EE 330/330L Energy Systems- Laboratory Equipment

Introduction/Background

In the laboratories for EE 330/330L Energy Systems, you will be setting-up and taking measurements on three-phase and single-phase ac circuits as well as dc circuits. In doing so, you will be using some devices and equipment that are new and possibly unfamiliar to you. This handout will describe/show what some of these items look like, and introduce you to their purpose and use. Items used extensively in earlier laboratories, e.g., multimeters, will not be covered.

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Figure 1 shows a 4-wire three-phase power cord and wall outlet. The wall outlet provides 60 Hz three-phase voltages where $V_{\phi n} \approx 120\ V_{rms}$ and $V_{\phi\phi} = V_{LL} \approx 210\ V_{rms}$. The 4-wire wall outlet allows for loads to be connected in either the Y- or Δ-configurations. For the power cord, the green wire (attached to the unique tab of the plug) is the ground wire while the black, red, and white wires are the three phase voltages (designation of phases as '*a*', '*b*', & '*c*' is totally arbitrary). The plug and corresponding wall outlet are keyed/locking, i.e., you insert the plug and rotate CW to lock. Do **NOT** try and unplug the cord by yanking the cable, instead grasp the plug, rotate CCW, and pull.

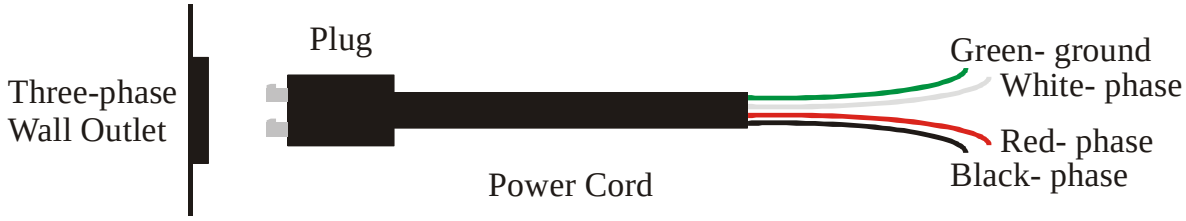

Figure 1 Three-phase power cord and wall outlet.

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Figure 2 shows a top view of a three-phase breaker box (switch box). It allows power to be switched on/off to three-phase circuits. In addition, it protects circuit components by 'breaking' the connection if a current overload (e.g., short circuit) greater than 15 A_{rms} occurs. For safety reasons, the black, red, and white wires (voltage phases) of the power cord should be connected to the breaker box **BEFORE** the power cord is plugged into the wall outlet. Also, for safety reasons, the ground wire is **NOT** switched. In case of a short circuit, you want a low impedance path for current to ground (as opposed to your body).

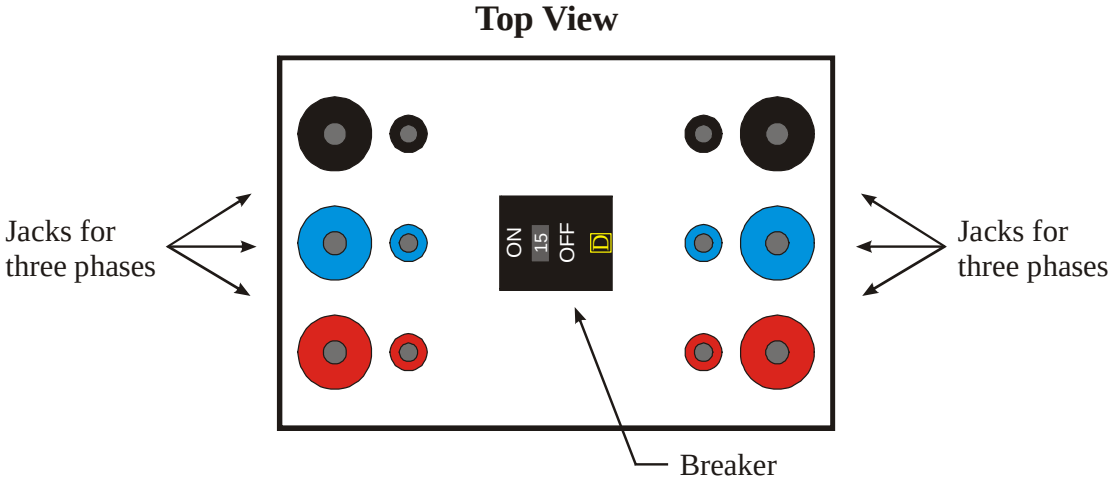

Figure 2 Three-Phase Breaker box.

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Figure 3 shows the front and back of a heavy device called a variac. By adjusting the dial/knob on the front panel, the user can scale the magnitude of the output ac phase voltages from 0 to 100% of the input magnitude. As shown, the jacks (black, red, and blue) for the INPUT and OUTPUT phase voltages are on the back panel, respectively. The variac is very sensitive to current surges and/or voltage spikes. Therefore, always have the dial/knob set to 0 (all the way CCW) **BEFORE** turning the power on with the breaker box, and always return the dial/knob to 0 **BEFORE** turning the power off.

