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Implementation of Wireless Power Transmission System

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***Abstract**:*

This paper investigates the contactless inductive charging techniques for wireless power transportation system. The design of coupling structure is established by analyzing the comparison of different wiring style.

Keywords

Contactless charging techniques, wireless power transmission, wiring

1. Introduction

In recent years, consumer electronics products have been popular. The use group has gradually expanded. Most consumer electronics products require DC power as their driving power. Whether it is a mobile phone, a digital camera, a digital player, a personal mobile assistant (PDA), all belong to the category of consumer electronic mobile devices. Light, thin, short and convenient will be the main goals of today's electronic product design. However, in the power supply part, often encounter different specifications of connectors and complex wires. If it is used to provide power supply by wireless power, it will undoubtedly save a lot of trouble for users and bring convenience in life. Therefore, designing a wireless power transmission and charging system will be a topic worth discussing.

In the traditional contact type power transmission is achieved through metal contact to contact connection. Although this method is easy to implement and can meet most uses. Under the goal of continuously improving the quality of electricity, safety, reliability, etc., this contact power transmission will produce defects that are not suitable for many applications. For example, in mining occasions such as oil well mines, explosions may be caused by sparks caused by metal contact points. The contact power transmission device (plug and socket) has the following drawbacks.

(1) Contact sparks generated when plugging and unplugging: In the presence of flammable gases, volatile solutions (the working environment itself or unintentional leakage), it may be caused by a small spark generated by the contact power supply device to cause combustion or explosion.

(2) The induced current may cause electric shock.

(3) Metal contact points are also susceptible to wear, deformation, oxidation or dust coverage, etc., resulting in poor contact, reduced transmission efficiency and reduced device life.

(4) Risk of electric shock and shock from personnel in wet or water leaking environments.

In biomedical technology, it charges the artificial auxiliary devices in the human body. If using traditional contact power transmission method requires regular operation to replace the battery. There are many risks and inconveniences not only to increase the suffering of patients. In daily life, the traditional contact power transmission method will cause troubles in plug and socket matching and operational convenience. The emergence of wireless induction power transmission will enable safe and convenient transmission of power to many special environments, and greatly improve the convenience of people's lives. It will be a technology that cannot be ignored in today's technological life of seeking innovation and progress.

Since the establishment of electromagnetic induction theory, the energy conversion between electrical energy and magnetic energy has been continuously studied and utilized. Through the conversion of electrical energy and magnetic energy to achieve the concept of wireless induction power transmission has also been continuously proposed for more than 100 years.

Until today, due to advances in technology and magnetic materials, the widespread increase in industrial demand, and the importance of safety and

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environmental protection, the research and application of wireless induction power transmission technology has gradually grown and expanded, and gradually integrated into people's daily life.

If powering the above equipment or charging the battery through wireless power transmission technology, the power transmission efficiency is poor due to the direct connection of the wireless circuit. However, compared with the traditional power cord connection socket or direct contact with metal contacts, it has practical features such as high safety, high insulation and high applicability.

Wireless power transmission technology can be widely used in various related fields. Applications include electric toothbrushes, wireless mouse charging devices and mobile phone chargers, portable or home electronics. The development direction has evolved from the power supply of a single electronic product in the past to the establishment of all portable or household electronic power supply lamp holders, which will be more flexible in practical use. The development of power supply and charging in high-power applications such as public transportation, electric vehicles, and industrial machinery is also a direction to be gradually developed. In medical applications, the use of wireless induction technology to develop fully implantable electrical exciters can improve the shortcomings of traditional electrical excisions that can easily cause open wounds on the skin surface. Even in many special places, such as oil well drilling operations, underwater equipment, robot power supply, and radio frequency identification system (RFID) transmission and reception devices, etc., are related applications of wireless power transmission [1-7].

Our implementation of wireless power transmission system is a non-contact power supply system (wireless power supply system). It adopts the electromagnetic field generated by the array-type coil is used to supply electrical energy, and the induction coil induces a magnetic field to generate current to provide power to the load. Its characteristic is that the microcontroller is used to detect the existence of the load. The electromagnetic field is only generated in the power supply coil below the load device, so there is no need to spend electricity on the coil without the load device above.

2. Contactless coil induction principle

The contact coil induction charging system uses the principle of electromagnetic induction to exchange and receive magnetic energy and electrical energy between the feeding coil and the receiving coil.

The operation principle is that an alternating current is fed from the primary coil of the feeder, and an alternating magnetic field is generated by the alternating current. The alternating magnetic field is received by the secondary coil of the power receiver. The current is converted back through the circuit, and then the battery charge. Figure 1 shows a schematic diagram of the power transmission method of coil inductive charging.

