Milestone One Report

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For the first objective of the power team on the trail counter project, we had to measure the power output from the STM32 in a variety of different states using the µCurrent and oscilloscope. We then quantified the data in the run, sleep, and standby modes. Our task did not require hardly any software design and instead required us to familiarize ourselves with new tools and establish baselines for power measurement. We succeeded in both of our requisite goals and recorded the expected results.

An oscilloscope measures the change in voltage across two potentials. It then visually displays this data on a graph of voltage over time on a digital display. The oscilloscope generates analog data which is a continuous output, however, this results in noisier data. This became a problem later when we put the processor into stop mode which operates at a voltage very near the noise threshold of the oscilloscope. The other device we used was the µCurrent which took in a voltage and using a resistor transformed that reading into a power reading the oscilloscope could display.

Initial difficulties that we had with the lab consisted of wiring our STM32 discovery board in such a way that we could read the power it was outputting with the oscilloscope provided to us. One source of error consisted of wiring the IDD jumper incorrectly, this would prevent us from measuring the current using the µCurrent tool and ultimately give us incorrect readings for voltage from the oscilloscope. Another issue we had to account for was that when forcing the board into standby and sleep modes it was not possible to download any new code onto the board. We got around this by resetting the board and using a jumper to force the board to boot into its default settings which then allowed us to download new code onto the board that change what state the board was currently in.

The approach we took to accomplish our objective of quantifying the system power in the run, sleep, and standby processor modes consisted of the following. First we connected our STM32 discovery board into another breadboard, however, we later abandoned this design because it gave us no added benefit. Our end design was simply the oscilloscope lead connected to the IDD jumper and that connected to the µCurrent device. Originally, we wired the breadboard incorrectly by pumping 3V into it and wiring the oscilloscope to board and not the power reading from the STM32. This produced a constant 3V reading from our oscilloscope. We determined this by turning the LED lights on and off which should have produced some fluctuation in the power reading. Lacking thorough knowledge of circuits, we asked Bryce for help and he re-wired our interface to utilize the µCurrent instead of the breadboard. The other issue he corrected was our graph on the oscilloscope. In order to get the reading from the STM32, we had to subtract the difference from the two readings since the oscilloscope was not grounded.

The results achieved for this section of the project are summarized in the table as follows:

Mode	**Difference across two channels (V)**
Running	0.45
Sleep	0.18
Standby	0.12

The results from our oscilloscope readings corresponded correctly to power consumption values given by the STM32 documentation. Running should be the most power-consuming followed by sleep and then standby. As seen in our table, each successive mode used less power than its predecessor. Our data was collected through a constant resistance and our voltage readings correspond to our current readings due to the relation established by Ohm's Law which is given by:

$$V = IR$$

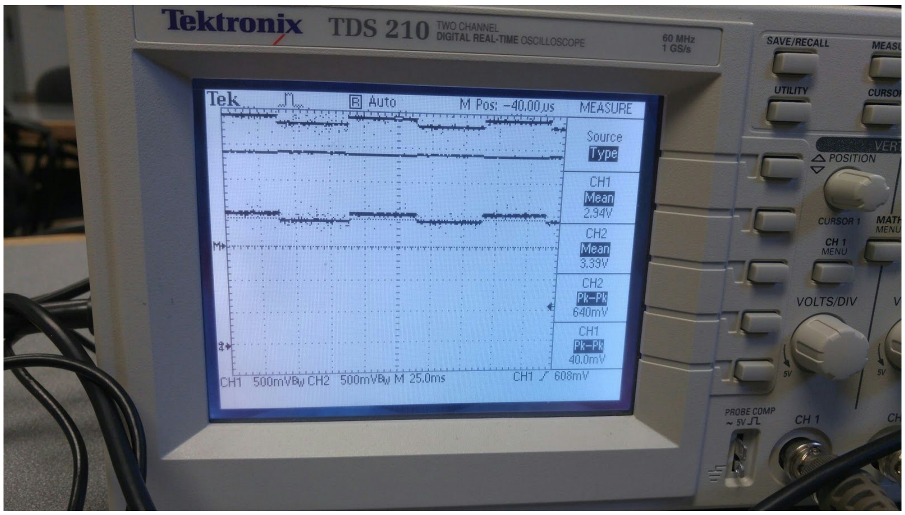
Where V is the voltage, I is the current, and R is the resistance. By the use of this formula we can find the current in our system which can be used to calculate the power being output by our system. Finally. we encountered no issues in the consistency of these readings compared to the values expected..

While our milestone goals were not overly complicated, we did encounter some errors in trying to read and interpret our voltages. The main lingering issue is our inexperience with oscilloscope. None of us had ever used it before so we are unfamiliar with what correct and incorrect readings look like. There are also some issues with reading the data accurately from the oscilloscope as well as the fact that the oscilloscope lacks the resolution to give accurate readings at low voltages. On top of this, we also have some issues manipulating the oscilloscope view window to scale the graphs properly. For this initial milestone Bryce greatly assisted us with setting up with the oscilloscope and showing us how to use it. Hence, more practice is required with the oscilloscope so we are able to use it independently.

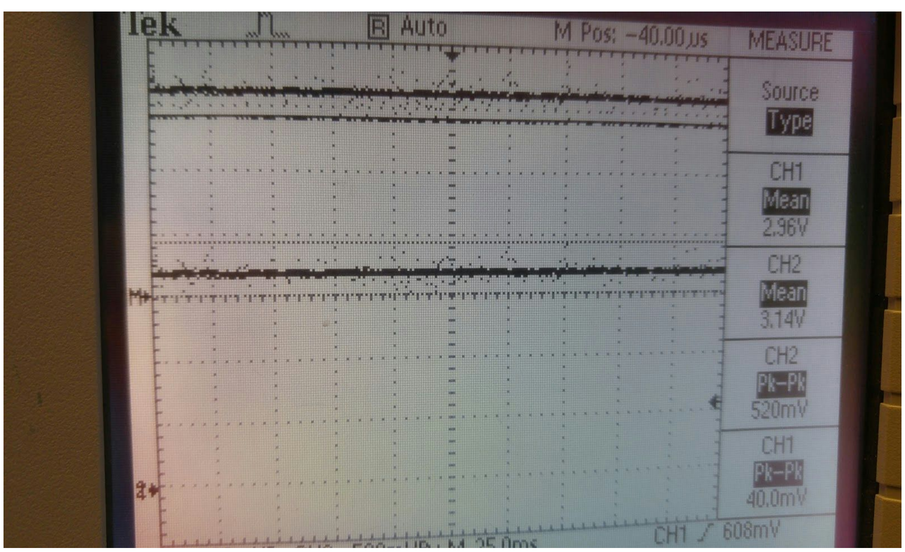
Overall, we are satisfied with the results from this initial foray into power management. The results we collected will serve as baselines for future measurements in the trail counter project. While we had some difficulties, we easily overcame them and finished the entire milestone in a matter of hours.

Appendix I: Images from Oscilloscope

State: Running



State: Sleep



State: Standby