MULTIBAND MICROSTRIP ANTENNA ARRAY FOR 5G MOBILE COMMUNICATION

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Abstract:

Mobile technology, nowadays is fast developing owing to its large impact on social life. As of now 5G is the latest mobile technology. In order to implement 5G technology, designing of 5G Antenna with good performance is very important, to achieve that a Microstrip patch antenna is chosen as it is having lower fabrication cost and capable of supporting wide bands. In this paper, a microstrip patch antenna array of 4 elements is designed by using microstrip-line feeding. The improved gain, directivity and other parameters are obtained after validating in HFSS tool and overall performance of antenna have been increased.

Index Terms – 5G-Antenna, Directivity, millimeter Wave and HFSS.

I. INTRODUCTION

As wireless communication system has an increase in demand the require antennas apt to be properly designed considering the requisite feature like gain, high speed of information, Range of Frequencies, dimensions of antenna and loss of power in transmission.

Optimum design needs comprise in the values of gain, dimensions with high reduce in efficiency and cost. The emerging technology for 5G requires 5 times the corresponding values of 4G. Including greater data rate, larger Range of Frequencies, system capacity.

Considering greater data rate and minimum latency, the optimum frequencies for 5G operation are 24 GHz, 38 GHz, 72 GHz. With Range of Frequencies of 500 MHz, 1 GHz, 2 GHz respectively. They are highly directional and obstacle sensitive due to narrow beam width they can be used for cellular applications [1]. Many substrates are available but as all substrates dielectric constants are below 10 GHz[4], except Rogers substrate, therefore Rogers substrate is best for millimetre wave. IT is most suitable for UHF (Ultra High Frequencies) because of low dielectric loss and low dispersion [10,11]. Rogers substrate have characteristics of low water absorption, lowest electric loss and low moisture absorption [10,11].

In general, substrate is fixed between ground and the radiator patch. The material for the both sides should be metal. Strip-line feeding is used to obtain 12dB gain which can be achieved through arrays for mobile communication. The centred frequency used is 38GHz which lies in Ka-band(27-40GHz) [11]. In reference paper [12]. work has been done on 38GHz and 54GHz frequency and obtained gain is 12.2 dB and return loss is -13.6 db. In this paper, microstrip patch antenna array is designed and simulated at 38GHz and 54GHz and obtained improved results. Some comparisons between proposed antenna and related work is given in following table 1. In second section, antenna design is explained. In third section, results are discussed and conclusion is given in fourth section.

II. ANTENNA DESIGN

As shown in fig.1, A microstrip patch antenna is designed with substrate Rogers 5880 having dielectric constant of 2.2 with dimensions 6mm x 6.25mm. Height of Rogers substrate is 0.508mm. the dimensions used for ground is same as that of substrate i.e. 6mm x 6.25mm. the dimensions of radiating patch is 2mm x 2mm.

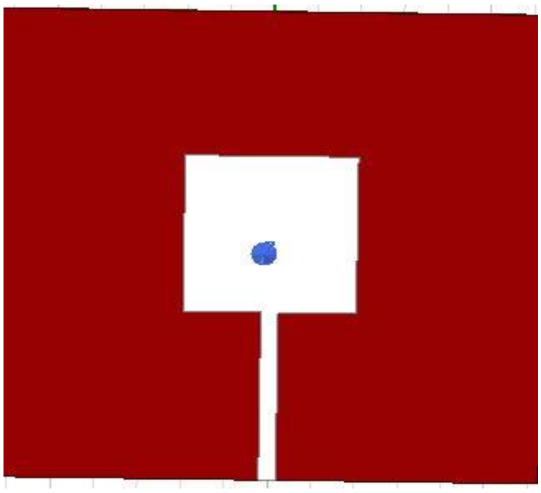

Fig 1. front view of single element radiating patch

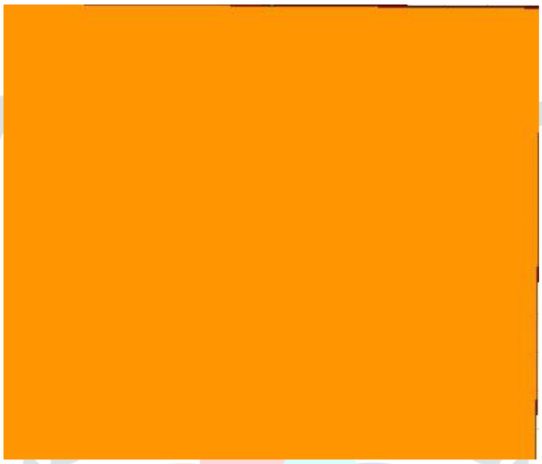

Fig 2. back view (groub)of single element

Design of Antenna Array:

In fig.2, an array of four element antenna is designed in this paper to achieve high gain for mobile communications. The substrate used is Rogers 5880 with dimensions 24mm x 6mm and the height of substrate is 0.508mm. Each radiating patch size is 2mm x 2mm. the distance between adjacent elements of array has a distance of 4mm. The dimensions of ground is same as that of substrate i.e. 24mm x 6mm and microstrip line feeding is given and simulated in HFSS.

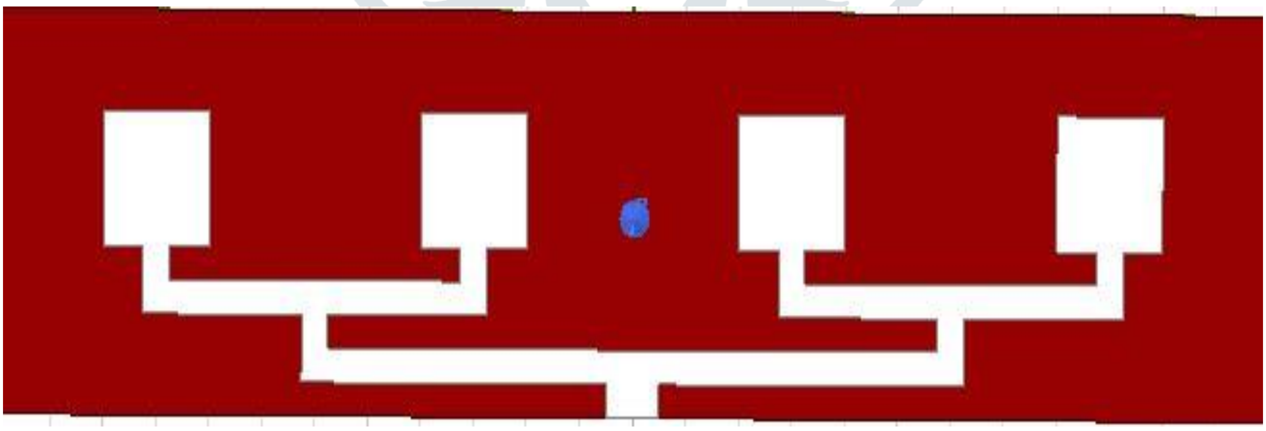

Fig 3. front view of 4 element array

Fig 4. back view (ground) of 4 element array

III. RESULTS:

Return Loss Plot:

S-Parameter shows the input to output relation between ports. The S(1,1) is called the return loss. When the S(1,1) is 0 dB then all power is reflected. If S(1,1) is -10 dB then 3 dB of total power is transferred to the antenna with the loss of -7 dB as reflected power, therefore S(1,1) should be less than -10 dB for antenna to perform effectively. Proposed antenna has a return loss of --18.95dB, -35.77dB and -16.6 dB for 36.7 GHz,44.6GHz and 52.1 GHz respectively.

