Design and Optimization of a High Gravimetric Power Density Receiver for Wireless Charging of Drones

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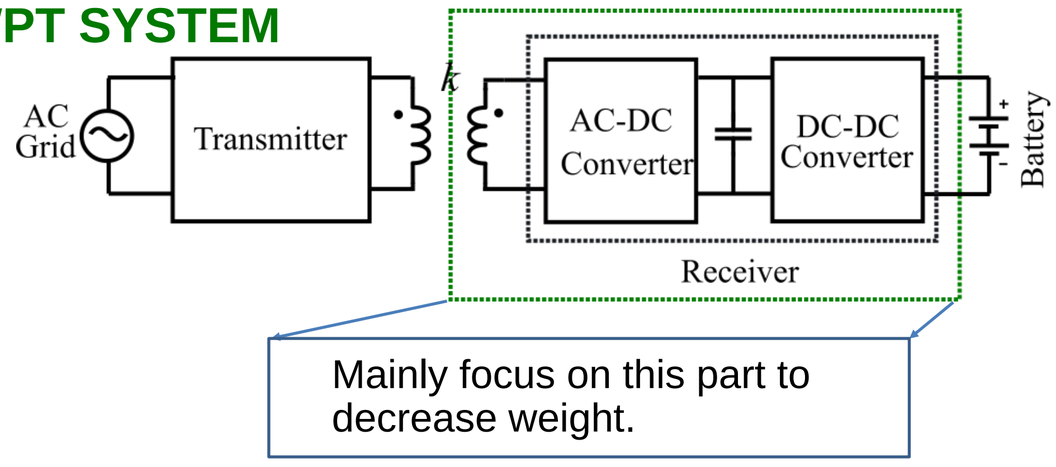
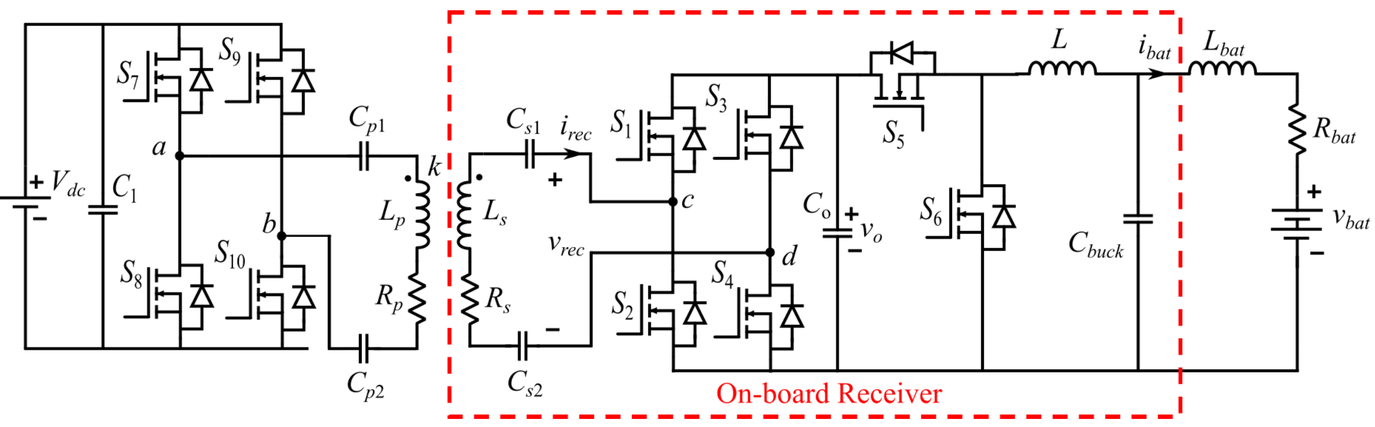
MOTIVATION FOR HIGH GRAVIMETRIC POWER DENSITY WPT SYSTEM

- Make the on board WPT receiver have high gravimetric power density by reducing weight of on-board components, such as Rx coil, converters etc. to maximize drone flight time.
- With lightweighting as a primary goal, high efficiency of the receiver is desirable only insofar as it allows reduced thermal management.



