Design of Hybrid Triangular Gap-Coupled Rectangular Microstrip Antenna for Multiband Operations

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Abstract— In this paper a design of hybrid triangular gap-coupled rectangular microstrip antenna for multiband operation is presented. The proposed antenna is printed on the glass epoxy substrate material of dielectric constant εr = 4.2 with thickness 1.6 mm. This antenna consists of a hybrid triangular radiating patch which is placed above the conventional rectangular microstrip antenna (CRMSA) with gap of 2 mm. The antenna is excited through a simple microstripline feed. Proposed antenna is operates between the frequencies from 2.80 GHz to 11.85 which gives a six operating bands with reasonable impedance bandwidth. A maximum gain of 3.4 dB is observed in its operating bands and gives a broadside linearly polarized radiation characteristics. The measured and simulated results of the antennas are in good agreement with each other. The design concepts of the proposed antennas are given and results are presented and discussed. This antenna may find application in wireless communication such as WLAN, IEEE 802.11a, C- and X-band and satellite communication.

Key words: Microstrip Antenna, Triangular, Gap-Coupled, Multiband

I. INTRODUCTION

In present era the microstrip antennas (MSAs) have reached very significant place in modern wireless communication systems due to their inherent features such as, planar structure, light weight, low profile, easy of fabrication, compatibility and integration with MMICS, ruggedness, low cost etc. [1].The MSA designers strived hard to put forth many methods and techniques such as embedded slots of different geometries like H-shape, U-shape, square ring, triangular, bow-tie, circular ring narrow slot, square etc. on the radiating patch [2-7]. These methods are quite effective at the cost constraints to design such antennas. Also, the other methods such as gap-coupling, using parasitic element etc. are proposed in the literature for the multiband operation and enhancement of gain of MSA [8].In view of this simple technique has been used to get multiband operations by using the gap-coupling technique. This technique also enhances the gain when compared to the gain of the CMSA designed for the same resonant frequency.

II. DESIGN OF THE ANTENNA

Figure 1 shows the top view geometry of CRMSA. This antenna is designed for the resonant frequency of 3 GHz using the design equations available in the literature for the design of CRMSA [9]. The CRMSA consist of substrate of area X × Y. The rectangular radiating patch of length L and width W is excited through a simple 50Ω microstripline feed of length Lf and Wf using quarter wave impedance matching transformer of length Ltr and Wtr. The proposed antennas are sketched using computer software AutoCAD and are fabricated on commonly available low cost glass epoxy substrate material of dielectric constant εr= 4.2 with thickness h = 1.6 mm.

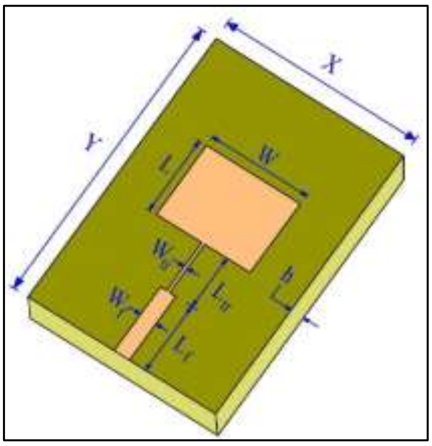

Fig. 1: Top view geometry of CRMSA

The top view geometry of triangular gap-coupled hybrid microstrip antenna (TGCRMSA) is as shown in Fig. 2. This antenna is constructed from the CRMSA. A triangular shaped radiating patch of side length TS1, TS2and Tb is placed above CRMSA. The various parameter dimensions of the CRMSA and TGCRMSA are listed in Table 1.

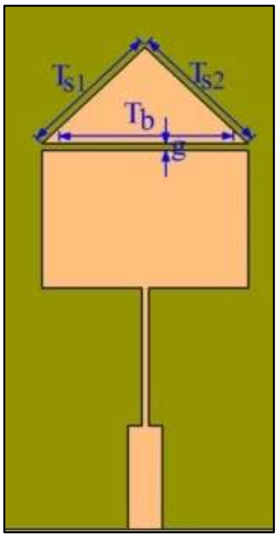

Fig. 2: Top view geometry of TGCRMSA

Antenna Parameters	W_g	L_g	**W**	**L**	L_f	W_f	W_{tr}	L_{tr}	Ts_1 & Ts_2	T_b	**g**
Dimensions in mm	56	104	31	24	21	3.7	0.7	18.5	22	31	2

