The Energy Monitoring and Management System:
Promoting Energy Availability in Developing Countries

Trieu Luu, Justin Martin, Joe Wambach

Our Project

The Need

In areas of the world with limited to no access to electricity, there is a lack of energy conservation among shared energy systems causing unreliable access.

Solution

The Energy Monitoring and Management System project is developing a meter to help manage energy use in order to maintain a reliable energy supply for these impoverished areas.

Our primary partner is *Open Door Development*, located in Mahadaga, Burkina Faso, a remote location in western Africa. We are developing meters to be used with isolated solar power systems the organization has installed throughout the region.

Partners

- Matt Walsh; *Open Door Development*, Mahadaga, Burkina Faso.
- Ray Motsi; *President of the Theological College of Zimbabwe*
- *IEEE Smart Village*

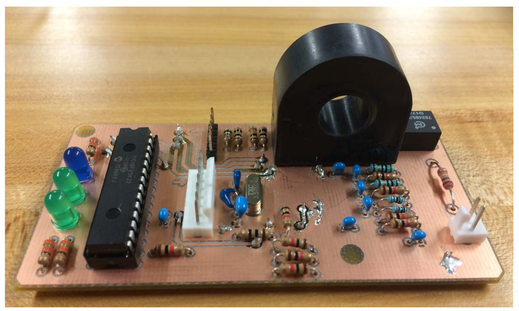
Power Sense Circuit Board Redesign

Circuit Design

The Power Sense 3.0 performs the energy metering function of our meter. The decision for the redesign was made due to recurring issues with the previous circuit board such as circuit issues proving impossible to diagnose and slow output data. This redesign of the circuit board was based around the MCP3909 energy metering IC and a PIC microcontroller. The MCP3909 has the ability to receive the input voltage and the input current of the meter and output the voltage, current, real power, and energy data. The PIC microcontroller is used to process and store data from the MCP3909. With the MCP3909 being the one of the main components of our board, the circuit design was then developed with careful consideration of the chip's data sheets and App Notes. Additional circuitry was added to the board for the purpose of programming the PIC microcontroller and for communication with the Command Board. The testing phase of the circuit board is currently underway.

Code

The goal of *Code* in the power sense redesign is to achieve both *pulse output*, for energy calculation (Watt-Hours), and *waveform output*, for power calculation (Watts). The most significant effect is the increased responsiveness of the board. *Pulse output* is accomplished by timing the energy use pulses from the MCP3909 and is based on existing code with changes to improve accuracy. *Waveform output* is digital sampling of the input voltage and current waveforms at a rate of 256 samples per cycle which can be processed to almost instantaneously calculate the power in watts. SPI communication is used to transfer the digital samples to the microprocessor (PIC18) where they are processed. Several implementation versions of SPI code, including the initialization and data output stage, are prototyped and under test.



Acknowledgements

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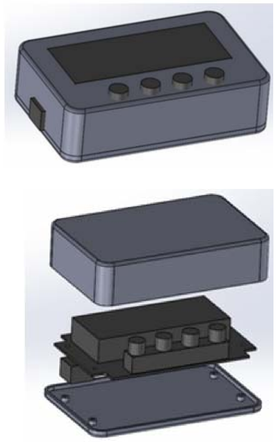
User Interface Enclosure



The previous manufacturing process for the User Interface enclosure using the drill press and milling machine would take nearly an *hour per box,* which is too long for sustainable manufacturing. With the goal of greatly reducing the manufacturing time and increasing precision, the team decided to convert the process to CNC.

To complete the goal, the measurements from the drill and milling process were used to develop the CNC process. First, the enclosure was modeled on SolidWorks which was then used to generate the CNC files. The next step of the process was to create a mount for the enclosure. This step proved challenging but was solved through creative problem solving with the help of John Meyer.

The resulting process is nearing completion. It is anticipated that the process can be reduced from *over an hour per box* to about *20 minutes or less*. The first trials are prepped and will be performed soon.

Conclusions

Progress

- Power Sense 3.0 circuit design complete. Testing of the circuit board is currently underway.
- Initial version of Waveform output code is finished and currently being tested.
- User Interface enclosure manufacturing process is complete and the first test is soon to be underway.

Future Work

- Complete testing of the Power Sense 3.0 circuit board and implement the board in the meter.
- Integrate pulse and waveform output code, as well as calculation into the power sense board.
- Use created files and mounts to cut test User Interface enclosures and finalize a CNC cutter method for manufacturing.
- Develop new module for WiFi communication with primary focus of remote meter access for payment system.
- Develop payment system to meet micro-grid needs of partner, and set groundwork for future large scale systems