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High Gain Patch Array Antenna For Future 5G Applications

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Abstract

Fifth generation (5G) is the current trend followed among the world's leading telecommunication companies. The compact designs of antennas made it possible for them to resonate at higher frequencies, thus to enable the devices to attain higher data rate as compared to 4G technology. This project deals with the design of a novel low cost, high gain antenna. The antenna has an array structure which is suitable for 5G cellular applications. It is designed on a low cost Flame resistant (FR4) substrate material. 5G antenna uses bandwidth over 27.5 GHz to 28.5 GHz. This antenna using 6x5 patch array elements on top of the substrate. Use of array elements enhances the gain of the antenna and the same is essential for 5G. Here transmission line feed is used and the power is divided across all the elements equally. The simulation is carried out using HFSS simulation tool. The final design is fabricated and tested using network analyzer for the return loss measurement.

Keywords – Patch antenna, Micro strip antenna, VSWR, Gain, Return loss, HFSS

I. INTRODUCTION

Current remote correspondence innovation is extending quickly because of the expansion in the quantities of clients as far as web use. We have gone over 1G, 2G, 3G and as of late 4G LTE advancements. One of the inciting factors that influence the present remote correspondence is absence of achievable recurrence assets. So to take care of this issue, look into has been begun in 5G remote correspondence at millimetre recurrence band, which extends between 20 GHz to 300 GHz. For the most part the recurrence extend utilized for 5G inquire about are in scope of 24 GHz to 60 GHz. One of the objectives of 5G innovation is to interface a huge number of gadgets together.

This future 5G innovation can be utilized in savvy urban communities, shrewd transportation and apply autonomy. This paper centres on the instance of fix exhibit radio wire to improve addition and transfer speed. It manages how to improve the exhibitions of a rectangular fix receiving wire and a rectangular fix reception apparatus cluster at28 GHz for future 5G applications took care of by a coaxial feed and a smaller scale strip line. The size of the receiving wire is extremely minimal and thus is appropriate for cell phones or the gadgets where the space is a significant issue. Reproduction and enhancement of the proposed receiving wire structure is performed utilizing the re-enactment apparatus called High Frequency Structure Simulator (HFSS). The reception apparatus accomplish an almost Omni-directional radiation design attributes. Regardless of having various points of interest, the radio wire experiences slender data transfer capacity that can be beaten utilizing various methods, for example, utilizing double fix, spaces on ground and emanating patch of the receiving wire and so forth.

II. DESIGN EQUATIONS FOR PATCH ANTENNA

The components of a microstrip patch antenna are a conducting rectangular patchand a ground plane separated by a dielectric substrate given by Fig. 1.

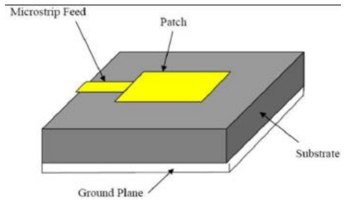

Figure 1 Rectangular patch antenna

A. Patch Width

$$W = \frac{c}{2f}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

w= width of the patch

c = velocity of light (3x10^8 m/s)
f = Resonant frequency (5 GHz)
ε_r = Dielectric constant of substrate

B. Patch Length

$$L = L_{eff} - 2\Delta L$$

L= length of the patch

L_{eff} = Effective length, it is given by

$$L_{eff} = \frac{c}{2f\sqrt{\varepsilon_{reff}}}$$

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

ε_{reff} =Effective dielectric constant

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

C. Substrate Length and Width

L_g =L+6h

W_g =W+6h

$$h = \frac{0.0606\lambda}{\sqrt{\varepsilon_r}}$$

III. PROPOSED MICROSTRIP ANTENNA

The estimations of patches are 2 mm x 2 mm. The substrate utilized is FR4 of thickness 1.6 mm with a rectangular opening cut on it. Unmistakable parameters are considered for building up the reception apparatus, for example, dielectric consistent, thickness of substrate (ts = 1.6 mm) and thunderous recurrence (rf = 28.5 GHz). The total measurements are appeared in figure beneath. The impedance of feed is 50 ohms. In HFSS the lumped port is utilized to energize the receiving wire. Since the receiving wire is of little size to coordinate the impedance of fix and feed line, inset type taking care of is picked for most extreme exchange of intensity.

