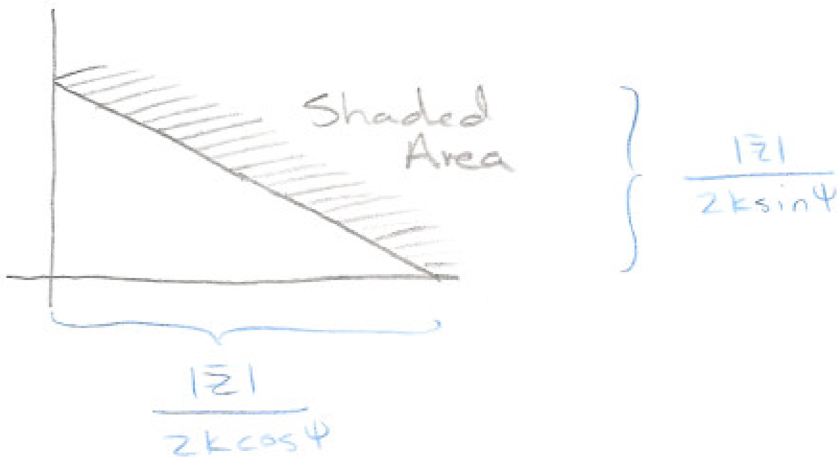
$$(k_1^2 - k_2^2)|\bar{Z}_L|^2 + 2|\bar{Z}_L|\left\{k_1|\bar{Z}_1|\cos(\psi_1 - \phi_L) - k_2|\bar{Z}_2| * \cos(\psi_2 - \phi_L)\right\} + |\bar{Z}_1|^2 - |\bar{Z}_2|^2 \leq 0$$




note: Shaded area operates trip signal.

## MHO RELAY

This can be obtained by making $k_1 = k$, $k_2 = 0$ and $\bar{Z}_1 = \bar{Z}_2 = \bar{Z}$ ; $\psi_1 = \psi_2 = \psi$.

As a result the general equation reduces to:

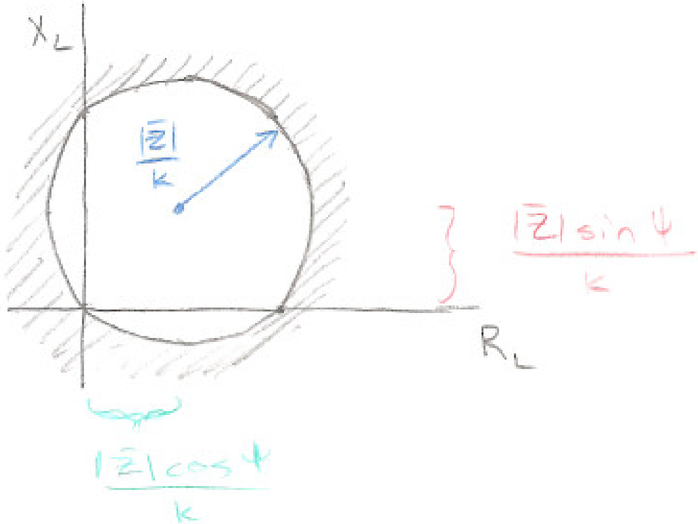
$$k^2|\bar{Z}_L|^2 - 2k|\bar{Z}_L||\bar{Z}|\cos(\psi - \phi_L) \leq 0$$

In terms of $R_L$ and $X_L$, then our equation becomes:

$$R_L^2 + X_L^2 - \frac{2|\bar{Z}|}{k}\left\{R_L\cos\psi + X_L\sin\psi\right\} \leq 0$$

$$\left(R_L - \frac{|\bar{Z}|}{k}\cos\psi\right)^2 + \left(X_L - \frac{|\bar{Z}|}{k}\sin\psi\right)^2 \leq \frac{|\bar{Z}|^2}{k^2}$$

Plotting this we get




## IMPEDANCE RELAY

Is obtained by making

$$k_1 = -k \qquad \bar Z_1 \neq \bar Z_2$$

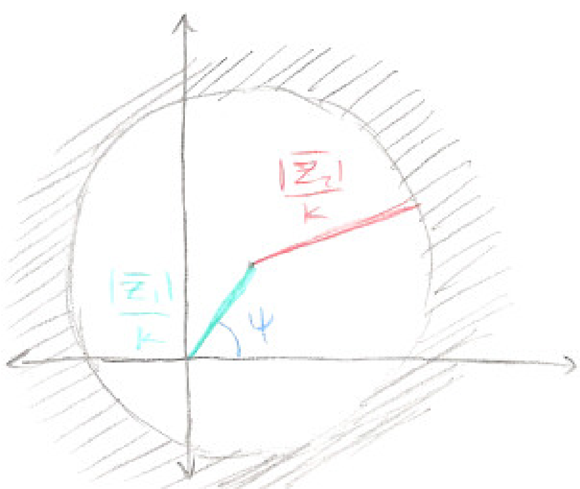
$$k_2 = 0$$

Again our general equation reduces to:

$$k^2|\bar Z_L|^2 - 2k|\bar Z_L||\bar Z_1|\cos(\psi_1 - \phi_L) + |\bar Z_1|^2 - |\bar Z_2|^2 \le 0$$

Rearranging the terms of $R_L$ and $X_L$ we get

$$\left(R_L - \frac{|\bar Z_1| \cos\psi}{k}\right)^2 + \left(X_L - \frac{|\bar Z_1| \sin\psi}{k}\right)^2 \le \frac{|\bar Z_2|^2}{k^2}$$



# PHASE COMPARISON

Comparitors in Phase comparison mode are obtained by letting

$$\bar{V}_1 = |\bar{V}_1| \angle \theta_1 = |\bar{V}_1| e^{j\theta_1}$$

$$\bar{V}_2 = |\bar{V}_2| \angle \theta_2 = |\bar{V}_2| e^{j\theta_2}$$

Phasor ratio $\frac{\bar{V}_1}{\bar{V}_2}$ we get

$$\frac{|\bar{V}_1|}{|\bar{V}_2|} \angle \theta_1 - \theta_2$$

define $\theta = \theta_1 - \theta_2$ a criterion for operation for a $\pm 90^\circ$ comparitor, then

$$-\frac{\pi}{2} \leq \theta \leq \frac{\pi}{2}$$

The above is chosen so

$$\cos\theta \geq 0$$

For phase comparison we have the earlier work

$$\bar{V}_1 = |\bar{I}_L| \{ k_1 |\bar{Z}_L| + |\bar{Z}_1| \angle \psi_1 - \phi_L \}$$

$$= a + jb.$$

where,

$$a = |\bar{I}_L| \{ k_1 |\bar{Z}_L| + |\bar{Z}_1| \cos(\psi_1 - \phi_L) \}$$

$$b = |\bar{I}_L| |\bar{Z}_1| \sin(\psi_1 - \phi_L)$$

and

$$\bar{V}_2 = |\bar{I}_L| \{ k_2 |\bar{Z}_L| + |\bar{Z}_2| \angle \psi_2 - \phi_L \}$$

$$= c + jd$$

where

$$c = |\bar{I}_L| \left\{ k_2 |\bar{Z}_L| + |\bar{Z}_2| \cos(\psi_2 - \phi_L) \right\}$$

$$d = |\bar{I}_L| |\bar{Z}_2| \sin(\psi_2 - \phi_L)$$

and

$$\frac{\bar{V}_1}{\bar{V}_2} = \frac{a + jb}{c + jd} = \sqrt{\frac{a^2 + b^2}{c^2 + d^2}} \angle \theta_1 - \theta_2$$