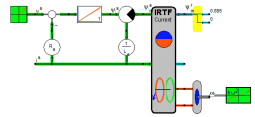


Wireless Power Transfer for Battery Charging

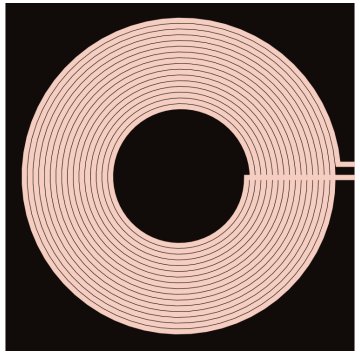
Electric & Hybrid Marine World Expo 2021

January 19,20,21, 2021

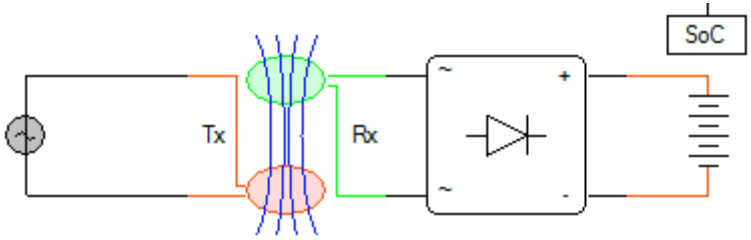
dr. ir. P.J. van Duijsen

info@caspoc.com

Learning by Simulation



THUAS DELFT
Simulation Research
The Netherlands



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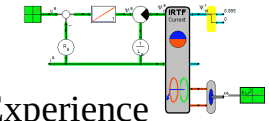
Content



- System Overview
- Principle of Wireless Power Transfer
- Transmitter en Receiver Coil Design
- Inverter Design
- Control
- Communication
- Regulation
- Applications

System Overview

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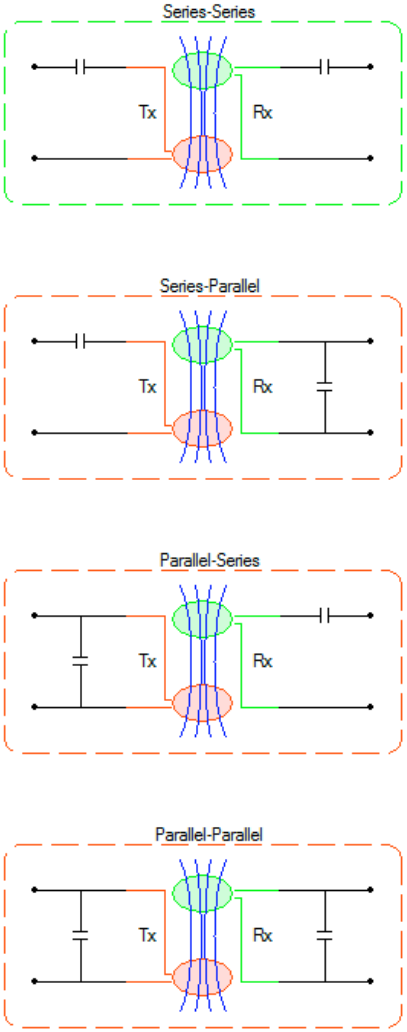
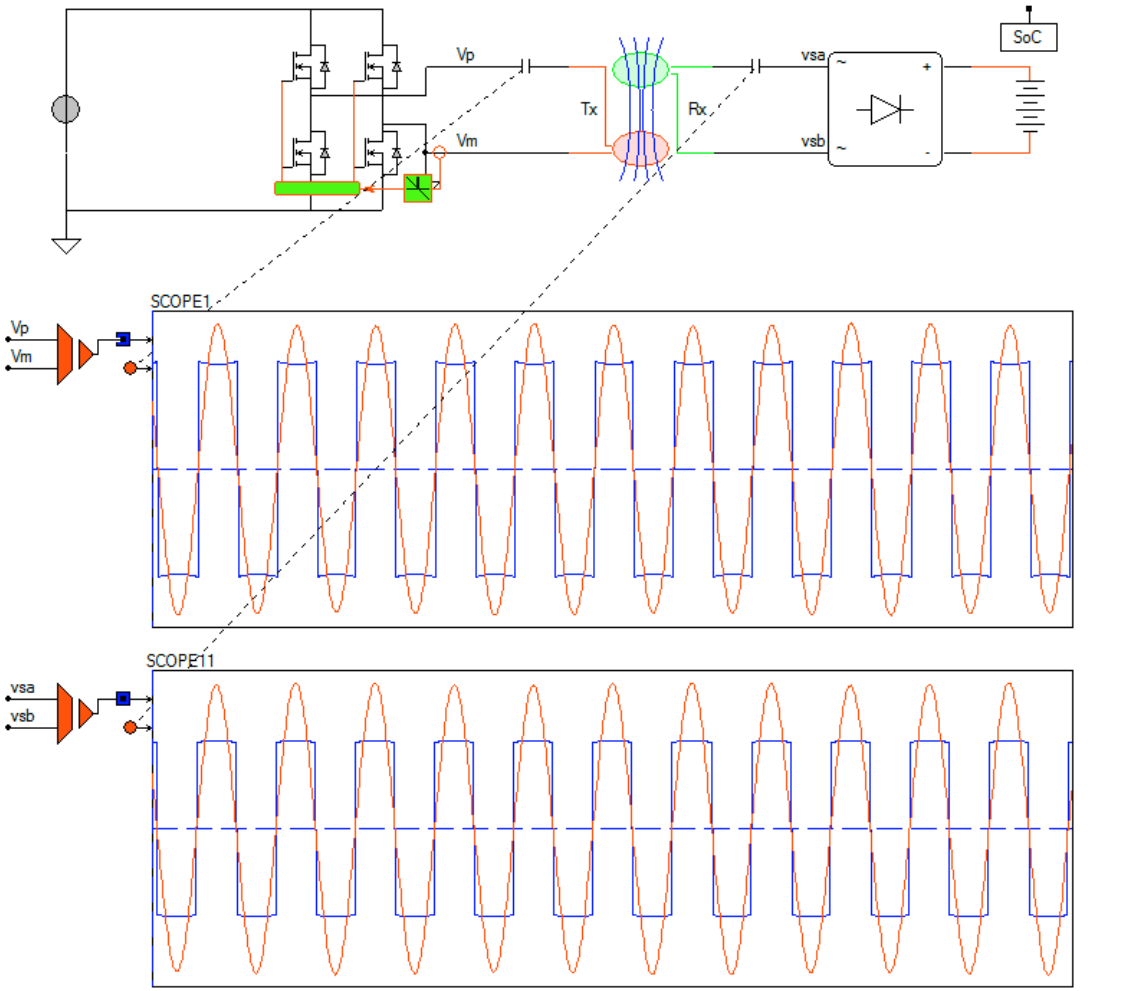
A Simulation Experience





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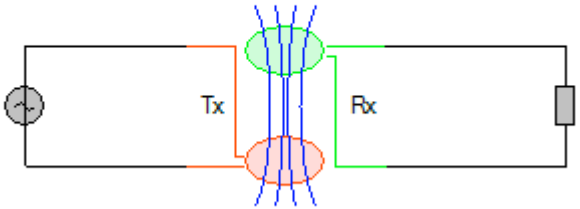
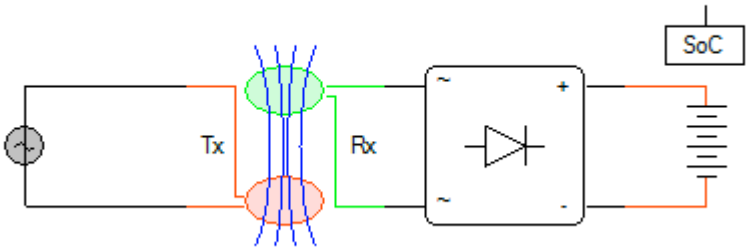
Magnetic coupling

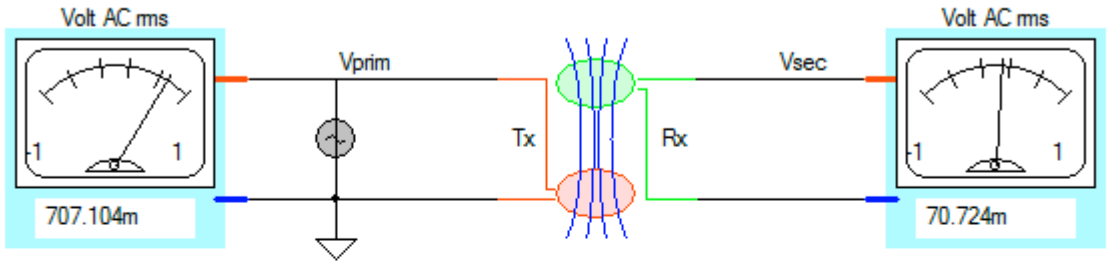


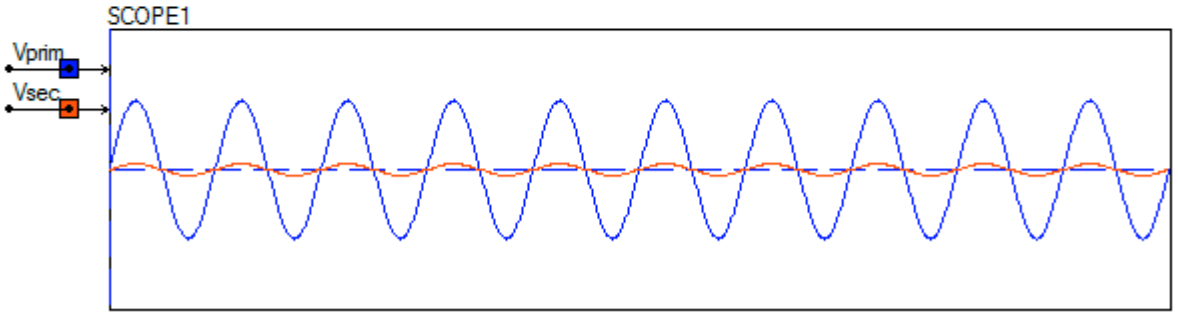
Battery charging



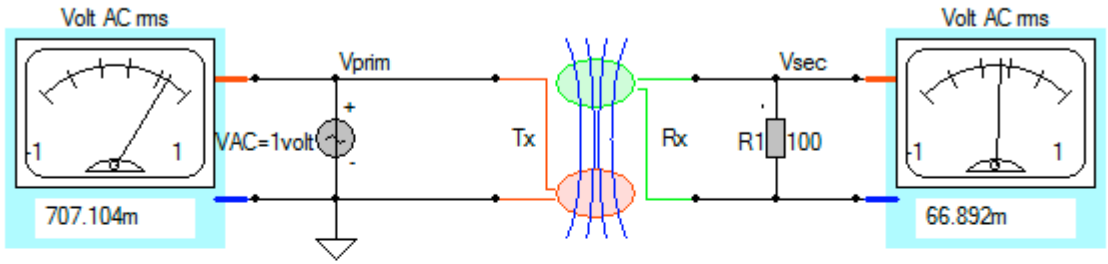
Voltage transfer depending on k

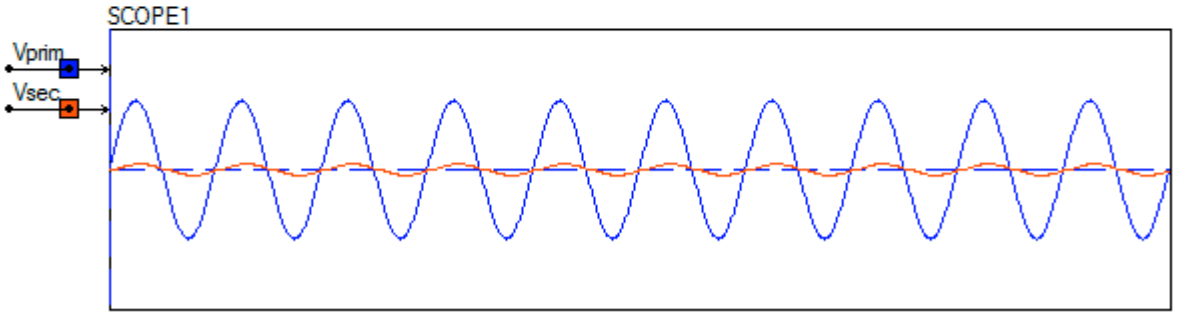
Small k gives nearly no secondary voltage





