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UWB Antenna for Wi-Fi and Radar Applications

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Abstract – **Wireless wideband communications are demandingly increasing rapidly, due to the need to support more users while providing higher data rates. Proposed in this paper's a re-investigation of UWB antennas for the purpose of designing a new design of UWB antenna that fulfills the FCC regulations. The band is further extended beyond to cover some radar applications. The antenna operates in the frequency range 3.848 GHz - 16.74 GHz with omni-directional radiation pattern. The antenna is fabricated on a Roggers-5880 substrate (ϵ_r= 2.2, tanδ = 0.02) with dimensions 30 × 30 × 1.04 in mm.**

I. INTRODUCTION

Recently, UWB antenna design motivated a lot of researches to implement this technology in different applications. On the other hand, the growth of wireless broadband communications systems including text, data, voice and video is an urgent demand as well [1-10]. As a matter of fact, it was first employed by the Italian physicist Guglielmo Marconi in 1901 purposed to transmit Morse codes sequences using spark gap radio transmitters. UWB signals are defined as those with either a large relative bandwidth (greater than 20%), or a large absolute bandwidth (greater than 500 MHz) [1, 2, 11, 12].

Actually, the frequency spectrum is a limited resource. The FCC attempted to introduce UWB technology for the market meanwhile dodging any conflicts that may occur with the other known narrowband technologies; therefore they imposed aggressive restrictions for the UWB transmitted power. FCC has set a power requirement of -41.3dBm/MHz for UWB systems. Such power restrictions allow UWB systems to reside below the noise floor of a typical narrowband receiver and enable UWB signals to coexist with current radio services with minimal or no interference [5,7-11].

This paper is devoted to the design, analysis and fabrication of a newly designed UWB antenna. The research work is validated through a comparison of the simulated and implemented results.

II. ANTENNA DESIGN

The microstrip-fed new-shaped UWB antenna is designed using CST Microwave Studio. It is fabricated on a Roggers-5880 substrate (ϵ_r= 2.2, tanδ = 0.02) with dimensions L × W × H, where L is 30 mm, W is 30 mm, and H is 1.04 mm. Figure 1 and 2 show the symmetrical geometry of the designed and fabricated antenna respectively. Whereas the microstrip feedline is connected to a 50 SMA connector for excitation. The feeder width Wf is 3.2 mm. The overall antenna's width; W and length; L are 24 mm and 25.104 mm respectively. Ground height; Gr is 10mm.

a) b)

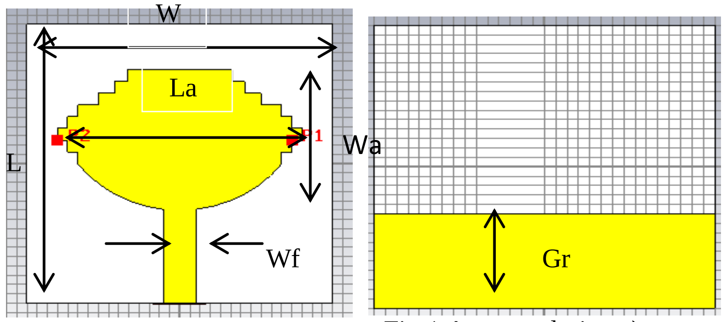
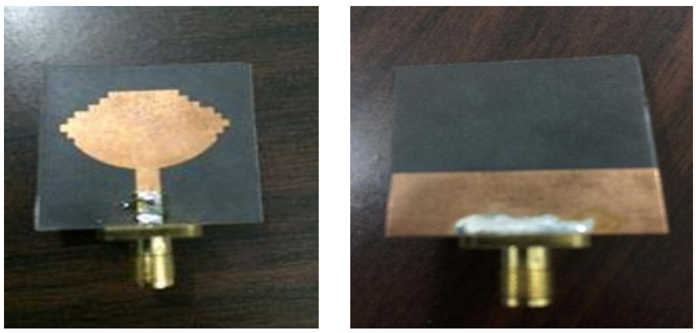


Fig.1 Antenna design a) top view; b) bottom view

a) b)

Fig.2 Fabricated antenna previewing a)



front view, b) back view

III. SIMULATED AND MEASURED RESULTS

The return loss is simulated using CST Microwave Studio. Real measurements are carried out using the Rohde and Schwarz vector network analyzer. The antenna operates within the band 3.848 GHz - 16.74 GHz. Shown in figure 3 the return loss of the simulated results versus that of the measured ones. The simulated and measured return loss results are in good agreement.

