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Design, Fabrication and Analysis of Dielectric Resonator Antenna for Dual band Application

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ABSTRACT: In this paper, a novel method for increasing the bandwidth of an antenna is presented. When a dielectric resonator (DR) with h=1.5mm is placed on the centre of the radiating patch, the antenna resonates for dual band of frequencies. The material used in this study as dielectric material is Calcium Carbonate ($CaCO_3$) in circular shape. Experimentally measured results and design concepts are presented and discussed. This antenna may find application in the frequency of 9 to 18 GHz.

KEYWORDS: DRA, Microstrip antenna, bandwidth, HPBW, Gain.

I.INTRODUCTION

Wireless communication has been developed widely and rapidly in the modern world during last decades. The future development of the personal communication device will aim to provide image, speech and data communication at anytime and anywhere around the world. So, present time is witnessing a very rapid growth of wireless technology. To increase access, communication terminals must meet the requirements of multi-band or wide band to sufficiently cover the possible operating bands and for broader connectivity. Wireless technologies has also revolutionized in the field of information technology by making use of high speed internet and data transfer 'wire free' via mobile gadgets. In application in which increased bandwidth is needed for operation of two or more separate sub-bands, a valid alternative to broadening of the total bandwidth is the use of dual or multi-frequency microstrip antennas. [1].

The other disadvantage is the excitation of surface waves that occurs in the substrate layer. Surface waves are undesired because when a patch antenna radiates, a portion of total available radiated power becomes trapped along the surface of the substrate. It can extract total available power for radiation to space wave. Therefore, surface wave can reduce the antenna efficiency, gain and bandwidth. [2]

Recently introduction of Dielectric Resonator Antenna (DRA) made a significant break-through in the improvement of microstrip antenna characteristics. DRA is energized by placing the material on the radiating patch of microstrip antenna; this disturbs the shield current distribution which influences the input impedance and current flow of the antenna. [3]

Many shapes of DRA have been studied for single element microstrip antenna such as rectangle, square, semi-sphere [4-6]. This paper discusses the influence of circular shape DRA towards the improvement of impedance bandwidth and radiation properties.

II.ANTENNA DESIGN

The proposed antenna is designed using low cost glass epoxy material having dielectric constant ϵ_r = 4.2 and thickness h = 16.6 mm. Figure 1 shows the geometry of DRA. An optimized circular DR of radius r = 11 mm, h_{1dr} = 1.5 mm with dielectric constant ε_r in the range of 8.2-9.2 is placed on the U-slot rectangular microstrip antenna of dimension L = 52.3

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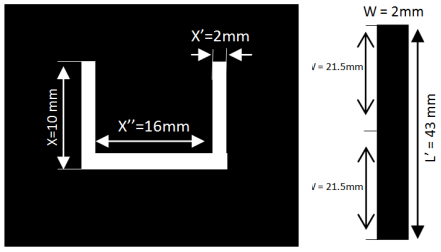
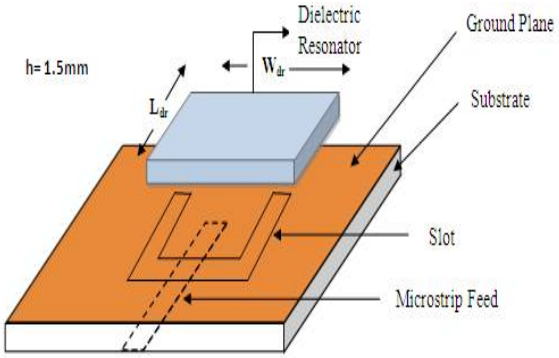
mm and width W = 44.8 mm. A 50 Ω microstrip feed line with L_f = 43 mm and W_f = 2 mm. At the tip of microstrip feed line, a 50Ω coaxial SMA connector is connected for feeding microwave power. If the dimensions of the DR are chosen such that L_{dr}, W_{dr}>>h_{dr}, then the simple relation for h_{dr} in terms of resonance frequency f_o is given as;

$$h_{dr} = \frac{C}{4 f_0 \sqrt{\epsilon_r}} = \frac{\lambda_0}{4\sqrt{\epsilon_r}} \quad \text{..... (1)}$$



