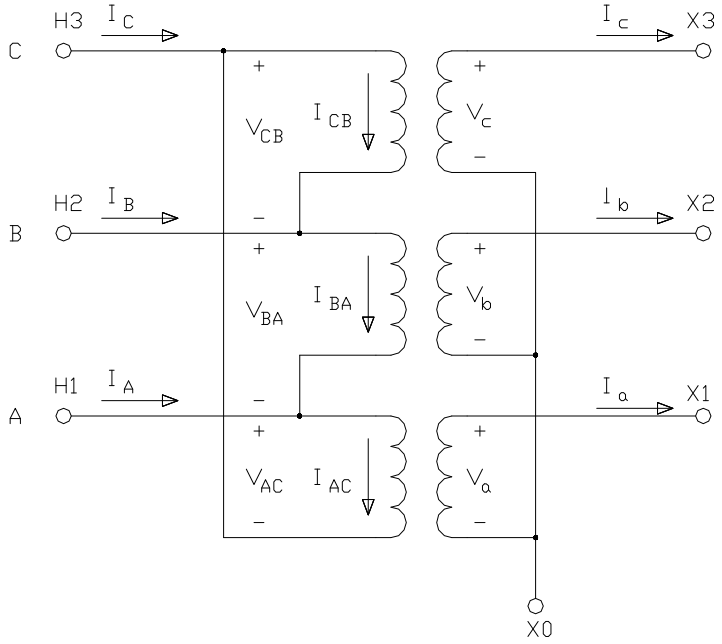
VOLTAGE AND CURRENT SHIFTS IN DELTA-WYE TRANSFORMER



Define: $kV \equiv 1000 \cdot volt \quad a := e^{j \cdot 120 \cdot deg} \quad MVA := volt \cdot amp \cdot 10^6 \quad kVA \equiv kV \cdot A$

$$\mathbf{A} := \begin{pmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{pmatrix}$$

Voltage ratio $N := \frac{30}{0.4}$ Turns ratio $n := N \cdot \sqrt{3}$

Base power $P_B := 1600kVA$

	Primary		Secondary	
Base voltage	$E_{Bp} := 30kV$		$E_{Bs} := \frac{E_{Bp}}{N}$	$E_{Bs} = 400\ V$
Base current	$I_{Bp} := \frac{P_B}{\sqrt{3} \cdot E_{Bp}}$	$I_{Bp} = 30.792\ amp$	$I_{Bs} := \frac{P_B}{\sqrt{3} \cdot E_{Bs}}$	$I_{Bs} = 2309.4\ amp$

Primary Voltages

$$V_A := \frac{30}{\sqrt{3}} \cdot \left(e^{j \cdot 30 \cdot deg} \cdot kV\right) \quad V_B := \frac{30}{\sqrt{3}} \cdot e^{-j \cdot 90 \cdot deg} \cdot kV \quad V_C := \frac{30}{\sqrt{3}} \cdot e^{j \cdot 150 \cdot deg} \cdot kV$$

$$VP := \left(V_A \ V_B \ V_C\right)^T \quad VPS := \mathbf{A}^{-1} \cdot VP \quad V_{A0} := VPS_0 \quad V_{A1} := VPS_1 \quad V_{A2} := VPS_2$$

$V_{A0} = 0\ volt \quad V_{A1} = (15000 + 8660.3i)\ volt \quad V_{A2} = 0\ volt$

$$V_{AC} := V_A - V_C \quad V_{BA} := V_B - V_A \quad V_{CB} := V_C - V_B$$

$$VWP := \left(V_{AC} \ V_{BA} \ V_{CB}\right)^T$$

Secondary Voltages

$VS := \frac{1}{n} \cdot VWP$ $V_a := VS_0$ $V_b := VS_1$ $V_c := VS_2$

$V_a = 230.9\,\text{volt}$ $V_b = (-115.5 - 200i)\,\text{volt}$ $V_c = (-115.5 + 200i)\,\text{volt}$

