CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

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Project Number

J1019

Project Title

Miniature Wireless Charging: The Future of Charging Hearing Aids

Abstract

Objectives

The goal of my engineering project was to create a functional miniature wireless charger that could be modified for a lithium-ion button cell battery in a hearing aid. Currently, hearing aids batteries are disposable zinc-air button cells that contribute to e-waste and are required to be changed often. I use hearing aids and understand their limitations so I wanted to engineer for the deaf and hard-of-hearing community.

Methods

To transmit power, both receiver and transmitter circuits need iterative designs. The transmitter circuit first uses a PICAXE microcontroller that I coded to generate a 100 kHz (resonant frequency) square wave at 5V. This is necessary to run the coil so that it produces the electromagnetic field to transmit power. The code I used to run the PICAXE was found on a free online source, then slightly modified. From the PICAXE, the signal is sent through a transistor circuit that turns on a MOSFET transistor. The MOSFET turns on and off from 0 to 12V, producing the square wave. Finally, the square wave is sent through the transmitter coil and a 0.1uF capacitor in parallel to produce the electromagnetic field and complete the transmitter circuit. The receiver circuit starts with a bridge rectifier after the receiver coil to convert the incoming AC into DC. Then, a series of capacitors and a linear voltage regulator regulate the voltage to 5V which leads to an LED that turns on when power is transmitted. All of the prototyping was done on breadboards and then soldered on PC boards.

Results

After five design iterations, the miniature wireless charger was able to transmit 15-20 watts at a maximum distance of 3 mm. Throughout the design iterations, the receiver circuit stayed very similar, but the transmitter circuit required many changes. In the transmitter circuit, one challenge was designing a circuit to allow enough voltage to turn on the MOSFET. Finally, a transistor circuit was used, and many components were traded for similar ones that would perform better in different conditions.

Conclusions

The amount of voltage transmitted, 20 V, is quite a lot for a homemade charger and acceptable for overnight bedside charging of a hearing aid. On the downside, most coils can be at least a centimeter apart and still be able to charge. The circuit still has performance limitations. One of the major issues with the charger is the inductive kickback coming from the MOSFET on the transmitter side. To counteract this problem, a small heat sink was built with an aluminum block. In the future, the project would be continued by modifying it to charge a Li-ion battery and the receiver control board would be customized to fit onto a hearing aid.

Summary Statement

I created a miniature wireless charging circuit that was designed to eventually be modified for a Li-ion button cell battery on a behind-the-ear hearing aid.

Help Received

The adult help received was purchase of all electronics parts on parents credit card and some guidance from a robotics coach, Mr. Saidin. When I was working on my final design, he gave some tips on soldering and also allowed use of his oscilloscope.