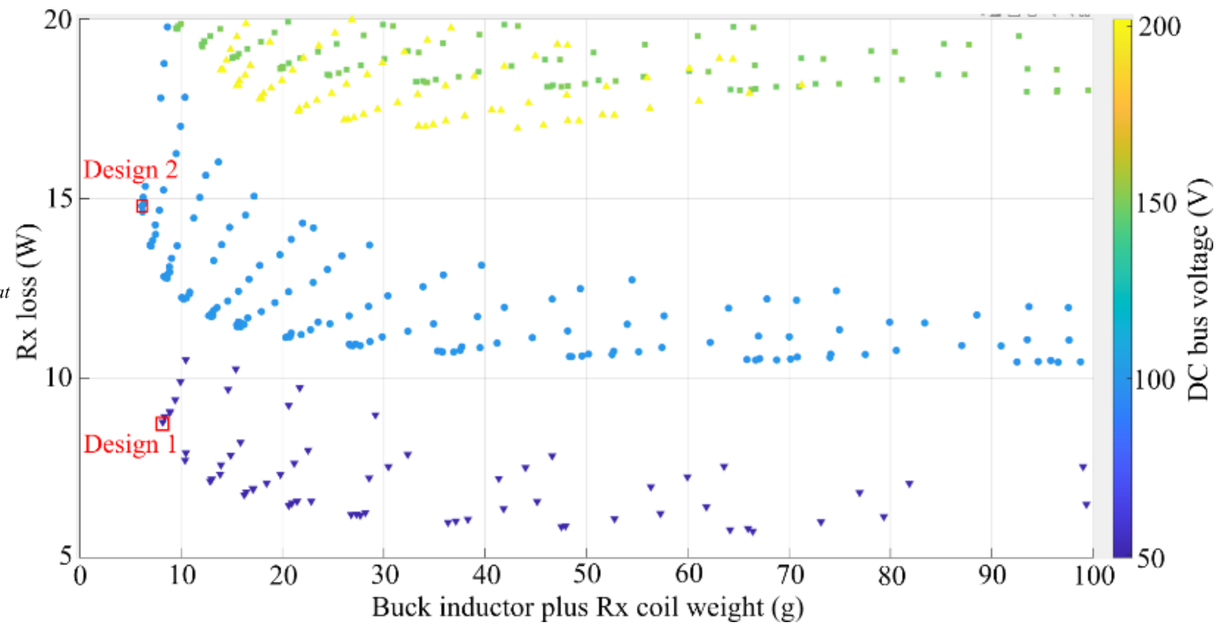
SYSTEMATIC DESIGN METHOD

Circuit schematic of the WPT system

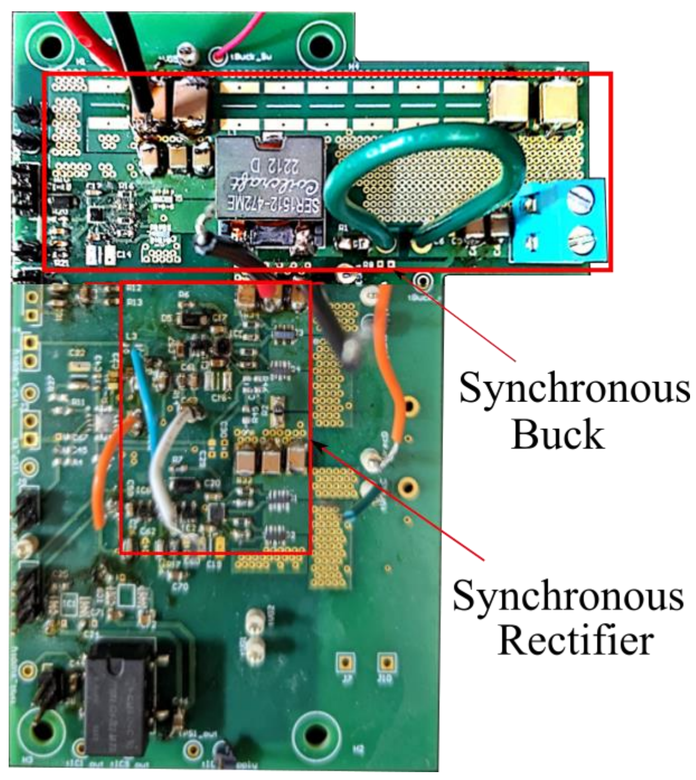


