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DESIGN OF PATCH ARRAY ANTENNA FOR 5G COMMUNICATIONS

[1]Ganugapanta sravan reddy, [2]CH.Ravindra naidu, [3]D.Kishore, [4]G.Madhuri

[1]Student, [2] Student, [3] Student, [4] Student,
[1]Department of Electronics and Communication Engineering,
[1]R. V. R. & J. C. College of Engineering, Guntur, India.

Abstract : In today's modern world, antenna plays a vibrant part in the development of wireless communication technology. The compact size, high bandwidth and efficiency of the Microstrip patch antenna make it preferable in favour of wireless communication modules. In recent times, 5G has been the strongest examined region for many researchers due to its high data rate. Moreover, the frequency bands used for 2G, 3G, and 4G communications have become overcrowded, and also the internet traffic and demand for high data rates are increasing day by day, hence 5G would be more suitable for the users to accommodate their wide band and broadband needs. For 5G communications requires high gain this cannot be provided by MIMO antennas so we use this array antennas for high gain. The proposed work involves designing a Micro-strip patch array antenna that uses a spectrum that has been set aside by the FCC for 5G communications. This work uses the corporate feed approach to design a high gain 1 × 4 linear antenna array at 37 GHz employing microstrip patch elements and Roggers/RT duroid 5880 as the substrate using CST Studio Suite software. When designed, the suggested antenna has a gain of 13 dBi. The proposed antennas will be simulated and their results like Gain, S-Parameters will be observed**.**

***Keywords* - 5G, Gain, Directivity, S-Parameters, millimeter-wave.**

I. Introduction

The area of wireless communication has advanced remarkably during the last several years. The current frequency bands are becoming congested due to the rise in user frequency, making allocation more difficult. Current cellular networks are at capacity, and there is a rising daily need for greater data rates, wide coverage, low latency, high dependability, and quicker speed. As a result, a move to the upcoming generation of technology is necessary.

The term "5G millimeter-wave" (mm-wave) technology is still undefined; instead, it is used to describe the combination of many methods, situations, and instances [1]. In order to reach greater data rates and bandwidths, this technology will make advantage of the unutilized millimeter waves spectrum, which is located between 30 and 300 GHz. The next generation's use of higher frequencies will cause free space path loss, indicating that atmospheric losses have a significant impact on higher frequencies [2,3,4]. This indicates that air attenuation is severely affecting higher frequencies. A technique with a high gain with a narrow beam radiation pattern formed by antenna is employed to decrease path losses at higher frequencies [5,6,7]. Thus, there is a requirement. Due to spectrum limitation in the conventional microwave bands, additional spectrum band has been determined within mm-wave band for 5G.The antenna must at least have a gain of around 12 dBi to meet 5G requirements but if we try to improve the gain of the MIMO antenna the design complexity increases[13]. So we use this linear array antennas to produce that gain. For 5G communication systems, a number of mmwave planar antenna layouts have been suggested in the literature. This work presents a microstrip array antenna on a Rogers RT/duroid 5880 substrate. Corporate feeding methodology will be the feeding method employed. The antenna that is suggested in this study operates in the 37 GHz frequency region because it provides high gain and date rates.

II. SINGLE ELEMENT DESIGN AND ANALYSIS.

2.1 ANTENNA DIMENSIONS

The suggested antenna's total dimensions are 6 x 5.4 mm2. The antenna is printed on a 0.11 mm-thick Rogers RT5880 (lossy) substrate material. The patch is 3.2 x 2.7 mm in size and is composed of annealed copper with a thickness of 0.035 mm. On the other hand, the ground is likewise composed of annealed copper, measuring 6 x 5.4 mm. The width of the microstrip feed is 0.31 mm. The single patch layout and dimensions are shown in the Fig. 1 and Table I.

