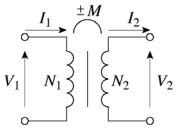
理想変成器

結合係数 $k=1$
励磁インダクタンス $L_1, L_2 \to \infty$



電流の向きに注意

(電圧比は巻数比に等しい)

$$V_1 = \pm\frac{N_1}{N_2}V_2$$
$$I_1 = \pm\frac{N_2}{N_1}I_2$$
$$\rightarrow V_1 I_1 = V_2 I_2 \quad \text{(無損失)}$$

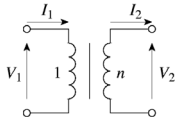
(電流比は巻数比の逆数に等しい)

$$Z_i = \left(\frac{N_1}{N_2}\right)^2 Z_L$$

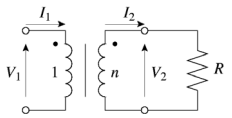
(インピーダンスは巻数比の2乗で変換される)

通常は巻数比で表記

$$n = \frac{N_2}{N_1}$$



(例)

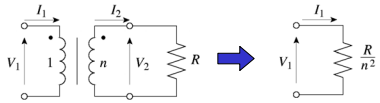


$n=10, \quad R=5\Omega, \quad V_1=3\text{V}$

I_1, I_2, V_2 ?

$$V_2 = nV_1 = 10\times 3 = 30\ \text{V}$$
$$I_2 = \frac{V_2}{R} = \frac{30}{5} = 6\ \text{A}$$
$$I_1 = nI_2 = 10\times 6 = 60\ \text{A}$$

(別解)



$$I_1 = \frac{V_1}{R/n^2} = \frac{3}{5/100} = 60\ \text{A}$$

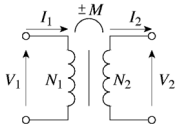
$$\rightarrow \begin{cases} V_2 = nV_1 = 10\times 3 = 30\ \text{V} \\ I_2 = \dfrac{I_1}{n} = \dfrac{60}{10} = 6\ \text{A} \end{cases}$$

理想変成器の関係式の導出

$$\begin{cases} V_1 = j\omega L_1 I_1 \mp j\omega M I_2 \\ V_2 = \pm j\omega M I_1 - j\omega L_2 I_2 \end{cases}$$

代入 ←　→ 変形

$$I_1 = \pm\frac{1}{j\omega M}V_2 \pm \frac{L_2}{M}I_2$$



$$\begin{cases} V_1 = \pm\dfrac{L_1}{M}V_2 \pm j\omega\left(\dfrac{L_1L_2}{M} - M\right)I_2 = \pm\dfrac{L_1}{M}V_2 \pm j\omega\left(\dfrac{L_1L_2(1-k^2)}{M}\right)I_2 \\ I_1 = \pm\dfrac{1}{j\omega M}V_2 \pm \dfrac{L_2}{M}I_2 \end{cases}$$

$k=1 \quad (M=\sqrt{L_1L_2})$
$L_1, L_2 \to \infty \quad (M \to \infty)$

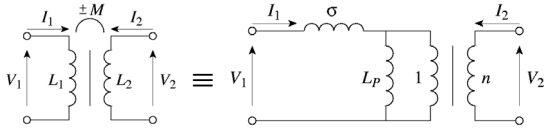
$$\begin{cases} V_1 = \pm\sqrt{\dfrac{L_1}{L_2}}V_2 \\ I_1 = \pm\sqrt{\dfrac{L_2}{L_1}}I_2 \end{cases}$$

$L_1 \propto N_1^2$
$L_1 \propto N_2^2$

$$\begin{cases} V_1 = \pm\dfrac{N_1}{N_2}V_2 \\ I_1 = \pm\dfrac{N_2}{N_1}I_2 \end{cases}$$

(電圧比は巻数比に等しい)
(電流比は巻数比の逆数に等しい)

一般の変成器の理想変成器による表現



二次側短絡

$$V_1 = j\omega\frac{L_1L_2 - M^2}{L_2}I_1 \qquad V_1 = j\omega\sigma I_1 \rightarrow \sigma = \frac{L_1L_2 + M^2}{L_2} = L_1(1-k^2)$$

二次側開放

$$V_1 = j\omega L_1 I_1 \qquad V_1 = j\omega(\sigma + L_P)I_1 \rightarrow L_P = L_1 - \sigma = k^2 L_1$$

一次側開放

$$V_2 = j\omega L_2 I_2 \qquad V_2 = j\omega(n^2 L_P)I_2 \rightarrow n = \sqrt{\frac{L_2}{L_P}} = \frac{1}{k}\sqrt{\frac{L_2}{L_1}}$$