



INTRODUCTION: WIRELESS POWER TRANSFER

David Martin, WPT TEAM

WURTH ELEKTRONIK MORE THAN YOU EXPECT



- Applications
- Technologies & Standards
- Coil Specific Considerations
- Würth Elektronik Products & Advantages





OH SO 20TH CENTURY.....



WIRELESS POWER TRANSFER HISTORY

1893 first wireless powered lightbulb N. Tesla

- 1980s electrical toothbrush
- **2008** founding of Wireless Power Consortium (WPC) Qi Standard
- **2011** first smart phones with integrated Qi receiver
- 2017 Apple join WPC

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2018 Wireless charging of EV's







Applications



...YOU USE WIRELESS POWER TRANSFER EVERYDAY ALREADY











APPLICATION AREAS BESIDES CONSUMER PRODUCTS



Industrial

Automotive



https://youtu.be/GlrcPrzuPMM



Medical Technology

Furniture / Infrastructure





Schmitz & Söhne Germany Remote control operating table





Power < 5W



Kanso[™] Sound Processor

Quick Guide



Attach your processor





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Heinrichs Weikamp gmbh Charge diving computer





Power < 5W



WIRELESS POWER

CONSORTIUM

More power

KEY BENEFITS OF A KI CORDLESS KITCHEN





INDUSTRIAL WIRELESS CHARGING









Technologies and Standards



HOW DOES WIRELESS POWER TRANSFER WORK?

- Power transfers via inductive coupling at short distances (mm range)
- Transmitter (Tx) and Receiver (Rx) Coils are inductively coupled coils.

 Magnetic field concentrated in small volume between Tx / Rx





HOW DOES WIRELESS POWER TRANSFER WORK?

Inductively coupled magnetic resonant system



- Frequency: kHz regime
- Distance: short range regime (e.g. 1-10mm)

Maximum Transmission Efficiency



FIGURE OF MERIT FOR EFFICIENT POWER TRANSFER



coupling κ is often limited by boundary conditions of the application

High Q coils allow

- long transfer distance
- higher freedom of positioning

$$\eta_{\max} = \frac{\kappa^2 Q^2}{\left(1 + \sqrt{1 + \kappa^2 Q^2}\right)^2} \approx 1 - \frac{2}{\kappa Q}$$

CLOSE-COUPLED INDUCTANCE



inductive power transfer

Closely coupled inductive

- Power transfer using resonant tank at very low frequency
- over short distances (typ. 10 mm)
- Resonant tank at 100 205 kHz
- promoted by: Wireless Power Consortium (Qi)
 - 'Baseline Power Profile' 5W
 - 'Extended Power Profile' 15W
 - (also proprietary, 'Fast-charging')
 - higher power classes in development: Kitchen (Ki'), laptops, power tools, robotics, LEVs, ...
 - over 300 members, over 5,600 products certified

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POWER THROUGH THE AIR / LOOSELY COUPLED



resonant power transfer

- Loosely coupled
 - Power transfer based on resonant tank at very high frequency

over longer distances (40mm)

- Ability to charge multiple devices at same time
- Resonant tank at 6.78MHz. (ISM Band)
- Capability up to *30W systems
- promoted by AirFuel Alliance



(formed from Alliance for Wireless Power (A4WP) and the Power Matters Alliance (PMA)



SO, WHAT IS GREAT ABOUT WIRELESS POWER TRANSFER?

- It's a Covid world: no-touch, no-contact
- It's a Green world: cable-less
- Completely sealed devices: hygienic, wipe clean
- No ports / metal contacts
- Damp-proof, water-proof
- Proven technology, established standards, established infrastructure
- Interoperability
- Safety your device, and metallic objects nearby
- Convenience
- Integration in IoT



Coil specific considerations



OPTIMIZING THE COIL – POINTS TO CONSIDER

- Use the largest possible coil
- Keep the distance in the range of maximum efficiency
- Keep the misalignment minimal
- Choose the best matching coil combination
- Be aware of parameters which influence performance or cost (FoM, wire,..)