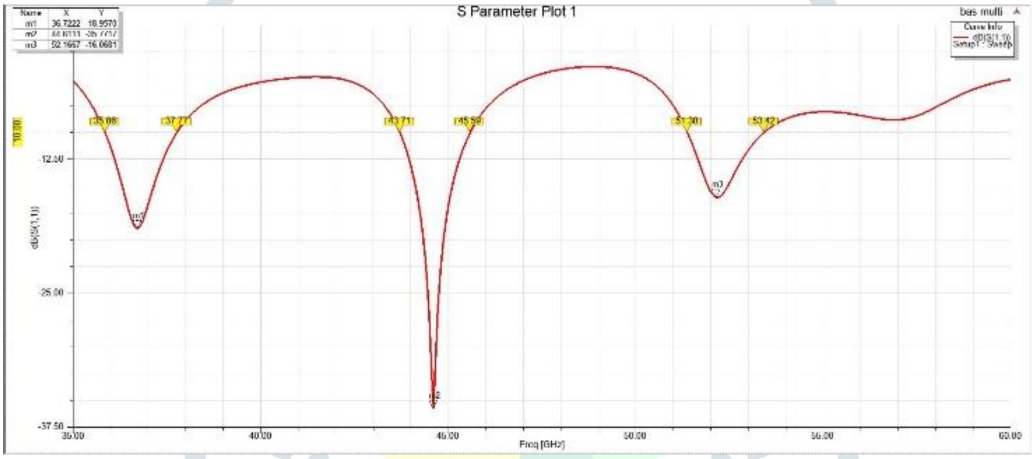

Fig 5. return loss of 4 element array

VSWR (Voltage Standing Wave Ratio):

VSWR is a measure of how effectively the radio frequency power is transmitted from the power source, and then transmission line and to the load. It is almost near to one. It is measured in the ratio of maximum voltage to the minimum voltage. The proposed antenna has a VSWR of 1.92dB, 0.29dB, 2.74dB for the frequencies of 36.7 GHz, 44.6 GHz, 52.1 GHz respectively.

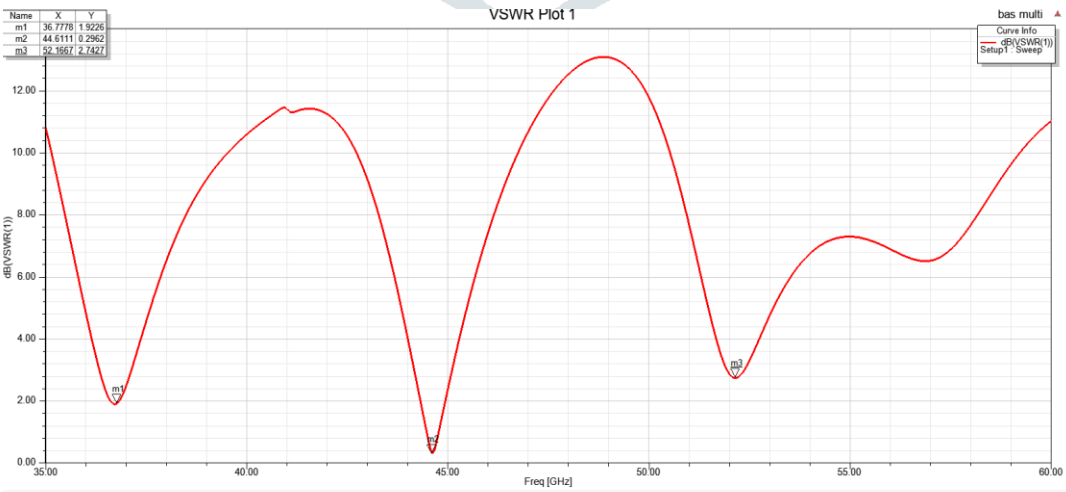

Fig 6. VSWR plot of 4 element array

Gain Plots:

The term antenna gain describes how much power is transmitted in the direction of peak radiation to that of an Isotropic source. In a receiving antenna, the gain describes how well the antenna converts radio waves arriving from a specified direction into electrical power. In a transmitting antenna gain describes how well antenna converts electrical power into the radio waves. Obtained gain is 12.76dB, 10.5 dB and 12.1 dB at resonating frequency 36.6 GHz,44.6 GHz and 52.1 GHz.

