Contents

1 Overview

Test out a KISS battery and solar panel, having the panel charge the battery. Log.

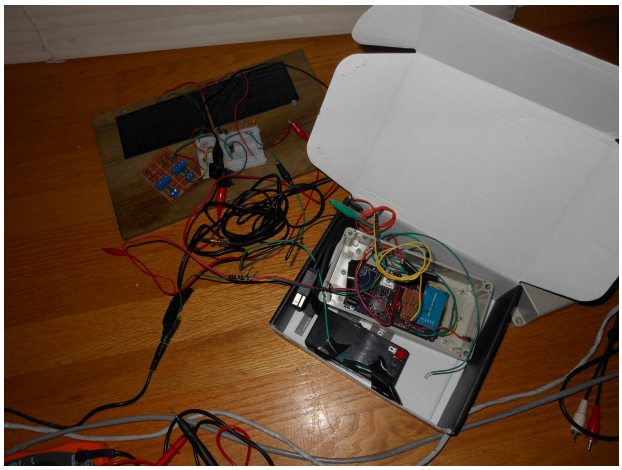

Figure 1: Windmill Data Logger was used with a 12V 1Ah battery. The Regulator used is a somewhat low power AP2204K-ADJTRG1, set to 13.7 or 13.8V

2 Work Log

General Build:

There are two solar panels in series, to make about 14 to 16 volts in direct sunlight. They go to a 150mA adjustable voltage regulator (AP2204K-ADJTRG1) on a piece of perfboard which sets the output voltage to be 13.7 or 13.8 volts on a breadboard. There is a diode outputting into the lead battery to prevent any backflow. There is an LED on the output of

the Vreg to signal that power is live. The externally power Arduino Mega and custom Windmill shield tap into the V+ of the battery, and have an ACS712 5A current meter in series with the current output. SD card logs data at about 1 per second. GPS keeps time (see windmill docs for detail on troubleshooting GPS).

Battery used:

A battery made in China with the Duracell brand tacked on. The side of it says distributed by Ascent Battery Supply, LLC from Wisconsin. See photo of the front. It's fairly small. Cost was $20-25.00 I need to find the data sheet for this battery to see how much current I can pull from it.

Diode:

There is some additional drop across the diode. I have to test other regulators that can go higher than the AP2204K which seems to have a limit around 13.7, in my setup.

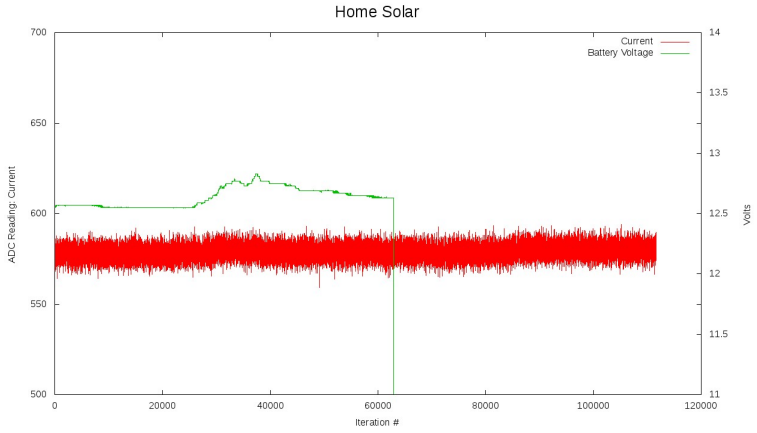

Figure 2: Morning hours on my east facing Window, there is a rise, then a drop off, where self discharge begins. The Sharp dropoff can be ignored - it was due to a poor connection. This data is from 062818, only one day.

Findings:

See the above graphs. Although the data cuts out (I knocked out by accident, the adc line into +) you can see a steady self discharge. The current meter used here is not sensitive enough to register the max of 10mA that is charging the battery (used a sparkfun breakout for an ACS712, of 5A current meter) but it may show a slight increase when the battery is increasing. How much self discharge do lead batteries have? We are going to test this particular battery and find out exactly how it performs.

