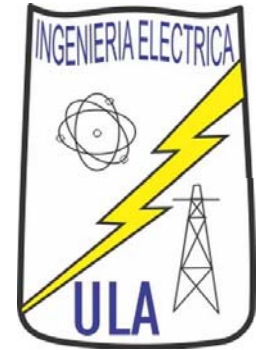




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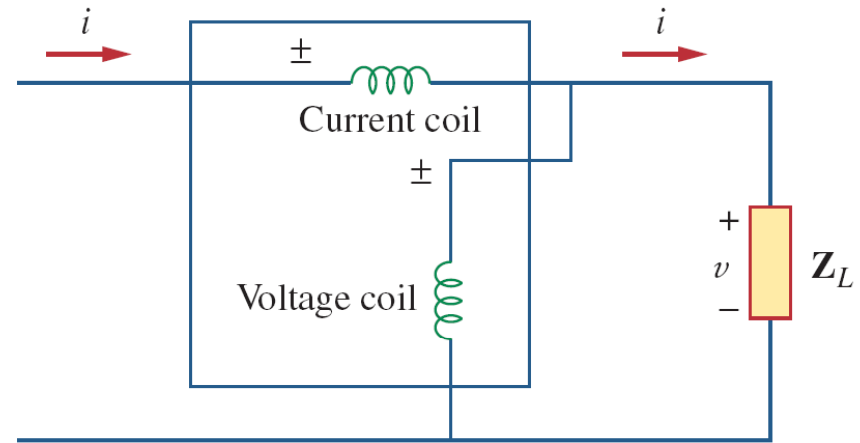
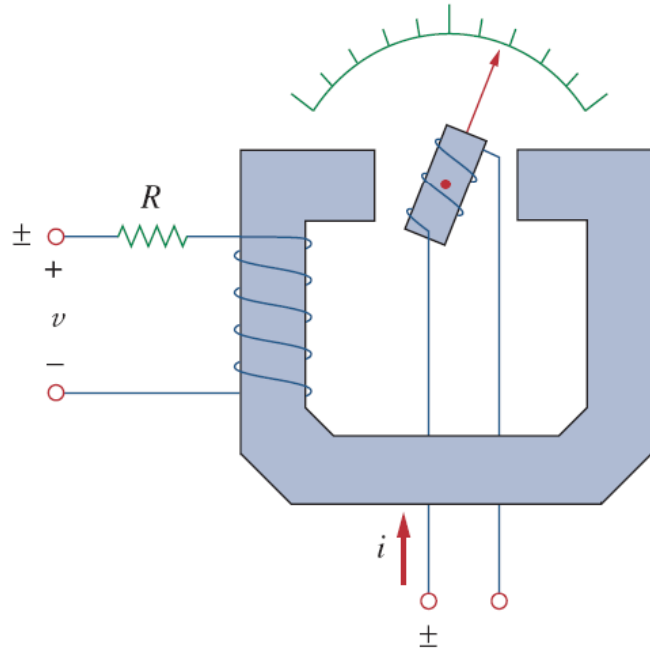


Vatímetro

Prof. Gerardo Ceballos



Vatímetro

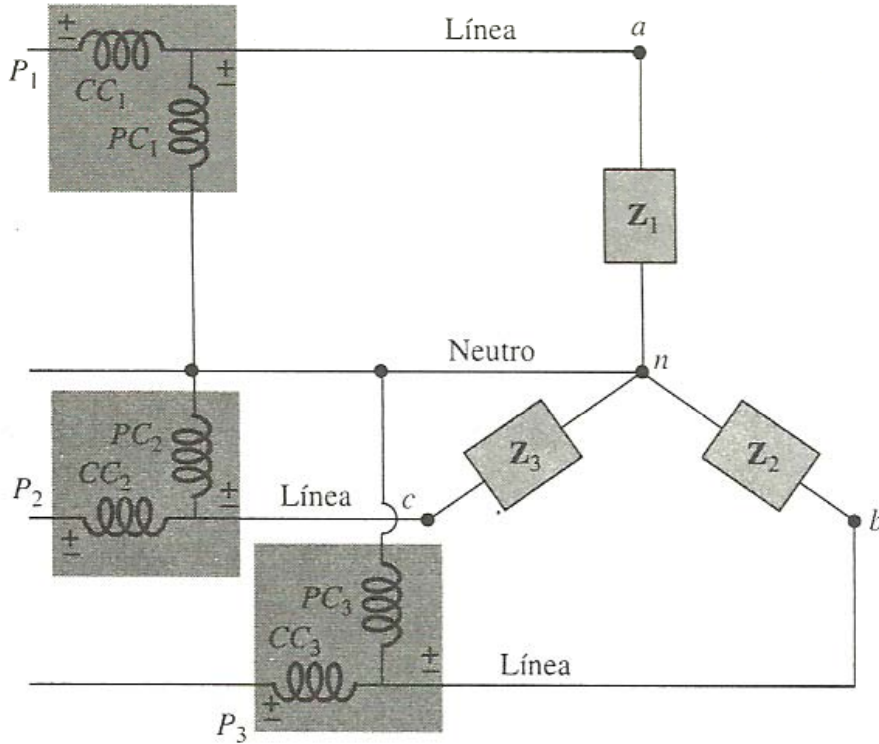
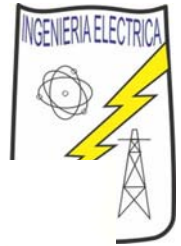


