AcuPDU

Network Managed Power Distribution Unit for Military Application
ELECOMP Capstone Design Project 2017-2018

Sponsoring Company:

Acumentrics, Inc
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Walpole, MA 02081
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Acumentrics is continuing their support of the Program they initiated last year:
http://web.uri.edu/elecomp-capstone/past-projects-2016-2017/acumentrics/

Team Acumentrics won 1st Prize at the 2016 ELECOMP Fall Symposium and 2nd prize at the 2017 ELECOMP Capstone Summit

Company Overview:

Acumentrics, Inc., headquartered in Walpole, Massachusetts, has been a trusted market leader in RUPS™ (rugged AC and DC uninterruptible power sources) for harsh and combat environments as well as heavy-duty industrial applications, since 1994. Acumentrics products provide clean power conditioning and battery backup when reliability is mission-critical. Acumentrics, is a preferred supplier of US-made power electronics to many of the world's largest prime defense contractors.

The modern military relies on computers and other sophisticated electronic equipment and relies on Acumentrics' products to keep that equipment online in harsh environments. Electrical variance, surges, spikes, sags, and interruptions can cause communication breakdown and data loss, especially during the rigors of active duty.

Acumentrics technology is based on over 20 years of experience in delivering trusted, reliable and rugged back up power solutions to military specifications.
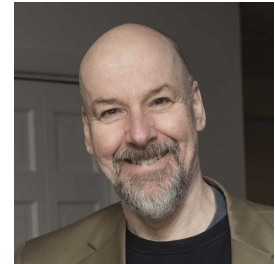
Technical Directors:

Peter Upczak
Senior Firmware Engineer
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Peter Upczak lead last year's team which was placed second at the 2017 May Summit Competition

Brenden Smerbeck (URI College of Engineering Class of 2017)
ELECOMP Capstone Graduate 2017
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Project Motivation:

As technology advances, so does the overwhelming need to for its users to be able to monitor, control, and manage it; regardless of location. It is because of this demand that the internet of things (IoT) and the presence of embedded systems in both consumer and industrial electronics has grown exponentially in recent years. This expansion, however, is not only limited to the consumer market. The military and industrial market requires not only the ability to monitor and manage devices, but to do so securely regardless of climate or environment.

Power distribution units (PDUs) are vital in the distribution of electric power to computers and other equipment and are primarily seen in server racks. In order to face an increasing requirement of protection and management, these devices have become "smart" and allow operator to maximize efficiency and uptime. In the military market, the presence of these devices are limited. It is for this reason that Acumentrics is seeking to create such a product.

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Anticipated Best Outcome:

The team will build an 8 outlet, prototype PDU capable of monitoring not only input and output statistics, but also environmental metrics. Using a standardized communication protocol (i.e. SNMPv3) the user will be able to control and manage the device through a graphical user interface (GUI). Following pcb design, programming, and testing done by the team, Acumentrics will be able to continue the development of the prototype and introduce it into their existing product line.

Project Details:

Overall system concept

The general design of the AcuPDU will be similar to that of a standard PDU. Following an AC line in, power will be passed to the outlets. Dependent on the operation of the device, power conditioning will be implemented.

In addition to the standard PDU design, the AcuPDU system will use sensors and other actuators to provide additional metrics for monitoring and management. Sensors will be added to monitor input and output voltage, current, and even humidity and temperature. A physical display will allow necessary information to be available upon visual inspection. A microprocessor controls the relay system, and receives information from the various sensors of the device.

The microprocessor also transmits and receives information to via a network interface. At a software level, management and monitoring occurs. Dependent on the system chosen, this information can be made available through multiple methods (SNMP, Web, Email).

