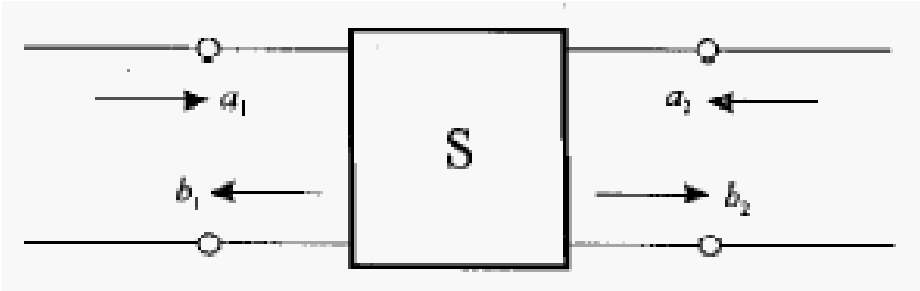
Network Analysis



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

Assumes linearity!

If port 2 is terminated by a perfect match of impedance Z_{02}, i.e. all of the incident energy is absorbed in the termination, we have the following properties

$$S_{11} = \left.\frac{b_1}{a_1}\right|_{a_2=0} \quad \text{and} \quad S_{21} = \left.\frac{b_2}{a_1}\right|_{a_2=0}.$$

The S-parameter representation equally applies to multi-port devices. For an n-port device, the S-parameter matrix is given by

$$\begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} & \cdots & S_{1n} \\ S_{21} & S_{22} & \cdots & S_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ S_{n1} & S_{n2} & \cdots & S_{nn} \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \\ \vdots \\ a_n \end{bmatrix}$$

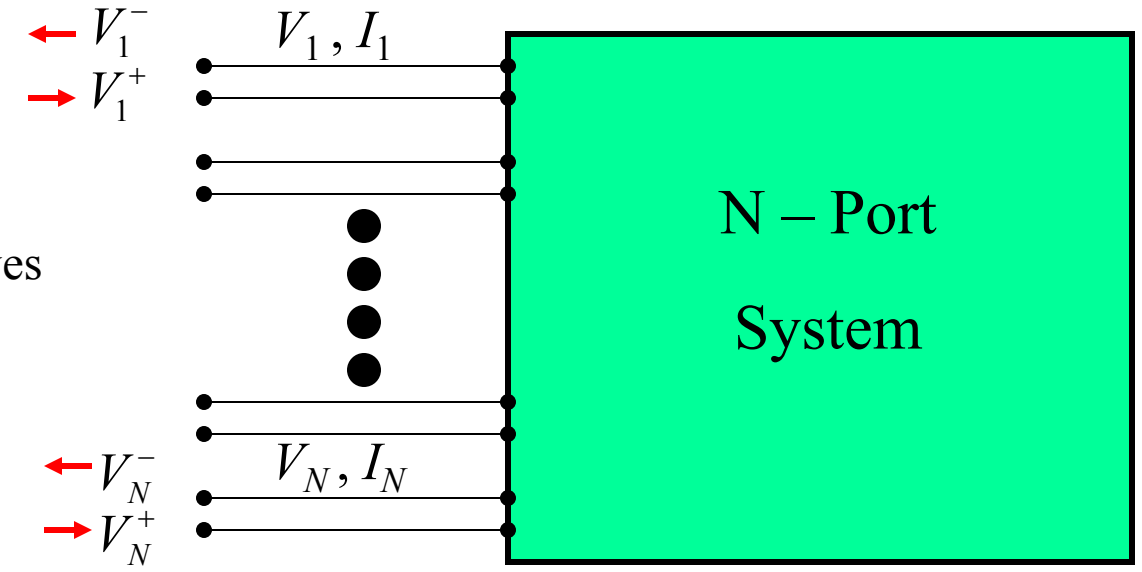
$$S_{ij} = \left.\frac{b_i}{a_j}\right|_{a_k=0 \text{ for } k \neq j}.$$

