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Feather Shaped Hyper-Band Antenna

Sarthak Singhal
Department of Electronics & Communication Engineering,
Amity School of Engineering & Technology, Amity University Madhya Pradesh
Gwalior, Madhya Pradesh, India

ABSTRACT— *A compact feather shaped monopole antenna for hyper band applications is presented in this paper. It comprises a feather shaped radiating patch fed by a microstrip feedline and notch loaded coplanar modified ground plane. It has an impedance bandwidth of 4.6 GHz to 36.8 GHz (155.56%) with an overall footprint of 17×15×1.6 mm^3. The designed antenna has stable radiation characteristics over the entire band of operation. It has miniaturized dimensions and wider bandwidth in comparison to previously reported structures.*

KEYWORDS— Coplanar waveguide feeding, Defected ground structure, Feather shaped radiator, Hyper-ultra wideband applications

INTRODUCTION

With the day to day developments in the wireless communication systems, the demands for wireless data transfer over a frequency range covering both long range and short range frequency spectrums have increased significantly. To fulfill these demands, super wideband or hyper band antenna structures are introduced. An antenna having a ratio bandwidth equal to or more than 10:1 is defined as hyper-band or super-wideband antenna [1-2]. Among the various SWB structures reported in the literature [2-8], planar monopole structures are proven to be very good candidates due their advantages like wide bandwidth, omnidirectional radiation patterns etc. The dimensions of reported structures are compact but they are not compatible with the reducing dimensions of the future devices.

In this paper, a hyper band monopole antenna is designed by using feather shaped radiating patch, coplanar waveguide feeding technique and rectangular notch loaded modified ground plane. The integration of above mentioned techniques lead to the size miniaturization and bandwidth enhancement. The antenna structure is designed and analyzed by using Ansoft's FEM based HFSS Simulator [9].

ANTENNA DESIGN

The designed antenna configuration with optimized dimensions is illustrated in Fig. 1. The feather shaped radiator is derived by overlapping multiple rotated conventional elliptical monopole structures. The conventional partial rectangular plane is replaced with a modified ground plane. The modified ground plane consists of a quarter elliptical section and a rectangular section. This modified ground plane is further loaded with a pair of quarter wavelength long rectangular notch to excite an additional resonance leading to further bandwidth enhancement. Coplanar waveguide feeding is used due to its advantages over microstrip feeding technique. All the antenna dimensions are optimized by using HFSS.

RESULTS AND DISCUSSION

The simulated reflection coefficient versus frequency characteristic is presented in Fig. 2. It is observed that the both characteristics are giving same data i.e. a impedance bandwidth of 4.6 to 3.8 GHz. The designed antenna has seven resonances at frequencies of 6.5, 13.5, 17.5, 20.5, 25, 28.5 and 35 GHz.

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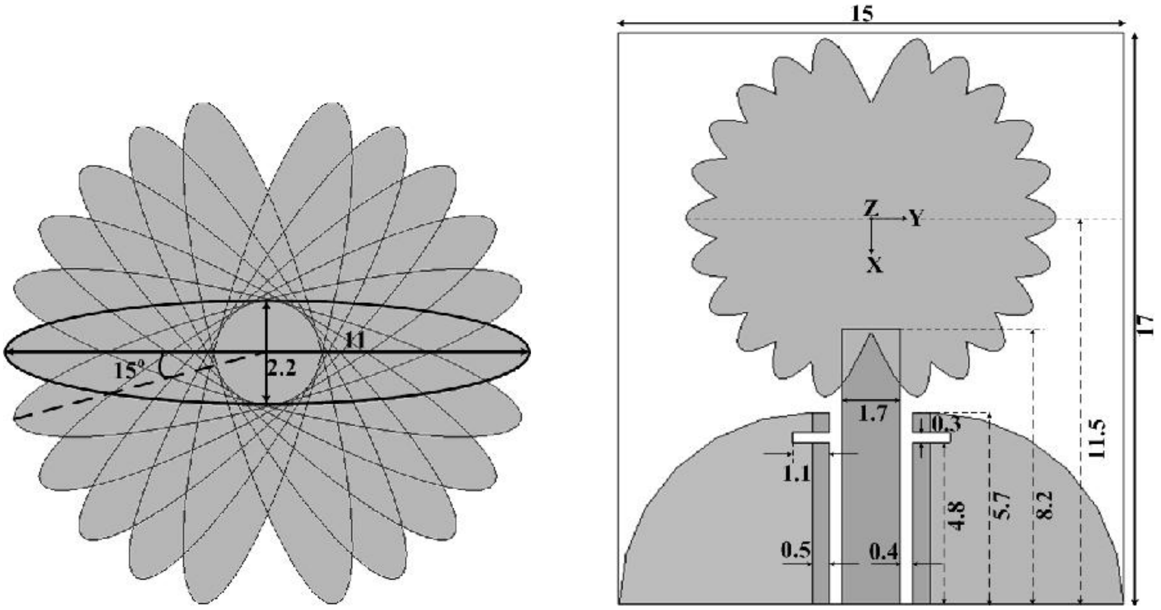

