Project Title: **Differential Transformer Protection Using the SEL 387 and SEL 587 Microprocessor Relays**

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Student’s Signature:

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**Summary of Functional Requirements**

The objective of this Senior Project is to use the SEL 387 current differential and overcurrent microprocessor relays to protect three-single-phase 1 KVA 120:208 transformers configured in ∆-∆, Y-Y, Y-∆, and ∆-Y connections. In the second phase of this project, is to create a functioning lab that uses the SEL 587 relay to teach basic differential transformer protection for the upcoming EE-444 students.

The protection schemes developed in both of the senior project phases require the use of differential and overcurrent protection elements by monitoring the changes of the input and output current through the transformer. When these currents fail to match, in the case of a fault, or reach a specified current set point, the relay must trip. Experimentally, these differential protection schemes will be tested by flipping the polarity of the currents going into the relay to simulate an internal fault in the transformer. Afterwards, the event report generated by the relay will be analyzed to verify the results. Because of safety limitations regarding circuit breakers, the overcurrent element will not be tested in this senior project.

The EE-444 lab will follow the same design and test procedure for the first phase of the senior project. However, the lab will use the SEL 587 in place of the SEL 387, the same 3 KVA transformers on the lab bench, and will only test the differential protection for the Y-Y transformer configuration.

**Primary Constraints**

The high-risk items are testing and verifying the settings of the relay correctly. Making sure that the tests accurately depict a transformer operating in nominal and failure cases is the most important step of this project. To prepare for mishaps, reference material on protection theory will give more insight how to correctly implement the settings of the relay correctly.

**Economic**

Table Cost Analysis of Senior Project

|  |  |
| --- | --- |
| **Item** | **Cost** |
| SEL 587 Relay | $ 2,080.00 |
| SEL 387 Relay | $ 5,250.00 |
| 3 Single Phase Transformers | $ - |
| Software | $ - |
| Test Equipment | $ - |

Table 1 shows the cost associated with the senior project. The SEL 387 and 587 relays and corresponding software were donated by SEL. Test equipment such as leads and meters were borrowed from the EE Project Lab. Professor Shaban provided the three single-phase transformers at no cost.

Figure 1 Gant Chart of Senior Project (At the Start of the Senior Project)

Figure 1 displays the Gant Chart of this Senior Project. The chart was created to provide a rough timeline for the design, construction, and testing of the project. However due to many changes throughout the life of the project, the chart tasks are inaccurate or no longer relevant to the project. Additionally, the scheduled outlined in the chart was loosely followed, as the project timeline was significantly modified throughout the development process.

Figure Senior Project Gant Chart (At the end of Senior Project)

Figure 2 displays the actual timeline of the Senior Project at the start of March 30, 2013 (Spring Quarter).

**If Manufactured on a Commercial Basis:**

Not applicable for this project.

**Environmental**

During the manufacturing of relays and test equipment, pollution associated with the production of everyday electronics can affect the environment. In addition, the cost of transporting and marketing the equipment can attribute to the burning of fossil fuels. Lastly, the manufacturing plants that produce the relays and test equipment takes large amounts of space and in order to accommodate them, surrounding environmental species such as plants and wildlife must be relocated and displaced.

**Manufacturability**

Not applicable for this project.

**Sustainability**

* Describe any issues or challenges associated with maintaining the completed device, or system.

Like any electrical power protection system, this product must be maintained regularly in order to keep the protection operational. Fortunately, the SEL relay is able to provide feedback to Power Engineers to let them know if the device is functioning properly. The only real issue is the ability to send a technician to the field to provide normal checkups on the device.

Describe how the project impacts the sustainable use of resources.

This project targets resources regarding electronic manufacturing. Unfortunately, sustainable resources such as wind, solar, and geothermal generation of electrical energy may or may not be used in the manufacturing process.

Describe any upgrades that would improve the design of the project.

A possible upgrade would be to install a newer model of the relay. With the installation of an upgraded relay, there will be an increase of reliability and functionality of the device. With more capabilities, engineers can develop protection schemes with more functionality without the need of extra relays.

Describe any issues or challenges associated with upgrading the design.

The main challenge is funding the upgrade. Without funding no one will be able to purchase the unit and other electrical equipment necessary to implement the protection scheme.

**Ethical**

The ethical implications would include relocating animal and plant species during the installation of the project. In addition, there is high voltage and current running through the electrical equipment and this could be hazardous if safety protocol is broken.

**Health and Safety**

The biggest safety concern is the implementation of this project. This project revolves around things that could potentially explode and be harmful to the user if safety is compromised. Installation of this project must follow the safety protocol listed by the manufacturer in order to mitigate injuries.

**Social and Political**

Socially, the installation of microprocessor relays into the power grid increases electrical reliability for a utility. There are no political associations with this project.

**Development**

In order to implement this project, information from SEL relay manuals and basic power protection theory was needed. The SEL relay manuals provided information on how to use the relay to protect a three-phase transformer. Information from *Protective Relaying Principles and Applications Third Edition* by Blackburn gave insight of how to implement differential protection for a three phase transformer.