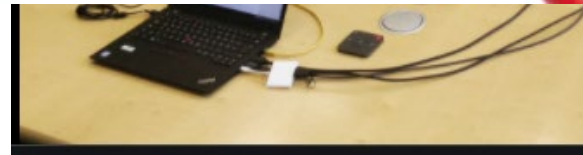
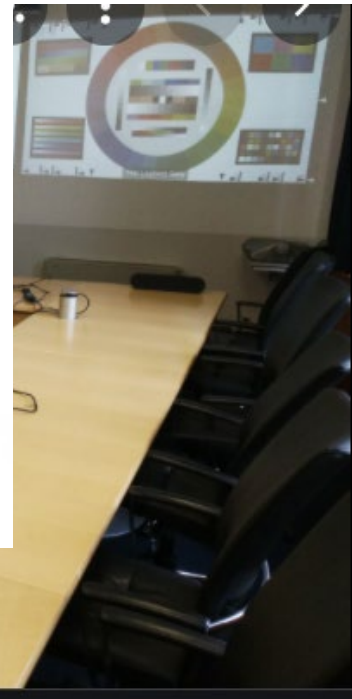




## OH SO 20<sup>TH</sup> CENTURY.....



# ...YOU USE WIRELESS POWER TRANSFER EVERYDAY ALREADY



# APPLICATION AREAS BESIDES CONSUMER PRODUCTS



Industrial

Automotive



<https://youtu.be/GIrcPrzuPMM>



Medical Technology

Furniture / Infrastructure



# AGENDA

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



# WIRELESS POWER TRANSFER HISTORY

**1893** first wireless powered lightbulb N. Tesla

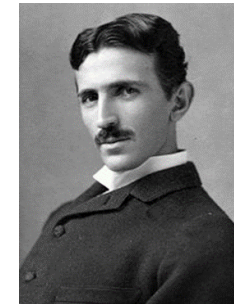
**1980's** electrical toothbrush

**2008** founding of Wireless Power Consortium (WPC) Qi Standard

**2011** first smart phones with integrated Qi receiver

**2017** Apple join WPC

**2018** Wireless charging of EV's



**WIRELESS POWER**  
CONSORTIUM

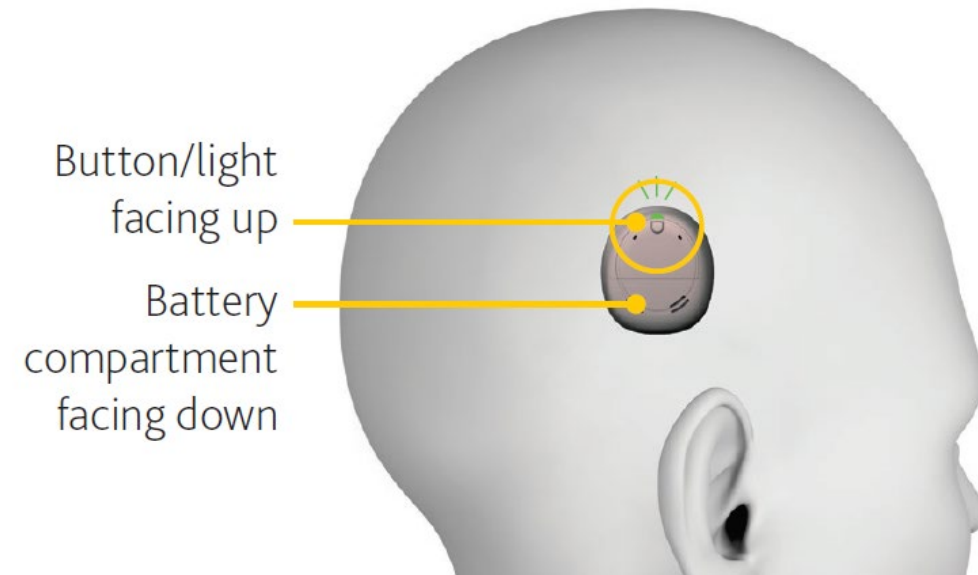


# Applications

# APPLICATIONS OF WE CUSTOMERS



## Attach your processor





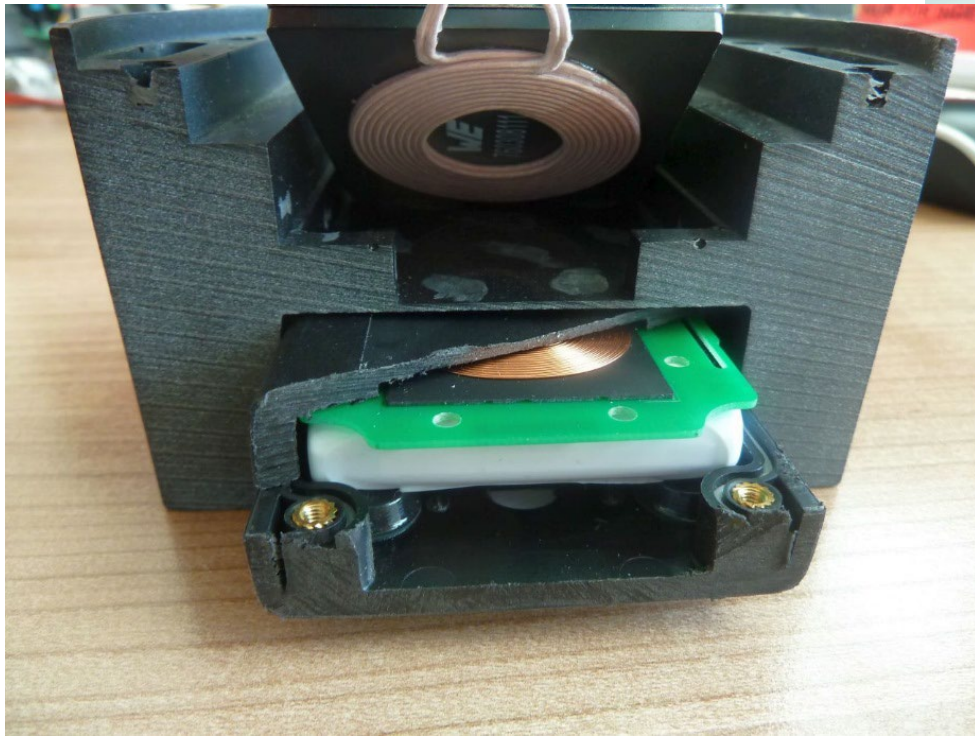
## APPLICATIONS OF WE CUSTOMERS



Lower power medical devices: hearing aids, maternity healthcare

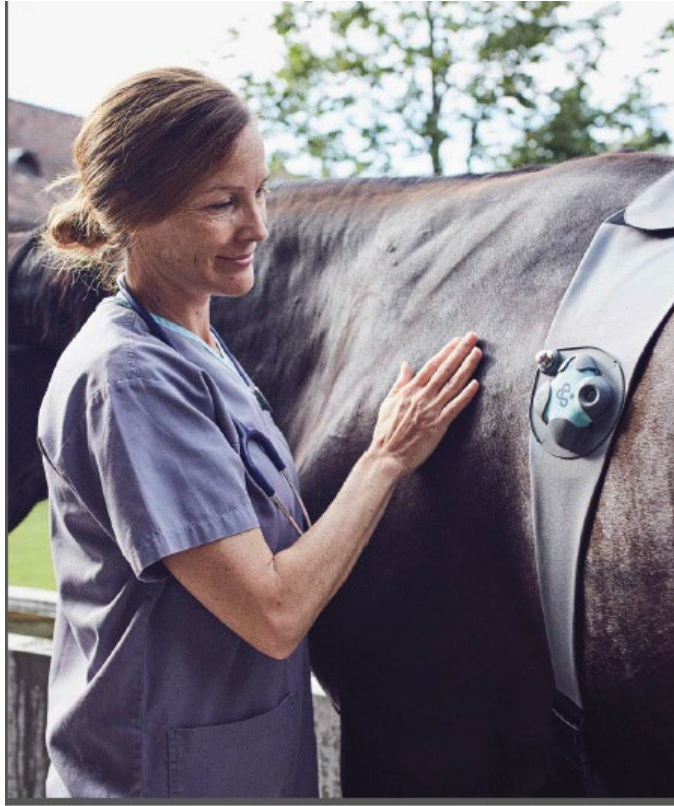
# APPLICATIONS OF WE CUSTOMERS

Schmitz & Söhne Germany  
Remote control operating table



Power < 5W

# APPLICATIONS OF WE CUSTOMERS







## THE FUTURE OF WIRELESS

With no charging cable required, Piavet Charger is truly designed for the wireless world. Charge your Piavet Measuring Device safe, fast and easy.



## HIGH DATA VOLUME

The Piavet Base Station enables the wireless transmission of high-volume medical data. It collects the recordings from the Piavet Measuring Device and visualize them in real-time on any internet-connected device.

