# Optimized Cylindrical and Rectangular DR Antenna for Ultra-Wideband Applications

**K. Srinivasa Naik, D. Madhusudhan, S. Chandini and S. Aruna**

## 1 Introduction

On human lives, the impact of wireless communications has become a part of daily life. Compact and efficient radiators are needed to achieve better wireless communications applications. One of the best radiators in microwave frequencies is dielectric resonator antenna (DRA). In microwave frequency applications, DRA is a good component. To fabricate DRA with high dielectric constant low loss materials are required with different shapes and dimensions. By using several improvement methods, impedance bandwidths can be increased. To transmit high data rate WLAN to meet the UWB range, DRAs are designed, and also, they are showing better properties in radar and micro-imaging applications [1–7].

## 2 Design Considerations

In this work, a *T*-shaped fed rectangular DRA (RDRA) has been designed for UWB applications with broadband impedance bandwidth from 0.31 to 0.55 GHz which can be obtained to cover both IEEE 802.11a WLAN and BAN frequencies, The

K. Srinivasa Naik (✉) · D. Madhusudhan · S. Chandini
Vignan's Institute of Information Technology (A), Visakhapatnam, Andhra Pradesh, India
e-mail: nivas97033205@gmail.com

D. Madhusudhan
e-mail: madhudonga@gmail.com

S. Chandini
e-mail: chandinispavan@gmail.com

S. Aruna
Andhra University College of Engineering, Visakhapatnam, Andhra Pradesh, India
e-mail: aruna9490564519@gmail.com



J. Fiaidhi et al. (eds.), *Smart Technologies in Data Science and Communication*, Lecture Notes in Networks and Systems 105, https://doi.org/10.1007/978-981-15-2407-3_27

overall dimensions of this antenna is 30.0 × 21.0 mm$^2$. For this design, lower UWB frequency band is selected, i.e., from 3.1 to 4.9 GHz with a dielectric constant of 9.4.

The designed antenna is shown in Fig. 1a, b. Rectangular ceramic block dimensions is 6.00 × 9.00 × 6.00 mm$^3$. FR4 Substrate with thickness 0.8 mm with permittivity of 4.5 to realize 50 Ω feed line of 18 mm × 1.5 mm dimensions is printed on the substrate.

Asymmetrical DRA with wideband single slot-fed antenna is designed with a pair of adjacently grouped CDRAs. The designed antenna dimensions are 30 × 25 mm$^2$, FR4 substrate with $\varepsilon_r = 4.5$, $t = 0.8$ mm. The feed line dimensions are

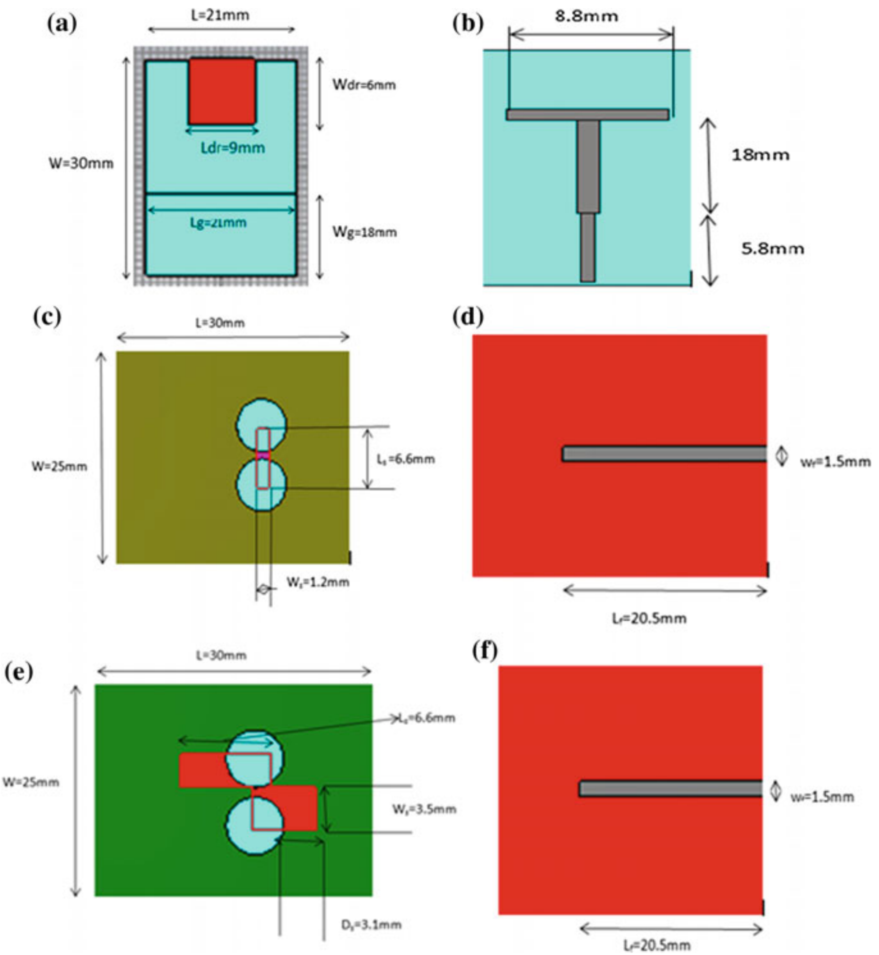


**Fig. 1** **a** Front view of RDRA with ceramic block, **b** back view of modified *T*-shaped feed, **c** front view of CDRA, **d** back view of CDRA, **e** front view of cylindrical DRA for $k_u$ band applications, **f** back view of cylindrical DRA for $k_u$ band applications