Secondary load





Input power factor <>1, no power transfer

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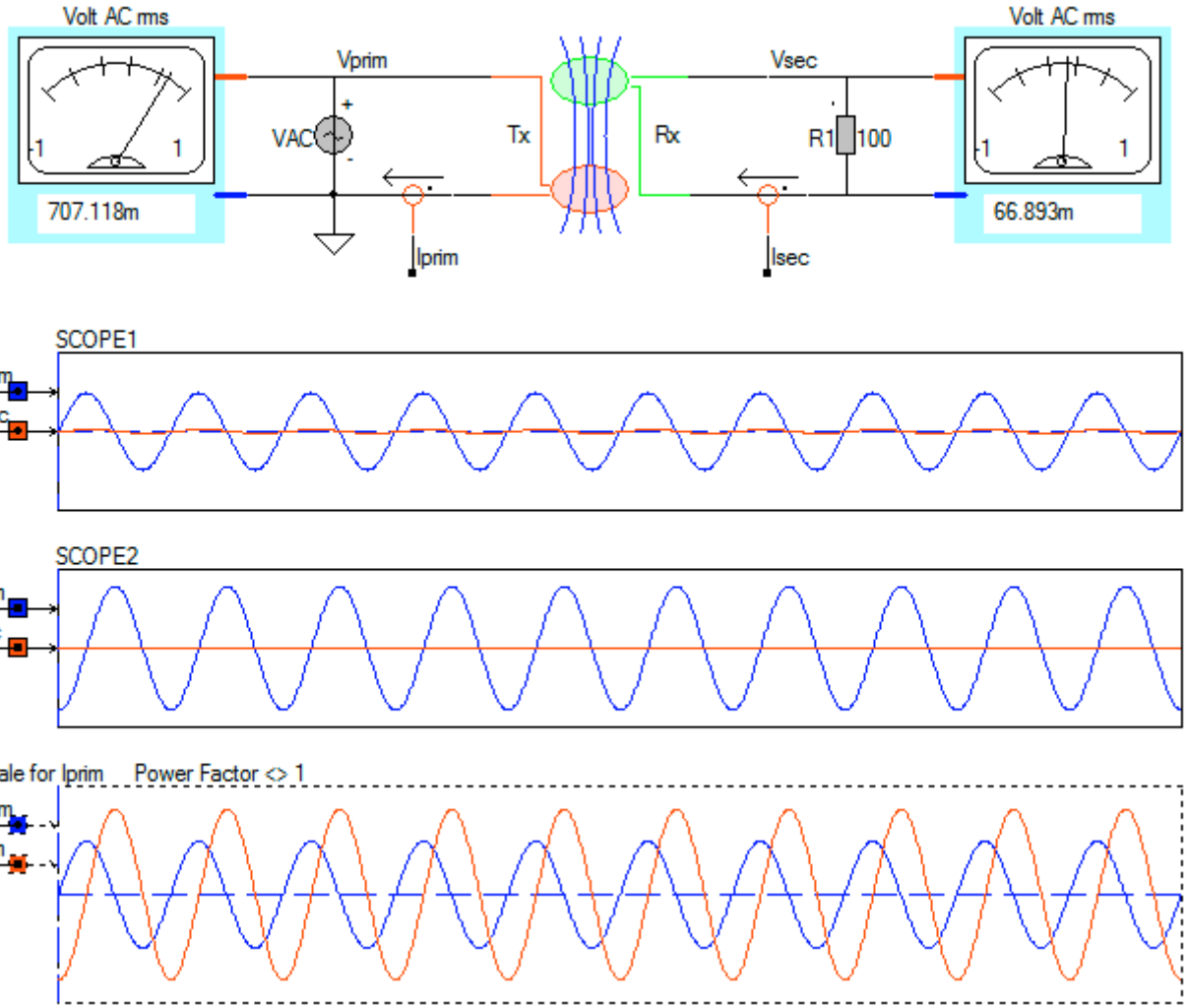

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Input power factor=1, power transfer

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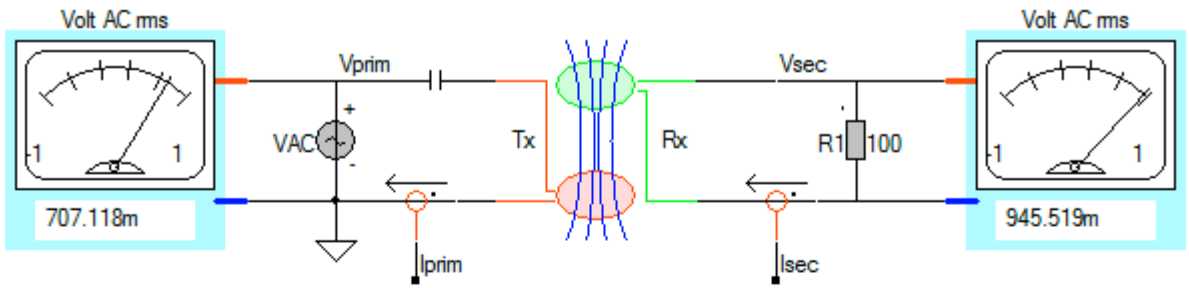

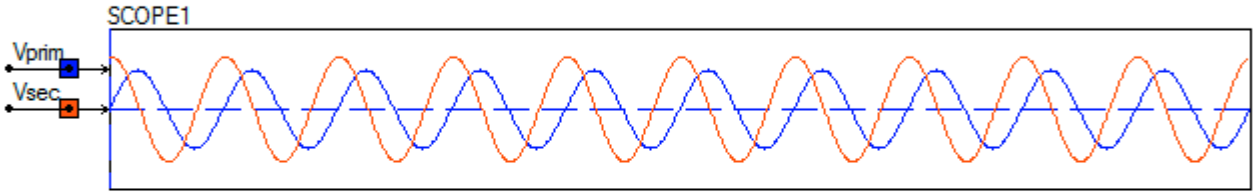

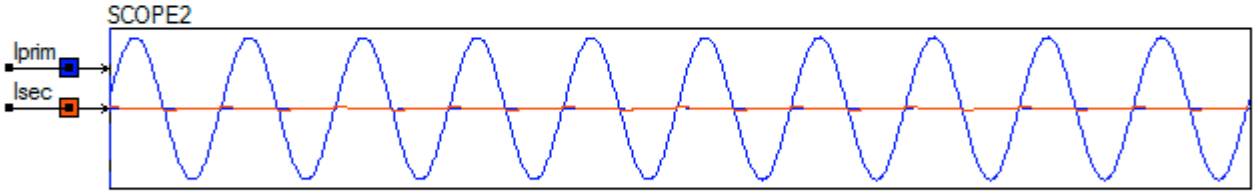

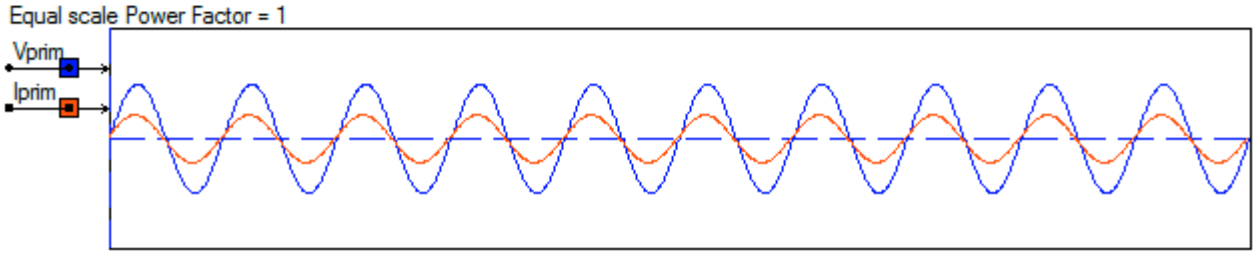

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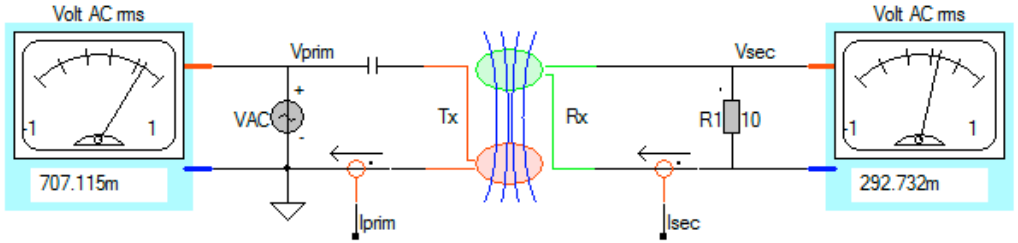
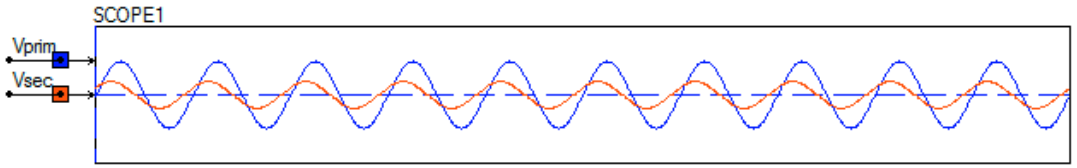
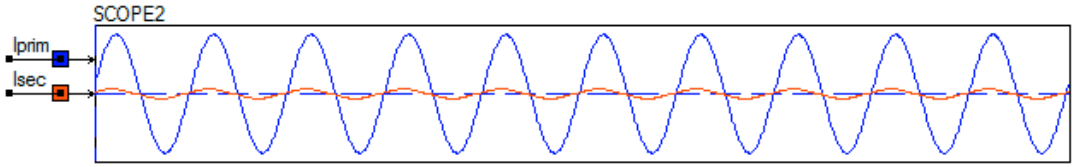
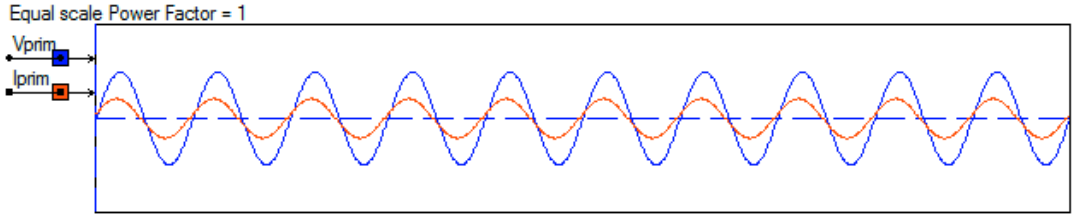
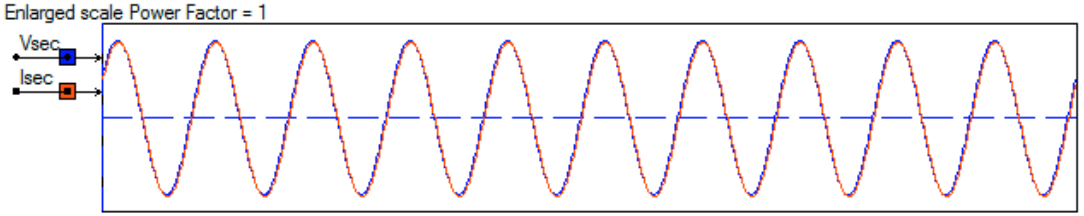
Power factor secondary = 1 Load=R



