WIP: Wireless Environmental Sensor Module Generation 3

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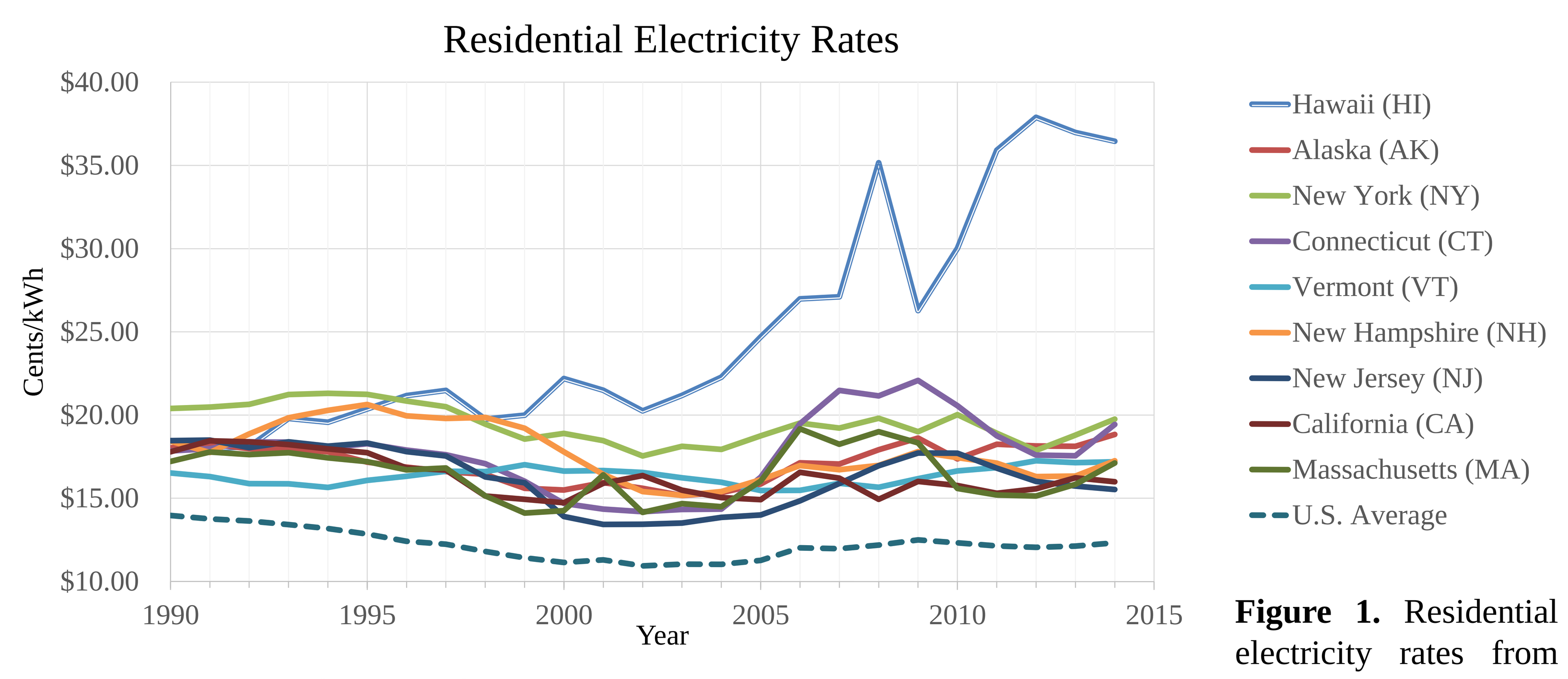
Introduction and Motivation

Hawaii has by far the most expensive electricity prices in the United States, largely due to a heavy dependence on imports of petroleum and coal for its energy needs. In 2013, 91% of the energy Hawaii consumed was imported. In order to reduce this dependency and lower electricity costs, Hawaii must look toward more available and sustainable sources of energy.

