Design Of 2 X 2 Mimo-Dra Antenna For 5g Communication

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Abstract: MIMO antenna with higher bandwidth and high-speed connectivity becomes the ideal solution for the future 5G wireless applications. The proposed structure has 2 x 2 MIMO DRA configuration with dimension of 20 mm x 20 mm with the thickness of 1.6 mm and feed used is slot coupled microstrip feed. The entire structure is fabricated on a FR4 structure and two dielectric resonators made up of Roger 5880 is placed on top of the slot which is act as feed. The structure is simulated using CST studio. The proposed 2 x 2 MIMO DRA antenna operating at 28 GHz from 26.7 GHz to 29.5 GHz have very low correlation coefficient less than 0.005 and reasonable gain above 9.99 dBi with stable pattern diversity which validates that our proposed structure is the right candidate for the next generation wireless 5G communication.

Index Terms: MIMO, two port antenna, 5G antenna, DRA, decouple.

1. INTRODUCTION
One of the smart antenna techniques [1] is Multiple Input Multiple Output (MIMO) Antenna Technology. The MIMO technology has gained more attention in the recent past because it can transmit more data with the help of multiple antennas. The MIMO technique consists of multiple numbers of antennas at the transmitter as well as the receiver side. MIMO make use of multipath phenomenon, where the data is received in the receiver multiple times with some time delay [2]. The performance of the MIMO is measured using envelope cross correlation (ECC) between the different antenna. The aim of MIMO is to maximize the capacity by reducing the ECC. The next generation mobile technologies will solely rely on the 5G standards in order to meet the ever-increasing demand of higher data rate, which can be achieved with the help of larger bandwidth. And therefore, the mm and sub-mm wave bands has attracted the researchers more. Several kinds of antenna such as micro strip and array are widely used in milli-meter wave band, but the major disadvantage is the surface wave loss and metallic losses. it is necessary [3] to overcome these barriers, [8] the dielectric resonators are used, which has many advantages such as no surface wave loss and high efficiency at mm-wave spectrum. This work [4] electric resonator antenna consists of the dielectric structure with relative dielectric constant varies from 3 to 100, that is excited with the help of coupling feed line. There are many geometries and their design procedures [5] available in the literature.

The met material [7] and dielectric resonators are integrated with antenna in order to achieve bandwidth, gain and multiband. It is used for [6] control both the quality factor and the resonant frequency. The dielectric resonator with high permittivity is used because it can restrict the quality factor. High quality factor will reduce the bandwidth, which is the key issue that needs to be addressed in the design of DRA [9-11]. But the use of DRA-MIMO antenna is not widely investigated for the 5G communication platform. Since the MIMO can able to overcome the multipath effects, the DRA-MIMO combination will result in novel antennas that can be used in 5G communication. The design procedure of the proposed two elements MIMO-DRA is explained in section II. The simulated results are explained in section III in order to validate the proposed MIMO-DRA for 5G communication and conclusion is arrived in section IV.

2. TWO ELEMENT MIMO-DRA DESIGN PROCEDURE
The geometry and its parameter values of the proposed MIMO-DRA for 5G communication is depicted in figure 1 and Table I respectively. The proposed antenna is a four layer structure, a FR4 structure is chooses for the fabrication with feed line on one side and ground with two slots is printed on the other side forming a three layer structure. The two dielectric resonators (DR) is placed on top of the slots forming the fourth layer. Two dielectric resonators are placed on top of the square ground plane of size 20 mm x 20 mm. The DR’s are made up of the roger 5880 material with relative permittivity of 9.8 with the dimension of 7.5 mm x 9.5 mm x 0.8 mm. The Two DR’s are excited with help of slot in the ground plane which is fed with microstrip feed which is printed on the FR4 substrate. In figure 1 the 3D view, front and back view of the proposed MIMO-DRA is clearly depicted. We can observe from figure 1, that the entire structure is printed on a FR4 substrate.
Figure 1 Geometry of the proposed antenna