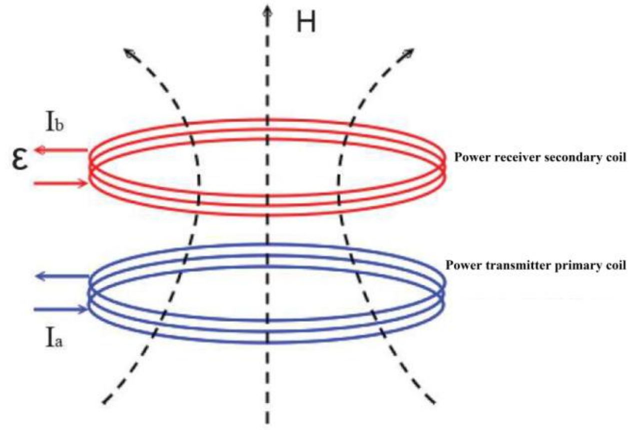

Figure 1. Schematic diagram of coil induction method.

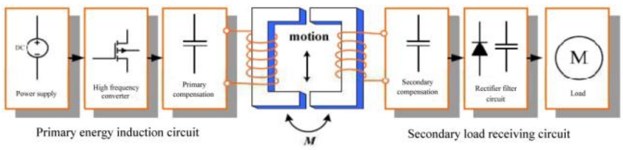

Figure 2. Basic contactless induction feeding system architecture.

3. Basic architecture of contactless induction feeding system

Figure 2 shows the proposed basic contactless inductive feeding system architecture.

(1) It is mainly composed of primary energy induction circuit and secondary receiver circuit. It is composed of microcontroller, sensor and LED light group.

(2) There is an air gap between the primary power induction circuit and the secondary receiver circuit, and energy transmission is performed through the relationship of electromagnetic field coupling.

(3) The primary circuit is connected to the power supply, and the secondary circuit supplies the energy required by the movable machinery in the form of feeding or charging.

(4) The coil winding on the primary is at the drive end of the power supply, and the coil winding on the secondary is mounted on the movable machinery.

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4. Complete hardware architecture

As shown in Figure 3, our complete hardware design architecture, its composition is described as follows:

(1) Use a power supply such as a transformer to generate DC 5V and provide power to the primary circuit.

(2) The primary circuit includes an oscillator, driver, coupler, and coil.

(3) The secondary includes a coil unit, a coupling unit, a circuit rectifier, a voltage limiter, and a voltage stabilizer.

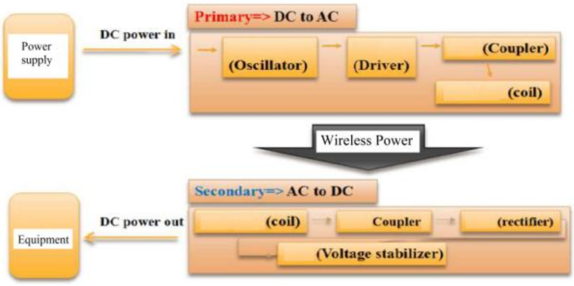

Figure 3. Complete hardware design architecture.

Figure 4. Small coil.

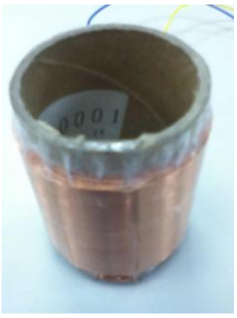

Figure 5. Middle coil.

4.1 Winding method

The winding method is to wind the coil on the paper tube in a spiral manner, as shown in Figure 4, Figure 5 and Figure 6. Our implementation using winding method is shown in Figure 7. First, the primary measuring coil is directly wound on a round paper cylinder, but the secondary measuring coil is also wound on a round paper cylinder. The secondary coil is larger than the primary coil by a diameter of about 2 cm, so that the secondary coil can freely shuttle the inner ring of the primary coil. In this way, the secondary coil and the primary coil can move freely and a contactless effect can be achieved.

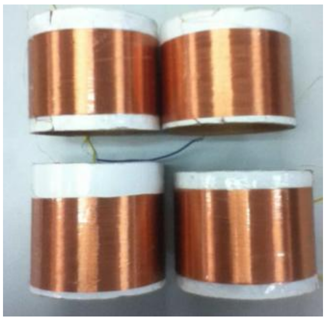

Figure 6. Large coil.

Figure 7. Large coil.

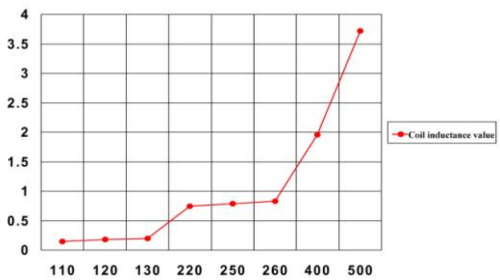

Figure 8. Inductance curve diagram.

