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Compact UWB MIMO Antenna with Notched Band Characteristics

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Abstract: The compact MIMO Antenna is used for Ultra Wide Band Applications with dual notched band Characteristics. The Proposed Antenna designing consist of two Square shaped Monopoles and T-shaped Depicted Ground Structure with two strips for better Isolation and to eliminated interference with W-LAN (5.15-5.85 GHz)band. The slot is arranged on both antenna elements for Eleminating the interference with Wi-MAX (3.3-3.7 GHz) Band. The Micro strip feeding is used at two ports with the impedance of 50 Ohms in antenna structure. To study the antenna parameters the simulation of antenna designing is done by using HFSS Software. Antenna parameters like return loss, Radiation characteristics, Impedance matching and Isolation and Gain are very important in UWB MIMO Antenna. Two application bands are notched by this proposed antenna in UWB range with better Isolation so this antenna is better model for desired applications.
Keywords: MIMO Antenna, notch band, HFSS software, Isolation, UWB (Ultra Wide Band).

I. INTRODUCTION

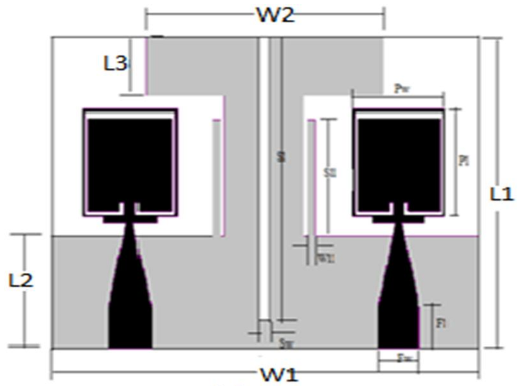
Multiple-input-multiple-output (MIMO) technology, with the potential of increasing channel capacity with-out requiring additional frequency spectrum or power, has been drawing much attention [1]. An MIMO communication system requires using multiple antennas installed in the transmitter and/or receiver with low coupling between them. However, for portable devices where the space is very limited, installing MIMO antennas with low coupling is always a great challenge for antenna designers. Various MIMO antennas have been studied for uses in portable devices in different wireless systems such as the LTE [2], UMTS [3], and WLAN [4]. In [5], studies showed that MIMO technology used in ultra wideband (UWB) system would provide superior channel capacity over that used in narrowband systems. Following this, studies were carried out to reduce coupling between antenna elements in MIMO UWB antennas [6]–[8].

The UWB from 3.1 to 10.6 GHz, assigned by the FCC for unlicensed use, overlaps with the WLAN frequency band from 5.15 to 5.85 GHz and Wi-Max band from 3.3 to 3.7 GHz; thus, the WLAN, Wi-Max systems are interfere with UWB System. One of the possible solutions to this problem is to design the UWB antenna with band-notched characteristic [9]–[11]. In [12]–[16], MIMO antennas with notched characteristics were studied to suppress interference from the WLAN systems. The UWB MIMO antenna in [12] was designed on a flexible film. Two heptagonal monopole elements were orthogonally and symmetrically placed on the substrate for good isolation between the two input ports. A slot was cut on each of the antenna elements to create a notch in the WLAN band. However, the two monopole elements did not have a common ground plane, making the MIMO antenna difficult to use in practice. The MIMO antenna in [13] employed two-folded monopole elements, each coupled with a parasitic inverted-L element, to achieve UWB operation. Two meander lines, a connection line and a short parasitic line, were used to enhance isolation between the two input ports. The band-notched characteristic was created using an open stub on the radiator. The antenna structure was a little complicated and required high fabrication accuracy. In [15] and [16], slot antennas were designed for UWB MIMO applications with a strip to ensure high isolation. The slots were etched on the feeding structure to create a band notch. However, this kind of structure had a relatively large size.

