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Design and Simulation of Microstrip Coupler

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Abstract
The project aims is to design microstrip coupler with accurate formulation.3 dB branch line coupler for wideband applications. The wideband matching property of the coupler with four λ/4 open circuited coupled lines is briefly derived. Using a cross coupled dual-band branch-line coupler structure for dual-band operation. To fabricate a Dual-band 90o coupler operating at 1.6 GHz and 2.1 GHz with microstrip technology. It comprises a complete design of symmetrical four Port microstrip directional coupler including physical length at desired optional frequency. The design procedure doesn't require Prior knowledge of physical geometry of the coupler but requires only the information of the port impedances, coupling and Optional frequency. The validation of design concept is done by observing a negative insertion loss in the output.
Keywords: *Microstrip, Directional Couper, Impedance, Insertion Loss.*

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I. INTRODUCTION

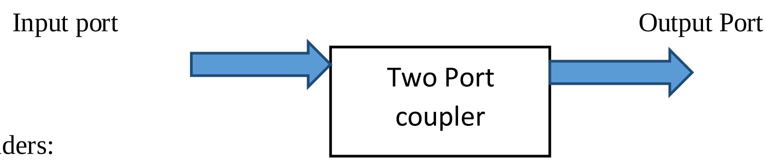
Couplers are passive three or four port devices that are commonly used in RF and microwave design. In a coupler, a known percentage of power from a transmission line is coupled to another output. Furthermore, couplers have a phase shift between the transmitted and the coupled port. This is one of the major differences between couplers and power splitters. This kind of microstrip couplers have a phase shift of 90-180 degrees. Their ease of fabrication and useful phase shifts made them ideal choices. These are maximum of 3db which means that half of the power should be output at the transmitted and the coupled port each. These couplers use the proximity of the microstrip transmission lines to achieve the coupling.

II. TYPES OF COUPLER

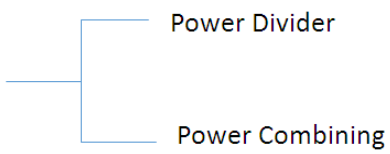
There are dozens of different types of couplers used in just as many different applications. Couplers can be categorized in two main categories waveguide couplers and microstrip couplers. Waveguide couplers usually have one or more holes between them for coupling. One simple waveguide coupler is the Bethe hole coupler, which uses one small hole to couple two waveguide transmission lines. Similarly, the multihole coupler is made of two waveguides coupled by two or more holes.

Couplers are normally of different types:

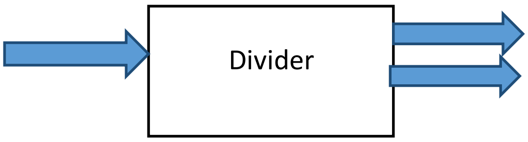
1) Two Ports: It Has One Input Port And Only Output Port.



2) Dividers:

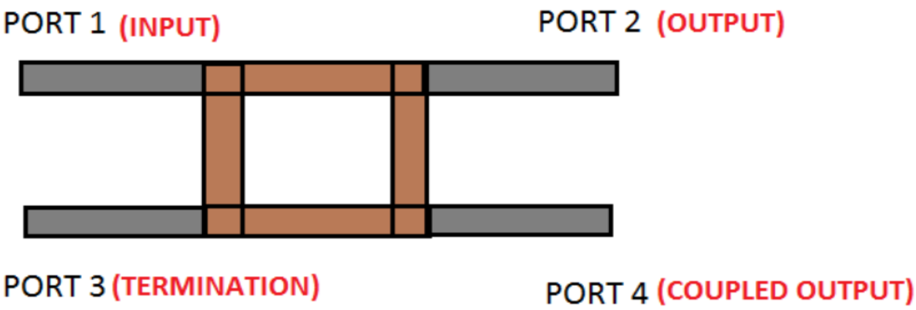


a) Power Divider: It Has One Input and Many Outputs

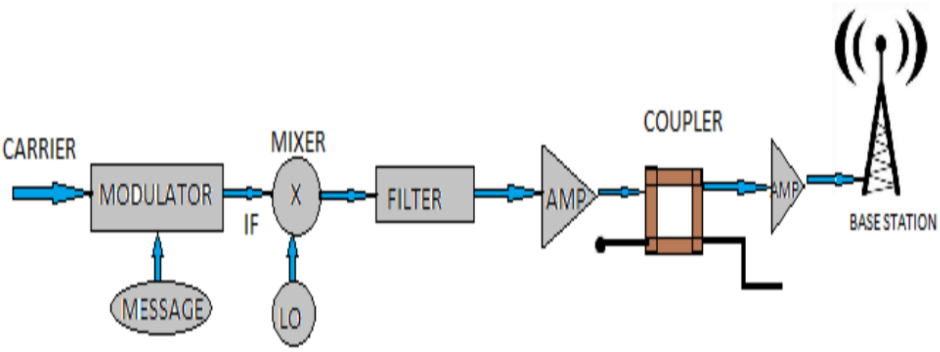


b) Power Combining: It Has Many Inputs and One Output

3) Four Port Coupler: It Has One Input Port, One Output Port, One Coupled Port



III. BLOCK DIAGRAM



The modulator gets two inputs, the carrier and the message signals. This output is given as infrared frequencies to the mixer wherein a local oscillator is connected. The output forms the input for the filter circuit which is followed by the amplifier. The output of the amplifier is given to the coupler where the signals are coupled together and at a very short distance another amplifier is placed in order to avoid interference. This output goes to the base station from where the signals are further generated.

