“ I hereby declare that I have read through this report entitle “*Narrow Band Electric Field Measurement Generated by Lightning Flashes*” and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power) ”

Signature : .....

Supervisor’s Name : .....

Date : .....

NARROW BAND FIELD MEASUREMENT GENERATED BY LIGHTNING FLASHES

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A report submitted in partial fulfillment of the requirements for

the degree of Bachelor of Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2013

I declare that this report entitle "*Narrow Band Electric Field Measurement Generated by Lightning Flashes*" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : .....

Date : .....

ACKNOWLEDGEMENT

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

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ABSTRACT

Lightning is the most fabulous nature phenomena generally known as lightning flashes. The lightning flashes will generate electric field considered as radiations which are high and low frequency radiation. The measurement of the voltage between clouds to ground produce by the lightning flashes on the electric field intensity will contribute the very important information to the things that will be measured. Furthermore, this project will support the researcher or power engineer to understand about radiation field in which lightning activities that can harm the sensitive devices system. This project measurement have been done by the combination of flat plate antenna that will use to sense the induced voltage produce by lightning flashes and the signal received will tune at interest frequency 3MHz with bandwidth operation in range 300kHz. The measurement was conducted at Faculty of Electrical Engineering, Universiti Teknikal Malaysia Melaka. The analysis has been done to determine the duration radiation of 3 MHz that produce from ground flashes which is return stroke flash. The mean duration and standard deviation for the radiation is 232.5μs and 134.5μs. Based on the comparison data from Sri Lanka and Sweden, the value are not different from the collected data. Besides, to get more smooth data, the measurement must use high technology equipment and at the place which have low resistance.

ABSTRAK

Kilat adalah fenomena alam semula jadi yang paling hebat umumnya dikenali sebagai pancaran kilat. Pancaran kilat akan menjana medan elektrik dianggap sebagai radiasi yang tinggi dan sinaran frekuensi rendah. Pengukuran voltan antara awan ke tanah yang dihasilkan oleh kilauan kilat pada keamatan medan elektrik akan menyumbang maklumat yang sangat penting kepada perkara-perkara yang akan diukur. Tambahan pula, projek ini akan menyokong penyelidik atau jurutera kuasa untuk memahami tentang medan sinaran di mana aktiviti-aktiviti kilat yang boleh membahayakan sistem peranti yang sensitif. Projek pengukuran telah dilakukan dengan gabungan antena plat rata yang akan digunakan untuk mengesan hasil voltan yang disebabkan oleh pancaran kilat dan isyarat yang diterima akan merujuk khas pada frekuensi 3MHz dengan operasi jalur lebar di antara 300kHz. Aktiviti mengumpul data ini telah dijalankan di Fakulti Kejuruteraan Elektrik, Universiti Teknikal Malaysia Melaka. Analisis telah dilakukan untuk menentukan tempoh radiasi pada 3 MHz yang dihasilkan oleh pancaran kilat dari tanah ke awan. Tempoh min dan sisihan piawai bagi data yang terkumpul adalah 232.5μs dan 134.5μs. Berdasarkan data perbandingan dari Sri Lanka dan Sweden, nilai yang dikumpul tidak kurang beza dengan nilai data yang sedia ada. Selain itu, untuk mendapatkan data yang lebih licin, ukuran mesti menggunakan peralatan teknologi tinggi dan di tempat yang mempunyai rintangan tanah yang rendah.

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CGs	Cloud to ground flashes
HF	High frequency
ICs	Clouds flashes
NBPs	Narrow Bipolar Pulses
NPBPs	Narrow Positive Bipolar Pulses
NNBPs	Narrow Negative Bipolar Pulses
VHF	Very High Frequency
UTeM	Universiti Teknikal Malaysia Melaka

CHAPTER 1

1. INTRODUCTION

1.1. Lightning Phenomena Overview

In electricity field, the lightning flashes are a very common because many researchers have doing experiment to prove that it produced electrical discharge. The research have been done Benjamin Franklin and proved that the lightning is an electrical discharge. This natural phenomenon is the things that we cannot predict when it will happen and what are the characteristics. From the view from old researcher, in each of the cloud it will bring the different characteristic of the lightning. Besides, it also depend at the places that the measurement was take place. But it can be conclude that at the return stroke is very important to be research because at that time it brings the very high frequency at the very fast reaction that can harm the sensitive equipment.