$20.5 \times 1.5\ \text{mm}^2$ and symmetrically placed with respect to the coupling aperture. The proposed asymmetrical CDRA is shown in Fig. 1c, d.

A rectangular aperture feed asymmetrical two cylindrical dielectric resonators are designed for UWB applications. The impedance bandwidth covers dual-band frequency in between 6.02 to 7.32 GHz and 8.72 to 16.57 GHz with a gain of 8 dBi. The feed lengths are $20.5 \times 1.5\ \text{mm}^2$.

## 3 Simulated Results

### A. **Return loss for RDRA**

The *S* parameter versus frequency plot of RDRA is shown in Fig. 2, and it resonates at 3.5 GHz frequency with return loss of −17.2 dB.

The VSWR ratio at a frequency of 3.5 GHz is 1: 1.31, respectively, for rectangular DRA, which is shown in Fig. 3.

### B. **Cylindrical DRA parameters**

The *S* parameters of a cylindrical DRA which resonate at a frequency of 12.2 GHz are shown in Fig. 4. The return loss is −49.2 dB.

The VSWR value at 12.2 GHz frequency is 1.31, respectively, for cylindrical DRA which is shown in Fig. 5.

### C. **Cylindrical DRA with asymmetric feed parameters**

The return loss of CDRA with asymmetric feed which reonates at 13.44 GHz are shown Fig. 6, and the return loss is −31.1 dB.

The VSWR value at a frequency of 13.4 GHz is 1.31, respectively, for rectangular DRA using CST, which is shown in Fig. 7.

