ECE SENIOR DESIGN PROJECT 2003-2004 FINAL REPORT

Digital Control for a 5kW/10kW Power Converter for Fuel Cell Energy

Submitted to Dr. Chika Nwankpa and the Senior Design Project Committee
of the
Electrical and Computer Engineering Department

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Executive Summary

Fuel Cells do not require the existence or maintenance of a power supply grid, provide a clean source of energy, and can operate at high efficiencies. However, fuel cells produce DC power, and there is no readily available method to produce low cost, efficient conversion to AC power. In this project we have modified the existing 5kW/10kW Fuel Cell Power Converter built by the senior design team from the previous year by introducing a Digital Signal Processor (DSP) controller. At the same time we have continued to provide two modes of functionality for the device, i.e., 120V 60Hz single phase and 240V 60Hz single phase and we have designed a voltage feedback control.

The previous design of the Power Converter used analog waveform generation circuitry to drive H-Bridge gates and Pulse Width Modulators (PWMs). We changed the waveform generation circuitry from many discrete components to a DSP.

We used Mathworks computer software applications for this project including Matlab, Simulink and Real-Time Workshop. We modeled the present inverter in Simulink, added digital controls, and downloaded C code from the Simulink model using Real-Time Workshop. This code was then uploaded to the DSP board to provide the necessary programmed waveforms and controlling signals for the device. The DSP board is designed to be connected to the existing inverter using special connectors. Special connectors were used throughout the project to preserve the integrity of the inverter, enabling it to operate in two alternative modes: analog or a digitally controlled. The result is that the digitally controlled inverter uses fewer components, is less expensive, and reduces the amount of space needed by the present analog components. At the same time, we maintained the same functionality and introduced constant voltage control. Finally, the controller is now fully programmable, allowing for future ease of modification and further experimentation of the 5kW/10kW Fuel Cell Power Converter.