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Dual Band Bowtie Patch Antenna with a Defective Ground Structure for Narrow Band Applications

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Abstract: Wireless communication is one of the most blooming areas in the communication field today. The increasing number of wireless standards and device technology improvements are placing a high demand for multiband antennas. In this work we propose a dual band bowtie antenna with C shaped defective ground structure and slot on the radiating surface. The antenna exhibits an improved reflection coefficient at frequencies of 1.5 Ghz as well as 4.5 Ghz. The defective structure helps decreasing the resonant frequencies without increasing the overall size of the antenna. The antenna can be used in GPS as well as INSAT applications.

Keywords: multiband antenna; bowtie antenna; defective ground; slot loading; reflection coefficient;

I. INTRODUCTION

Wireless communication is one of the most blooming areas in the communication field today. It means the transfer of information between two or more points that are not connected by an electrical conductor. In modern wireless communication systems, multiband antenna has been playing a very important role for wireless service requirements. Because of the rapid increase in communication standards has lead to a great demand for multiband with low real estate area, low cost fabrication and ease of integration with feed networks. Compact, multiband, low-profile and low-cost antennas are widely used in personal communication devices along with the rapid development of the wireless communication systems.

Bowtie antennas are considered to be more compact than rectangular microstrip patch antennas. A bow-tie patch actually is the combination of imaginary image of two triangular patches which are fabricated in a single substrate. In [9] the authors established an empirical formula for the resonant frequency of a bow-tie structure and observed that without increasing the aperture area, this geometry considerably reduces the resonant frequency compared to conventional patches.

Several techniques are commonly used to achieve multiband operation. Some of them are 1) changing surface instantaneous current distributions of resonance modes by loading or etching slot on a single patch [1],[4],[6],[7]; 2) utilizing multiple microstrip patches on the single-layer substrate etc [1]. In [1], Hai Wen Liu et all have proposed a triband bowtie antenna using slot technique. In [1] the authors have used slot loading to change the surface current distribution on the bowtie antenna to obtain triband operation. In [2] the authors have designed a modified bowtie antenna for Wifi and Wimax applications by incooperating circular and triangle shaped slots. In [3],[5] miniaturization of microstrip patch antenna has been achieved by using defective ground structure to shift the resonant frequency by disturbing the antenna current distribution.

In this work we use C shaped defective ground structure as well as slots on bowtie antenna to obtain resonant frequencies at 1.5 Ghz as well as 4.5 Ghz. The antenna is designed and simulated using Anys HFSS software. In order to simplify the feed networks, the geometry of the bowtie antenna is symmetrical to the direction of the feedline. Details of the antenna design are presented. Simulation and measurement results are also presented and discussed.

II. PROPOSED ANTENNA DESIGN

In this section the steps under taken for designing the antenna are discussed. The first practical step in antenna design is substrate selection. For our design FR4 substrate is selected. It is one of the most commonly available as well as cheap substrate. It has a dielectric constant of 4.4 and a loss tangent of 0.02.

The geometry of the proposed antenna is shown in figure 1. The antenna is designed on 70×90×1.6 mm^3 substrate. The dimensions of the antenna are shown in table 1. In order to obtain another resonance at 1.5 Ghz a C shaped slot is incooperated on the ground plane. The dimensions of this slot are shown in table 2. From a previous study [8] conducted on bowtie antennas it is evident that rounding the corners of the antenna results in better return loss characteristics. So we filleted the sharp corners of the antenna with fillet radius =1 mm. All the dimensions are obtained after optimization using HFSS software. The antenna structure is shown in figures 1 and 2.

