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A Novel Printed UWB Antenna with Band Rejection Characteristics

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Abstract*— Low cost, simple structure Ultra Wideband (UWB) antenna with band notch characteristic is proposed. in this paper. The design opens a new dimension for the microstrip antenna design engineers by avoiding the necessity of cutting any slot within the radiating patch for getting the band notch characteristics. In our design the impedance bandwidth is obtained from 3.08GHz to 11.1GHz matching with the Federal Communication Commission (FCC) regulated band. The steps need to be adjusted properly to obtain the desired impedance bandwidth. The antenna is also found with a band rejection property from 4.5GHz to 7.2GHz for -10dB return loss.

Index Terms **— Fractional Bandwidth, UWB Antenna, Band notch characteristic, CPW, WLAN, Impedance Bandwidth.**

I. INTRODUCTION

February 2002 witnessed the allocation of UWB spectrum (3.1GHz to 10.6GHz) by the Federal Communication Commission (FCC) which in terms opened a vast scope of research for the microstrip antenna engineers [1]. A signal can be classified as UWB signal if its fractional bandwidth (*FBW*) is greater than 0.25 [2].

$$(FBW) = 2\frac{(f_H - f_L)}{(f_H + f_L)}$$

The FCC defined the UWB as any signal that occupies more than 500MHz bandwidth in the 3.1GHz to 10.6GHz. Advantages like low power consumption, high data rate wireless connectivity and simple hardware configuration made microstrip patch antenna a primary choice for application in wireless communication technology. Also microstrip fed patch antenna as well as coplanar waveguide fed microstrip UWB antenna gained much attention due to its bidirectional radiation pattern and wideband characteristics. Various designs based on the modification of the patch have been proposed and studied satisfying the UWB specifications. Some of the designs in this field are given in [2-5]. Conventional designs are based on obtaining a band-stop filter characteristic within the allocated impedance bandwidth for obtaining band notch characteristics at the IEEE 802.11a band or the WLAN frequency band to avoid any transmission or reception interference when used in proximal environment. Loading the UWB antenna with a resonant slot at the center frequency of the stop band is required for getting the band notch characteristics. In our design we tried to omit the necessity of cutting slot inside the patch for getting the band rejection characteristics.

II. ANTENNA DESIGN AND PARAMETRIC ANALYSIS

Basic design started with a half wave (λ/2) monopole structure realized on RT/duroid substrate of height 0.786mm with ε_r=2.32 and tanδ=0.0012. The structure is fed with coplanar waveguide feeding technique (CPW) with 50Ω input impedance. The surface current flowing on the rectangular shaped conductor can be regarded as a primary source of radiation. *Figure1* illustrates the geometry of the proposed antenna. It consists of a rectangular patch over a substrate of length 44mm, breadth 34mm and thickness of the patch is 0.02mm fed by a Coplanar Waveguide (CPW) structure. While designing an UWB antenna with band notched characteristics we had to consider two things simultaneously. Primarily the antenna needs to operate within the desired frequency band (3.1GHz to 10.6GHz) and for this

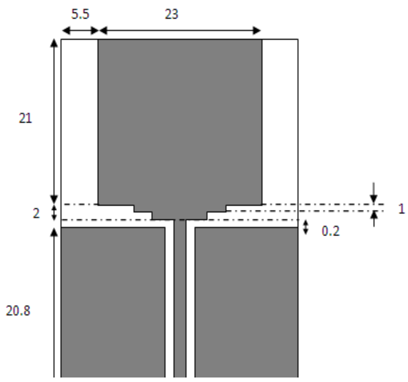

Fig 1:

Geometry of the Proposed Band Notched UWB Antenna

Proper impedance matching has to be done by adjusting the gap between the patch and the ground plane. The gap between patch and the ground plane has been parametrically studied and for 0.2mm gap length proper impedance matching has been obtained. Our next objective is to avoid interference with the existing WLAN frequency band (5.15 to 5.8GHz). For this we need to create a notch characteristic at the WLAN frequency band. Since our objective was to avoid cutting any slot within the radiating patch so we focused on modifying the patch itself. After various modifications of the patch it has been found that step cut at the bottom half of the patch has its effect in creating notch within certain frequency band. Also good gain characteristic of the antenna has been maintained by avoiding any modification at the top half of the patch. The number of steps has been found to be an important parameter for shifting the

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patch to a desired part of the total impedance bandwidth. It has been noticed that the gap between the patch and the ground plane *g* has to be adjusted for obtaining the desired UWB band with the notch characteristics. The variation of the return loss obtained by varying g has been shown in Figure 2. For **g**=0.2 a maximum return loss has been observed and the gap between the patch and the ground plane has been fixed to 0.2mm. It is observed that this gap has its effect also on the higher cutoff in the impedance bandwidth.

