DIELECTRIC RESONATOR ANTENNA FOR UWB MIMO APPLICATIONS

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ABSTRACT: In this paper, two port based multiple input multiple-output (MIMO) dielectric resonator antenna (DRA) is designed for ultra-wideband characteristics. The proposed MIMO DRA is implemented within the shape of rectangular DR into a rack shaped DR. It has improved S21 within the UWB range. Inverted T- shaped parasitic strip is used to improve AR ≤ 24.9 dB and also helps to control the impedance bandwidth (106.2 %). The proposed two element MIMO antenna can be utilized for ultra-wideband (UWB) 3.3 to 11.1 GHz. The MIMO diversity boundaries are achieved as ECC ≤ 0.0059, DG ≥ 9.94 dB. All the acquired MIMO antenna boundaries are inside as far as possible and furthermore gives high information rate to UWB applications.

KEYWORDS: Ultra-wideband, Rectangular dielectric resonator. Multiple input multiple-output.

1 INTRODUCTION

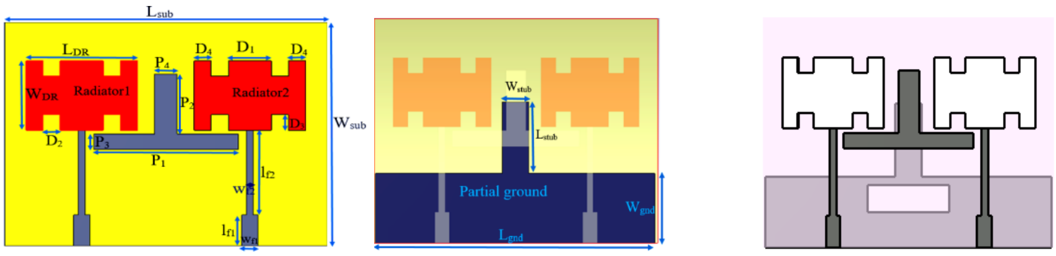
After the characterization of the 3.1– 10.6 GHz unlicensed band by the Federal Communications Commission (FCC), the ultra-wideband (UWB) range was restored. UWB marks its place in enormous fields of wireless sensor systems because it demands low power spectral density, the equipment required are of the fundamental design, information transmission rates are quite good, imparts high accuracy extending ability with low power utilization (ET-Docket 2002). Dielectric resonator antenna (DRA) has made its path in recent years for UWB applications. DRA possesses several striking features, including low conductor losses, high radiation efficiency, inherent design flexibility, and easy to excitation. As the dimensions of the dielectric resonator (DR) is inversely correlated with the permittivity, the small size of DR is preferred for high permittivity (Luk & Leung 2003).

Unlike the obstacles in traditional wireless devices, to obtain the high data rate, less channel capacity loss, high diversity gain, multiple-input multiple-output (MIMO) antenna has been developed (Abedian et al. 2017). To give high isolation between the spaces, multiple antennas are employed at the transmitting and receiving sites to implement the MIMO (Wu et al. 2018). In recent years, the MIMO antenna concept has been developed in UWB applications (Yadav et al. 2018, Zhang et al. 2009, Li et al. 2013).

In the present study, a new MIMO rectangular two-element dielectric resonators are presented with keeping the distance of $\lambda/2$ to achieve the good isolation. T- shaped MPS is fixed on the top of substrate layer to achieve the widen impedance bandwidth and AR ≤ 24.9 dB. Antenna size is 39.6 × 29 mm^2 ($\varepsilon_r = 4.4$) with 0.8 mm height. ground is pasted, and on the upper side of the substrate, DR structure along with feedline is etched.

2 ANTENNA CONFIGURATION

Figure 1 presents the structure of the proposed MIMO DRA. This DRA consists of two radiator elements having permittivity ($\varepsilon_{DR} = 10.2$) Rogers RT 6010. The dimensions of DR is 14 × 9 ×5, excited by quarter-wave transformer type microstrip fed (4 × 1.9; 11 × 0.8). As Figure 1 (a & c), Inverted T-shaped parasitic strip (PS) is designed on the top of the substrate, placed between DRs and a ground plane (37.6 × 9) is etched on the bottom side of the substrate (37.6 × 29 × 0.8 mm^3). A stub (9.2 × 3.5) is added to improve the impedance and S21. The AR of antenna is through an inverted T-shaped PS with P_1, P_2, P_3, and P_4 (16.8, 7.9, 2 and 2.6 mm) parameters.

