DESIGN OF RECONFIGURABLE DEFECTED GROUND STRUCTURE FOR UWB APPLICATION

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This report submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Telecommunications) With Honours

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BORANG PENGESAHAN STATUS LAPORAN

PROJEK SARJANA MUDA II

Tajuk Projek : Design of Reconfigurable Defected Ground Structure (DGS) for UWB Application

Sesi Pengajian :

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APPROVAL

This report is submitted to the Faculty of Electronics and Computer Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronics Engineering (Telecommunication). The member of the supervisory committee is as follows:

……..

Dr. Zahriladha bin Zakaria

(Official Stamp of Supervisor)

DEDICATION

"In the Name of Allah, the most Beneficent, the Most Merciful"

Special dedication to my beloved parents:

Salim bin Abu & Rohana binti Hj. Japar

My supporting siblings:

Muhammad Syafiq bin Salim

Nursyahirah bte Salim

My respects supervisor:

Dr. Zahriladha bin Zakaria

My friends and my fellow lecturers

Thank you for all your care, support and believe in me

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First of all, I thank God for giving me all kinds of opportunities in completing this project. Without a long life, wisdom is able to function as well as the spirit given; I may not be able to complete this project well.

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ABSTRACT

Defected Ground Structure (DGS) has been widely used and they have shown increasing potential due to its drastic development of the several applications in this recent year. Most of the applications nowadays have the similar range of other applications which causes the signal overlapped. Defected ground structure is used to solve this problem by removing the unwanted signal. This project presents the reconfigurable DGS resonator on microstrip technology. The objective of this project is to design the band stop filter which can operate at resonant frequencies 3.5 GHz and 5.2 GHz by employing U-shaped DGS design on the ground plane. Six sets DGS have been simulated and analyzed but only three sets DGS have been measured due to prove the theoretical concepts. First until fifth design present the U-shaped DGS with single and double slot which produce the resonant frequency at 3.5 GHz and 5.2 GHz. Square-shaped is the last design which produced in order to make this filter available to reconfigure with PIN diode. It is because U-shaped design cannot reconfigure with the PIN diode cause of the ground plane of this structure does not separate. The DGS is reconfigured by PIN diode is operating at frequency 3.48 GHz and 5.18 GHz with a return loss at -17.34 dB and -17.50 dB. The operating bandwidth is 168 MHz and 251 MHz which indicates the Q-factor of this design is 20.7 and 20.64. This type of DGS is useful for applications when the undesired signal needs to remove such as radar and wideband systems. It has simple structure, equivalent *LC* circuit model and great potential applicability to design RF circuit.

ABSTRAK

Struktur Ground berpaling tadah (DGS) telah digunakan secara meluas dan mereka telah menunjukkan peningkatan potensi akibat pembangunan yang drastik daripada beberapa permohonan pada tahun baru-baru ini. Kebanyakan aplikasi yang kini mempunyai rangkaian yang sama dengn aplikasi lain menyebabkan isyarat bertindih. Struktur tanah berpaling tadah digunakan untuk menyelesaikan masalah ini dengan mengeluarkan isyarat yang tidak diingini. Projek ini membentangkan DGS konfigur resonator teknologi mikrostrip. Objektif projek ini adalah untuk mereka bentuk band penapis stop yang boleh beroperasi pada frekuensi salunan 3.5 GHz dan 5.2 GHz dengan menggunakan berbentuk U DGS reka bentuk kapal terbang tanah. Enam set DGS telah simulasi dan dianalisis tetapi hanya tiga set DGS telah diukur kerana membuktikan konsep teori. Pertama sehingga reka bentuk kelima membentangkan DGS berbentuk U dengan slot satu dan dua yang menghasilkan frekuensi resonan pada 3.5 GHz dan 5.2 GHz. Berbentuk persegi reka bentuk terakhir yang dihasilkan untuk membuat penapis ini disediakan untuk menyusun semula dengan cahaya PIN. Ia adalah kerana reka bentuk berbentuk U tidak boleh menyusun semula dengan PIN cahaya punca pesawat alasan struktur ini tidak berasingan. DGS yang diatur semula oleh diod PIN beroperasi pada frekuensi 3.48 GHz dan 5.18 GHz dengan kerugian pulangan pada -17,34 dB dan -17,50 dB. Jalur lebar operasi adalah 168 MHz dan 251 MHz yang menunjukkan faktor-Q reka bentuk ini adalah 20.7 dan 20.64. Jenis ini DGS adalah berguna untuk aplikasi apabila isyarat yang tidak diingini perlu mengeluarkan seperti radar dan sistem Wideband. Ia mempunyai struktur yang mudah, bersamaan model litar LC dan kesesuaian potensi yang besar untuk reka bentuk litar RF.

