CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Weston D. Braun

Project Number

S0901

Project Title

Active Load Distribution for Increased Efficiency in Piezoelectric Converters

Abstract

Objectives/Goals

One of the greatest obstacles in the further minimization of electronic devices is the switch mode power supply (SMPS). The size of SMPSs is limited by the magnetic transformer they contain. One device that promises to eliminate this magnetic transformer is the piezoelectric transformer (PT). PTs are lighter weight, have a greater power density than ferrite core transformers and emit little electromagnetic interference. The implementation of PTs in SMPSs has been hindered by two main disadvantages: the fact that the efficiency of a PT is highly dependent on loading, and that there is no single unit PTs capable of matching the high power output of a magnetic transformer. This project attempts to tackle both these disadvantages by utilizing a parallel arrangement of piezoelectric transformers under microprocessor control. Through parallel operation, the maximum power output is increased, and through microprocessor control the loading on each PT is optimized for maximum efficiency.

Methods/Materials

Three PT drivers were designed and constructed to drive piezoelectric transformers that were modeled and optimized in Mathematica and etched from commercially available piezoelectric material. An Arduino development board was used to measure power output and control the state of each PT driver. The number of PTs being driven was determined in software based on the load resistance and the optimum load resistance of a single PT.

Results

The PT converter assembly was able to convert an 8 volt input to 18 volts and achieve a peak efficiency of 68.1%. A maximum power output of 5.48 watts was achieved. The microprocessor controlled assembly was able to output much greater power at a higher efficiency than that of a single PT.

Conclusions/Discussion

This project has demonstrated a feasible way of overcoming some of the major limitations of PTs and reliable control method for PTs was developed. With further research, PTs promise to allow for significantly smaller and lighter weight power supplies.

Summary Statement

An active control scheme was developed and tested to overcome some of the limitations of piezoelectric transformers through the use of a parallel configuration.

Help Received

Dr. Ian Galton was my project advisor and provided access to lab equipment at UCSD and also reviewed my electrical schematics.