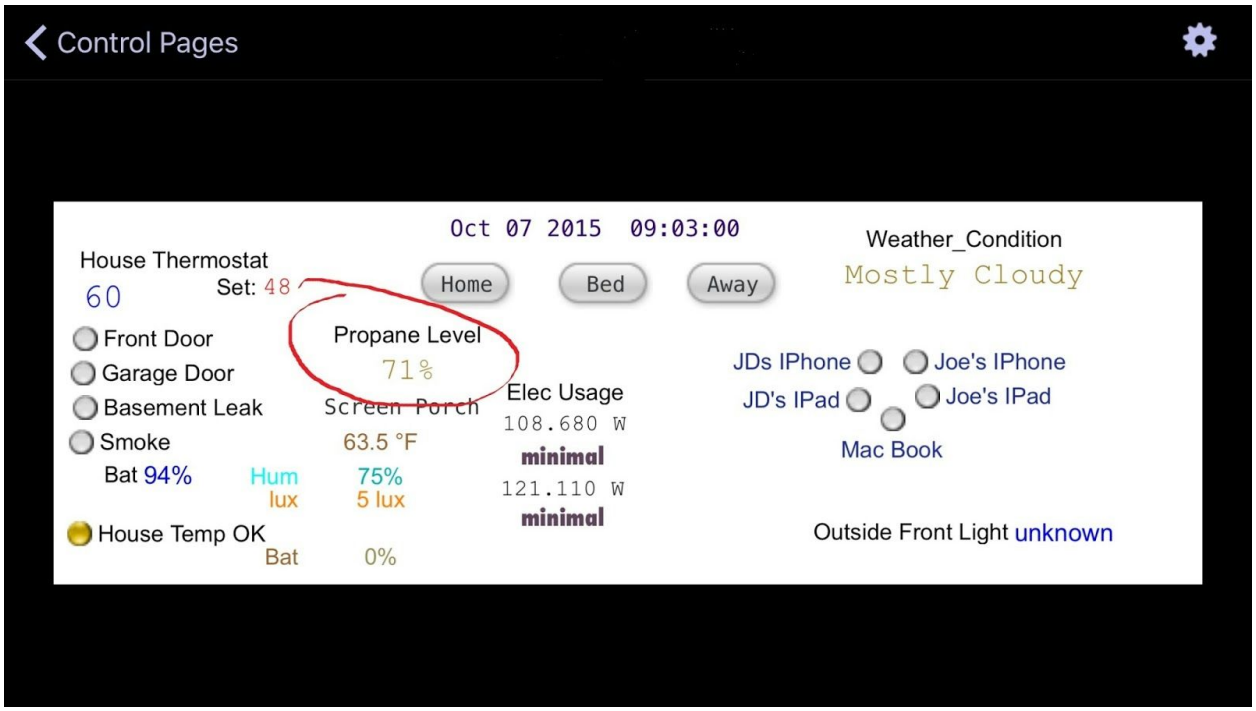
LP Tank Remote Level Monitoring with Indigo

Have a home or business that is heated with propane? Been looking for a solution to monitor the level of fuel in tanks remotely? Instantly get texts when it goes below thresholds you care about or is refilled while you're away? If so then this application will be of interest to you. Your propane company need not be involved, and no subscriptions to any monitoring services are required.

I had been searching in vain for an off the shelf solution for quite a while that I could plug into Indigo. I finally gave up last year and implemented one myself. I'm happy to say it has worked reliably for almost a full year, including a very cold winter. This solution is not overly complex, but does require a basic understanding of electrical currents, and a small amount of wiring work.



Prerequisites

- your propane tanks have the widely used Rochester 3D analog gauges on them, which have an indentation that allows for a 'snap in' module. The piece that fits there is boot shaped and is a Hall Effect (HE) module. It determines where the analogue gauge's

needle is using magnetism, and converts that reading into electrical resistance to be applied to the current that is being passed through it from a power source.
This gauge's specs are at:http://www.rochestergauges.com/products/R3D.html
- you have an electrical receptacle within 25' of the tank(s) that is indoors, or weather proof and will not be exposed to freezing temperatures

Required Items

- A dedicated Mac OSX machine with Indigo
- Z Wave Controller - I use the Aeotec DSA07203 Z Wave USB dongle
- MimoLite, a Z Wave application device http://www.fortrezz.com/index.php/products/mimolite
- Low voltage A/C adapter, between 3.5 and 6V
- 6 amp inline fuse
- R3D Hall Effect 'snap-in' module(read on)
- Wire cutter / stripper
- If installing inside for outside tanks, tools necessary to route the R3D cable through a wall

This Hall Effect device is not directly available to end consumers (at least as far as I was able to determine), so this is the only part that can be a little tricky and/or expensive to obtain. In my area, some propane companies provide a service that allows them to be notified when your fuel is low by attaching a cellular transmission device to your tank using the snap-in. Typically this service is available for a monthly fee. If you happen to have a way to obtain one of these from a transmitter no longer being used, you are fortunate indeed. I obtained mine the easy, but expensive way:
On amazon.com, search for *Taylor Products LP Gas Remote Monitor.* There should only be one match. If you go this route, make sure the gauge works by snapping it into the R3D gauge on your tank. Once you're satisfied, you'll no longer need the box on the other end that gives you the reading. Cut its cable near the box, strip a few inches of the outer cable off, exposing the three wires inside, which should be stripped themselves about ½ ".