Table.1: Design parameters of CRMSA and TGCRMSA

III. EXPERIMENTAL RESULTS AND DISCUSSION

Figure 3 shows the variation of return loss of CRMSA. From this figure it is seen that the CRMSA resonates at 2.88 GHz of frequency which is nearer to the designed frequency of 3 GHz. The experimental impedance bandwidth over return loss less than -10dB is calculated using the formula,

$$Bandwidth = \frac{[f_H - f_L]}{f_r}\,\% \qquad (1)$$

Where, fH and fL are the upper and lower cut-off frequencies of the resonating bands when their return loss reached -10 dB and fr is a center frequency of fH and fL. The impedance bandwidth of CRMSA is found to be 2.84%.The simulated results of CRMSA are also shown in Fig.3. The comparison of experimental and simulation results are found in good agreement with each other. The German Make (Rohde and Schwarz. ZVK 1127. 8651) vector network analyzer is used to measure the various antenna parameters experimentally. All simulation work is done by using electromagnetic simulation software Ansoft HFSS.

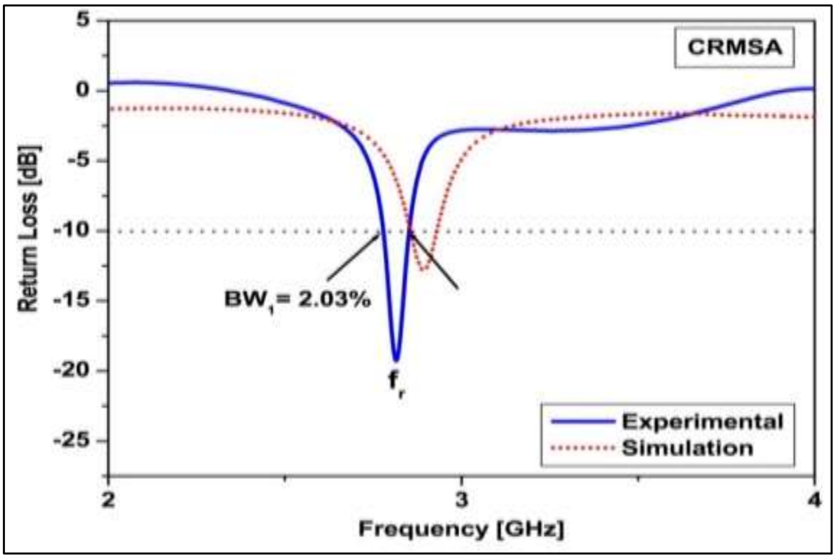

Fig. 3: Variation of return loss versus frequency of CRMSA

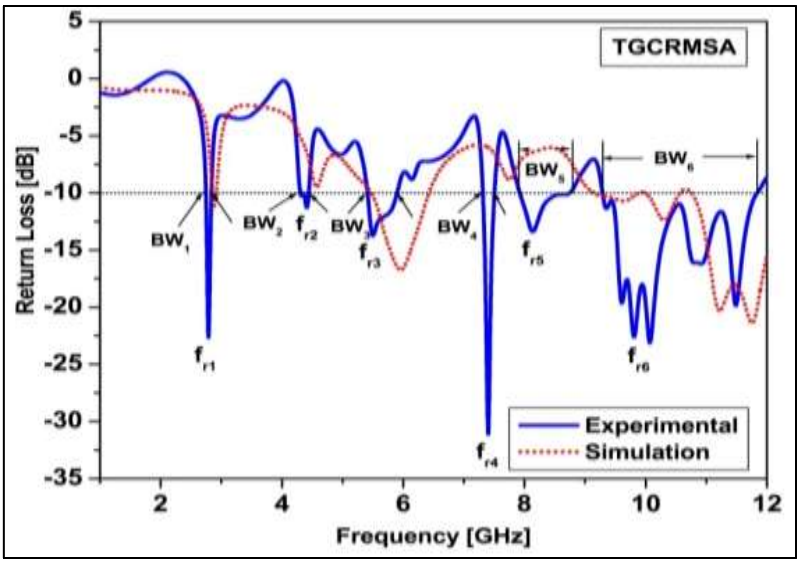

Fig. 4: Variation of return loss versus frequency graph of TGCRMSA

Figure 4 shows the variation of return loss versus frequency of TGCRMSA. The antenna resonates at six frequency modes at fr1, fr2, fr3, fr4, fr5and fr6 with their respective impedance bandwidths of BW1 = 1.07% (2.80 – 2.77 GHz), BW2 = 3.66% (4.44 – 4.28 GHZ), BW3 = 8.36% (5.86 -5.40 GHz), BW4 = 2.97% (7.51 – 7.29 GHz), BW5 = 10.94% (8.79 – 7.90 GHz) and BW6 = 24.97% (11.85 – 9.33 GHz). The first band BW1 is due to the fundamental resonance of the patch.

