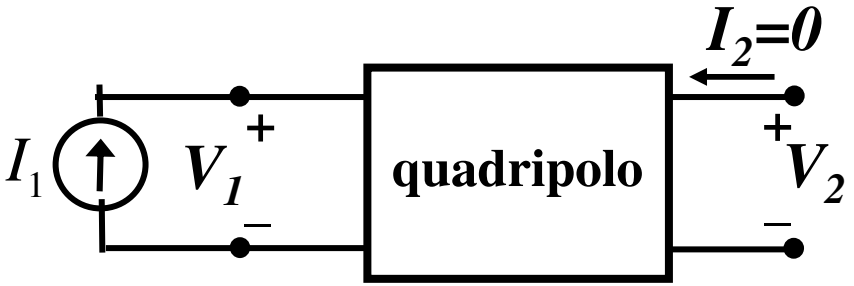
- **CARACTERIZAÇÃO:** **Estabelecimento de relações que envolvam V_1, I_1, V_2, I_2, no domínio da frequência, recorrendo-se à análise fasorial.**

- **PARÂMETROS DE IMPEDÂNCIA (I_1, I_2 variáveis independentes):**

$$\begin{cases} V_1 = Z_{11} I_1 + Z_{12} I_2 \\ V_2 = Z_{21} I_1 + Z_{22} I_2 \end{cases} \Leftrightarrow \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

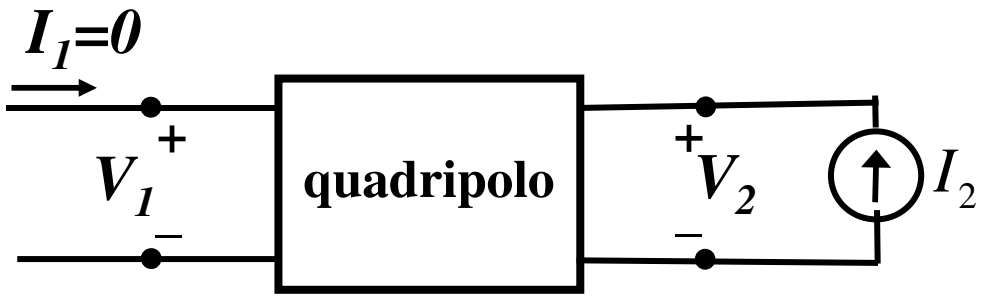
$$Z_{11} = \left. \frac{V_1}{I_1} \right|_{I_2=0} \qquad Z_{21} = \left. \frac{V_2}{I_1} \right|_{I_2=0}$$



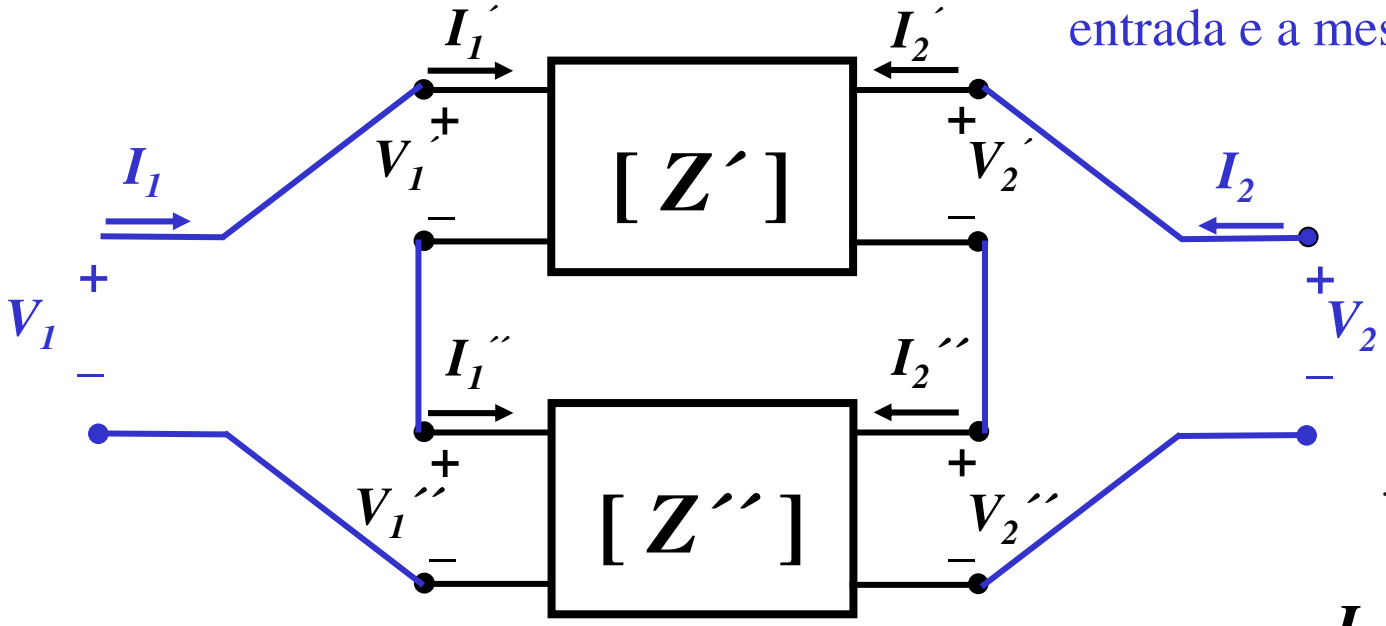
- **PARÂMETROS DE IMPEDÂNCIA (I_1, I_2 variáveis independentes):**

