DESIGN AND DEVELOPMENT OF U-SLOT OPEN STUBS PARTIAL GROUND PLANE RECTANGULAR MICROSTRIP ANTENNA FOR WIRELESS COMMUNICATION APPLICATIONS

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Abstract

This paper presents the design and development of U-slot, open stubs microstripline feed partial ground plane rectangular microstrip antenna for broadband wireless communication applications. By inserting U-slot of dimension 0.625 cm the antenna gives a bandwidth of 92.6% with a virtual size reduction of 38.88% with gain of 4.19 dB. However this 92.6% of bandwidth can be enhanced to 138% again by placing two stubs simultaneously on left and right side of microstripline without effecting the gain and virtual size reduction. The antennas are designed on low cost modify epoxy substrate material of dielectric constant ε_r = 4.2 and h = 0.16 cm at 3 GHz. The antennas are use full for WiMAX, LAN, Bluetooth and IEEE 802.11a application.

Keywords— *U-slot, Open stubs, Partial ground plane*

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1. INTRODUCTION

The recent wireless communication technology requires an antenna with a compact radiating structure, enhanced bandwidth and capable of adequate gain. To fulfill this many techniques are reported in the literature [1-5]. Some are like introducing slots on radiating patch and ground plane, use of tuning stubs, parasitic patches, single line feed arrangements [6-11] etc. The radiating patch antenna with a single line feed and a partial ground plane is becoming more popular in these applications. Recently the design of broadband antennas has become a challenging task. In view of this a design and development of U-slot implanted on the radiating patch and open stubs placed simultaneously on left and right side of the single microstripline feed on the same patch with partial ground plane for satisfying the bandwidth requirements for wideband communication is presented. The novel geometries of the proposed antennas are very simple and compact can be easily fabricated and mounted with any other device, cost effective and gives large gain compared to the conventional antenna defined for the same resonant frequency.

2. ANTENNA GEOMETRY AND DESIGN

The proposed antennas are designed on modified glass epoxy substrate material with a dielectric constant 4.2 and height of substrate is 0.16 cm at 3 GHz. The rectangular shape is selected as patch geometry due to its simplicity in design and fabrication. A single microstripline feeding technique and partial ground plane is used for exciting the antennas. A U-slot of length L_u =1cm and width W_u=0.25cm is placed on the patch. The geometry of U-slot rectangular microstrip antenna (USRMSA) with parameters is as shown in Fig. 1. In Fig. 1 L and W are the length and width of the rectangular patch and L_f and W_f are the length and width of the microstripline feed, L_s and W_s are the length and width of the substrate and L_g is the height of the partial ground plane.

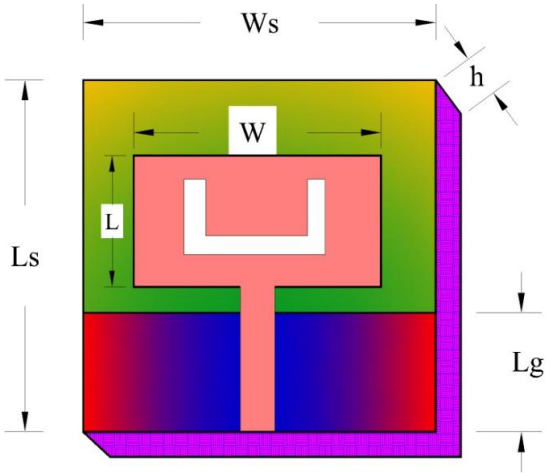


Fig. 1 Geometry of USRMSA

For better performance working on USRMSA after number of iterations two open stubs S1 and S2 with identical dimensions of length L_1=0.4cm and width W_1=0.55cm are placed on left and right side of the microstripline feed. The geometry of U-slot with open stub rectangular microstrip antenna (USWSRMSA) is as shown in Fig. 2 (a) and (b). Figure 2(a) shows the top view and Fig. 2(b) shows the side view geometry of USWSRMSA. The ground plane of this antenna is same as that of Fig. 1.

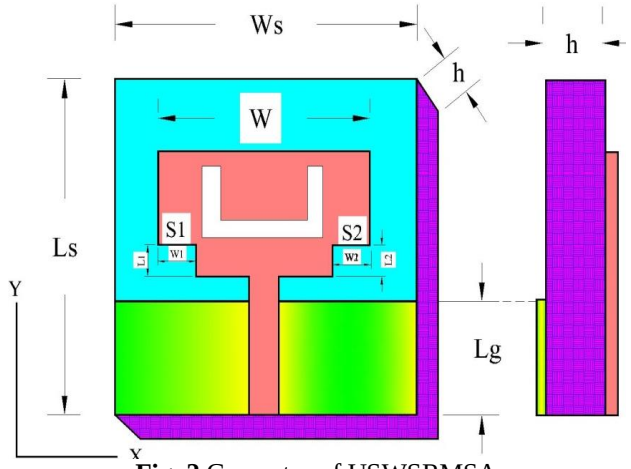


Fig. 2 Geometry of USWSRMSA

3. RESULTS AND DISCUSSIONS

The simulations of proposed antennas are performed using HFSS simulating software. The return loss characteristic of USRMSA is as shown in Fig. 3. It is seen that, the antenna operates for single band of bandwidth BW 92.6% ranging from 1.38 – 3.76 GHz with two resonant frequencies at 1.76 and the second at 3.07 GHz with virtual size reduction of 38.88% compared to the designed frequency of 3 GHz. The operating range of this antenna covers PCS (1.85 – 1.99 GHz), WCDMA (1.92 – 2.17), LTE 2300 (2300 – 2400 MHz), WLAN (2.4 – 2.48 GHZ), GPS (1 – 3 GHz) bands for wireless communication applications.

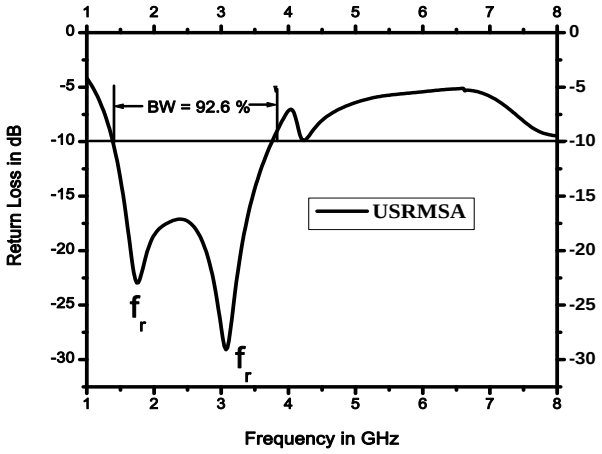


Fig. 3 Variation of return loss versus frequency curve of USRMSA

Fig. 4 shows the return loss characteristics of USWSRMSA. When two open stubs of same dimensions placed on left and right side of the microstripline feed it is seen that the antenna resonates from 1.45 – 8.02 GHz and gives a bandwidth of 138% which is 45% more than the bandwidth of USRMSA with four resonant modes at 1.78, 3.83, 4.62 and .178 GHz with a virtual size reduction of 38.19%. The gain of the antenna measured with operating band. The peak gain of this antenna is found to be 4.19 dB which is quite large compared to the conventional rectangular microstrip antenna designed for the same resonant frequency of 3 GHz which is nearly equal to 1 dB [12]. The operating band of USWSRMSA covers almost all present microwave frequencies used for various wireless communication applications.

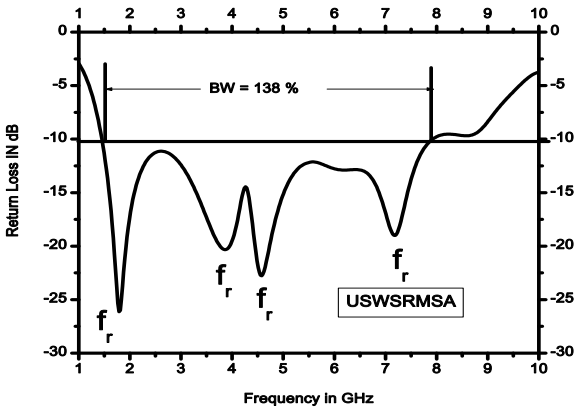
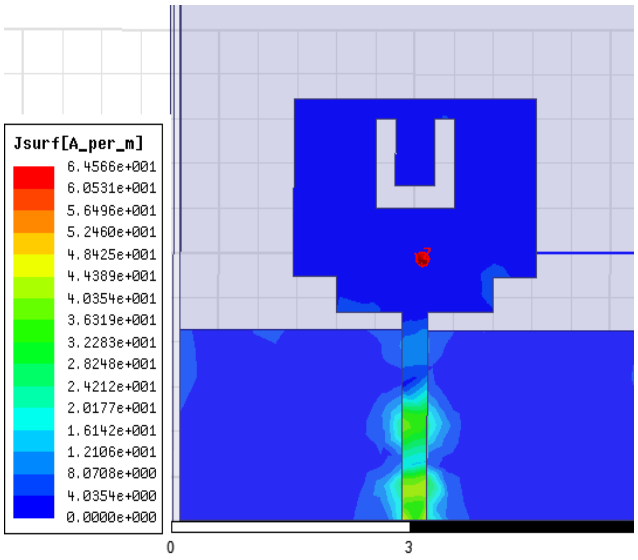
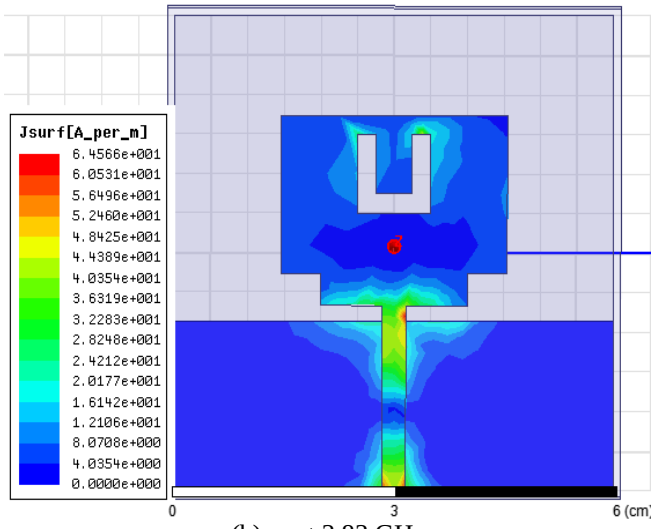


