Project Green

UPS compliant with Department of Energy efficiency requirements

ELECOMP Capstone Design Project 2017-2018

Sponsoring Company:

Schneider Electric
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Company Overview:

Schneider Electric develops connected technologies and solutions to manage energy and process in ways that are safe, reliable, efficient and sustainable. The Group invests in R&D in order to sustain innovation and differentiation, with a strong commitment to sustainable development.

In 2007, Schneider Electric acquired APC. Over nearly four decades, APC has become the industry-standard for reliable power and physical IT infrastructure. APC is the leading name in all sizes of IT departments and among our vast community of channel partners. Our history of innovation has pushed our products into the global spotlight with infrastructure, management, and data security solutions protecting organizations around the world.

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Project Motivation:

The efficiency of Uninterruptible Power Supplies (UPS) has always been important for large scale systems. Electricity savings and reduced heat load can provide significant reductions in the operating costs of data centers and other facilities.

Efficiency for lower power UPSs' that connect to regular 120V outlets has not been an issue. For the consumers that are concerned about efficiency, there is an Energy Star® program for UPS products. It provides information so consumers can easily choose more efficient models to save energy and operating costs. Whether a manufacturer meets the Energy Star® requirements is voluntary. APC by Schneider Electric is concerned about energy conservation and sees the

higher efficiency as a benefit to customers so we proudly design our UPS products to meet the requirements.

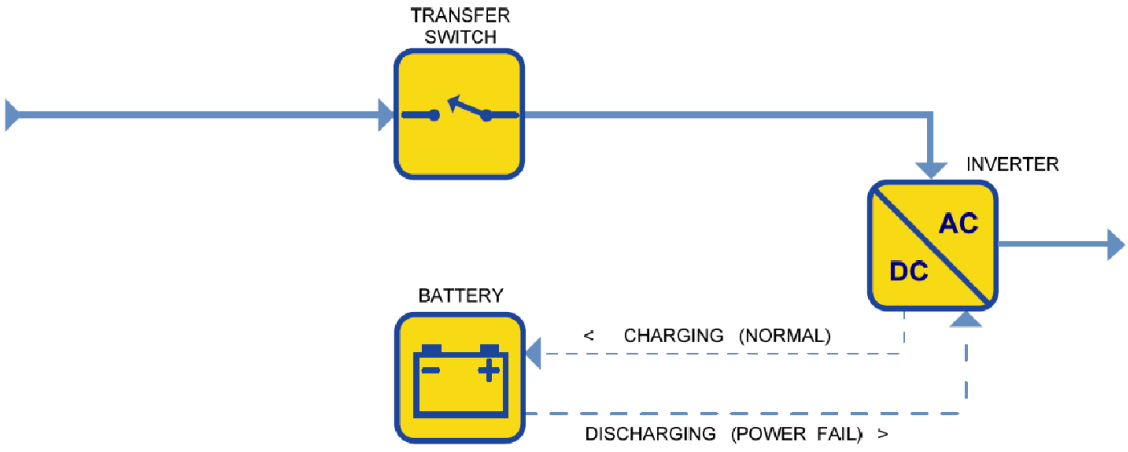
The Department of Energy (DOE) has recently stated that it will implement regulations for UPS efficiency. The efficiency requirements the DOE intends to release are more stringent than the current Energy Star® program. Compliance will be mandatory. If the regulation is approved, products that are sold in the United States must comply or be removed from the market.

Anticipated Best Outcome:

The team will modify an existing UPS design so it can meet DOE requirements. A prototype with updated PCB design and firmware will be built to validate the modified design. The modified design will then be used by Schneider Electric to update several existing UPS models (SMX750, SMX1000, SMX1500RM2U) when the DOE requirements come into effect.

Project Details:

The team will modify a line interactive UPS design. The illustration below shows the basic operation of the UPS. During normal on line operation, the transfer switch is closed. The AC power is passed to the output and the inverter is run in reverse to charge the battery. When the input power fails, the transfer relay opens. The inverter draws power from the battery and provides it to the output as an AC voltage.

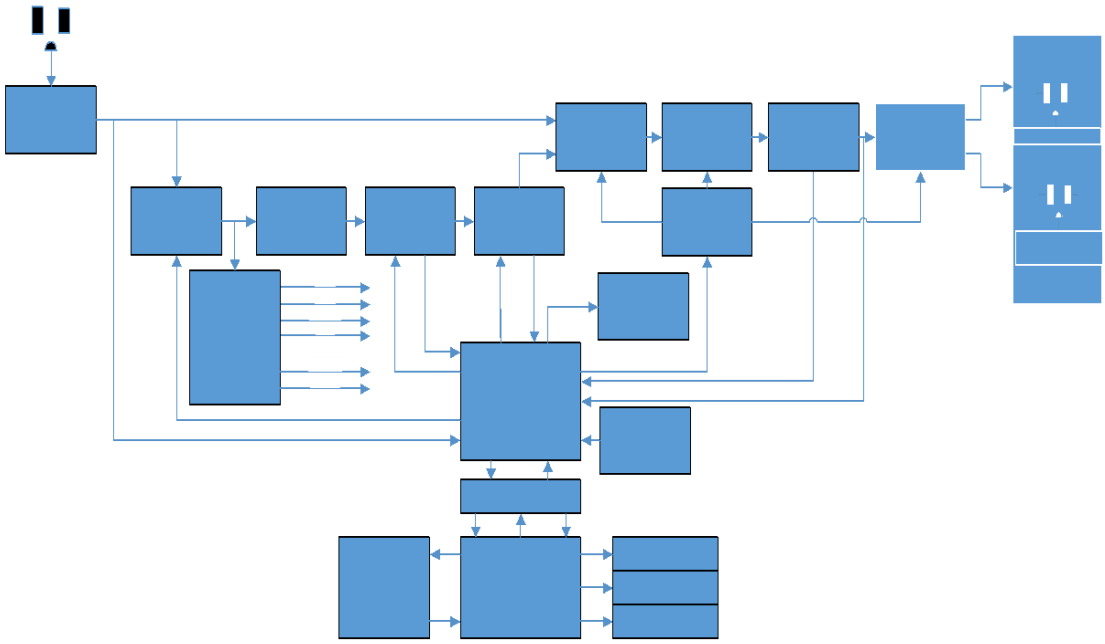


Apart from transferring between line and battery, the UPS has several other functions:

- Provide local users with information about the status of the UPS
- Provide remote users with information about the status of the UPS

- Control whether power is provided to specific loads
- Suppress surges present on the input voltage
- Filter noise from the UPS electronics
- Increase or decrease the input voltage to levels acceptable to the load
- Determine if subsystems are operating properly
- Monitor various parameters (input voltage, output voltage, output current, etc) to determine the proper mode of operation.

Different subsystems are responsible for the various functions. Some of the UPS subsystems are shown below.



Testing for DOE compliance involves loading the UPS in on line operation to specific percentages (25, 50, 75, 100) of its output power rating and measuring the efficiency. The measured efficiencies are combined into an overall efficiency. The unit is compliant if the overall efficiency is above the minimum set by the DOE. The goal is to modify the subsystems so the UPS complies with the requirements.

Electrical Engineering Tasks:

- Review the overall UPS efficiency (on-line mode) and compare to the limit set by the DOE.
- Breakdown the UPS into sub-systems and determine the efficiency or power consumption of each.
- Identify opportunities for sub-system efficiency improvements.
- Estimate (via calculations and/or simulations) efficiency savings.
- Prototype and test potential circuit improvements.

Computer/Firmware Engineering Tasks:

- Identify embedded control changes required to realize sub system efficiency improvements.
- Implement and validate required changes.

Composition of The Team:

2 electrical engineers and 1 computer/firmware engineer

Skills Required:

Electrical Engineering:

- Circuit Analysis
- Capable of performing accurate power/efficiency measurements
- Knowledge of power conversion fundamentals
- Knowledge of battery charger fundamentals
- Schematic capture
- PCB layout

Computer/firmware Engineering:

- Experience programming in C
- Knowledge of power conversion fundamentals
- Knowledge of battery charger fundamentals
- Knowledge of embedded MPU or CPU programming

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

Allow Schneider Electric to continue marketing and selling single-phase (120Vac 1500VAmax) UPS systems in the United States, and potentially to gain market-share from key competitors in a multibillion-dollar market.

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

Utilize the knowledge gained to improve efficiency in other UPS products, including 208Vac models, 230Vac models and models greater than 1500VA. This will put Schneider Electric at a competitive advantage.