

ELECTRIC VEHICLE WIRELESS CHARGING OVER STOPPAGES FOR EXTENDED RANGE

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Abstract- Magnetic-coupled wireless power transfer technology is widely used in wireless charging for electric vehicles (EVs). The simulation model of WPT charging system for EVs. The magnetic fields from different sights and the E- field strength when the wireless power transmission system is working are simulated and judged by comparing with International Committee on Non-Ionizing Radiation Protection (ICNIRP) guidelines. The current and the voltage of the transmitter coil and receiver coil are given in this paper. Power grid harmonic is also evaluated as the working frequency is offset.

Keywords: magnetic field, power transfer

1. INTRODUCTION

In order to save energy and reduce environmental pollution, electric vehicles (EVs) have been greatly promoted by countries all over the world. However, storage battery capacity and high cost of charging infrastructure restricts the development and application of electric vehicles. As a novel technology, applying the wireless power transfer (WPT) can release these limitations well.

WPT has four commonly used technologies. The microwave WPT and the laser WPT can be carried out in long-distance wireless transmission of energy, the application range is greatly limited due to its shortcomings such as strict transmission directivity, low efficiency of energy conversion and great harm to living organisms. Inductive WPT technology has the advantages of large transmission power and high transmission efficiency, but it also has shortcomings such as short transmission distance and high energy transmission directivity. By means of large transmission power, high transmission efficiency, long transmission distance, low energy transmission directivity, and little impact on living organisms, the magnetic-coupled wireless power transfer technology has gradually attracted great attention from researchers, became the main method of EV's charging

1.1 Basic concept of wireless power transfer Inductive Coupling

Inductive or Magnetic coupling works on the principle of electromagnetism. When a wire is proximity to a magnetic field, it generates a magnetic field in that wire. Transferring energy between wires through magnetic

fields is inductive coupling.

If a portion of the magnetic flux established by one circuit interlinks with the second circuit, then two circuits are coupled magnetically and the energy may be transferred from one circuit to another circuit. This energy transfer is performed by the transfer of the magnetic field which is common to the both circuits.

In electrical engineering, two conductors are referred to as mutual-inductively coupled or magnetically coupled when they are configured such that change in current flow through one wire induces a voltage across the end of the other wire through electromagnetic induction. The amount of inductive coupling between two conductors is measured by their mutual inductance.

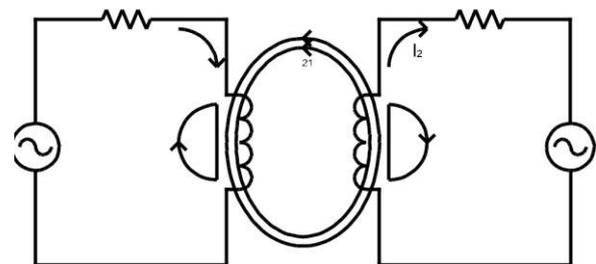


Figure 1

Circuit 1 Inductive coupling with four component fluxes. Power transfer efficiency of inductive coupling can be increased by increasing the number of turns in the coil, the strength of the current, the area of cross-section of the coil and the strength of the radial magnetic field. Magnetic fields decay quickly, making inductive coupling effective at a very short range.

1.2 Inductive Charging

Inductive charging uses the electromagnetic field to transfer energy between two objects. A charging station sends energy through inductive coupling to an electrical device, which stores the energy in the batteries. Because there is a small gap between the two coils, inductive charging is one kind of short-distance wireless energy transfer.

Induction chargers typically use an induction coil to create an alternating electromagnetic field from within a charging base station, and a second induction coil in the portable device takes power from the electromagnetic field and converts it back into electrical

current to charge the battery. Greater distances can be achieved when the inductive charging system uses resonant inductive coupling.

2. Inductance of Coil and Coil Design

Introduction

An ideal inductor has inductance, but no resistance or capacitance, and does not dissipate or radiate energy. However, real inductors have resistance (due to the resistance of the wire and losses in core material), and parasitic capacitance (due to the electric field between the turns of wire which are at slightly different potentials). At high frequencies the capacitance begins to affect the inductor's behavior; at some frequency, real inductors behave as resonant circuits, becoming self-resonant. At frequencies above this the capacitive reactance becomes the dominant part of the impedance. Energy is dissipated by the resistance of the wire, and by any losses in the magnetic core due to hysteresis. At high currents, iron core inductors also show gradual departure from ideal behaviour due to nonlinearity caused by magnetic saturation. At higher frequencies, resistance and resistive losses in inductors grow due to skin effect in the inductor's winding wires. Core losses also contribute to inductor losses at higher frequencies.