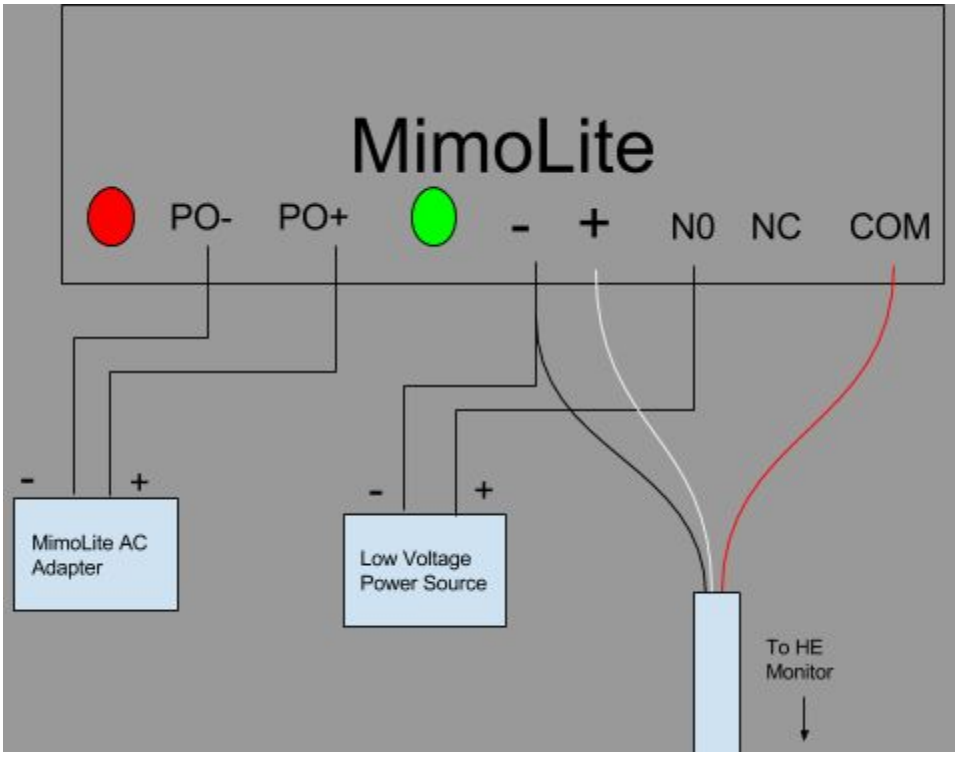
For the HE power source, I repurposed the 5V AC adapter that charged my wife's old cell phone, cutting off the plug at the end and stripping the + and - wires. Refer to the R3D spec sheet at the link above to ensure that your your power source can safely be used with the HE montior before attempting to use it.

Hardware Installation

1. The first step is to find the location where you will be installing the Mimo Lite (ML). It goes without saying that it shouldn't be installed in a place where it is exposed to

adverse outdoor weather conditions or extreme temperatures. For my installation, there are three 100 gallon (joined) propane tanks are on the outside wall of the basement. I drilled a hole through the cinder block wall 2 feet away from the tank, and mounted the ML on the wall on the other side (inside the garage). If you need to route the cable from outside to inside in a similar way, do this step now. Make sure there is enough length of the cable on both sides of the wall to reach the ML on one side and the tanks on the other, with at least a foot or two of slack, and weatherproof the hole once the cable is where you want it to be. Do not snap the HE module (HEM) in place yet.

2. Mount or secure the ML in its place. Wire your connections to it as follows, from left to right:
    a. ML AC adapter red to PO +, black to PO -. Mine came with these already connected.
    b. AC adapter power source neg and HE black (ground) to -
    c. HE white (output) to +
    d. Power source pos to NO
    e. HE red (power) to COM
    f. I also put a 6 amp inline fuse on the red wire going out to the HEM. Not sure if an overload to the HEM could be possible without it, but it certainly can't hurt to have extra protection. Refer t o the below illustration as a guide:



3. Plug in the ML's AC adapter.
4. Plug in your low voltage power source
5. Pair the ML with your Z Stick, and add it to Indigo. Refer to the ML and Indigo documentation for this process.

