Three-Phase Power Measurement

Exp. No: **Date:**

Aim: To measure power in a three phase circuit using two wattmeter's method under

a) Balanced resistive load condition

b) Unbalanced resistive load condition

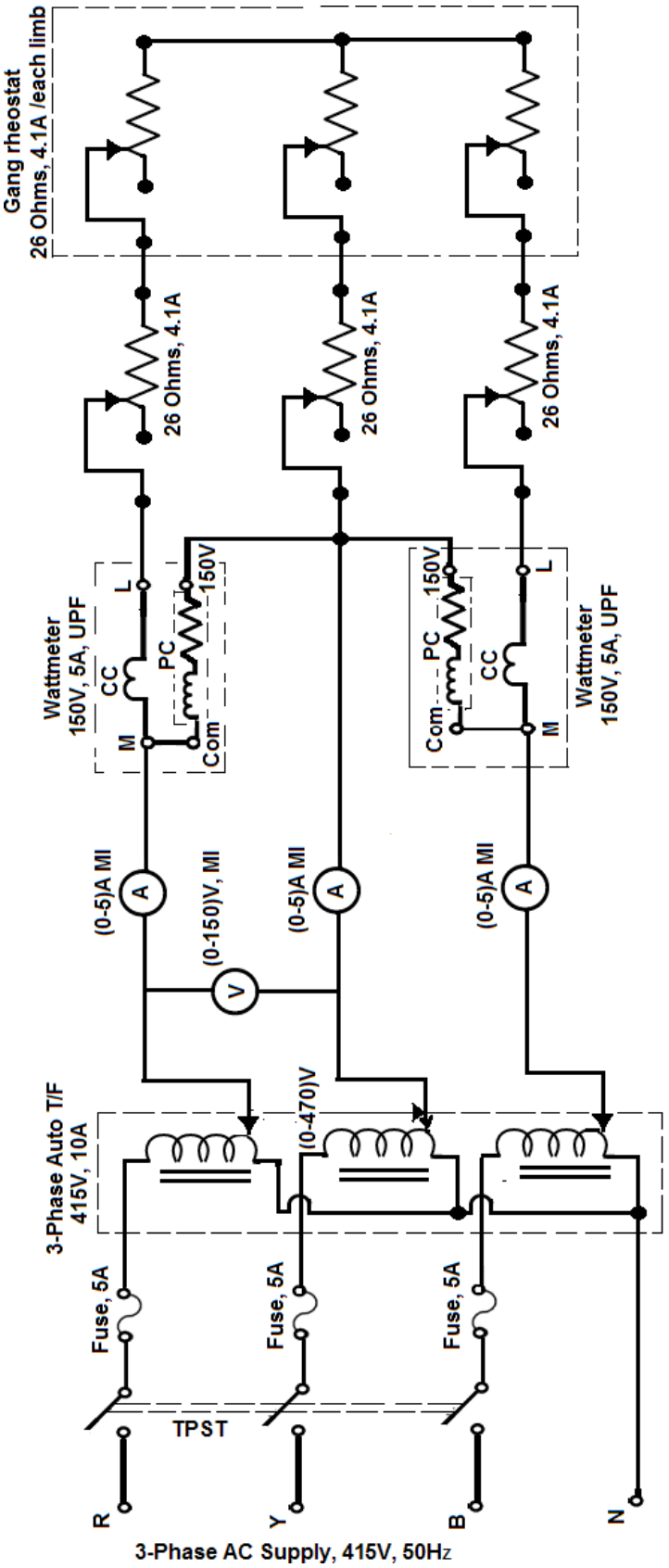
Apparatus required:

S.No	Name of the equipment	Range/ Specification	Type	Quantity
1	Voltmeter	(0-150) V	MI	1
2	Ammeter	(0-5) A	MI	3
3	Wattmeter	150V, 5A,UPF	Electro-dynamic	2
4	3- Phase Auto Transformer	I/P: 3-ϕ, 415V O/P: (0-470)V,10A	Core type	1
5	Gang Rheostat	26Ω, 4.1A Per each limb	Wire wound	1
6	Rheostat	26Ω, 4.1A	Wire wound	3
7	Connecting wires	1.5sq.mm	copper	Required

