Chapter 4
Miniaturization of Printed Microstrip Antennas Array by Using Defected Ground Structure Technique

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ABSTRACT

In this chapter, the authors present different techniques used to miniature microstrip antennas, particularly planar antennas array, for different applications demanding small dimensions. This will cover DGS, slot technique, and metamaterials. After the presentation of these techniques based on theoretical studies, the second part of this chapter will be about the authors' contribution in the miniaturization of microstrip antennas arrays. This part will include the presentation of some miniature antennas array which they have validated into simulation and measurement by using DGS techniques. The different structures were validated into simulation by using tow electromagnetic solvers ADS (advanced design system) and CST-MW (computer simulation technology) which permit one to validate and to verify the different performances of antennas arrays as radiation pattern, matching input impedance and small dimensions.

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INTRODUCTION

The rapid development of telecommunications systems has allowed the creation and innovation of several technologies as well as led to a wave of new wireless devices and systems to meet the demands of multimedia applications. Multi-frequency and multi-mode devices such as cell phones, wireless local area networks (WLANs) and wireless personal area networks (WPANs) place multiple requests on the antennas. Mainly, antennas must have a high gain, a small physical size, wide bandwidth, versatility, integrated installation, etc. In particular, the bandwidths for input impedance, polarization or axial ratio, radiation patterns and gain are becoming the most important factors affecting the application of antennas in contemporary fields and future wireless communication systems. On the one hand, there is a tendency towards the miniaturization of components linked to mobile devices, and on the other hand there is an increasing demand for fast data transfer, which in turn requires broadband components and multiband behavior. These two contradictory constraints must be raised with inexpensive solutions, and providing a high yield.

Since the design of the microstrip antenna half a century ago, its application in telecommunication systems has increased rapidly, especially over the past two decades. Due to the many unique and interesting properties of the microstrip antenna, there seems to be little doubt that it will continue to find many applications in the future. These properties include a low profile, lightweight, compact and compliant with the mounting structure, easy to manufacture and to integrate with solid-state devices. The results of these properties have contributed to the success of microwave antennas not only in military applications such as aircraft, missiles, rockets and spacecraft, but also in commercial areas such as mobile satellite communications, direct broadcast satellite (DBS) system, global positioning system (GPS), remote sensing and hyperthermia. Although the microstrip antenna is generally known for its bandwidth weakness, recent technological advances have improved its bandwidth by a few percent to tens of percent.

In recent years, the reduction in the size of components has attracted a great deal of interest among researchers in the telecommunications world. The race to this miniaturization is motivated by the integration of microstrip antennas in the architecture of mobile terminals to reduce their size as much as possible.

An advantage inherent to patch antennas is the ability to have polarization diversity. Patch antennas can easily be designed to have vertical, horizontal or circular polarizations, using multiple feed points, or a single feed point with asymmetric patch structures. This unique property allows patch antennas to be used in many types of communications links that may have varied requirements.

The importance of circular polarization is that we can have the same magnitude with phase difference of 90 degrees. This kind of polarization produces two orthogonal components $E\theta$ and $E\varphi$ with 90 degrees out of phase.

The use of antenna array is one of the possible solutions permitting to get higher directivity and a pattern adjustment. The choice and shape of the radiating element depends on the application and on certain factors: the resonance frequency, the radiated power, the polarization, the gain as well as the antenna bandwidth. One of the disadvantages of antenna array is the array area because of the association of many elements and the different microstrip lines network assuring the feeding of each antenna element. To resolve this problem many methods and techniques can be used as mentioned in (Sidhu, 2014). The networking of several antennas makes it possible to compensate for the limitations of an antenna alone. An antennas array is conventionally constituted by separately excited or sub-array radiating elements in order to increase the gain and radiation performances (for example, to increase the directivity in a direction of space). One of the main advantages of antennas arrays is their ability to scan the beam in certain