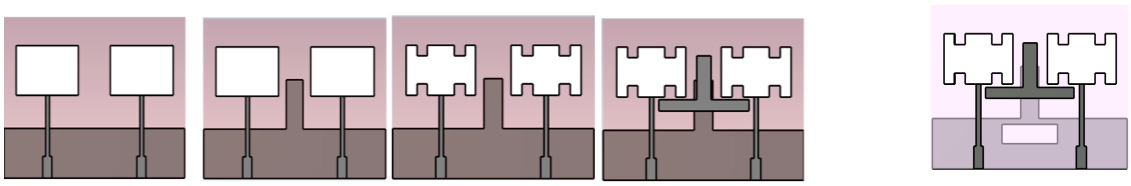


a) b) c)

Fig. 1 a-c MIMO antenna different views

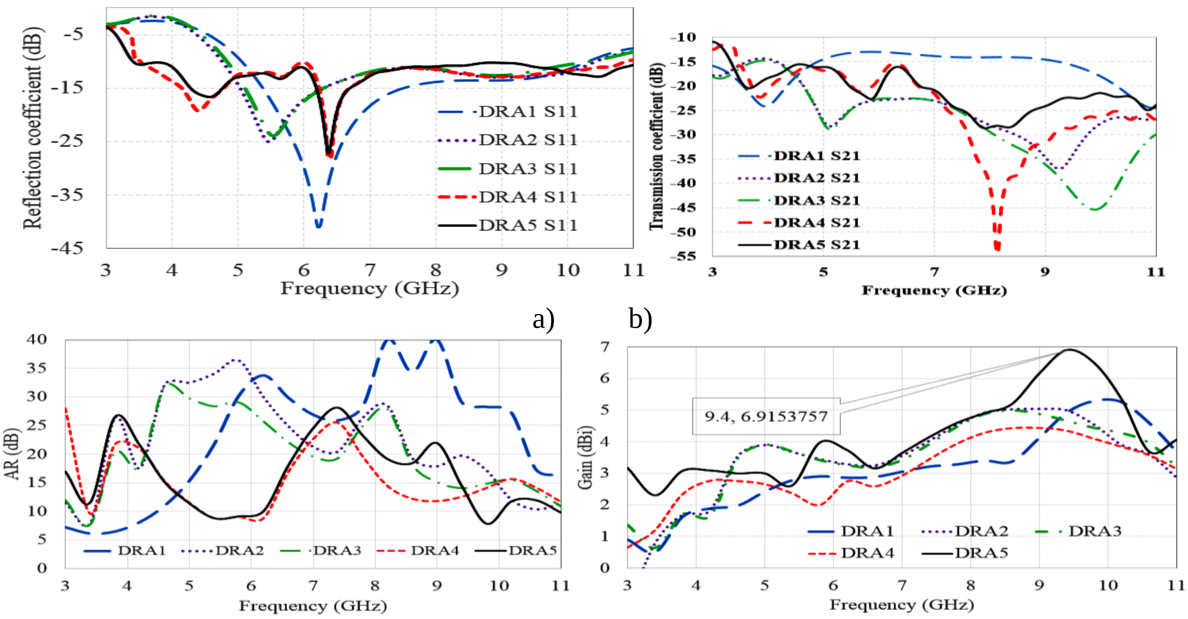
2.1 Antenna Iterations

The iterations of DRA are shown in Fig. 2 a-e. The simulated antenna follow five steps to achieve the final design DRA 5. Step1 have rectangular DR with modified ground plane, which provided peak AR 40dB and constant gain. In step2, a matching stub is added in the ground to achieve the better impedance matching and transmission coefficient (S21). Step 3 have modified the shape of DR to achieve the better transmission coefficient with slightly improved the impedance bandwidth. In step4, the electrical path of antenna is increased by using of inverted T-shaped parasitic element to achieve the UWB range. In step 5, proposed antenna is designed with a rectangular DGS slot cut in the ground, to achieve the high peak gain (9.4 dBi) and UWB range. Figure 3a-d are shown the steps performance results in Table 1. Proposed MIMO DRA5 have best results within UWB range and improved AR bandwidth $\leq$ 24.9 dB.