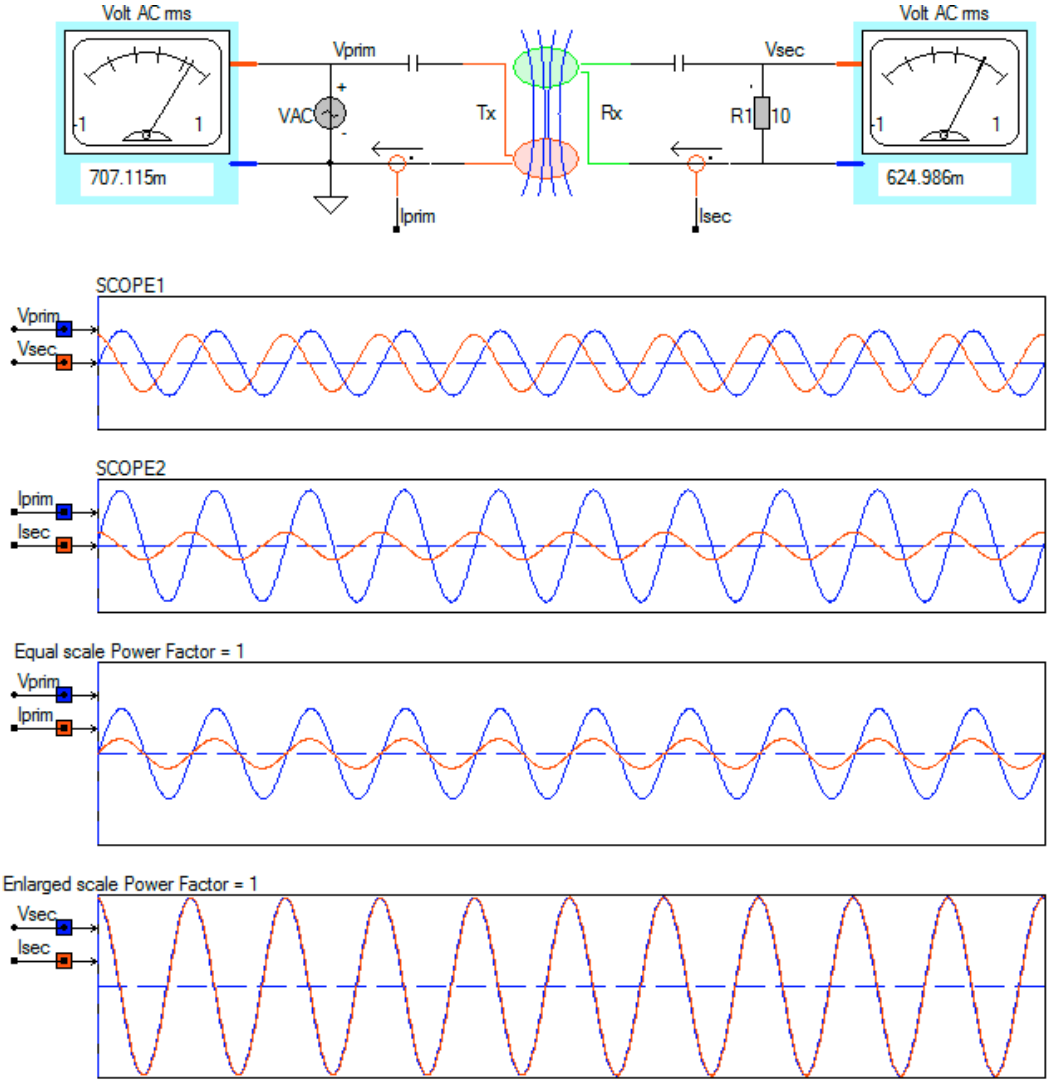




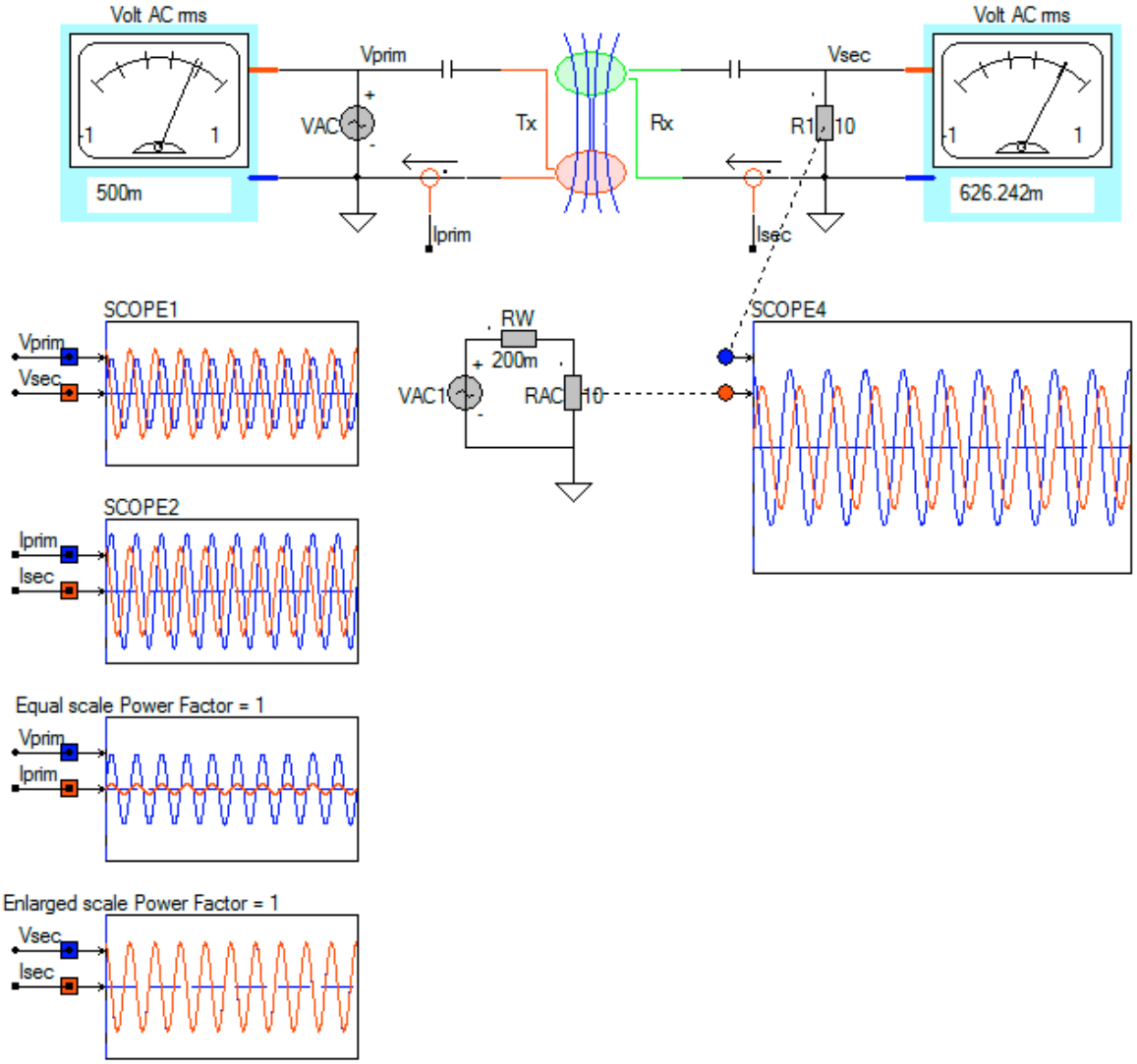




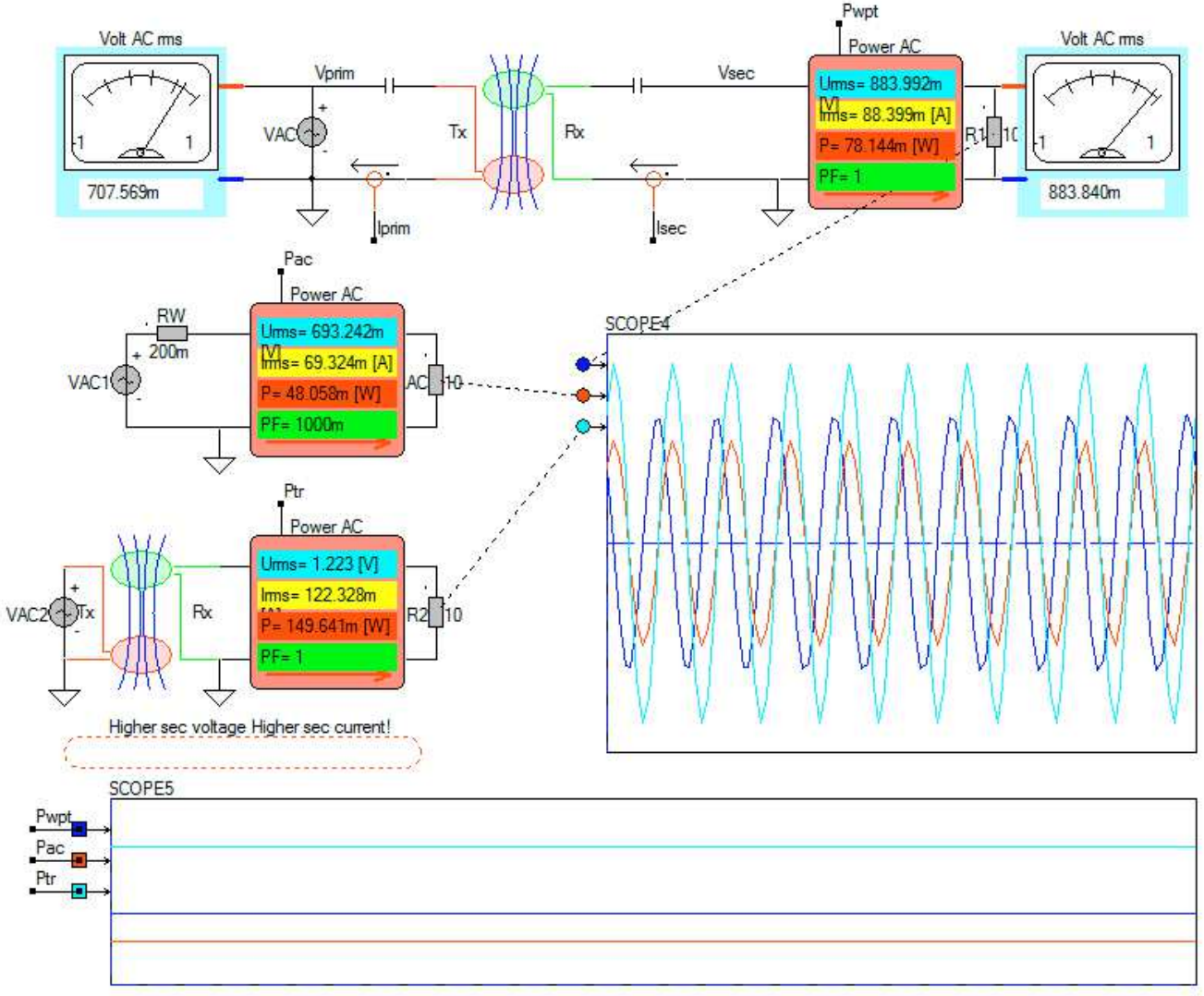
Compensation on secondary side



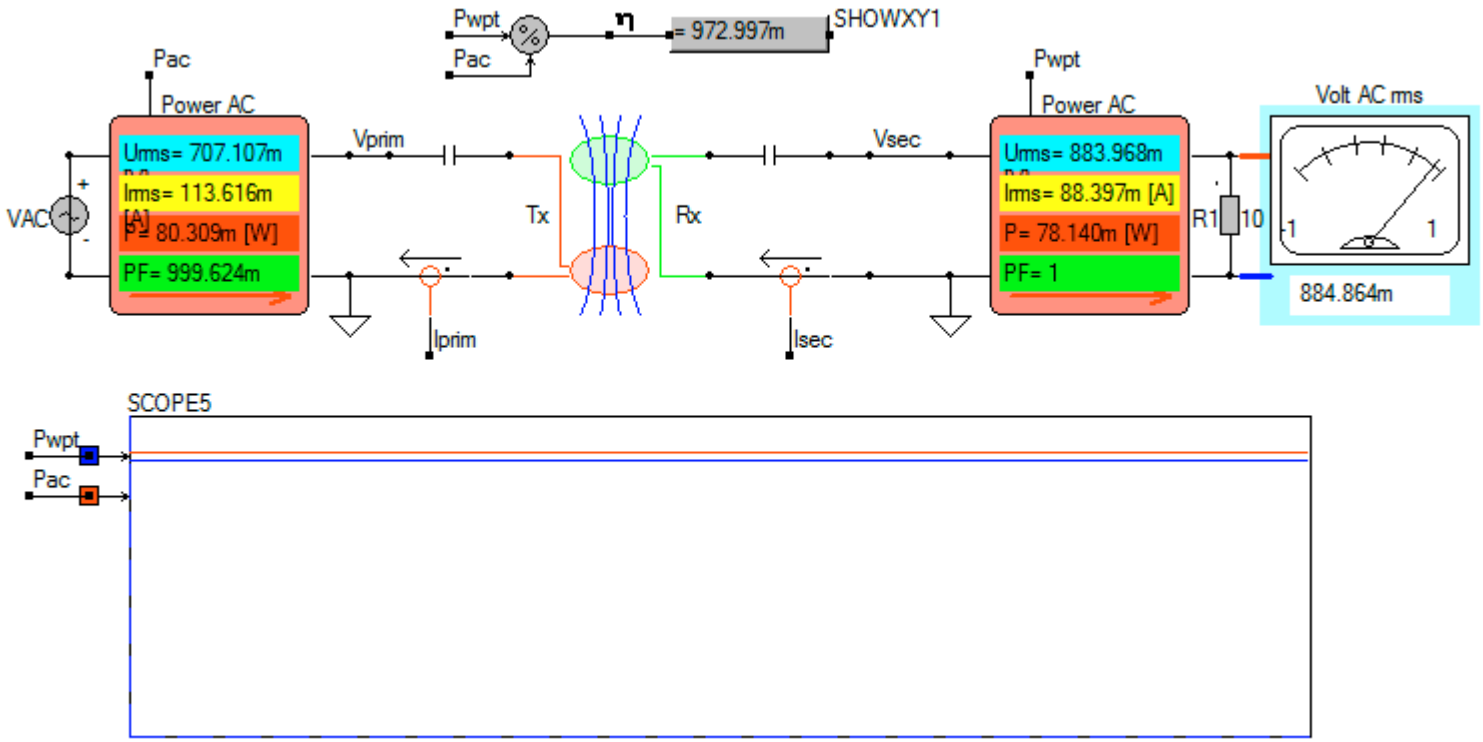
Output current even higher????