Power < 5W

## APPLICATIONS OF WE CUSTOMERS

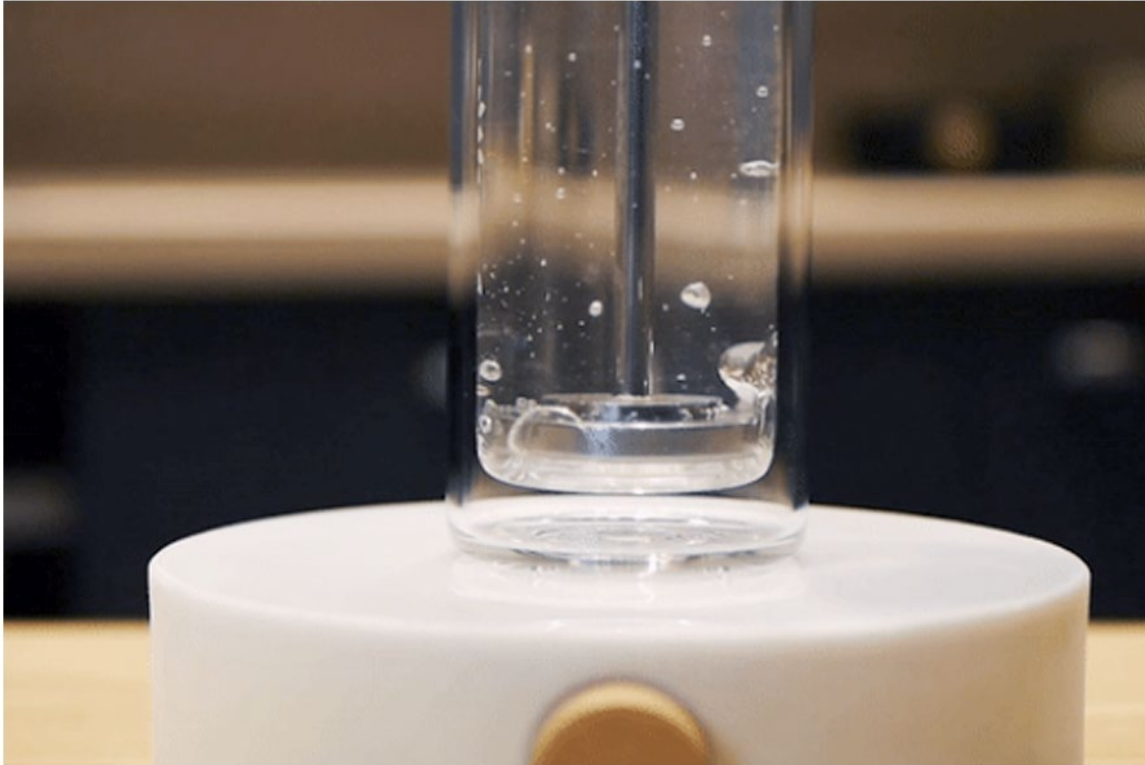
Heinrichs Weikamp gmbh  
Charge diving computer



Power < 5W



## APPLICATIONS OF WE CUSTOMERS



# More power

**60 – 200 Watt**



17 February 2017

**200 – 2400 Watt**

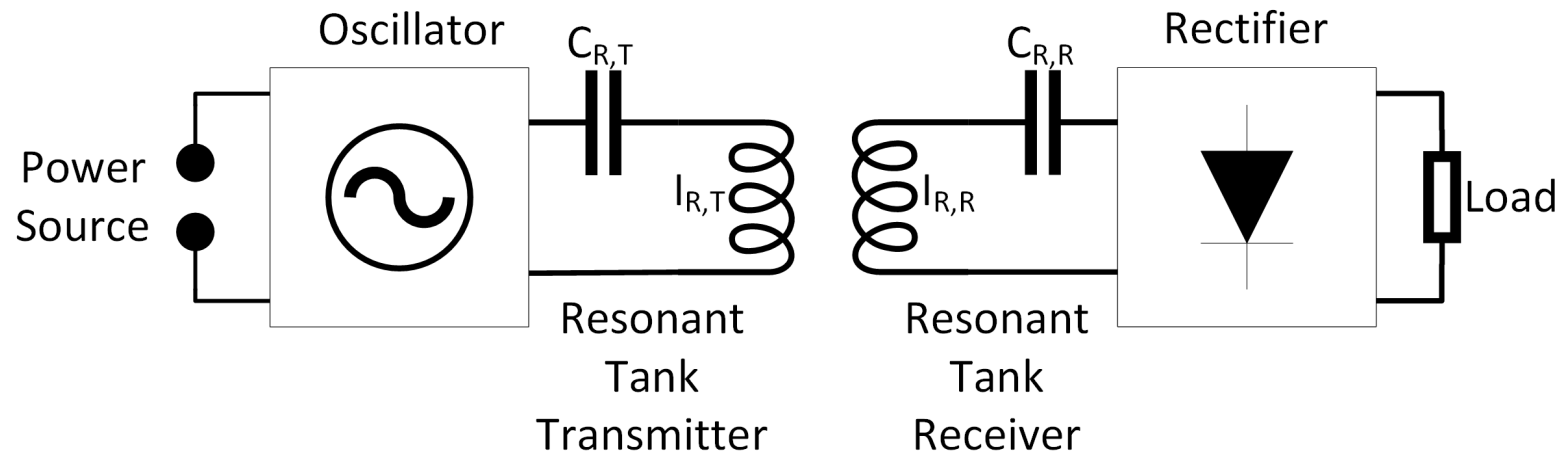


2

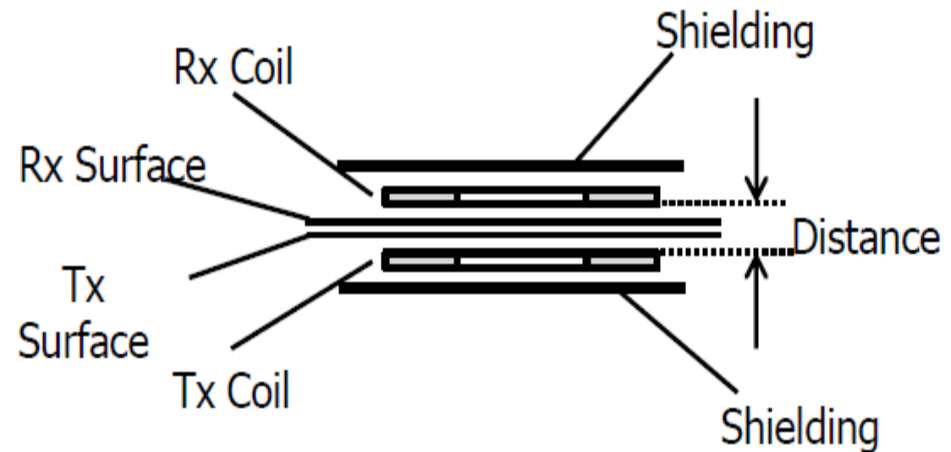


# Technologies and Standards

# HOW DOES WIRELESS POWER TRANSFER WORK?

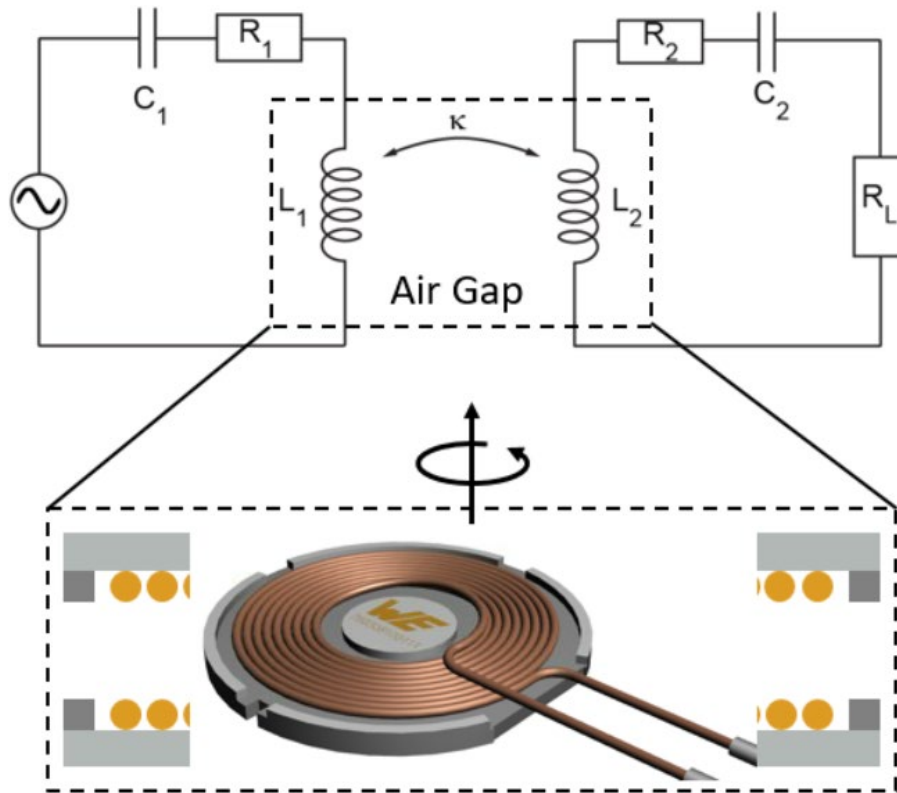


- Power transfers via inductive coupling at short distances (mm range)
- Transmitter (Tx) and Receiver (Rx) Coils are inductively coupled coils.
- Magnetic field concentrated in small volume between Tx / Rx



