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LOW PROFILE SLOT LOADED RECTANGULAR UNIPOLAR MICROSTRIP ANTENNA WITH THREE BAND-NOTCHED PROPERTY AND UWB OPERATION

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ABSTRACT: A low profile slot loaded rectangular unipolar microstrip antenna is proposed for three band-notched property to eliminate GPS and WLAN interference signals in UWB operation. The antenna has a simple structure consisting of a wide rectangular slot loaded on the centre axis of the radiating patch to obtain triple band notched property in the frequency range of 1.30 to 4.69, 4.76 to 7.15 and 10.09 to 10.33 GHz which cover Global Position System (GPS) and Wireless Local Area Network (WLAN) interference in UWB operation. The proposed antenna is simple in structure and use low cost substrate material. The antenna operates between 1 to 16 GHz and gives ominidirectional radiation characteristics with peak gain of 8.62 dB and maximum virtual size reduction of 57.66 %. The proposed antenna may find application in microwave communication systems.

Keywords: Microstrip Antenna, Monopole, Slot, Ominidirectional, Parasitic Strip.

I. INTRODUCTION

Recent advances in microwave communication systems, microstrip antennas are popular because of explosive growth of wireless communication system and booming demand for verity of new wireless application. There is a great need to design broadband antennas to cover a wide frequency range and to eliminate undesired frequency ranges. Therefore designers are focused to design UWB antennas with single, dual and triple band notched property with compact size, simple in design, low cost, thin profile, light weight, planar configuration and easy fabrication. The microstrip antenna is the better choice for these requirements. Number of investigations have been reported in the literature for band-rejected antenna with the operation such as use of parasitic strip for UWB [3], microstrip-fed monopole antenna with a shorted parasitic element for wideband covering Bluetooth/ISM, 2.5 GHz WiMAX, 3.5 GHz WiMAX, 5.2/5.8 GHz WALAN [4], a triple-band CPW-fed microstrip antenna for WLAN and WiMAX [5], a triple-band CPW-fed monopole antenna for WLAN and WiMAX [6], design and development of notch band operation [7-12] etc. But the design and development of low profile wide slot loaded unipolar microstrip antenna for triple band-notched property, virtual size reduction and UWB operation together is rarely found in the literature. Further most of the antennas presented in the literature are either complex in their structure or bigger in size and hence require carful manufacturing procedure than that of the regular microstrip antenna for practical applications.

II. DESIGN OF ANTENNA GEOMETRY

The art work of the proposed antenna is sketched by using computer software Auto-CAD to achieve better accuracy and is fabricated on low cost FR4-epoxy substrate material of thickness of h = 0.16 cm and permittivity $\varepsilon_r = 4.4$.

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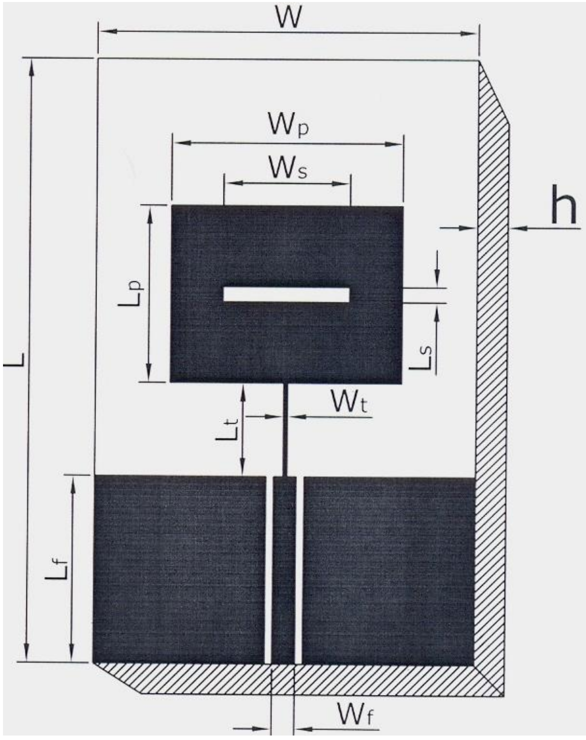

Fig. 1 Top view geometry of SURMSA

Figure 1 shows the top view geometry of low profile slot loaded rectangular unipolar microstrip antenna (SURMSA). In Fig.1 the area of the substrate is L × W cm. On the top surface of the substrate a ground plane of height which is equal to the length of microstripline feed L_f is used on either sides of the microstripline with a gap of 0.1 cm. On the bottom of the substrate a continuous ground copper layer of height L_f is used below the microstripline. The SURMSA is designed for 3 GHz of frequency using the equations available for the design of conventional rectangular microstrip antenna in the literature [2]. The length and width of the rectangular patch are L_p and W_p respectively. The feed arrangement consists of quarter wave transformer of length L_t and width W_t which is connected as a matching network between the patch and the microstripline feed of length L_f and width W_f. A semi miniature-A (SMA) connector is used at the tip of the microstripline feed for feeding the microwave power. In Fig.1 a wide rectangular slot is loaded at the centre axis of the radiating patch. The length and width of slot is L_s and W_s respectively. The design parameters of the proposed antenna is shown in Table 1

