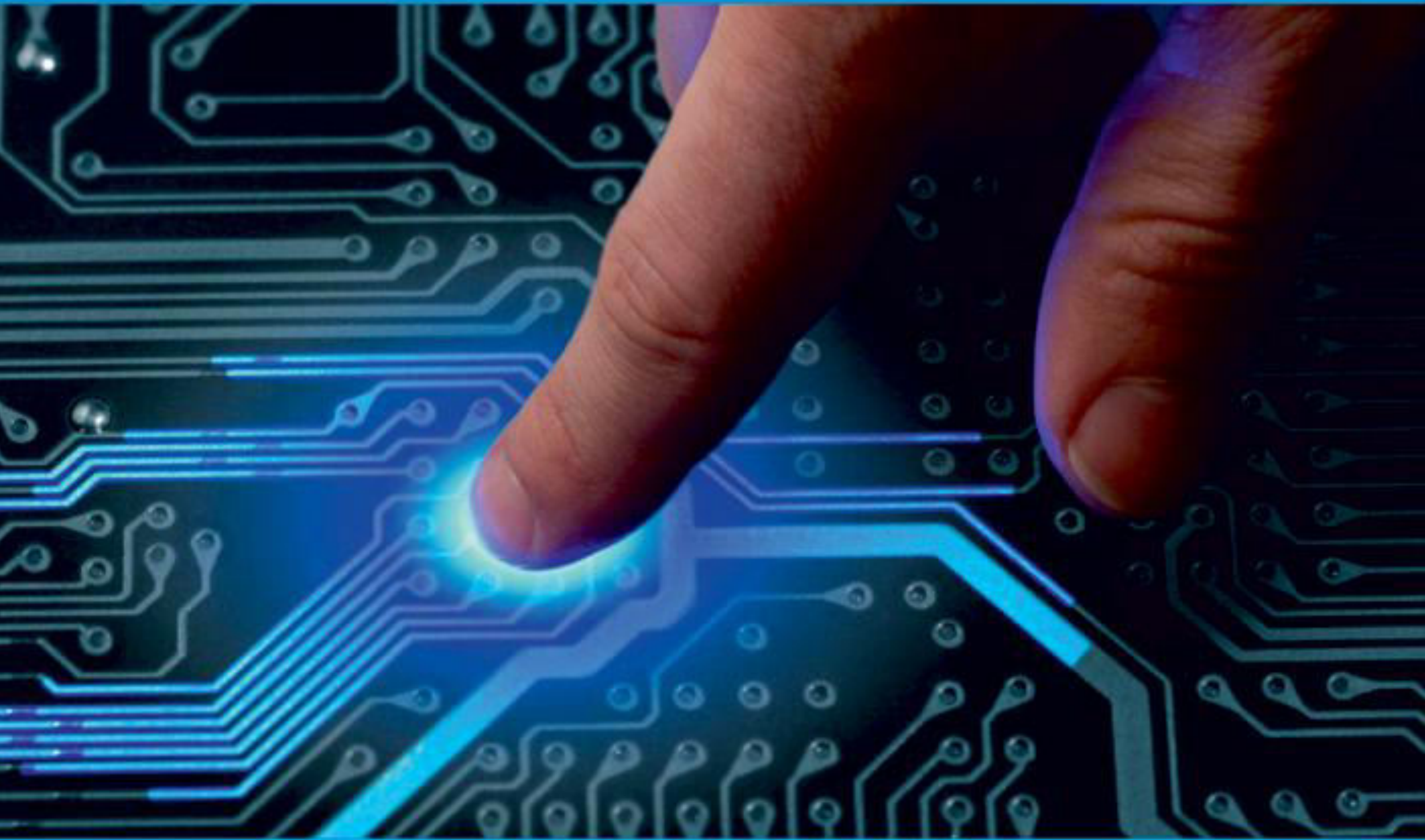
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 9, Issue 6, June 2021

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.542

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542 |

|| Volume 9, Issue 6, June 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0906227 |

Design and Analysis of Fractal MIMO Antenna for Multiband Wireless Applications

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ABSTRACT: A hexagonal fractal MIMO antenna for multiband wireless applications is designed and analyzed in this article. The patch contains four hexagonal structures are combined and a Defected Ground Structure [DGS] is placed in the ground plane. DGS is a hexahedral-shaped dumbbell structure. In this design, antenna elements are placed perpendicular to each other with the usual ground plane. Because of the type of design, it gives better Isolation. The antenna is constructed using an FR4 substrate with a 1.6mm thickness. The peak gain of 4.6dB at 5.8 GHz. The multiple strip MIMO antenna vibrates at frequencies 5.8GHz, 8.8GHz. The designed perpendicular MIMO antenna is applicable for GSM, PCS, Wi-Max, and other wireless applications.