(a) Radiating patch **(b) Final Antenna**

Fig. 1 Antenna configuration (all dimensions are in mm)

The variations of simulated real and imaginary of the antenna input impedance with frequency are presented in Fig. 3. It is observed that the real part is varying around 50 Ω and imaginary part is oscillating about 0 Ω in the entire band of operation. The overall input impedance of designed antenna is approximately equal to 50 Ω i.e. characteristic impedance of the coaxial connector.

The radiation patterns of the designed antenna in both i.e. E-plane (Φ=0º) and H-plane (Φ=90º) at all the resonance frequencies are shown in

Fig. 4. It is observed that the patterns are omnidirectional in H-plane and bidirectional in E-plane for the frequencies less than 10 GHz. For the frequencies more than 10 GHz, the bidirectional patterns of E-plane have acquired distorted omnidirectional nature. These distortions at higher frequencies are due to the excitation of higher order modes at those frequencies.

The variation of peak realized gain with frequency is depicted in Fig. 5. It is observed that the gain is varying between a maximum of 8.3 dB and a minimum of 1.5 dB. Fig. 6 displays that the radiation efficiency of the designed antenna is varying from 76% to 97%. The efficiency is decreasing with frequency due to the varying performance of the substrate at different frequencies.

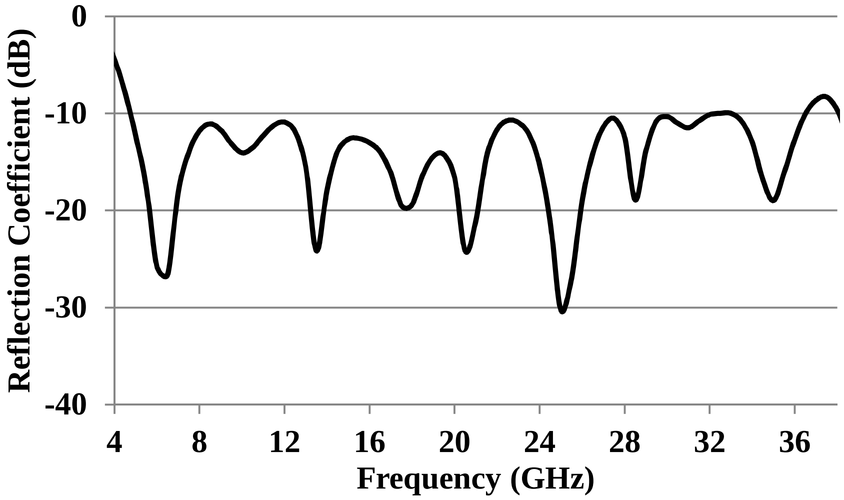

Fig. 2 Reflection coefficient versus frequency characteristic

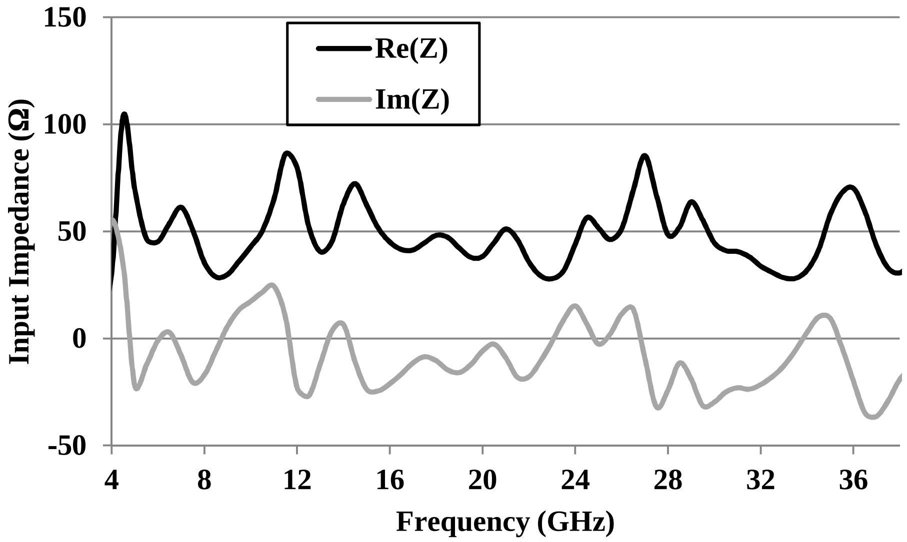

Fig. 3 Input impedance versus frequency characteristic

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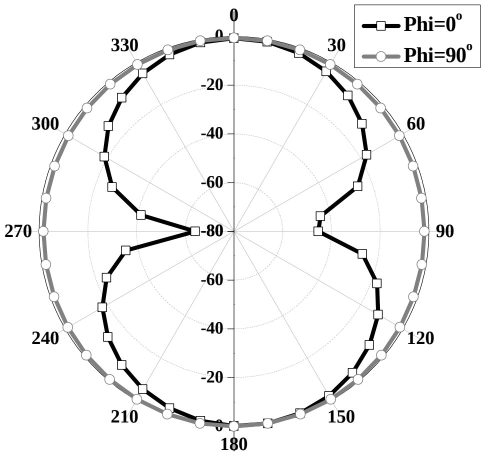
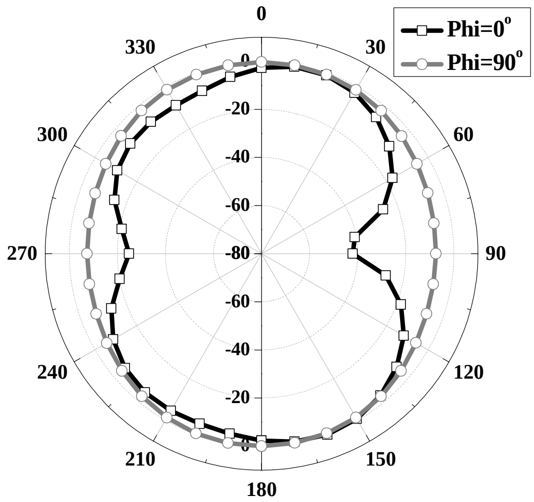
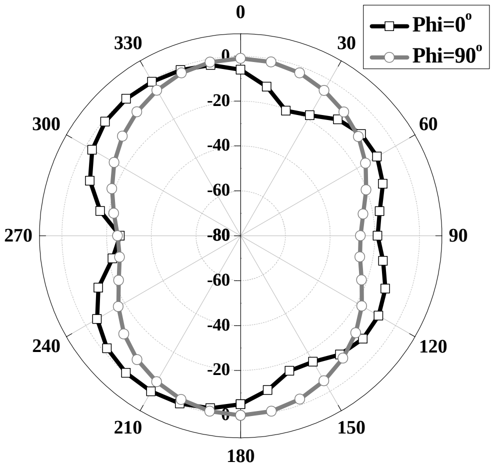


