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Milli meter Wave antenna for 5G Wireless Communication System

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ABSTRACT

This paper proposes a Rectangular Micro strip Patch (RMPA) for future fifth generation (5G) wireless and mobile communication applications.Theantenna is constructed on FR-4 substarte having dimensions of 3.763 ×2.815× 0.02 mm^3 .This antenna is designed and simulated in CST micro wave studio.Simulation results shows that the antenna is resonating at 24.09 GHz with a reflection coefficient (S_{11}) -33.802 and VSWR is 1.04.Furthermore , this antenna is performing well interms of gain , directivity and band width.

1. INTRODUCTION

In the last decade wireless and mobile communications have come across different generations right starting from zeroeth generation (0G) to fourth generation (4G) [1][2].First generation supports only analog voice.Second generation (2G) and third generation(3G) technology evolved to support digital data and high data rate wireless communication. Fourth generation (4G) or LTE and LTE-A is a broad band cellular network technology.It supports mobile web access,IP technology,gaming services,high definition TV(HDTV),video conferencing and 3D television.The major challanges of 4G technolgy even today is high energy consumption,spectrum usage,poor quality of service (QoS),poor coverage ,flexibility and poor inter connectivity[3][4].Variety of digital communication schemes like modulation techniques,packet switching and frequency reuse are used as different generations evolved[5].The challenges of 4G technolgy are deemed to be addressed by 5G systems and expected to be releasedby 2020 and beyond [6].To adress the future challanges some researchers have designed 5G antennas using mm wave frequencies[7][8][9][10].The major difficulty to design a mm wave antenna is the size of the antenna become smaller thus the fabrication process require more laborious effort.

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2. LITERATURE SURVEY

Micro strip antenna is a good choice for wireless communication applications due to its light weight,low cost,easy to transform into arrays and can be easily adopted to desired shape.Further they can be easily fed in different ways like co-axiale cable and micro strip lines [11]. N.N.daud et al [11] have designed a slotted micro strip patch antenna for 5G wireless communication system.Adjusting slot width and size they were succeded to resonate the antenna at 24.25 GHz and 38 GHz.The gain of the antenna is 7.23 dGi at 24.25 Ghz and 3.69 dBi at 38 Ghz but impedance band width is poor .N.Kumar Reddyet al [12] have designed an elliptical inset fed micro strip patc natenna at 28 Ghz on FR-4 substate for wireless communications.In their work they have designed antenna in different shapes to meet the expected reflection co efficient (S_{11}) and impedance band width . Mohamed BE et al [13] ave designed an inset fed rectangular micro strip antenna at 28 GHz for 5G wireless communication syste.In their work they have desigend an arary of 2×1 and 4×1 antennas to enhance antenna performnce.Using single antenna they have obtained 6.92 dBi gain .But when used an array of 2×1 and 4×1 antenna the gainis raised to 9.52 dBi and 11.23 dBi.

3. RESEARCH METHOD

In this work paper [11] is staken as reference and is implemented with the same specifications as mentioned .Its performence is compared with the proposed antenna.The proposed antenna is desigend on FR-4 substrate with a thickness of 0.3836 mm with $\varepsilon_r = 4.4$.The ground plane and patch are developed using perfect electric conductor (PEC) material.The antenna is fed by discrete port instead of inset fed as used in [11].Antenna performence is estimeated at different feed locations based on error and correction method .Better performance is obtained at a feed position of (X_f,Y_f) $(-1.7\ ,\ 1.7)$.The reference antenna is designed to operate at two ferquencies at the expence of gain ,directivity and band width.The proposed antenna is mainly focussed to operate at a single frequency with improved gain ,directivity and band width.

Table 1: Antenna specifications

parameter	Reference antenna	Proposed Antenna
Frequency	24.25GHz	24.25GHz
Ground plane dimension $(W \times L \times h)mm$	6.887 × 4.630 × 0.02	5.9146 × 4.96 × 0.02
Substrate height mm	0.787	0.3586
Substrate material	RTRogers5880	FR-4 lossy
Relative permitivity	2.2	4.4
Patch dimension $(W \times L \times\ h)mm$	4.6 x 3.6 x0.035	3.763 ×2.815 × 0.02

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4. RESULTS AND ANALYSIS

Both the antennas are designed and simulated in CSt micro wave studio .from figure 1 and figure 2 it is observed that the proposed antenna is resonating at 24.09 Ghz and the reference antenna is resonating at 23.85 Ghz.The reflection co efficient (S_{11}) of proposed and reference antenna is -33.802 and -23.517.Impedance band width of proposed antenna and reference antenna is 2.56 GHz and 0.581 GHz.Proposed antennas impedance band width is almost 5 times to referenec antenna. From figure 3 and figure 4 it is obvious that the VSWR value of proposed antenna is better than reference antenna . From figure 5,6,7,8,9,10,11 and figure 12 it is observed that the reference is showing far better performance than the proposed antenna in terms of electric field ,magnetic field, surface current and power .

