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Microstrip UWB Antenna With WiMax Notched Band Characteristics

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Abstract- **In this paper a compact ultra-wideband printed microstrip patch antenna with single band-notched characteristics is presented. The antenna is constructed on an FR-4 epoxy substrate with thickness of 1.6 mm and ε_r =4.4. The antenna uses a circular split ring slot on a circular patch to create single band-notched characteristics in 3.3–3.6 GHz for WiMAX. Surface current distributions are used to show the effect of these slots. The proposed antenna shows broad bandwidth and good omnidirectional radiation patterns in the passband, with a compact size of 30x30 mm^2. The proposed antenna operates over 3.0 to 13.5 GHz for VSWR < 2. All simulations in this work were carried out by using Ansoft HFSS 13. Proposed antenna has advantages in simple design, wide bandwidth, and good band-notch characteristic, compact in size and easy in fabrication**
Keywords- **UWB Antenna; Notch Band Antenna; Microstrip Antenna; Planar Antenna**

I. INTRODUCTION

Federal communication commission (FCC) declared unlicensed radio frequency band 3.1-10.6 GHz for commercial use, ultra wideband (UWB) has received great attention from academics and industries of telecommunication [1]. In recent years, researchers have given more attention to improve the UWB antennas impedance bandwidth, radiation patterns, matching characteristics and to decrease the size of the antenna. UWB has attractive merits which drawn the most researchers attention, such as compact size, low cost, resistant to severe multipath and jamming, ease of fabrication, and good omnidirectional radiation characteristics [2]. However, the ultra-wideband systems are very sensitive to electromagnetic interferences with exciting narrowband wireless communication systems and X-band satellite communication system, it is necessary to design antennas with multiband filtering characteristics to avoid interferences with applications working in this band. For instance, Worldwide Interoperability for Microwave Access (WiMAX) operating in 3.3-3.6 GHz band (IEEE 802.16), wireless local area networks (WLAN) operating in 5.15-5.825 GHz band (IEEE 802.11a), and X-band satellite communication system operating in 7.2-8.4 GHz band (7.25-7.745 GHz for uplink and 7.9-8.395 GHz for downlink). These bands could be rejected with three bandstop filters in UWB but this approach will increase the complexity of the system. Therefore, it is necessary to design the UWB antenna with band notched characteristic to reduce the complexity of the system and make it cost effective.

To solve the above problems, make antenna with notched band characteristics, different methods have been proposed and presented to design UWB PMAs with band notched characteristics. These include different types of slots on the radiating patch or on the ground plane, use of split-ring resonators, tuning stubs, meandering, folded strips, resonated cells on CPW, EBG structure etching on patch/ground plane [3-15]. For example, etching of U slot [3-4], V- shaped slot [5], C-shaped slot [6], S- shaped slot [7], a quasi-complementary split ring resonator (CSRR) in fed line [8], a quarter- wavelength tuning stub in a large slot on the patch [9], or compact folded stepped impedance resonators (SIRs) or capacitively loaded loop (CCL) resonators in fed [10-11], a parasitic slit along with tuning stub used [12], C shaped slot on patch and L shaped stub on ground [13], semi-circular slot on patch [14], rectangular slots on patch [15].

In this paper, we propose a compact UWB planar microstrip antenna with single notched band for

3.3-3.6 GHz band (WLAN) using CSRR slot on patch. The complete antenna size is 30x30 mm^2.

II. ANTENNA DESIGN AND ANALYSIS

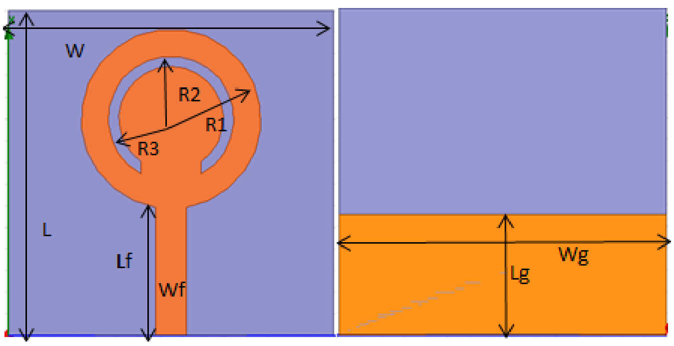
The geometry and configuration of the proposed antenna optimized with the Ansoft HFSS 13 is shown in Fig. 1(a). This antenna is printed on the FR-4 substrate with thickness of 1.6 mm, relative dielectric constant of ε_r = 4.4, and loss tangent of 0.02. The proposed antenna is with microstrip feed line width 2.8 mm to achieve 50-Ω characteristic impedance. Microstrip has a ground of length 11mm and width 30 mm shown in Fig.1 (b). CSRR (Circular split ring resonator) Slot has outer radius of 5.8 mm and inner radius of 4.9 mm. Proposed antenna has circular patch with radius 8.3 mm to achieve the UWB range without any notch. Optimized dimension of patch along with CSRR and ground has been shown in table I.

