CHAPTER 1
INTRODUCTION

1.1 Background

Branch Line Coupler is one of series of important passive microwave, usually serves as a divider or combiner power in a sub-system of communication devices or radar [1]. This device is implemented with a variety of ways to acquire capabilities. Branch Line Coupler generally consists of four ports which the ideal one would have matched, not having losses and reciprocal. Basically Branch Line Coupler is a passive device with four terminals that have 4 pieces of arms linear symmetrical to produce output signal 90 different phase [1]. Branch Line Coupler performance is determined by parameters such as: return loss, insertion loss, coupling factor and isolation. The duplexer is one of the application of the Branch Line coupler, duplexer is one part of the pulses radar. Pulse radar has only one antenna which is used to transmit and receive signals. In [2] it was described the ability of duplexer for separating the transmitted signal and the received signal

The conventional Branch Line Coupler basically have large enough dimensions and have the isolation value less than -20 dB, but in high frequencies this isolation value (-20 dB) can not be used because of the many signals with different phase angle [3]. The purpose of this study was to obtain better isolation of the Branch Line Coupler (less than -55 dB).

In another study, similar parallel microstrip coupler has been widely used because it was easily made and has a simple shape [23]. Weakness and lack of good isolation and directivity of a microstrip because inhomogeneous dielectric constant, causing an odd mode wave propagation faster than even mode on the microstrip line [5]. Several methods have been made to improve the isolation value of this microstrip coupler. To reduce the phase velocity wave propagation mode is used a dielectric overlay.

To improve the isolation value of the coupler can be done by adding ground plane aperture, this method can fix isolation on conventional coupler, but because of difficulties in the fabrication, This technique can not be done in the form of

MMIC [9]. There are several ways to generate high isolation value, namely the technique of modifying the channel impedance as the feed forward technique which is done by modifying the dimensions of the T-junction Branch Line Coupler. Dimensional change is necessary to produce a structure size that can produce the best isolation characteristics. Research topics have been selected to obtain the appropriate size that can provide the best isolation value. The sizes of Branch Line Coupler consist of a length and width of the series arm and parallel arm, the arm has a series $Z_o = 50\ \Omega$ impedance and $Z_o = 35.35\ \Omega$ and parallel arm $Z_o = 50\ \Omega$.

On the application of radio frequency (RF) and microwave radiation, it is required to obtain a high speed. These applications offer a high level of integration to reduce the size, weight and lower power consumption [3]. Components on the form of Monolithic Microwave Integrated-Circuit (MMIC) [7] and Multilayer thin-film multichip module technology (MCM-D) [8] which is integrated in the form of microstrip [9] and T / R switching circuit [10]. it is necessary to design integration of the active and the passive component. Besides lumped element, distributed elements, such as branch-line coupler, is an essential element necessary for it to be integrated in microwave systems. However, the integration methods of the components mentioned above is resulted in a low isolation values below -20 dB. In simultaneously Tx/Rx applications where the ability to separate the signals between transmitted and received signals, it is required a high isolation because of the received signal at the receiver port is often very weak. [4].

In [11], antennas that transmit and receive signals in a different state of polarization. This is to obtain the right signal by means of the sender and receiver in a single carrier frequency. In [11], branch-line coupler was used as a separator between the sender and receiver, branch-line divides the input power coupler on one port into two ports are the same as the phase difference $+90^o$ or -90^o. This can be used to acquire the right side (right hand side) and the left side (left-hand side) circular polarization by using two cross-polarization antenna input. In [11], it is also used two variable capacitance diodes on a circuit which is useful as tuning to obtain the desired operating frequency. The simulation obtained an isolation improvement of - 52 dB [12]. The dimension modification of branch-line coupler at the T junction

with the physical parameter W50Ω : 2,952 mm, L50Ω : 15.2 mm and W35.35Ω : 5.14 mm, L35.35Ω : 15.2 mm has a simulation results obtained isolation value of -31.185 dB. In [13], it is used a form of slot-coupled patch directional coupled that have ellipse-shaped patches with 22.5 mm arm length, substrate dielectric constant 4003C Rogers Ro 3.38 at the working frequency of 2 GHz, has -45 dB isolation.

In this study, Branch-Line coupler is applied in the form of microstrip with the substrate used is FR-4 that has a dielectric constant of 4.6 and a thickness of 1.3 mm with operating frequency of 3 GHz. We used FR-4 because it is easily obtained in the market. To obtain the best isolation value, we optimize of the transmission line coupler by modifying the length and width of the arms series (Zo = 50 Ω), the length and width of the arms series (Zo = 35.35 Ω), the length and width of the arms parallel (Zo = 50 Ω) using CST software of 2014. The simulation optimization results of isolation value is -67.786 dB.