2.1. Single Layer Coil

A single layer coil, as shown in figure, has two advantages. Firstly, like all air core coils, it is free from iron losses and the non-linearity mentioned above. Secondly, single layer coils have the additional advantage of low self-capacitance and thus high self-resonant frequency.

In the simple case of a single layer solenoidal coil the inductance may be calculated as follows:

$$L = (d^2 n^2) / (l + 0.45d) [\mu H]$$

Where L is the inductance, d is the coil diameter in meters, l is the coil length in meters and n is the number of turns.

3. LITERATURE SURVE

Review of Battery Charger Topologies, Charging Power Levels, and Infrastructure for Plug-In Electric and Hybrid Vehicles

Authors: M. Yilmaz, Philip T. Krein

Reviews the current status and implementation of battery chargers, charging power levels, and infrastructure for plug-in electric vehicles and hybrids. Charger systems are categorized into off-board and on-board types with unidirectional or bidirectional power flow. Unidirectional charging limits hardware requirements and simplifies interconnection issues.

Bidirectional charging supports battery energy injection back to the grid. Typical on-board chargers restrict power because of weight, space, and cost constraints. They can be integrated with the electric drive to avoid these problems. The availability of charging infrastructure reduces on-board energy storage requirements and costs. On-board charger systems can be conductive or inductive. An off-board charger can be designed for high charging rates and is less constrained by size and weight. Level 1 (convenience), Level 2 (primary), and Level 3 (fast) power levels are discussed. Future aspects such as roadbed charging are presented. Various power level chargers and infrastructure configurations are presented, compared, and evaluated based on amount of power, charging time and location, cost, equipment, and other factors.

3.1. Wireless Power Transfer for Vehicular Applications: Overview and Challenges

Authors: DevendraPatil, Student Member, K. Mcdonough

More than century-old gasoline internal combustion engine is a major contributor to greenhouse gases. Electric Vehicles (EV) have the potential to achieve eco-friendly transportation. However, the major limitation in achieving this vision is the battery technology. It suffers from drawbacks such as high cost, rare material, low energy density and large weight. The problems related to battery technology can be addressed by dynamically charging the electric vehicle while on the move. In-motion charging can reduce the battery storage requirement which could significantly extend the driving range of an electric vehicle. This paper reviews recent advances in stationary and dynamic wireless charging of electric vehicles. A comprehensive review of charging pad, power electronics configurations, compensation networks, controls, and standards is presented

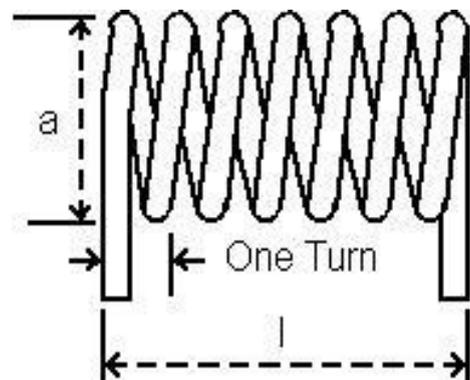


Figure 2

3.2. Wireless power transmission trends Authors: Mohammad Shidujaman; HoomanSamani; Mohammad Arif

Wireless power transmission (WPT) has been attracting a wide range of subjects in various fields and also become a highly active research area because of their potential in providing high technology to our daily lives. The wireless power transmission will be mandatory to use in the near future because this technology enables the transmission of electrical energy from a power source to an electrical load across an air gap without interconnecting wires. In this paper, we carry out a pilot study to present the existing technologies of wireless power transmission, their recent technology as well as its future trends. Furthermore, we also describe plenty of applications in wireless transmission.

