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Design A Compact Mimo Antenna For 4G Wimax Applications

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ABSTRACT

MIMO antennas are a type of antennas using more than one antenna for transmission and reception of signals. The proposed 2x2 MIMO antenna having two antennas in that one antenna is horizontally polarized and another antenna is vertically polarized. The proposed antenna works on C band. The newly designed 2x2 MIMO system works on 5GHz with 250MHz-300MHz bandwidth with reduced VSWR and high gain. The advantages of proposed MIMO antenna system are compact size, maximum reduced interference and high data rate and can used for WiMax applications.

Keywords: VSWR, MIMO, WiMAX, 3G, 4G, LTE, IEEE

I. INTRODUCTION

Wireless communication technology developed to make progress in data rate speed of communication applications. MIMO technology takes benefit of a radio-wave phenomenon so-called multipath where transmitted data spring back off walls, ceilings, and other objects, reaching the receiving antenna multiple times via different angles and at somewhat unlike times. MIMO wireless technology is able to significantly increase the capacity of a given channel. By raising the number of receive and transmit antennas it is possible to linearly increase the throughput of the channel with every pair of antennas added to the system. This makes MIMO wireless technology one of the most important wireless techniques to be employed in recent years. As spectral bandwidth is becoming an ever more valuable commodity for radio communications systems, techniques are needed to use the offered bandwidth more effectively.

Antennas play in significant role in transmitting and receiving data through the system. The present 3G and 4G technologies needs larger data rates with high speed, quality of transmission, and accuracy. MIMO systems are very much suitable for the present and evolving communication systems like WiMAX, 3G and 4G, etc.

WiMAX is the telecommunication protocol standard providing secure and fully mobile internet access. Practically, it is analogous to Wi-Fi but covers the wide areas with high speed for a great number of users. It contains one tower which delivers the wide coverage over its surrounding and in the customer premise; there should be installed customer premise equipment. It can be connected either the backhaul transmission the connection from one tower to another with high frequency microwave links or connection to internet. 4G LTE telecommunication technology is serving as the recent service for current industry.

Similarly, IEEE standard of WiMAX has been the interest of many researchers since it evolution. Wireless network is very popular in this time. It removes the hassles of cabling and authorization from the base station to customer premises. Apart from that, the higher data throughput and greater coverage areas are the fascinating sectors of the technology.

In this proposed paper a simple monopole antenna and inverted F antenna is been used as 2x2 MIMO antenna which is able to resonate in 5GHz. The multiple antennas placed at lesser spacing in the MIMO system ache from a major problem named as mutual coupling. The physical causes of the mutual coupling between simple monopole antenna and inverted F antenna. Usually, in multiple input and multiple output systems the basic aim is to minimize the correlation between the multiple signals.

The constraint that describes the correlation between the received signals is mutual coupling, which declines the performance of the communication system. The main source of mutual coupling is surface current flowing through the ground surface. To reduce these surface currents flowing on the ground surface, there are several techniques like Electromagnetic band gap structure, defected ground structure, decoupling techniques, etc... However, all these methods make the design of the antenna more complex.

This paper is organized as follows. In Section II, the design methodology of the proposed system Section III incorporates the use of above antenna to design MIMO antennas and simulated results are analysed further and Section V concludes the analysis of the paper.

II. METHODS AND MATERIAL

MIMO Antenna Design and Methodology

In this proposed system a simple monopole antenna and an inverted F antenna constitutes 2x2 MIMO antenna design. FR4 epoxy substrate of permittivity, or= 4.4 and loss tangent 0.02 are used. The structure of monopole antenna is shown below figure 2.a

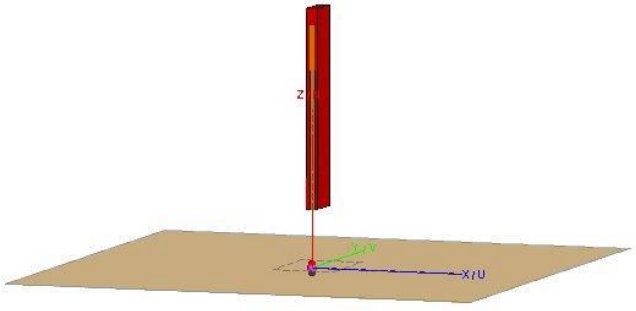

Figure 2. (a) Monopole Antenna Structure

In the proposed design of 2x2 MIMO antenna one antenna is vertically polarized and another antenna is horizontally polarized hence to achieve eliminate interference with maximum throughout. The monopole antenna vertically polarized with single feed from the bottom of the antenna. Wire feed technique is used to feed the antenna with meshing of 0.1mm. The design parameters and dimensions of monopole antenna are shown in table 1.

