Improving Range and Efficiency of Wireless Charging

John Contovasilis
Adviser: Dean Arakaki

Overview

The purpose of this project is to create a prototype wireless charging system for mobile devices with improved range and efficiency compared to existing wireless charging products. The end goal of these improvements is to support the creation of a new long-range wireless charging system which will allow users to charge their mobile devices anywhere within an average size room.

Existing Solutions

The majority of commercially available wireless chargers utilize the Qi wireless power transfer standard. The Qi system relies on inductive coupling and has a max transmit distance of approximately 4cm. In addition, Qi charging systems use a backscattering control loop in which the impedance of the receiving coil is modulated. This allows information to be sent from the receiver to the transmitter and is used to adjust the amount of power that is transferred. This limits the system's ability to charge multiple devices simultaneously.

Block Diagram

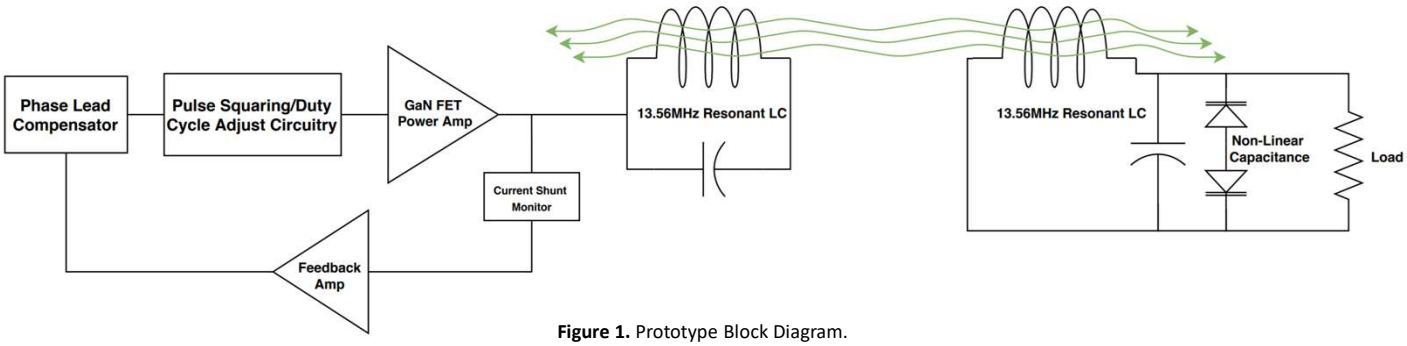

Figure 1. Prototype Block Diagram.

Key Improvements

This project utilizes a resonant inductive power transfer technique which provides improved coupling and subsequently improved range compared to purely inductive based systems. In addition, the receiver is implemented entirely with passive components which greatly simplifies the design. In order to achieve high efficiency with no active tuning on the receiver, non-linear capacitance is used in the resonant circuit. This allows the efficiency to remain relatively constant over the operating range of the system. In traditional inductive charging systems, the efficiency can only be optimized at one particular transfer distance.

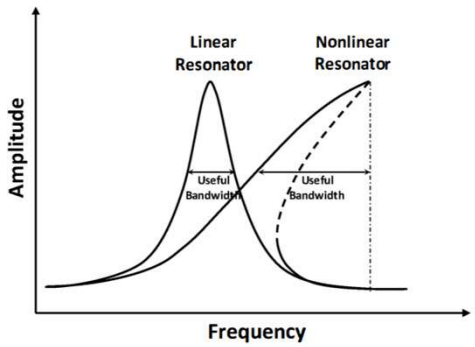

Figure 2. Duffing Resonator Frequency Response.

Future Work

The next steps for achieving the project goals are to extend the usable range of the system by designing higher Q factor resonant circuits and creating a more complex control system for the transmitter. The latter is required because transmitting power at large distances will require special startup conditions for the transmitter control circuitry to establish efficient power transfer. This will most likely need to be prototyped with an FPGA. The ultimate goal for this project is to create a system similar to WiFi in which an arbitrary number of devices can be charged in a room.