Sonia,, 2022, 10:4
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

Design & Simulation Of Om Shape Antenna For 4g Applications

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Abstract- This research article reports a new Dielectric Resonator Antenna (DRA) with its Dielectric resonator (DR) modified to an "OM" shape for UWB (3.1-11.1 GHz), to support high data rate multimedia applications for 4G/5G communications. The proposed DRA reports a peak gain of 7.68 dB and a dual polarization behavior for a frequency band from 6 to 11.1 GHz. It has overall antenna dimensions of 50 × 40 × 4.87 mm3 and is fabricated on a commercially available Rogers RT 5880 substrate (with εr = 2.2), which is fed using a microstrip feedline with a P-type transformer that offers an input impedance of 50 Ω to the DR. A conformal strip between the feedline and the OM shaped DR improves the impedance matching at the UWB frequency response of the DRA. The proposed DRA therefore exhibits an elliptically polarized behavior with axial ratio bandwidth of 5.1 GHz (≤10 dB) from 6 to 11.1 GHz. A measured impedance bandwidth of 5.25 GHz from 3.8 to 9.05 GHz and 1.5 GHz from 10 to 11.5 GHz and a peak-measured gain of 7.68 dB at 10.5 GHz (with an average gain of 4.6 dB) has been reported for the proposed DRA. An UWB performance, with good gain properties and an elliptically polarized behavior allows the proposed "OM" shaped DRA to be suitable for short range 4G/5G UWB wireless communications for future multimedia rich WPAN (wireless personal area networks), WLAN, Wi-MAX, INSAT applications, satellite applications, and X band RADAR (for defense communication) applications.

Keyword- Om Shape Antenna

I. INTRODUCTION

Resonators are important components in microwave communication systems. They function as· frequency determining components in filters, oscillators, amplifiers, tuners etc. A resonator is said to be 'resonating' at a particular frequency when the electromagnetic energy is stored inside the resonator like an inductor-capacitor-resistor (LCR) circuit. As in the case of LCR circuit, here too, the impedance of the resonator is purely real at the resonant frequency. At frequencies <100 MHz, Quartz resonators are used.

Recent advances in the communication systems have increased the number of transmitter and receiver channels in a particular geographical area. Therefore, one has to choose the microwave frequency range in order to prevent interferences due to the crowding of channels. The global satellite system, now in operation, uses microwaves for the transmission of meteorological data, telemetry and for international telephone and television channels [1]. The useful range of operation is limited by the allocated frequencies and noise. The extra-terrestrial radiation (sky noise) is a minimum near 4 GHz.It is possible to generate microwave frequencies using a quartz resonator by using frequency multipliers.

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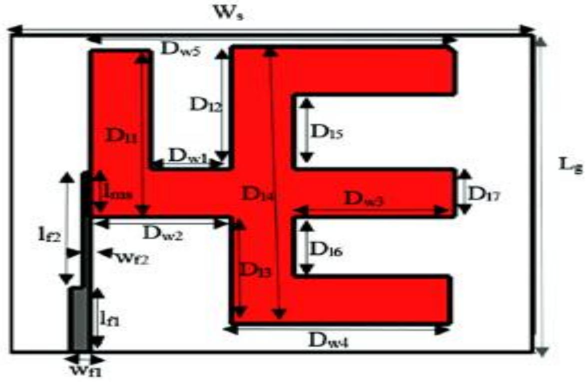
However, this increases the noise. In the microwave frequency range, cavities made up of copper, brass, invar etc. are used as resonators taking the advantage of metallic properties. The resonant frequency is determined by the cavity dimensions. The progress in integrated circuit technology led to the miniaturization of components used in microwave communication circuits. Since cavity resonators were bulky and could not be integrated, the microstrip resonators were the only solution to the problem of miniaturization of circuits. But microstrip resonators have poor temperature stability of resonance and low quality factor when compared with metallic cavity resonators. Thus miniaturization was possible only by sacrificing quality factor and temperature-stability. But recent progress in electronic ceramics technology has proved that temperature-stable, high Q resonators for almost all MIC applications can be realized.
It is fold that ceramic materials known as 'Dielectric Resonators (DRs)' are very useful for application in the microwave frequency range[l -18].

