DUAL BAND HYBRID DRA ANTENNA DESIGN FOR WLAN APPLICATION

Abstract

The Dielectric resonator seems to be a good alternative for Micro-strip Patch Antenna (MPA) due to its ability to resonate at high frequencies more efficiently. When only DRA is used we require high complex structures such as superstrates to get the optimum results at the desired frequencies, so we prefer Hybrid DRA over simple DRA. Hybrid DRA means there is a micro-strip patch which is used for exciting the DR and since the radiating element is DR there will be no conductor losses and surface waves. The impedance bandwidth is improved by 10% when we use Hybrid DRA. The design is simulated using HFSS tool for the two resonant frequencies at 2.8 GHz and 5.6 GHz.

Keywords*:* Dielectric Resonator antenna, Dual Band DRA, Hybrid DRA, Cylindrical DRA, offset well, Dual Band.

Authors

V. M. S. N Pavan Kumar Ch
Assistant Professor
Department. of Electronic and Communication Engineering
Bapatla Engineering College
Bapatla, India

Venkat Ramana
Professor
Department. of Electronic and Communication Engineering
Sree Vidyanikethan Engineering College
Tirupathi, India

B. Siva Kumari
Assistant Professor
Department. of Electronic and Communication Engineering
Bapatla Women's Engineering College
Bapatla, India

S. Harichandra Prasad
Associate Professor
Department of Electronic and Communication Engineering
Aditya Engineering College
Kakinada, India

I. INTRODUCTIN & LITERATURE REVIEW

The major problems associated with the use of MSAs are **s**urface wave power leakage and conductor loss problems [4]. To cope up this problems Mr. R.D.Richtmyer [3] proposed the idea of Dielectric resonator and proved that non-metallic objects can also resonate for certain frequencies (microwave frequencies). His idea is to design filters and oscillators using the Dielectric resonator but later due to their performance, it is known that they can be used efficiently as antennas by adopting proper shapes and effective excitations. DRAs itself find better replacement to conventional, widely used Micro strip patch antennas by exhibiting better performance characteristics like having high-radiation efficiency, ease of fabrication, low production cost, bandwidth and polarization flexibility.

Generally, the most common physical configuration of DRA would generally consist of a dielectric material slab which is mounted on the surface of ground plane. The dielectric material is also available both in solid state and liquid state and is chosen depending upon the selected application. Most probably ceramics and water are widely used because of its tendency to exhibit low loss characteristics at desired frequencies with their distinct relative permittivity. DRAs are available in many shapes and are well associated with radiation pattern since the resonant frequencies are depending on the certain aspect ratios like height and radius of the dielectric resonator. The size of these DRA is chosen proportionately in the order of λ_0/ϵ_r.

Where λ_0= wavelength of operation= c/f and ϵ_r= permittivity of dielectric material.
So compact antennas are designed by selecting high permittivity dielectric materials. This simplified construction is more flexible and can withstand harsh environments [5], [6]. Most often these DRAs are excited by the feed given trough ground plane or sometimes they get directly excited in the middle of resonator as a result is possible to achieve high impedance matching and at the same time they are highly compatible with existing hybrid MIC circuits. Because of these promising advantages, DRAs are well suited for the applications in wireless communications like Wireless Local Area Networks.DRAs when resonate at microwave frequencies, exhibit some attractive and unique features. This uniqueness made them best suited for wireless communication technology. So on identifying the increasing demand for wireless LANs, the best antenna is proposed and designed by integrating the properties of Dielectric resonator and micro strip patch Antenna. The resultant hybrid DRA is turned out to be most economical by delimiting all the demerits of Micro Strip Patch Antenna [7] and at the same time it preserves all the properties of dielectric resonator.

