UNIT 4

Two Port Networks

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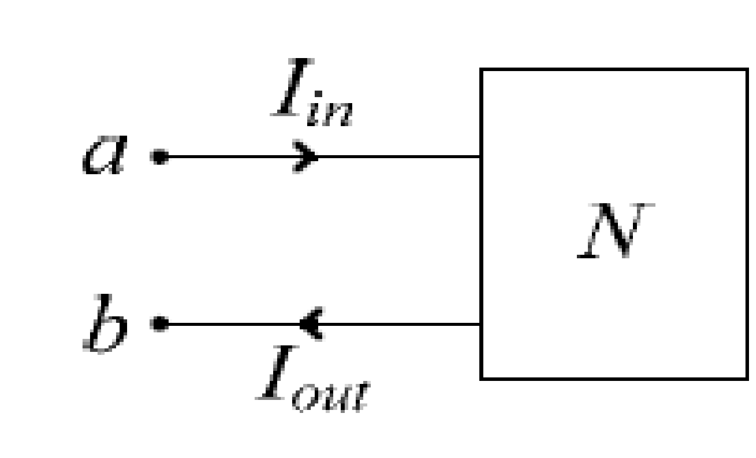
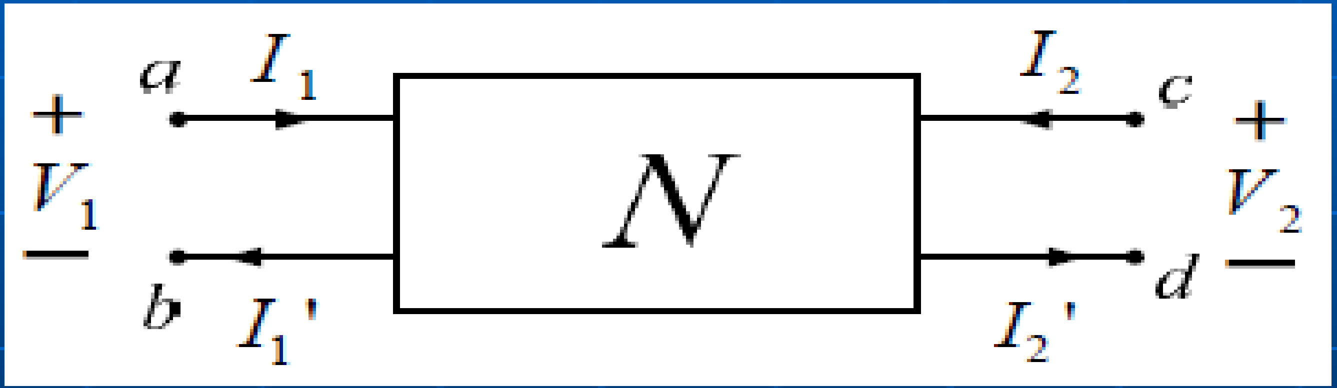
1. Introduction to two port networks

Consider a linear two-terminal circuit N consisting of no independent sources as follows :



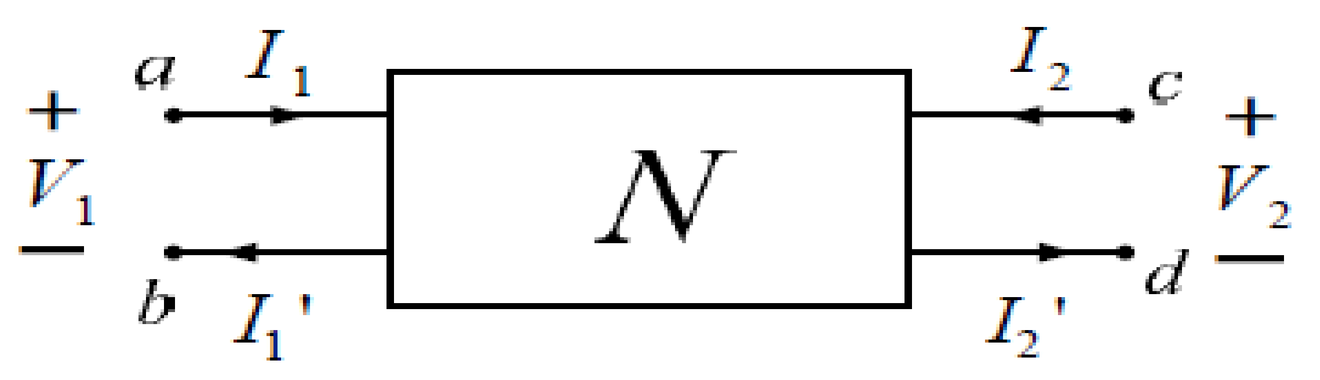
For a, b two terminals, if $I_{in} = I_{out}$, then it constitutes a port.

