Review Paper for Dielectric Resonator Antenna

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Abstract

Dielectric resonator antenna with its circulator characteristics and radiation properties are presented in this paper. Dielectric resonator antenna replaced the traditional radiating element, especially for the high frequency range. Dielectric resonator antenna has high radiation efficiency and large bandwidth resistance. In this paper, comparison of different paper has been presented with updated literature survey.

Keywords

Microstrip Antenna, Dielectric resonator antenna, high Gain and large bandwidth resistance, isolation.

I. Introduction

The microstrip antennas [1] are considered to be a key component for these applications due to its advantages such as, low profile, low cost, ease of integration with microwave integrated circuits (MIC) and light weight. It consists of a perfect conducting patch over a thin dielectric material called the substrate that is placed above a ground plane. There are many different patch shapes such as the rectangular, circular, is, circular ring, triangular and hexagonal [2]. There are various techniques for feeding the antenna such as microstrip line feed, coaxial probed feed, aperture-coupled and electromagnetically coupled [3]. The major disadvantages of microstrip antennas are low power handling capability and narrow bandwidth . There are continuous works for increasing the bandwidth using different techniques. One of them is using the dielectric resonator antenna which has enormous advantages over traditional radiating elements . Dielectric resonator antenna has wider impedance bandwidth, large gain, and negligible dielectric loss, ease of integration with other antenna and high temperature tolerance and flexible excitation techniques.

One of the design constraints on the new mobile handset generation is antenna-size miniaturization, as more antennas need to be integrated in the same handset to support multiple standards. Furthermore, antennas need to maintain good performance in terms of bandwidth, gain, and radiation pattern [4]. PIFA antennas are widely used in mobile phones due to their small-size and moderate performance. Size reduction of PIFA antennas can be achieved using several techniques. In, a small-size PIFA antenna operated at its one-eighth wavelength (λ/8) mode was proposed, the proposed PIFA constituted by two radiating strips of length about (λ/8) was fed using a coupling feed. Another mechanism to miniaturize PIFA antenna is to have slots in the ground plane to make the ground plane appear electrically longer. Although the slotted ground plane reduced the height of the antenna, this will add complexity in the design and housing of the mobile handset. Further, bandwidth becomes extremely narrow as antenna height is reduced. It was shown that the emitted power from current handset phones results in significant power loss absorbed by user's human head; thus, decreasing the efficiency and possibly the gain of the antennas [5,6].

It is the demand and appetite for innovations which is driving the overall rapid growth of wireless technology and literally changing people's lives in all sorts of useful ways [7]. Telecommunication industry is not the only market that benefits from the advances in wireless technology; the healthcare, medical diagnosis, treatment and monitoring systems, automotive production and industrial remote monitoring systems have also considerably gained from improvement of the wireless systems.

II. Literature Survey

In this section, comparison would be made by studying the research work done by authors of dielectric resonator antennas. Jonathan C. Johnstone [8] proposed an eight-port cylindrical dielectric resonator antenna (DRA) is presented for multiple-input and multiple-output (MIMO) systems. The antenna was defined by a cylindrical dielectric resonator with _r = 30. Four HE11_ modes are excited within the DRA by slots which are etched out of the ground plane of the FR-4 substrate onto which the DRA is mounted. Each of these slots was excited by two 50- microstrip transmission lines. In this design, DRA is placed on top of a 31 mil square. The design of antenna is shown in **Figure 1**.

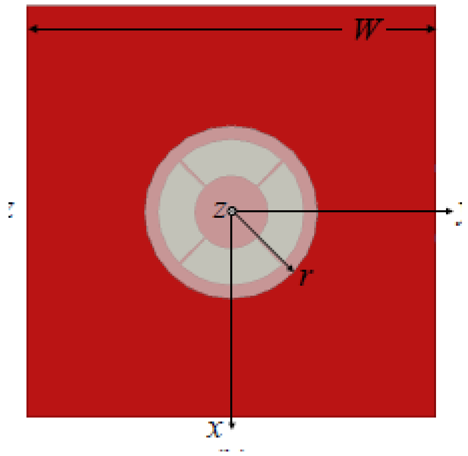


Figure 1 Top view with circular DRA

This antenna has a 7dB impedance bandwidth from 1.0 GHz to 1.62 GHz. In addition, the gain of the compact antenna unit is greater than 0 dB from approximately 1.175 GHz to 1.70 GHz defining a bandwidth of more than 35%.