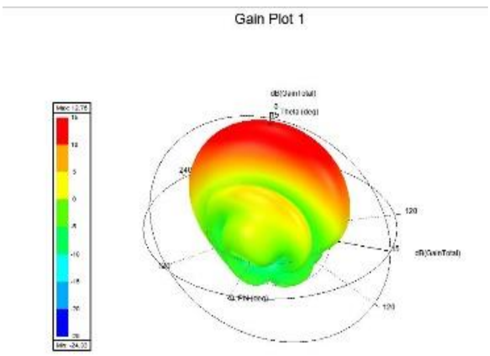

Fig 7. gain plot at resonant frequency of 36.6 GHz

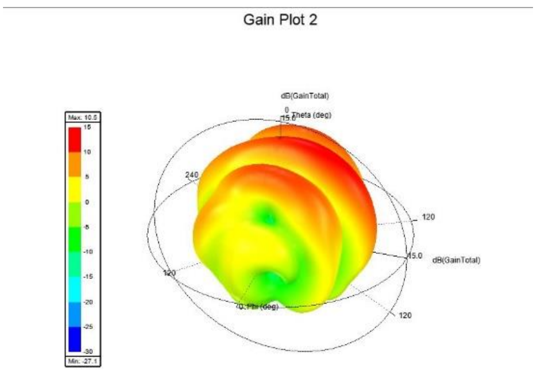

Fig 8. gain plot at resonant frequency of 44.6 GHz

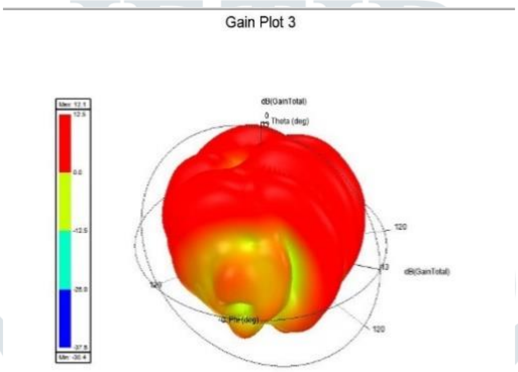

Fig 9. gain plot at resonant frequency of 52.1 GHz

Directivity Plot:

Directivity is a parameter of antenna which measures how effective the directionality of radiation pattern is Obtained directivity is 12.60dB,10.3dB and 11.8dB at resonant frequencies 36.7GHz, 44.6GHz and 52.1GHz.

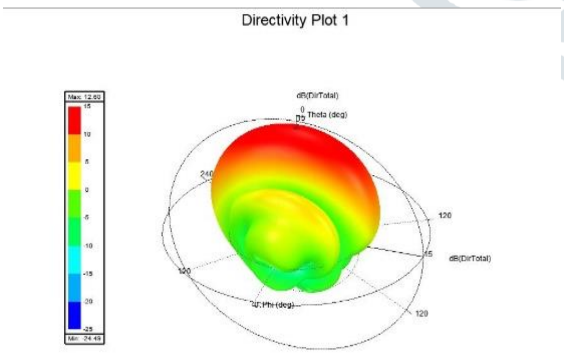

Fig 10. directivity plot at resonant frequency of 36.6 GHz

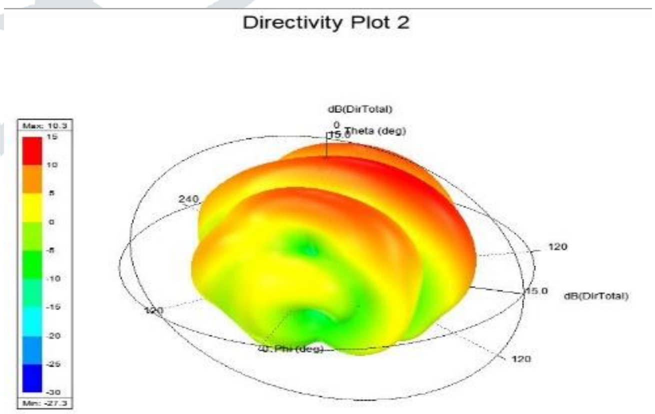

Fig 11. directivity plot at resonant frequency of 44.6 GHz

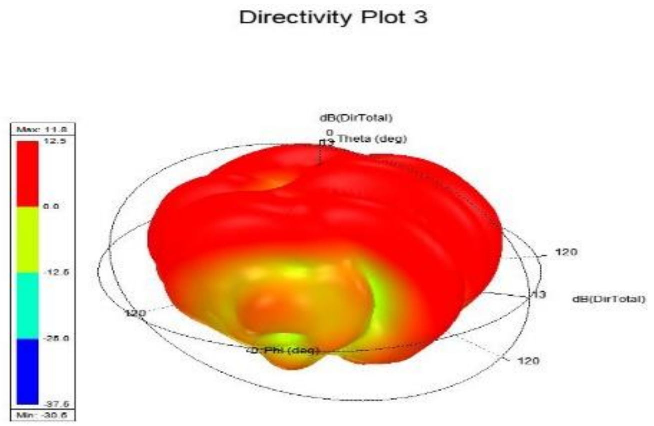

Fig 12. directivity plot at resonant frequency of 52.1 GHz

Table 1 :