$$\mathbf{V}_{\text{rms}} = \frac{V_m}{\sqrt{2}} \angle \theta_v \quad \mathbf{I}_{\text{rms}} = \frac{I_m}{\sqrt{2}} \angle \theta_i$$

$$P = |\mathbf{V}_{\text{rms}}| |\mathbf{I}_{\text{rms}}| \cos(\theta_v - \theta_i)$$



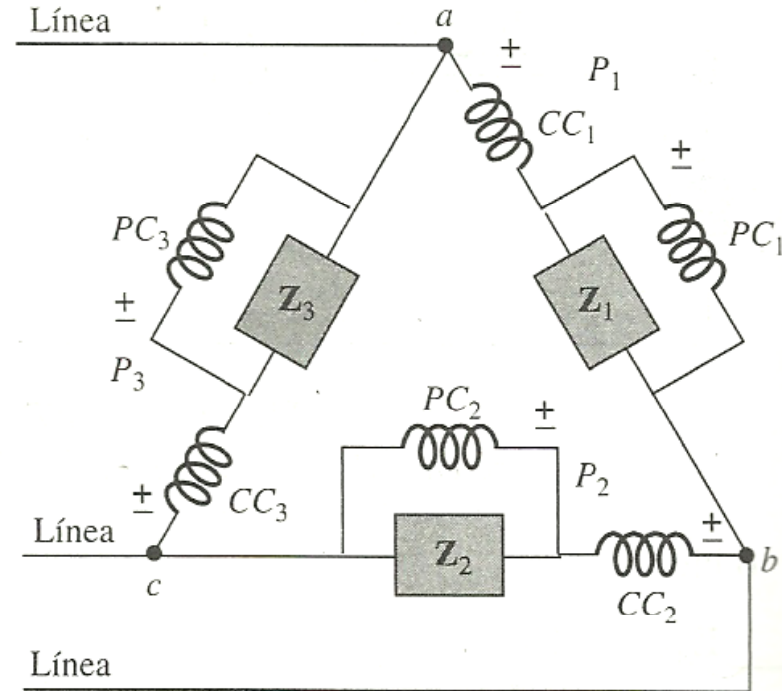
Método de los 3 vatímetros



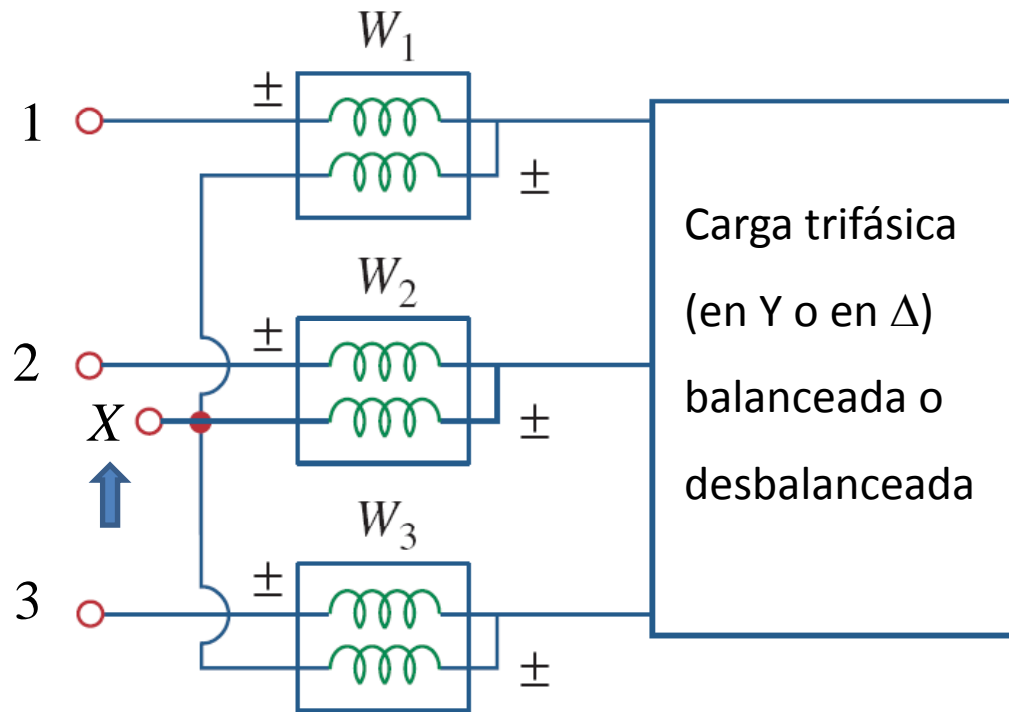
4 hilos, carga Y balanceada
o desbalanceada

$$P_T = P_1 + P_2 + P_3$$

Balanceada $P_T = 3P_1$



3 hilos, carga en Δ balanceada
o desbalanceada



$$W_1 = \frac{1}{T} \int_0^T V_{1X} I_{A1} dt$$

