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Double-Sided Cup-Shaped UWB Antenna For Wireless Applications

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Abstract

A cup-shaped double-sided UWB antenna for various communication systems is presented. The antenna has the total size of 22mm× 24mm, printed on FR4 1.6 mm thick substrate. This study presented a tapered-fed cup-shaped radiator with a modified ground plane. The semicircle slot etched in the radiator and the modified ground plane is used to improve the impedance matching. The appropriate combination of feed and slot shapes provides the wide operational bandwidth. The simulation results show that the presented prototype provided wideband from 2.8 to 11 GHz and has attained stable patterns with constant group delay.

I. INTRODUCTION

Federal Communication Commission allotted the unlicensed band for commercial applications from 3.1-10.6-GHz in 2002[1]. UWB technology has gained the attention of the researches. The prime issue faced in UWB Technology is design ofcompact and multifunctional antenna that can be assimilated with portable systems. As this type of antenna designs basically reduce the complexity of the system. The certain advantages of microstrip antennas like simple structure, easy integrationwith monolithic microwave integrated, light weight, low profile and easy to fabricate has gained much attention in last fewdecades. Many techniques are reported in the literature for UWB systems such as [2] bandwidth enhancement was achieved byusing shorting pins and folded-patch feeding technique. In [3] bandwidth is achieved by etching semi-elliptic slot in the groundplane. In [4] reported bow-tie for achieving the band. Numerous shapes like tapered-slot [5], octagonal-shaped [6], a circular slotfeed with trident-shaped [7], Inverted-L-Shaped [8], hexagonal-shaped [9] have been reported in order to cover the desire bandallocate by FCC.

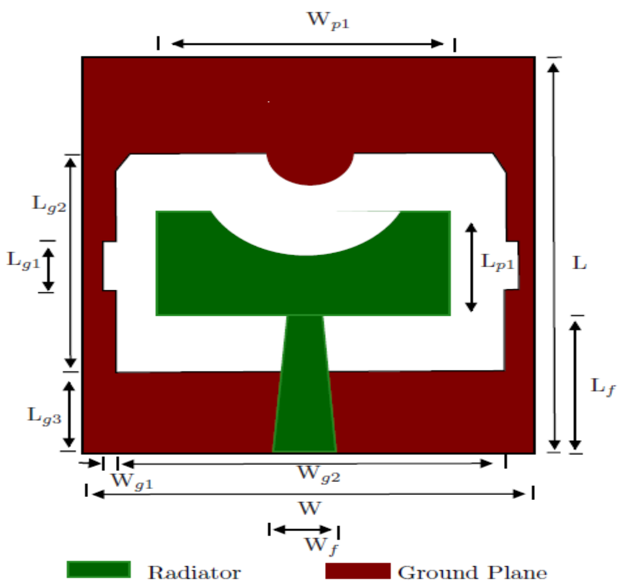

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Fig. 1 Configuration of the Cup-shaped antenna.

This study states, a cup-shaped antenna of total area of 22 mm× 24 mm printed on 1.6 mm FR4 dielectric with modifiedground plane is presented to carter the present communication systems. The tapered-fed cup-shaped radiator with the slottedground is used to improve the impedance matching. The antenna design and the variables that affect the performance of theantenna are discussed in the next section.

TABLE I
VARIABLES OF CUP-SHAPED FIG. 1

Parameters	L	W	L_f	W_f	W_{p1}	L_{p1}
Unit(mm)	22	24	6	3	13	7
Parameters	W_{g1}	L_{g1}	W_{g2}	L_{g2}	L_{g3}	W_{g3}
Unit (mm)	18	10.75	1	3.3	5.25	24

II. DESIGN ANALYSIS AND PARAMETRIC STUDY

The conventional design of microstrip antenna has a narrow bandwidth. But they are capable of generating wider band with appropriate implementation of suitable techniques. Configuration of the antenna designed is depicted in fig1. It is printed ondouble-sided inexpensive commercially available FR4 dielectric substrate.The prototype consist of a modified ground plane which initially consist of simple rectangular from where a rectangularshapedslot of length L_{g2} and width W_{g2} is etched from the ground. A semicircle of radius 2 mm is added in the upper portionof the ground plane with truncated corners to adjust the band at higher frequency. Further, two rectangular slot are etchedon the both side of the ground plane of length L_{g1} and width W_{g1} to further enhance the bandwidth. Initially, rectangularpatch of length Lp1 and width Wp1 is used to obtain wideband which was further optimized to a Cup-shaped radiator witha tapered-fed line of length and width of $L_f \times W_f$ with 50 Ω characteristic impedance.

Ansoft HFSS [10] solver is used tosimulate in order to finalize the parameters of designed antenna.In this section simulated parametric variations are shown. Fig.2 depicts the variation in the radius of semicircle in the patchfrom 3.25 mm to 7 mm. The main effect of the variable is observed on the lower portion of the band from 4 to 6 GHz. Theoptimized value is taken as 5 mm as it covers the entire band.