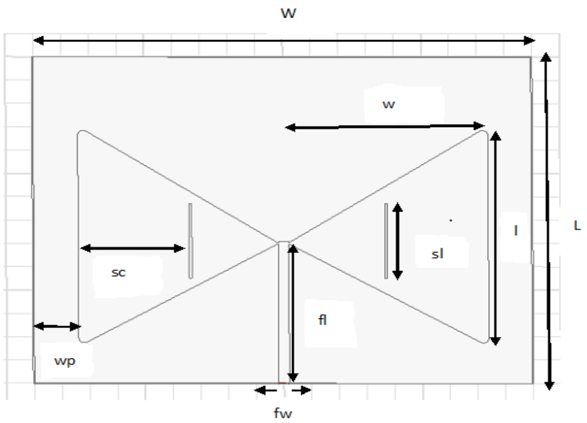

Fig. 1 Front View of the proposed antenna

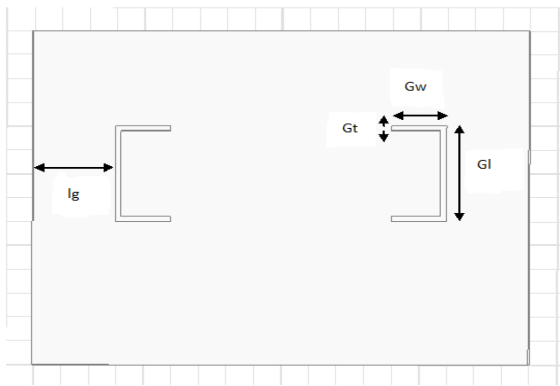

Fig. 2. Back view of antenna showing the ground slots

TABLE I

Antenna dimensions

Parameters	Value in mm
L	90
W	70
l	36.2
w	47.2
fl	30.5
fw	1.8
sl	16
sw	0.5
sc	17
wp	18

TABLE II

Dimensions of the slot on the back side of the proposed antenna

Parameters	Value in mm
Gl	20
Gw	10
Gt	1
lg	15

III. Simulation Results and Analysis

In this section the simulation results obtained for the proposed antenna are presented. The antenna shows resonance at two frequencies as can be identified from the plot of VSWR. The obtained dual band operation can be explained by using the current distribution at both frequencies. The plot of VSWR for the proposed antenna is shown in Figure 3 and the same for the bowtie antenna of same dimensions without ground slots is shown in Figure 4. We obtained a bandwidth of 3.6 % at 1.5 Ghz and 2.4 % at 4.5 Ghz. We compared the obtained plot of VSWR with the plot obtained for the same bowtie antenna without the ground slot. It can be seen that resonance frequency is at 3.55 Ghz for the bowtie antenna with the same dimensions without ground slot. Introducing the ground slots causes another current distribution to occur decreasing the resonant frequency and results in dual band operation.

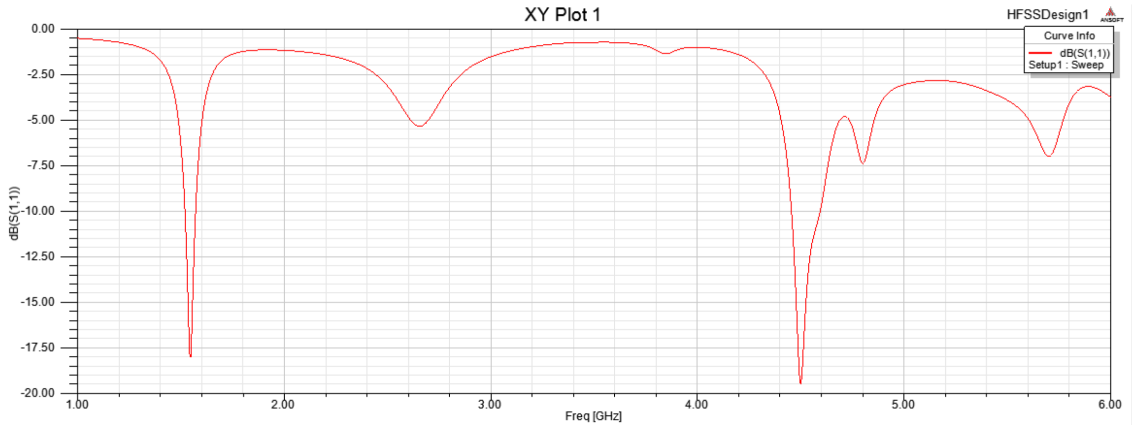

Fig. 3. Plot of VSWR obtained for the proposed antenna.