1.2. Motivation

Nowadays, many scientist, researchers and power engineer still do research on the lightning behavior because it is the thing that is not really predictable. Recently, there has been a lot of interest in strong emission is impulsive and the large amplitude represents a potential hazard to any system which is sensitive to the transient field because lightning produce high radiation frequency. Even though certain parts of the discharge process have been understood, however certain mechanism of radiation field associated in lightning processes (cloud to cloud and ground flashes) still poorly understood.

1.3. Problem Statement

Lightning is a very huge electrostatic that always happen between the cloud to ground, cloud to cloud or within cloud and it is the natural phenomena. Nowadays, in the modern technology communication system (for instance wireless, satellite, antenna, and radio transmission), avionics and electronics industries have raised a demand for progressive lightning research work. Even though certain parts of the discharge process have been understood, however some of the scientists still trying to find and research to know more on what initiates lightning flashes because still remain popular subjects to be discuss. So, that it is very important to have a good knowledge and information on the initiation process of the lightning

1.4. Objective

i. To construct the radiation field measurement system at 3 MHz to be used for recording the cloud flashes and ground flashes.
ii. To analyze the important parameter of high frequency (HF) radiation generated by lightning flashes.
iii. To do the statistical analysis by comparing the data with other data from different locations.

1.5. Scope Of The Project

The purpose of the project title Narrowband field measurement generated by the lightning flashes in Malaysia is to know the lightning characteristics. The construction circuits for the measurement start by design and simulate the circuit by using ORCAD software. The design is important to construct the PCB board design and then continue with the hardware construction. The recording data for the radiation generated by lightning flashes will focus on cloud to cloud flashes and also ground flashes at the interest 3 MHz frequency. The ground flashes are return stroke while clouds flashes are narrow bipolar pulse at the radiation of 3 MHz and broadband. Besides that, Faculty of Electrical Engineering in Universiti Teknikal Malaysia Melaka near to machine laboratory as the main location used to observe the lightning activity. In the principle, the measurement for radiation will using flat plate antenna, circuitry for 3MHz, fast field circuit and oscilloscope. Besides that, to identify the important parameters of high frequency radiation produce by cloud flashes and ground flashes that occur in certain frequency that is 3 MHz. The data collected has been analyzed by using matlab software and the statistical data to compare with the data collected from other location.

CHAPTER 2

2. LITERATURE RIVIEW

2.1. Introduction

Previously, the record on the electric field about the negative on cloud to ground flashes produce by first return stroke based on the old researches experiments [3],[4],[5],[6]. The high frequency radiation produced by the lightning can be classified as broadband frequency in range of kHz to GHz and also narrowband in range 3MHz and 30MHz. The HF radiation at 3MHz during the leader and return stroke process has been studied Jayaratne and Cooray[13]. In the other case to measure the high frequency radiation field, the three parallel plate antennas are needed to be used [2]. There are many possible causes of HF radiation from lightning. From Brooke and Kitagawa [4] suggested that the radiation from lightning is associated with the formation streamer.

Although the cloud flashes are known will not affect to human, animal and the other structure on the ground, the understanding on the HF emission that produced by cloud flashes is important for both scientific investigation and also for engineering assessment. That is because, the HF radiation from lightning very considerably with frequency, the magnitudes are conveniently decided upon by consulting several amplitude [14].

2.2. Types of lightning

There are several types of lightning that is produced by the thundercloud. The cloud discharge is one if the lightning type which happen in the cloud itself. Besides that, the lightning between could to cloud that occur between the one cloud and the other cloud), between cloud and the earth (cloud-to-ground or ground discharges) and also the air discharge which happen between the cloud and it air surrounding. Usually, the lightning can be classified mainly as ground flashes (CGs) and also cloud flashes (ICs) [3]. All the negative cloud to ground flashes brings the negative charge to the ground and 90% show from the electromagnetic field measurement [1].

