Equitable Regulation of Solar Power For the SIM Mission Station, Mahadaga, Burkina Faso

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Introduction

The Serving in Mission (SIM) compound in Mahadaga, Burkina Faso shares power from a small solar power system between multiple buildings. In 2007, SIM asked the Collaboratory to develop a device to measure, display, and regulate the energy consumption of individual buildings in order to help educate community members about conscientious energy use and protect the solar generation system from damage due to overloading.

In 2009 the Kilowatt Hour Meter project began with the goal of producing such a device, and delivered the first prototype to Mahadaga in January 2012. In spring 2013, the Kilowatt Hour Meter team began working on a completely new version of the meter. This redesign incorporates lessons learned from the installation of the original prototypes and is build upon a more flexible, inexpensive platform. The team produced a new prototype meter and plans to deliver five working prototypes to Mahadaga in the summer of 2014.

Client

Matt Walsh, a missionary serving with SIM in Mahadaga, Burkina Faso, saw the potential need for dozens of the devices in the region where he lived and worked. He proposed the Kilowatt Hour Meter project to the Collaboratory in 2007.

Meter Components

Two-box design:

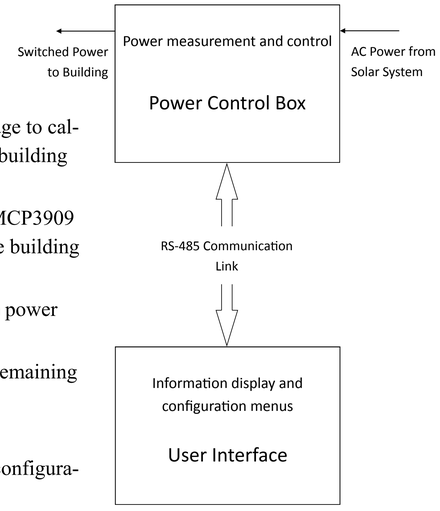
The Version 2 Kilowatt Hour Meter is composed of to two subsystems housed in separate enclosures: a power control box to measure and control power flow, and a user interface box to display information to the user and configure the power control box.

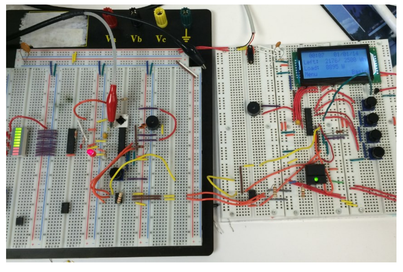
Power Control Box

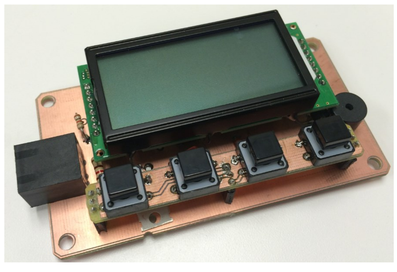
- AC1030 Current Transducer: measures current being drawn to power building
- MCP3909 Power Metering IC: uses output from current sensor and the line voltage to calculate the power being consumed by the building at each moment in time
- PIC24 Microcontroller: reads output of MCP3909 and calculates the total power used by the building since the start of the day
- Relay: interrupts power to building when power allocation is exceeded
- LED Bar Graph: displays percentage of remaining power at a glance

User Interface Box

- LCD Display: displays information and configuration menus to the user
- Buttons: allows user to interact with on-screen menus and configure the Power Control Box
- Buzzer: notifies user when remaining power has







Further Information

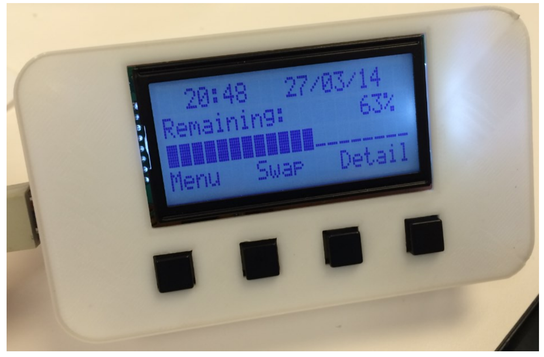
Visit our wiki page at http://www.thecollaboratoryonline.org/wiki/kwhr for more information.

Design Highlights

To reduce prototyping costs, our project is using a MakerBot 3D printer to make custom ABS plastic enclosures in-house. This also allows for rapid prototyping and many iterations without additional expense. The meter is comprised of two separate enclosures, a user interface box and a power control box. When installed in Burkina Faso, it is possible that the power control box will be located outdoors. Because it may be exposed to the elements, it is necessary to ensure the enclosure will be both waterproof and UV resistant.

The previous version of the meter had several issues pertaining to current sensing with temperature sensitivity and inaccuracy. While designing this version of the meter, we sought to fix those issues by using a current sense transformer instead of a hall effect sensor. Our testing shows that this design performs consistently over a wide range of temperatures, and it is accurate within 5%.

One drawback to the power sensing strategy we implemented in this design is that the power metering IC operates at a low output frequency when measuring low powers. This means that when the system is under small loads, the user interface will only be updated every few seconds.



Current Status and Next Steps

The Kilowatt Hour Meter project has produced a prototype that is able to monitor and regulate power. This design presents a solution that is an effective and affordable solution to the issues presented to SIM in Burkina Faso. Our next goal is to implement additional features, improve reliability, and ramp up production to satisfy our client's need for 50 or more units over the next several years.

Acknowledgements

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