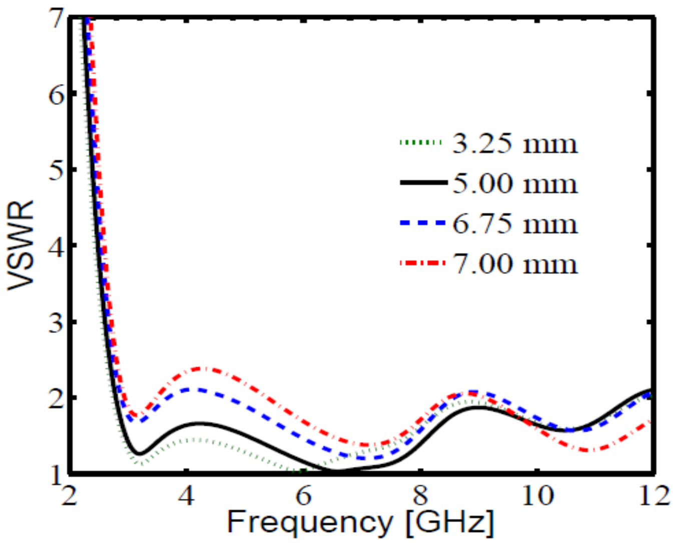

Fig. 2.Simulated Current distribution of the Cup-shaped antenna.

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A. Current Distribution

Fig.3, states simulated current distribution at three resonant frequencies (a) 3.2 GHz, (b) 6.6 GHz and (c) 10.24 GHz. The lower band is mainly affected by the two rectangular slots etched on either side of ground plane and tapered-fed, clearly indicates in Fig3 (a), the main concentration of the current is around the slots and the fed-line. Similarly, Fig3 (b) states that the concentration is around the radiator and in some portion of the ground plane and in Fig3(c), it is equally distributed around radiating patch and ground plane. It is observed that the currents are distributed asymmetrically somewhere current concentration is higher and other have minimum in amplitudes. Accordingly metal areas are added and subtracted.

III. RESULT AND DISCUSSION

In this section, the simulated results as VSWRs, radiation patterns and group delay are discussed that are obtained from Ansoft HFSS ver. 14 solver based on finite element method. Fig4, depicts the VSWR curve and it is observed that the entire band from 2.7 GHz to 11 GHz is <2. Thus, impedance matching requirement stated by FCC is satisfied in this study for the entire UWB band. In the study of UWB systems group delay is also a substantial factor. As distortion of the transmitted pulse in this system is provided by this parameter. If group delay is constant throughout the band is means the transmission of pulse is good. Fig.5 provides the group delay graph. It is observed that it is around 1 ns (almost constant) for the complete band.

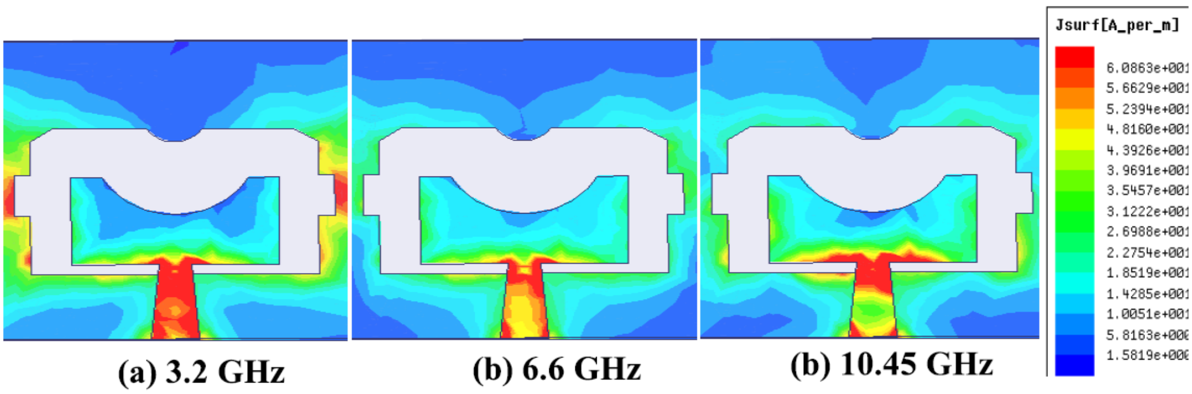
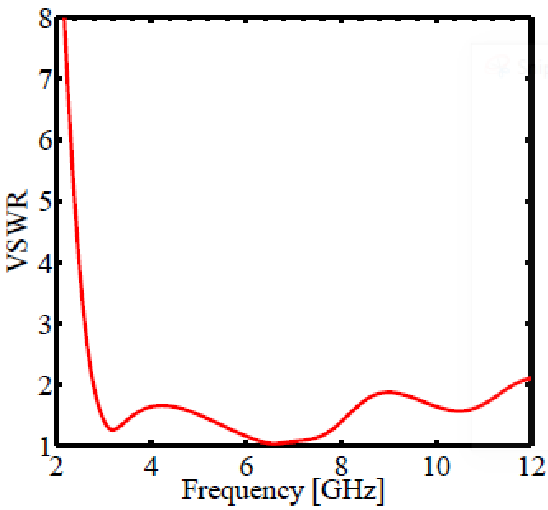


Fig. 3.Simulated Current distribution of the Cup-shaped antenna.



