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Triangular Cut Modified Rectangular Patch Antenna in S and C-band for Wireless Applications

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Abstract: In this paper, modified rectangular patch antennas with a triangular cut is presented. The fabricated antennas are designed on a single layer (FR4) substrate with dimensions of 30 mm x 40 mm and are co-axially fed. The measured results indicate that the antenna resonates at two distinct frequencies with a tuning range from 3.45 GHz to 3.90 GHz and 4.71 GHz to 5.13 GHz at both frequencies.
Keywords: TC-MPA, tunable, resonating, dual frequency, C band

I. INTRODUCTION

Wireless communication is widely recognized as one of the fastest growing technologies. Modern day requirements are for small size, low cost and high performance transceiver systems. Microstrip antennas have proven to be the preferred choice in these applications because of its inherent advantages [1]. They can be made conformal and well suited for integration with microwave integrated circuits.

A single tunable antenna eliminates the need for multiple antennas for operation in multiple frequency bands. Various techniques have been used to tune the resonant frequency, which include adjusting the effective length of the patch using varactor diodes [1–4]. Patch antennas can also be optically tuned over a narrow frequency range of about 100 MHz using an optically controlled pin diode as reported in [3]. A microstrip patch in L-band was reported where tuning was achieved with multiple varactors mounted at both the radiating edges [4]. In the early 1980, a manually tunable circular microstrip patch antenna was reported by Lee et al. [5, 6]. Recently, MEMS based electro statically tunable microstrip antennas had been reported in [7, 8] where a MEMS based tunable square patch antenna was fabricated on a flexible Kaptonplymide film using printed circuit processing technique. In this paper, triangular cut rectangular microstrip patch antennas (TC-MPA) have been designed with co-axial probe feeding as shown in Fig. 1. Optimisation of feed point location is carried out for best matching**.**

II. ANTENNA DESIGN

The antenna is fabricated on a copper clad FR4 substrate with a dielectric constant of 4.8 (ε_r) and substrate thickness of 1.5 mm (h). A dual frequency rectangular patch is designed to resonate at 3.49GHz AND 4.85 GHz. Dimensions of the simple patch are 20 mm x 30 mm with a thickness of 1.5 mm. The arms of the isosceles triangle [A, B, C (=B)] are varied as shown in the Fig 1. Table I gives the dimensions of the TC-MPA.

TABLEI. Dimension of the designed antenna (mm)

Lg(mm)	Wg(mm)	Lp(mm)	Wp(mm)	f_p(mm)
75	80	20	30	6

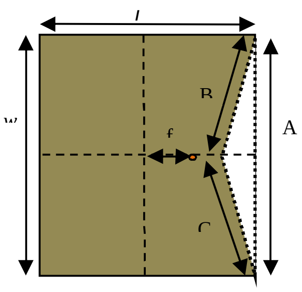

Fig1. The structure of the patch antenna with triangular cut

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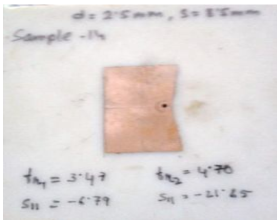

Fig2. Photograph of the TC-MPA.

One of the fabricated samples with varying arms (A, B, C) is shown in the Fig 2. The unmodified rectangular patch antenna and its RL plot are shown in Fig 3 and Fig 4 below.

Fig3. The rectangular patch antenna without triangular section.

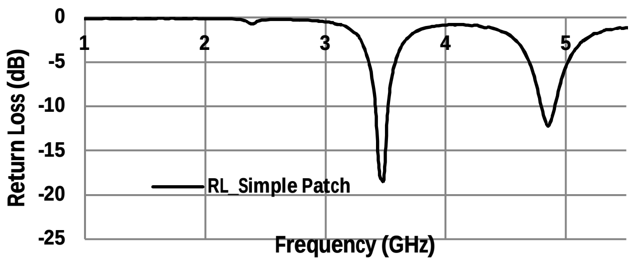

Fig4. Measured return loss vs. frequency.

III. MEASURED RESULTS

The measurements are carried out using the Vector Network Analyzer (Agilent make, PNA Network Analyzer E8362C, 10MHz-20GHz) RL performance plot of fabricated patch samples are discussed in the following paragraph.

The simple rectangular patch resonates at two frequencies of 3.49 GHz and 4.85GHz which shows return loss peaks of -18.39 dB and -12.23 dB. The patch is then modified with triangular shaped section (Fig 1). Table II summarizes the modified patch structures with their resonant frequencies and return loss values for 11 fabricated structures.

