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Vertical Slot Loaded Rectangular Monopole Microstrip Antenna for Triple Band Operation

Srinivas Ramacharya[1], Nagraj Kulkarni[2], P.V. Hunagund[3]
[1]Research Scholar Department of PG Studies and Research in Applied Electronics, Gulbarga University, Gulbarga-585106, Karnataka, India
[2]Assistant Professor of Electronics, Govt. College(Autonomous) Kalaburagi.
[3]Professor Department of PG Studies and Research in Applied Electronics, Gulbarga University, Gulbarga-585106, Karnataka, India

Abstract: This paper presents the design and development of simple vertical slot loaded rectangular monopole microstrip antenna for triple band operation. The proposed antenna is excited through microstripline feed arrangement. The low cost glass epoxy substrate material is used to fabricate the antenna. The antenna operates between 2.77 to 8.29 GHz. giving linearly polarized broadside radiation characteristics with a peak gain of 3.8dB. The proposed antenna may find applications in WLAN.
Keywords: slot, microstrip antenna, triple band, gain.

I. INTRODUCTION

In recent years the microstrip antennas are becoming increasingly popular because of their small size, lightweight, low cost, easy to fabricate and compatible to microwave integrated circuits [1-2]. However, the modern communication systems such as wireless local area networks (WLAN) often require antennas possessing two or more discrete frequency bands, which can avoid the use of multiple antennas. The single, dual and triple band microstrip antennas are designed by cutting slots of different geometries like bow-tie, rectangular, square ring, annular ring etc. on the radiating patch [3-12].In this paper a vertical slot loaded rectangular monopole microstrip antenna is presented for triple band operation giving better radiation characteristics. This kind of study is found to be rare in the literature.

II. DESIGNING OF ANTENNA

The conventional rectangular microstrip antenna (CRMSA) is fabricated on low cost glass epoxy substrate material of thickness h = 1.6 mm, loss tangent 0.02 and dielectric constant ε_r = 4.2. The artwork of is developed using computer software AUTO CAD to achieve better accuracy. The antennas are etched by photolithography process. The bottom surface of the substrate consists of a tight ground plane copper shielding.

