# Energy Management System

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## Motivation

Many homeowners and businesses are not aware of their power usage habits. This lack of awareness leads to potentially inefficient power usage. Existing products are either too expensive or do not include all functionality, such as the ability to remotely control, monitor, and manage power consumption. A system is needed to allow for monitoring and basic management of a home's or business's power usage for a reasonable price.

## Hardware

Technologies Used
- I2C
- Frequency Shift Keying
- VHDL

Design Goals
- Electrical Isolation / Safety
- Measurement Accuracy
- Fast Transmission Data Rates

## Software

Technologies Used
- Vaadin Web Framework
- Java
- Python
- MySQL

## Measurement Algorithms

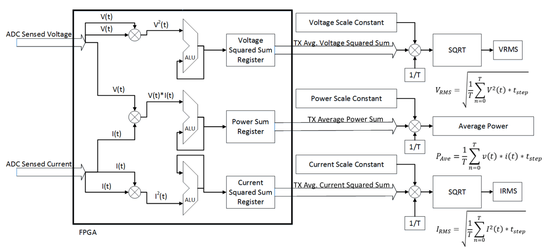


Fig 1. RMS Calculations

## Acknowledgements

A special thanks to Cypress for their generous donation of 2 CY3272 PLC Evaluation kits.

## Overview

The Energy Management System is designed to allow homeowners and businesses to easily monitor and manage their power usage and consumption. The system consists of two main components: the main hub and many separate outlet modules. The main unit is installed anywhere in the home or business and receives power consumption data. The outlet modules are replacement outlets for the infrastructure that monitor the power consumption of only that outlet. The main unit collects the usage data from all of the outlet modules and compiles the information. The Energy Management System also has a web application where all of the usage data can be viewed in graphical form. From the web application the user can also control whether each outlet module is on or off and can limit the current of each outlet. In addition, a schedule can be created to turn outlet modules on and off automatically at certain times of the day.