1. **Design and analysis of proposed antenna:** The Hybrid Dual Band Dielectric Resonator Antenna is designed by using a Cylindrical Dielectric Resonator and a micro-strip patch. Dielectric resonator having high quality factor and high permittivity are placed on a ground plane with low permittivity to have a proper resonant action at desired frequencies. Later it is combined with micro strip patch antenna. When this structure is excited using a micro strip feed line, the electromagnetic radiation passes through the dielectric resonator and upon touching the other closed end of resonator it travels back thereby forming standing waves inside a resonator and radiates through the thinly designed walls of resonator. The designed antenna works at dual band frequencies operated from 2.75GHz to 2.85GHz and 5.55GHz to 5.65GHz. The physical dimensions of the design are shown in Fig 1 and Fig 2.

Here FR-4 Epoxy material with permittivity of Ɛs= 4.3 and 1.584mm thickness is used as substrate. The dimensions of the substrate and the ground are 52 mm×40 mm. The patch is copper with dimensions of 29 mm×28 mm. The CDRA is made up of a material with permittivity Ɛs=36 and the height is 12mm with a radius of 7.75. An offset well is created of same height in the cylinder (vacant area shown in Figure 1) with radius 2mm [9]. The patch is excited with a strip line of impedance 50ohms and the excitation is given to the lumped port at the rectangle that is shown in Figure 2.

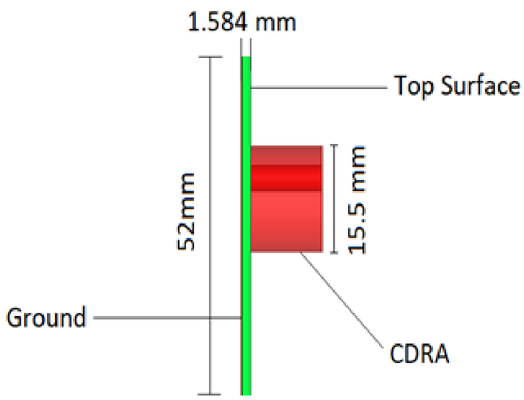

Figure 1: Top view of Antenna

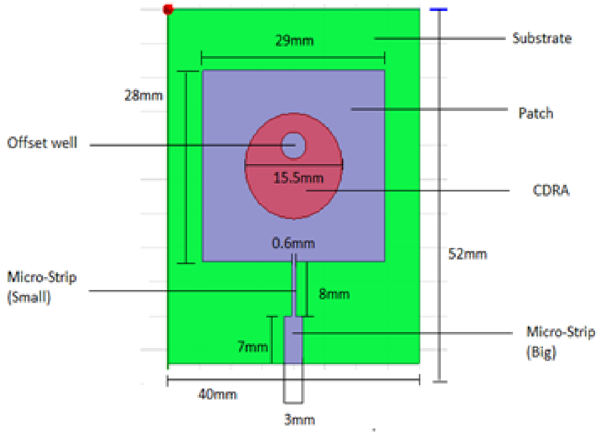

Figure 2: Bottom view of antenna

Table 1: The parameters of the Antenna Design

Parameters	**Material**	**Height(mm)**	**Length (mm)**	**Width (mm)**
CDRA	ε_s=36	12	15.5 (Diameter)	-
Substrate	FR-4	1.584	52	40
Ground	Copper	0	52	40
Patch	Copper	0	29	28
Micro-Strip (Big)	Copper	0	0.7	3
Micro-Strip (Small)	Copper	0	0.8	0.3

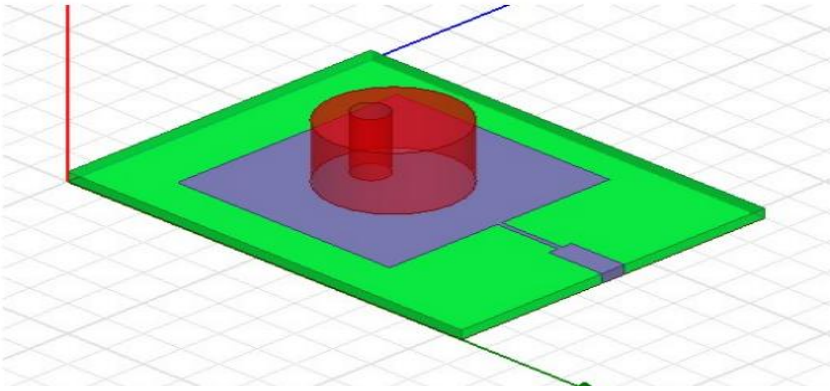

Figure 3: Hybrid DRA-Cross-sectional View

2. **Results and discussion:** The proposed model is designed a simulated using HFSS and found that it gives satisfactory results for the following important antenna parameters.