DRs possess high dielectric constant (ε_r), high quality factor (Q) and small temperature coefficient of resonance (t_r) at microwave frequency. Devices employing DRs have low cost, small size, light weight and high efficiency and are easy-to-use. The versatility and adaptability of DRs have made them indispensable components for filters [19-30], oscillators (DRO) [22,31-39], duplexers etc. in modem microwave integrated circuit (MIC) applications.

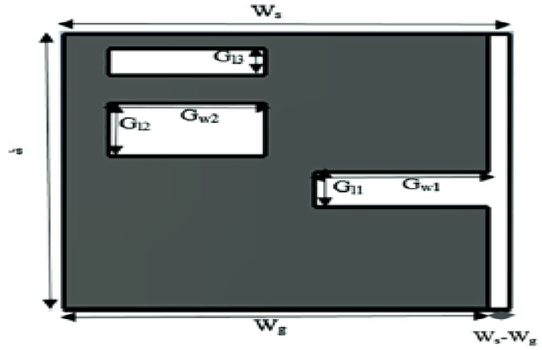
Hence the recent advances in Cellular radio, Satellite TV, Military radar etc. have raised the demand for DRs. Materials technology, especially electronic ceramics technology, has gained a lot of attention from scientists who are in search of new materials to satisfy the demands of communication explosion.The global annual sales market of dielectric ceramics, including piezoelectric,ferrites, IC packages etc., used by the industries is expected to exceed 8,500 million by the year 2000. It is now possible to have small and compactresonators for applications from 800 MHz to 100 GHz frequency range.

II.ANTENNA GEOMETRY

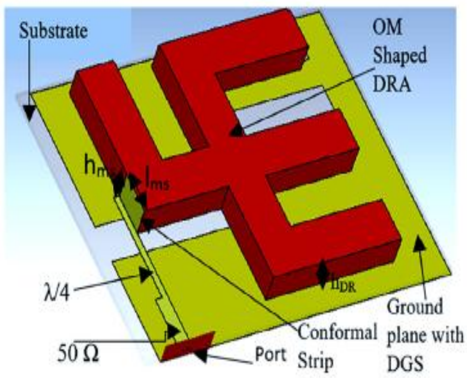
Figure 1 (a) ,(b) shows the top and back view of the proposed UWB dual polarized "OM" Shaped DRA, respectively, designed using a 3D EM tool HFSS. The 3D sideview of the proposed DRA is also shown in Figure 1 (c).The proposed UWB DRA is made from an "OM" shapedblock of Alumina (Al2O3 with ε_{DR} = 9.8, height = 4 mmand tan δ = 0.002) pasted over a Rogers 5880 substratesheet (with ε_r = = 2.2, height = 0.8 mm and tan δ = 0.0009)with dimensions of Ls × Ws as 50 mm × 40 mm.Figure 4.1 (a) ,(b) shows the top and back view of the proposed UWB dual polarized "OM" Shaped DRA, respectively, designed using a 3D EM tool HFSS.



(a)



(b)



(c)

Fig 1 "OM" shaped DRA. (a) Top view. (b) Back view. (c) 3D view of the proposed 'OM' shaped DRA

The 3D sideview of the proposed DRA is also shown in Figure 1 (c).The proposed UWB DRA is made from

an "OM" shapedblock of Alumina (Al2O3 with ε_{DR} = 9.8, height = 4 mmand tan δ = 0.002) pasted over a Rogers 5880 substratesheet (with ε_r = = 2.2, height = 0.8 mm and tan δ = 0.0009)with dimensions of Ls × Ws as 50 mm × 40 mm.

