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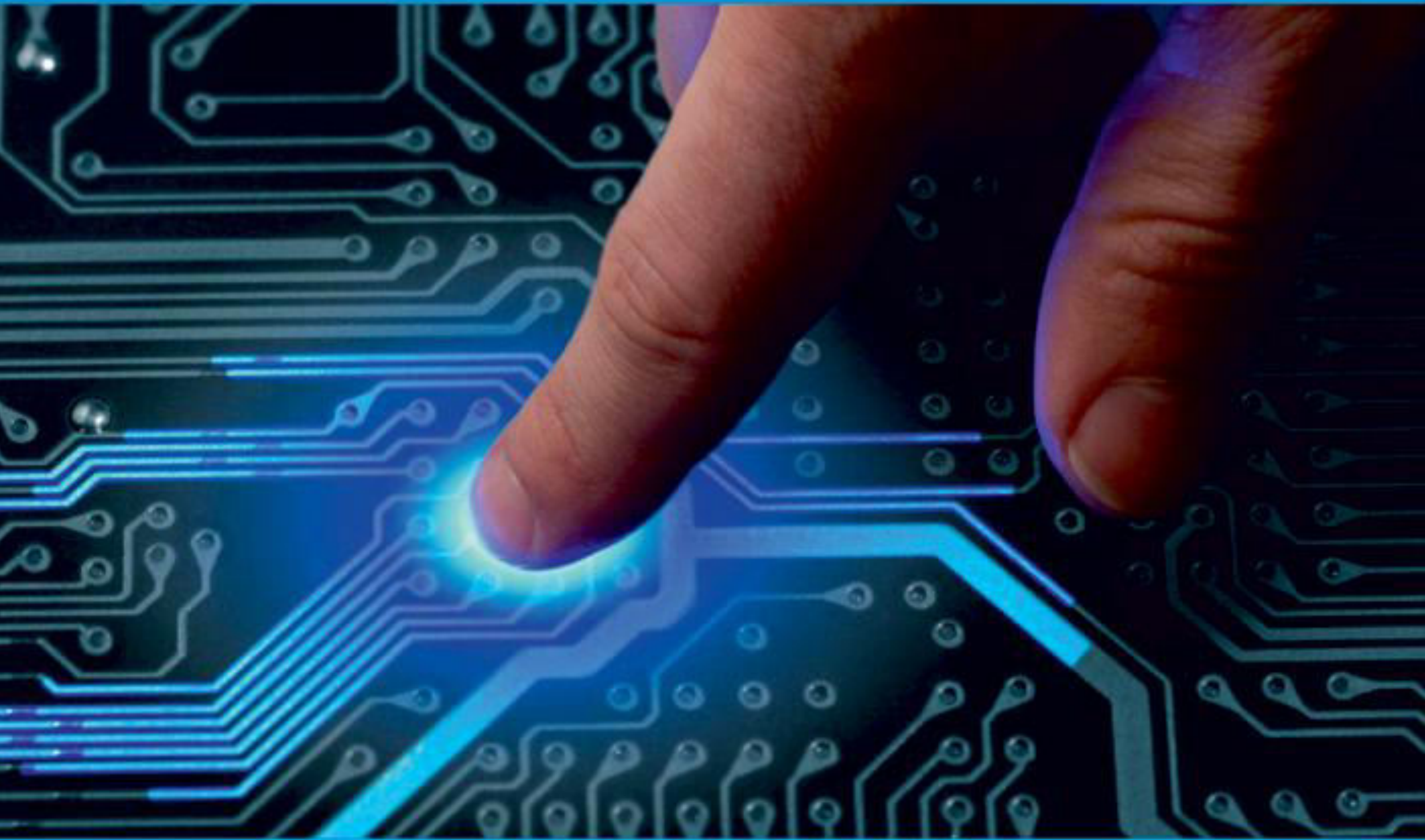

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Design and Simulation of Notch Band UWB MIMO Antenna for Wireless Applications

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ABSTRACT: In this paper, two novel multiple-input multiple-output (MIMO) antenna designs with effectively rejected notch bands are presented for portable ultrawideband (UWB) applications. This UWB MIMO Antenna measures 18.02 mm x 34 mm. Antenna panel with microstrip-fed slots combines an inverted L-shaped slit with a tapered body to act as a single radiating element at the cellular ISM and IEEE INSAT bands. Over the entire operating spectrum (2-20 GHz), less than 50 dB of mutual coupling is achieved. It appears that all is well in the interference suppression performance of the antenna at the center of the notched band. An analysis is conducted for the performance of the MIMO antenna in terms of isolation among the ports, the radiation pattern, efficiency,gain, directivity, Voltage Standing Wave Ratio (VSWR), Current distributions and radiation efficiency.

KEYWORDS: Isolation, multiple-inputmultiple- output(MIMO) antenna, Mutual coupling, ultrawide band (UWB)antenna.

