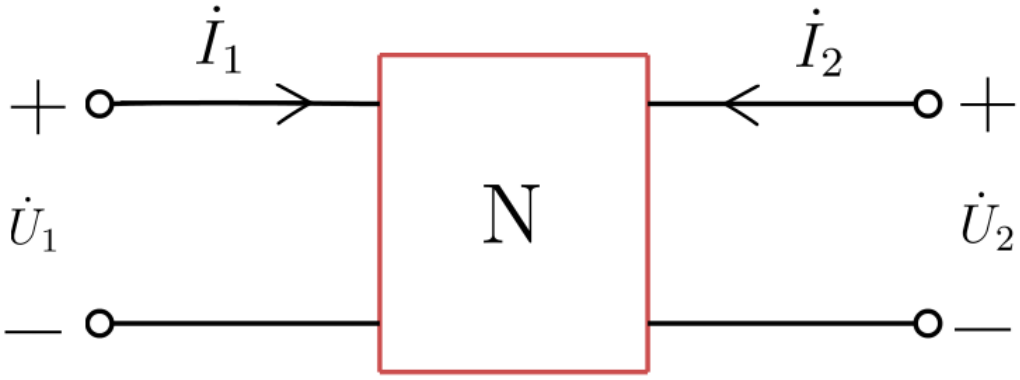
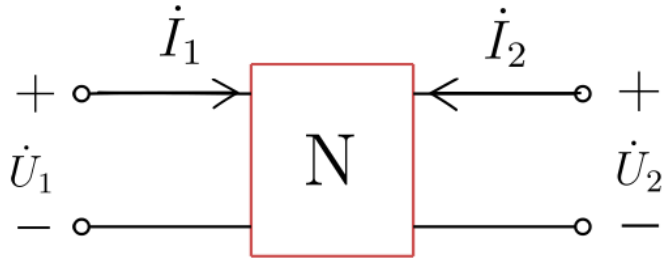
12-2　二端口的方程和参数

二端口网络有两个电压和两个电流，



为了体现二端口网络的电压电流关系，需要定义相应的参数。

*Z*参数　*Y*参数　*H*参数　*T*参数

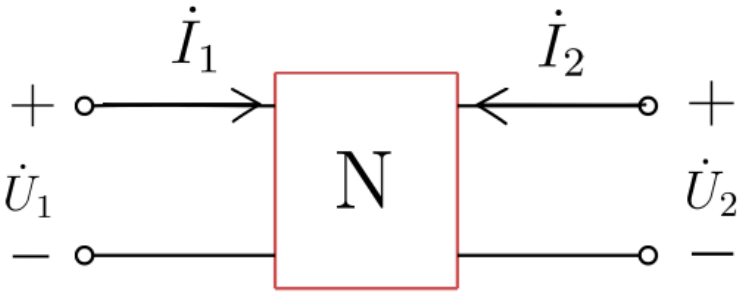


*Z*参数　用二端口电流表示二端口电压

$$\begin{aligned}\dot{U}_1 &= Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 &= Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2\end{aligned} \qquad \begin{bmatrix}\dot{U}_1 \\ \dot{U}_2\end{bmatrix} = \begin{bmatrix}Z_{11} & Z_{12} \\ Z_{21} & Z_{22}\end{bmatrix}\begin{bmatrix}\dot{I}_1 \\ \dot{I}_2\end{bmatrix} \qquad Z = \begin{bmatrix}Z_{11} & Z_{12} \\ Z_{21} & Z_{22}\end{bmatrix}$$ 称为*Z*参数。

*Z*参数又称为开路阻抗参数。这是因为，若要求出 Z_{11}，

可令 $\dot{I}_2 = 0$（端口2开路）　$Z_{11} = \dfrac{\dot{U}_1}{\dot{I}_1}$（阻抗）

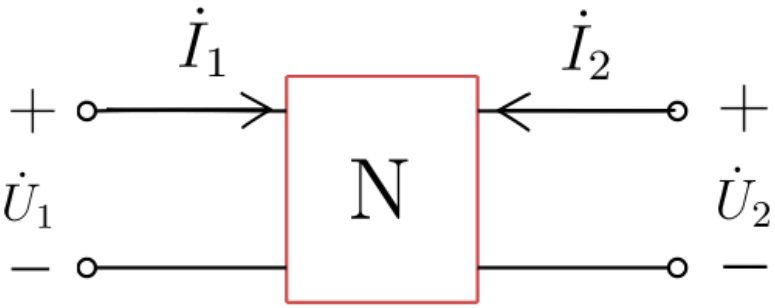


*Y*参数 用二端口电压表示二端口电流。

$$\begin{aligned}\dot{I}_1 &= Y_{11}\dot{U}_1 + Y_{12}\dot{U}_2\\ \dot{I}_2 &= Y_{21}\dot{U}_1 + Y_{22}\dot{U}_2\end{aligned} \qquad \begin{bmatrix}\dot{I}_1\\ \dot{I}_2\end{bmatrix} = \begin{bmatrix}Y_{11} & Y_{12}\\ Y_{21} & Y_{22}\end{bmatrix}\begin{bmatrix}\dot{U}_1\\ \dot{U}_2\end{bmatrix} \qquad Y = \begin{bmatrix}Y_{11} & Y_{12}\\ Y_{21} & Y_{22}\end{bmatrix}$$ 称为*Y*参数