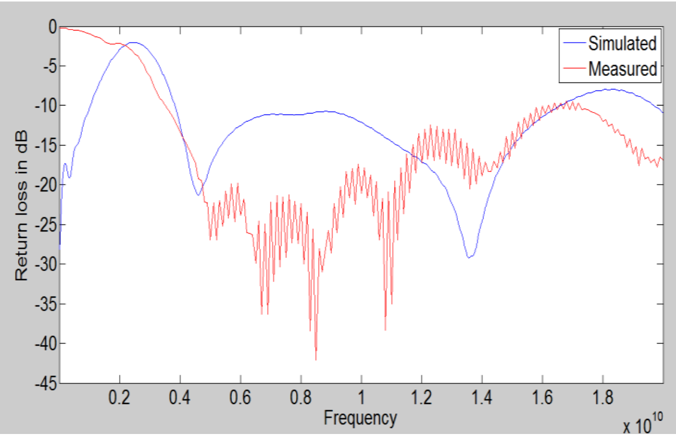
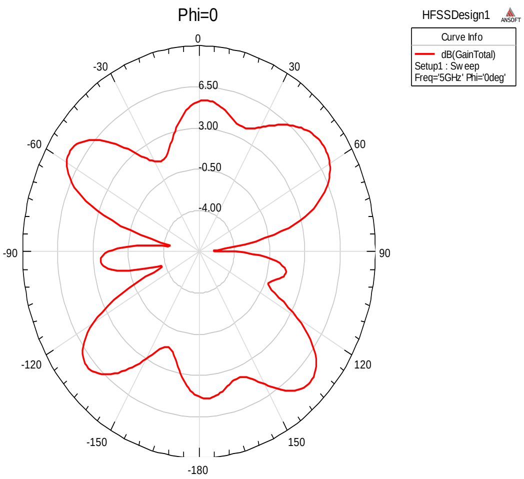
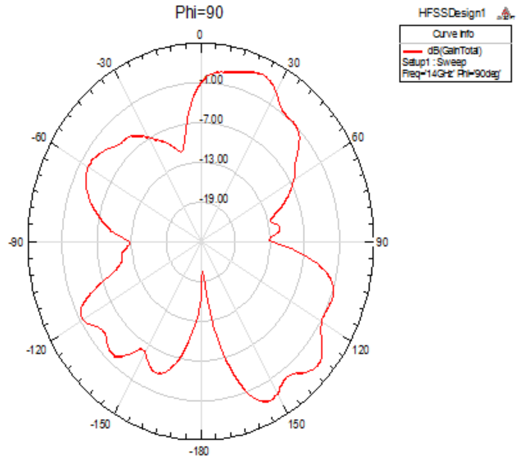


Fig.3 Return loss across the band 3.848 GHz – 16.74 GHz

Figures 4, 5 and 6 depict the radiation pattern at frequencies 5 GHz, 14 GHz and 15 GHz respectively. It is clear that the radiation pattern is Omni-directional. Figure 7 depicts 3D radiation pattern at 15 GHz.