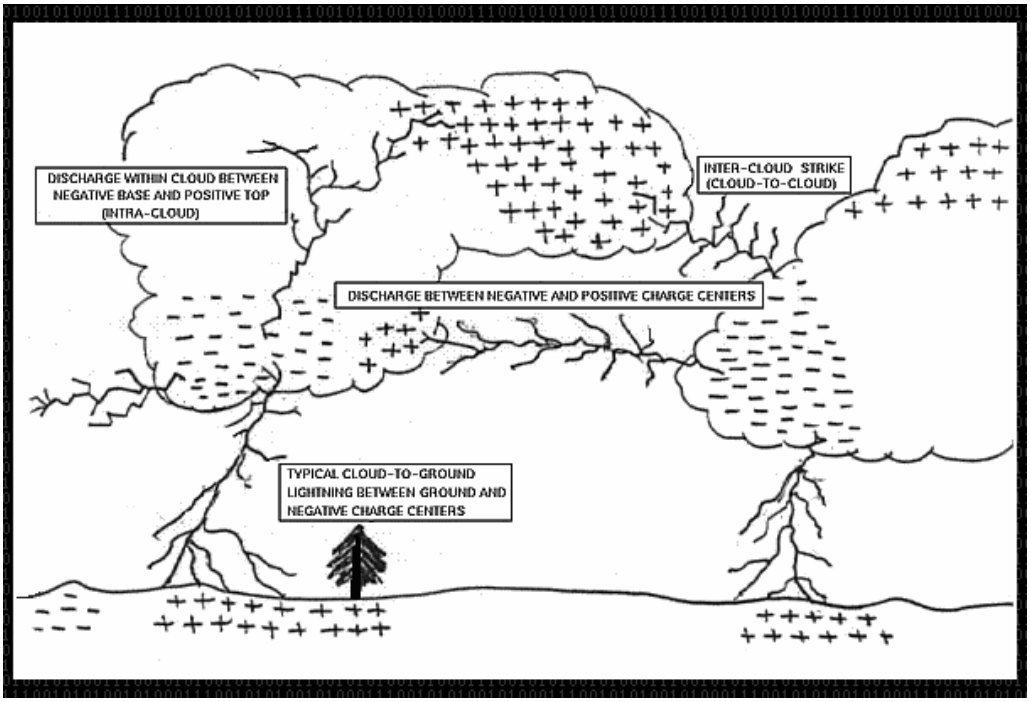

Figure 2.1: Electric charges distribution inside the cloud and types of lightning

2.3. Stepped Leader And Return Stroke

Before the lightning strike to the ground, there was the activity happen in the cloud itself that is call preliminary breakdown. When the ionization of the atom in the cloud gained the electron (negative ions) and it will become electrically charged. When there was very strong value of negative charge in the cloud, which will produce the electric fields and will caused negative charge to be propelled downward to the earth. This phenomenon is called stepped leader because it appear downward to the earth (Figure 2.2). The stepped leader from the cloud come downward to the ground can be class as a series of branches or steps.