$$W_1 + W_2 + W_3 =$$

$$\frac{1}{T} \int_0^T (V_{1X} I_{A1} + V_{2X} I_{B2} + V_{3X} I_{C3}) dt$$

$$W_1 + W_2 + W_3 =$$

0

$$V_{1X} = V_{1N} + V_{NX}$$

$$V_{2X} = V_{2N} + V_{NX}$$

$$V_{3X} = V_{3N} + V_{NX}$$

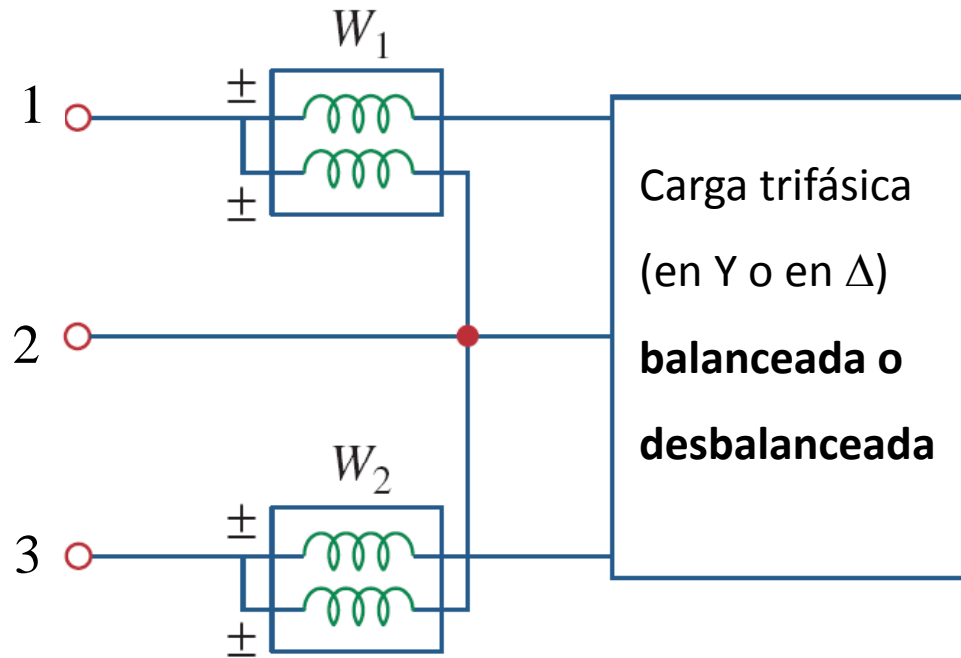
$$\frac{1}{T} \int_0^T (V_{1N} I_{A1} + V_{2N} I_{B2} + V_{3N} I_{C3}) dt + \frac{1}{T} \int_0^T V_{NX} (I_{A1} + I_{B2} + I_{C3}) dt$$

$$W_1 + W_2 + W_3 = P_1 + P_2 + P_3 = P_T$$

X en cualquier parte del circuito:
Para 3 hilos (balanceado o desbalanceado)
ó para 4 hilos balanceado