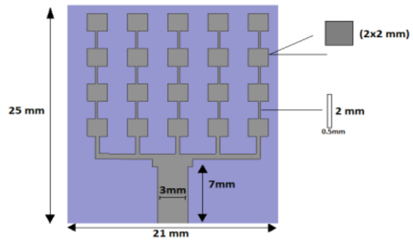

Figure 2 proposed antenna layout

The following table shows the comparison between existing and proposed work

Table 1- Comparison

Parameter	Existing	Proposed
Frequency	26-28.5 GHz	25.1-29.16 GHz
Bandwidth	2.5 GHz	4.06 GHz
Size	102 × 96.5 mm	25 × 21 mm

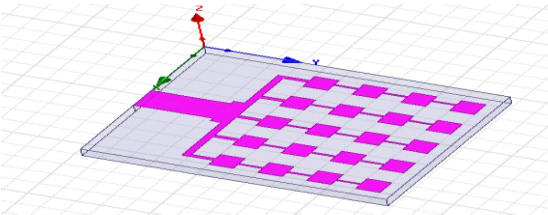

Figure 3 proposed micro strip antenna

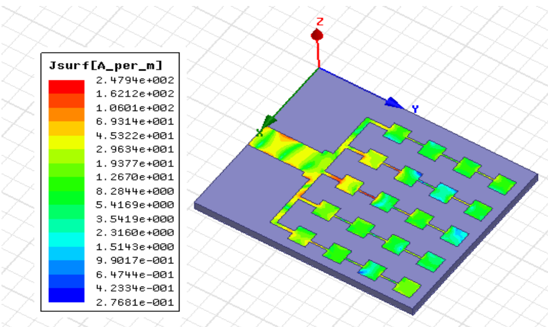

Figure 4 Current distribution in antenna

IV. SIMULATION AND RESULT

The hypothetical parameters of the single rectangular fix were streamlined for the miniaturized scale strip and coaxial feed to meet the prerequisite of the thunderous recurrence at 28 GHz dependent on the upgraded parameters return loss, VSWR, gain and radiation pattern.

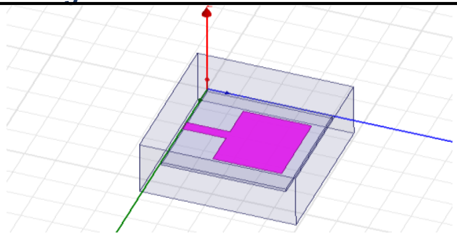

Figure 5: Single patch antenna

A. Return loss

Utilizing wave port design, S11 parameters are gotten as reception apparatus bring return loss. Estimation of - 10dB is taken as the base worth which is viewed as great if there should be an occurrence of portable correspondence. The patch antenna works at proposed band for 5G remote standard. The fix reception apparatus in figure 6 resonates 5.03 GHz with a return loss of - 13.47 dBand covering a band from 3.15 GHz to 5.23 GHz.

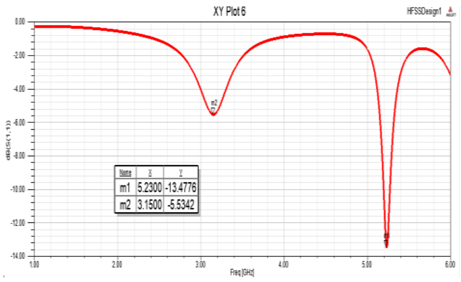

Figure 6: Return loss of patch antenna

Figure 7 shows return loss plot of the proposed micro strip antenna with return loss of - 10.19 dB and covering a band from 25.1 GHz to 29.1 GHz.

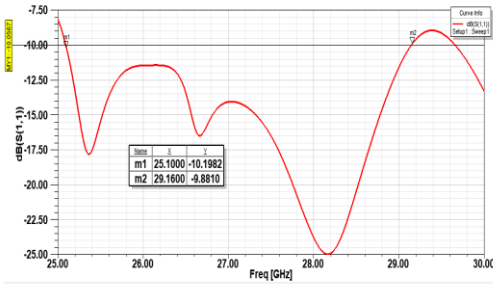

Figure 7:Return loss of proposed antenna

A. VSWR

The Voltage Standing Wave Ratio (VSWR) plot of the antenna is introduced in figure 8. The satisfactory degree of VSWR for the greater part of the wireless applications ought not to be more than 2.5 dB and it ought to be 1 dB in a perfect world. As found in figure 8, the VSWR estimation of fix reception apparatus accomplished at resounding recurrence of 3.16 GHz is 3.24 dB which is adequate for its utilization in 5G applications. The VSWR esteem for proposed antenna (figure 9.) at resonating frequency of 4.42 GHz is 1.42 dB.

