Senior Design
ENG EC 464

To: Professor Pisano

From: Smart Grid ECE Senior Design Team

Team: Power Pooches: 14

Date: 2/12/2015

Subject: Second Deliverable Test Plan

1.0 Test to be Performed

1.1 The overall objective of this Smart Grid Test Facility project is to make an educational tool for engineering students, allowing them to test various circuitry on a small-scale electricity grid. While developments have been made across all aspects of our project (transmission lines, loads, etc.), this testing procedure focuses on two key components of the project.

1.2 This testing procedure focuses on the development of the generation scheme for the power grid. The objective of generation is to create three synchronous sources that generate 60Hz, 12V DC power that propagates throughout the grid. Transmission lines and loads will consume this power across the grid. In order to most efficiently and effectively create this system, we are developing the first generation scheme, and then we plan to replicate the scheme twice to create three equivalent generators.

1.3 This testing procedure also demonstrates on the progress made on the DAQ. The sensor suite is a system that enables a user to measure current at various points along the grid. The suite interfaces with MATLAB, so users can work on their available lab monitors to observe changes in the power flow within grid.

2.0 Significance of Deliverable

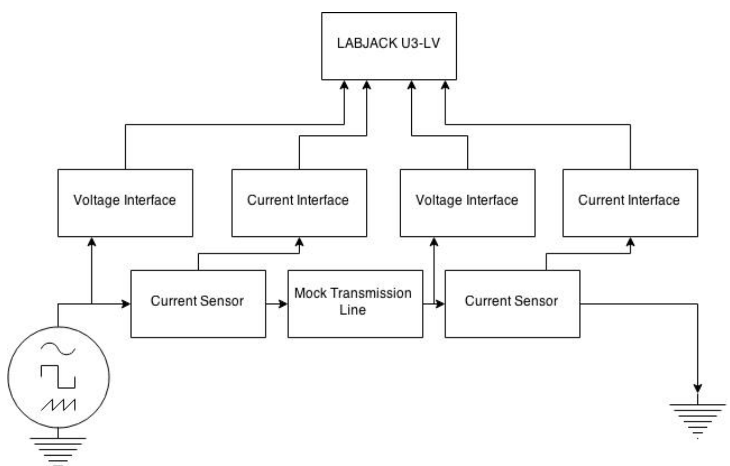
2.1 This deliverable is essential because it validates the development of our generation scheme. The generators are responsible for the overall power flow of the system. A major near-future goal of ours is to create a functional motor-alternator scheme that outputs 12V at 60Hz. This test demonstrates our progress in acquiring the motor and alternator and shows how they can operate together.

2.*2* The significance of this deliverable test is also to provide the basis for the sensor suite that will be used to measure the functionality of the grid test facility. Using this as a proof of concept we will move on to analyze power flow and expand the functionality of the data acquisition system.

3.0 Procedure I: Equipment and Setup

3.1 The overall setup of the generation scheme will include a test of our motor and alternator. This represents one of the three eventual generation points that will be connected into our grid. As of now, the generation scheme includes a 24V DC motor and a fourteen-pole wind turbine alternator. The DC motor is powered by a power supply that provides a nominal voltage of 15V at 9A. Using this as proof of concept, an order has been placed for a 24V:20A switching power supply (Siemens SITOP Modular Power Supply 6EP1336-3BA00) that will be used as the power supply for the final assembly. This will be able to power three motor-alternator systems in parallel.

3.2 The setup of the sensor suite test bench will be similar to that of the first deliverable test. In this test the LabJack DAQ will be used in conjunction with two current sensing circuits to measure a test signal from an AC/DC power supply available in the lab. The current sensing capabilities of our data acquisition unit were not available during the previous deliverables test because we had not devised a way to correctly measure the current without altering its characteristics too much with biasing currents for the sensors. We will now be using an RL circuit to interface to the LabJack.



4.0 Procedure II: Data Collection

4.1 For testing the generation, we perform a torque test to verify that the frequency of the generation output varies linearly with the voltage supplied at the input. To do this, we track the input voltage at the motor and the corresponding frequency of the AC waveform produced on the windings of the alternator (output voltage signal). After this is concluded, we verify that there is a set nominal voltage that can be supplied to the motor resulting in a 60 Hz or higher frequency of the alternator output power. Varying the input voltage should vary the frequency, if this is possible the frequency of the system can be controlled by voltage modulation.

4.2 For testing the DAQ, the ground of the DAQ should be connected to the ground of the circuit. Then, the other DAQ ports should probe various points throughout the grid network. This can be done by simply connecting a lead from a flexible input output port (FIO) to a part of the circuit and observing the output on a computer. For testing purposes, we have attached leads to the outputs of two voltage interface and two current interface circuits attached to our circuit.

5.0 Criteria for Success

5.1 The criteria for success with the test of the power system is the demonstration of a spinning system with a linear frequency-voltage relationship. Since a frequency control system has not be developed yet any consistent values are acceptable as long as it is possible to achieve a frequency of output above 60 Hz without exceeding the limitations of the DC power supply.

Sample Generation Data

Frequency: 60 Hz +/- 5%

Voltage: 17 V +/- 5%

5.2 The criteria for success with the data acquisition system are as follows:

5.2.1 There must be a wave form read by the current interface circuits that is centered around 1.2V. This is median voltage that will give the best resolution for the DAQ unit.

5.2.2 The phase between current and voltage is being read from the interface circuits. This can be used to calculate power factor for power flow in the system.

5.2.3 The input and output power factor will be read so that the power flow of the system can be characterized through the system. This is necessary for the ultimate functioning of the DAQ within the final system.

5.2.4 Current sensors show a value within 5% of one another (on the same line).

Sample MATLAB Output

Output (FI00, FI01) and input (FI02, FI03) waveforms of
current and voltage interfaces into the DAQ.