Novel Flower-shaped Multiple Input Multiple Output Dielectric Resonator Antenna

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NOVEL FLOWER-SHAPED MULTIPLE INPUT MULTIPLE OUTPUT DIELECTRIC RESONATOR ANTENNA

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Abstract

In modern communication systems, dielectric resonator antennas (DRA) play an important role due to its several advantages over contemporary antennas. In this paper, novel flower-shaped multiple input multiple output (MIMO) DRA is proposed for wireless applications in X- band. The proposed antenna with four ports displays more than -15 dB isolation between ports with defected ground technique. The antenna exhibits 7.2-7.5 GHZ impedance bandwidth and 4.66 dBi gain at 7.3 GHz. MIMO performance parameters: Envelope Correlation Coefficient (ECC) and Diversity Gain (DG) of the proposed antenna are also studied and calculated.

Key words: Dielectric Resonator Antenna, DRA, MIMO, X-band

1. Introduction

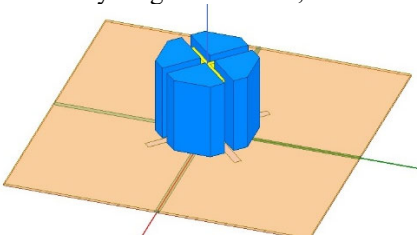
Dielectric resonator antenna (DRA) offers numerous advantages over contemporary antennas such as flexibility in design due to three dimensionality, low loss, high gain and high efficiency [1-4]. DRA has plenty of wireless applications and recently these are used in implantable applications also [5-6] which was considered for microstrip patch antennas only at one time. Even concept of liquid DRA is also presented in recent times [7-8] which shows multi-specialty of DRA in different wireless applications. High speed wireless data transfer became possible because of advent of multiple input multiple output (MIMO) technology. Different configurations of MIMO DRA are presented in recent times [10-16]. In [10] authors reviewed recent MIMO DRAs with various perspective and concluded that multi-port MIMO DRA are tough to design owing to problems associated with them. In [12-16], dual-port, dual-band, four-port and multi-band MIMO DRA for various wireless applications such as 5G, sub-6 GHz, X- band applications have been proposed. In MIMO DRAs as the number of ports increased, complexity and problem of maintaining isolation between feeding ports, also become prominent. This issue has been raised by many researchers but problem associated with increasing number ports hamper performance of antenna system.

In this paper a novel flower-shaped MIMO DRA is proposed for X-band applications. Four dielectric resonator (DR) elements have been placed on a substrate and excited by aperture couple feed. An investigation is carried out to understand radiation and diversity performance of proposed MIMO DRA.

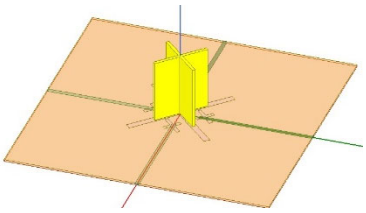
Envelope Correlation Coefficient (ECC) and Diversity Gain (DG) has been calculated using MATLAB calculation software. The simulated impedance bandwidth of proposed antenna is 7.2 GHz-7.5 GHz and peak gain at 7.3 GHz is 4.66 dBi.

2. Flower-Shaped DRA Design

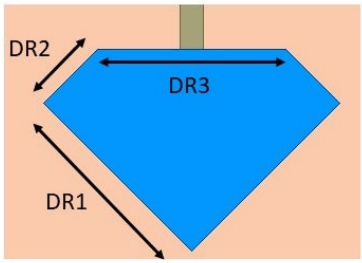
In [10] authors, stated that mostly MIMO DRA are fabricated by researchers using dielectric material with relative permittivity ranges from 9-12, because various advantages and availability of material. The proposed flower-shaped MIMO DRA is also fabricated with anisotropic dielectric material with ϵ_r=10. Four elements dielectric resonator are excited by aperture coupled feed on dielectric substrate with ϵ_r=3.55 and thickness 0.508 mm. These four elements resemble four petals of a flower which confirm its nomenclature. Symmetry is maintained in feeding the four elements so that MIMO operation of antenna does not affect. Figure 1 (a) shows trimetric view of proposed antenna. To minimize mutual radiation effects on neighboring elements, a cross-shaped wall made up of PVC plastic ϵ_r= 2.7 is used as shown in Fig. 1 (b). In Fig. 1 (c) single petal of DR flower is shown. In Fig. (d-e), top view of feed arrangement is displayed without DRA. Defected ground system (DGS) technique is used to maximize isolation between feeding ports as shown in Fig. 1(d). Table 1 shows design parameters of the proposed antenna.



