Bandwidth Enhancement for Dielectric Resonator Antenna using Modified Microstrip Patch Feeding Technique

Rajeswari. P[1], Gopinath. A[2], Aswitha. J[3], Abilasha Jayan. J[4], Vetri Selvi. A[5]
[1]Assistant Professor, [2,3]B.E-Final Year
[1,2,3,4,5] Department of Electronics and Communication Engineering
Velammal College of the Engineering and Technology, Madurai

Abstract **- A dielectric resonator antenna with modified microstrip patch feeding structure is proposed to enhance the bandwidth. The performance of the novel technique is compared with the existing methodology. Simulated result of the proposed antenna shows that this antenna provides -17dB impedance bandwidth and return loss is less compared to the existing method. This proposed DRA has high bandwidth and high efficiency.**

Keyword: DRA (dielectric resonator antenna), Modified microstrip feeding, return loss, high bandwidth.

I INTRODUCTION

Dielectric Resonator Antenna has become popular among antenna engineers. Due to numerous features of a dielectric resonator antenna(DRA) such as small size, low loss, wide bandwidth, ease of excitation, high radiation efficiency, and compatibility to various feeding techniques[1]-[6]. Traditional microstrip antennas have more conduction losses, less bandwidth, and low radiation efficiency. That is why, to overcome these problems, DRA is another option for the researcher in modern wireless communication systems. Multi-segment DRA or stacked DRA has been proved to be an effective approach to broaden the impedance bandwidth. It uses a combination of dielectric layers with different permittivities to function as a whole DRA. Impedance bandwidth up to 20% or even wider can be achieved by either placing the dielectric layer of low permittivity under or above the layer of high permittivity.

The material used for the substrate of existing method is glass with dielectric permittivity of 6.5 and for the resonator is ceramic material with dielectric permittivity of 9.8.

The material of the substrate in proposed model is FR4 and that of the resonator is ceramic. Thus the size of the proposed model is reduced. This is very much useful in wireless application as today's world is using miniaturized technologies.

II DIELECTRIC RESONATOR ANTENNA

A dielectric resonator antenna (DRA) is a antenna mostly used at microwave frequencies and higher, the dielectric resonator is mounted on a ground plane. Radio waves are introduced into the inside of the resonator material from the transmitter circuit and it bounces back and forth between the resonator walls, forming the standing waves. The walls of the resonator are partially transparent to radio waves, allowing the radio power to radiate into space[2]-[10]. The basic structures of the dielectric resonator antenna are rectangular, hemispherical and cylindrical DRA. A circularly polarized cubic-shaped dielectric resonator antenna (DRA) was excited with a new question-mark-shaped microstrip feeding is shown in fig 1.

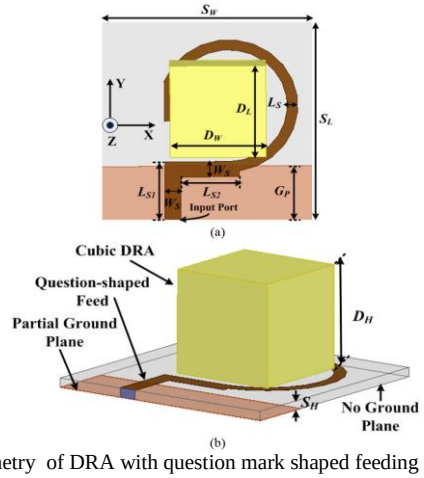


Fig. 1. Geometry of DRA with question mark shaped feeding technique (a) Top view. (b) 3-D view.

Fig 1. Shows the geometric structure of dielectric resonator antenna. A Simple cubic shaped resonator is placed above the question shaped microstrip feeding which gives -24.74dB impedance bandwidth (at center frequency 3.4 GHz. The dimensions are $D_L = D_W = D_H = 18$, $S_L = S_W = 40$, $S_H = 1.6$, $W_S = 3.5$,$L_S = 2$, $L_{S1} = 12$, $L_{S2} = GP = 11$ [all dimensions in mm].In this design, the ground plane substrate used is FR4 with dielectric constant of 4.4, and dielectric resonator is made of Al_2O_3 material with dielectric constant of 9.8[1].