N-Port Description of an Arbitrary Enclosure

N Ports

← Voltages and Currents,

← Incoming and Outgoing Waves



S matrix

$$\begin{bmatrix} V^-_1 \\ V^-_2 \\ \bullet \\ \bullet \\ \bullet \\ V^-_N \end{bmatrix} = [S] \cdot \begin{bmatrix} V^+_1 \\ V^+_2 \\ \bullet \\ \bullet \\ \bullet \\ V^+_N \end{bmatrix}$$

Z matrix

$$\begin{bmatrix} V_1 \\ V_2 \\ \bullet \\ \bullet \\ \bullet \\ V_N \end{bmatrix} = [Z] \cdot \begin{bmatrix} I_1 \\ I_2 \\ \bullet \\ \bullet \\ \bullet \\ I_N \end{bmatrix}$$

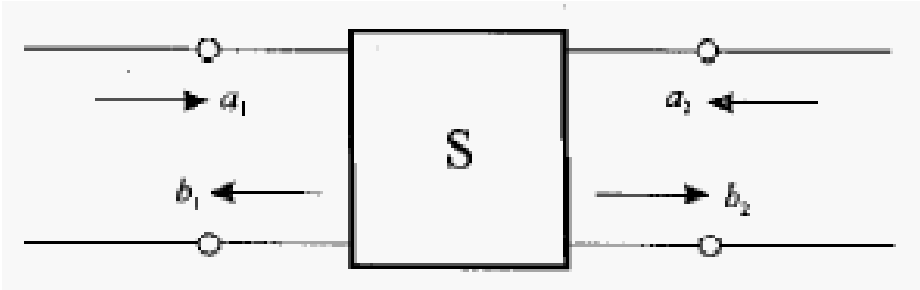
$$S = (Z + Z_0)^{-1}(Z - Z_0)$$

$$Z(\omega), S(\omega)$$

← Complicated Functions of frequency

← Detail Specific (Non-Universal)

Network Analysis



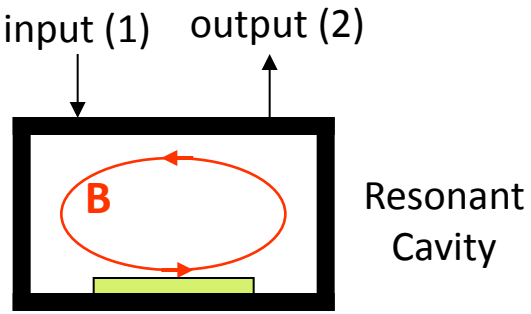
2-port system

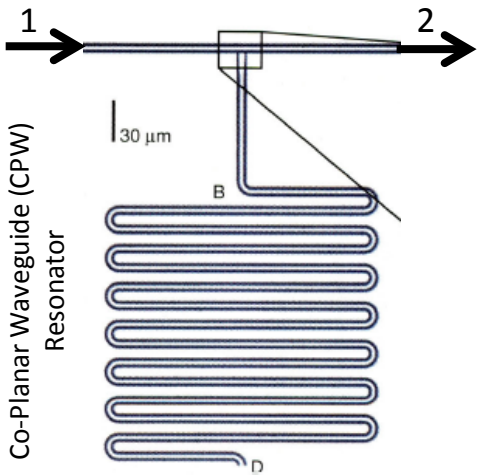
$$\begin{bmatrix} b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \end{bmatrix}$$

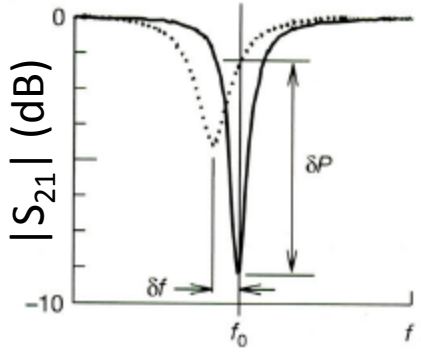
Assumes linearity!

If port 2 is terminated by a perfect match of impedance Z_{02}, i.e. all of the incident energy is absorbed in the termination, we have the following properties

$$S_{11} = \left.\frac{b_1}{a_1}\right|_{a_2=0} \quad \text{and} \quad S_{21} = \left.\frac{b_2}{a_1}\right|_{a_2=0}.$$







P. K. Day, Nature, 2003

$|S_{21}(f)|^2$