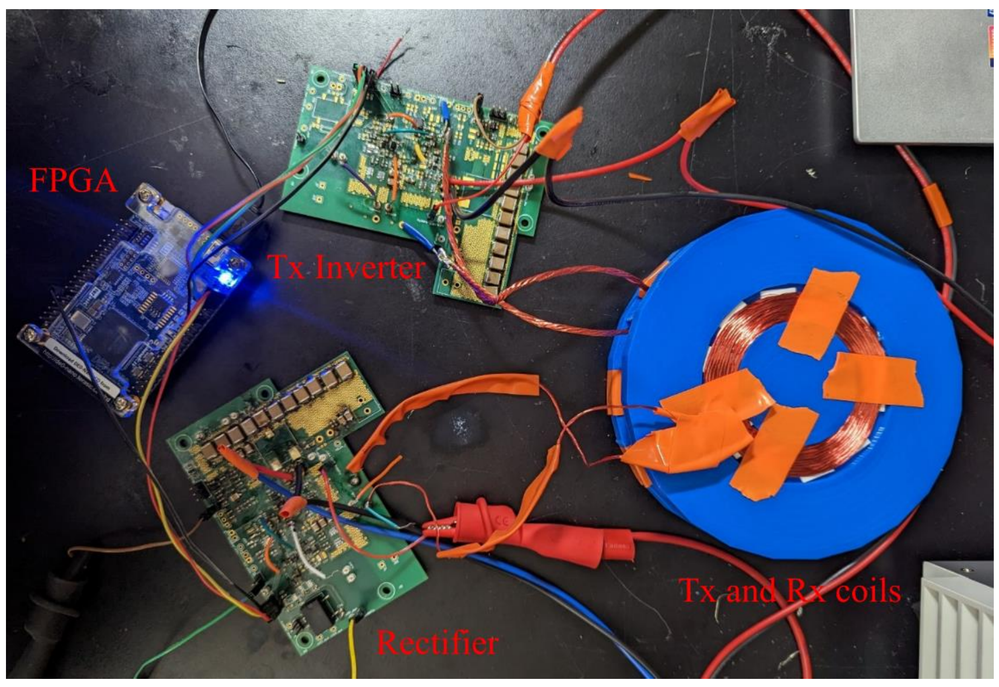
- The goal of the WPT system-level design is to optimize all stages of the receiver simultaneously to achieve high gravimetric power density.