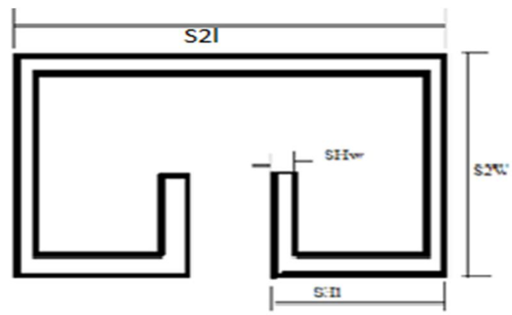
In this paper, we propose an UWB MIMO band notched antenna even smaller than the design in [14]. It has a compact size of only 22 × 36 mm^2 (or 0.34 λ_g × 0.56 λ_g) = 792 mm^2(or 0.19 λ^2_g), which is 14% smaller in electric size than the design in [16]. A strip on the ground plane is used to create the band notch at WLAN band (5.15-5.8 5 GHz) with a total efficiency of only 7%, and a slot on the patch is used to create band notch at the Wi-MAX band (3.3-3.7 GHz) much smaller than all those in [12]–[16]. The simulated and measured results show that the proposed MIMO antenna has good impedance matching, high isolation, and good diversity performance throughout the UWB with band notched characteristics in 5.15–5.85 GHz and 3.3-3.7 GHz.

II. DESIGN OF THE ANTENNA

The Designing of the proposed MIMO Antenna as shown in fig.1. In fig.1 (a) shows the front view of antenna structure with dimensions. It has 2-square shaped Radiators with a very compact Area of $22\times36mm^2$. In this UWB antenna the Ultra Wide Bandwidth is obtained by etching ground slot is nothing but depicted ground structure (DGS) on ground. A T-shaped ground stub is nothing but DGS with a vertical slot is placed as a ground between the square shaped radiators with adjusting the gap (1.6mm) between the ground and radiators to improve the Isolation between two input ports. To create a notch in the 5.5 GHz band to suppress interference in the WLAN band, two strips are added between the monopole elements and at the T-shaped ground stub, and to create a notch in the 3.5 GHz band to suppress interference in the Wi-MAX band, two slots are arranged in both square shaped radiators, the slot in patch element is shown in fig.1 (b) with dimensions. And the total structure of antenna dimensions with values are shown in fig1. (c), and 3-D view is showed in fig.1. (d).



(a)



S2l	S2w	SHl	SHw
7.5	7.2	3.25	0.25

(b)

L1	L2	Pl	Fl	S1l	Sl	L3
22	8	8	3	8.3	21	4
W1	W2	Pw	Fw	S1w	Sw	
36	20	8	3.5	0.25	1	

(c)

fig.1.(a)front view of the antena with dimensions. (b).slot cut on the patch with dimensions (c).table of measurements of antenna structure

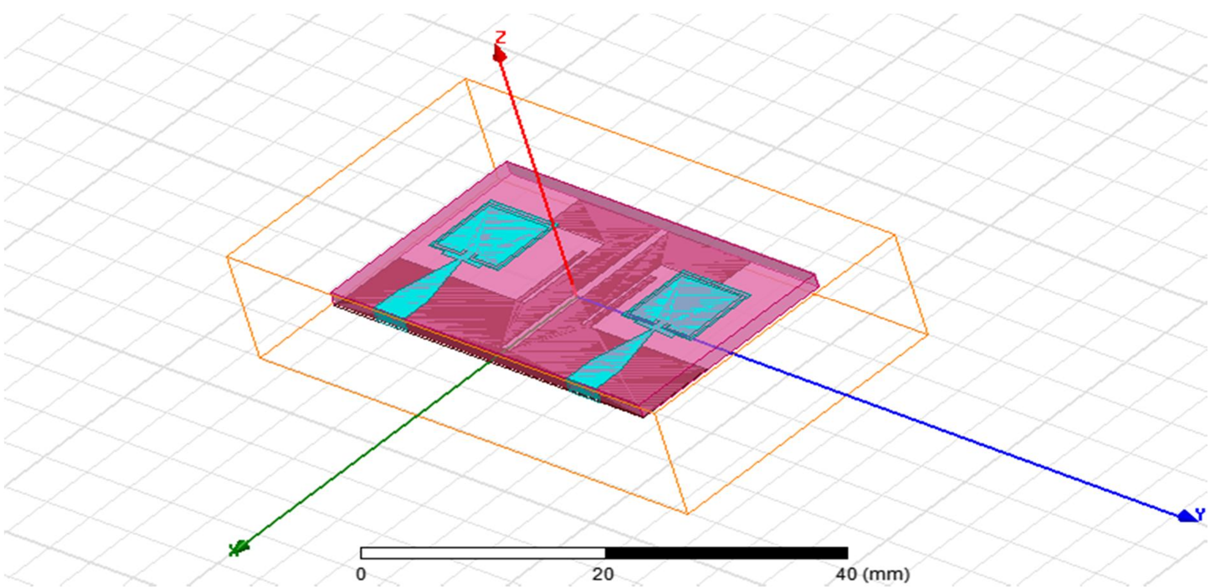


fig.1. (d) 3-D view of antenna design

III. SIMULATION AND RESULTS

The Antenna design and simulation is done by using HFSS Software. HFSS is commercial electromagnetic simulator produced by Ansys company. The Antenna parameters like return loss, VSWR, Radiation patterns and Gain patterns were plotted using this software.