KEYWORDS: DGS ground plane, MIMO, Hexagonal fractal shape

I. INTRODUCTION

The recent demand for miniaturization and compact multi-band antennas having its application in mobile handsets. The advantage of multiband antennas is small size, simple for integrating, and low cost. The multiband antenna is the single terminal used for various wireless applications. The shape of the multiband antenna is square, rectangle, triangle, circle, and hexagon. Recently, a lot of researches have done in the design of multiband operation. A microstrip patch antenna having the defective structure in the ground plane used is designed for various wireless applications [1]. Dumbbell-shaped slots have been created in the ground plane to improve the bandwidth. DGS structure with slots aids in reducing the size of the patch antenna. A novel small triple-band monopole antenna with crinkle fractal structure [2]. A quad-band circular patch antenna with fractal elements for S-Band and C-Band Applications [3]. A design of quad-band hexagonal antenna with fractal slots using inset feeding technique [4]. A new triple-band microstrip fractal antenna for C-band and S-band applications [5]. Wideband directional antenna system with different polarizations for wireless communication system [6]. An X-shaped fractal antenna with DGS is designed for multiband applications [7]. A multi-slot microstrip antenna is designed for ultra-wideband applications [8]. A fractal-based ultra-wideband antenna is developed for wireless personal area communication applications [9]. Hexagonal ring fractal antenna with the dumb-bell shaped defected ground structure for multiband wireless applications [10]. Defective ground corner rounded ultra-wideband microstrip patch antenna for biomedical applications [11].

II. ANTENNA DESIGN

The hexagonal shaped fractal structure antenna is designed as shown in the fig1.It is designed by four hexagons merged with dimensions 14 mm,10 mm,7 mm and 6 mm. A hexagonal shaped double dumbbell structure is inserted in ground plane for reducing the size and to increases the isolation.Two element MIMO structure is derived from single hexagonal shaped fractal design.To measure the performance by placing the antenna in different polarization. At first the antennas are placed in parallel at same plane After that they are placed in orthogonal to each other.

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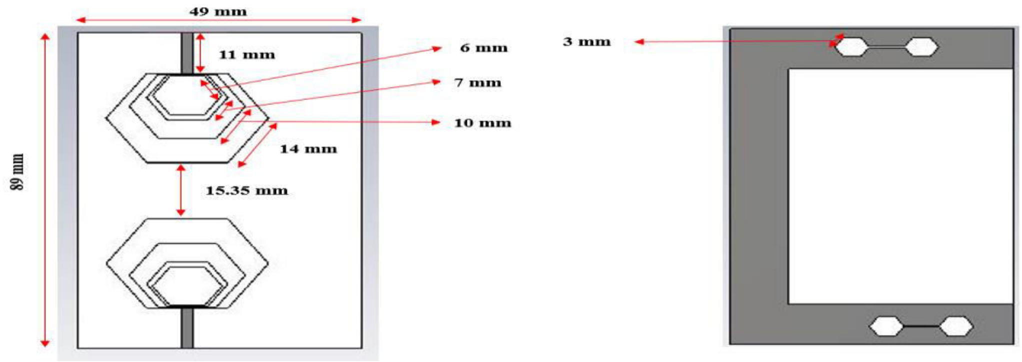

(a) Front plane (b) Back plane

Fig 1:- Proposed Final design

The design is carried out by FR4 substrate with dielectric and thickness 4.6 and 1.6mm.The various antenna parameters like gain, directivity, radiation efficiency and radiated power are simulated and measured for the operating range of frequencies for all the designs.