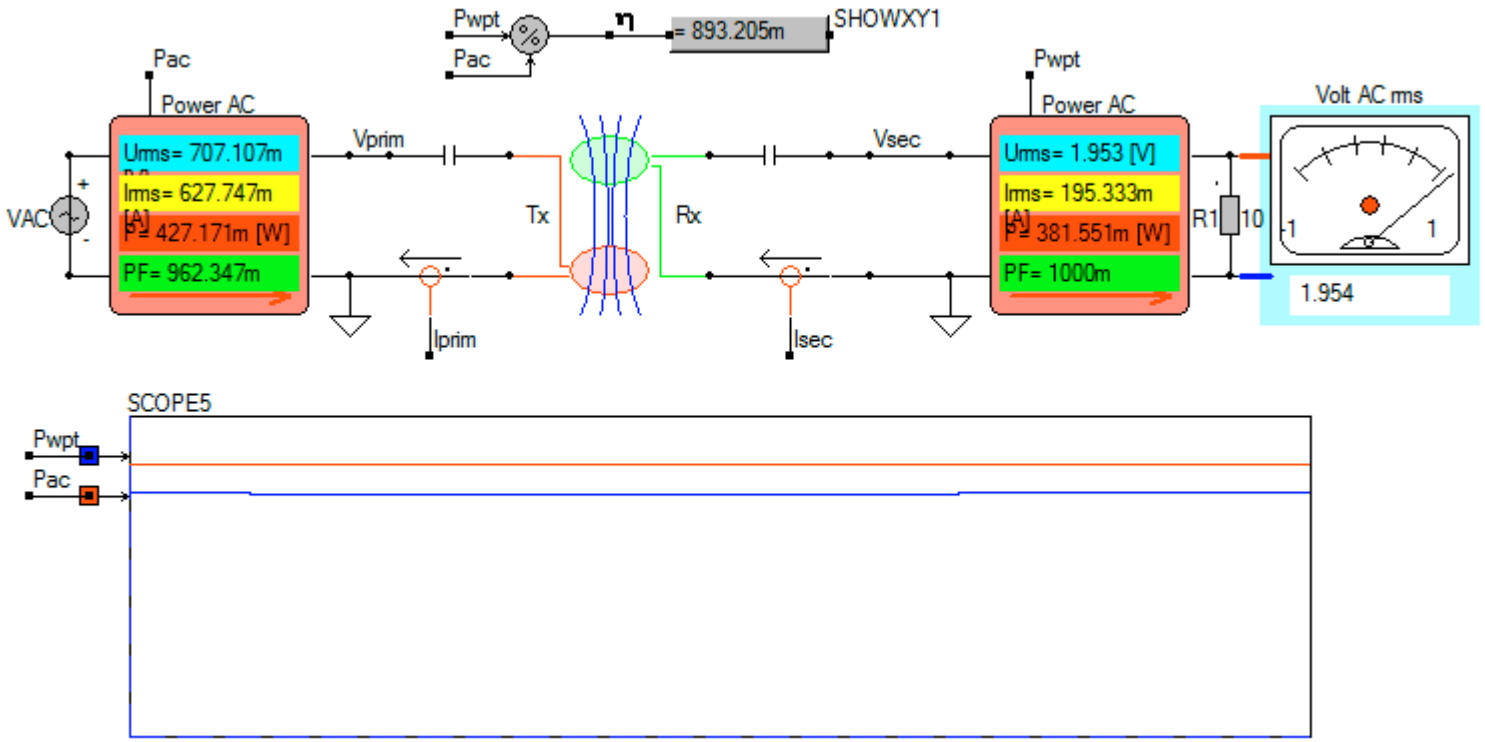
Do not forget about ratio Lprim : Lsec



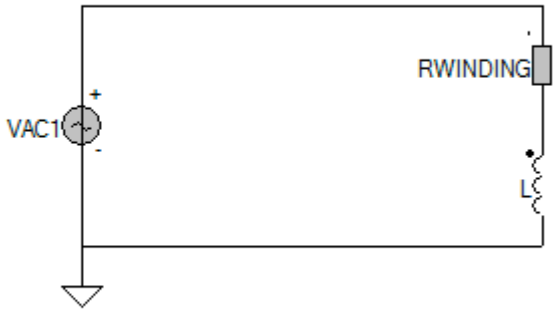
Efficiency k=0.25



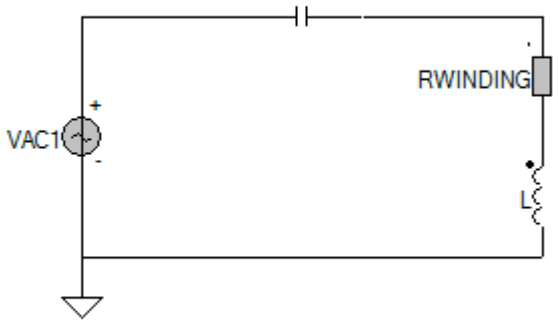
Efficiency k=0.1



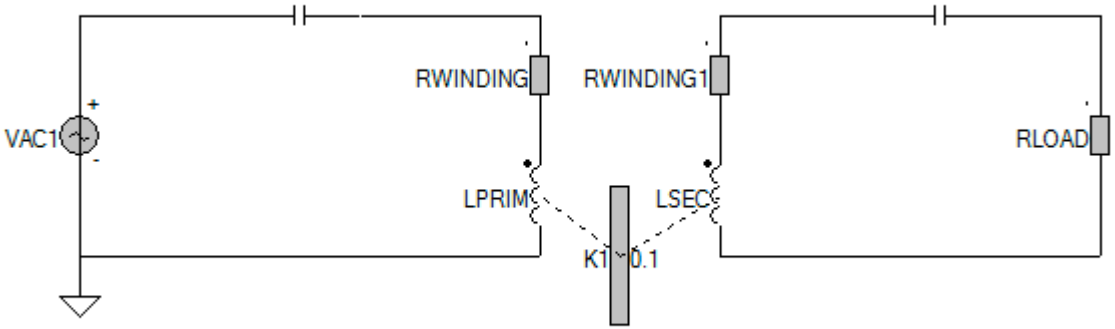
Where are the losses?



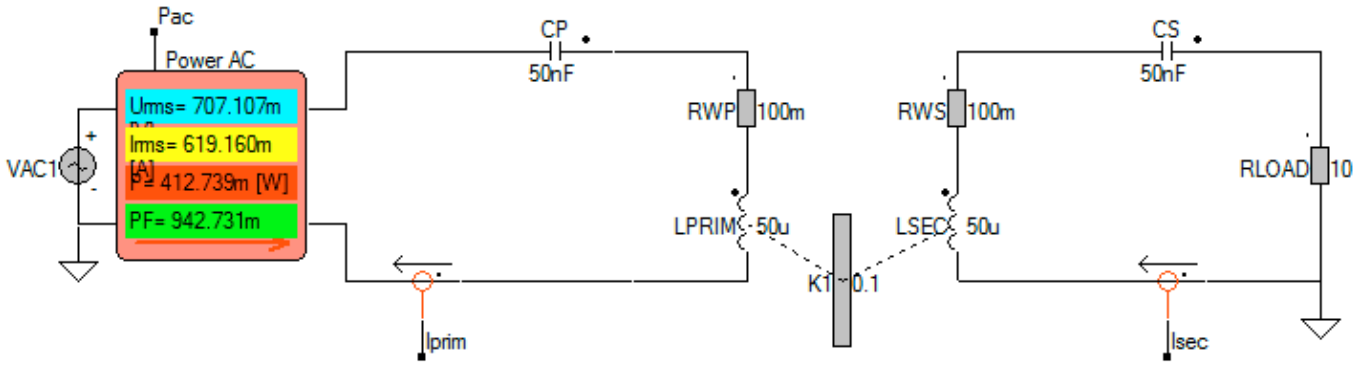
Still only winding resistance losses

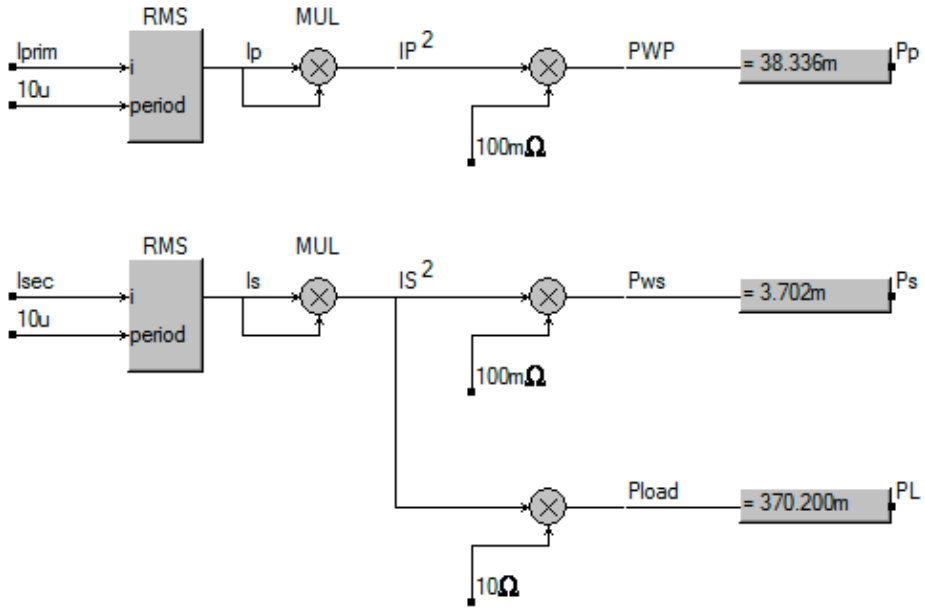


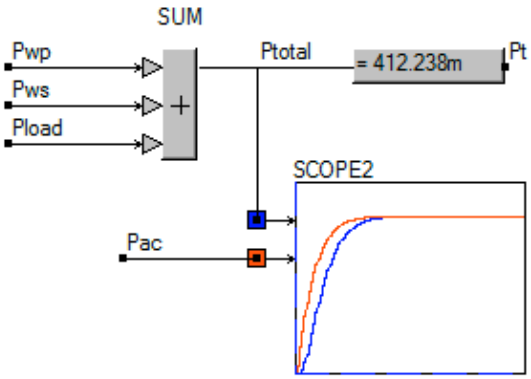
Again only winding resistance losses



Apart from Ferrite losses, only winding loss







Transmitter en Receiver Coil Design

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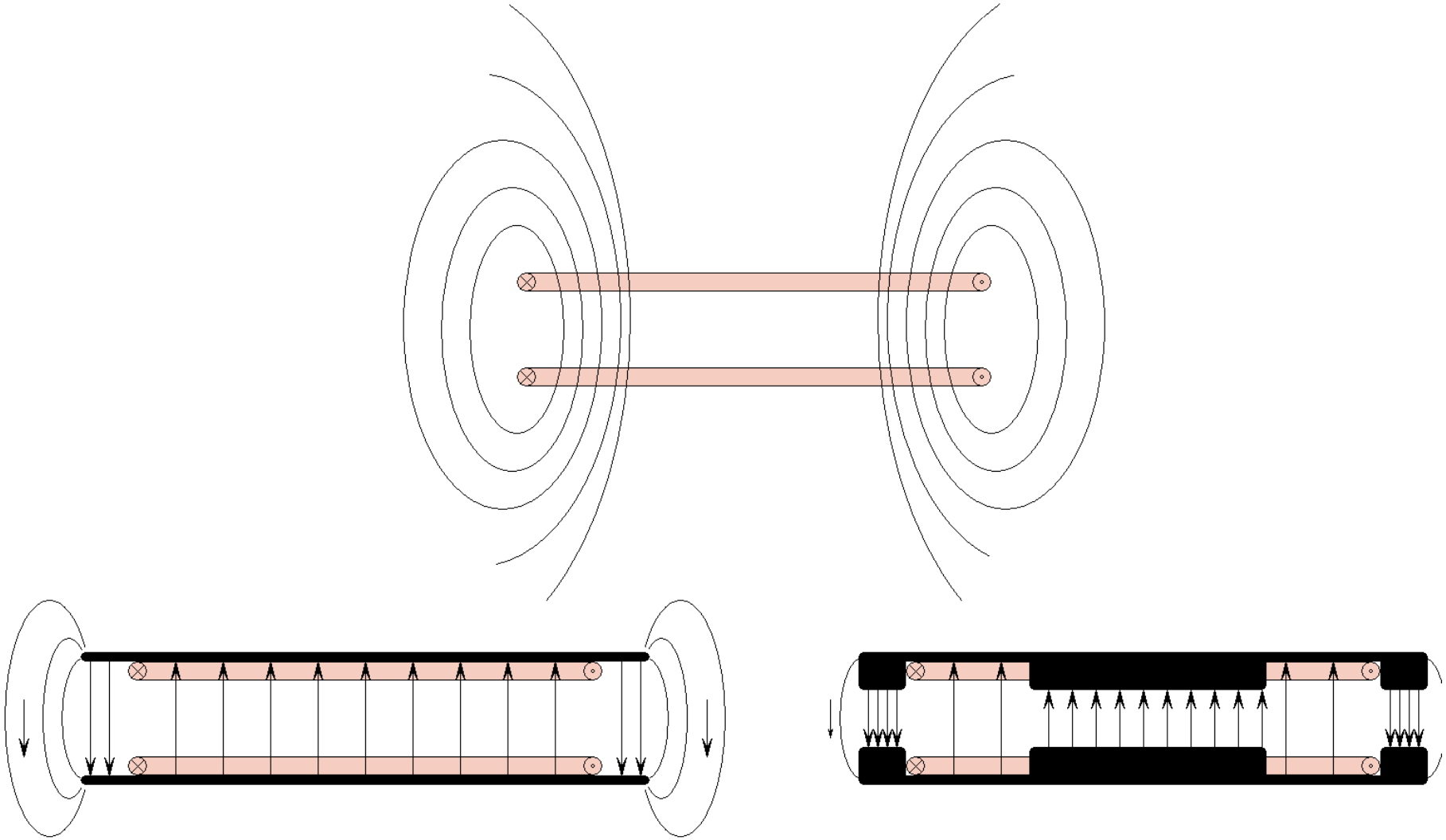

