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Broadband Cylindrical Dielectric Resonator Antenna Excited by Modified Microstrip Line — Source link

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Broadband cylindrical dielectric resonator antenna excited by modified microstrip line

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The impedance bandwidth of a high permittivity cylindrical dielectric resonator antenna excited by a microstrip line was significantly improved by modifying the feed geometry. The 10 dB return loss bandwidth is enhanced from 12 to 26% without much affecting the gain and other radiation properties of the antenna. Good agreement has been observed between the predicted and measured results.

Introduction: In the recent past dielectric resonators (DRs) have been used extensively in shielded microwave circuits as oscillators and filters [1]. It has also been reported that open cylindrical DRs, mounted on top of large ground planes can serve as an effective radiator [2]. Dielectric resonator antennas (DRAs) offer several advantages including mechanical simplicity, large impedance bandwidth, simple coupling schemes to all commonly used transmission lines, different radiation characteristics by exciting different modes of the resonators and high radiation efficiency owing to the absence of conductor losses [3]. Moreover the size and operating bandwidth of a DRA can be easily varied by suitably choosing the dielectric constant of the resonator material and its dimensions. Cylindrical DRAs have attracted much attention owing to their wide applicability in wireless communication techniques [4]. Recently Lethakumari *et al.* reported [5] wideband microstrip patch antennas excited employing T-shape microstrip line methods. In this Letter we present the effect of feed geometry variations on the characteristics of a cylindrical DRA.

Antenna configuration: The configuration of the proposed cylindrical DRA is shown in Fig. 1. It comprises a DR of diameter $D = 24.15$ mm and height $H = 6.81$ mm fabricated using low-loss $Ca_5Nb_2TiO_{12}$ [6] ceramic of dielectric constant $\varepsilon_{dr} = 48$. The DR is energised by a 50 Ω T-shaped microstrip line of width 3 mm, extends a length of $S_1 = 50$ mm and arm length $S_2 = 30$ mm printed on a substrate of thickness $h = 1.6$ mm and dielectric constant $\varepsilon_r = 4.28$. The cylindrical DRA is excited at the broadside TM_{110} mode. The return loss, radiation pattern and antenna gain are measured and the results compared with simulated values (Micro-stripes, 6.5).

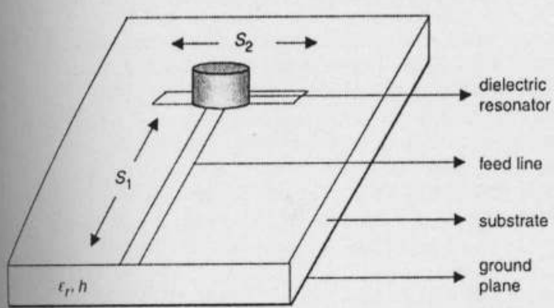

Fig. 1 *Geometry of proposed cylindrical dielectric resonator antenna*

Results and discussion: The antenna characteristics were measured using conventional as well as modified microstrip line excitation in T-symmetry. The arm length S_2 was optimised for maximum impedance bandwidth, fixing S_1 at 50 mm. In each case the position of the DR on the feed line was optimised for maximum impedance bandwidth. The per cent bandwidth of the cylindrical DRA excited using a T-shaped microstrip line with different arm lengths is shown in Fig. 2. With $S_2 = 0$ mm, the feed geometry reduces to a simple microstrip line. In this case, maximum impedance match was obtained at 2.62 GHz, when the DR was placed symmetrically over the feed line with its geometric centre at $S_1 = 36$ mm. With this configuration the 2:1 VSWR bandwidth is 2.459–2.773 GHz (12%) as depicted in Fig. 3. The per cent bandwidth attained a maximum value when the arm length of the T-geometry reached $S_2 = 30$ mm. In this case, the position of the DR for maximum bandwidth was optimised to be at the junction of the T-shaped stripline as shown in Fig. 1. Bandwidth of 26% (2.4–3.075 GHz) at a resonance of 2.6 GHz was obtained. The measured bandwidth and resonant frequencies in both cases were close to the simulated values as is evident from Fig. 3. It is worth mentioning that the proposed antenna configuration provides much better impedance bandwidth than that reported in similar earlier cases [7, 8].