COIL TYPES - FREEDOM OF POSITIONING







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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

$$k = \frac{M}{\sqrt{L1 \cdot L2}}$$

A coupling factor of 1 is ideal

3D FEMM ANALYSIS OF WPT MODEL-ANGULAR MISALIGNMENT





IMPROVEMENT USING FERROMAGNETIC SHIELDING









COUPLING FACTOR K DEPENDING ON COIL SIZE RATIO



• is defined by current and coil diameter $= \frac{\phi_1}{\phi_{21}}$



Examples from *WE* Mix&Match and RedExpert



TX/RX SIZE RATIO IMPACT

760 308 100 111 (A11)



k= 0.29 A_{Rx}/A_{Tx} = 1:6



760 308 101 214

760 308 101 104



k= 0.60 A_{Rx}/A_{Tx} = 1:1



760 308 101 214



RECEIVER COILS SIZE IS A KEY FOR SUCCESS

Applications





https://de.ifixit.com/Teardown/iPhone+12+und+12+Pro+Teardown/137669



WE Products



WE WIRELESS POWER COILS

Broadest portfolio of wireless power coils





CUSTOMER SPECIFIC COILS



Use template on WPT website:

Wireless Power Coil Inquiry Sheet

MOQ: 5.000



www.we-online.com/wirelesspower/200WKit

- The current profile is almost sinusoidal
- By changing the resonance frequency the output voltage can be regulated
- It is scalable from low to high power (10 W 10kW)
- The MOSFETs switch close to the zero crossover point (ZVS)
 - \rightarrow efficiency > 90%
- It is scalable for many different voltages/currents
- Data transfer from receiver to transmitter possible
 www.we-online.de/ANP070





www.we-online.com/wirelesspower/200WKit





Transmitter col

www.we-online.com/wirelesspower/200WKit

Structures for EMC protection, signal filtering

- Resonant tank: series resonant circuit for better magnetic coupling between the two coils better efficiency, wider transmission range
- XMC controller to control all signals (PWM, LEDs, RS232, Debug, Encoder, operating mode and other internal signals)
- Full Bridge circuit and bridge control: transformation of DC current to AC current
- Interfaces: RS232 (e.g. display board), debug, operating mode (man./auto.), incremental encoder

Input power 200 W:

Input voltage 19...24 V

Input current 10 A max.



www.we-online.com/wirelesspower/200WKit



- Smooting capacitors for a stable output voltage
- Resonant tank: series resonant circuit for better magnetic coupling between the two coils better efficiency, wider transmission range
- XMC controller to control all signals (PWM, LEDs, I²C, Debug and other internal signals)
- Active rectifier: transformation of AC current to DC current
- Interfaces: I²C (e.g. temperature sensor), debug, interface to define



WIRELESS POWER TRANSFER ENABLES IIOT WECUT THE CORD!





Information Material



WIRELESS POWER TRANSFER WEBSITE

HTTP://WWW.WE-ONLINE.COM/WIRELESSPOWER



FAQ - HOTLINE

http://www.we-online.com/wirelesspower/faq



Other requests to wirelesspower@we-online.com





REDEXPERT FOR WIRELESS POWER COIL

https://www.we-online.com/redexpert/wirelesspower



NEW! TRILOGY OF WIRELESS POWER TRANSFER

1 Basic Principles Part 1: Basic Principles 1.1 Wireless Power Transfer Methods. 1.1.1 Near-field Technology 1.1.2 Far-field Technology 1.2 Wireless Power Transfer Standards. 1.2.1 Wireless Power Consortium 1.2.2 AirFuel Alliance



2 WPT Systems

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3 Application

Part 3: Application

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3.1.6	Closely Coupled Systems.
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744018



- INE have the broadest publicly available portfolio of wireless power coils
- INE do customer specific coils
- INE have a high performance / quality product line
- IVE have a high volume product line
- IVE have supporting tools (Mix&Match, Red Expert, Trilogy)