A. Return Loss

Return loss (S11) is a parameter which represent how much power is reflected from the Antenna. Return loss is a measure of how well devices or lines are matched. The return loss for this UWB MIMO Antenna is shown in fig.2. The return loss is shown as less than -10dB for UWB range 3.1 to 10.6 GHz except notched bands 3.3-3.7 GHz and 5.15-5.85 GHz.

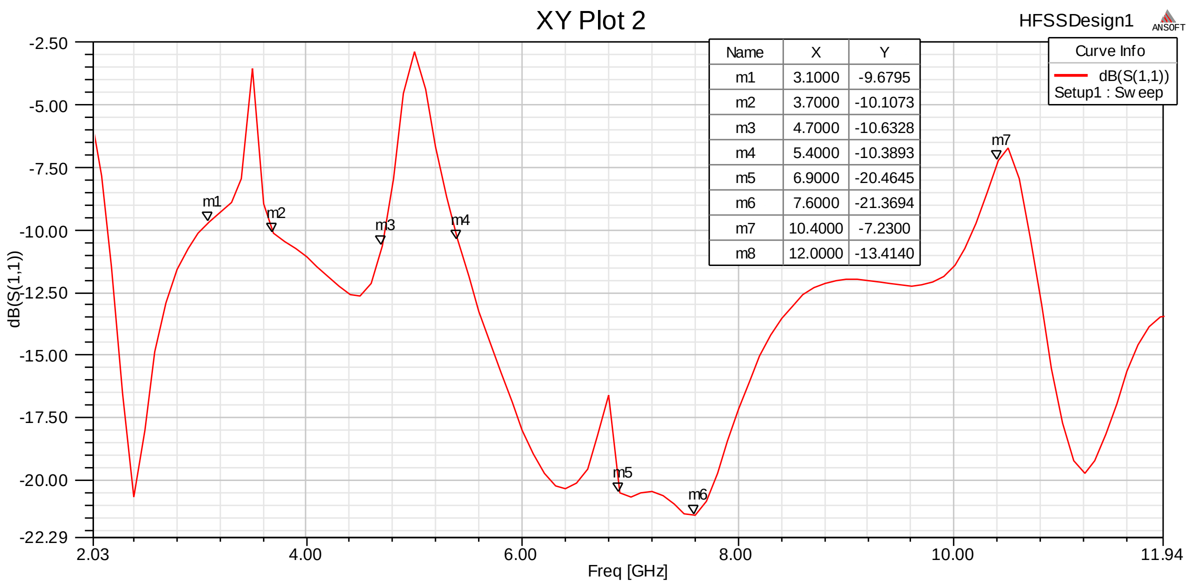


Fig.2.Return loss (S11) Vs. Frequency plot

B. Voltage Standing Wave Ratio (VSWR)

VSWR is a measure that numerically describes how the antenna impedance is matched with transmission line impedance. The VSWR of this antenna is below 2 in UWB operating band except notched bands. At notched bands the VSWR is above 2 is shown in fig.3.

