SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

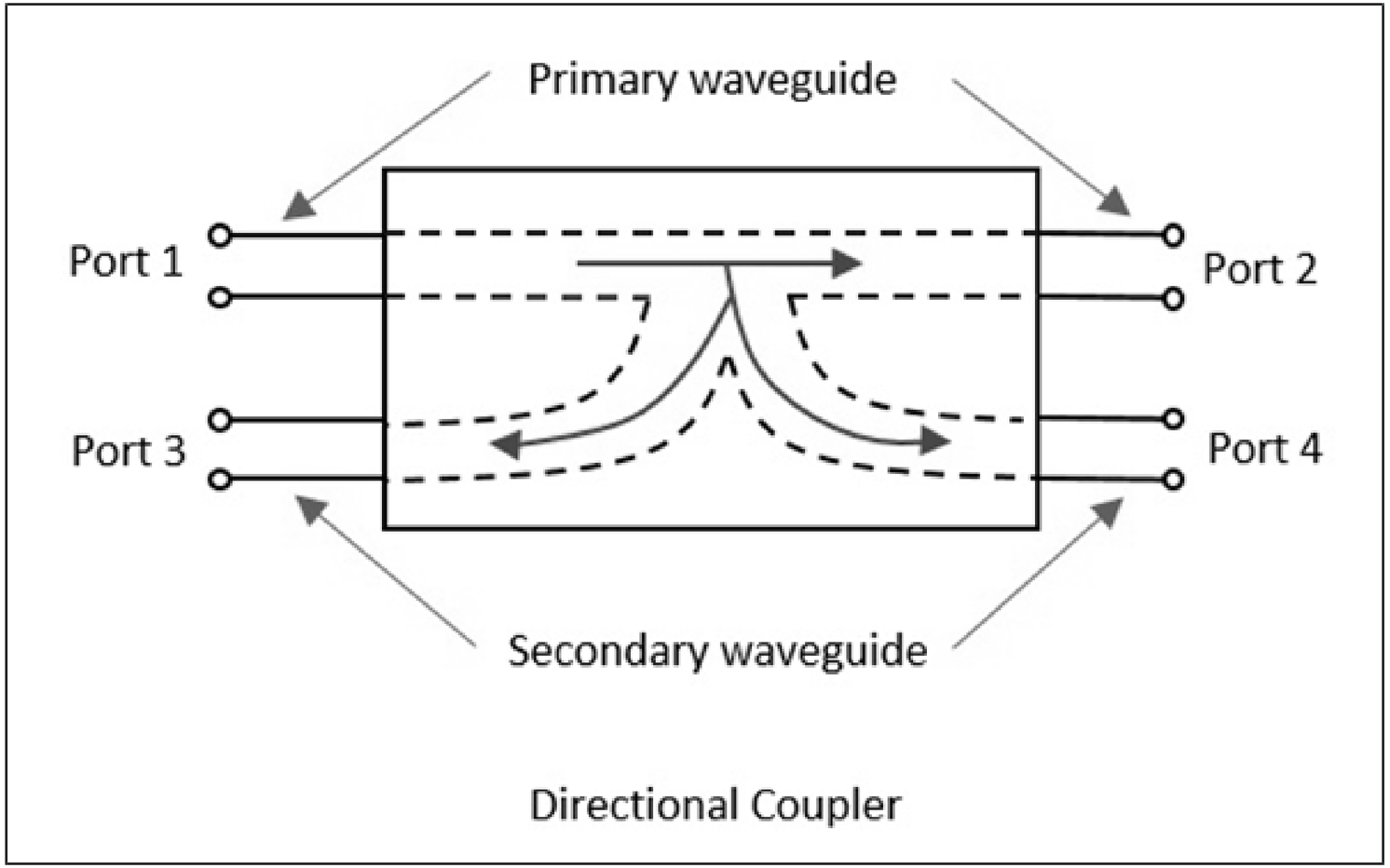
OPTICAL AND MICROWAVE ENGINEERING

III YEAR/ VI SEMESTER

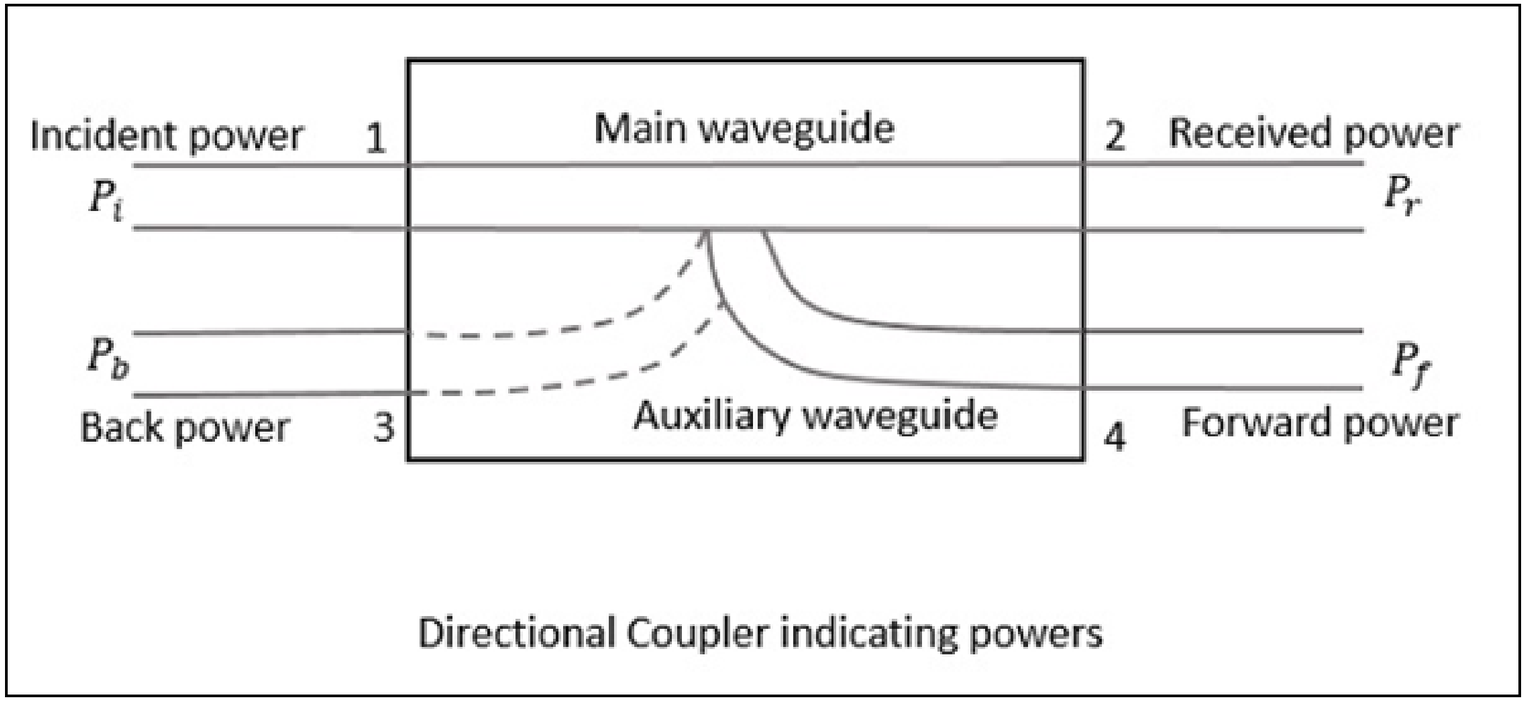
UNIT 1 – MICROWAVE PASSIVE DEVICES

TOPIC– Directional Couplers

Directional Coupler

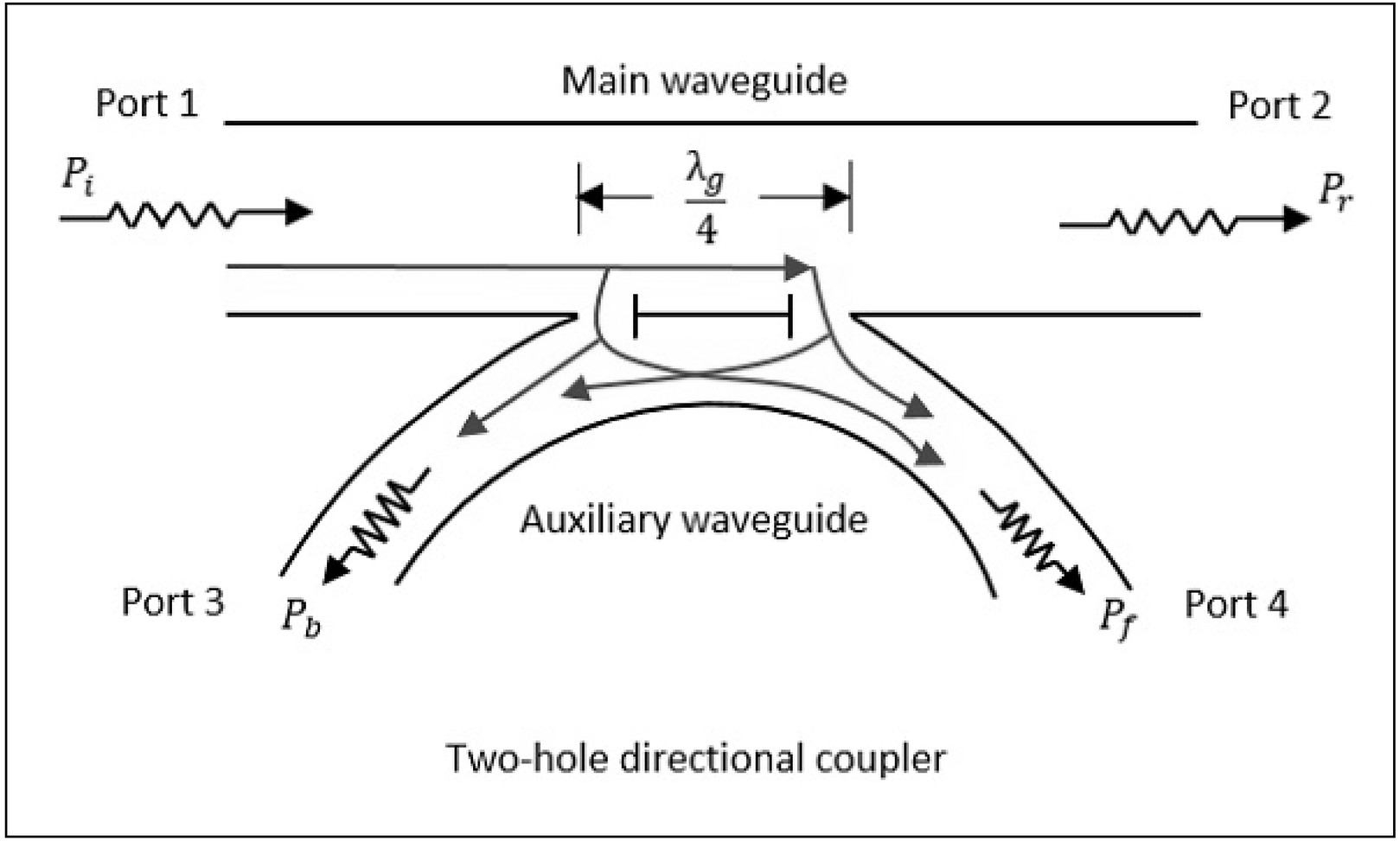


Properties of Directional Coupler



Directional Coupler indicating powers

Two Hole Directional Coupler



Two-hole directional coupler

Directional Coupler Parameter

- The performance of directional coupler is measured in terms of four basic parameters:

1. Coupling Factor (C):
   - Measure of how much of power is being sampled.
   - Ratio of power levels in main and auxiliary waveguides.

$$C_{(dB)} = 10 \log_{10}\left(\frac{P_1}{P_4}\right)$$

2. Directivity (D):
   - Measure of how well the directional coupler distinguishes between forward and reverse travelling power.
   - Ratio of forward coupled power level and reverse power level in auxiliary waveguide.

$$D_{(dB)} = 10 \log_{10}\left(\frac{P_4}{P_3}\right)$$

3. Isolation (I):

- Measures the directional properties.
- Ratio of incident power in main waveguide to the reverse power at auxiliary waveguide.
- I = C.D
- I (dB)= $[C]_{dB}+[D]_{dB}$

