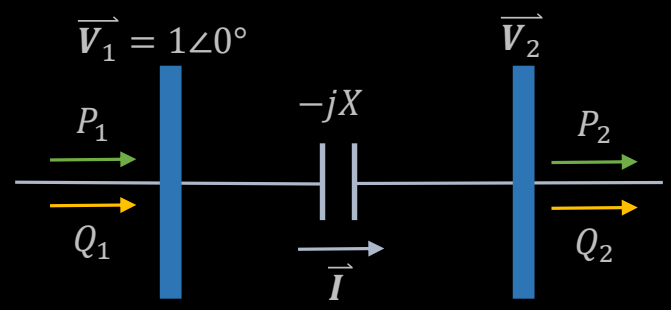
Series Capacitor Voltage Rise Equations



$$\boldsymbol{I} = \frac{1 - \boldsymbol{V}_2}{-jX} = \frac{1 - |\boldsymbol{V}_2|e^{j\theta_2}}{-jX}$$

$$\boldsymbol{I} = \frac{j - j|\boldsymbol{V}_2|e^{j\theta_2}}{X}$$

$$\boldsymbol{I}X = j - j|\boldsymbol{V}_2|e^{j\theta_2}$$

$$\boldsymbol{I}X = j - |\boldsymbol{V}_2|e^{j\theta_2}e^{j90}$$

$$\boldsymbol{I}X = j - |\boldsymbol{V}_2|e^{j(\theta_2+90)}$$

$$\boldsymbol{I}X = j - |\boldsymbol{V}_2|[\cos(\theta_2 + 90) + j\sin(\theta_2 + 90)]$$

$$\boldsymbol{I}X = j - |\boldsymbol{V}_2|[-\sin\theta_2 + j\cos\theta_2]$$

$$\boldsymbol{I}X = j + |\boldsymbol{V}_2|[\sin\theta_2 - j\cos\theta_2]$$

$$\boldsymbol{I}X = j + |\boldsymbol{V}_2|\sin\theta_2 - j|\boldsymbol{V}_2|\cos\theta_2$$

$$\boldsymbol{I}X = |\boldsymbol{V}_2|\sin\theta_2 + j - j|\boldsymbol{V}_2|\cos\theta_2$$

$$\boldsymbol{I}X = |\boldsymbol{V}_2|\sin\theta_2 + j[1 - |\boldsymbol{V}_2|\cos\theta_2]$$

$$\boldsymbol{I} = \frac{|\boldsymbol{V}_2|}{X}\sin\theta_2 + j\left[\frac{1 - |\boldsymbol{V}_2|\cos\theta_2}{X}\right]$$

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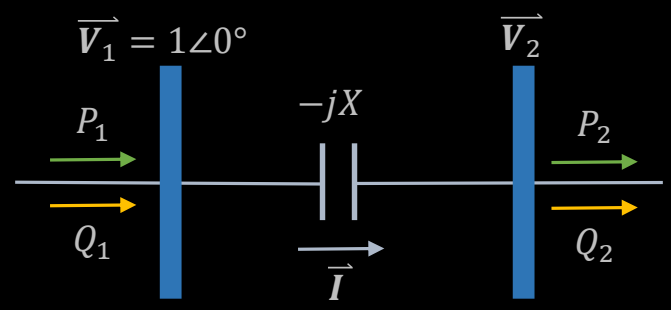

$$\boldsymbol{S}_1 = \boldsymbol{V}_1\boldsymbol{I}^* = 1\angle 0°\boldsymbol{I}^* = \boldsymbol{I}^*$$
$$\boldsymbol{S}_1^* = \boldsymbol{I}$$

$$\boldsymbol{S}_1^* = \boldsymbol{I}$$
$$P_1 - jQ_1 = \frac{|\boldsymbol{V}_2|}{X}\sin\theta_2 + j\left[\frac{1 - |\boldsymbol{V}_2|\cos\theta_2}{X}\right]$$
$$P_1 = \frac{|\boldsymbol{V}_2|}{X}\sin\theta_2$$
$$Q_1 = \frac{|\boldsymbol{V}_2|\cos\theta_2 - 1}{X}$$
$$Q_1X = |\boldsymbol{V}_2|\cos\theta_2 - 1$$
$$Q_1X + 1 = |\boldsymbol{V}_2|\cos\theta_2$$
$$|\boldsymbol{V}_2| = \frac{Q_1X + 1}{\cos\theta_2}$$
$$\Delta V = |\boldsymbol{V}_2| - |\boldsymbol{V}_1| = |\boldsymbol{V}_2| - 1$$
$$\Delta V = \frac{Q_1X + 1}{\cos\theta_2} - 1$$

$$\boldsymbol{S}_1^* = \boldsymbol{I}$$
$$P_1 - jQ_1 = \frac{1 - \boldsymbol{V}_2}{-jX} = \frac{\boldsymbol{V}_2 - 1}{jX}$$
$$jP_1X + Q_1X = \boldsymbol{V}_2 - 1$$
$$\boldsymbol{V}_2 = (Q_1X + 1) + jP_1X$$
$$|\boldsymbol{V}_2| = \sqrt{(Q_1X + 1)^2 + (P_1X)^2}$$
$$\theta_2 = \tan^{-1}\left[\frac{P_1X}{Q_1X + 1}\right]$$

$$|\boldsymbol{V}_2| = \sqrt{(Q_1X + 1)^2 + (P_1X)^2}$$
$$\theta_2 = \tan^{-1}\left[\frac{P_1X}{Q_1X + 1}\right]$$

if θ_2 is small:

$$\Delta V \approx Q_1X$$

series capacitor reactance (X) is a positive value

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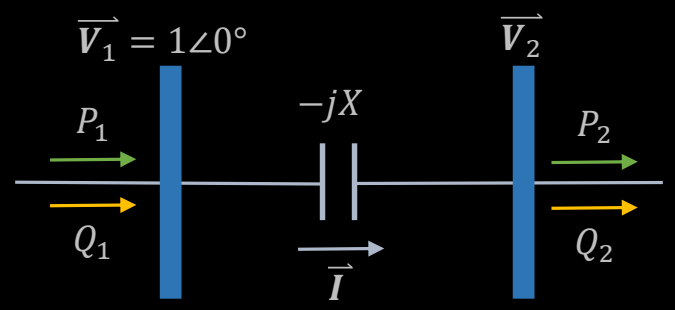

$$\boldsymbol{S}_2 = \boldsymbol{V}_2 \boldsymbol{I}^*$$
$$\boldsymbol{S}_1^* = \boldsymbol{V}_2^* \boldsymbol{I}$$
$$P_2 - jQ_2 = \boldsymbol{V}_2^* \left[\frac{1 - \boldsymbol{V}_2}{-jX}\right] = \frac{|\boldsymbol{V}_2|^2 - \boldsymbol{V}_2^*}{jX}$$
$$jP_2X + Q_2X = |\boldsymbol{V}_2|^2 - \boldsymbol{V}_2^*$$
$$jP_2X + Q_2X = |\boldsymbol{V}_2|^2 - |\boldsymbol{V}_2|[\cos\theta_2 - j\sin\theta_2]$$
$$jP_2X + Q_2X = |\boldsymbol{V}_2|^2 - |\boldsymbol{V}_2|\cos\theta_2 + j|\boldsymbol{V}_2|\sin\theta_2$$
$$P_2X = |\boldsymbol{V}_2|\sin\theta_2$$
$$Q_2X = |\boldsymbol{V}_2|^2 - |\boldsymbol{V}_2|\cos\theta_2$$
$$P_2 = \frac{|\boldsymbol{V}_2|\sin\theta_2}{X}$$
$$Q_2 = \frac{|\boldsymbol{V}_2|^2 - |\boldsymbol{V}_2|\cos\theta_2}{X}$$

$$\Delta Q = Q_2 - Q_1$$
$$\Delta Q = \frac{|\boldsymbol{V}_2|^2 - |\boldsymbol{V}_2|\cos\theta_2}{X} - \frac{|\boldsymbol{V}_2|\cos\theta_2 - 1}{X}$$
$$\Delta Q = \frac{|\boldsymbol{V}_2|^2 - 2|\boldsymbol{V}_2|\cos\theta_2 + 1}{X}$$

series capacitor reactance (X) is a positive value

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Questions or Comments …

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