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Bandwidth enhancement of triangular microstrip antenna using dual stub

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Abstract—A new stub loaded equilateral triangular microstrip antenna(ETMSA) has been proposed . The new structure has the enhanced bandwidth of 13.63% in the Ku band.Stub loading technique is used to enhance the bandwidth performance. Two rectangular stubs are inserted on the radiating edge of the patch. The gain of the antenna is stable at about 5.78 dBi.Detailed analysis of the patch has been done in this paper using MOM based IE3D simulator.

Index Terms—Bandwidth enhancement,ETMSA,Secondary stub effect,STUB effect.

1 INTRODUCTION

Microstrip antenna are very popular in wireless communication systems due to their several advantages like low cost,thinprofile,light weight etc.,but on the other hand,microstrip antenna suffers due to its bandwidth problem [1].The most straightforward way to overcome the low bandwidth problem is to use the thicker substrate [2]. Unfortunately , the thick substrate results in impedance mismatch,large radiation loss [3] [4]. There are several techniques of Bandwidth enhancement processes. Lots of slotting mechanisms [5] i.e. wide rectangular type slot [6] [7] , circular slot [8] , U type slot [9], etc. are adapted for bandwidth enhancement [10] . Another procedure for Bandwidth enhancement is Bow-Tie shape antenna [11] and slot antenna with EBG structure [12].

2 ANTENNA DESIGN AND SIMULATION

The proposed antenna is designed using RT/Duroid 5880 substrate material and dielectric constant ε_r=2.2. The patch geometry is the equilateral trianglular shape with arm length L=10.2mm. This triangular antenna radiates at f_r=13.4GHz. Using the cavity model and assuming perfect magnetic sidewalls,the equilateral triangular patch antennaThe formula used for calculating the resonant frequency is,

$$f_r = 2c/3L\sqrt{\varepsilon_r}$$

The optimum coaxial probe feeding location at 3.875mm from the vertex of antenna as given in fig 1a and 1b.

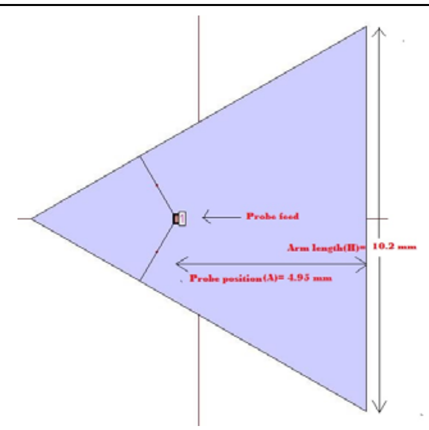

Fig. 1. Geometry of equilateral triangularmicrostrip antenna

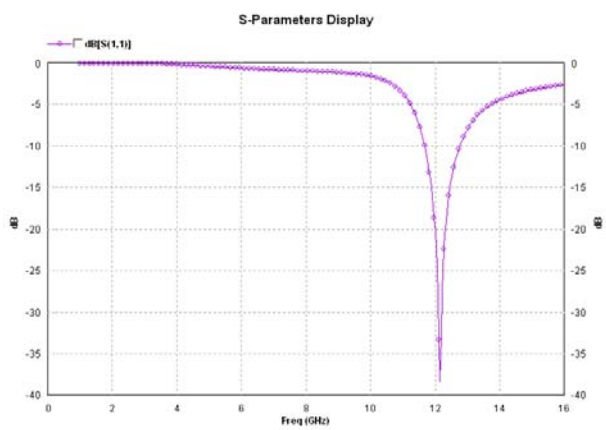

Fig. 1b return loss performance of equilateral triangular patch .

2.1 EFFECT OF DUAL STUB LOADING

The dual stub of length L1 and L2 are loaded on radiating edge as shown in fig. 2a. The return loss performance is shown in fig. 2b.The difference on stub of length L1 = 4mm is fixed and L2 is varying. The length ratio L2/L1 vs bandwidth is shown at the optimum value of L2/L1 = ½. The maximum bandwidth of 13.63% is achieved at center frequency f_c = 13.193 GHz as shown in fig. 2c.

