High-Frequency Wireless Power Transfer for In-Flight Drone Power

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Overview

1. Background

Drones have become incredibly versatile in consumer, industrial, and military applications. This technology suffers from short flight times caused by heavy battery technology.

2. Problem Statement

Current technology for extending drone flight time lack **power transfer range, scalability, an/or are not applicable to consumer quadcopters.**

With **Gallium Nitride transistor (GaNFET)** technology, we designed a 13.56 MHz **inductive power transfer (IPT)** system that acted as a **standalone power system** for a small **consumer drone**.

Design

1. Overview

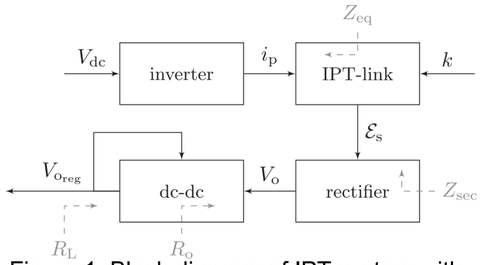


Figure 1. Block diagram of IPT system with variable coupling, from [1].

We implemented an IPT system as in [1]. This takes a DC voltage in, V_{dc}, that is then transferred via IPT to a rectified and output as V_o as seen in the block diagram in Figure 1.

Design Cont'd

2. Inverter

We built a Class EF inverter following the design in [1]. We did make modifications for heat dissipation and added a driver circuit for the GanFET.

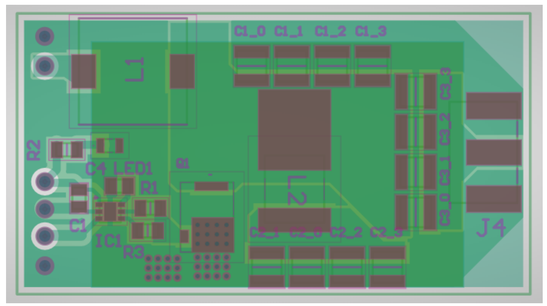
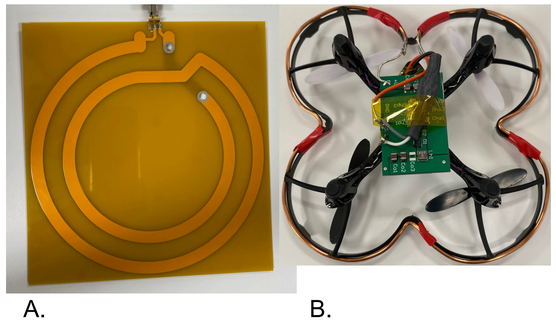


Figure 2. Rendering of the Inverter circuit with some heat management vias.

3. Inductive Coils

The Inverter created a high frequency AC current that was fed to the IPT system. The coil on the side of the inverter followed the design in [1]. The coil on the rectifier was built to fit on the propeller guard of the drone. This was built with copper wire.



A. B.

Figure 3. Pictures of A) printed circuit board inverter-side coil and B) the rectifier side coil mounted on the drone.

Design Cont'd

4. Rectifier

Connected to the coil on the drone is a Hybrid Class E rectifier that feeds a DC-DC voltage converter that powers the drone as in [1].

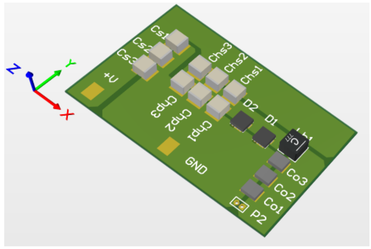


Figure 4. A rendering of the rectifier board that is mounted on the drone.

5. Simulations

This system, including the drone load was modeled in LTspice before building and voltages across the inductive coils were matched to results in [1].

Results

This design resulted in a drone that received power only from the IPT system. However, not enough power was transferred to sustain flight due to the GaNFET overheating.

Figure 5. Drone powered, lights on and propellers rotating but not achieving enough lift to take off.

Future Work

Future work on this project should include redesigning the inverter board with better heat management and could include coupling multiple systems to increase drone fly area.

References

[1] J. M. Arteaga, S. Aldhaher, G. Kkelis, C. Kwan, D. C. Yates and P. D. Mitcheson, "Dynamic Capabilities of Multi-MHz Inductive Power Transfer Systems Demonstrated With Batteryless Drones," in IEEE Transactions on Power Electronics, vol. 34, no. 6, pp. 5093-5104, June 2019.

Acknowledgements

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