Setup in Indigo

Now, you're ready to test the hardware you've set up. In indigo, the ML will be represented by 4 devices: Analog Input, Binary Input, Pulse Count, Relay Count. You will only be using the first one for taking readings.

1. Send a pulse to the unconnected HEM by clicking 'On' on the Relay Output device. This closes the HEM circuit momentarily, which allows current to flow between the positive and negative terminals of your low voltage power source, with some resistance applied. Note the resulting 'Analog Input' pulse count. Repeat two or three more times. The subsequent readings should be the same or close, give or take a few counts.
2. Snap the HEM into the tank's analog gauge, and take a new set of readings. Here, as before the readings should be the same or close to each other. However, they should all be substantially different from the ones in the previous step. Now, carefully remove the HEM from the top of the gauge and repeat this and the previous step one or two more times. If the readings are not consistent when done successively, or if there doesn't seem to be any difference between readings with HE snapped in or out, something isn't right with your hardware setup. Inspect your hardware, make sure all connections and power sources are correct, and if need be test your low voltage power source with a voltmeter to ensure it is producing current.
3. This step begins the calibration process, and will span enough time to cover one complete tank refill to as low a level as you're comfortable allowing it to go. You'll need to take two sets of readings throughout this process:
    a. A visual reading of the tank's analog gauge, rounded to 1% is sufficient, and the date/time of this reading.
    b. The 'Analog Input' pulse count. The easiest way to do this is to set up an action in Indigo that sets 'Relay On' on a fixed schedule. For me, once a day was more than sufficient. Extracting the counts from the Indigo Event Log is very easy to do later on, by looking for statements similar to:
    `2015-09-29 15:45:09.355  Z-Wave  received "008 - Analog Input" sensor update to 2751`
    Alternatively, you can manually take this reading at the same time as the analog reading. This method is best if you are able to do so. The more readings the better, especially during higher periods of fuel usage, like cold weather. In my case, I wasn't able to be physically at the tank's location to take readings for a few extended periods. This wasn't ideal, but my calibration was accurate enough.

Calibration

Once you've completed your data collection cycle, you need to use it to establish the thresholds that will be used to calculate the tank's level. There are probably different methods that can be used to do this, but I'll describe the way I did it. If you have a google account, you already have access to a full featured spreadsheet with graphing functionality, by creating a sheets document on drive.google.com. Otherwise, you can do this manually on paper if you prefer or using other spreadsheet software. It's not strictly necessary to create a graph from your collected data, but it will make the step of correlating readings a lot easier.

1. Populate the spreadsheet with your data.
2. Make a graph with your X Axis representing the date/time. You'll plot two lines on the Y Axis, one for tank % full readings, the other for the analog pulse counts recorded in indigo. Because these will be different scales, you'll have to adjust your graph scales so that the plotted lines overlap. One of the reasons to plot lines on a graph rather than just correlating your two sets of data, is so that you can see the trend of pulse count readings during fuel depletion. It most likely will not be a straight line. In my case, the pulse counts decreased gradually until the tank was about 65% full and then dropped off sharply.
3. Establish the thresholds, or watermarks that the Indigo python script will use to calculate the percentage full your tank is. In other words, use the lines in your graph to correlate a manual gauge reading with the pulse count. Once the plotted line for the manual gauge readings was finished, I ignored the readings themselves. I used their plot line to establish pulse count thresholds at 5% increments, so that I had 20 in all. While this worked fine for me, you may want smaller or larger increments.
4. The thresholds you established in your previous step will be recorded in the python script as an array. For an actual reading, since the pulse count will only be at one of these thresholds every 5 percentage points, the script determines the ones in between by taking the difference in pulse counts between thresholds, and dividing that by 5 (or whatever increment size you use). This method is not extremely precise, but for this application should be more than accurate enough. My propane company will never fill my tanks over 80%, so I could have made that my real ‘100%’, but I chose instead to use the actual level, and populate fake pulse counts above that (9999 in my case).
5. Create two Indigo Variables: ‘PropaneLevel’ and ‘PropaneLevelStr’
6. Make an Action in Indigo called ‘Check Propane Level’ or something appropriate, and set its type to a python script. Copy and paste it in, and change the device names in it, and thresholds for your setup.
7. Now for the fun part, you get to see your setup in action. Run your new action. If all is set up correctly you’ll see something like this in the event log.:

```
2015-09-29 15:45:12.092    Action Group    GetPropaneTankReading
2015-09-29 15:45:12.166    Z-Wave     sent "008 - Relay Output" on
2015-09-29 15:45:13.103    Script     sensor value is: 2751.0
2015-09-29 15:45:13.105    Script     Propane reading is:
72.2857142857
```

At this point, you'll have the percentage stored in the ‘PropaneLevel’ and ‘PropaneLevelStr’. display it in your control page, set alerts on it, and enjoy the new peace of mind you'll have not wondering whether you have enough fuel to last a cold spell while you're away.