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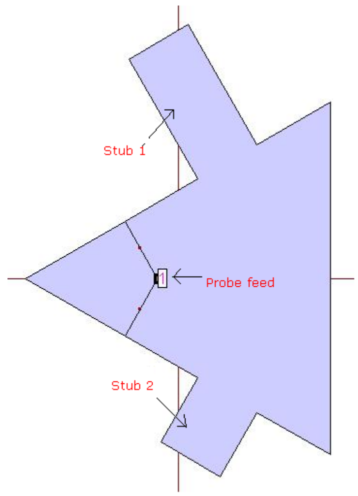

Fig. 2a.View of triangular microstrip patch antenna with dual stub

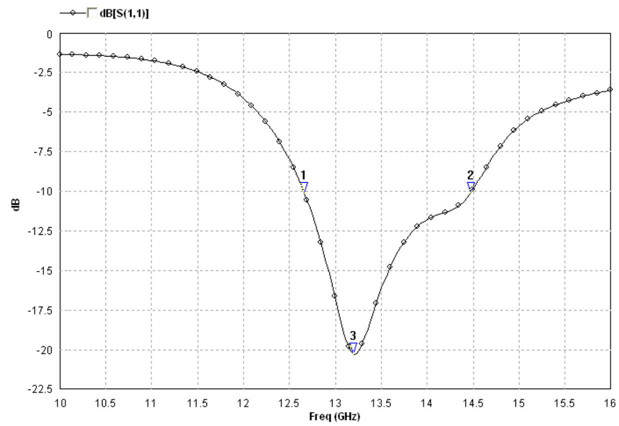

Fig. 2b..S-parameter plot for return lossvs frequency

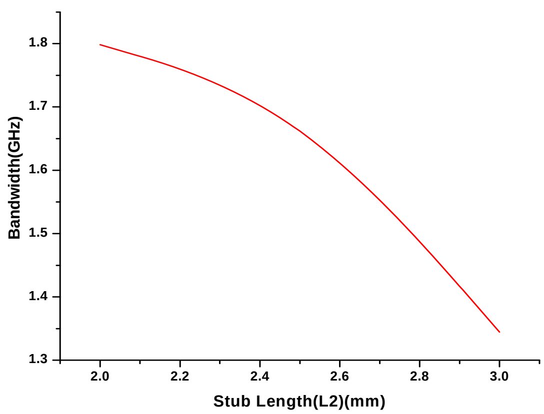

Fig. 2c.Plot for bandwidthvs stub length

Table 1a. EFFECT OF STUB LENGTH VARIATION

DIE-LECTRIC CON-STANT (ε_r)	STUB LENGTH (L1) IN mm	STUB LENGTH (L2) IN mm	CENTER FRE-QUENCY IN GHz	% OF BAND-WIDTH EN-HANCE-MENT
2.22	4	2	13.193	13.63
2.22	4	2.5	13.3062	12.829
2.22	4	3	13.6095	9.878

Table 1b.STUB LENGTH VS BANDWIDTH

LENGTH OF SECOND STUB (L2) IN mm	BANDWIDTH IN GHz
3	1.34443
2.5	1.70713
2	1.79825

2.2 RADIATION PATTERN

The co-polarized field components and also cross-polarized field components are almost stable in the entire operating bands as shown in fig. but at the upper cut off frequency 14.47 GHz , the co-polarized fields are disturbed as shown in fig. 3a, 3b and 3c.

