

EE 3113

INTRODUCTION TO RF

CIRCUIT DESIGN

Lecture Notes for A-term 1999

LECTURE 15

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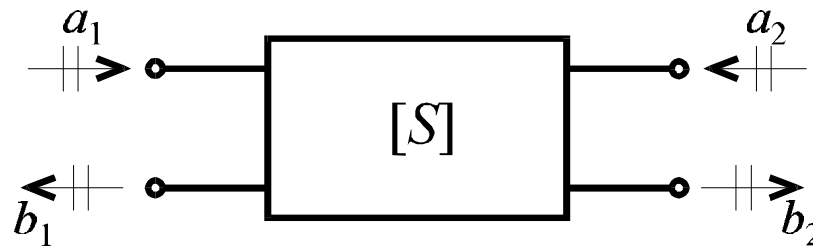
Scattering parameters

- 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



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

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

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

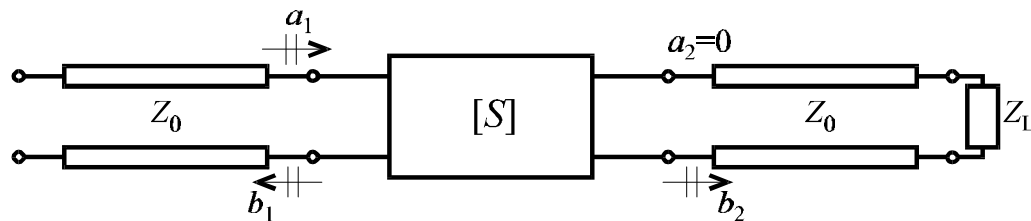
$$S_{12} = \frac{b_1}{a_2} \Big|_{a_1=0}$$

Require proper termination
on port 2

Require proper termination
on port 1

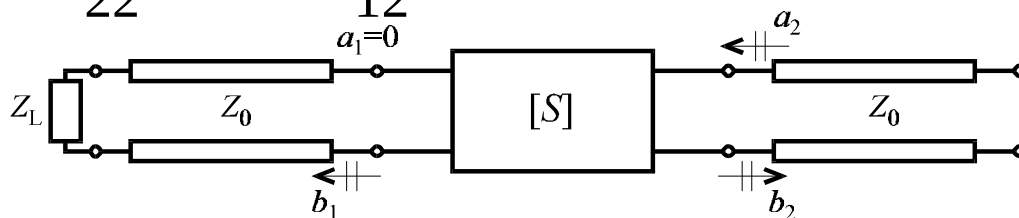
Arrangement for measuring S-parameters

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



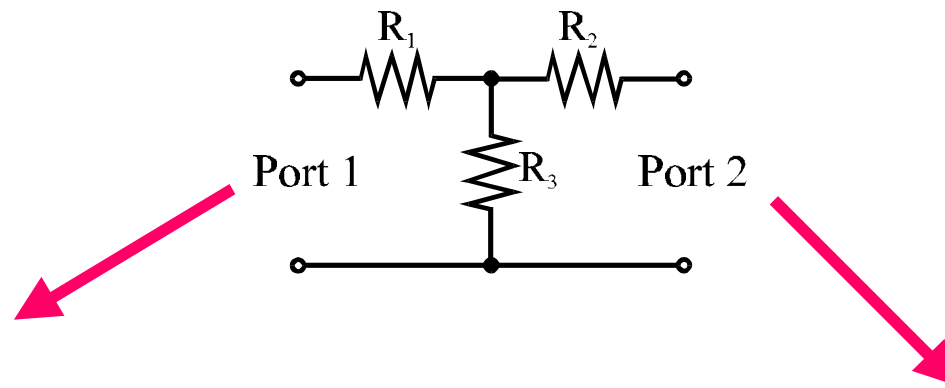
Load impedance =
line impedance

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

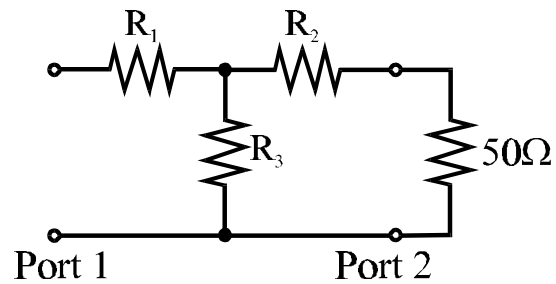


input impedance =
line impedance

Example: S-parameters of T-network



Port 1 measurements



Port 2 measurements

