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)
Basic configuration

\[ S_{11} = \left. \frac{b_1}{a_1} \right|_{a_2=0} = \frac{\text{reflected power wave at port1}}{\text{incident power wave at port1}} \]

\[ S_{21} = \left. \frac{b_2}{a_1} \right|_{a_2=0} = \frac{\text{transmitted power wave at port2}}{\text{incident power wave at port1}} \]

\[ S_{22} = \left. \frac{b_2}{a_2} \right|_{a_1=0} = \frac{\text{reflected power wave at port2}}{\text{incident power wave at port2}} \]

\[ S = \left. \frac{b_1}{a_2} \right|_{a_1=0} = \frac{\text{transmitted power wave at port1}}{\text{incident power wave at port2}} \]
Set-up for measuring S-parameters

• Properly terminated output

\[ Z_0 \]

\[ Z \]

\[ Z_1 \]

Load impedance = line impedance

• Properly terminated input side

\[ Z_1 \]

\[ Z_0 \]

\[ Z \]

\[ Z_1 \]

input impedance = line impedance