Método de los 2 vatímetros



3 configuraciones posibles

Si X se ubica sobre una de las líneas, uno de los vatímetros va a tener lectura=0 y los otros dos sumarán la potencia total

$$W_1 = V_{12} I_{A1} \cos(\angle V_{12} - \angle I_{A1})$$

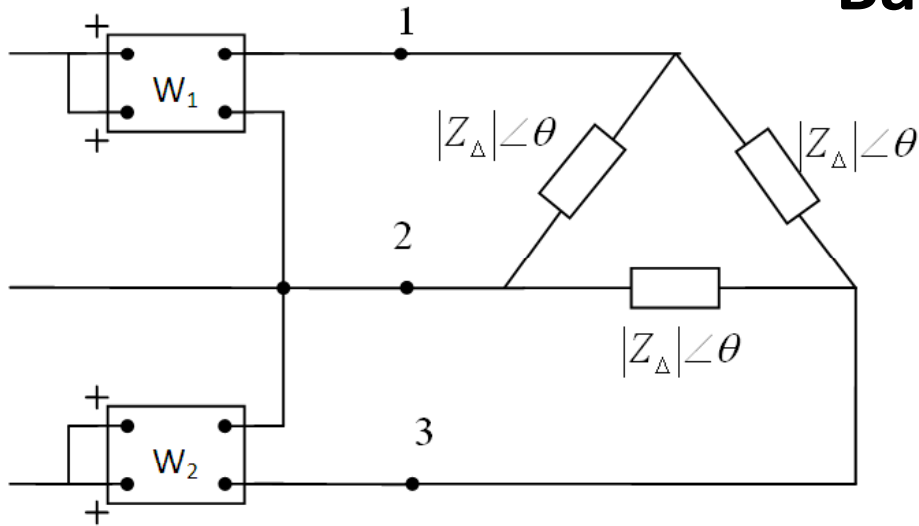
$$W_2 = V_{32} I_{C3} \cos(\angle V_{32} - \angle I_{C3})$$

$$W_1 + W_2 = P_1 + P_2 + P_3 = P_T$$

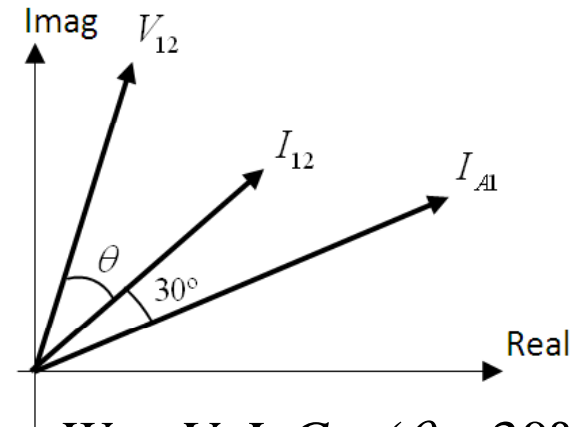
Para 3 hilos (balanceado o desbalanceado)
ó para 4 hilos balanceado



Métodos 2 vatímetros Balanceado



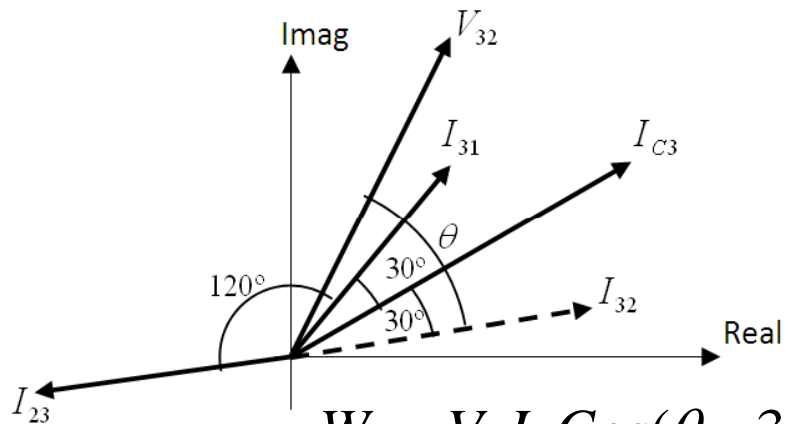
$$W_1 = V_{12} I_{A1} \cos(\angle V_{12} - \angle I_{A1})$$



