SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

OPTICAL AND MICROWAVE ENGINEERING

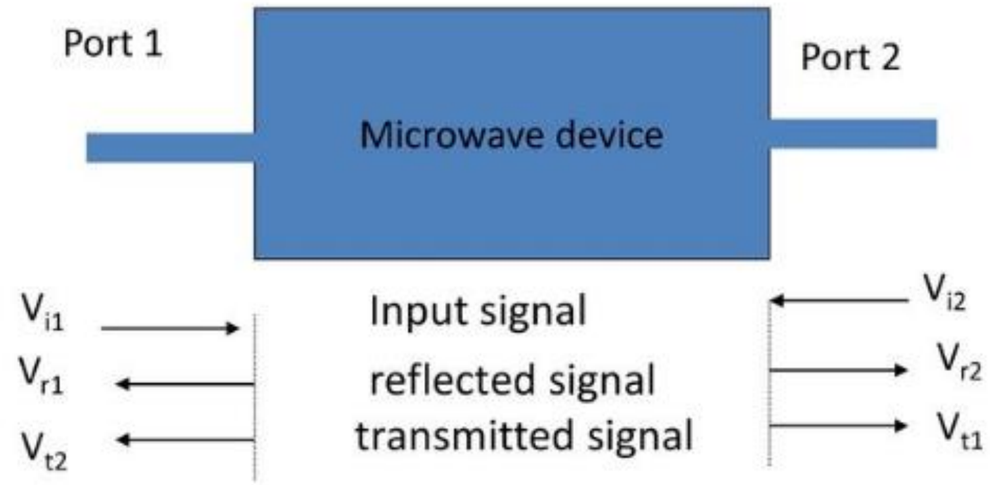
III YEAR/ VI SEMESTER

UNIT 1 – MICROWAVE PASSIVE DEVICES

S PARAMETERS

Guess the Topic????

S PARAMETERS

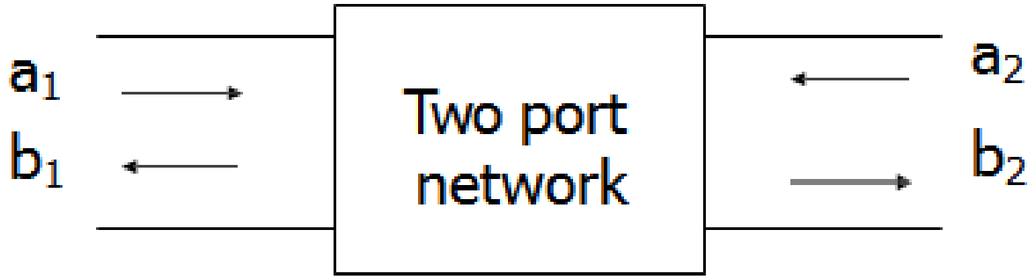


Transmission and reflection coefficients

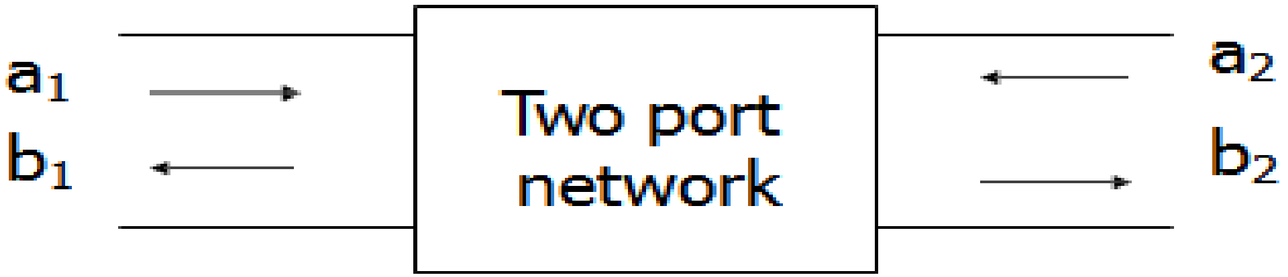
$$\tau = \frac{V_t}{V_i} \qquad \rho = \frac{V_r}{V_i}$$

S PARAMETERS

- Incident and reflected waves are being monitored instead.
- Resistive termination is employed.
- Active devices are normally quite stable under resistive termination.



Scattering Parameters



$$a_1 = \frac{v_{i,1}}{\sqrt{Z_o}} \qquad a_2 = \frac{v_{i,2}}{\sqrt{Z_o}}$$

$$b_1 = \frac{v_{r,1}}{\sqrt{Z_o}} \qquad b_2 = \frac{v_{r,2}}{\sqrt{Z_o}}$$

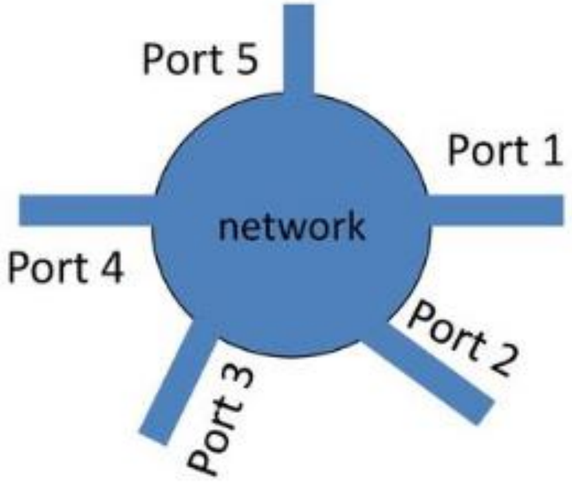
Scattering parameters

$$b_1 = S_{11}a_1 + S_{12}a_2$$

$$b_2 = S_{21}a_1 + S_{22}a_2$$

$$\Longrightarrow \quad \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \end{bmatrix}$$