Jamal Nasir [9] presented compact dual multiple input and multiple output (MIMO) dielectric resonator antenna with high resolution. In this paper author designed the dual port single element dielectric resonator antenna. The presented antenna was simulated with High Frequency Structure Simulator version 14. This DR antenna feed by two probe one touching the side wall of DR and other was drilled in the middle of DR. This antenna was suitable for the LTE application and high resolution. This design of antenna as shown below gave the isolation of 15 dB between the two ports (**Figure 2**).

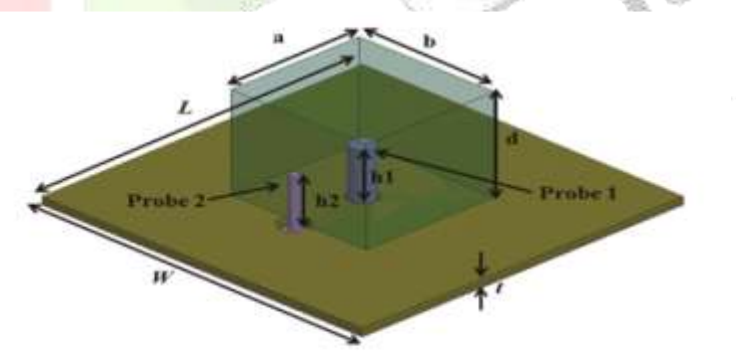


Figure 2 Rectangular shape DRA for High resolution

Shardul R. Borkar [10] proposed the wireless Multiple Input Multiple Output Dielectric Resonator Antenna is designed to resonate for Long Term Evolution (LTE) application bands. One metallic strip was introduced to extend the electrical length of second CPW port that was responsible to resonate the antenna for different frequencies. The impedance bandwidth obtained for port 1 and port 2 is (2.16-2.34 GHz) and (2.27-2.38 GHz) respectively. The diversity gain is obtained as 9.6 dB with correlation coefficient as 0.276 at 2.3 GHz. Author choose the rectangular shape because it provides one more degree of freedom than spherical and cylindrical DRAs, which can be used to control the impedance bandwidth of the antenna. The antenna gave broadside and bidirectional radiation pattern. It also gave good isolation between the two ports (**Figure 3**). The gain obtained is 4.95dBi for port1 and 4.5dBi for port 2. Furthermore, the proposed antenna had excellent correlation coefficient as 0.276 at 2.3 GHz.

Figure 3 DRA for LTE application

Abhishek Sharma [11] designed a two-element multiple-input–multiple-output (MIMO) dielectric resonator antenna having wideband characteristics. The author achieved the wideband characteristics by using the mushroom shaped dielectric resonator. The isolation accomplished by this antenna was larger than 20 dB between the two ports and radiation pattern was of broadside shape. It concluded that polarization diversity had been achieved and it also offered better bandwidth impedance. The design of antenna is shown below with mushroom DR (**Figure 4**).