$$W_1 = V_L I_L \cos(\theta + 30^\circ)$$

También se demuestra con carga en Y

$$W_2 = V_{32} I_{C3} \cos(\angle V_{32} - \angle I_{C3})$$



$$W_2 = V_L I_L \cos(\theta - 30^\circ)$$



Métodos 2 vatímetros Balanceado



W1 se mide en la línea que está atrasada 120° respecto a donde se mide W2

$$W_1 = V_L I_L \cos(\theta + 30^\circ)$$

$$W_2 = V_L I_L \cos(\theta - 30^\circ)$$

$$\frac{W_1}{W_2} = \frac{\cos(\theta + 30^\circ)}{\cos(\theta - 30^\circ)}$$

$$\frac{W_1}{W_2} = \frac{\cos(\theta + 30^\circ)}{\cos(\theta - 30^\circ)}$$

$$\cos(\alpha \pm \beta) = \cos\alpha\cos\beta \mp \text{Sen}\alpha\text{Sen}\beta$$

$$\frac{W_1}{W_2} = \frac{\cos\theta\cos30 - \text{Sen}\theta\text{Sen}30}{\cos\theta\cos30 + \text{Sen}\theta\text{Sen}30} = \frac{\frac{\sqrt{3}}{2}\cos\theta - 0,5\text{Sen}\theta}{\frac{\sqrt{3}}{2}\cos\theta + 0,5\text{Sen}\theta} = \frac{\sqrt{3}\cos\theta - \text{Sen}\theta}{\sqrt{3}\cos\theta + \text{Sen}\theta}$$

$$\frac{W_1}{W_2} = \frac{\sqrt{3} - \tan\theta}{\sqrt{3} + \tan\theta}$$

$$W_1(\sqrt{3} + \tan\theta) = W_2(\sqrt{3} - \tan\theta)$$

$$\tan\theta(W_1 + W_2) = \sqrt{3}(W_2 - W_1)$$

$$\tan\theta = \sqrt{3} \frac{W_2 - W_1}{W_1 + W_2}$$

Se puede calcular fp



Métodos 2 vatímetros Balanceado



- Medición de la potencia reactiva

$$\tan \theta = \sqrt{3} \frac{W_2 - W_1}{W_1 + W_2}$$

$$\frac{\text{Sen} \theta}{\text{Cos} \theta} = \sqrt{3} \frac{W_2 - W_1}{P_T}$$

$$\frac{|S_T| \text{Cos} \theta \text{Sen} \theta}{\text{Cos} \theta} = \sqrt{3} (W_2 - W_1)$$

