

# Chapter 7

## Design of New Reconfigurable and Miniature Microstrip Planar Antennas

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### ABSTRACT

*Recently, wireless communication systems have developed rapidly and have become more mobile and small. This necessarily requires the adequacy of its design. The materials used should be as much as possible small and at a lower cost. So low cost with reduced volume and low weight are some of the major challenges that must be faced by the designer of modern telecommunications equipment. The microstrip planar antenna is an attraction and the most crucial component used in mobile systems, and its miniaturization is one of the research challenges. This chapter focuses on the concept of miniature reconfigurable antennas by presenting and discussing the state of art with contributions in designing reconfigurable miniature printed antennas.*

### INTRODUCTION

The need of both mobility and communication leads to the integration of miniature wireless communication devices. This type of wireless components reduces the complexity and performance compared to the cable system. Antennas are necessary and critical components of the communication chain. It can be said that different types of antennas have proliferated during the past 50 years in both wireless

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communication and radar systems. These varieties include dipoles/monopoles, loop antennas, reflector antennas, microstrip antennas, log periodic antennas, helical antennas, etc (Abla, 2010). The need of miniaturizing microstrip patch antennas to allow their integration with small objects is increasing and its design is one of the most important current challenges for designers.

The miniaturization of antennas can be done by reducing the size and keeping the fidelity of performance characteristic. Among the different existing techniques, we can find methods based on adding inductance, altering the geometry of the structure, adding additional components, or modifying the material characteristics (Roy, 2014).

However, the miniaturization of antennas is generally due to a degradation of its efficiency and its bandwidth. In order to overcome this bandwidth problem and to achieve the multi-frequency behavior (multiband antenna), the frequency agility technique or reconfigurability may be useful and suitable in wireless communication system. Reconfigurability, when used in the context of antennas, is the capacity to change an individual radiator's fundamental operating characteristics (Mosallaei, 2002; Bernhard, 2003).

Reconfigurable antennas can be classified into different categories: the frequency reconfigurable antenna is a structure that is able to change its operating frequency, radiation pattern reconfigurable antenna is a structure that is able to tune its radiation pattern and polarization reconfigurable antenna that is a structure that can change its polarization (Huff, 2006).

Frequency agility is obtained by modifying the resonant frequency of the resonator. For this purpose, the antenna is loaded with active elements whose resistance can be controlled electronically by using (varicap diode), or by components acting as a switch (PIN, FET or MEMS ...) (Brown, (2001)).

This chapter will be divided into two parts. The first one will be about the most common used techniques of antenna miniaturization and a comprehensive study of the frequency agility techniques. The second part will focus on some contributions and current results of new miniature antennas by using Defected Ground Structure (DGS) technique, and other contributions of reconfigurable antennas based on PIN diodes.

## **MICROSTRIP PATCH ANTENNAS**

### **Introduction**

In its most basic form, a microstrip patch antenna consists of a radiator mounted on an FR4 substrate associated to a ground plane as shown in Figure 1 (Carver, 1981).

The different parameters of the antenna are as follows:  $L$  is the length of the patch,  $w$  is the width;  $h$  is the thickness of substrate and  $t$  is the metallization thickness of the patch.

The patch is generally square, rectangular, circular, triangular, and elliptical or other shapes as illustrated in Figure 2. Square, rectangular, and circular are the most celebrated because of ease of analysis, fabrication, and their attractive radiation characteristics, especially low cross-polarization radiation (Bahl, 1980; Wheeler, 1959; Abla, 2010).

### **Feeding Methods**

Microstrip planar antennas can be fed by four fundamental methods. These methods can be distributed into two categories. For the first type, the power is fed directly to the microstrip patch by using a con-

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