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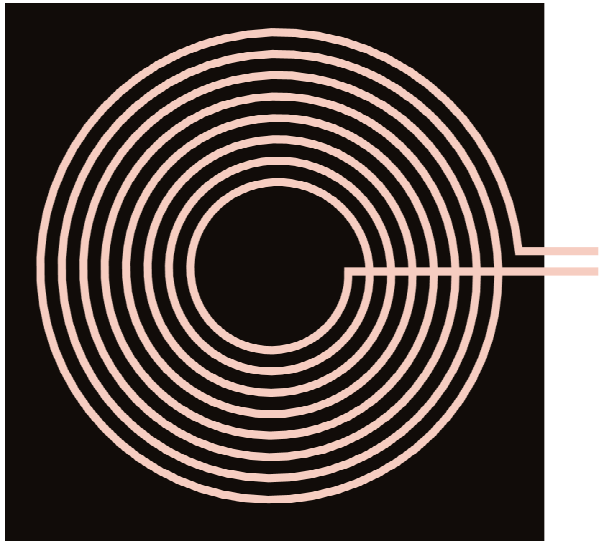
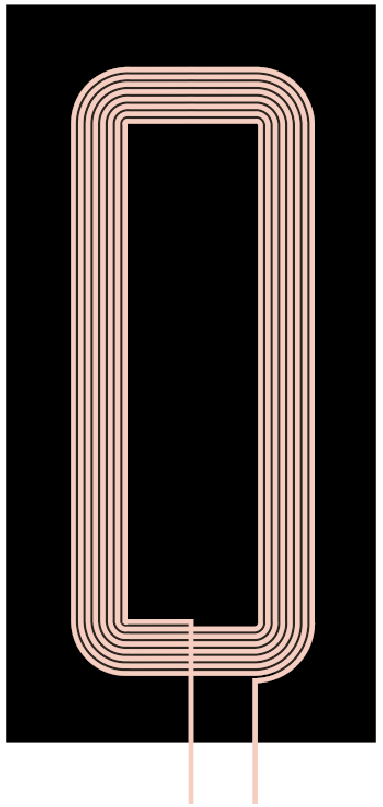
Transmitter en Receiver Coil Design





Transmitter en Receiver Coil Design

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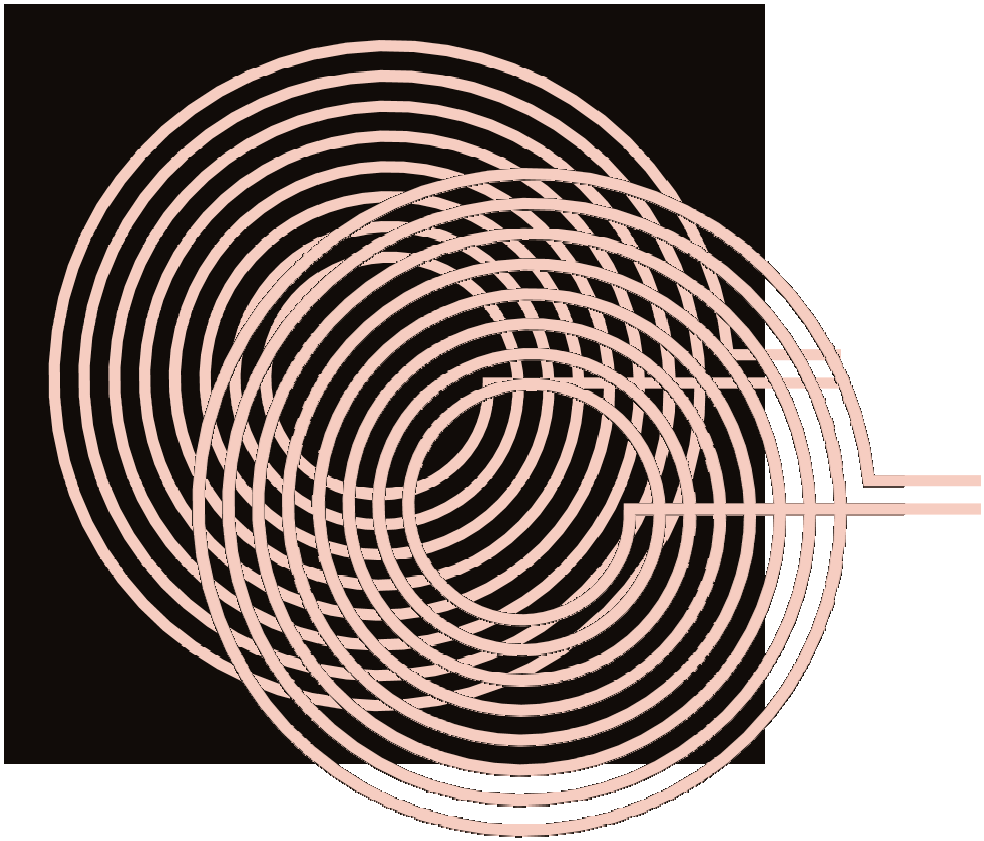

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Transmitter en Receiver Coil Design

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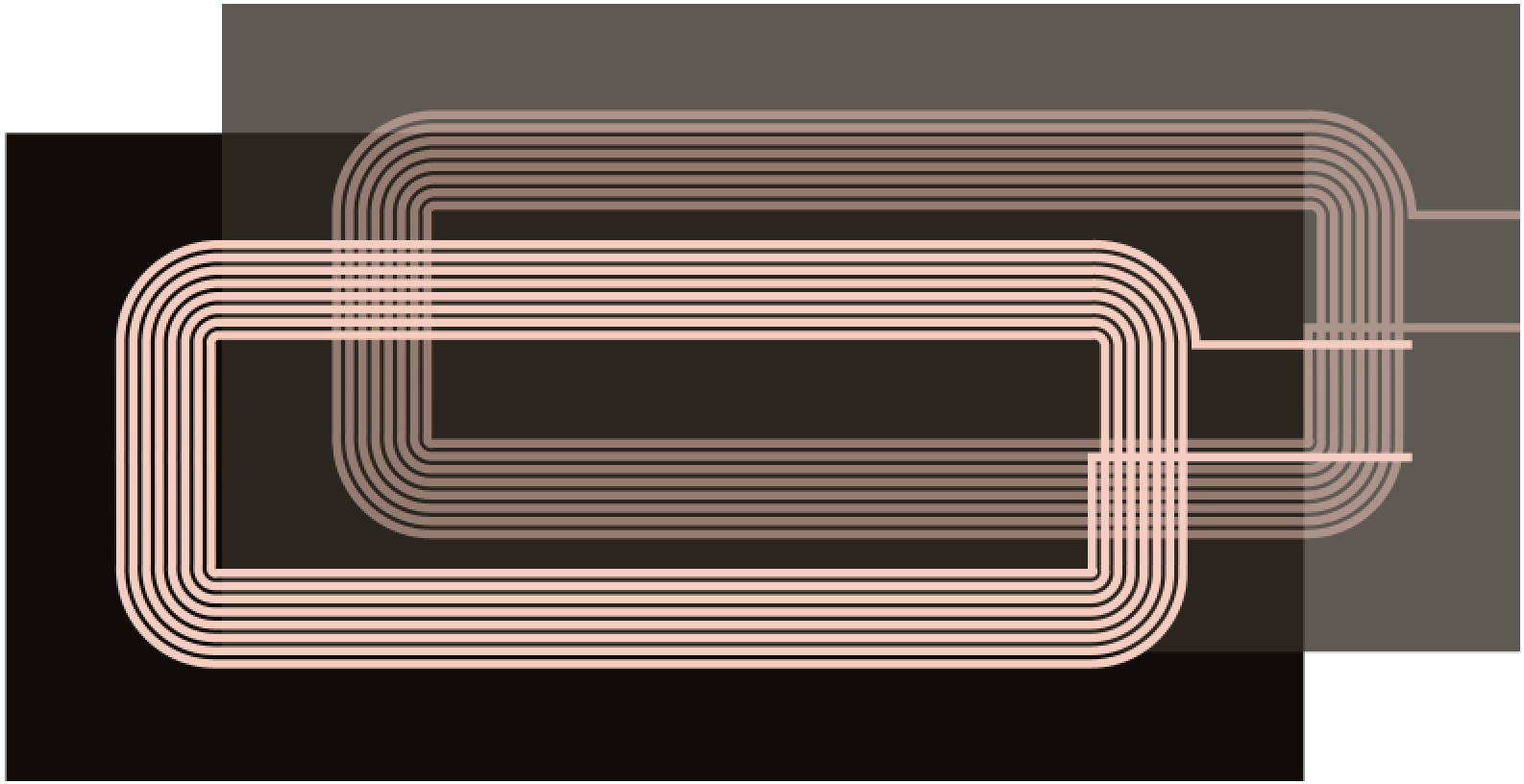

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Transmitter en Receiver Coil Design

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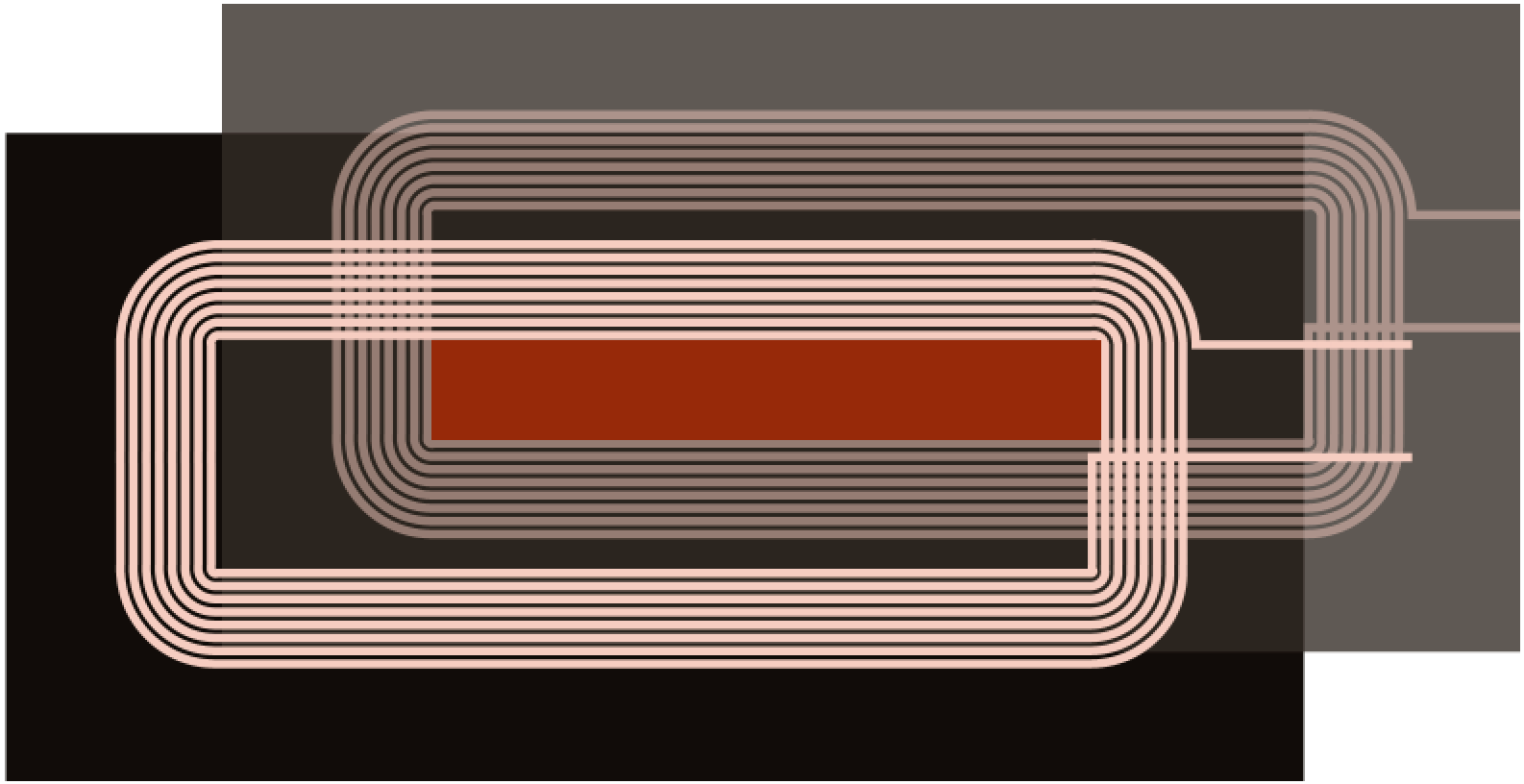
A Simulation Experience



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Inverter Design

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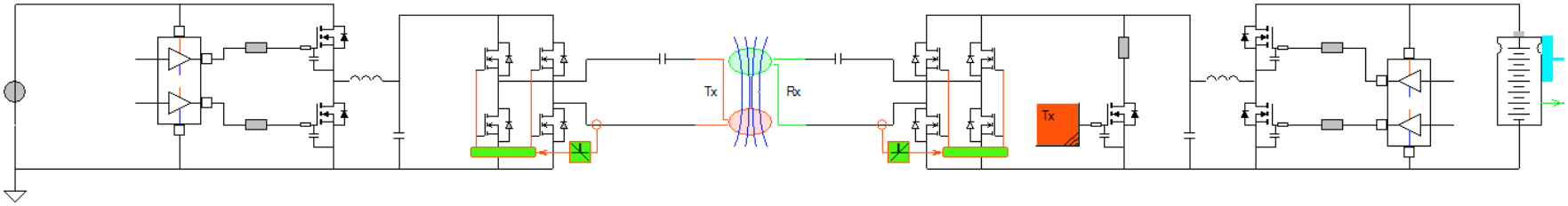