IV. CALCULATION

$$Zo = \frac{87}{\sqrt{\varepsilon r + 1.41}} \ln \frac{5.98 \times H}{0.8 \times W + T}$$

I calculated microstrip trace widths for the values needed in the two couplers; .707 ZO, ZO, and 1.414 ZO. There are numerous approximation equations for microstrip impedance calculations. I based my choices off of Equation (1), but all the equations yielded very similar answers. Where εr is the dielectric constant, Zo is the

characteristic impedance, W is the trace width, T is the copper thickness, and H is the substrate height between the ground plane and the microstrip transmission line
To determine the length of each branch of the couplers, the equations below are used:

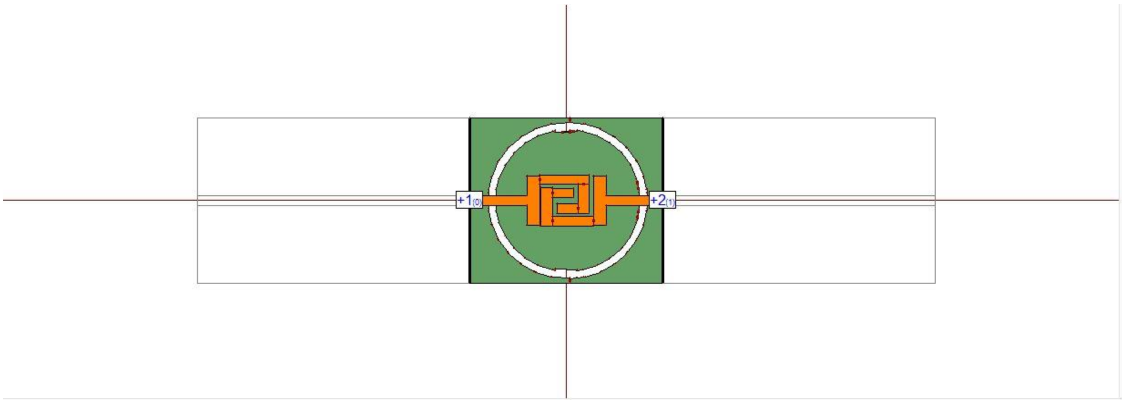
$$\lambda = \frac{c}{f\sqrt{\varepsilon eff}}$$

Where λ is the wavelength, c is the speed of light, f is the frequency, and

$$\varepsilon eff = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2\sqrt{1+12\frac{H}{W}}}$$

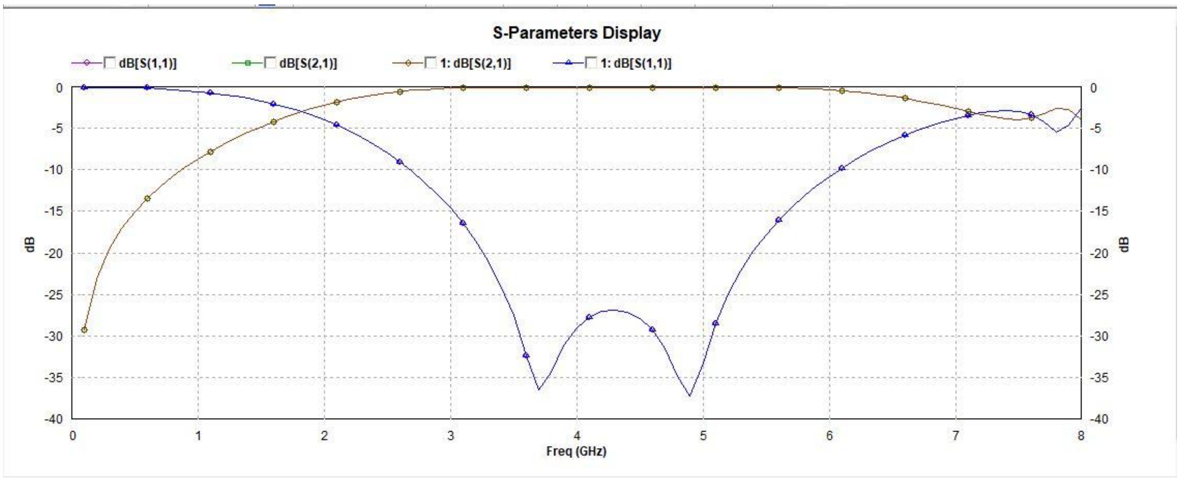
εeff is the effective dielectric constant, and when $\frac{W}{H} \geq 1$. Unfortunately, during my initial design, I overlooked the εeff factor in the wavelength equation

V. CIRCUIT DESIGN



The circuit is designed in the Mentor Graphics IE3D software .The circuit consists of four port microstrip coupler. Top and ground level materials are selected and the required values for the materials are given based on our requirements. Ports are assigned and the numbering for the ports is given. Numbering should be given carefully because the result is analyzed based on the port numbering s-parameters. Design of Microstrip Coupler After the circuit design is complete then circuit is analyzed using "analyze project". After analyzing output s-parameters are obtained by using "view response". Finally current distribution is checked by "view currents".

VI. RESULT ANALYSIS



This is the obtained output which shows the graph of insertion loss. The insertion loss of the coupler should be negative which says that the current loss is low and the output is nearly equal to the input.

VII. CONCLUSION

Thus output signal shows very low insertion loss. Insertion loss obtained is negative. If the signal has negative insertion loss then the loss message during the transmission is less.so output signal at the receiving end is similar to the signal sent at the transmission end with less data loss.

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