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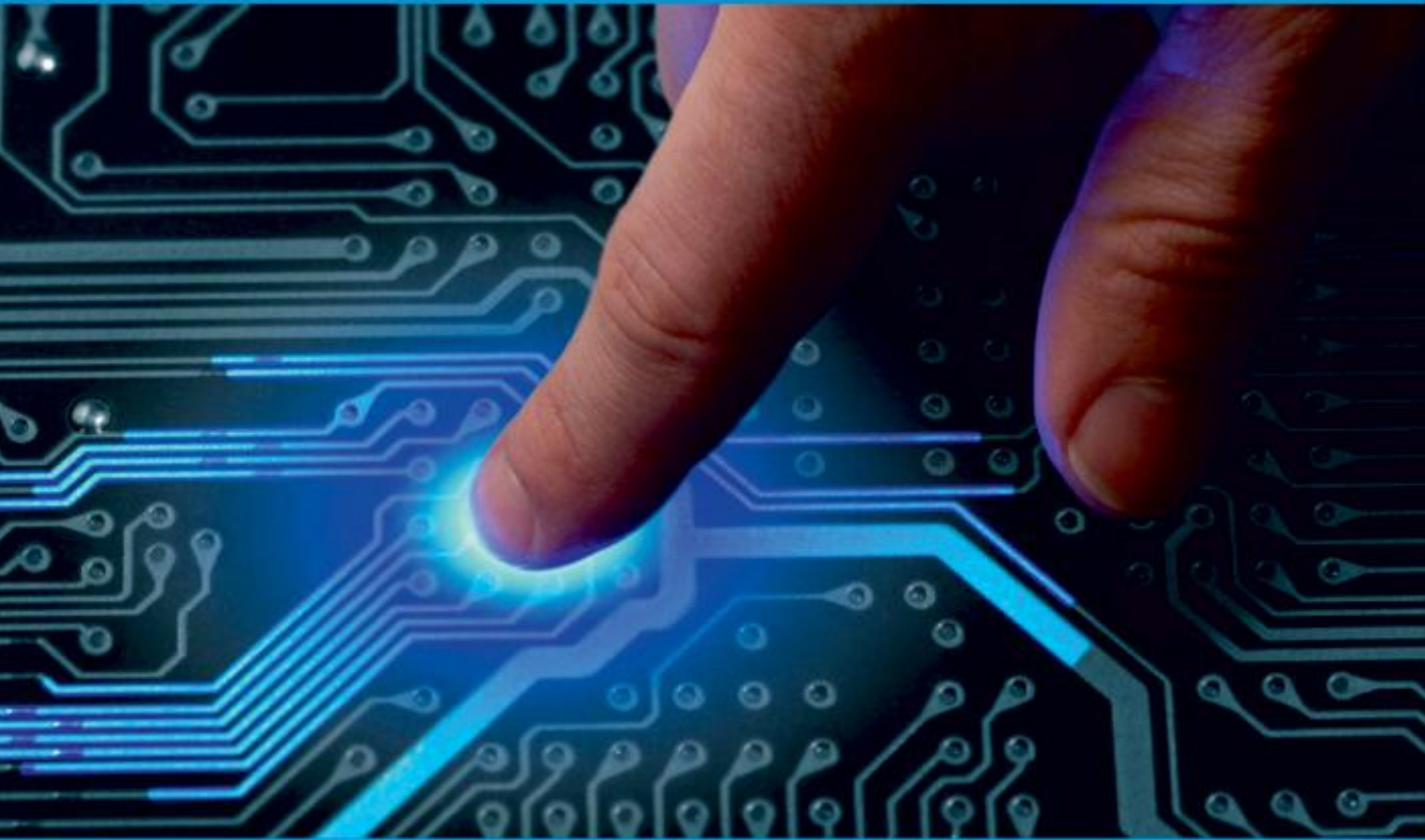

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Designing of Multiple-Input-Multiple-Output Antenna for Wireless Applications

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ABSTRACT: In this article, A multiple-input-multiple-output(MIMO) antenna consisting of a compact two-element design is proposed. In order to realize polarization diversity, two elements of the MIMO antenna are oriented horizontally. MIMO provides additional degrees of freedom by providing a number of antennas at both transmitter and receiver. The antenna is designed using FR4 substrate with 1.6 mm thickness. Two antenna elements sharing a common ground plane. In this arrangement, the antenna resonating elements are adjacently placed to each other, as it reduces interelement coupling and offers a consistent link with the wireless systems/devices. The proposed antenna shows a bandwidth (S11 ≤ -10 dB) of 1.36 GHz (6.64-8 GHz).

