Directional Coupler

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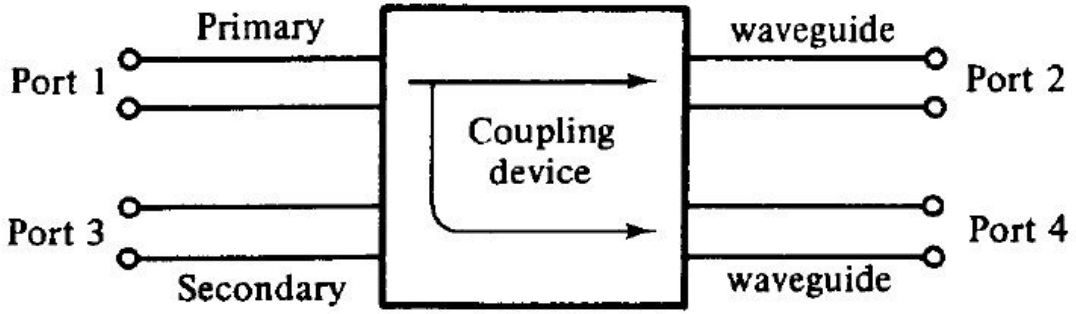
Directional Coupler

- A directional coupler is a four-port waveguide junction as shown in Figure.
- It consists of a primary waveguide 1 & 2 and a secondary waveguide 3 & 4.
- A coupling device is there between port 2 & port 4.
- Similarly, a coupling device is present between port 1 & port 3.
- When all ports are terminated in their characteristic impedances, there is free transmission of power, without reflection, between port 1 and port 2, and there is no transmission of power between port 1 and port 3 or between port 2 and port 4 because no coupling exists between these two pairs of ports.



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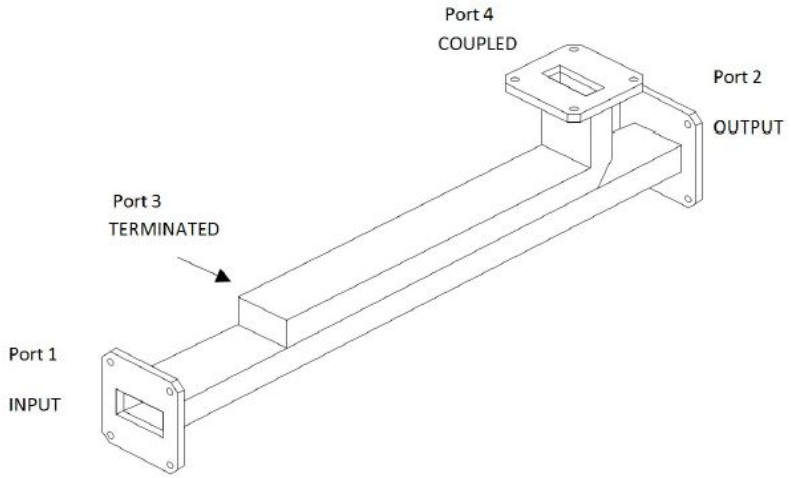

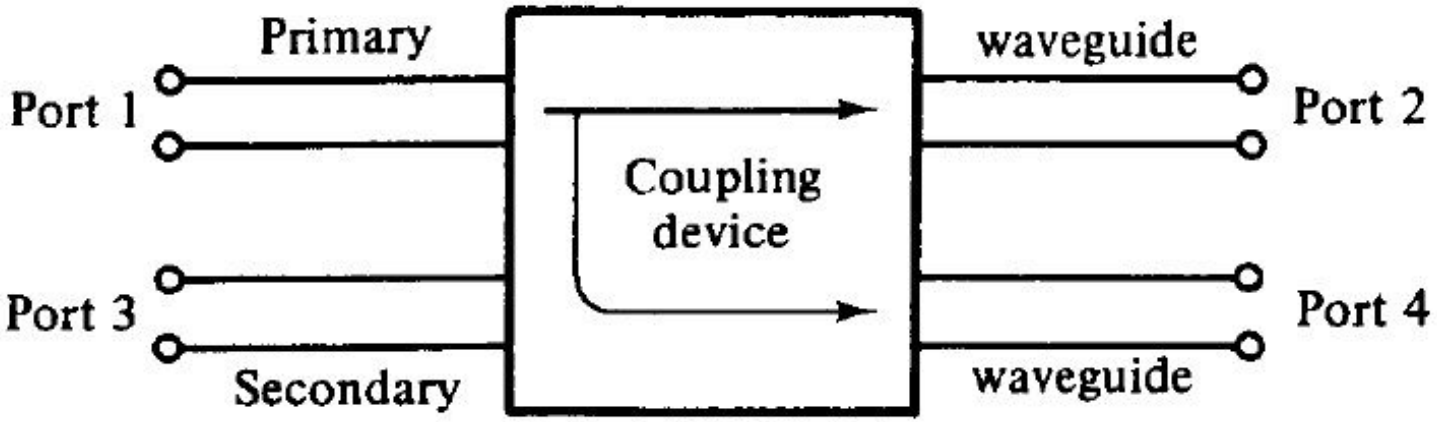

Directional Coupler

- The degree of coupling between port 1 and port 4 and between port 2 and port 3 depends on the structure of the coupler.
- The characteristics of a directional coupler can be expressed in terms of its coupling factor and its directivity.
- Assuming that the wave is propagating from port 1 to port 2 in the primary line, the coupling factor and the directivity are defined,
- **Coupling factor(dB):-** The coupling factor is a measure of the ratio of power levels in the primary and secondary lines. Hence if the coupling factor is known, a fraction of power measured at port 4 may be used to determine the power input at port 1.

$$\text{Coupling factor(dB)} = -10 log_{10} \frac{P_1}{P_4}$$

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- **Directivity:-** The directivity is a measure of how well the forward travelling wave in the primary waveguide couples only to a specific port of the secondary waveguide

$$\text{Directivity(dB)} = -10log_{10}\frac{P_4}{P_3}$$

- An ideal directional coupler should have infinite directivity. In other words, the power at port 3 must be zero because port 2 and port 4 are perfectly matched. Actually, well-designed directional couplers have a directivity of only 30 to 35 dB.

- **Isolation:-** Isolation can also be defined between the two output ports. In this case, one of the output ports is used as the input; the other is considered the output port while the other two ports (input and isolated) are terminated by matched loads.

$$\text{Isolation(dB)} = -10log_{10}\frac{P_1}{P_3}$$

Directional Coupler

- **Insertion Loss:-** The insertion loss is defined as loss in power that occur when the wave travels between port 1 & port 2.(primary waveguide)

$$\text{Insertion Loss}\,(\text{dB}) = -10 log_{10} \frac{P_1}{P_2}$$

- There are different types of directional couplers like single, dual directional, coaxial, waveguide and even combination types.

Applications

- Use as power dividers.
- Measurement of incident & reflected power.