Design space for optimization

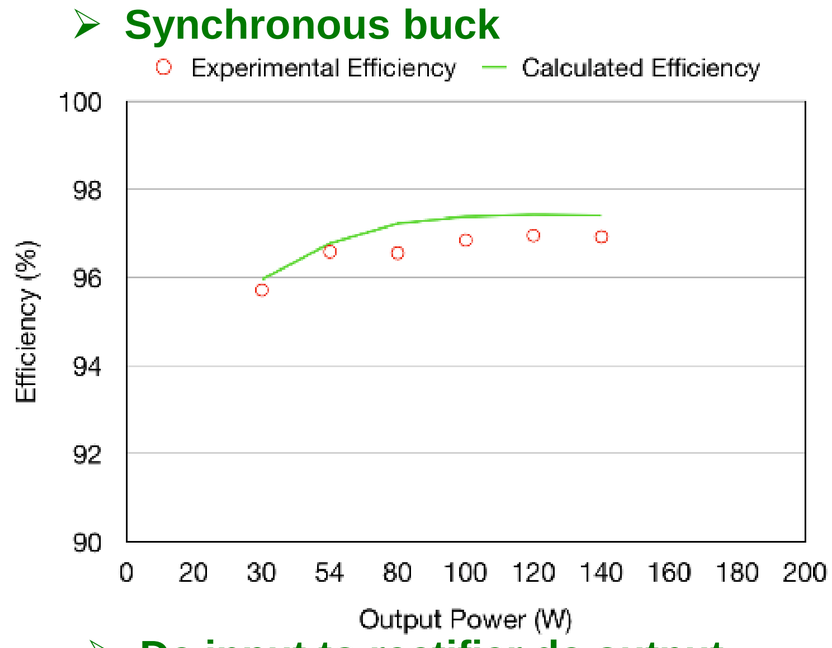


PROTOTYPE VERIFICATION

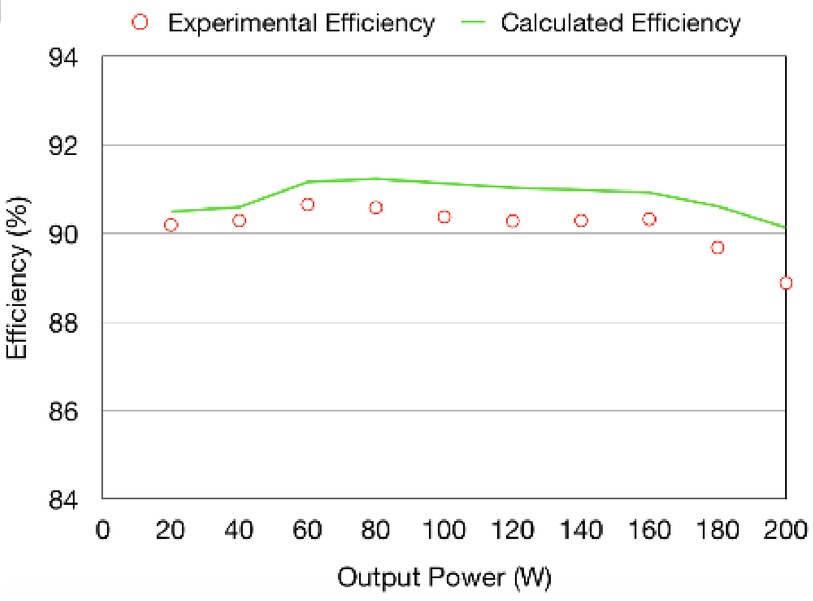




Synchronous buck

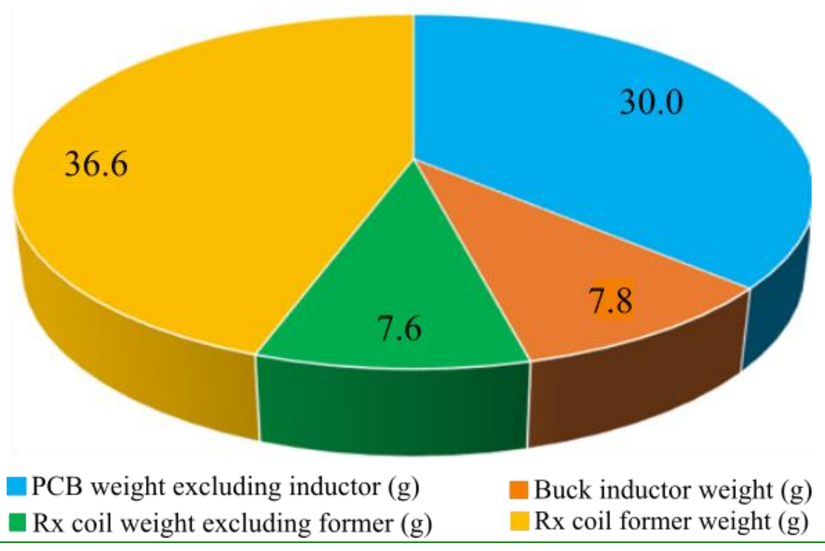


Dc input to rectifier dc output



Gravimetric power density estimates

- Current power density of the entire receiver = 140 W/82 g = 1.71 W/g
- Achievable power density of the receiver after optimizing the PCB and coil former weight, and with a FC based dc-dc topology = 200 W/43 g = 4.65 W/g



CONCLUSION and FUTURE WORK

- This poster has shown that high gravimetric power density of a receiver for wireless drone charging application can be achieved through a systematic design and optimization method.
- Buck tested up to 140 W. To test up to higher powers, a higher resolution modulator will be implemented to reduce dead time reverse conduction loss.
- Weight modeling of the PCB and passive components will be done to construct a more comprehensive weight model.
- For a 600 W prototype consider topologies such as SC, FCML converters to eliminate or reduce in size the low energy density inductor. Also consider different coil designs, such as a SR Rx coil and uniform-field Tx coil.