*Y*参数又称短路导纳参数。这是因为，若要求Y_{11}，

可令$\dot{U}_2 = 0$（端口2短路） $Y_{11} = \dfrac{\dot{I}_1}{\dot{U}_1}$（导纳）

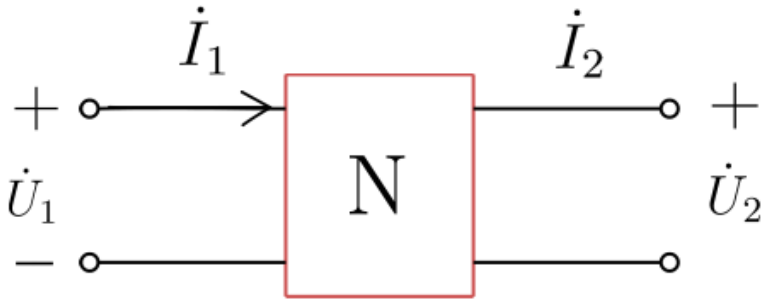


*H*参数 用 $\dot{I}_1, \dot{U}_2$ 表示 $\dot{U}_1, \dot{I}_2$

$$\begin{aligned}\dot{U}_1 &= H_{11}\dot{I}_1 + H_{12}\dot{U}_2\\ \dot{I}_2 &= H_{21}\dot{I}_1 + H_{22}\dot{U}_2\end{aligned} \qquad \begin{bmatrix}\dot{U}_1\\ \dot{I}_2\end{bmatrix} = \begin{bmatrix}H_{11} & H_{12}\\ H_{21} & H_{22}\end{bmatrix}\begin{bmatrix}\dot{I}_1\\ \dot{U}_2\end{bmatrix}$$

$$H = \begin{bmatrix}H_{11} & H_{12}\\ H_{21} & H_{22}\end{bmatrix}$$ 称为混合参数。

为什么叫混合参数，只要看上述方程有多难记就明白了。



*T*参数 用端口2的电压电流表示端口1的电压电流。

$$\dot{U}_1 = A\dot{U}_2 + B(-\dot{I}_2)$$
$$\dot{I}_1 = C\dot{U}_2 + D(-\dot{I}_2)$$

$$\begin{bmatrix}\dot{U}_1\\ \dot{I}_1\end{bmatrix} = \begin{bmatrix}A & B\\ C & D\end{bmatrix}\begin{bmatrix}\dot{U}_2\\ -\dot{I}_2\end{bmatrix}$$

$$T = \begin{bmatrix}A & B\\ C & D\end{bmatrix}$$

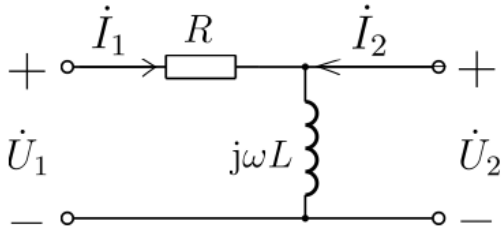
为什么叫传输参数?

是因为*T*参数体现了二端口左右两侧电压电流的传输关系。

$-\dot{I}_2$ 中的负号相当于将 $\dot{I}_2$ 反方向，这样更能体现传输的作用。

二端口网络参数的求解方法

例题



求二端口网络的*Z*参数和*T*参数。

$$\dot{U}_1 = R\dot{I}_1 + \dot{U}_2$$
$$\dot{U}_2 = \mathrm{j}\omega L(\dot{I}_1 + \dot{I}_2)$$

$$\dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2$$

$$\dot{U}_1 = R\dot{I}_1 + \mathrm{j}\omega L(\dot{I}_1 + \dot{I}_2)$$
$$= (R + \mathrm{j}\omega L)\dot{I}_1 + \mathrm{j}\omega L\dot{I}_2$$

$$\dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2$$

$$Z = \begin{bmatrix}R + \mathrm{j}\omega L & \mathrm{j}\omega L\\ \mathrm{j}\omega L & \mathrm{j}\omega L\end{bmatrix}$$

$$\dot{I}_1 = \frac{\dot{U}_2}{\mathrm{j}\omega L} + \frac{1}{\mathrm{j}\omega L}(-\dot{I}_2)$$

$$\dot{U}_1 = R\left[\frac{\dot{U}_2}{\mathrm{j}\omega L} + \frac{1}{\mathrm{j}\omega L}(-\dot{I}_2)\right] + \dot{U}_2$$

$$= (\frac{R}{\mathrm{j}\omega L} + 1)\dot{U}_2 + \frac{R}{\mathrm{j}\omega L}(-\dot{I}_2)$$

$$T = \begin{bmatrix}\frac{R}{\mathrm{j}\omega L} + 1 & \frac{R}{\mathrm{j}\omega L}\\ \frac{1}{\mathrm{j}\omega L} & \frac{1}{\mathrm{j}\omega L}\end{bmatrix}$$

先列写电压电流方程，再整理方程为所求参数对应的方程。