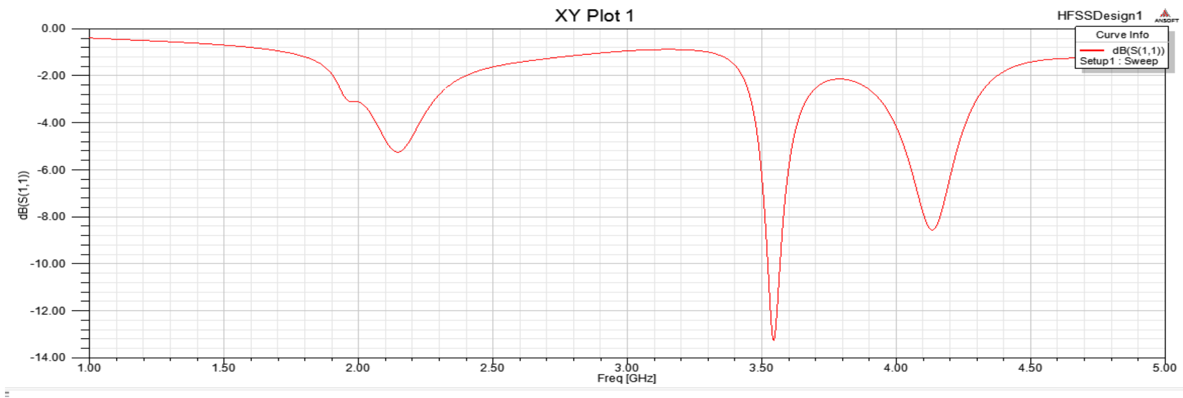

Fig. 4 . Plot of VSWR obtained for bowtie antenna of same dimensions without ground slot

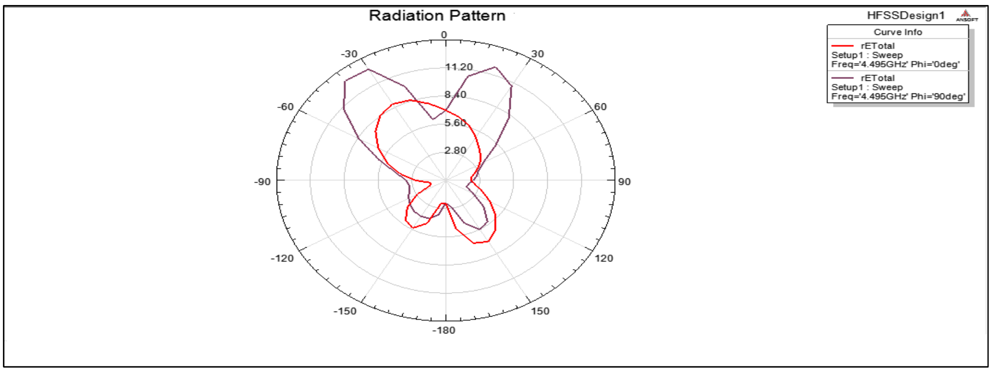

Fig. 5 Radiation Pattern at 4.5 Ghz

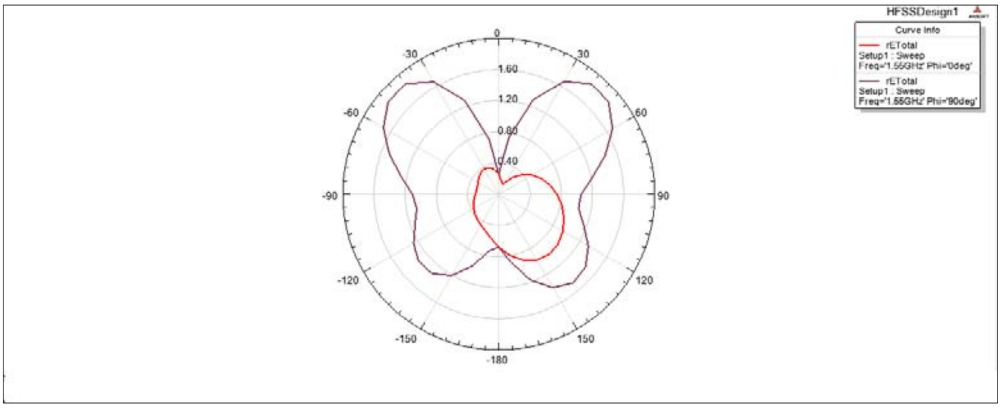

Fig. 6 Radiation Pattern at 1.5 Ghz

IV. Conclusion

In this paper a dual band bowtie antenna with C shaped ground slot and rectangular slots on the radiating patch is presented. The proposed antenna is designed and analyzed by using HFSS software. The dual band operation of the antenna can be explained by using the current distribution on the antenna at these frequencies. The antenna has two resonances at 1.5 Ghz and at 4.5Ghz. By using ground slots we were able to decrease the resonant frequency of the antenna without increasing its length and thus it is compact in nature. The antenna geometry is such that it is easy to fabricate. Consequently the proposed antenna is suitable for dual frequency wireless applications where miniaturization is important.

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