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

\[ S_{11} = \frac{b_1}{a_1} \bigg|_{a_2=0} \]
\[ S_{21} = \frac{b_2}{a_1} \bigg|_{a_2=0} \]
\[ S_{22} = \frac{b_2}{a_2} \bigg|_{a_1=0} \]
\[ S_{12} = \frac{b_1}{a_2} \bigg|_{a_1=0} \]

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

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

Load impedance = line impedance

input impedance = line impedance
Example: S-parameters of T-network

Port 1 measurements

Port 2 measurements