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Novel Environmentally Safe Dual Port UWB MIMO Antenna with Triple Band Notch Characteristics with Sustain Enhanced Isolation

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Abstract

This paper elaborates the design of a Printed dual port CPW fed ultra-wide band triple band notched MIMO antenna which is environmentally safe. The two radiating antennas where placed parallel to each other with adequate separation, to achieve better isolation between radiating elements a Conducting strip is introduced two slot were placed on it, conducting strip acts as a obstructer in reducing surface waves which leads to better isolation. Key parameters Energy ,ECC,TARC were analyzed. The total size of the proposed structure is 50.45mm*24.45mm*1.6mm.

Keywords:MIMO, CPW, Ultra wideband, RT Duroid, ECC

1 Introduction

In present day scenario the center of attraction is towards the MIMO antenna systems with enhanced capacity of the antenna which high data rate, and high signal to noise ratio also reliability of the systems. In MIMO system more number of radiating elements were placed in the transmitter and

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receiver part of the system to send and receive data simultaneously , crucial thing found to keep the antenna elements compactly without affecting the performance ; usually MIMO systems faces fading in the channel and they are more viable to the noise present in the environment [1].so while designing such MIMO antenna ,isolation between two radiating elements is the crucible parameter to evaluate the performance it is the major Challenging task to reduce the mutual coupling between the radiating elements, mutual coupling between patches drastically affects the performances of the antenna envelope correlation co efficient, channel capacity loss are mainly due to placement of the radiating elements nearby. For reducing mutual coupling and enhance the performance various techniques were deployed in the early days by using resonating slots [2] utilizing neutralization lines [3] meander line resonator [4] f shaped stubs[5] t shaped slots [6], met materials [7] Defected grounds, protruding grounds[8-11] ,tree structures[12], artificial magnetic conductors [13], asymmetric coplanar strip[14-15] electromagnetic band gap[16],decoupling network[17] , and offset micro strip MIMO[18] and also defected ground structures on that defected ground structures exhibit a high front to back ratio and also among various fed type Coplanar wave guide fed antennas[19-23] are also found to be good candidate for the MIMO systems. By analyzing all aforementioned literatures minimized size and good isolation between antenna is aimed in this article.

1.1 Antenna Geometry

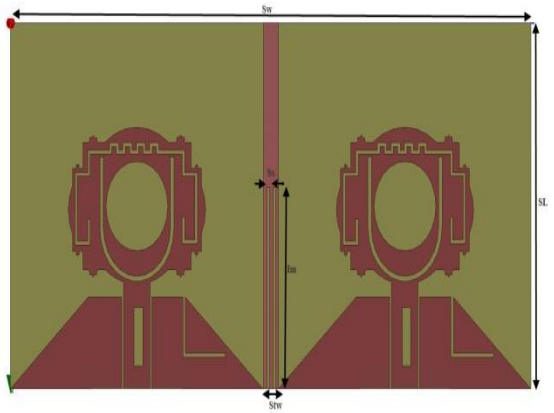

Figure 1 Layout of the Proposed MIMO Antenna

Proposed Layout of two port MIMO antenna is depicted in the Figure 1 and dimensions were listed in the Table1. MIMO system is consisting of

two radiating patches which are alike in shape are printed over the RT Duroid 5880 substrate whose relative permittivity is 2.2 and loss tangent is 0.0009 respectively. Two patches were fed with coplanar wave guide line of 50 ohm characteristic impendence. The ground is tapered CPW ground. Novel monopole is taken as radiating element initially which exhibit ultra-wide band with triple band notched characteristics .In order to achieve better isolation two radiating patches where placed apart 1.55mm apart and the gap between the radiating elements plays a vital role in the impedance mismatch so that is optimized to 1.55mm and then a conducting strip sized 1.4mm*24.45mm is placed in between the antennas. On which two slots were engraved and optimized the values of the engraved slots are 0.3mm*13.5mm.

Table 1 Antenna Parameters

S.No	Parameters	Value (mm)
1	Width of the substrate(sw)	50.45
2	Length of the substrate(Sl)	24.45
3	Width of the strip(Stw)	1.4
4	Width of the slot(Ss)	0.3
5	Length of the slot(Im)	13.5
6	Thickness of the substrate	1.6

2 Simulated Results and Discussion

2.1 Bandwidth Features

The proposed antenna is designed using FEM based software, antenna aimed to work over the ultra wide band region over which three interfering bands such as X band , WLAN and WIMAX were notched out, further the antenna is extended to MIMO Simulated scattering parameters is given in the Figure 2 which Enumerates the scattering parameters of the proposed variant after inserting the isolation element with original triple notched ultra wide band antenna which clearly shows that the mutual coupling is reduced drastically by using the introduced strip in between the elements and Figure 3 shows the VSWR performance of the antenna which is in the acceptable range below 2 over the region.

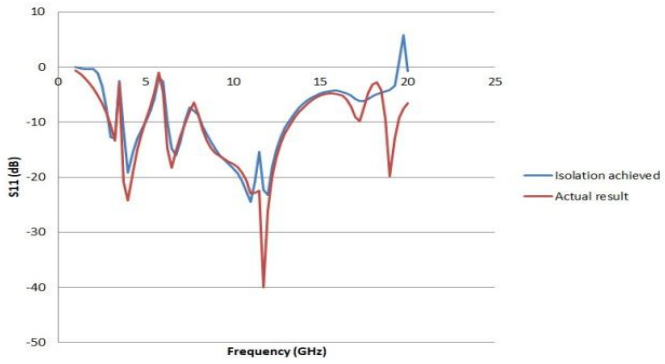

Figure 2 Scatering Parameters of MIMO Antenna With Isolation and Orginal Notched UWB Antenna

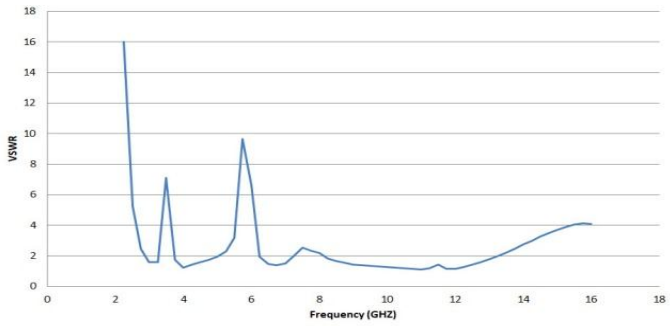

Figure 3 VSWR Of The Proposed Antenna

While focusing towards the MIMO antenna, design adequate attempt to reduce the mutual coupling is made . Mutual coupling is due to the surfaces waves which are exited from one of the radiating antenna since placement of two antenna have impact on impedance mismatch, which is shown in the Figure 4.

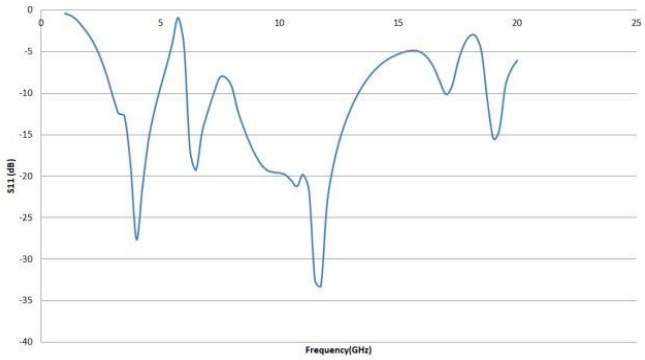

Figure 4 Without Isolation Element

To reduce mutual coupling, a conducting strip size 1.45 mm is further introduced over which two slots were engraved to achieve better isolation a parametric analysis is carried out.

2.2 Parametric Study

This segment for parametric analysis of the slot length variation is performed while analyzing keeping all other parameters as constant values two slot lengths are raised equally at the point of13.5mm which produces a good isolation and gives the better result the parametric study details is represented in the Figure 5.

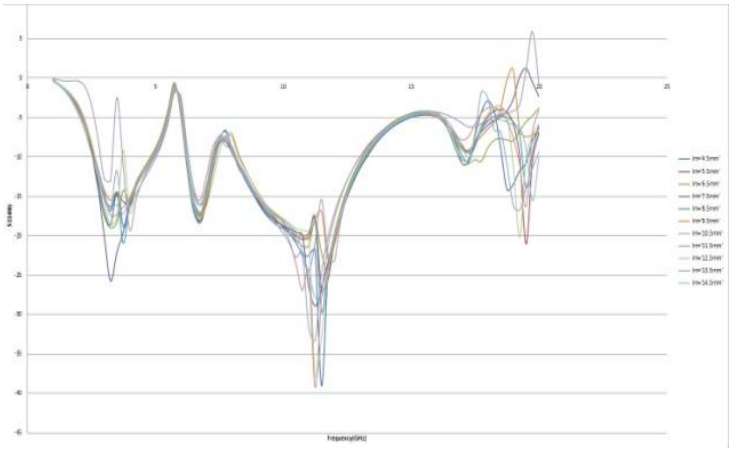

Figure 5 Parametric Results Of Slots In The Conducting Strip

Figure 6 gives complete scattering parameters of the proposed variant from the graph its clearly seen that antenna is well isolated and give isolation of -20 dB. Figure 7 gives the Freezed Results.

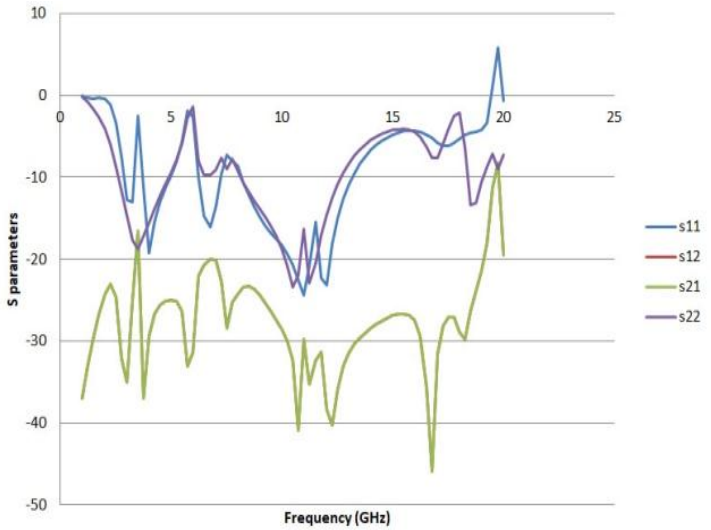

Figure 6 Simulated S Parameters

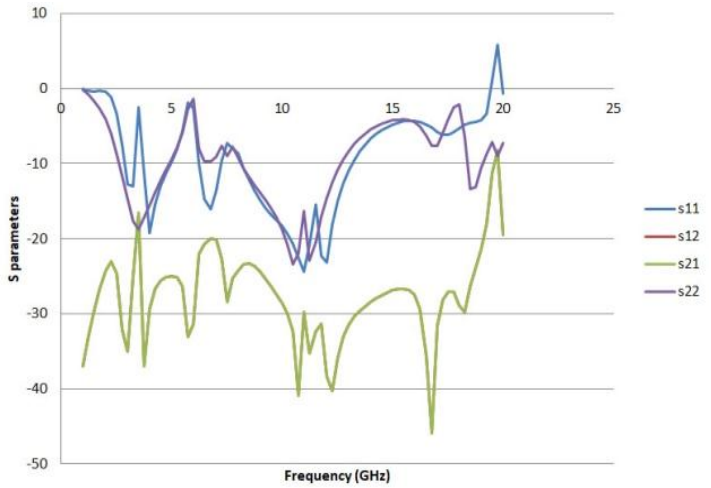

Figure 7 Freezed Results

2.3 Surface Current Distribution

To study the isolation characteristics the surface current distribution of the antenna is analyzed which is shown in the Figure 8-15 at the resonating peak frequencies with isolation and Figure 12-14 shows without the isolation element which clearly depicts that after introducing isolation element the surface wave propagation is reduced hence it not affected; Space wave propagation of one element to another element is also reduced.

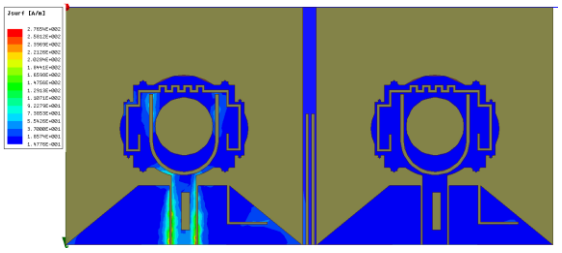

Figure 8 Surface Current Density at 6.75 GHz

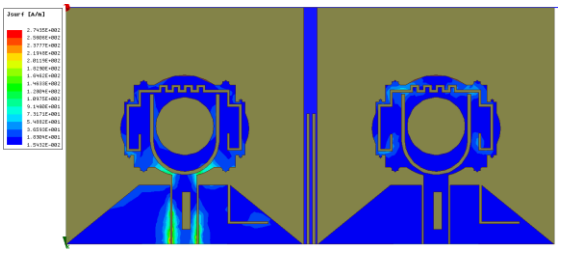

Figure 9 Current Density at 11GHz

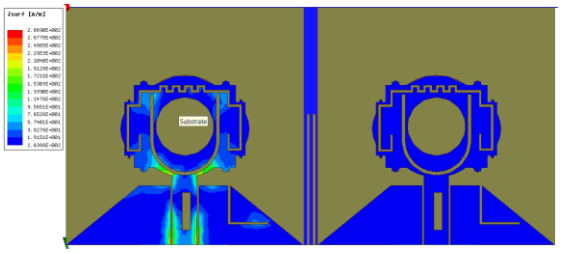

Figure 10 Current Density at 12.25 GHzWithout Isolation

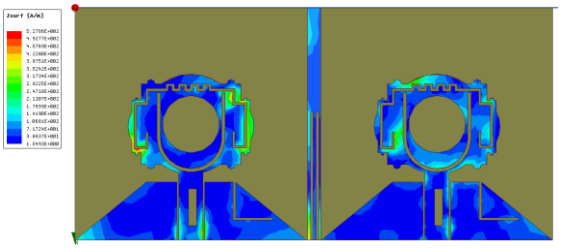

Figure 11 Current Density at 3.25 GHz

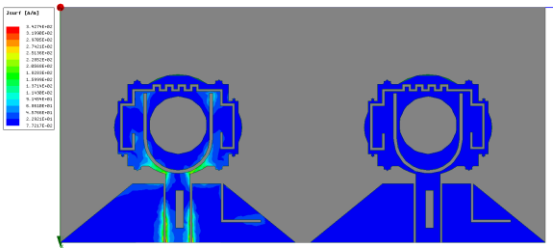

Figure 12 Current Density at 12.25GHz

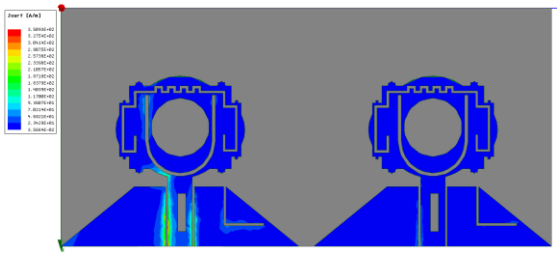

Figure 13 Current Density at 6.75GHz

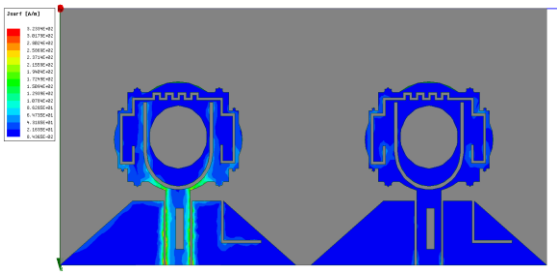

Figure 14 Current Density at 3.25GHz

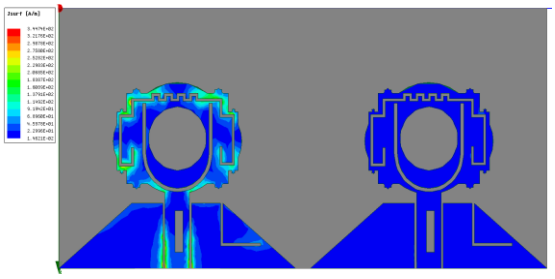

Figure 15 Current Density at 11GHz

2.4 Radiation Performance

The antenna exhibits a Omni directional radiation pattern over the range both the H plane and E plane shows good characteristics which is shown in the figures, from Figure 16 to Figure 25

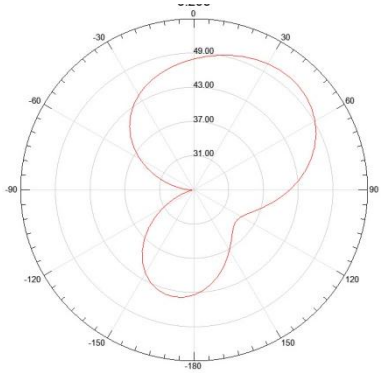

Figure 16 Simulated Radiation E plane at3.25 GHz

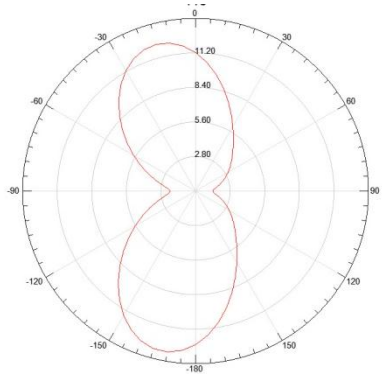

Figure 17 Simulated Radiation E plane at 11GHz

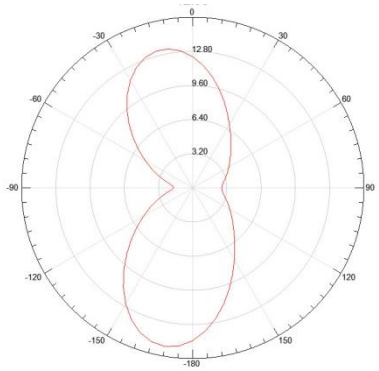

Figure 18 Simulated Radiation E plane at 12.5 GHz

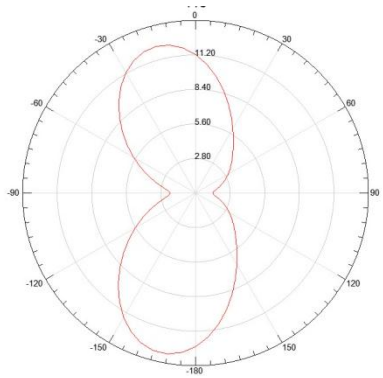

Figure 19 Simulated Radiation E plane at 11GHz

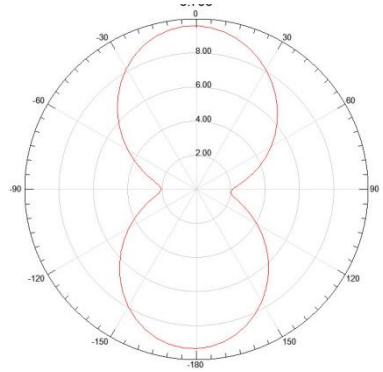

Figure 20 Simulated Radiation E plane at 6.75GHz

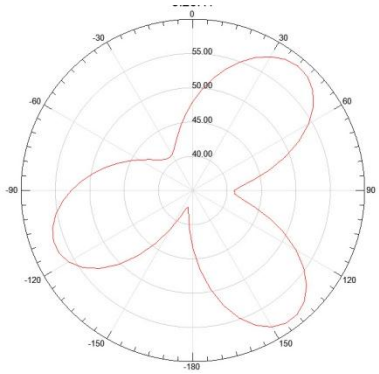

Figure 21 Simulated Radiation H plane at3.25GHz

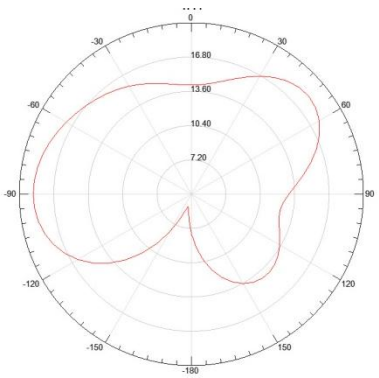

Figure 22 Simulated Radiation H planeat 4 GHz

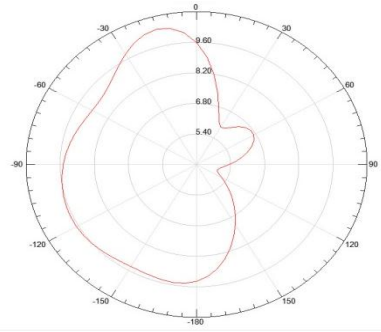

Figure 23 Simulated Radiation H plane 6.75 GHz

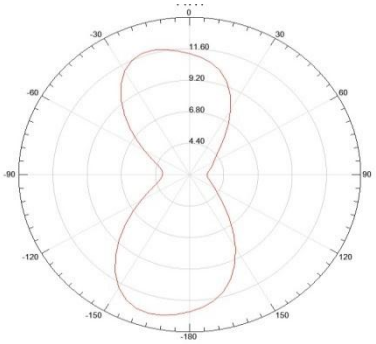

Figure 24 Simulated Radiation H plane at 11 GHz

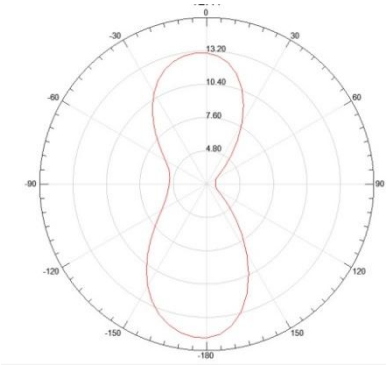

Figure 25 Simulated Radiation Pattern H Plane at 12GHz

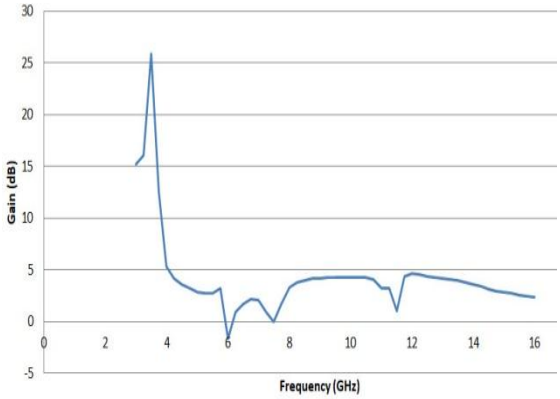

Figure 26 Simulated Gain of the Proposed MIMO Antenna

The gain of the antenna is presented in the Figure 26 which clearly shows the gain over the frequency range is increased the maximum simulated gain of 4.2dB.

3 Diversity Performances

3.1 ECC (Envelope Correlation Coefficient)

Diversity parameter of the proposed variant is verified by using envelope correlation co efficient which detail gives about how both antennas were correlated In general the envelope correlation below 0.5 is satisfactory cases for the real time applications and ought to be 0 in ideal ECC this could be evaluated by using the s parameters of the antenna as given in the [1] how much radiation pattern of one antenna affects the another antenna

$$\rho_e = |S_{11}*s_{12}+s_{21}*s_{22}|^2 \div (1-|s_{11}|^2-|s_{21}|^2)(1-|s_{11}|^2 - |s_{12}|^2) \quad (1)$$

ECC simulated is shown in the Figure 27 which point outs that good diversity performance is achieved in this antenna

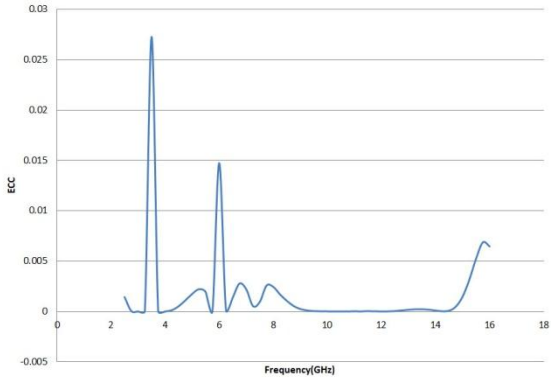

Figure 27 Simulated ECC

3.2 TARC (Total Active Reflection Coefficient)

TARC is defined as the ratio of the square root of the total reflected power divided by the square root of the total incident power [24] in a MIMO system Figure 28 gives the TARC of the proposed variant.

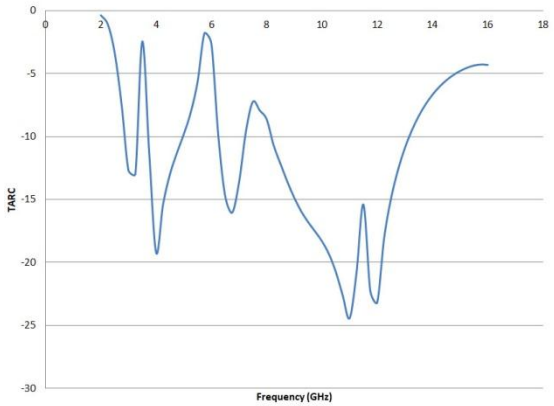

Figure 28 TARC of the Proposed Antenna

3.3 Diversity Gain

Diversity gain is said to [25] dependent of the ECC

$$DG = 10\sqrt{1- (ECC)^2} \quad (2)$$

It's found to be around 9 dB over the working range which is acceptable range which is shown in the Figure 29

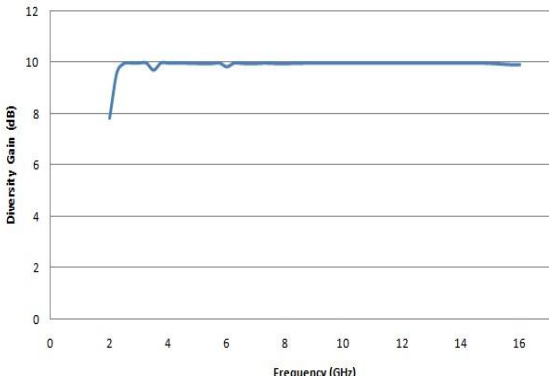

Figure 29 Diversity Gain

3.4 Group Delay

It is one among the factor which gives the crucial parameter which point outs the performance of the antenna especially about the distortion of the signal phase response of transmitting signal is measured using group delay group delay is mathematically given as [26]

$$\text{Group Delay} = -\Delta\gamma/\Delta\xi \quad (3)$$

where $\Delta\gamma$ and $\Delta\xi$ are the deviations in phase and frequency of the signal. Figure 30 gives the group delay parameter of the proposed antenna confirms the acceptable range of values

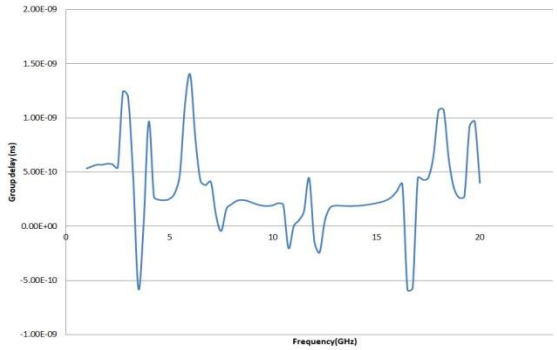

Figure 30 Group Delay

4 Conclusion

A low profile CPW fed dual port ultra-wide band antenna with triple notched characteristics is presented. with good isolation of –20dB over the bands , measured return loss VSWR are good agreement with simulated results diversity performance parameters are also found to be within satisfactory limit hence proposed variant is a good candidate for the ultra wideband MIMO applications. Further antenna can be miniaturized in size and also work it may be redesigned for better isolation.

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Biographies

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