$$\begin{cases} V_1 = Z_{11} I_1 + Z_{12} I_2 \\ V_2 = Z_{21} I_1 + Z_{22} I_2 \end{cases} \Leftrightarrow \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

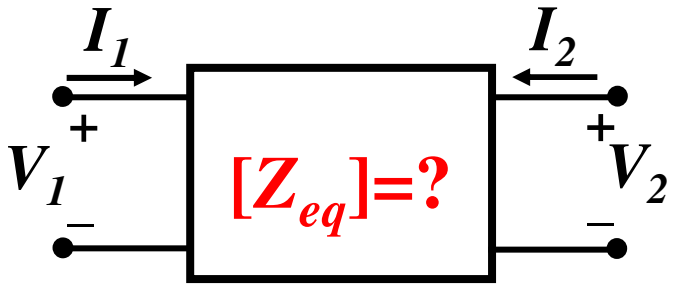
$$Z_{12} = \left. \frac{V_1}{I_2} \right|_{I_1=0} \qquad Z_{22} = \left. \frac{V_2}{I_2} \right|_{I_1=0}$$



LIGAÇÃO DE QUADRIPÓLOS EM SÉRIE: Partilham a mesma corrente de entrada e a mesma corrente de saída.



$$\begin{cases} V_1 = Z_{eq11} I_1 + Z_{eq12} I_2 \\ V_2 = Z_{eq21} I_1 + Z_{eq22} I_2 \end{cases}$$



$$Z_{eq11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} \qquad Z_{eq11} = Z'_{11} + Z''_{11}$$

$$Z_{eq22} = \left.\frac{V_2}{I_2}\right|_{I_1=0} \qquad Z_{eq22} = Z'_{22} + Z''_{22}$$

$$\left[Z_{eq}\right] = \left[Z'\right] + \left[Z''\right]$$

$$Z_{eq21} = \left.\frac{V_2}{I_1}\right|_{I_2=0} \qquad Z_{eq21} = Z'_{21} + Z''_{21}$$

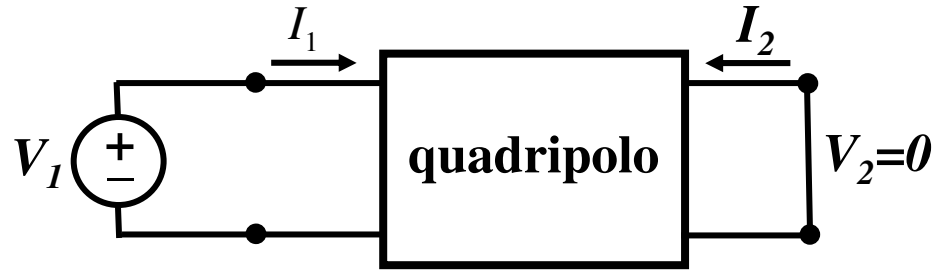
$$Z_{eq12} = \left.\frac{V_1}{I_2}\right|_{I_1=0} \qquad Z_{eq12} = Z'_{12} + Z''_{12}$$

PARÂMETROS DE ADMITÂNCIA

$$\begin{cases} I_1 = Y_{11}V_1 + Y_{12}V_2 \\ I_2 = Y_{21}V_1 + Y_{22}V_2 \end{cases} \Leftrightarrow \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$$[I] = [Y][V],$$

