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Microwave-Based Wireless Power Transfer System for Battery Charging Application

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***Abstract-* This paper cover all basis and design of wireless battery charager. the wireless battery charger the wireless charger will cover the RF / microwave signal at 900 megahertz frequency into a DC signal, and then store the power into an AAA battery This project is divided into a 3 part: transmitter, antenna, and charging circuit. A complete discussion of the specifications of the battery charger is provided after data measurements. This report also included components list, financial, data result and other key information.**

***Keywords*: - Wireless Power Transfer (WPT), Inductive Charging, Charging Efficiency.**

I. INTRODUCTION

The portable electronic device are very popular nowadays. As the uses of these portable electronic devices increasing the demand for longer battery life are also increasing. This batteries need to be chargeable or replace periodically. It is a hassel to charge or change the battery after a while, especially where there is a no power outlet around. This wireless battery charger is expected to eliminate all the hassle with 2 days battery technology. As for now, there are no known companies that are developing the wireless battery charger. This means that there are might to be a good opportunity in the market for this type of product. More over people 10 to spend more money for convenience that means the price. Outlook of these device is supported by above predictions.

II. LITERATURE SURVEY

(1) Lu, Wang, Niyato, Kim, & Han (2015). Wireless Charging Technologies: Fundamentals, Standards, and Network Applications.

Offers a comprehensive overview of wireless charging principles and standards, plus insights into networked scheduler systems..

(2) Mou & Sun (2015). Wireless Power Transfer: Survey and Roadmap.

Reviews inductive, resonant, and electromagnetic WPT, exploring performance, distance, multi-transmitter setups, and future trajectories

(3) Odeyemi et al. (2023). Development of an Inductive Wireless Charger for Mobile Phones.

Describes a 200 kHz inductive charging system driven by a microcontroller (ATMEGA328P), achieving 5 V/450 mA output and 6 cm charging distance

(4) (Energies journal, 2022). Inductive Wireless Power Transfer Systems for Low-Voltage and High-Current Electric Mobility Applications: Review and Design Example.

Focuses on coil design: mutual inductance, coupling factor, ferrite usage, shielding, and coil geometries (circular, rectangular, double D) for EV charging applications.

(5) Inductive Power Transfer: Past, Current, and Future Research.

Chronicles IPT's progression (10 kHz–250 kHz), highlights efficiency up to ~97%, and discusses its relevance to electric mobility...

(6) Inductive Power Transfer Battery Charger with IR-Based Closed-Loop Control.

Introduces a hybrid IPT architecture that uses infrared-based wireless feedback to implement precise closed-loop control (CC-CV switching). IR helps avoid EMI and improves voltage stability.

(7) Mubarak et al. (2024). Wireless Power Transfer for Deep-Cycle Lithium-Ion Batteries in Electric Vehicles Using Inductive Coupling.

Explores both static and dynamic EV charging, highlighting a 6 km inductive charging road in Sweden and systems operating at ~70 kHz.

(8) (MDPI, 2022). Wireless Chargers for Electric Vehicle: A Systematic Review on Converter Topologies, Environmental Assessment, and Review Policy.

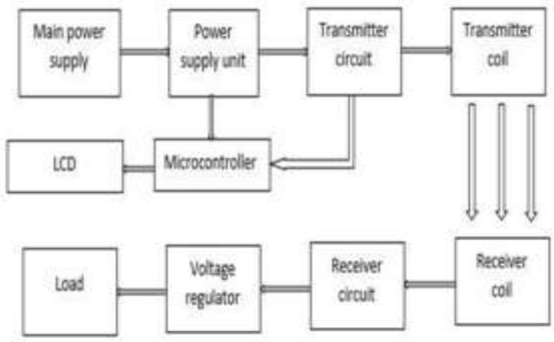
Performs life-cycle evaluations, noting EV wireless charging can reduce CO_2 emissions by ~38% while balancing infrastructure burdens against benefits.

(9) (Renewable & Sustainable Energy Reviews, 2022). Wireless Charging Systems for Electric Vehicles.

Offers a state-of-the-art review, tabulating various EV wireless charging methods, covering both static and dynamic implementations, communication, and control systems.

III. Design Overview

This wireless battery charger is resign to operate at 900 MHz.in this project a power transmitter act as a power source. It will be transmit power to receiver side. And then, the rectifier circuit in the receiver will be convert the RF/microwave signals into DC signal. After the DC signal is produced, the charging circuit will store the power into the battery. Here is a block diagram of overall design. Considerations in below Figures.



Block diagram of wireless charger

Since the group does not designed the transmitter, therefore the design is mainly focus on the receiver side. A power transmitter is bought from a commercial website. It is a 9 00MHz video / audio transmitter. Here specification of transmitter
Power: 12 DC, 900 mA
Output power: 3 watts
Operation frequency: 900 MHz
Connector type: SMA - female
Output Impedance: 50 ohm.
1. Antenna

The antenna plays a very important role. To charge a battery power signal is needed. The wireless battery charger circuit must be the power loss to minimal. Therefore there are many considerations to choose the correct part of the design. The considerations of choosing the appropriate antenna are
1. Impendence of the antenna
2. Gain of the antenna. Taking the about design SP EC in a consideration the team found the yagi antennas that fit our specification below is the picture of yagi antenna.

