# Senior Design
ENG EC 464

To: Professor Pisano

From: Smart Grid ECE Senior Design Team

Team: Power Pooches: Team 14

Date: 4/24/2015

Subject: Customer Installation Report

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## 1.0 INSTALLATION LOGISTICS

1.1 Customer installation occurred in the BU ECE Senior Design Lab, PHO113.

1.2 Installation took place on Thursday, April 23, 2015 at about 1:00pm.

1.3 All five team members were present at the time of installation. In addition to the customer, Professor Horenstein, Professor Pisano and Professor AlShaykh were present at the time of testing.

## 2.0 PROJECT REQUIREMENTS

2.1 Generation

- 2.1.1 12V-AC (+/- 5%) at 60Hz (+/- 5%) ***Final Product***
- 2.1.2 Three generators: minimum of two motor-alternator sets ***Final Product***

2.2 Transmission

- 2.2.1 Real-world, lumped-element (per unit length) parameters ***Final Product***
- 2.2.2 3+ total transmission lines ***Final Product***

2.3 Loads

- 2.3.1 RLC Binary Boxes (1 each) ***Final Product***

2.4 Safety

- 2.4.1 Motors/alternators inside a safety enclosure ***Final Product***
- 2.4.2 No exposed high voltage (12V) for classroom setting ***Final Product***

2.5 Data Acquisition

- 2.5.1 Measure voltage and current of waveforms ***Final Product***
- 2.5.2 Measure power factor and phase angle (+/- 5%) ***Final Product***
- 2.5.3 MATLAB interface requested ***Final Product***

2.6 All elements labeled "***Final Product***" are in complete and as-installed form. Updates to the product that are planned to occur before ECE Day are described in section 4.0 of this document.

## 3.0 INSTALLATION DEMONSTRATION PROCESS

3.1 Overall, the customer installation session went well and according to the prepared installation plan. The team described the structure of the cart and its elements from the lower level to the top level.

3.2 This began by first describing generation, which includes the two motor-alternator sets. We also showed the step-down transformers and safety enclosures that protect users from the spinning elements and the high voltage. Also on this lower level are the rotary encoders, which are used for the frequency stability feedback loop.

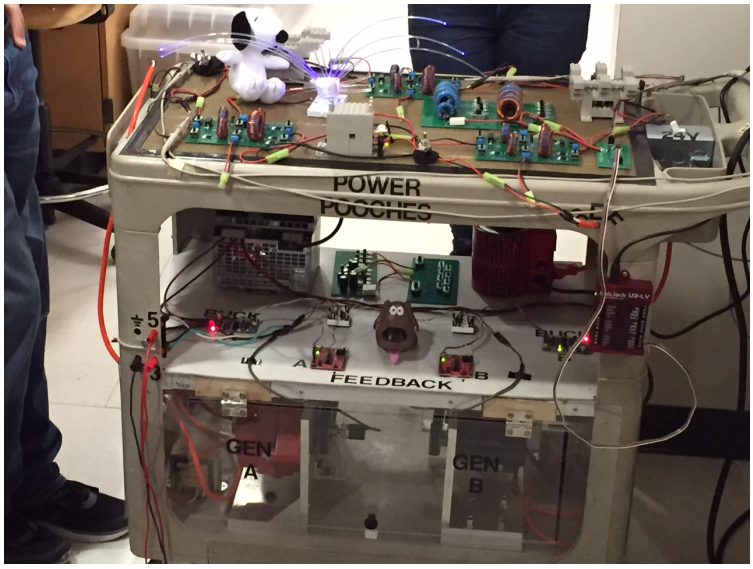
3.3 We next moved to the middle shelf, which includes power supplies, the reference generator, and the feedback loop. We described the programs on the MSP430s; the MSP430 changes its output PWM signal to the motor driver depending on how far deviated the alternator is from 60Hz. The MSP samples the alternator frequency via the rotary encoder.

