CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

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Project Number

S1005

Project Title

Optimizing Wireless Energy Transfer System to Power Biomedical Implants

Abstract

Objectives/Goals

Many patients depend on implantable medical devices, such as pacemakers and left ventricular assist devices (LVAD). Some of these devices require electrical wires to supply energy from external power sources, making patients vulnerable to infections from the exposed lead. A wireless power transfer system would eliminate the wires, and thus reduce the risk of infection. This project highlights the potential use of wireless power technology in biomedical devices. The goal of this project is to compare two different wireless energy transfer systems in circuit designs with regard to their impact on the power capability and efficiency.

Methods/Materials

Computer simulations were conducted to optimize the circuit designs for Class-C and Class-E based power oscillators. Two types of power oscillators with resonant inductive links were built into wireless energy transfer systems on breadboard to study the total power transfer and system efficiency.

Results

The Class-C based system transferred about 60 mW to the receiver with a total system efficiency of about 13%. In comparison, the Class-E based system transferred about half of a watt of power with a total system efficiency of about 15%. It is clear that the Class-E system transferred 800% more power than the Class-C system, with greater efficiency.

Conclusions/Discussion

While the Class-C oscillator is relatively easy to tune, it is limited by the operating voltage and current imposed by the bipolar junction transistor. The Class-E oscillator makes use of the high current capacity and fast switching characteristics of the MOSFET, as well as the zero-volt/zero current switching tuning, achieving higher performance than the Class-C oscillator. I hope that better tuning strategies can be achieved for the Class-E oscillator so the efficiency can be further improved in the future to use wireless energy transfer for fully implantable artificial heart systems.

Summary Statement

Resonant coupled inductive links based on Class-E power oscillator was built to demonstrate potential to power biomedical devices to eliminate the risk of lead-induced infection.

Help Received

I used lab equipment at the University of California, Irvine under the supervision of Professor William Tang. He also provided different papers to read, explained the concept of wireless energy transfer, and helped with circuit design selection. My parents drove me to the lab and purchased the supplies.