

A Dual Frequency Wide Band Equilateral Triangular Shaped Microstrip Antenna (TMSA) For Radar And KU Band Applications

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Abstract

In this paper, a dual frequency wide band equilateral triangular shaped microstrip antenna (TMSA) is presented for radar and Ku band applications. The proposed antenna has been designed by etching triangular shape structure on Glass epoxy (FR4) substrate. It radiates 8GHz for radar and 13.4GHz for Ku band applications. The return loss S_{11} for 8GHz and 13.4 GHz is -21 dB and -30dB respectively. The proposed antenna exhibits small return loss and high efficiency 89%.Design of an antenna using ADS (Advanced Design System), simulated result shows that achieves gain 5.1dBi.

Keywords: Dual band, return loss, TMSA, ADS, Ku band

I INTRODUCTION

Patch antennas are assigned different names such as printed antennas[10], microstrip patch antennas, or simply microstrip antennas (MSA). Microstrip antennas are often used where thickness and conformability to the host surfaces are the key requirements. Since patch antennas can be directly printed onto a circuit board, these are becoming increasingly popular within the mobile phone market. They are low cost, have a low profile and are easily fabricated. A Micro strip antenna (MSA) consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side. The radiation can be regarded as being produced by the Radiating slots at top and bottom or equivalently as a result of the current flowing on the patch and ground plane [11].One of the key drawbacks of such devices is their narrow bandwidth. In order to achieve wider bandwidth a relatively thick substrate is

used [3]. The MSA may have a square, rectangular, circular, triangular and elliptical shape. Various slots shape have been designed and proposed like E shaped, H shaped, C shaped and triangular shaped [5]. The size and selection of a shapes dependent upon on specific application and frequency of interest.

In this paper introduces the new concept of triangular microstrip patch antenna (TMSA) [15]. The triangle MSA is one for which the patch conductor is a triangular shape. Section II introduces the concept of proposed TMSA [6].

II ANTENNA DESIGN

A) ANTENNA GEOMETRY

Fig 1 shows the configuration of proposed Dual frequency wide band Equilateral triangular shaped microstrip antenna.

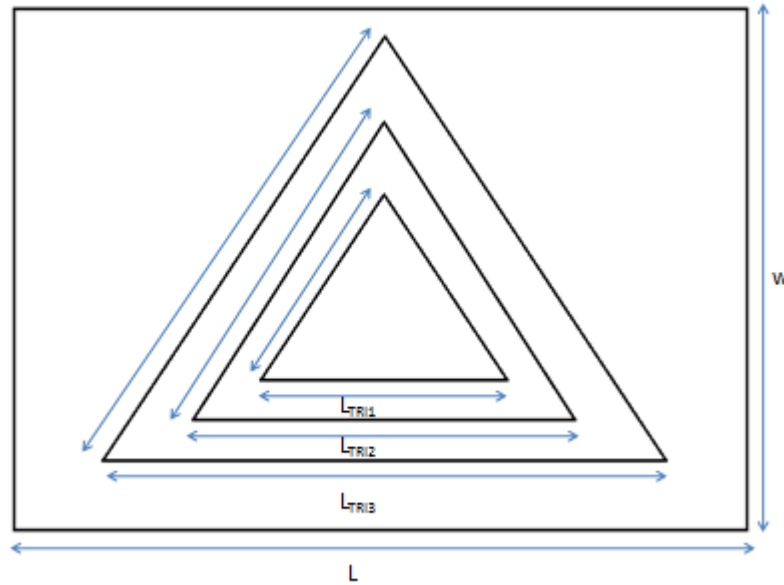


Fig.1. Proposed structure of TMSA

B) PRINCIPLE OF OPERATION

According to Chang–kuester model a plane wave is assumed incident in to the cavity [15]. The triangle microstrip antenna (TMSA) is one for which the patch conductor is the triangular shape. The patch conductor normally copper and silver, can assume any shape (Circular, triangular, rectangular)[1] major advantages of the cavity model over transmission line model. The patch conductor and the ground plane form two dielectric walls, the edge of the patch being surrounded by an ideal magnetic wall. The simple model is very instructive and easily understood, being especially valuable for finding the electric and magnetic field distributions under the patch.

