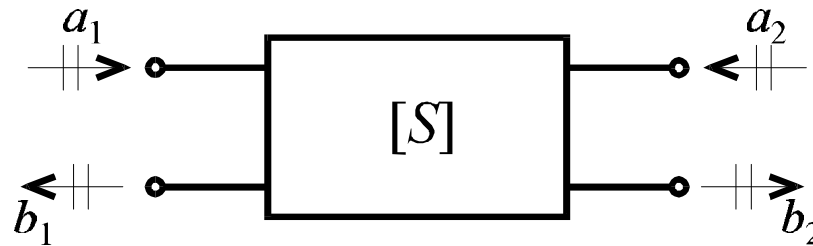# Scattering parameters

- There is a need to establish well-defined termination conditions in order to find the network descriptions for **Z**, **Y**, **h**, and **ABCD** networks

- Open and short voltage and current conditions are difficult to enforce

- RF implies forward and backward traveling waves which can form standing waves destroying the elements

Solution: S-parameters

- Input-output behavior of network is defined in terms of normalized power waves

- Ratio of the power waves are recorded in terms of so-called scattering parameters

- S-parameters are measured based on properly terminated transmission lines (and not open/short circuit conditions)

Measurements of Scattering Parameters

$$S_{11} = \frac{b_1}{a_1}\bigg|_{a_2=0}$$

$$S_{22} = \frac{b_2}{a_2}\bigg|_{a_1=0}$$

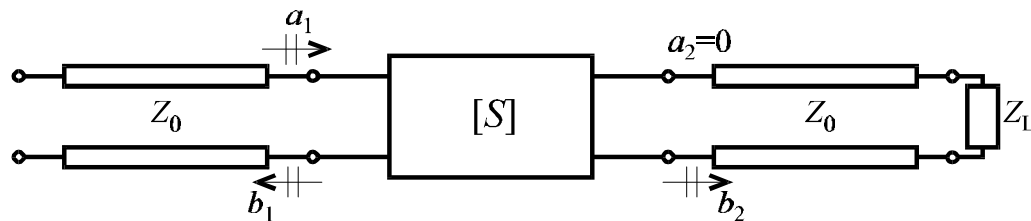$$S_{21} = \frac{b_2}{a_1}\bigg|_{a_2=0}$$

$$S_{12} = \frac{b_1}{a_2}\bigg|_{a_1=0}$$

Require proper termination on port 2

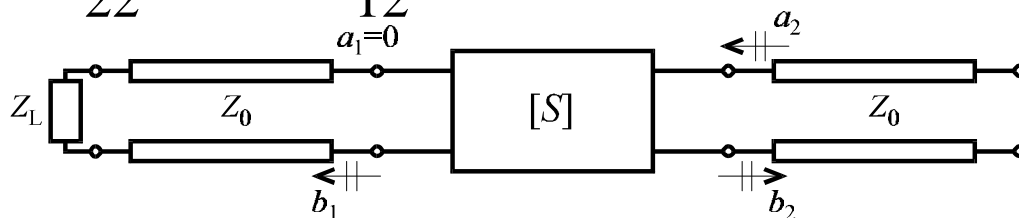Require proper termination on port 1

Arrangement for measuring S-parameters

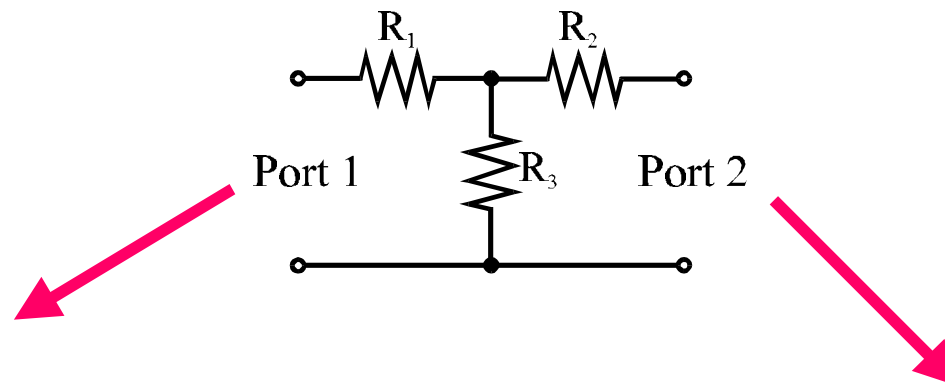- Properly terminated port 2 in order to make S_{11} and S_{21} measurements

Load impedance = line impedance

- Properly terminated port 1 in order to make S_{22} and S_{12} measurements
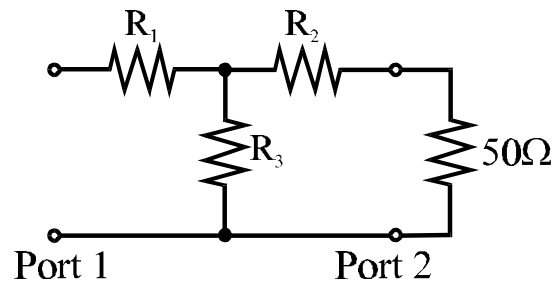

input impedance = line impedance

Example: S-parameters of T-network

Port 1 measurements

Port 2 measurements