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# Isolation Enhancement in A Flower Shaped Tunable Terahertz MIMO Dielectric Resonator Antenna

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**Abstract**: This paper proposes a novel approach for enhancing isolation in a Multiple-Input Multiple-Output (MIMO) system utilizing flower-shaped tunable terahertz dielectric resonator antennas (DRAs). Terahertz frequency bands offer promising opportunities for high-speed wireless communication systems due to their wide bandwidth and potential for high data rates. However, achieving sufficient isolation between closely spaced antennas remains a challenge in MIMO systems, particularly at terahertz frequencies. A two-port flower shaped DRA provides the isolation of 20dB which is further enhanced to 32.01dB by inserting L-shape slot in the ground plane of this antenna structure.

**Keywords:** *CST, DRA, silicon, and silicon dioxide material*

## I. INTRODUCTION

Terahertz refers to the electromagnetic spectrum with frequencies ranging from about 0.1 to 10 terahertz (THz).[1]. Terahertz waves can transmit data at rates of up to 1 Tbps, which is 10 times faster than the current 5G technology. The terahertz frequency range has several advantages including higher bandwidth, lower interference, and greater security.[2]. Dielectric resonator antenna (DRA) is a type of antenna that uses a dielectric resonator as its radiating element. [3]. In a DRA, the dielectric resonator is excited by a feed structure, typically a coaxial probe or microstrip line, to radiate electromagnetic waves. The basic structures of DRA shapes like Rectangular, circular, cone, cylinder…, etc. [4]. Antenna with multi-input and multi-output (MIMO) facility can be utilized for enhancing the data transfer rate in THz communication systems. [5]. The main requirement in MIMO antennas is high isolation between the ports. The high value of isolation between the ports makes possible to radiate most of the power from the radiating element. [6]. Another way of implementing the MIMO antennas is utilization of single radiator with multiple ports. [7]. Isolation enhancement techniques in DRAs: Meta material, Physical separation, Electromagnetic Band gap, tuning elements, Defected ground structures, graphene. These techniques can be used to design for Dielectric resonator antenna.

## II. Antenna Design

### 2.1 Design of DRA:

The flower shape DRA is designed with the dimensions of closed loop of DRA With x-axis of radius 8 and y-axis of radius 20 with the height of the above substrate the DRA is placed. The flower shape is consisting of material silicon. The Elliptical cylinder shape with dimension and it is rotated with the angles 90, 45, -45.

### 2.2 Construction of Proposed Antenna:

**Stage 1:** The ground plane is designed with copper material.

**Stage 2**: The antenna structure can be implemented with a substrate of silicon di-oxide (SiO2) having relative permittivity εs = 3.38.

**Stage 3:** The two feed lines are in perpendicular to each other and material of copper.

**Stage 4**: For the two feed lines the two ports is applied.

**Stage 5**: The flower shape DRA of material silicon with relative permittivity εr = 11.2 is then placed above the metallic feedlines in the centre of the substrate for obtaining the resonance in antenna.

**Stage 6**: The L-shape slot is placed in ground plane to reduce the overflow of current from port-1 to port-2 and isolation enhancement.