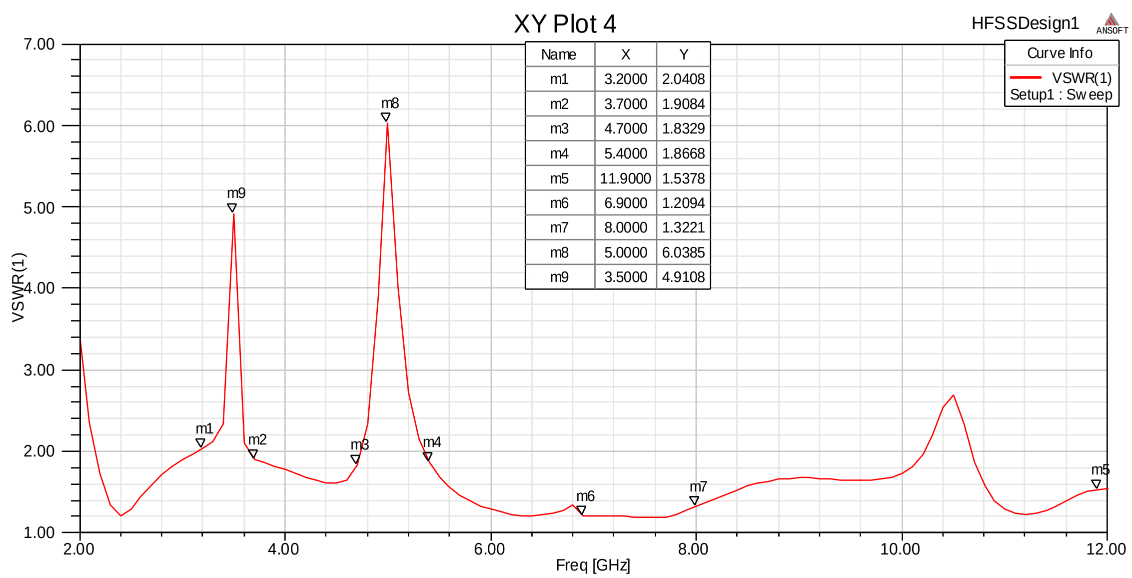


Fig.3.VSWR Vs. frequency plot

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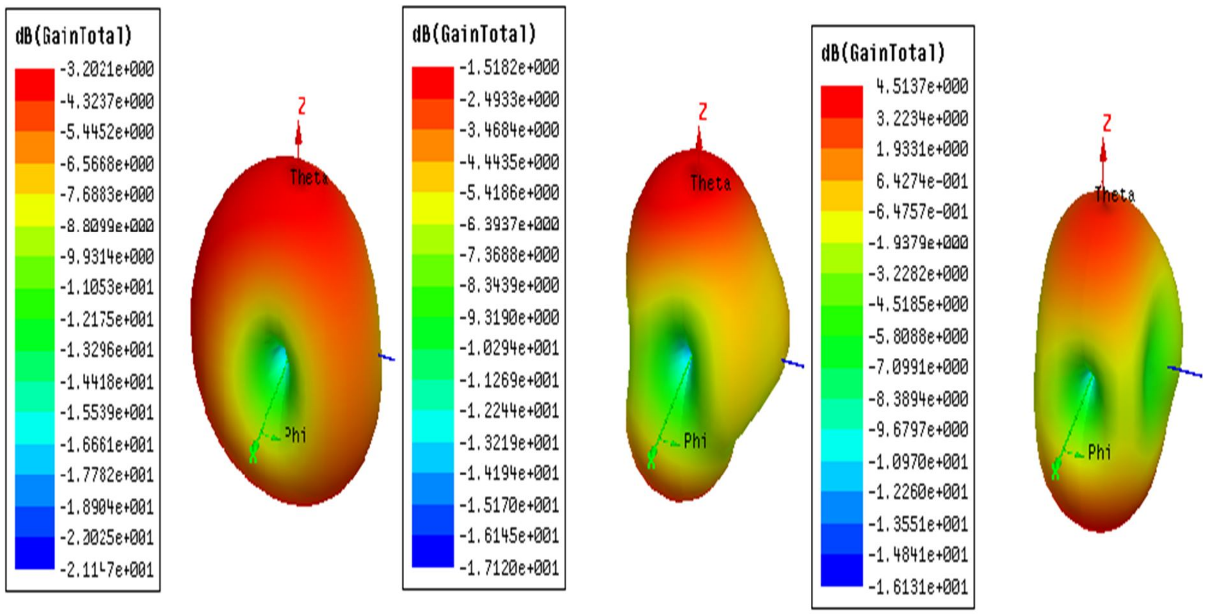
C. Gain

Antenna Gain describes how much power is transmitted in the direction of peak radiation of isotropic source. The gain is high at the operating band and very low at the notched bands. We plot gain at 7 GHz in operating band and notched bands. The gain at the 7 GHz is 4.5137dB is shown in fig.4. (c), and the notch bands at 3.5GHz gain is -3.2021dB is shown in fig.4. (a) and at 5GHz -1.5182dB is shown in fig.4. (b). The gain plot is shown in fig.4.