This antenna is used mainly for Wi-MAX (3.3–3.7 GHz) applications[11]-[12].

(a)

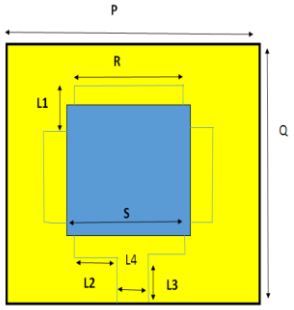
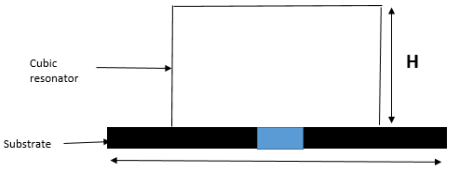


Fig 2a. Geometry of proposed structure

(a) Top view (b) side view

(b)



The geometry of the proposed cubic shaped dielectric resonator antenna with modified microstrip feeding is shown in fig 2a and fig 2b.The dimensions of the proposed structure is P = Q = 40, S = H = 20 , L1 = L2 = 3 , L4 = 3,L3 = 15. The material used for the substrate is FR4(ϵr=4.4) an the material used for the cubic resonator is ceramic material(Al_2O_3) with ϵr=9.8. In this letter, a cubic shaped dielectric resonator antenna was excited using a new Modified microstrip feeding to obtain high bandwidth. The proposed dielectric resonator antenna has a simple structure and feeding technique so design is easy. The results of this DRA show improvement in impedance.

III RESULTS AND DISCUSSIONS

The existing and proposed structure of the dielectric resonator antenna is simulated using Ansoft HFSS simulation tool.

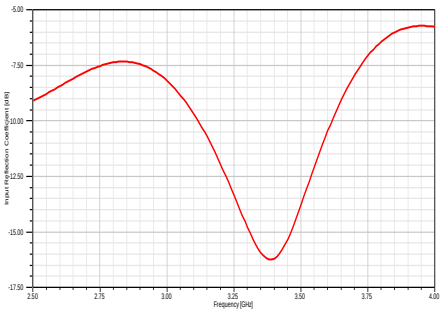


Fig 3.Reflection coefficient of existing DRA

The return loss of the existing DRA for the frequency range of 2.5 GHz-4 GHz is shown in fig 2. The simulated impedance bandwidth of the DRA is -10dB.the bandwidth of the proposed structure is increased.

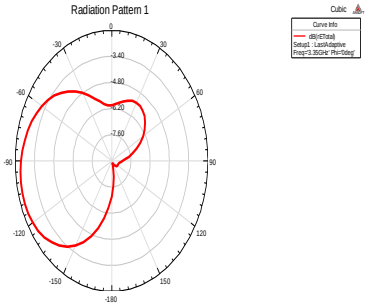


Fig. 3b. 2D Radiation pattern

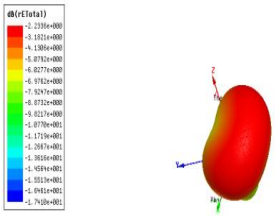


Fig 3c. 3D view of radiation pattern

The 2D view and 3D view radiation pattern of the DRA with question mark shaped Microstrip feeding is shown in the fig 3b and fig 3c. The reflection coefficient of the proposed structure for the frequency range of 2.5GHz-4GHz is simulated using Ansoft HFSS.

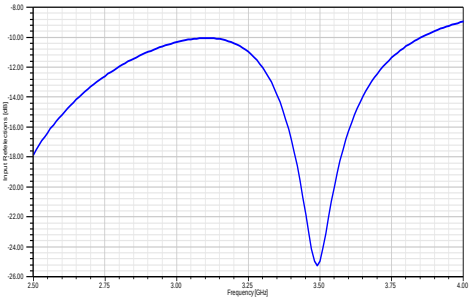
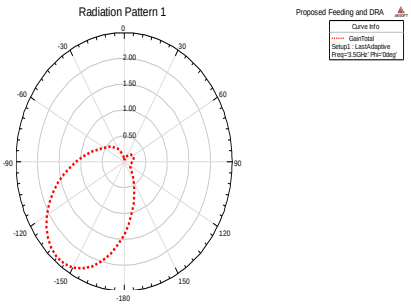


Fig 4a. Reflection coefficient of proposed DRA



Radiation pattern

Fig 4b.

