A MIMO ANTENNA FOR 5G APPLICATIONS

P. Sasireka[1], S. Malini[2], B. Sreemathi[3], T. Srinithi[4]

[1]*Associate Professor, B.E-Department of Electronics and Communication Engineering, S.A. Engineering College, Poonamalle, Chennai-77.*

[2, 3, 4] *U.G student, B.E- Department of Electronics and Communication Engineering, S.A. Engineering College, Poonamalle, Chennai-77.*

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ABSTRACT*: This paper introduces a 4-antenna array for Multiple-Input Multiple-Output (MIMO) applications in future handheld fifth generation (5G) terminals. A modular planar plus form micro strip array is provided in this work, designed for dual band frequency in a 4 plus patch with two ports configuration, This antenna has small dimensions as a solution for next 5 G network applications. Antennas are designed and simulated using HFSS (High-frequency Structure simulator) software and operated at 8- 12 GHz. The proposed configuration can find applications within 8 to 12 GHz frequency range in personal mobile communication, blue tooth and Wi-Fi applications due to the realized bandwidth and gain. The design is very simple and easy to fabricate.*

Keywords: *MIMO, HFSS, micro strip array, plus patch, dual band frequency*.

1. INTRODUCTION

Advancements in personal mobile communications systems involving higher digital data rates have increased the need for bandwidth (BW) antennas within the range of just a few GHz. At individual resonant modes, the higher BW in monopole antennas is due to the larger BW. Monopole antennas can find applications in such systems, as they deliver BW in only a few tens of GHz. Because of this variant of the Micro strip planar monopole antennas is commonly used. Many printed patch variations of the planar monopoly antenna have been documented using simple radiating shapes such as, rectangular, circular, equilateral triangular, yielding BW in the range of few GHz. Due to its limited size and conformity Micro strip patch antenna was considered for compact mobile devices.

However because of their immense dimensions, they are rarely used as elements of MIMO antenna systems. Several approaches to reduce the scale of the patch antennas have been suggested.

A new plus shaped antenna is proposed in this article, realized by combining two rectangular shaped planar monopoly patches. The proposed configuration will be tested on substratum FR4

(εr = 4.4, h = 1.6 mm, tan δ = 0.025). It presents a detailed parametric analysis for variation of two rectangular patches in place that yields plus shaped structure.

The development of plus shaped patch optimizes the input impedance of the respective rectangular patches at lower and higher resonant modes, which yields equivalent ultra-wideband input impedance. The simulated and calculated BW is obtained from under 8 GHz to over 12 GHz. Due to the proposed printed monopoly architecture antenna displays almost Omni-directional pattern of radiation over the entire BW with a co-polar gain of about 1 to 3 dBi. Because of the above impedance and pattern features plus shaped architecture, applications can be found in 8 to 12 GHz frequency ranges in blue-tooth, Wi-Fi and personal mobile communications systems applications.

A four-MIMO antenna array on a substratum 95x11.4x1.6mm3. Though the ground plane isolation substratum at the bottom of the technique shown in this paper contributed substrate. The FR4 substratum has been used for very good isolation but this antenna manufactures antenna which has a 1.6 mm device has a gain of less than 2 dB. Even the specification with a complicated. Loss tangent of 0.025 is very thickness and relative permittivity 4.4. When this antenna is combined with a four element patch antenna with a co-axial feed stimulation.

2. ANTENNA DESIGNS AND CONSIDERATIONS

The geometry of the antenna proposed is given in Fig.1, the dimensions are given in Tab.1.This antenna is printed on FR-4 substrate with the dielectric constant of 4.4 and loss tangent of 0.025. The antenna covers the overall size of 95.6mm x 95.6mm which makes it compact. Four similar sized plus-shaped antenna elements are created on the top of the substrate. A 50-ohm matched coaxial feed line is used to feed the structure.

