Directional Couplers

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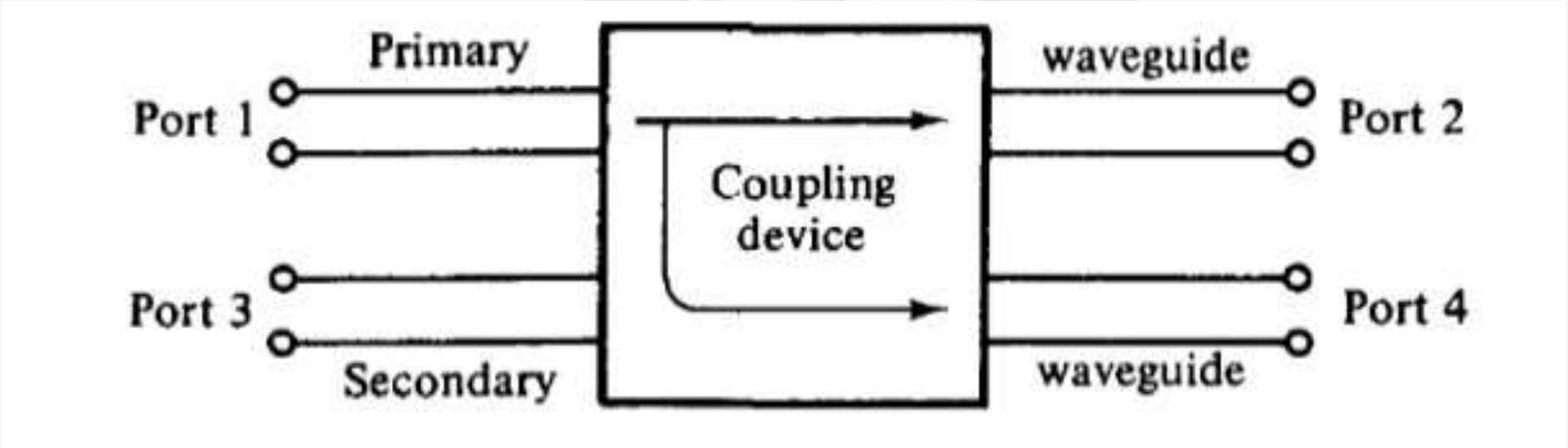
- A directional coupler is a four-port waveguide junction. It consists of a primary waveguide 1-2 and a secondary waveguide 3-4.
- When all ports are terminated in their characteristic impedances, there is free transmission of power, without reflection, between port 1 and port 2, and there is no transmission of power between port 1 and port 3 and vice versa.

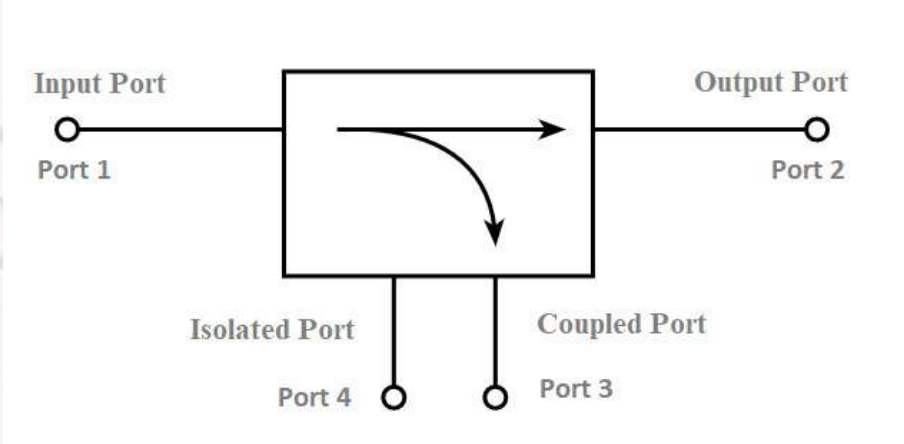
The characteristics of a directional coupler can be expressed in terms of its coupling factor and its directivity.