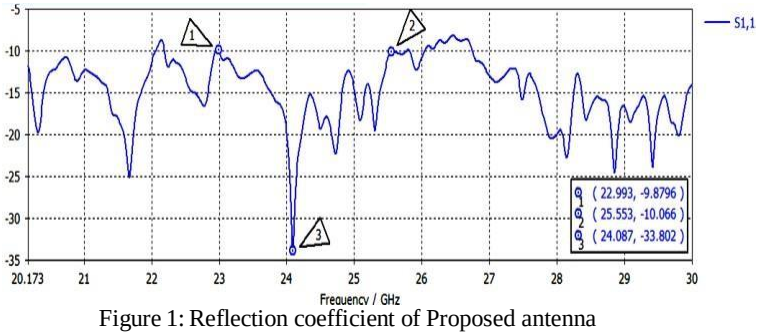

Figure 1: Reflection coefficient of Proposed antenna

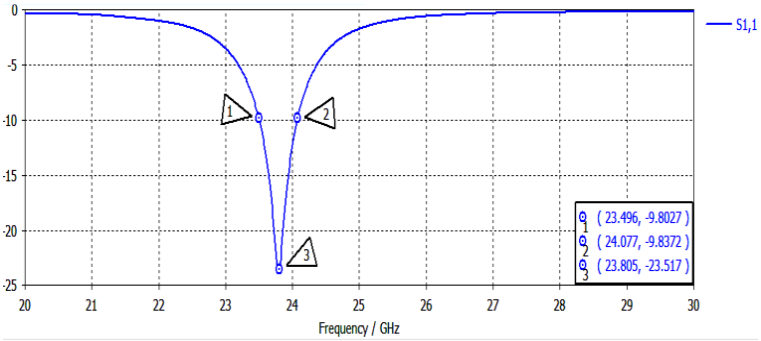

Figure 2: Reflection coefficient of Proposed antenna

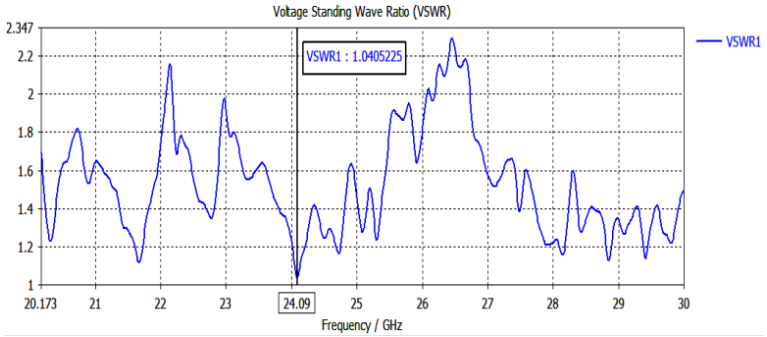

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Figure 3: VSWR of Proposed antenna

