



CALIFORNIA STATE SCIENCE FAIR 2011 PROJECT SUMMARY

Name(s) Erik Z.S. Meike	Project Number J0917
Project Title Inductors and Pulse Width Modulation in Boost Converters	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The purpose of this project was to determine whether a Maximum Power Point Tracking (MPPT) solar battery charger should match the Pulse Width Modulation (PWM) frequency to the resonant frequency of the inductor in order to increase the overall efficiency.</p> <p>Methods/Materials I designed and built an MPPT boost converter so that I could measure the efficiency with different frequencies of PWM. The circuit included an Arduino which I programmed to find the Maximum Power Point (MPP). The Arduino was coordinated with a Parallax Propeller microcontroller that I programmed to generate controlled frequencies of pulses. Experiments were performed sweeping the pulse width frequency from 1 kHz to 250 kHz in 1 kHz steps. Additional experiments were performed in select 1 kHz ranges with 1 Hz steps under both controlled laboratory lighting and natural outdoor sun conditions. Inductors were tested with inductances ranging from 35 μH to 350 μH.</p> <p>Results Based on the measurements taken by my circuit, I was able to calculate the amperage and power into and out of the boost converter. The ratio of the power output to the power input of the boost converter is the efficiency. By correlating the efficiency and the PWM frequency, I can identify resonant frequencies and harmonics. These would appear as spikes in efficiency at certain frequencies. Efficiencies ranging from 0 to over 90% were observed, however no spikes correlating to pulse frequencies were visible. Further analysis showed that there was a strong positive correlation between the input power and efficiency.</p> <p>Conclusions/Discussion Surprisingly, it does not seem that there would be an advantage to continuously tune the PWM frequency to the inductor's resonant frequency, since there appears to be no efficiency gains at any harmonic frequencies. The discovery of a strong positive correlation between the input power and efficiency indicates that the conversion process is very inefficient at low power inputs. This can be caused by low light conditions suggesting that there is more room for improvement in these situations.</p>	
Summary Statement A maximum power point tracking solar panel battery charger does not appear to be made more efficient by tuning its pulse width modulation frequency to the inductor's resonant frequency.	
Help Received Mother helped glue poster. Dad helped keep me on schedule, and reviewed my Parallax Propeller PWM code.	