Senior Design
ENG EC 464

To: Professor Pisano

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Team: Smart Grid (30)

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Subject: Hardware Readme

1.0 Introduction

For more specific information on the test facility's hardware and construction, refer to the previous group's Hardware readme. This has more information on how the hardware was designed and built on the test facility, excluding the data acquisition unit. This document gives a brief overview of setup for the grid and how the data acquisition unit works.

2.0 Grid Basic Setup for Operation

1. Plug the power strip into the wall. This powers the variac (which starts in the OFF position), the +/- 15 V power supply that powers the sensor boards, the 24 VDC power supply that powers the generators.
2. Make sure that all transmission lines have the top three switches ON and the bottom three switches OFF.
3. Before connecting the model, plug in the 5V 1A power adapter that powers the synchronization circuits. Once plugged in, the LEDs on the MSP430's should light up.
4. Wait a few seconds to let the MSP430's settle, and then turn on the main switch on top, labeled 24V, to bring power to the rest of the model.
5. The variac/reference generator is turned on after.

3.0 Picoscope Setup

1. Plug the PicoScope into a computer.
2. Attach the probes to point 1 and point 3 (comparing Generator A to the point it is being added to the grid), according to Figure 1.

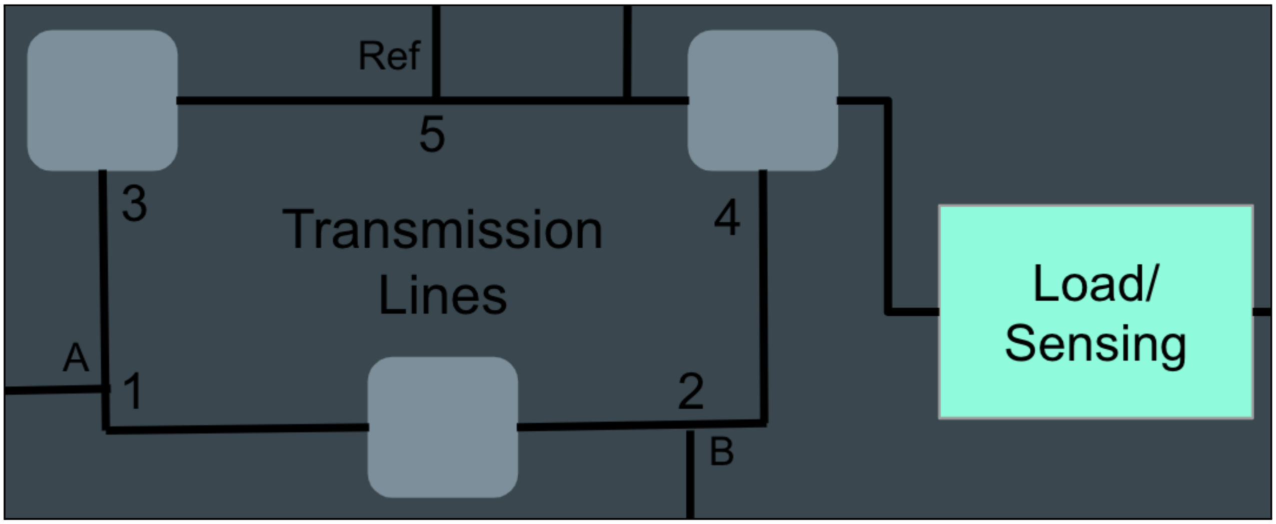

Figure 3.1: Basic schematic of the grid

3. Pulling up the PicoScope 6 application should bring up a live feed with the 60 Hz, 24Vpp wave being visible on the computer, which is coming from the reference variac.

4.0 Activating the generators and synchronizing

1. To turn on a generator, we reset the microcontroller by pressing the button labeled by an arrow for the MSP430 corresponding to that generator. When the button for A is pressed, the generator will begin its rotation and it should now be visible on the PicoScope (from point 1). The peak-to-peak voltage should be about the same as the reference.
2. Next, flip the slide switch on the synchronization circuit for A to the green/on position, which will give additional feedback via the LED. The LED will flicker on and off due to the phase differences between the reference generator voltage and the signal produced by generator A; the two signals are in phase when the LED is dim, and out of phase when it is lit up (i.e. out of phase means there will be a voltage difference across the diode causing it to be lit).
3. The toggle switch (with on/off labels) should be closed (switched to on) at a moment when the two waves are in phase.
4. Closing this will short circuit the two nodes we're measuring on the PicoScope, so the probe at point 1 should be moved to point 5 to compare generator A to the reference. This way we can check that the peak-to-peak voltage is remaining constant, and if it's not then the main 24V switch should be switched off, along with the variac, to reset the model and start over. The frequency of generator A should also stabilize to the reference 60Hz, but there may be some instability.

5. The synchronization and feedback circuits are powered by a voltage divider that uses a 5V wall adapter to get 5V and 3.3V inputs.

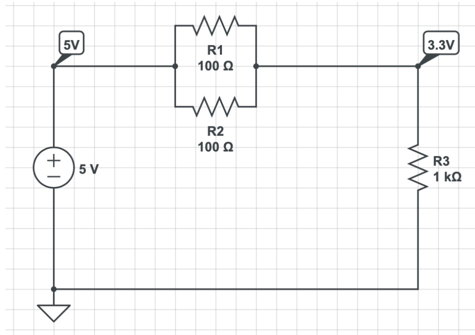

Figure 4.1: Voltage Divider Circuit. The 5V voltage source comes from the AC/DC wall adapter that it plugged into the orange power strip. The 5V powers the encoder, the 3.3V powers the MSP430.