KEYWORDS: antenna, MIMO, polarization, diversity, coupling, bandwidth

I.INTRODUCTION

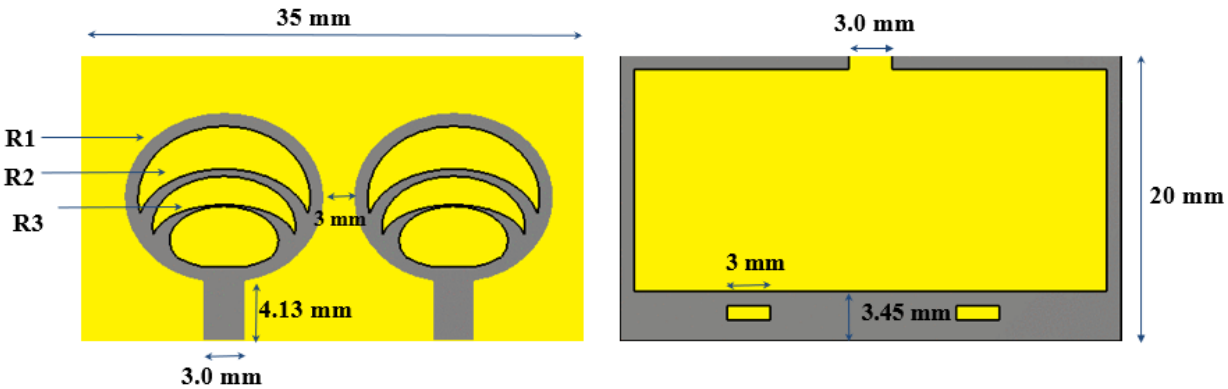
The evolution of MIMO took place in the year 1993,when it was thought of as a method of broadcasting by splitting a high-rate signal into various low-rate signals transmitted from spatially separated transmitters and then based on differences in directions-of-arrival recovered by the receiver antenna array. In the modern communication world Multiple-input-multiple-output (MIMO) technology is used ubiquitously, to improve bandwidth efficiency and capacity by employing multiple antenna elements. It is a favorable solution to cater to the increasing demands for a higher data rate in wireless communication systems,exploiting multipath propagation.Thus MIMO achieves spatial diversity and spatial multiplexing.

The great challenge to MIMO antenna industry is to fitting the multiple antenna elements within the compact space of portable equipments is the biggest challenge in the multiple-input-multiple-output industry, wherein mutual coupling arises due to electromagnetic interference of radiation from adjacent antennas causing information loss as well as performance degradation. Mutual coupling alters the matching criteria of antenna elements and thus changes the received element power and radiation pattern. It is detrimental to antenna performance and has attracted a large volume of research to study its causes and remedies. The emergence of ultra compact radio transceivers has favoured the development of small-size antennas in recent years thus placing the study of mutual coupling in top most priority.[1]

The multiple-input-multiple-output(MIMO) antennas can be classified as planar and nonplanar. Generally, in planar MIMO antennas, the antenna elements are arranged in a horizontal/vertical plane with minimum spacing, which impacts interelement coupling.[4]Although, the large spacing between antenna elements is not proposed, as it increases the final size of the MIMO antenna. For improving interelement isolation, a number of techniques have been reported in the literature using T-shaped ground stub,[5] electromagnetic bandgap structures,[6] split-ring resonators,[7] parasitic decoupling elements,[8] defected ground structures,[9] frequency selective surfaces (FSS).[10]

II.ANTENNA DESIGN

The proposed unit cell of the antenna is designed using FR-4 substrate with dielectric constant of 4.4, loss tangent of 0.02, and height of 1.6 mm. The volume of the unit cell is $35 \times 20 \times 1.6$ mm^3.The length of the substrate is 35mm and breadth of the substrate is 20mm with a width of 1.6mm. The feed line has length 4.13mm and breadth 3.0mm. The diameters of the elliptical rings are mentioned in Table 1. The separation between the patches is 3.0mm. A simple elliptical ring which is introduced as a radiator with a ground surface of breadth 3.45mm, which is chosen for realizing a good impedance matching in the radiating band. In order to improve impedance bandwidth, one more elliptical ring is introduced and integrated by inductive loading into the region nearer to the feed line. A third elliptical ring is integrated in the front plane of the patch for providing additional bandwidth.



