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Magnetic Field Distribution in a WPT System for Electric Vehicle Charging

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Introduction

Wireless power transfer technology has various applications.

- Smart phones & Tablets
- AA Battery Powered Devices

Source: www.iectechnology.com
Source: http://powerbyproxi.com/wireless-charging/
Medical Devices & Equipment

Source: rahulmittal.wordpress.com/2014/03/31/wireless-charging-do-we-need-this-technology-in-its-current-form/
Vehicles & Transport

Source: http://articles.sae.org/12647/
Introduction

- Wireless power transfer technology has various applications.
- Wireless power transfer technology has many benefits.

- Convenience;
- Compatibility;
- Safety;
- Durability;
Motivations

- Efficient design of WPT for electric vehicles;
- Safety consideration of WPT system.
System Overview

- Wireless charging electric vehicle;

Source: http://gcep.stanford.edu/images/news/wireless_car_charging_400px.jpg
System Overview

- Wireless charging electric vehicles;
- Inductive coupled power transfer (ICPT) system;

- Near range
- High power efficiency
- Low frequency

Ref. J. Kim, 2013
**System Overview**

- Wireless charging electric vehicles;
- Inductive coupled power transfer system;
- 3-D finite-element analysis in system design;

Chassis: steel sheet (1250mm x 1900mm).

Transmitter/Receiver Pad:
- Copper coils (4 turns);
- Ferrite Core (840mm x 680mm);
- Aluminum shield (914mm x 914mm).
System Overview

- Wireless charging electric vehicles;
- Inductive coupled power transfer system;
- 3-D finite-element analysis in system design;

![Diagram of chassis, receiver pad, and transmitter pad with coil spacing measurements.]
System Overview

- Wireless charging electric vehicles;
- Inductive coupled power transfer system;
- 3-D finite-element analysis in system design;
- Experimental system.
Results Outline

1) Effect of output power on magnetic field distribution (MFD)
2) Effect of coil spacing on MFD
3) Effect of chassis on MFD
4) Effect of misalignment on MFD
Effect of Output Power

- The transmitter pad and the receiver pad are perfectly aligned.
- Coil spacing is 200mm.
- Chassis is in position.
- Load resistance is 5.54Ω.
- MFD is measured 300mm above ground.

How is the magnetic field distribution for——

5kW, 15kW and 20kW output power?
Effect of Output Power

Experimental Results

5kW

15kW

20kW
Effect of Output Power
Experimental Results (Scaled to 20kW)
Effect of Coil Spacing

- The transmitter pad and the receiver pad are perfectly aligned.
- Chassis is in position.
- MFD is measured 300mm above ground.

How is the magnetic field distribution for——

100mm, 150mm, 200mm and 250mm coil spacing?
Effect of Coil Spacing

100mm

150mm

200mm

250mm
Effect of Coil Spacing

Put all results in the same-size window. All results are scaled to 20kW.
Effect of Chassis

- The transmitter pad and the receiver pad are perfectly aligned.
- Coil spacing is 200mm.
- Output power is 15kW.
- MFD is measured 300mm above ground.

How is the magnetic field distribution for——

with chassis and without chassis case?
Effect of Chassis

With chassis

Without chassis
Effect of Misalignment

- Coil spacing is 200mm.
- 15kW output power;
- MFD is measured 300mm above ground.

How is the magnetic field distribution for—

aligned and misaligned coils, with/without chassis?
Effect of Misalignment

Aligned, with chassis

200mm misaligned, with chassis

Aligned, no chassis

200mm misaligned, no chassis
Conclusion

1. We have studied the impact of four parameters on the magnetic field distribution in wireless power transfer system for EVs.

2. We have verified that the magnetic field distribution is proportional to the square root of output power.

3. Small gap leads to smaller fringing fields.

4. Inclusion of chassis in the system effectively shields the magnetic field.

5. Misalignment between coils increases the magnetic field.