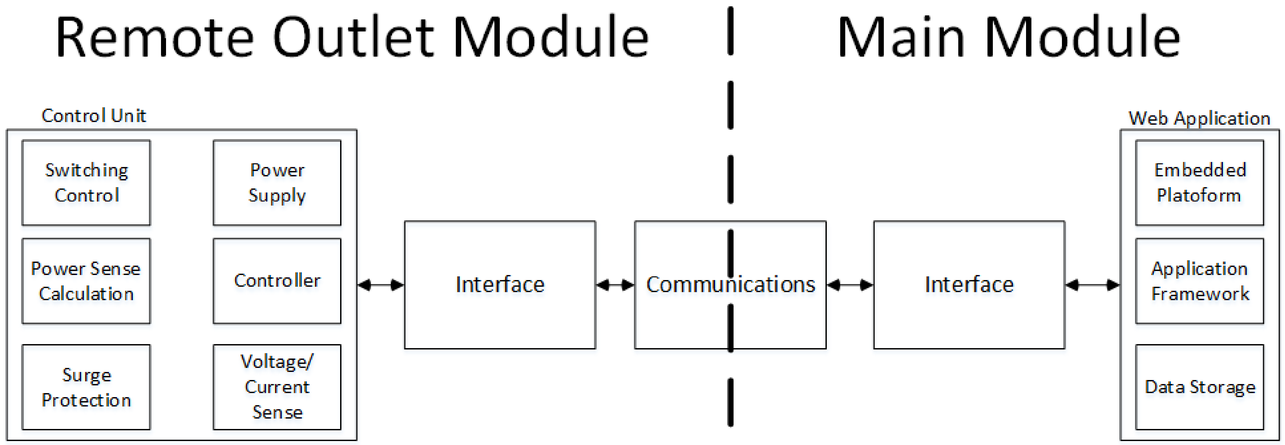


Fig 2. EMS Modular Description

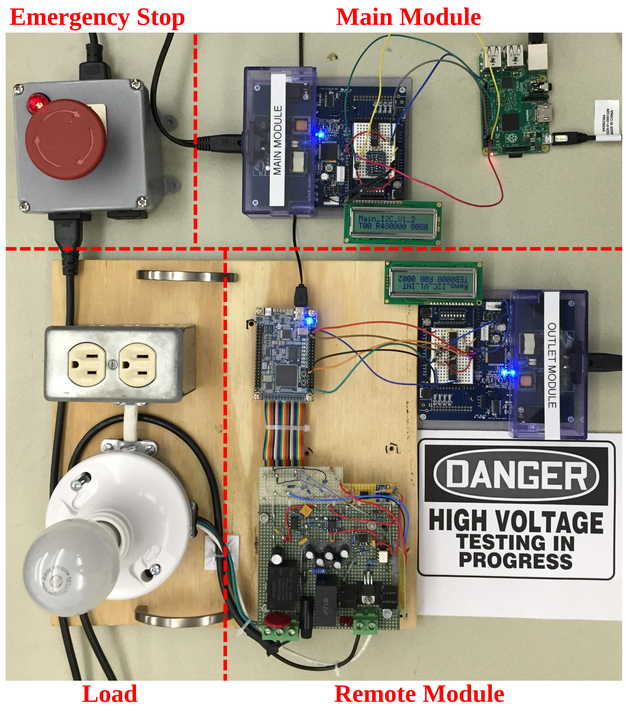


Fig 3. EMS Hardware Prototype

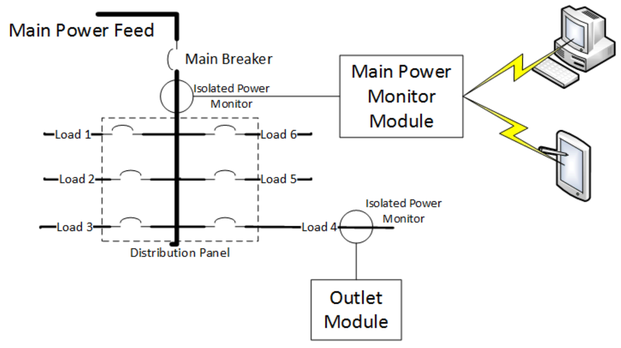


Fig 4. System Concept Diagram

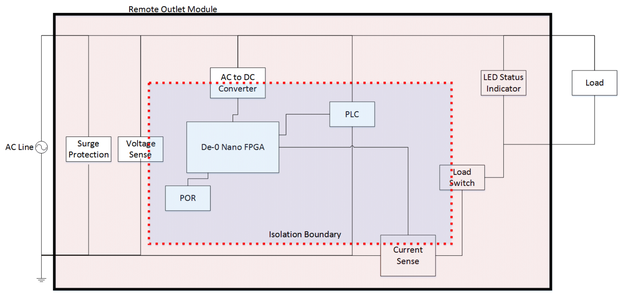


Fig 5. Remote Module Functional Block Diagram

## Web Application

Hosted on the Raspberry Pi 2, the web application is built in Java using the Vaadin Web Framework, and controls the outlet modules using Python, I2C, and PLC. Features include:
- Power Usage Visualization
- Set Outlet Current Limits
- Turn Outlets ON/OFF
- Schedule ON/OFF for Groups of Outlets
- Estimate Power Usage Costs

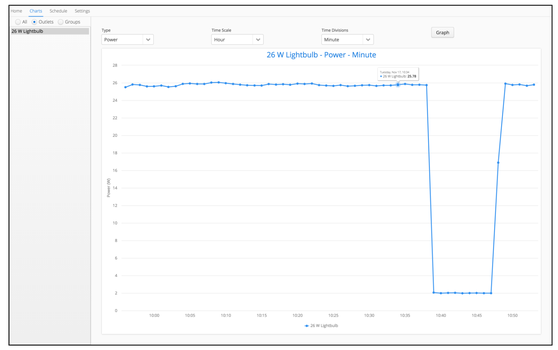


Fig 6. Web Application Interface

## Costs

| | Component | # | Normal Cost | Our Cost |
|---|---|---|---|---|
| Main | Raspberry Pi 2 | 1 | 35.00 | 0.00 |
| | 16 GB microSD | 1 | 8.59 | 0.00 |
| PLC | PLC Eval Kit | 2 | 499.98 | 0.00 |
| Remote | Switching Supply | 1 | 12.34 | 12.34 |
| | Triac | 1 | 1.97 | 1.97 |
| | Hall Effect IC | 1 | 5.27 | 5.27 |
| | Voltage Sensor | 1 | 6.42 | 6.42 |
| | De-0 Nano Board | 1 | 86.25 | 86.25 |
| | Misc. Comps. | 1 | 23.15 | 7.59 |
| Total | | | $ 678.97 | $ 119.84 |

Fig 7. Bill of Materials

## The Team