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Compact Novel Design of Slit Loaded Microstrip Antenna for WLAN and Wi-MAX Applications

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ABSTRACT: In this paper a compact novel design of slit loaded rectangular microstrip antenna (SRMSA) is presented. This antenna resonates from 2.28 GHz to 9.16 GHz of frequencies and exhibits multiband operation. A centre fed 50Ω microstripline feed arrangement is used to excite antenna. The antenna shows the virtual size reduction of 28.75% with linearly polarized broader radiation characteristics. The design details of the proposed antenna are given. This antenna may be useful for WLAN and Wi-MAX applications.

KEYWORDS: Microstrip antenna, WLAN, Wi-MAX.

I. INTRODUCTION

The rapid development of the wireless communication systems is currently observed in the microwave band. Since for past few decades, the microstrip antennas (MSA) have gained popularity because of their inherent features like light weight, low cost, simple design and capacity to resonate at more than one frequency bands [1], which can avoid the use of multiple antennas for different wireless applications.

Several methods and techniques have been reported in the literature. The miniaturization of antenna and multiple frequency bands can be achieved by cutting slots of different geometries like rectangular, triangular, H-shape, U-shape etc. on radiating patch [2-5]. An antenna designed with some slots on the ground plane and T slot on the radiating patch is designed for multi frequency operation [6]. Moreover, in the modern communication era, it would be a difficult task to design the single antenna capable of performing transmission and reception operations. In this paper, a simple technique has been proposed for multiple frequency operation and virtual size reduction by loading the rectangular patch antenna with slits. This kind of technique is found to be rare in the literature.

II. ANTENNA DESIGN CONSIDERATION

The proposed antenna has been realized from conventional rectangular microstrip antenna (CRMSA) designed for the frequency of 3.2 GHz. The geometry of CRMSA is as shown in Fig (1). The radiating patch with size W x L is etched on glass epoxy substrate material of dielectric constant ε_r = 4.2 and tan δ = 0.02, having dimension of X x Y with thickness h = 0.16 cm. A simple 50Ω microstripline feed structure of length L_f and width W_f is used to excite the antenna at the center of the rectangular radiating patch. The quarter wavelength matching transformer of length L_t and width W_t is used to match the impedance of microstripline feed and radiating patch.

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The configuration of SRMSA is shown in Fig. (2). All the slits S1 to S4 are of same length L_s and width W_s. The slits S1 and S3 are inserted vertically from the bottom side of the radiating edge of the patch, while the slits S2 and S4 are inserted vertically from the top side of the radiating edge of the patch. All the slits are extended such that they are perpendicularly crossing the center axis of the patch by a distance of 0.18cm. The distance D between adjacent slits S1, S2 and S3, S4 is 0.4cm. The distance of S2 and S3 from the center axis is d_C = 0.4cm. The distance between the slit and edge of the patch is taken as d1 = 0.255cm and d2 = 0.255cm. Simulated models of CRMSA and SRMSA are shown in Fig. 3 – (i) and (ii).

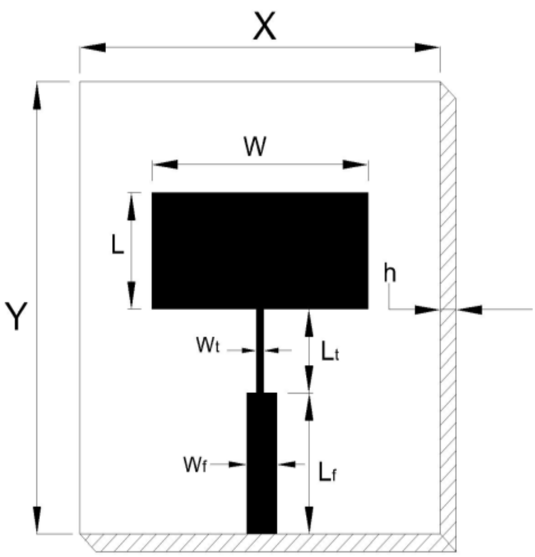

Fig. (1) Top view geometry of CRMSA

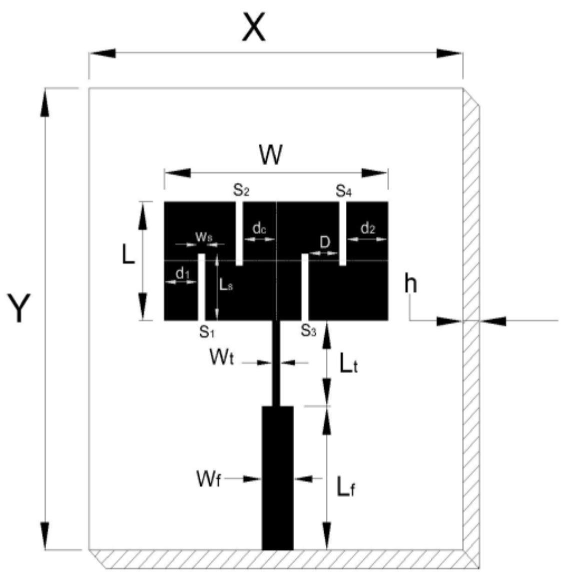

Fig.(2) Top view geometry of SRMSA

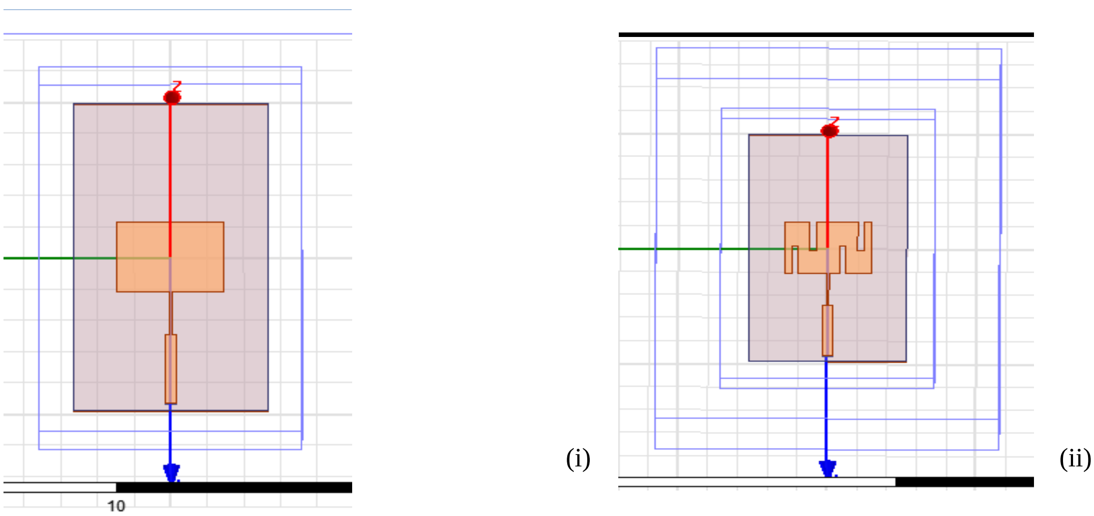

Fig. (3) Simulated antenna models of i) CRMSA and ii) SRMSA.

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The designed parameters of CRMSA and SRMSA are shown in Table - 1 and Table - 2 respectively.

Table - 1.

Antenna parameters	Dimensions in cm
X	5.3
Y	9.82
W	2.91
L	2.24
W_f	0.317
L_f	2.183
W_t	0.078
L_t	1.372
h	0.16

Table - 2.

Antenna parameters	Dimensions in cm
W_S	0.2
L_S	1.3
D	0.4
d1	0.255
d2	0.255
d_C	0.4

III. SIMULATION RESULTS AND DISCUSSION

The software Ansoft HFSS Electromagnetic (EM) 3-D tool is used to model and simulate the conventional and slit loaded microstrip antenna structure. It is also used for plotting and calculating characteristic parameters of an antenna like return loss, resonant frequency, radiation pattern, bandwidth etc.

The simulated results are summarized in Table – 3.

Table - 3.

Antenna	Resonant frequency in GHz	Return Loss in dB	Band Width %
CRMSA	3.115	-27.38	2.56
SRMSA	f_1 = 2.28	-12.30	1.84
	f_2 = 3.02	-15.34	3.97
	f_3 = 5.36	-17.48	17.35
	f_4 = 6.94	-19.35	6.05
	f_5 = 7.52	-10.83	1.46
	f_6 = 9.16	-15.67	0.65

The return loss versus frequency of CRMSA is shown in Fig. 4. It is seen from this figure that, the resonant frequency for CRMSA is 3.115 GHz which is nearer to designed frequency 3.2 GHz and the impedance bandwidth over return loss less than -10 dB is found to be 2.56%.

