Coil Specific Considerations when designing a Wireless Power System

Joerg Hantschel
Würth Elektronik eiSos GmbH

September, 2015
The Würth-Group – A strong family

The Würth Group
- Over 66,000 employees*
- 10.12 billion € sales*
- 400 companies*
- In more than 80 countries*

The Würth Elektronik Group
- Over 7,500 employees*
- Sales of 610 million €*
- 3 Business Units (eISos, CBT, ICS)*
- WE eISos: one of the biggest European manufacturers of passive components
- In 50 countries*
- The biggest producing entity of the Würth-Group

* Preliminary figures 2012

© All rights reserved by Würth Elektronik, also in the event of industrial property rights. All rights of disposal such as copying and redistribution rights with us.

www.we-online.com
The Würth Elektronik Group

Electronic & Electromechanical Components
Printed Circuit Boards
Intelligent Systems

Standard
Custom

eiSos

Passive Components
Power Modules
LEDs
Electromechanical Components

eiCan

Connectors
Automotive
Magnetics

Sales:
eiSos: 400 million €
CBT: 155 million €
ICs: 55 million €

March 2013 · Page 3
www.we-online.com
Wireless Power Transmitter and Receiver
Coil System Requirements

- Available space within Rx device
- Thickness of Rx coil
- Distance between Tx and Rx
- Freedom of positioning Rx
- Electrical performance (efficiency, Q-factor, $R_{DC}$, shielding..)
- Price
Skin Effect

The penetration depth $\delta$ can be described with the following formula:

$$\delta = \sqrt{\frac{2\rho}{\omega \mu}}$$

- $\rho$: specific resistance
- $\omega$: angular frequency
- $\mu$: sheared effective permeability (e.g.: 100)

Source: en.wikipedia.org
Proximity Effect

The proximity effect causes current constriction or current displacement in closely spaced conductors.

Source: itwissen.info

Source: electrical4us.com
Coupling factor / alignment tolerances

Good coupling and maximum energy transmission depends on:
- size of the effective area of the receiver coil in the magnetic field
- the distance in the z direction

A coupling factor of 1 is ideal
2D FEMM Analysis of WPT model-angular misalignment

Response of coupling factor for angular displacement

Gap (mm) between Transmitter coil and Receiver coil

Coupling factor, k

- 10 deg
- 20 deg
- 30 deg
- 40 deg
Improvement using ferromagnetic shielding
EMI Measurement at Receiver Side
Performance analysis of WPT system based on Rx coil shielding material

Frequency (Hz)

Amplitude (dBm)

Type 1 - low emissions

Type 1 Rx coil

Type 2 Rx coil

Type 4 Rx coil
Würth Elektronik Wireless Power Coils WE-WPCC

- Fully compliant to WPC Qi standard
- Efficiency up to 93%
- Supreme shielding characteristics for low leakage inductance
- Outstanding performance due to usage of litz wire:
  - lowest $R_{DC}$
  - highest Q values
15 Transmitter Coils

15 Receiver Coils
Thank you