The Smart Campus Energy Lab (SCEL) is currently researching solutions to Hawaii's energy problems. One of the main projects is a low-cost environmental sensor module which is used to create a self-sustaining weather sensor network. The collected data will then be used to optimize the planning of future renewable energy source installations.



Source: U.S. Energy Information Administration.
Adjusted to 2013 dollars using the inflation factor from U.S. Bureau of Labor Statistics CPI.

Figure 1. Residential electricity rates from nine states, plus the U.S. national average.

Project Description

Project Description: The third generation environmental sensor module (Cranberry) is a weather sensor module capable of measuring barometric pressure, humidity, temperature, and solar irradiance. The module is integrated as part of a weather sensor network that communicates with a central server.

Objective: Troubleshoot and fix the hardware design problems of the third generation SCEL sensor module *Cranberry*.

Main *Cranberry* Goals:

- Update and maintain *Cranberry* documentation.
- *Version 1*: Troubleshoot problems with original design to produce an operational board.
- *Version 2*: Improve the *Cranberry* board layout and implement personal design preferences.
- Prepare *Cranberry* boards for deployment into the weather sensor network.

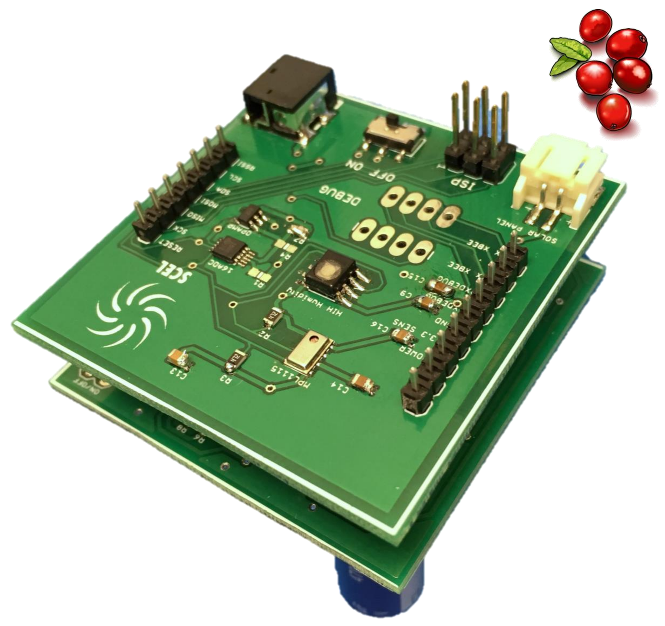


Figure 2. Fully assembled Cranberry board (V1) showing the main board and sensor board stacked upon each other.

Materials and Methods

***Cranberry* Approach and Deliverables:**

- Understand the purpose and goals of the weatherbox project. Familiarize the team with the current design through datasheets and previous documentation.
- Update Cranberry's documentation, including EAGLE part library, schematic, board layout, bill of materials, and power budget for easier accessibility and readability.
- Layout a modular testing procedure. Determine and document existing design problems and their respective solutions in order to produce an operational sensor module.
- Communicate with other teams to revise current design with corrections, improvements, and added functionality to PCB schematic and layout.