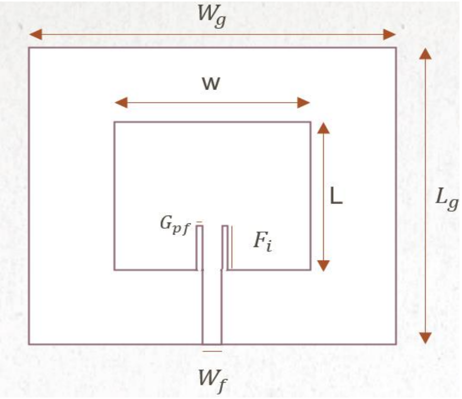


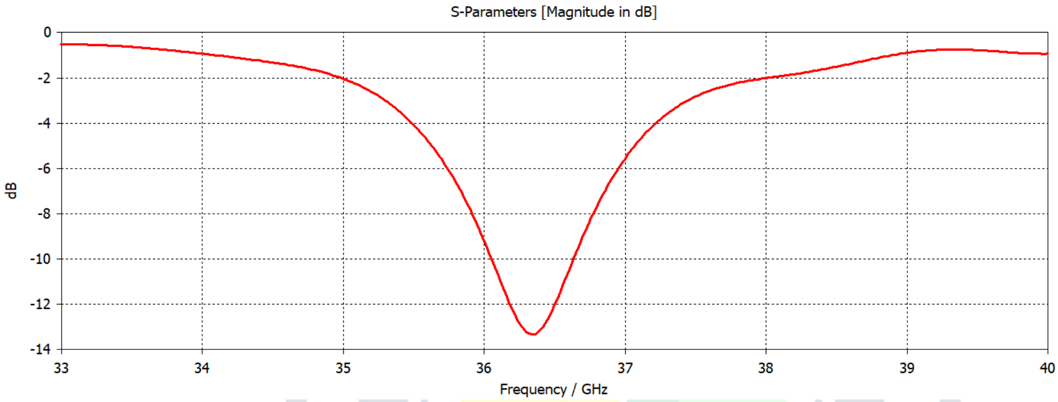
Fig. 1. Single element layout

TABLE I

PARAMETERS	DESIGN VALUES	PARAMETERS	DESIGN VALUES
Substrate height (h)	0.108 mm	Inset feed length (F_i)	0.81 mm
Width (W)	3.2 mm	Feed line width (W_f)	0.31 mm
Actual length (L)	2.7 mm	Gap (G_{pf})	0.088 mm
Width of ground (W_g)	6 mm	Thickness (patch and ground)	0.035 mm
Length of ground (L_g)	5.4 mm		

2.2 REFLECTION COEFFICIENT (S-Parameters)

Fig. 2 represents the s-parameter plot (simulated) of a single element. From the plot, it is evident antenna is resonating at 36.4 GHz. The bandwidth is with in the range stated by FCC.



. Fig. 2. Simulated return loss (S-Parameter)

2.3 REALIZED GAIN AND DIRECTIVITY

At the resonance frequency, the suggested and its directivity is 8.024 dBi and antenna's gain is 7.192 dBi Figures 3 and 4, respectively, display the three-dimensional graph of achieved gain and directivity.