(a) Top-view **(b) Bottom view**

FIGURE 1 Schematic of the antenna unit cell

By introducing two L-shaped strips in an upturned manner with a separation of 3.0mm on the ground plane of the antenna, which increases the electrical size of the antenna, which will enhance the bandwidth of the antenna. A small rectangular-shaped slotted part of length 3.0mm is etched out near the feed region from the ground plane of the antenna. This etched slot decreases the capacitance induced between the radiating plane and the ground surface of the antenna, so it provides a better impedance matching in the entire resonating band. The simulation of the proposed antenna structure is carried out by using CST Microwave Studio software.

TABLE 1 Radii of elliptical rings of the antenna element

	R_3 (mm)	R_2 (mm)	R_1 (mm)
Major axis			
External radius	5	6	7
Internal radius	3.8	5	6
Minor axis			
External radius	2.5	4	6
Internal radius	2.4	3.5	5

III.**RESULTS & DISCUSSION**

Return Loss(dB):

S11 gives the reflection coefficient at port 1 where we apply the input to the microstrip patch antenna. It should be less than -10 dB for the acceptable operation. It shows that the proposed antenna resonates at a frequency equal to 6.96 GHz.

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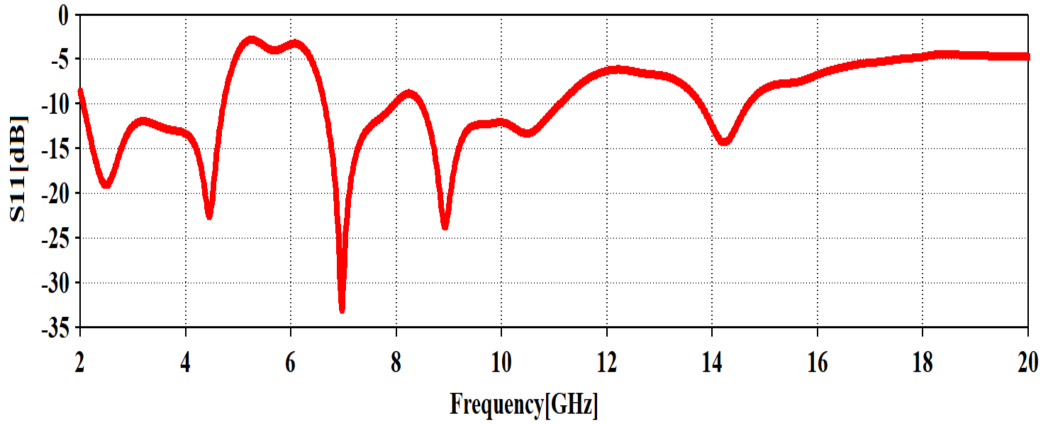

FIGURE 2 S11 response of the antenna element

S21 represents the power received at antenna 2 relative to the power input to antenna 1. For a MIMO antenna S21 should be less than -15dB.

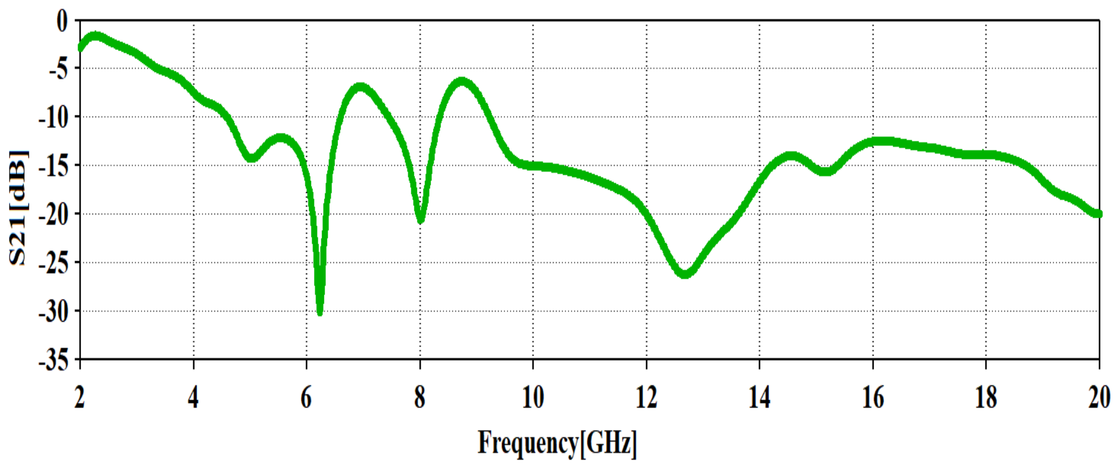

FIGURE 3 S21 response of the antenna element

VSWR Parameter:

VSWR (Voltage Standing Wave Ratio), is a measure of how efficiently radio-frequency power is transmitted from a power source, through a transmission line, into a load.The value of VSWR should lie between 1 and 2.

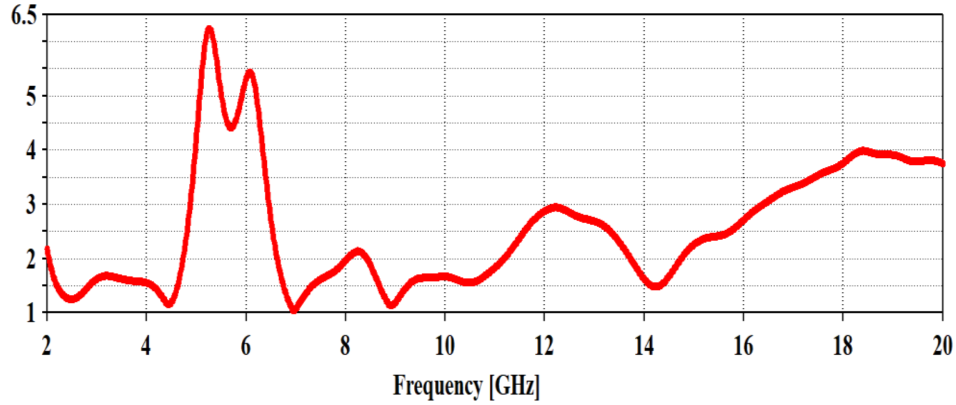

FIGURE 4 VSWR1 response of the antenna element

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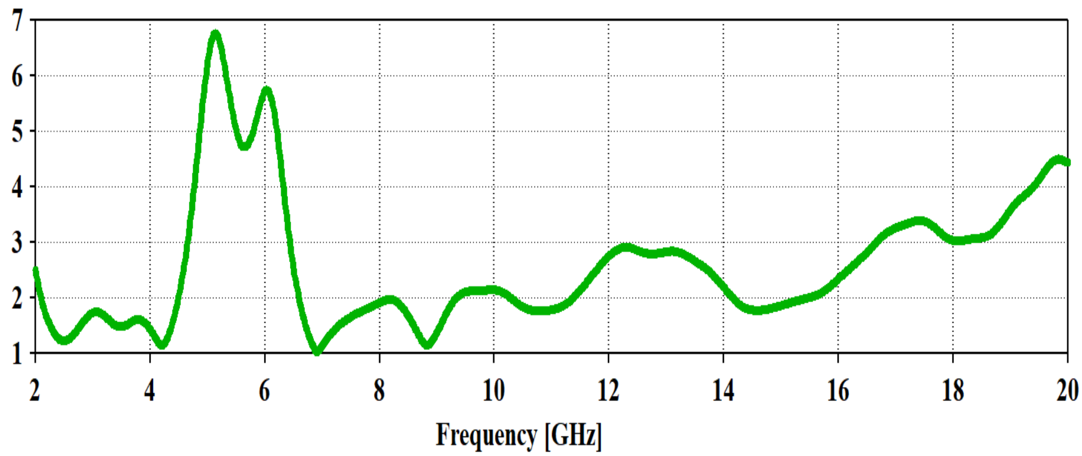
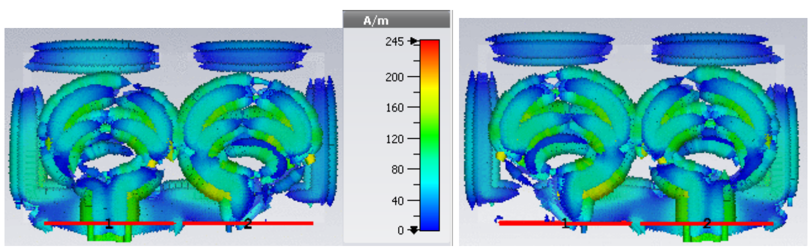


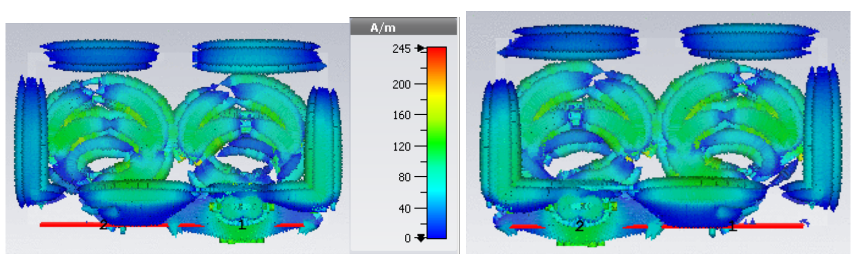
FIGURE 5 VSWR2 response of the antenna element

Surface Current Distributions:



PORT-1 EXCITED PORT-2 EXCITED

FIGURE 6 SURFACE CURRENT FRONT PLANE AT 6.96 GHz



PORT-1 EXCITED PORT-2 EXCITED

FIGURE 7 SURFACE CURRENT GROUND PLANE AT 6.96 GHz

Z-Parameters:

For any antenna we can plot z-parameters. It consists of the real part and imaginary part. Real part of antenna impedance represents power that is either radiated away within the antenna. Imaginary part of the antenna impedance represents the power stored in the near field of the antenna.

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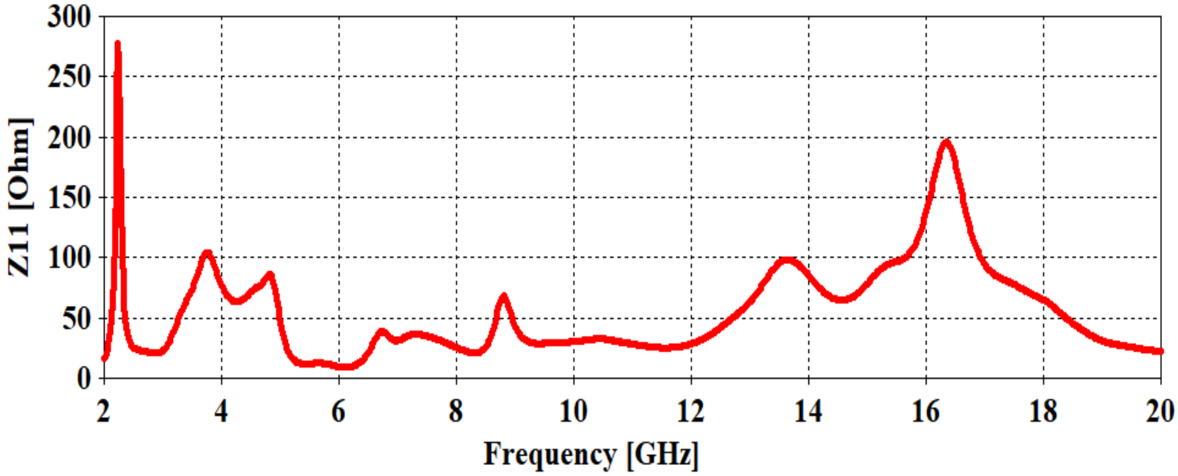

FIGURE 8 Z11 Real part ofthe proposed antenna

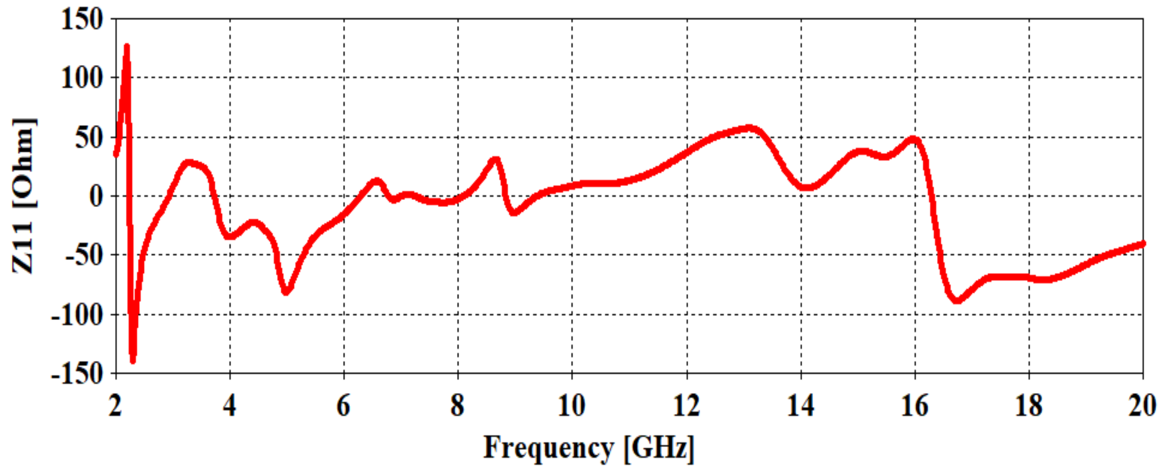

FIGURE 9 Z11 imaginary part of the proposed antenna

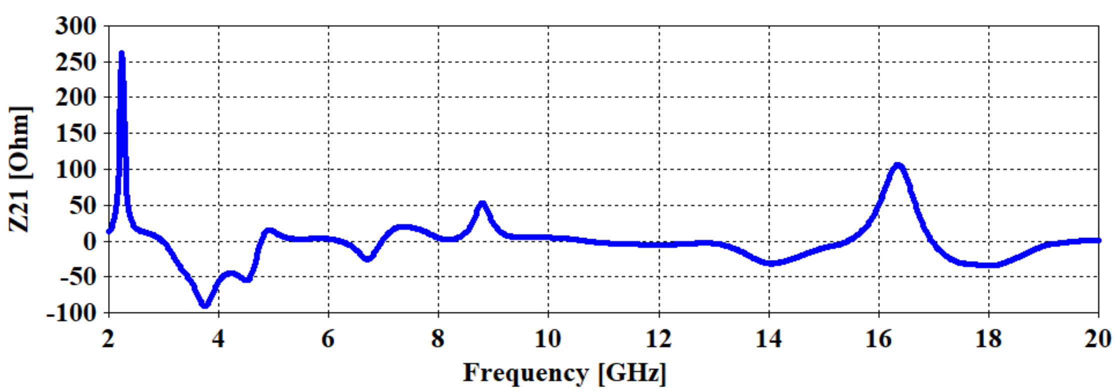

FIGURE 10 Z_{21} Real part of the proposed antenna

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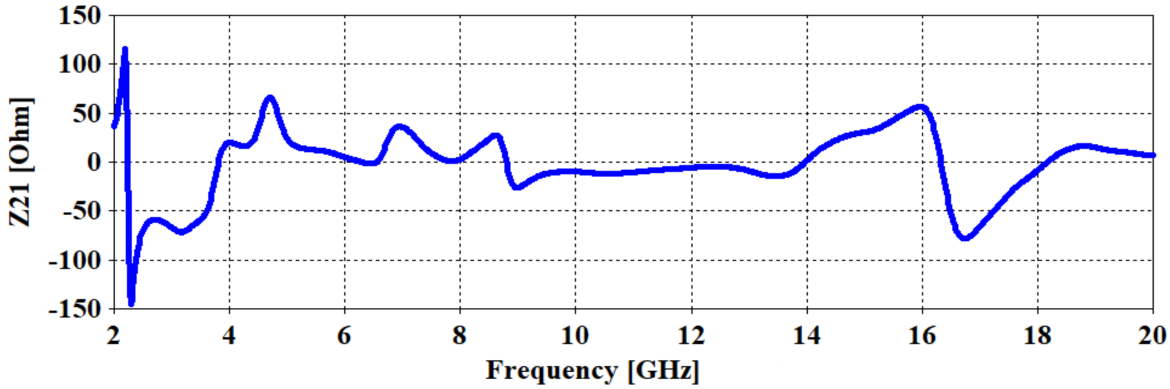
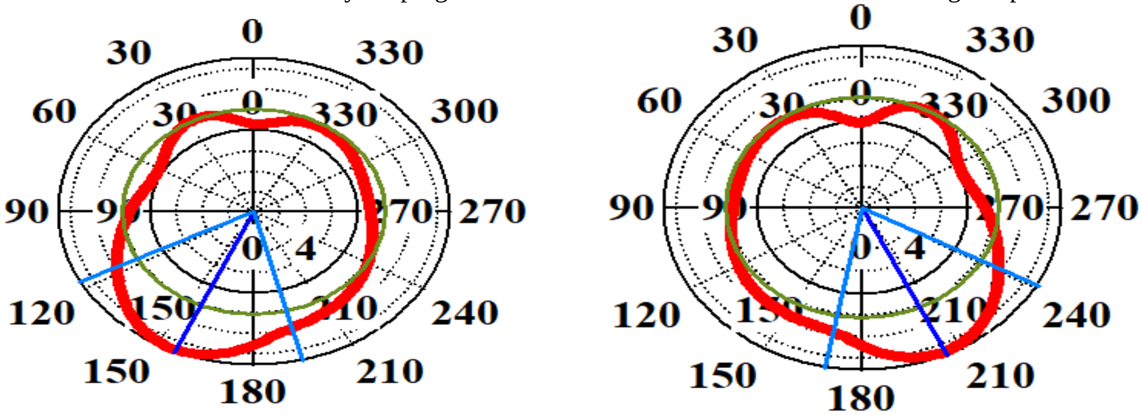


FIGURE 11 Z21 Imaginary part of the proposed antenna

E-FIELD DISTRIBUTION:

E-Filed distribution is measured by keeping □as constant and □ = 0^{o} and is measured along XZ plane at 6.96GHz



(a) (b)

FIGURE 12 E-FIELD When (a) Port-1 Excited and (b) Port-2 Excited

H-FIELD DISTRIBUTION:

H-Field distribution is measured by keeping □ as constant and □ = 90^{o} and is measured along YZ plane at 6.96GHz

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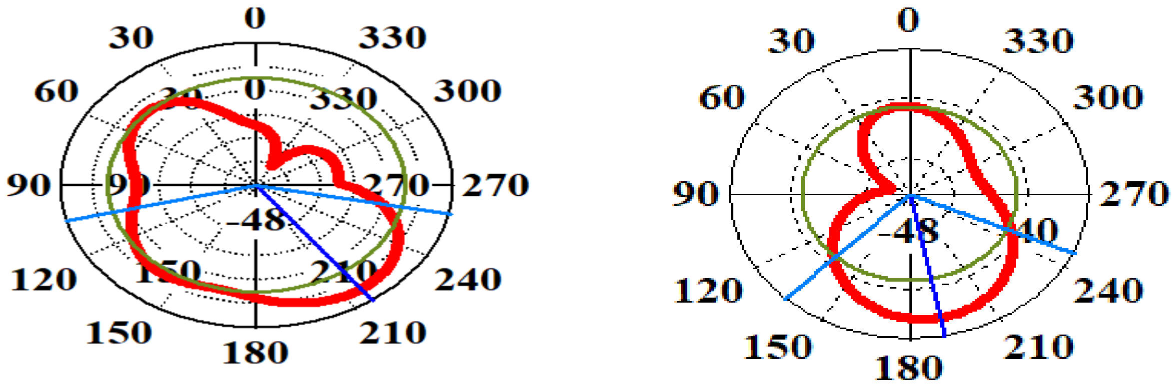

(a) (b)

FIGURE 13 H-FIELD When (a) Port-1 Excited and (b) Port-2 Excited

Gain:

The term antenna gain describes how much power is transmitted in the direction of peak radiation to that of an isotropic source. • Gain is usually measured in dB. Antenna gain takes the losses that occur also into account and hence focuses on the efficiency.

