CHAPTER 1
INTRODUCTION

1.1 Background

The development in information and communication technology is currently growing very rapidly and bring positive impact on every aspect of human life. However, this development also has a negative impact where the electromagnetic interference occurs because some of the technologies have a frequency that close to various applications due to limited frequency resources within a certain frequency range. Both 2.4 GHz and 3.7 GHz band considered in this thesis because many vital roles in communication technology such as ISM Band, Wireless LAN, Satellite Communications, etc [1].

Therefore, the need for a device which has the ability to minimize the effects of electromagnetic wave interference is very important to optimize the technology performances in each aplication of frequency spectrum. In the last few years, research has been carried out on some material which absorb elegtromagnetic wave in the RF/microwave field, it has the ability to minimize electromagnetic waves energy or reduce reflected electromagnetic waves [2]. One of type material that is classified as a metamaterial is AMC (artificial magnetic conductor). AMC has characteristics similar to PMC (Perfect Magnetic Conductor) with these properties being the ability to reflect incoming electromagnetic waves without changing its phase [3]. Several forms of application of electromagnetic wave absorbers have the ability to reduce electromagnetic interference include anechoic space, stealth technology, antenna support components, etc.

One example of its application in tracking radar applications, electromagnetic wave absorbers can be used to reduce the Radar Cross Section (RCS) when an object is detected by the radar. [4]. Another benefit of using the Electromagnetic wave absorber can also be used to create a free space environment with the concept of eliminating reflections in anechoic space. This has many benefits in terms of optimizing measurements as it reduces electromagnetic interference [5]. The type of absorber used in the anechoic chamber is required to have a wideband frequency coverage capability.

Besides the nature characteristic possessed by metamaterial based on AMC, it also has the disadvantage of a narrow bandwidth at its resonant frequency [6]. Some of single layers of electromagnetic wave absorber bandwidth have been created [5]. Another approach is carried out with research that focuses on adding two or more resonator shape structures to produce new resonator shapes capable of working at multiple multi-resonant frequencies with geometric structure complexity. [5]. Implementing a metallic hexagonal patch on three layers of the dielectric substrate and two layers of the air gap with various thicknesses, the absorption bandwidth could achieve 14.2 GHz from the frequency of 4.3–19.1 GHz [8]. Multilayer EM wave absorber composed of metasurface is proposed for X-band application to aim wideband metamaterial with SRR at the bottom layer and a narrow thin strip on the top layer side [9]. a structure consisting of a combination of five different element unit cells, where each of its works at a certain resonant frequency from 9.7-10.47 GHz [11].

Based on the background of the problem this thesis purpose to design of metamaterial with modification in adding two split ring resonator is used for one unit cell to achieve multiband effect from previous research. Some techniques are also added using multilayer structure or air gap.

1.2 Problem Identification

There is limited research on dualband absorbers for 2.4 GHz and 3.7 GHz frequency band. Meanwhile the application of 2.4 GHz frequency band has many vital roles in communication technology [1]. In the 2 GHz band, especially 2.4 Ghz, there is an overlap between the use of frequencies for IEEE Wi-Fi standards 802.11b, 802.11g and 802.11n, bluetooth applications and microwave ovens and ISM Band. 3.7 GHz Band is used for C-band satellites downlink from 3.7 to 4.2 GHz, and 5.925 to 6.425 GHz for the uplinks part. For 3.7 GHz band is overlaps with the IEEE S band for radars and wireless broadband services that have been determined by the Ministry of Communication and Information in the range frequency of 3.4-3.7 GHz. This matter become of consideration too because Indonesia is one of the countries that uses the C-Band band as a communication satellite frequency even though the quota is full due to interference due to overlap or other satellites. The large number of devices used in applications in adjacent frequency bands may cause electromagnetic wave interference.

1.3 Objective

This thesis aims to design Multiband absorber for 2 – 6 GHz. The overall contributions are summarized as follows:

1. Propose design for multiband metamaterial with modification to achieve multiband frequency application.
2. Provide analysis of the performance multiband metamaterial.

1.4 Scope of Work

The limitations in this research problem are as follows:

1. Metamaterial absorber design using some calculation to get value of the shape and for processing with simulation software.
2. The simulation will be conducted using single-element for the start and later consist of some array unit cell modeling with boundary condition to simulate structures as if they had infinite size.
3. For metamaterial prototypes, certain sizes will be provided according to the simulations that have been carried out.
4. Matematerial prototype will be tested on laboratory for further verification with the simulation result.
5. Design analysis.

1.5 Research Method

This thesis is divided into 5 work packages (WP) to produce high quality results.

- WP1: Study of literature

  Studies on basic theories related to metamaterial concept and theories from the previous research. Literature studies help explain theories related to how metamaterial works, proposed the design of multiband metamaterial and provide some theories for result analysis.

- WP2: Metamaterial Absorber Design and Simulation
  Design of metamaterial will be conducted with the various modification from the previous research. The size and model of metamaterial using some calculation and processing with simulator.
- WP3: Metamaterial Absorber Test
  Design result from the experiment will be produced using dielectric material FR4 and cooper layer as outer part of the metamaterial will be tested in laboratory.
- WP5: Perfomance Evaluation
  Analyzing and comparing the result from the simulation and laboratory test.

1.6 Organization of Thesis

The contents of this thesis are composed as follows:

- **CHAPTER 2: Basic Concept**
  This chapter will describe basic concept of metamaterial, Electromagnetic wave inside the absorber.
- **CHAPTER 3: Proposed Design and Simulation**
  This chapter will give us further discussion about how proposed design and simulation scenario of metamaterial unit cell process to obtain multiband absorber.
- **CHAPTER 4: Result and Analysis**
  This chapter will provide a summary of the results that have been carried out in the thesis and mention about recommendation that can be applied for future works.