Fig. 4 Variation of return loss versus frequency of USWSRMSA

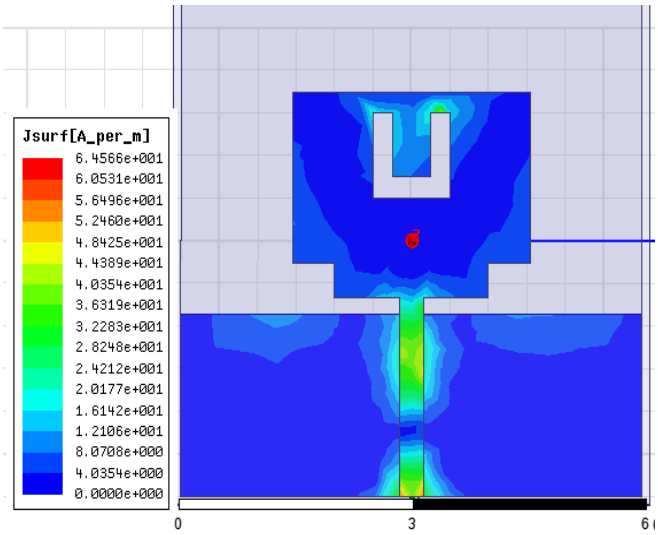
The surface current distributions on patch and ground plane of USWSRMSA measured at resonance frequencies are shown in Fig. 5 (a) to (d) where the currents are mainly concentrated around the U-slot, open stubs and on corners of the ground plane, makes the antenna resonates for wide frequency range.