I. INTRODUCTION

By using multiple-input, multiple-output (MIMO) or diversity techniques, a system is far more reliable and has a higher capacity than single-antenna systems [1]. It is essential for MIMO communication systems to use an antenna installation with low mutual coupling in the transmitter or receiver. Antenna designers have always been constrained by the size of their antennas. When multiple antennas are closely packed in a portable MIMO system, there is inevitably a strong mutual coupling between the antenna elements, which deteriorates the diversity performance. Thus, combining high mutual coupling between MIMO Antenna elements with compact size is the major issue encountered while designing an MIMO Antenna.

According to the FCC, the agency has allocated unlicensed UWB spectrum from 3.1 to 10.6 GHz [2] for future communication. Signal fading in multipath environments, however, is one of the drawbacks of UWB systems. MIMO and UWB techniques can be combined to resolve this problem. In [3], researchers studied the use of MIMO technology in UWB systems and concluded that its channel capacity is significantly better than that of MIMO technology in narrowband systems such as for mobile telecommunications systems [4] and wireless local area networks (WLANs) [5]. Multiple techniques have been investigated for the purpose of reducing the mutual coupling between the radiating elements in UWB MIMO systems [6]-[12]. Several ground structures were wrong or introduced stubs and slots between two radiating elements of MIMO antennas studied in [6]-[10]. A symmetric coplanar strip is connected to an I-shaped slot in the radiator and via a rectangular patch mounted on the back in [11], while in [12], a mushroom-shaped electromagnetic band gap structure offers additional isolation between two antennas.

An antenna with band-notched characteristics can solve theproblem of electromagnetic interference caused by MIMO devices operating in the UWB band. Different techniques for suppressing interference have been described in literature, including inserting short stubs [13], an arc-shaped slot [14], or by etching two split-ring resonator (SRR) slots in the antenna element [15]. There is an etched L-shaped slit located on the Ground to create a notched band [16], as well as a T-shaped spacer between the antenna elements to reduce mutual coupling. UWB characteristics are obtained by using two circular radiating elements powered by CPWs in [17]. The UWB MIMO Antenna in [18] employed two heptagonal mono-pole elements with a slot cut in the top of every element to create a notch in the network band; this also allowed us to achieve excellent isolation from the two input ports. In keeping with the designed antenna, the current antenna has an operational bandwidth of 2-20 GHz, while the designed antenna had a 2.08 to 20-GHz bandwidth and had 50 decibels of isolation.

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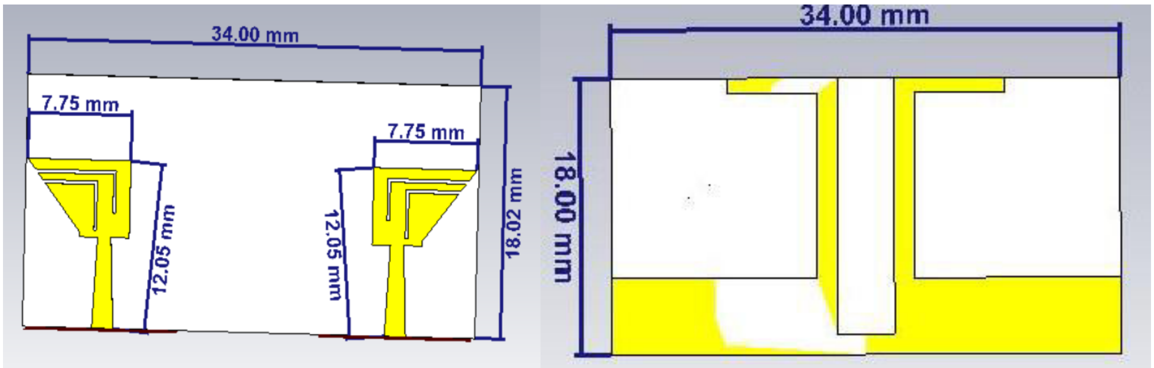
II. ANTENNA DESIGN

We propose that the antenna unit cell be fabricated on FR-4 substrates with relative permittivity 4.4, dielectric loss tangents of 0.02, and thickness of 1.6 mm. Unit cells have dimensions of 34 m wide, 18.02 mm long, and 1.6 mm thick. The length of the substrate is 34 mm and its width is 18.02 mm. This antenna suppresses the WLAN bands (5.09–5.8 GHz) in the UWB bands by etching a simple L-shaped slit on the upper portion of the radiator. As a result, the bottom portion of the radiator has an L-shaped slit etched into it to suppress interference at high frequencies of the IEEE INSAT/Super Extended C-band (6.38-7.27 GHz).

FIGURE:1



A. Top view **B.Bottom view**

Due to the presence of two horizontal rectangular strips in Ground, the resonance is now at 3.7 GHz, but the mutual coupling is extremely poor in the frequency band below 4 GHz.In addition, the lower resonance frequency can be shifted lower to 3.2 GHz by utilizing inverted L-shaped strips, as shown in the Ground. There is a significant reduction in the mutual coupling throughout the band (2to 20 GHz) caused by these strips inverted L.It is obtained that the MIMO performance can be sufficient for an isolation of less than 50dB.