Working Principle

- When an input signal travels from port 1 to port 2, a part of this signal is coupled to port 3.
- The portion of the power coupled to port 3 depends on the coupling value of the coupler being used
- For example if we use a 3 dB coupler, the power split between port 2 and port 3 would be 50%, however, if we use a 10 dB coupler, then this power split would be 9:1.
- The coupling is one of the key parameters on the basis of which a directional coupler is selected.

- Typical coupling values vary from 6 dB to over 30 dB. Another important specification of a directional coupler is directivity.
- Port 4 of the directional coupler is known as the isolated port. In an ideal directional coupler, no signal should appear at the isolated port, however practically, a small amount of power called back power is obtained at Port 4.
- The directional coupler as the name suggests operates in a single direction i.e its ports cannot be interchanged. There are some other types of coupler configurations like Bi-Directional Couplers and Dual-Directional Couplers whose ports can be interchanged.



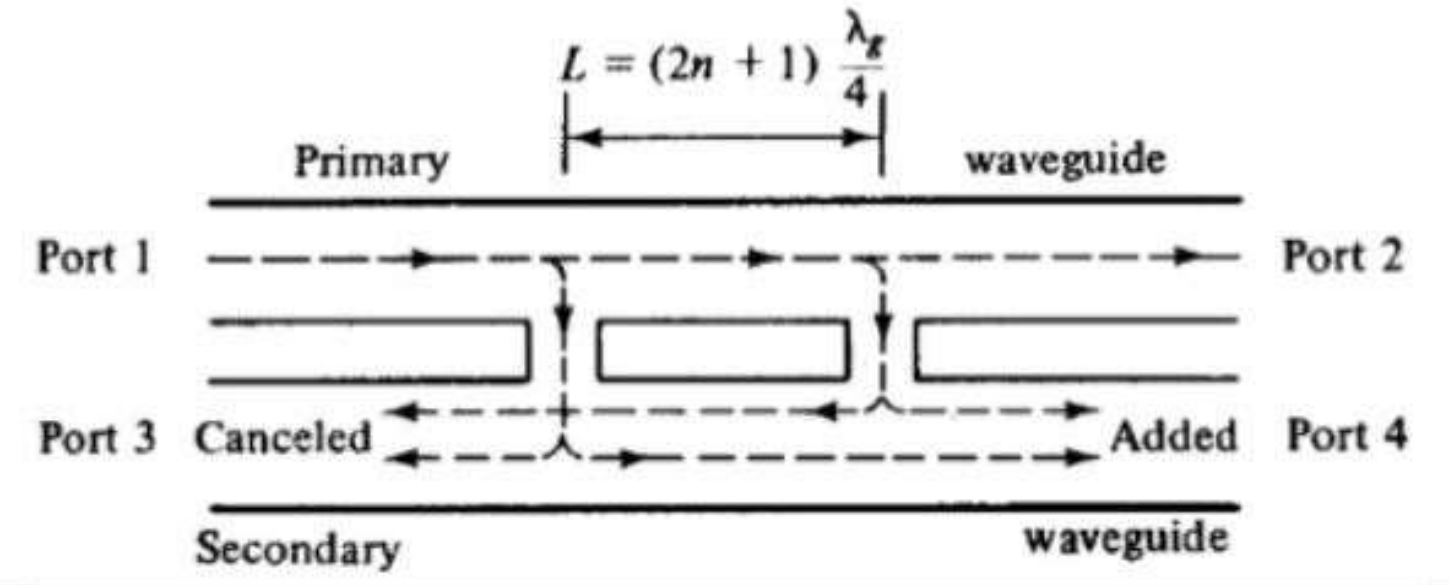
Several types of directional couplers exist

1. A two-hole directional coupler
2. Four-hole directional coupler
3. Reverse-coupling directional coupler (Schwinger coupler)
4. Bethe-hole directional coupler

❖ Only the very commonly used two-hole directional coupler is described here.

Two-Hole Directional Couplers

- A two-hole directional coupler with traveling waves propagating in it is illustrated in Fig. The spacing between the centers of two holes must be L Where n is any positive integer.

