A ± 45^0 Dual-Polarized Equilateral Triangular Dielectric Resonator Antenna

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Abstract— A ±45^0 dual-polarized dielectric resonator antenna operating at 5.5 GHz is presented. The slant polarization is achieved by edge feeding the equilateral triangular dielectric resonator through a conformal strip. The proposed antenna exhibits an impedance bandwidth of 12.04% (5.23-5.90 GHz) for both the ports and the port-to-port isolation is better than 15 dB throughout the bandwidth. The antenna radiates along the broadside direction and the difference between the co-polar and cross polar field is 15 dB in both the planes. The diversity performance of the antenna is found to be good with envelope correlation coefficient below 0.014. The proposed antenna is suitable for WLAN applications.

Keywords-conformal feed, dielectric resonator antenna, polarization diversity, slanted polarized

I. INTRODUCTION

In modern wireless communication systems, dual-polarized antennas have gained enormous attention and are widely applied to combat multipath propagation effects and to enhance channel capacity and signal reliability. The dual-polarized antennas with horizontal (H) and vertical (V) polarization have been studied in the past [1]-[2].

However, the symmetrical propagation characteristics of ±45^0 slant polarized antennas make them preferable over the H/V counterparts for certain applications such as base station [3]. Several ±45^0 dual-polarized antennas have been reported to mitigate multipath fading problem and to enhance channel capacity in modern wireless communication [4]-[6]. Furthermore, the advantage of using ±45^0 slanted polarization as compared to H/V polarization has been demonstrated in [7] for wireless cellular communication in urban environment and in [8] for indoor wireless communication link.

Compared to conventional microstrip antennas, the dielectric resonator antennas (DRAs) have several attractive advantages such as small size, low loss, high radiation efficiency (due to lack of surface wave and conductor losses), relatively wide bandwidth etc [9]. Moreover, different modes with diverse radiation characteristics can be excited within a single DRA which makes it a potential candidate for diversity applications.

In this paper, a ±45^0 dual-polarized DRA operating at 5.5 GHz is presented. The slant polarization is obtained by exciting the equilateral triangular DR by a conformal strip located at the edge the DR. All the simulations are done using Ansoft HFSS.

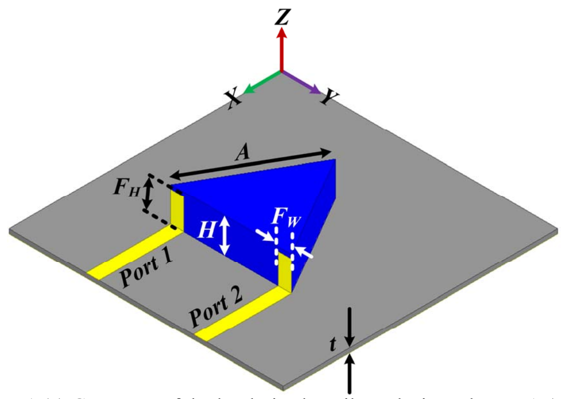

Figure 1 (a) Geometry of dual polarized equilateral triangular DRA (A=22, H=6.25, F_H=5.5, F_W=2.4, t=0.787, all dimensions are in mm)

II. ANTENNA DESIGN

Figure 1 shows the schematic of proposed dual-polarized equilateral triangular DRA. The antenna is excited by a conformal strip of height F_H and width F_W, situated at the edge of the triangular DR. The feed is printed on one side of a low permittivity substrate (ε_r=2.2, tanδ=0.0009) having dimensions 50×50×0.787 mm^3, whereas the ground plane is printed on the other side. The triangular DR is made of RT/Duriod 6010 of relative permittivity 10.2. The dimensions of the DR are given in the caption of Figure 1.

III. RESULTS AND DISCUSSIONS

The simulated response of the dual-polarized antenna is shown in Figure 2. The simulated resonant frequency of the proposed antenna is 5.5 GHz and agrees with the theoretical value of 5.42 GHz which is calculated using the equations given in [10]. The impedance bandwidth of the antenna is 12.04%, covering 5.23-5.90 GHz frequency band and the isolation between the ports is below 15 dB across the bandwidth.

Figure 3 depicts the electric field distribution in the equilateral triangular DR at 5.5 GHz, where the fundamental TM_{101} mode is excited. Since, the triangular DR is excited from the edge, the electric field vector is tilted at an angle of 45^0 with respect to the x-axis.

