Network Managed Power Distribution Unit for Military Application

acumentrics.com

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PROJECT MOTIVATION:

Power Distribution Units (PDU) are an integral component in providing power to a number of electrical appliances, which many entities rely on. With the explosion in interest of Internet of Things (IoT) devices utilizing embedded systems, companies are realizing the demand for these networked devices. With networking capabilities, products can have remote monitoring and management ensuring a higher amount of fault detection, safety tracking, and statistics accumulation to further develop better products and give notice for possible system failures. Currently, Power Distribution Units have seen some integration with networking capabilities in commercial markets. With regards to the market for Power Distribution Units that adhere to military quality and safety standards, there is a gap that is seeking to be filled. Having the capability to remotely monitor device statistics and manage the devices that provide power to their appliances can bring much needed security and safety to the military. This gap and need for safety is the project motivation for Acumentrics.

ANTICIPATED BEST OUTCOME:

The best outcome is to have a fully functioning Smart PDU prototype that can be presented and painlessly handed off to the Acumentrics engineering team. The prototype will provide sufficient power to connected appliances and will meet military quality and safety standards. Users will have the ability to remotely control the device via a web application's GUI, to switch outlets on and off; monitor statistics such as current, voltage, wattage, temperature and humidity; receive notifications when something goes wrong: overheating; view logs of monitored statistics; and generate reports from said logs.

IMPLICATIONS FOR COMPANY AND INDUSTRY:

With the Internet of Technology bubble growing fast, networked technologies are becoming a norm today, and it is up to companies such as Acumentrics to provide products that allow management and monitoring of devices in a protected and practical form, for both industry and military. A large implication is the usability and ease of use of said technology to guarantee a pleasant and stress-free user experience. To remain an industry leader, Acumentrics must take this into account when building its products. This will help expand Acumentrics' market offerings to satisfy growing customer demands for ruggedized network-capable PDUs.

PROJECT OUTCOME:

The Anticipated Best Outcome was achieved; the initial goals were surpassed with the product near market-readiness.

KEY ACCOMPLISHMENTS:

Component Selection: Researched and performed a cost-benefit analysis to select viable components. Components were required to meet “rugged” requirements including temperature, isolation (Hall Effect sensors, shown in Fig. 2), and performance (analog-to-digital converters).

Formal Schematic and PCB Fabrication: Designed a circuit with the selected components and fabricated PCBs from our circuit, shown in Fig. 1. They have been tested and fitted for parts on both the low and high power sides. Extra connectors are used for the extra Raspberry Pi GPIO’s as well as the open slots for the ADC that allow for expandability, including extra sensors.

Ruggedized Case: The chassis, shown in Fig. 3, is designed to meet the following certifications EMI/RFI - MIL-STD-461F, Blown Precipitation - MIL-STD-810G, Shock - MIL STD-810F, Vibration - MIL-STD-167-1, Shipboard - MIL-STD-1399, Vehicle Power - MIL STD-1275. It is currently pending certification testing.

Functionally Complete Web Application: All functional aspects from the best anticipated outcome have been met, explored in more detail below, along with many additional functional and non-functional aspects not originally asked for.

Live Data and Interaction: The user is able to see live data is a chart format, as well as select which data is shown. The user also has the ability to remotely toggle outlets on and off for their convenience.

Data History: The user is able to see historical data in tabular format. The table is sortable and can be filtered based on metrics the viewer wants to view.

Notifications: Users can receive email, SMS, and popup notifications at user-set intervals when metrics fall outside of user-set thresholds.

Report Generation: Users have the ability to export data to a CSV file so that they can manipulate data how they see fit.

UPS Communication: The system is able to communicate with an Uninterruptible Power Supply (UPS) that is connected to via the Simple Network Management Protocol (SNMPv3). The PDU is able to, once configured, receive SNMPv3 trap notifications from an Acumentrics UPS and respond by limiting power consumption, turning of outlets, etc.

Web Application Security: Prepared statements are used to prevent SQL injection; Anti-DDOS technology is implemented; HTTPS is forced and the user can upload their own certified SSL certificate; user authentication and authorization is required.

Error Handling: Development of client and server side error handling in addition to error-logging to make things easier for the transition to the Acumentrics team.

Responsive Web Design: The web application was written using responsive web design to allow the web application to function on a variety of screen sizes, allowing for mobile use.

Auto-Ranging Input: The schematic and simulation is complete. The prototype has been proven to work and shift between 120v and 240v. The circuit consists of an AC-DC transformer and comparators to use hysteresis to track previous voltage values and switch during a certain range.

Documentation: The project has sufficient documentation to facilitate a swift knowledge transfer. Acumentrics shall be continuing development upon the completion of the Capstone project.