Y – Matriz de admitâncias



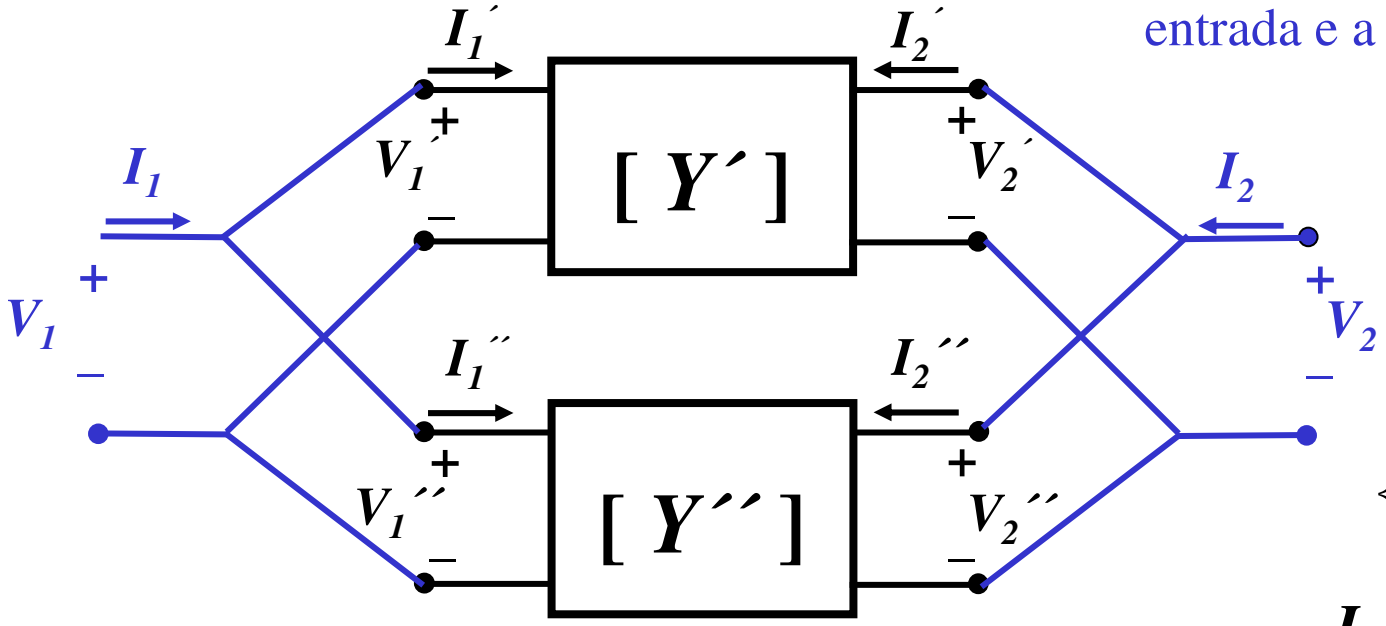
$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0}$: **Admitância de entrada**

$Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0}$: **Admitância de transferência inversa**

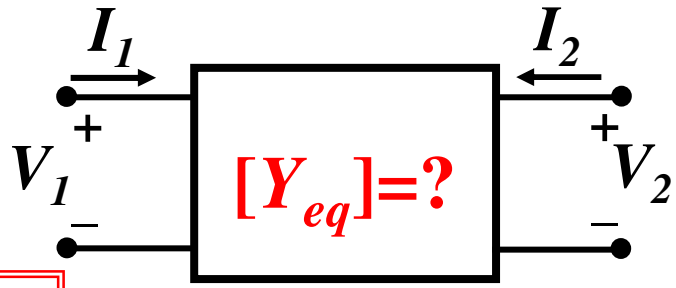
$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0}$: **Admitância de transferência directa**

$Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$: **Admitância de saída**

LIGAÇÃO DE QUADRIPÓLOS EM PARALELO: Partilham a mesma tensão de entrada e a mesma tensão de saída.



$$\begin{cases} I_1 = Y_{eq11}V_1 + Y_{eq12}V_2 \\ I_2 = Y_{eq21}V_1 + Y_{eq22}V_2 \end{cases}$$



$$Y_{eq11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} \qquad Y_{eq11} = Y_{11}^{'} + Y_{11}^{''}$$

$$Y_{eq22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} \qquad Y_{eq22} = Y_{22}^{'} + Y_{22}^{''}$$