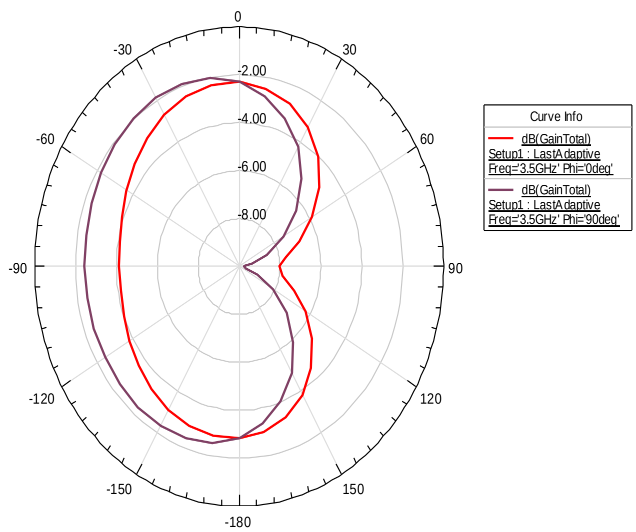
(a)3-D polar plot at 3.5GHz (b)3-D polar plot at 5 GHz (c)3-D polar plot at 7 GHz

Fig.4. Gain plots at 3.5GHz, 5GHz, and 7GHz.

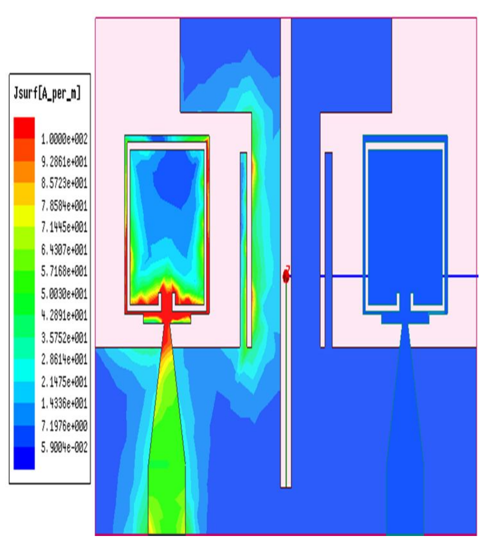
D. Radiation Pattern

Radiation pattern is a graphical representation of the radiation properties of antenna as a function of space coordinates. The radiation pattern for this antenna is shown in fig.5. When port 1 is excited, the radiation pattern and the current distribution of antenna are plotted in below figures.

1) At 3.5 GHz:

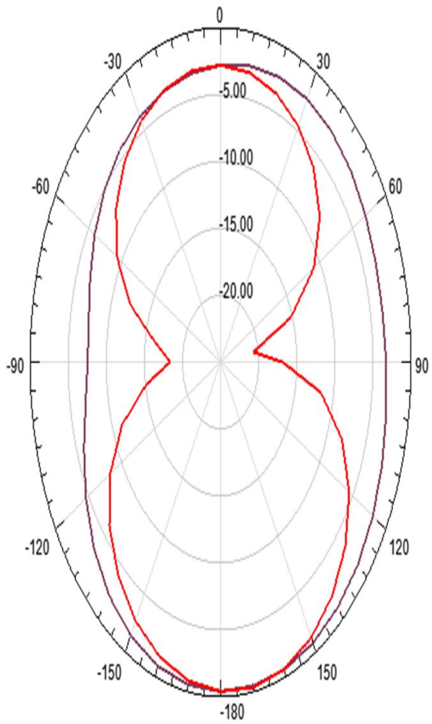


2-D Radiation pattern

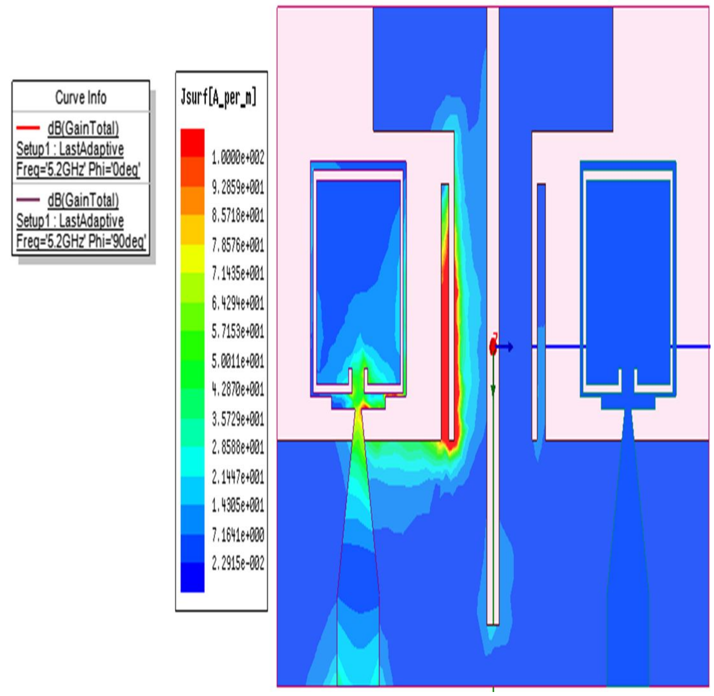


Current distribution

2) At 5.2 GHz:

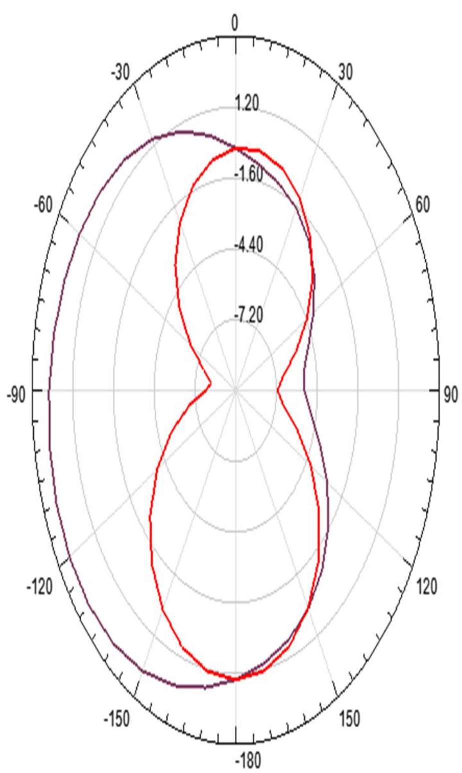


2-D radiation pattern

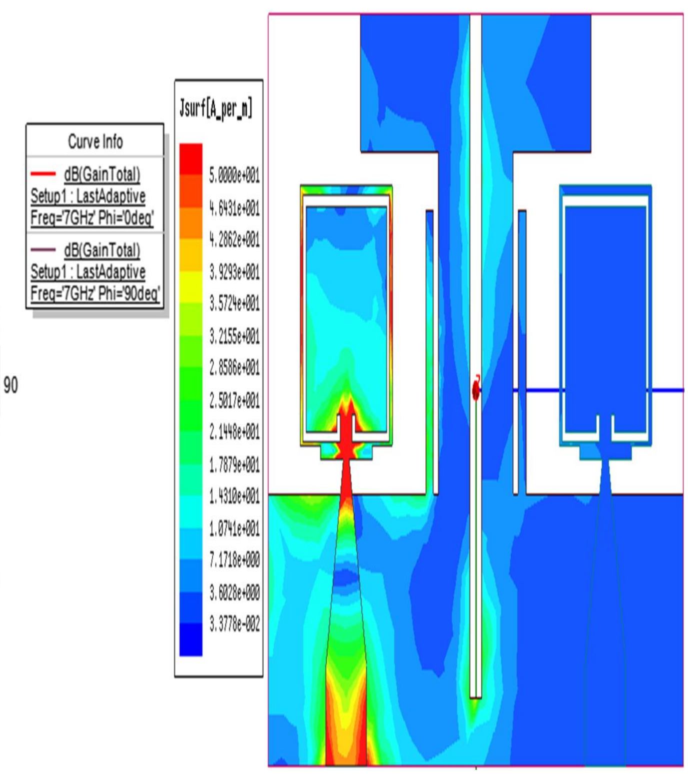


current distribution

3) At 7 GHz:



2-D radiation pattern



current distribution

Fig: 5. Radiation pattern (a) at 3.5GHz (b) at 5.0 GHz (c) at7.0 GHz when port1 excited

IV. CONCLUSION

An Ultra Wide Band MIMO antenna is used for short range and speed communication system. And it contain wide band width so through this antenna large information is transmitted or received. and this antenna is designed to notch the Wi-MAX (3.3-3.7 GHz), W-LAN (5.15-5.85 GHz) frequency bands to suppress the interference with them. Proposed antenna is prototyped on Rogers RO4350(tm) substrate. Average gain of 4dB is attained in the operating band and at notch band antenna is showing poor gain. The proposed antenna can be used to notch the desired bands and applicable for wireless communication applications.