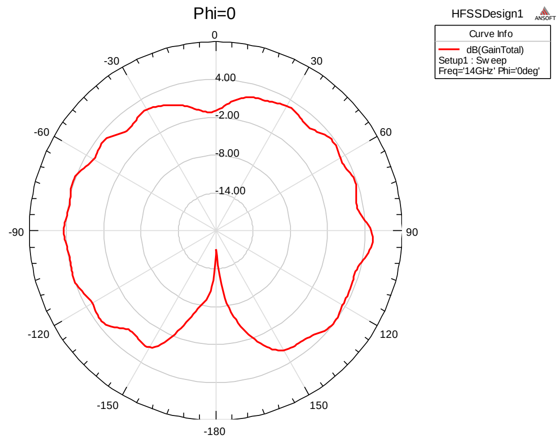


a) Phi = 0

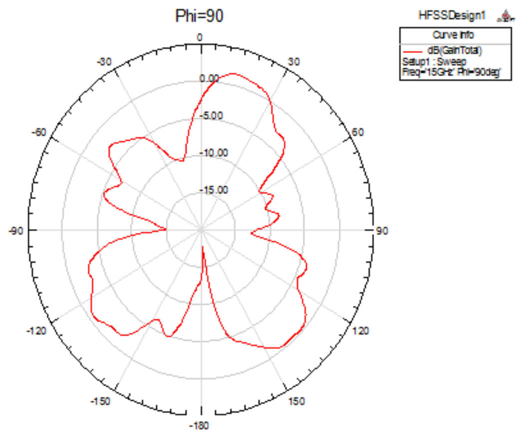


b) Phi = 90

Fig.4 Radiation pattern at 5 GHz

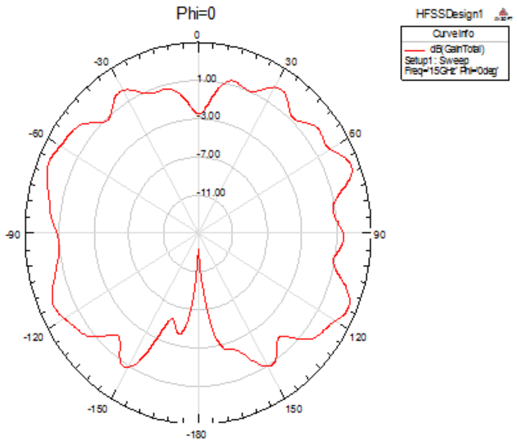


a) Phi = 0

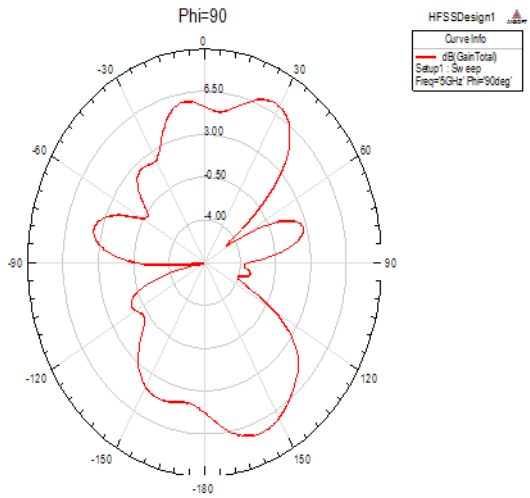


b) Phi = 90

Fig.5 Radiation pattern at 14 GHz



a)



b) Phi = 90

Fig.6 Radiation pattern at 15 GHz

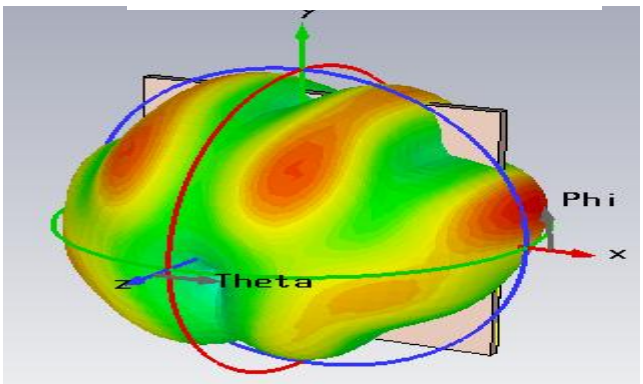


Fig.7 Radiation pattern in 3D at 15 GHz

Figures 8, 9 and 10 depict the surface currents at frequencies 5 GHz, 8 GHz, and 10 GHz respectively. One notices that the surface current is aligned properly on the edges of the antenna.

