APPLICATION NOTES

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COUPLERS

Overview

Couplers are four port devices that are mostly used to sample an input RF signal. There are different types of couplers including, directional, bi-directional, hybrid, etc. Although, different in design and look, they all share a common function, that is, the ability to sample an input signal without much signal degradation. Generally, the smaller the portion of the input signal extracted, the lesser the signal degradation. Hence, a larger coupling value is indicative of the same phenomenon, this is of course not taking the mainline loss (resistive, thermal, etc). Figure 2 below shows the general layout of a coupler. Port 1 and 2 are input and output ports respectively. Port 3 is the coupled port and port 4 is the isolated port . The isolated port can be either internally or externally terminated. Models have 3 ports and others four ports with one terminated externally and sometimes coated with epoxy and paint. Some of the port devices come with an open isolated port, available for external termination (See Figure 1).

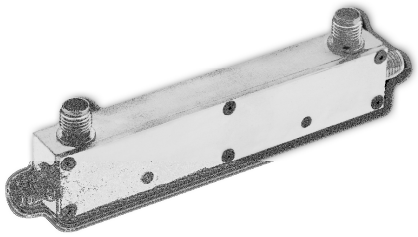

Figure 1: Broadwave directional coupler

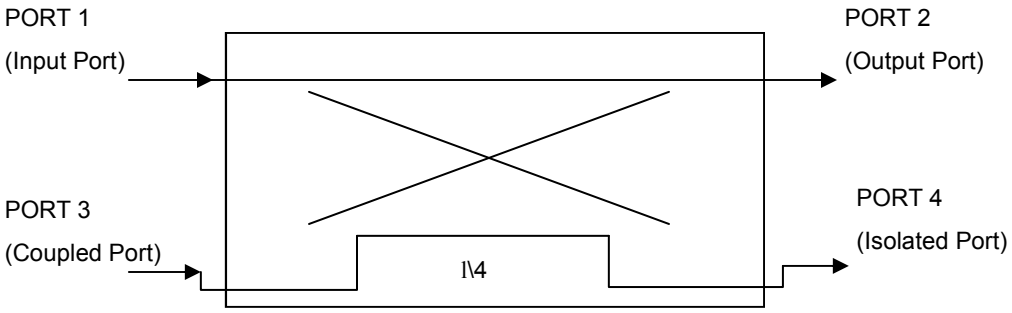

Figure 2: General layout of a coupler

The directional coupler

The directional coupler has a similar layout to that of Figure 2, however ports 3 and 4 can be interchanged, according to forward or backward coupling modes. The directional coupler can be made from waveguides that couple in the forward direction (forward wave couplers) and microstrip or stripline that couple in the reverse direction (backward couplers). An easy way to figure this out is by looking at the coupler and finding the port (input or output) that is closest to the coupled port. For example if the coupled port is close to the input port (Figure 3) it is a backward wave coupler and if it is close to the output port (Figure 4) it is a forward wave coupler.

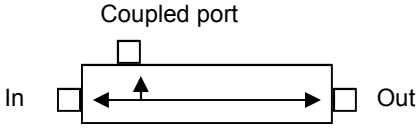

Figure 3: Backward wave coupler

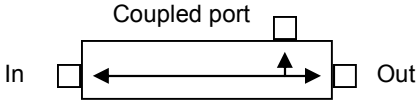

Figure 4: Forward wave coupler

COUPLERS

Terms and Definitions

When choosing a coupler, here are some key parameters you need to consider.

Frequency Range (Hz): This is application specific.

VSWR: Voltage Standing Wave Ratio (VSWR) is the ratio of maximum and minimum voltage at a given point along a transmission line. VSWR is a good measure of power transfer efficiency. A low VSWR (i.e. closer to unity with little or no reflections) means more power is delivered from the source to the load, while a high VSWR (i.e. much greater than 1 with lots of reflection within unit) has less power delivered to the load.

Insertion Loss (dB): Insertion loss is the decrease in the transmitted signal power due to the insertion of a device (i.e. coupler) in a transmission line. It is defined as the ratio of the output to input power.

Coupling Factor (dB): Ratio of power transferred to coupled port with respect to the input port.

Isolation (dB): Ratio of input power with respect to power at isolated port. The greater the isolation the lesser the power loss to the isolated port.

Directivity (dB): It is defined as the difference in dB of the power output at a coupled port, when power is transmitted in the desired direction, to the power output at the same coupled port when the same amount of power is transmitted in the opposite direction. Directivity is also the difference between isolation and coupling.; Directivity = Isolation - Coupling Factor (all units in dB). Simply put, directivity is a measure of how independent are the coupled and input ports from one another.

Octave Bands (Hz): A doubling in frequency is represented by an octave. 1-2 Ghz is an octave, while 8-12 Ghz is half an octave.

Input Power (W): Both average and peak power need to be taken into account when choosing a coupler according to the application.

Mainline Loss (dB): The resistive and thermal loss caused by the coupler.

Coupling Loss (dB): Theoretical power lost from the input signal to coupled and isolated ports. True coupling loss is the theoretical value plus mainline loss.

Calculations

Below are the formulae for some key parameters that are calculated for the forward wave coupler, change P3 and P4 accordingly for a backward wave coupler. (Refer to Figure 2)

Parameter (Units)

P1-Power at port 1 (Input Port) (W)

P2-Power at port 2 (Output Port) (W)

P3-Power at port 3 (Coupled Port) (W)

P4-Power at port 4 (Isolated Port) (W)

Insertion Loss = 10 log(P1/P2) (dB)

Coupling Factor = 10 log(P1/P4) (dB)

Isolation = 10 log(P1/P4) (dB)

Directivity = 10 log(P3/P4) (dB)

Coupling Loss = 10 log(P1/(P3+P4)) (dB)

Applications

- Test equipment, including network analyzers (reflectometers).
- Any application where a signal needs to be sampled, like power meters, antenna monitors, etc.

COUPLERS

Broadwave Technologies Couplers

Given below are some of the general specifications of Broadwaves's directional couplers. Most are available in standard coupling values For more detailed information, specifications or to view entire catalog, please visit our website. If you are unable to find a product that meets your specifications, feel free to contact us.

Directional Couplers (Part no: 25X-XXX-XXX)		
Connector Types		SMA, N, TNC, BNC
Directivity		Typically High
Input Power (Average)		25W to 100W
Coupling *	All standard values	(6,10,15,20,30 dB)
Frequency Range *		500 Mhz to 18Ghz
Operating Temperature *		- 55 °C to +85 °C
Number of Ports **		3 port and 4 ports models available

Note: * Different coupling values are available. Most models operate at octave bands. Most of our couplers are weather resistant models.

** 4 port models come with an open isolated port available for addition of external termination.

Broadwave Technologies, Inc.

500 Polk Street, Suite 25

Greenwood, IN 46143

Phone; 317-888-8316

Email: sales@broadwavetechnologies.com

Website: http://www.broadwavetechnologies.com