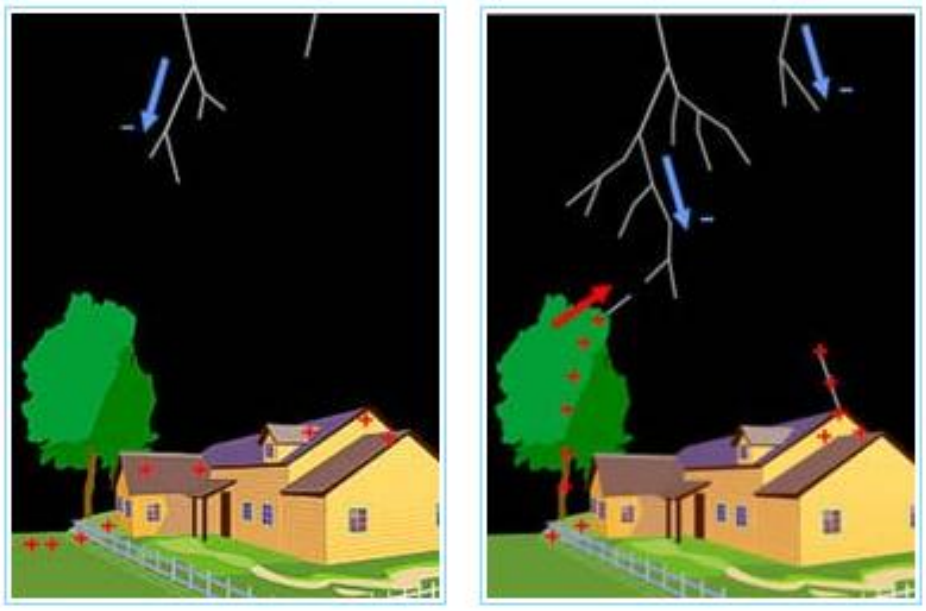

Figure 2.2: Stepped Leader from Cloud to Ground

When the lightning is near to the ground which contains positive ions, the negative ions from the cloud will be attract to the positive ions on the ground. The positive ion from the ground will cause the upward moving discharge from the ground to the cloud. This process is called the return stroke and the flash can be up 26 strokes but in average are only three to five strokes. This return stroke has very high emission radiation based on the previous experiment. In this return stroke there was fast front and also slow front that only happen in very short time. This to parameter is very important to know the effect of the return stroke to the equipment that is very sensitive.

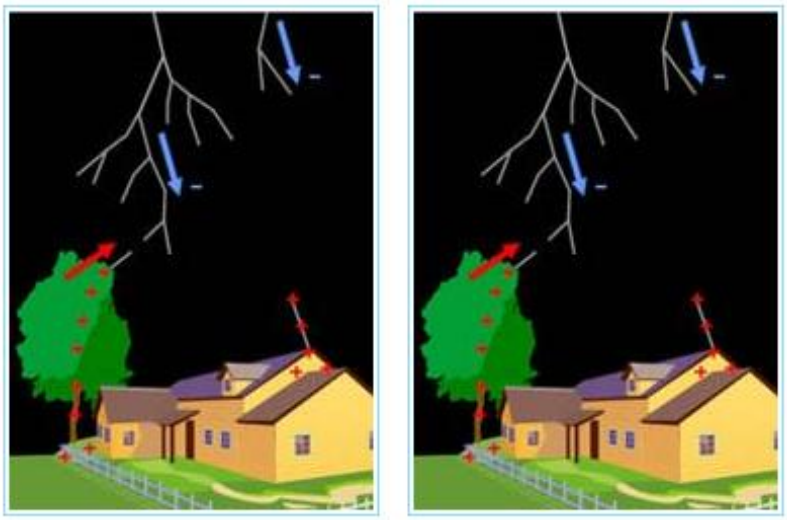

Figure 2.3: Return Stroke Process (Ground to Cloud)

2.4. Narrow Bipolar Pulses (NBPs)

Narrow Bipolar Pulses (NBPs) is also can be recognize and known as a compact of intracloud discharges (CIDs), [1][18] from the lightning process due to the association of the strong radio frequency (RF) radiation. There are two types of NBPs that are known as Narrow Positive Bipolar Pulses (NPBPs) and also Narrow Negative Bipolar Pulses (NNBPs). These NBPs was observed easily in the country that have the tropical region compared to the country that in temperate region, [1]. The other information, the positive NBPs was reported happen at the range of 6 km – 15 km while the negative NBPs at the higher range which is 15 km – 21 km, [1]. Besides that, this NBPs also known as very high power, short distance discharge of the radio waves which is produces the very strong emission radiation.