a) b) c) d) e)

Fig. 2 Steps performance view of antenna a) DRA 1 b) DRA 2 c) DRA 3 d) DRA 4 e) DRA 5



c) d)

Fig. 3 Frequency response concerning a) S_{11}, S_{22} parameters b) S_{21} parameter c) AR bandwidth d) Gain vs. frequency

Table 1 Step performance of all antennas

Step antenna	**S_{11}, S_{22} 10 dB**	**Impedance bandwidth %**	**S_{12}, S_{21} (dB) Isolation**	**Gain range (dBi)**	**Axial ratio (dB)**
DRA1	5.09 to 10.1 GHz	66	12 to 26	0.5 to 5.4	6 to 41
DRA2	4.9 to 10.12 GHz	69.34	15 to 36	0.6 to 5.1	7.2 to 36.5
DRA3	4.8 to 10.28 GHz	72.67	16 to 46.1	0.8 to 5	7.1 to 33
DRA4	3.54 to 10.89 GHz	101.87	15.5 to 54.2	1.5 to 4.5	8.1 to 25.4
DRA5	3.32 to 11.1 GHz	106.2	16.8 to 29	1.8 to 9.4	8.1 to 27.3

2.2 In the metallic part of Antenna surface current distribution

In Fig. 4, is shown the current distribution in the antenna. It can be observed from Fig. 4 a-b with DGS slot all current flow in a single direction and supporting the fundamental mode. The decoupling structure provides the maximum surface current on the edge of the metallic part at the different frequencies. If move to higher frequencies, multiple resonant path generated to support the widen bandwidth and higher order modes as Fig. 4c-e.

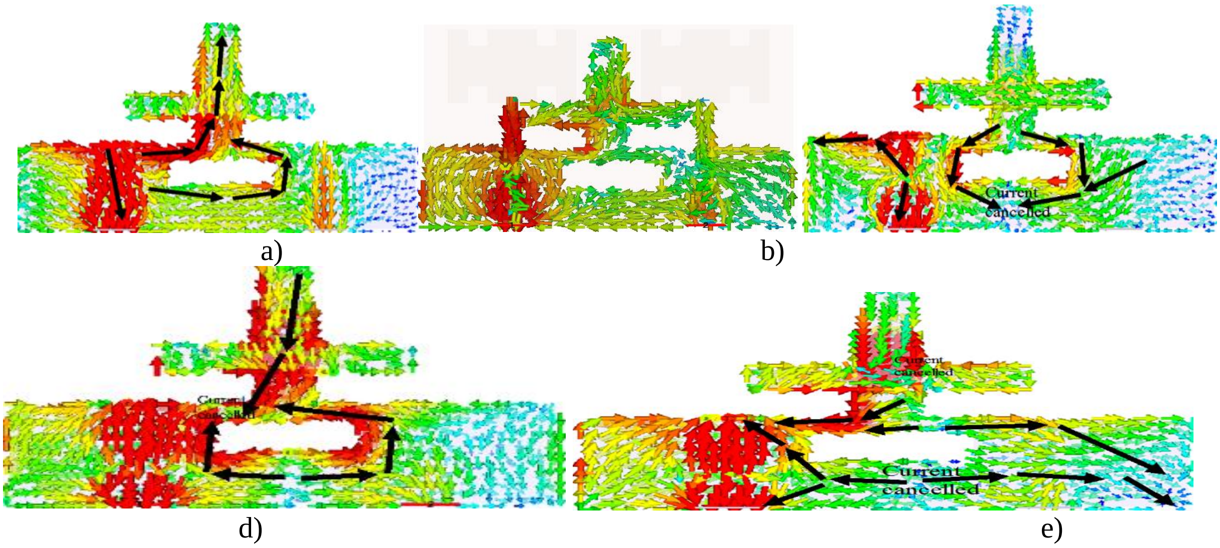


Fig. 4 Metallic part surface current at: a) 4.4 , b) 6.3, c) 8.3, d) 10 and e) 10.8 GHz