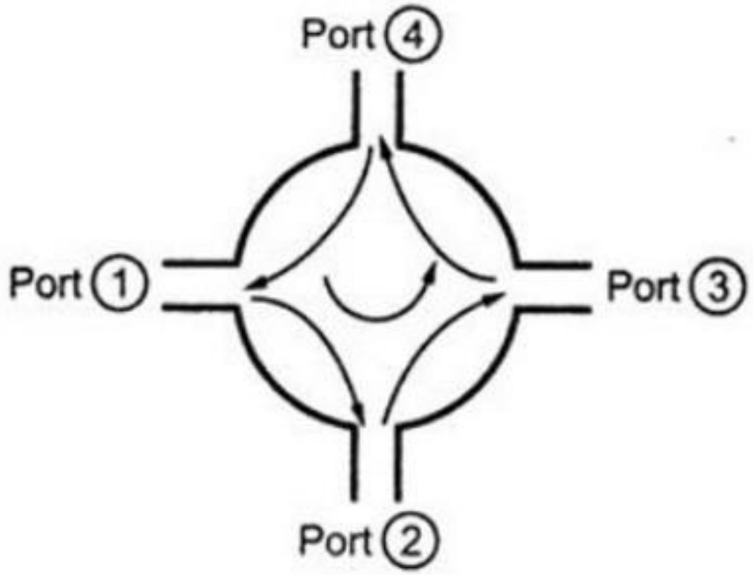
$$I = 10 \log_{10}\left(\frac{P_1}{P_3}\right) \text{ dB}$$

4. Return/Insertion Loss (R):

- Ratio of power incident to the power transmitted in the primary arm.