$$\boxed{\left[Y_{eq}\right] = \left[Y^{'}\right] + \left[Y^{''}\right]}$$

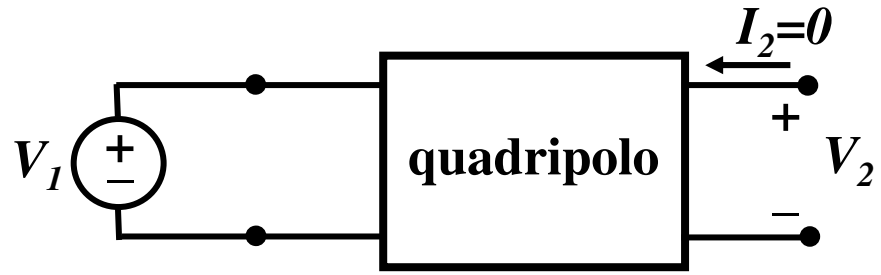
$$Y_{eq21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} \qquad Y_{eq21} = Y_{21}^{'} + Y_{21}^{''}$$

$$Y_{eq12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} \qquad Y_{eq12} = Y_{12}^{'} + Y_{12}^{''}$$

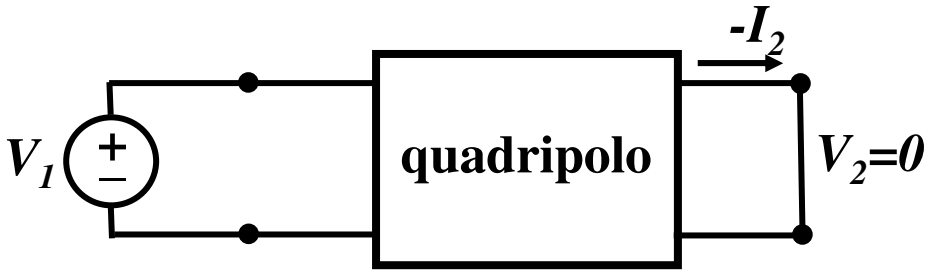
PARÂMETROS SÉRIE OU CASCATA

$$\begin{cases} V_1 = A_{11}V_2 - A_{12}I_2 \\ I_1 = A_{21}V_2 - A_{22}I_2 \end{cases} \qquad \begin{bmatrix} V_1 \\ I_1 \end{bmatrix}_2 = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

A **– Matriz dos parâmetros série**



$$A_{11} = \left.\frac{V_1}{V_2}\right|_{I_2=0}$$: **Ganho de tensão inverso**

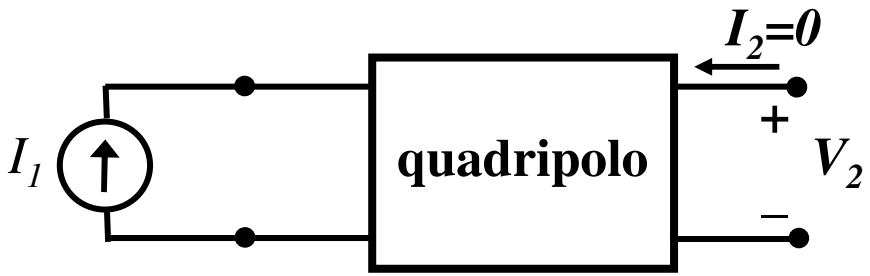


$$A_{12} = \left.\frac{V_1}{-I_2}\right|_{V_2=0}$$: **Inverso do ganho de transcondutância.**

PARÂMETROS SÉRIE OU CASCATA

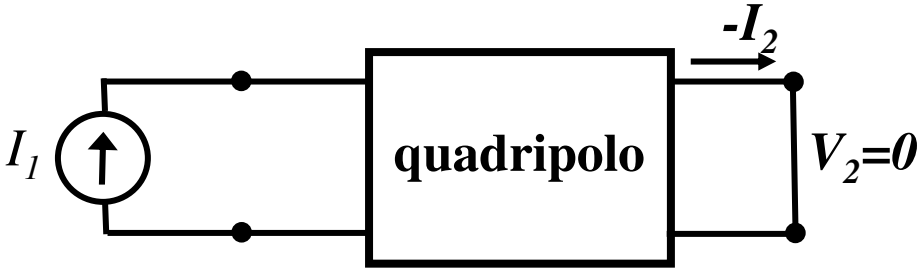
$$\begin{cases} V_1 = A_{11}V_2 - A_{12}I_2 \\ I_1 = A_{21}V_2 - A_{22}I_2 \end{cases} \qquad \begin{bmatrix} V_1 \\ I_1 \end{bmatrix}_2 = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

A – Matriz dos parâmetros série



$$A_{21} = \left.\frac{I_1}{V_2}\right|_{I_2=0} :$$

Inverso do ganho de transimpedância.



$$A_{22} = \left.\frac{I_1}{-I_2}\right|_{V_2=0} :$$

Ganho de corrente inverso.