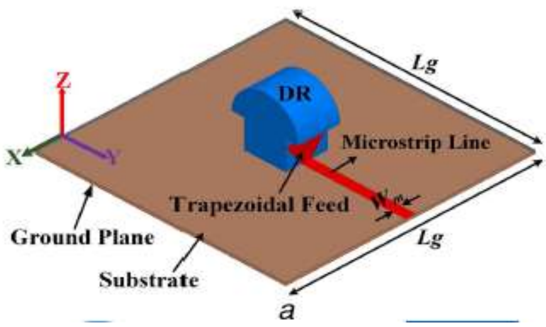


Figure 4 Mushroom shaped DR for high isolation

Kumar Mohit et al. presented a two-element dielectric resonator antenna configuration, designed by using a magnetodielectric material, excited by single co-axial feeding technique, by keeping them at the both sides of the co-axial probe for achieving the angle diversity (**Figure 5**). This material has been designed such that its temperature coefficient value is -1.02ppm/°C, which is near to zero. The microwave dielectric constant (εr) and permeability (μr) are determined by Hakki–Coleman dielectric resonator method and Nicholson-Ross-Weir conversion technique and found to be 8.02 and 1.64 respectively. The designed antenna shows its radiation toward two directions 46° and 308° at the resonance frequency of 4.81GHz, hence can be utilized for angle diversity. The bandwidth of the antenna is 400MHz, which is suitable for the application of Radiolocation and Fixed Mobile & Satellite communication. The obtained gain on both radiated directions is 2.93 dB and 3.72 dB respectively. This proposed antenna has been fabricated and there is good agreement between the simulated and measured results [12].

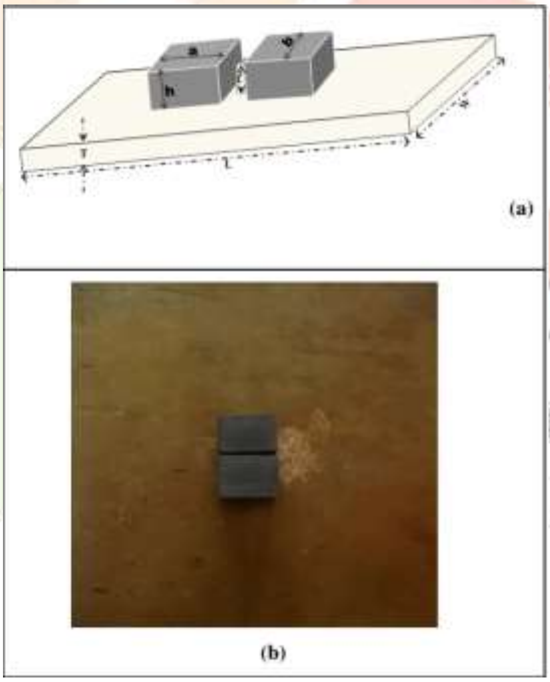
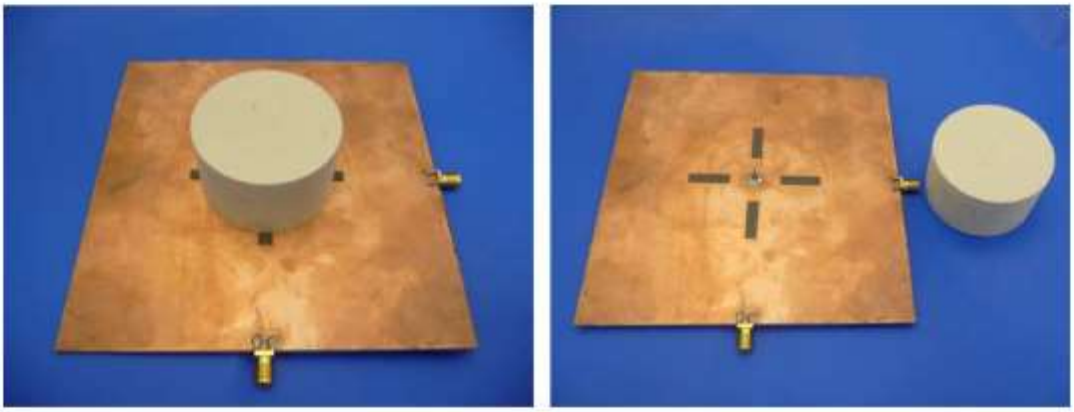


Figure 5 (**a**) The schematic representation of Antenna configuration and (**b**) photograph of Antenna configuration

