DESIGN OF X BAND MIXER FOR MICROWAVE COMMUNICATION

SITI SAHHIADA ASHIKIN BINTI MOHD YASIM

This Report Is Submitted In Partial Fulfillment Of Requirements For The Bachelor Degree of Electronic Engineering (Wireless Communication)

Faculty of Electronics and Computer Engineering
Universiti Teknikal Malaysia Melaka

Jun 2012

UNIVERSTI TEKNIKAL MALAYSIA MELAKA

FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN

PROJEK SARJANA MUDA II

Tajuk Projek : DESIGN OF X BAND MIXER FOR MICROWAVE COMMUNICATION

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"I hereby declare that I have read this report and in my opinion this report is sufficient in term of the scope and quality for the award of the Bachelor Degree of Electronic Engineering (Wireless Communication) "

Signature :……...
Supervisor Name : 1)Mr. Abd Shukur bin Jaa'far
Date :……...

Signature :……...
Supervisor Name :2) Mr. Azlishah bin Othman
Date :……...

Specially dedicated to

My beloved parents, brother, sister and my lover who have encouraged, guided and inspired me throughout my journey of education

ACKNOWLEDGEMENT

Special thanks to Allah S.W.T the all mighty, which with His Blessing, I manage to complete this project report. This report represents the collective efforts of many people, all of whom have contributed in some way to make it as good as it can be. I would like to take this opportunity to I would like to express my gratitude and thanks to my supervisor Mr. Abd Shukur bin Jaa'far and Mr. Azlishah bin Othman who guides me a lots in completing this project. They have helped me very much on explaining of the project and taught me with full commitment in order to make me understand. Their contribution and personal sacrifices are truly appreciated and will be remembered. Next, I would also like to extend my heartfelt appreciation to my parents, Mohd Yasim bin Salim and Sazana binti Sulaiman for their understanding and constant support in this academic pursuits. Last but not least I would like to give thanks to my classmates, colleagues and friends for their assistance and friendship during the course of the study. They have made my graduate studies an enjoyable and memorable experience of my life.

ABSTRACT

This project is about designing a X band mixer for RF communication. X band is the frequency spectrum which has range from 8 GHz until 12 GHz. The mixer is required to operates at 10 GHz . The basic function of mixer that need to understands is perform the sum and a difference frequency at a single output port when two distinct input frequencies are inserted into the other two ports. For transistor selection, FET is be decided because of its features compare with BJT. There are many types of mixer which are as their own characteristic performance. For this project, active mixer is choose as the first step in designing this mixer. The other theories and method that explore in this project is about the calculation how to get the value of resistance and the smith chart utility to get the value of the capacitor and inductor besides determined the types of DC biasing that will be used during designing this mixer. Based on the finding simulation result, it shows that active mixer and the transistor used be able to be used in this designing even though from the studying on journal, almost of them used Gilbert Cell mixer that can perform at high frequency.

ABSTRAK

Projek ini bertujuan untuk menghasilkan sebuah pencampur (*mixer*) untuk kegunaan di dalam komunikasi signal radio signal bagi frekuensi X band . Frekuensi X band ini berada dalam lingkungan 8GHz sehingga 12 GHz. Pencampur ini mestilah direka untuk beroperasi pada frekuensi . 10 GHz . Fungsi utama pencampur ini yang perlu difahami ialah menambah atau menolak dua frekuensi yang berlainan pada dua sumber yang berlainan yang menjadikan hanya satu frekuensi sebagai nilai keluaran. Bagi pemilihan transistor , FET telah dipilih kerana ciri-ciri yang ada padanya berbanding dengan BJT. Terdapat pelbagai jenis pencampur yang masing-masing mempunyai ciri-ciri tersendiri . Bagi pelaksanaan projek ini, pencampur aktif telah dipilih yang mana merupakan langkah pertama bagi permulaan untuk mencipta pencampurini. Teori dan langkah lain yang telah diekplotasi di dalam projek ini adalah berkenaan dengan kira-kira di mana bertujuan untuk mendapatkan nila rintangan dan juga cara menggunakan dan mengaplikasikan penggunaan *smith chart* bagi mendapatkan nilai kapasitor and induktor di samping menetapkan jenis pincangan bagi arus terus (*DC biasing*) yang mana akan digunakan semasa mereka bentuk pencampur ni. Hasil keputusan dari simulasi dari ADS menunjukkan pencampur aktif dan transistor yang digunakan boleh digunakan untuk menghasilkan pencampur pada frekuensi ini walaupun pencampur yang banyak digunakan adalah jenis Gilbert Cell bagi tujuan frekuensi tinggi.

