



**CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY**

Name(s) John M. Grosen	Project Number J0916
Project Title The Effect of Changing Frequency on CPU Energy Usage	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The purpose of this experiment was to find whether it is more energy efficient to run a CPU at a high frequency (running a task quickly, then having the CPU sleep for the remainder of a set period of time) or at a low frequency (running the task more slowly, then having the CPU sleep for a shorter amount of time or not sleep at all).</p> <p>Methods/Materials A program was written for the DSP (digital signal processor) CPU of the OMAPL138 system-on-a-chip to characterize its power usage while busy (actively computing); it was run, and a multimeter was used to measure power draw for four different frequencies: 100 MHz, 200 MHz, 300 MHz, and 456 MHz, and the results were recorded. A similar program was used to measure its power usage while sleeping. Next, the number of cycles needed to go to sleep and the number of cycles needed to wake up were measured. Then the total actual energy used was measured. Finally, an equation was written to model the energy usage, and the theoretical values were compared to the measured quantities to verify the validity of the equation.</p> <p>Results When testing for a period of 50 ms, the highest frequency, 456 MHz, used the least energy whenever the number of cycles was above 1,300,000. Below 1,300,000 cycles, 100 MHz used the least energy. When computing 5,000,000 cycles, 456 MHz used the least energy as long as the amount of time was below 190 ms; above this, 100 MHz used the least.</p> <p>Conclusions/Discussion In order to maximize energy efficiency, a dynamic clock rate is necessary. The highest frequency yields the lowest energy usage when the ratio of the period to the number of cycles is reasonably small. If the period is long and the task is short, the lowest frequency is best.</p>	
Summary Statement The purpose of this experiment was to find whether it is more energy efficient to run a CPU at a high frequency or at a low frequency, assuming the CPU is able to sleep.	
Help Received Father provided equipment and documentation; mother helped with construction of board	