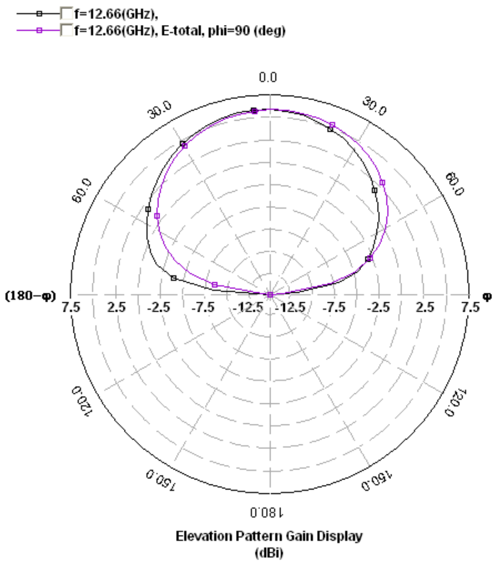

Fig. 3a Simulated radiation pattern at 12.66 GHz

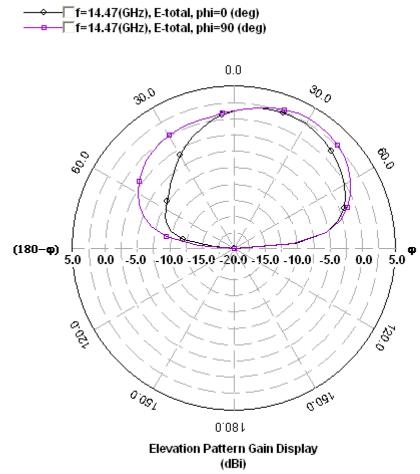

Fig. 3c Simulated radiation pattern at 14.47 GHz

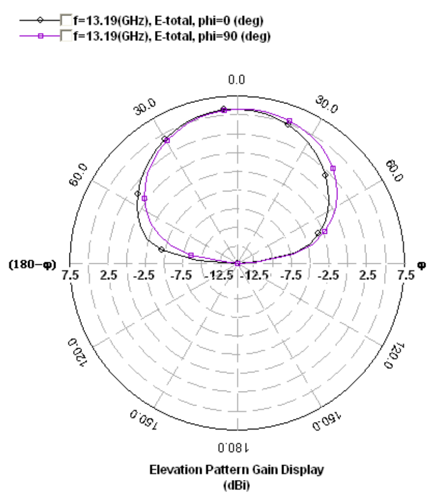

Fig. 3b Simulated radiation pattern at 13.19 GHz
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2.3 GAIN

The almost better gain of maximum 6dBi (approx.) has been achieved within the operating range of 12.66 GHz – 14.47 GHz. The peak gain of 5.77 dBi achieved at f_c = 13.19 GHz.

As L2/L1 tends to unity,the peak gain falls sharply as shown in fig.

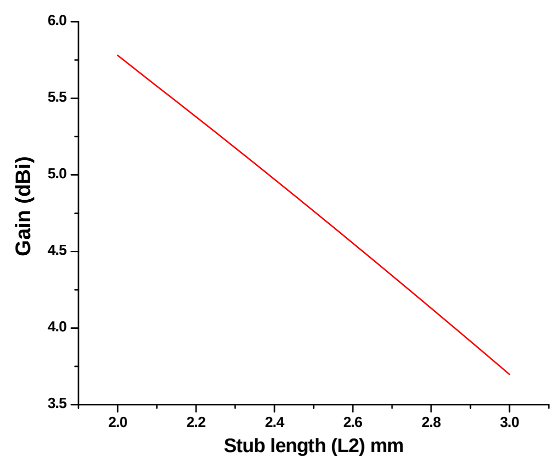

Fig 4a Plot for gain vs stub length

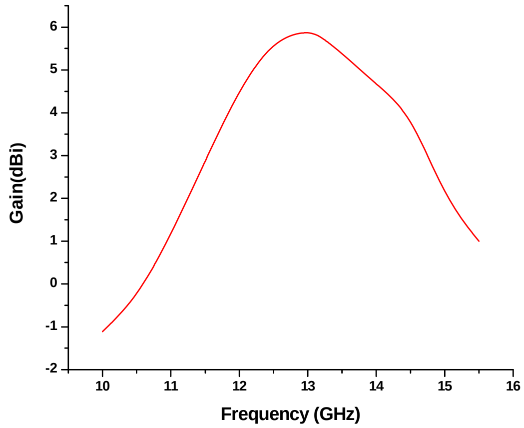

Fig 4b Plot for gain vs frequency

Table 2. STUB LENGTH VS PEAK GAIN

LENGTH OF SECOND STUB (L2) IN mm	PEAK GAIN IN dBi
2	5.77953
2.5	4.77801
3	3.69842

CONCLUSION

The double stubs loaded triangular microstrip antenna has been proposed for enhanced bandwidth operation. A 13.63% bandwidth enhancement has been achieved with two unequal length stub loading . Within the enhanced bandwidth , the considerable gain has also been achieved. Simulation studies have been performed on the proposed antenna. The design is very useful . The proposed antenna is applicable in Ku band.

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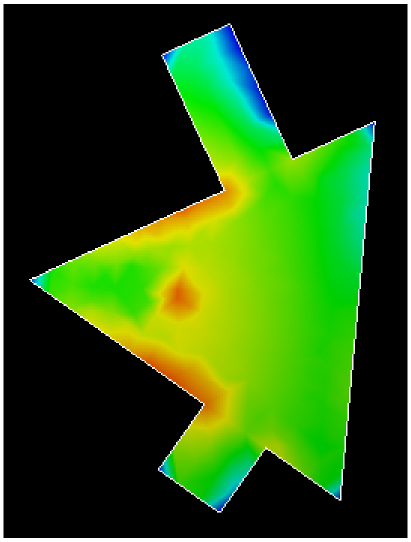

Fig. 5.Current distribution using dual stub.

6.The impedance bandwidth of the antenna is enhanced by changing the corner of the wide rectangular slot from right angle to round.
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