Block Diagram
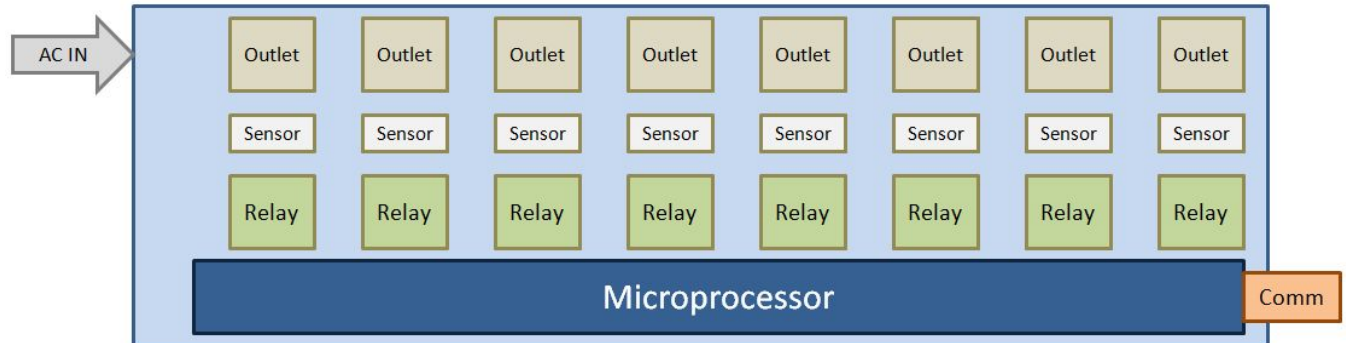
Electrical Tasks

- Using an existing model from Acumentrics, learn the basic functionality of power distribution systems and design principles.
- Create a simulation of a single-input, eight-output PDU.
- Benchmark an existing Smart PDU and develop a theory of operation for the AcuPDU prototype.
- Using the Acumentrics PDU, create a proof of concept demonstrating switching on a single outlet.
- From the schematic, construct a bill of materials (BOM) that meet the operational and environmental requirements of the product.
- Design a PCB supporting all required components
- From the fabricated PCB, construct the AcuPDU prototype

Firmware Tasks

- Gain experience with a Raspberry Pi, GPIO programming, and controlling devices using the GPIO pins.
- Using the Raspberry Pi's GPIO pins, create a proof of concept demonstrating switching on a single outlet.
- Using the Raspberry Pi, determine a method of controlling all required components of the AcuPDU, including: eight outlets, voltage and current sensors, humidity and temperature sensors, and a visual display.
- Develop a program capable of retrieving all necessary monitoring information from the PDU.
- Based on the communication protocol chosen by the team, develop firmware capable of translating received signals to their equivalent responses on the PDU.

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Software Tasks

- Gain experience with the Simple Network Management Protocol, the MIB tree structure, and how SNMP is used to both monitor and control devices. Additionally, determine if an existing MIB will be applicable for PDU control or if a proprietary MIB is needed.
- Using the Raspberry Pi or system with a similar operating system, gain experience creating and issuing SNMP commands programmatically.
- Following benchmarking of a Smart PDU, design and create a mockup graphical user interface for the AcuPDU.
- Design and develop an application capable of querying a device using SNMP and storing the retrieved data.
- Design and develop an application for monitoring and managing the AcuPDU.

Composition of Team:

2 Computer Engineers and 2 Electrical Engineers

Skills Required:

Electrical Engineering Skills Required:

- Analog and digital circuits and signals
- Knowledge of power electronics
- Printed circuit board design and layout

Computer Engineering Skills Required:

- Low level programming experience
- Firmware
- Embedded MPU or CPU programming knowledge and/or experience
- Networking
- GUI development experience
- Experience with Linux

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Anticipated Best Outcome's Impact on Company's Business:

The inclusion of a network managed PDU will expand Acumentrics' competitive offering, improve our existing product line available to our customers, and assure that we remain at the forefront of total power solutions and their associated technologies.

Broader Implications of the Best Outcome on the Company's Industry:

With networked and managed technologies becoming imperative in the modern world, it is the job of companies like Acumentrics to provide such products in a ruggedized, safe, and secure form for both industry and military. By creating the AcuPDU, our nation's armed forces will be able to continue to improve and enhance their electronic systems - allowing greater security and overall efficiency.

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