It is the "OM" shaped DR with a DGS, that excites the desired UWB from 3.1 to 11.1 GHz by exciting two higher order modes TE211 and TE221 at 6.5 and 10.5 GHz, respectively, and presents a simulated improved peak gain of 7.66 dB at 11 GHz. This "OM" shaped DR also generates both horizontal and vertical components of 'E' field giving rise to elliptically polarized waves (axial Ratio < 10 dB), for a frequency band from 6 to 11.1 GHz.

The DR in the antenna is fed using a P type transformer based microstrip feedline as shown in Figure 1C with a length (lf1 + lf2) as 22.5 mm, offering an impedance of 50 Ω at the antenna's drive point. A conformal rectangular metallic strip of copper with length 5.7 mm and height 4 mm with impedance of 50 Ω is connected between the feedline and the DR. This has one of its edge on the feedline and the other edge on the drive point of the DR. This allows better coupling of EM fields to the DR and hence an improved impedance bandwidth is achieved. The bottom of the Rogers substrate has a metallic ground layer of copper with three slots cut out from it that make it a DGS.

This DGS allows the formation of multiple resonant current loops in the ground layer at the same or nearby frequencies of DR's resonance and thus helps in improving the impedance bandwidth of the antenna's operation. The detailed design parameters of the proposed OM shaped DRA are labeled in Figure 1AC and their optimized parametric values are mentioned in Table 4.1. The next section of this article explains the DRA design process and the equations that are used to obtain the optimized DRA parameters.

III.PROPOSED DRA DESIGN IN HFSS

The proposed antenna is designed with om shaped dielectric resonator antenna. There is two layers of antenna. One is substrate and another one is om shape dielectric resonator antenna.

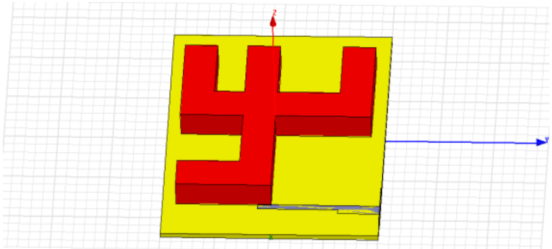


Fig 2 Top View of Proposed Antenna.

The ground layer of proposed antenna is shown in the fig 2. In this layer 3 slots are cut from the ground & these cuts act as defected ground structure.

IV.RESULT ANALYSES

Scattering parameter is one of the parameter which represents proper impedance matching at particular frequency. It is also known as return loss. Return loss may be defined as ratio of reflected back power to the incident power. It is represented in db. In ideal case, return loss must be -10db. As, return loss is minimum, the antenna characterization used to measure.

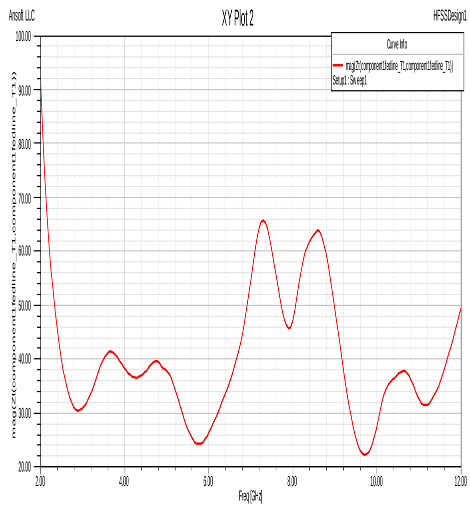


Fig 3 Impedance Matching.

The impedance matching of proposed DRA is shown in fig 3. The impedance bandwidth is analyzed from 2 GHz to 12 GHz. This graph shows that 50 Ω impedance matching is find out at 7.8416 GHz.0.7604-j0.224 , 0.7274+j0.2060 and 0.7186 - 0.3117 j

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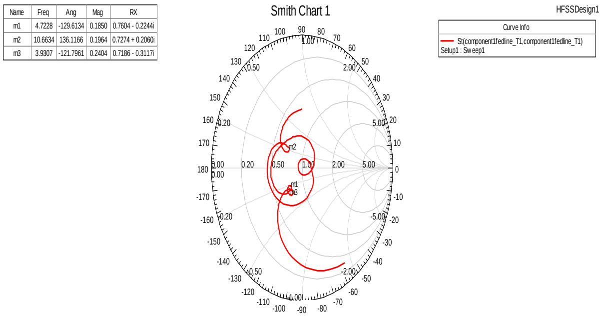

Fig 4 Smith Chart.