- **Return loss:** Return Loss is the crucial metric in assessing the antenna performance. Preferably the return loss coefficient must be as low as possible in order to reduce the backward or reflected power gain. Generally its value is increased if there is an impedance mismatch between the radiator and the transmission medium. If return loss coefficient S(1,1) is greater than 10dB then more than 90% of the power is being transmitted by that antenna. [10][11].

  The designed Hybrid DRA gives a return loss of -13.2dB when operated at first resonant frequency and -12dB at second resonant frequency which is shown in Figure 4. The results are quite satisfactory and give a radiation efficiency of around 85%.

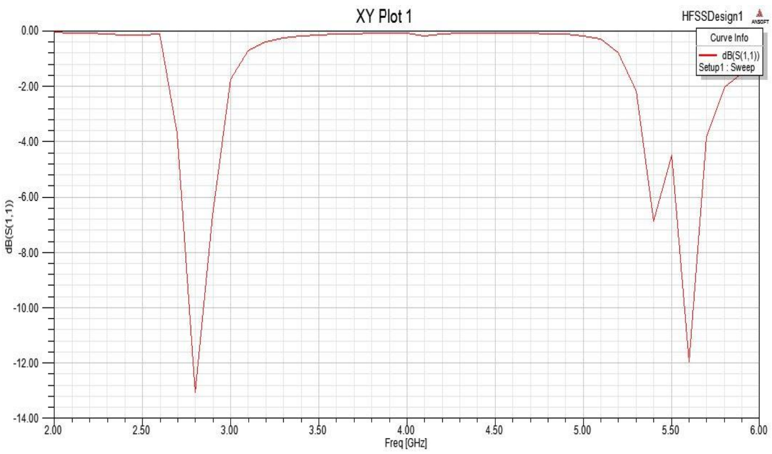

Figure 4: Return Loss of Hybrid DRA

- **VSWR:** It is considered as key metric to check whether the source can capable of delivering all the incident power on to the transmission line. It is always preferable to have VSWR value ranging in between 1 to 2. The VSWR (voltage wave standing ratio) is the same parameter as the Return loss but expressed in a different manner.

The VSWR at the two resonant frequencies are 1.55 and 1.675 at 2.8 GHz and 5.6GHz respectively and are plotted in Figure 5.

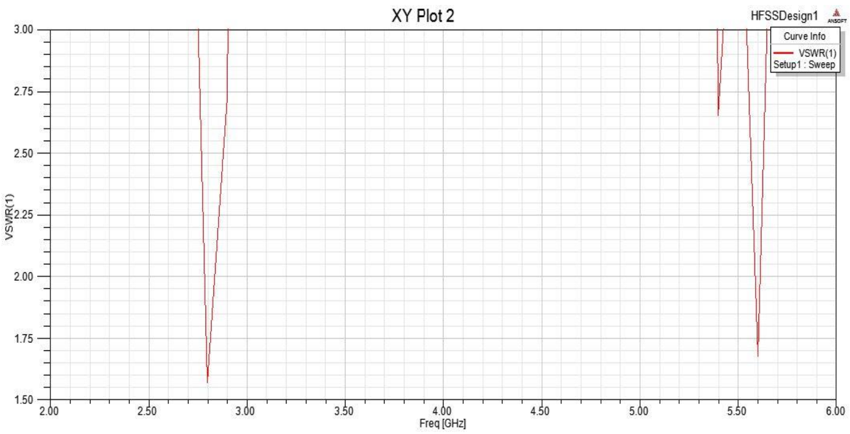

Figure 5: VSWR of Hybrid DRA.

