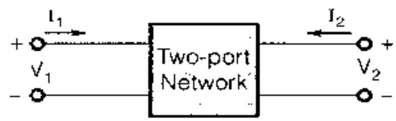
7

Two Port Network

Two Port Network



Driving Point Impedance and Admittance Functions

- Driving point impedance function

$$Z_{11}(s) = \frac{V_1(s)}{I_1(s)} \text{ and } Z_{22}(s) = \frac{V_2(s)}{I_2(s)}$$

- Driving point admittance function

$$Y_{11}(s) = \frac{I_1(s)}{V_1(s)} \text{ and } Y_{22}(s) = \frac{I_2(s)}{V_2(s)}$$

Impedance and Admittance Transfer Function

- Impedance Transfer Function

$$Z_{21}(s) = \frac{V_2(s)}{I_1(s)} \text{ and } Z_{12}(s) = \frac{V_1(s)}{I_2(s)}$$

- Admittance Transfer Function

$$Y_{21}(s) = \frac{I_2(s)}{V_1(s)} \text{ and } Y_{12}(s) = \frac{I_1(s)}{V_2(s)}$$

Voltage and Current Transfer Function

- Voltage transfer function

$$G_{12}(s) = \frac{V_1(s)}{V_2(s)} \text{ and } G_{21}(s) = \frac{V_2(s)}{V_1(s)}$$

- Current transfer function

$$\alpha_{12} = \frac{I_1(s)}{I_2(s)} \text{ and } \alpha_{21} = \frac{I_2(s)}{I_1(s)}$$

Parameters

Impedance or z-parameters (Open circuit parameters)

$$V_1 = z_{11} I_1 + z_{12} I_2$$
$$V_2 = z_{21} I_1 + z_{22} I_2$$

Admittance or y-parameters (Short circuit parameters)

$$I_1 = y_{11} V_1 + y_{12} V_2$$
$$I_2 = y_{21} V_1 + y_{22} V_2$$

h-parameters (Hybrid parameters)

$$V_1 = h_{11} I_1 + h_{12} V_2$$
$$I_2 = h_{21} I_1 + h_{22} V_2$$

g-parameters (Inverse hybrid parameters)

$$I_1 = g_{11} V_1 + g_{12} I_2$$
$$V_2 = g_{21} V_1 + g_{22} I_2$$

ABCD parameters (Transmission parameters)

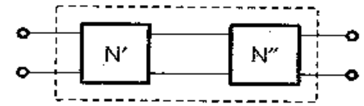
$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$

Conditions for a network to be symmetrical and reciprocal

Reciprocal	Symmetrical
$z_{12} = z_{21}$	$z_{11} = z_{22}$
$y_{12} = y_{21}$	$y_{11} = y_{22}$
$\begin{vmatrix} A & B \\ C & D \end{vmatrix} = 1$	$A = D$
$h_{12} = -h_{21}$	$\begin{vmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{vmatrix} = 1$
$g_{12} = -g_{21}$	$\begin{vmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{vmatrix} = 1$

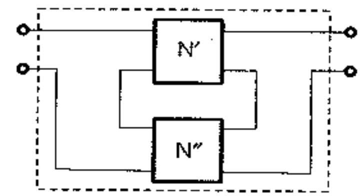
Interconnection Between two-port Network

Cascaded Network



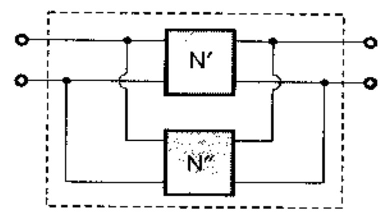
$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} A' & B' \\ C' & D' \end{bmatrix} \begin{bmatrix} A'' & B'' \\ C'' & D'' \end{bmatrix}$$

Series Network



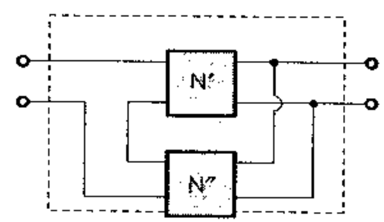
$$\begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} = \begin{bmatrix} z'_{11} + z''_{11} & z'_{12} + z''_{12} \\ z'_{21} + z''_{21} & z'_{22} + z''_{22} \end{bmatrix}$$

Parallel Network



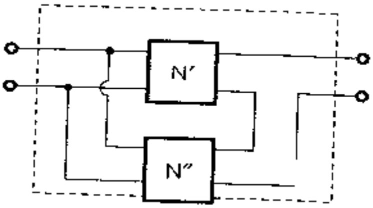
$$\begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} = \begin{bmatrix} y'_{11} + y''_{11} & y'_{12} + y''_{12} \\ y'_{21} + y''_{21} & y'_{22} + y''_{22} \end{bmatrix}$$

Series-parallel Network



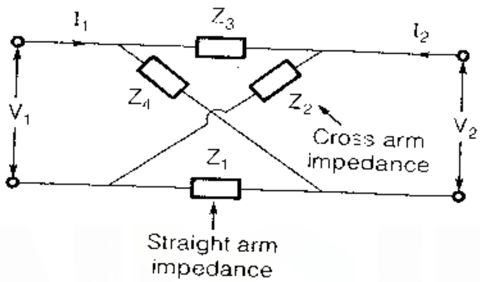
$$\begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} = \begin{bmatrix} h'_{11}+h''_{11} & h'_{12}+h''_{12} \\ h'_{21}+h''_{21} & h'_{22}+h''_{22} \end{bmatrix}$$

Parallel-series Network



$$\begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix} = \begin{bmatrix} g'_{11}+g''_{11} & g'_{12}+g''_{12} \\ g'_{21}+g''_{21} & g'_{22}+g''_{22} \end{bmatrix}$$

Lattice Network



1. A lattice network is said to be symmetrical if the two straight arm impedances are equal i.e. $Z_1 = Z_3$.

   Therefore, $$z_{11} = z_{22}$$

2. A lattice network is said to be reciprocal if the two cross arm impedances are equal i.e. $Z_2 = Z_4$.

   Therefore, $$z_{12} = z_{21}$$