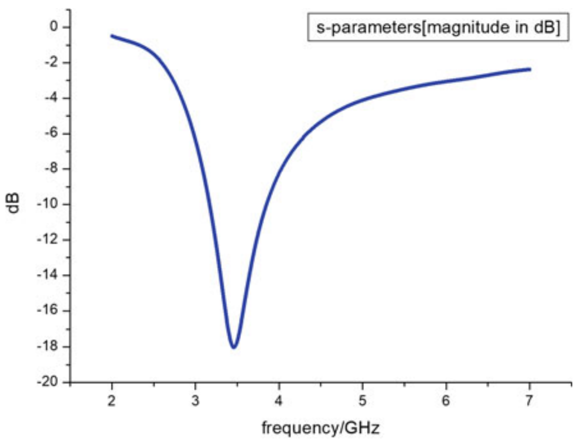


**Fig. 2** *S*-parameter curve of a rectangular DRA for UWB applications

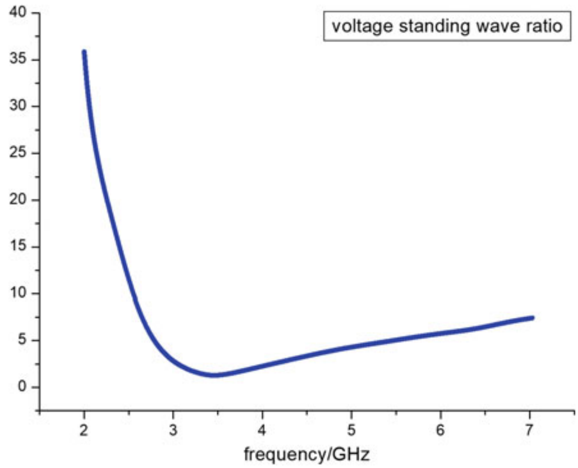


**Fig. 3** VSWR of a rectangular DRA of UWB applications

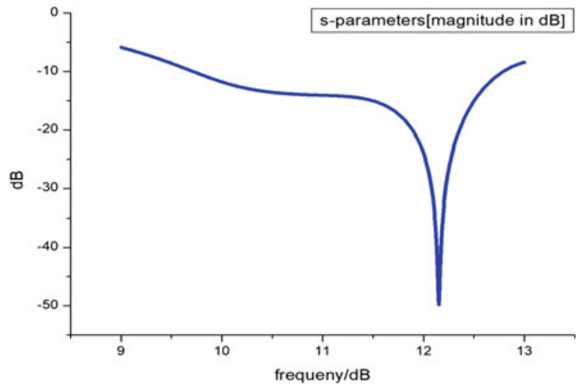


**Fig. 4** *S*-parameter curve of a cylindrical DRA

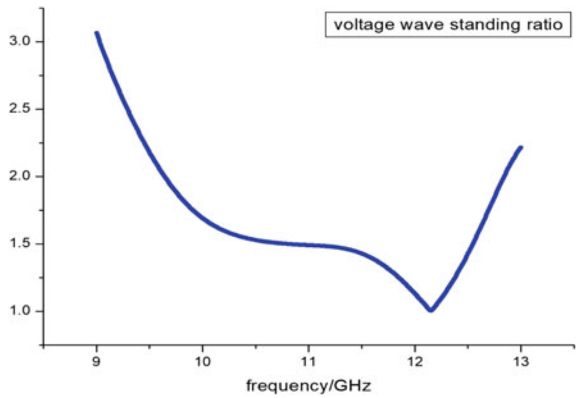


**Fig. 5** VSWR of a cylindrical DRA

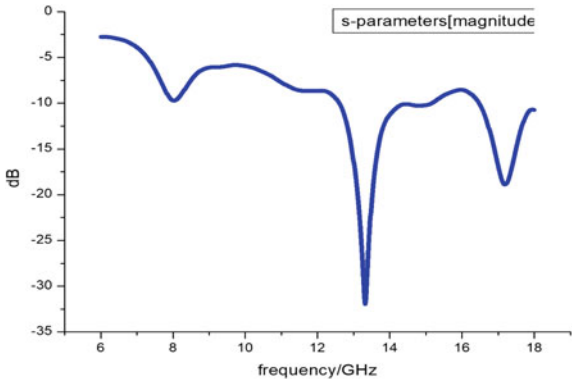


**Fig. 6** Impedance bandwidth cylindrical of DRA using for $k_u$ band applications

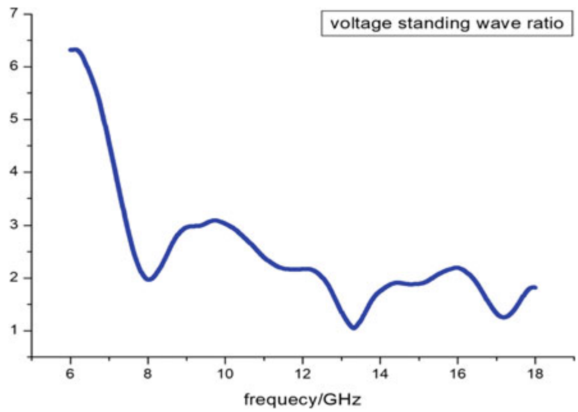


**Fig. 7** VSWR of cylindrical DRA using for $k_u$ band applications

## 4 Conclusion

A lower UWB band rectangular DRA has been designed with micro-band power matching lines on FR4 substrate with average gain of 3 dB for WiMAX applications. The performance of the proposed antennas can be increased by using Hybrid DRAs with microstrip line feed. To achieve best spectrum performance, asymmetric DRAs are used and optimized. The total bandwidth achieved is 29% of frequency range 9.62–12.9 GHz, with gain of 8 dB. An asymmetric pair of cylindrical DRA with zigzag opening is designed. In this work, 62% of bandwidth is achieved which covers dual-band frequency range from 6.02 to 7.32 GHz and 8.72 to 16.57 GHz, and a gain of 9 dBi is obtained.

## References


1. Y. Gao, Z. Feng, L. Zhang, Experimental investigation of new radiating mode in rectangular hybrid dielectric resonator antenna. IEEE Antennas Wirel. Propag. Lett. **10**, 91–94 (2011)
2. K.K. So, K.W. Leung, Bandwidth enhancement and frequency tuning of the dielectric resonator antenna using a parasitic slot in the ground plane. IEEE Trans. Antennas Propag. **53**, 4169–4172 (2005)
3. M. Abedian, S.K.A. Rahim, Sh Danesh, S. Hakimi, L.Y. Cheong, M.H. Jamaluddin, Novel design of compact UWB dielectric resonator antenna with dual band rejection characteristics for WiMAX/WLAN bands. IEEE Antennas Wirel. Propag. Lett. **14**, 245–248 (2015)
4. S. Danesh, S.K.A. Rahim, M. Abedian, M.R. Hamid, A compact frequency reconfigurable rectangular dielectric resonator antenna for LTE/WWAN and WLAN applications. IEEE Antennas Wirel. Propag. Lett. **14**, 486–489 (2015)
5. K. Srinivasa Naik et.al., Design, analysis and parametric study of rectangular dielectric resonator antenna arrays. Int. J. Adv. Sci. Technol. 112, 67–78 (2018)
6. K. Srinivasa Naik et.al., Design and analysis of different patch geometry and complementary split ring resonator for X-band applications. Int. J. Recent Technol. Eng. (IJRTE) **7**(5S4), 858–869 (2019)
7. Sh. Danesh, S.K.A. Rahim, M. Abedian, Frequency reconfigurable rectangular dielectric resonator antenna for WiMAX/WLAN applications. Microwave Opt. Technol. Lett. **57**(3), 579–582 (2015)