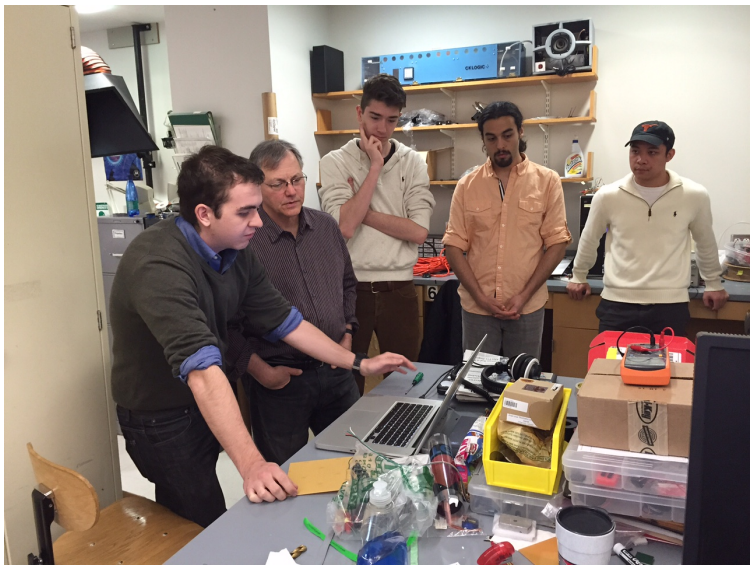
3.4 Next we moved to the top shelf, which is a Velcro-based plug-and-play layout. We described transmission lines, loads, and the sensor system.

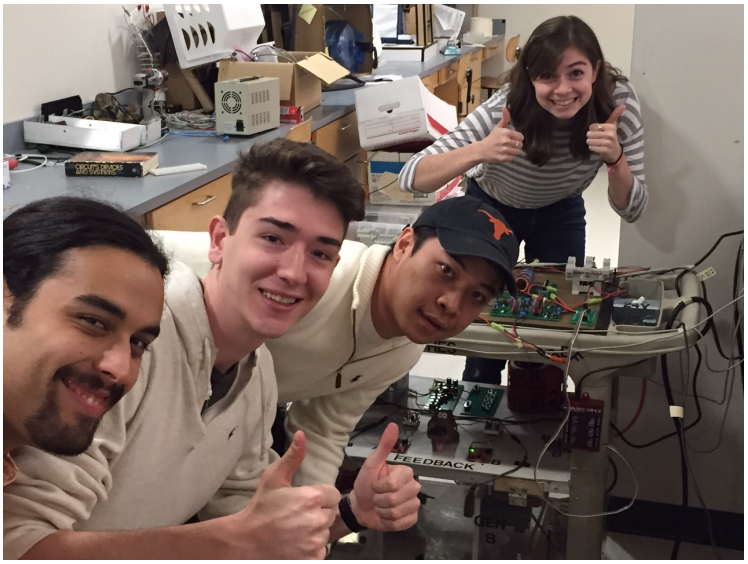
3.5 Once each part had been described, we tested the entire grid network. This included showing proper power-up, synchronization of the three generators, load attachment, and sensor circuit attachment. Finally, MATLAB data acquisition was demonstrated for voltage and current waveforms across a load.

3.6 Through this demonstration, all of the requirements outlined in the previous section were shown. Other components of the project that were not explicitly stated as requirements, but were necessary for full grid functionality, were also shown, such as synchronization and feedback control.

3.7 Photos from the customer installation process are shown below.


POWER
FEEDBACK
GEN
A
GEN
B




FEEDBACK

## 4.0 INSTALLATION CUSTOMER FEEDBACK & FUTURE PLANS

4.1 The customer stated interest in an additional feature regarding the feedback control loop. Specifically, the customer requested a way that a user could manually alter frequency (thus, power input to the motor) in order to change the relative phase of the signal compared to the reference signal. This would allow a slower and clearer method of synchronization across the synchronization circuit LED. Our team plans to work toward this goal within the week before ECE Day. The current plan is to implement a two-button (per generator) system that feeds into the MSP430 and increases or decreases the desired output frequency of the alternator accordingly. We anticipate needing debouncing mechanisms in order to avoid poorly read signals on the buttons. Pseudocode for this process has been prepared and will be implemented within the coming days.

4.2 We are also continuing to clean up and finalize the cart, such as shortening wires and improving labels. We also have since incorporated a power strip so that the user only need plug in one cord into a wall outlet in order to power the cart. We have also made the DAQ easier to plug into by making six available ports on a small breadboard on the top of the cart so the user does not need to unscrew the power supply ports in order to power more sensor circuits. We plan to continue organizing the cart's elements in the week leading to ECE day while also developing the manual frequency control unit.

## 5.0 CUSTOMER PROJECT ACCEPTANCE

5.1 The team has requested an official confirmation of acceptance of the project via email and is awaiting reply. Once a confirmation is received, it will be forwarded to the Senior Design faculty accordingly.