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Dual Band and Tri Band Pentagonal Microstrip Antenna for Wireless Communication Systems

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Abstract— ***This paper presents multiband compact pentagonal shaped antenna. A flexible design approach allows both dual band and triple band keeping the constant coaxial feed location and using the simple variation of radiating edge; the dual band and triple band operations are possible. Such antennas are implemented on RTduroid 5880 dielectric. All the simulations are carried out in IE3D software.***

Index Terms— ***dual band, pentagonal patch, radiating arm, tri band.***

I. INTRODUCTION

Modern wireless communication system often requires the antenna to work at several frequencies simultaneously. Multiband microstrip antenna has attracted much attention in modern wireless communication.[1] Several types of structures such as slot loading, T-type slot, H-slot antenna, different types of monopole antenna. Different types of stub loading can also produce multiple resonant frequencies.[2-7] A novel pentagonal structure patch has been introduced in this paper obtained from the RMPA. The tri bands are achieved using the modified structure. The good agreement of VSWR, gain and radiation efficiency at these resonant frequencies makes the antenna more practical and efficient. Simulation and analysis of proposed antenna are performed using the methods of MOM based IE3D simulator.

II. BASIC PRINCIPLES OF OPERATION OF RMPA

According to the transmission line analysis method, the rectangular patch antenna model

$$W = \frac{c}{2f_0\sqrt{(\varepsilon_r + 1)/2}}$$

The effective dielectric constant

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\sqrt{\frac{1}{1+12^{h}/_{w}}}$$

So, the effective length is

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} - 2\Delta L$$

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III. ANTENNA DESIGN AND SIMULATION

A. Geometry 1

The proposed antenna is made up of a rectangular patch having dimensions 20(mm) x 23(mm). The proposed structure has a fundamental position for best matching is given at (x_f, y_f) = (4,0). The structure is given in fig.1

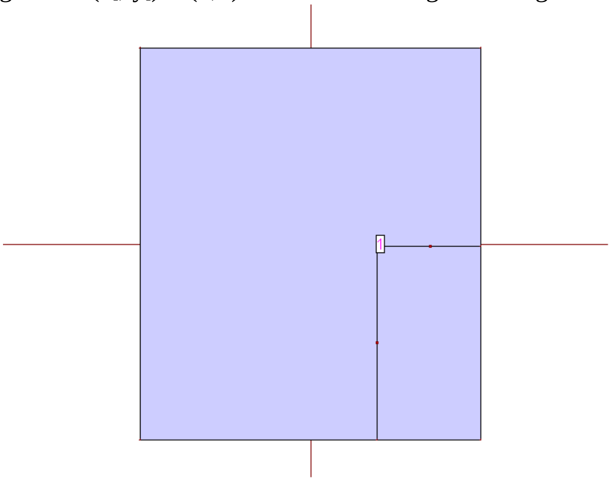

Fig.1. Rectangular patch of geometry 1

The resonant frequency is obtained at 4.55 (GHz). In this frequency range the VSWR obtained is excellent (VSWR=1.77)

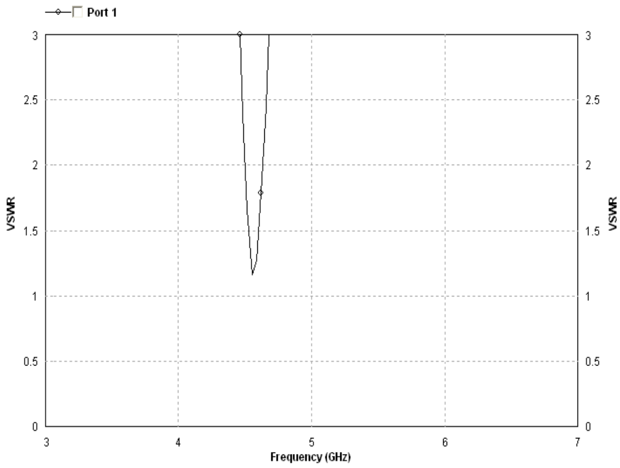

Fig.2. VSWR vs Frequency output for the geometry 1

B. Geometry 2

The structure is now further modified to form a pentagonal structure by protruding the radiating edge of the patch to form an isosceles triangle of side L1=L2. This modification causes the introduction of dual bands. The basic parameters and feed point are same. The structure is shown in fig.3