V. BIOGRAPHIES

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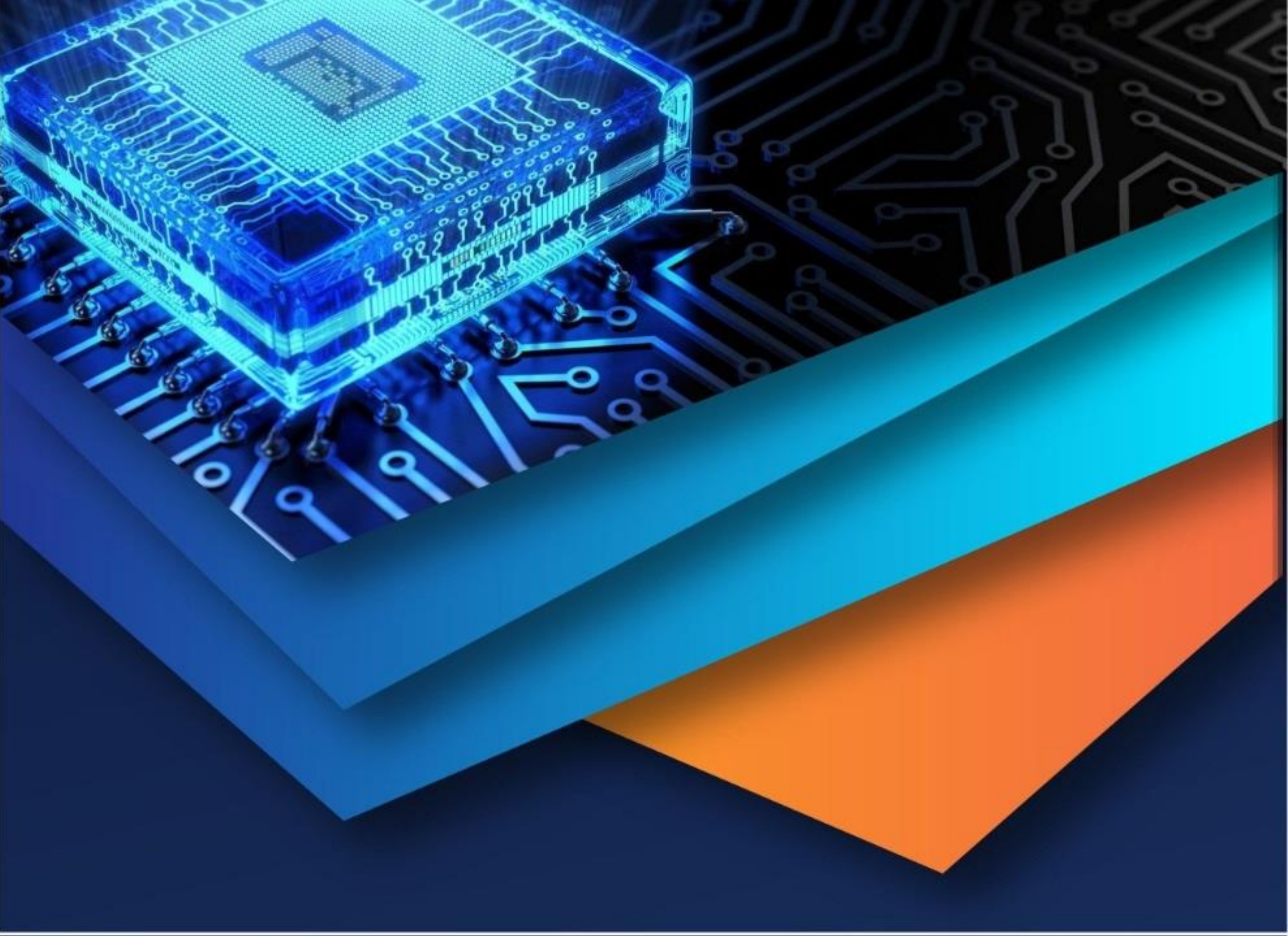

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