IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 17, Issue 5, Ser. I (Sep. – Oct. 2022), PP 11-14
www.iosrjournals.org

Design of Circularly Polarized Circular Patch antenna for 5 G Applications

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Abstract: *In this article a circularly polarized circular microstrip patch antenna is proposed for 28 GHz, 5 G applications. The proposed antenna is designed on RT duroid of relative dielectric constant of 2.2 and height 0.508 mm. Two orthogonal feed lines are used to excite the circular patch, to generate the two orthogonal fields. The various parameters such as return loss, radiation pattern and axial ratio etcof the purposed antenna has been investigated.*

Key Words: *5G, Microstrip Patch Antenna, Circular Polarization*

Date of Submission: 02-09-2022 Date of Acceptance: 15-09-2022

I. Introduction

Although 4G has been implemented and is reaching maturity, a lot of attention is being given to the upcoming 5G communication technology. The majority of research efforts are focused on land communication, especially the linear polarization of the associated antennas. However, satellite communication could be a feature of 5G mobile phones. Urban areas have well-developed terrestrial cellular systems that offer excellent coverage and high-quality telecommunications services. Instantaneous two-way audio, message, and even data communications are available to users so they may share images or view streaming videos. The world's distant places might not all be completely covered by the terrestrial network, nevertheless [1,2].Globally active research has been conducted to advance the fifth-generation (5G) wireless networks. In today's wireless networks, phone, data, and other applications are operated on more than five billion devices that require wireless connections. Due to the availability of smart portable devices that offer broadband wireless applications like multimedia and interactive gaming, the volume of mobile data has increased substantially over time. The creation of small yet effective antennas is necessary for the effective deployment of 5G systems.The development of effective antenna designs for the upcoming 5G, specifically those designed to function in the two 5G-frequency bands: 28 GHz band, has generated a lot of interest in the antenna research community. The substantial propagation loss at millimetre waves owing to air absorption must be considered while designing an antenna for mm-wave 5G. Additionally, mm-wave antennas need to be small in order to fit within mobile devices [3,4]

In order to minimize the spread of the delay in a multipath environment, circularly polarised (CP) antennas are greatly wanted in millimeter-wave mobile communication [5]. For 5G applications in the millimeter-wave range, single band circularly polarised patch antennas have so far been proposed [6,7].

This work proposed a circular microstrip patch antenna for the 28 GHz frequency. The orthogonal feeds are used to excite the antenna and to produce the circular polarization in given frequency bands.

II. Antenna Design

The proposed antenna is constructed on an RT duroid 5880 dielectric substrate with a relative dielectric constant of 2.2. The substrate has a thickness of 0.508millimetres. The dimension of the substrate is 8.75mm X 7.5mm X 0.508 mm. The radius of the patch is calculated for 28 GHz from the following formula.

$$R_c = \frac{K}{\sqrt{1+\frac{2h}{\pi\varepsilon_r K+\left(\ln\left(\frac{\pi K}{2h}\right)+1.7726\right)}}} \quad (1)$$

$$K = \frac{8.791\ X\ 10^3}{f_r\sqrt{\varepsilon_r}} \quad (2)$$

$$R_{ceff} = \frac{1.8412\,C}{2\pi f_r\sqrt{\varepsilon_r}} \quad (3)$$

Where, h is the height of the substrate and C is the speed of light.
The calculated radius of the circular patch is 1.93 mm patch. The width (w)of the feed line is calculated for the 50 ohm impedance from the following formulas.

$$Z_0 = \frac{120\pi}{\sqrt{\varepsilon_{\mathrm{eff}}\left[\frac{w}{h}+1.393+0.667\ln\left(\frac{w}{h}+1.444\right)\right]}} \quad (4)$$

$$\varepsilon_{eff} = \frac{(\varepsilon_r+1)}{2} + \frac{(\varepsilon_r-1)}{2}\left[1+12\frac{h}{w}\right]^{-1/2} \quad (5)$$

Fig. 1 shows the configuration of the proposed antenna.

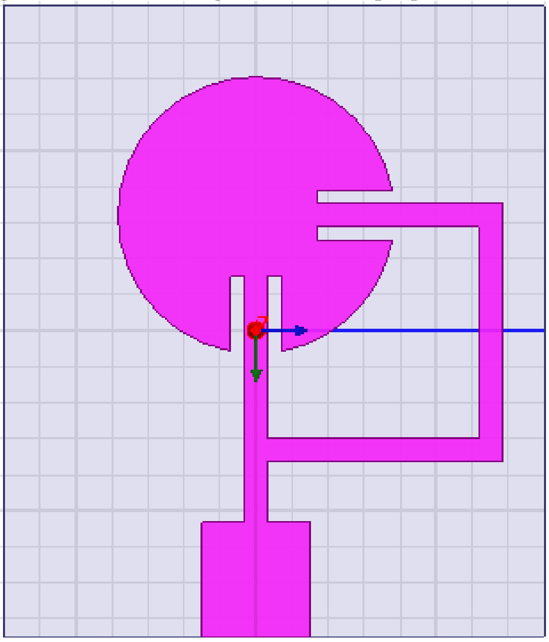

Figure 1. Geometrical Configuration of the proposed antenna

III. Results and Discussions

Fig. 2 shows the return loss curve of the proposed antenna.