Table I Design parameters of proposed antenna

Antenna parameter	L	W	L_p	W_p	L_f	W_f	L_t	W_t	L_s	W_s
Dimensions in cm	8.0	5.0	2.34	3.04	2.48	0.3	1.24	0.05	0.2	1.666

III. EXPERIMENTAL RESULTS AND DISSCUSION

The antenna bandwidth over return loss less than -10 dB is tested experimentally on Vector Network Analyzer (Rohde & Schwarz, Germany make ZVK model 1127.8651). The variation of return loss verses frequency of SURMSA is as shown in Fig. 2. From this graph the experimental bandwidth (BW) is calculated using the equations,

$$\mathrm{BW} = \left[\frac{f_2 - f_1}{f_c}\right] \times 100\ \% \qquad (1)$$

were, f_1 and f_2 are the lower and upper cut of frequencies of the band respectively when its return loss reaches – 10 dB and f_c is the centre frequency of the operating band. From this figure, it is found that, the antenna operates between 1 to

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16 GHz and gives four resonant modes at f_1 to f_4, i.e. at 1.27, 4.74, 7.56 and 14 GHz respectively and three notch-bands from 1.30 - 4.69, 4.76 – 7.15 and 10.09 – 10.33 GHz. The magnitude of experimental -10 dB bandwidth measured for BW_1 to BW_4 by using the equation (1) is found to be 130 MHz (10.52 %), 70 MHz (1.48 %), 2.94 GHz (34.10 %) and 5.67 GHz (31.50 %) respectively. Further from Fig.2 it is clear that, the antenna is capable of rejecting GPS (1.30 - 4.69), WLAN (4.76 – 7.15) and 10.09 – 10.33 GHz frequency range between BW_1 to BW_2, BW_2 to $BW_3$and BW_3 to BW_4 respectively. Hence the geometry of Fig.1 is capable of rejecting the undesired frequency bands in its operating frequency range.

The resonant mode at 1.27 GHz is due to the fundamental resonant frequency of the patch and others modes are due to the novel geometry of SURMSA. The multi mode response obtained is due to different surface currents on the patch. The fundamental resonant frequency mode shifts from 3 GHz designed frequency to 1.27 GHz due to the coupling effect of microstripline feed and top ground plane of SURMSA. This shift of fundamental frequency gives a virtual size reduction of 57.66 % when compared to the designed frequency of 3 GHz.

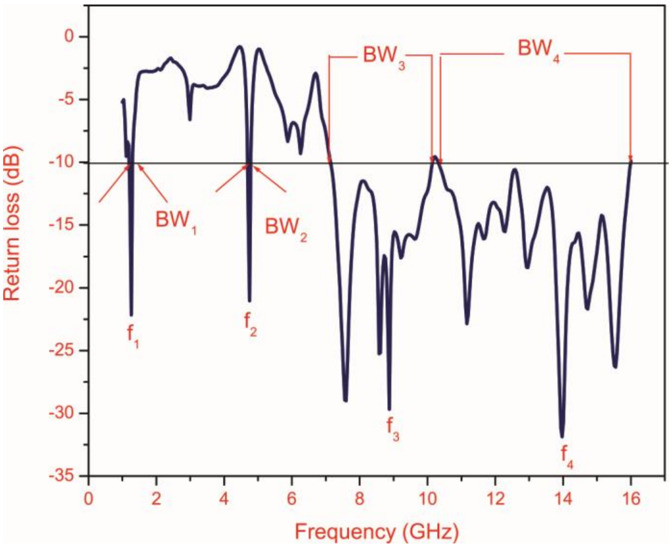

Fig. 2 Variation of return loss versus frequency of SURMSA

The gain of the proposed antennas is measured by absolute gain method. The power transmitted ‘P_t’ by pyramidal horn antenna and power received ‘P_r’ by antenna under test (AUT) are measured independently. With the help of these experimental data, the gain (G) dB of AUT is calculated by using the formula,

$$(G)\ dB = 10\log\left(\frac{P_r}{P_t}\right) - (G_t)\ dB - 20\log\left(\frac{\lambda_0}{4\pi R}\right) dB \qquad (2)$$

where, G_t is the gain of the pyramidal horn antenna and R is the distance between the transmitting antenna and the AUT. Using equation (2), the peak gain of the SURMSA measured in their operating bands is found to be 8.62 dB.