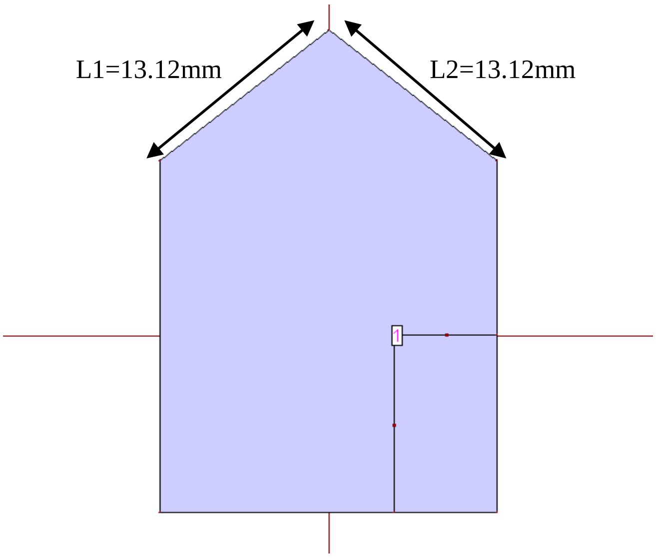

Fig.3. Pentagonal patch of geometry 2

The dual band frequencies are obtained at 4.67(GHz) and 6.489 (GHz). Both frequency bands give an excellent VSWR i.e. 1.38 and 1.270 respectively as shown in fig.4.

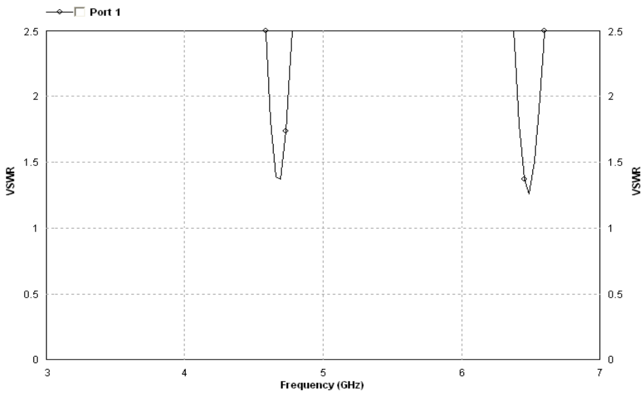

Fig.4. VSWR vs Frequency output for the geometry 2

C. Geometry 3

The pentagonal structure is further modified by increasing the length of the sides L1 and L2 of the isosceles triangle above the radiating edge. This introduces the triple band. Again the basic parameters and feed point are same. The structure is shown in fig.5

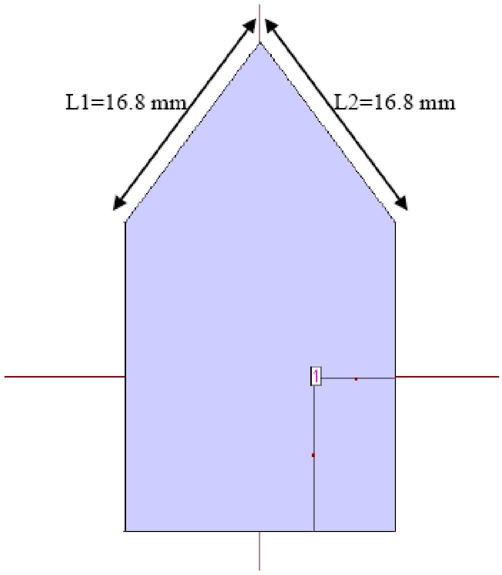

Fig.5. Pentagonal patch of geometry 3

The triple band frequencies are obtained at 3.06GHz, 4.673(GHz) and 5.63(GHz). In this case also all frequency bands give an excellent VSWR i.e. 1.213, 1.396 and 1.412 respectively as shown in fig.6.

