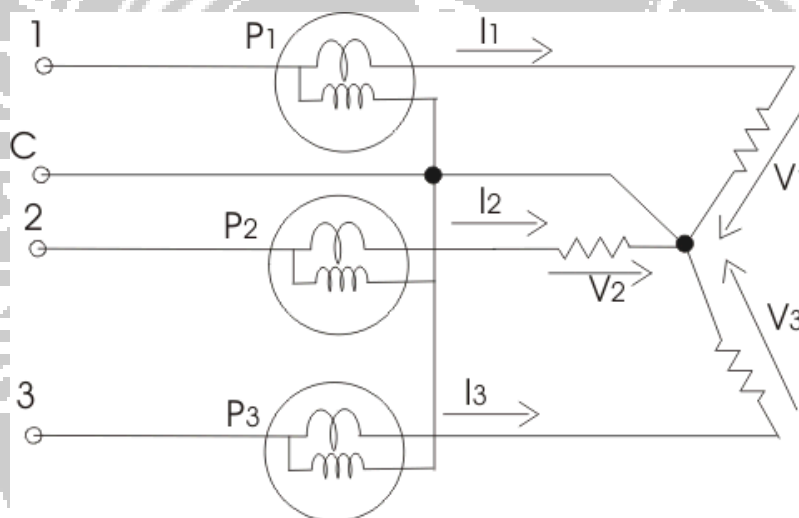


5.8 TYPES OF THREE PHASE POWER MEASUREMENT:

Various methods are used for measurement of three phase power in three phase circuits on the basis of number of wattmeters used. We have three methods to discuss:

1. Three wattmeters method, 2. Two wattmeters method & 3. Single wattmeter method.

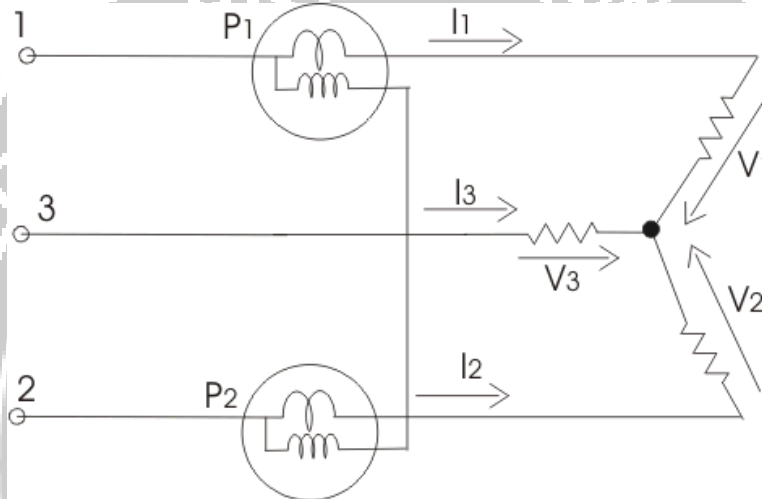
Measurement of Three Phase Power by Three Wattmeters Method



Here, it is applied to three phase four wire systems, current coil of all the three wattmeters marked as one, two and three are connected to respective phases marked as one, two and three. Pressure coils of all the three wattmeter are connected to common point at neutral line. Clearly each wattmeter will give reading as product of phase current and line voltage which is phase power. The resultant sum of all the readings of wattmeter will give the total power of the circuit. Mathematically we can write