(a) U-slot and Feed



(b) With DR
Fig. 1 Antenna Geometry

III.EXPERIMENTAL RESULTS

The experimental study is carried out by placing the Dielectric Resonator (DR) of height h = 1.5 mm on the centre of the U-slot in order to achieve maximum impedance bandwidth. The impedance bandwidth for the proposed antenna is measured at 4 to 18 GHz frequencies. The measurements are taken on Vector Network Analyzer (Rohde & Schwarz, German make ZVK Model No. 1127.8651). Fig. 2 shows the reflection coefficient versus frequency graph of DRA. From this figure the impedance bandwidth is calculated by using the equation:

$$BW = \frac{f_H - f_L}{f_c} \quad \text{..... (2)}$$

where f_H and f_L are higher and lower cut-off frequencies of the band, respectively, and f_c is the centre frequency.

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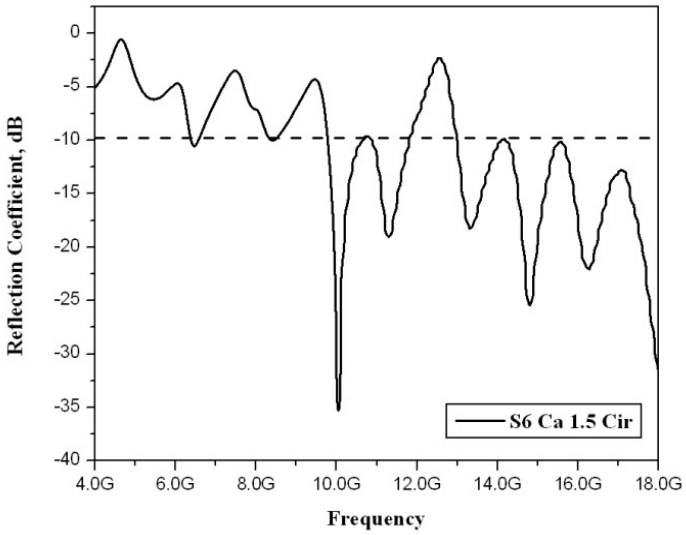

Fig. 2 Reflection coefficient versus frequency graph

From Fig. 2 it is observed that the DRA resonates for dual band of frequencies with a magnitude of 1991 MHz (18.41%) and 5010 MHz (32.33%). The minimum reflection coefficient is found to be -36.006 dB. The VSWR of the proposed antenna is also measured using VNA and is found to be 1.034.

The X-Y plane co-polar and cross-polar radiation pattern of the proposed antenna is measured at the resonating frequencies and the figure indicates that the antenna shows broader side radiation characteristic as shown in Figure 3.

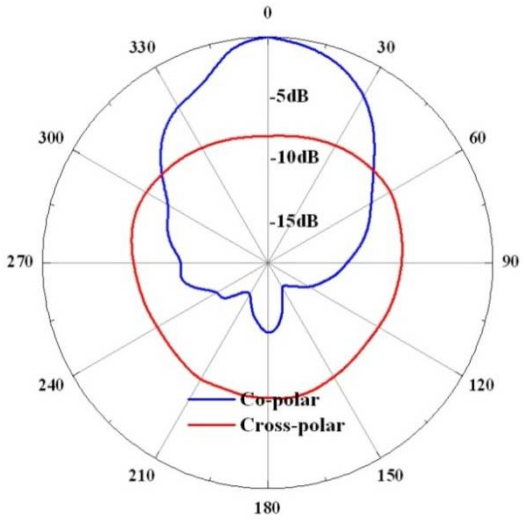

Fig. 3 Radiation Pattern at 10.02 GHz

To find the gain, the power transmitted (P_t) by the pyramidal horn antenna and the power received (P_s) by proposed antenna is measured separately. Gain of antenna under test (G_T) in dB is calculated using the formula: [7]

$$(G_T)\ dB = (Gs)\ dB + 10\log\ (P_t/P_s) \qquad \text{..... (3)}$$

where Gs is the gain of pyramidal horn antenna. From the analysis obtained gain of the proposed antenna 15.57 dB.

