EE 340L

EXPERIMENT 1 – POWER MEASUEMENT & POWER FACTOR CORRECTION (SINGLE-PHASE CIRCUIT)

Note: The current and capacitive values shown in red on this page are for those students using Lucas-Nuelle Equipment (i.e., the one workstation on the right side).

A single-phase 120V, 60 Hz, AC motor produces 1/4 hp while drawing 192 W and 2 A (1.78 A) from a 120V, 60 Hz power supply.

a) Calculate the motor reactive power consumption, apparent power, and power factor. Also calculate the motor equivalent impedance and phase angle.
V = 120 V
I = 2 A (1.78 A)
S = ………….. VA
Q = ………….. VAR
PF = ………%
Z = ……….. Ω,
θ = …………. deg.

b) The above motor can be represented by a parallel R-X_L circuit. Calculate the values of the parameters for such parallel representation.
R = ……………. Ω
X_L = …………… Ω

c) A shunt capacitor whose reactance X_C = 200 Ω (265 Ω) is now placed across the motor terminals. Calculate the resulting source current, reactive power, apparent power, and power factor.
S = ………….. VA
Q = ………….. VAR
PF = ………%
I = ……….. A
V = 120 V

d) Determine the capacitor reactance that will improve the motor power factor to 100% (or unity). Recalculate the resulting source current, reactive power, apparent power, and power factor.
S = ………….. VA
Q = ………….. VAR
PF = 100 %
I = ……….. A
V = 120 V

Verify the calculations above in the laboratory.

Two important safety rules

Observe the following safety rules when using electrical equipment:

- Always make sure that the ac power source is disabled (turned off) when connecting or disconnecting leads or components.
- Never leave any electrical lead unconnected. Touching the unconnected end of a lead while the ac power source is enabled could give you an electric shock. A short circuit could also occur if the unconnected end of a lead touches a conducting surface.

Procedure:

1. Set up the circuit shown in Figure 1below: Note the square boxes are used to indicate voltage and current measurements. For Lucas-Nuelle Equipment, the procedure is essentially, but the equipment is obviously different.
    a. Use the Impedance Table for the resistive, inductive and capacitive load modules below to determine the position of the switches that correspond to the calculated values
    b. Connect the voltage and current measurements to the Data Acquisition and Control Interface (DACI) and power supply. Use terminals 4-5 as the voltage source in the Power Supply. Use inputs I1 and E1 of the Data Acquisition and Control Interface to measure the source current and voltage.
    c. Connect the Power Input of the DACI to a 24 V ac power supply.
    d. Connect the USB port of the Data Acquisition and Control Interface to a USB port of the host computer.
    e. Turn the host computer on, and then start the LVDAC-EMS software.
    f. Turn on the power supply. Make sure that the Voltage Control knob is set to 4-5. This allows the ac power source to be controlled manually. Turn the knob clockwise till the voltage reading on the computer screen is 120 V (this may be slightly different from the LCD display on the power supply)
2. Record the following
   V = 120 V
   I = ……… A (1.78 A)
   P = …………… W
   S = ………….. VA
   Q = ………….. VAR
   PF = ………%
   Z = ……….Ω
   θ = ………… deg.

3. Turn off the power supply. Add a 200 Ω shunt capacitor as shown in Figure 2. Turn the power supply back on – adjust the voltage if necessary. Then repeat the above recordings:
   V = 120 V
   I = ……… A
   P = …………… W
   S = ………….. VA
   Q = ………….. VAR
   PF = ………%
4. Turn off the power supply. Adjust the shunt capacitor to the value calculated in d) above. Turn the power supply back on – adjust the voltage if necessary. Then repeat the above recordings:
   V = 120 V
   I = ……… A
   P = …………… W
   S = ………….. VA
   Q = ………….. VAR
   PF = ………%
5. Turn off all the power supplies. Disconnect the cables and arrange.