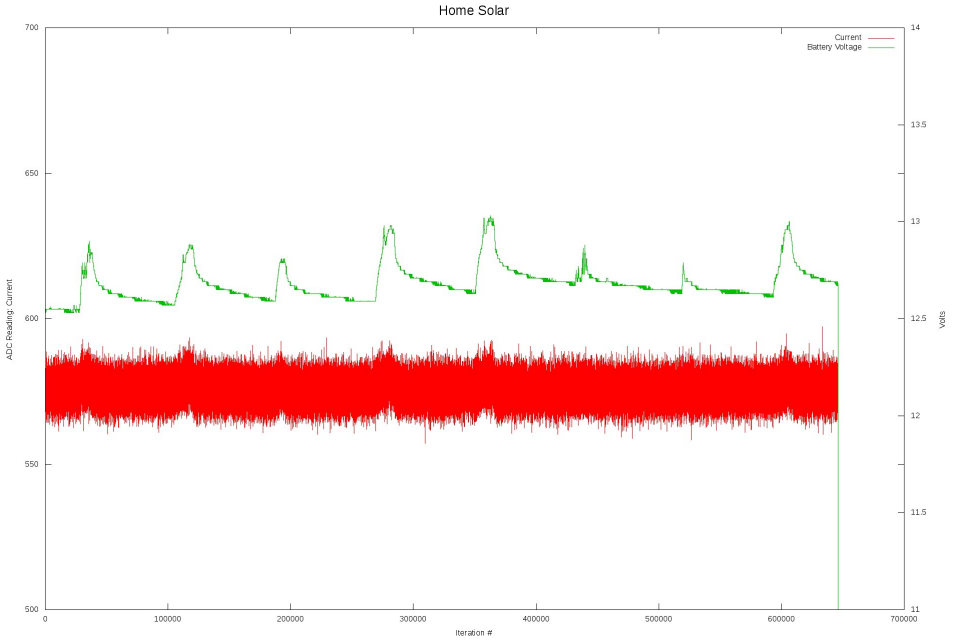

Figure 3: Data from 07-01 to 07-08-18 Note that a few cloudy days, cause the battery to discharge, (overall) with this setup. The current readings, do show a slight increase, though still in the noise. We need more panels.

2.1 Work Log 08/2018

I've put everything on one piece of 1/8th inch plywood, and will begin logging again. I may want to have the battery covered up, so sunlight doesn't heat it up. We are heading into fall now, so I expect sunlight to diminish as we head towards December. See photo. I've added fuses to the battery and to the Logger PSU connector. The additional two panels wired in parallel should give us additional current, and hopefully show greater peaks and troughs in the readings.

2.2 Work Log 082818

The data from the past ten days has been collected. I will admit, that I'm doing this fast, so I expect to make mistakes, but I plan to learn from each mistake.

Here the data shows a few things. One the date and time is not included, which is OK for short periods of time, but I can do better.. I'm going to

alter the code to include a unix timestamp. This unix timestamp will allow other devices to sync to this, with an easy interval, and conversions are straightforward, I believe. It will hopefully also allow me to graph the date and time better. I'm not quite sure how to approach time and data with Gnuplot yet. Second, I will do a better job of connecting the Voltage monitor. You can see the voltage line drop out, and that isn't from the battery dying, but from the wire being disconnected. I will use wire wrapping or solder to connect them this time. I also have obtained a portable (butane) powered soldering iron, which I can use if I open the windows. The data lines or sensor lines are everything here, so I can't afford to lose one. I could also use a terminal block, if I can find one in my junk box. What I need is a foolproof connection, but also one that I can disconnect when necessary. I considered adding a math conversion for the current, but I'm not entirely worried about how much current is passing through the device yet. Maybe I will add one in addition to the existing ADC however.

Some links that reference the date and time:

http://gnuplot.sourceforge.net/docs_4.2/node76.html

http://lowrank.net/gnuplot/datetime-e.html

http://web.archive.org/web/20180216201121/http://lowrank.net:80/gnuplot/datetime-e.html

The lowrank link in particular is helpful:

```
gnuplot> set xdata time
gnuplot> set timefmt "%Y-%m-%d"
gnuplot> plot "sample.dat" using 1:2 with boxes
```

Figure 4: Board in the Window

2.3 Work Log 082918

I looked at voltages this morning while the sun was out. It appears that outside of the voltage being disconnected in the last graph (the ground wire was pulled from the breadboard), everything is working. It is floating at a voltage of 12.8, so max voltage has been reached. There is ample current available from the solar panels. The voltages of the panels differ one is about 18 volts, the other 11.5 volts. I should do something to keep them similar (more notes below). The Vreg seems to be managing the different voltages. Solar cells are photodiodes, so it being a diode, I am making the assumption we should be OK, with a reasonably close voltage. (reference: https://romikoderbynew.com/2011/02/25/reverse-bias-in-solar-cells/).

However, looking closely at the two panels, I can see 13mA passing out of the 18V panels, and -12 mA passing into the smaller 11V solar panels, so apparently it is not ok, and that link is not entirely correct. A solution would be either a diode, or tune another Vreg so that they are the same on the panels (maybe both). I don't want to connect them all in series for the Vreg. I read there is danger of them impacting each other if the currents are different enough. One might burn out the other, if the currents are not close. I also don't like one of them breaking or being shadowed, and

stopping the others. I could connect up reverse bias diodes, to passover any non working cells, but this is not necessary in this small setup. I think I will pursue two separate Vregs, both set to output a fixed voltage, and the sum of these Vregs will output into the battery. That all being said we have another issue. We need to start using the battery.

Load

I have a sparkfun beefcake relay board, I will setup some kind of device to be powered on, by the 12.8V battery (probably another Arduino Uno logging something) for a period of time each day. So this adds more code todo. What would be useful to log for short periods throughout the day, but not constantly? Temperature? Maybe I could take a picture, of outside every ten minutes... I think I will start with Temperature for simplicity sake.

References: https://www.vishay.com/docs/89398/solarcell.pdf Solar Cell Bypass Diodes in Silicon Crystalline Photovoltaic - Vishay