UNIT 4

Two Port Networks

GALGOTIAS UNIVERSITY

Contents

Y - PARAMETER

- Y – parameter also called admittance parameter and the units is siemens (S).
- The "black box" that we want to replace with the Y-parameter is shown below.

- The terminal current can be expressed in term of terminal voltage as:

$$I_1 = y_{11}V_1 + y_{12}V_2 \quad \text{——— (1)}$$

$$I_2 = y_{21}V_1 + y_{22}V_2 \quad \text{——— (2)}$$

- In matrix form:

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

- The y-parameter that we want to determine are Y_{11}, Y_{12}, Y_{21}, Y_{22}. The values of the parameters can be evaluate by setting:
  i) $V_1 = 0$ (input port short – circuited).
  ii) $V_2 = 0$ (output port short – circuited).

- Thus;

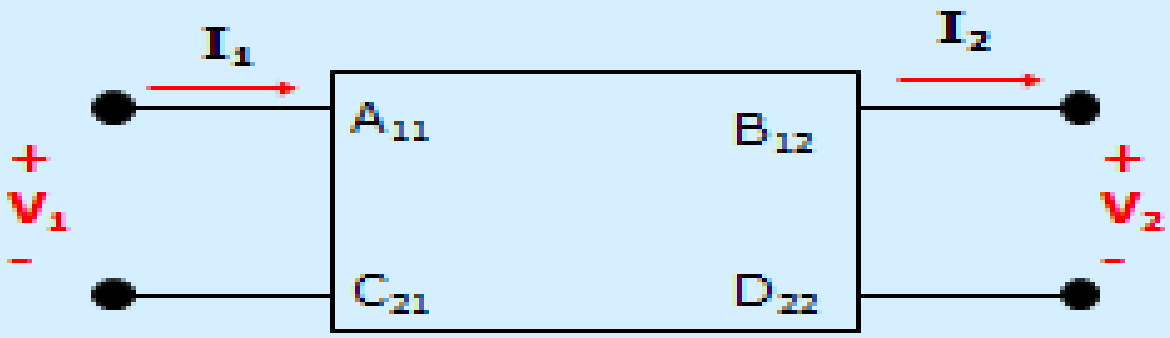
$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} \qquad Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0}$$

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} \qquad Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$$

T (ABCD) PARAMETER

- T – parameter or ABCD – parameter is a another set of parameters relates the variables at the input port to those at the output port.
- T – parameter also called *transmission parameters* because this parameter are useful in the analysis of transmission lines because they express sending – end variables (V_1 and I_1) in terms of the receiving – end variables (V_2 and $-I_2$).

- The "black box" that we want to replace with T – parameter is as shown below.



- The equation is:

$$V_1 = AV_2 - BI_2 \ldots\ldots(1)$$

$$I_1 = CV_2 - DI_2 \ldots\ldots(2)$$

- In matrix form is:

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

- The T – parameter that we want determine are A, B, C and D where A and D are dimensionless, B is in ohm (Ω) and C is in siemens (S).
- The values can be evaluated by setting
  i) $I_2 = 0$ (input port open – circuit)
  ii) $V_2 = 0$ (output port short circuit)

- Thus;

$$A = \left.\frac{V_1}{V_2}\right|_{I_2=0} \qquad B = \left.\frac{V_1}{I_2}\right|_{V_2=0}$$

$$C = \left.\frac{I_1}{V_2}\right|_{I_2=0} \qquad D = \left.\frac{I_1}{I_2}\right|_{V_2=0}$$

- In term of the transmission parameter, a network is reciprocal if;

$$AD - BC = 1$$

Summary

- A two-port network has an input port and an output port, each with each port involving a single current and a single voltage.
- If the two-port network is linear and does not contain any independent sources, it may be possible to characterize up to 6 different sets of matrix relationships. We discussed four: admittance [y], impedance [z], hybrid [h], and transmission [T]. If the parameters exist, they can be calculated or measured individually by short-circuiting or open-circuiting the appropriate port.
- A two-port network is reciprocal if $y_{12}=y_{21}$, $z_{12}=z_{21}$, $h_{12}=-h_{21}$. If the linear network only contains passive elements, it is reciprocal.
- When two-port networks are connected (a) in series, their impedance parameters add; (b) in parallel, their admittance parameters add; and (c) in cascade, their transmission parameters multiply.

References

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