Table 1

Parameter	Dimension
Length	8.28mm
Width	0.25mm
Ground Plane	20mmx15mm

Inverted-F antenna is horizontally polarized, so taking it as an advantage in considering MIMO antenna technology as the monopole antenna is vertically polarized.

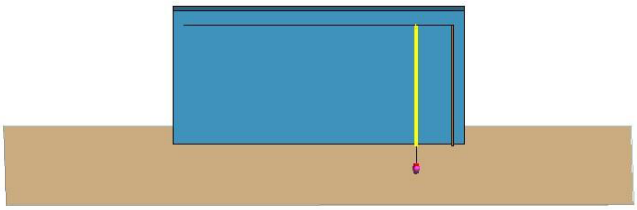

Figure 2. (b) Inverted-F antenna structure

The structure of inverted-F antenna is shown above in figure 2.b. The mesh size of inverted-F antenna is also 0.1mm with horizontal polarization. Wire feeding technique is been used here.
In the proposed antenna the width very much reduced to avoid vertical polarization on the legs of the antenna. Table 2 shows the dimensions of the proposed inverted-F antenna below.

Table 2

Parameter	Dimension
Length	12mm
Height	5.45mm
Width	0.06mm
Distance between two legs	1.65mm

Combining two antennas in single plane without interference is possible by placing the antennas orthogonally. Orthogonal polarization consists of two antennas with 90 degree apart polarization. The proposed antenna system consists of two antennas having difference in polarization. Circular ground plane should be used for MIMO antenna system as its ground plane is having the advantage of equal mesh distribution all over the system.

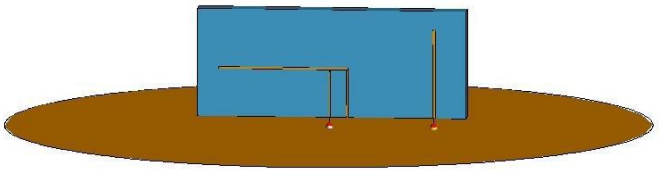

Figure 3. (c) Proposed MIMO antenna

The distance between the antennas is also a big concern as it should be 0.1. The proposed MIMO system is shown in figure 2.c above.

III. RESULTS AND DISCUSSION

The performance of proposed antenna system is simulated using CAD FEKO 14.0. The 2x2 MIMO system works in 5GHz with 250MHz-300MHz bandwidth range.

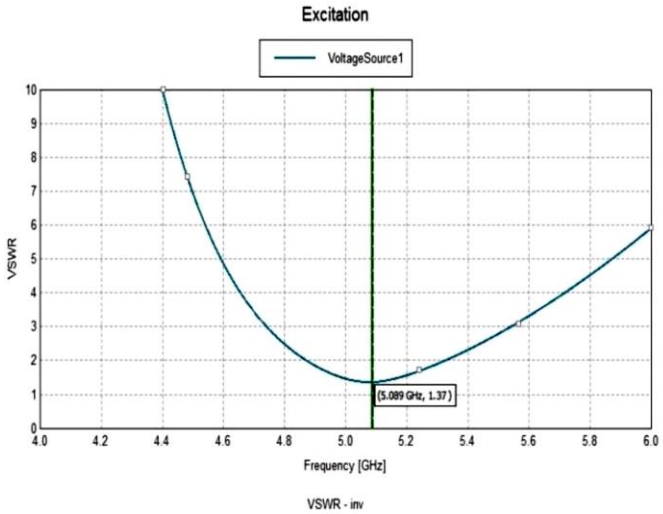

Figure 3. (a) VSWR of inverted-F antenna

Design parameters such as VSWR, S-parameter and Gain are considered and evaluated. The VSWR of inverted-F antenna is shown in figure 3.a above and monopole antenna is shown below in figure 3.b

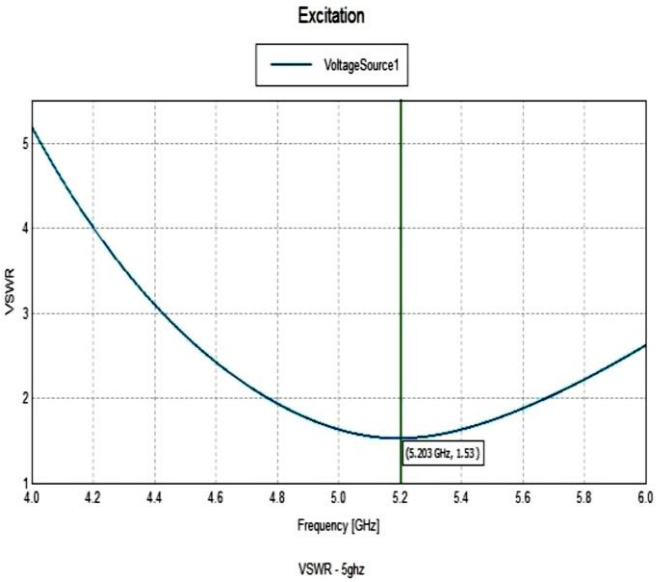

Figure 3. (b) VSWR of monopole antenna

The VSWR of monopole antenna is 1.53 at 5.203GHz and of inverted-F antenna is 1.37 at 5.089GHz are at acceptable levels and both antennas works properly at their resonant frequencies. The S-parameter of monopole and inverted-F antenna is shown in figure 3.c and 3.d below.

