

## **\*\*Objective:**

- 1\* Calculate the theoretical & experimental complex, apparent, real & reactive power, & the power factor.
- 2\* Determine the parallel reactance & component values required for power factor correction.

## **\*\*Theory:**

### **A- The complex power:**

It can be determined by

1\* the general complex power equation:

$$\hat{S} = V_{\text{eff}} \tilde{I}^*_{\text{eff}} = V_{\text{eff}} I_{\text{eff}} \angle (\theta_v - \theta_i) = S \angle \theta = P + jQ$$

Where I & V are RMS values.

2\* the sum of individual component powers (also I, V in RMS)

#For R:

$$P_r = V_{\text{eff}} I_{\text{eff}} = V^2_{\text{reff}}/R = I^2_{\text{reff}} * R$$

$$Q_r = 0$$

#For C:

$$P_c = 0$$

$$Q_c = V_{\text{ceff}} * I_{\text{ceff}} = V^2_{\text{ceff}}/X_c = I^2_{\text{ceff}} * X_c$$

#For L:

$$P_l = 0$$

$$Q_l = V_{\text{leff}} * I_{\text{leff}} = V^2_{\text{leff}}/X_l = I^2_{\text{leff}} * X_l$$

$$\hat{S} = V_{\text{eff}} \tilde{I}^*_{\text{eff}} = \sum P + j[Q_L - Q_C]$$

Where P is real or average power & Q is the reactive power.

### **B- the apparent power & the power factor:**

it's can be obtain by using the following formulas:

$$\text{apparent power (V.A)} \quad V_{\text{eff}} * I_{\text{eff}} = (P^2 + Q^2)^{1/2}$$

$$\text{PF} = \text{average power} / \text{apparent power} = P / (V_{\text{eff}} * I_{\text{eff}}) = \cos(\theta_v - \theta_i)$$

### **C- power factor correction:**

it's achieved by limiting the reactive power in the circuit, this lead to make the value of the apparent power closer to

the value of the average power (it's aim to make the power factor as possible equals to 1.

The basic objective of the power factor correction is to decrease the power cost (the reactive power & it's cost are not desired).

To find the right load should selected to make the  $PF = 1$  follow the steps:

1\* if the circuit has inductive load then the capacitor load should added to make  $PF=1$ (correction load)

& it's value determine by :  $X_c = V^2/Q_L$

Where  $Q_L$  is the reactive power of the inductor load in the circuit .

Then  $L = X_L/W$

2\* if the circuit has capacitor load then the inductor load should added to make  $PF=1$ (correction load)

& it's value determine by :  $X_L = V^2/Q_c$

Where  $Q_c$  is the reactive power of the capacitor load in the circuit .

Then  $C = 1/(w * X_c)$

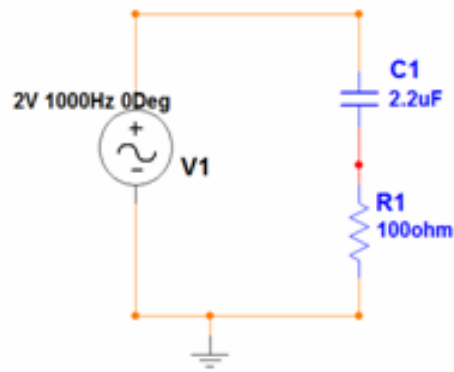
## **\*\* Equipment:**

DMM , FG, Oscill(CRO) ,resistor, leads , capacitive ,inductive & resistance boxes, breadboard, wires.

## **\*\*Procedure:**

### **Part A:**

- 1- use the FG to generate a sinusoidal wave of 2Vpk & 1000Hz (as we learn in previous experiment).
- 2- Provide 2.2  $\mu$ F , 100 $\Omega$  by using the suitable boxes & then select the desired values.
- 3- Fix the component as shown in the figure:



- 4- determine the value of VR1 by connected channel one to it(read the value peak - peak)
- 5- Divide the above by two to take the value in peak .
- 6- Divide the above by square root of two to take the value in RMS.
- 7- Measured the value of the phase angle by connect channel two between the capacitor & the ground but remain channel one in R1 the press dull & determine the value of  $\theta$ .
- 8- Calculate the value of PF by take cos of the angle.
- 9- Calculate PR, QR, Ssource, PL, QL

**Note:**

**QR ,PL will be zero.**

### **Part B:**

- 1- calculate the value of QL then determine the value of the correction load as shown in the calculation part.
  - 2- Calculate the ratio of L/C.
  - 3- fix the circuit in the breadboard.
  - 4- calculate the value of VR2 p-p then p-only then in RMS
  - 5- determine the value of the phase of the circuit by connected channel one between the capacitor & the ground ,& channel two to R2 & calculate the value of the phase.
  - 6- take cos of the previous angle to determine the PF
- note :

1\* the value of the phase should be zero (this requires to make  $PF=1$ ) & if it doesn't like this your calculation will be wrong.

2\* you added inductor load to generate a reactive power that cancels the one caused by capacitive load.

## **\*\*Conclusion:**

- A. if the circuit contains inductor load the correcting load must be capacitive load connected in parallel with it, & if it contains capacitor load the correcting load must be inductive connect in parallel.
- B. the average power "P" for inductors & capacitors equal zero but for the resistance it's not.
- C. reactive power "Q" for resistor equal zero but for the capacitors & inductors it's not.
- D. Power factor correction aims to cancel the imaginary part of the equivalent impedance so that the reactive power will be zero & the real part (resistance) only will be remain.



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Experiment "8" (Complex Power & Power Factor)

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