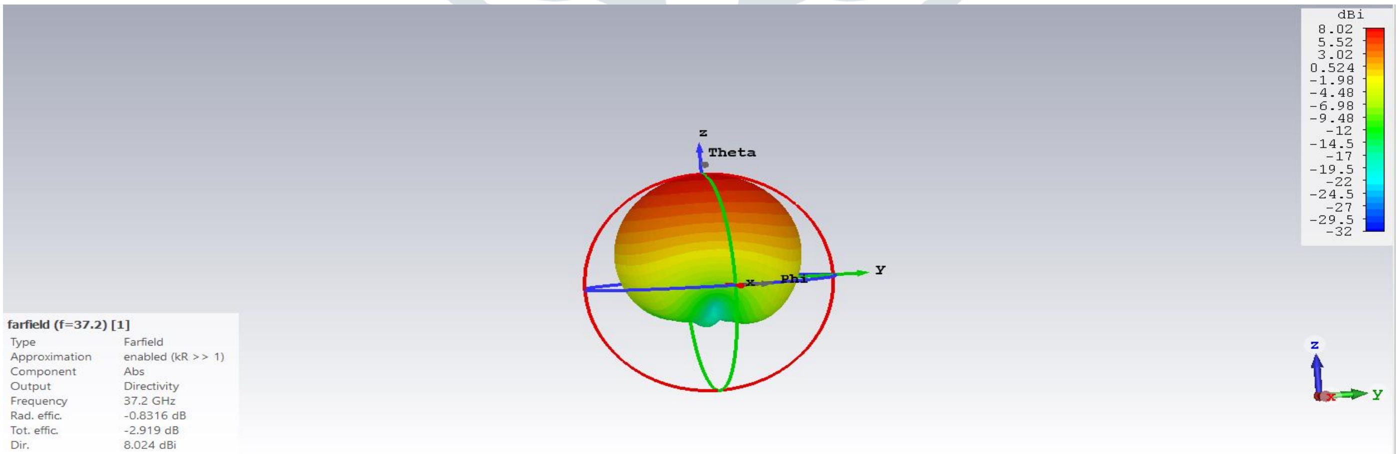


Fig. 3. Directivity

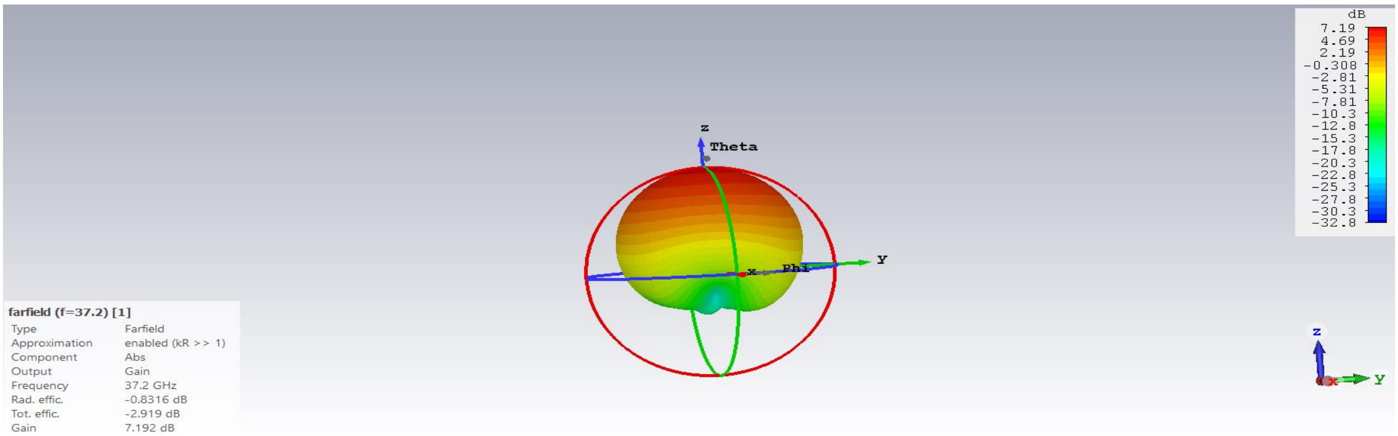


Fig. 4. Gain

III. ANTENNA ARRAY DESIGN AND ANALYSIS

3.1 FEEDING DIMENSIONS

Here the array antenna was designed using four antenna elements. Quarter wave microstrip transformer wires attached to the patch provide power to the individual elements of the microstrip patch array. The patch components are fed by these quarter wave transformers, which match the patch input impedance to an impedance that can be effectively achieved with microstrip lines.

The feed lines for this particular single-layer microstrip array are printed on the same side of the substrate as the patch components, and it is supplied by a corporate network. This antenna has a single feed point that supplies power to all four of its co-polarized patches. To lessen mismatch brought on by reflections from discontinuities, mitered sections can be utilized on T-junctions and 90-degree corners. Before every T-junction, quarter wave transformers have been inserted to provide some degree of impedance matching [8,9,10,11].

The antenna's efficiency is limited by parasitic radiation from the feed network, ohmic and dielectric losses in the feed network, and other factors. Some of these loss processes are mitigated by the use of low loss tangent dielectrics. The corporate feed layout and dimensions are shown in the Fig. 5 and Table II.

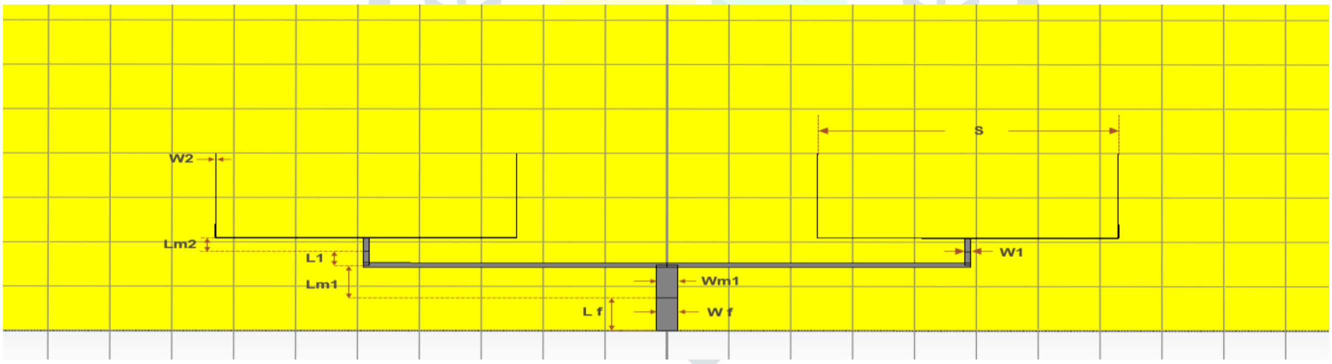


Fig. 5. Corporate feed layout

Table II

LENGTHS	VALUES
S	4.835 mm
Lm1	0.7364 mm
Lm2	0.3038 mm
Wm1	0.3327 mm
L1	0.3038 mm
W1	0.9679 mm
W2	0.0114 mm
Lf	0.7364 mm
Wf	0.3327 mm

3.2 RETURN LOSS OF ARRAY ANTENNA (S-Parameters)

The S-Parameters of the proposed array antenna is show in the Figure. The return loss of array antenna is offering an impedance bandwidth from 36.9 GHz to 37.6 GHz as depicted in Fig 6.