The impedance of the antenna should match with the output of power transmitter and input impedance of the rectifier circuit. Non matching impedance between circuits can cause a tremendous power loss due to the signal distortion. Since the output impedance of the transmitter is a 50 ohm the antenna should have 50 ohm impedance.

The higher of the antenna gain the yields a better result of the design, however higher gain will also increase the cost and size of the antenna. This becomes a major factor in a choosing the antenna due to the group limited financial resources. After the consideration, a 9 dB yagi antenna is chosen for the design**.**
2. Receiver

The receiver's men purpose it’s to charge and an AAA battery. A simple battery charging theory is run current through the battery and apply a voltage difference between the terminal of the battery to reverse chemical process. By doing so, it recharges the battery. There is other efficient and faster way to charge the battery but it requires large amount of energy which is the wireless battery charger cannot be obtained yet. Therefore in our design we use the straight forward method to charge battery

Microwave signal is an AC signal with a frequency range of 1 GHz - 1000 GHz .900 MHz is in between the RF/ microwave range. No matter how high is the frequency is, AC signal. therefore, the signal can also treated as a low frequency AC signal. In order to get the DC signal out of the AC signal rectifier circuit is needed.

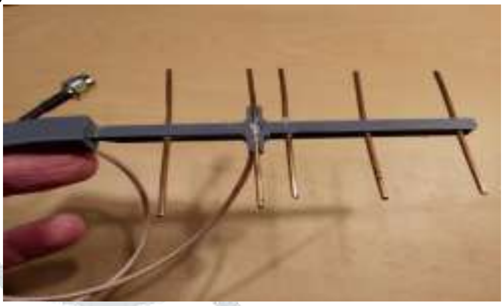
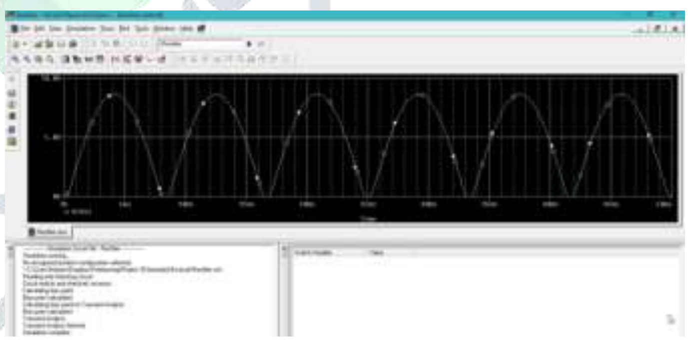


Fig-Yagi Antenna

Full wave rectifier is chosen for the project due to its simplicity and efficiency in covering the AC signal. The full wave rectifier is consist of four diode. Since the power received by the receiver will be relatively low and signal frequency is high, the diode are required to have very low turn on voltage and operating frequency at 900MHz. For this reason a short key diode by Skyworks is chosen for the design. At the output of the rectifier, the signal is not a fully DC signal yet, thus, by the adding a capacitor and resistor can smooth out of output to become DC signal. However the time constant produced by the capacitor and resistor should be calculated carefully to fit the desire time constant..

Final Design

1. P spice stimulation result



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2. The final design output

1. Transmitter, 2. Yagi antenna, 3.full wave rectifier,

4. RC circuit, 5. Battery holder

The input impedance of the quad bridge rectifier diode is nonlinear. The base on the bi curve of a diode the impedance a turn on diode is relatively high. The data should does not provide the IV curve data does the group assume that the impedance of the rectifier is very high. Therefore the width of the input transmission line is getting thinner as it get

IV. Harware Result

The length and the shape of the transmission line is need to be considered. The length of transmission line has to be approximately a cottered wave of the wavelength. The shape of the transmission line is need to be a smooth as possible to avoid the power loss. Our design use a circular shape and give us the best result.

voltage and current values versus the distance between two antenna distance (ft)	Volt(v)	Current (mA)	Power (mW)
0.5	3.4	27	91.8
1	3.24	17.2	55.728
1.5	3.1	9.8	30.38
2	3	7.3	21.9
2.5	2.7	4	10.8
3	1.93	1.5	2.895
3.5	1.4	0.51	0.714
4	1.29	0.03	0.0387

V. Conclusion

The wireless battery charger project demonstrates the growing potential of wireless power transfer (WPT) technology in providing convenient, safe, and efficient charging solutions for modern electronic devices. Through the use of electromagnetic induction—particularly inductive or resonant inductive coupling—this system eliminates the need for physical connectors, reducing wear and improving user experience.

This project highlights not only the fundamental working principles and design considerations but also practical challenges such as coil alignment, power efficiency, and heat dissipation. Despite these challenges, the results affirm that wireless charging systems can deliver reliable performance over short distances and are scalable for broader applications, including electric vehicles and medical implants.

As the demand for contactless energy solutions continues to rise, advancements in coil design, power electronics, and control strategies will further improve the efficiency, range, and safety of wireless charging systems. This project contributes to this evolving field by offering a compact and functional prototype, laying the groundwork for future innovation in sustainable and user-friendly power delivery systems.

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