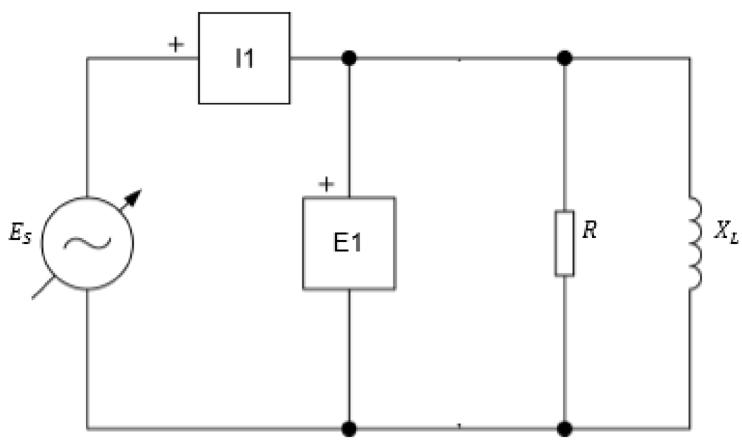


Figure 1

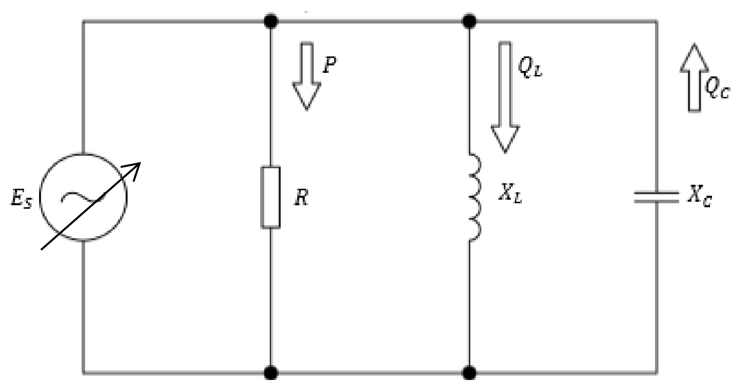
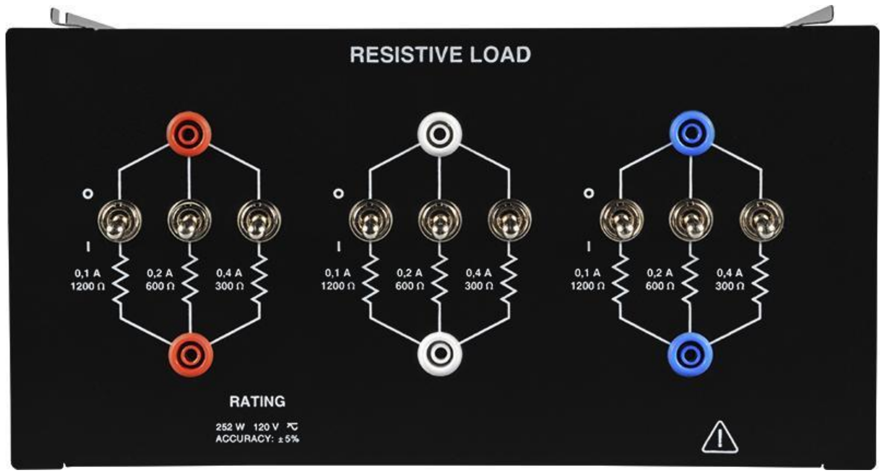


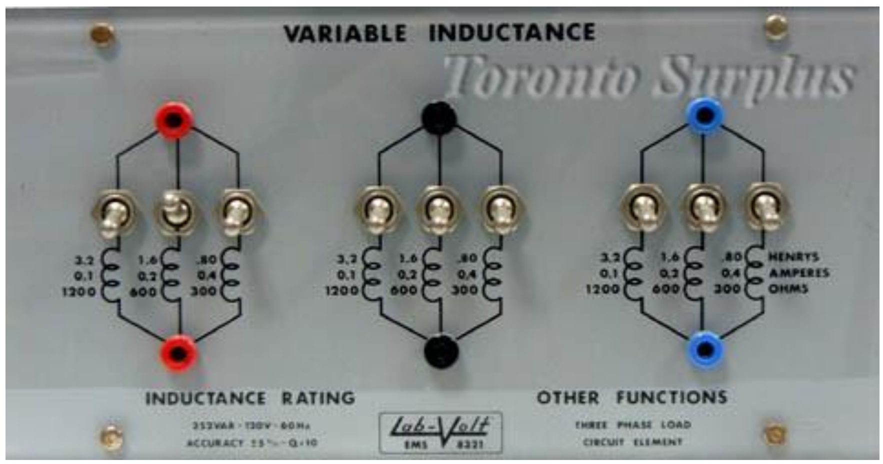
Figure 2

Lab Volt Power Supply.

