ECE Senior Design Project 2004-2005
Final Report

Multi-Purpose Inductive Device for Loading and Fault Experiments

Submitted to Dr. Karen Miu
and the Senior Design Project Committee of the
Electrical and Computer Engineering Department
Drexel University

Team Number: ECE-17

Team Members:

Antonios Boulos	Electrical Engineer
Charles Mai	Electrical Engineer
Craig Zemaitatis	Electrical Engineer

1. Executive Summary

The multi-purpose inductive device for loading and fault experiments has been successfully created and tested in the Reconfigurable Distribution Automation and Control Laboratory (RDAC). The hardware device can be configured and placed in series with resistive loads to mimic realistic inductive loads in RDAC for electric power system loading experiments. In addition, the device can be reconfigured as a fault limiter, and experiments were created to study various types of faults in RDAC. Software for controlling, monitoring and performing the hardware experiments has been coded and successfully tested. Accompanying laboratory manuals were written and approved by the Center for Electric Power Engineering faculty. The experiments are ready for Drexel students to read about and perform. These upgrades to the laboratory have contributed to the education of future generations of power engineering students at Drexel University.

This project's objectives were to design, construct, and implement an inductive device for the RDAC Laboratory that would serve multiple purposes. The device has expanded the functionality of the laboratory by allowing additional types of loading and fault experiments to be performed. Most significantly, the ability to observe and analyze faulted systems is critical in assisting engineers to understand and plan for these events. Thus, both types of experiments will provide students, the future engineers, with hands-on experience in actual power system operations.

The overall design incorporates three sections: hardware design, software design, and experiment design. Significant results are now summarized.

1. **Device Hardware:**

Two identical hardware devices have been designed, constructed and tested. Each device contains 6 40mH/15A inductors which can be connected in various series and parallel combinations. Digital relays were also included to allow for automated control of the inductors in future experiments. Appropriate heat sinks and fans were included for cooling. Each device is housed in a 26"x22"x14" steel box and mounted on moving carts. Testing of each individual inductor and the device as a whole has been completed.

2. **Software Modules for Experiments:**

Two software modules were addressed in this project. Visual Basic was the platform chosen to design and code the software. The team adopted and modified an existing Visual Basic power load module which had only allowed for resistive loads. A significant portion of effort in software design was made towards the creation of the fault experiment module. This involved new code for: control of digital relays to physically create faults, measurement tools for capturing fault transients and user interfaces for displaying the system and creating faults.

3. **Experimental Setups and Procedures:**

With the hardware and software in place, experiment design required the creation of specific laboratory setups and procedures. Calculations for choosing specific inductor and resistor load combinations were performed to create electrical loads which mimic real power system loads. Each experiment required a laboratory introduction, experiment objectives, hardware setups, procedures, report write-up activities for students and conclusions. Laboratory manuals addressing each of these points were written for an improved Multi-Phase Power Flow Experiment which can now include inductive loading and for a Distribution Fault Experiment. Each experiment has been run successfully.

The Multi-Purpose Inductive Device is a custom part specifically designed for the RDAC laboratory in the CEPE. The actual costs of what we delivered were lower than estimated costs for a private contractor to custom build the device. This additional system will be sold to Drexel University's CEPE for educational experiments and laboratory procedures.