UNIVERSITI TEKNOLOGI MARA

DEVELOPMENT OF COMPACT MICROSTRIP ANTENNA INTEGRATED WITH LIGHT EMITTING DIODE (LED) FOR ILLUMINATION AND WI-FI APPLICATION

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ABSTRACT

Presently, integration of active components into the antenna is now seen by the industry as inevitable to allow them to meet future antenna requirements. Currently, plasma antenna is one of the antennas that have potential for future development in wireless communication technology where it supports dual functions especially in indoor application. However, plasma requires energy to be ionized and the gas is more complex and expensive. In relation to the issues, this project presents the development of a rectangular microstrip patch antenna integrated with Light Emitting Diode (LED) in order to have dual applications in a device, namely illumination and operated at 2.45 GHz for wireless communication. The research starts with design and analysis on effect of semiconductor stacked on radiating patch to verify the effect of several semiconductors used with different permittivity in LED. Numerical simulations was carried out using Computer Simulation Technology (CST) to optimize the position of LED within the antenna. LED used in the design was SMD LED 5050 and the conducting part of the LED was considered throughout the optimization process. There are three sets of designed antenna presented, namely ILMAr A, ILMAr B and ILMAc. ILMAr A is Integrated Microstrip Antenna with LED directly, ILMAr B is Integrated Microstrip Antenna with LED indirectly and ILMAc is Integrated Microstrip Antenna with LED stacked technique. The antenna was fabricated on RT Duroid 5880 substrate with permittivity, $\varepsilon_r = 2.2$ and thickness, $h = 1.57$ mm as low permittivity and low loss gives high performance in order to obtain maximum radiation and good efficiency. The performances of these antennas were compared between the simulation and experimental results. Numerical simulation results showed that the integration of LED within the patch affected the resonant frequency when the position of LED attached at the non-radiating edge. Measurement results showed low gain and efficiency of ILMAr A. In order to improve the gain, ILMAr B was designed to have an indirect connection between LED with the radiating patch. To have miniaturization and high gain, ILMAc was designed to operate at 2.45 GHz. The corresponding gain increased and the overall size was reduced to 17% compared to ILMAr A and ILMAr B . The gain of three designs were increased when the LEDs were in the ON-state compared to OFF-state. Each corresponding -10dB reflection bandwidth was also narrow, i.e. less than 5.2%. The LED integrated within the patch was conducted parallel and was measured by Vector Network Analyser (VNA) to demonstrate the capacity and potential of the antenna. The small discrepancy between simulated and measured operating frequency was significantly contributed by fabrication imperfection and the integration process of LED within the antenna. However, the designed antenna contributes to dual-function in a device and the use of integrated LED in the design supports green environment and will contribute to energy consumption.

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CHAPTER ONE
INTRODUCTION

1.1 RESEARCH BACKGROUND

Nowadays, the need for wireless devices and applications has increased and the incorporation of active components into the antenna is now seen by manufacturing as inevitable to let them meet future antenna requirements. There are many researches that integrate components into a single module for compact and multifunction wireless communication system [1][2][3]. As the technology of mobile communication system is deployed, manufacturers and the scientific community increasingly focus their research interests toward future wireless communication system. They have spotted this opportunity and initiated developments of integrated, miniaturized communication system and modules. Among all wireless communication spectrum, transmission using Radio Frequency (RF) or microwaves has dominated. This domination was primarily due to the availability of high-sensitivity receivers and the ability to provide either broad coverage at low frequencies or line-of-sight propagation at high frequencies [4]. One of the necessary components in wireless communication system is an antenna. A good antenna system has the capability of improving overall system performance and will lead to reduced system cost. There are many researches in developing multifunction purposes in an antenna such as reconfigurable antenna [5],[6],[7], active integrated antenna [8][9][10], and dielectric resonator antenna [11][12][13]. Most of these developments are focussed on enhancing the performance of an antenna in terms of frequency operating, higher gain, and broad bandwidth.

As the concept of miniaturization becomes a reality, compact devices that are capable of being multifunction are in great need. The planar integrated antenna is one of the devices that has the fitness has been a growing area of research in recent years. The integration is defined as bringing together component subsystems into one system. It involves integrating existing systems, which are often disparate systems. Mostly, the integrated antenna system involves active circuits or devices on the same layer as the radiating element. Some of the active devices used are amplifiers [14],[15], oscillators [16],[17] , PIN diodes [18][19], and many other solid state devices. One driving factor