$$Q_T = \sqrt{3} (W_2 - W_1)$$

Pot. Reactiva

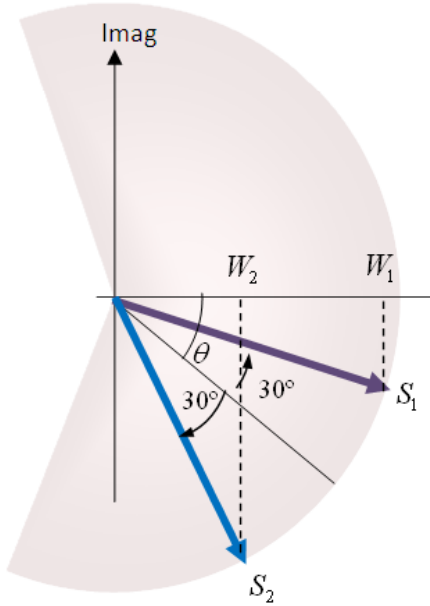
$$P_T = W_1 + W_2$$



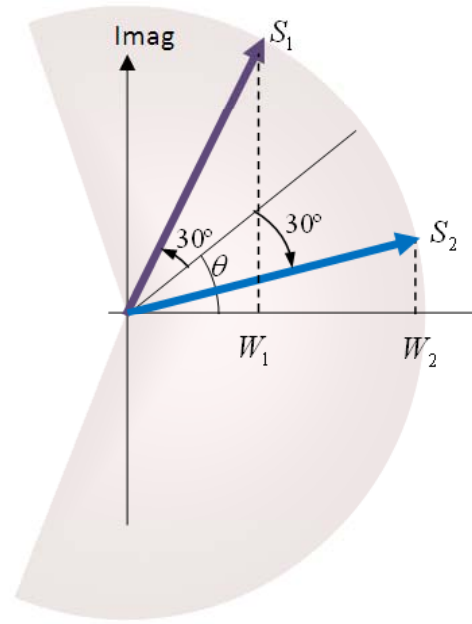
Balanceado



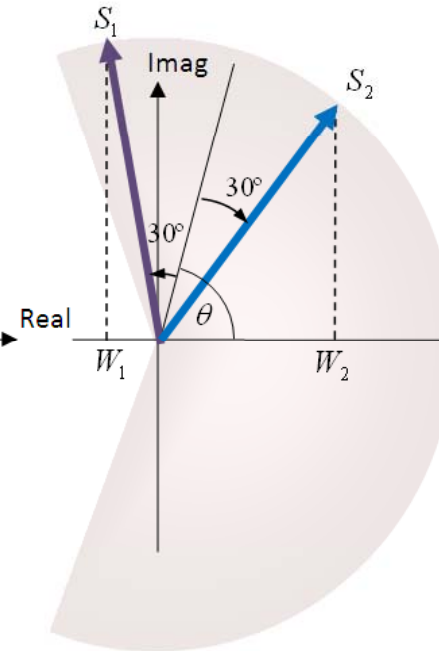
Línea donde se mide W_1 atrasada 120° respecto a donde se mide W_2



