EXCITATION OF LOW-PROFILE EQUILATERAL-TRIANGULAR DIELECTRIC RESONATOR ANTENNA USING A CONDUCTING CONFORMAL STRIP

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ABSTRACT: *A new configuration that employs a conducting conformal strip to excite the low-profile equilaterial-triangular dielectric resonator antenna (DRA) of very high permittivity is proposed. As compared with*

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the previous aperture-coupling configuration, the new configuration has a wider impedance bandwidth (~ 5.5%) and a higher front-to-back radiation ratio. The return loss, radiation patterns, and antenna gain are measured and discussed.

Key words: *conducting conformal strip; low profile; dielectric resonator antenna of very high permittivity*

I. INTRODUCTION

The dielectric resonator antenna (DRA) [1] is an attractive radiator because of its inherent merits of small size, low cost, no conductor loss, and high radiation efficiency. Traditionally, studies of DRAs have concentrated on using relatively low-dielectric-constant material ($\varepsilon_r \sim 5$–30) [1–4]. Using DRAs of very high permittivity, however, is becoming increasingly popular among DRA investigations [5–7]. The reason is that high-ε_r DRAs can be made low profile, and hence, the antenna size can be reduced significantly. This is important in DRA array design since a larger range for the spacing between array elements is allowed. For low-profile DRAs, the aperture coupling is the most popular excitation method [5–7]. However, under some circumstances, the coaxial probe would be a better choice to excite the antenna. For example, it is simpler to enjoy a coaxial probe to excite the DRA resting on the rooftop of a vehicle. Nevertheless, using the probe excitation has the drawback that a hole is needed to accommodate the probe. Moreover, in exciting the low-profile DRA, the probe will be very short if it is totally embedded inside the DRA. To have a good impedance match, the probe should penetrate through the low-profile DRA, and have a significant portion exposed to air. In other words, the DRA no longer will be low profile. All of these problems can be avoided by using a conducting conformal strip [2] since the strip is simply stuck on the surface of the DRA, and therefore, no extra space is needed. So far, the conducting conformal strip has only been applied to DRAs of relatively low ε_r [2–4]. In this letter, a newly designed high-ε_r and low-profile equilateral-triangular DRA excited by a conducting conformal strip is investigated experimentally. The new configuration achieves a wider impedance bandwidth (5.5%) when compared with the previous aperture-coupled design (3%) [7]. Moreover, a higher front-to-back radiation ratio is obtained in the new configuration [7] as the undesirable backlobe radiation in the previous configuration is avoided in the new one. In this letter, the return loss, radiation patterns, and antenna gain of the present configuration are presented.

II. ANTENNA CONFIGURATION

Figure 1 illustrates the configuration of the triangular DRA. A conducting conformal strip of length $L = 3$ mm and width $W = 2.5$ mm is stuck in the middle part of one side of the equilaterial-triangular DRA, which has a side length $a = 20$ mm, thickness $h = 0.98$ mm and $\varepsilon_r = 82$. The conducting conformal strip is soldered to the coaxial probe of an SMA connector. A 210 × 210 mm square aluminum plate is used as the DRA ground plane.

III. RESULTS

The measured return loss of the equilateral-triangular DRA is shown in Figure 2. Referring to the figure, the resonance of the antenna, where $|S_{11}|$ is minimum, occurs at $f = 8.8$ GHz. The theoretical resonant frequency for the triangular DRA can be calculated by using the formula given in [7], where it frequency band used in many wireless communication applications, the patch size would be only 2 cm × 2 cm and 1.6 cm thick, which is small enough for many applications.

The effects of the size and placement of the notches on the operation of the antenna were investigated next. The dimensions N, D, and D_2 were varied, where N governs the size of the notch and D determines the distance of the notch from the edge of the patch. If these dimensions are chosen correctly, a second resonance can be obtained at ~ 1.1 GHz while still maintaining the original resonance at ~ 490 MHz, thus producing an antenna with dual-band performance, as shown in Figure 2. The critical dimension required to match the upper resonance is D_2. If D_2 is greater than 10 mm, the upper resonance cannot be matched, and as D_2 is decreased, the bandwidth of the upper resonance increases. The bandwidth of the upper resonance remains approximately the same for values of N between 40 and 70 mm, but if N is less than 40 mm, the upper resonance cannot be matched. For large values of N, the bandwidth of the lower resonance is less than half of the bandwidth when the antenna is operating in single-band mode, but as N is decreased, the bandwidth of the lower resonance steadily increases, approaching the single-band mode bandwidth of 13.2%. As N is increased, the resonant frequency of the upper resonance decreases, while the resonant frequency of the lower resonance slowly increases. The optimal value of N is 50 mm, which gives a bandwidth of 8.72% for the lower resonance and 7.07% for the upper resonance.

Figure 3 shows the simulated radiation patterns at the center frequency of each band, 480.8 MHz and 1.11 GHz. The E-plane and H-plane patterns at 480.8 MHz are similar to those presented in [4], although the H-plane cross-polarization level of the shorted notched patch antenna is higher. At 1.11 GHz, both the E-plane and H-plane cross-polarization levels are approximately 10 dB lower than the copolarization levels in the broadside direction.

4. CONCLUSION

This letter reports simulation results of a probe-fed notched square patch antenna with a shorting post. The area of the patch is 94% smaller than the area occupied by a square half-wave patch, and the antenna maintains a bandwidth of 13.2%. A parametric study on the size of the notch was done, showing that, with the proper dimensions, this antenna can be made to operate over two frequency bands, although both of these bands have a smaller bandwidth than the single-band case.

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