# 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

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

↑  
high Q

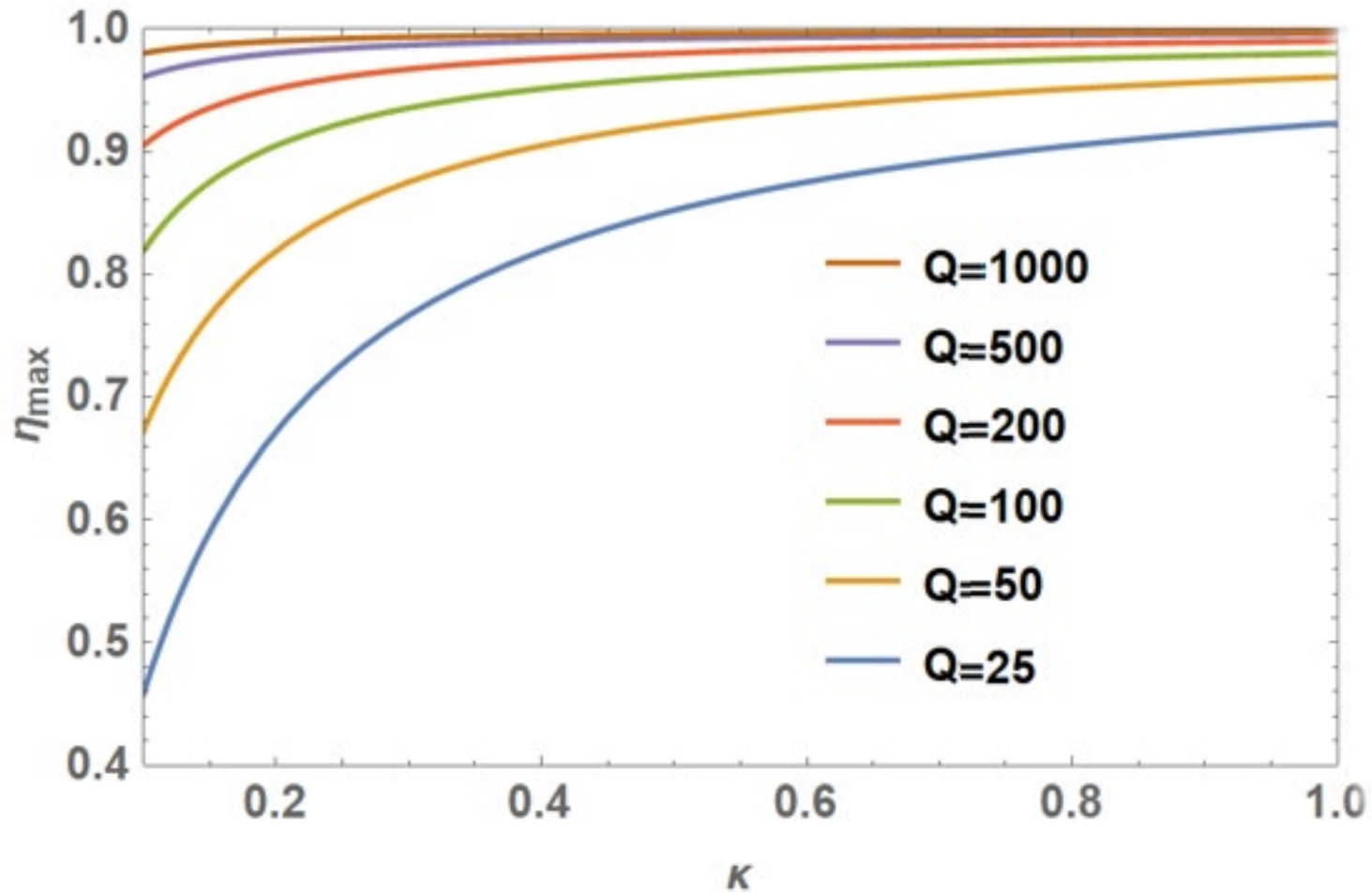
$\kappa$

coupling factor

$Q$

quality factor

## FIGURE OF MERIT FOR EFFICIENT POWER TRANSFER



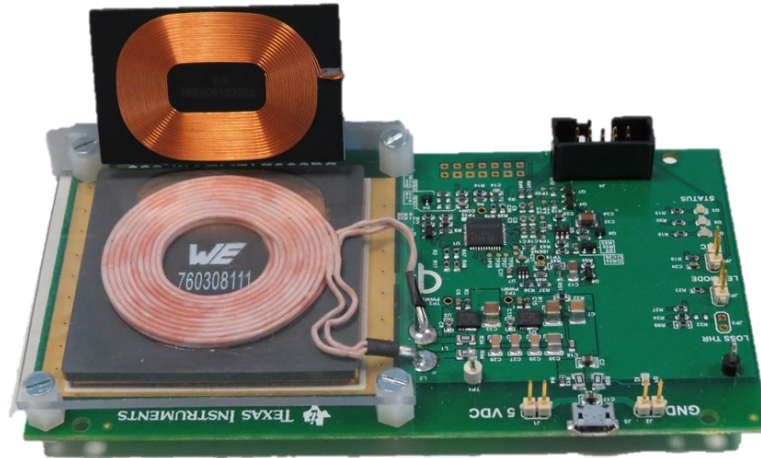
coupling  $\kappa$  is often limited by boundary conditions of the application

High  $Q$  coils allow

- long transfer distance
- higher freedom of positioning

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

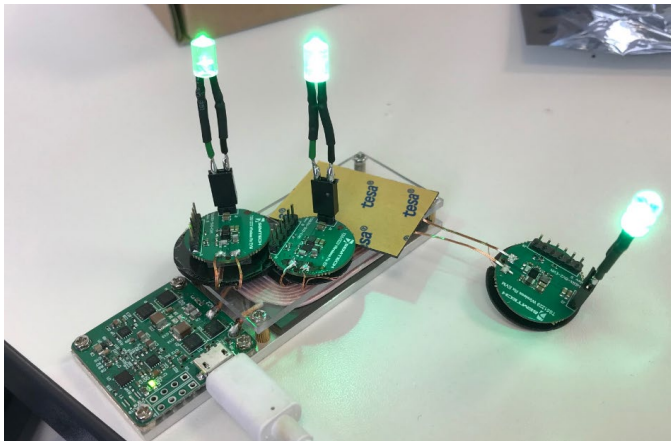
# CLOSE-COUPLED INDUCTANCE



inductive power transfer



resonant power transfer



# WIRELESS POWER STANDARDS



- **Loosely coupled**

- AirFuel Alliance *(formed from Alliance for Wireless Power (A4WP) and the Power Matters Alliance (PMA))*
  - 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
  - Under 50 products certified



# SUCCESS FACTORS OF WIRELESS POWER TRANSFER

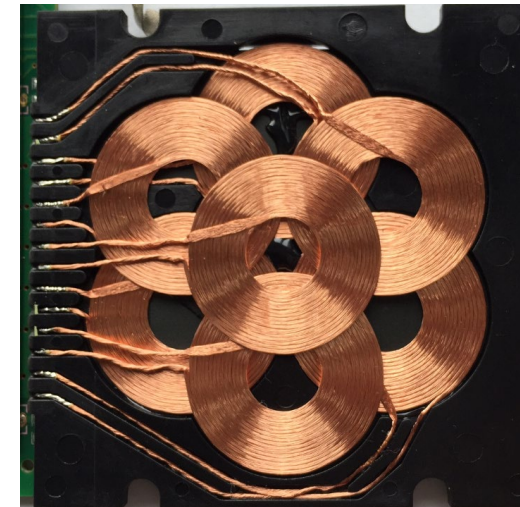
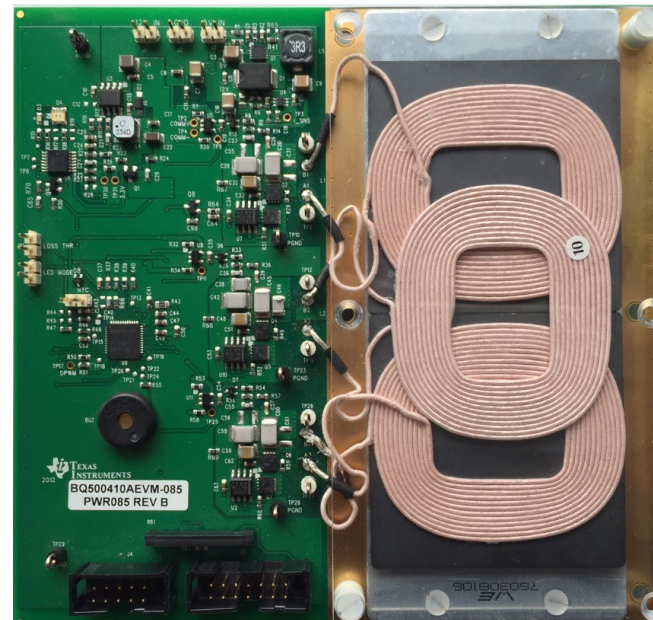
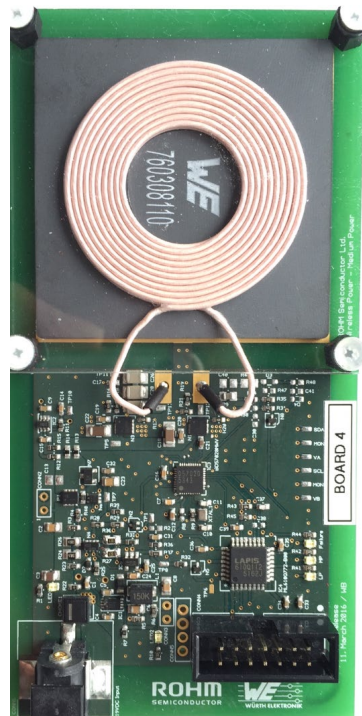
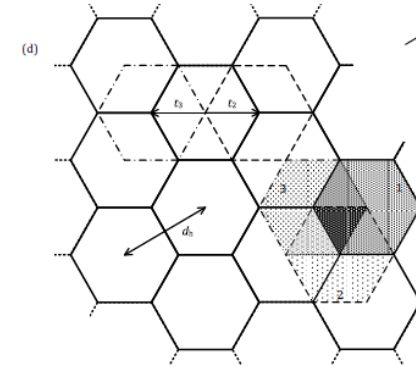
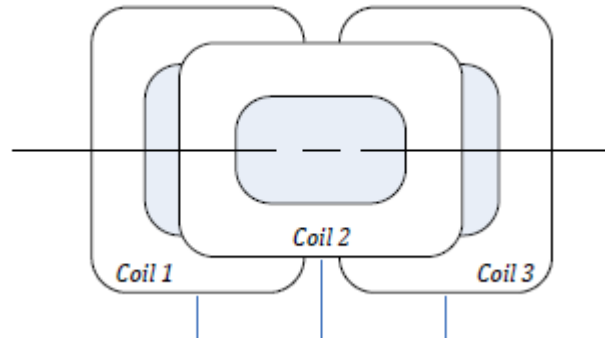
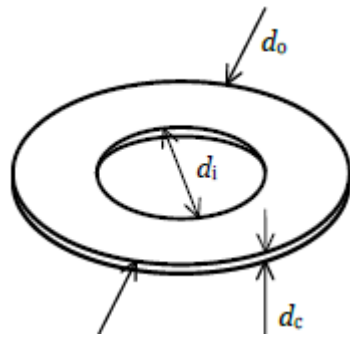
- No metal contacts
- Completely sealed devices
- Standard
- Interoperability
- Safety
- Convenience
- Integration in IoT