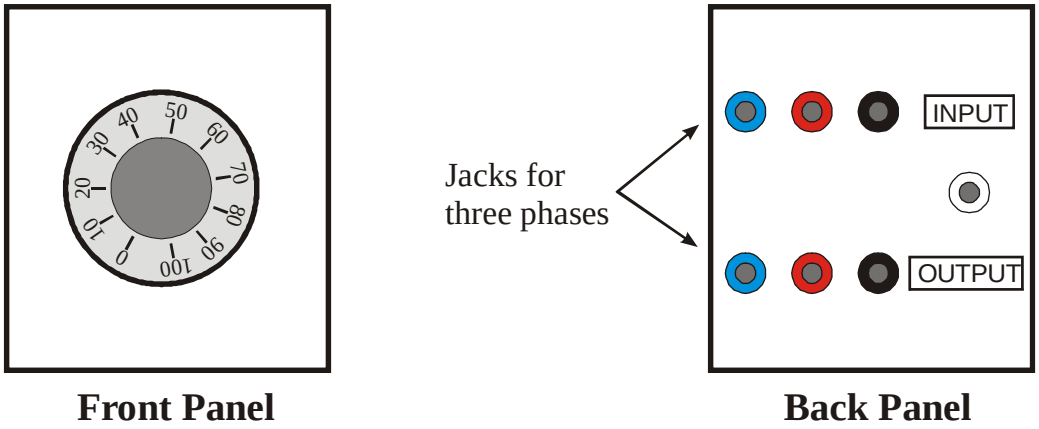

Figure 3 Front and back panels of variac.

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Figure 4 shows top views of some resistive loads- a rheostat (essentially a variable resistor) and pack of fixed 100 Ω, 50 W power resistors. For the rheostats, the resistance between the outer terminals (red and green) is fixed (100, 300, and 1000 Ω rheostats available). In addition, the resistance between the left and center terminals (red and yellow) is variable from 0 (dial/knob turned all the way CCW) to 100% (dial/knob turned all the way CW) of the rated value.

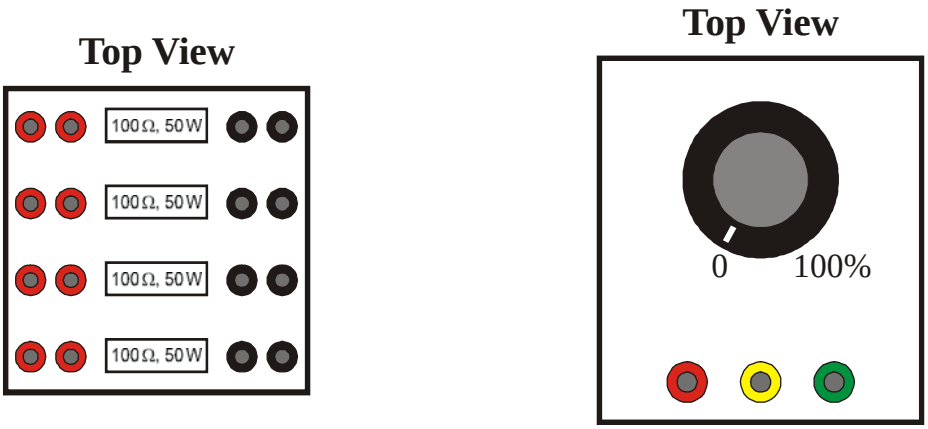

Figure 4 Top views of a fixed resistor pack (left) and rheostat (right).

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Figure 5 shows a top view of a four-terminal wattmeter. This is different than the three-terminal wattmeters shown in many introductory texts. The key advantage is that the four-terminal wattmeter allows the instrument to measure rms current through the load, rms voltage across the load, and real power supplied to the load. However, most multimeters will give more accurate current and voltage measurements, and are the preferred instrument for current and voltage measurements.

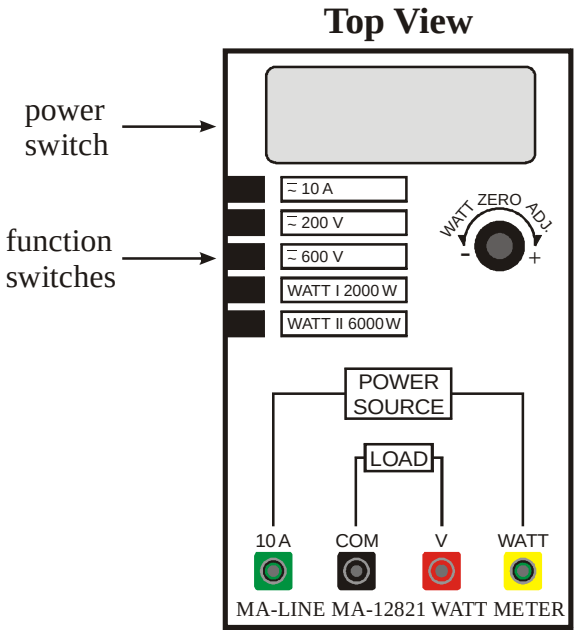

Figure 5 Top view of a four-terminal wattmeter.