$$R_{(dB)} = 10\log\left(\frac{P_1}{P_2}\right) \text{ dB}$$

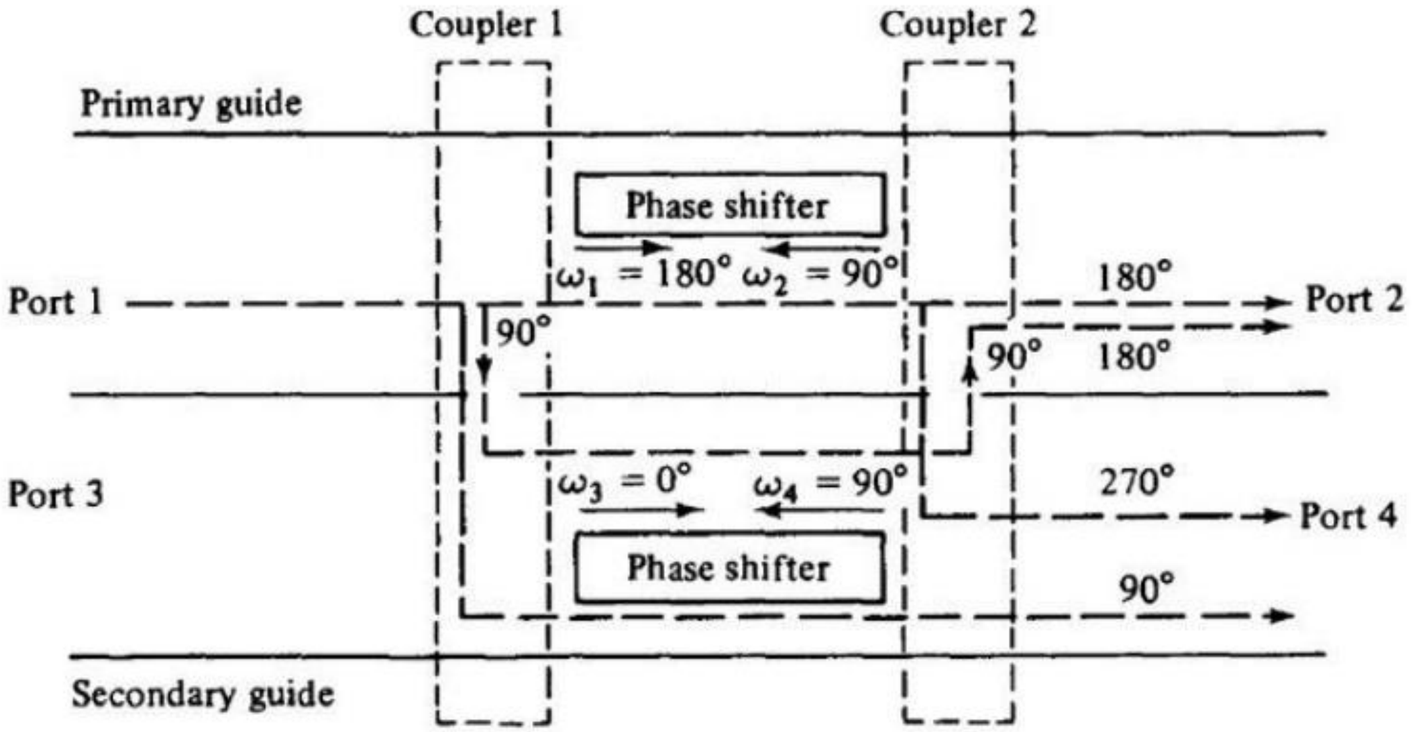
Microwave circulators



4-port Circulator Symbol

54

Microwave circulators



Four-port Circulator Schematic

56

A perfectly matched, lossless, and nonreciprocal four-port circulator has an **S** matrix of the form

$$\mathbf{S} = \begin{bmatrix} 0 & S_{12} & S_{13} & S_{14} \\ S_{21} & 0 & S_{23} & S_{24} \\ S_{31} & S_{32} & 0 & S_{34} \\ S_{41} & S_{42} & S_{43} & 0 \end{bmatrix}$$

Using the properties of S parameters as described previously, the **S** matrix in Eq.

$$\mathbf{S} = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

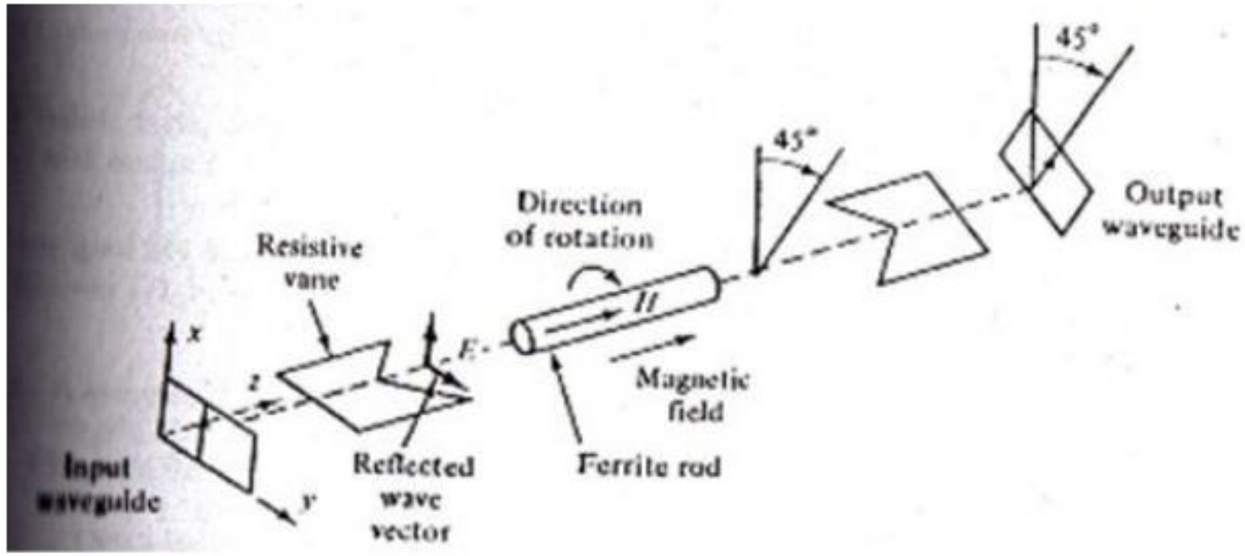
Microwave Isolators

- An *isolator* is a nonreciprocal transmission device that is used to isolate one component from reflections of other components in the transmission line.
- An ideal isolator completely absorbs the power for propagation in one direction and provides lossless transmission in the opposite direction.
- Thus the isolator is usually called *uniline.*
- Isolators are generally used to improve the frequency stability of microwave generators, such as klystrons and magnetrons, in which the reflection from the load affects the generating frequency.

61

Working Principle

- The input resistive card is in the y-z plane, and output resistive card is displaced 45 degree with respect to the input card.
- The DC magnetic field, which is applied longitudinally to the ferrite rod, rotates the wave plane of polarization by 45 degree.



63

THANK YOU