# Coil specific considerations

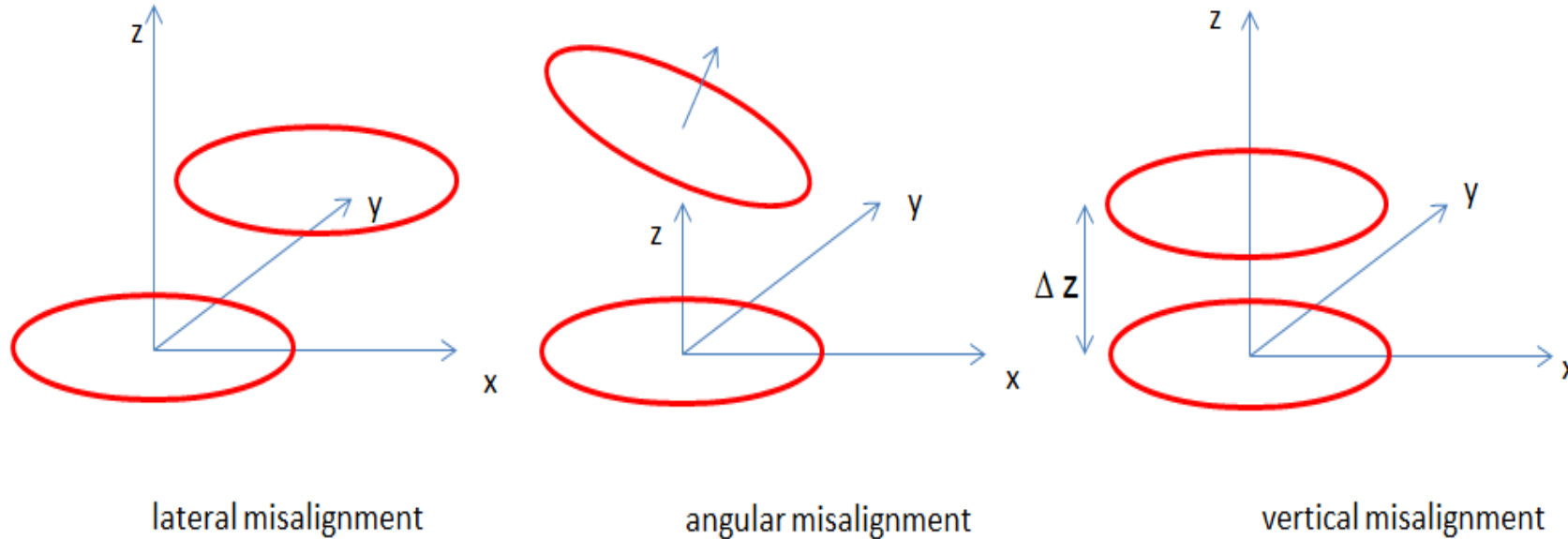
## OPTIMIZING THE COIL – POINTS TO CONSIDER

- 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



## COUPLING FACTOR / ALIGNMENT TOLERANCES



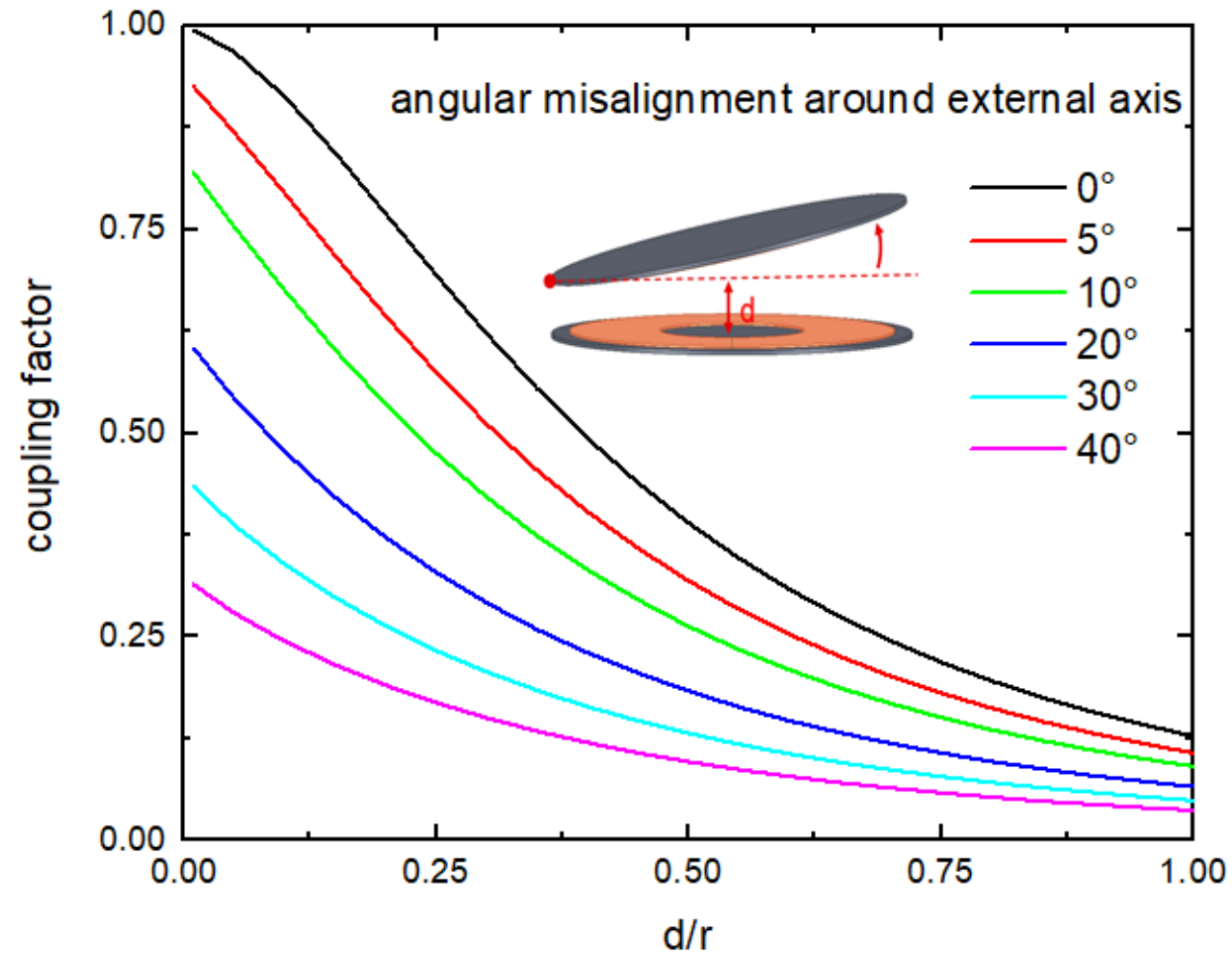
Good coupling and maximum energy transmission depends on