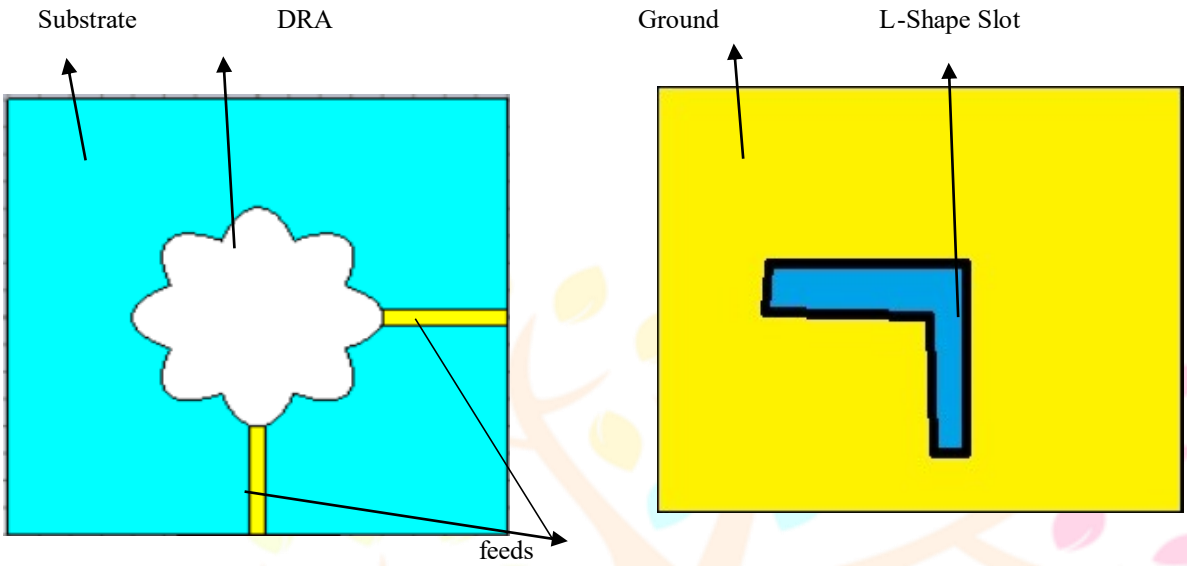



**Fig.1: Front and bottom view of Antenna**

**Table-1: Dimensions and Parameters**

| S.NO | Dimensions | Parameters |
|---|---|---|
| 1. | W=80 | Width and length of ground and substrate |
| 2. | x-radius=8 | Elliptical cylinder(x-radius) |
| 3. | y-radius =20 | Elliptical cylinder(y-radius) |
| 4. | h=12.47 | Height of DRA |
| 5. | hs=2.435 | Height of substrate |
| 6. | lf=29.8 | Length of feed |
| 7. | wf=2.8 | Width of feed |

## III. Result and Discussion:

**Table- 2: 3.1. Parametric analysis of slot:**

| S.NO | Parameter(µm) | | Frequency (THz) | S21(dB) |
|---|---|---|---|---|
| | Slot-1 | Slot-2 | | |
| 1. | L1=25 &W1=7 | L2=5 &W2=10 | 7.72 | 19.7 |
| 2. | L1=25 & W1=7 | L2=5 & W2=17 | 7.73 | 19.8 |
| 3. | L1=25 & W1=5 | L2=3 & W2=20 | 7.78 | 20 |
| 4. | L1=25 & W1=5 | L2=5 & W2=15 | 7.77 | 21.8 |
| 5. | L1=20 & W1=11 | L2=8 & W2=20 | 7.73 | 32.01 |