Results Discussion:

Return Loss(dB):

S11 provides the reflection coefficient at port 1 where the input of the microstrip patch antenna is applied.The minimum acceptable level should be less than -10 dB.A resonance frequency of 4.916 GHz is shown for the proposed antenna.

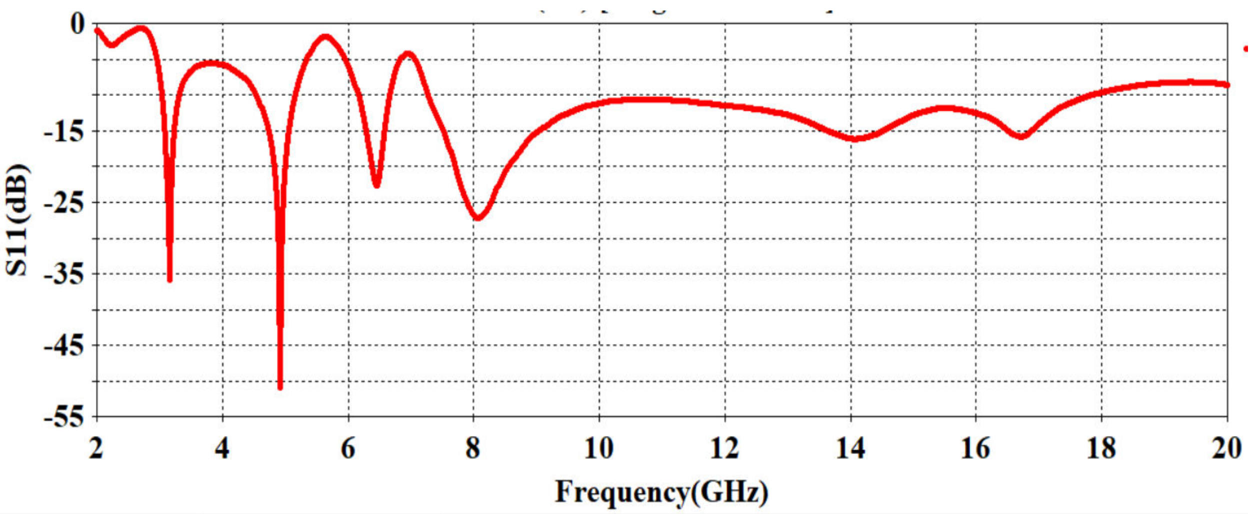


FIGURE:2:S11 response of the antenna element

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In S21 we see the power received at antenna 2 as a relative to antenna 1. MIMO antennas should have an S21 lower than -15dB.

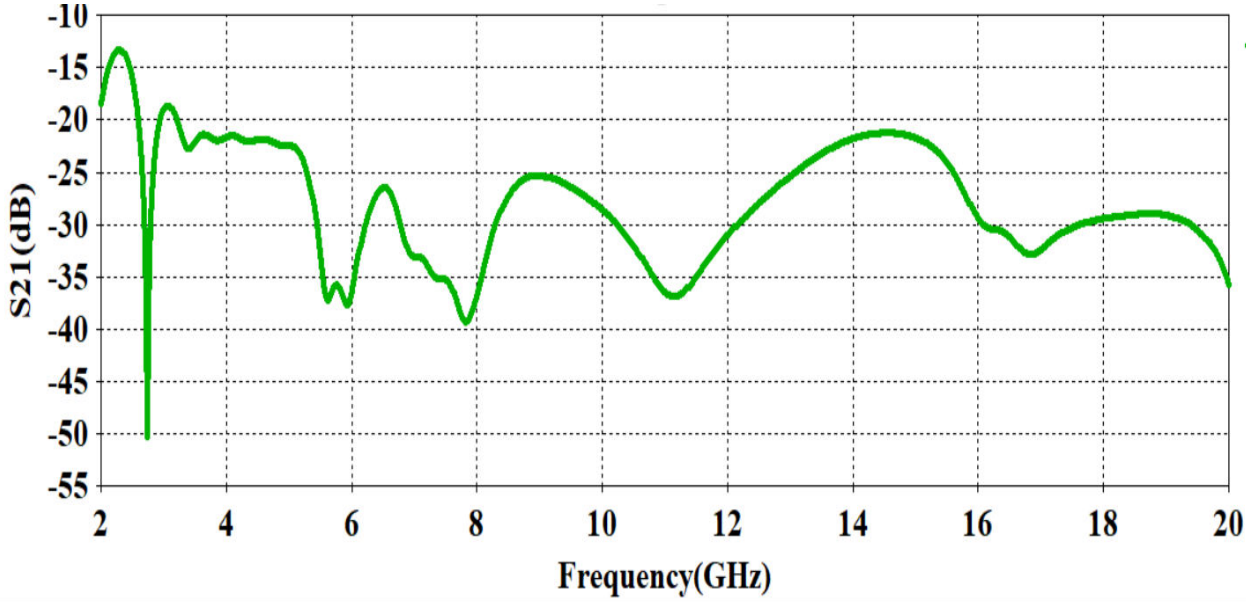

FIGURE:3:S21 response of the antenna element

VSWR PARAMETERS:

In radio-frequency communication, VSWR (Voltage Standing Wave Ratio) measures how well a signal travels from a power source through a transmission line into a load. The value of VSWR should be in the range of 1 to 2.

