Microwave Diplexer Design for WLAN application

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"I hereby declare that this report is the result of my own work except for quotes as cited in the references."

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Date :

Specially.....

To beloved and supportive parents

And to all my lecturers and friends

For their Love , Encouragements and Best wishes

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ABSTRACT

This thesis present the design , simulation , measurement and observation and the development of WLAN diplexer which applies at 2.4Ghz and 5.8Ghz .This project focused on designing the diplexer using microstrip transmission line in which will combine dual bandpass filter and a matching circuit .The diplexer is used to split or combine frequency according to the selective frequency used for RF front end system.To achieve this design, a software called Advance system design (ADS) is used and will be materialized using an FR4 board..Once the prototype is finished , network analyzer will be used to test the parameters.

ABSTRAK

Tujuan utama projek ini dijalankan adalah untuk mereka, simulasi dan juga membina sebuah ‘diplexer’ yang mengunakan dua penapis frekuensi dan litar persamaan. Litar ini merupakan satu perantaraan antenna dan litar yang digunakan untuk aplikasi WLAN.’Diplexer’ ini adalah untuk mengabungkan atau memisahkan frequency bedasarkan spesifikasi frekuensi yang telah dipilih untuk Frekuensi radio. Kaedah untuk mencapai desain projek ini adalah melalui simulasi yang mengunnakan satu perisian ‘Advance Design System (ADS)’ .Setelah simulasi siap, sterusya rekaan ini akan diaplikasikan di atas papan FR4 dan diuji oleh ‘Network Analyzer’.

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RF- Radio Frequency

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CHAPTER 1

INTRODUCTION

1.1 Project Background

During these day, the advancement of Wireless Local Area Network (WLAN) is one of the most main attraction and always constantly developed in the communication industry. With the rapid growth of the wireless technology , the need of mobility and higher specification is a must according to the demands.

In the wireless front end system, one of the system consists of a diplexer which mostly use a dual frequency function and this project will emphasize the usage of diplexer design in 2.4Ghz and 5Ghz .A diplexer is a passive device that implemented frequency-domain multiplexing which in this case, using dual frequency. Therefore , to ensure maximum power transfer for these dual band filter design, an impedance matching is also taken into account. In the early stage of diplexer designs , it is important to do research to meet the requirements of the wireless diplexer. Numerous designs of wireless diplexers will be analyzed and observed especially in the return losses , resonant frequencies , gain and size of the diplexer itself. These observation can be observed from the ADS (Advance system design) in which it also can be used to

fabricate on an FR4 board and lastly the results of the measured design will be analyzed by using network analyzer and also compared with the simulation result.

One advantage of a diplexer is that the diplexer can ensure high performance strength and also possible to change the frequency by changing the length of the phasing lines.

There are many technique in which used to make the diplexer where one of the most important is filter selection , coupling technique and matching circuits where it is used to select desired frequency by using the calculation method where there is numerous selection ranging from Chebyshev, Bessel-Thomson , and Gaussian. [1]

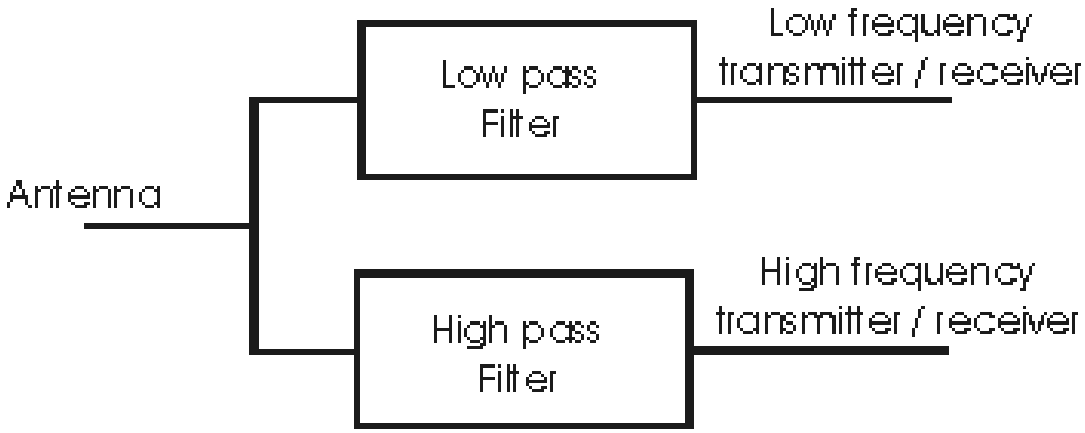

Figure 1.1: Diplexer Block Diagram [2]

1.2 Project Overview

For WLAN front end module, in which the diplexer is located in the RF front end which generally defined as any circuit between the antenna and the digital baseband system . For the receiver , the section includes all the filter, low-noise amplifiers and down-conversion mixer needed to process and operates the modulated signal received to be a suitable form of input into the analog-to-digital converter.

For this project , the compact microstrip is designed with a dual-bandpass filter with two simple matching circuit for a maximum power transfer. By only using a single dual-bandpass filter, the proposed diplexer may be made smaller when compared to the conventional diplexer which used the combination of two separate bandpass filters. The

dual-bandpass filter is achieved by using parallel coupled microstrip lines , open-loop stepped-impedance resonator in which the optional setting of two shunt open stubs and the matching circuit in which the matching circuit will be developed by referring to the tuning of single-stub and double-stub tuning circuits. This is to ensure the diplexer meets the demands of the WLAN applications in which the band operation of 2.4-2.5 and 4.9-5.8Ghz frequency band.The project discussed on the return loss, insertion loss , center frequency and size of the designed diplexer.