Table I Dimension of the Proposed MIMO-DRA

<table>
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<tr>
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<tr>
<td>20</td>
<td>20</td>
<td>7.5</td>
<td>9.5</td>
<td>1.4</td>
<td>1.8</td>
<td>10</td>
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<tr>
<td>f</td>
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<td>x</td>
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<td>z</td>
<td>h</td>
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<tr>
<td>0.5</td>
<td>2.2</td>
<td>5.62</td>
<td>12.3</td>
<td>4</td>
<td>1.6</td>
<td>0.0035</td>
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</tbody>
</table>

In figure 2 the simulated S parameter of the proposed MIMO-DRA is depicted, which shows the S11 is reasonably below -10dB in the resonating band of 28GHz from 26.7GHz to 29.5GHz which is the FCC standard spectrum for 5G communication.

Figure 2 S-parameter of the proposed MIMO-DRA

3. RESULT AND DISCUSSION

Figure 3 and Figure 4 clearly depicts the reflection and transmission coefficient plot, it is observed that at 28GHz resonant frequency the return loss is -37dB and the isolation is above -15dB. The proposed MIMO DRA structure is having a decent value in both the return loss and isolation and hence it is used for the 5G communication.
In Figure 5 the surface current of the proposed MIMO-DRA is presented when the a) port 1 is excited and b) port 2 excited respectively. From the Figure 5, it is observed that the surface current is evenly spread over the entire structure and there is very less mutual coupling without any external isolation improvement technique. Similarly, in figure 6 the 3D gain pattern when port 1 and 2 excited is presented, from which we can observe that maximum gain in turn directivity is achieved perpendicular to the DRA axis.
In figure 6, the E field and H field pattern when port 1 and port 2 is excited is presented. The radiation pattern of the proposed MIMO DRA is showing a stable pattern in the entire resonating band. The E plane and H plane has an unidirectional pattern which is the major requirement for any communication application. The antenna MIMO performance is decided with the help of antenna diversity parameter. There are three types of diversity realization techniques 1) spatial diversity, 2) polarization diversity and 3) pattern diversity. This work makes use of spatial diversity technique to realize the antenna diversity and to improve the isolation between two closely coupled antennas. The ECC is used to measure the isolation between two closely couple antennas, which can be measure either with the help of far field pattern or S parameter. When the value of ECC is lower, then the MIMO antenna diversity performance is good. The formulae to find out the Envelope correlation coefficient between antennas i and j in an N-element MIMO antenna system is

\[
\rho_{e}(i,j,N) = \left| \frac{\sum_{k=1}^{N} e_{i,k} e_{j,k}}{\sqrt{\prod_{k=1}^{N} (1 - |e_{i,k} e_{j,k}|^2)}} \right|
\]  

Figure 7 shows the diversity gain performance of the proposed MIMO DRA antenna for 5G communication. The diversity gain is more than 9.99 dB. In figure 8 the simulated ECC using CST software based on S parameter is presented. The ECC value is less than 0.005 in the resonating band, which clearly reveals that the proposed MIMO-DRA antenna for the 5G communication application is having a good antenna diversity performance.

Figure 7 Diversity Gain of the proposed MIMO-DRA

Figure 8 ECC of the proposed MIMO-DRA

4. CONCLUSION
A 2 x 2 MIMO DRA antenna is designed for 5G communication application. Two dielectric resonators are place on top of the slot in the ground. A novel microstrip feed slot is used as feed for the dielectric resonators. The dielectric resonator is made up of high permittivity dielectric material Roger 5880. The entire structure is resonating at 28 GHz band from 26.7 GHz to 29.5 GHz with a maximum return loss value of -37 dB. It is also observed that good isolation performance is shown by proposed MIMO-DRA structure. The Diversity gain of the proposed structure is maintained above 8.5 dBi in the entire operating frequency and its envelope correlation coefficient is less than 0.005. The surface current of designed antenna clearly shows that the structure is having very less coupling fields and a stable radiation pattern. The proposed MIMO DRA is the best choice for the 5G communication because of its small size and good performance.

REFERENCES