CSRR length have been calculated from $\lambda=(C/f_c\sqrt{(\varepsilon_{eff})})$ to create a notch band at frequency band from 3.3 to 3.6 GHz. Length of proposed circular split ring resonator have been calculated from equations 1 and 2.

$$Leq = 2\pi r - S \quad (1)$$

$$f_c=(C/2*Leq*\sqrt{(\varepsilon_{eff})}) \quad (2)$$

value of optimized S is 5.5 mm.



(a) (b)

Fig.1. (a) Top view of Proposed Antenna (b) Back view of Proposed Antenna

TableI

Optimized dimensions of proposed antenna

Variables	L	W	Lf	Wf	R1	R2	R3	Lg	Wg
Unit(mm)	30	30	11.8	2.8	8.3	5.8	4.9	11	30

To achieve the band notch characteristic through proposed antenna for WiMAX band, we first cut a CSRR slot on primary antenna which provides an UWB range. The return loss (S_{11} in dB) and VSWR due to the primary antenna with circular patch have been presented by Fig.2 and Fig. 3 respectively. From Fig. 2 and Fig. 3, we can see that without slot antenna provides an UWB characteristic. Now to achieve the notch at WiMAX frequency we have used CSRR slot cut on primary antenna, operating in UWB band without any notch. From Fig. 4 and Fig. 5 it can be seen that CSRR slot provides a single notch at frequency band 3.3 – 3.6 GHz. The return loss and VSWR of combined slot on radiating patch have been presented in Fig.4 and Fig.5 respectively.