The complex graph is represented by Smith chart. The smith chart is analyzed with three frequencies 4.7228, 10.6634 and 3.9307 GHz respectively. The received signal value is 0.7604-j0.224, 0.7274+j0.2060 and 0.7186 -0.3117 j respectively.

V.CONCLUSION

The design & simulation of different shape of DRA antenna had being studied using HFSS software. The simulation work gives good result through patch calculator. Here accurate patching via resonant frequency has been done. The investigation has been completely done throughout simulation work. The operating frequency is 8 GHz. The proposed Om Shap/e DRA has high gain & best resonant frequency i.e. 7.84 GHz as compared to other shapes of DRA antennas.The proposed Patch Antenna with Ground Slot Antenna have minimum RL i.e -27.7095 db at its resonant frequency 7.84 GHz . Bandwidth of proposed antenna is also improved up to 5.7-11.1 GHz.

REFERENCES

[1] Alzidani, Magid, Islam Afifi, MuftahAsaadi, and Abdel RazikSebak. 2020. "Ultra-Wideband Differential Fed Hybrid Antenna with High-Cross Polarization Discrimination for Millimeter Wave Applications." IEEE Access 8: 80673–83. https://doi.org/10.1109/ACCESS.2020.2988000.

[2] Sharma, Piyush, ArtiVaish, and R. S. Yaduvanshi. 2019. "The Design of a Turtle-Shaped Dielectric Resonator Antenna for Ultrawide-Band Applications." Journal of Computational Electronics 18 (4): 1333–41. https://doi.org/10.1007/s10825-019-01374-8.

[3] Song, Zhiwei, Hongxing Zheng, Mengjun Wang, Yan Li, Tao Song, Erping Li, and Yongjian Li. 2019. "Equilateral Triangular Dielectric Resonator and Metal Patch Hybrid Antenna for UWB Application." IEEE Access 7: 119060–68. https://doi.org/10.1109/ACCESS.2019.2936013.

[4] Trivedi, Kedar, and DhavalPujara. 2019. "Design and Development of Ultrawideband-Stacked Triangular Prism-Shaped Dielectric Resonator Antenna." Microwave and Optical Technology Letters 61 (5): 1193–99. https://doi.org/10.1002/mop.31738.

[5] Wang, Fan, Chuanfang Zhang, Houjun Sun, and Yu Xiao. 2019. "Ultra-Wideband Dielectric Resonator Antenna Design Based on Multilayer Form." International Journal of Antennas and Propagation 2019. https://doi.org/10.1155/2019/4391474.

[6] Wang, Fan, Chuanfang Zhang, Houjun Sun, and Yu Xiao. 2019. "Ultra-Wideband Dielectric Resonator Antenna Design Based on Multilayer Form." International Journal of Antennas and Propagation 2019. https://doi.org/10.1155/2019/4391474.

[7] Zebiri, Chemseddine, Huthaifa A. Obeidat, Raed A. Abd-Alhameed, DjamelSayad, Issa T.E. Elfergani, Jamal Sulieman Kosha, WidadFaraj A. Mshwat, et al. 2019. "Antenna for Ultra-Wideband Applications with Non-Uniform Defected Ground Plane and Offset Aperture-Coupled Cylindrical Dielectric Resonators." IEEE Access 7: 166776–87. https://doi.org/10.1109/ACCESS.2019.2949527.

[8] Zitouni, Ahmed, and NoureddineBoukli-Hacene. 2019. "T-Shaped Compact Dielectric Resonator Antenna for UWB Application." Advanced Electromagnetics 8 (3): 57–63. https://doi.org/10.7716/aem.v8i3.1077.