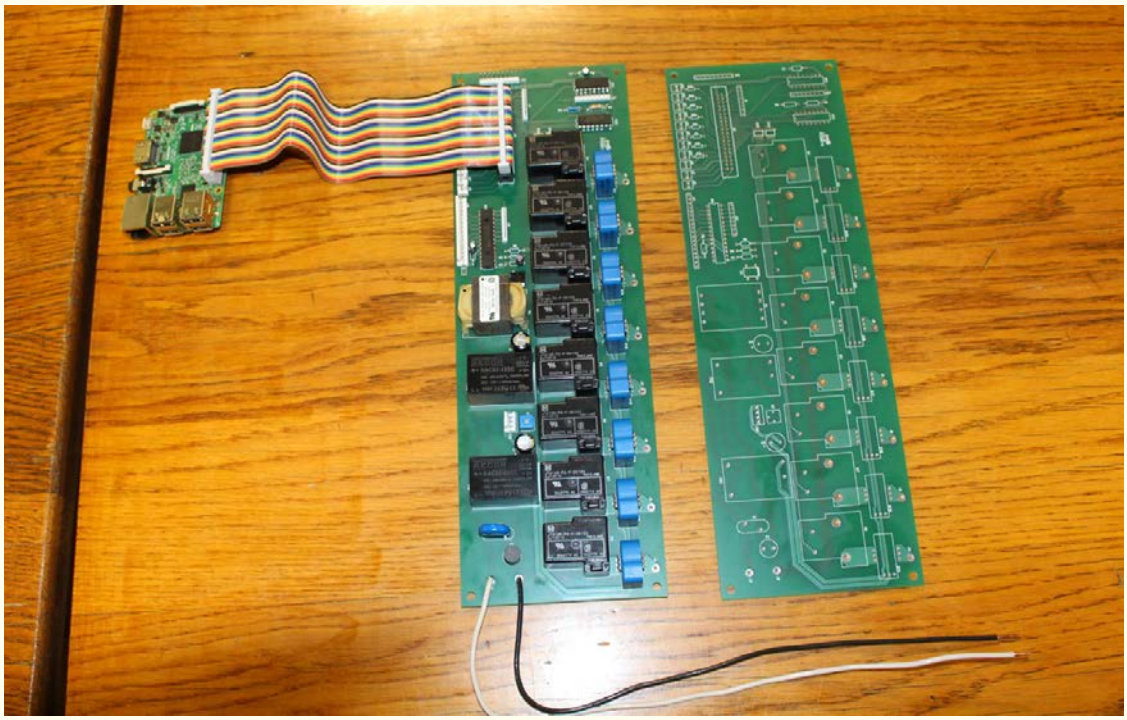

Fig 1: Empty PCB Board pictured next to the assembled circuit board with microcontroller.

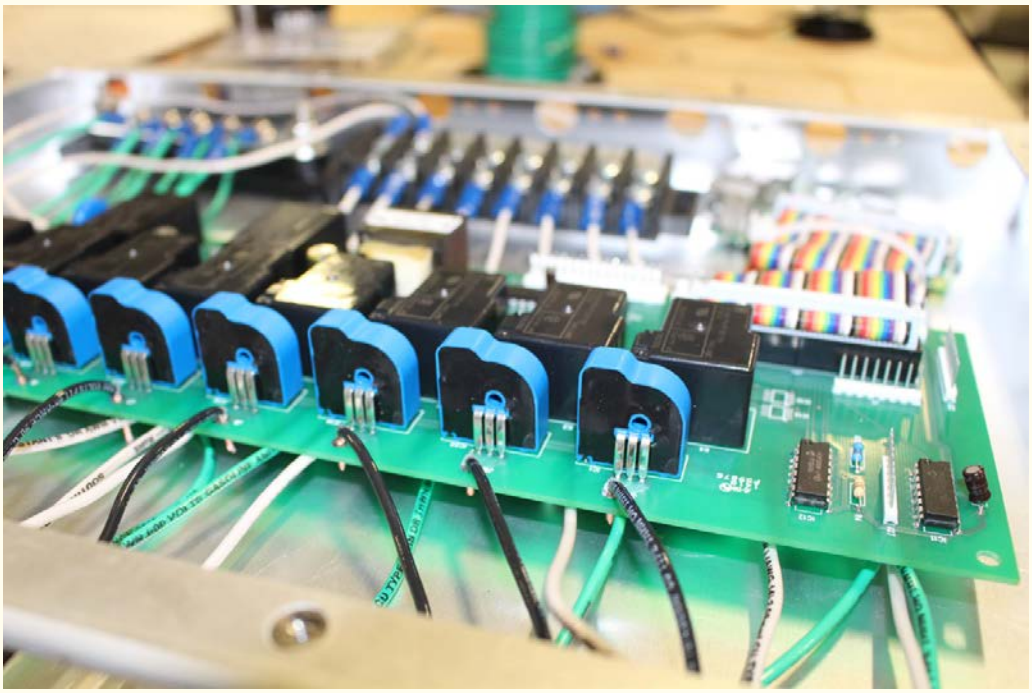

Fig 2: Hall-Effect Sensors were selected for their naturally isolating properties and simplicity when compared to alternative current-sensing systems.

