Chapter 6
Miniaturization and Reduction of Mutual Coupling Between Antennas Arrays Using DGS and Planar EBG Structures

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ABSTRACT

As the size of the antenna often has a significant influence on overall dimensions of the wireless system, its reduction in size becomes a significant challenge. The objective of this chapter is to present new contributions made for reducing the size of the antenna array while maintaining excellent performance. An overview of the antenna array is introduced. Then, two designed and fabricated antenna arrays with compact size and good performances are exposed. The first microstrip patch antenna array is miniaturized using a novel shape of defected ground structure (DGS) etched in the ground plane of each radiating element of the antenna array. While the second one is two antenna arrays which are separated by two magnetic walls of a planar compact electromagnetic band gap (EBG) structure, with the aim to miniature and to reduce the mutual coupling between them, keeping both the antenna arrays separation smaller than 0.6λ5.8GHz. A full-wave electromagnetic analysis had achieved to evaluate the electrical performances of the proposed structures by using HFSS and CST-MWS.

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INTRODUCTION

We define a communicating system by a multitude of physically dispersed objects, each having a data processing unit and access to a communication network. Several inventors have set numerous standards distinguished by the frequency of emission used, the speed and range of transmission of each technology. Wireless networks make it possible to connect different equipment, which is far from each other by many kilometers. In recent years, telecommunications systems have undergone rapid development, marked in particular by the creation of new standards such as GSM (Global System for Mobile communications), GPRS (General Packet Radio Service), EDGE (Enhanced Data Rates for GSM Evolution), UMTS (Universal Mobile Telecommunication System), LTE (Long Term Evolution), WiMAX (Worldwide Interoperability for Microwave Access)...etc. At the same time, new applications (GPS, Bluetooth, WiFi, 3G, 4G, etc.) have implemented on mobile terminals operating in specific frequency bands. In wireless transmission, the antenna is the transitional structure between free-space and a guiding device. A guided environment is a structure, where an electromagnetic wave is confined and propagates along the path defined by the environment. These media are usually in the form of a waveguide (Zarifi, Farahbakhsh, & Zaman, 2017), coaxial cable (Xing, Liu, Guo, Wei, Zhao, & Ma, 2017) or microstrip line (Basilio, Khayat, Williams, & Long, 2001). The antenna is a component used to transmit or receive the electromagnetic waves. It ensures the transition between the guided wave and the wave transmitted in the free space. We have a transmitting antenna when the antenna allows electromagnetic energy to radiate from a guided environment to free space. In the reverse case, the antenna is called a receiver. However, the antennas respect the principle of reciprocity. It is possible to deduct the characteristics of a receiver antenna by characterized its transmission performance and vice versa. The characterization of an antenna is made using several parameters, which controlled as a function of frequency. Among these parameters, there are the reflection coefficient, the radiation pattern and the polarization. Microstrip patch antennas play an integral part in many applications. Are widely preferred for wireless communication systems and navigation systems. Notably, these last two applications require antennas with low fabrication cost, thin profile and can handle the linear and circular polarization (Xue, Yang, & Ma, 2015). Unlike the conventional microwave antennas, the printed antennas are extremely compatible with the wireless devices such as cellular phones. Another major advantage associated with a planar antenna is that it could be easily integrated with the microwave integrated circuits (MICs). For various applications, it is necessary to design antennas which have a broad bandwidth and who radiate into total space not only into half space, with very high directive characteristics -very high gain- to meet the demands of long-distance communication. For several years, a lot of research had undertaken to overcome the limitations associated with these kinds of antennas. Actually, the gain of conventional microstrip patch antenna is limited a low level because of their limited size at resonance frequency. Some of the popular techniques proposed by researchers to increase the gain are: increase the electrical size of the antenna (Constantine & others, 2005), use a thin, low loss and low permittivity substrate (Alboni & Cerretelli, 2001). Another method proposes the use of artificial magnetic conductors in the design of low-profile high-Gain printed Antennas with high-permittivity dielectric superstrate, had mentioned in (Foroozesh & Shafai, 2009). While others (Zhang & Zhu, 2016) loading two sets of shorting pins along the two orthogonal diagonals of a square patch resonator. So far, the most common method of improving the antenna radiation characteristics, especially the gain, is to form an assembly of radiating elements -in one, two or three -dimensional- in an electrical and geometrical configuration. This new antenna formed had referred to as an array.