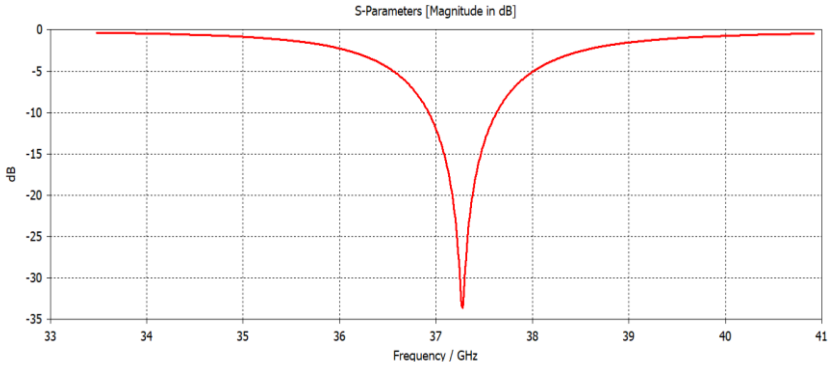


Fig. 6. S_{11} for an array element

3.3 GAIN OF AN ARRAY ANTENNA

The increase in signal-to-noise ratio (SNR) between the array output and the individual channel input is known as an array antenna's gain. The process of combining the signal from N array members coherently and the noise from those same elements incoherently yields array gain. The gain of the array antenna is shown in the Fig.7.

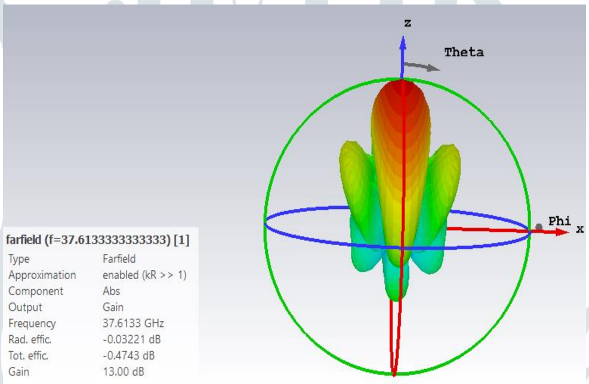


Fig. 7. Gain of an array element.

3.4 DIRECTIVITY OF AN ARRAY ANTENNA

Directivity is a parameter that measures how concentrated an antenna's radiation is in a single direction and directivity of an antenna is defined as the ratio of the radiation intensity in a given direction from the antenna to the radiation intensity averaged over all directions. The directivity of an array element is shown in the Fig. 8.

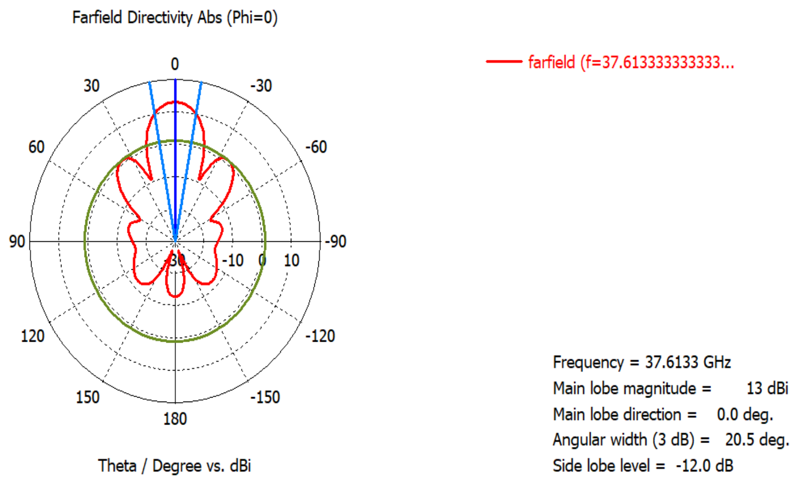


Fig. 8. Directivity of an array element

IV. CONCLUSION

The gain and directivity of the array antenna is about 13 dBi which is suitable for 5G requirements and it also have high data rates. In urban areas, this arrays can be deployed for 5g small cells, where precise coverage and capacity Are essential. The main advantages of this array antennas are low latency, directional coverage where as Some disadvantages are also associated with this like multipath fading. To avoid the effects of multipath fading and obtain high diversity, MIMO (Multiple Input Multiple Output) antennas are utilized. By converting array antennas into MIMO antennas this multipath fading effect will be solved. This hybrid approach can optimize the performance and can produce better results.

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