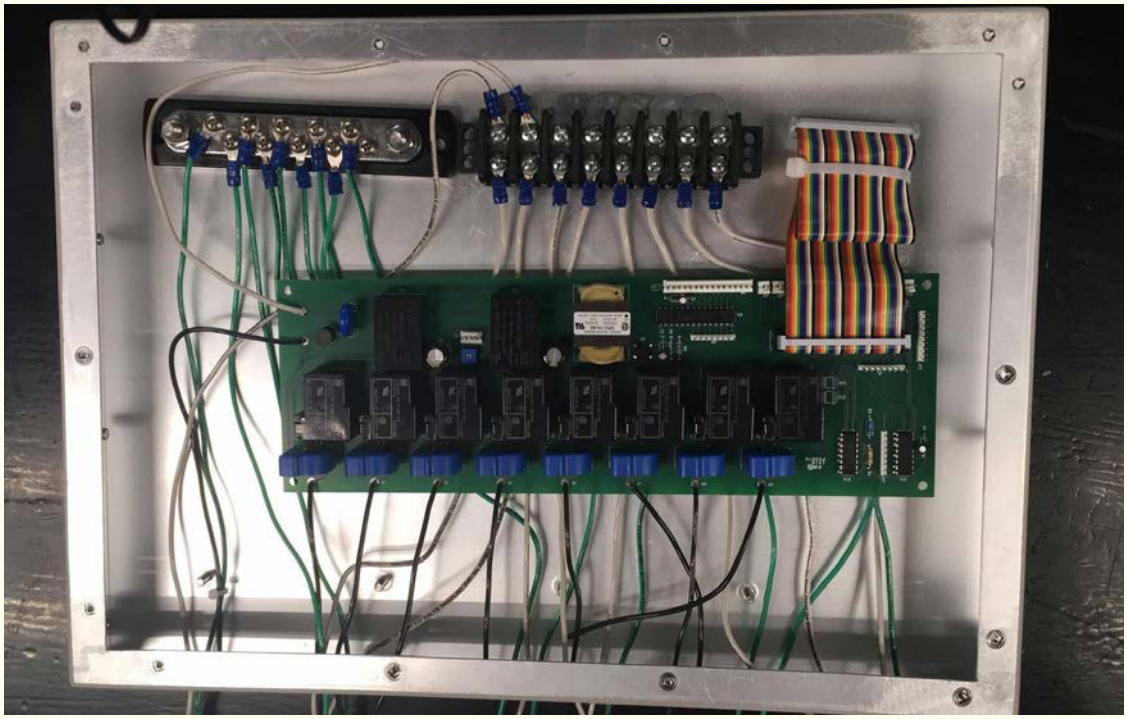

Fig 3: Top-down view of the initial prototype assembled within the half-depth aluminum chassis.

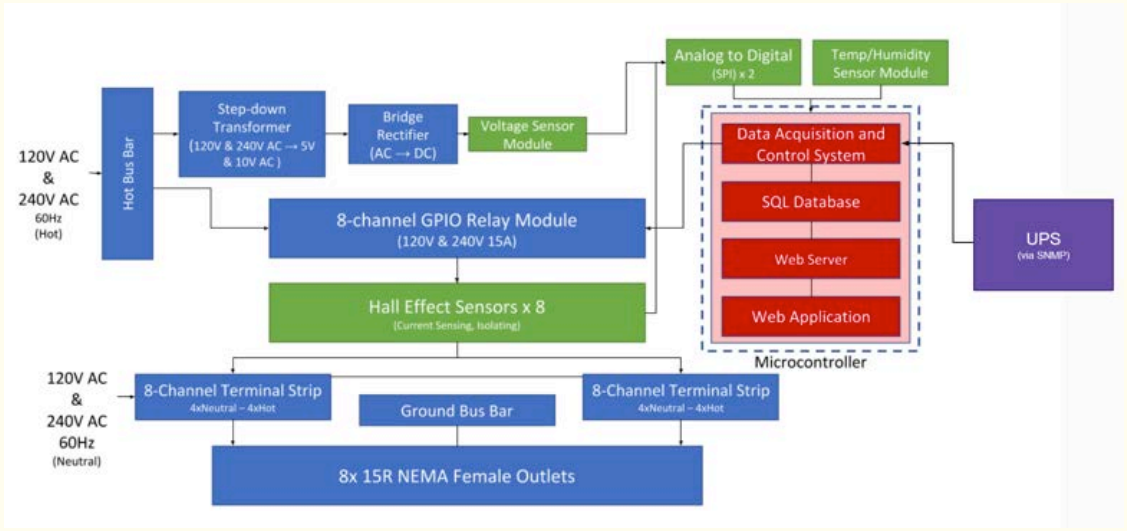

Fig 4: Updated block diagram for the product. Capabilities for UPS communication as well as 240v have been added.