

**Symmetrical Components**

Define a:  $a := e^{j \cdot \left(\frac{2 \cdot \pi}{3}\right)}$

Sequence Matrix  $\underline{\underline{A}} := \begin{pmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{pmatrix}$  phase A reference

$\underline{\underline{B}} := \begin{pmatrix} 1 & a & a^2 \\ 1 & 1 & 1 \\ 1 & a^2 & a \end{pmatrix}$  phase B reference

$\underline{\underline{C}} := \begin{pmatrix} 1 & a^2 & a \\ 1 & a & a^2 \\ 1 & 1 & 1 \end{pmatrix}$  phase C reference

Define a balanced three phase current signals  $\underline{I}_{abc} := \begin{bmatrix} 1000 e^{j \cdot (0)} \\ 1000 e^{j \cdot \left(\frac{-2 \cdot \pi}{3}\right)} \\ 1000 e^{j \cdot \left(\frac{2 \cdot \pi}{3}\right)} \end{bmatrix}$

$I_{012} := A^{-1} \cdot I_{abc}$

$I_{012} = \begin{pmatrix} 0 \\ 1 \times 10^3 \\ 0 \end{pmatrix} \xrightarrow{|I_{012}|} \begin{pmatrix} 0 \\ 1 \times 10^3 \\ 0 \end{pmatrix} \xrightarrow{\arg(I_{012})} \begin{pmatrix} -11.571 \\ 0 \\ -153.435 \end{pmatrix} \text{ deg}$

If we used B phase reference sequence matrix and recompute the sequence components

$I_{012\_b} := B^{-1} I_{abc}$

$I_{012\_b} = \begin{pmatrix} 0 \\ -500 - 866.025i \\ 0 \end{pmatrix} \xrightarrow{|I_{012\_b}|} \begin{pmatrix} 0 \\ 1 \times 10^3 \\ 0 \end{pmatrix} \xrightarrow{\arg(I_{012\_b})} \begin{pmatrix} 5.972 \\ -120 \\ 45 \end{pmatrix} \text{ deg}$

Notice the magnitude in the positive sequence is identical and the phase shift of -120 is reflected when we used the B phase reference sequence matrix.

Let us examine the sequence components if the magnitudes of phase A and B are changed to zero (Currents at the fault location for a phase C to ground fault).

Redefining the phase matrix:

$$I_{abc} := \begin{bmatrix} 0 \cdot e^{j \cdot (0)} \\ 0 \cdot e^{j \cdot \left(\frac{-2 \cdot \pi}{3}\right)} \\ 1000 \cdot e^{j \cdot \left(\frac{2 \cdot \pi}{3}\right)} \end{bmatrix}$$

**Unless otherwise mentioned use phase A reference sequence components:**

$$I_{012} := A^{-1} \cdot I_{abc}$$

$$I_{012} = \begin{pmatrix} -166.667 + 288.675i \\ 333.333 \\ -166.667 - 288.675i \end{pmatrix} \xrightarrow{|I_{012}|} \begin{pmatrix} 333.333 \\ 333.333 \\ 333.333 \end{pmatrix} \xrightarrow{\arg(I_{012})} \begin{pmatrix} 120 \\ 0 \\ -120 \end{pmatrix} \text{ deg}$$

Notice the sequence magnitudes are identical to each other. This relationship holds good for any single phase to ground fault.