Three-Phase AC (2)

Balanced Delta Connected Load

Loads may also be connected is a delta configuration. Let's consider a balanced delta connected load as depicted in Figure 1. The Load phase currents are I_{RY}, I_{YB}, I_{BR} and the line currents are I_R, I_Y, I_B.

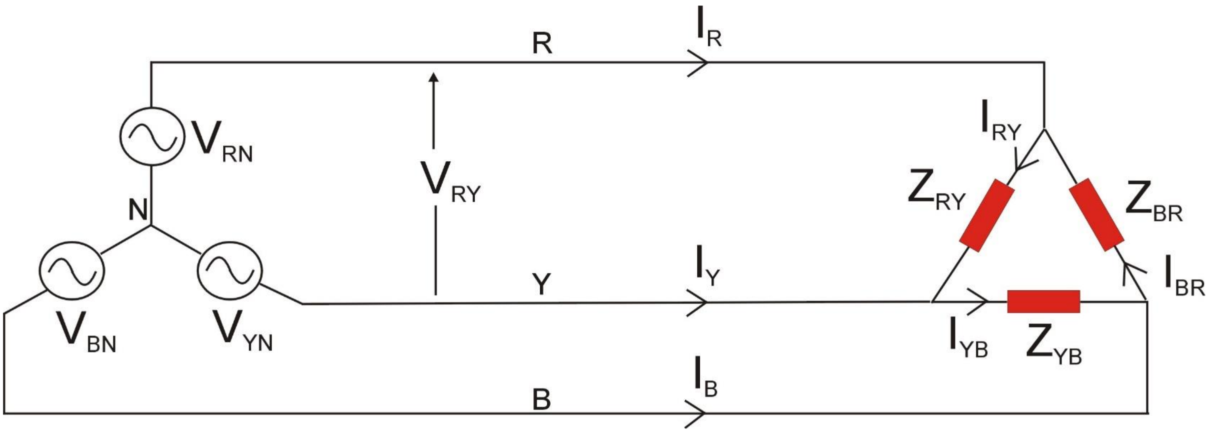

Figure 1. A Balanced Delta (Δ) connected load where ZRY=ZYB=ZBR.

We can now write expressions for the phase currents:

$$I_{RY} = \frac{V_{RY}}{Z_{RY}} = I_{PH}\angle -\phi \tag{1}$$

$$I_{YB} = \frac{V_{YB}}{Z_{YB}} = I_{PH}\angle(-\phi - 120^o) \tag{2}$$

$$I_{BR} = \frac{V_{BR}}{Z_{BR}} = I_{PH}\angle(-\phi + 120^o) \tag{3}$$

We can now find expressions for the line currents:

$$I_R = I_{RY} - I_{BR} = \sqrt{3}I_{ph}\angle -\phi - 30^o \tag{4}$$

$$I_Y = I_{YB} - I_{RY} = \sqrt{3}I_{ph}\angle -\phi - 150^o \tag{5}$$

$$I_B = I_{BR} - I_{YB} = \sqrt{3}I_{ph}\angle -\phi + 90^o \tag{6}$$

A phasor diagram is shown in Figure 2:

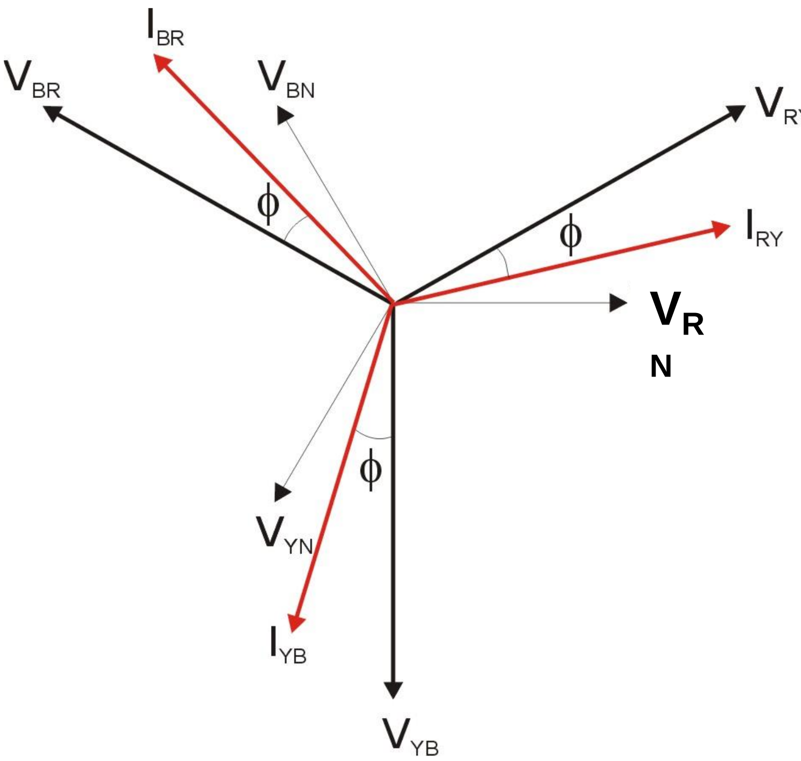

Figure 2. Phasor Diagram for Balanced Delta Load

For any single phase we can calculate the apparent power (S), real power (P) and reactive power (Q):

$$S = |V_{RY}||I_{RY}| = V_L I_L \qquad (7)$$

$$P = S \cdot \cos\phi \qquad (8)$$

$$Q = S \cdot \sin\phi \qquad (9)$$

where $\boldsymbol{V_L}$ is the rms magnitude of the line voltage, $\boldsymbol{I_{ph}}$ is the rms load phase current and $\boldsymbol{\Phi}$ is the angle between them.

The total real power in the 3-phase system is three times the single-phase real power:

$$P_T = 3V_L I_{ph} \cos\phi = 3V_{ph} I_L \cos\phi \qquad (10)$$