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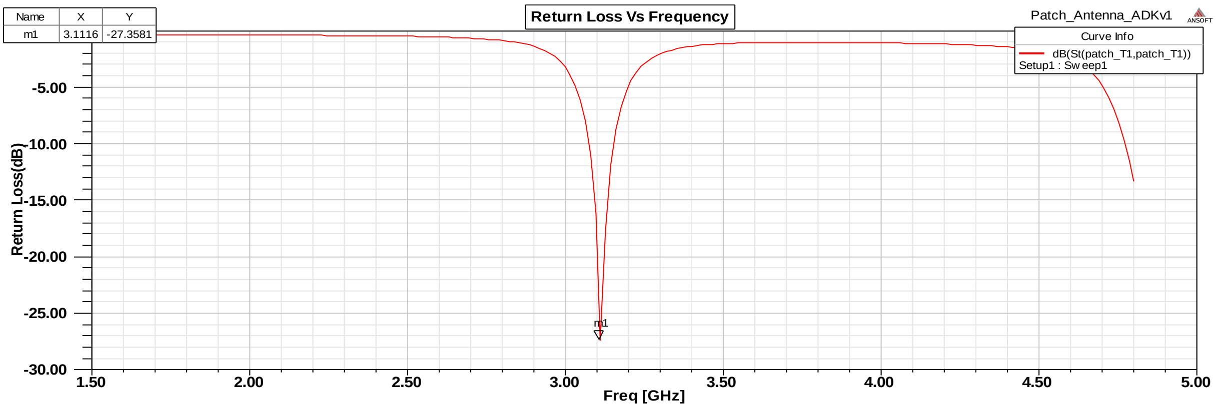

Fig. 4 Variation of return loss versus frequency of CRMSA

From the Fig. 5, it is clear that, the slits loaded antenna resonates for six bands of frequencies from 2.28 GHz to 9.16 GHz, i.e. f_1= 2.28 GHz, f_2 = 3.02 GHz, f_3 = 5.36 GHz, f_4 = 6.94 GHz, f_5 = 7.52 GHz and f_6 = 9.16 GHz with their respective bandwidths, BW1 = 1.84%, BW2 = 3.97%, BW3 = 17.35%, BW4 = 6.05%, BW5 = 1.46% and BW6 = 0.65%. The first resonant frequency f_1 = 2.28 GHZ is observed to be shifted towards the lower frequency side from the designed frequency of 3.2GHz that gives the virtual size reduction of 28.75% with a maximum bandwidth of 17.35% which is nearly 6.7 times more when compared to the bandwidth of CRMSA.

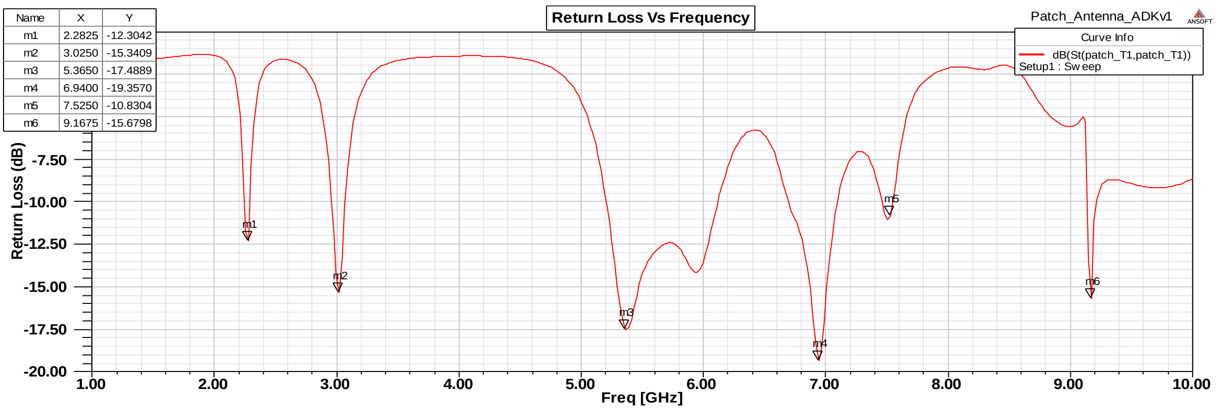

Fig. 5 Variation of return loss versus frequency of SRMSA.