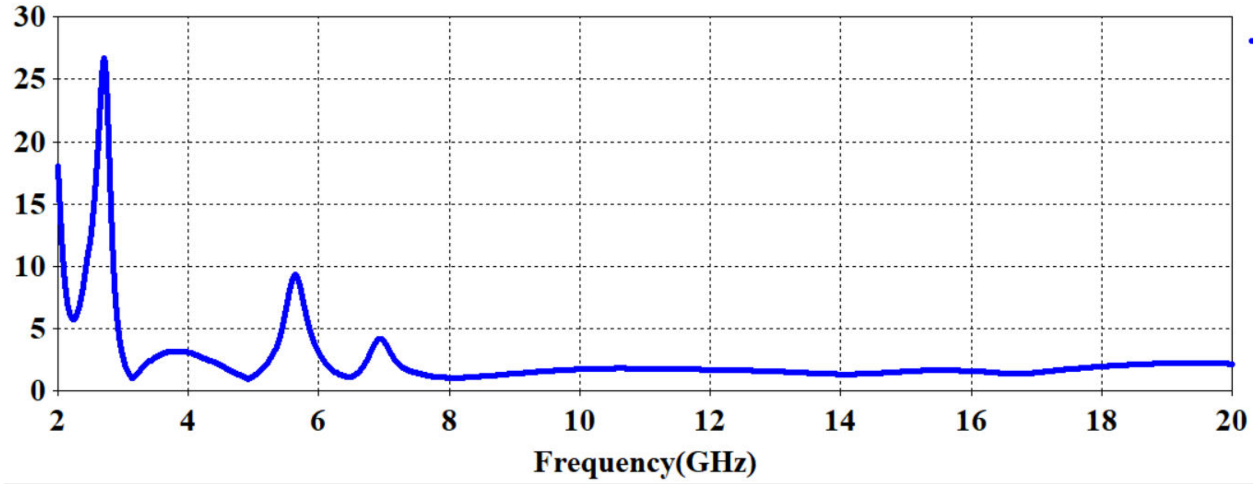

FIGURE:4:VSWR1 response of the antenna element

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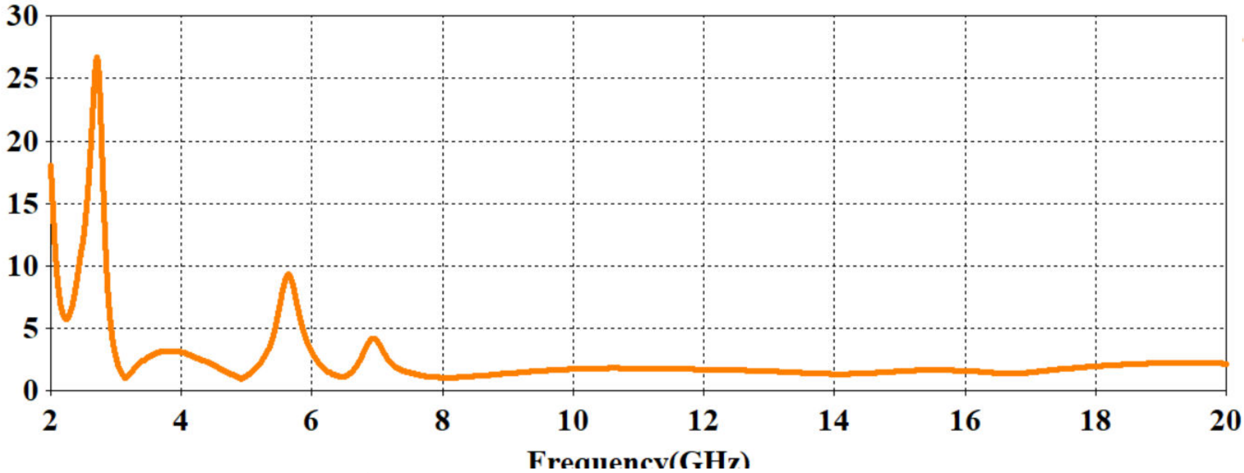
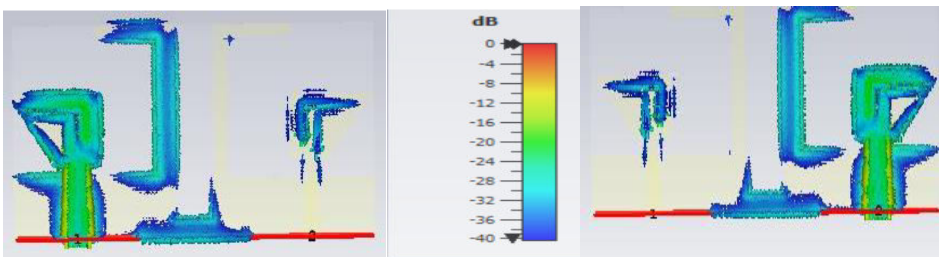