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LIST OF ABBREVIATIONS

RF	-	Radio Frequency
IF	-	Intermediate frequency
LO	-	Local oscillator
ADS	-	Advanced design system
S Parameter	-	Scatterring parameter
FET	-	Field effect transistor
BJT	-	Bipolar junction transistor
LNA	-	Low noise amplifier
dB	-	Decibel
IIP	-	Input intercept point
OIP	-	output intercept point
DC	-	Direct current
L network	-	Lumped network
T network	-	Transformer network
X band	-	Frequency range from 8 GHz until 10 GHz

ABSTRACT

Now a days, a number of communication technologies are increased. The high performance of the technologies is very important to perform the process of transmit and receive the signal. Amplifier, frequency converter (mixer and oscillator) and filter are the basic function blocks in RF system Mixer is a transceiver component that can transmit and receive signal. It will combine two or more signal into one composite signal and operates in any frequency depend on requirement. X band is a one electromagnetic spectrum which operates at 8GHz until 12 GHz. This project is about designing of X band mixer for microwave communication.

Microwave communication is communication via radio using the antenna tower and also knows as line of sight (LOS). The gain and the conversion for this communication is very important in order to get the exact signal as we have transmitted. The purpose of this project is to design the mixer that because the higher bandwidth will allow to transmit more data.

The objectives of this project is to perform a simulation that fall at desired frequency which is 10 GHz. By exploring the journal about the mixer and about the for software, the simulation is as expected. To complete this project have four stages of methodology.

The first stage is literature review which need student to do some research about the theory based on the project title. To complete the literature review, student can refer from internet, journals, books and articles.

Next the second stage is design simulation which need student to explore more about the software use. In this project, the software use is ADS (Advanced Design

System 2011) and third is characterization and experimentation. In this stage, student will analyze the DC analysis and RF analysis. The last stage is thesis writing and report. This thesis will include overall of the project flow until the getting the desired result as expected.

CHAPTER 1

INTODUCTION

1.1 Project overview

This project is to design a X band mixer for radio frequency (RF) communication. The X band is a segment of the microwave radio region of the electromagnetic spectrum. In some cases, such as in communication engineering, the frequency range of X band is rather 7.0 to 11.2 gigahertz (GHz). In radar engineering, the frequency range is specified by the IEEE at 8.0 GHz to 12.0 GHz. For this project, the mixer required to operates at 10 GHz.

RF Mixer are 3 port-active or passive devices. They are designed to yield both, a sum and a difference frequency at a single output port when two distinct input frequencies are inserted into the other two ports. Microwave mixer is usually based on the nonlinearity that provided by either a diode or a transistor. A nonlinear component can generate a wide variety of harmonic and other types input frequencies