1.2 The Gap of the Real Condition and Design Requirement

There are some research regarding improved isolation, such as in [3], which is used a feed forward technique that consists of Wilkinson combiner, Couple line, Branch line coupler, and microstrip lines. This technique used Teflon as a substrate with a thickness of 0.78 mm, a dielectric constant of 2.45, the operating frequency of 5.8 GHz. To do 'cancelation', there are two processes, namely the distortion cancelation input loop and signal used for linearizing. This study does not have the power amplifier, in addition to the input signal to generate a sample signal to eliminate signal leak on a branch line coupler. Therefore, there are coupler lines to set the level of the sampled signal and the signal leaked in order to have the matching impedance, on port 5 microstrip structure to adjust the phase of the signal leaking opposite phase to the signal samples. These signals in combination right on the port 6. In this research, the value of -55 dB isolation in simulation results.

In a study [13] improve isolation in the slot directional coupler coupled with the elliptical patch, using a substrate Rogers Ro 4003 c, the dielectric constant ε_r = 3.38, a thickness of 1.524 mm, from the simulation results, it is obtained an isolation value of -44 dB. In another study [14], to improve the isolation between the two

loop antennas using the 'cell absorber' at the operating frequency of 2.56GHz. By entering a metamaterial, it will be able to control the effects of mutual coupling on controlling the wave propagation on the surface and near-field radiation [15]. Because the metamaterial has a negative permeability, the number of magnetic coupling can be reduced. This metamaterial has the form of split ring resonator (SRR) are designed on FR4 material, this research was obtained from the value of -35 dB isolation.

1.3 Problem Definition

There is some research on Branch Line Coupler which aims to improve isolation, adding bandwidth, smaller dimensions but the research related to improve BLC isolation is still very few. Branch Line Coupler is a passive component with 4 terminals that has four long arms with sleeve linear λ/4. Branch line coupler has the disadvantage that a conventional large size and has a value of insulators around -20 dB but can not be implemented at high frequency because of the many signals coming from different phases [3].

Problem definition with this research is to investigate whether there are any effects in changing the dimensions of the isolation characteristics.

1.4 Problem Limitation

This research discussion is limited to Branch line coupler design by using simulation software of Computer Simulation Technology (CST) 2014, applied to the duplexer on the type of radar pulses at a frequency S band, with FR4 (Epoxy) as a substrate material, dielectric constant of Ɛr = 4.6 , with a thickness of 1.3 mm. This research carried out:

1. Design Branch line coupler with a predetermined geometry.
2. Modifications performed only on the transmission line A (arm series that have Zo = 50 Ω impedance), the dimensions of the transmission line B (which has a parallel arm impedance Zo = 50 Ω) and the dimensions of the transmission line C (the arm that has a series impedance Zo = 35.35 Ω).
3. Optimization is done to obtain the isolation value <- 55dB.

1.5 Objectives

The purpose of this research is to modify the Branch Line Coupler to get the dimensions that produces the best isolation values (<-55 dB) at operation frequency of 3 GHz to be applied to a pulse radar duplexer .

There are three variables in this research:

1. Dependent variables : Branch Line Coupler
2. Independent variables : Optimization dimension
3. Control variables : Characteristics Isolation

1.6 Hypotheses

Branch Line Coupler has the disadvantage of the conventional value in the range of -20 dB isolation with isolation value of this magnitude can not be used at high frequency while the other studies obtained isolation value of - 55 dB.

In this research, optimization by modifying the dimensions of length and width of the transmission line impedance arm series (P50Ω and L50Ω) and the length and width of the transmission line impedance parallel arms (P35 Ω, 35 Ω and L35,35 Ω) to obtain a better isolation value.

The hypothesis of this study:

1. There is the effect of dimensional changes on the branch line coupler to the isolation value.
2. From the simulation results and measurements can be seen whether the branch line coupler can be applied to the duplexer

1.7 Research Method

To support this thesis and in order to obtain the desired results, then some method performed in this study include:

a. Study Literature

Selection of reference related to the topic of the thesis submitted by references drawn from various handbooks and relevant national and international journals.

b. Design and simulation

At this stage, the result of calculating the dimensions of the coupler of the formula is there, then performed a simulation of the design results. Design and simulation software to use CST (Computer Simulation Technology) in 2014.

c. optimization

From the simulation results of further calculations do optimization, to increase the isolation value. The simulation results of the optimization will be obtained Branch Line Coupler sizes that have isolation <- 55 dB.

d. Realization and Measurement

After optimization of simulation results. and obtained the desired dimensions, further realization of using PCB. And then do the measurements for comparison with the simulation results.

e. Make a report