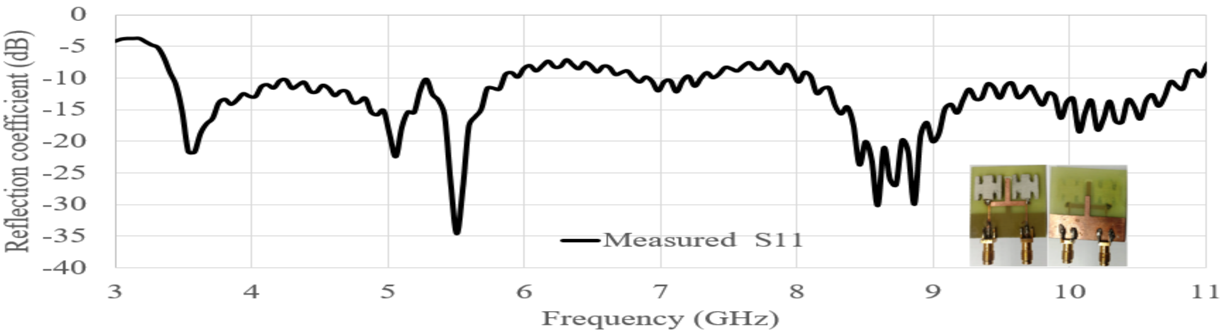


Fig. 5 S11 measured

Figure 5, shows the measured S11 with cover the frequency from 3.4 to 10.8 GHz. The ECC is shown in Fig. 6b with ≤ 0.0059 existing UWB range (Zhang et al. 2009, Li et al. 2013. The other important MIMO parameter DG is shown in Fig. 6a to give the informatics signal through the high capability of the diversity, calculated through S-parameters.

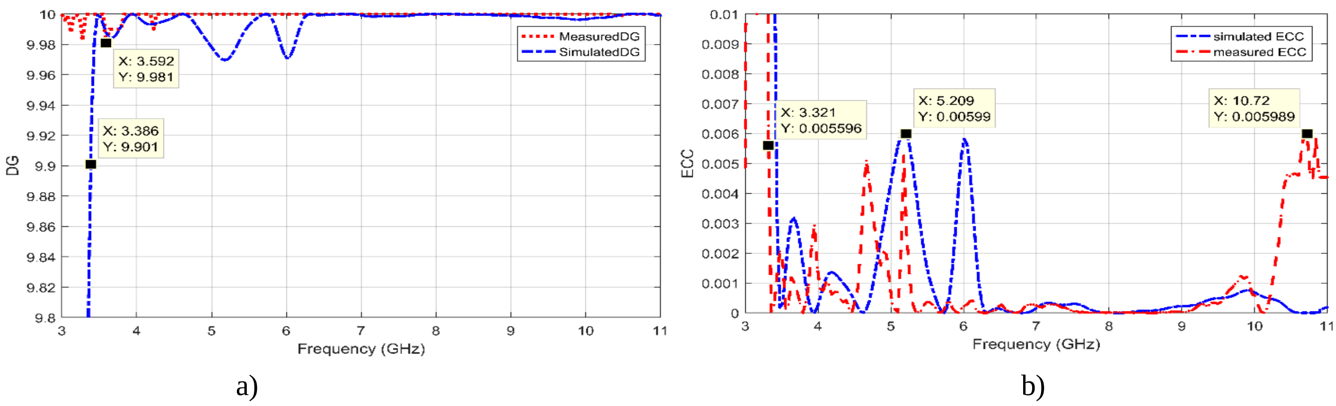


Fig. 6 a. DG b. ECC

3. CONCLUSION

Proposed high gain UWB MIMO DRA excited by a filter type microstrip fed is designed for UWB applications. It covers frequencies from 3.32 GHz to 11.1 GHz (106.2 %), supporting partial S, C, and X bands for high data rate applications. An inverted T-shaped parasitic strip is used to improve AR ≤ 24.9 dB in UWB range. Further, it includes a rectangular DGS slot in partial ground with a stub to achieve the widen impedance bandwidth and better impedance within UWB range. The performance of MIMO antenna is reported low ECC ≤ 0.0059, DG ≥ 9.94dB, and transmission coefficient ≤ -16.8 dB, it is used for high data rate applications.

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