III. RESULTS AND DISCUSSION

Return loss:

S_{11} represents how much power is reflected from the antenna and hence it is known reflection coefficient. It should be lessthan -10dB for the acceptable operation.In the proposed design it resonates at 2 frequencies 5.8GHz, 8.8GHz with return losses -37.6dB,-24.6dB

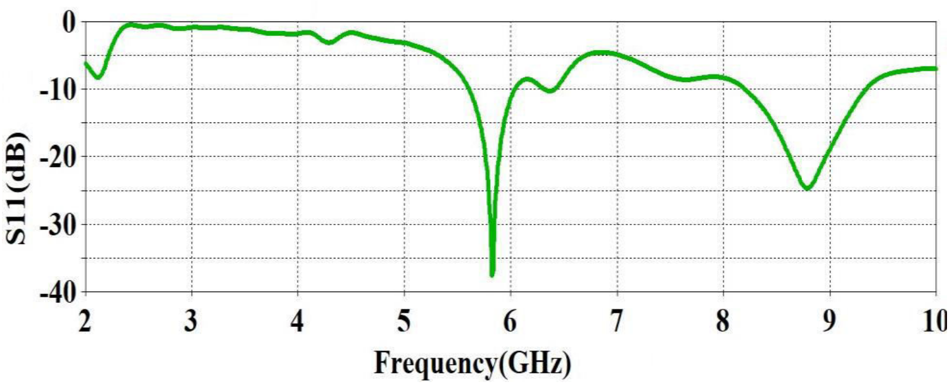

Fig 2:-S_{11} response of final design

S_{21} represents the power transferred from port 1 to port 2. For a MIMO system S_{21} must be less than -15dB.In the proposed design return losses -24.57dB,-22.4dB

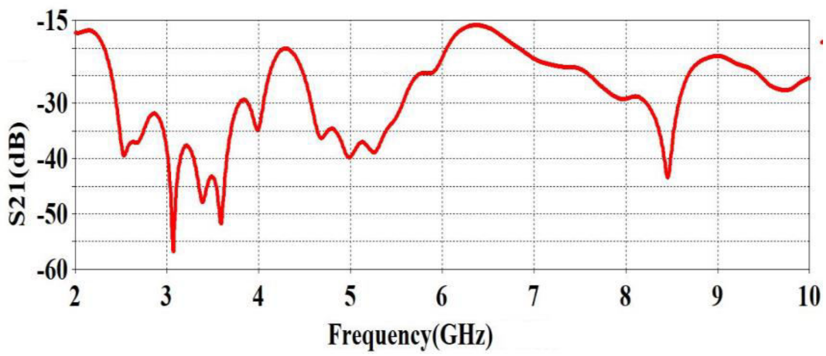

Fig 3: S_{21} response of final design

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VSWR Parameter:

Voltage standing wave ratio(VSWR) is a function of the reflected coefficient row, it describes the power reflected from antenna . It is to measure how the efficiently the power will transfer to a power source through transmission line like feeding line. The VSWR should less than 2 . In the proposed design it is 1.02 at port 1 and 1.26 at port 2.