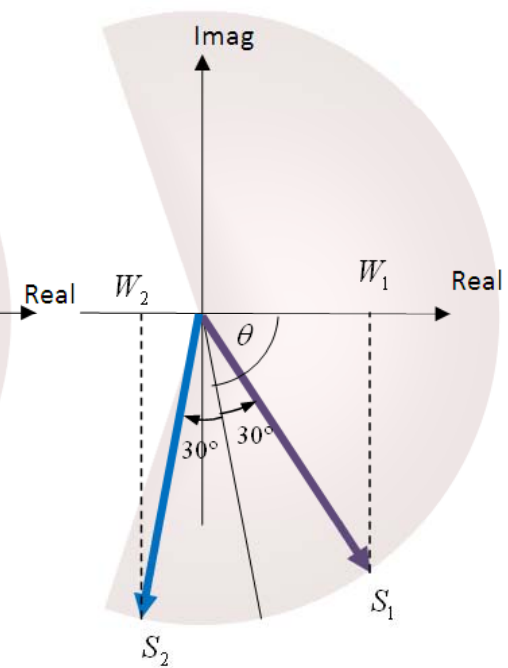
$W_1 > W_2$ capacitiva
 $\theta < 0$



$W_2 > W_1$ inductiva
 $\theta > 0$



$\theta > 60^\circ$ ó $\theta < -60^\circ$ $fp < 0,5$
Hay una medida negativa

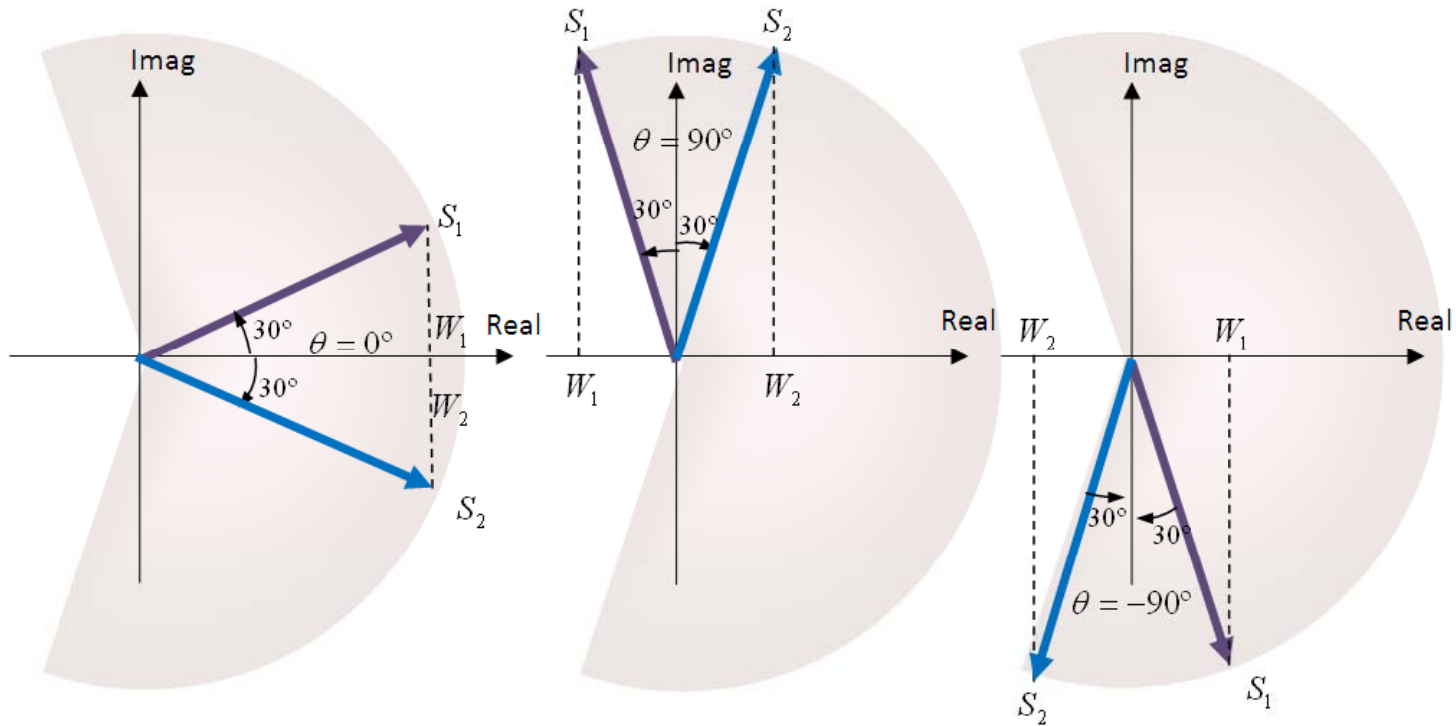




Balanceado



Línea donde se mide W_1 atrasada 120° respecto a donde se mide W_2



$$W_2 = W_1$$

$$\theta = 0$$

$$fp = 1$$

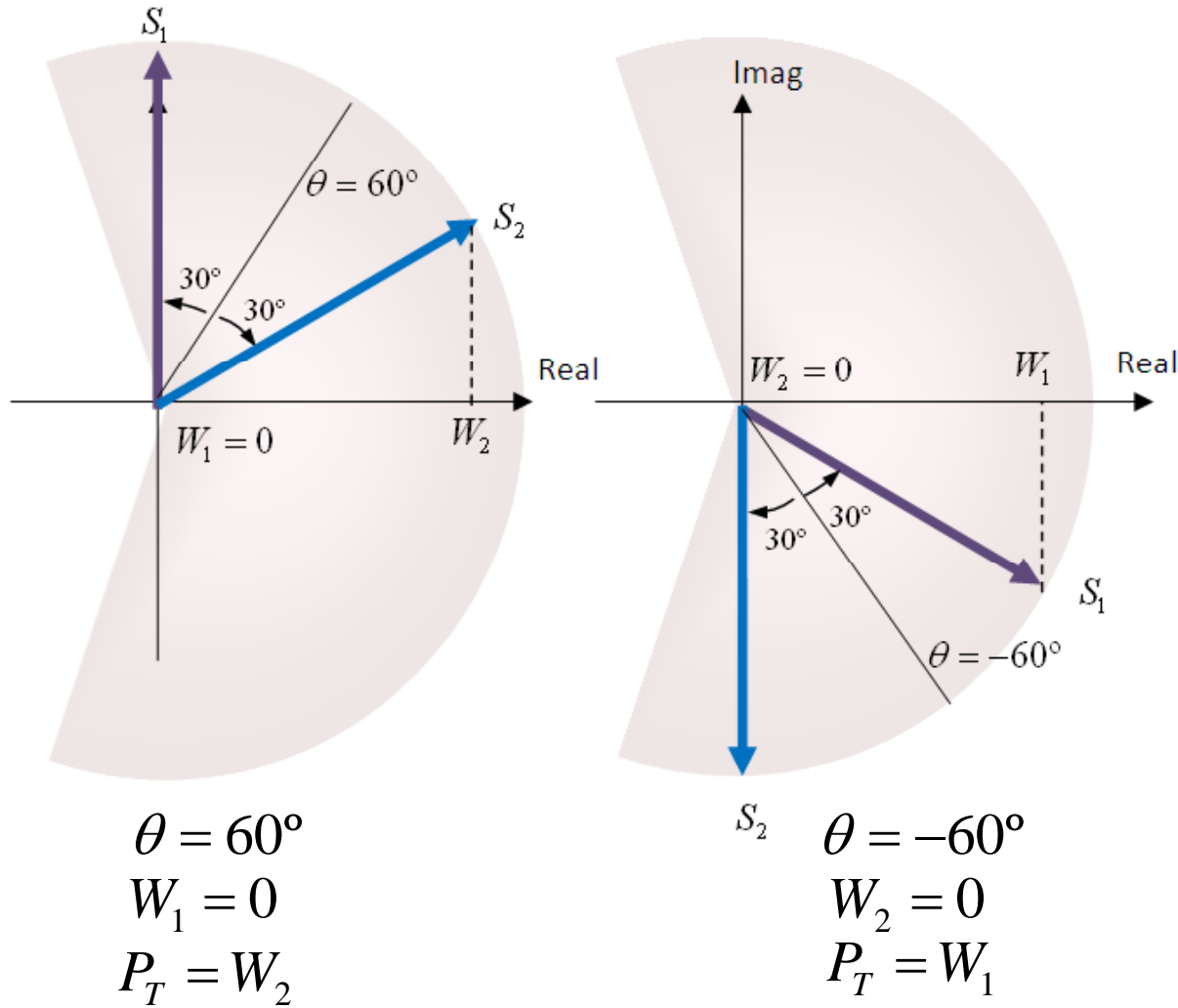
$$W_2 = -W_1$$

$$\theta = \pm 90$$

$$fp = 0$$

