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Study of Cylindrical Antenna Structure With 50Ω Microstrip Transmission Line

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ABSTRACT

In this present paper, we studied about cylindrical antenna structure with 50Ω microstrip transmission line. Due to these two properties the Dielectric resonators have been found worthy of applications in microwave and millimeter wave antennas. An interesting feature of DR is that certain low-Q modes can be excited, which can radiate energy rather than confining it over a considerable frequency band.

Keywords: Antenna, Metal Strip Grating, Fabry-Perot Cavity, Microstripline.

I. INTRODUCTION

It has already been found in experiment that the Q-factor of dielectric resonators is very high and it has very low conduction loss. Due to these two properties the Dielectric resonators have been found worthy of applications in microwave and millimeter wave antennas. An interesting feature of DR is that certain low-Q modes can be excited, which can radiate energy rather than confining it over a considerable frequency band [1-4]. Radiation characteristics of various modes can be different. For example, modes like HEM11δ, TE01δ and TM11δ radiate maximum power in the bore sight direction but TM01δ operation produce a null in that direction. Excitation of a mode depends on the DR geometry, feed structure and the feed location. Among various feed structures [5-7], the simplest one is an open-ended microstrip transmission line [6] to excite the DRA. The amount of coupling depends on the distance between the tip of the strip and the centre of the DR which may burdened as the overlapping distance. This is one way of tuning a DR where the resonant frequency is a function of its position on the feed. Section of a non-resonant microstrip line coupled to the DR has been shown as an effective tuning element [8]. By correctly selecting the length of the microstrip tuning line, a known range of reactance can be added to the resonator. It has been shown [9] that conducting strip loading on the DR surface can enhance the impedance bandwidth and can change the polarization characteristics. The present design shows how the impedance bandwidth of a cylindrical DRA can be enhanced by adding a parasitic coplanar strip adjacent to the microstrip feed. At an optimum strip position and dimensions, dual radiating modes of similar polarizations are excited in close vicinity to form a linearly polarized, wide impedance band.

II. MATERIAL AND METHODS

The antenna structure is shown in Fig. 1. A cylindrical DR of permittivity ε_{r1} ==22.6., diameter 2a =28 mm and height h =8.0 mm is fed with a 50Ω microstrip transmission line of 80 mm(length) × 3 mm(width), fabricated on a microwave substrate of permittivity e_{r2}= 4 and size 140 mm(length) × 110 mm(breadth) × 1.64mm(thickness). The condition that er1 > e_r2 for efficient coupling between the strip line and the DR is satisfied here. The microstrip feed provides a much easier means of optimizing the feed position. The transmission line is excited via a 50Ω SMA connector soldered to its one end. Reflections from the open end of the microstripline produces standing waves of wavelength $\frac{\lambda 0}{\sqrt{\epsilon r}}$ where λo is the operating wavelength. If the DR is located at the point of maximum electric field on the feed, maximum energy is coupled capacitive. Antenna measurements have been made with HP 8510C Vector Network Analyzer. The reflection (S), impedance (Z) and radiation (S12) characteristics of the DRA are measured and discussed in the following sections.

III. RESULTS AND DISCUSSION

The DR is placed off-centered on the microstrip feed line which excites the broadside HEM mode. The theoretical resonant frequency of HEM 11d mode is given as:

$$f_o = \frac{6.324c}{2\pi a}\left[0.27 + 0.36\left(\frac{a}{2h}\right) + 0.02\left(\frac{a}{2h}\right)^2\right] \quad \text{---------------------} \quad 1$$

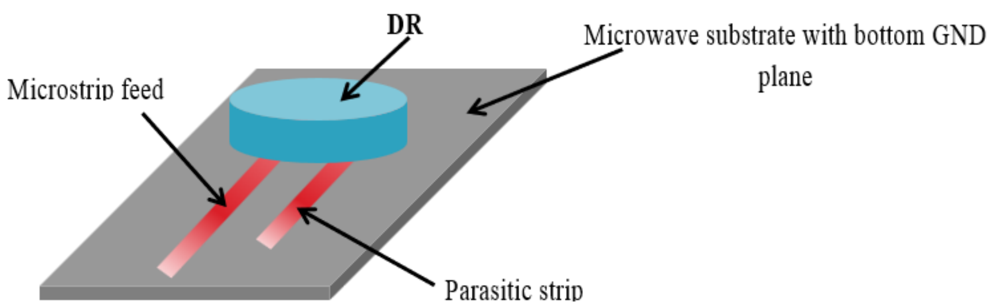

Figure 1. Antenna structure side view

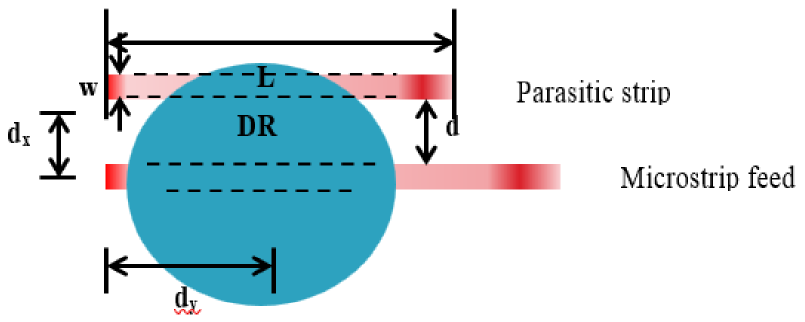

Figure 2. Antenna structure top view

Where c is the velocity of light. The frequency is calculated as 2.67 GHz which is quite close to the measured value of 2.605 GHz as shown in Fig. 2. It is clear from the figure that the return loss is below -10 dB over a bandwidth of 7.37% ranging from 2.545 to 2.74 GHz. This wide impedance bandwidth is the result of the low Q-factor of the excited HEM mode. The measured input impedance as a function of frequency shows relatively good and uniform impedance matching throughout the band.

IV. CONCLUSIONS

A coplanar parasitic strip loaded DRA has been presented in this section. The antenna offers an impedance bandwidth of 17.33% at the centre frequency of 2.77 GHz. It also produces linear polarization of the radiation throughout the band. The wide impedance bandwidth is the result of dual radiating modes, which are excited in close vicinity as a result of the strip loading. Radiation patterns are found to be broad over the entire bandwidth with good cross-polarization levels. The possibility of shifting the operating band to the wireless application band is under investigation.

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