To connect, first ensure that power is off. Then, as shown, the outer terminals should be connected to the power source (e.g., phase voltage or line-to-line voltage) and the inner terminal should be connected across the load. Select the WATT I 2000 W function switch (we will not exceed 2000 W). Ensure the wattmeter power switch is in the 'on' position. Adjust the 'WATT ZERO ADJ.' dial/knob until the display shows '0'. Apply power to the load and take the power measurement. The rms current and voltage may be measured by selecting the ~ 10 A and ~ 200 V function switches, respectively.

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Figure 6 shows a top view of a device called a single-phase breaker box (switch box). It allows power to be switched on and off to single-phase circuits. In addition, it protects the circuit components by 'breaking' the connection if a current overload (e.g., short circuit) greater then 30 A_{rms} occurs. For safety reasons, wires should be connected to the breaker box **BEFORE** energizing the circuit

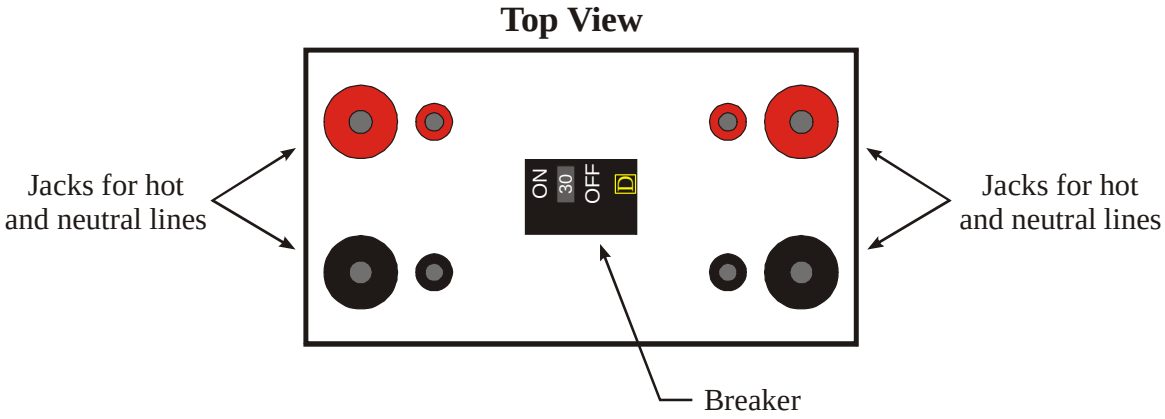

Figure 6 Single-Phase Breaker Box.

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Figure 7 shows a top view of a 500 VA General Electric single-phase transformer. It may be configured in several modes, depending on how the two 'high' voltage coils (H2-H1 & H4-H3) and two 'low' voltage coils (X2-X1 & X4-X3) are configured. For example, the possible input:output voltage combinations are 120:120, 120:240, 240:120, and 240:240. To step from 120 V_{rms} to 240 V_{rms}, one set of coils should be connected in parallel (120 V_{rms} side) while the other set of coils should be connected in series (240 V_{rms} side).

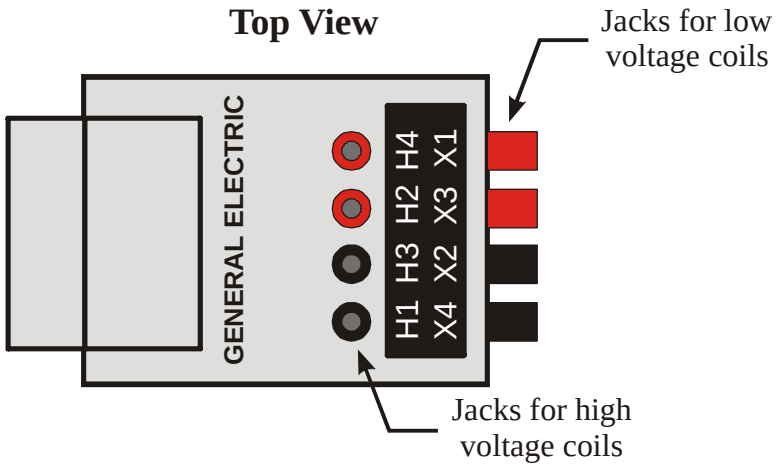

Figure 7 Single-Phase Transformer.

TO BE CONTINUED