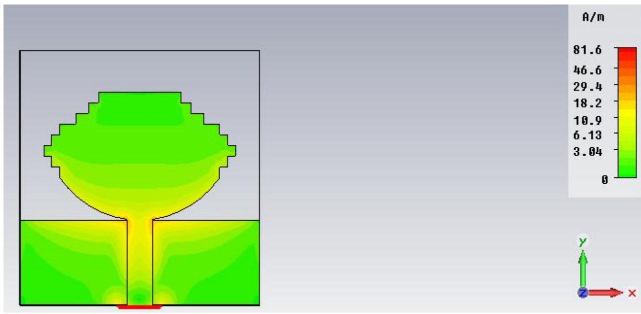


Fig.8 Surface current at 5 GHz

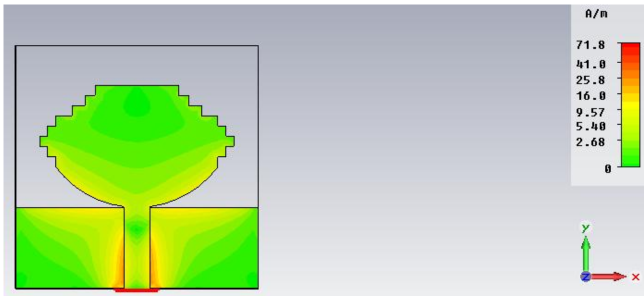


Fig.9 Surface current at 8 GHz

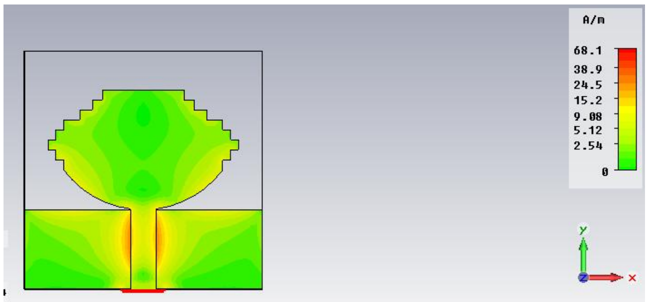


Fig.10 Surface current at 10 GHz

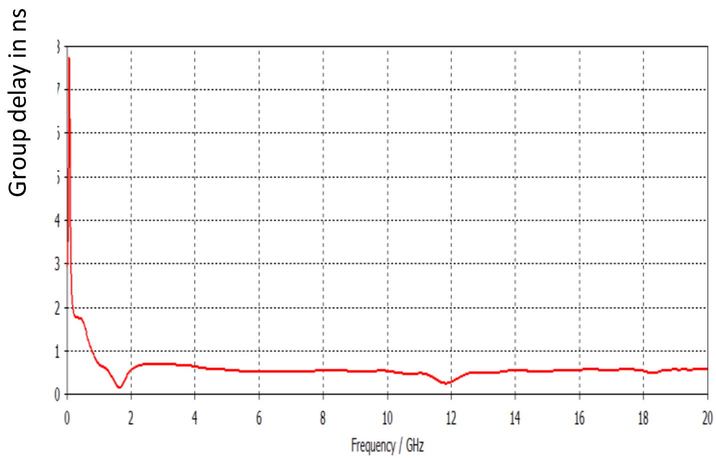


Fig.11 The group delay along the bandwidth

Figure 11 illustrates the group delay of the antenna along the operating band. It is clear that the group delay is within 0.5 ns, which is convenient for digital communications.

IV. UWB with notch for WiMAX

Figure 12, illustrates the UWB with notch to cancel the WiMAX band at 5.8 GHz. The dimensions of three slots and their notch band are depicted in table 1, and the return loss is shown in figure 13.

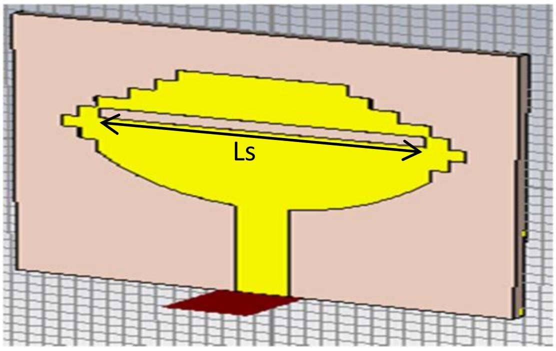


Fig.12 Antenna design with rectangular cut

Table1 Band notches at different rectangular slots

	$Ls \times Ws$ *in mm*	BW	Notch BW in GHz
1	22x1.2	13.754 GHz	4.16 – 5.82
2	19.4 × 1.2	13.586 GHz	4.7 – 6.09
3	15.6 × 1.2	13.102 GHz	5.6 – 6.5 6.9 – 8.7

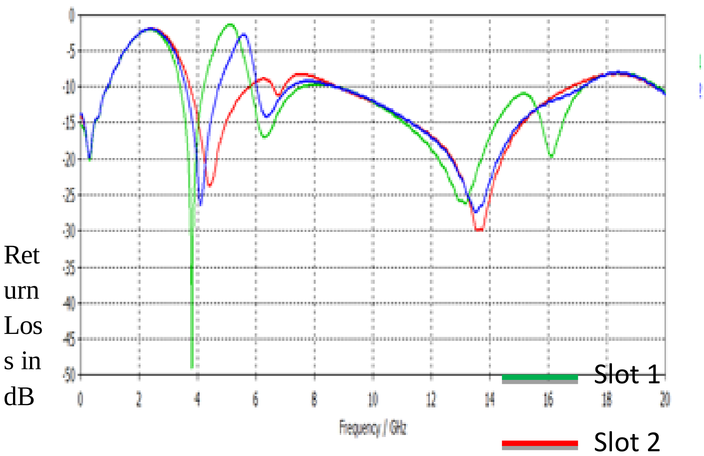


Fig.13 Return loss of the notching design

V. CONCLUSION

This article has successfully designed the new-shaped UWB antenna which has proven to operate on many applications like the WiFi, WiMAX, and radar applications. This has been demonstrated throughout the research’s design through a sophisticated comparison of the simulated parameters with the measured ones, thus proving authenticity of the research, whereas the antenna operates within the band of 3.848 GHz – 16.74 GHz with respect to the -10dB. A notch for WiMAX is presented.

VI. ACKNOLEDGEMENT

I would like to express my deepest gratitude to my supervisor Prof. Dr. Abdelmegid Allam for all his support.

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