In a perfect electrical system where only Watts exist, the power triangle is a straight line as no VARs are produced. See Figure 1-23 to see a power triangle where only pure power is produced.

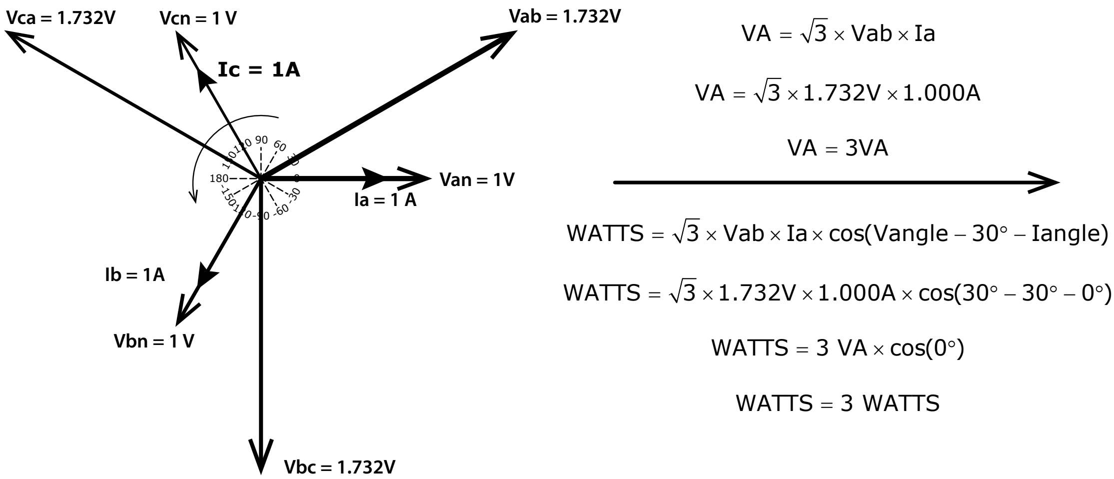


Figure 1-23: Three-Phase Power Triangle - Watts Only

When the electrical system supplies a purely inductive source, the current will lag the voltage by 90 degrees, and the power triangle is a vertical line as shown in Figure 1-24:

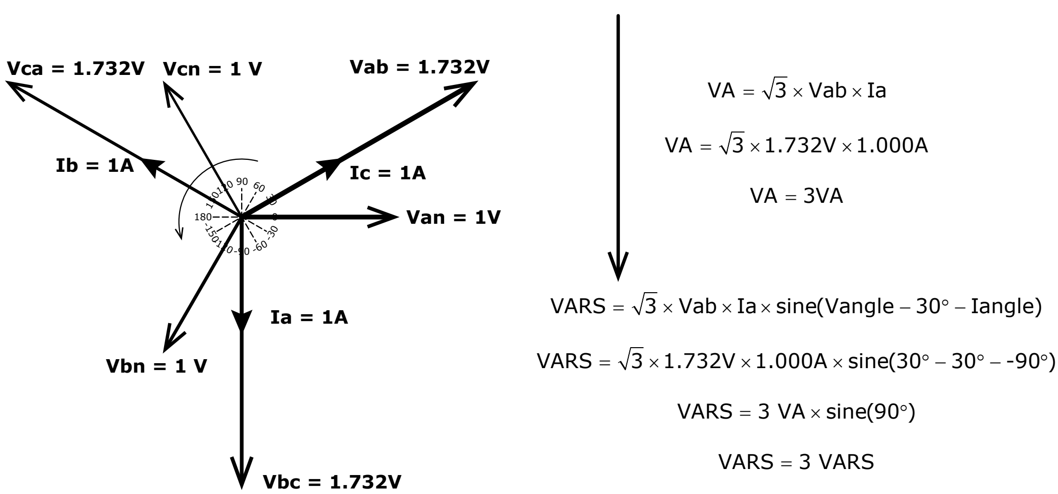
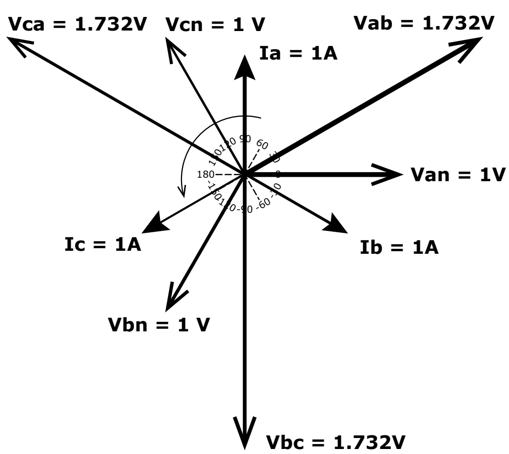