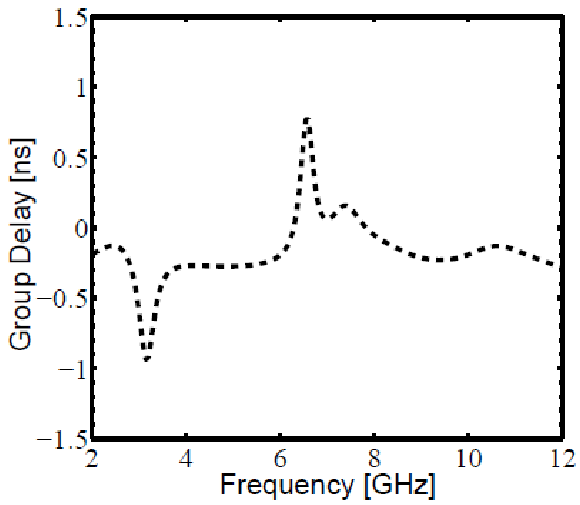


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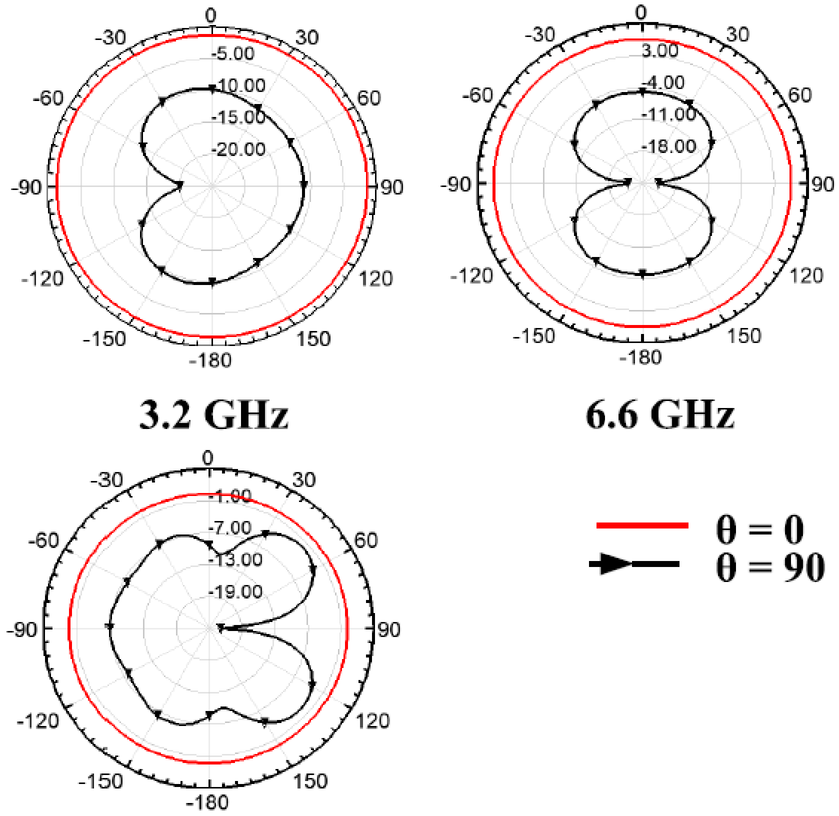
Fig. 4.VSWR of theCup-shapedantenna.Fig. 5.Group Delay of the Cup-shaped antenna.

Fig.6 (a)-(c) states, radiation pattern at three resonant frequency (a)3.2 GHz (b) 6.6 GHz (c)10.24 GHz. At lower frequencythe patters are omnidirectional in the E-plane and at higher frequencies they are less omnidirectional due to higher-orderresonant modes. These patterns are appropriate for various applications.



IV. CONCLUSION

A tapered-fed Cup-shaped antenna is presented in this article. The simulated results shows VSWR <2 from 2.8 to 11GHz which indicates that the antenna confirms UWB bandwidth. It revels simple and compact design, virtuous wide bandcharacteristics with constant group delay and stable radiation pattern which indicates that the antenna is suitable for various
communication systems.

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