Chapter 8
A Comparison Between the Microstrip and the Co-Planar Wave-Guide Antennas in Ultra-Wide-Band Applications by Using Fractal Geometry

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ABSTRACT

This chapter describes a comparison study between the techniques of coplanar waveguide (CPW) and microstrip line applied to antenna in the ultra-wide band by analyzing the different parameters achieved into simulation and fabrication. Fractal geometry has been chosen to design the radiating patch of both types of antennas by including two electromagnetic solvers based on two different numerical methods: CST of microwave studio and ADS. The parameters S11, current density, gain, and the radiation pattern have been achieved into simulation and measurement in the frequency range 3.1 – 10.6GHz released by the Federal Communications Commission (FCC) as a commercial UWB. The photolithographic technique, the network analyzer, and the anechoic chamber have been involved to perform the fabrication and the measurement of the validated microstrip and CPW antennas.

DOI: 10.4018/978-1-5225-7539-9.ch008

INTRODUCTION

With the enormous progress of wireless communications, a growth demand of Ultra-Wideband (UWB) applications appeared, which push researchers to design the UWB systems due to a number of advantages that make them attractive such as low complexity, low cost and a good time domain resolution allowing for location and tracking applications. In the past twenty years the UWB was used only in Radars, sensing and military communications, therefore UWB and since February 2002 when the Federal Communications Commission (FCC) released the regulation (2002 a, b) the UWB become dramatically involved in the data communications. The famous passive devices that can be used in this kind of systems are the Microstrip antenna (MSA) and the Coplanar waveguide Feed line antenna (CPW). Those categories of antennas will be deeply detailed in this chapter in order to compare the advantages and the disadvantages between them and to identify the appropriate applications for each type of antenna.

Firstly the MSA in its simplest definition considered as a radiating conductor element on the top side of a dielectric and a ground plane conductor on the bottom side, the radiator can be a geometric shape, such as a square, a circular, a triangular, a semi-circular, a sectorial and an annular ring. The first concept of this kind of patch antenna appeared in 1953 by Deschamps, after that Munson and Howell designed the first practical MSA antenna in 1970. The MSA antenna has many advantages such as low profile, light weight, small size and ease of manufacturing, which make it suitable for personal and mobile communications, therefore the MSA suffer from the narrow bandwidths by nature, therefore many techniques are used in order to improve the bandwidth some of them is to increase the thickness or decrease the dielectric constant of the substrate, use a partial ground plane and modify the shape of the radiating element by using the fractal geometry for example, which is now more popular in the MSA.

Secondly, the CPW antenna defined as a planar transmission line located symmetrically or asymmetrically in between two grounds collocated in the same side of the dielectric material with the fed line and the radiator, which is totally opposite of the MSA antenna concept. The CPW technique has been appeared in 1969 by Cheng P. Wen in RCA Sarnoff Laboratories in New Jersey. The supports of CPW can be TE Mode in higher frequencies, therefore are shown slightly TEM Mode in lower frequencies, also the dielectric thickness has no impact factor on the characteristic impedance of the CPW antenna however the CPW antenna depends to the width and the length of the substrate element. Regarding the benefits, the CPW antenna presents a low dispersion, a facility of manufacturing due the exiting of all antenna elements in the same side, which help the CPW antenna to be integrate easily in the passive and active RF circuits. But the CPW is not suitable candidate in terms of circuit size compare to the MSA, so one of the methods to reduce the antenna size is to etch the patch by using the fractal technique.

The fractal geometry defined as rough or fragmented shape that can subdivided to copies of the original form with reduced sizes, this geometry has two principal properties which are self-similarity and space filling, the first one is used in MSA in order to increase the input bandwidth matching in some specific wavelengths therefore the other one is used in CPW antenna to get miniaturization.

This chapter, in the beginning, detailed the definition of the ultra-wide band (UWB), the microstrip transmission line antenna, the coplanar waveguide antenna and the fractal geometry, than depicted a study of an original CPW antenna validated into simulation and measurement by the way described the conception of a microstrip antenna by using the computed and measured parameters. At the end a brief comparison between the two kind of antennas will presented in summarized table based on the studied parameters for each antenna in order to identify the appropriate applications for the microstrip antenna and the CPW antenna.