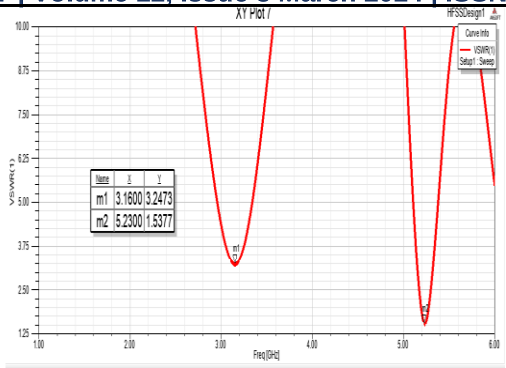

Figure 8:VSWR - patch antenna

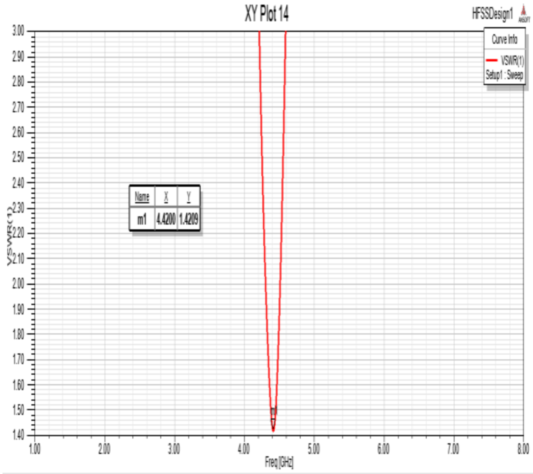

Figure 9:VSWR - array antenna

B. Gain

The 3D gain plot determines the antenna efficiency. The proposed patch antenna achieved moderate gain of 9.56 dB which is considered excellent in terms of a compact antenna design. Figure 10 presents the 3D gain plot for proposed patch antenna. The proposed antenna (figure 11) achieved moderate gain of 9.8 dB at 27.5 GHz and 11.4 dB at 28.5 GHz.

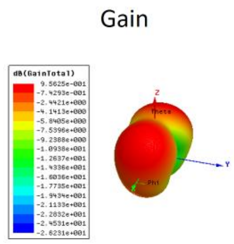

Figure 10: Gain - patch antenna

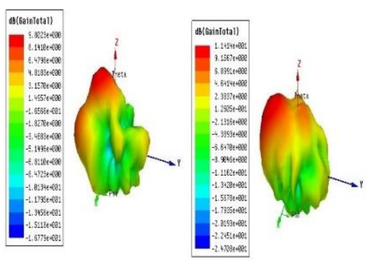

Figure 11: Gain at 27.5, 28.5 GHz

C. **Radiation pattern**

The 2D radiation pattern of the proposed antenna is introduced in figures below. An Omni directional example has been appeared by the proposed antenna which is attractive for 5G correspondence. Figures represent 2D Radiation Pattern of Patch Antenna with phi = 00 and 900. The antenna shows a decent radiation design with great gain. The antenna can be utilized for 5G applications. 5G wireless standard has advanced as another and novel standard for rapid transmission joins. Sooner rather than later different improvements will be seen for 5G standard.

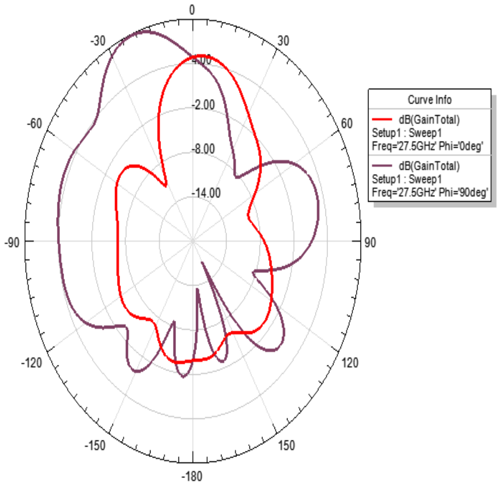

Figure 12: Radiation Pattern at 27.5 GHz

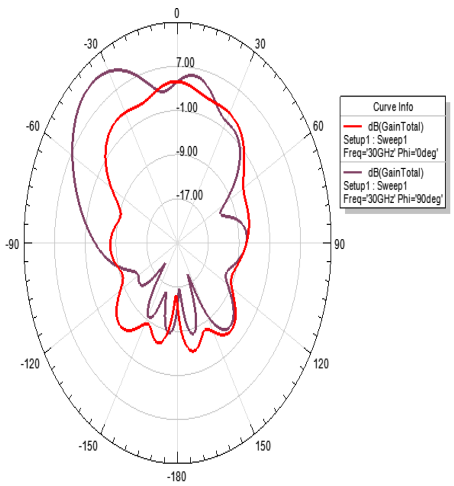

Figure 13: Radiation Pattern at 28.5 GHz

V. CONCLUSION

Right now, smaller miniaturized scale micro strip antenna has been proposed for 5G standard. The gigantic increment in versatile information, innovations are drawing nearer from 4G i.e., fourth era to 5G, fifth era. The proposed antenna resonates somewhere in the range of 25.1GHz and 29.1 GHz with a return loss of -10.19 dB and can be utilized in future 5G wireless gadgets. The proposed micro strip antenna shows great radiation example and great increase of 9.8 dB at 27.5 GHz and 11.4 dB at 28.5 GHz. The structure of the antenna is exceptionally low profile i.e., 25 mm × 21 mm × 1.6 mm and can be effectively incorporated in gadgets where space is a significant issue.

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