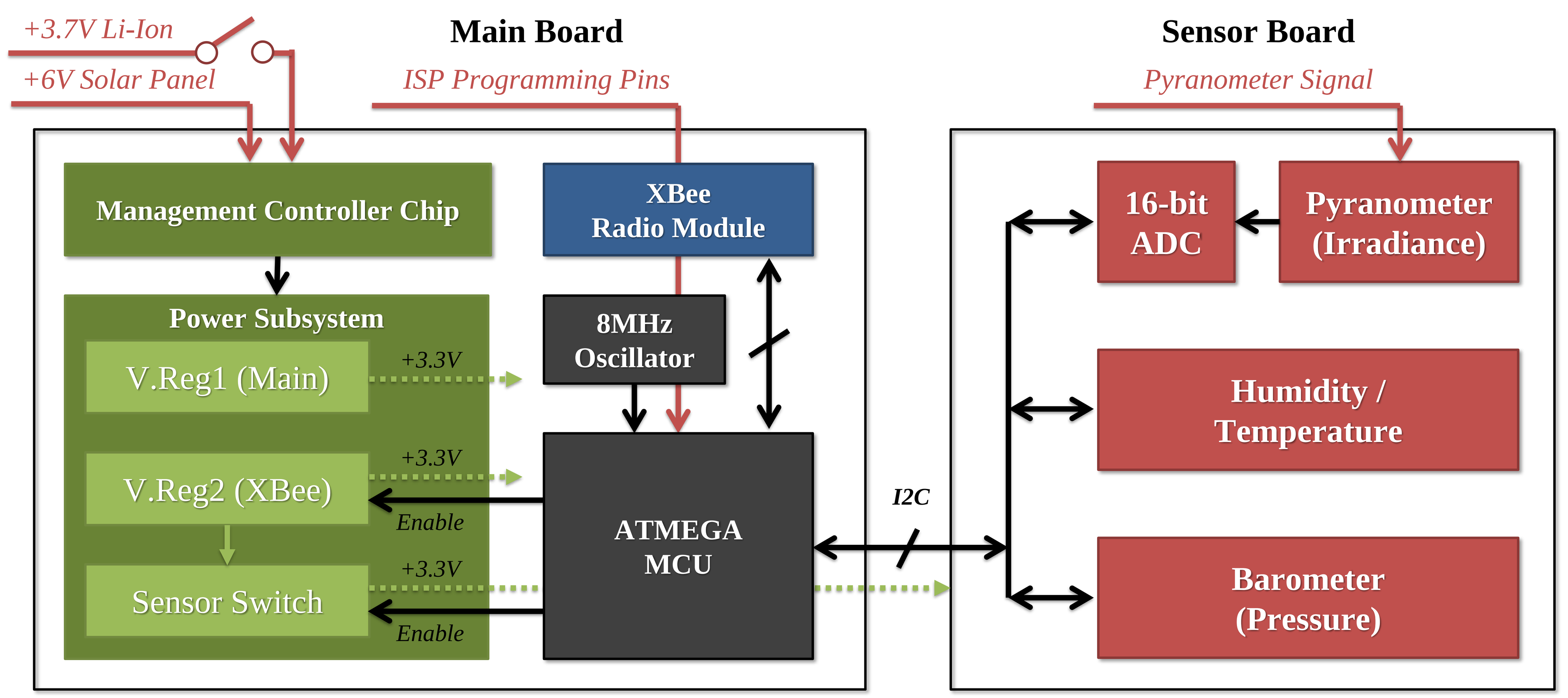
Modular Testing Procedure

Each subsystem is incrementally tested based on a general test procedure. The procedure identifies problems localized to individual subsystems, allowing for more efficient identification and repair.

- Divide design into subsystems: power, microcontroller (MCU), sensor, and communications
- Compare the EAGLE schematic with datasheets
- Solder on appropriate components
- Perform continuity checks and ensure proper power and ground connections
- Test the validity of I/O values

Figure 3 (Left). Fully assembled Cranberry board (V1) showing, from left to right, the sensor and main board.

Figure 4 (Right). Simplified block diagram of the Cranberry board design. Diagram depicts the internal and external signals of the various subsystems across the main board and sensor board.