$$P = P_1 + P_2 + P_3 = V_1 I_1 + V_2 I_2 + V_3 I_3$$

Measurement of Three Phase Power by Two Wattmeters Method



In this method we have two types of connections

1. Star connection of loads & 2. Delta connection of loads.

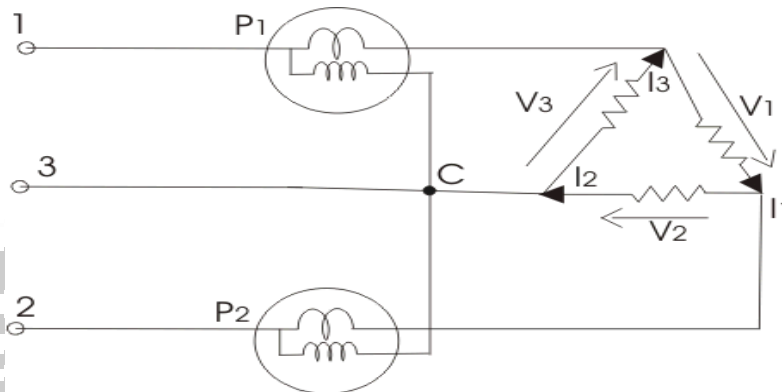
When the load is star connected load, the diagram is shown in below-

For star connected load clearly the reading of wattmeter one is product of phase current and voltage difference ($V_2 - V_3$). Similarly the reading of wattmeter two is the product of phase current and the voltage difference ($V_2 - V_3$). Thus the total power of the circuit is sum of the reading of both the wattmeters. Mathematically we can write,

$$P = P_1 + P_2 = I_1(V_1 + V_2) + I_2(V_2 - V_3)$$

but we have $I_1 + I_2 + I_3 = 0$, hence putting the value of $I_1 + I_2 = -I_3$.

We get total power as $V_1 I_1 + V_2 I_2 + V_3 I_3$. When delta connected load, the diagram is shown in



below,

The reading of wattmeter one can be written as $P_1 = V_3(-I_1 - I_3)$ and reading of wattmeter two is $P_2 = V_2(I_2 - I_3)$

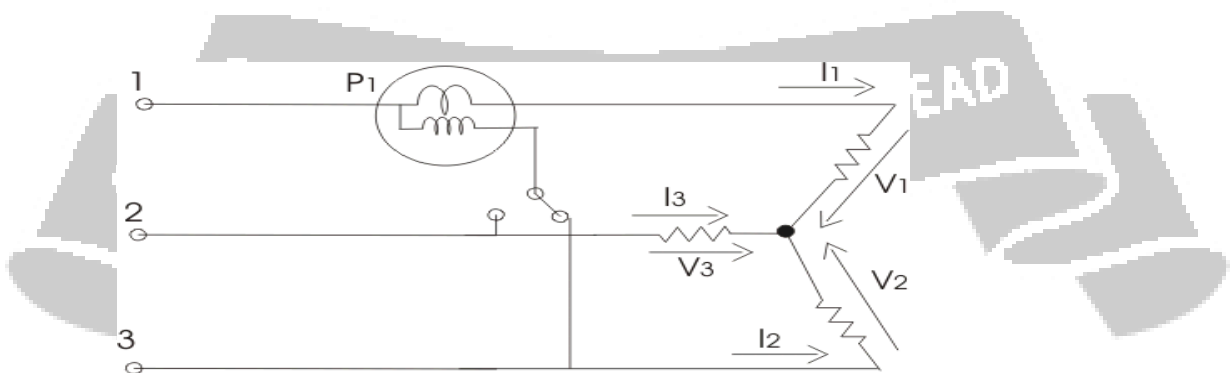
Total power is $P = P_1 + P_2 = V_2 I_2 + V_3 I_3 - I_1(V_2 + V_3)$

but $V_1 + V_2 + V_3 = 0$,

Hence expression for total power will reduce to $V_1 I_1 + V_2 I_2 + V_3 I_3$.

Measurement of Three Phase Power by One Wattmeter Method

Limitation of this method is that it cannot be applied on unbalanced load. So under this condition we have $I_1 = I_2 = I_3 = I$ and $V_1 = V_2 = V_3 = V$



Two switches are given which are marked as 1-3 and 1-2, by closing the switch 1-3 we get reading of

$$P_1 = V_{12} I_1 \cos(30 + \phi) = \sqrt{3} \times VI \cos(30 + \phi)$$

Total power is $P_1 + P_2 = 3VI \cos \phi$

Similarly the reading of wattmeter when switch 1-2 is closed is,