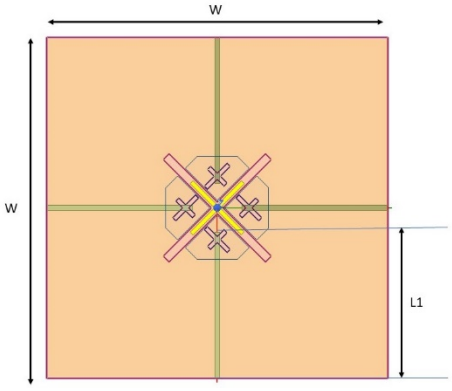
(a) Trimetric View



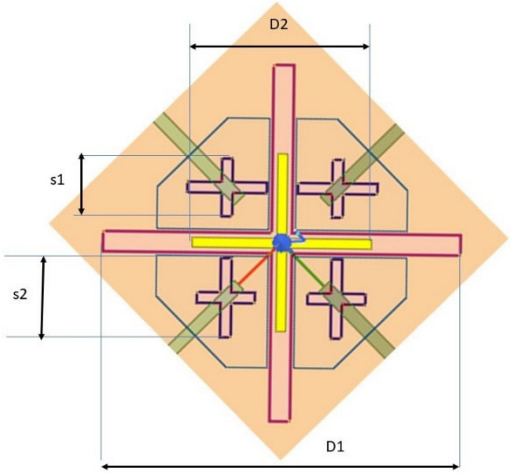
(b)Trimetric view without four DRs



(c) Single element DRA



(c) Top view



(d) Feed arrangement top view

Fig. 1: Geometry of flower-shaped MIMO DRA

Table 1: Design Parameters

Parameter Name	Value (in mm)
W	60
Substrate thickness	0.508
DR1	10
DR2	5.66
DR3	6.14
DRA Height	19.3
PVC plastic sheet height	18
L1 Microstrip line length	32.5
Microstrip line width	1.15
S1 (slit)	5.16
S2 (slit)	7.5
D1 (DGS slot)	32
D2 (PVC Plastic)	16
Slit width	1

3. Results and Discussion

The simulated performance of the proposed antenna is obtained from ANSYS HFSS electromagnetic simulator. The simulated

impedance bandwidth of MIMO DRA is 7.2-7.5 GHz and gain at center frequency 7.35 GHz is 4.66 dBi. Figure 2 illustrates various scattering parameters with respect to frequency. Figure 3 shows a 3-D plot of gain at 7.3 GHz.

To ensure mutual coupling and isolation between ports, surface current distribution is shown in Fig. 4, which confirms high isolation between ports.

Major MIMO performance parameters: ECC and DG have also been calculated using equations mentioned in [12,15] and tabulated in Table 2. For satisfactory MIMO performance ECC should be less than 3 dB which is fulfilled by proposed antenna for complete operating band.

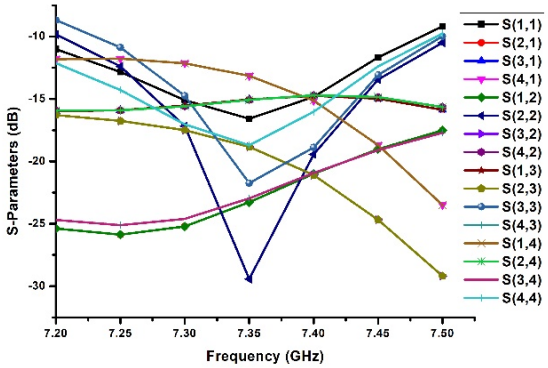


Fig. 2: Simulated S-parameters of flower-shaped MIMO DRA

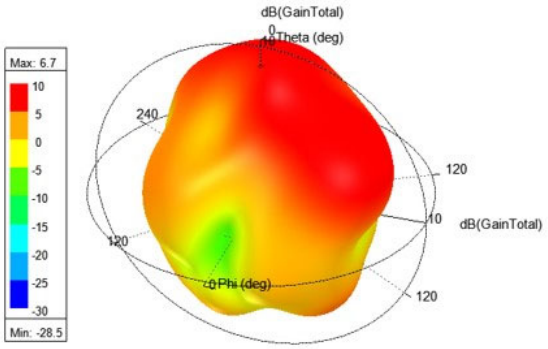


Fig. 3. Three-Dimensional gain plot at 7.3 GHz

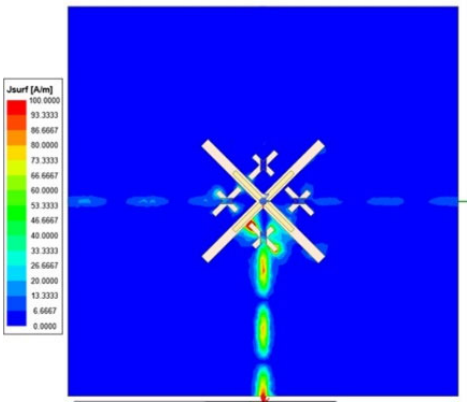


Fig. 4. Surface current distribution at 7.3 GHz

Table 2: MIMO Parameters

Freq (GHz)	Envelope Correlation Coefficient (ECC) dB	Diversity Gain (DG) dB
7.2	0.006866	9.999764
7.25	0.006804	9.999768
7.3	0.006421	9.999794
7.35	0.004366	9.999905
7.4	0.00127	9.999992
7.45	0.001605	9.999987
7.5	0.011242	9.999368

4. Conclusions

In this paper, novel flower-shaped MIMO DRA is proposed for X-band applications. Complete structure made up of four DR elements which are excited by aperture coupled feed. DGS and PVC plastic are used to increase isolation between ports and reduce mutual coupling between DR elements. The radiation performance of MIMO DRA is also studied and simulated impedance bandwidth of proposed antenna is 7.2- 7.5 GHz. The gain of antenna at center frequency is 4.66 dBi and radiation efficiency is above 90% throughout the operating band which make it a good candidate for X-band wireless applications.

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