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A UWB Fractal Slot Patch Antenna with Ground Optimization

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Abstract

A miniaturized patch monopole ultra-wideband (UWB) antenna of size 18mm x 12mm x1.6mm on commercially available FR4 material with dielectric constant 4.4 is proposed. The antenna consists of insertion of fractal slot geometries to obtain the desired very large band characteristics. While the modification in the various patch length provides perfect match of impedance bandwidth. Therefore, it provides a very ultra wide band from 1.55 to 12.0 GHz inclusive of all associated applications released by FCC. Choice of suitable filter makes the antenna widely useful for particular band of operation. The proposed structure consists of several half wave length slots interconnected with each other. In this article, the variation of ground geometry with respect to slot insertion is depicted. The design validation is made through successive simulation and proposed antenna is fabricated for measurement of return loss and VSWR parameters. The radiation properties are also found consistent over the ultra wide band.

Keywords: Ground defects, UWB, fractal, resonant frequency, slotted antenna.

INTRODUCTION

The Federal Communication Commission has declared an unlicensed band of frequency from 3.1 to 10.6 GHz for UWB wireless communications. This has enticed many researchers to put their efforts in this field. A typical UWB is defined in principal to occupy more than 500 MHz bandwidth [1]. Interestingly UWB systems has a sequence of short pulses of several pulses per second, results in wide bandwidth with extremely low power transmitted enabling UWB systems to be suitable with extensive low power applications.

Several methods have been employed by which an UWB antenna can be obtained. The widely used method is to create shaped slots in the radiating patch and to ground base. Multiple geometries have been reported like U, H or C-shaped slots [2]–[6]. While, few of them have been developed for one or more notched band. UWB device has become the key factor for market for high-bit-rate, short-range wireless products for home networking, wearable computing and wireless desktop [7]. Microstrip antennas are becoming more interesting due to their advantages for simple structure, ease of design and cheap in cost. While, a certain frequency range for UWB systems may cause interference to the existing frequency range from 5.15-5.35 GHz and 5.75-5.85 GHz which is for Wireless Local Area Network (WLAN). This can be stopped by band filters and can be added to eliminate interference. Therefore it is always the main course to design a compact antenna having stable radiation property with good wideband characteristics for the complete operating range. This paper introduces fractal symmetry over the radiating structure along with optimized ground geometry to design a compact UWB antenna. The slot is so sequenced to obtain the resonance of antenna in much lowered frequency of operation. The ground is stepped in multiple folds to achieve desirable performance of the antenna. It is also observed that the loading of parasitic patch works as band stop filter in [8]–[11], additionally also causes to significant decrease to the lower edge frequency of the radiating element and justifies the impedance bandwidth as reported in [12]–[15]. In the proposed antenna, the main resonating structure can significantly resonate at the fundamental frequency and the slotted fractal symmetry of patch is used as a main resonator, which is mutually coupled to the slotted structure of the patch. With respect to the physical structure of an antenna, in principle, the electric or magnetic field causes effective changes in the actual electric length of the antenna due to inductive or capacitive loading. The same phenomenon also persists in parasitic loading but may cause to over coupling between patches may result in decrease in lower edge of bandwidth [16]-[20]. Hence, by avoiding the above discussed effect, the mutual coupling is controlled by introducing slot geometry to change overall electrical length of the radiating

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Fractal Fork Shape UWB Monopole Antenna with Ground Deformities

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Abstract

This paper presents a compact size ultra wide band antenna for wide range of wireless applications. The antenna is designed on 18x12x1.6 mm^3 substrate using FR4 material with wide band characteristics using fractal structure of fork shape antenna. The ground is deformed and slots are cut in the broader dimension of antenna. These cuts enables antenna to produce band gaps and optimizing the impedance matching for complete range of operation. The proposed antenna is consisting of a fork shaped repeated geometry patch as a dominating mode of a frequency function. In addition to avoid spurious feed radiations the ground dimensions are optimized to force the antenna structure with in specific range of frequency of 2.4 GHz. On other hand the slotted structure matches the impedance width of the antenna. The proposed structure is simulated and fabricated on commercially available FR4 (4.4) substrate. The Measured and simulated results has good match and operates in frequency range of frequency from 1.55GHz to 13.33 GHz. Therefore the antenna is suitable for ultra wide band applications as referred by IEEE standards and FCC.

Keywords: Fork Shape, fractal, bandgap, ultra-wideband (UWB), impedance matching.

INTRODUCTION

The fast development of communication devices in the wireless systems generated the need of Ultra Wide Band antenna with compact geometry. WPAN is an example of such highly desirable applications. UWB communication is excited to fulfill the requirements the FCC approved 3.1GHz to 10.6 GHz band of frequency. Many researchers' has their keen interest to develop such antenna to receive all of its application opportunities within the same compact area. A wide range of UWB printed antennas with multiple structures and shapes are reported in literature. These antennas require a good control in bandwidth, desired radiation pattern, cheap and simple design structure. In the article [1] improvements are made to the simple elliptical monopole antenna by varying the axial ratio of the ellipse in form of a patch to increase bandwidth, while a circular hole helps patch to enhance the effect of the matching of impedance, [2]-[3], also by reshaping of ground plane to suppress the lower edge of frequency and supports the impedance matching, hence impedance bandwidth in the upper band of frequency [3].

At the same time, many techniques gives a wide range of impedance bandwidth in specific function of cutting notches to corners of the square planar monopole at two side [4], by creating U slot [5], to have a small strip like bar [6], moreover the combinations of multiple type slots [7], more specific even W-shape slot [8], another interesting combination of J& L slots [9] and creatively deforming ground plane structure [10].

In principle UWB is defined by Federal Communications Commission (FCC) for a signal having 500MHz bandwidth. The issued bandwidth from 3.1 to 10.6 GHz for unlicensed use in UWB wireless communications has given an opportunity to develop ultra wideband devices and hence a suitable antenna [11].The main feature of the UWB systems is to use short pulses to have a wide bandwidth with very low power transmitted which makes it more compatible for personal devices in modern world like every day wireless systems around us [12].

Meanwhile most important to maintain the basic characteristics of the antenna as low profile , cheap and easy to fabricate [13].In this paper the proposed antenna is developed from a basic square shape patch by modifying the patch as well as ground geometry to obtain desirable impedance bandwidth.

DESIGN METHOD

In this part, the antenna for the full UWB band is developed which has equivalent to a parallel LC oscillating circuit. Specifically at low frequencies, the main distribution of current is more at the center of patch as compared to the corners of the patch. In fact, the effective length of the patch is responsible to total current distribution as well as the resonating frequency. Therefore, any increase in the length of