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Control

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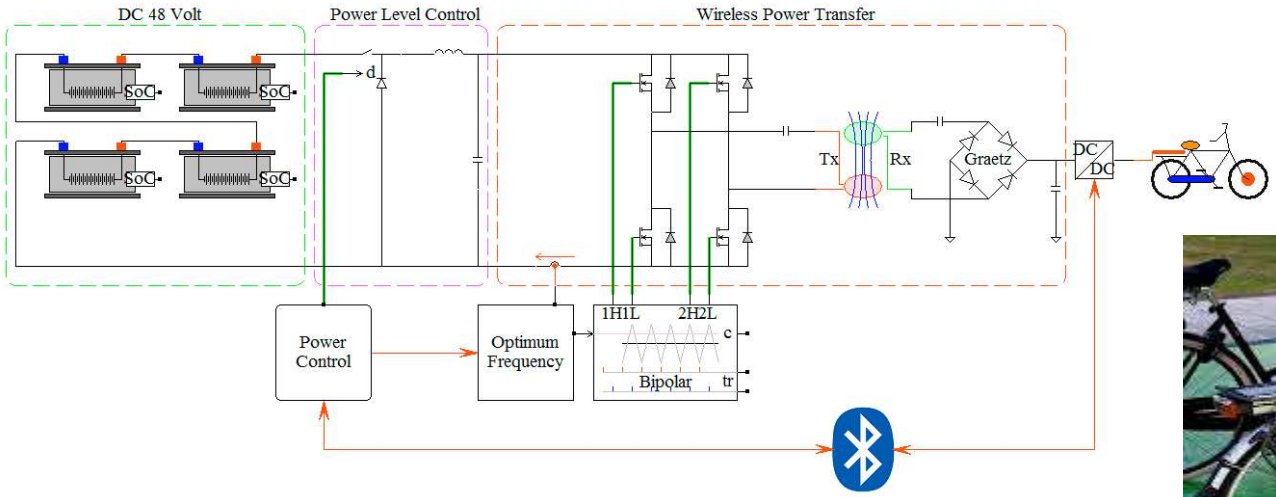

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Control Fixed Frequency 100kHz

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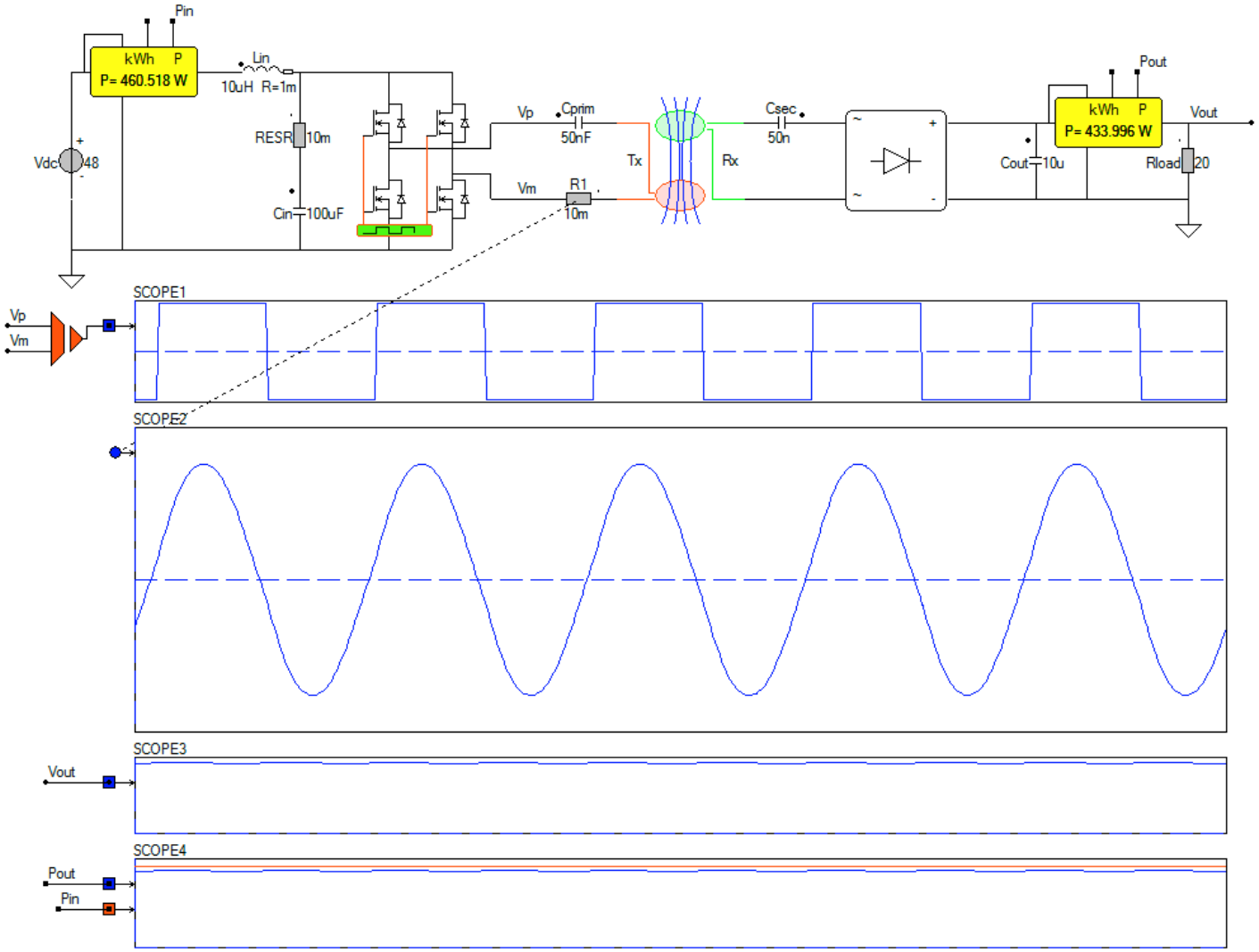

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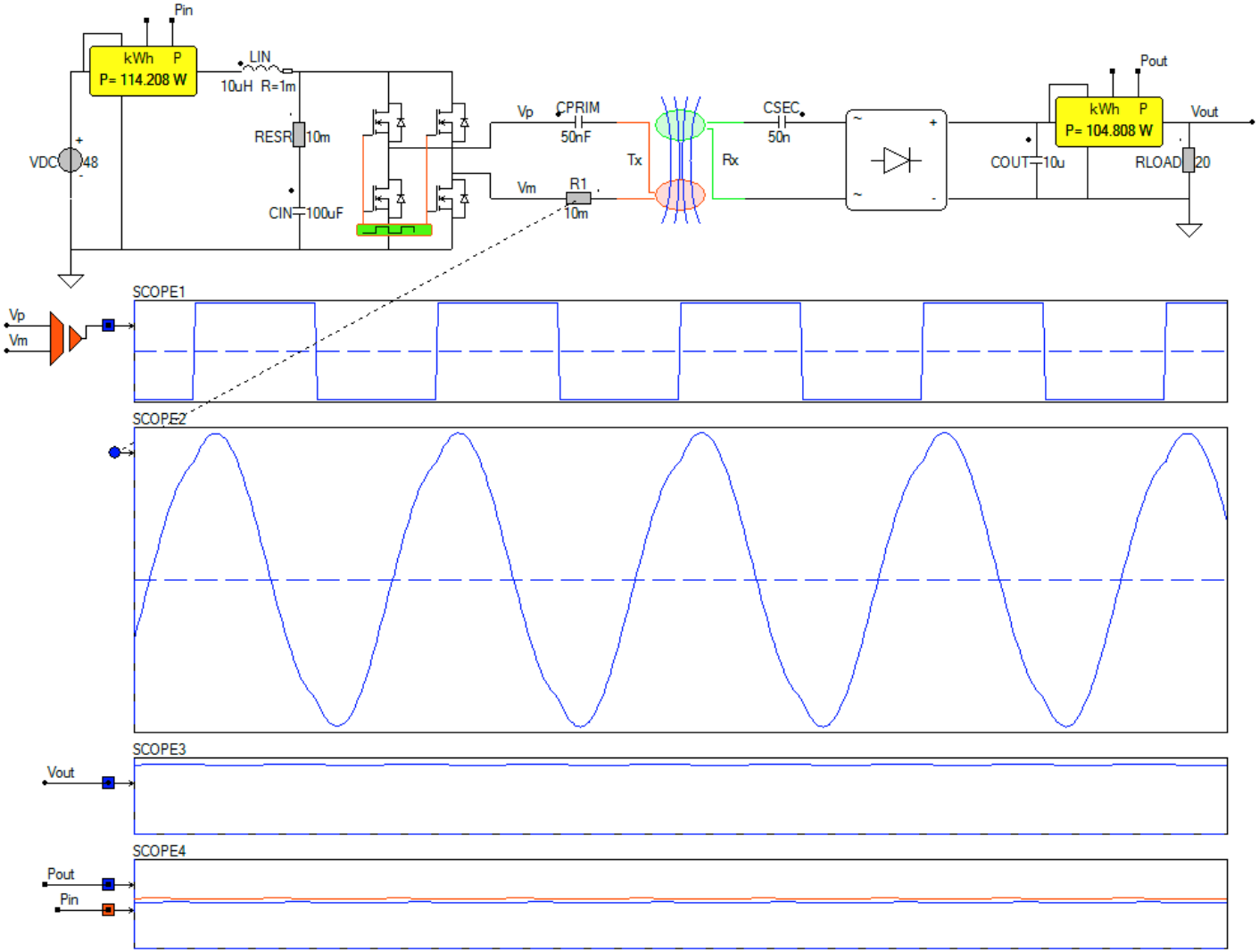
Control Fixed Frequency 90kHz



Control Fixed Frequency 120kHz

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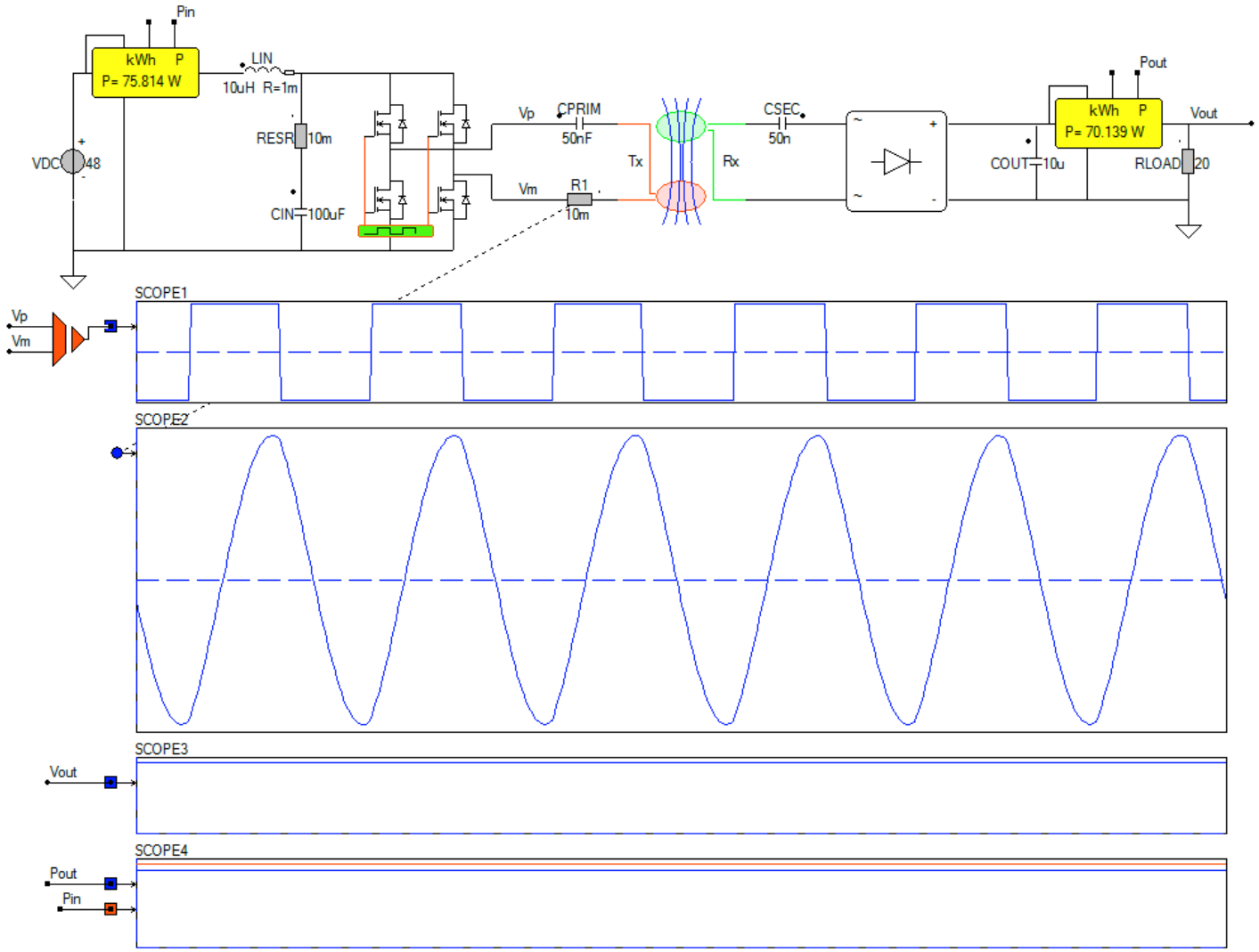

