

Design, Simulation and Development of RF switch with Defected Ground
Structure (DGS) for WiMAX at 2GHz band.

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
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Tajuk Projek : *Design, Simulation and Development of RF switch with Defected Ground Structure (DGS) for WiMAX at 2GHz band.*

Sesi Pengajian :

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Specially....

To my beloved parents

To my kind supervisor

And to all my friends

For their love, Encouragement, and Best Wishes

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ABSTRACT

This thesis represents the design, simulation and development of RF switch with Defected Ground Structure (DGS) for WiMAX at 2GHz band. This project is focused on RF Switch designing. PIN diode will be use to design the RF Switch. Besides, this project will also use Single Pole Double Throw (SPDT) switch type of the RF switch. This SPDT switch has three poles where the single pole is connect to the antenna while the double throw will connect to the receiver and transmitter. This design also use Defected Ground structure (DGS) as quarter wavelength in the circuit switch topologies. This DGS replace the conventional quarter wave length transmission line. ADS software will be use for design and simulation then the design will be realized on the FR4 board. Once the prototype has been finish, network analyzer will be used to test it for parameter measurement.

ABSTRAK

Tesis ini mengandungi cara-cara membina sebuah suis RF dengan kombinasi “Defected Ground Structure (DGS)” untuk kegunaan sistem WiMAX yang beroperasi pada jalur frekuensi 2GHz. Projek ini memfokuskan terhadap pembinaan dan penghasilan suis RF. PIN diod akan digunakan di dalam projek ini yang berfungsi sebagai suis. Projek ini juga menggunakan suis jenis satu kemasukan dan dua keluaran (SPDT). Suis SPDT ini mempunyai tiga cabang dimana cabang yang pertama disambung kepada penerima, cabang yang kedua disambungkan kepada antenna dan cabang yang ketiga disambungkan kepada pemancar. Projek ini juga menggunakan “ Defected Ground Structure (DGS)” sebagai suku panjang gelombang. Perisian ADS akan digunakan didalam projek ini semasa proses penghasilan rekabentuk litar. Selepas selesai merekabentuk litar yang dikehendaki, papan FR4 akan digunakan untuk merealisasikan litar yang dibina. Setelah selesai menghasilkan prototaip suis RF, penganalisa rangkaian akan digunakan untuk menguji prestasi prototaip tersebut.

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LIST OF ABBREVIATIONS

SPDT	-	Single Pole Double Throw
DGS	-	Defected Ground Structure
RF	-	Radio Frequency
ADS	-	Advance Design System
WiMAX	-	Worldwide Interoperability for Microwave Access

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CHAPTER 1

INTRODUCTION

This chapters covers the introduction of the project, background study regarding the project topic, project objective, the problem statement involves, the scope of work and the methodology of this project.

1.1 Project Background

Nowadays, WiMAX system is very popular in this country. WiMAX system is one of data communication type. WiMAX operate in same frequency. That's mean the receive and transmit frequency for WiMAX is same. So, for this type of data communication system, time division will explain how the system operates. In time division duplex, frequency for transmit and receive is same but the time will be is different. So, the controller that chooses to transmit or receive a signal is known as RF switch. In WiMAX system, there have many parts to design it. One of the parts is switching RF front-End. The main control for this part is RF switch

RF switch is one of the components in the WiMAX system. This project will focus on RF Switch designing. RF switch is use for receive and transmit operate. In

this project, PIN diode will be use to design the RF Switch. Besides, this project will also use Single Pole Double Throw (SPDT) switch type of the RF switch.

This SPDT switch has three poles where the single pole is connect to the antenna while the double throw will connect to the receiver and transmitter. This design also use Defected Ground structure (DGS) as quarter wavelength in the circuit switch topologies. This DGS replace the conventional quarter wavelength transmission line. ADS software will be use for design and simulation then the design will be realized on the FR4 board. Once the prototype has been finish, network analyzer will be used to test it for parameter measurement.

1.2 Project Objective

To Design, Simulation and Development of RF switch with Defected Ground Structure (DGS) for WiMAX at 2GHz band.

1.3 Problem Statement

RF Switch is used to allow the RF front-end to operate transmitted and received with same frequency. Besides that, the conventional quarter wavelength will consumes board spaces. So, with this Defected Ground Structure (DGS), it will reduce the size of the RF switch circuit board.

1.4 Scope of Work

The RF switch will be design with the Defected Ground Structure (DGS) for the WiMAX application. So, this project will focus on designing the RF Switch with Defected Ground Structure (DGS).

The scope of this project as follows:

- a. Understand the basic of RF switch and Defected Ground Structure (DGS).
- b. Understand the different type of SPDT switch for WiMAX.
- c. Understand the PIN diode as a switch.
- d. Understand the ADS software.
- e. Design the selected SPDT switch topologies with ADS software.
- f. Analyze the selected RF switch topologies and Defected Ground Structure (DGS) in ADS software.
- g. Draw RF Switch layout in ADS.
- h. Fabricate the layout on FR4 board.
- i. Develop RF Switch prototype.
- j. Test the prototype using network analyzer for s-parameter measurement.