Figure 1-24: Power Triangle - Only Inductive VARs

When the electrical system supplies a purely capacitive source, the current will lead the voltage by 90 degrees, and the power triangle is a vertical line as shown in Figure 1-25:



$$VA = \sqrt{3} \times Vab \times Ia$$

$$VA = \sqrt{3} \times 1.732V \times 1.000A$$

$$VA = 3VA$$

$$VARS = \sqrt{3} \times Vab \times Ia \times sine(Vangle - 30^\circ - Iangle)$$

$$VARS = \sqrt{3} \times 1.732V \times 1.000A \times sine(30^\circ - 30^\circ + 90^\circ)$$

$$VARS = 3\ VA \times sine(+90^\circ)$$

$$VARS = +3\ VARS$$

Figure 1-25: Power Triangle - Only Capacitive VARs

Our next example is closer to real life with the current lagging the voltage by 30 degrees. Most power systems have all three parts of the power triangle with Watts, VARs, and VA as shown in Figure 1-26.

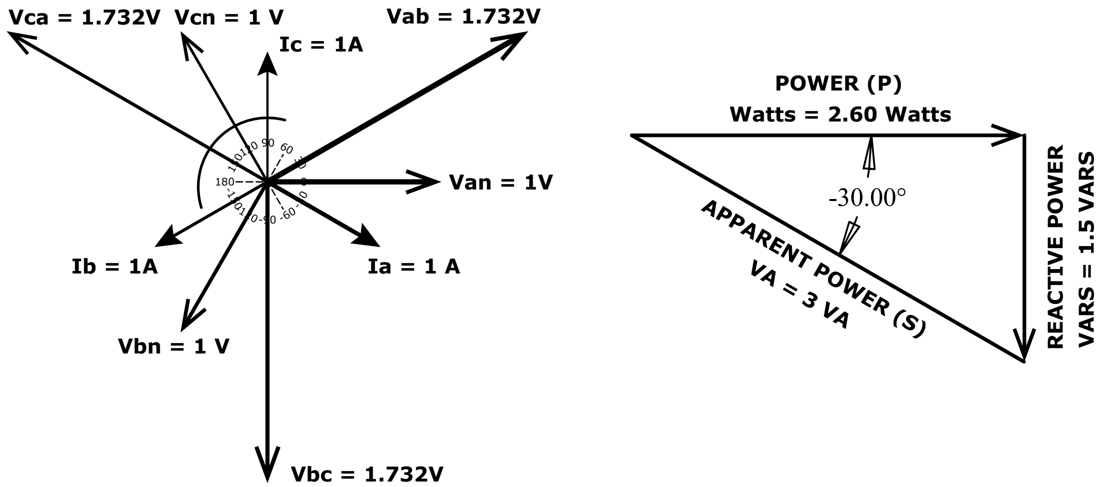


Figure 1-26: Power Triangle

$$\text{WATTS} = \sqrt{3} \times \text{Vab} \times \text{Ia} \times \cos(\text{Vangle} - 30^\circ - \text{Iangle})$$

$$\text{WATTS} = \sqrt{3} \times 1.732\text{V} \times 1.0\text{A} \times \cos(30^\circ - 30^\circ - -30^\circ)$$

$$\text{WATTS} = 3 \times \cos(30^\circ)$$

$$\text{WATTS} = 3 \times 0.866$$

$$\text{WATTS} = 2.60\ \text{WATTS}$$

$$\text{VA} = \sqrt{3} \times \text{Vab} \times \text{Ia}$$

$$\text{VA} = \sqrt{3} \times 1.732\text{V} \times 1.0\text{A}$$

$$\text{VA} = 3\text{VA}$$

$$\text{VARS} = \sqrt{3} \times \text{Vab} \times \text{Ia} \times \text{sine}(\text{Vangle} - 30^\circ - \text{Iangle})$$

$$\text{VARS} = \sqrt{3} \times 1.732\text{V} \times 1.0\text{A} \times \text{sine}(30^\circ - 30^\circ - -30^\circ)$$