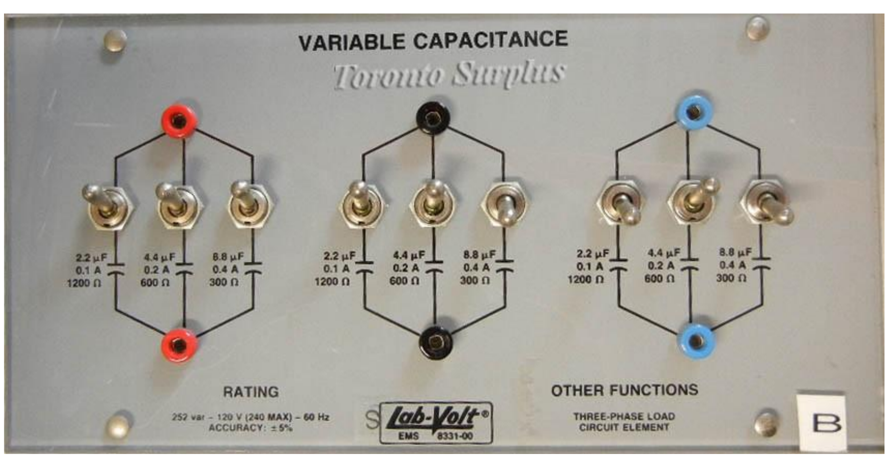
Lab Volt Data Acquisition Interface



Lab Volt Resistive Load



Lab Volt Inductive Load



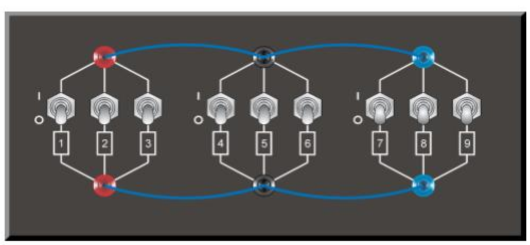
Lab Volt Capacitive Load

Impedance Table for Lab Volt Load Modules

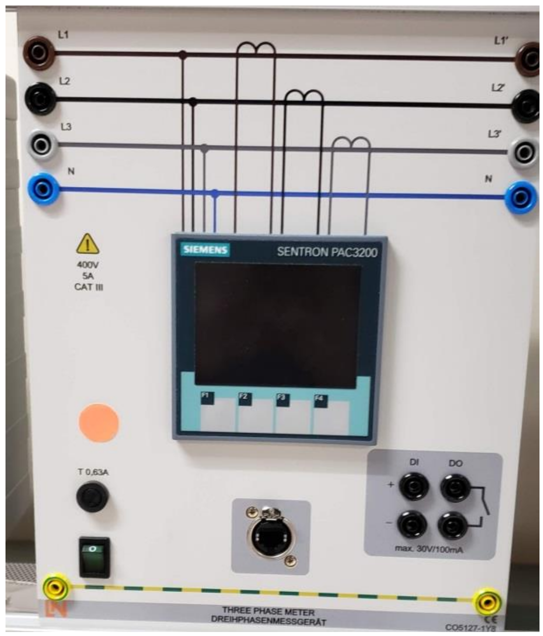
The following table gives impedance values which can be obtained using either the Resistive Load, Model 8311, the Inductive Load, Model 8321, or the Capacitive Load, Model 8331. Figure C-1 shows the load elements and connections. Other parallel combinations can be used to obtain the same impedance values listed.

Table C-1. Impedance table for the load modules.

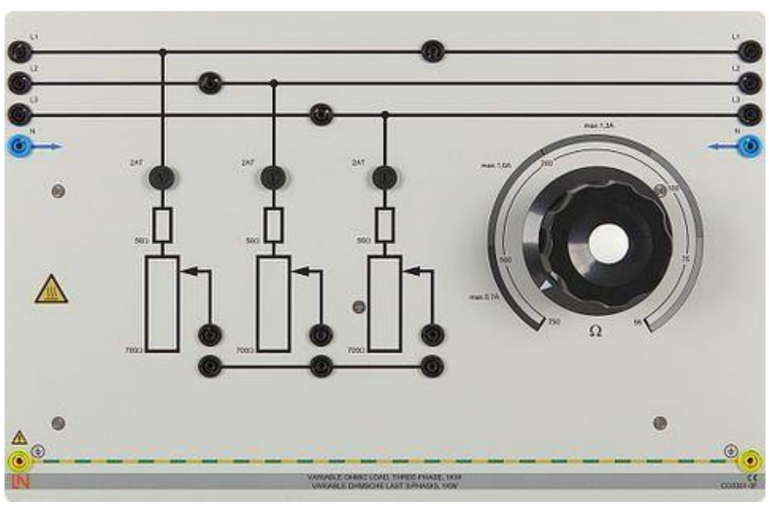
Impedance (Ω)			Position of the switches								
120 V 60 Hz	220/230 V 50 Hz/60 Hz	240 V 50 Hz	1	2	3	4	5	6	7	8	9
1200	4400	4800	I								
600	2200	2400		I							
300	1100	1200			I						
400	1467	1600	I	I							
240	880	960	I		I						
200	733	800		I	I						
171	629	686	I	I	I						
150	550	600	I			I	I	I			
133	489	533		I		I	I	I			
120	440	480			I		I	I			
109	400	436			I	I	I	I			
100	367	400	I		I	I	I	I			
92	338	369		I	I	I	I	I			
86	314	343	I	I	I	I	I	I			
80	293	320	I			I	I	I	I	I	I
75	275	300		I		I	I	I	I	I	I
71	259	282			I		I	I	I	I	I
67	244	267			I	I	I	I	I	I	I
63	232	253	I		I	I	I	I	I	I	I
60	220	240		I	I	I	I	I	I	I	I
57	210	229	I	I	I	I	I	I	I	I	I



