CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Atul Raghunathan

Project Number

S0919

Project Title

Recovering and Recycling Excess Thermal Energy to Improve the Net Efficiency of Common Lighting Sources

Abstract

Objectives/Goals

Even the most efficient consumer light form, the LED, converts between 5-40% of its energy input into heat. Everyday household LED bulbs have large radial heatsinks to remove and dissipate this heat. This project aims to utilize this wasted heat by collecting it, converting it into electrical energy, and recycling that energy to partially power the LED bulb. With a combination of inexpensive thermoelectric generators, capacitors, and transistors, I intend to capture at least 60 milliwatts and successfully recycle it to power a Cree Xlamp CXA 1304.

Methods/Materials

I created my apparatus from four small Peltier CPU coolers used as thermoelectric generators. With a NiMh Battery and a 3 Ohm resistor, I was able to provide the manufacturer specified current to the four LEDs. I charted the output every 5 seconds for 10 minutes to view the trend of the power being produced by the generators. A function was also generated to predict future data. Four iterations in design yielded a consistent output.

To recycle the power, I use an LTC3108 boost Converter to convert the output of the four thermoelectric generators to a usable 8-12 volts. This is then used to charge a capacitor, which breaks the circuit powering the LED with a depletion mode N-Channel MOSFET through a voltage regulating P-Channel enhancement mode MOSFET. The LED switches to the power output of the capacitor for a fraction of a second. The design of this component was perfected in five iterations.

Results

The thermoelectric generator was able to produce 132 milliwatts at first, but that declined and stabilized at 109 milliwatts. With data from the second prototype, the LED was 80-90 degrees cooler with use of the thermoelectric generator; it reduced the temperature on an average from 210 degrees to 120 degrees Fahrenheit.

Conclusions/Discussion

This mechanism effectively recycles power to the LED in a closed loop system. This LED bulb can increase the efficiency of LED lighting and reduce the amount of heat dissipated. Therefore, air conditioning costs can be lowered and smaller heatsinks can be used due to cooler ambient air. As the LED also runs at a cooler temperature, the lifespan of the LED can be increased by up to ten years. If instituted in the average American home, such bulbs can save between 129 and 322 kilowatts of power. With a consistent 109 milliwatts, the engineering goal was achieved and surpassed.

Summary Statement

I converted the waste heat produced by an LED bulb into electricity, and recycled it to partially power the same LED bulb.

Help Received

My physics teacher explained to me the principles behind a MOSFET. I designed and built the apparatus myself.