Design of Dual Notch UWBMIMO Antenna with Defected Ground Structure.

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Abstract*: In this paper A dual band notched MIMO antennais designed with defected ground structure as ground plane and its characteristics are analyzed. The antenna covers UWB frequency ranging from 3.1-10.6 GHz with single notch band characteristics with maximum gain of 3.7 dB. The antenna provides radiation efficiency of 94% with front to back to ratio of 64%. The simulated studied is carried for many frequency band applications. The designed antenna shows patterns similar to that of a the dipole. The substrate used to design this antenna is FR4 withdimensions of 26mm x40mmx1.6mm and dielectric constant of 4.4.The notch bands are at WLAN and WiMax frequencies.

Index Terms: MIMO Antenna, ultra wideband range,defected ground structure, notch band, parametric analysis.

I. INTRODUCTION

To perform best quality of services MIMO technique is considered as prominent key. This system can improve the reliability and capacity over single antennas. In designing the MIMO systems requires multiple antennas with less mutual coupling in MIMO systems [1]. MIMO antennas has the capability to ameliorate multipath fading, channel capacity, data rates for wireless applications. Recent advancements UWB technology has gained more attention in short range communication with wide bandwidth, low cost, high data rate [2]. The main limitation in UWB systems is multipath propagation which can be addressed by MIMO systems. The combination of UWB-MIMO can provide better efficiencies in scattering environment with communication operating range and improved channel capacity.

The main attraction of MIMO technology is enhancing the channel capacity and due to limited availability of free spectrum it's difficult to place antenna with low isolation. The the compact MIMO antenna with high isolation consists of meandering monopoles [3]. To reduce the isolation inverted T- shaped slot are etched on the ground structure and meandering structures on patch. The low-profile antenna foe multiband applications are designed with mending loops for mobile phone applications [4].

The MIMO antenna is designed and presented with inverted F-shape antenna with slot-based frequency agile antennas for dual band applications. The MIMO antenna with notch band UWB antenna is designed with two identical elements [5]. In the back side of the ground structure rhombic structure is used. Usually the orthogonally feed MIMO antenna achieves polarisation diversity and very high isolation [6]. A compact broad band antenna for dual polarised applications is designed with cavity backed Bowtie antenna in conjunction with parasitic elements [7].

The Quad element MIMO antenna is designed with T-shaped stub and CSRR. the antenna is designed to cover many frequency applications like ISM/Bluetooth (2.4-2.45) and LTE (2.3-2.4) WiMAX (5.25-5.58) and K-band (7.2-8.39) applications. The triple notch band antenna is designed to WiMAX and WLAN frequencies [8]. Mushroom shaped electromagnetic band is used to attain the notch bands. To minimize the mutual coupling radiating elements are separated by with stepped structure.

The compact UWB MIMO antenna is designed with inverted U-shaped slots to notch WLAN bands in operating frequency bands. Dual port MIMO antenna is designed for band rejection facility [9]. To achieve the notching rectangular shaped elements are chosen and stepped stub is added and envelope correction coefficient of 0.013 and capacity loss of 0.35 is achieved. Tapered fed compact UWB antenna is designed dual band notch characteristic and mutual coupling of -22dB is obtained over operating band [10].

II. ANTENNA DESIGN

A. Antenna Design Approach

The MIMO antenna with dimensions of 26mm x 40mm is designed on FR-4 epoxy substrate material with dielectric constant of 4.4 and having a thickness of 1.6mm.the antenna is feed by 50ohm microstrip line. the basic antenna is designed with rectangular patch.in the modified structure antenna is feed by triangular shape on the rectangular patch antenna. The width of the antenna is given by the equation

$$W \leq \frac{c}{2fr}\left(\in r + \frac{1}{2}\right) - \frac{1}{2} \text{----------(1)}$$

The effective dielectric constant of the substrate is given by $\in e = 1/2[\varepsilon_{r+1+(}\ \varepsilon_{r-1)(1+12h/W)}^{-1/2}]$ ----------(2)

The length of the patch is given by

$$L=\frac{c}{2fr}\sqrt{\varepsilon_e}\ ^{-}2\Delta L \quad \text{----------(3)}$$

Length of the U shaped Stubfor notch band is given by the eqn1 $L_N = \frac{c}{2fN\sqrt{\in eff}} \approx \frac{\lambda}{2}$ ---------- (4)

In ground structure radiating stubs are added. And this stub is placed between the two defected grounds as shown in Fig 1. the analysis has been done for the antenna and sequentially discussed and table of parameters regarding the model has been demonstrated.

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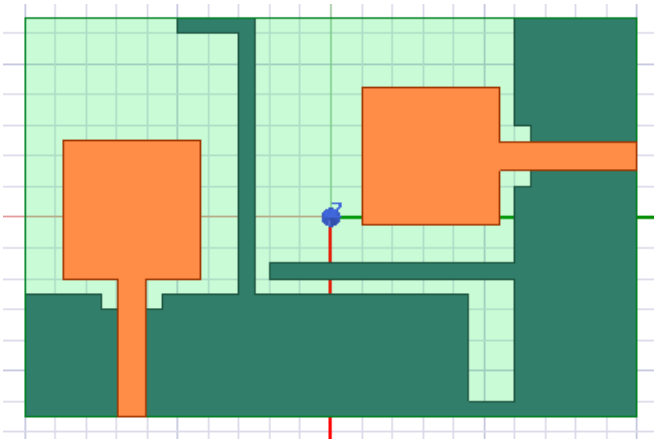


Fig 1. Layout and Dimensions of the antenna

Table 1. Dimensions of the the antenna

W	40mm	A	1mm
L	26mm	B	4mm
WF	1.8mm	C	1mm
LF	9mm	S1	4mm
LG	8mm	S2	1mm
WG	31mm	ST1	3mm
H	1.6mm	ST2	3mm

The above table represents the dimensions of the the antenna.

III. RESULTS AND DISCUSSION

The basic structure consists of two rectangular patches placed orthogonally and the antenna operates in UWB frequency range. In the Fig .2a it represents that the antenna operates from 3GHz to 10GHz and with two notch bands.In Fig 2b represents S-Parameters of the antenna which covers the frequencies from 2.1 GHz to 12.7 GHz. In the ground structure the stubs are loaded in the ground structure which helps in the to get the band notch characteristics.

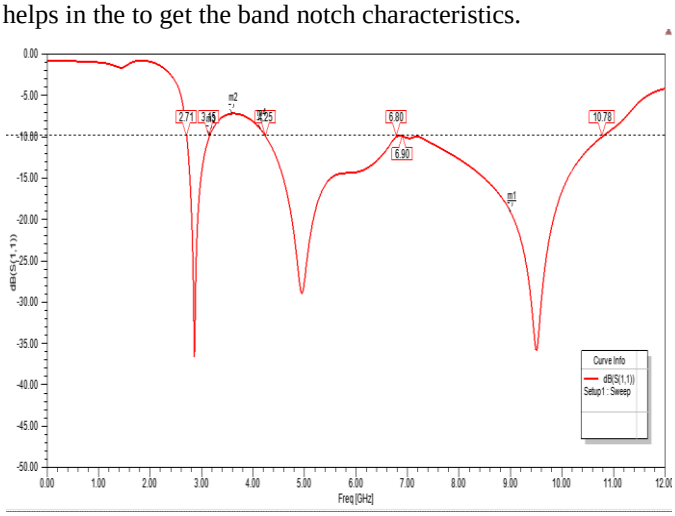


Fig 2a. S parameters results of antenna

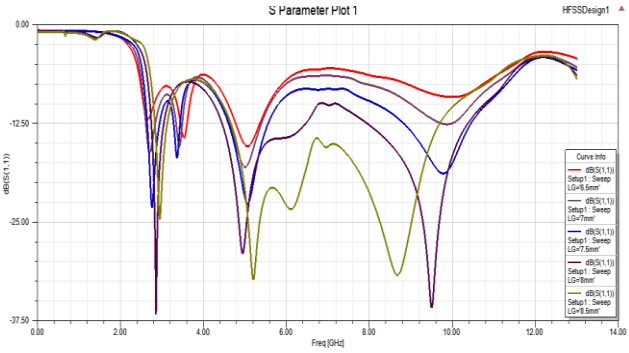


Fig 2b. S parameters curve of the antenna

The rejection band of the antenna ranges from 3GHz to 4. 1GHz. In the fig 2 the isolation losses are also presented. The antenna covers almost all applications frequencies that are suitable for wireless communication applications.

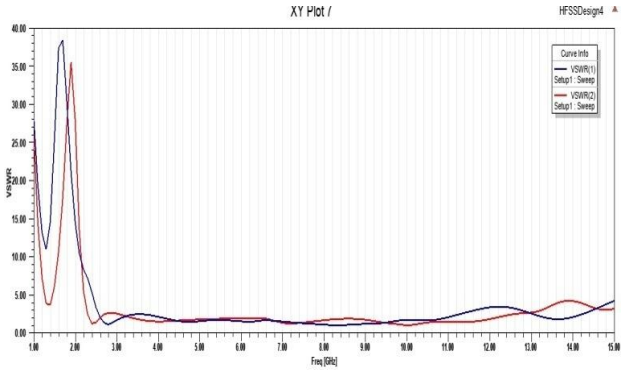
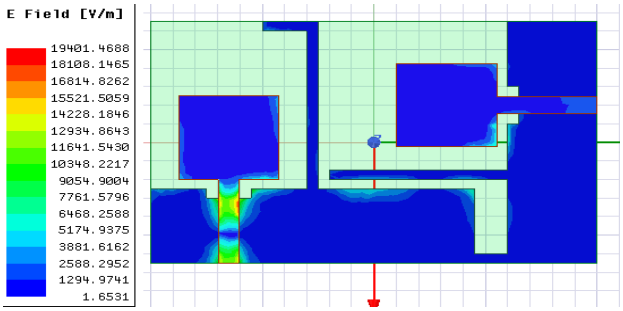
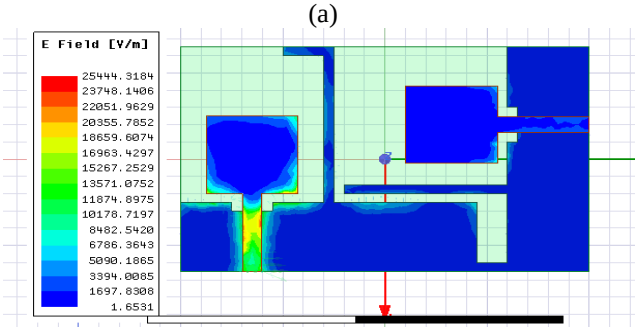


Fig 3. VSWR of the antenna

Fig 3 indicates the VSWR for the antenna the observed values of the antenna shows VSWR below than 2 at the operating frequency range.



(a)



(b)Fig 4. E-field of an antenna at 5GHz(a) PORT-2, (B) PORT-1

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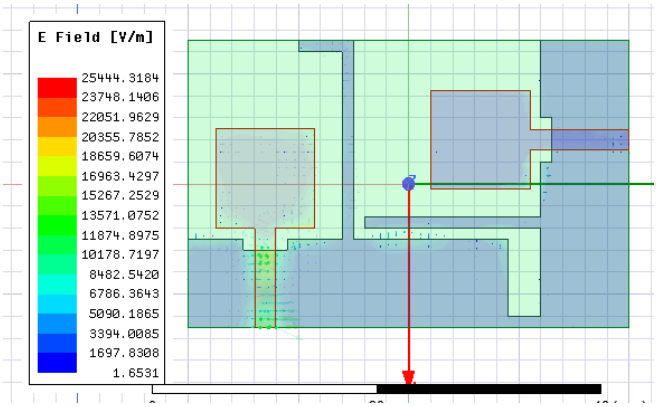
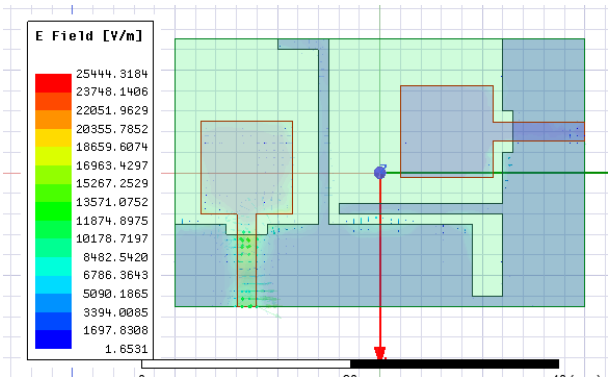
Fig.4 shows the e-field pattern antenna most of the E-field is distributed along the feedline and the edges of the patch antenna in this case study individual antennas are excited and analyzed the performance.



(a)

Fig 5a & b represents the current distributions of the the antenna are presented. In this analysis two cases are studied by exciting the individual antennas. In this case maximum intensity of red color is observed at the feed line and corners of radiating patch and in the edges of the ground structure.



(b)

Fig 5: current distribution of the antenna at 5GHz

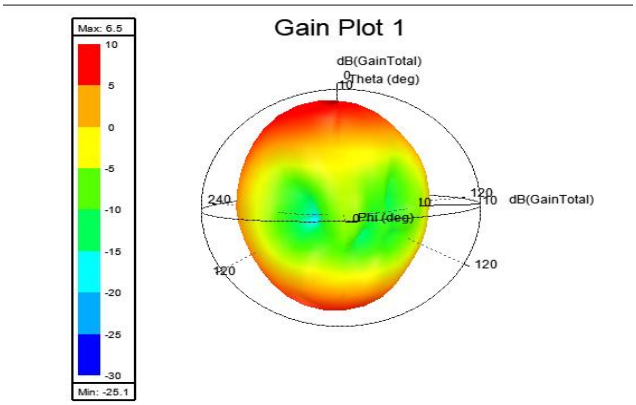
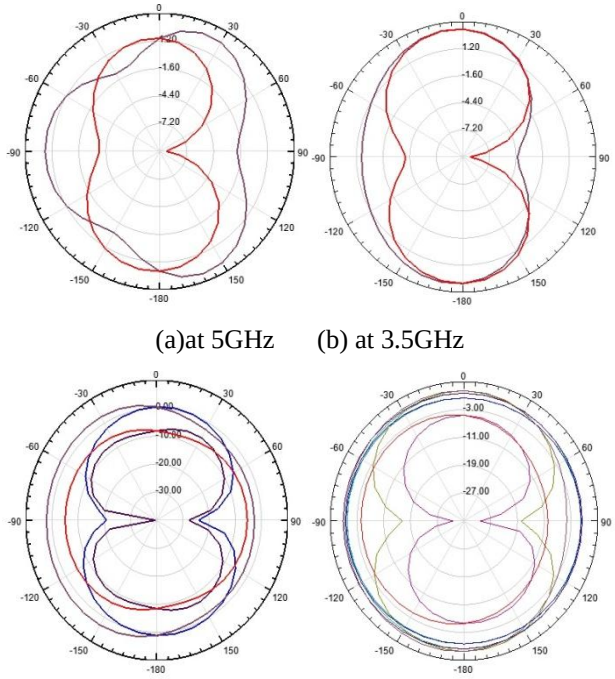


Fig 6. Gain of the antenna

Fig 6. represents gain of the the antenna at constant gain of about 3.7 dB 5.5 GHz with a peak gain of 6.5db. In the fig 7 the radiation patterns of the antenna are presented with representation of co and cross polarization levels. The antenna shows the bidirectional and omni directional radiation patterns. In the Fig 7 (c) and (d) represents the notch frequency characteristics of the antenna in all the figures the red colored lines represent the orientation towards E-plane and other color as the H-plane. In Fig 7(a) represents that a dipole type of radiation patterns at fig 7 (b) a slight variation in the orientation of the H-plane changes has been noticed under the notch band fig 7(c) and (d) shows the co-polarization and cross polarization at working frequency and notch bands are observed. bands some Fig 8 represents the peak gain the antenna which shoes the maximum peak gain of 5.5 Db at 9.8 GHz



(a)at 5GHz (b) at 3.5GHz

(C) at 5GHZ (d) at 3.5GHz

Fig 7. Radiation patterns and co and cross polarization of the antenna at working band (a) and (c)5GHz and at notch band (b)5GHz (d) 3.5GHz

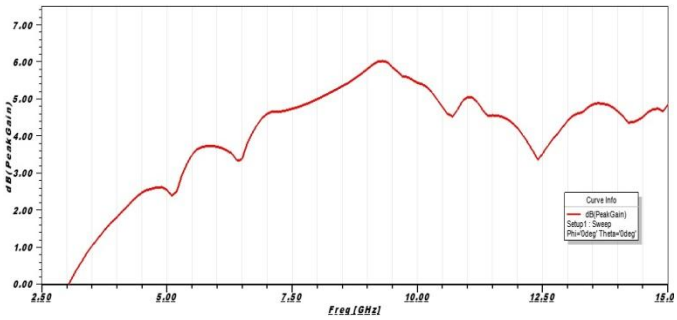


Fig 8: Gain vs frequency of the antenna

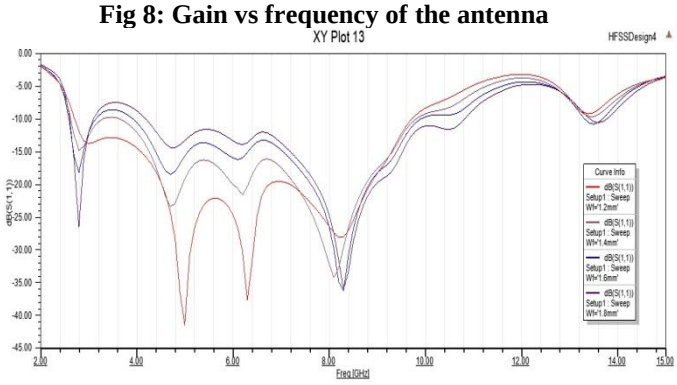


Fig 9. parametric study by changing width of the feedline

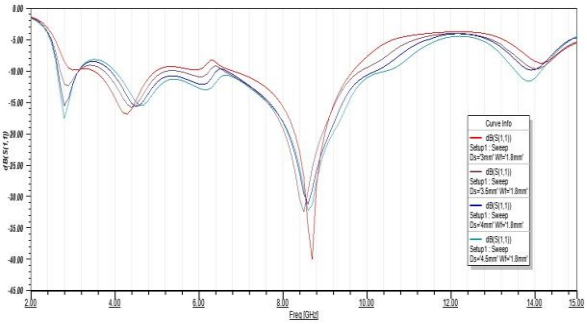


Fig 10. Parametric study by changing the radiating stub(Ds)

To obtain the optimized antenna parameters the antenna studied using the parametric analysis which is represented in the Fig 9 and Fig 10. The analysis is studied by varying the width of the feed and the radiating stub. With change in the dimensions of the antenna the antenna shows the wide band characteristics show enhance by reducing the size and with changing the radiating stub the best output can be observed at dimension that is at 5mm.

Table.2 Comparison of proposed model with existing literature

REFERENCE	Dimensions	Operating Frequency	Bands	Isolation	ECC
[1]	80 x 40 x 1.6	2.4-2.6 5.2-6	Dual	15	0.01
[3]	90 x 40 x 1.6	2.1-2.7 5.1-6.1	Dual	15	0.0023
[5]	42 x 62 x 1.6	2.38-2.52 3.19-6.44	Dual	10	0.02
[7]	70 x 90 x 0.8	2.4/5.2	Dual	33	0.016
[9]	70 x 40 x 0.8	2.4/5.8	Dual	20	0.01
[12]	40 x 20 x 1.6	2.4-2.5 4.9-5.75	Dual	15	-
[13]	52 x 75 x 1.6	2.4-2.48 5.15-5.85	Dual	15	0.03
Proposed work	26 x40 x 1.6	1.7-1.87 2.45-4.15 9.62-11.16	Dual	10	<0.05

IV. CONCLUSION

The antenna is designed for UWB applications with attached stubs in the ground structure antenna shows the notch band characteristics. The designed antenna having good isolation characteristics at the notch band. The antenna provides the impedance bandwidth of 130 % at the operating range of the antenna. the observed values antenna is suitable for wide number of frequency band application.

FUTURE SCOPE

The mimo antenna with attached stubs in the ground structure shows the notch band characteristics. The designed antenna having good isolation characteristics at the notch band. The antenna provides the impedance bandwidth of 130 % at the operating range of the antenna. the observed valuesantenna is suitable for wide number of frequency band application.

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