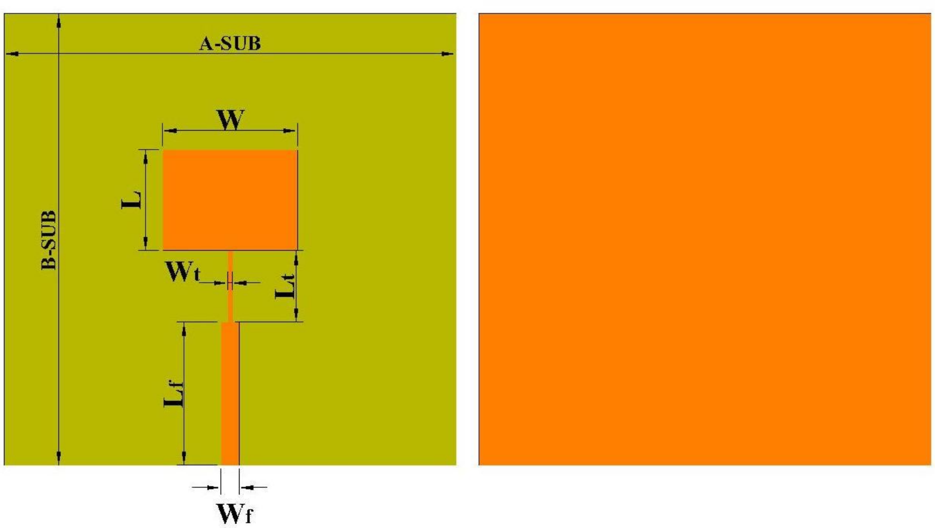

Fig. 1 Geometry of CRMSA

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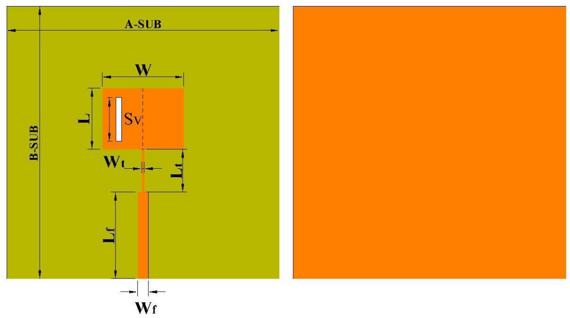
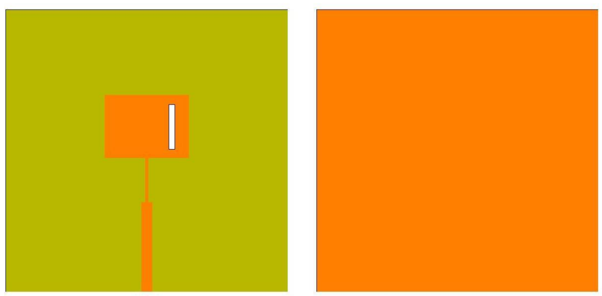
Figure 1 shows the geometry of CRMSA This antenna is designed for the resonant frequency of 3.0 GHz using the equations available in the literature for the design of rectangular microstrip antenna on the substrate area A-SUBSTRATE x B-SUBSTRATE [13]. This antenna consists of a radiating patch of length L and width W. A quarter wave transformer of length L_t and width W_t is incorporated to match the impedances between Patch and microstripline feed of length L_f and width W_f. A 50 Ω semi miniature-A (SMA) connector is used at the tip of the microstripline to feed the microwave power.

Figure 2 shows the geometry of vertical slot loaded rectangular monopole microstrip antenna (VSRMMSA) which has all the dimensions same as present in CRMSA.

A vertical slot of width 2 mm and length S_V= 1.8 cm is placed on the patch to achieve triple band operation. The designed parameters are tabulated in Table No 1.



(a)



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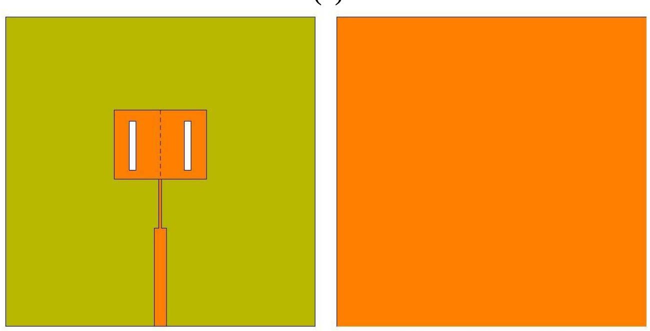

(c)

Fig. 2 Geometry of VSRMMSA

Table No 1

Antennas	Parameters(cm)								
	A-SUB	B-SUB	W	L	L_f	W_f	L_t	W_t	h
CRMSA	8	8	3.1	2.4	1.26	0.32	1.26	0.054	0.16
VSRMMSA	8	8	3.1	2.4	1.26	0.32	1.26	0.054	0.16

Figure 3 shows the variation of return loss versus frequency of CRMSA. It is clear from this figure that, the antenna resonates at 2.8 GHz which is very close to the designed frequency of 3 GHz. The CRMSA exhibits the band width of 2.15% which is determined by the relation

$$BW = \frac{FH - FL}{FC} \times 100\%$$

Where F_H and F_L are the higher and lower cut off frequencies of return loss curve when it is below -10dB value. The proposed antennas are simulated by HFSS 15.0 version software

