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Design of Millimeter Wave Micro Strip Patch Antenna for 5G Mobile Application

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Abstract*—This paper present the design and simulation of a single band micro strip patch antenna for 5G wireless application operating at 60GHz with a maximum reflection coefficient of -41.648731dB,a very wide bandwidth of 30GHz and a gain of 8.82dB.The transmission line of the antenna used is an inset feed. The substrate used is Rogers RT5880 which has a dielectric constant of 2.2, loss tangent 0.0009, and height 1.6mm.The antenna dimensions were calculated and simulated results have been displayed and analyzed using CST software.

Keywords—millimeter-wave, 5G, u slot and H slot, microstrip, 60GHz

I. INTRODUCTION

Today and in the recent future, to fulfill the presumptions and challenges of the near future, the wireless based networks of today will have to advance in various ways. The 5G technology uses a higher frequency range of 28-72 propose by FCC on October 22nd 2015 as the FCC 15138 rule, which is able to deliver a high data of multi-Gbp and will be able to support as much as 1000x by 2030.With the competence of 5G,a lot of industries will be enhanced such as Artificial intelligence, and the Internet of Things (IoT) that is fueling a need for massive connectivity of devices, and also a need for ultra-reliable, ultra-low-latency connectivity over Internet Protocol (IP).

In this paper, the propose single patch antenna is designed to resonate at 60GHz millimeter wave frequency.The patch is design using the substrate Roger RT5880 with a dielectric constant of 2.2,thickness of 0.254mm with 3.5mm × 2.9mm as the dimension of the patch. The design antenna uses the 50Ω microstrip line feeding and simulated by the CST software.

II. MATERIALS AND METHODS

The proposed micro strip patch antenna operating at 60GHz for 5G is shown in Figure 1

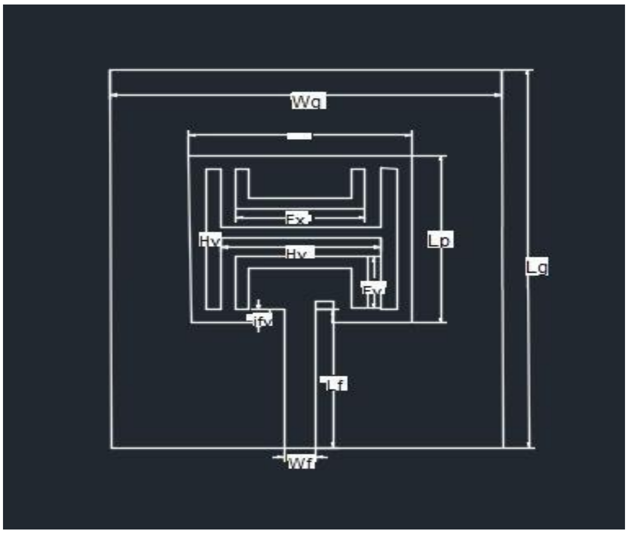

Figure 1: Proposed Micro strip Patch Antenna

TABLE I. Dimension of proposed antenna

Parameter	**Dimension (mm)**
wg	8
lg	7.5
Wp	3.5
Lp	2.9
Wf	0.41
Lf	2.15
Ifx	0.2
Ify	0.2
Hx	2.4
Hy	2.5
Ex	1.5
Ey	1.35
D	0.3

The copper plate with dimensions of 8mm x 7.5mm and thickness of 0.003 mm is used as the ground plane. The H and U slot cut on the patch help to enhance the impedance bandwidth, the length and width is 1.5 mm and 1.35 mm. The feed lines have a length and width of 0.41mm and 3.25 mm. The single band antenna has been designed at work 60 GHz millimeter wave frequency.

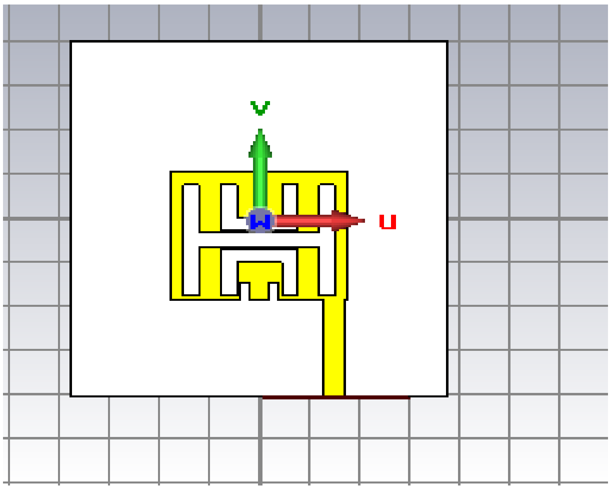

Figure2: The Simulated Micro Strip Patch Antenna

III. RESULTS AND DISCUSSIONS

The antenna was modeled and simulated using CST Microwave commercial software programs and each layer of the proposed design was assigned with its respective physical and electrical properties. The result of the return loss, VSWR (Voltage Standing Wave Ratio), gain and the radiation pattern of the single patch element obtained is shown in Figure 3 - 7. The S11 parameters were obtained to be -41.65 dB taken as the base value which is favorable for mobile communication. The single patch resonates at 60 GHz with a return loss of -41.65 dB as seen in Figure 3 below. The acceptable level of VSWR for wireless application should be less than 2 and as seen in Figure 4, the VSWR of the single patch antenna is 1.8 The antenna achieved a high gain of 8.82 dB which is considered excellent in terms of a compact micro strip patch antenna as shown in Figure 4. The radiation pattern at phi=0° and theta = 90 is presented in Figure 5 and 6. An omnidirectional pattern of the proposed antenna is seen with a small back lobe.

