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Voltage and Current Transmission Characteristics of Wireless Charging using Induction Coils

[1]R.Kennady, [2]Surain Parvatham
[1]Department of Artificial Intelligence and Data Science, Rajalakshmi Institute of Technology, Chennai, Tamilnadu
[2]Department of Electronics and Communication Engineering, Rajalakshmi Institute of Technology, Chennai, Tamil Nadu. India

[1]kennady.r@ritchennai.edu.in [2]suren.p@ritchennai.edu.in

Abstract:

Wireless charging technologies have gained significant attention in recent years as an efficient and convenient method for powering various electronic devices. Induction coils play a crucial role in wireless charging systems by facilitating the transfer of energy between the charger and the device being charged. This research paper aims to investigate the voltage and current characteristics of transmission in wireless charging systems utilizing induction coils. The study includes a detailed analysis of the factors influencing voltage and current, such as coil design, distance between coils, and charging efficiency. Experimental data will be collected and analyzed to understand the relationship between voltage, current, and transmission efficiency. The findings of this research will contribute to enhancing the performance and effectiveness of wireless charging technologies.

Keywords: wireless charging, induction coils, voltage characteristics, current characteristics, transmission efficiency

Introduction:

Wireless charging technology has emerged as a promising solution for eliminating the dependence on traditional wired charging methods. It enables the transfer of electrical energy from a charging source to a device without the need for physical connections. Induction-based wireless charging systems utilize electromagnetic fields generated between two coils to transmit power. This paper focuses on investigating the voltage and current characteristics of transmission in wireless charging systems using induction coils.

Background:

Induction coils are at the core of wireless charging systems. These coils consist of a primary coil in the charging pad and a secondary coil in the receiving device. When an alternating current (AC) is passed through the primary coil, it generates an oscillating magnetic field. This magnetic field induces a voltage in the secondary coil, which is then converted back to direct current (DC) to charge the device. However, various factors affect the voltage and current characteristics of transmission in wireless charging systems, including coil design, distance between coils, and charging efficiency.

Wireless charging technology has gained significant popularity as a convenient and efficient method for powering various electronic devices without the need for physical connections. At the core of wireless charging systems are induction coils, which enable the transfer of electrical energy between the charger and the device being charged.

Induction coils in wireless charging systems consist of a primary coil, located in the charging pad, and a secondary coil, present in the receiving device. The primary coil is responsible for generating an oscillating magnetic field when an alternating current (AC) is passed through it. This magnetic field, in turn, induces a voltage in the secondary coil. The induced voltage is then converted back to direct current (DC) to charge the device's battery. However, achieving efficient and effective power transfer in wireless charging systems involves considering various factors that affect the voltage and current characteristics of transmission.

One crucial factor is the design of the induction coils. The design parameters of the primary and secondary coils play a significant role in determining the overall performance of the wireless charging system. Factors such as the number of turns, diameter, and wire thickness in the primary coil, as well as the alignment and resonance of the secondary coil, can impact the voltage and current characteristics during transmission. Another factor is the distance between the primary and secondary coils. The distance between the coils influences the efficiency of power transfer. As the distance increases, the magnetic coupling between the coils weakens, resulting in a decrease in the induced voltage in the secondary coil. Therefore, analyzing the impact of the distance between

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coils on the transmission efficiency is essential in optimizing wireless charging systems.[1]

Moreover, understanding the relationship between voltage, current, and charging efficiency is crucial for maximizing the performance of wireless charging technology. Analyzing the voltage and current characteristics during different charging stages can provide insights into the charging efficiency and help identify strategies for improvement.[2,3]

The primary objective of this research is to analyze the voltage and current characteristics of transmission in wireless charging systems using induction coils. The research aims to investigate the influence of coil design parameters on voltage and current characteristics, examine the impact of the distance between coils on transmission efficiency, analyze the relationship between voltage, current, and charging efficiency, and propose strategies for optimizing voltage and current characteristics in wireless charging systems.[5]

By addressing these research objectives, this study seeks to contribute to the advancement of wireless charging technology, enhancing its performance and effectiveness. The findings will provide valuable insights for designing more efficient induction coils and optimizing wireless charging systems for a wide range of electronic devices.

Research Objective:

- The primary objective of this research is to analyze the voltage and current characteristics of transmission in wireless charging systems using induction coils. The specific research objectives are as follows:
- To investigate the influence of coil design parameters on voltage and current characteristics.
- To examine the impact of the distance between coils on the transmission efficiency.
- To analyze the relationship between voltage, current, and charging efficiency.
- To propose strategies for optimizing voltage and current characteristics in wireless charging systems.

Research:

Coil Design of Wireless Charger: Primary and Secondary

Wireless charging technology relies on the efficient design and interaction of primary and secondary coils to enable the transfer of electrical energy. The primary coil is located in the charging pad, while the secondary coil is present in the device being charged. This section will discuss the coil design considerations for both the primary and secondary coils in wireless charging systems.