- size of the effective area of the receiver coil in the magnetic field
- the distance in the z direction

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

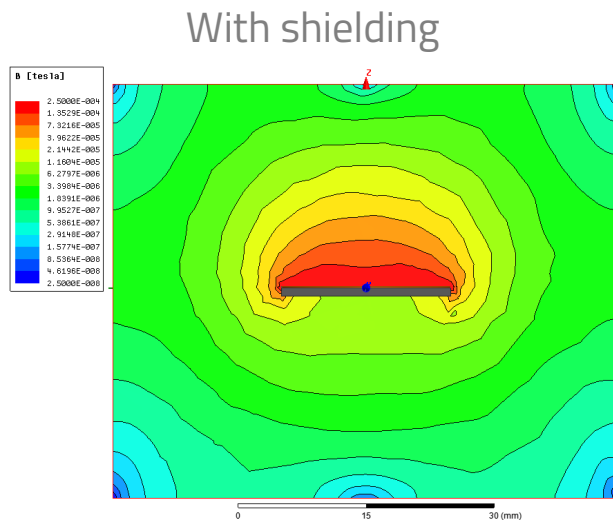
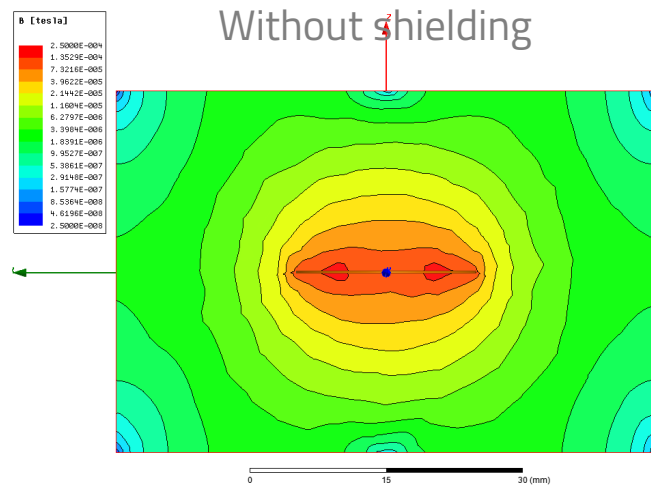
A coupling factor of 1 is ideal

# 3D FEMM ANALYSIS OF WPT MODEL-ANGULAR MISALIGNMENT

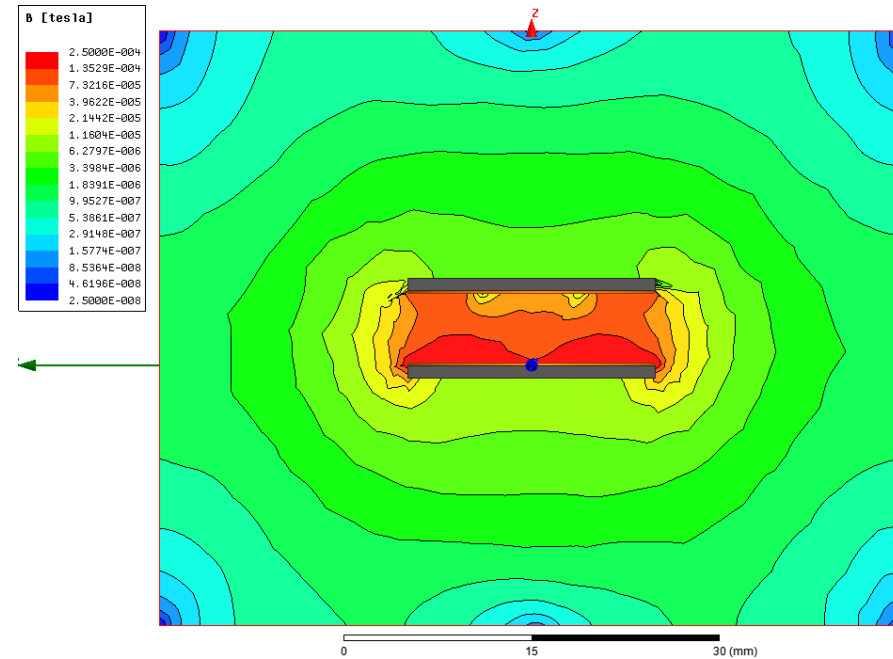




# IMPROVEMENT USING FERROMAGNETIC SHIELDING



Tx\_Rx with shielding



# COUPLING FACTOR K DEPENDING ON COIL SIZE RATIO

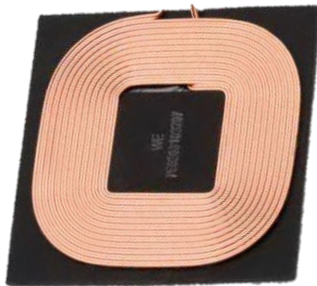
- Tx/Rx coil size impacts coupling factor k

$$k = \frac{\phi_1}{\phi_{21}}$$

$$\Phi_{21} = B_1 A_2 = \left( \frac{\mu_0 I_1}{2R_1} \right) \pi R_2^2 = \frac{\mu_0 \pi I_1 R_2^2}{2R_1}$$



k= 0.81  
 $A_{Rx}/A_{Tx} = 1:1$



k= 0.75  
 $A_{Rx}/A_{Tx} = 1:1.1$



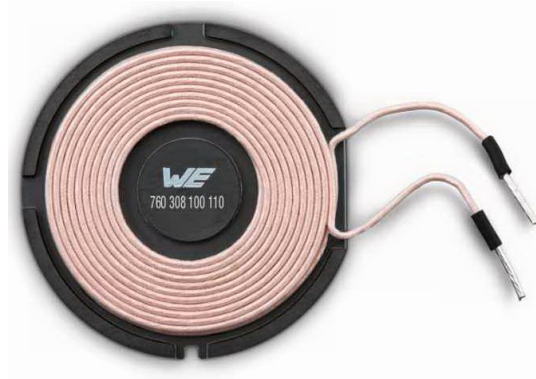
k= 0.61  
 $A_{Rx}/A_{Tx} = 1:2$



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



$k = 0.60$

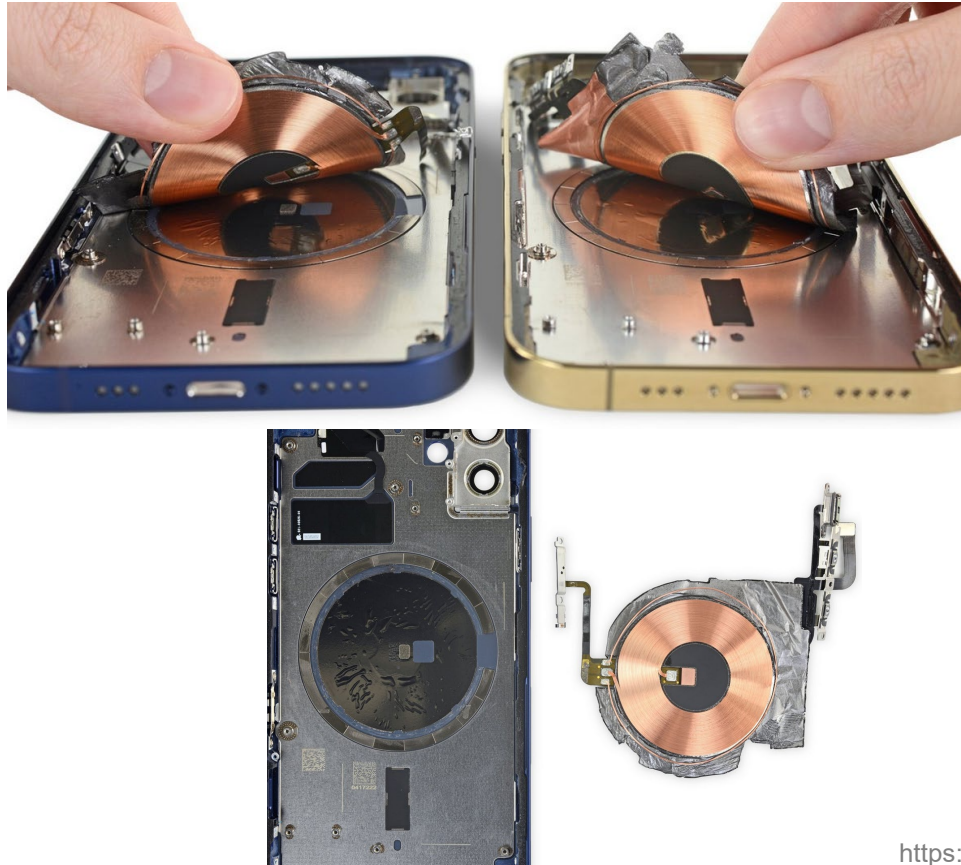
$A_{RX}/A_{TX} = 1:1$



760 308 101 214

# RECEIVER COILS SIZE IS A KEY FOR SUCCESS

## Applications



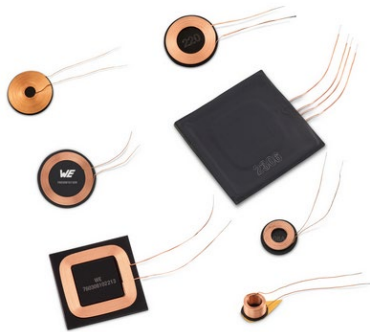
<https://de.ifixit.com/Teardown/iPhone+12+und+12+Pro+Teardown/137669>