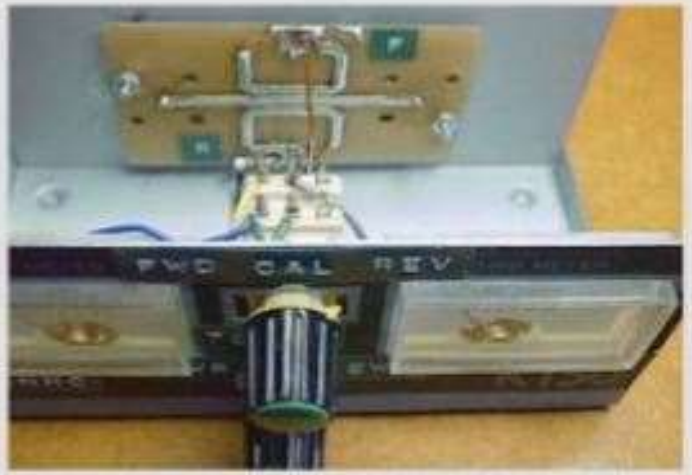


- A fraction of the wave energy entered into port 1 passes through the holes and is radiated into the secondary guide as the holes act as slot antennas.
- The forward waves in the secondary guide are in the same phase, regardless of the hole space, and are added at port 4.
- The backward waves in the secondary guide (waves are progressing from right to left) are out of phase by (2L/ A8)27T rad and are canceled at port 3.

Applications

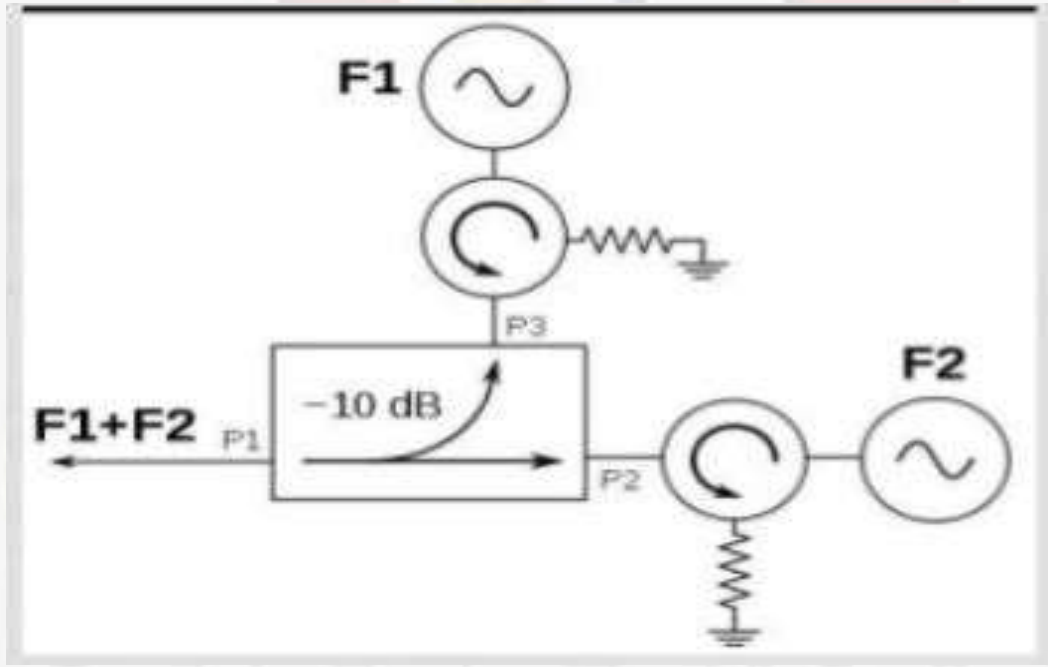
- Monitoring / Power measurements

  The coupled output from the directional coupler can be usedto monitor frequency and power level on the signal without interrupting the main power flow in the system.



- Frequency measurements
- Signal levelling
- Reflection coefficient measurements
- Signal sampling
- Signal injection
- Measure incident and reflected power to determine VSWR 13

- Making use of isolation
  - If isolation is high, directional couplers are good for combining signals to feed a single line to a receiver.



Conclusion

Directional couplers are most frequently constructed from two coupled transmission lines set close enough together such that energy passing through one is coupled to the other. This technique is favored at the microwave frequencies where transmission line designs are commonly used to implement many circuit elements

Thank you