1.3 Problem Statement

A microstrip diplexer designed from two planar bandpass filter has been widely used in many wireless communication device as a front end module . However , a good diplexer comes in large size (conventional configuration) based on the dual bandpass filter and reducing the size will affect the performance of the diplexer.

1.4 Project Objective

1. To create a compact diplexer without affecting the performance.

2. To create a diplexer that comply within the IEEE 802.11 standard.

1.5 Project Scope

This project is to design a compact diplexer for WLAN front-end module which support dual band frequency of 2.4-2.5Ghz and 4.9-5.8Ghz frequency band which is used for WLAN applications.This scope is to ensure the process of the diplexer design proceed accordingly until completion.

1. Determine the suitable diplexer circuit used for compact design
2. The simulation of the circuit using appropriate software and the design of the diplexer circuit (dual bandpass filter and matching circuits)
3. Fabrication and measurement observation.

4. Analysis and discussion between the simulation and measured reading obtained from the fabrication.
5. Technical report writing for the project

CHAPTER 2

Literature Review

Chapter 2 will discuss precisely information, theories and results related to this project and will also overview the characteristic, components and approach taken in designing the diplexer. This chapter will discuss on the Wi-Fi diplexers type, functions and classifications as well as the requirement needed for the Wi-Fi designs.

2.1 Technique

The technique used for this diplexer is usually by selecting the frequency in which the Wi-Fi used where it used 2.4Ghz and 5.8Ghz where the approach is by selecting the filter designs for the filter. For this , there are numerous filter design available to be used. In or case the compact design is selected where hairpin filter fits the specification of a compact design.

Using Open-Loop Ring Resonators [3] , which can conduct maximum electric field density near the open ends of the line and the maximum magnetic field density around the center valley of the line at resonance. This which have the advantage of low insertion loss, wide tunable range and easy to design.

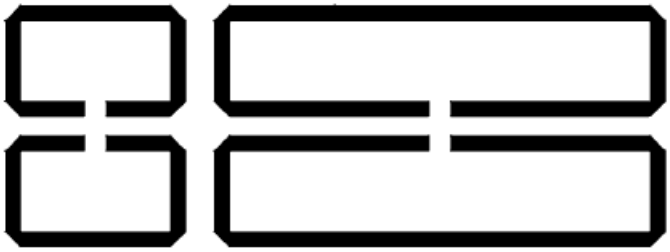

Figure 2.1 : Open Loop Resonators [3]

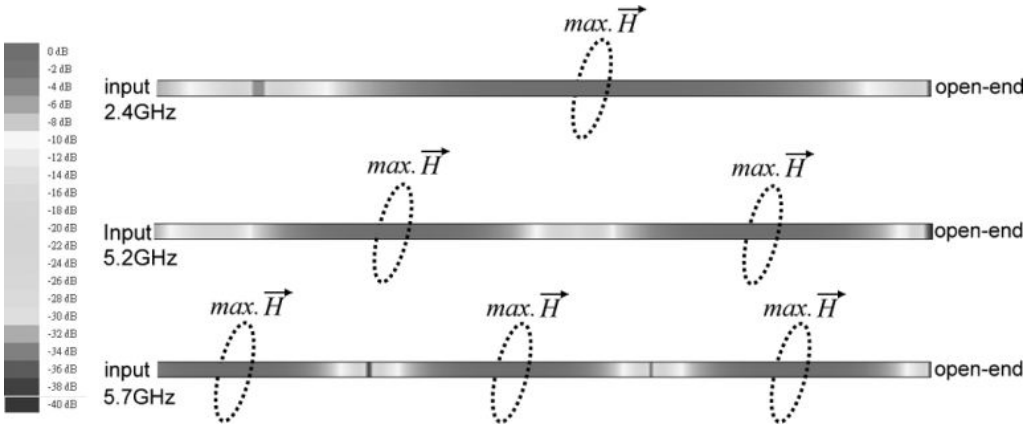

Figure 2.2:Distribution of Microstrip line [3]

The fundamental resonance frequency is related to the total length of the resonator which can be fixed to retain the central passband frequency.The second passband of the diplexer is obtainable by changing the relative position and size of the stub and the length of the coupling microstrip line.To ensure there is more variable in the frequencies , the stub-loaded technique is applied to ensure more flexible frequency for the passbands.[3].The parameter that should be observe for this project is as follows. From figure 3 , we can see that the $Zs\,,\theta s$ is a stub which is used with the Open Loop Resonators.

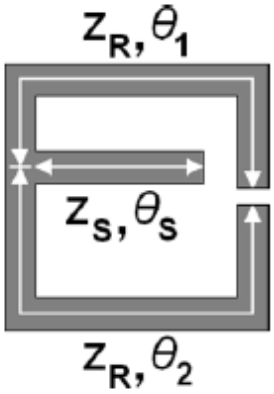

Figure 2.3 :Stub Loaded Open Loop Resonators [4]

2.1.1 Return Loss

In telecommunications, return loss is the loss of power in the signal reflected in a transmission line. This discontinuity can be a mismatch with the terminating load or when there is a device inserted in the line where it is expressed in decibles (dB).

Return loss is related to both standing wave ration (SWR) and reflection coefficient where the increase return loss corresponds to lower SWR. Return loss is a measure of how well the device is matched in which high return loss contributes to a good match.