Balanced resistive load condition

Procedure:

1. Connect the circuit as per the circuit diagram.
2. Adjust the gang rheostat and Individual rheostats for the maximum resistance position.
3. Initially keep the output voltage of the 3-Phase autotransformer at zero.
4. Switch ON the supply and set the autotransformer output voltage to 120V.
5. Read the meters to obtain $\mathbf{V_L}$, $\mathbf{I_1}$, $\mathbf{I_2}$ and $\mathbf{I_3}$. Note the wattmeter reading $\mathbf{W_1}$ and $\mathbf{W_2}$ (Note the multiplying factor on the wattmeter).
6. Vary the Gang rheostat resistance (decrease) and obtain at least five sets of observations, the current should not exceed the maximum load current limit of (4.1 A).
7. Tabulate the readings and verify the results with theoretical calculations.



Measuerment of 3-Phase power by two wattmeter method under Balanced load condition

Observation table -1 Three phase power in a balanced load

Sl	V_L (v)	I_1 (A)	I_2 (A)	I_3 (A)	W_1 (W)	W_2 (W)	Calculated power (Wc)= $(V_L/\sqrt{3})$ $(I_1+I_2+I_3)$	(W)m= (W_1+W_2)	Error $\frac{W-W_c}{W_c} * 100\%$

Theoretical calculations:

For Star connected Unbalanced load:

$$V_{Ph} = V_L / \sqrt{3}$$

$$I_{Ph} = I_L$$

$$W_1 = \sqrt{3}\, V_{Ph}\, I_{Ph}\, Cos\,(30 + \Phi)\ (OR)\ V_L\, .I_L\, Cos\,(30 + \Phi)$$

$$W_2 = \sqrt{3}\, V_{Ph}\, I_{Ph}\, Cos\,(30 - \Phi)\ (OR)\ V_L\, .I_L\, Cos\,(30 - \Phi)$$

$$W_1 + W_2 = \sqrt{3}\, V_L\, .I_L\, Cos\,\Phi$$

Calculated power $W_C = V_{Ph}\, I_{Ph1} + V_{Ph}\, I_{Ph2} + V_{Ph}\, I_{Ph3}$

$$W_C = \frac{V_L}{\sqrt{3}}\,(I1+I2+I3) \qquad \rightarrow V_{Ph} = V_L / \sqrt{3}$$

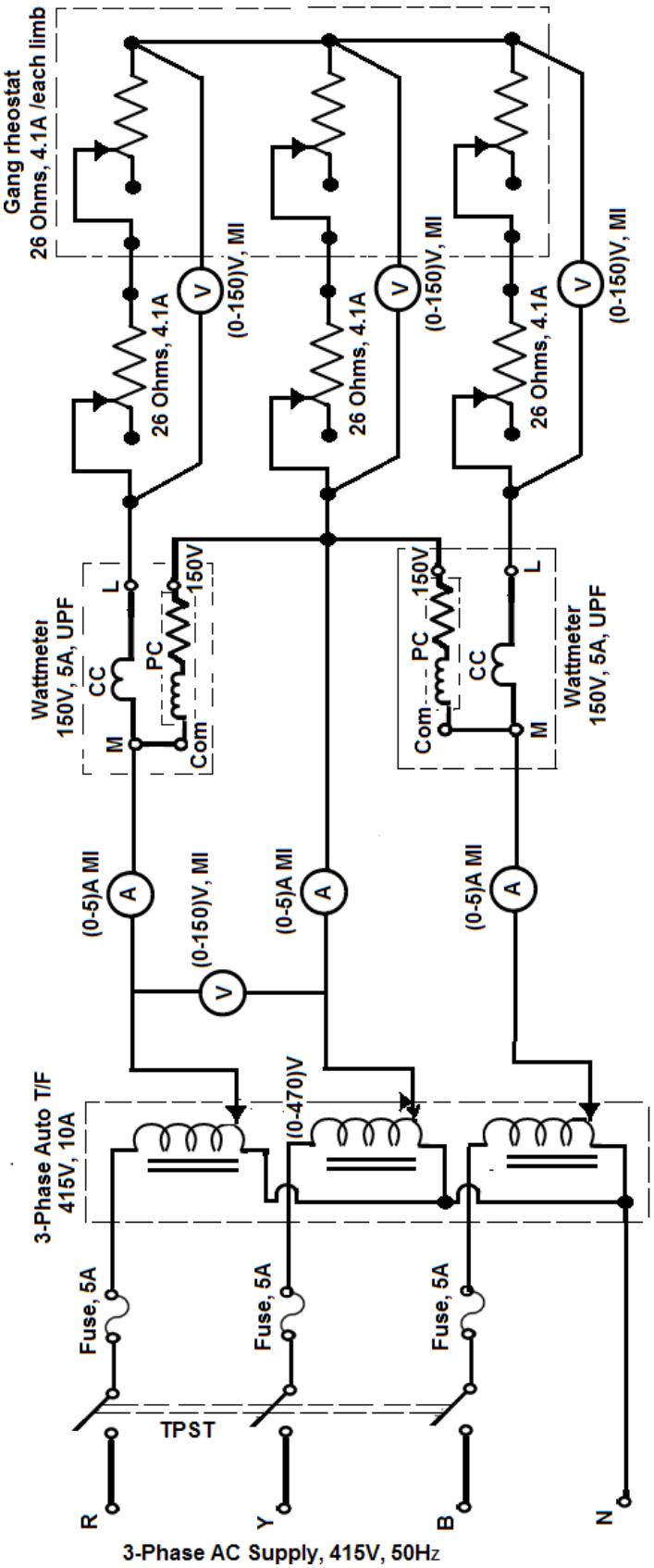
Determination of power factor for the balanced load

