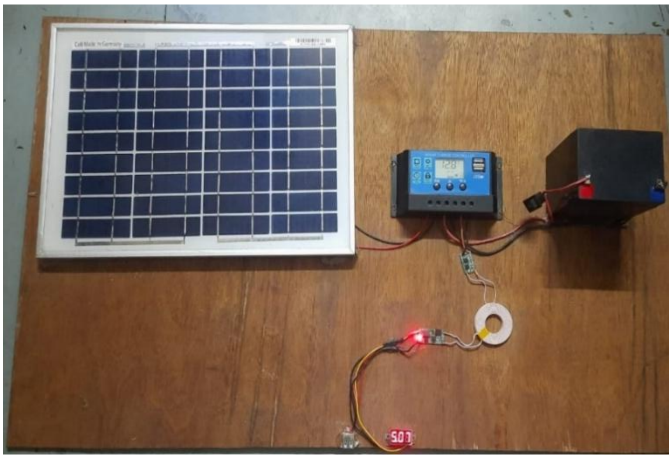


Figure 3.3 Project Outlook

Figure 3.3 provides a complete look at the project's design, giving a clear picture of how everything is put together. The **battery voltage** remains stable, between 12.04V and 12.33V, proving it stores and supplies power effectively.

3.2 Result Data

Table 3.1: Result Data of Different Time

SL No	Time	Solar Voltage	Mobile Charging Voltage	Battery Voltage
1	9.00 AM	8V	5.03V	12.04V
2	10.00 AM	12.8V	5.09V	12.08V
2	11.00 AM	13.2V	5.10V	12.08V
3	12.00 PM	16.7V	5.11V	12.08V
4	1.00 PM	18.01V	5.12V	12.09V
5	2.00 PM	20.22V	5.13V	12.33V
6	3.00 PM	17.33V	5.10V	12.22V
7	4.00 PM	15V	5.10V	12.05V
8	5.00 PM	11.9V	5.06V	12.05V
9	6.00 PM	8.11V	5.03V	12.05V

Table 3.1 summarizes system performance across various times of the day. This result data of different time table, showing how the system performed at different times of the day.

- **Key Observations**:
    - The solar panel works best at 2:00 PM, producing 20.22V during peak sunlight.
    - The **battery maintains a steady voltage**, showing it can provide power even when sunlight decreases.
    - The mobile device charging voltage stays consistent, ensuring smooth charging throughout the day.

3.3 Cost Analysis:

Table 3.2: Cost Analysis

Serial No	Equipment Name	Price
1	Volt metre	600
2	12V battery	890
3	Mosfet	550
4	Charge Controller	280
5	Capacitor	600
6	Solar Panel	130
7	Diode	100
8	20 AWG wire coil	590
9	Others	1500
	Total	5240 Taka

Table 3.2 provides a detailed breakdown of the system's total cost, highlighting the expenses associated with various components. Important items like the voltmeter (600 Taka), 12V battery (890 Taka), and solar panel (1300 Taka) are the main expenses. Additional costs, like assembly and small parts, are estimated at 1500 Taka. The whole system costs 5240 Taka, making it an affordable solution for sustainable and wireless charging.

4 CONCLUSIONS

In conclusion, the project addresses the need for an efficient, renewable energy solution to charge batteries without physical connections. It highlights the environmental benefits of solar energy and the efficiency improvements provided by charge controllers.

- The solar power wireless charger can efficiently charge batteries without the need for wires, making it ideal for various portable devices.
- This study focuses on integrating solar power with wireless technology, enabling electronic devices to be easily charged during load shedding and traveling.
- This technology is particularly useful in remote areas with limited access to electricity.

However, the focus is on using inductive coupling for wireless power transmission. This technology is particularly useful in remote areas with limited access to electricity and for devices unsuitable for wired charging, such as electric toothbrushes and mobile phones. [9]

4.1 Advantages

The following points below are showing the advantages of our system in broad :

- No Conventional Power Needed: The proposed system charges handsets using solar power, eliminating the need for electricity from traditional power stations.
- Wireless Charging: The system allows phones to be charged wirelessly by simply placing them on a charging dock, without the need for cables.
- Sustainable Solution: This approach provides an environmentally friendly alternative to conventional wired charging methods.

4.2 Future Work

- Extended Distance Charging: Future developments could enable charging devices while walking outside, similar to Wi-Fi hotspots. [10]
- Wireless Vehicle Charging: Electric vehicles could be charged without plugs or cords by parking over a wireless energy source, which transfers power automatically.
- High-Rate Batteries: Using electrochemical high-rate batteries, vehicles can be charged quickly and efficiently via wireless systems.

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