Lifelong Learning in the Energy Transition: Implementation of Wireless Power Transfer

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June 5 , 2025

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Lifelong Learning

- Create awareness and understanding
- Show the applications
- Teach the principle and technology behind

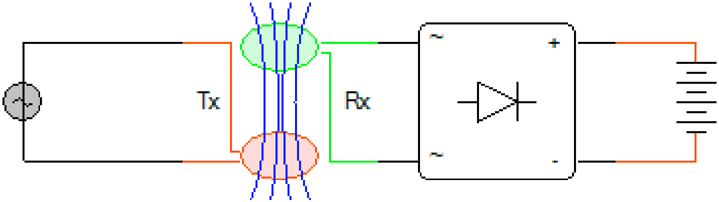
Lifelong Learning

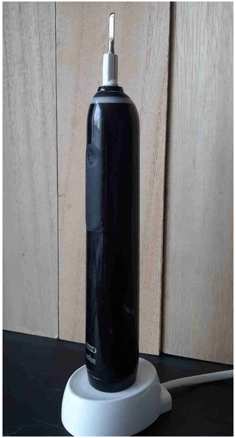
- Society:
  Adjust distance and alignment to show that it is possible to transfer power and the influence of correct placement of receiver and transmitter.
- Industry:
  Measure input and output power as function of distance and alignment, to give insight in the possibilities of a typical application design.
- Education:
  Measurement of voltage, current, in relation to L and C of the transmitter and receiver and distance, alignment, switching frequency and load.

Lifelong Learning

	Presentation	Example
Society	Awareness	Toothbrush/Phone
Industry	Applications	eVehicle Charging
Education	Principle	Demo Kit

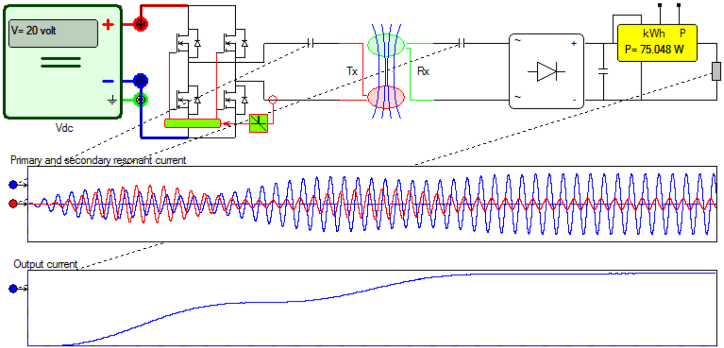
	Design Tool	Simulation	Measurement
Society	-	-	Demonstration
Industry	Design	Verification	Proof of concept
Education	Mathematics	Understanding	Practical Laboratory





Wireless[50Hz] inductive charging of a battery in a toothbrush.

Methods and Readiness



Wireless[100kHz] resonant charging of a smartphone

Methods and Readiness

(a) (b) (c)

(d) (e)

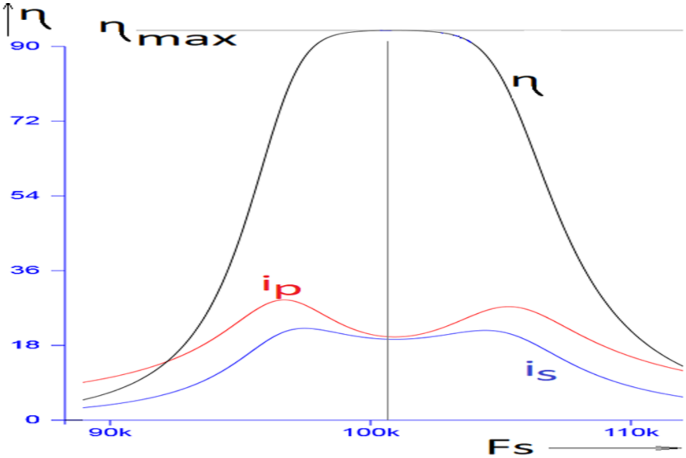
(f)

Standards in Wireless Power Transfer, (a)Qi, (b)Qi2, (c)Ki, (d)PMS, (e)AWP, (f)AirFuel.