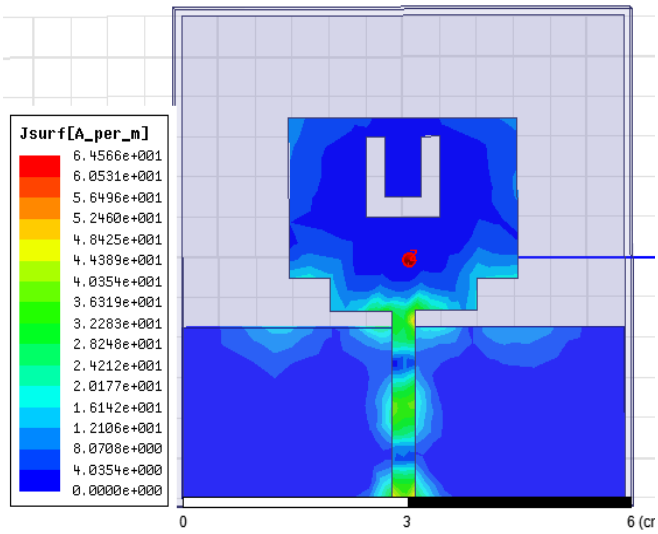
(a) at 1.78 GHz



(b) at 3.83 GHz



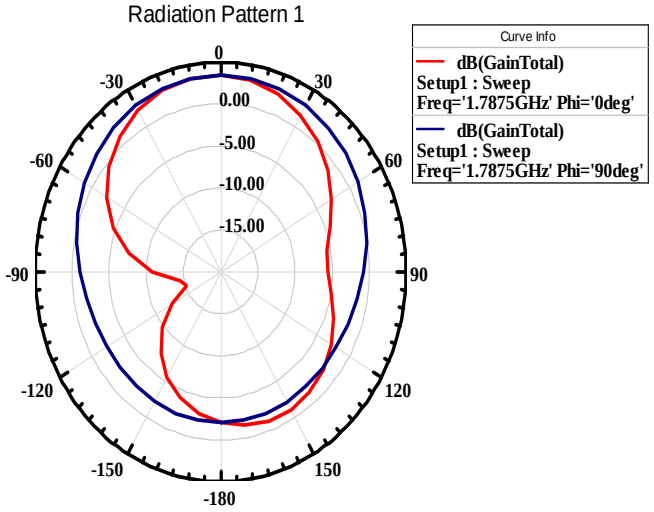
(c) at 4.62 GHz



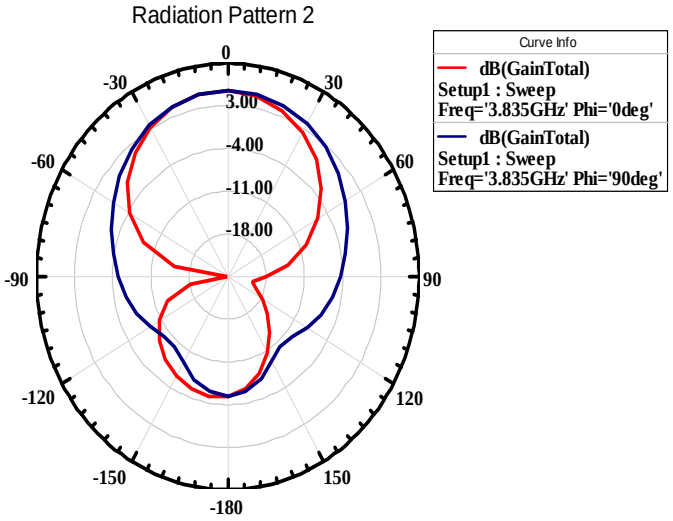
(d) at 7.18 GHz

Fig. 5 Surface current distribution of USWSRMSA measured at resonant frequencies 1.78, 3.83, 4.62 and 7.18 GHz

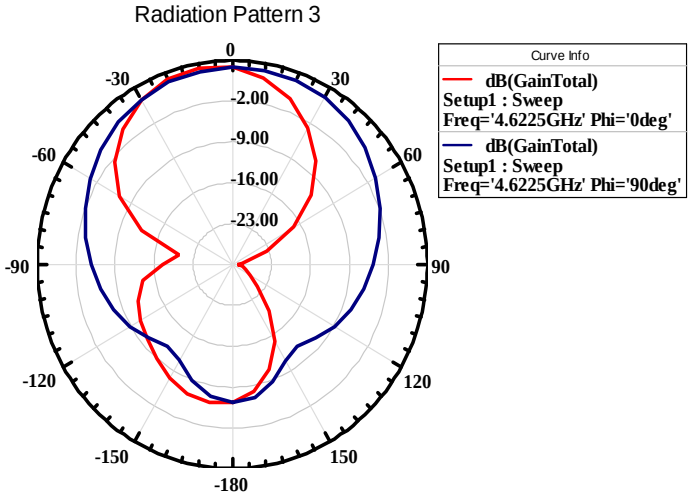
The radiation patterns of USWSRMSA measured at resonant frequencies of 1.78, 3.83, 4.62 and 7.18 GHz are shown in Fig. 6 (a) to (d) respectively. It is clear that, the antenna shows nearly omnidirectional radiation pattern.



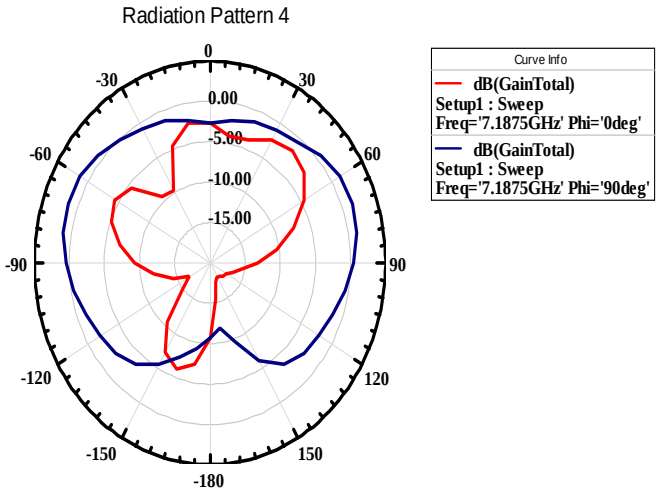
(a) at 1.78 GHz



(b) at 3.83 GHz



(c) at 4.62 GHz



(d) at 7.18 GHz

Fig.6 Typical radiation pattern of USWSRMSA

4. CONCLUSION

In this work it is found that, a simple U-slot single microstripline feed and partial ground plane rectangular microstrip antenna gives bandwidth of 92.6% with a virtual size reduction of 38.88% and the gain is 4.19dB. However, the 138 % of bandwidth is obtained which is enhanced from 92.6% by placing two open stubs of same dimensions on left and right side of the microstripline of USRMSA without effecting much the gain and virtual size reduction. The proposed antennas are simple in its geometry, cost effective and quite useful for many microwave communication applications.

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