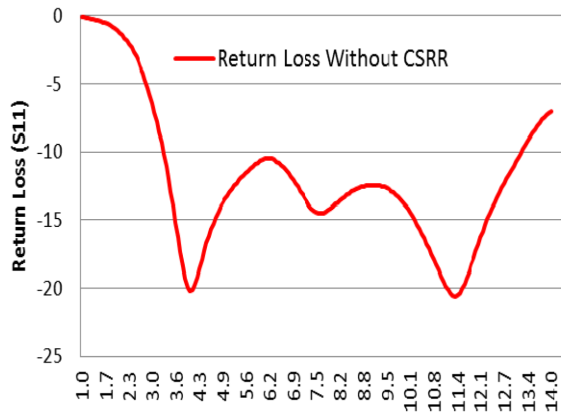


Fig. 2 Return loss Without CSRR slot

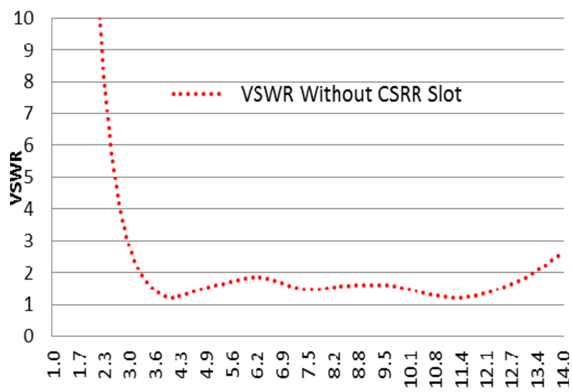


Fig.3 VSWR Without CSRR slot

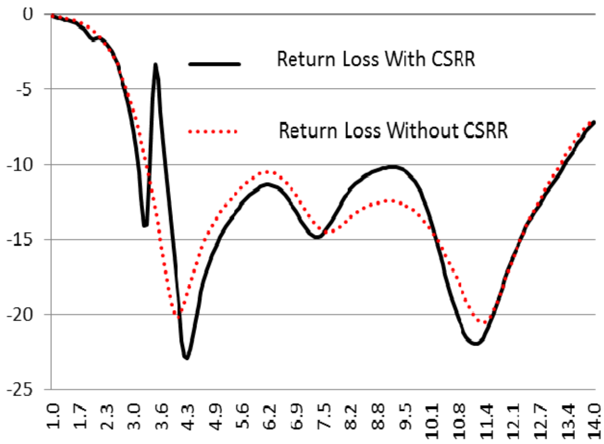


Fig. 4 S_{11} With and Without CSRR slot

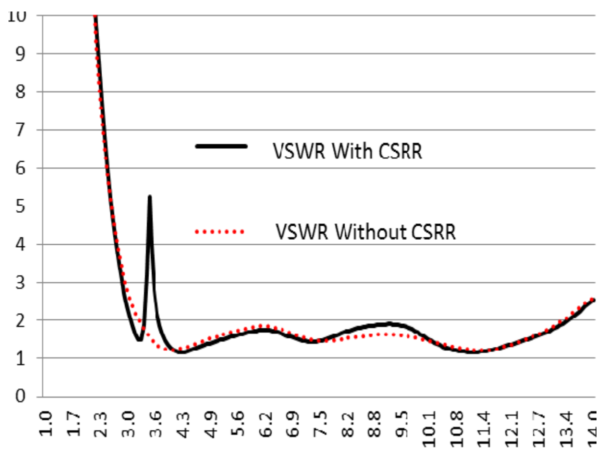
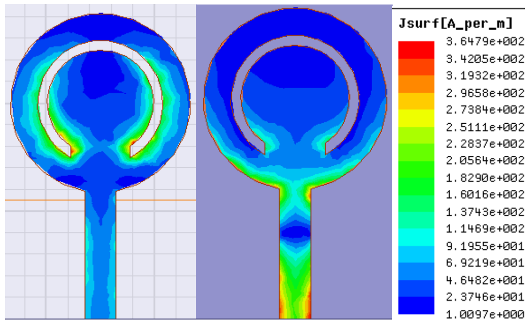


Fig.5 VSWR With and Without CSRR slot

From Fig.4 and 5, it can be seen that with the CSRR slot only one notch band have been developed for WiMAX band and all other band passed without any notch. CSRR Slot proposed width is 0.9 mm, which is λ / 4 of wavelength calculated at 3.5 GHz for WiMAX band.

In order to observe the effects of CSRR slot in getting the notched band, the surface current distributions on the radiating patch of the proposed antenna at two different frequencies have been shown in the Fig.6. At a passband frequency of 5.5 GHz i.e. outside the notched band, the distribution of the surface current is uniform as shown in Fig.6. (b). But in Fig. 6 (a), stronger current distributions have been concentrated near the edges of the CSRR slot at the center frequency of the first notched band 3.5 GHz. This clearly shows the positive effects of the slots upon obtaining the band notched characteristics.

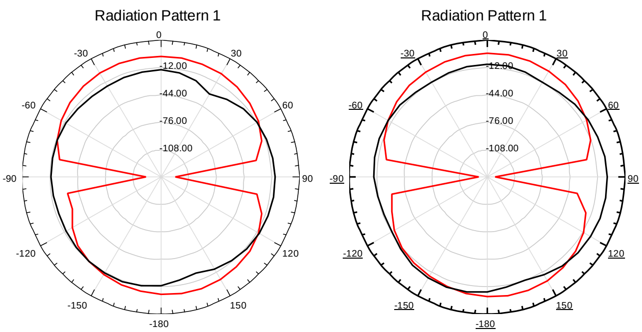


(a) (b)

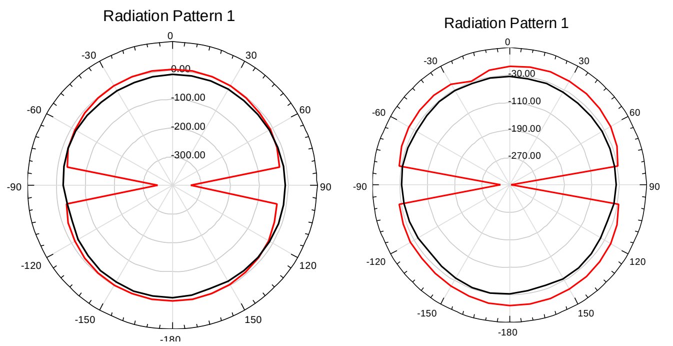
Fig. 6. Current density distribution over patch (a) 3.5 GHz, (b) 5.5 GHz.

III. RESULT AND DISCUSSION

Simulated result of proposed antenna has been shown in Fig.7 (a) & (b). The antenna with CSRR quarter wavelength slots successfully exhibits notched band of 3.3 - 3.6 GHz, maintaining broadband performance from 3.1 to 13 GHz (UWB frequency band) with VSWR less than 2. The simulated radiation patterns at 3.5, 4.5, 5.5 and 7.5 GHz have been shown in Fig.7. (a) - (d), respectively. At the passband frequencies out of the notched bands (4.5, 5.5, and 7.5 GHz), the antenna displays good omnidirectional radiation patterns in the H-plane and dipole like radiation patterns in E- plane as shown in Fig.7. (a) - (d). Meanwhile, at notched band frequency 3.5GHz the antenna displays distorted and unstable radiation patterns as shown in Fig.7 (a). The calculated peak gain and radiation efficiency of the proposed antenna is shown in Fig.8.