Reference paper	Resonant Frequency (GHz)	Return Loss (dB)	Gain (dB)	Directivity (dB)	Bandwidth (GHz)
[12]	38.6,54	-13.6, -18	12.2, 12.1	12.2, 12.4	3.5, 1.3
This work	36.7, 54	-18.95, -16.6	12.76, 12.1	12.6, 11.8	1.91, 2.4

Table 1 shows the comparative results of reference paper [16] and this paper. Gain of antenna at resonant frequency 36.7GHz and 54GHz is 12.76dB and 12.1dB having bandwidth 1.91GHz and 2.4GHz. Return loss is -18.95 and -16.6 at the same resonant frequency.

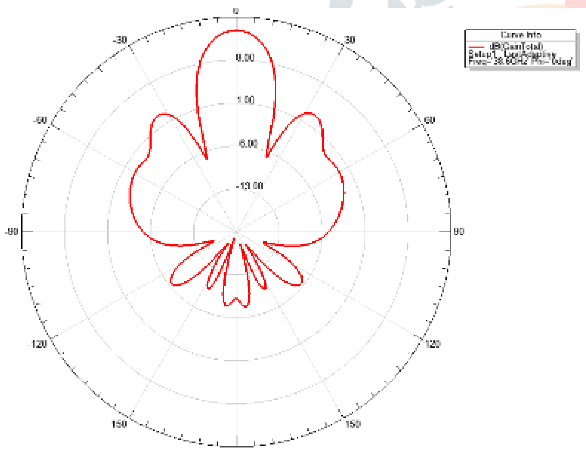

Fig 13. 2D gain plot at frequency of 38.6 GHz

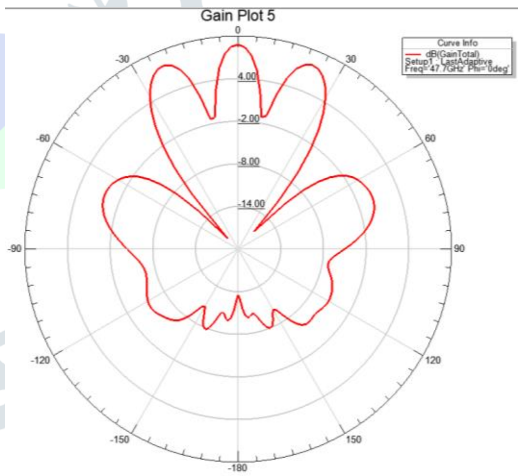

Fig 14. 2D gain plot at frequency of 47.7 GHz

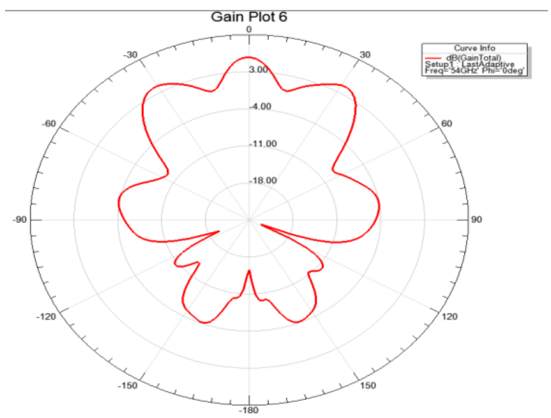

Fig 15. 2D gain plot at frequency of 54 GHz

IV. Conclusion :

In this paper, An Antenna array of four elements taken from the reference paper [12] designed and simulated in CST Microwave Studio having the gain of 12.2 is validated by designing and simulating in ANSOFT ANSYS Electronics Desktop software with an improved gain of 12.76dB and 12.1dB at operating frequencies 36.7GHz and 54GHz as it is simulated in HFSS with Microstrip line feeding. Further, the size of ground can be reduced by using DGS method to get improved results.

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