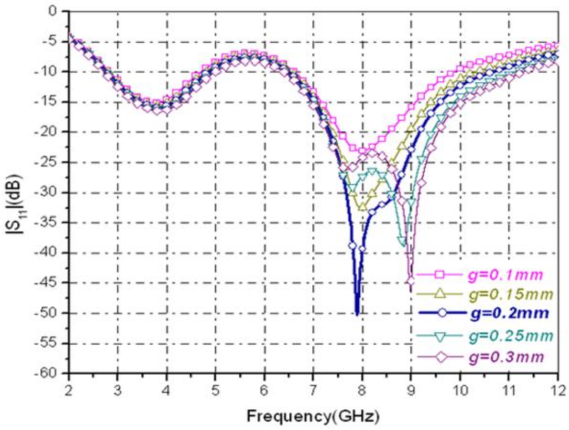


Fig 2: Simulated Return Loss for Different Gap between Patch and Ground Plane (G)

The width of the feed ***w*** too has been found to be an important parameter for obtaining the desired impedance bandwidth. The variation of the return loss by varying ***w*** as obtained by using CST Microwaves Studio has been shown below in *Figure 3.* A slight tuning effect on the total impedance bandwidth has been observed. We selected 1.5 mm as for the most appropriate impedance bandwidth characteristics.

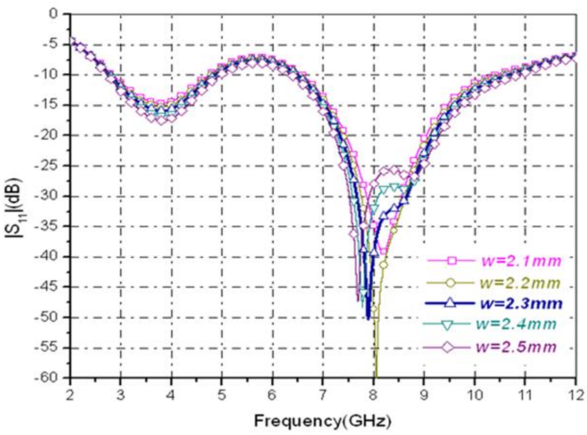


Fig 3: Variation of Simulated Return Loss for Different Feed Width (*W*)

Our next object is to tune the return loss for increased accuracy of the system. The gap between the feed and the ground plane ***p*** is found to be an important parameter for the purpose. This is also parametrically studied for improving the accuracy in the antenna return loss characteristics shown below in *Figure 4.* This gap is found to be an important parameter for controlling the frequency band to be notched. Although we fixed this gap at 1 mm, it seems that further research in this respect is needed for more accurate control of the band notch characteristic.

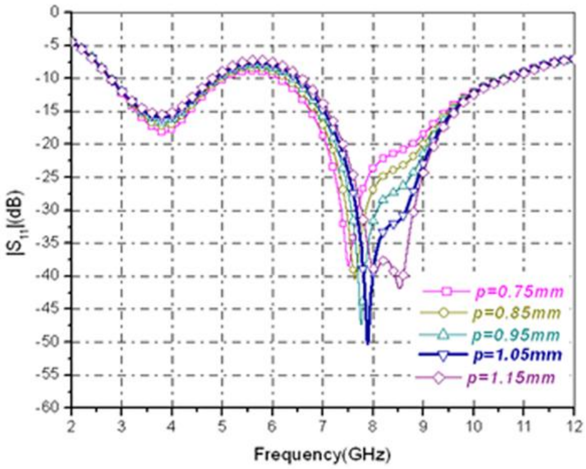
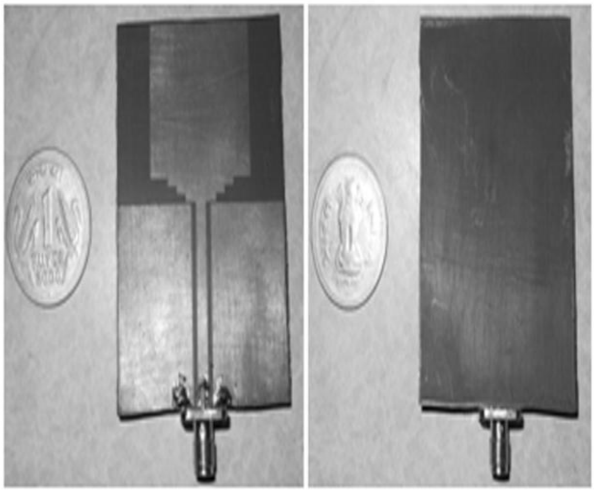


Fig 4: Simulated Return Loss for Different Gap between Feed and Ground Plane (P)

The antenna has been fabricated and the measured result shows a good match with the simulated version.