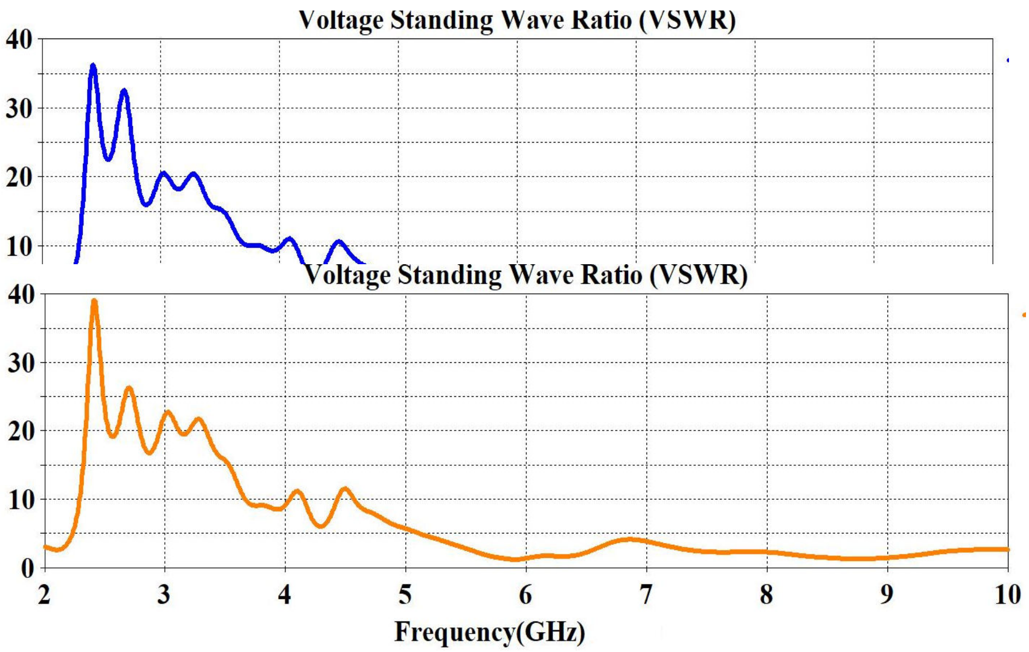

Fig 5:-VSWR at port 2

Surface current Distributions:

Here we can observe the surface current distribution of our proposed antenna the first one is surface current distribution in excited front plane and second one is current distribution in excited ground plane and also here The average current density is shown in different colors. We can see the average current distribution on the surface of the antenna. As we can observe the current is in the range of -12 to -28 on the top edge, it is almost maximum at the centre and it is minimum at the edge of the feed line.

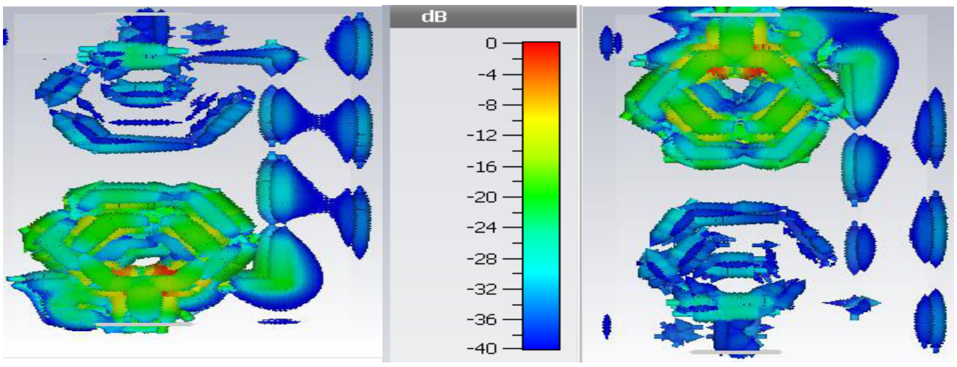

Fig 6:-Surface current distribution port 1 and port 2 excited

Z-Parameters:

The input impedance of an antenna is defined as "the impedance presented by an antenna at its terminals or the ratio of the voltage to the current at the pair of terminals or the ratio of the appropriate components of the electric to magnetic fields at a point. For any antenna we can plot z-parameters. It consists of the real part and imaginary part. Real part of antenna impedance represents power that is either radiated away within the antenna. Imaginary part of the antenna impedance represents the power stored in the near field of the antenna.

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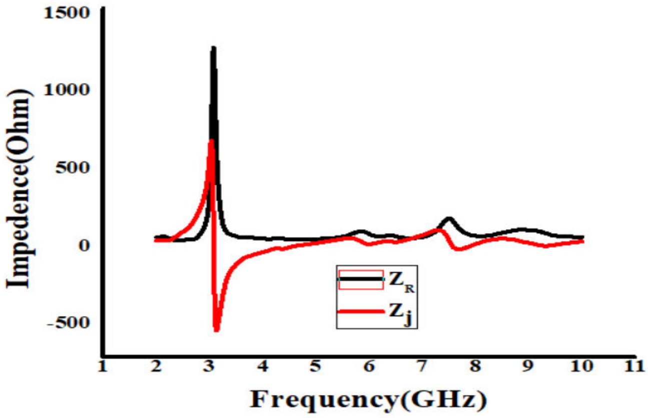