5. Experimental results

The structure of inductive induction can convert energy into magnetic energy. Due to the change of magnetic energy and the configuration of the coupling unit and the coil on the secondary side to form a band-pass filter, the changed magnetic flux can be received and converted into an AC energy signal on the secondary side. Figure 8 shows several

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different coil styles used in this article, as well as their turns and inductance values. Figure 9 is a test chart using an LCR meter.

Figure 9. Inductance data measurement.

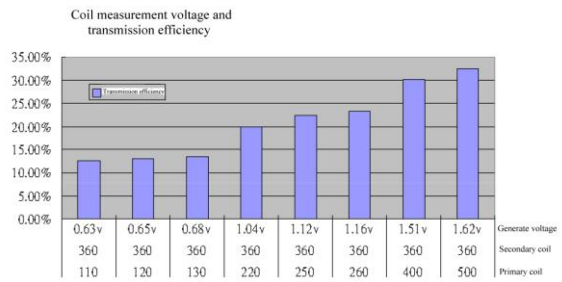

Figure 10. Method for measuring the relationship between induction coil and transmission efficiency (small coil).

5.1 Relationship between induction coil and transmission efficiency

In this paper, coils of different sizes, inductances, and turns are also used. In the experiment, it was found that different coil combinations will also seriously affect the efficiency of the system. Therefore, we did a series of experiments to study and verify. During measurement, the oscillation frequency generated by the primary oscillator is 10 MHz. Figures 10 and 11 are methods for measuring the relationship between the induction coil and the transmission efficiency. Using the aforementioned circuit, the total power input from the primary to the circuit and the maximum power of the secondary load are obtained and recorded. At the same time, its wireless energy transmission efficiency can also be obtained. During the actual measurement, there are no metal substances around the system to eliminate the influence of external environment on the measurement results.

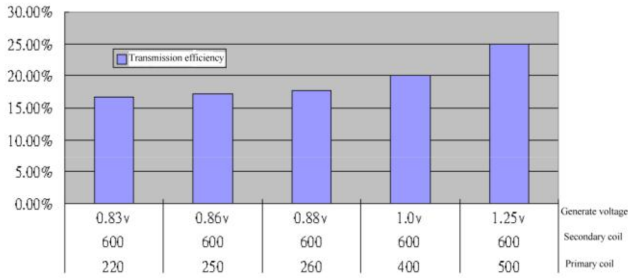

Figure 11. Method for measuring the relationship between induction coil and transmission efficiency (large coil).

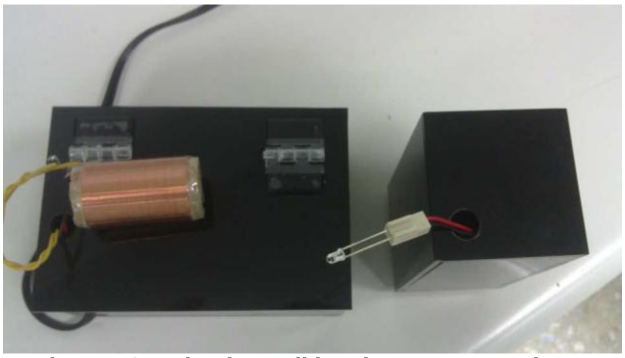

Figure 12. Inductive coil has been separated.

Figure 13. Inductive coil close to the object (with packaging).

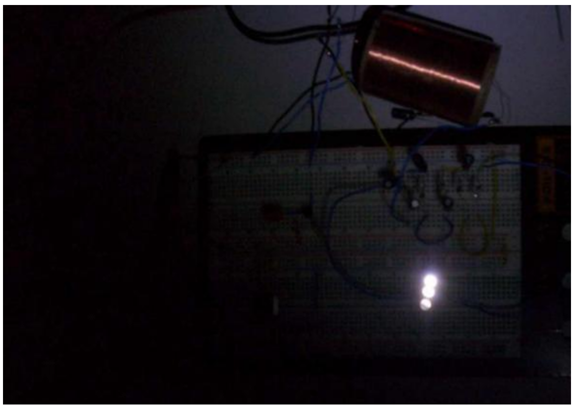

Figure 14. Inductive coil close to the object (without packaging).

6. Conclusion

The photos of the results are shown in Figure 12, Figure 13 and Figure 14. In this paper, the study eliminates the traditional use of huge conductive magnet cores with high transmission efficiency of wireless energy, and simply uses magnetic resonance of electrical energy to generate magnetic energy to achieve the purpose of wireless transmission. Through the research in this article, we can deeply understand the characteristics of resonant magnetic energy transmission. For example, directivity, area, inductance value, and energy resonance characteristics are all effects that affect wireless power transmission, and are of great reference value for subsequent research.

The future technology of our proposed wireless power transmission system made can avoid the various problems that may be caused by the traditional contact power supply device, and may also save the trouble of pulling and plugging the plug. At the same time, because there is no mechanical point connection, it is more suitable for special environments (such as certain hospital wards and clean rooms) that want to avoid unnecessary openings.

7. Acknowledgements

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