6. These steps will be repeated for generator B, with the PicoScope initially measuring at points 2 and 4 in Figure 1 (moving point 2 to point 5 in step 4). After closing the toggle switch, if voltage amplitudes are remaining constant, then the grid is running properly.

5.0 Sensing

1. The myDAQ should have wires plugged in according to Figure 2. The red represents the voltage sensor, the black represents the current sensor, and the green represents ground.

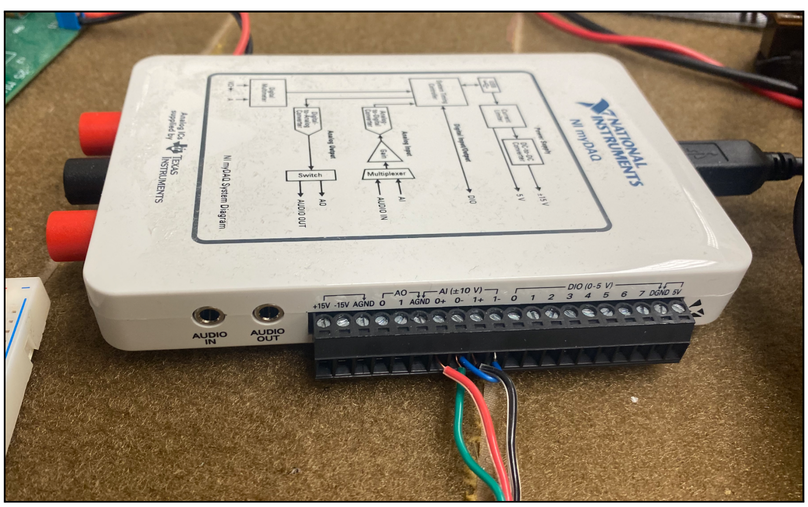

Figure 5.1: myDAQ with connections

2. The sensor board scales the voltage signal down and turns the current signal into a voltage signal that can be read by the DAQ through a system of op-amps.

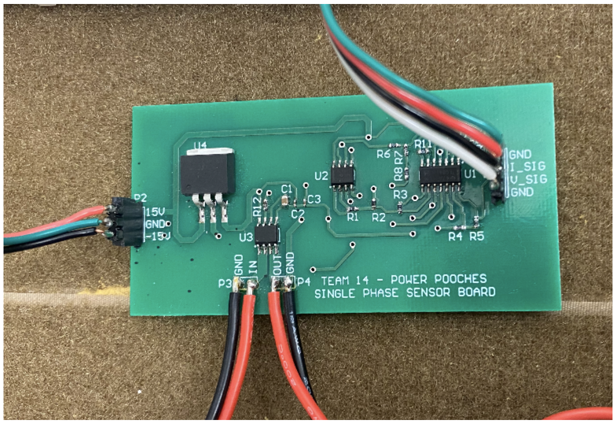

Figure 5.2: Sensor Board connections. The I_Sig, V_Sig, and GND connections come from the DAQ. The 15V, GND, and -15 V come from the +/- 15V power supply in Figure 5.3. The Out/GND wires connect to the load. The In/GND wires connect to the transmission line boards via Tamiya Clips

3. The +/- 15V power supply powers the sensor boards. The supply is an AC/DC converter that plugs into the orange power adapter and outputs into the sensor board.

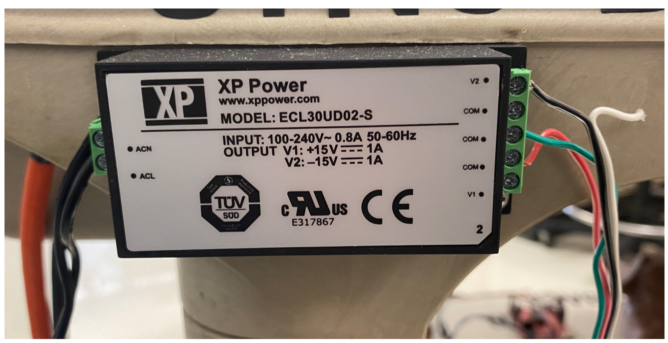

Figure 5.3: +/- 15V power supply. The left side is plugged into the orange power strip. The right side is plugged into the sensor board to power the op-amps.

4. To connect the DAQ to the computer, move to the GUI in MATLAB app designer, and press the "Connect DAQ" button. When connected, the bulb next to the button will turn green.

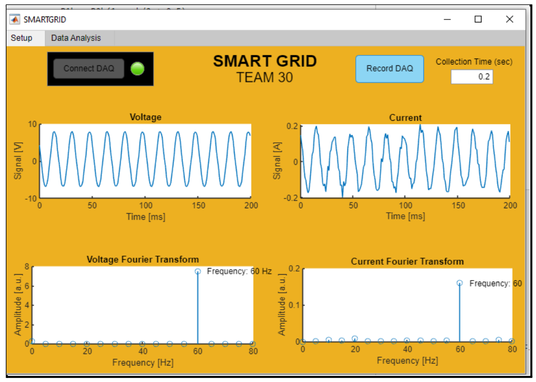

Figure 5.4: myDAQ GUI. By pressing the "Connect DAQ" button, the myDAQ is connected to the computer and the bulb next to it becomes green. See the User's Manual for information on handling potential errors at this step.