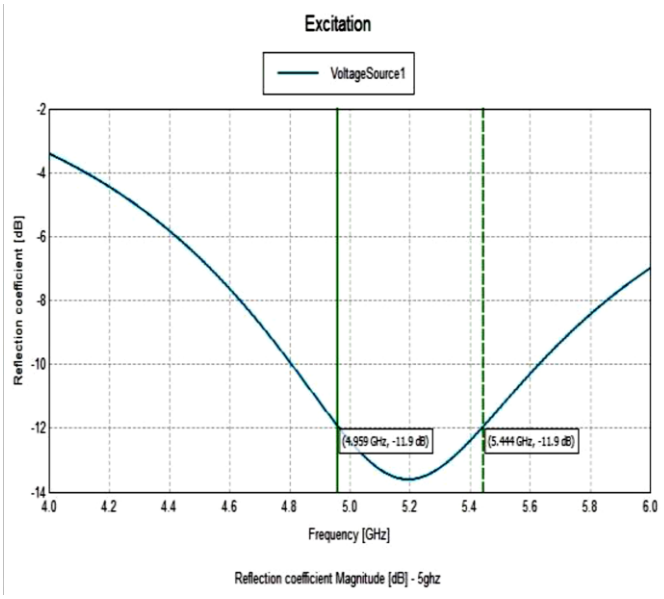

Figure 3. (c) S-parameter of monopole antenna

The return loss of monopole antenna of MIMO system is -13.8dB having more than 300MHz bandwidth between 4.959GHz to 5.444GHz.

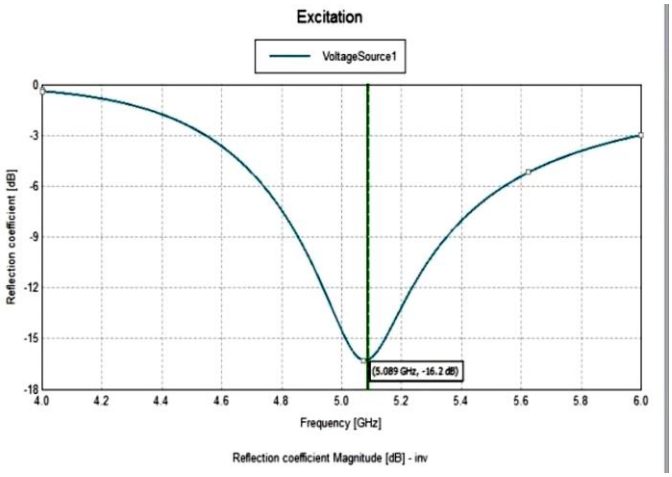

Figure 3. (d) S-parameter of inverted-F antenna

Reflection coefficient of inverted-F antenna is -16.2dB with 300MHz bandwidth 4.829GHz to 5.213GHz. Reflection coefficient of both antennas is below -10dB hence both work effectively at relevant resonant frequencies of the antenna.

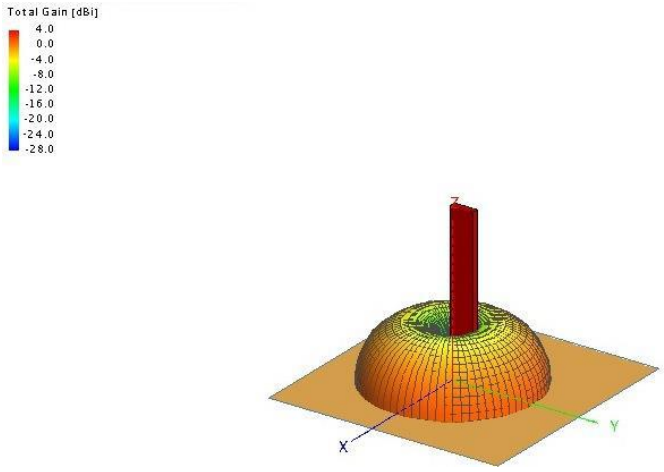

Figure 3. (e) Gain of Monopole antenna

Gain of monopole antenna is shown in figure 3.e above. The achieved gain of monopole antenna is 4dB at 5GHz. The achieved gain of proposed inverted-F antenna is 4.50dB at 5GHz with perfect hemispherical shape shown in figure 5.f below