# WE Products

# WE WIRELESS POWER COILS

Broadest portfolio of wireless power coils: in total 65

Receiver coils



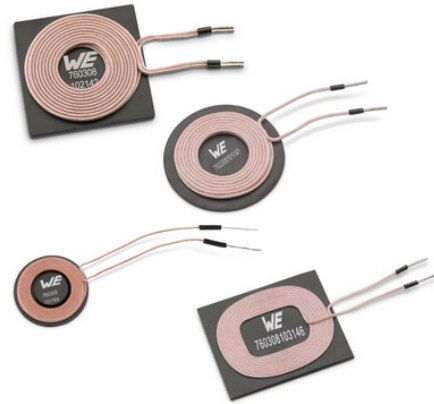
24 coils

Size: 6 – 48 mm

Power: 5 – 80 W

Magnet wire

Transmitter coils



28 coils

Size: 20 – 75 mm

Power: 40 – 400 W

Litz wire

Array coils



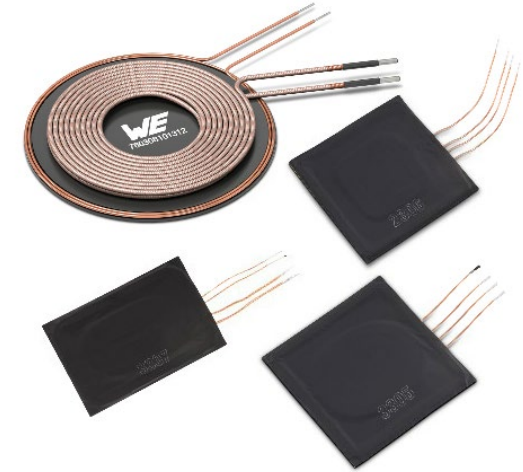
8 coils

Size: 71 – 130 mm

Power: 150 W

Litz wire

WPT / NFC coils



5 coils

Size: 40 – 65 mm

Power: 20 – 100 W

Magnet / Litz wire



## CUSTOMER SPECIFIC COILS



Use template on WPT website:

**[Wireless Power Coil Inquiry Sheet](#)**

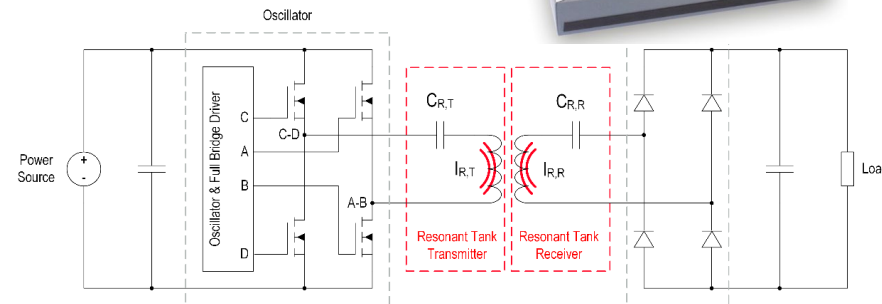
MOQ: 5.000

## NEW 200W WPT solution with data transfer

[www.we-online.com/wirelesspower/200WKit](http://www.we-online.com/wirelesspower/200WKit)

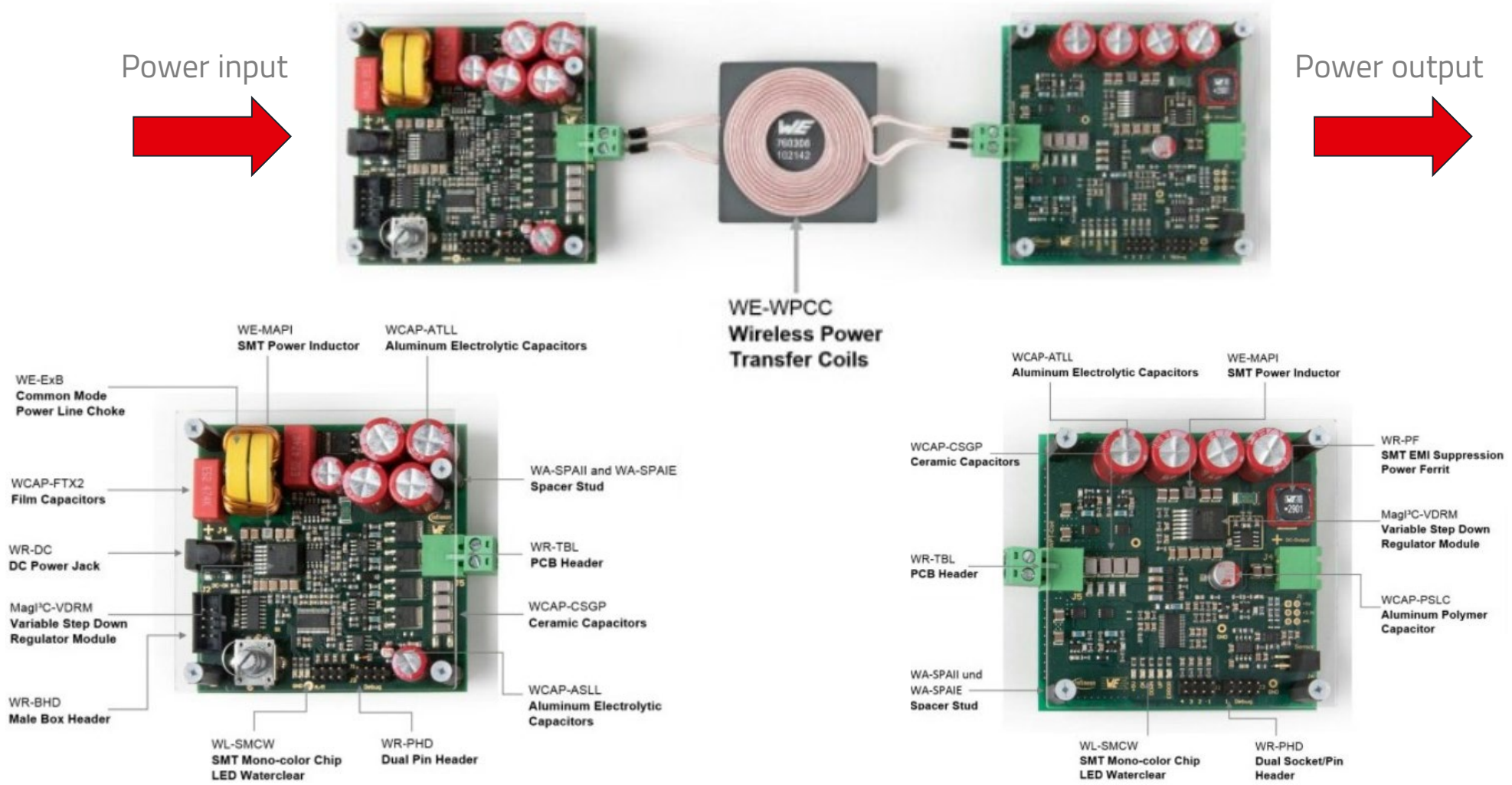
- The current profile is almost sinusoidal
- By changing the resonance frequency the output voltage can be regulated
- It is scalable from low to high power (10 W – 10kW)
- The MOSFETs switch close to the zero crossover point (ZVS)  
→ efficiency > 90%
- It is scalable for many different voltages/currents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

[www.we-online.de/ANP070](http://www.we-online.de/ANP070)



## NEW 200W WPT solution with data transfer

[www.we-online.com/wirelesspower/200WKit](http://www.we-online.com/wirelesspower/200WKit)



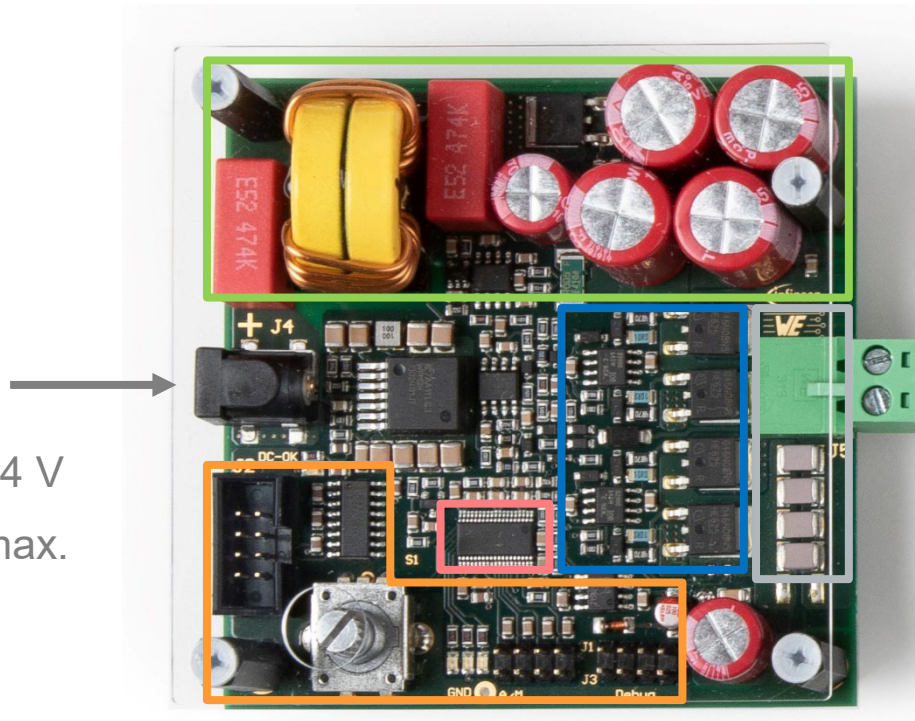


## NEW 200W WPT solution with data transfer

[www.we-online.com/wirelesspower/200WKit](http://www.we-online.com/wirelesspower/200WKit)

Input power 200 W:

- Input voltage 19...24 V
- Input current 10 A max.