(a) (b)

Fig 5: Fabricated Antenna (A) Top View and (B) Bottom View with RT Duriod Substrate

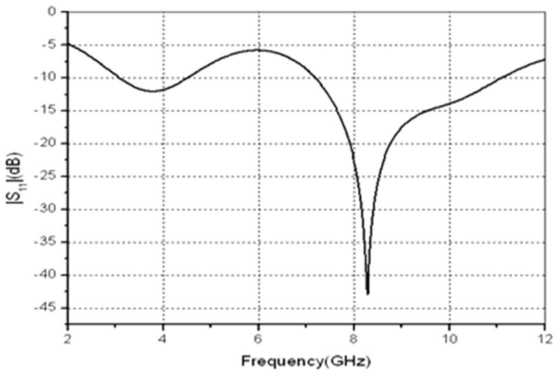


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Fig 6: Simulated Return Loss of the Proposed UWB Antenna

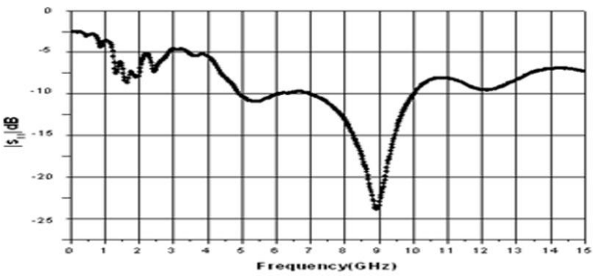
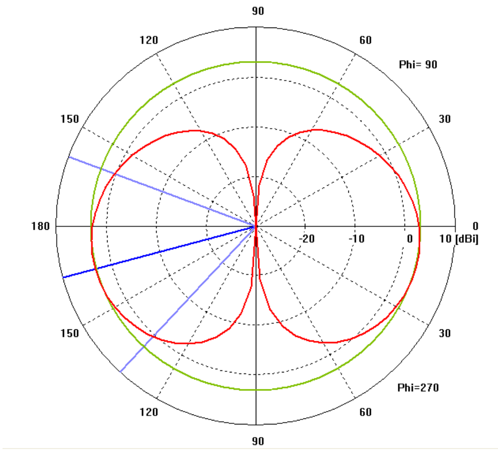


Fig 7: Measured Return Loss of the fabricated Antenna Prototype

III. RADIATION PATTERN

Because the radiation pattern of the antenna at frequencies 4GHz, 6.85GHz and 10.6GHz has been studied and are shown in *Figure 8-9*. The measured peak gain at 4GHz, 6.85GHz and 10.6GHz are found to be 3.28dB, 4.32dB and 5.92dB respectively. From the above study the gain of the antenna is found to be proportional to the operating frequency. The simulated radiation pattern of the proposed UWB antenna is omni-directional and is found to be consistent over the entire band of interest.



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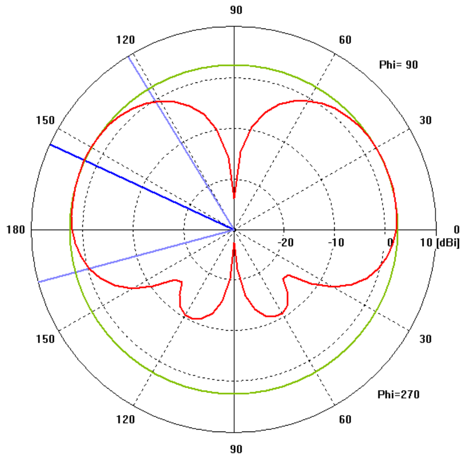