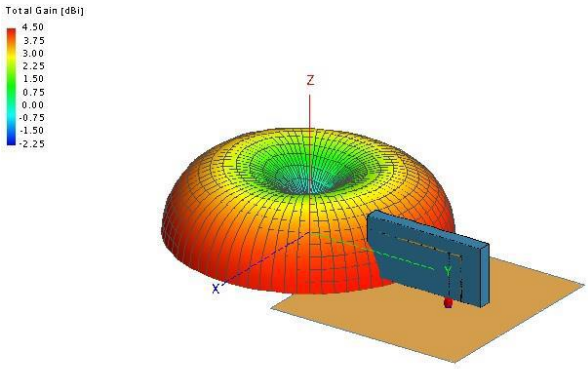

Figure 3. (f) Gain of inverted-F antenna

Combining both together to same plane we get the MIMO system. Thus the obtained results are evaluated. VSWR of proposed MIMO antenna is shown in figure 3.g below

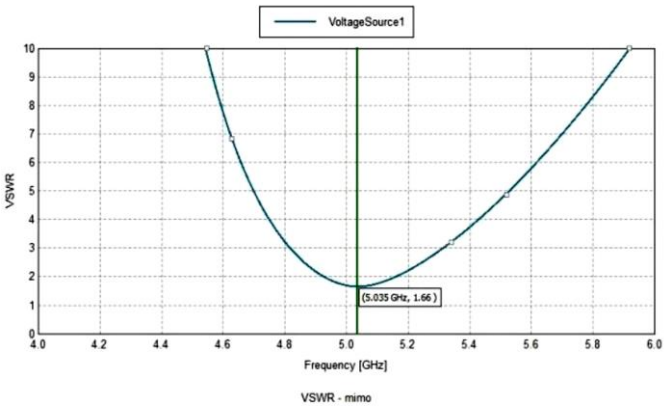

Figure 3. (g) VSWR of MIMO antenna

The VSWR of MIMO antenna system obtained is 1.66 at 5.035GHz. The S-parameter of MIMO antenna is shown in figure 3.h below

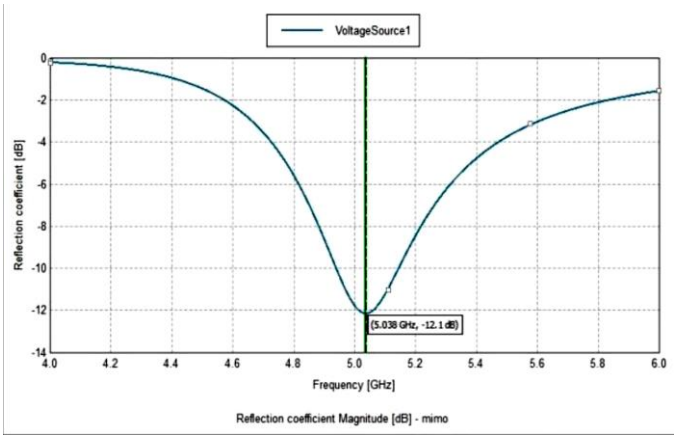

Figure 3.(h) Sparameter of MIMO antenna

The achieved S-parameter of MIMO antenna system is -12.1dB at resonant frequency 5.038GHz.

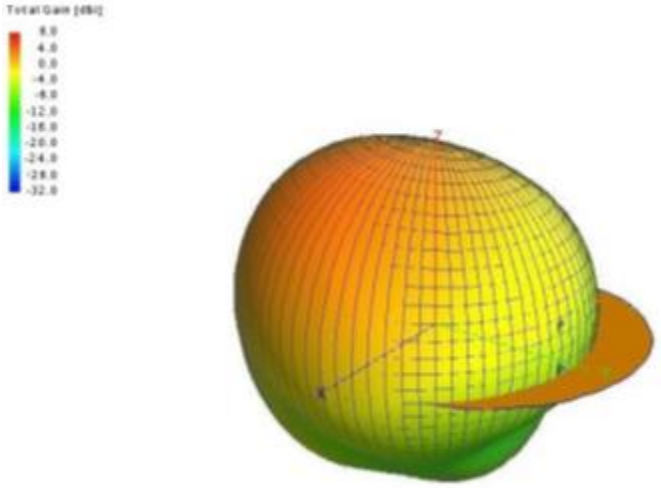

Figure 3. (i) Gain of MIMO antenna

The maximum Gain achieved by MIMO antenna system is 8dB shown in figure 3.i above.

IV. CONCLUSION

The proposed MIMO antenna system has been designed with monopole antenna and inverted-F antenna. The antenna can be used for new generation WiMax application. The antenna has a wide bandwidth of more than 250MHz-300MHz at the reflection coefficient level below −10dB. The high gain of MIMO antenna shows good performance in WiMax applications. The proposed MIMO antenna system having low loss and much lesser interference between them.

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