The bands BW2 to BW6 are due to triangular gap-coupled present on the radiating patch. The use of gap-coupled helps in producing multiband having wider impedance bandwidth compared to the magnitude of primary band of CRMSA.

Figures 5-7 shows the typical radiation pattern of CRMSA and TGCRMSA respectively measured in their operating bands. It can be observed from these figures that, the patterns of the proposed antennas are broadside in nature and linearly polarized.The maximum gain of the CRMSA and TGRMSA is found to be 2.67 and 3.4dB at each operating bands.

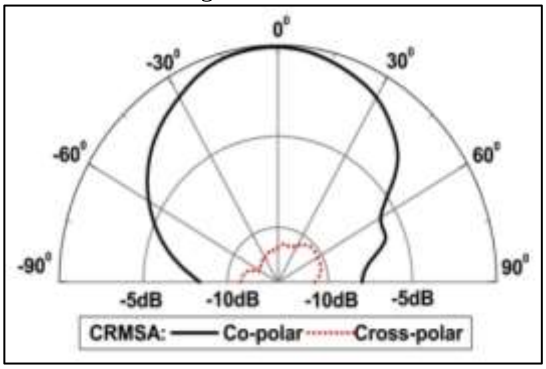

Fig. 5: Radiation pattern of CRMSA measured at 2.88 GHz

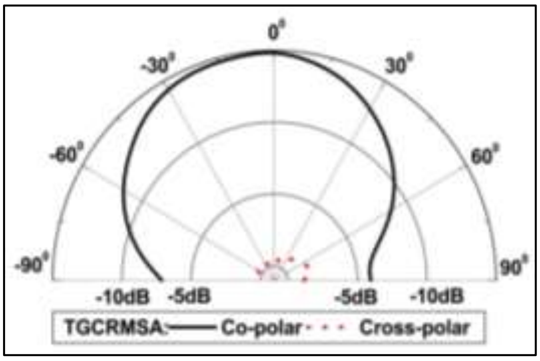

Fig. 6 Radiation pattern of TGCRMSA measured at 2.58 GHz

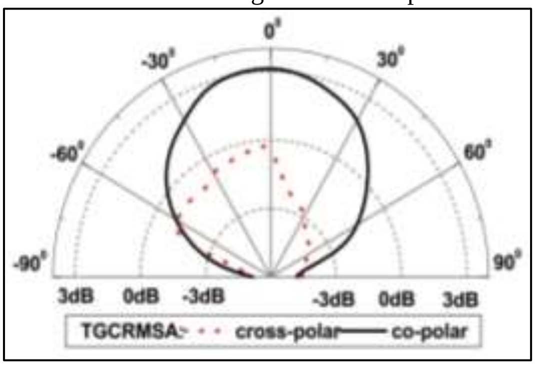

Fig. 7 Radiation pattern of TGCRMSA measured at 7.40 GHz

IV. CONCLUSION

From the detailed study, it is concluded that, the proposed antenna resonates for six independent modes between 2.80 to 11.85 GHZ. The magnitude of each operating band is found wider when compared to the impedance bandwidth of CRMSA by using triangular gap- coupled on the patch. The TGCRMSA gives the highest bandwidth of 24.97% at BW6 and a gain of 3.4 dB with linearly broadside radiation characteristics. The proposed antenna is simple in its geometry and easy to construct. The

TGCRMSA may be used for microwave communication systemsoperating in the frequency range of 2.80 – 11.85 GHz particularly WLAN, C and X band microwave system.

ACKNOWLEDGEMENT

The author would like to thank the Dept. of science and Technology (DST), Govt. of India, New Delhi, for sanctioning Vector Network Analyzer to this Department under FIST Project.

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