- **Antenna Gain:** It is also a key factor in deterring the power coupled to the hybrid DRA and power emitted from DRA. Fig. 6 clearly depicts the gain plot for proposed hybrid antenna and it is observed that the maximum gain is 5.8042 dB in the direction of 0 degrees for 2.8 GHz and 4.0162 dB in the direction of 60 degrees for 5.6GHz. The Directivity plots are shown in the Fig 7 where the maximum directivity of the antenna is 4.0706 for 2.8 GHz and 4.3169 for 5.6GHz.

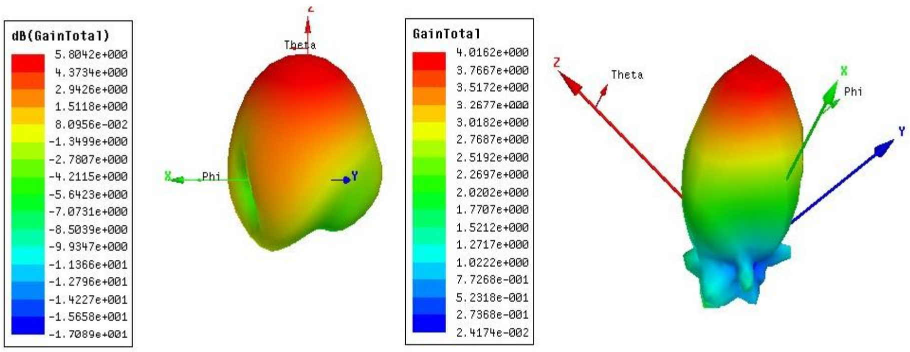

Figure 6: Gain at 2.8 GHz and 5.6 GHz

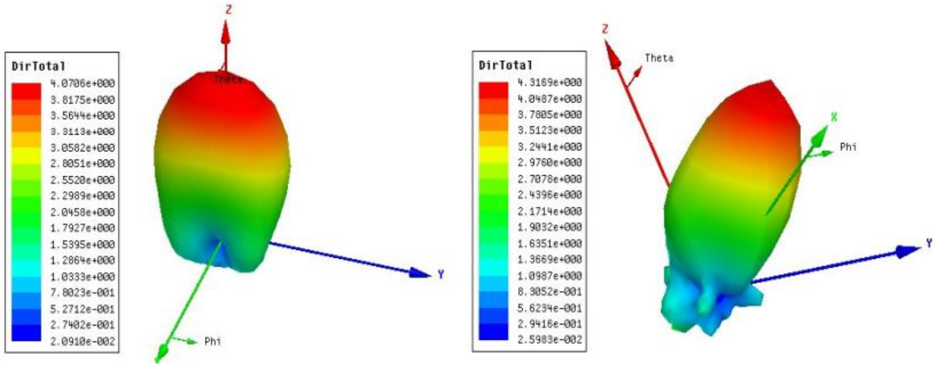

Figure 7: Directivity at 2.8 GHz and 5.6 GHz

- **Radiation pattern:** The coverage area of WLAN is actually decided by one of the antenna parameter, Radiation pattern. Upon simulating the Hybrid DRA is giving the desired coverage for the two operated frequencies at 2.8GHz and 5.6GHz and is shown in below Figure 8.

