Laboratory Application Assignment

In this lab application assignment you will examine the real power, apparent power, and power factor (PF) in a parallel *RL* circuit. You will also examine how a capacitor can be added in parallel to bring the power factor closer to 1 or unity. The procedure of adding a capacitor in parallel to raise the power factor is called power factor correction.

Note: *In this lab we will assume that the dc resistance, r_i, of the inductor is negligible.*

Equipment: Obtain the following items from your instructor.

- Function generator
- Oscilloscope
- DMM
- 100-mH inductor
- 0.22-μF capacitor
- 10-Ω and 680-Ω resistors

Real Power, Apparent Power, and Power Factor

Examine the parallel *RL* circuit in Fig. 23–34*a*. (Ignore the 0.22-μF capacitor.) Calculate and record the following circuit values:

$X_L =$ _____, $I_L =$ _____, $I_R =$ _____,
$I_T =$ _____, $Z_{EQ} =$ _____
$\theta_I =$ _____, real power = _____,
apparent power = _____, PF = _____

Construct the circuit in Fig. 23–34*a*. (Again, ignore the 0.22-μF capacitor.)

Adjust the applied voltage, V_A, to exactly 5 Vrms. With a DMM, measure and record the following circuit values:

$I_L =$ _____, $I_R =$ _____,
$I_T =$ _____

Using the measured values of I_L and I_R, calculate the total current, I_T as $I_T = \sqrt{I_R^2 + I_L^2}$. Does this value agree with the measured value of total current? _____ If not, list one possible reason why. _____
_____

Using the measured values of I_L and I_R, calculate the circuit's phase angle, θ_I. (Recall that in a parallel circuit, $\tan \theta_I = -I_L/I_R$.)

$\theta_I =$ _____. Next, using measured values, determine the following: real power = _____, apparent power = _____, PF = _____ How do these experimental values compare to those initially calculated? _____
_____
_____

Power Factor Correction

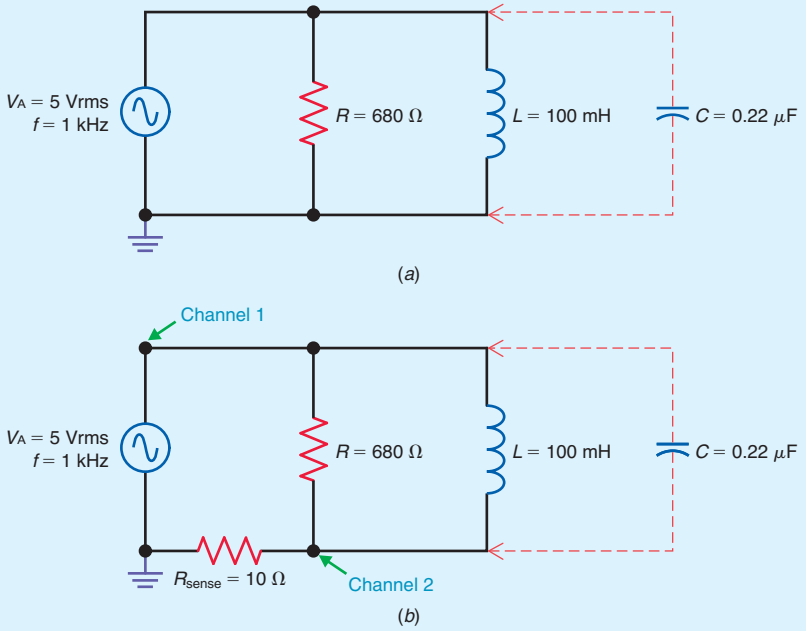
Mentally connect the 0.22-μF capacitor in Fig. 23–34*a*. Calculate and record the following circuit values:

$X_L =$ _____, $X_C =$ _____, $I_L =$ _____,
$I_C =$ _____, $I_X =$ _____
$I_R =$ _____, $I_T =$ _____, $Z_{EQ} =$ _____,
$\theta_I =$ _____, apparent power = _____,
real power = _____, PF = _____

Construct the circuit in Fig. 23–34*a* including the 0.22-μF capacitor. Adjust the applied voltage, V_A, to exactly 5 Vrms. With a DMM, measure and record the following circuit values:

$I_L =$ _____, $I_C =$ _____,
$I_R =$ _____, $I_T =$ _____

Figure 23–34



While measuring the total current, I_T, connect and disconnect the 0.22-μF capacitor several times. You should notice that I_T decreases when the capacitor is connected. Explain why this happens. _____

_____

Using measured values, calculate the net reactive current, I_X, as $I_L - I_C$ or $I_C - I_L$ depending on which current is larger.
I_X = _____
Using the experimental value of I_X and the measured value of I_R, calculate the circuit's phase angle, θ_I. θ_I = _____
Using measured values, calculate the following:
apparent power = _____, real power = _____,
PF = _____

In Figure 23–34*a*

a. Did the apparent power increase, decrease, or stay the same when the capacitor was added? _____
b. Did the phase angle, θ_I, become more negative, less negative, or did it stay the same when the capacitor was added? _____
c. Did the real power increase, decrease, or stay the same when the capacitor was added? _____
d. Did the power factor, PF, increase, decrease, or stay the same when the capacitor was added? _____

Add a 10-Ω sensing resistor as shown in Fig. 23–34*b*. Next, connect the oscilloscope to measure the phase angle, θ_I, between V_A and I_T. Note the connections designated for channels 1 and 2 in the figure. While viewing the displayed waveforms on the oscilloscope, connect and disconnect the 0.22-μF capacitor several times. Explain what happens to the phase angle when the capacitor is connected. _____

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