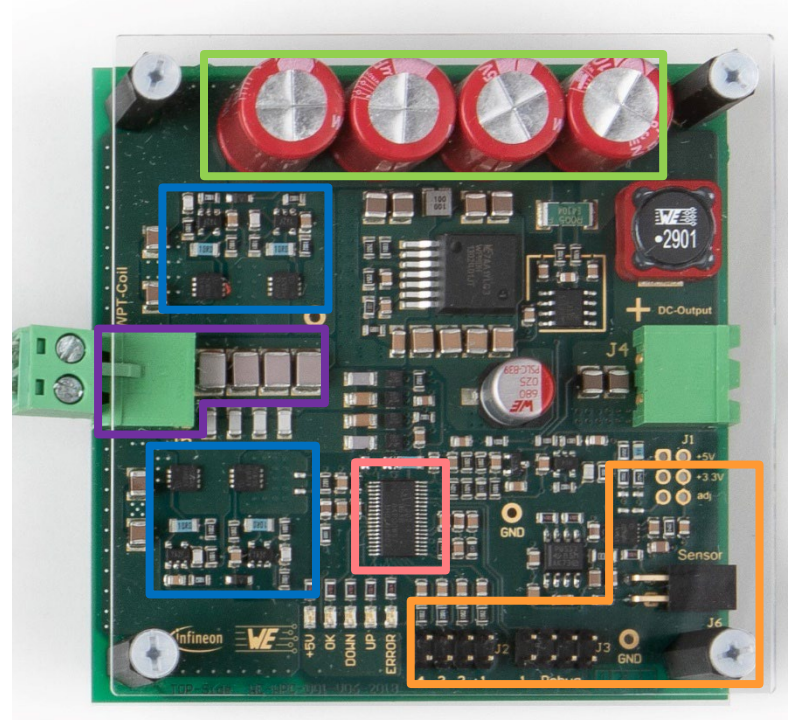
Transmitter coil

- 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

## NEW 200W WPT solution with data transfer

[www.we-online.com/wirelesspower/200WKit](http://www.we-online.com/wirelesspower/200WKit)

Receiver coil →



→ Output power 200 W:

- Output voltage 19 V
- Output current 10 A max.


- Smoothing 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, I<sup>2</sup>C, Debug and other internal signals)
- Active rectifier: transformation of AC current to DC current
- Interfaces: I<sup>2</sup>C (e.g. temperature sensor), debug, interface to define




# Information Material




# WIRELESS POWER TRANSFER WEBSITE


[HTTP://WWW.WE-ONLINE.COM/WIRELESSPOWER](http://www.we-online.com/wirelesspower)



Home Career Contact  English  more than you expect 

Search 

Electronic & Electromechanical ComponentsPrinted Circuit BoardsIntelligent Power and Control SystemsWürth Elektronik Group

 > Electronic & Electromechanical Components > Products & Services > Applications > Wireless Power

Welcome

Products & Services

Online Catalog

New Products

Innovations

Applications

USB

TI-PMLK Learning Kit

AMBER PI

Digital Power

Energy Harvesting

Power Tools

Wireless Power

15 W Kit Renesas Electronics

200 W Kit

Reference Designs


Mix and Match

Infographic

FAQ

Design Your EMC filter

Custom Shielding Cabinets

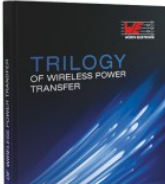


### Wireless Power Coils WE-WPCC

Wireless Power Coils WE-WPCC offer the best performance with highest Q-factor and lowest RDC values. Standardized coils, according to Wireless Power Consortium (WPC), and other off-the-shelf components from 50 mW to 200 W are available. Customized solutions for wireless power coils up to 11 kW are possible. Therefore we offer the industry's broadest portfolio of wireless power transfer coils.

[To product portfolio of Würth Elektronik](#)

[Wireless Power Transfer Coils Flyer 2021](#)




### NEW! The Trilogy of Wireless Power Transfer

With the new book Trilogy of Wireless Power Transfer you get to know the basic principles of Wireless Power Transfer, WPT systems and Applications.


[Get free extracts](#)

#### Power through the air




[read more about this topic](#)

#### Custom Coils




[Ask for custom coils](#)

#### Wireless Power Charging Coil



[more](#)

#### Reference Designs



# FAQ - HOTLINE

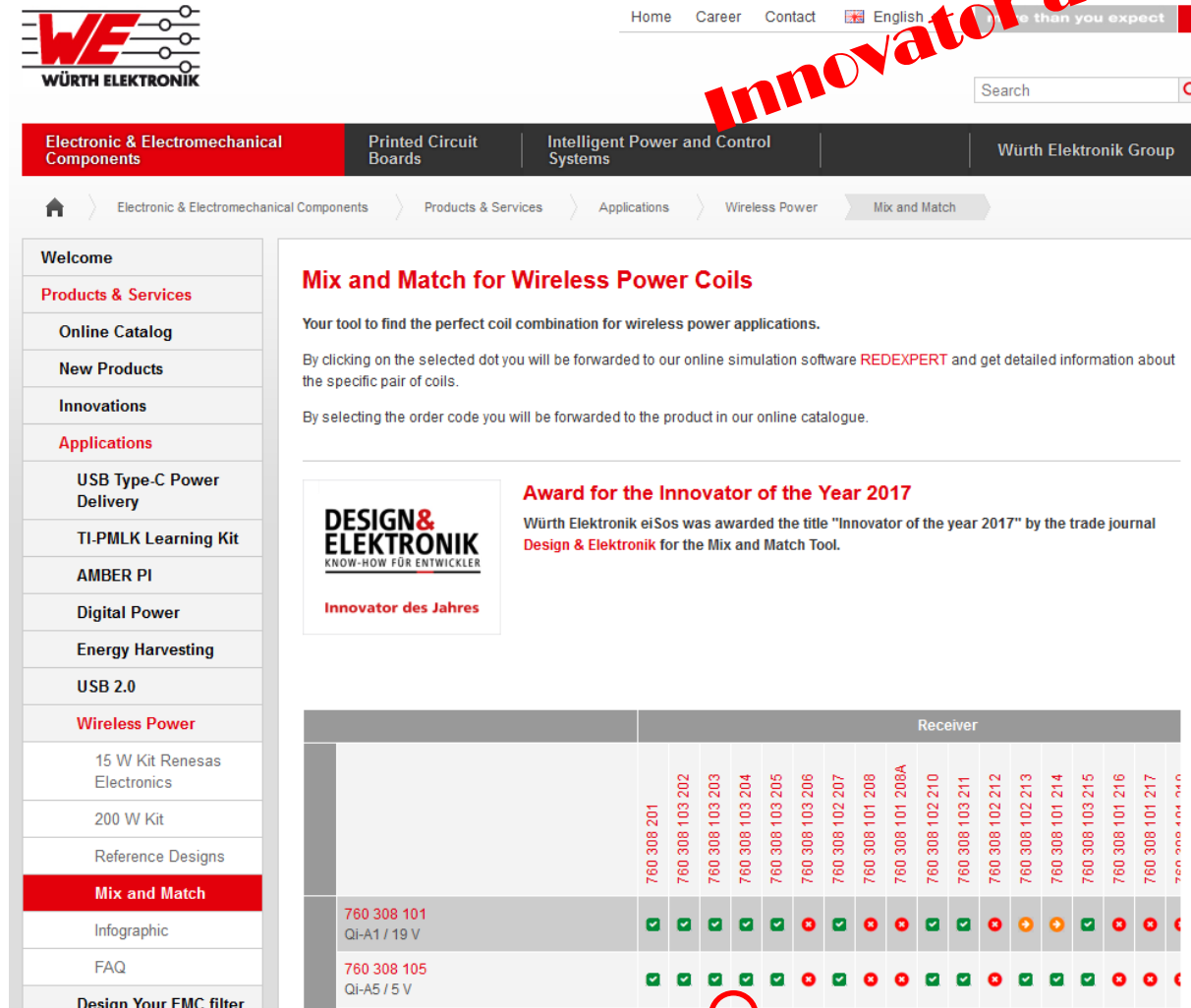
- <http://www.we-online.com/wirelesspower/faq>