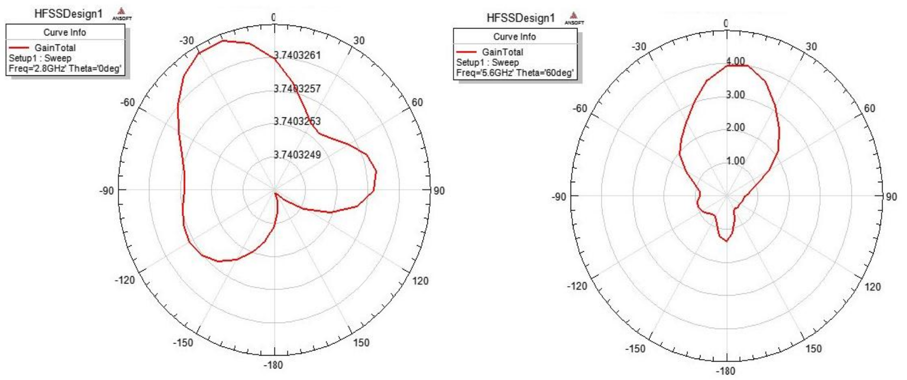

Figure 8: Far Field Radiation pattern at 2.8GHz and 5.6GHz

II. CONCLUSION

The designed Hybrid DRA, optimum gain and directivity have been achieved by reducing the conduction losses with an dielectric material. The required gain is achieved at dual band frequencies, 2.8GHz and 5.6GHz. The main design in the antenna that improved the gain is the use of offset well in the cylindrical ceramic material. Simulation has been performed on the DRA design using HFSS software to produce the results practically. The operated frequencies selected fall under ISM (Industrial, Scientific and Medicine bands) band. Thus the proposed Hybrid DRA works pretty well in the specified frequency bands for communication protocol standard, WLAN (Wireless Local Area Network) giving better performance in crucial metrics.

REFERENCES

[1] M. N. Rahman, M. T. Islam, M. S. J. Singh, N. Misran, K. Mat and M. Samsuzzaman, "Compact microstrip patch antenna for multi- service wireless communications," IEEE Asia Pacific Microwave Conference (APMC), Kuala Lumpar, 2017, pp. 1048-1050, 2017.
[2] C. Wang, H. Liu, P. Wen and X. Zhang, "Dual mode circularly polarised patch antenna exited by dual mode defected ground square ring resonator," 2017 Progress in Electromagnetics Research Symposium - Fall (PIERS - FALL), Singapore, pp. 1152-1155, 2017.
[3] S. Keyrouzand D. Caratelli, “Dielectric Resonator Antennas: Basic Concepts, Design Guidelines, and Recent Developments at Millimetre-Wave Frequencies,” International Journal of Antennas and Propagation Volume 2016, Article ID 6075680, 20 pages.
[4] M.S.M. Aras, M.K.A. Rahim, A.Asrokin, M.Z.A. Abdul Aziz, “Dielectric Resonator Antenna (DRA) for Wireless Application,” IEEE International RF And Microwave Conference Proceedings December, 2008.
[5] Aldo Petosa and Apisak Ittipiboon, “Dielectric Resonator Antennas: A Historical Review

and the Current State of the Art," Communications Research Centre Canada.
[6] Alexandre Perron, Tayeb A. Denidni, Abdel-Razik Sebak, "High-Gain Hybrid Dielectric Resonator Antenna for Millimeter-Wave Applications: Design and Implementation," IEEE Transactions on Antennas And Propagation, Vol. 57, No. 10, October 2009.
[7] N.Ashikin Jaafar, M. H. Jamaluddin, J. Nasir and N.M. Noor, "H-Shaped Dielectric Resonator Antenna for Future 5G Application," 2015 IEEE International RF and Microwave Conference.
[8] Tze-Hsuan Chang,Jean-Fu Kiang, "Broadband Dielectric Resonator Antenna with an Offset Well," IEEE Antennas and Wireless Propagation Letters, vol. 6, 2007.
[9] "Wireless Communications" by Andrea Goldsmith, Stanford University, 2005, Cambridge UniversityPress.
[10] C. A. Balanis, "Antenna Theory, Analysis and Design" 2nd Edition, John Wiley & Sons, Inc., New York1982.
[11] Runa Kumari, Kapil Parmar and S K Behera, "Conformal Patch Fed Stacked Triangular DielectricResonator Antenna for WLAN Applications", IEEE International Conference on Emerging Trends inRobotics and Communication Technology, 3-5 December, 2010, Satyabhama University, Chennai.
[12] R. Chair, Member, IEEE, A. A. Kishk, Fellow, IEEE, and K. F. Lee, Fellow, IEEE "Wideband Simple Cylindrical Dielectric Resonator Antennas,"IEEE microwave and wireless components letters, vol. 15, no.4, April 2005