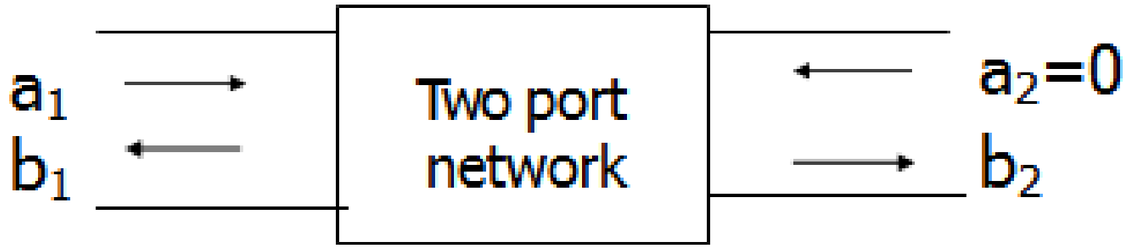
Multiport Network



$$\begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \\ b_5 \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} & S_{13} & S_{14} & S_{15} \\ S_{21} & S_{22} & S_{23} & S_{24} & S_{25} \\ S_{31} & S_{32} & S_{33} & S_{34} & S_{35} \\ S_{41} & S_{42} & S_{43} & S_{44} & S_{45} \\ S_{51} & S_{52} & S_{53} & S_{54} & S_{55} \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \end{bmatrix}$$

Scattering parameters

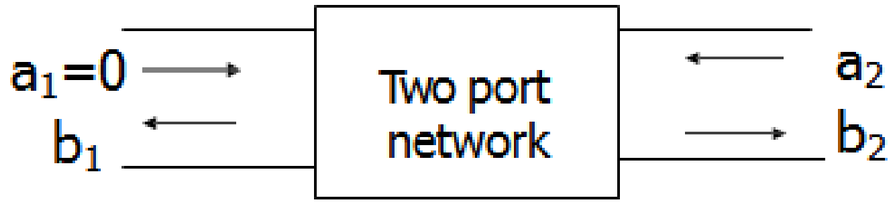
$$S_{11} = \left.\frac{b_1}{a_1}\right|_{a_2=0}$$ = reflection coefficient at port 1 with $a_2=0$



$$S_{21} = \left.\frac{b_2}{a_1}\right|_{a_2=0}$$ = forward transmission coefficient from port 1 to 2 with $a_2=0$

2-port network (new terms)

$$S_{12} = \left.\frac{b_1}{a_2}\right|_{a_1=0}$$ = reverse transmission coefficient from port 2 to 1 with $a_1=0$



$$S_{22} = \left.\frac{b_2}{a_2}\right|_{a_1=0}$$ = reflection coefficient at port 2 with $a_1=0$

Properties of S Matrix

Properties of S matrix

For m-port network, it is always square matrix with order m × m

$$\begin{bmatrix} b_1 \\ b_2 \\ . \\ . \\ b_{m-1} \\ b_m \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} & \cdots & \cdots & S_{1(m-1)} & S_{1m} \\ S_{21} & S_{22} & \cdots & \cdots & S_{2(m-1)} & S_{2m} \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ S_{(m-1)1} & S_{(m-1)2} & . & . & S_{(m-1)(m-1)} & S_{(m-1)m} \\ S_{m1} & S_{m2} & . & . & S_{m(m-1)} & S_{mm} \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \\ . \\ . \\ a_{m-1} \\ a_m \end{bmatrix}$$

Properties of S Matrix

Properties of S matrix

For lossless network, [S] matrix is unitary

$$[S][S]^{*} = I$$

$$\Rightarrow \begin{bmatrix} S_{ii} & S_{ij} \\ S_{ji} & S_{jj} \end{bmatrix} \begin{bmatrix} S_{ii} & S_{ij} \\ S_{ji} & S_{jj} \end{bmatrix}^{*} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

Properties of S matrix

[S] is symmetric for all reciprocal networks

$$[S] = [S]^{T}$$

$$\Rightarrow \begin{bmatrix} S_{ii} & S_{ij} \\ S_{ji} & S_{jj} \end{bmatrix} = \begin{bmatrix} S_{ii} & S_{ji} \\ S_{ij} & S_{jj} \end{bmatrix}$$

$$\Rightarrow S_{ij} = S_{ji}$$

Properties of S Matrix

Properties of S matrix

Under this condition

$$\sum_{i=1}^{N} S_{ij} S_{ij}^{*} = 1 \qquad \sum_{i=1}^{N} S_{ij} S_{ik}^{*} = 0$$

THANK YOU