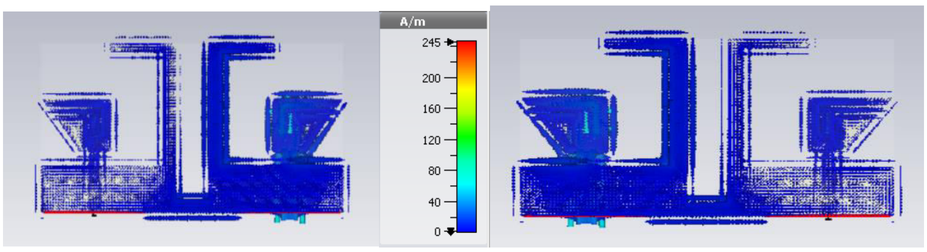
FIGURE:5:VSWR2 response of the antenna element

SURFACE CURRENT DISTRIBUTION:
Surface current distribution of simulated antenna design at 4.916GHz



PORT-1 EXCITED PORT-2 EXCITED

FIGURE:6:SURFACE CURRENT TOP VIEW



PORT-1 EXCITED PORT-2 EXCITED

FIGURE:7:SURFACE CURRENT GROUND VIEW

Z-PARAMETERS:
The z-parameters of any antenna can be determined. Real and imaginary parts make up the whole. An antenna's real impedance measures the power each antenna radiates. Power stored in the near-field of the antenna is represented by the imaginary part of the antenna impedance.

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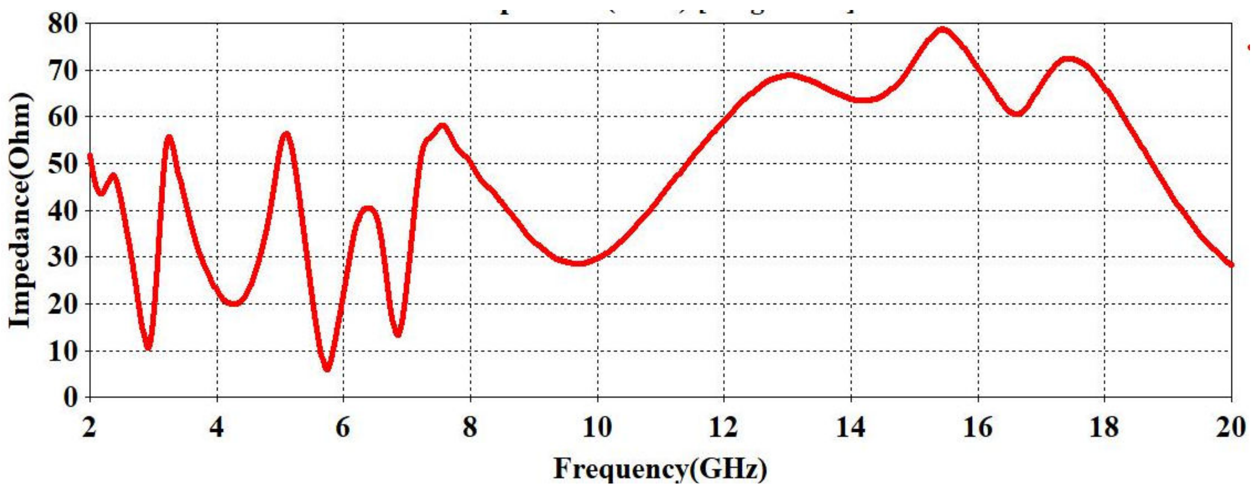