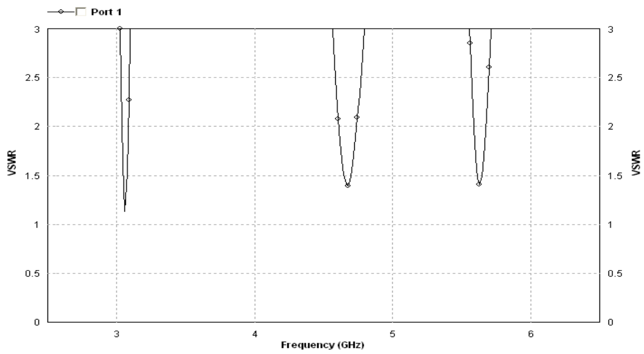

Fig.6. VSWR vs Frequency output for the geometry 3

IV. PATCH AREA

Due to the pentagonal structure the area of the patch is increased when dual and triple bands are obtained. This increment in the patch area is considerable taking in account the advantages of the dual and triple band. The following table shows the percentage increase of patch area with respect to the total area.

Table I: No of frequency band and % patch area

Sl. No.	BAND	Excess patch area in %
1	Single	0
2	Dual	17.11
3	Triple	22.69

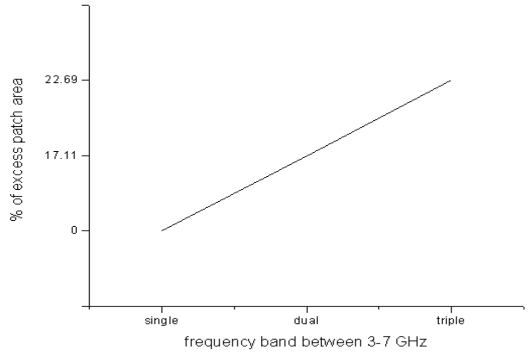

Fig.7. No of frequency band vs % of excess patch area

V. RADIATION PATTERN

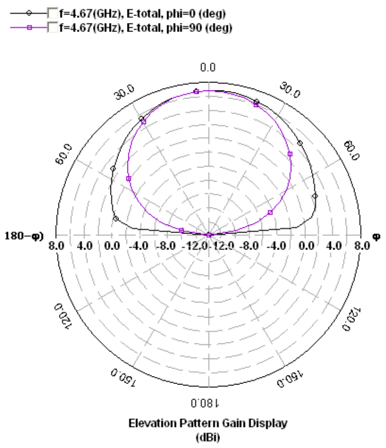

Fig.8. (a) Radiation pattern of geometry 2 at 4.67(GHz)

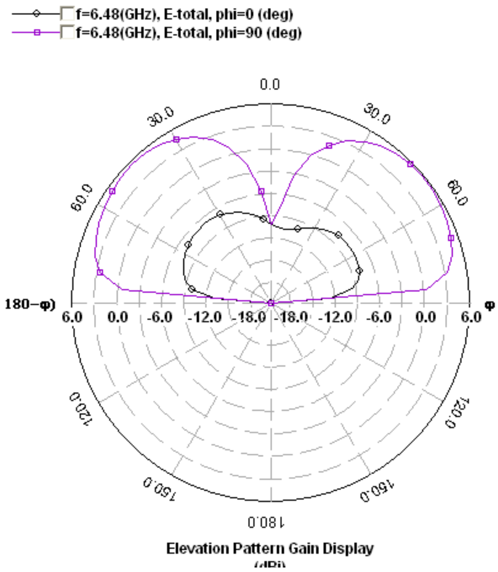

Fig.8 (b) Radiation pattern of geometry 2 at 6.48 (GHz)