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LIST OF ABBREVIATIONS

DGS	-	Defected Ground Structure
CPW	-	Coplanar Waveguide
PBG	-	Photonic Band Gap
UWB	-	Ultra Wideband
WLAN	-	Wireless Local Area Network
WiMAX	-	Wireless Maximum
RF	-	Radio Frequency
UV	-	Ultraviolet
ADS	-	Advanced Design System
RLC	-	Resistance Inductance Capacitance
LC	-	Inductance Capacitance
LPF	-	Low Pass Filter
FCC	-	Federal Communications Commission
EBG	-	Electromagnetic Band Gap

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CHAPTER 1:

INTRODUCTION

1.1 Project Background

The increase in developments of wireless applications introduces new requirements for transceiver architecture that feature compact size, good microwave performance and enhanced integration density [1, 2].

Recently there is a much interest in developments of high-performance microwave components using slow-wave structure, such as electromagnetic band gap (EBG) structures and defected ground structures (DGS). They have attracted the interest of many researchers, due to their interesting properties in terms of size miniaturization, suppression of surface wave and arbitrary stop bands [3].

DGS is one of technique where the ground plane metal of microstrip, stripline or coplanar waveguide will defect to improve the performance. It is considered to be an approximation of an infinite, perfect-conducting current sink. Furthermore, a ground plane at microwave frequencies is far removed from the idealized behaviour

of perfect ground. The extra perturbations of DGS aren't giving as defective even though it is altering the uniformity of the ground plane [4].

This project proposes the design of reconfigurable defected ground structure (DGS) resonator to produce band stop response. The reconfigurable DGS will be designed based upon microstrip technology to exhibit band stop characteristic at 3.5 GHz and 5.5 GHz using FR-4 on a 1.6 mm dielectric substrate thick with dielectric constant = 4.6. This topology of reconfigurable DGS is useful for applications when the undesired signals need to be removed such as in wideband systems.

1.2 Problem Statement

At present, most of the system frequency range overlaps with the frequency range of other systems. An example is the ultra wideband (UWB) systems where it faces interferences of other signal such as WiMAX system and Wireless Local Area Network (WLAN) radio signal. Therefore, many people tried to find a solution for this problem. So, to overcome this problem, the DGS reconfigurable concept has been implemented into the UWB system by obtaining the resonant frequency at 3.5 GHZ which is for WiMAX system and 5.2 GHZ for IEEE 802.11a lower band of a WLAN system.

1.3 Objective of Project

The objective of this project is to design a band stop filter where it involves the DGS to reconfigure at any desired resonant frequencies. To implement it, the capabilities of DGS to reconfigure at an arbitrary frequency have been investigated. The PIN diode will be added to this band stop filter to see the effects on the system and to reconfigure this filter at the resonant frequency. This project has potential to

be applied in the UWB application such to remove the undesired frequencies that interfere the UWB systems.

1.4 Scopes of Project

In this project, the scope of work is divided into few parts which are research analysis, simulation, optimization, fabrication and measurement analysis on the result. The research processes are based on the review studies of DGS technology and Ultra-Wideband. In this part, some calculations are needed before the filter layout is designed. The simulation process includes the design of layout, simulation and optimizes the frequency response that already targeted. Advanced Design System 2011 (ADS) software has been chosen as simulation tools, while U-shaped design is chosen as DGS-shaped design.