For TMSA the thickness of the dielectric substrate is assumed small compared to the free space wavelength (λ) of the operating frequency. The most of the EM energy is concentrated under the conductive patch [2]. Its open edge allows the radiation of EM energy. The TMSA can be viewed as a poor cavity in the sense there is substantial radiation loss. The E and H fields under the patch have no variations. The electromagnetic fields are disturbed in the edge region where radiation occurs [9]. It also has some disadvantages. First, since the edge boundary is not an ideal magnetic wall, the resonant frequency so obtained will deviate from the true value. Usually higher than the true value because the fringe effects of EM fields at the edge correspond to the slight outward extension of the slight conductor. The deviation is very small in order to 1%. Since the bandwidth of TMSA is very narrow. Second, no energy leak from the cavity, making the theoretical calculations of resonant frequency value is impossible [6]. These problems are tackled by using equivalence principle.

C) DESIGN EQUATION

The proposed antenna printed on GLASS EPOXY (FR4) substrate having a thickness a 4.4 with the size of 15mm*15mm. The radiating element of dual band design is composed of three triangular strips.

$$L = W = \frac{C}{F_r \sqrt{\epsilon_r/2}}$$

$$L_{tri1} = \frac{0.875 * C}{F_r \sqrt{\epsilon_{reff}}}$$

$$L_{tri2} = \frac{C}{2f_r \sqrt{\epsilon_{reff}}}$$

$$L_{tri3} = \frac{0.175 * C}{F_r \sqrt{\epsilon_r}}$$

Spacing between Triangles = $0.0295 * \lambda$

Dimensions of the proposed antenna given below

TABLE I GEOMETRIC PARAMETERS OF THE DUAL BAND COMPACT TMSA

Substrate	Glass epoxy(FR4)
Dielectric constant(ϵ_r)	4.4
Length	15.5 mm
Width	15.5 mm
L_{tri1}	10.5mm
L_{tri2}	5.5mm
L_{tri3}	1.3mm
Spacing	0.6 mm
H_{tri1}	10.5mm
H_{tri2}	5.5mm
H_{tri3}	1.3mm

The proposed antenna consists of three triangular patches which are printed on a low loss dielectric substrate [10]. The antenna fed by a 50 ohm transmission line, in order to get a perfect impedance matching over the two bands.

III RESULTS AND DISCUSSIONS

The proposed antenna simulated by ADS (Advanced Design System) softwares. The numerical method of this package namely Finite Element Methods (FEM). The FEM is a numerical technique for finding approximate solutions to boundary value problems. It uses whole problem domain in to simpler parts called FEM.

The dimension of the conductive patch should be carefully controlled. The resonant frequency is related to the conductive patch. Finally large size conductive patch is preferred. The dielectric constant is the another parameter to affect the resonant frequency.