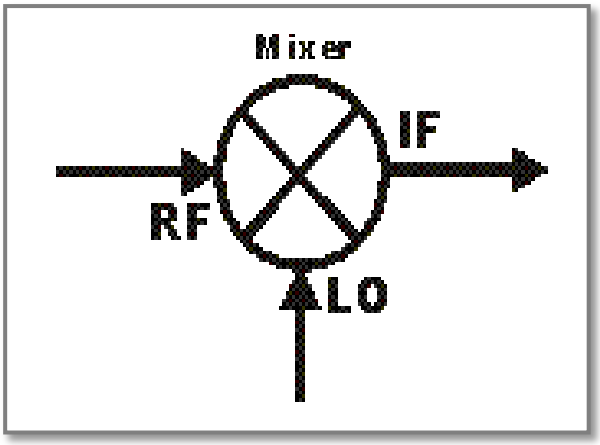

Figure 1.1 : Down converting mixer model

$$V_{RF} = A\cos(\omega_{RF})t$$
$$V_{LO} = B\cos(\omega_{LO})t$$
$$V_{IF} = A\cos(\omega_{RF})t) * (B\cos(\omega_{LO})t$$
$$V_{IF} = \frac{AB}{2}[\cos(\omega_{RF} - \omega_{LO})t + \cos(\omega_{RF} - \omega_{LO})t]$$

Equation 1.1.1

Where A and B is constant

The two signals inserted into the two input ports are usually the Local Oscillator signal, and the incoming (for a receiver) or outgoing (for transmitter) signal. To produce a new frequency requires a nonlinear device. In a mixing process, of we want to produce an output frequency that is lower than the input signal frequency, it is called down conversion and if we want to produce an output signal that is at a higher frequency that the input signal, it called up conversion

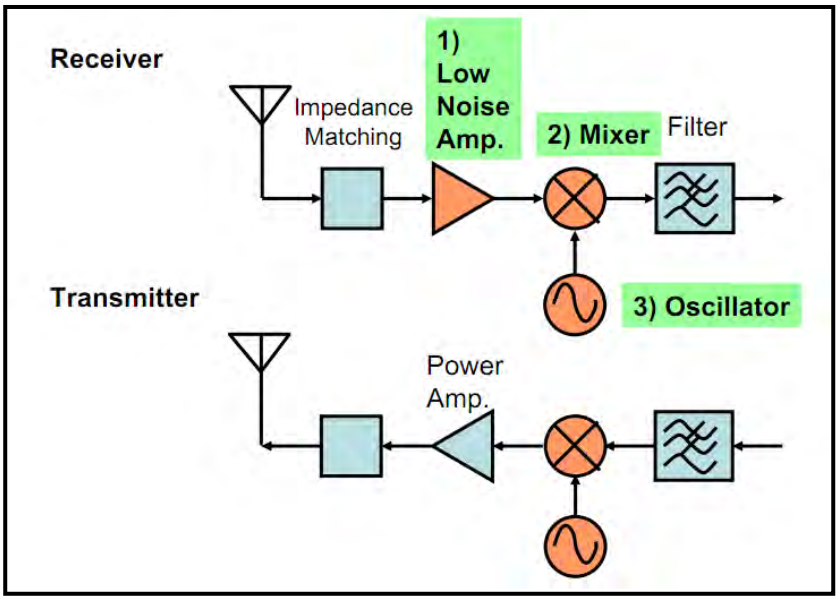

Figure 1.2 : Basic of RF Block

1.2 Objective Of The Project

1.2.1 To study the X band mixer which operates at 10 GHz

1.2.2 To study the ADS software in order to get the design for X band

1.2.3 To design X band mixer using ADS for microwave communication .

1.3 Problem Statement

Mixer is a design to sum or difference frequency at single output when two distinct input frequencies are inserted into the two port X band mixer if one of most highest frequency that can operates by RF communication .The higher frequency will speed up the sending of data transmission.

Because of too many users , the speed getting slow and need to upgrade the speed so that the RF communication will running smooth. The problem of this project is when

need to choose the suitable biasing for the types of mixer chosen. Calculation need to be careful so that the value that will obtained in software is right.