The fabrication part starts from layout printing onto transparent paper, UV exposure on a substrate using the UV machine, etching, cutting and soldering processes. The measurement process will be done by measuring the filter using the Network Analyzer to obtain the frequency response. U-shaped DGS is chosen to defect the ground plane, thus give the impact on the filter. Figure 0-1 shows the layout for U-shaped DGS.

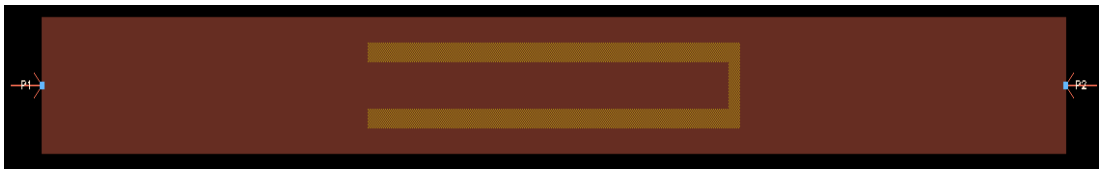

Figure 1-1: U-Shaped Layout

1.5 Importance of Work

This project proposes to design DGS structure which can be applied in UWB system. Many systems now have same frequency range, so to avoid the signal at UWB system overlapped with another signal like WiMAX and WLAN, so DGS is used to remove undesired signal.

1.6 Report Structure

This report has five chapters. Chapter 1 describes the background, problem statement, objectives and scope of the project. Chapter 2 presents the brief theory of DGS and related literature review in designing the U-shaped DGS structure. Chapter 3 describes the methodology of the project which includes the design specification and procedure flow process. Chapter 4 presents the simulation and measurement results. The results obtained are analyzed and discussed. The last chapter concludes the report and recommendations for further work are given.

CHAPTER 2:

LITERATURE REVIEW

The purpose of this chapter is to provide a review of past research effort relate to DGS technology, reconfigurable DGS, resonator, coplanar waveguide and the process used in this study. The chapter begins with the discussion of fundamentals of DGS. A review of other relevant research studies is also provided. The review is organized chronologically to offer sight to how past research efforts have laid the groundwork for later studies, including the present research effort. The review is detailed so that the present research effort tailored to the present body of literature as well as to justly the scope and direction of the present research effort.

2.1 Defected Ground Structure (DGS) Technology

DGS is realized by etching a defected pattern in the ground plane [5]. DGS is a defect structure which etched in the ground plane of microstrip or coplanar lines

where it disturbs the shield current distribution in the ground plane. This disturbance will change the characteristics of a transmission line such as line capacitance and inductance [1].

The DGS in the microstrip line uses an artificial defect on the ground and it provides a band-rejection characteristic of the resonance property. The cutoff frequency of DGS depends on the etched area on the ground plane, while the designs gap distance will effects to the attenuation pole location [6]. Because of that, DGS has been used in filtering circuits to improve the stop band characteristics [1, 7-9]. A shielding plane could be used to suppress the back radiation, although this could affect severely the antenna performance due to parallel plate modes propagation [9].

The basic element of DGS is a resonant gap or slot in the ground metal, placed directly under a transmission line and aligned for efficient coupling to the line. Figure 2-1 shows several resonant structures that may be used. Each one differs from occupied areas, equivalent L-C ratio, coupling coefficient, higher-order responses, and other electrical parameters. A user will select the structure that works best for the particular application [4].

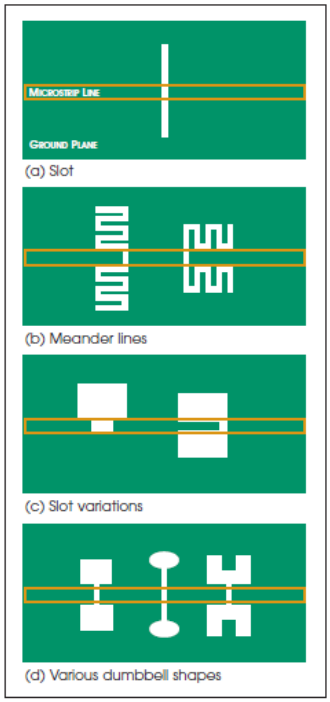

Figure 2-1: Some common configurations for DGS resonant structures[4]