Now consider the following linear four-terminal circuit containing no independent sources.



with $I_1 = I_1'$
$I_2 = I_2'$

Then terminals a , b constitute the input port and terminals c , d constitute the output port.



No external connections exist between the input and output ports.

The two-port model is used to describe the performance of a circuit in terms of the voltage and current at its input and output ports.

Two-port circuits are useful in communications, control systems, power systems, and electronic systems.

They are also useful for facilitating cascaded design of more complex systems.

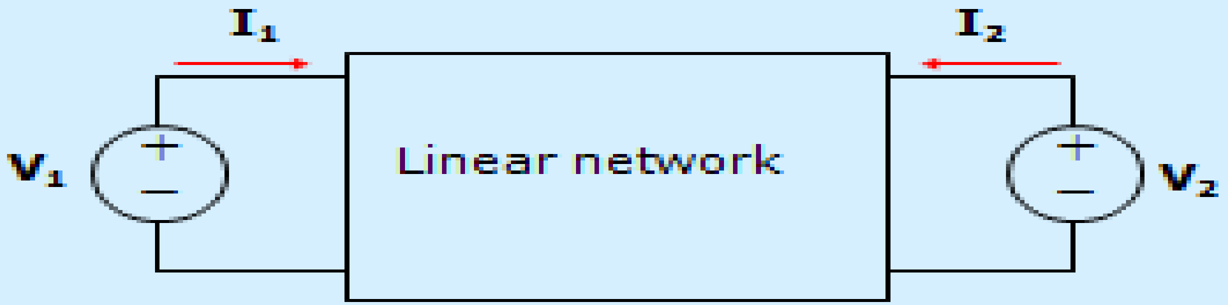
Z Parameters

Z – parameter also called as impedance parameter and the units is ohm (Ω)

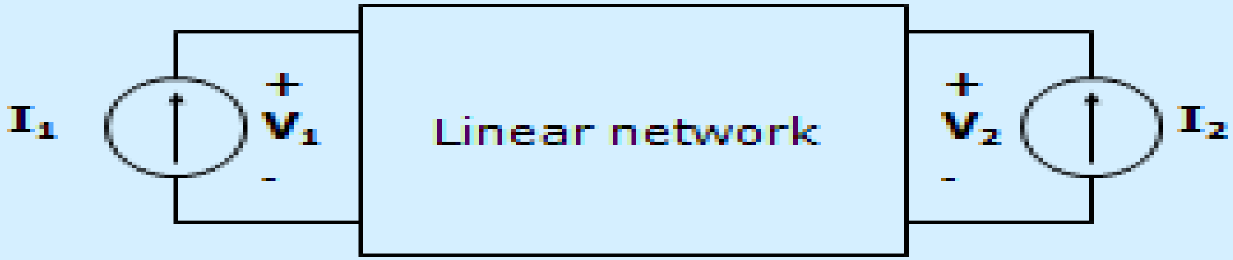
Impedance parameters is commonly used in the synthesis of filters and also useful in the design and analysis of impedance matching networks and power distribution networks.

The two – port network may be voltage – driven or current – driven.

- Two – port network driven by voltage source.



- Two – port network driven by current sources.



- The "black box" is replace with Z-parameter is as shown below.

- The terminal voltage can be related to the terminal current as:

$$V_1 = z_{11} I_1 + z_{12} I_2 \quad \text{------------} \quad (1)$$

$$V_2 = z_{21} I_1 + z_{22} I_2 \quad \text{------------} \quad (2)$$

- In matrix form as:

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

- The Z-parameter that we want to determine are z_{11}, z_{12}, z_{21}, z_{22}.
- The value of the parameters can be evaluated by setting:

  1. $I_1 = 0$ (input port open – circuited)
  2. $I_2 = 0$ (output port open – circuited)

$$z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} \qquad z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0}$$

$$z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0} \qquad z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0}$$

Where;

z_{11} = open – circuit input impedance.

z_{12} = open – circuit transfer impedance from port 1 to port 2.

z_{21} = open – circuit transfer impedance from port 2 to port 1.

z_{22} = open – circuit output impedance.

References

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