(a) (b)



(c) (d)

Fig.7. E- field and H- field (a) 3.5 GHz, (b) 4.5 GHz, (c) 5.5 GHz and (d) 7.5 GHz

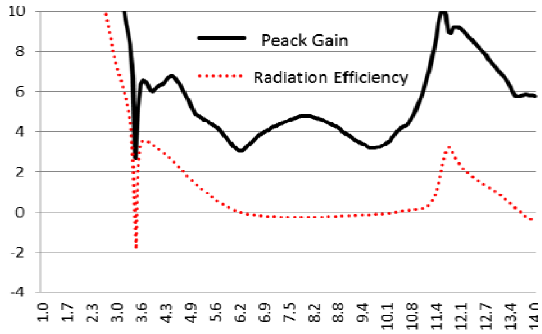


Fig. 8. Peak gain and Radiation efficiency Vs frequency graph of proposed antenna

IV. CONCLUSION

A compact dual band notched UWB antenna is presented in this letter. This antenna has simple structure and compact size of 30 x 30 mm ^{2} , which is easy to be integrated in miniature devices. Proposed antenna covers frequency band from 3.1 to 13 GHz to prevent interferences with WiMAX band. Results & analysis of this antenna indicates that it is applicable in miniature devices, simple design & compact size as added advantage. Surface current distributions were used to show the effect of these slots in getting the notched bands.

V. REFERENCES

[1] First report and order, Revision of part 15 of the commission's rule regarding ultra-wideband transmission system FCC 02-48, Federal Communications Commission, 2002.

[2] Z. N. Chen, "UWB antennas: From hype, promise to reality," in *IEEE Antennas Propag. Conf.*, 2007, pp. 19–22.

[3] W.-S. Lee, K.-J. Kim, D.-Z. Kim, and J.-W. Yu, "Compact frequency notched wideband planar monopole antenna with an L-shaped ground plane," *Microw. Opt. Technol. Lett.*, vol. 46, no. 4, pp. 340–343, 2005.

[4] F. Fan, Z. Yan, T. Zhang, and Y. Song, "Ultra-wideband planar monopole antenna with dual stopbands," *Microw. Opt. Technol. Lett.*, vol. 52, no. 1, pp. 138–141, 2010.

[5] Y. Kim and D.-H. Kwon, "CPW-fed planar ultrawideband antenna having a frequency band notch functions," *Electron. Lett.*, vol. 40, no.7, pp. 403–404, 2004.

[6] Q.-X. Chu and Y.-Y. Yang, "A compact ultrawideband antenna with 3.4/5.5 GHz dual band-notched characteristics," *IEEE Trans. Antennas Propag.*, vol. 56, no. 12, pp. 3637–3644, Dec. 2008.

[7] S.-W.Qu, J.-L. Li, and Q. Xue, "Aband-notched ultrawideband printed monopole antenna," *IEEE Antennas Wireless Propag. Lett.,* vol. 5, pp. 495–498, 2006.

[8] W. T. Li,X.W. Shi, and Y. Q. Hei, "Novel planar UWBmonopole antenna with triple band-notched characteristics," *IEEE Antennas Wireless Propag. Lett.*, vol. 8, pp. 1094–1098, 2009.

[9] K. S. Ryu and A. A. Kishk, "UWB antenna with single or dual band notches for lower WLAN band and upper WLAN band,"*IEEE Trans. Antennas and Propag.*, vol. 57, no. 12, pp. 3942–3950, Dec. 2009.

[10] Y. Sung, "UWB monopole antenna with two notched bands based on the folded stepped impedance resonator," *IEEE Antennas Wireless Propag. Lett.*, vol. 11, pp. 500–502, 2012.

[11] C.-C. Lin, P. Jin, and R. W. Ziolkowski, "Single, dual and tri-band-notched ultra-wideband (UWB) antennas using capacitively loaded loop (CLL) resonators," *IEEE Trans. Antennas Propag.*, vol. 60, no. 1, pp. 102–109, Jan. 2012.

[12] Rezaul A., M.T. Islam, and A.T. Mobashsher "Design of a Dual band notch UWB slot antenna by means of simple parasitic slits," *IEEE Antennas Wireless Propag. Lett.*, vol. 12, pp. 1412–1415, 2013.

[13] Peng Gao, L.X., J.Dai, S.He and Y.Zheng, "Compact Printed wide slot UWB antenna with 3.4/5.5 GHz dual band-notched characteristics," *IEEE Antennas Wireless Propag. Lett.*, vol. 12, pp. 983–986, 2013.

[14] D. T. Nguyen, D. H. Lee, and H. C. Park, "Design and analysis of printed triple band-notched UWB antenna," *IEEE Antennas Wireless Propag. Lett.*, vol. 10, pp. 403–406, 2011

[15] D. T. Nguyen, D. H. Lee, and H. C. Park, "Very compact printed triple band-notched UWB antenna with quarter-wavelength slots," *IEEE Antennas Wireless Propag. Lett.*, vol. 11, pp. 411–414, 2012.