Xiao Sheng Fang et al., [13] presented the three-port polarization-diversity cylindrical dielectric resonator antenna (DRA) for the first time. The design makes use of the $TM_{01\delta}$ and $HEM_{12\delta+1}$ modes of the cylindrical DRA. Using the covariance matrix adaptation evolutionary strategy, engineering formulas are obtained to determine the dimensions of the polarization-diversity cylindrical DRA for a given operating frequency and dielectric constant. To demonstrate the usefulness of the formulas, a three-port polarization-diversity cylindrical DRA was designed at 2.4 GHz for WLAN applications. The $TM_{01\delta}$ mode of the cylindrical DRA is excited with a coaxial probe and an omnidirectional radiation pattern is obtained. Two slot pairs are used to excite the broadside $HEM^x_{12\delta+1}$ and $HEM^y_{12\delta+1}$ modes of the cylindrical DRA. The reflection coefficient, port isolation, radiation pattern, and antenna gain of the antenna were simulated using ANSYS HFSS, while the envelope correlation was calculated from the S-parameters. Measurements were carried out to verify the simulations, and reasonable agreement between them is observed. Measured results show that the isolation between any two ports of the diversity DRA is over 24 -dB across the 10-dB impedance bandwidth. A parameter study was carried out to characterize the proposed DRA (**Figure 6**).

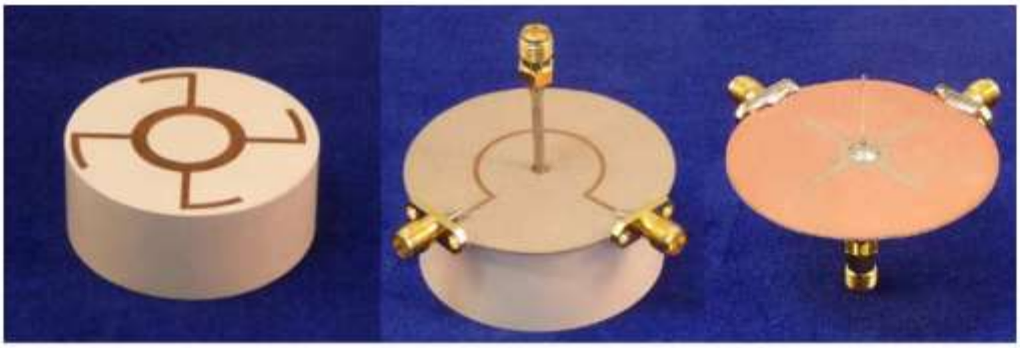


(a) (b)

Figure 6 Prototype of three-port polarization-diversity cylindrical DRA: (a) cylindrical DRA covering the probe and slots and (b) cylindrical DRA removed for showing the probe and slots.

Wei Wei Li et al., [14] presented a new compact omnidirectional circularly polarized (CP) cylindrical dielectric resonator antenna (DRA) with a top-loaded modified Alford loop is investigated. Fed by an axial probe, the DRA is excited in its $TM_{01\delta}$ -mode, which radiates like a vertically polarized electric monopole. The modified Alford loop comprises a central circular patch and four curved branches. It is placed on the top of the DRA and provides an equivalent horizontally polarized magnetic dipole mode. Omnidirectional CP fields can be obtained when the two orthogonally polarized fields are equal in amplitude but different in phase by 90^o . This CP DRA is applied to the design of a two-port CP diversity DRA which provides omnidirectional and broadside radiation patterns. The broadside radiation pattern is obtained by making use of the broadside

$HEM_{12\delta+1}$ -mode of the DRA, which is excited by a balanced slot serially fed by a microstrip line. For demonstration, both the omnidirectional CP DRA and the diversity CP DRA were designed at ~2.4 GHz for WLAN applications. Their S-parameters, axial ratios, radiation patterns, antenna gains, and antenna efficiencies are studied. The envelope correlation is also found for the diversity design. Reasonable agreement between the simulated and measured results is observed (**Figure 7**).



(a) (b) (c)

Figure 7. Photos of the CP pattern diversity DRA prototype. (a) Perspective view showing the top face of the DRA. (b) Perspective view showing the microstrip feedline. One of the horizontal ports is connected to a 50-load. (c) Perspective view showing the balanced slot and the coaxial probe.

III. Conclusion

In this work, study has been made on the different dielectric resonator antenna. Study concluded that Dielectric resonator antenna are good to provide the large isolation between the different port and it also provide the polarization diversity. It is also concluded that DRA has also numerous advantage over other antenna in the sense of radiation pattern, gain of the antenna and high impedance matching property.

IV. References

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