FIGURE:8:Z11 Real part ofthe proposed antenna

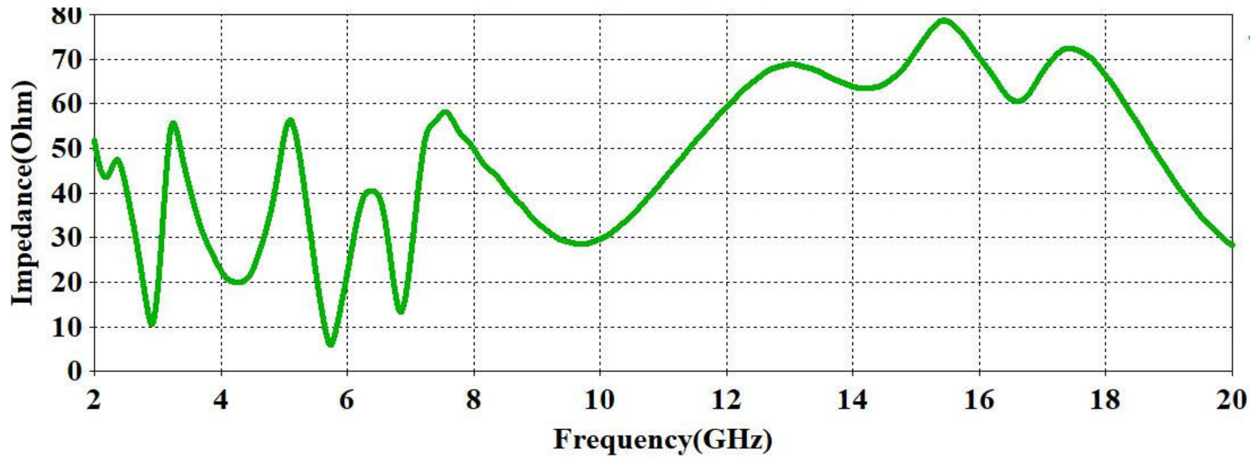

FIGURE:9:Z11 imaginary part of the proposed antenna

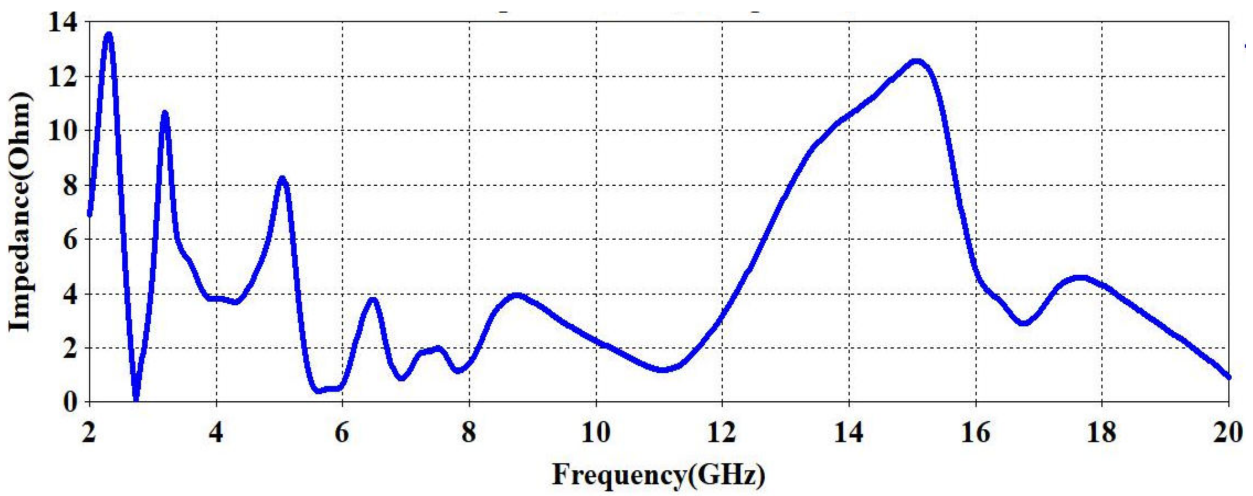

FIGURE:10:Z21 Real part of the proposed antenna

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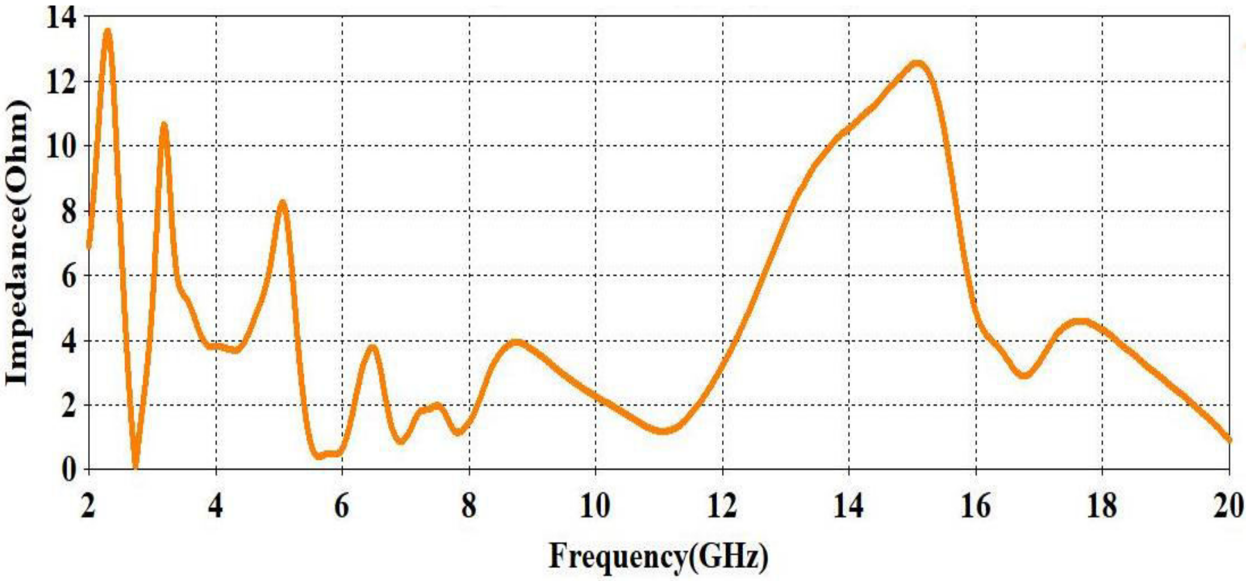

FIGURE:11:Z21 Imaginary part of the proposed antenna

E-FIELD DISTRIBUTION:

E-Filed distribution is measured by keeping □as constant and □ = 0^o and is measured along XZ plane at 4.916GHz.