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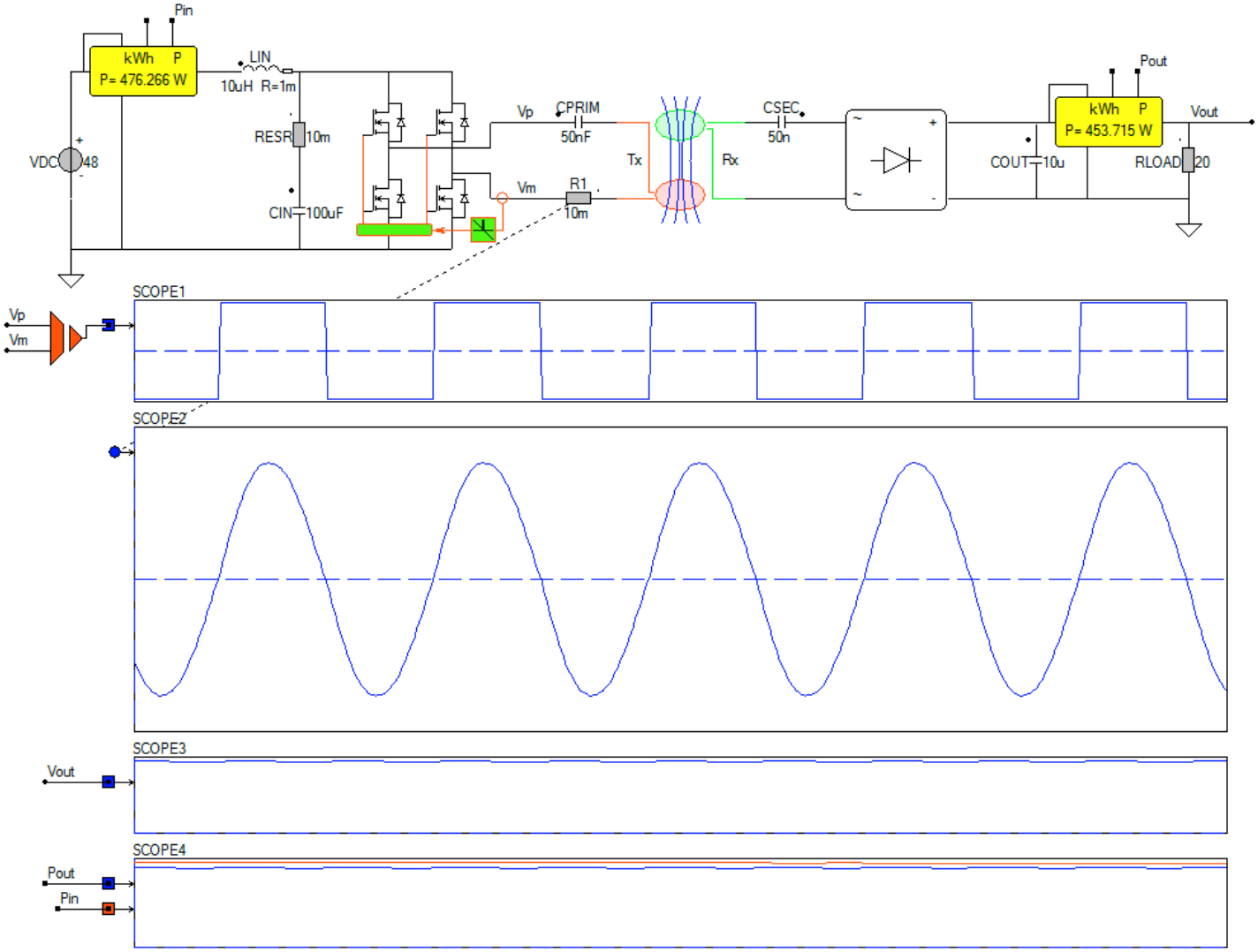
Control AutoResonant



Control via Vdc

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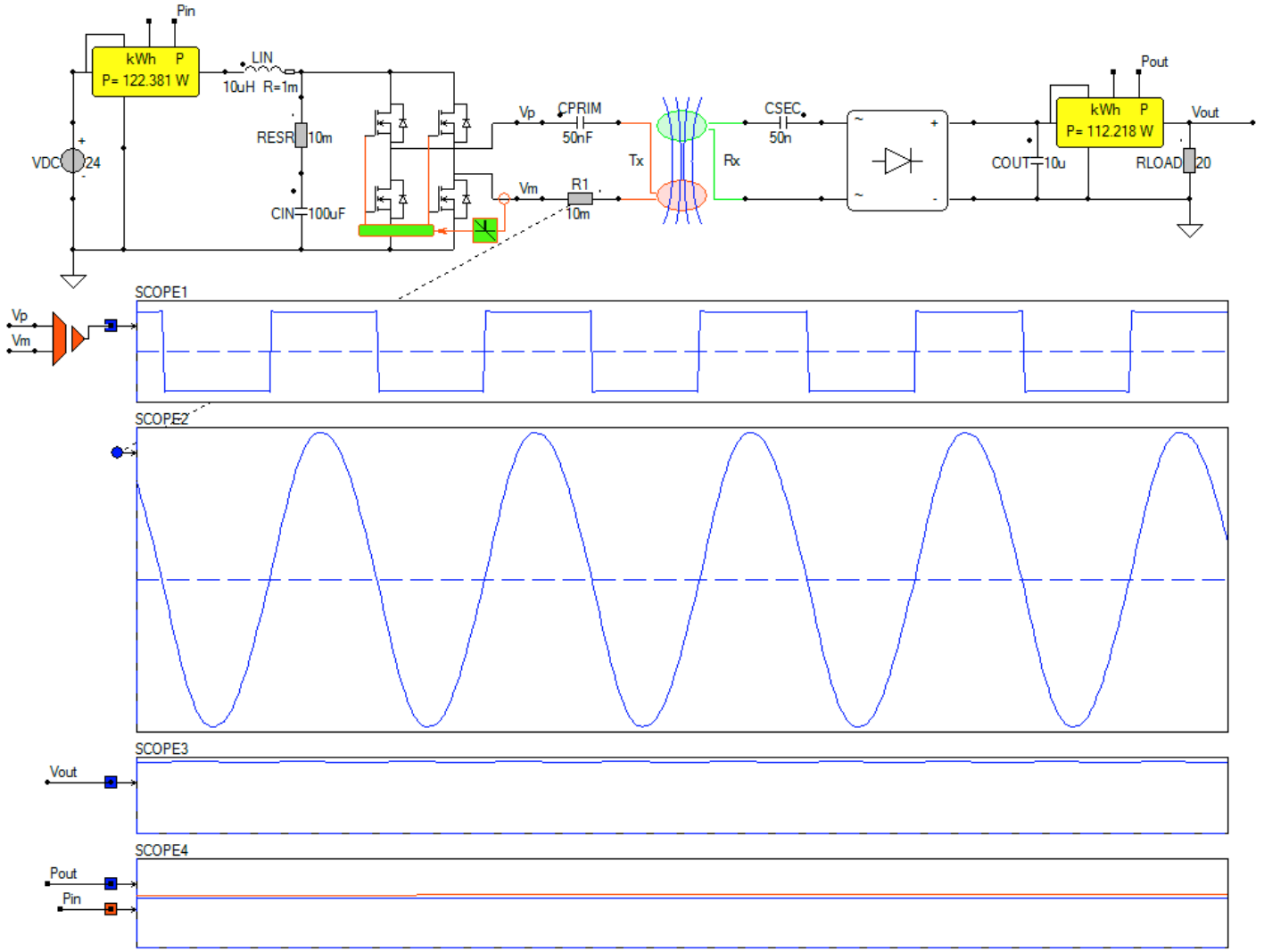

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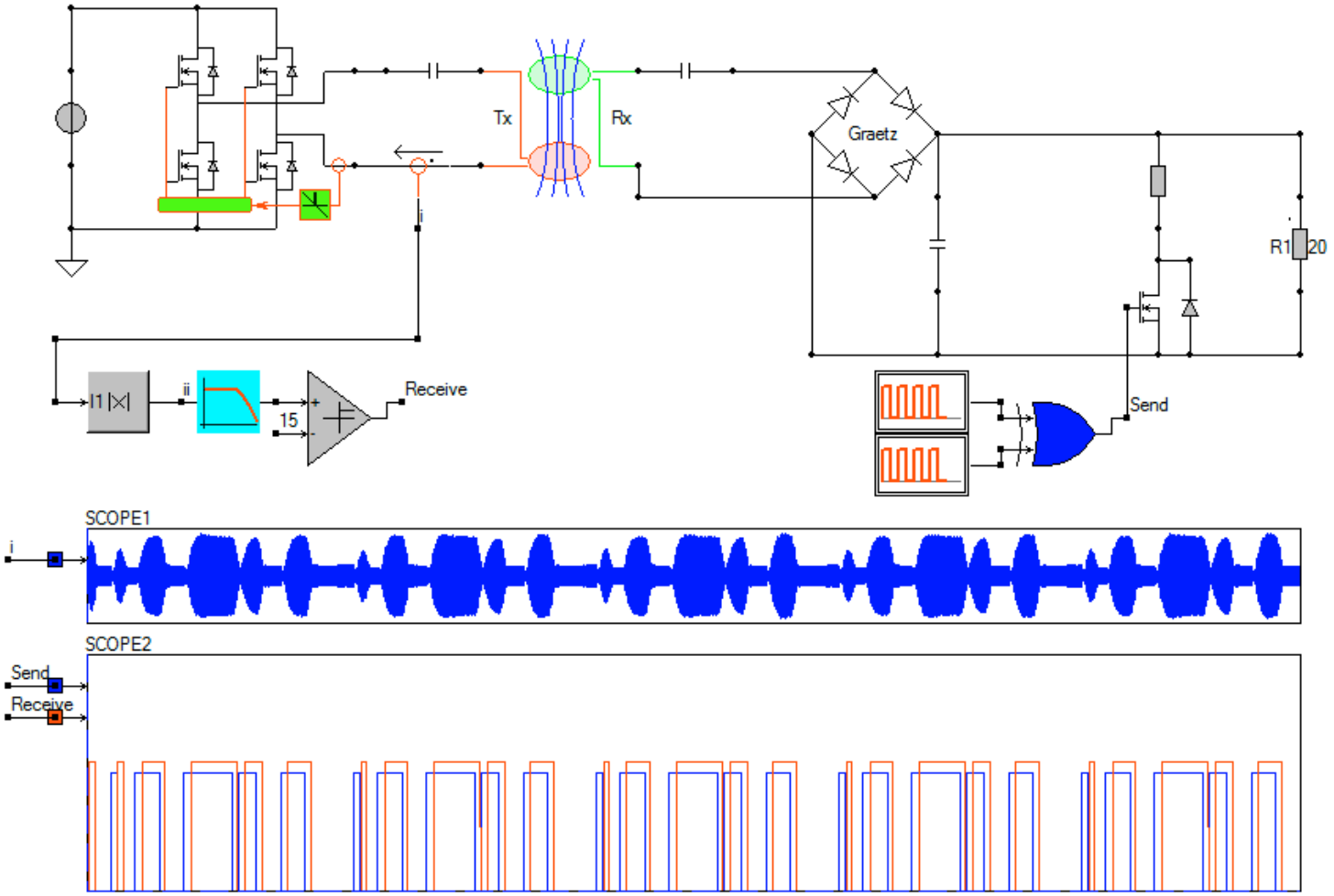
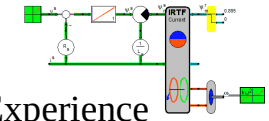
Communication



Regulation



A Simulation Experience

- Several standards:
  - IEC 61980-1
    - Electric vehicle wireless power transfer (WPT) systems
    - Part 1: General requirements
  - SAE J2954 RP
    - Electrically propelled road vehicles
    - Magnetic field wireless power transfer
    - Safety and interoperability requirements
  - ISO/PAS 19363:2017
    - (R) Wireless Power Transfer for Light-Duty Plug-In/ Electric Vehicles and Alignment Methodology
- More info: DOI:10.23919/EETA.2019.8804573