1.4 Scope Of Work

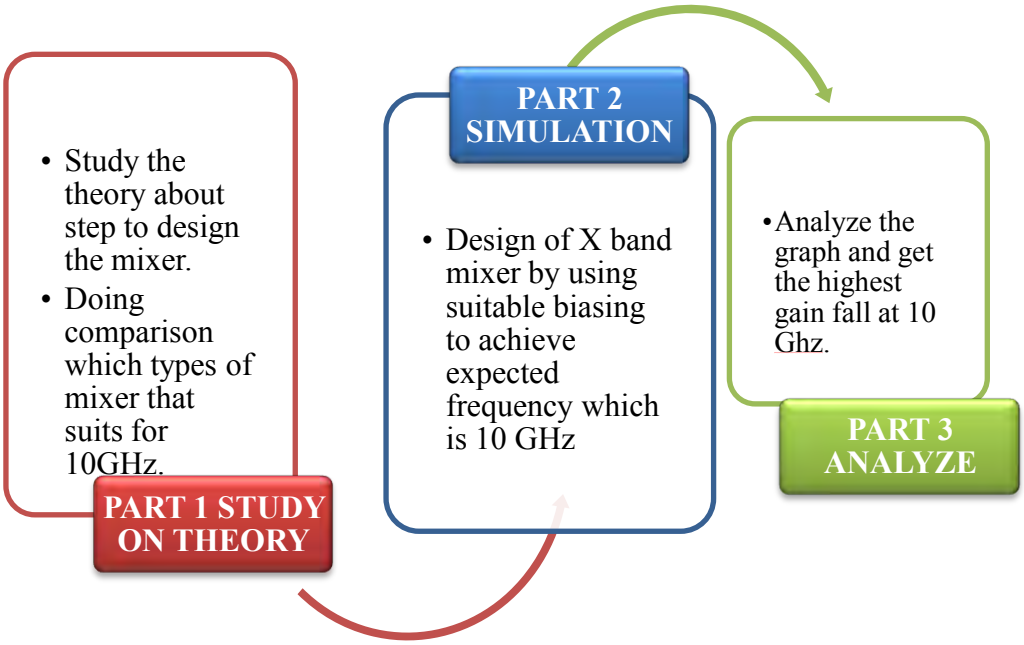

Figure 1.3 : Scope of work

There are three scope of work in order to complete the simulation of this project. The first part is study on theory. This part is important in order to explore how the mixer works and the step to design the mixer because there are many types of mixer have in this communication. We also need to choose which type of mixer that will be used as our design to for this project.

The second part is simulation part . In this part, the ADS software is used to design the mixer. The biasing of mixer based on the type of mixer that we choose. Before starting with the simulation, the calculation for the biasing must be completed first.

The last part is analyzing the result and graph from the simulation. The graph must fall at 10 GHz because it is the desired frequency.

1.5 Methodology

For methodogy, this project involves 4 major stages:

1 st phase: Literature Review

- Collectiong the project‟s information from text book, Internet, journals and reference books
- Doing research to know more detail about designing the X band mixer for microwave communication
- Famaliarize with ADS software
- Have discussion with supervisor

2nd phase: Design and simulation

- Analyzed and calculated all the parameters that related to design
- Construct the X band mixer by using the ADS software and the parameter

3rd phase: Characterize and experimentation

D*C Analysis*

- The purpose of DC analysis is to establish the appropiate bias condition for the device area or width that needed in the mixer
- DC analysis is very useful because it will clarifies the range of operating conditions possible without cause into the ohmic or cut of regions

RF Analysis

- RF analysis is important to avoid leakage effect, complicating the design of the complete system.
- The example of measurement using this analysis is gain conversion, voltage conversion gain vs LO signal power,S parameter,power dissipation and others.

4th phase: Thesis writing or report writing

Thesis or report writing is the last stage for this project. Student will write the thesis about overall process or work flow about their project. Supervisor will give mark based on performance of the report and the result of the simulation.