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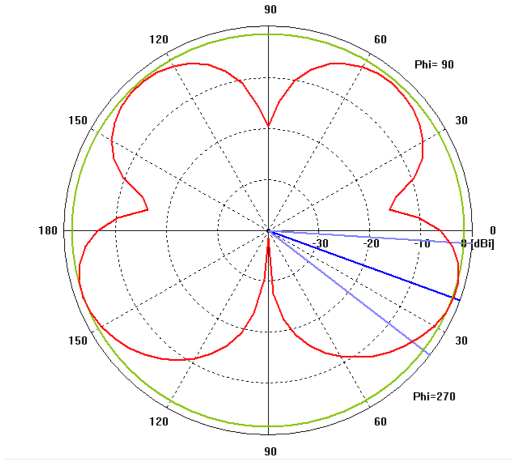
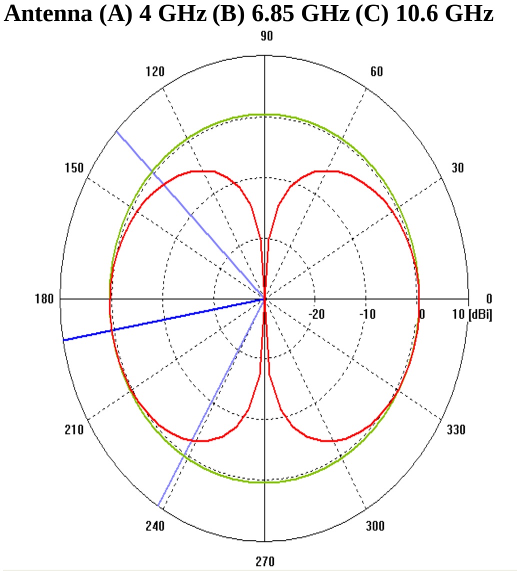
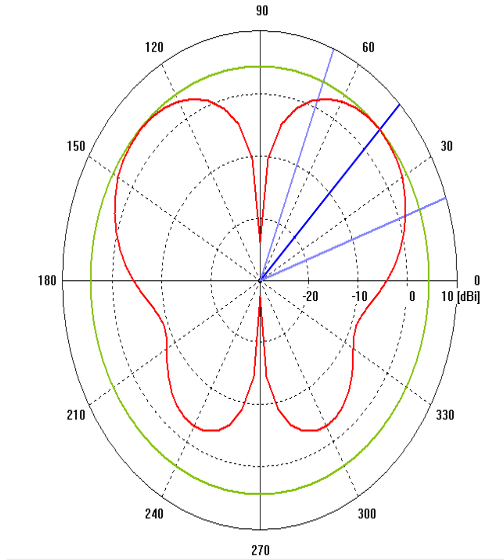


(c)

Fig 8: Simulated Results of E-Plane Pattern Of the Proposed Antenna (A) 4 GHz (B) 6.85 GHz (C) 10.6 GHz



(a)



(b)

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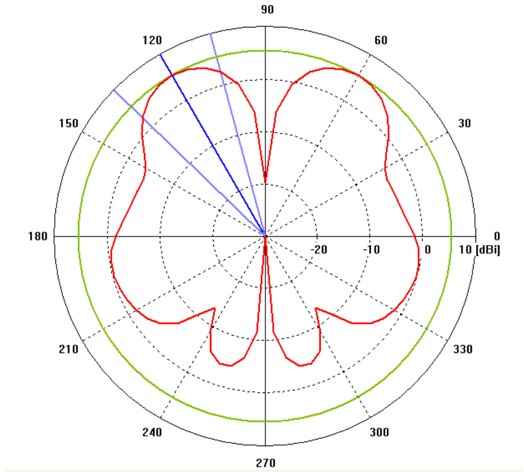

(c)

Fig 8: Simulated Results of H-Plane Pattern Of the Proposed Antenna (A) 4 GHz (B) 6.85 GHz and (C) 10.6 GHz

IV. ACKNOWLEDGMENT

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Sourav Moitra received his B-Tech (Electronics & Communication Engineering) in 2005 from the West Bengal University of Technology. He was associated with Hutch, Elcon Engineering Pvt. Limited in between 2005 to 2007. He received his M-Tech (Microwave Engineering) in 2009 from The University of Burdwan. He has been associated with Dept. of Atomic Energy, Govt. of India on a project related to the development of high power RF tubes. At present he is associated with Dr. B. C. Roy Engineering College, Durgapur, India as Assistant Professor in the Dept of Electronics & Communication Engineering. He has several publications in International Journals & Conferences. His current research interest includes design & development of microwave & millimeter wave passive circuits based on microstrip line and substrate integrated waveguides applicable in wireless networks.

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