3.3. Research on the wireless power transmission system based on coupled magnetic resonances Authors: Qiang Wang; Hong Li

This analysis and designs a kind of wireless power transmission system via coupled magnetic resonances. It introduces the wireless power transmission technology, and expounds the principle of coupled magnetic resonant wireless power transmission technology and its superiority. Then it analyzes the influence of the related parameters such as the transmission distance d and load resistance R_L of the emitting and receiving resonant coils on the transfer efficiency and transfer power of the system. The experiment tests the proposed wireless power transmission system, and the results show that the above relevant parameters should be comprehensively considered, in order to achieve the optimization design of the transmission efficiency or transmission power. The experiment results also show the validity of the theoretical analysis.

4. EXISTING SYSTEM

The limitations of the current generation of EVs. Using charging, an electric vehicle can be charged by power cables embedded in the road.

4.1 DISADVANTAGES OF EXISTING SYSTEM

- Wireless power transmission can be possible only in few meters.
- Efficiency is only about 40 %, Aswitrlicity is in development stage, lot of work is done for improving the efficiency and distance between transmitter and receiver.

5. PROPOSED SYSTEM

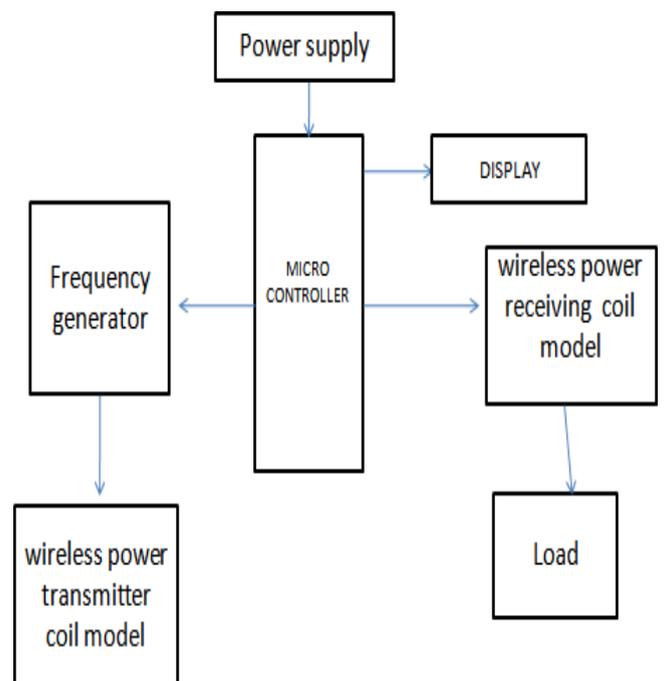
In contrast, roadway powered electric vehicles (RPEV) among other electric vehicles do not necessarily require battery energy storage for their traction as they are using dynamic wireless power transfer systems (WPTS)

to get the power as they are moving on roads. This is seen as a promising candidate for future propulsion of small cars, taxis, buses, trams, trucks and trains. It can even be competitive with internal combustion engine powered vehicles.

5.1. ADVANTAGES OF PROPOSED SYSTEM

- ❖ Very Simple design
- ❖ Frequency operation is very low
- ❖ Very Low cost
- ❖ Practical for learne

5.2. BLOCK DIAGRAM



5.3. HARDWARE



Figure 3

6. WORKING PRINCIPLE

The transmitter module of our project is made up of a D.C. power source, an oscillator circuit (commonly known as an inverter) and a transmitter coil. The D.C. power source provides a constant D.C. voltage to the input of the oscillator circuit. There, this D.C. power is converted to a high frequency A.C. power and is supplied to the transmitter coil. The transmitter coil, energized by the high frequency A.C. current, produces an alternating magnetic field.

The receiver module of our project is made up of a receiver coil, a rectifier circuit and a voltage regulator IC. And additional buck converter to get more current by decreasing output voltage to 5 volts. An A.C. voltage is induced in the receiver coil. The rectifier circuit converts it to D.C. and the voltage regulator IC helps to maintain a constant limited voltage at the load.

7. CONCLUSION

The goal of this project was to design and implement a wireless charger for low power devices via resonant inductive coupling. After analyzing the whole system step by step for optimization, a circuit was designed and implemented. Experimental results showed that significant improvements in terms of power-transfer efficiency have been achieved. It was described and demonstrated that resonant inductive coupling can be used to deliver power wirelessly from a source coil to a load coil and charge a low power device. As it was mentioned earlier, wireless charging could be the next big thing.

8. REFERENCES

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