The reflection coefficient of the proposed Structure with modified microstrip feeding is shown in fig 4a and the radiation pattern of the proposed structure is shown in fig 4b.The simulation result shows that the return loss of the proposed structure less compared to the exiting model and it is obtained for the range of 3.50-3.55GHz.The impedance bandwidth of the proposed structure is -17dB.

IV CONCLUSION

Thus in the proposed structure the bandwidth is increased and the return loss is reduced compared with the existing structure. The proposed dielectric resonator antenna has a simple structure and simple feeding technique. The simulated results show improvement in impedance and reduced return loss. It is mainly used in wireless application.

REFERENCE

[1] Rajkishor Kumar and Raghvendra Kumar Chaudhary "A Wideband Circularly Polarized Cubic Dielectric Resonator Antenna Excited With Modified Microstrip Feed" IEEE antennas and wireless propagation letters, vol. 15, 2016

[2] Sudipta Maity and Bhaskar Gupta "Experimental investigations on Wideband triangular dielectric resonator antenna" IEEE transactions on antennas and propagation, vol. 64, no. 12, december 2016.

[3] Saeed Fakhte, Homayoon Oraizi, and Ladislau Matekovits "High Gain Rectangular Dielectric Resonator Antenna Using Uniaxial Material at Fundamental Mode" IEEE Transactions on antennas and propagation, vol. 65, no. 1, january 2017.

[4] M. R. Nikkhah, J. Rashed-Mohassel, and A. A. Kishk, ''Compact lowcost phased array of dielectric resonator antenna using parasitic elements and capacitor loading,'' IEEE Trans. Antennas Propag., vol. 61, no. 4, pp. 2318–2321, Apr. 2013.

[5] M. K. Saleem, M. A. Alkanhal, and A. F. Sheta, ''Switched beam dielectric resonator antenna array with six reconfigurable radiation patterns,'' Int. J. RF Microw. Comput.-Aided Eng., vol. 26, no. 6, pp. 519–530, 2016.

[6] S. F. Roslan, M. R. Kamarudin, M. Khalily, and M. H. Jamaluddin, ''An MIMO rectangular dielectric resonator antenna for 4G applications,'' IEEE Antennas Wireless Propag. Lett., vol. 13, no. , pp. 321–324, 2014.

[7] L. Zou, D. Abbott, and C. Fumeaux, ''Omnidirectional cylindrical dielectric resonator antenna with dual polarization,'' IEEE Antennas Wireless Propag. Lett., vol. 11, pp. 515–518, 2012.

[8] M. R. Nikkhah, A. A. Kishk, and J. Rashed-Mohassel, ''Wideband DRA array placed on array of slot windows,'' IEEE Trans. Antennas Propag., vol. 63, no. 12, pp. 5382–5390, Dec. 2015.

[9] Jiajun Lia ,Shengli Zhang, "Orbital angular momentum (OAM) generation by cylinder dielectric resonator antenna for future wireless communication" journal of latex class files, vol. 14, no. 8, august 2015.

[10] M. Nikfalazar et al., ''Steerable dielectric resonator phased-array antenna based on inkjet-printed tunable phase shifter with BST metal insulator metal varactors,'' IEEE Antennas Wireless Propag. Lett., vol. 15, pp. 877–880, 2015.

[11] M. Khalily, M. R. Kamarudin, and M. H. Jamaluddin, "A novel square dielectric resonator antenna with two unequal inclined slits for wideband circular polarization," IEEE Antennas Wirel. Propag. Lett., vol. 12, pp. 1256–1259, 2013.

[12] J. Pan and M. Zou, "Wideband hybrid circularly polarised rectangular dielectric resonator antenna excited by modified cross-slot," Electron. Lett., vol. 50, no. 16, p. 1123–1125, Jul., 2014.