[9] Trivedi, Kedar, and DhavalPujara. 2018. "Mutual Coupling Reduction in UWB Modified Maltese Shaped DRA Array for MIMO Applications." 2018 48th European Microwave Conference, EuMC 2018, 1117–20. https://doi.org/10.23919/EuMC.2018.8541664.

[10] Abioghli, Mehdi, AsgharKeshtkar, Mohammad Naser-Moghadasi, and BehbodGhalamkari. 2018. "A Frequency Reconfigurable Band-Notched UWB Dielectric Resonator Antenna with a Wide-Tuning Range for Cognitive Radio Systems." *IETE Journal of Research* 0 (0): 1–10. https://doi.org/10.1080/03772063.2018.1554458.

[11] Al-Azza, Ali A., Nuhad A. Malalla, Frances J. Harackiewicz, and Kiyun Han. 2018. "Stacked Conical-Cylindrical Hybrid Dielectric Resonator Antenna for Improved Ultrawide Bandwidth." Progress in Electromagnetics Research Letters 79

(September): 79–86. https://doi.org/10.2528/pierl18081008.

[12] Elkorany, Ahmed S., Sammar A. Saad, and Demyana A. Saleeb. 2018. "Compact Reconfigurable Band Notched UWB Cylindrical Dielectric Resonator Antenna Using Single Varactor Diode." Advanced Electromagnetics 7 (3): 35–39..v7i3.672.

[13] Iqbal, MianShahzad, and Karu P. Esselle. 2018. "Pulse-Preserving Characteristics and Effective Isotropically Radiated Power Spectra of a New Ultrawideband Dielectric Resonator Antenna." IET Microwaves, Antennas and Propagation 12 (7): 1231–38. https://doi.org/10.1049/iet-map.2017.0172.

[14] Dash, UpaliAparajita, and SudhakarSahu. 2018. "UWB Dual-Band Notched Conical Dielectric Resonator Antenna with Improved Gain." IETE Journal of Research 66 (5): 643–53. https://doi.org/10.1080/03772063.2018.1515672.

[15] Kshirsagar, Poonam, Shubha Gupta, and Biswajeet Mukherjee. 2018. "A Two-Segment Rectangular Dielectric Resonator Antenna for Ultra-Wideband Application." Electromagnetics 38 (1): 20–33. https://doi.org/10.1080/02726343.2017.1406682.

[16] Priya, A Keerthanai, and B Bhuvaneswari. 2018. "Miniaturized Wide Bandwidth MIMO Dielectric Resonator Antenna Using Defective Ground Structure for UWB Applications." International Research Journal of Engineering and Technology, 3–6. www.irjet.net.

[17] Sharma, Anand, Gourab Das, and Ravi Kumar Gangwar. 2018. "Composite Antenna for Ultrawide Bandwidth Applications." IEEE Antennas and Propagation Magazine 60 (june): 57–65.

[18] Yang, Hailong, Xiaoli Xi, Yuchen Zhao, Lili Wang, and Xiaomin Shi. 2018. "Design of Compact Ultrawideband Slot Antenna with Improved Band-Edge Selectivity." IEEE Antennas and Wireless Propagation Letters 17 (6): 946–50. https://doi.org/10.1109/LAWP.2018.2825453.

[19] Zebiri, C. E., M. Lashab, D. Sayad, I. T.E. Elfergani, K. H. Sayidmarie, F. Benabdelaziz, R. A. Abd-Alhameed, J. Rodriguez, and J. M. Noras. 2017. "Offset Aperture-Coupled Double-Cylinder Dielectric Resonator Antenna with Extended Wideband." IEEE Transactions on Antennas and Propagation 65 (10): 5617–22. https://doi.org/10.1109/TAP.2017.2743741.

[20] Madhav, B.T.P., A. Sudeepa, V. Manikanth, P.S. Bharathi, P.L. Srikanth, and A.N.M. Kumari. 2017. "Dielectric Resonator Integrated UWB Antenna with Dual Band Notch Characteristics." International Journal of Pure and Applied Mathematics 115 (7 Special Issue): 375–79.