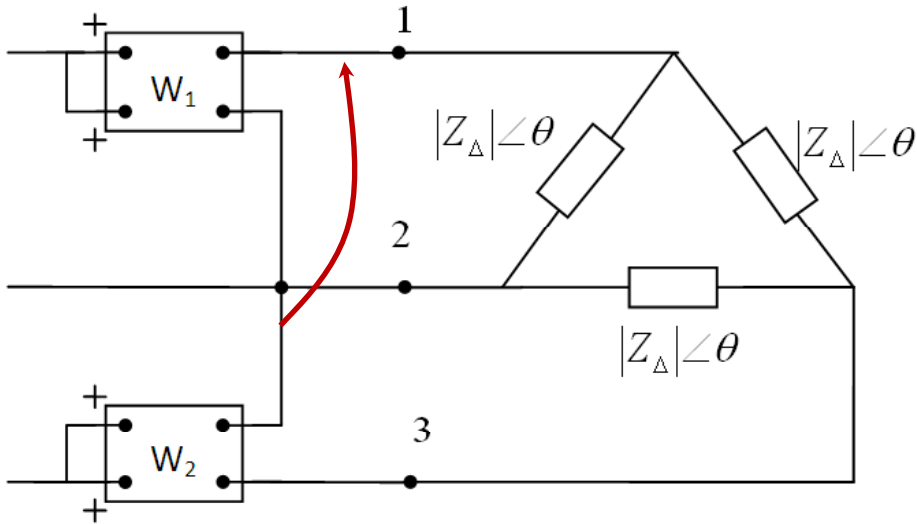
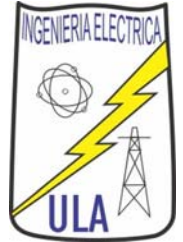


Línea donde se mide W_1 atrasada 120° respecto a donde se mide W_2





Si no se sabe cual línea atrasa a cual y el vatímetro solo es capaz de dar medidas positivas



- 1-Cambiar los conectores de la bobina amperimétrica para lograr medidas +
- 2-Mover el conector del vatímetro de menor lectura hacia la otra línea medida
- 3-Si defleca negativamente se restan, sino se suman

Si se conoce el fp:

