DEVELOP A 2.4 GHZ DIRECTIONAL COUPLER USING MICROSTRIP TECHNOLOGIES.

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Special dedicated to my beloved parents, family and fellow friends, who has strongly encouraged and supported me in my entire journey of learning.....

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ABSTRACT

Applications of the hybrid include mono pulse comparators, mixers, power combiners, dividers, modulators, and phased array radar antenna systems. By the basis of equation in microstrip, simulation by microwave office software terminated by 50Ω is made using ideal transmission line. Also from microstrip technology, the actual designed was fabricated on substrate double layer. It shows good agreement between experimental results and theoretical results.

ABSTRAK

Pengganding arah diaplikasikan sebagai pembanding denyut mono, penggabung kuasa, pembahagi kuasa, penyuai dan radar antenna. Berdasarkan formula di dalam microstrip, operasi di dalam perisian 'Microwave office 2003' direka menggunakan galangan 50 ohm untuk garis pemancarnya. Teknologi'Microstrip' juga digunakan untuk mereka bentuk yang sebenar menggunakan papan 2 lapisan. Hasil yang diperolahi daripada pembinaan system yang sebenar dibandingkan dengan hasil yang diperolehi daripada perisian 'Microwave'. Kedua-duanya memberi keputusan yang hampir sama.

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CHAPTER I

INTRODUCTION

1.1 PROJECT OVERVIEW

This project will develop a directional coupler using Microstrip Technologies. Using microwave office as a CAD the directional coupler will be design and then determine the best specs refer to simplicity in fabricating. The directional coupler will be simulate, fabricate and tested. Several sets will be fabricate then choose the best one that meet specification.

A directional coupler is a passive device which couples part of the transmission power by a known amount out through another port. When the power coupled out to coupled and transmitted ports is half the input power (i.e. 3 dB below the input power level), such a coupler is referred to as a 3 dB coupler.

. Due to their structural simplicity and easy fabrication, the directional couplers are widely used in many microwave circuits.

1.2 PROJECT OBJECTIVES

To achieve the goal of these object, an objective are defined as a guided. The objectives are:

- Developed a directional coupler's using 2.4GHz.
- To gain knowledge about microwave office software and microstrip technology.

1.3 PROBLEM STATEMENT

Directional create by Microstrip is a new innovation to substitute planar lines. Microstrip is a good solution because its cost more cheaply compared with other technologies. Besides that, it easy to developed and also flexible as balanced amplifier, high-power transmitters and antenna array feed network. This application helps an engineer to implement more effectively by knowing their nuances.

1.4 PROJECT SCOPE

There have two parts in this project which are Project Sarjana Muda I for first semester and Projek Sarjana Muda II for second semester. By the first semester, three sessions have been finished. There are literature review, calculation and simulation. The proposal of project have been submit regarding by the literature review. After that, the calculation will be produce. By using the related formula in Directional Coupler, the circuit has been designed. From that process, a simulation will be running by microwave office software.

For Project Sarjana Muda II also have 2 sessions which are fabrication process and testing process. By using the microstrip technologies, the circuit will be fabricated. If the fabricated is done, the circuit had been test by the SMA connector.

1.5 THESIS OUTLINE

This thesis represent by five chapters. The following is the outlines of this develop directional coupler by 2.4 GHz project in chapter by chapter. Chapter 1 discuss about the brief overview about the project such as introduction, objectives, problem statement and scope of the project.

Chapter 2 describes about the research and information about the project. Every facts and information, which found through by any references had been selected. This literature review has been explain about the directional coupler.

Chapter 3, discuss about the project methodology used in this project such as calculation, simulation, fabrication and testing. All these methodology should be followed for a better performance.

Chapter 4, describe about the discussion and project finding such as the result and analysis. The result is presented by calculation. Finally, Chapter 5 tells about expected result. For this project and conclusion are achieved in this project.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

Power divider and directional couplers are passive microwave components used for power division or power combining. In power division, an input signal is divided by the coupler into two (or more) signals power. The coupler may be a three-port component as shown, with or without less or may be a four-port component. Three port networks take the form of T-junction and other power dividers, while four-port networks take the form of directional coupler and hybrids.

Power dividers are often of the equal-division (3dB) type, but unequal power division ratios are also possible. Directional couplers can be designed for arbitrary power division, while hybrid junctions usually have equal power division. Figure 2.1 is the part of power divider and directional.

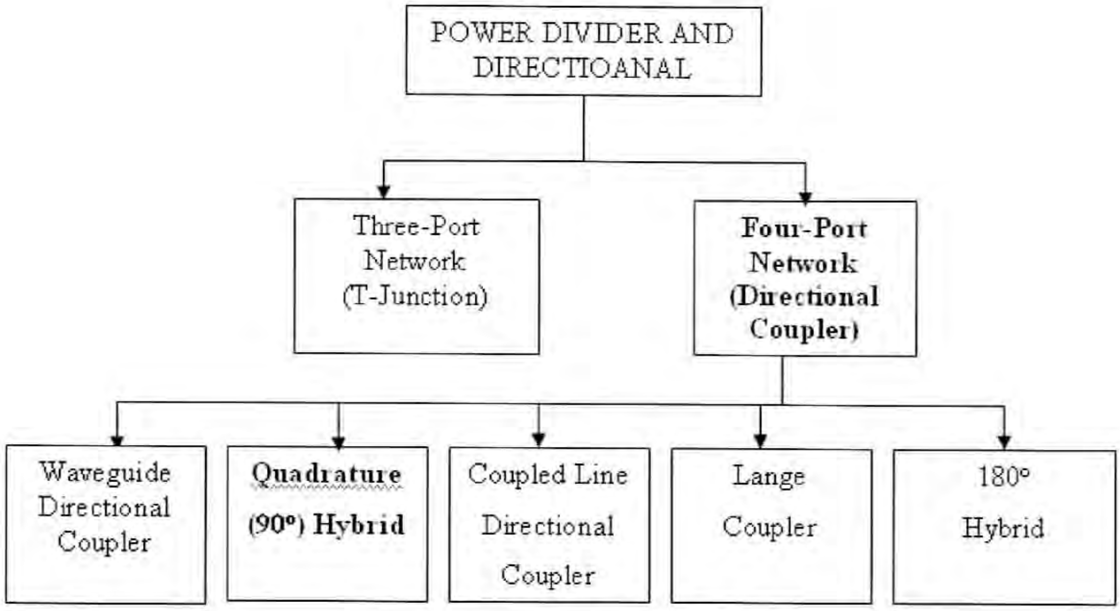

Figure 2.1 : The part of power divider and directional

In this project is develop a 2.4 GHz directional coupler by using Microstrip Technologies. One from the directional coupler type which is **quadrature (90°) hybrid** is choose. A hybrid is a special case of directional coupler, where the coupling factor is 3 dB (equal spilt) and the phase relation between the output ports is either 90° (quadrature hybrid) or 180° (magic-T or rat-race hybrid).

2.2 THEORY OF DIRECTIONAL COUPLER

A directional coupler is a passive device which couples part of the transmission power by a known amount out through another port, often by using two transmission lines set close enough together such that energy passing through one is coupled to the other. As shown in Figure 2.2, the device has four ports which are input, transmitted, coupled, and isolated. The term "main line" refers to the section between ports 1 and 2. On some directional couplers, the main line is designed for high power operation (large connectors), while the coupled port may use a small SMA connector. Often the isolated port is terminated with an internal or external matched load (typically 50 ohms). It should be pointed out that since the directional coupler is a linear device, the notations on Figure 2.2 are arbitrary. Any port can be the input, which will result in the directly connected port being the transmitted port, adjacent port being the coupled port, and the diagonal port being the isolated port.

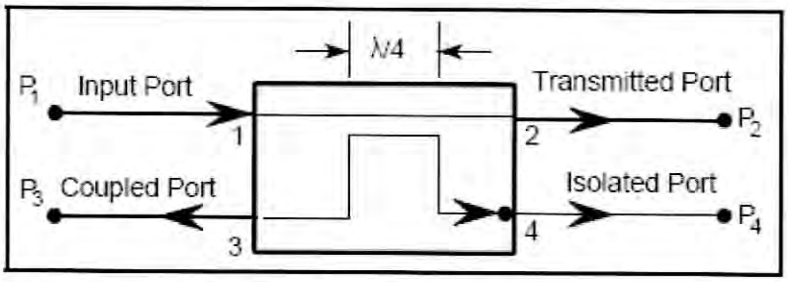

Figure 2.2 : Directional Coupler

Physical considerations such as internal load on the isolated port will limit port operation. The coupled output from the directional coupler can be used to obtain the information (i.e., frequency and power level) on the signal without interrupting the main power flow in the system (except for a power reduction - see Figure 2.3).

When the power coupled out to port three is half the input power (i.e. 3 dB below the input power level), the power on the main transmission line is also 3 dB below the input power and equals the coupled power. Such a coupler is referred to as a 90 degree hybrid, hybrid, or 3 dB coupler.

The frequency range for coaxial couplers specified by manufacturers is that of the coupling arm. The main arm response is much wider (i.e. if the spec is 2-4 GHz, the main arm could operate at 1 or 5 GHz. However it should be recognized that the coupled response is periodic with frequency. For example, a $\lambda/4$ coupled line coupler will have responses at $n\lambda/4$ where n is an odd integer. Common properties desired for all directional couplers are wide operational bandwidth, high directivity, and a good impedance match at all ports when the other ports are terminated in matched loads.

These performance characteristics of hybrid or non-hybrid directional couplers are self-explanatory. Some other general characteristics will be discussed.

2.2.1 Coupling Factor

The coupling factor is defined as:

$$\text{Coupling factor (dB)} = -10 \log \frac{P_3}{P_1}$$

where P1 is the input power at port 1 and P3 is the output power from the coupled port (see Figure 2.2).

The coupling factor represents the primary property of a directional coupler. Coupling is not constant, but varies with frequency. While different designs may reduce the variance, a perfectly flat coupler theoretically cannot be built. Directional couplers are specified in terms of the coupling accuracy at the frequency band center.

For example, a 10 dB coupling ± 0.5 dB means that the directional coupler can have 9.5 dB to 10.5 dB coupling at the frequency band center. The accuracy is due to dimensional tolerances that can be held for the spacing of the two coupled lines. Another coupling specification is frequency sensitivity. A larger frequency sensitivity will allow a larger frequency band of operation.

Multiple quarter-wavelength coupling sections are used to obtain wide frequency bandwidth directional couplers. Typically this type of directional coupler is designed to a frequency bandwidth ratio and a maximum coupling ripple within the frequency band. For example a typical 2:1 frequency bandwidth coupler design that produces a 10 dB coupling with a ±0.1dB ripple would, using the previous accuracy specification, be said to have 9.6 ± 0.1 dB to 10.4 ± 0.1 dB of coupling across the frequency range.

2.2.2 Loss

In an ideal directional coupler, the main line loss port 1 to port 2 (P1 - P2) due to power coupled to the coupled output port is:

$$\text{Insertion loss } (dB) = 10 \log \left[1 - \frac{P_3}{P_1} \right]$$

The actual directional coupler loss will be a combination of coupling loss, dielectric loss, conductor loss, and VSWR loss. Depending on the frequency range, coupling loss becomes less significant above 15 dB coupling where the other losses constitute the majority of the total loss. A graph of the theoretical insertion loss (dB) vs coupling (dB) for dissipation less coupler is shown in Figure 2.3

Coupling dB	Insertion Loss - dB
3	3.00
6	1.25
10	0.458
20	0.0436
30	0.00435

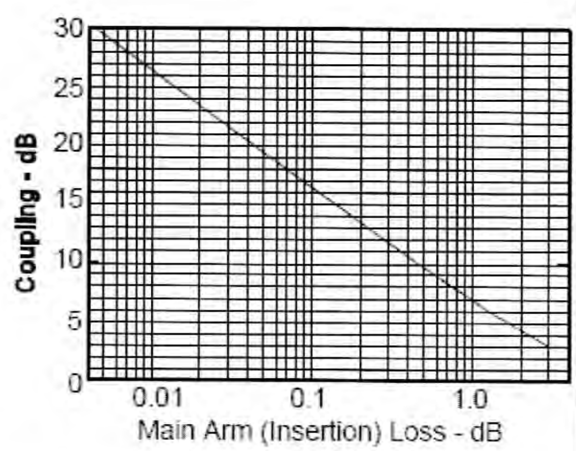

Figure 2.3: Coupling Insertion Loss

2.2.3 Isolation

Isolation of a directional coupler can be defined as the difference in signal levels in dB between the input port and the isolated port when the two output ports are terminated by matched loads, or: