

The 4-Port Coupler

Guess what! I have determined that a matched, lossless, reciprocal **4-port** device is **physically possible!** In fact, I've found **two** possible solutions!



The two solutions are:

$$\bar{\mathbf{S}} = \begin{bmatrix} 0 & \alpha & j\beta & 0 \\ \alpha & 0 & 0 & j\beta \\ j\beta & 0 & 0 & \alpha \\ 0 & j\beta & \alpha & 0 \end{bmatrix}$$

and

$$\bar{\mathbf{S}} = \begin{bmatrix} 0 & \alpha & \beta & 0 \\ \alpha & 0 & 0 & -\beta \\ \beta & 0 & 0 & \alpha \\ 0 & -\beta & \alpha & 0 \end{bmatrix}$$

where it is evident that in order for the scattering matrix to be unitary, the values α and β are related as:

$$\alpha^2 + \beta^2 = 1$$

We will study three types of 4-port couplers:

- 1) The 90° Hybrid
- 2) The 180° Hybrid
- 3) The Coupled-Line Coupler