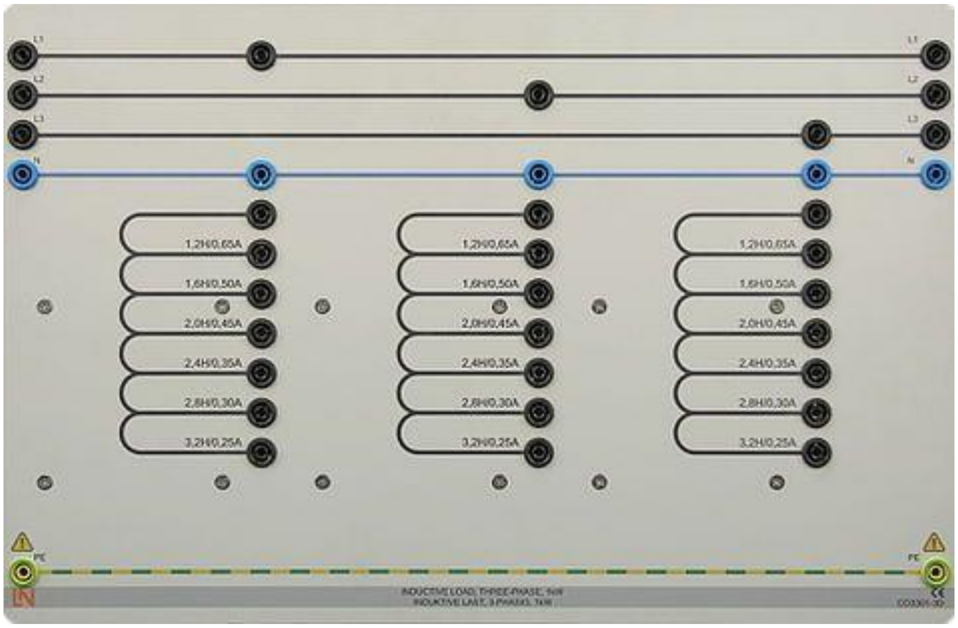
Lucas-Nuelle Power Supply (Use L1-N for voltage source).



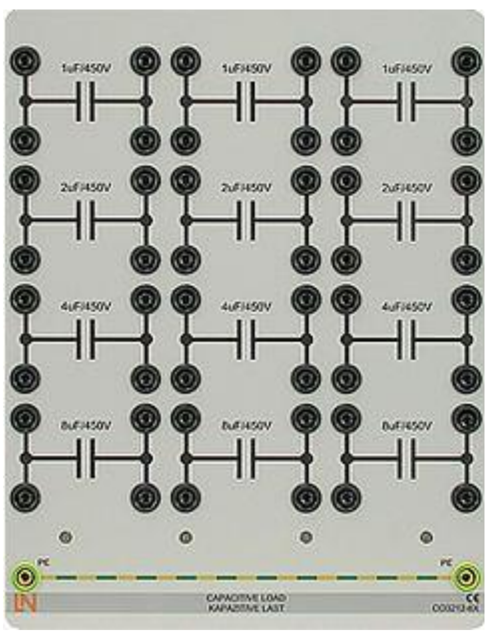
Lucas-Nuelle Measuring Device (connect source on left-side and load on right-side)



Lucas-Nuelle Resistive Load (each phase variable smoothly from 754 Ω down to 54 Ω)



Lucas-Nuelle Inductive Load (each phase variable from 3.2 H (or 1,206 Ω) down to 1.2 H (or 452.4 Ω) in discrete steps)



Lucas-Nuelle Capacitive Load (each phase variable from 1uF (or 2,650 Ω) down to 15 uF (or 176.8 Ω) in discrete steps)