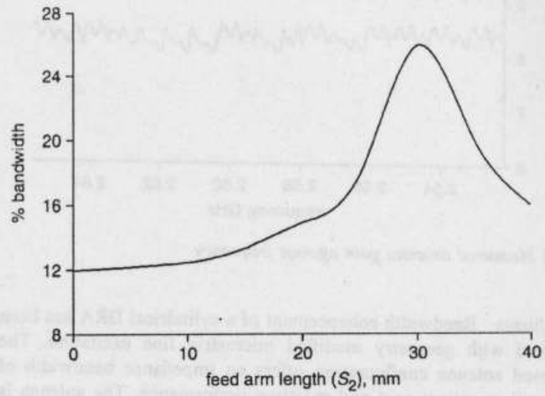

Fig. 2 ***Variation of per cent bandwidth with arm length (S_2)***

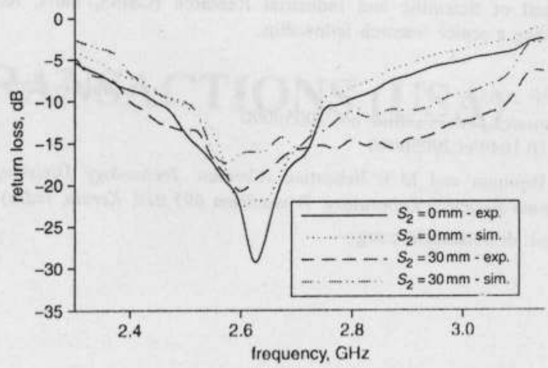

Fig. 3 *Variation of measured and predicted S_{11} with frequency*

The E-plane and H-plane patterns at the centre frequency of the cylindrical DRA excited on a T-shaped microstrip line feed are shown in Fig. 4. The patterns are similar to those of a short electric dipole, which is typical of the radiation patterns of DRAs operating in the fundamental $TM_{11\delta}$ mode. The ripple in the pattern was due to scattering from finite edges of the ground plane onto which the DRA was mounted. The cross-polarisation level was measured to be about 20 dB below the co-polarisation pattern. At the resonant frequency the HPBW of the antenna in the E- and H-planes are 120° and 90°, respectively. Fig. 5 shows the gain of the antenna configurations in the broad side ($\theta = 0$) direction in the operating band. The cylindrical DRA excited using a T-shape microstrip line has a gain of 9.2 dBi when the arm length $S_2 = 0$ mm and that of the proposed antenna with feed arm length $S_2 = 30$ mm has a gain of 8.5 dBi, as evident from Fig. 5.

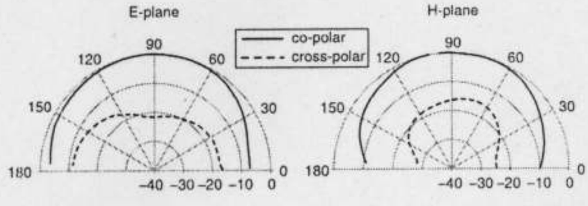

Fig. 4 *Measured radiation pattern of proposed cylindrical DRA at 2.62 GHz*

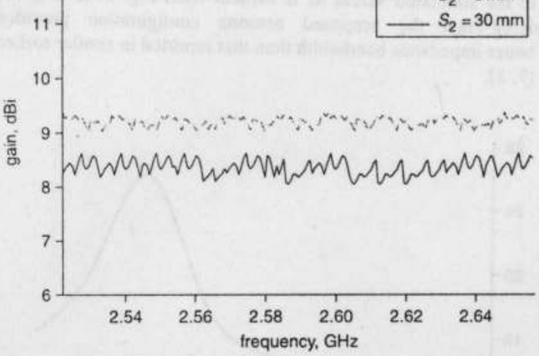

Fig. 5 *Measured antenna gain against frequency*

Conclusion: Bandwidth enhancement of a cylindrical DRA has been achieved with geometry modified microstrip line excitation. The proposed antenna configuration offers an impedance bandwidth of 26% with excellent gain and radiation performance. The antenna is very easy to design and fabricate and ensures light weight owing to the low density of the DR material used.

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