Figure 4 depicts the 3D radiation pattern of the proposed antenna for both the ports. It is observed that antenna radiates

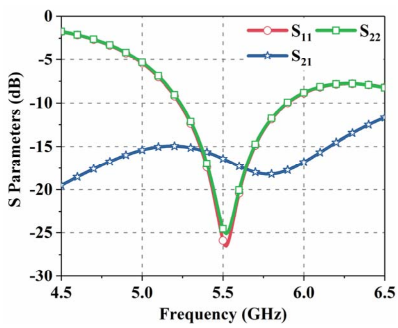

Figure 2 Simulated response of the proposed antenna

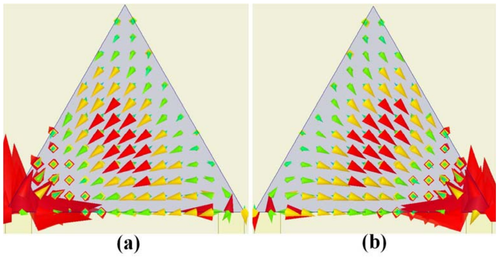

Figure 3 Electric field distributions at 5.5 GHz (a) *Port 1* (b) *Port 2*

in the broadside direction and exhibits the change of polarization with change of excitation port (-45^0 for *Port 1* and +45^0 for *Port 2*) without much variation in the radiation pattern. This confirms the polarization diversity nature of the antenna. Figure 5 shows the radiation pattern in the two planes. The cross polar level in both the plane is below -15 dB and the peak gain at the operating frequency is 6.67 dBi for both the ports.

IV. Diversity Performance

Diversity performance of the proposed antenna is evaluated in terms of envelope correlation coefficient (ECC). ECC measures the amount of correlation between the communication channels. Under the uniform propagation scenario, ECC can be computed using 3D radiation pattern as [11]

$$\rho_{eij} = \frac{\left| \iint_{4\pi} [\vec{F}_i(\theta,\phi) * \vec{F}_j(\theta,\phi)] d\Omega \right|^2}{\iint_{4\pi} |\vec{F}_i(\theta,\phi)|^2 \, d\Omega \iint_{4\pi} |\vec{F}_j(\theta,\phi)|^2 \, d\Omega}$$

where $\vec{F}_i(\theta,\phi)$ is the 3D field radiation pattern of the antenna when the i^{th} port is excited and Ω is the solid angle.

The computed ECC is below 0.014 over the entire operating band, which lies within the acceptable limit (ECC<0.3 [11]), indicating effective diversity performance.

V. Conclusion

A ±45^0 dual linearly polarized equilateral triangular dielectric resonator antenna has been proposed. The slant polarization is achieved by exciting the triangular DR by a conformal strip located at the edge of the DR. The proposed antenna exhibits an impedance bandwidth of 12.04% (5.23-5.90 GHz) for both the ports and the inter port isolation < 15 dB has been

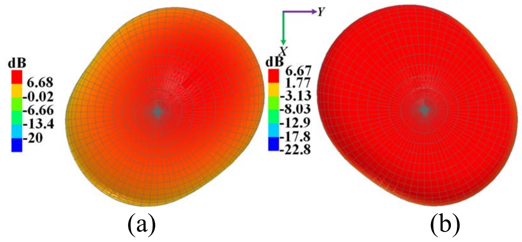

Figure 4 3D radiation pattern of the dual-polarized DRA (a) *Port 1* (b) *Port 2*

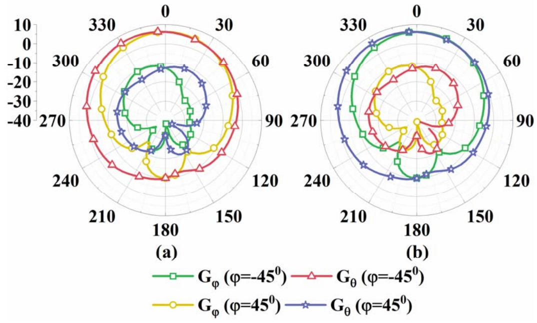

Figure 5 Simulated radiation pattern of the dual-polarized DRA (a) *Port 1* (b) *Port 2*

achieved over the bandwidth. The antenna radiates in the broadside direction with the cross polar level below -15 dB and the peak gain of 6.67 dBi has been achieved at the operating frequency. The antenna shows a good diversity performance with ECC below 0.014 throughout the operating band.

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