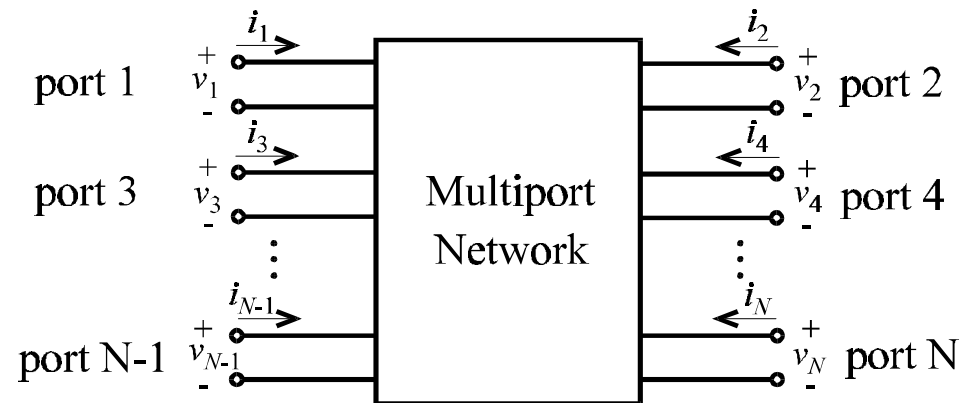
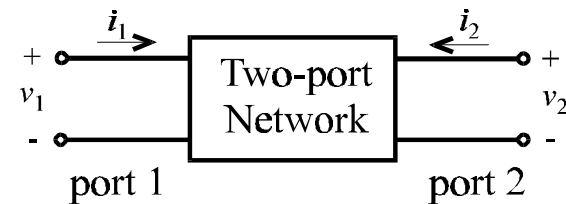
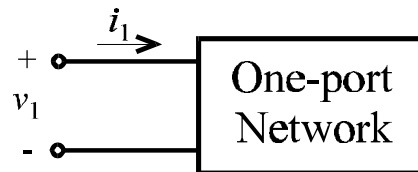


# Single and Multi-Port Networks

- basic current and voltage definitions



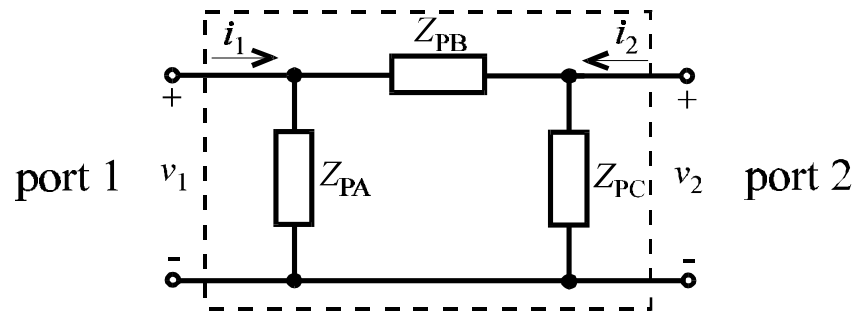
- Impedance and admittance networks


$$\{V\} = [Z]\{I\} \qquad \{I\} = [Y]\{V\}$$

$$\{V\} = [Z][Y]\{I\}$$

$$[Y]^{-1} = [Z]$$

- Example Z-representation of Pi-network



$$Z_{nm} = \frac{v_n}{i_m} \Big|_{i_k=0 (k \neq m)}$$

$$[Z] = \frac{1}{Z_{PA} + Z_{PB} + Z_{PC}} \begin{bmatrix} Z_{PA}(Z_{PB} + Z_{PC}) & Z_{PA}Z_{PC} \\ Z_{PA}Z_{PC} & Z_{PC}(Z_{PA} + Z_{PB}) \end{bmatrix}$$

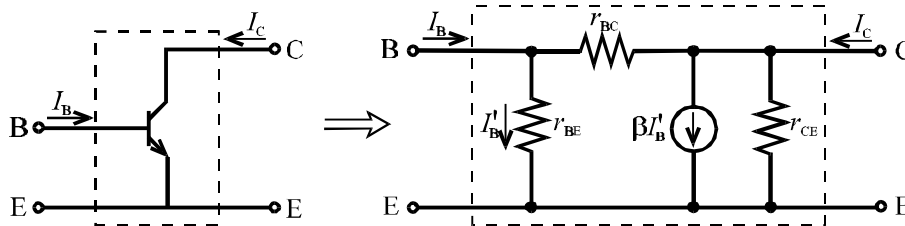
- Additional networks

$$\begin{bmatrix} v_1 \\ i_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} v_2 \\ -i_2 \end{bmatrix}$$

Chain or ABCD network  
(often used for cascading)

$$\begin{bmatrix} v_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} i_1 \\ v_2 \end{bmatrix}$$

Hybrid or h-network  
(often used for active devices)



Typical example  
of h-network  
(small signal, low  
frequency model)