The radiation patterns of CRMSA and SRMSA measured at four resonating frequencies are shown in fig 6(i) – (v). The radiation pattern measured at 3.02 GHz is same as the CRMSA designed for 3.2 GHz which is observed to be broadside in nature and linearly polarized. The radiation pattern of proposed antenna measured at 5.36 GHz shows small tilt towards left side of the 0^0 whereas the same antenna shows the tilt towards right side of the 0^0 at 6.94 GHz. Further the SRMSA shows symmetric co-polar pattern about the 0^0 at 7.52 GHz.

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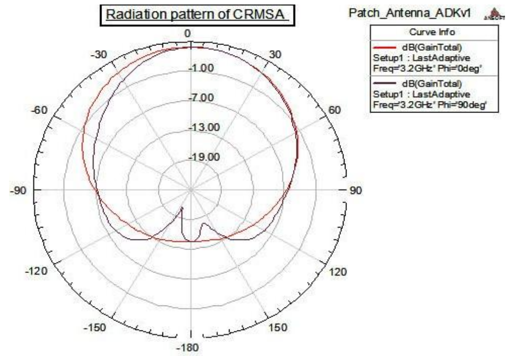
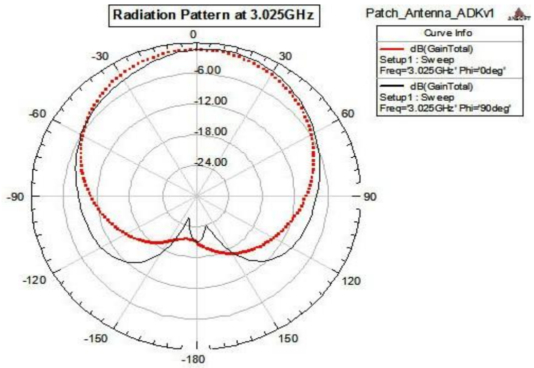
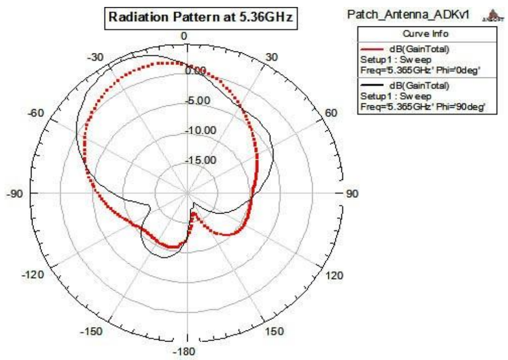


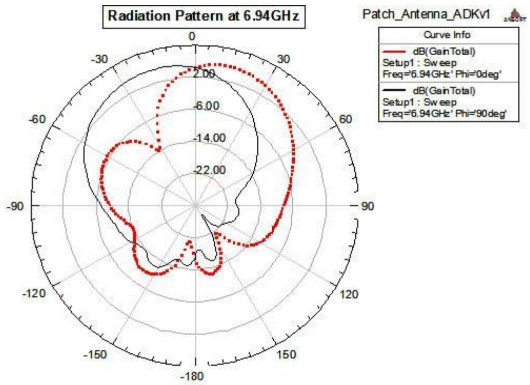
(i)



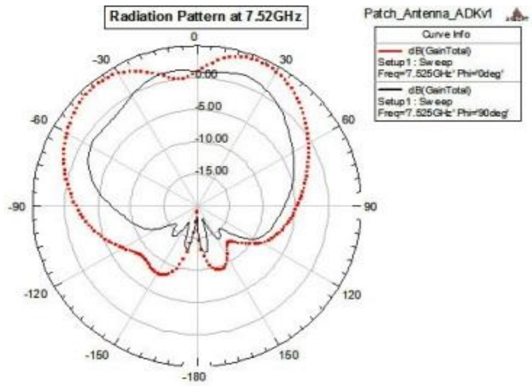
(ii)



(iii)



(iv)



(v)

Fig. 6) Simulated radiation patterns of CRMSA at i) 3.2 GHz and SRMSA measured at ii) 3.025 GHz, iii) 5.365 GHz, iv) 6.94GHz v) 7.525 GHz respectively.

VI. CONCLUSION

The designed antennas CRMSA and SRMSA are simulated using Ansoft HFSS Electromagnetic (EM) 3-D tool software. The introduction of slits makes the SRMSA to show multiband operation with a virtual size reduction of

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about 28.75% with better broadside radiation characteristics. The design method is simple and this antenna may be useful for WLAN and Wi-MAX applications.

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