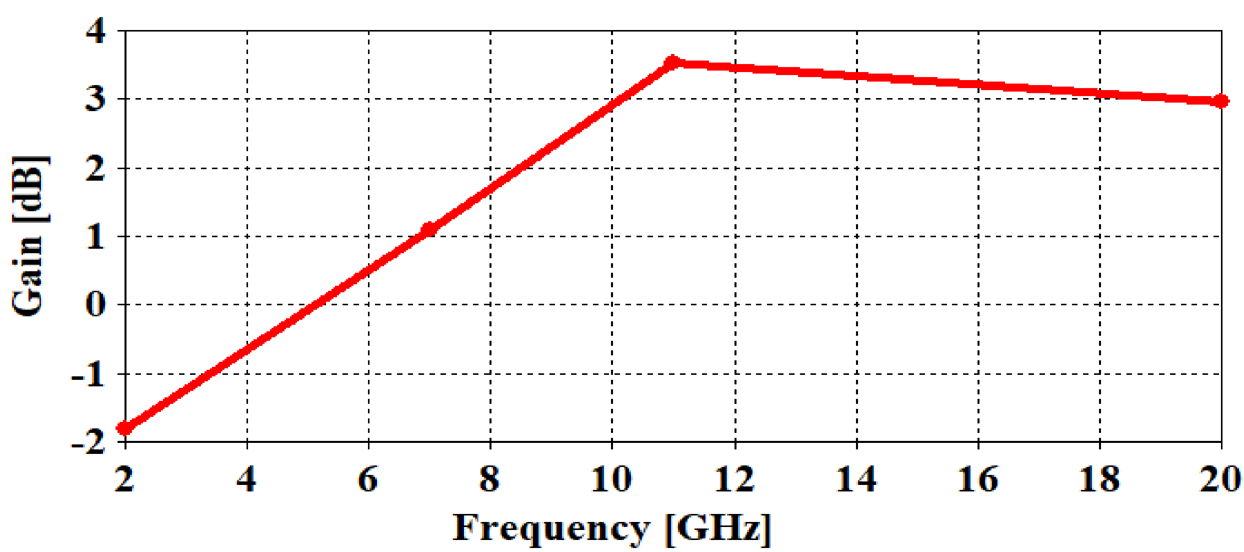

FIGURE 14 Gain of the proposed antenna

Directivity:

Here the directivity defines the ratio of the radiation intensity in a given direction from the antenna to the radiation intensity averaged over all directions and if in that given direction the radiation intensity is maximum then it is called the maximum directivity.

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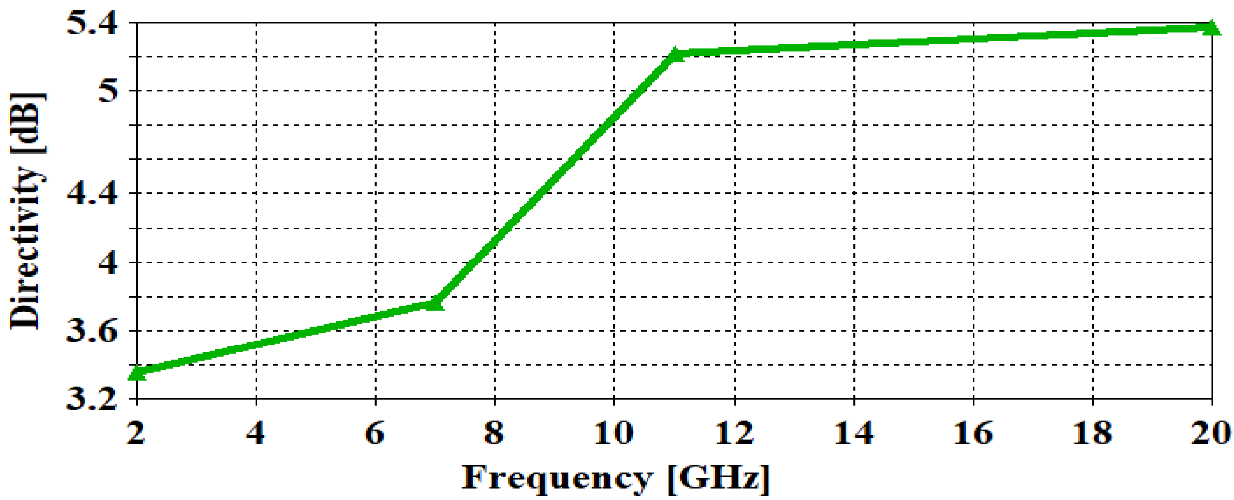

FIGURE 15 Gain of the proposed antenna

IV.CONCLUSION

A compact two element multiple-input-multiple-output MIMO antenna is presented in this paper. A multiple-input-multiple-output (MIMO) antenna consisting of a compact two-element design is proposed.Polarization diversity is realized by placing the two elements of the MIMO antenna in horizontal orientation. MIMO provides additional degrees of freedom by providing a number of antennas at both transmitter and receiver. The antenna is designed, using FR4 substrate with 1.6 mm thickness. Two antenna elements sharing a common ground plane. In this arrangement, the antenna resonating elements are adjacently placed to each other, as it reduces interelement coupling and offers a consistent link with the wireless systems/devices. The proposed antenna shows a bandwidth ($S11 \leq -10$ dB) of 1.36 GHz (6.64-8 GHz).

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