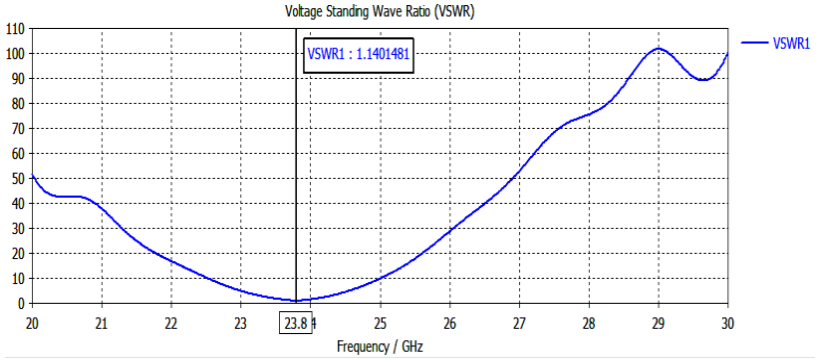

Figure 4: VSWR of reference antenna

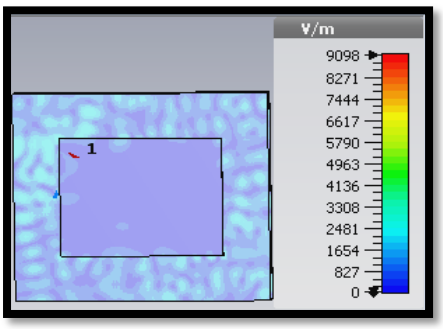

Figure 5: Electric field of proposed antenna

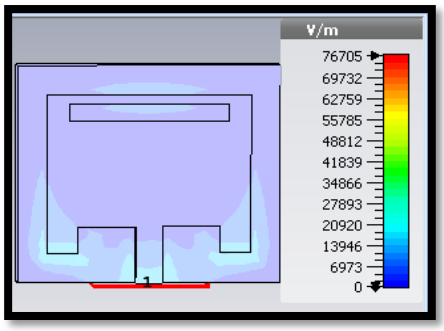

Figure 6: Electric field of reference antenna

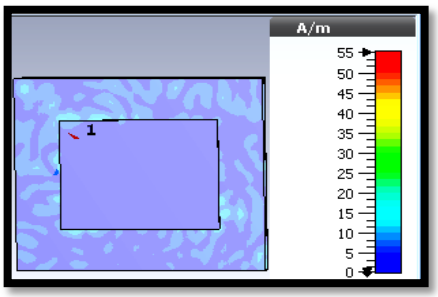

Figure 7: Magnetic field of proposed antenna

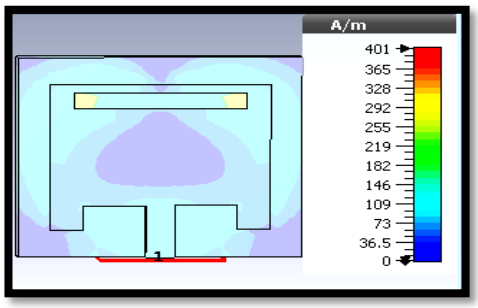

Figure 8:Magnetic field of reference antenna

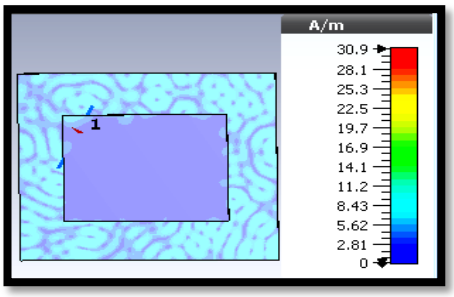

Figure 9: Surface current of proposed antenna

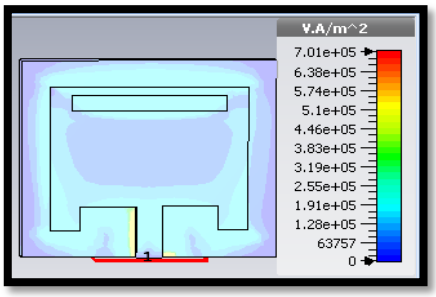

Figure 10: surface current of reference antenna

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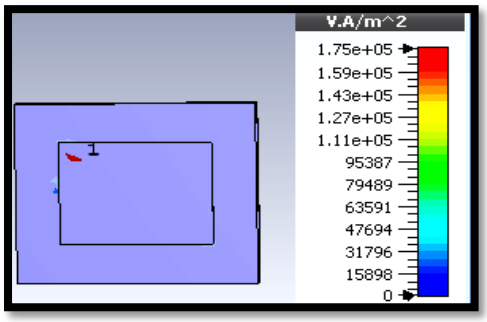