Fig 7:-Z_{11} response of the design

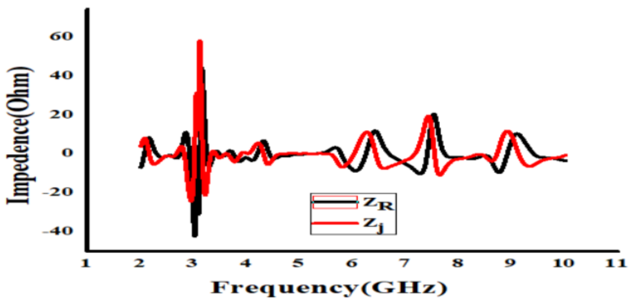

Fig 8 :-Z_{21} response of the design

E-FIELD DISTRIBUTION:

E-Filed distribution is measured by keeping θas constant and $\phi = 0^o$ and is measured along XZ plane at 5.8 GHz

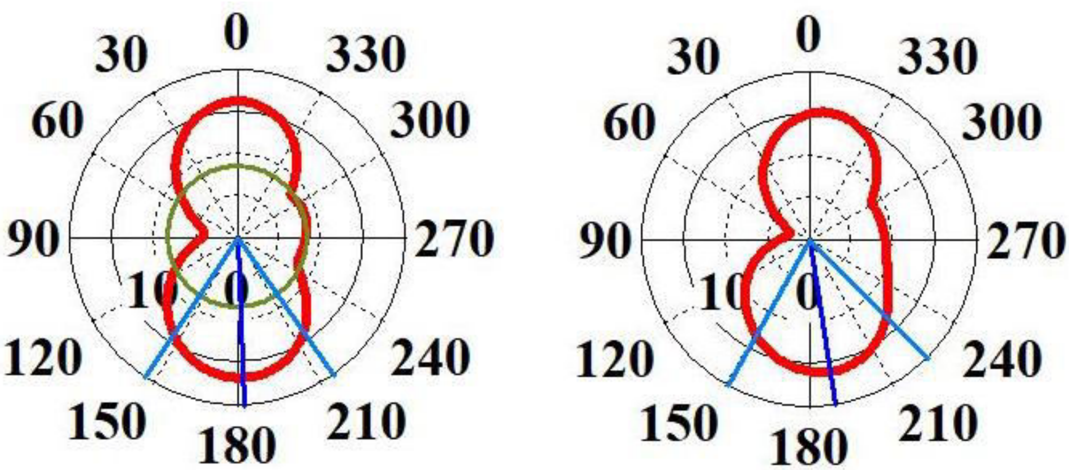

Fig 9:-E-field distribution when port 1 and port 2 excited

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H-FIELD DISTRIBUTION:
H-Field distribution is measured by keeping θ as constant and $\phi = 90^o$ and is measured along YZ plane at 5.8 GHz

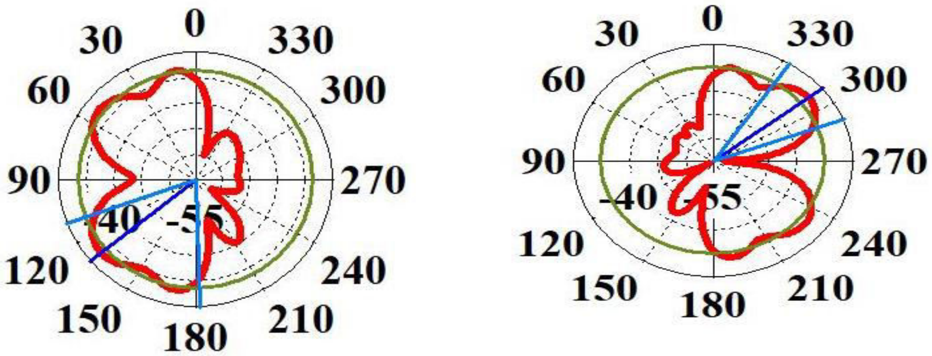

Fig 10:-H-field distribution when port 1 and port 2 are excited

Gain:
The term antenna gain describes how much power is transmitted in the direction of peak radiation to that of an isotropic source. Gain is usually measured in dB. antenna gain takes the losses that occur also into account and hence focuses on the efficiency.