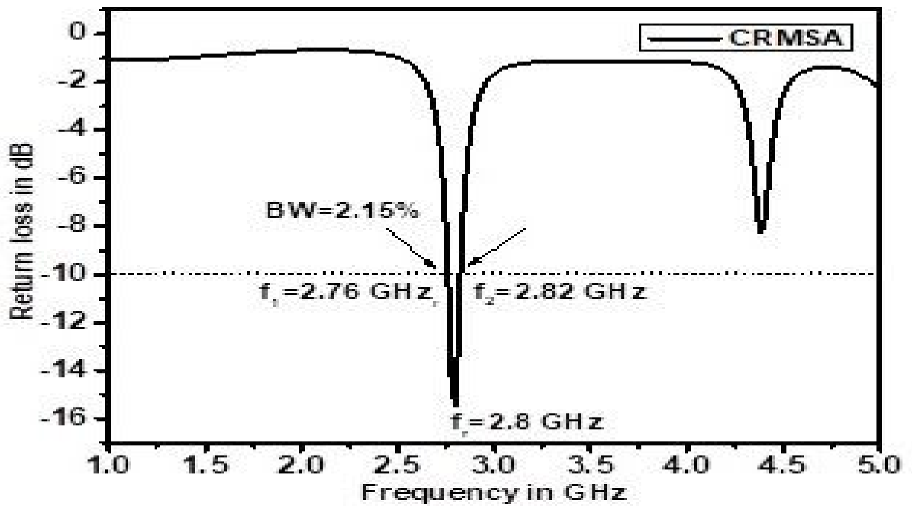

Fig.3 Variation of return loss versus frequency of CRMSA

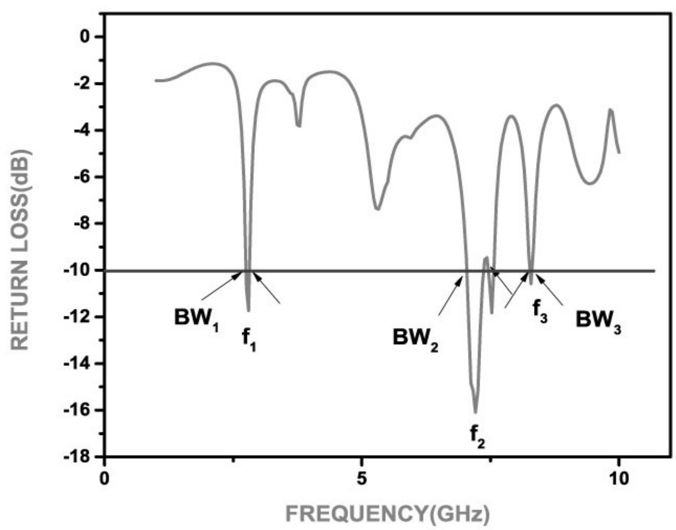

Fig.4 Variation of return loss versus frequency of VSRMMSA (Slot on Left side)

Figure 4 shows the variation of return loss versus frequency of VSRMMSA when the slot is on left side of the central line of the patch. It is seen from this figure that the antenna resonates for triple bands f_1, f_2 and f_3 with respective bandwidths BW_1=2.52% (2.81-2.74GHz), BW_2=4.72%(7.37-7.03 GHz) and BW_3=1.46% (7.56-7.45 GHz). The BW_1 is due to fundamental resonance of the patch while BW_2 and BW_3 are due to the insertion of the slot on the radiating patch.

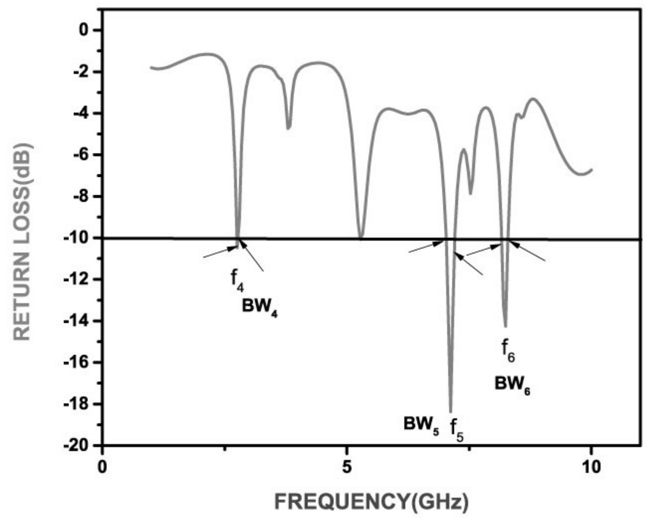

Fig.5 Variation of return loss versus frequency of VSRMMSA (Slot on Right side)

Figure 5 shows the variation of return loss versus frequency of VSRMMSA when the slot position on the right side about the central line. It is seen from this figure that, the antenna operates for three bands f_4, f_5 and f_6 with respective band widths BW_4 = 1.08 % (2.77-2.74 GHz), BW_5= 2.53(7.20-7.02 GHz) and BW_6 = 1.58(8.29-8.16 GHz).

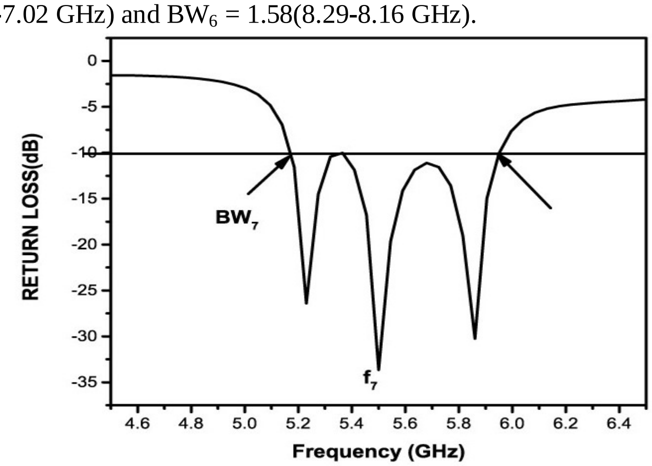

Fig.6 Variation of return loss versus frequency of VSRMMSA (Two slots)

Figure 6 shows the variation of return loss against the frequency of the VSRMMSA when two slots are places symmetrical about the central line on the patch, It is observed that the antenna resonates for a single band f_7 with the bandwidth BW_7=14.23(5.95-5.16GHz). The bands BW_4 to BW_6 all merge in to a single band giving a bandwidth of 14.23%.

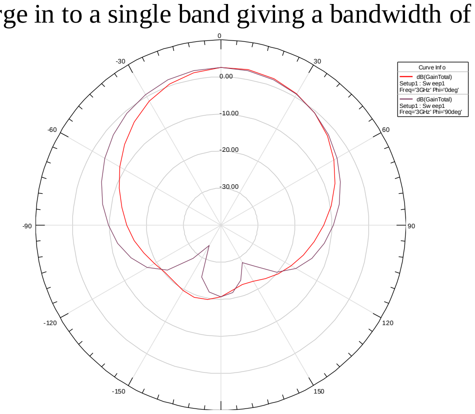

Fig. 7 radiation pattern of CRMSA

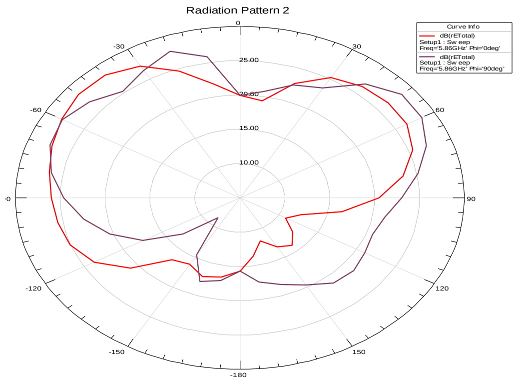

Fig. 8 Typical radiation pattern of VSRMMSA

Figure 7 and 8 show the radiation pattern of CRMSA and VSRMMSA. It is seen from these figures that the patterns are linear and broad sided. 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 equation,

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

where, G_t is the gain of the pyramidal horn antenna and R is the distance between the transmitting antenna and the AUT. The maximum gain CRMSA and VSRMMSA measured in their operating bands are found to be 1.01 dB and 3.8 dB respectively.

III. CONCLUSION

From the detailed study, it is concluded that, the CRMSA can be made to operate at three frequency bands between 2.77 to 8.29 GHz by loading vertical slot on the radiating patch. The maximum bandwidth of 14.23 % is achieved with linear broad side radiation pattern. The peak gain of 3.8 dB is achieved by the VSRMMSA. The proposed antennas are simple in their geometry and are fabricated using low cost glass epoxy substrate material. These antennas may find applications in wireless local area network(WLAN).

