Two-port Network parameters

Introduction: characterization of LTI two-port N/w.

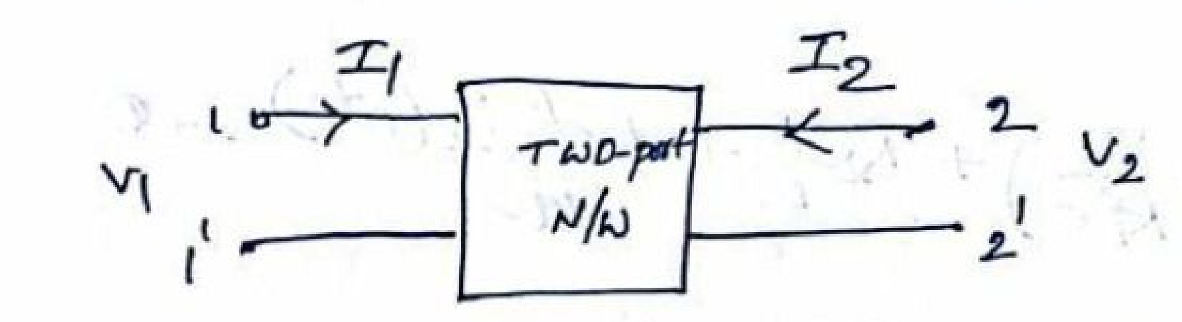
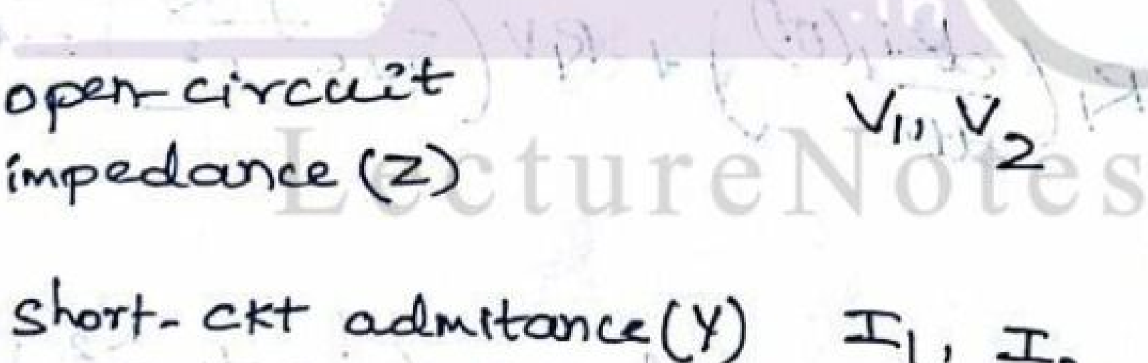


Fig 3.1.

A two-port Network is illustrated in fig. one of ports (labelled 1-1') is called input port 1, while other (labelled 2-2') is termed the output port 2. The External networks that maybe connected at input and output ports are called terminations.

Name of parameter.	Function. Express	In terms of
1. open-circuit impedance (Z)	V_1, V_2	I_1, I_2
2. Short-ckt admittance (Y)	I_1, I_2	V_1, V_2
3. Transmission (T) or ABCD parameters.	V_1, I_1	V_2, I_2
4. Inverse T	V_2, I_2	V_1, I_1
5. Hybrid (H)	V_1, I_2	I_1, V_2
6. Inverse hybrid (g)	I_1, V_2	V_1, I_2.

open circuit impedance parameters.



Expressing two-port voltages in terms of two-port currents.

$$(V_1, V_2) = f(I_1, I_2)$$

$$\left.\begin{aligned} V_1 &= Z_{11} I_1 + Z_{12} I_2 \\ V_2 &= Z_{21} I_1 + Z_{22} I_2 \end{aligned}\right\} \quad \text{--- (1)}$$

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

$$[V] = [Z][I].$$

Now, $Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0}$ i/p impedance with o/p port open-circuited.

$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0}$, forward transfer impedance with o/p port open-circuited.

$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0}$, reverse transfer impedance with i/p port open-circuited.

$Z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0}$, The o/p impedance with i/p port open-circuited.

$C = \left.\frac{I_1}{V_2}\right|_{I_2=0}$; transfer admittance with receiving end open-ckted.

$B = \left.\frac{V_1}{-I_2}\right|_{V_2=0}$; transfer impedance with receiving end short-circuited

$D = \left.\frac{I_1}{-I_2}\right|_{V_2=0}$; reverse current ratio with receiving end short-circuited.

Condition for reciprocity :-

For network to be reciprocal,

Apply V_S at sending end, with receiving end shorted.

$V_1 = V_S,\ V_2 = 0,\ -I_2 = I_2'$

so $V_S = B I_2'$

$I_2' / V_S = 1/B.$ --- (4)

Interchange position of excitation & response.

$V_1 = 0 \quad V_2 = V_S \quad I_1 = -I_1'$

Then T-parameter becomes

$0 = AV_S - BI_2$

$-I_1' = CV_S - DI_2$

on simplification, $-I_1' = CV_S - \frac{DA}{B}V_S = \frac{(BC-AD)V_S}{B}$

$\frac{I_1'}{V_S} = \frac{AD-BC}{B}$ --- (5)

In order to make reciprocal, (4) & (5) should be identical

$$\boxed{AD - BC = 1}$$

or $\begin{vmatrix} A & B \\ C & D \end{vmatrix} = 1.$