$|V_a| = 230.9\,\text{volt}$ $|V_b| = 230.9\,\text{volt}$ $|V_c| = 230.9\,\text{volt}$

$\arg(V_a) = 0\,\text{deg}$ $\arg(V_b) = -120\,\text{deg}$ $\arg(V_c) = 120\,\text{deg}$

Secondary Currents

$I_a := 1000 \cdot \text{amp}$ $I_b := 1000 \cdot e^{-j \cdot 100 \cdot \text{deg}} \cdot \text{amp}$ $I_c := 1000 \cdot e^{j \cdot 120 \cdot \text{deg}} \cdot \text{amp}$

$IS := \begin{pmatrix} I_a & I_b & I_c \end{pmatrix}^T$ $ISS := \mathbf{A}^{-1} \cdot IS$ $I_{a0} := ISS_0$ $I_{a1} := ISS_1$ $I_{a2} := ISS_2$

$I_{a0} = (108.8 - 39.6i)\,\text{amp}$ $I_{a1} = (979.9 + 114i)\,\text{amp}$ $I_{a2} = (-88.7 - 74.4i)\,\text{amp}$

$|I_{a0}| = 115.8\,\text{amp}$ $|I_{a1}| = 986.5\,\text{amp}$ $|I_{a2}| = 115.8\,\text{amp}$

$\arg(I_{a0}) = -20\,\text{deg}$ $\arg(I_{a1}) = 6.636\,\text{deg}$ $\arg(I_{a2}) = -140\,\text{deg}$

Primary Currents

$IWP := \frac{1}{n} \cdot IS$ $I_{AC} := IWP_0$ $I_{BA} := IWP_1$ $I_{CB} := IWP_2$

$I_{AC} = 7.7\,\text{amp}$ $I_{BA} = (-1.3 - 7.6i)\,\text{amp}$ $I_{CB} = (-3.8 + 6.7i)\,\text{amp}$

$|I_{AC}| = 7.7\,\text{amp}$ $|I_{BA}| = 7.7\,\text{amp}$ $|I_{CB}| = 7.7\,\text{amp}$

$\arg(I_{AC}) = 0\,\text{deg}$ $\arg(I_{BA}) = -100\,\text{deg}$ $\arg(I_{CB}) = 120\,\text{deg}$

$I_A := I_{AC} - I_{BA}$ $I_B := I_{BA} - I_{CB}$ $I_C := I_{CB} - I_{AC}$

$I_A = (9 + 7.6i)\,\text{amp}$ $I_B = (2.5 - 14.2i)\,\text{amp}$ $I_C = (-11.5 + 6.7i)\,\text{amp}$

$|I_A| = 11.79\,\text{amp}$ $|I_B| = 14.47\,\text{amp}$ $|I_C| = 13.33\,\text{amp}$

$\arg(I_A) = 40\,\text{deg}$ $\arg(I_B) = -80\,\text{deg}$ $\arg(I_C) = 150\,\text{deg}$

$IP := \begin{pmatrix} I_A & I_B & I_C \end{pmatrix}^T$ $IPS := \mathbf{A}^{-1} \cdot IP$ $I_{A0} := IPS_0$ $I_{A1} := IPS_1$ $I_{A2} := IPS_2$

$I_{A0} = 0\,\text{amp}$ $I_{A1} = (10.6 + 7.8i)\,\text{amp}$ $I_{A2} = (-1.5 - 0.3i)\,\text{amp}$

$|I_{A0}| = 0\,\text{amp}$ $|I_{A1}| = 13.15\,\text{amp}$ $|I_{A2}| = 1.54\,\text{amp}$

$\arg(I_{A0}) = -13.16\,\text{deg}$ $\arg(I_{A1}) = 36.636\,\text{deg}$ $\arg(I_{A2}) = -170\,\text{deg}$