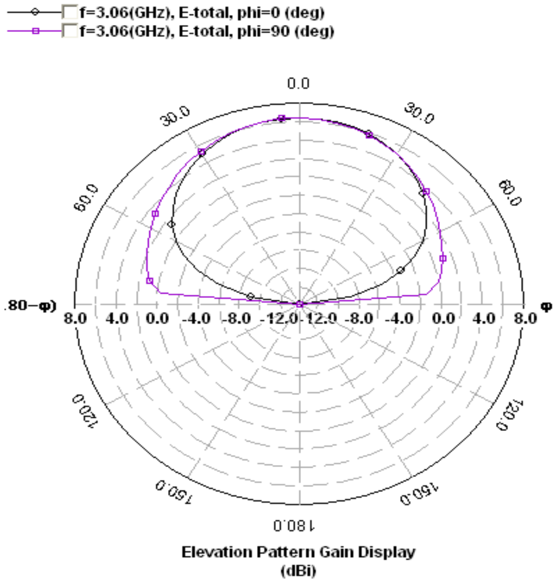

Fig.9 (a) Radiation pattern of geometry 3 at 3.06(GHz)

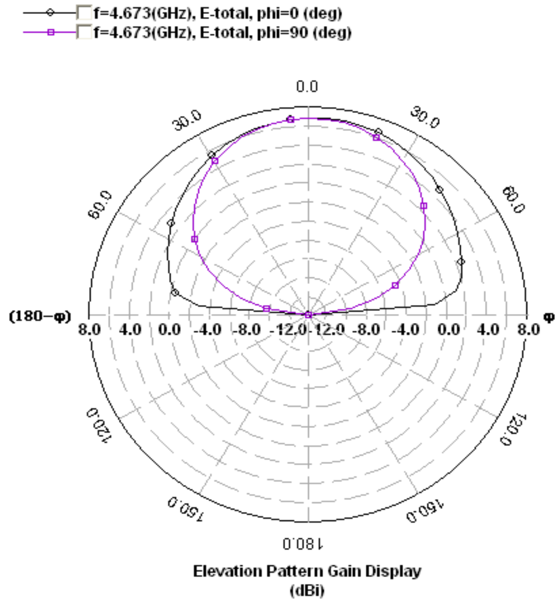

Fig.9 (b) Radiation pattern of geometry 3 at 4.673(GHz)

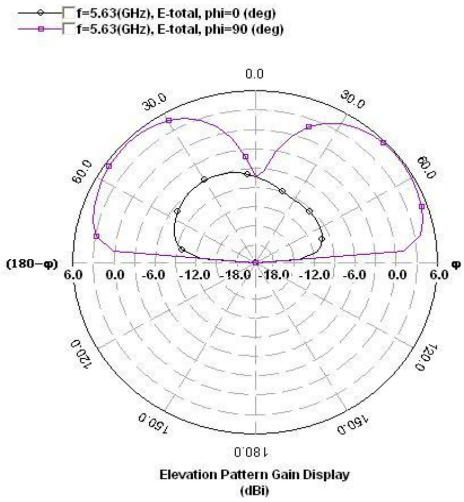

Fig.9(c) Radiation pattern of geometry 3 at 5.63(GHz)

The radiation pattern of dual band and tri band exhibit the broad side pattern. At the lower resonant frequency the broad side co-polar and cross polar patterns are more stable across the band in comparison with the higher frequency as shown in Fig. 9. At f=4.67(GHz) the cross polar pattern well inside the co polar pattern, but at f=5.63(GHz) the cross polar pattern becomes much larger than co polar pattern.

VI. GAIN

Peak gain of the proposed antenna in the operating frequency band is simulated. At each frequency band, around 6 (dBi) gain is achieved. Simulated gain for dual band and triple band pentagonal structure are shown in Fig.10(a) and Fig.10(b).