Design

Design of the coils in design tool Caspoc

Design



Maximum efficiency in relation to the primary and secondary current amplitude as function of resonant frequency in the design tool in Caspoc. Although the currents are not maximum at the resonant frequency, the efficiency is over 90% for the resonant frequency of $100.7kHz$

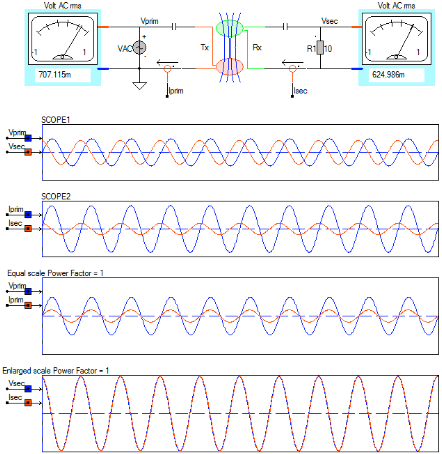
Design

The efficiency (η) for wireless power transfer in a series-series

$$\eta = \frac{R_s R_L}{R_s(R_L + R_s) + \frac{(R_L+R_s)^2}{k^2 Q_1 Q_2}}$$

- R_L is the load resistance
- R_s is the source resistance
- k is the coupling coefficient between the coils
- Q_1 and Q_2 are the quality factors $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$ of the transmitter and receiver coils, respectively

Simulation



Simulation of the primary[Red] and secondary[Blue] voltage and currents in Caspoc

Simulation

The topics included in the training cover the influence of:

- Distance and displacement
- Switching frequency
- Coupling factor k
- Load resistance

Measurements

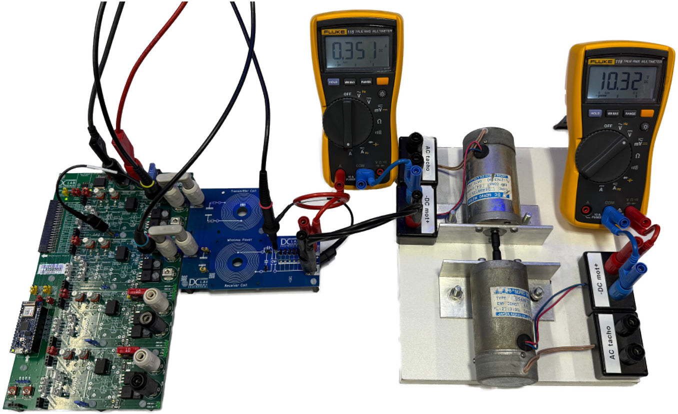
The WPT setup consists of two planar PCBs, which can be positioned at a specific distance from each other using spacers. By adjusting the spacer height, different coupling factors can be tested, allowing for controlled variations in the receiver coil's position.

Measurements

Typical measurements are performed using an oscilloscope and include for example

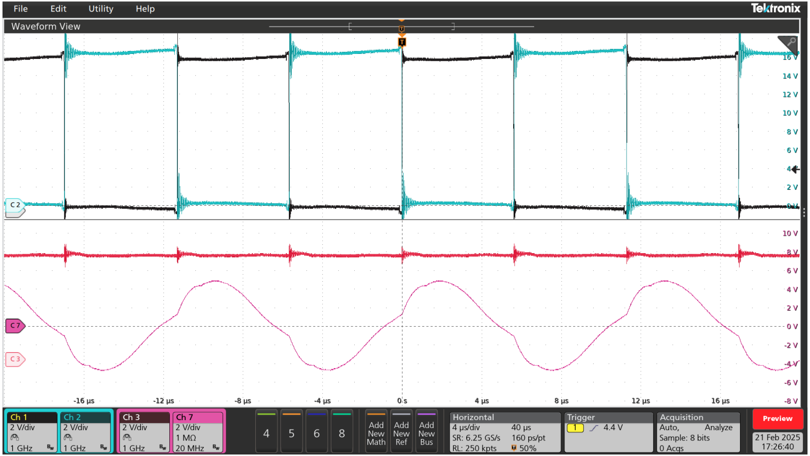
- Primary and secondary voltages
- Primary and secondary currents
- Input and output power

Measurements



The full hardware setup. On the left, the green U4L hardware trainer is connected to the blue WTP PCB. As a load, two 12V DC motors are mechanically coupled via their shafts. On the receiver side, a current of 350mA flows with a voltage of approximately 10V, both visible on the multimeters.

Measurements



Typical measurement, where, from top to bottom the transmitter switching nodes(black and blue), the current trough the transmitter coil (pink) and the rectified receiver voltage(red).

Conclusion

- Lifelong learning for three different groups
- Low level to detailed tehcnical level
- Design and Simulation Tools
- Practical measurements

Thank you!

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