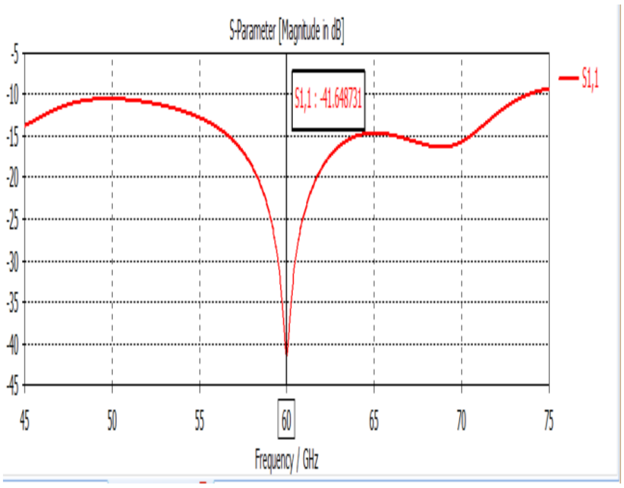

Figure 3: Return Loss

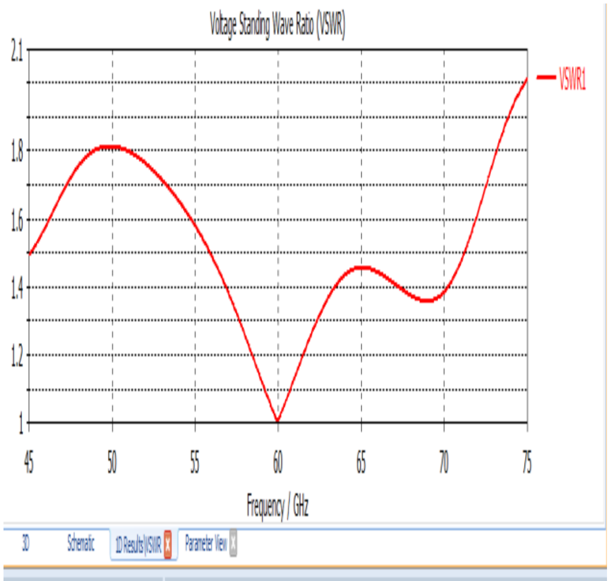

Figure. 4: VSWR curve of proposed antenna

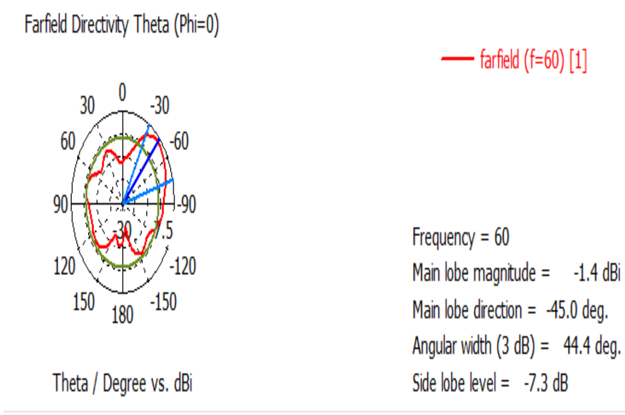

Figure 5: Radiation Pattern

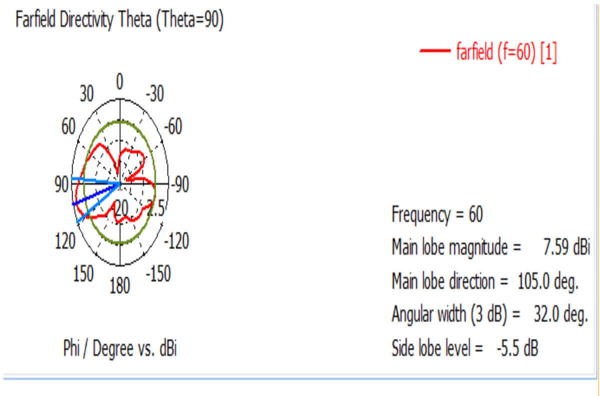

Figure 6: Radiation Pattern at 90

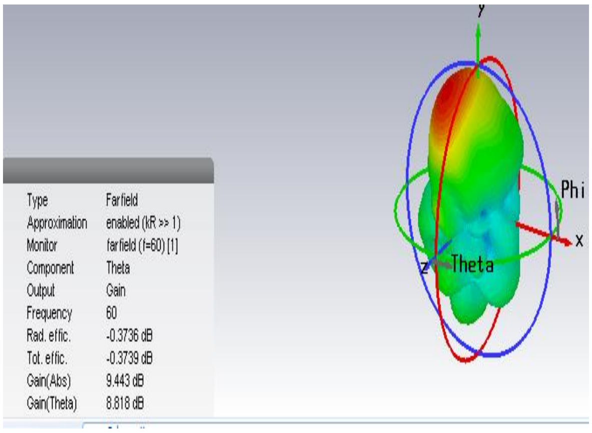

Figure 7: 3D Display of antenna gain

The summary of result is shown in Table 2 below. The obtained parameters shows that the proposed antenna is a suitable for 5G mobile communication.

Table 2: Summary of Results

Antenna parameter	S11 parameter	VSWR	Realized Gain	bandwidth
Specification Detail	60 GHz at -41.65 dB	1.8	8.82 dB	30 GHz

IV. CONCLUSION

In this paper, a rectangular micro strip patch antenna has been proposed for 5G wireless communication. The antenna resonates at 60 GHz with a return loss of -41.65 dB. The achieved gain of the antenna is 8.84 dB and the radiation pattern is omnidirectional. The integration of the antenna can be done in devices where space is a major concern and can be used in future 5G wireless devices.

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