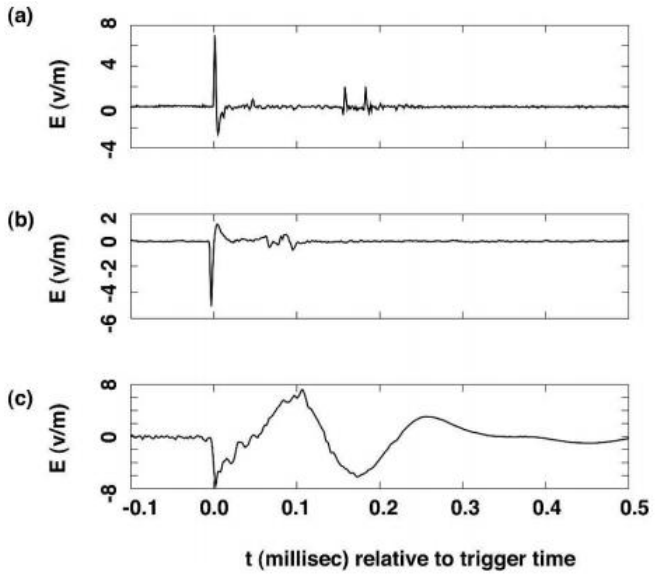

Figure 2.4: Sample result (a) NPBPs, (b) NNBPs and (c) non-NBPs (ordinary) lightning signal

CHAPTER 3

3. METHODOLOGY

3.1. Flow Chart

The flow charts below show the progress of the project start from PSM 1 and continue until the end of the project. After get the title for the final year project, the first step should be done is to gather as many information as possible from the journal that have been done before. Then the info should be summarizing to help what is important that related to the project title.