1.6 Work Schedule

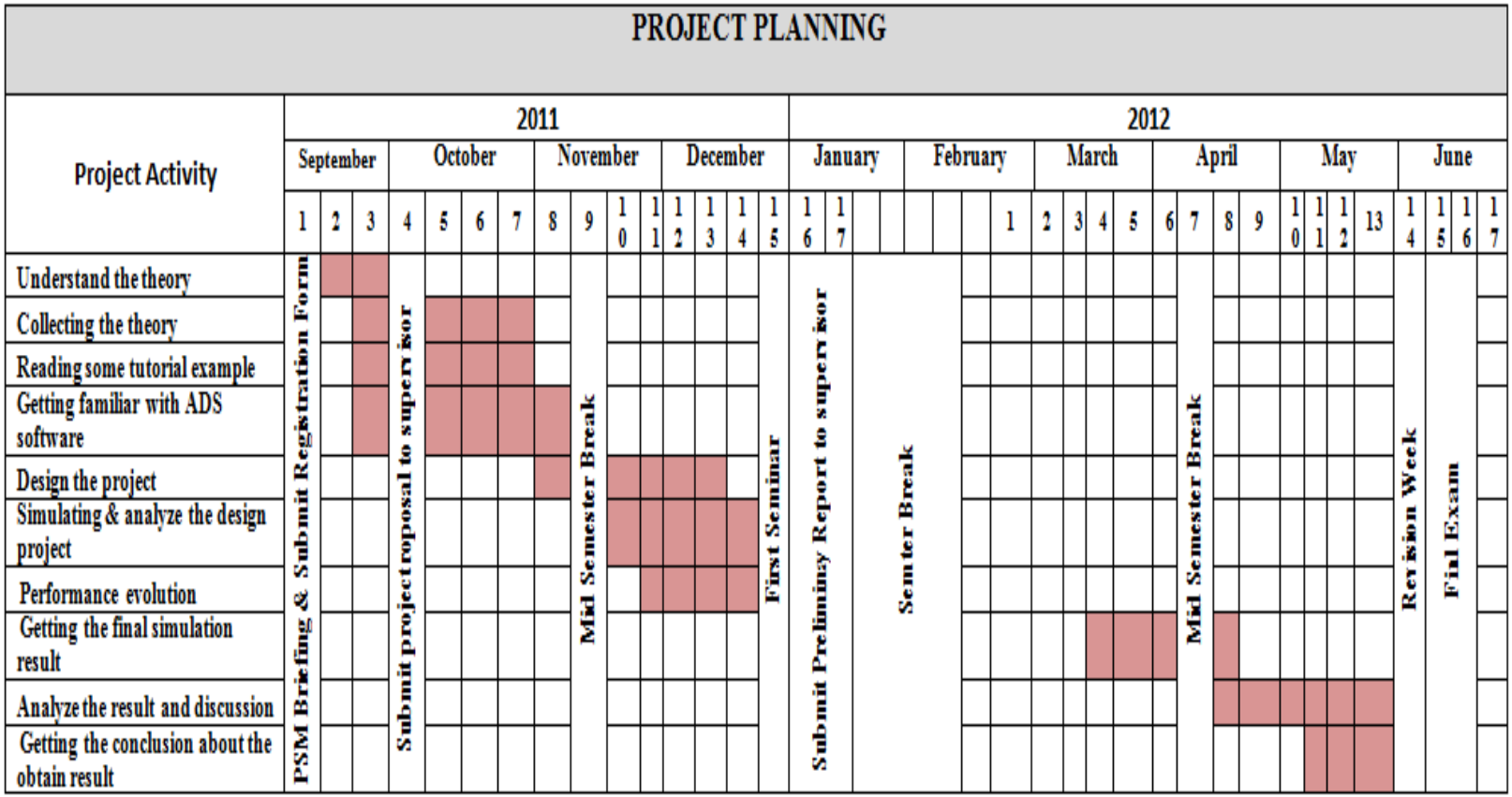

Table 1.1 : Project Planning