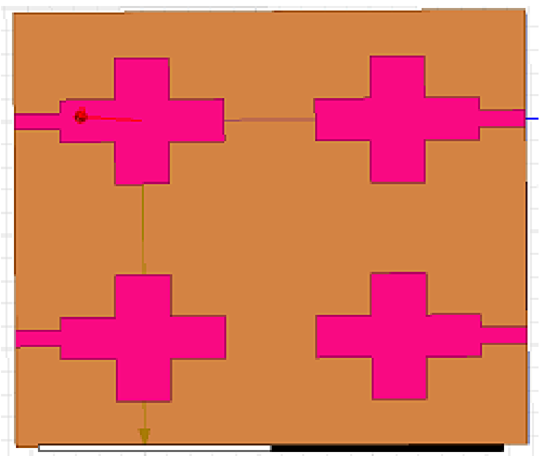

Fig 1-Antenna geometry

Parameters	Substrate	Patch	Ground
Length	95.66mm	27.83mm	95.66mm
width	112.16mm	36.08mm	112.16mm

Tab 1-Dimensions of antenna

The coaxial probe feed can be effectively produced and matched, and has low spurious radiation. It has a narrow bandwidth, however, and simulation is more difficult, particularly for thick substrates (h > 0. 02 γ). But in the array design with thousands of components, the large number of solder joints makes manufacturing difficult and reduces reliability. The equivalent circuit is similar to the feed line for micro strips.

The width is calculated using,

$$W = \frac{v_o}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

And the length is calculated using,

$$L = \frac{v_o}{2f_r\sqrt{\varepsilon_{reff}}} - 2\Delta L$$

Where,

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2}$$

$$\Delta L = 0.412h\frac{(\varepsilon_{reff} + 0.3)(W/h + 0.264)}{(\varepsilon_{reff} - 0.258)(W/h + 0.8)}$$

Where h=1.6mm, Er=4.4(FR4).

3. STIMULATED RESULTS

The designed antenna results was verified on HFSS (High Frequency Structural Simulator) based on Finite Element Method. The antenna which was designed to operate in the range that is (8-12) GHz.

3. a. RETURN LOSS/S-PARAMETER

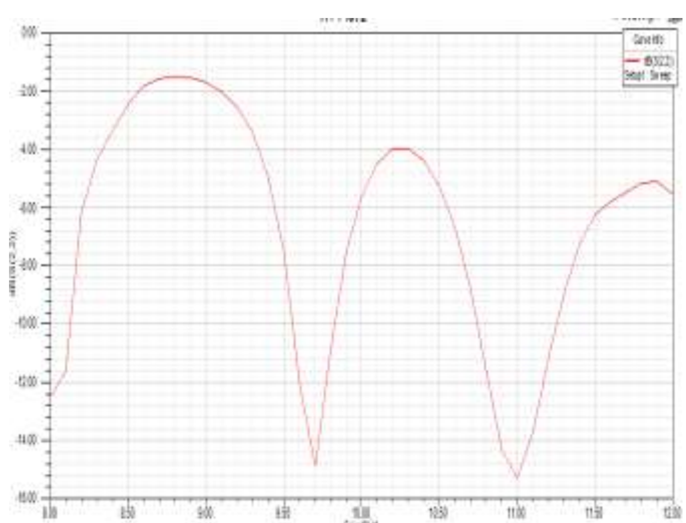

Fig 2 - Return loss/S-parameter

The propagation coefficient between antennas is shown in Fig.2, indicating a dip (about -15 dB) for frequencies in the operating band at around 9.6 GHz and 11 GHz, which is suitable for 5 G applications. For the efficiency of the antenna given in Fig.2, all in the operating band is above 50 percent, which is good for MIMO operation.

A patch's radiating edges can be seen as two radiating slots positioned above a ground surface, and, assuming all radiation happens in one half of the hemisphere (on the ground's patch side), we get a 3 dB increase in direction. The width of the 3 dB beam is the width at which the beam gain decreases by 3 dB proportional to the gain at either side of the main beam in the broadside.