Results and Analysis

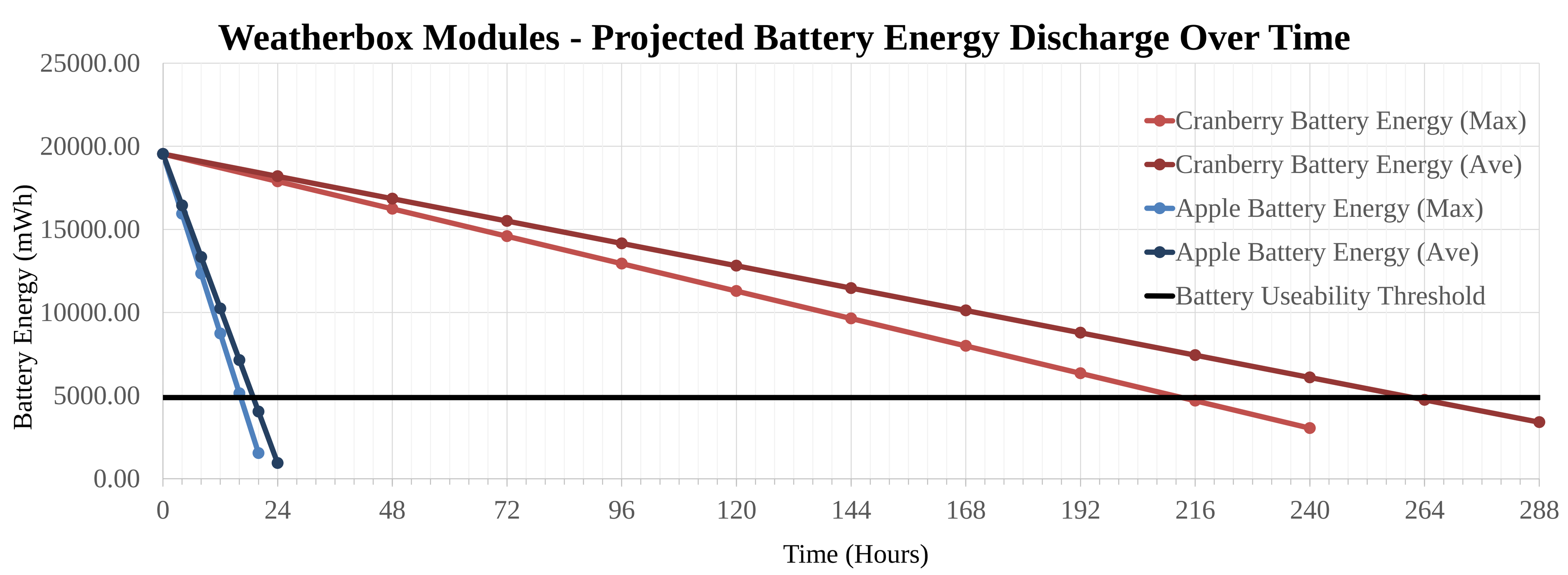


Figure 5. Simulated battery discharge over time, showing the maximum vs. average power draws of *Apple* (Gen. 1) and *Cranberry* (Gen. 3).

Power Module

- Charges the Li-Ion battery
- Correct voltages and currents were measured and compared across multiple boards

MCU Module

- ATMEGA programmed and tested to produce a $1Hz$ square wave output

Power Budget

- Calculations estimate a minimum battery runtime of approximately 9 days, 11.5 hours

Conclusion

Completed Objectives

- Completed bill of materials (BOM) and initial power budget
- Completed custom EAGLE part library and schematic update
- Schematic redone to include troubleshooting fixes, proper labeling, and documentation
- Power and MCU modules fully assembled and tested

Future Work and Improvements

- Verify and calibrate sensor readings, XBee communication capabilities, and battery runtime *(Version 1)*
- Research alternative parts and packages to improve overall design quality *(Version 2)*
- Redesign board layout with updated schematic changes and additional functionality *(Version 2)*

Acknowledgements

Leadership Team
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Managers: Zachary Dorman, Kenny Luong, Christie Obatake
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SCEL Teams
Apple, Dragon Fruit, Firmware, Verification. Networking and Server, Forecasting, and Wind Sensor

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