Technology

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Step by Step Guide to Design a Magneto-Electric Dipole Antenna

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INTRODUCTION

1.1 Background

With the rapid and extensive usage of mobile phones, wireless communication systems and technologies have entered into many important domains of our daily lives, which include social media, business development, medical and healthcare applications, agriculture, scientific applications and many more. The antenna plays a pivotal role in all the wireless communication applications to determine the overall system performance and the various novel applications have urged strong demands for new high performance antenna systems.

Precisely, the development of numerous wireless communication systems and applications have triggered the all-time high demand for wideband, low profile and unidirectional antennas that can accommodate various wireless communication applications while exhibiting good electrical characteristics, including stable gain, wide impedance bandwidth, low cross-polarization and low back lobe radiations across the entire range of frequency operation. Many designs have been proposed in the literature to accommodate various wireless communication applications with enhanced antenna parameters. The standard L-shaped probe feed patch antenna are able to achieve an impedance bandwidth of 35% with an average gain of 7.5dBi [1]. With slot antenna an impedance bandwidth of 17% - 40% can be achieved [2-3]. But each of these unidirectional antennas exhibits an asymmetric E-plane and H-plane radiation pattern and unable to provide stable gain bandwidth product in the range of frequency of operation. Recently, a novel wideband antenna, known as the ME dipole antenna, is proposed by Luk *et. al.* [4-5], which has been derived from the complementary antenna. The basic structure of ME dipole antenna consists of a vertically oriented quarter wave shorted patch and a horizontal planar dipole, equivalent to a combination of a magnetic dipole and an electric dipole. This antenna has demonstrated good electrical characteristics like identical E-plane and H-plane radiation pattern, low cross polarization, low back lobe radiations and stable gain in the range of operating frequency.

The large size of this antenna, owing to the presence of magnetic dipole, is a matter of concern but it is also observed that the size of the ME dipole can be further reduced [6], and two ME dipole antenna elements can be integrated to form a wideband dual-polarized antenna with excellent electrical characteristics [7].

In the last few years, there have been tremendous increase in the demand for multifunctional antennas and many novel shaped antennas have been proposed in the literature to achieve high level of performance. These diversified antenna systems approaches have received much desired attention in wireless communication sectors. Broadly these diversified antennas have raised the platform for demand and supply in terms of capabilities of wireless communication system [8]. Different categories of diversity antennas include, the spatial diversity antenna, the frequency diversity antenna [9], the polarization diversity antenna [8, 10] and the pattern diversity antenna [11-12]. The pattern diversity antenna and polarization diversity antenna are most commonly used to analyze and compute the effects of multi-path fading and providing compatible solutions in the complex environment [9]. As compared to classical unidirectional antenna systems, the pattern diversity antennas are used to radiate and receive signals through different radiation modes and hence they are capable of providing high effective gain and maintaining the same installation space [11]. Various antenna structures that are offering pattern and polarization diversities for different applications have been proposed in the literature [11-12]. But the major drawback of these available pattern and polarization diversity antennas is that they suffer from narrow overlapped impedance bandwidth of the excitation ports [11] and incomplete pattern diversity modes [12], and hence, their implementation for various applications is limited.

In this thesis, several new classes of ME dipole antennas for various wireless communication applications are proposed, which include- end-fire radiation pattern ME dipole antenna for airborne radar application, an improved UWB ME dipole element with differential feeding structure for Monolithic Microwave Integrated Circuits (MMIC) and Radio Frequency Integrated Circuits (RFIC) applications, an UWB ME dipole antenna with modified ground structure for high gain applications, a novel planar circularly polarized ME dipole antenna for satellite communication and a novel design of ME monopole antenna for UWB applications. All these proposed antennas are based on a structure that is composed of a planar electric dipole antenna and a shorted magnetic dipole antenna, which are excited simultaneously to obtain almost symmetrical E-plane and H-plane radiation patterns, wide