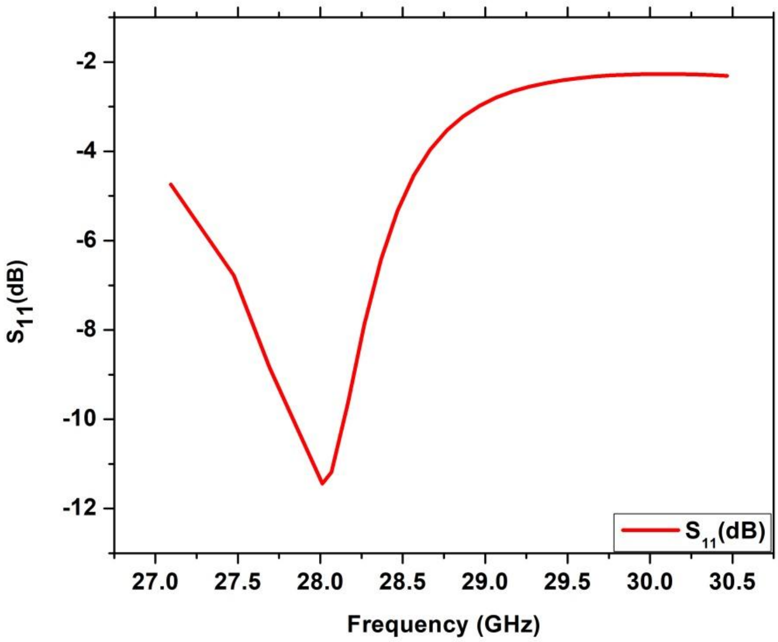

Figure 1. S_{11} vs. frequency curve of the proposed antenna.

The return loss of the proposed antenna is 11.5 dB at the resonant frequency of 28 GHz.

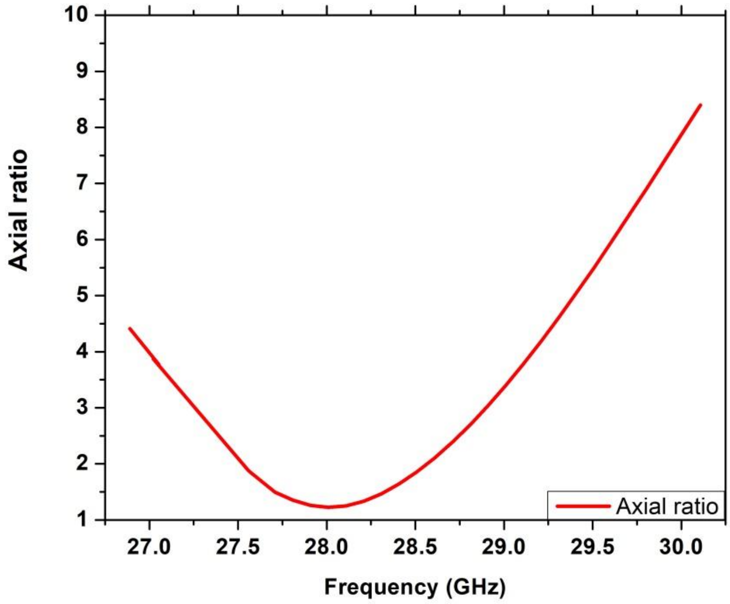

Figure 3. Axial ratio vs frequency curve

The value of axial ratio of the proposed antenna is 1.2 at the 28 GHz , which shows that antenna is circularly polarized. The Figure 4 shows the E-plane and H-plane radiation pattern of proposed antenna at 28 GHz.

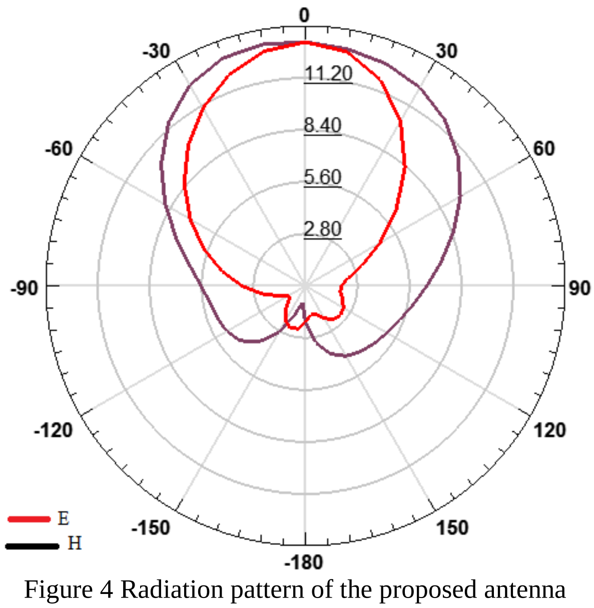

Figure 4 Radiation pattern of the proposed antenna

From the above curve it is shown that the antenna is radiating at the broad side in the resonating frequency.

IV. Conclusions

The circularly polarized micro strip antenna for 5G applications is provided in this work by creating a rectangular slit in the radiating patch. The antenna was simulated using HFSS software on an RT duroid substrate with 2.2 relative dielectric constant, 0.508 mm thickness. As a result, the suggested slotted antenna can function at the necessary band (27.5-28.5 GHz) with good performance, making it suitable for use with the 5G mobile communication system.

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Umesh Chandra, et. al. "Design of Circularly Polarized Circular Patch antenna for 5 G Applications." *IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)* 17(5), (2022): pp 11-14.