3. b. RADIATION PATTERN

The Radiation Pattern of the designed antenna is shown in Fig 3

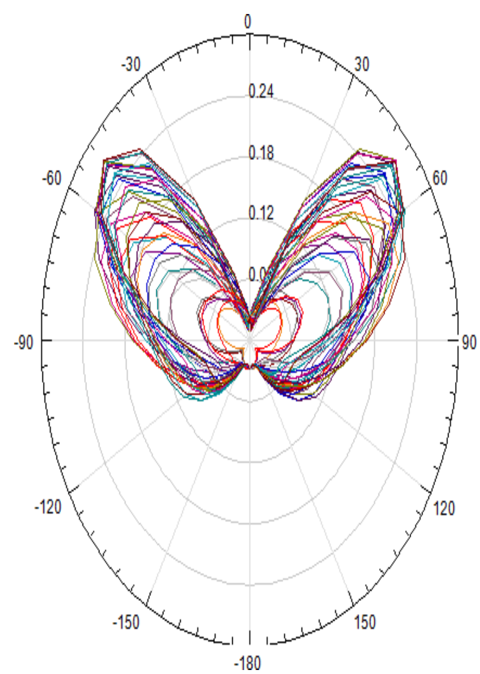

Fig 3 -Radiation Pattern.

3. c. VSWR

The Voltage Wave Standing Ratio (VSWR) of the designed antenna at 9.5GHz is shown in Fig 4,

