UNIVERSITI TEKNOLOGI MARA

RECONFIGURABLE MICROSTRIP ANTENNAS INTEGRATED WITH TRUNCATED RHOMBUS-LIKE SLOTTED PATCH STRUCTURE

SUZILAWATI BINTI MUHAMUD @ KAYAT

Thesis submitted in fulfilment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Electrical Engineering

November 2015

CONFIRMATION BY PANEL OF EXAMINERS

I certify that a panel of examiners has met on 15th January 2015 to conduct the final examination of Suzilawati binti Muhamud @ Kayat on his Doctor of Philosophy thesis entitled "Reconfigurable Microstrip Antennas Integrated With Truncated Rhombus-like Slotted Patch Structure" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examniners recommends that the student be awarded the relevant degree. The panel of Examiners was as follows:

Muhamad Dani Baba, PhD
Professor
Faculty of Electrical Engineering
Universiti Teknologi MARA
(Chairman)

Zaiki Awang, PhD
Professor
Faculty of Electrical Engineering
Universiti Teknologi MARA
(Internal Examiner)

Tharek Abdul Rahman, PhD
Professor
Faculty of Electrical Engineering
Universiti Teknologi Malaysia
(External Examiner)

Ahmed Ibrahim Al-Shamma'a, PhD
Professor
Liverpool John Moores University
United Kingdom
(External Examiner)

SITI HALIJJAH SHARIFF, PhD
Associate Professor
Dean
Institute of Graduates Studies
Universiti Teknologi MARA
Date: 12th November, 2015

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Suzilawati binti Muhamud @ Kayat
Student I.D No	:	2010184585
Programme	:	Doctor of Philosophy (Electrical Engineering)
Faculty	:	Faculty of Electrical Engineering
Thesis Title	:	Reconfigurable Microstrip Antennas Integrated With Truncated Rhombus-like Slotted Patch Structure
Signature of Student	:	.....
Date	:	November 2015

ABSTRACT

Reconfigurable microstrip antennas have so many attractive features to offer such as the ability to reconfigure independently in order to perform entirely different functions for numerous applications. They can provide diversity functions to mobile communications in three main categories: operating frequency, radiation pattern and polarization. This is in contrast with the conventional antennas which normally offer one particular function at a time in a single antenna. There are many types of reconfigurable antennas that have been demonstrated in previous researches with regards to these three different categories. In this research, the development of reconfigurable antennas can be divided into two main categories, which are based on operating frequency and radiation pattern. Prior to that, two novel structures of aperture coupled microstrip antennas in a single configuration at two different frequencies have been developed, which are denoted as TRSPA-1 and TRSPA-2. Each antenna employs a truncated rhombus-like patch shape embedded with a unique 'zig-zag' patch slots. The introduction of different orientations of slot embedded on the radiating patch has resulted in two different operating frequencies. Each antenna has the same patch size although two different frequencies are achieved due to the fact that the size of the patch slot and its orientations in x- and y-axis give significant effects on the excitations of the resonant frequency. Based on the combination of these two designs, a frequency reconfigurable microstrip antenna was developed in two-element array configuration, denoted as FRTRSPA-1. To further enhance the characteristics, the antenna elements of FRTRSPA-1 have been extended to four elements in a planar or corporate feed configuration, which is known as FRTRSPA-2. Both antennas can operate at two different frequency modes, F_1 = 5.3 GHz and F_2 = 5.8 GHz in a single structure. For pattern reconfigurable antennas, the development of the antenna structures namely, PRTRSPA and BRTRSPA were based on the design of FRTRSPA-2 with an addition of parasitic elements embedded on the same substrate as the radiating elements. The application of parasitic elements enables PRTRSPA to steer its main lobes to three different directions in the E-plane ($\phi = 90°$) at two different frequency modes, F_1 = 5.3 GHz (0°, +15° and -15°) and F_2 = 5.9 GHz (0°, +25° and -25°) and six different directions for BRTRSPA, F_1 = 5.3 GHz (0°, 10°, 170°, 180°, 190° and 350°) and F_2 = 5.9 GHz (0°, 20°, 160°, 180°, 200° and 340°). All simulation and measurement results were in good agreement.

TABLE OF CONTENTS