### 3.2. Surface currents:

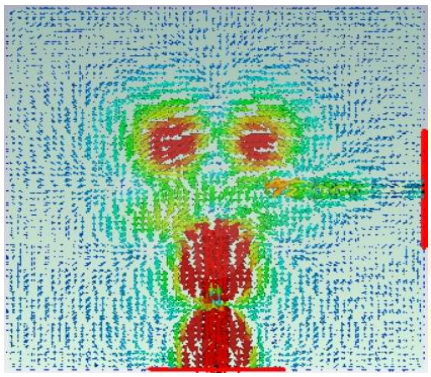


**Figure. 2: Without Slot**

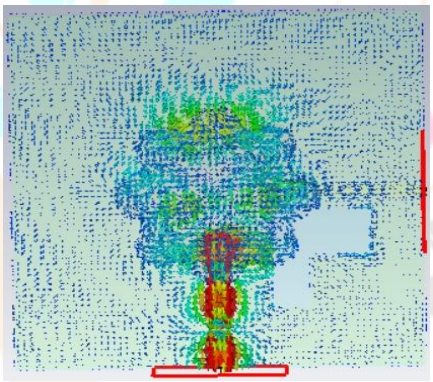
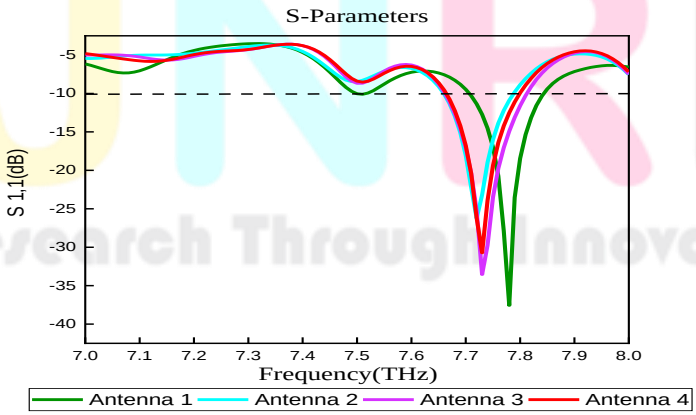


**Figure. 3: With Slot**

### 3.3.S-parameters



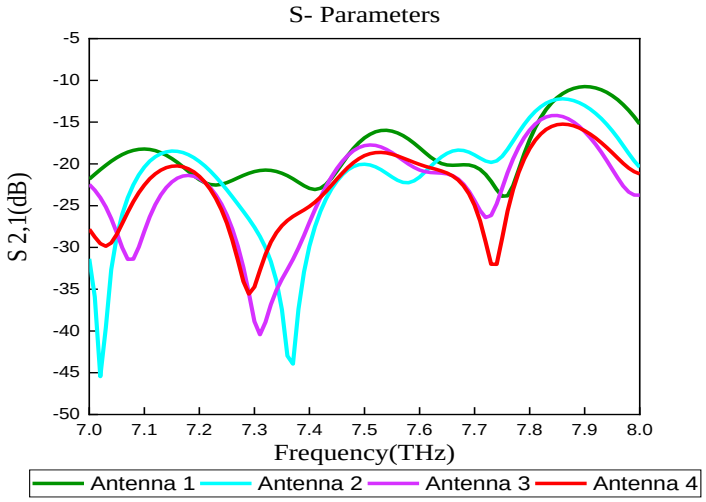



Figure.4: S-Parameter of S11 &S-Parameter of S21

### 3.4. Radiation pattern

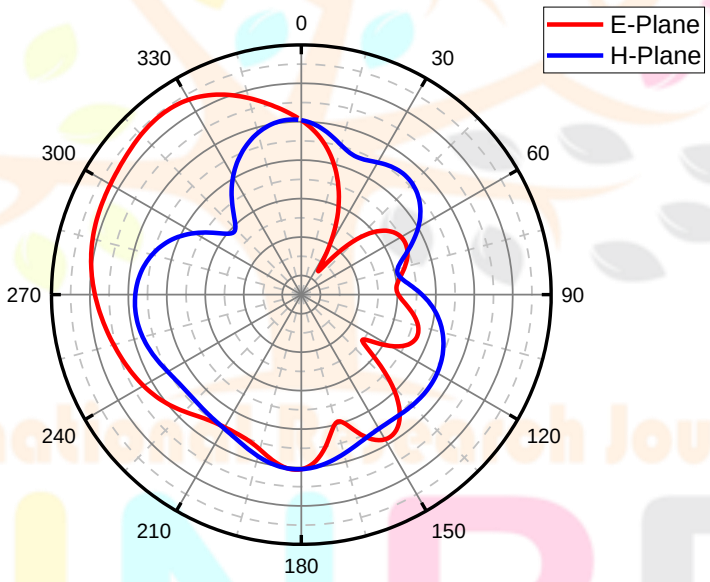



**Figure.5: Radiation pattern**

## IV. Conclusion

This technique is developed for the enhancement of isolation between the ports of a tunable THz multi-port flower shaped DRA with a single radiator. A L-shaped slot has been inserted in the ground plane of the antenna, and it has been enhanced up to 32.01 dB. The obtained high value of isolation can allow to use this antenna in THz simultaneous transmit and receive systems.

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