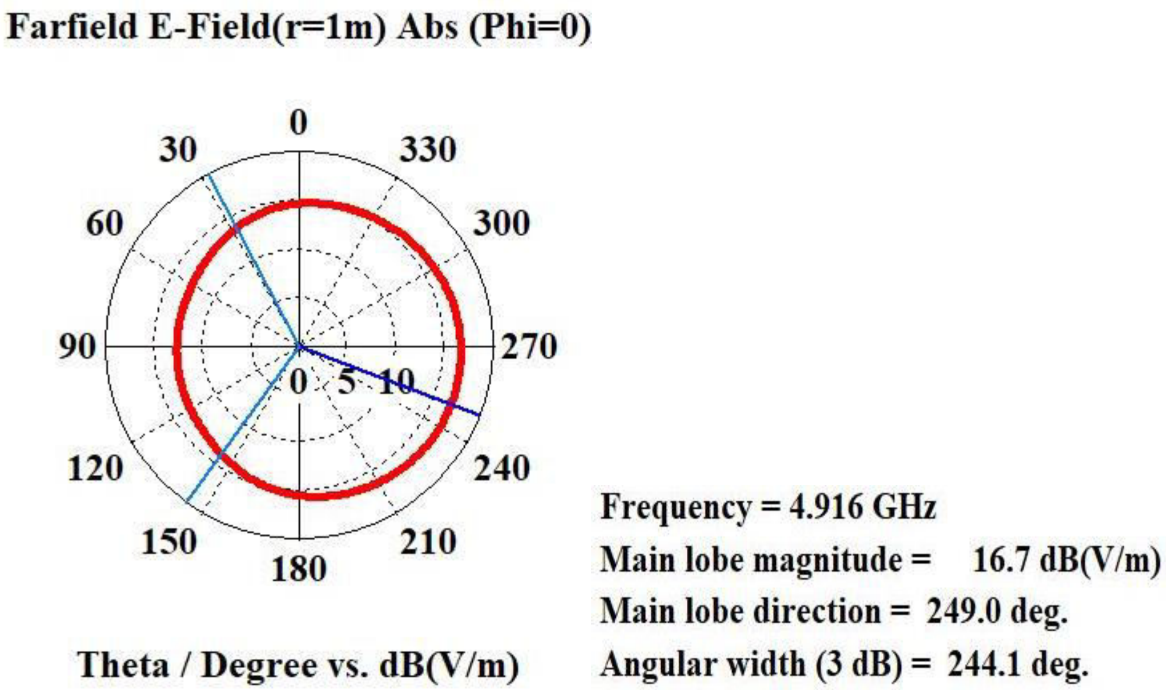

FIGURE:12:E-FIELD

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H-FIELD DISTRIBUTION:

H-Field distribution is measured by keeping □ as constant and □ = 90^{o} and is measured along YZ plane at 4.916GHz

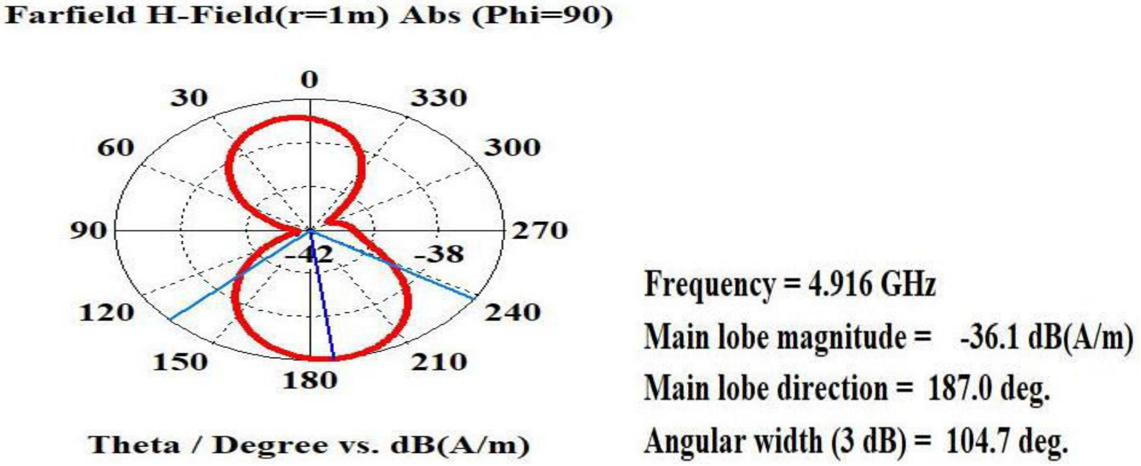

FIGURE:13:H-FIELD

Gain:

Gain in antennas refers to the amount of energy transmitted in the direction of peak radiation compared to an isotropic source. Db is the usual unit of measure for gain. Gains from antennas also take into account losses, so that antenna efficiency is maximized.