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Further, as the DRA gives dual band, its variation of input impedance is shown in Fig. 4. It is seen that the input impedance has multiple loops at the centre of Smith chart that validates its wideband operation and dual band operation.

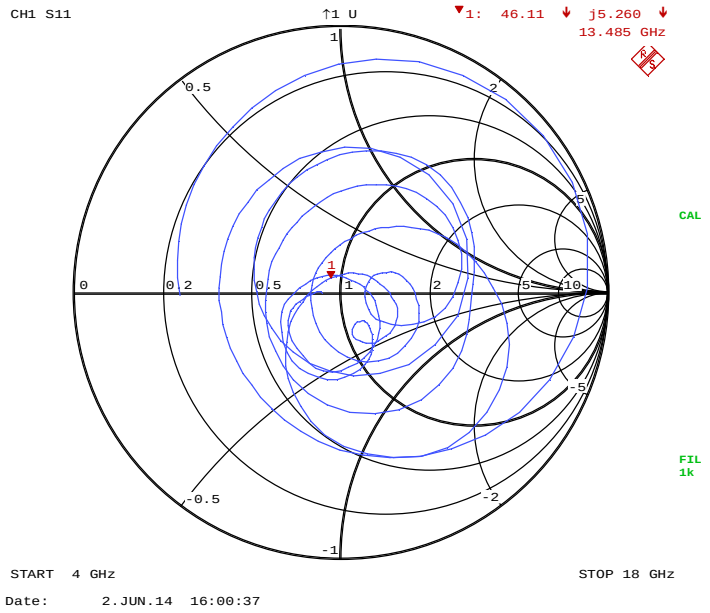

Fig. 4 Smith chart of proposed antenna

IV.CONCLUSION

From the study, it is clear that the proposed antenna is quite simple in design and fabrication and good in enhancing the impedance bandwidth. A dual band is obtained by placing a dielectric resonator on the centre of the U-slot. The experimental result shows the proposed antenna gives better gain of 15.57 dB with broader side radiation pattern at the resonating frequency. The proposed antenna is useful for modern wireless communication where dual wide band antenna is needed in the frequency range of 9 to 18 GHz.

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REFERENCES

[1] K. L. Wong, “Compact and broadband microstrip antennas”, John Wiley & Sons Inc., New York, 2003.
[2] S.L. Mallikarjun and P.M. Hadalgi, “Study on Effect of Defective Ground Structure on Hybrid Microstrip Array Antenna”, Wireless and Mobile Technologies, Vol. 1, No.1, pp.1-5, 2013.
[3] Shailashree S, S.L. Mallikarjun and P.M. Hadalgi, “Design, Fabrication and Analysis of Wideband High Gain Dielectric Resonator Antennas”, International Journal of Electronics and Communication Engineering & Technology, Vol.5, No.1, pp.56-62, July, 2014.
[4] Qinjang Rao, A T Denidmi & A R Sebak, “Study of broadband dielectric resonator antennas”, Progress in Electromagnetic Research Symposium (China), 137, 2005.
[5] A V Praveen Kumar, V Hamasakutty, Y Yohannan & K T Mathew, “Microstrip fed cylindrical dielectric resonator antenna with a coplanar parasitic strip”, Prog Electromag Res- PIER (China), 60, pp 143-152, 2006.
[6] K W Leung & H K Ng, “The slot-coupled hemispherical dielectric resonator antenna with a parasitic patch Applications to the circularly polarized antenna and wideband antenna”, IEEE Antennas Propag Mag (USA), 53, 1762, 2005.
[7] Constantine Balanies A, Antenna Theory Analysis and Design (John Wiley & Sons Inc.., New York) 1982.

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