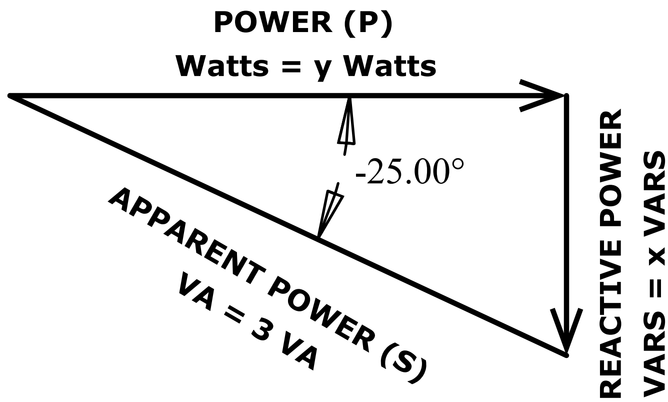
$$\text{VARS} = 3 \times \text{sine}(30^\circ)$$

$$\text{VARS} = 3 \times 0.5$$

$$\text{VARS} = 1.5\ \text{VARS}$$

Figure 1-27: Example Three-Phase Power/VARS/VA Formula Calculations

You can apply the Pythagorean Theorem in nearly every aspect of phasor diagrams and other electrical properties as shown in the following example:



$$\text{WATTS} = \sqrt{3} \times \text{Vab} \times \text{Ia} \times \cos(\text{Vangle} - 30° - \text{Iangle})$$

$$\text{WATTS} = \text{VA} \times \cos(30° - 30° - -25°)$$

$$\text{WATTS} = 3 \times \cos(25°)$$

$$\text{WATTS} = 3 \times 0.906$$

$$\text{WATTS} = 2.72 \text{ WATTS}$$

$$\cos\theta = \frac{y}{\text{VA}}$$

$$\cos(-25) = \frac{y}{3\text{VA}}$$

$$y = \cos(-25) \times 3\text{VA} = 0.906 \times 3\text{VA}$$

$$y = 2.72 \text{ WATTS}$$

$$\text{VARS} = \sqrt{3} \times \text{Vab} \times \text{Ia} \times \text{sine}(\text{Vangle} - 30° - \text{Iangle})$$

$$\text{VARS} = \text{VA} \times \text{sine}(30° - 30° - -25°)$$

$$\text{VARS} = 3 \times \text{sine}(25°)$$

$$\text{VARS} = 3 \times 0.423$$

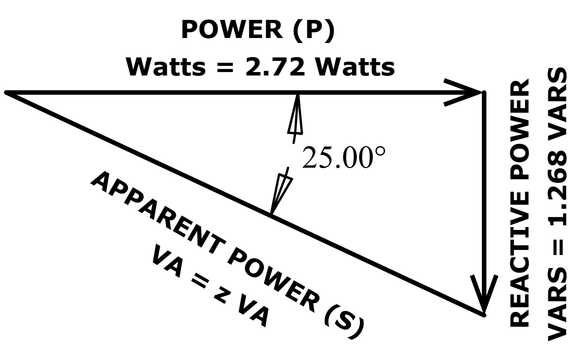
$$\text{VARS} = 1.268 \text{ VARS}$$

$$\text{sine}\theta = \frac{x}{\text{VA}}$$

$$\text{sine}(-25) = \frac{x}{3\text{VA}}$$

$$x = \text{sine}(-25) \times 3\text{VA} = 0.423 \times 3\text{VA}$$

$$x = 1.268 \text{ VARS}$$



$$\text{VA} = \sqrt{(\text{WATTS}^2 + \text{VARS}^2)}$$

$$\text{VA} = \sqrt{(2.72^2 + 1.268^2)}$$

$$\text{VA} = \sqrt{(7.3984 + 1.6078)}$$

$$\text{VA} = \sqrt{(9.00)} = 3 \text{ VA}$$