TABLEII. Dual band characteristics of the antenna

SAMPLE	FR_1 (GHz)	RL_1 (dB)	FR_2 (GHz)	RL_2 (dB)
Simple patch	3.49	-18.39	4.85	-12.24
Structure1	3.52	-20.33	4.83	-12.86
Structure2	3.48	-18.38	4.85	-12.24
Structure3	3.52	-19.61	4.71	-8.74
Structure4	3.59	-31.09	4.89	-11.99
Structure5	3.45	-5.94	4.79	-19.50
Structure6	3.59	-17.51	4.89	-10.29
Structure7	3.73	-26.75	5.03	-19.58
Structure8	3.90	-20.86	5.13	-10.87
Structure9	3.84	-14.94	5.09	-13.53
Structure10	3.66	-21.57	4.92	-10.64
Structure11	3.49	-7.19	4.71	-23.58

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From the summarized table (TABLE II), it is observed that the basic rectangular patch antenna which is a dual frequency antenna can be tuned by varying the triangular shaped section. The tuning parameter is the three sides of the triangular arms (arms A, B and C). The original patch antenna resonates at two distinct frequencies at 3.49 GHz and 4.85 GHz respectively. Best matching is observed at lower resonating frequency with a RL value of -18.39 dB compared to upper resonating frequency which is -12.24 dB. Structure 4 shows best matching at LRF with a RL value up to -31dB while structure 11 shows best matching at URF which is -23.58 dB among all the structures fabricated. However, RL value at lower resonating frequency for structures 2, 6 and 9 are decreased compared to basic patch antenna whereas RL value at higher resonating frequency for structures 4, 6, 8 and 10 are decreased. However for other structures RL values are increased. Structures 5 and 11 show poor matching (RL value below -10dB) in lower resonant frequencies and can be ignored for practical applications, but these structures can be used as for higher resonating frequencies as single frequency antenna

Again structure 9 shows dual frequency characteristic with comparable RL values in both the resonant frequencies and both the operating frequencies are shifted to higher side as compared to basic unmodified patch antenna. Return loss plot for the fabricated patch structures are shown in the Fig 5.

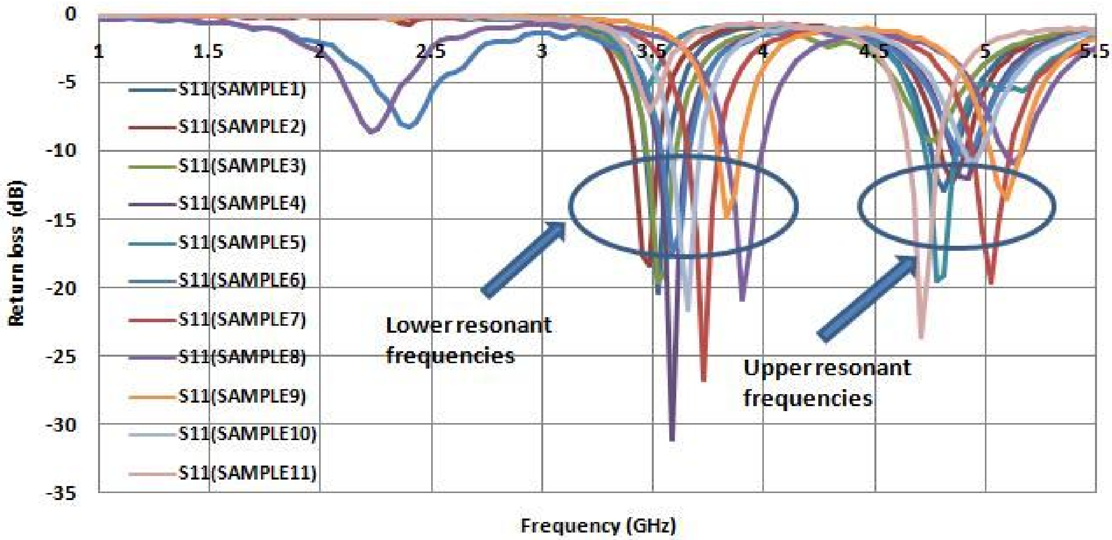

Fig5. Measured return loss vs. frequency for fabricated structures

Radiation pattern measurements are carried out using an automated pattern measurement system, which includes a signal generator as source, a spectrum analyzer, and a PC controlled turntable. E- Plane and H- plane radiation patterns for the simple microstrip patch antenna, patch with triangular slot and patch with varying slot length i.e. varying arms A, B, C are carried out at their respective resonant frequencies.

The pattern plots indicate that introduction of the triangular slot with varying arms have not significantly altered the radiation patterns of the antennas from that of the simple patch antenna. The measured radiation pattern plots of simple patch and some of the modified structures i.e. structures 3, 4, 8 and 11 are shown in the following figures.