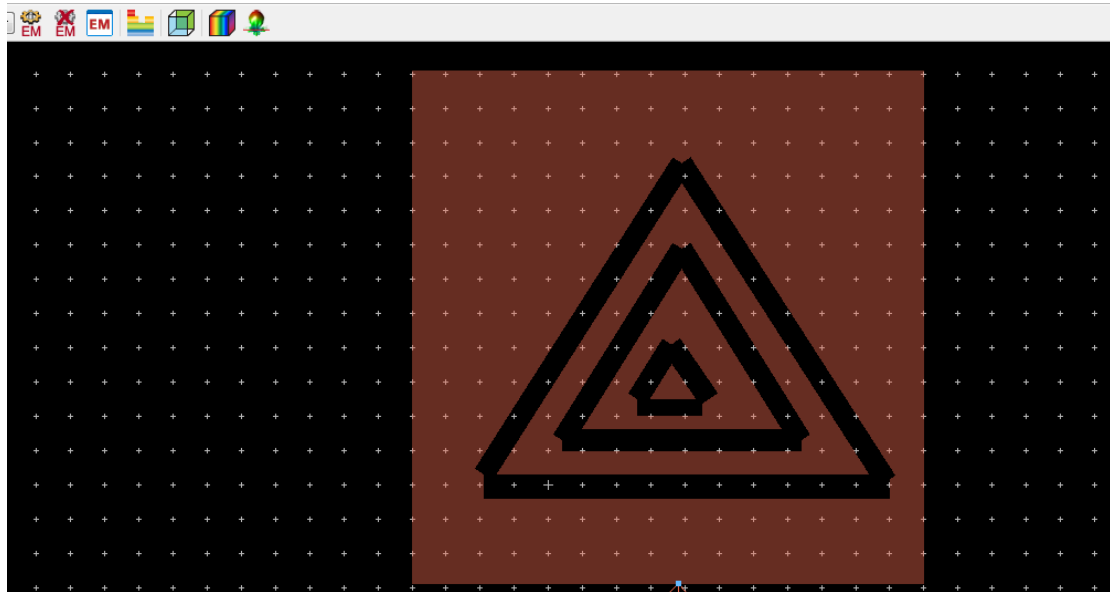
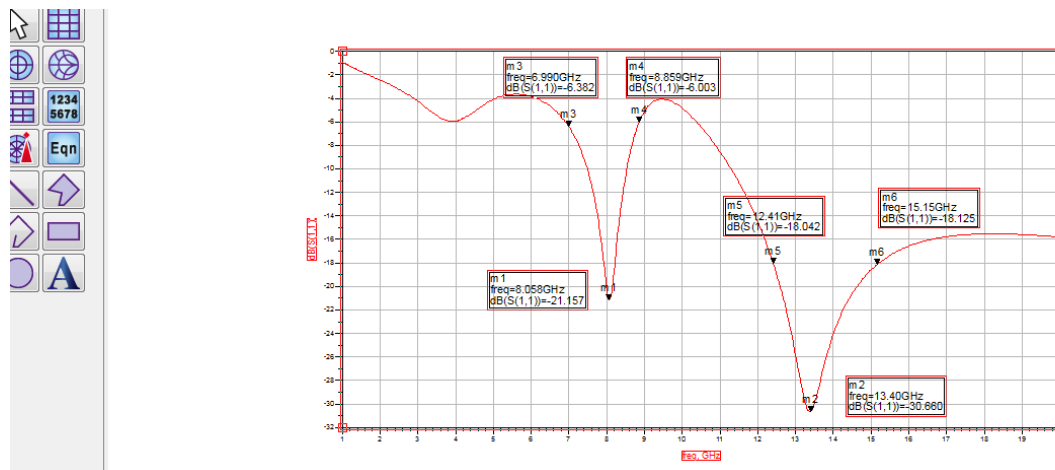


Fig.2.Layout structure of TMSA

Fig.3.Simulated return loss (S_{11}) of proposed TMSA

From the acquired result it can be clearly shown that antenna resonate at two different frequency 8GHz (6.9GHz -8.8GHz) and 13.4 GHz (12.4-15.1 GHz) respectively. The return loss of those frequencies is -21dB and -30 dB respectively. The resonant mode has 1900MHz and 2700 MHz bandwidth. The antenna peak gains of 5.1dBi and 5dBi are achieved at 8 GHz and 13.4 GHz respectively.