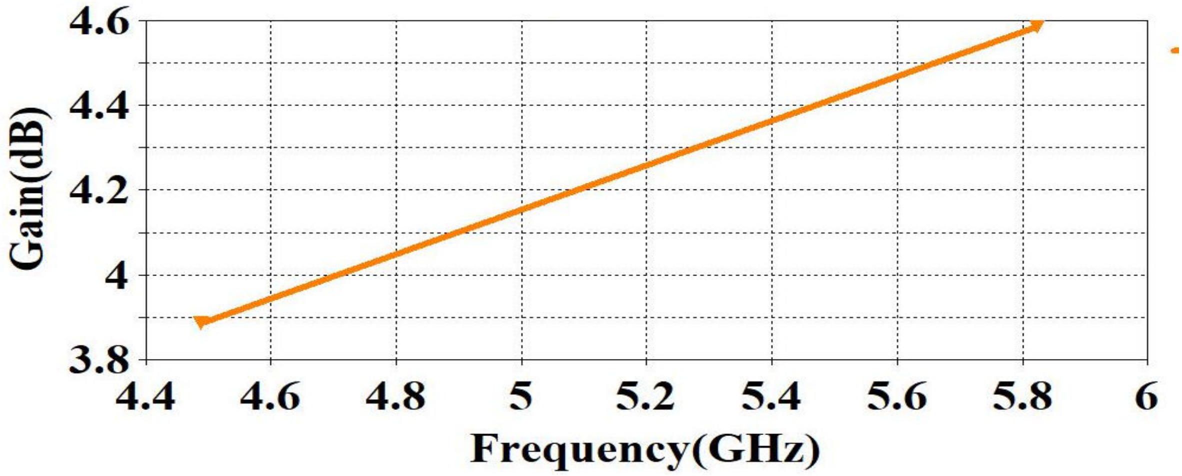

Fig 11:- Gain of the proposed design

Directivity
Here the directivity defines the ratio of the radiation intensity in a given direction from the antenna to the radiation intensity averaged over all directions and if in that given direction the radiation intensity is maximum than it is called the maximum directivity.

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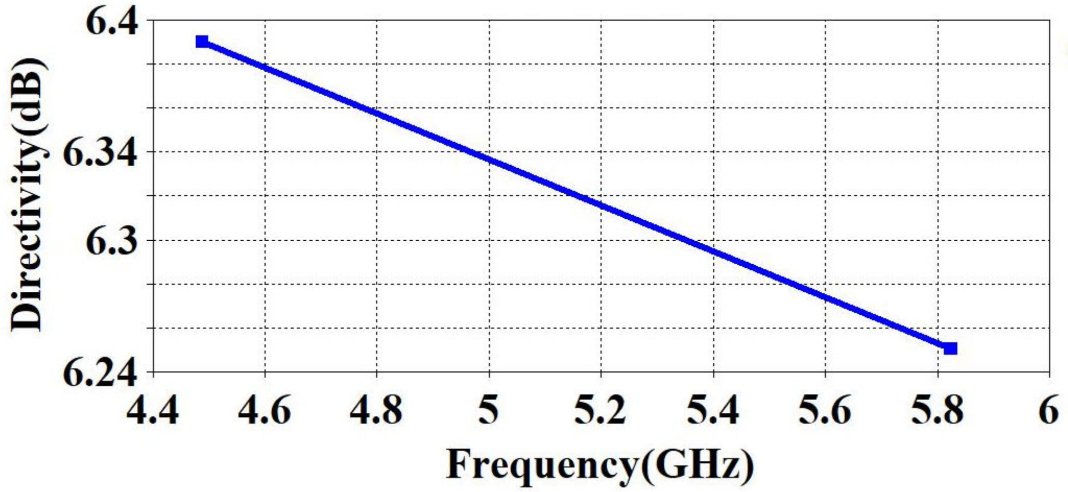

Fig 12:-Directivity of the proposed design

IV. CONCLUSION

A two element orthogonal MIMO antenna has been suggested for GSM, PCS, WLAN and Wi-MAX applications. Each antenna element consists of a four hexagonal shaped fractal structure embed with the dumbbell shaped DGS. The design of two element antenna with common ground plane significantly increases its effectiveness and feasibility. The hexagonal shaped fractal antenna with monopole structure helps to realize multiband characteristics and good isolation of greater than - 20 dB. The simulation results illustrates that the two element orthogonal MIMO antenna produces better isolation, multiband tuning, increased gain and good radiation efficiency which ensures that it is appropriate for recent wireless communication systems.

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