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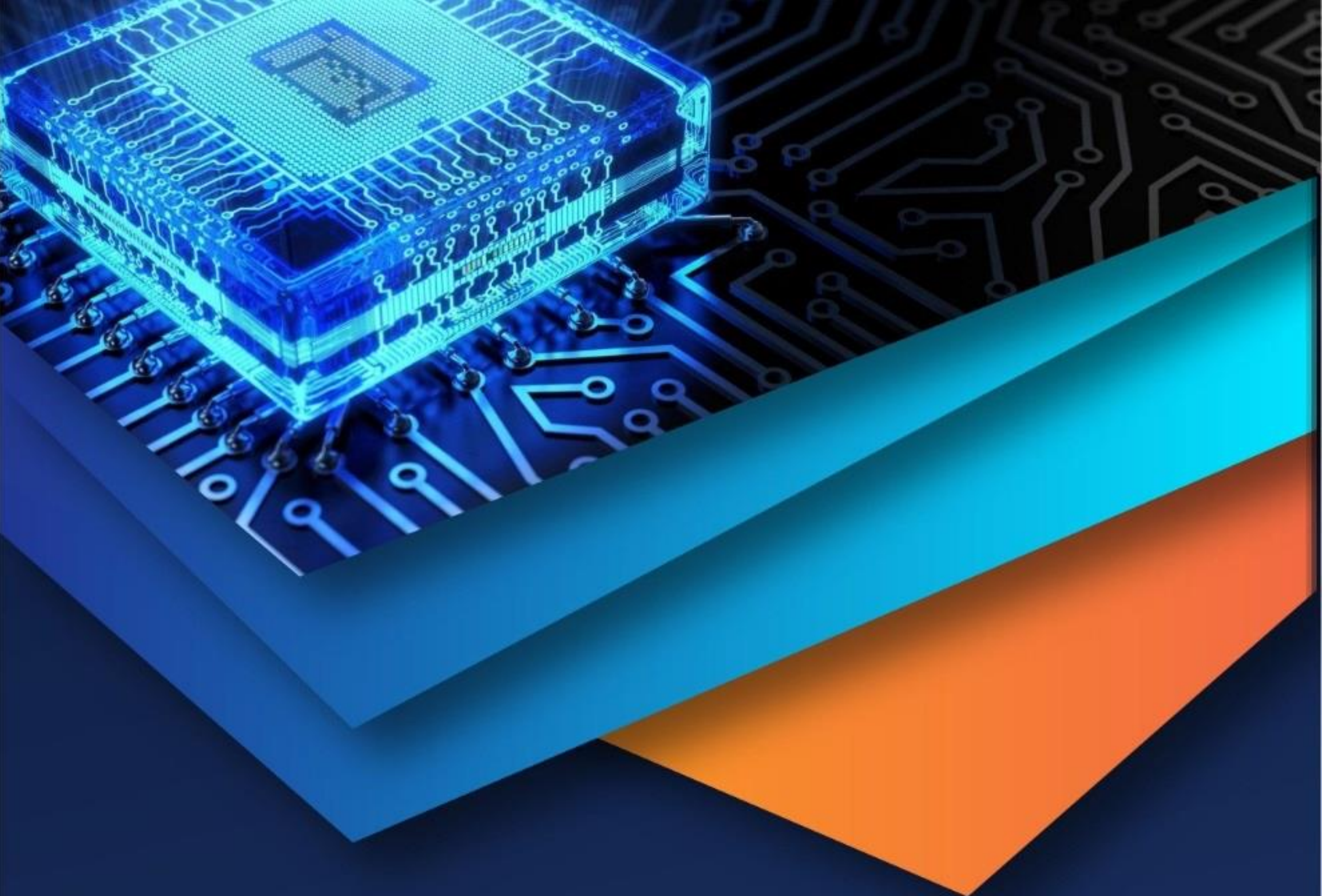

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