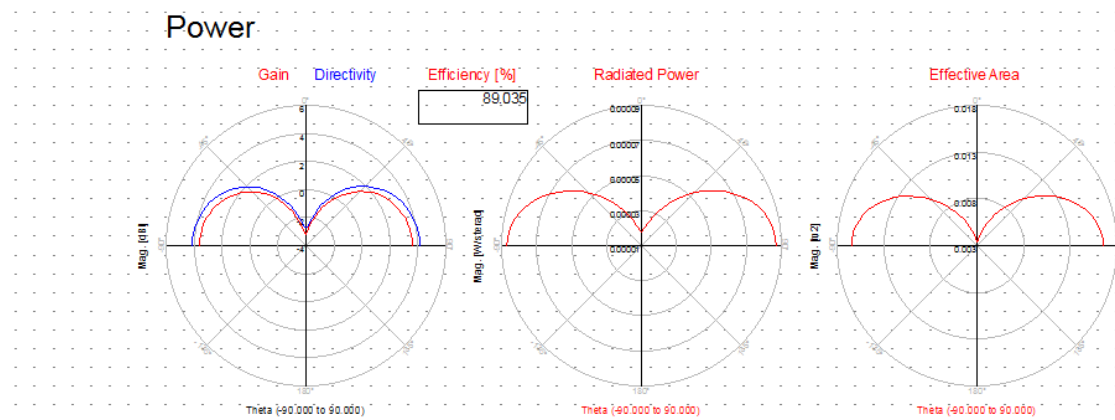


Fig. 4. Efficiency and radiated power of the TMSA

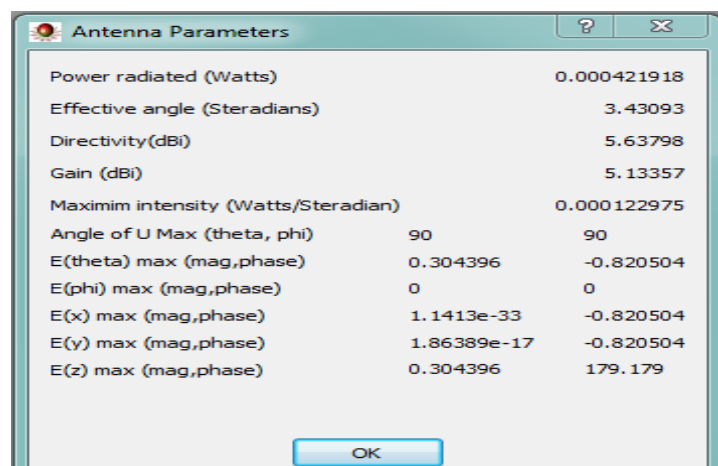


Fig.5.Gain of the proposed TMSA

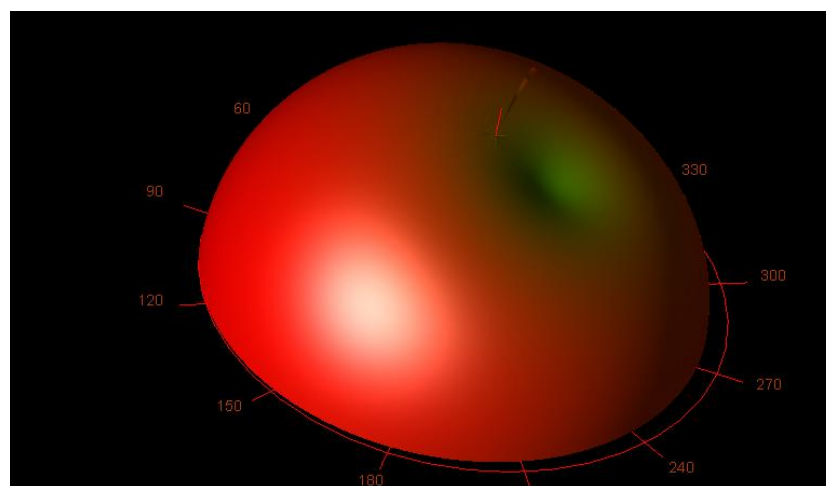


Fig. 6.Radiation pattern of the proposed TMSA

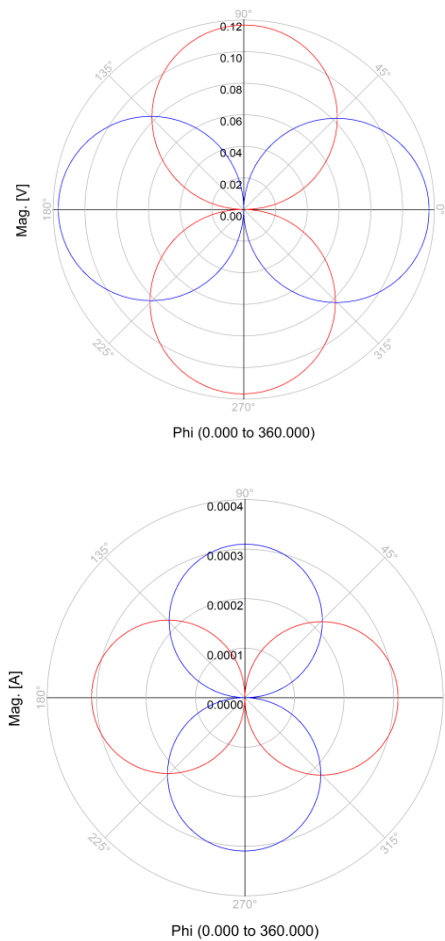


Fig.7. E and H fields of the proposed TMSA

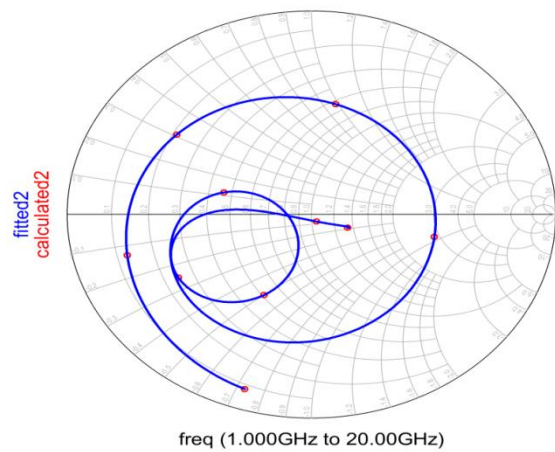


Fig. 8. Smith chart representation

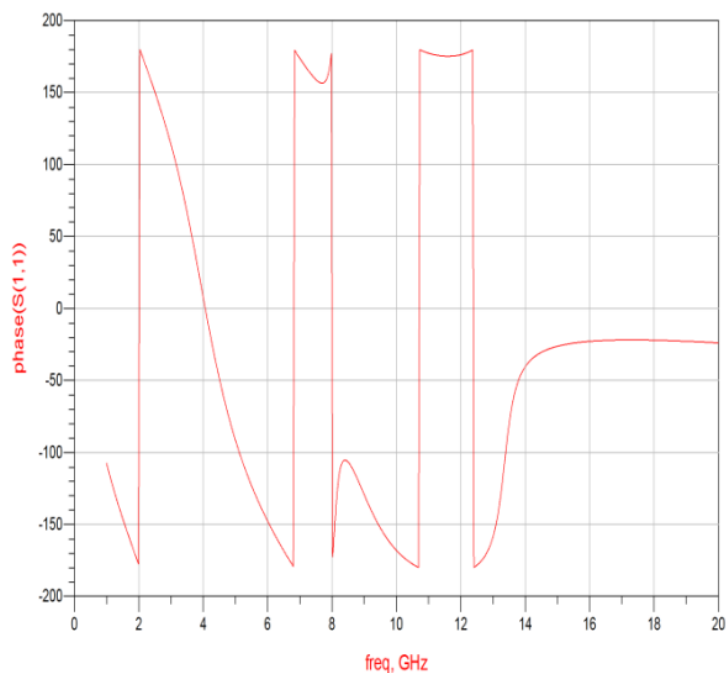


Fig.9.Relationship between frequency and phase

The radiation efficiency is higher than 85% suitable for radar and Ku band applications.

IV CONCLUSION

A new type of dual band equilateral triangular microstrip antenna has been proposed and analysed. This prototype that is suitable for radar and Ku band applications in the 8GHz and 13.4GHz has been studied. Three triangular patches printed on same substrate. The compact dual band TMSA achieves desirable radiation pattern with the gain of 5.1dBi for 8GHz and 13.4 GHz. Thus it may find applications in radar and Ku band applications. An additional resonant frequency could be achieved by cutting triangular patch on the ground plane.

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