The co-polar and cross-polar radiation pattern of SURMSA is measured at 8.87 GHz and is as shown in Fig 3. The obtained pattern is ominidirectional in nature.

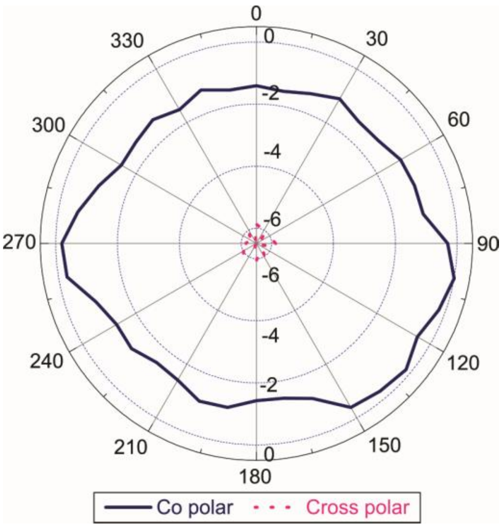

Fig. 3 Radiation pattern of SURMSA measured at 8.87 GHz

IV.CONCLUSION

From the detailed experimental study, it is concluded that, the SURMSA with microstripline feed gives triple band notched property in the frequency range of 1.30 to 4.69, 4.76 to 7.15 and 10.09 to 10.33 GHz which cover GPS and WLAN interference in UWB operation. The proposed antenna is simple in its structure and use low cost substrate material FR4. The antenna operates between 1 to 16 GHz and gives ominidirectional radiation characteristics with peak gain of 8.62 dB. The antenna also gives virtual size reduction of 57.66 %. The proposed antenna may find application in microwave communication systems.

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REFERENCES

[1] Constantine A. Balanis, Antenna theory analysis and design, John Wiley, New York, 1997.
[2] I. J. Bahl and P. Bharatia, Microstrip antennas, Dedham, MA: Artech House, New Delhi, 1981.
[3] Ki -hak kim and seong-ook park, "analysis of the small band-rejected antenna with the parasitic strip for UWB", IEEE Trans Antennas and Propagat, vol. 54, no. 6, pp.1688-1692. 2006.
[4] C.-F. Tseng, C.-L. Huang, C.-H. Hsu, "microstrip-fed monopole antenna with a shorted parasitic element for wideband application", Progress In Electromagnetics Research Letters, vol. 7115–125.,2009.
[5] Vijeta, Davinder Parkash, "a triple-band CPW-fed microstrip antenna for WLAN and WiMAX applications", BPR Technologia AJournal of Science, Technology & Mangement, vol. 1, no.1, pp.77-85, 2012.
[6] Y.-Y. Cui, Y.-Q. Sun, H.-C. Yang, C.-L.Ruan, **"**A new triple-band CPW-fed monopole antenna for WLAN AND WiMAX applications*"*,Progress In Electromagnetics Research M, vol. 2, pp. 141–151, 2008.
[7] Xin Zhang, Wei Wu, Ze-Hong Yan, Jun-Bo Jiang and Yue Song, "Design of CPW-fed monopole UWB antenna with a novel notched ground" Microwave and Optical Technology Letters, vol. 51, no. 1, pp.88-91 January 2009.
[8] Li-Xian Li, Shun-shi Zhong and Min-Hua Chen, "Compact band-notched ultra-wideband antenna using defected ground structure" Microwave and Optical Technology Letters, vol. 52, no. 2pp.286-289, February 2010.
[9] Yadong Yan,Xilang Zhou, Linsheng Wu and Wenyan Yin, "A novel microstip-fed dual band- notched wideband antenna with defected ground structure" Microwave and Optical Technology Letters,vol. 53, no. 4, pp.704-706 April 2011.
[10] M. Veereshappa, S. N. Mulgi and S. K. Satnoor, "A novel design and development of simple monopole antenna for UWB operation" Microwave and Optical Technology Letters, vol. 54, no. 4, pp.953-955, April 2012.
[11] M. Naser-Moghadasi, L. Asadpor and B. S. Virdee, " Compaect Ultra-Wideband slot antenna with band-notch property" Microwave and Optical Technology Letters, vol. 54, no. 8, pp.1829-1832, August 2012.
[12] Huiqing Zhai, Jinxia, Ou, Tong Li, Guihong Li Long Li and Changhong Liang, "A compact ultra-wideband antenna with two band notches" Microwave and Optical Technology Letters, vol. 55, no. 3, pp.583-586, March 2013.

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