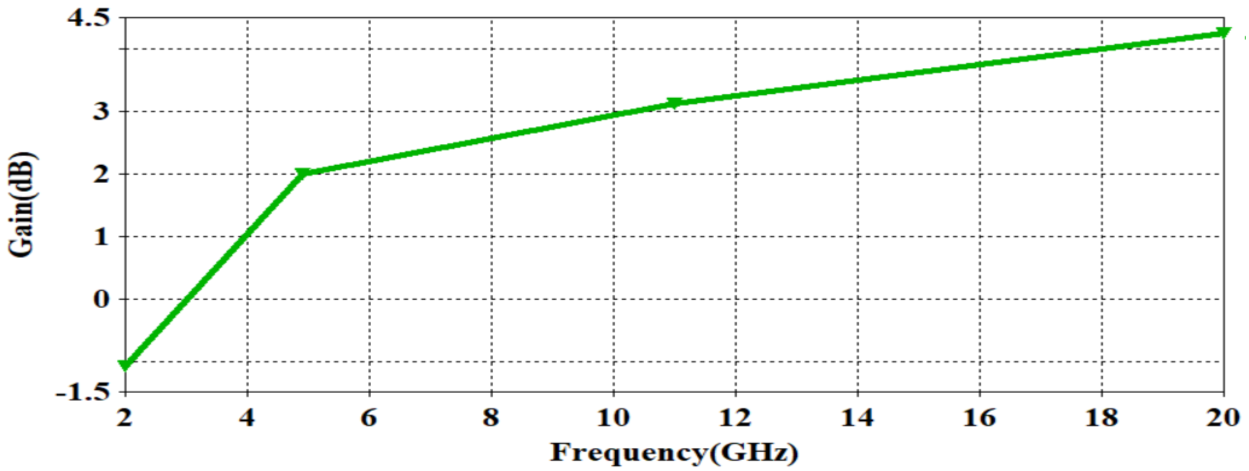

FIGURE:14: Gain of the proposed antenna

Directivity:

Using the antenna, directivity is defined as the ratio between the radiation intensity in one direction and the radiation intensity averaged over all directions, and if the maximum radiation intensity has been measured in that direction, that is the maximum directivity.

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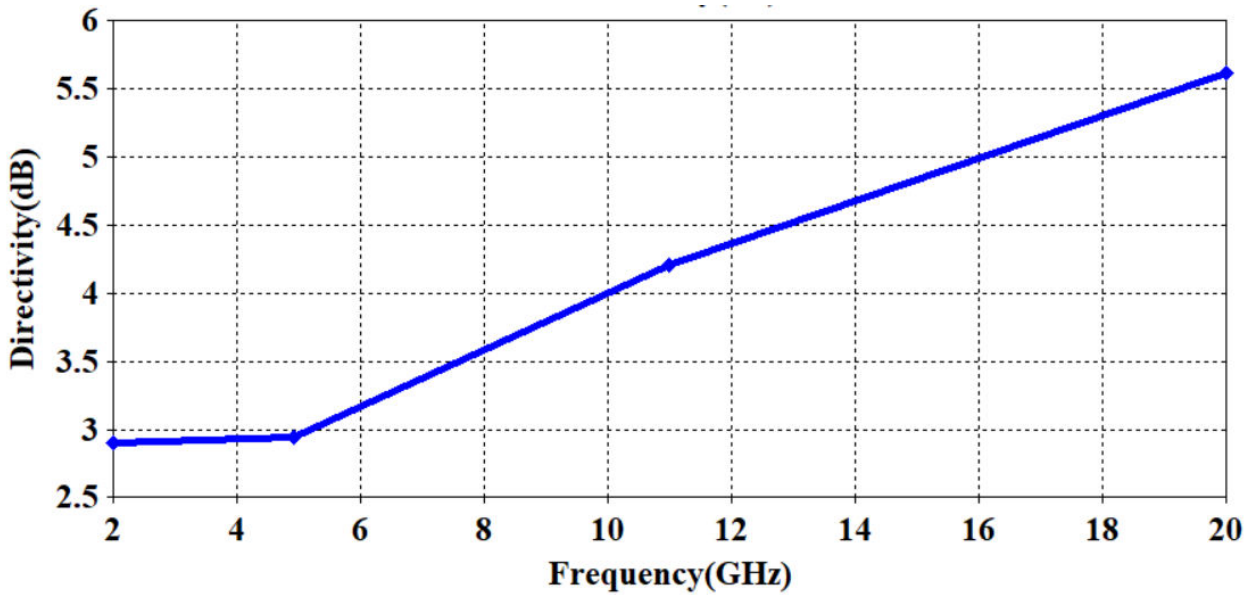

FIGURE:15: Directivity of the proposed antenna

III. CONCLUSION

The proposed MIMO antenna includes dual-band notching characteristics. The designed antenna achieves an impedance bandwidth from 2-20GHz withsharp rejection at the WLANband (5.09–5.8 GHz) and the IEEE INSAT/Super-ExtendedC-band (6.3–7.27 GHz) with an isolation lessthan22 dB,byusingasimpleinvertedL-shapedstructureinGroundplane,portisolation,andbandwidthisimproved. Moreover, the results indicate that the MIMO Antenna can also perform well in terms of diversity, making it a great candidate for portable UWB applications.

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