SAE exception for 85kHz range

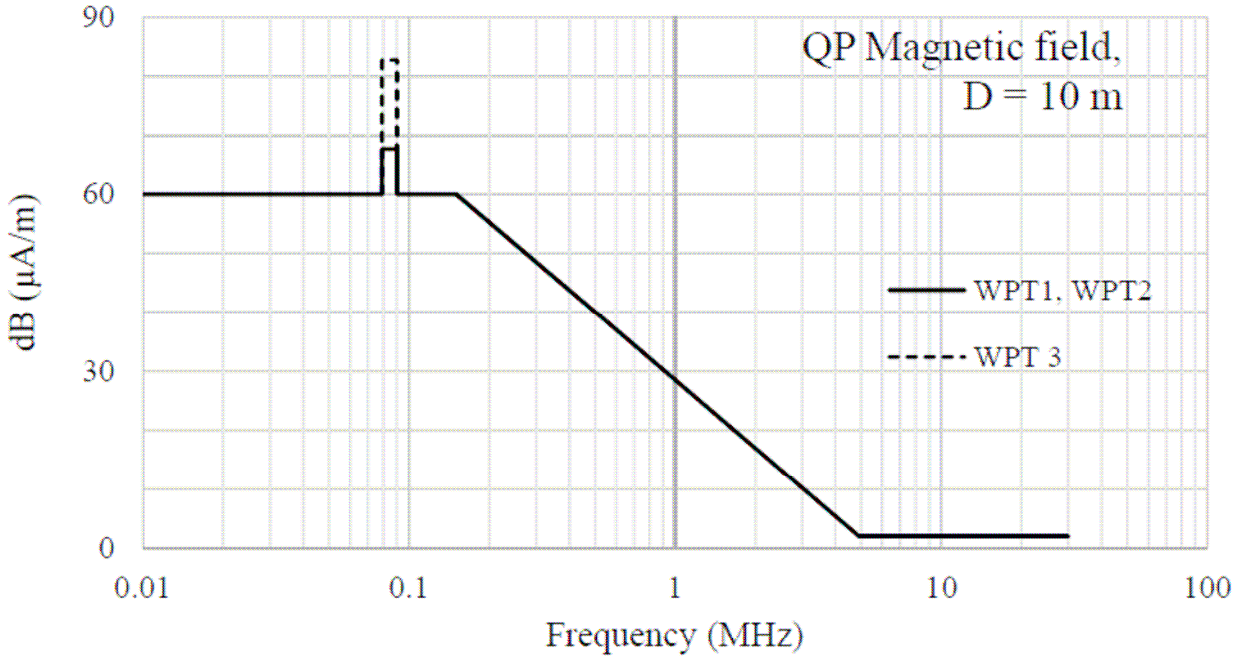


Fig. 4. SAE J2954/1 proposed limits for the radiated disturbances in residential environments below 30 MHz, for WPT1, WPT2 and WPT3.

- From:
  - F. Grazian, W. Shi, J. Dong, P. van Duijsen, T. B. Soeiro and P. Bauer, "Survey on Standards and Regulations for Wireless Charging of Electric Vehicles," 2019 AEIT International Conference of Electrical and Electronic Technologies for Automotive (AEIT AUTOMOTIVE), Torino, Italy, 2019, pp. 1-5, doi: 10.23919/EETA.2019.8804573.

Applications

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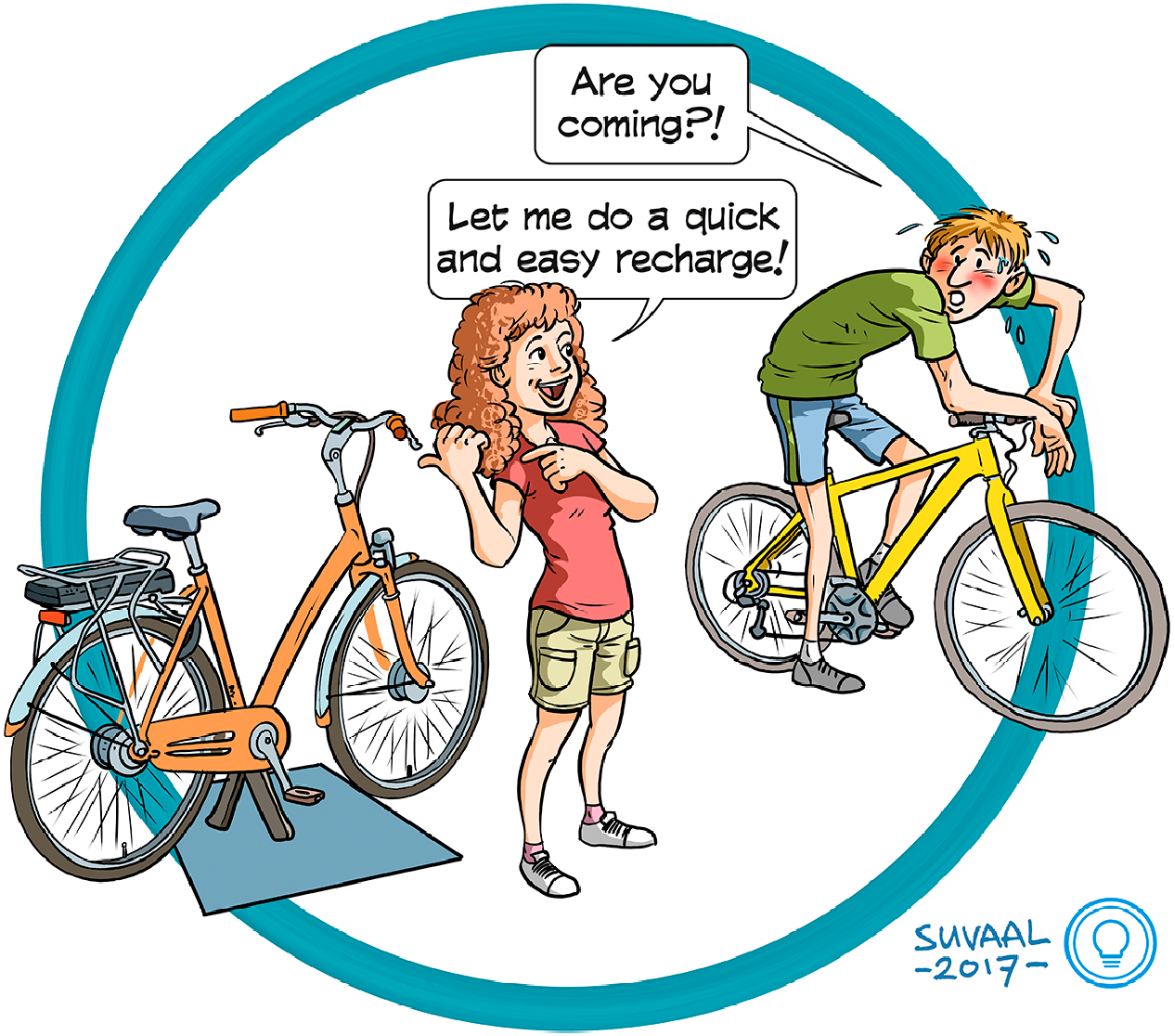

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Canal Cruiser

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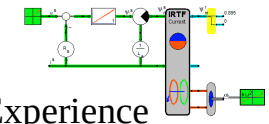

- Inductive charging for Amsterdam Canal Cruisers
- https://www.est-floattech.com/inductive-charging-system/
- 100kW / 30kHz
- Airgap = 5cm
- Area = 1.5 m2

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Ferry

- https://ipt-technology.com/ships-ferries/

- 2kWh charge energy per stop, 145 charge stops per day, 112 seconds charging time

Wartsila

- https://www.wartsila.com/marine/build/power-systems/shore-connections/wireless-charging

Wartsila

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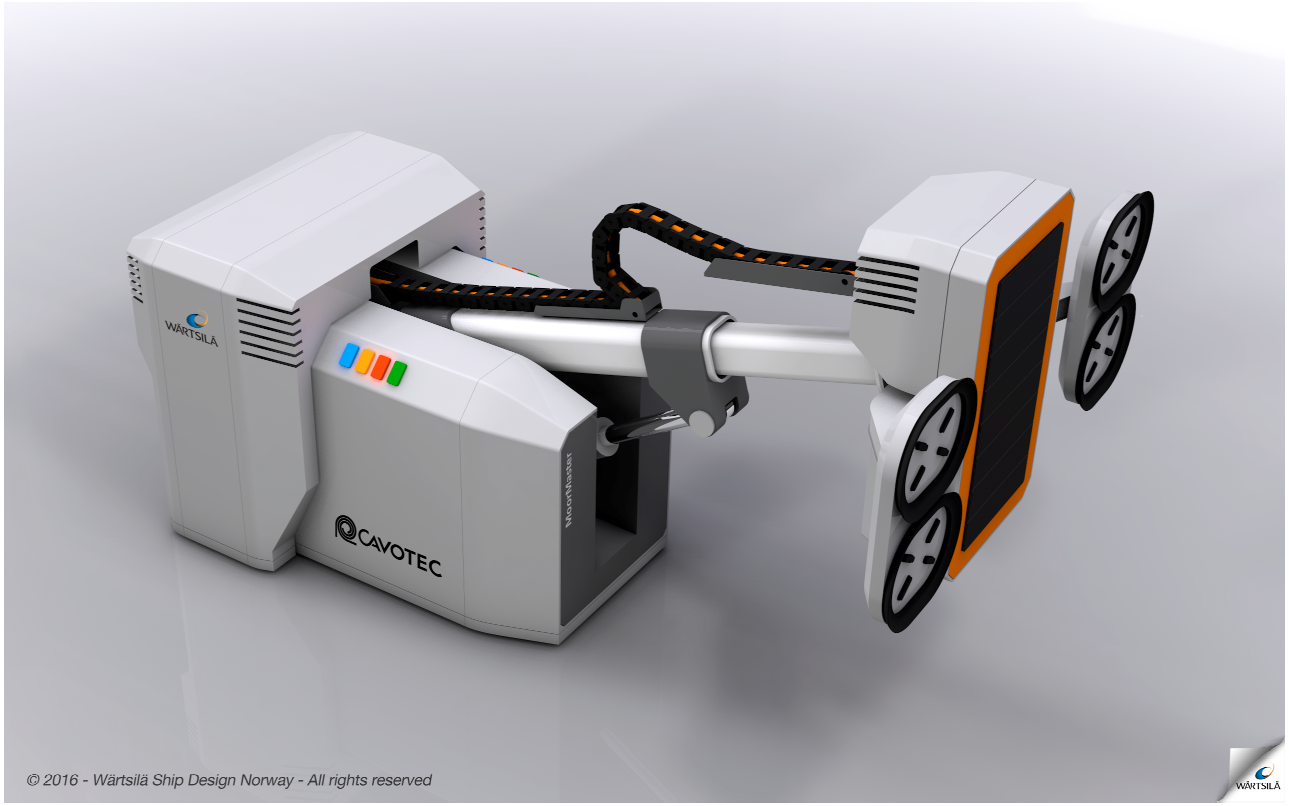

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Conclusion

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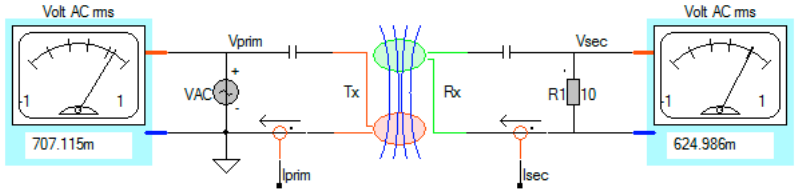
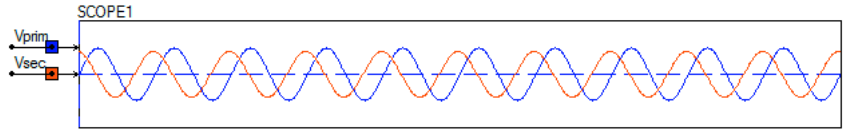
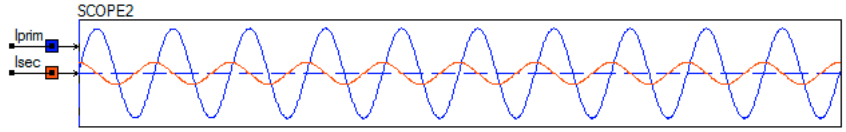
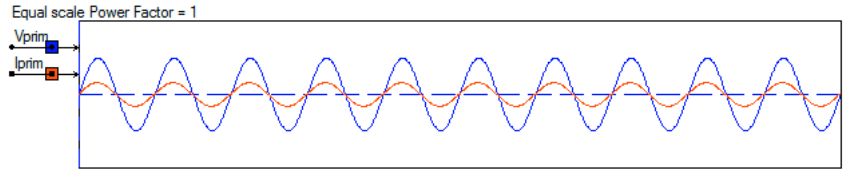
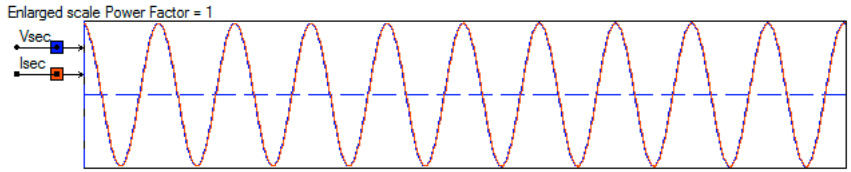
- Is it Possible?
- Is it Feasable?
- Satisfied about Efficiency?
- Questions?
  - Info@caspoc.com











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