The screenshot shows the Würth Elektronik website's FAQ page for Wireless Power. The header includes the WE logo, navigation links (Home, Career, Contact), a language selector (English), and a search bar. The main navigation bar highlights 'Electronic & Electromechanical Components', 'Printed Circuit Boards', 'Intelligent Power and Control Systems', and 'Würth Elektronik Group'. The breadcrumb trail indicates the path: Home > Electronic & Electromechanical Components > Products & Services > Applications > Wireless Power > FAQ. The left sidebar contains a 'Welcome' section and a 'Products & Services' menu with links to Online Catalog, New Products, Innovations, Applications, USB, TI-PMLK Learning Kit, AMBER PI, Digital Power, Energy Harvesting, Power Tools, and Wireless Power. The 'Wireless Power' section lists '15 W Kit Renesas Electronics', '200 W Kit', 'Reference Designs', 'Mix and Match', 'Infographic', 'FAQ' (highlighted), 'Design Your EMC filter', 'Custom Shielding Cabinets', and 'Alpha/Omega Rack'. The main content area features a large banner with the text 'WE CUT THE CORD' and a pair of scissors cutting a red cord. Below the banner is the 'FAQ' section with a list of questions: 'What is the maximum distance between transmitter and receiver?', 'Which power can be transmitted with WPC coils?', 'What is the operational frequency for Qi transmission?', 'Any problems (heating) with foreign objects?', 'Are transmitter and receiver standardized?', 'Is the data communication of WPC the same as Near Field Communication?', 'Why should the Q value of the coils be high?', 'Are application notes available for WPC coils from Würth Elektronik?', 'What is the purpose of the ferrite?', 'Are ICs available which support more than the 15W in Qi Standard?', and 'Can you offer a wireless power evaluation kit?'. The right sidebar contains a 'Product Catalog' section with a monitor icon and a link to 'Enter Catalog'.

Other requests to [wirelesspower@we-online.com](mailto:wirelesspower@we-online.com)

# MIX AND MATCH FOR WIRELESS POWER COIL

<http://www.we-online.de/wirelesspower/mixandmatch>



**WE WÜRTH ELEKTRONIK**

Home Career Contact English More than you expect

Search

Electronic & Electromechanical Components | Printed Circuit Boards | Intelligent Power and Control Systems | Würth Elektronik Group

Electronic & Electromechanical Components > Products & Services > Applications > Wireless Power > Mix and Match

Welcome

Products & Services

Online Catalog

New Products

Innovations

Applications

USB Type-C Power Delivery

TI-PMLK Learning Kit

AMBER PI

Digital Power

Energy Harvesting

USB 2.0

Wireless Power

15 W Kit Renesas Electronics

200 W Kit

Reference Designs

**Mix and Match**

Infographic

FAQ

Design Your EMC filter

## Mix and Match for Wireless Power Coils

Your tool to find the perfect coil combination for wireless power applications.

By clicking on the selected dot you will be forwarded to our online simulation software **REDEXPERT** and get detailed information about the specific pair of coils.

By selecting the order code you will be forwarded to the product in our online catalogue.

**DESIGN & ELEKTRONIK**  
KNOW-HOW FÜR ENTWICKLER

**Innovator des Jahres**

**Award for the Innovator of the Year 2017**

Würth Elektronik eiSos was awarded the title "Innovator of the year 2017" by the trade journal **Design & Elektronik** for the Mix and Match Tool.

	Receiver																
	760 308 201	760 308 103 202	760 308 103 203	760 308 103 204	760 308 103 205	760 308 103 206	760 308 102 207	760 308 101 208	760 308 101 208A	760 308 102 210	760 308 103 211	760 308 102 212	760 308 102 213	760 308 101 214	760 308 103 215	760 308 101 216	760 308 101 217
760 308 101 Qi-A1 / 19 V	✓	✓	✓	✓	✓	✗	✓	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗
760 308 105 Qi-A5 / 5 V	✓	✓	✓	✓	✓	✗	✓	✗	✗	✓	✓	✗	✓	✓	✓	✗	✗

**Innovator award winning**



# REDEXPERT FOR WIRELESS POWER COIL

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

**REDEXPERT®** WIRELESS POWER TRANSMISSION APPLICATIONS HOW TO SHARE

WPT Resonant Tank App

SELECTION

**760308101**  
TX  
24.0  $\mu$ H · 90.0

Options  
☐ Show both, transmitters and receivers

**WE-WPCC - 760308103205**

res 100 kHz

Cs	C1	C2	C3
(C1+C2+C3)	100 nF	47.0 nF	22.0 nF
	169 nF		

Cd	C4	C5
(C4+C5)	2.20 nF	-

Lp	k	Ls
24.0 $\mu$ H	0.54	11.0 $\mu$ H

QI	Order Code	Series	Match	Coupling Factor	Type	Size	L	Spec	Compliance	L @125kHz	Q@125kHz	IR	Isat	Roc,max	fres	Length Max
✓	760308103205	WE-WPCC	✓	0.54	RX	3426			works with Qi Rx IC's	11.0 $\mu$ H	30.0	2.50 A	4.00 A	200 m $\Omega$	16.0 MHz	34.30 mm
✓	760308201	WE-WPCC	✓	0.55	RX	3737			works with Qi Rx IC's	10.0 $\mu$ H	50.0	3.50 A	8.00 A	200 m $\Omega$	15.0 MHz	37.00 mm
✓	760308103202	WE-WPCC	✓	0.66	RX	4832			works with Qi Rx IC's	12.0 $\mu$ H	33.0	3.00 A	6.00 A	200 m $\Omega$	25.0 MHz	48.30 mm
✓	760308103203	WE-WPCC	✓	0.59	RX	4832			works with Qi Rx IC's	12.0 $\mu$ H	21.0	1.80 A	3.00 A	550 m $\Omega$	20.0 MHz	48.30 mm
✓	760308103204	WE-WPCC	✓	0.60	RX	3830			works with Qi Rx IC's	16.7 $\mu$ H	32.0	2.00 A	4.00 A	430 m $\Omega$	11.0 MHz	38.50 mm
✓	760308103206	WE-WPCC	✗		RX	2815			works with Qi Rx IC's	7.50 $\mu$ H	16.0	1.55 A	3.00 A	380 m $\Omega$	23.0 MHz	28.00 mm
✓	760308101208	WE-WPCC	✗		RX	Ø 10			works with Qi Rx IC's	13.0 $\mu$ H	17.0	800 mA	2.00 A	500 m $\Omega$	26.0 MHz	10.00 mm

Click and type or drop an Order Code here

ADD MORE

Show Panel: L vs f Q vs f ΔQ vs I μ' vs f Dimensions

Inductance / Frequency

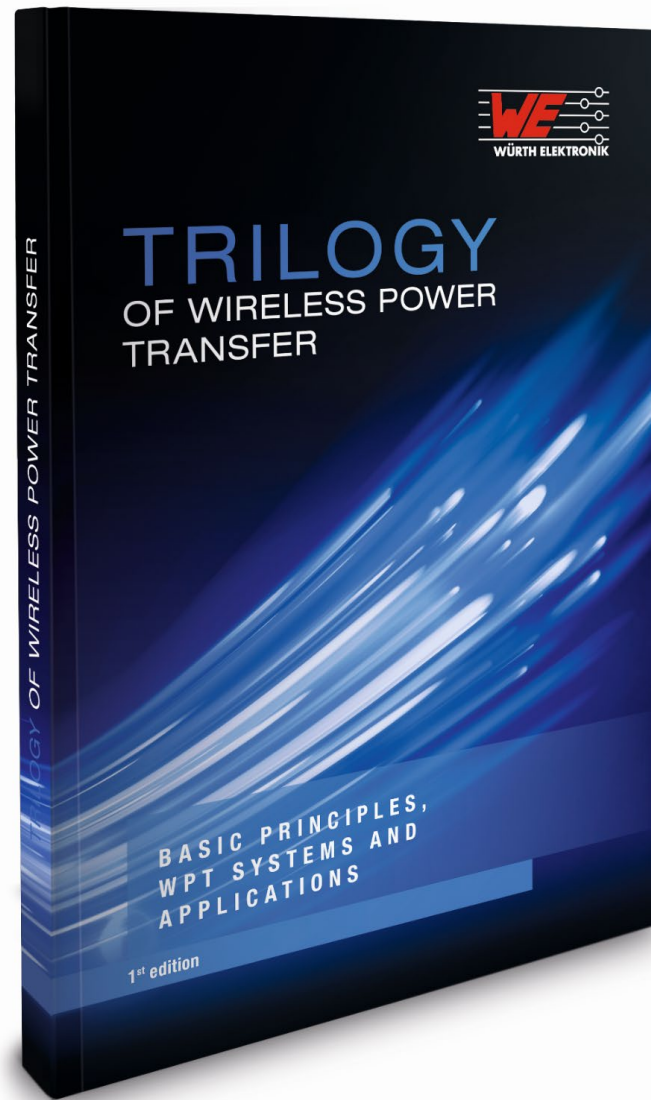
Q-Factor / Frequency

Temperature Rise / DC Current

Complex Permeability μ' / Frequency

Picture

## NEW! TRILOGY OF WIRELESS POWER TRANSFER



744018

## ARGUMENTS TO USE WPT

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





Over to you....

[wirelesspower@we-online.com](mailto:wirelesspower@we-online.com)