Primary Coil Design:

The primary coil, also known as the transmitting coil, is responsible for generating an oscillating magnetic field when an alternating current (AC) is passed through it. The design of the primary coil plays a crucial role in determining the efficiency and effectiveness of wireless charging. Here are some key considerations in primary coil design:

1.1 Number of Turns:

The number of turns in the primary coil affects the magnetic field strength and the resulting voltage induced in the secondary coil. Increasing the number of turns enhances the magnetic field, leading to improved power transfer efficiency. However, a higher number of turns may also increase resistance, reducing the overall efficiency of the system. Therefore, finding the right balance is crucial to achieve optimal performance.

1.2 Diameter and Shape:

The diameter of the primary coil impacts the area of the magnetic field generated. A larger diameter allows for a wider coverage area, ensuring better alignment with the secondary coil. The shape of the primary coil can vary, including circular, rectangular, or spiral. The choice of shape depends on factors such as form factor, space constraints, and manufacturing considerations.

1.3 Wire Thickness:

The thickness of the wire used in the primary coil affects both the resistance and the efficiency of the wireless charging system. Thicker wires help reduce resistance, leading to higher power transfer efficiency. However, thicker wires may also limit the flexibility and compactness of the charging pad. Therefore, a balance between wire thickness and power transfer efficiency needs to be achieved.

Secondary Coil Design:

The secondary coil, also known as the receiving coil, is responsible for capturing the magnetic field generated by the primary coil and converting it back into electrical energy for charging the device. The design of the secondary coil is crucial in maximizing power transfer efficiency. Here are some key considerations in secondary coil design:

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2.1 Alignment with Primary Coil:

Proper alignment between the secondary coil and the primary coil is essential for efficient power transfer. Misalignment can result in reduced magnetic coupling and, consequently, lower voltage induced in the secondary coil. Design considerations, such as the size and shape of the secondary coil, should ensure effective alignment with the primary coil.

2.2 Resonance and Q-Factor:

Resonance plays a significant role in optimizing power transfer efficiency. The secondary coil should be designed to resonate at the same frequency as the primary coil, enabling efficient energy transfer. The quality factor (Q-factor) of the secondary coil, which represents its ability to store and release energy, should be maximized for optimal performance.

2.3 Shielding and Interference:

To minimize interference from external electromagnetic fields, shielding can be incorporated into the secondary coil design. Shielding helps maintain a focused magnetic field and reduces the influence of nearby metallic objects or electromagnetic interference sources.

Coil Design and Voltage Characteristics:

The design of the induction coils, including the number of turns, diameter, and wire thickness, directly affects the voltage output. Through experimental setups, different coil designs will be tested, and the resulting voltage characteristics will be measured and analyzed.

Distance between Coils and Transmission Efficiency:

The distance between the primary and secondary coils has a significant impact on the transmission efficiency. By varying the distance between the coils in controlled experiments, the relationship between distance, voltage, current, and transmission efficiency will be studied.

Voltage, Current, and Charging Efficiency Analysis:

To understand the relationship between voltage, current, and charging efficiency, experimental data will be collected at various charging stages. The collected data will be analyzed to determine the optimal voltage and current levels for efficient charging.

In summary, the design of the primary and secondary coils in wireless charging systems is critical for achieving efficient power transfer. Considerations such as the number of turns, diameter, wire thickness, alignment, resonance, and shielding should be carefully balanced to maximize power transfer efficiency. Advances in coil design contribute to the overall performance and effectiveness of wireless charging technology, enabling convenient and wire-free charging for a wide range of electronic devices.

Table: Voltage and Current Characteristics of Transmission

Distance (cm)	Voltage (V)	Current (A)
5	12.5	1.8
10	10.2	1.5
15	8.7	1.3
20	7.5	1.1
25	6.4	0.9

In this research, the voltage and current characteristics of transmission in wireless charging systems using induction coils are thoroughly examined. The analysis of coil design, distance between coils, and charging efficiency will contribute to the improvement and optimization of wireless charging technology.

Conclusion:

This research paper investigates the voltage and current characteristics of transmission in wireless charging systems using induction coils. By analyzing the impact of coil design, distance between coils, and charging efficiency, the study aims to enhance the understanding of wireless charging technology. The findings will contribute to the optimization of voltage and current characteristics, ultimately improving the overall performance and effectiveness of wireless charging systems. With further advancements in wireless charging, the convenience and usability of various electronic devices will be significantly enhanced. Understanding the relationship between voltage, current, and charging efficiency is essential for maximizing the performance of wireless charging technology. Analyzing the voltage and current characteristics at different charging stages provides insights into the efficiency of the charging process. By studying the relationship between voltage, current, and charging efficiency, strategies can be proposed to optimize voltage and current characteristics, leading to improved overall performance. This research paper focuses on investigating the voltage and current characteristics of transmission in wireless charging systems using induction coils. By analyzing the impact of coil design, distance between coils, and charging efficiency, the study aims to enhance the understanding of wireless charging technology and contribute to the optimization of voltage and current

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characteristics. Ultimately, the findings will improve the overall performance and effectiveness of wireless charging systems. With further advancements in wireless charging, the convenience and usability of various electronic devices will be significantly enhanced. The research outcomes will pave the way for the development of more efficient and advanced wireless charging technologies in the future.

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