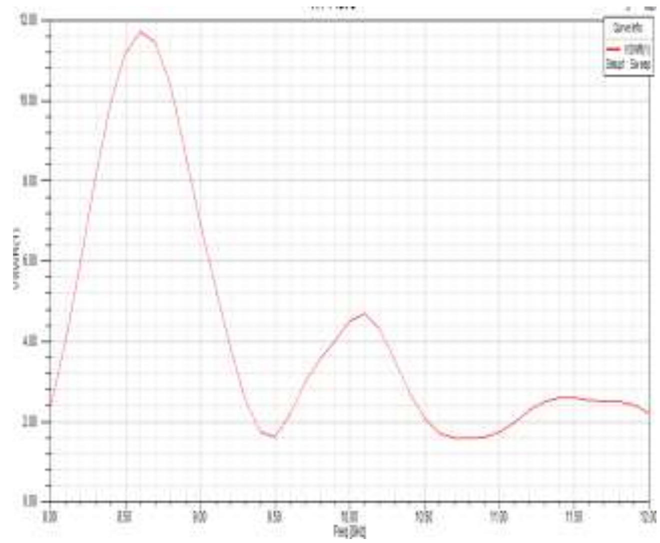

Fig 4-VSWR Parameter

3. d. E-FIELD DISTRIBUTION AND GAIN

The Electric field intensity of designed antenna is shown in Fig 5,

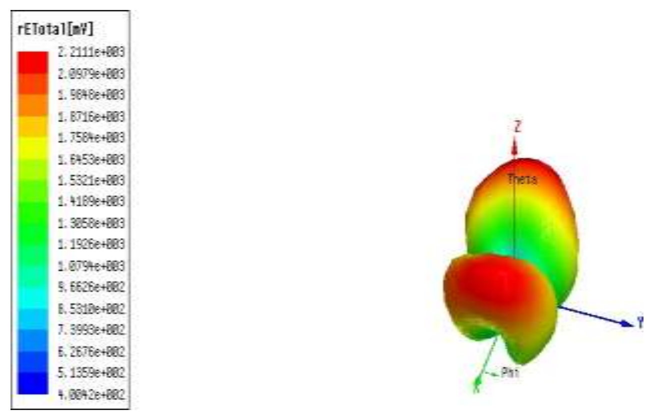

Fig 5-E-field distribution

Similarly, the gain of designed antenna is shown in Fig 6,

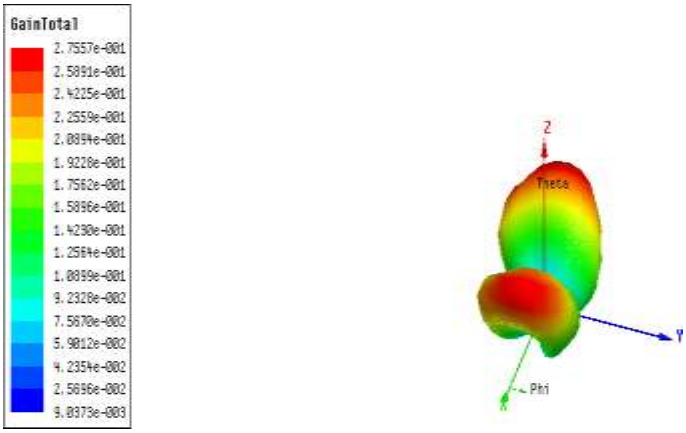

Fig 6 -Gain of Antenna

3. e. DIRECTIVITY

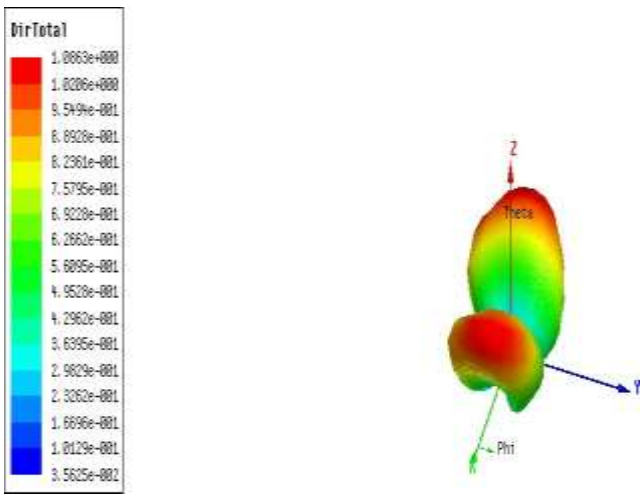

Fig 7-Directivity of Antenna

Antenna gain is defined as antennal direction times a radiation efficiency factor. Radiation output is usually greater than 100 percent so that the antenna gain is always greater than the direction of the antenna. The average level of radiation is equal to the total antenna-divided with radiating power of 4π. If the direction is not specified it implies the direction of the peak intensity of the radiation. The non-isotropic source's directivity is equal to the ratio of its radiation intensity in a given direction to an isotropic source's.

4. CONCLUSION

In this paper, MIMO is documented using plus- patch antenna array. HFSS simulator is used to simulate possible antenna features. The simulated results reflect enhanced antenna efficiency. The simulated result shows Bandwidth and Gain and Lower VSWR enhanced MIMO operation. According to the simulation results, reflection coefficient <-12 dB, isolation is better than -15 dB, Frequency band between 9.50-10GHz and at 11GHz.

For resonant frequency of 9.5 GHz an enhanced VSWR of 1.6<2 is achieved. The obtained gain value is 2.2 dB. The proposed antenna can be generally used in modern 5 G communication system like Radar, satellite, X-band applications, due to all of these merits.

REFERENCES

[1] D. Sarkar, K. V. Srivastava, "Compact four-element SRR-loaded dual-band MIMO antenna for WLAN/WiMAX/WiFi/4G-LTE and 5G applications", Electron. Lett., volume. 53, pp. 1623-1624, 2017.
[2] Deepika Sipal, Mahesh P. Abegaonkar, and Shiban Kishen Koul, “Easily Extendable Compact Planar UWB MIMO Antenna Array”, IEEE Antennas and Wireless Propagation Letters, Vol. 16,2017.
[3] Yan-Yan Liu, Zhi-Hong Tu, “Compact Differential Band-Notched Stepped-Slot UWB-MIMO Antenna with Common-Mode Suppression”, IEEE Antennas and Wireless Propagation Letters, 2016.
[4] Ahmed A. Ibrahim, Mahmoud A. Abdalla, John L. Volakis, “4 Elements UWB MIMO Antenna for Wireless Applications”, Antennas and propagation and USNC/URSI National Radio Science Meeting IEEE Symposium, 19 October2017.
[5] X.–L. Liu, Z.–D. Wang, Y.–Z. Yin, J. Ren, and J.–J. Wu, “A Compact Ultra wideband MIMO Antenna Using QSCA for High Isolation”, IEEE Antennas and Wireless Propagation Letters, pp no. 1497 – 1500, vol.13, 17 July2014.
[6] T Vidhyavathi, G S N Raju, M Satyanarayana,N Balasubrahmanyam “Design and Implementation of MIMO Antenna Using Swastika Slot for Wireless Applications 2019 IEEE Students' Conference on Electrical, Electronics and Computer Science (SCEECS).