Figure 11: Power of proposed antenna

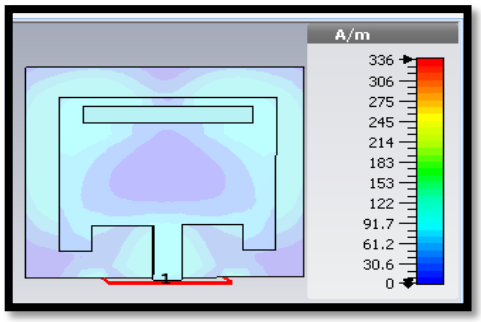

Figure 12: Power of reference antenna

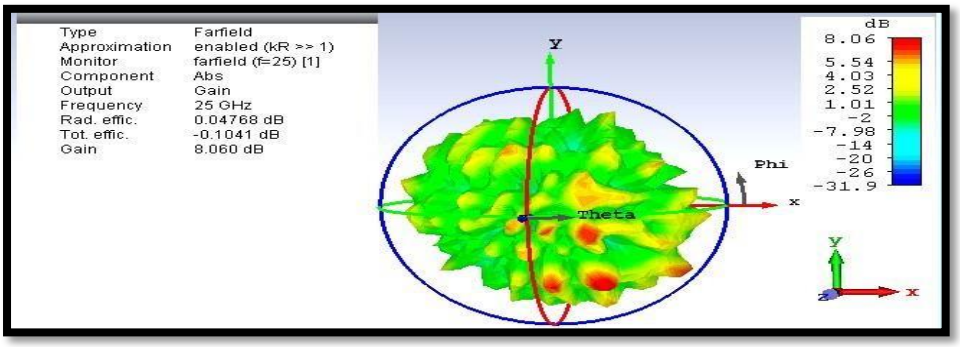

Figure 13: Gain of the proposed antenna

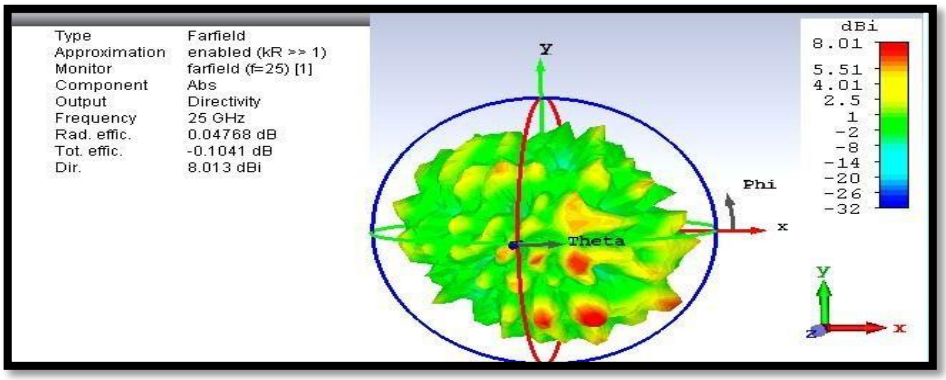

Figure 14: directivity of the proposed antenna

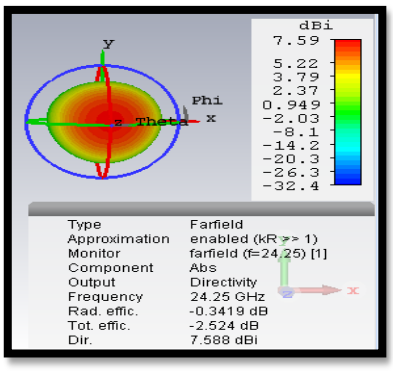

Figure 15: Directivity of reference antenna

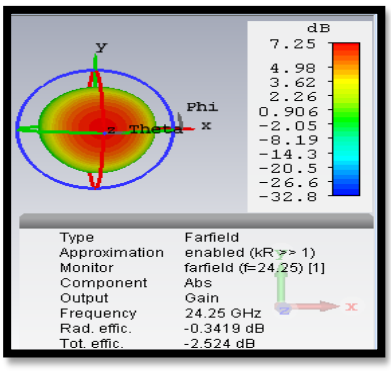

Figure 16: Gain of reference antenna

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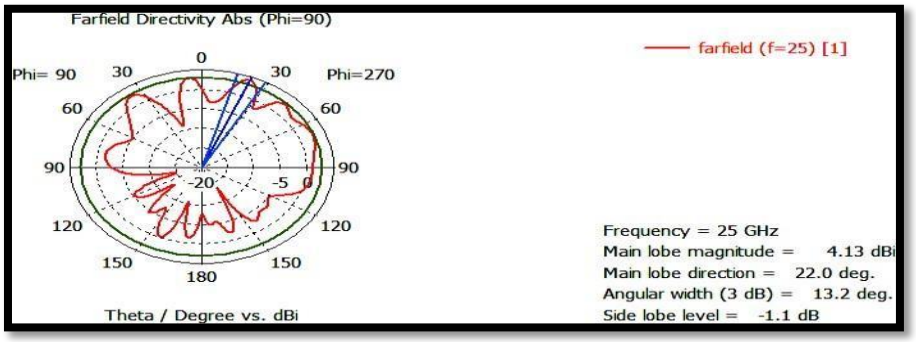