1.5 Project Methodology

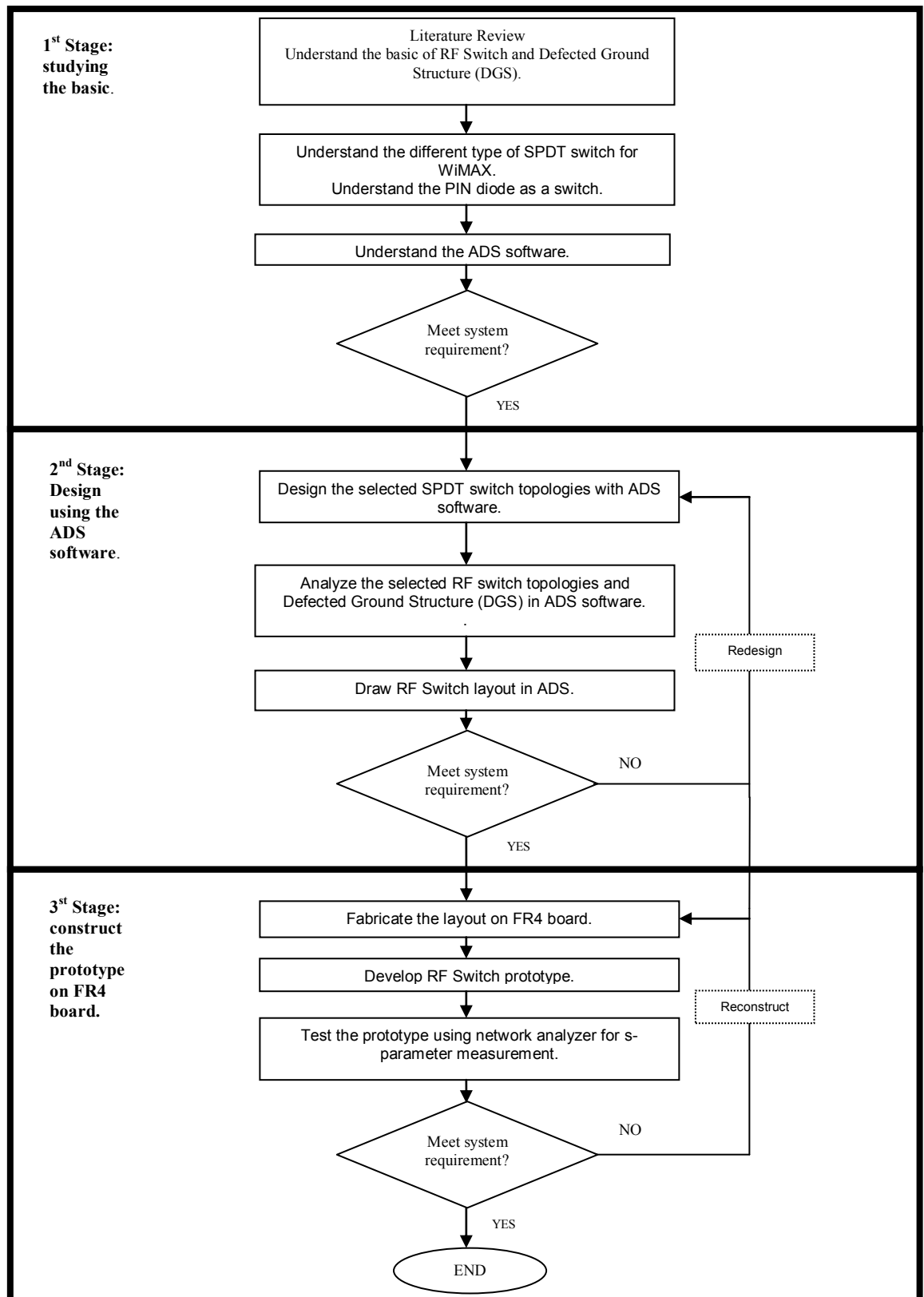


Figure 1.0: Flow chart of methodology project

CHAPTER 2

LITERATURE REVIEW

This chapter is discusses precisely about the information and theory relates to this project also the overview of major component involved. Factors that should be consider while developing this project also will be covered. The literature reviews will start with reviewing the RF switches types, classification and functions. Further on, the RF switch will be design based on the types, function and requirements of WiMAX system. The design that has been chosen will be stated at the end of this chapter.

2.1 RF Switch

RF switch is one of the components in the WiMAX system. There is much type of switches known as *reflective* and *non-reflective*[1]. Examples of the reflective type are single-pole single-throw, single-pole double-throw and single-pole four-throw. This means when this entire switch is closed between ports In and Out 1, port Out 2 is not connected or it is open and any signal appearing at this port will be reflected. The reflective switch configurations provide lower insertion loss than non-reflective switch topologies. Besides, this project will also use Single Pole Double Throw (SPDT) switch type of the RF switch.

This SPDT switch has three poles where the single pole is connect to the antenna while the double throw will connect to the receiver and transmitter. Switch configuration can be divided into three categories such as series, shunt and series-shunt. For this project, shunt configuration will be use as the design of the RF switch.

In this project, switching parameter or S-parameter is the main character that must be consider. Insertion loss is define as the ratio of the power delivered to the load on the “ON” state of the ideal switch to the actual power delivered by the practical switch, in the ON state. It is usually expressed in decibels and is a positive quantity.

For isolation, it can define as the ratio of the power delivered to the load for an ideal switch in the ON state to the actual power delivered to the load when the switch is in the “OFF” state. This also express in decibels and is a positive quantity.

2.2 PIN diodes

The most important property of the PIN diode is the fact that it can, under certain circumstances, behave as an almost pure resistance at RF frequencies, with a resistance value that can be varied over a range of approximately 1Ω to $10\text{ K}\Omega$ through the use of a DC or low frequency control current.

When the control current is varied continuously, the PIN diode is useful for leveling and amplitude modulating an RF signal. When the control current is switched “on” and “off” or in discrete steps, the device is useful for switching, pulse modulating, attenuating, and phase shifting of an RF signal.

In addition, the PIN’s small size, weight, high switching speed, and minimized parasitic elements make it ideally suited for use in miniature, broadband RF signal control components.