Energy Delivery System

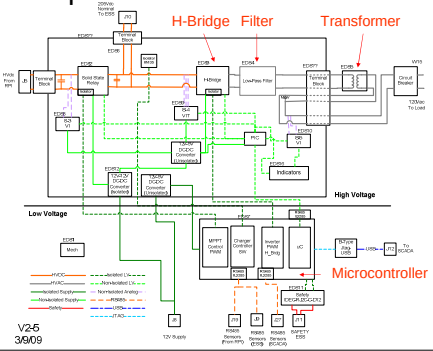
LPRDS-ETS 2009

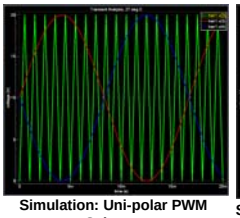
Functionality

- Convert DC voltage to 120vAC
- Output is at 60.25Hz
- Interface with RPI and ESS
- Handle variable loads

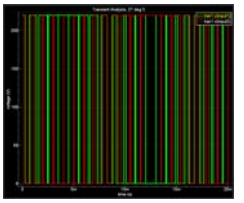
Design

- Input voltage is determined by the battery voltage ranging from 160v to 235v (205v nominal)
- Output 120vAC





Simulation: Uni-polar PWM Scheme



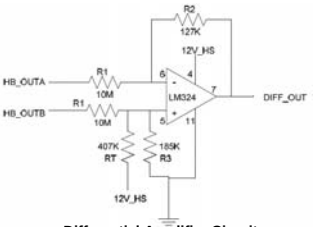
Simulation: Signals going into the gate driver

Design Elements:

- Voltage inverted using an H-bridge
- Signals to the H-bridge are driven by an Atmega128 microcontroller using a uni-polar PWM scheme
- Low and High voltage signals are isolated
- LC filter is used to filter the output of the H-bridge into a sine wave
- Transformer isolates the load

PWM Scheme:

- The uni-polar PWM scheme is created by comparing reference sine waves to a triangle wave
- This reduces the harmonics



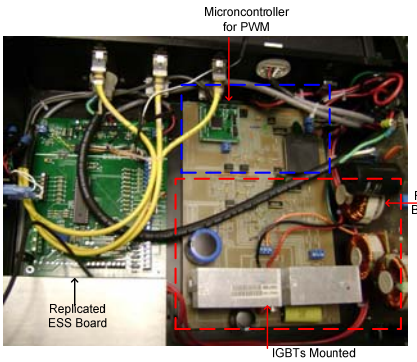
Differential Amplifier Circuit

Differential Amplifier:

- A diff-amp was designed to measure the output voltage after the filter
- The diff-amp could regulate the output voltage with a closed loop system

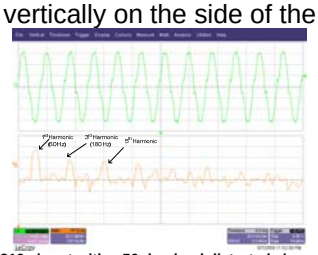
Implementation

- System converts 210vDC (from power supply) to 124Vac
- Two PCB boards
  - One fabricated at Lafayette (Right)
  - One copy-cap board from ESS with sensors (Left)
- Filter board was mounted vertically on the side of the case



Custom Parts Designed:

Parts designed	Parts purchased
H-Bridge/Inverter	Isolation Transformer
Differential Voltage measurement	12v DC-to-DC converter (hi-lo voltage isolation)
Filter	microcontroller



210v input with a 50ohm load distorted sine wave (top), frequency analysis (bottom)

Distortion:

- At high voltage the sine wave became distorted
- This may be due to resonance in the filter
- There may be core saturation in the inductors

Problems interfacing with ESS:

- When ESS is connected to EDS it appears an initial current surge occurs
- This causes damage to the IGBTs
- The Hi-Lo isolation worked and no low side components were harmed

Board after interfacing with ESS

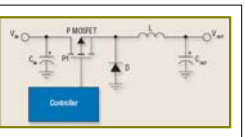
Damage from high current to the heat sink and IGBTs

Conclusion

- EDS met basic requirements of changing DC voltage into AC voltage
- Requirements on THD (less than 3%) and frequency accuracy (60 +/-.05% were failed
- There was not enough time to implement a closed loop system for voltage regulation
- New inductors may produce better response at high voltage and current
- A delay circuit could be designed to prevent the problem interfacing EDS with ESS

Next Steps:

- Implement a buck converter and use a Maximum Power Point Tracking algorithm to increase power intake 12-15%
- Create a current controller for the current going to ESS to improve efficiency in storing excess voltage in the batteries



Buck Converter controls the ratio of the input to output voltage

George Foreman Grill Cooking Hamburgers

Demonstration:

- With the EDS board connected to a 210vDC supply we cooked burgers on a George Foreman Grill using the AC voltage out of the EDS board

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