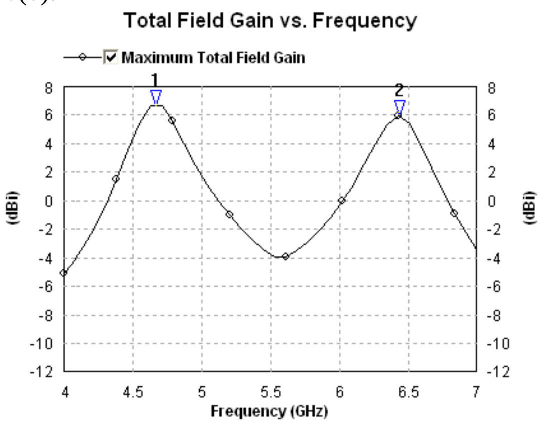

Fig.10(a) Total field gain for geometry 2

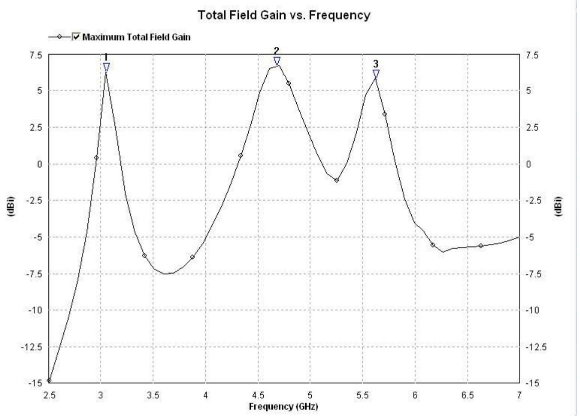

Fig.10 (b) Total field gain for geometry 3

VII. RADIATION EFFICIENCY

The radiation efficiency at each frequency band is above 80%.

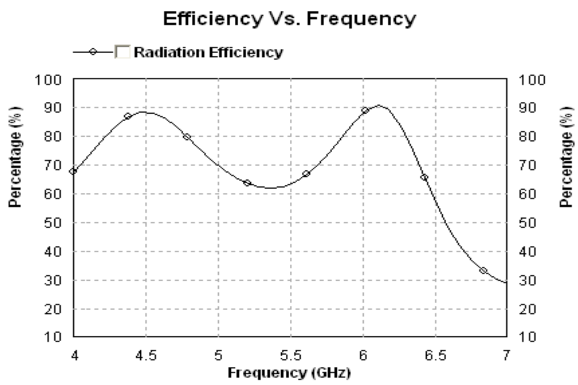

Fig.11(a) Radiation efficiency for geometry 2

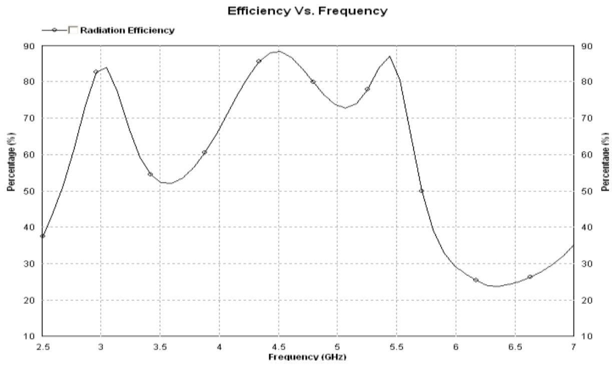

Fig.11(b) Radiation efficiency for geometry 3

VIII. CONCLUSION

The novel pentagonal antenna has been investigated. The dual and triple band achieved for VSWR≤ 2 at 4.67 (GHz) and 6.489 (GHz) for dual band and 3.06 (GHz), 4.673 (GHz) and 5.63 (GHz) for triple band. Though the patch surface area increased up to 22.69% for tri band, yet the patch geometry is very simple. The frequency range of proposed antenna is between 3 (GHz) to 7 (GHz) makes it widely applicable in WLAN, Wi-MAX, RFID, radar imaging technology, satellite communication etc.

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