Figure 17: Far field of proposed antenna

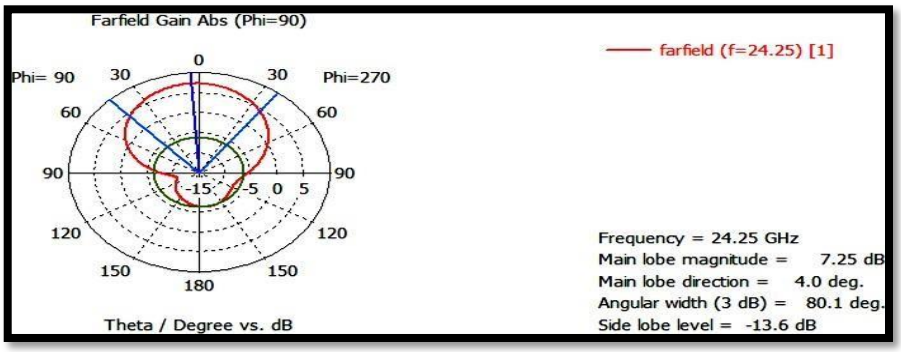

Figure 18: far field of reference antenna

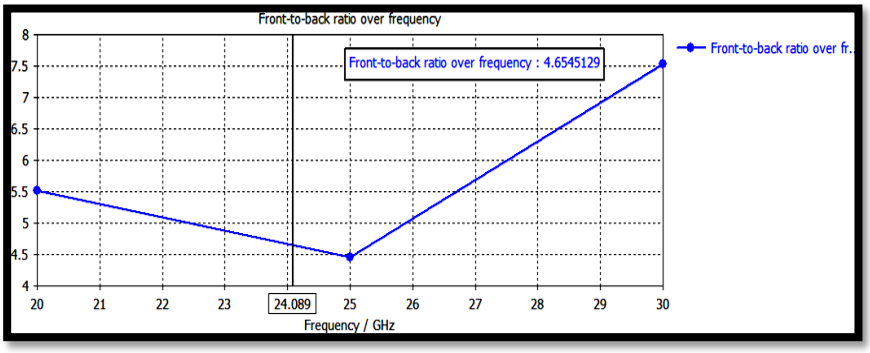

Figure 19: FBR of proposed antenna

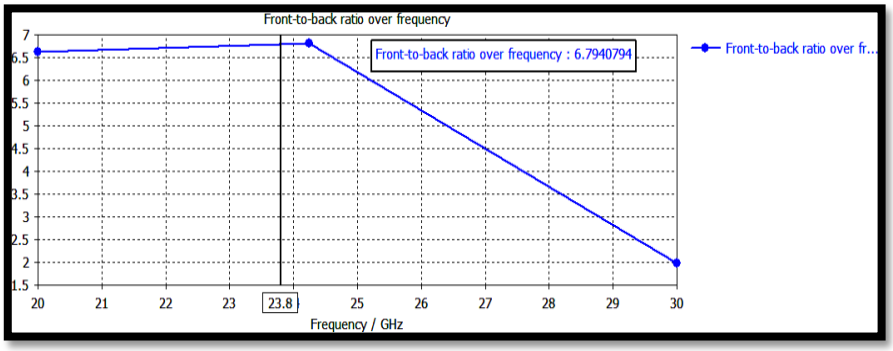

Figure 20: FBR of reference antenna

From figure 13 ,14,15 and figure 16 it is clear that the gain and directivity of proposed antenna is 0.81 dB and 0.425 dBi more than reference antenna. The high gain proposed antenna provides a large coverage area for data exchange .So proposed antenna can be used in air craft , space craft, satellites, missiles, rockets, cars and even in hand held mobile phones .Figure 19 and figure 20 indicates that the reference antenna has more front to back ratio than proposed antenna.

Table 2: Performance comparison of reference and proposed antenna

parameter	Reference antenna	Proposed antenna
S_{11}	-23.517	-33.802
VSWR	1.14	1.04
Electric field V/m	76705	9098
Magnetic Field A/m	401	55
Surface Current A/m	336	30.9
Power V.A/m^2	7.01e+05	1.75e+05
Gain dB	7.246	8.06
Directivity dBi	7.588	8.013
Impedance band Width GHz	0.581	2.56
FBR	6.79	4.64

Table 2 indicates that the proposed antenna is showing better performance in terms of reflection co efficient, VSWR, band width, gain and directivity. But the reference is antenna is showing better performance in terms of electric field , magnetic field, surface current , power and front to back ratio.

5. CONCLUSION

A milli meter wave antenna is designed at 24.25 GHz for 5G wireless communication system .This antenna shows better performance than reference antenna in terms of gain ,directivity and band width to cover all the requirement of 5G.The proposed antenna has good performance in relation to reflection co efficient and VSWR. Gain ,directivity and band width of the antenna can be further improved by designing array antennas.

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