Docket #: S19-136

Optimized air-core coil design for wireless power transfer

Stanford researchers have optimized air-core coil design for wireless power transfer and demonstrated a 2x improvement over current designs. Existing resonant tank and coils are restraining MHz frequency inductive wireless power transfer efficiency. In response, researchers in the Stanford University Power Electronics Research Lab optimized the cross-section of air-core coils based on a number of key parameters (figure 1). Using additive manufacturing methods, they built and tested optimized coil cross-section designs. The coils are electroplated with copper at arbitrary thicknesses based on the desired frequency of operation. The simple, easy to fabricate, non-magnetic, optimized coil performance is nearly 2x better (size-normalized quality factor) than state-of-the-art designs.

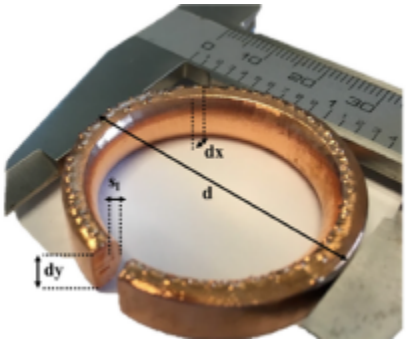


Figure 1 Copper-plated coil with key parameters

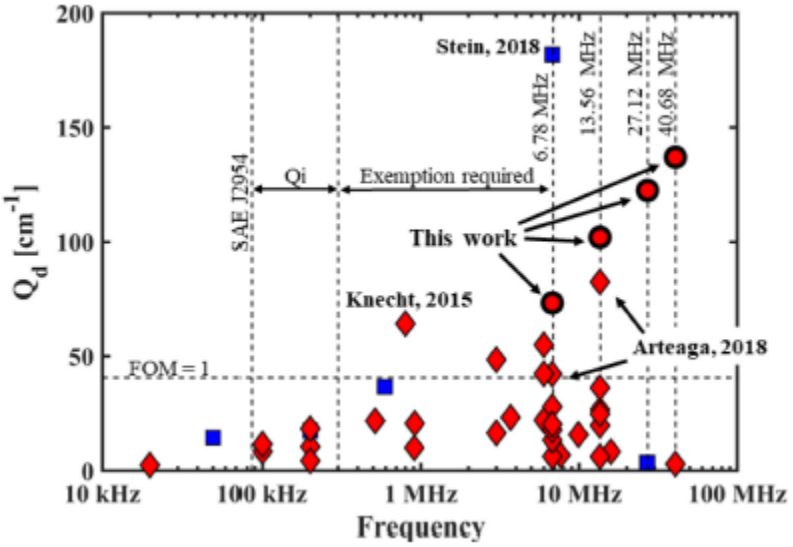


Figure 2 Comparison between this work and the state-of-the- art in coils demonstrated in inductive WPT systems. Red- fill 'diamonds' (existing literature) and '•' (this work) indicate air- core designs and blue-fill 'squares' indicate designs using magnetic materials. The minimum of Q_L and Q_T are plotted if both are provided. FOM = 1 is simulated performance for a loop of wire. Only the highest Q_d design at each ISM band from this work is shown.

Stage of Research - Prototype
Researchers in the Stanford University Power Electronics Research Lab achieved a maximum dc–dc efficiency above 89% with a gap (3 cm) equal to the coil radius (wireless power transfer system at 6.78 MHz and 500-W output power).

Applications

- Wireless power transfer for electric vehicles, drones, automated mobile robots, implanted medical devices, portable electronics, etc.

Advantages

- 2x improvement in size-normalized quality factor over existing air-core designs. Losses are 50% that of existing wireless power system design.

- Simple, easy-to-fabricate, non-magnetic (cheaper and more readily available), extensible coils.

Publications

- Zulauf, Grayson, and Juan Manuel Rivas Davila. "Single-Turn Air-Core Coils for High-Frequency Inductive Wireless Power Transfer." *IEEE Transactions on Power Electronics* (2019). DOI: 10.1109/TPEL.2019.2932178

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