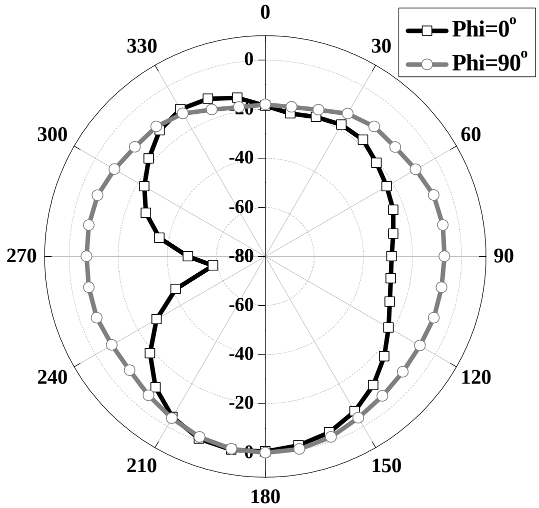
(a) 6.5 GHz



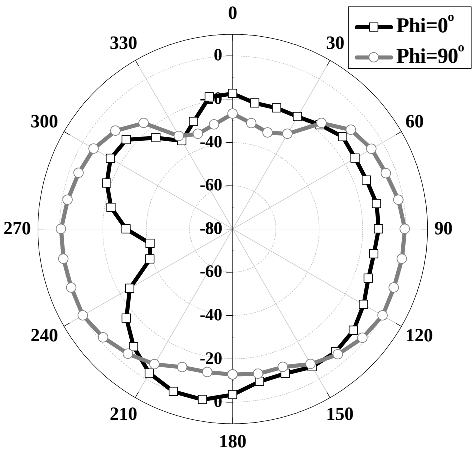
(b) 10.5 GHz



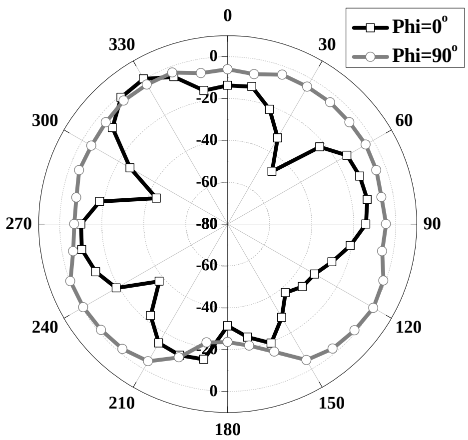
(c) 13.5 GHz



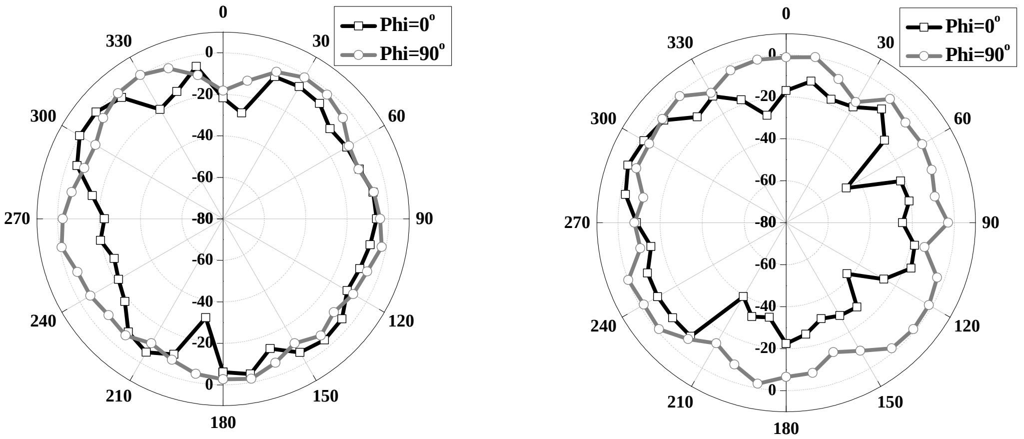
(d) 17.5 GHz



(e) 20.5 GHz



(f) 25 GHz



(g) 28.5 GHz (h) 35 GHz

Fig. 4 Radiation patterns at different resonance frequencies

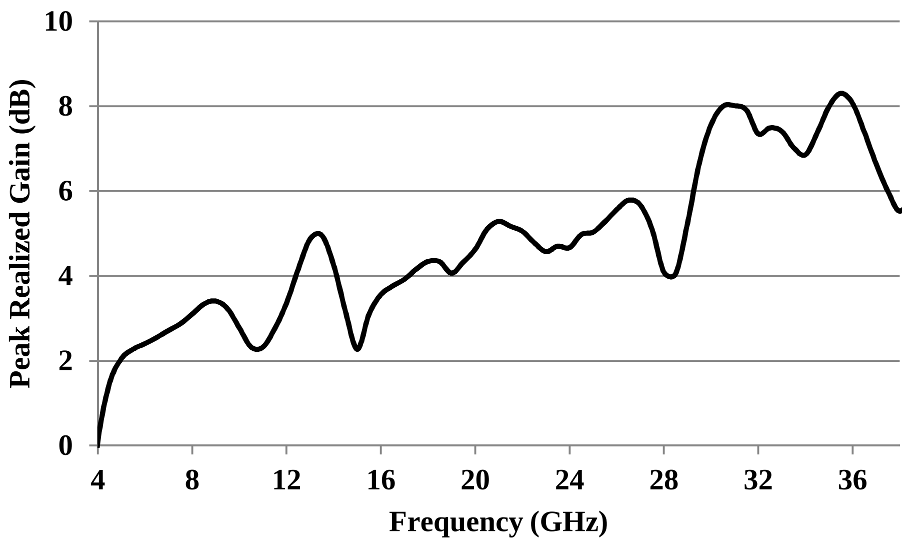


Fig. 5 Peak realized gain versus frequency characteristic

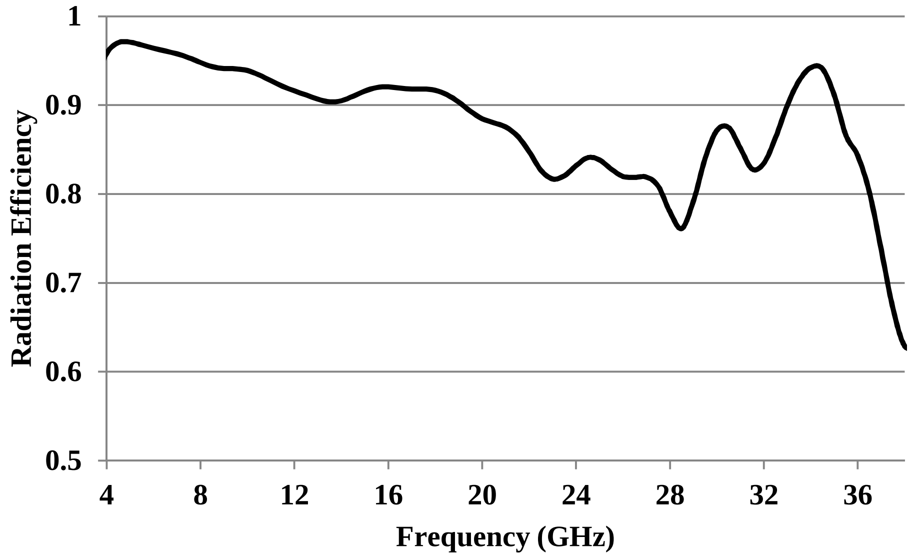


Fig. 6 Radiation efficiency versus frequency characteristic

CONCLUSION

A compact feather shaped monopole antenna is designed and analyzed. The simulated frequency domain results justify the suitability of this antenna structure for hyper band applications. The operating bandwidth of this antenna structure covers the unexplored Ku, K and Ka bands for communication purpose. Along with hyper bandwidth, the designed antenna has miniaturized dimensions in comparison to previously reported structures. Due to these advantages, this antenna structure will be useful for UWB and SWB applications etc [10].

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