$$\emptyset = Tan^{-1}\left(\sqrt{3}.\frac{(W2-W1)}{(W2+W1)}\right)$$

Unbalanced resistive load

Procedure:

1. Connect the circuit as per circuit diagram in Fig. 2.
2. Adjust the three rheostats and gang rheostat at the maximum resistance position.
3. Switch ON the supply and set the autotransformer output voltage to120V.
4. Take five sets of observation for different rheostat settings such that the reading of **I1, I2** and **I3** in each set is appreciably different to create unbalanced loading condition. (Don't vary the gang rheostat).The current should not exceed the limits in each arm.
5. Note down $\mathbf{I_1}$, $\mathbf{I_2}$, $\mathbf{I_3}$, $\mathbf{V_1}$, $\mathbf{V_2}$, $\mathbf{V_3}$, $\mathbf{W_1}$ and $\mathbf{W_2}$. Check the result by completing the computations indicated in Table.2.



Measuerment of 3-Phase power by two wattmeter method under Unbalanced load condition

Observation table -2 (three phase power in an unbalanced load)

Sl No	V_1 (V)	V_2 (V)	V_3 (V)	I_1 (A)	I_2 (A)	I_2 (A)	W_1 (W)	W_2 (W)	Calculated power= Wc= $V_1I_1+V_2I_2+V_3I_3$	Wm= (W_1+W_2)	Error $\frac{W-W_c}{W_c}$ * 100%

Theoretical calculations:

Star connected Unbalanced load:

$$V_{Ph=} V_L / \sqrt{3}$$

$$I_{Ph}=I_L$$

$$W_1=\sqrt{3}\ V_{Ph}\ I_{Ph}\ Cos\ (30 + \Phi)\ (OR)\ V_L\ .I_L\ Cos\ (30 + \Phi)$$

$$W_2=\sqrt{3}\ V_{Ph}\ I_{Ph}\ Cos\ (30 - \Phi)\ (OR)\ V_L\ .I_L\ Cos\ (30 - \Phi)$$

$$W_1 + W_2 = \sqrt{3}\ V_L\ .I_L\ Cos\ \Phi$$

Calculated power $W_C = VR_{Ph}\ I_{Ph1} + VY_{Ph}\ I_{Ph2} + VB_{Ph}\ I_{Ph3}$

Determination of power factor for the balanced load

$$\emptyset = Tan^{-1}\ (\sqrt{3}.\frac{(W2-W1)}{(W2+W1)})$$

Precautions:

1. All the connections should be tight.
2. Initially keep the output voltage of the autotransformer to zero.

Result: