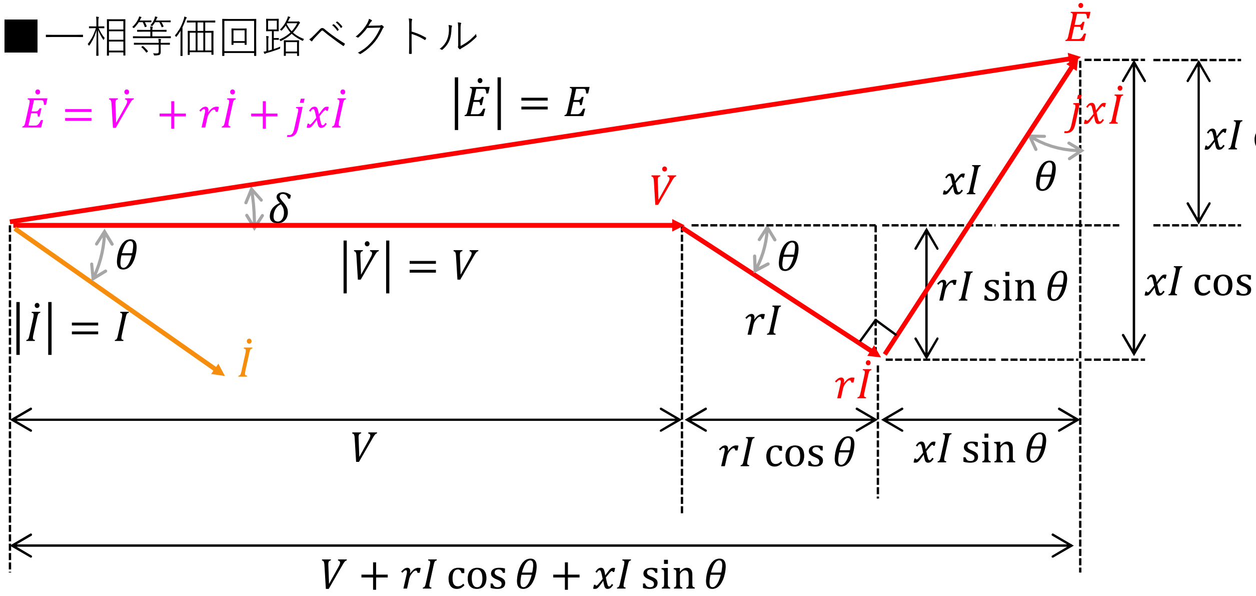
送配電（１）　《電圧降下(三相３線式)》

■一相等価回路ベクトル

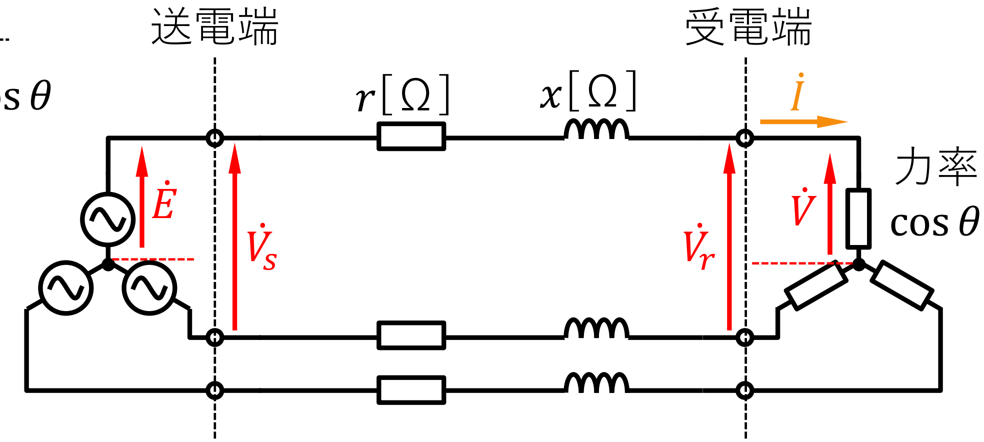
$\dot{E} = \dot{V} + r\dot{I} + jx\dot{I}$



δが小さければ

$xI\cos\theta - rI\sin\theta \fallingdotseq 0$

$$\begin{cases} |\dot{V}_s| = \sqrt{3}|\dot{E}| & E = \dfrac{\dot{V}_s}{\sqrt{3}} \\ |\dot{V}_r| = \sqrt{3}|V| & V = \dfrac{\dot{V}_r}{\sqrt{3}} \end{cases}$$



$$E = \sqrt{(V + rI\cos\theta + xI\sin\theta\ )^2 + \underbrace{(xI\cos\theta - rI\sin\theta\ )^2}_{\fallingdotseq 0}}$$

相電圧：$E \fallingdotseq V + rI\cos\theta + xI\sin\theta = V + I(\underbrace{r\cos\theta + x\sin\theta}_{\text{等価抵抗}})$

電圧降下

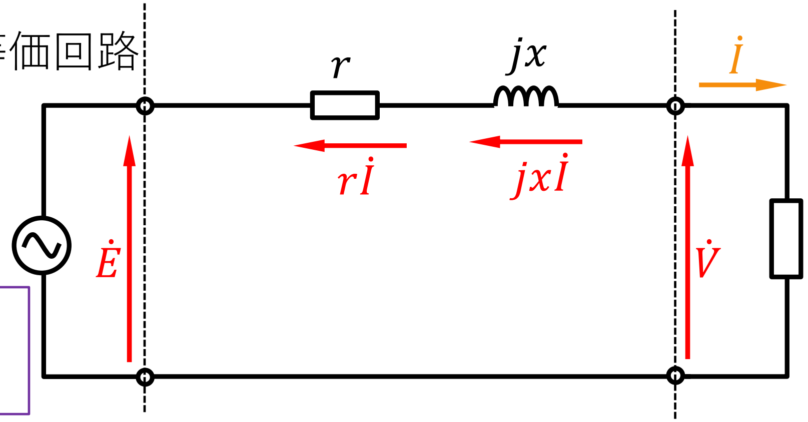
線電圧：$\dfrac{\dot{V}_s}{\sqrt{3}} \fallingdotseq \dfrac{\dot{V}_r}{\sqrt{3}} + I(r\cos\theta + x\sin\theta)$

$\dot{V}_s \fallingdotseq \dot{V}_r + \sqrt{3}I(r\cos\theta + x\sin\theta)$

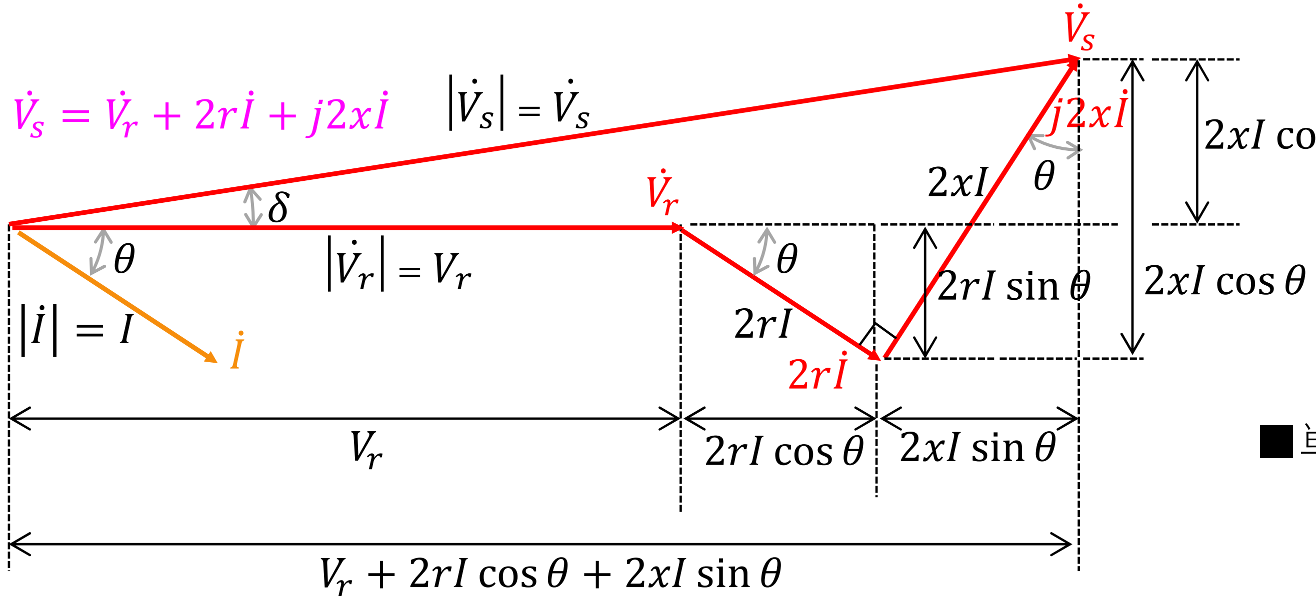
三相３線式の電圧降下

$\boldsymbol{\sqrt{3}I(r\cos\theta + x\sin\theta)}$

■一相等価回路



送配電（1）　《電圧降下(単相２線式)》



δが小さければ

$2xI\cos\theta - 2rI\sin\theta \fallingdotseq 0$

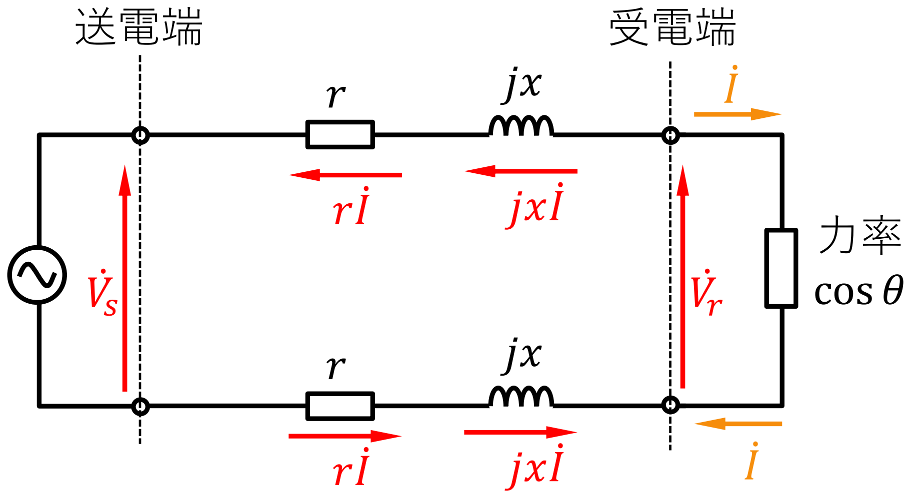
$$V_s = \sqrt{(V_r + 2rI\cos\theta + 2xI\sin\theta\ )^2 + (\underbrace{2xI\cos\theta - 2rI\sin\theta}_{\fallingdotseq 0}\ )^2}$$

$$\dot{V}_s \fallingdotseq \dot{V}_r + 2I(r\cos\theta + x\sin\theta)$$

単相２線式の電圧降下

$\boldsymbol{2I(r\cos\theta + x\sin\theta)}$

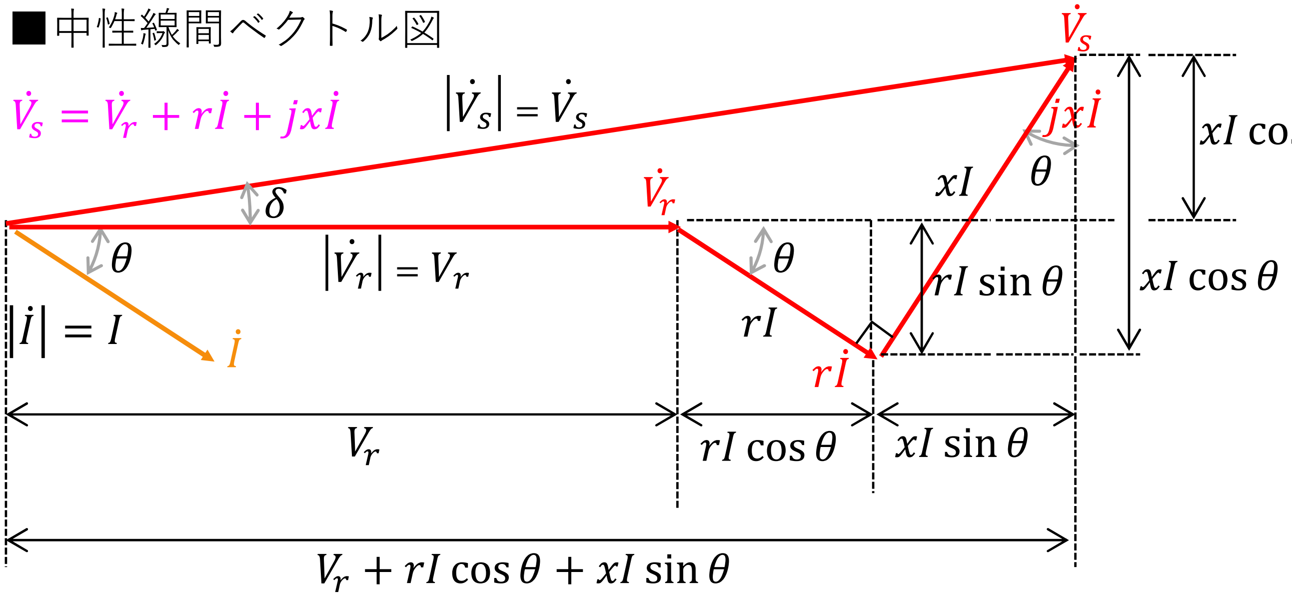
■単相２線式回路



送配電（１）　《電圧降下(単相３線式)》

■中性線間ベクトル図

$\dot{V}_s = \dot{V}_r + r\dot{I} + jx\dot{I}$



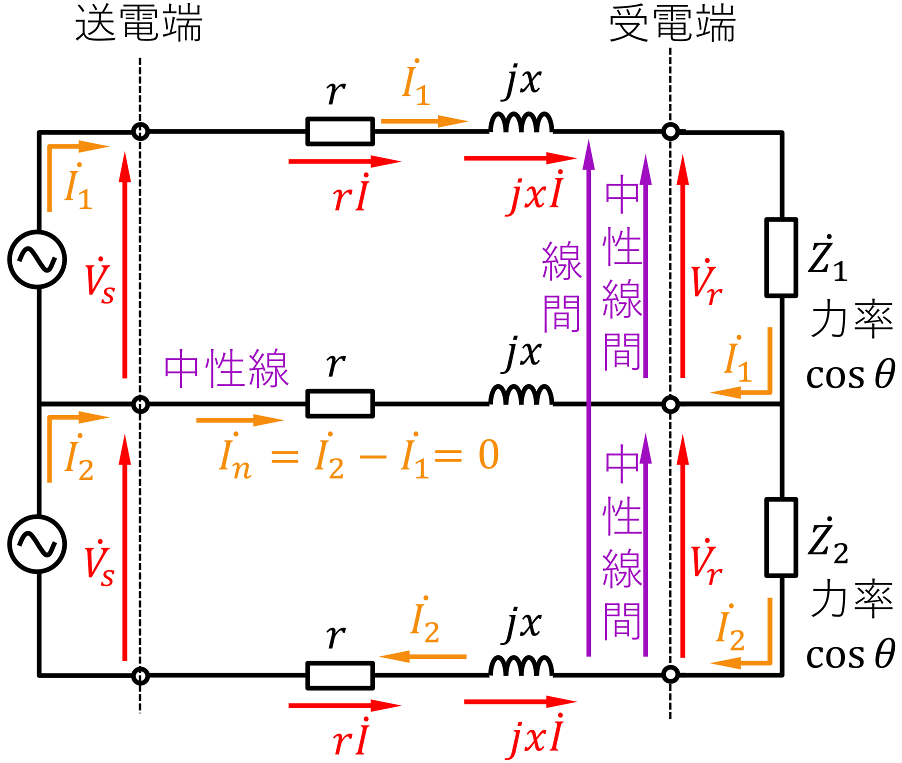
δが小さければ
$xI\cos\theta - rI\sin\theta \fallingdotseq 0$

$$V_s = \sqrt{(V_r + rI\cos\theta + xI\sin\theta\ )^2 + (\underbrace{xI\cos\theta - rI\sin\theta\ )^2}_{\fallingdotseq 0}}$$

$$\dot{V}_s \fallingdotseq \dot{V}_r + I(r\cos\theta + x\sin\theta)$$

■単相３線式回路

均等負荷$\dot{Z}_1 = \dot{Z}_2$の場合、$\dot{I}_1 = \dot{I}_2 = \dot{I}$



単相３線式の電圧降下(均等負荷)

中性線間　$I(r\cos\theta + x\sin\theta)$

線間　$2I(r\cos\theta + x\sin\theta)$

送配電（１） 《末端集中負荷の電圧降下》

■末端集中負荷

電圧降下の基本計算式

$$v_d = k r_e L I$$

等価抵抗 $r_e = r\cos\theta + x\sin\theta$ [Ω/m]

配電方式による係数 k

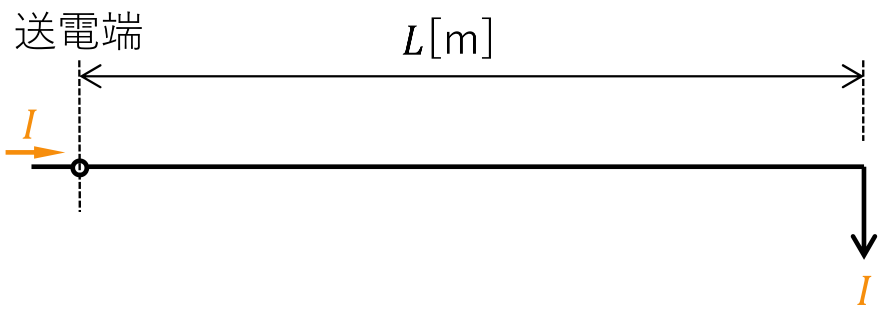
- 直流又は単相２線式 又は単相３線式(線間) $k = 2$
- 単相３線式(中性線間) 又は三相４線式(中性線間) $k = 1$
- 三相３線式 又は三相４線式(線間) $k = \sqrt{3}$

簡略計算式 （電線の断面積 A [mm²]）

$$v_d = \frac{35.6LI}{1000A} = 2r_eLI = 2 \times \frac{17.8}{A \times 10^3} \times LI$$

$$v_d = \frac{17.8LI}{1000A} = r_eLI = \frac{17.8}{A \times 10^3} \times LI$$

$$v_d = \frac{30.8LI}{1000A} = \sqrt{3}r_eLI = \sqrt{3} \times \frac{17.8}{A \times 10^3} \times LI$$



簡略計算式の前提条件

硬質銅の抵抗率 $\rho = 1.777 \times 10^{-8}$ [Ω・m] at 20°C

銅線の断面積 S [m^2] ※$S = A \times 10^{-6}$

抵抗[Ω/m] $r = \frac{\rho}{S} = \frac{1.777 \times 10^{-8}}{S} = \frac{17.77}{S \times 10^9} \fallingdotseq \frac{17.8}{A \times 10^3}$

力率を1としたときの等価抵抗r_eは

$$r_e = r\cos\theta + x\sin\theta = r \times 1 + x \times 0 = \frac{17.8}{A \times 10^3}$$

送配電（1）:付録　《電圧降下(三相３線式)－別表現》

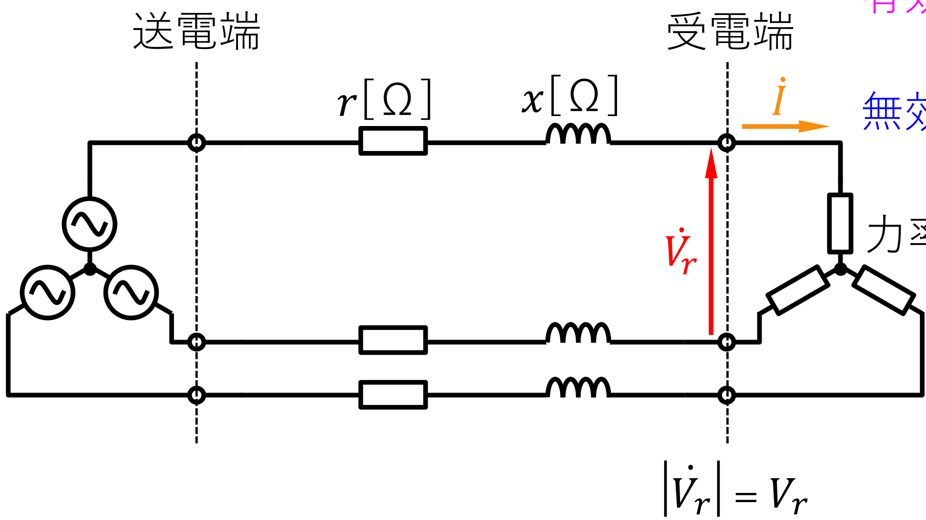
三相３線式の電圧降下

$$v_d = \sqrt{3}I(r\cos\theta + x\sin\theta)$$

$$= \frac{\sqrt{3}V_r I(r\cos\theta + x\sin\theta)}{V_r}$$

$$= \frac{\sqrt{3}V_r I\cos\theta \cdot r + \sqrt{3}V_r I\sin\theta \cdot x}{V_r}$$

$$= \frac{Pr + Qx}{V_r}$$



有効電力[W]：

$P = \sqrt{3}V_r I\cos\theta$

無効電力[var]：

$Q = \sqrt{3}V_r I\sin\theta$