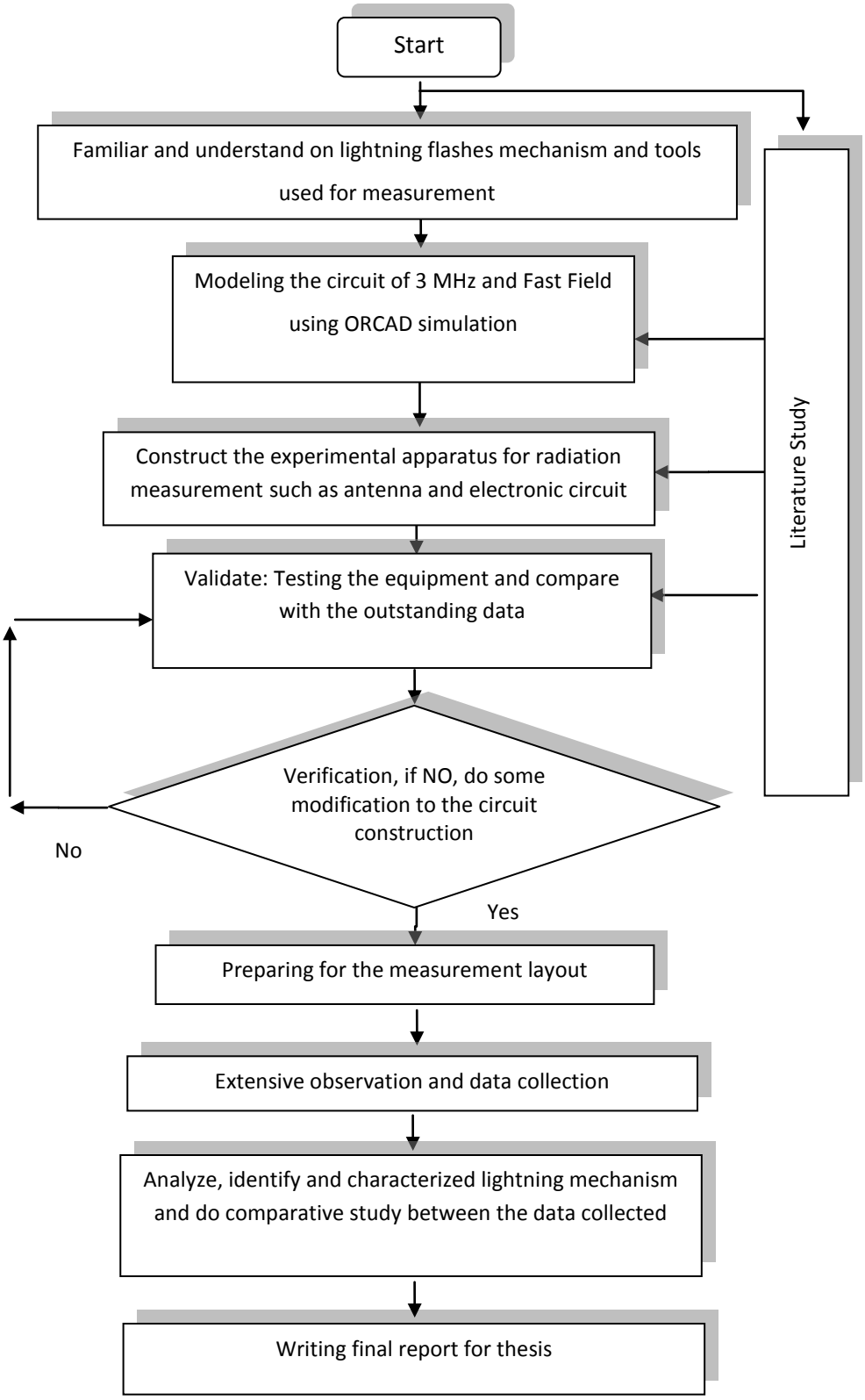

Figure 3.1: Flow Chart of the Project

3.2. Circuit Simulation Using Orcad

3.2.1. 3 MHz

For this 3MHz circuit, it only used the simple RLC circuit. The inductor 47uF was connected in series with the antenna capacitor 59p and 50 ohm matching resistor as Figure 3.2. From the result simulation as in Figure 3.3, the bandwidths for 3MHz in range 267 kHz.

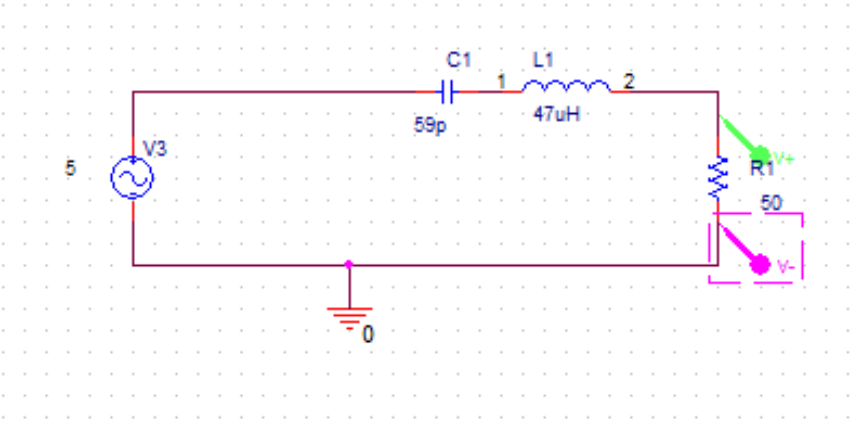

Figure 3.2 : Equivalent Circuit for 3MHZ

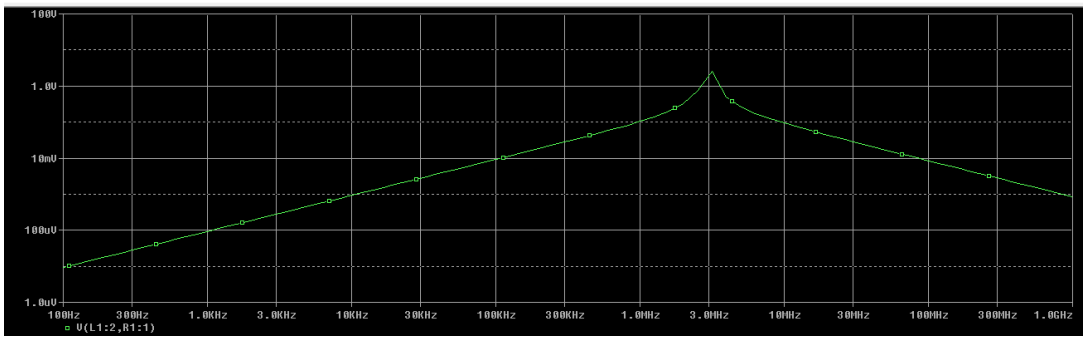

Figure 3.3 : Output from OrCad Simulation