IV. DISCUSSION & CONCLUSION

The reported TC-MPA is the outcome of optimisation carried out through multiple prototypes. Triangular cuts were designed at the radiating edges in order to obtain tuning of both resonant frequencies. The antenna is co-axially fed. Return loss measurements show significant tuning range 450 MHz and 420 MHz at both the lower and upper resonant frequencies. The promising results obtained with the designed structure can be followed up with further studies to obtain a comprehensive understanding of the effects of cutting triangular edges with more variations of dimensions of arms A, B, and C of the triangles.

V. ACKNOWLEDGMENT

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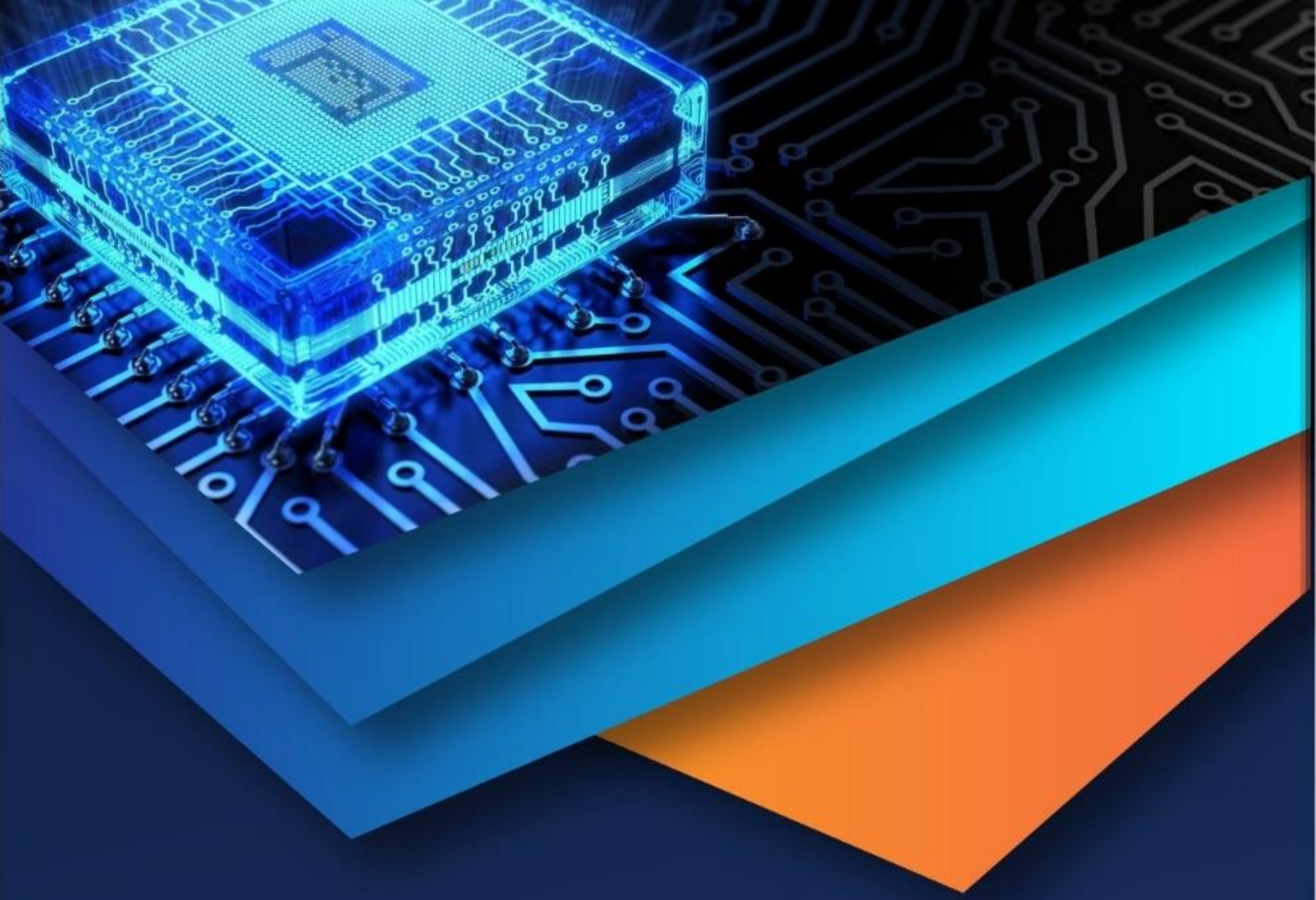

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