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A Wideband Rectangular Patch Antenna For 5 G Communications

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ABSTRACT- Millimeter-wave (mmW) range for 5 G application becomes an attractive area of research. This allows communication at high speed and low latency rates. To meet this requirement, we require an antenna that can resonate at a particular frequency or covers multiband and ultraband. All these requirements are fulfilled by the patch antenna, which is small in size, less in weight, has good bandwidth, with less complexity. In this paper, we design an ultra-band antenna with C shape slot on its patch and one small slot on its ground plane. The resultant band covers frequencies from 25.99 GHz to 40 GHz with a maximum return loss of -20 dB. The presented antenna finds application in 5G mobile communication.

KEYWORDS- Microstrip Antenna, Defective Ground Structure, Bandwidth, Return Loss, VSWR.

I. INTRODUCTION

With the increasing use of cellular phone, the development in wireless communication system increase drastically. This increases the demand of small, compact size antenna with higher gain and large bandwidth. But the design antennas have to face tradeoff between the high gain low loss antenna, to achieve 70 % plus radiation efficiency, transmitting data with higher data rate. These tradeoffs can be overcome by the upcoming 5th Generation (5G), which is five times faster compared to the 4th Generation (4G) technology. It provides high data rate, low cost with large bandwidth [1,15].

On 5G networks, peak speeds are 20 times faster than 4G. An example for clarity: while on a fourth generation device you download one movie in Full HD quality, your 5G neighbor will download from two dozen of the same movies during this time. And even if this is an ideal situation, everything will be about the same under adverse conditions: 5G cellular networks will turn out to be much faster [2,16]. The number of mobile devices that we use for different purposes is growing every day. Smartphones, tablets, laptops, fitness bracelets, game consoles - they all work over mobile networks. The Internet of Things promises difficult times for today's 4G networks : numerous sensors, video cameras and other devices that are actively used in smart technologies also need to be connected to a mobile network. 4G will not cope with such an invasion in the foreseeable future, but 5G is quite. 5G allows you to create up to a million connections per square kilometer, which is an order of magnitude higher than that of the previous generation of networks [3]. 5G networks will be able to work with low-power devices of the Internet of Things. Many microsensors and sensors will serve autonomously for months without changing or recharging the battery. This is important, because providing millions of IoT devices with access to the power grid would be an extremely difficult engineering task, often not solvable at all: it would negate all the advantages of the emergence of the Internet of Things [4, 5].

Millimeter waves provide the basic ground for the 5G wireless communication. These waves cover the frequency band lies between 3GHz to 300 GHz. The work has been performed at different frequencies including 28 GHz, 38 GHz that covers bandwidth around 500 MHz to 1 GHz, which is sufficient for high data rate with low latency rate [6]. Because of their directional features these antenna can be used for mobile applications. In existing research, below 10 GHz, many substrate materials are available except the "Rogers" substrate. Therefore, it is considered as best dielectric material above 10 GHz or millimeter waves. This is used at higher frequencies because of its low loss tangent (2.2) and low dispersion [7, 8].

In this research, we have design microstrip patch antenna for 5 G application having substrate of RT duroide, which was placed between the patch and ground layer. Both top and ground layers are made up of copper material. The excitation to the antenna is provided using microstrip line with inset feed.

II. RELATED WORK

Mungur and Duraikannan [9] have presented patch antenna resonated at 28 GHz frequency, which was used for 5G communication. The antenna has been resonated at 27.91 GHz, having S11 parameters of -12.59 dB, bandwidth (582 MHz), and gain of 6.69 dB. The antenna was excited using inset feed line connected to the top layer of patch. The patch was placed over Rogers RT Duroid 5880 material having dielectric constant of 2.2 and thickness of 0.254 mm.

Lee et al. [10] have presented a dual band millimeter wave resonated patch antenna at 28 and 39 GHz frequencies. At 28

GHz, the bandwidth of 400 MHz and at 39 GHz bandwidth of 720 MHz has been achieved. Here three substrate layers have been used that were excited using proximity feeding approach. To improve the electromagnetic coupling between the lower bands parasitic strips have been used. This had provided better gain with better return loss.

Noor et al. [11] have presented a millimeter based patch antenna used for 5G application. The antenna has designed for 28 GHz frequency. The patch was placed on the top of substrate (FR4) having dielectric constant of 4.4 and thickness of 1.6mm. The antenna was having dimension of 12.884* 11.27 mm2.

Abdelaziz, and Hamad [12] have designed a tri band antenna for 5G millimeter applications. The antenna has been designed on Rogers RT 5880 dielectric substrate having a dimension of 20 × 16.5 ×
0.508 mm3 . DGS has been applied to enhance the performance of antenna in terms of return loss and to obtain wider bandwidth. The antenna was operated at 10, 28, and 38 GHz. For providing isolation between resonated frequencies a pair of T shaped slots are used.

Colaco and Lohani [13] have designed a patch antenna fr 5G application using millimeter band. Rectangular patch, which was placed on the top of substrate having dielectric constant of 2.2 has been used. The simulation has been performed on FEKO software. The parameters such as return loss, gain bandwidth has been examine and analysed to have better performance that need to design an antenna.

Imran et al. [14] have presented a 5G application based patch antenna that was centered at 38 GHz and 54 GHz. The antenna provides bandwidth of 1.94 GHz and 2 GHz respectively. The antenna was manufactured using a Rogers RT5880 (lossy) substrate having dielectric constant of 2.2, with a thickness of 0.508mm. Ground and patch of PEC material having dimension 6* 6.25 mm2 and 2*2 mm2 have been taken.

III. PROPOSED WORK

In this work, we have proposed a 28 GHz microstrip patch antenna, which is designed in CST software. This is a simple type of patch antenna in which the middle part of the patch is cut in U shape as shown in Figure 1.

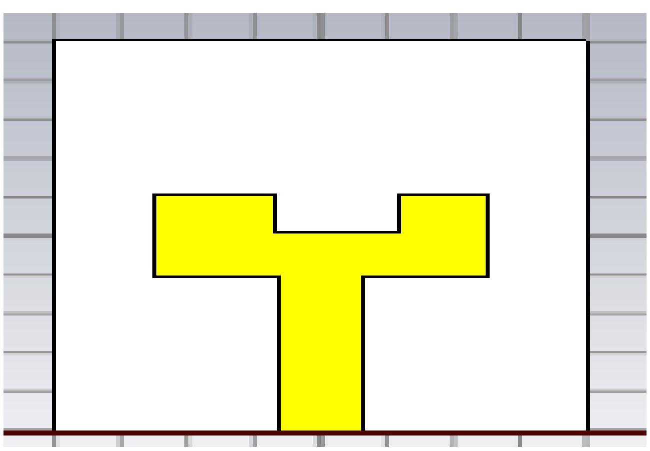


Figure 1: Proposed antenna at 28 GHz

Antenna is fed using microstrip feedline, which is selected as multiple of wavelength (λ) to match impedance upto 50 ohms so that return loss can be minimized. Initially we have considered length and width of patch antenna as 1.664 mm*3.258mm respectively. After optimization, the antenna get resonated at 28 GHz, having patch of dimension length*width= 2.1mm*5mm. The patch is constructed on a substrate of width=8mm and length=10mm. The substrate is made up of Rogers RT duroid 5880 having dielectric constant of 2.2 and loss tangent of 0.0009. The strip line of length 4.8mm and width 1.3mm have been obtained. The width of feedline is selected by calculating the impedance matching for strip line in CST software at which the antenna meets impedance of 50 ohm.

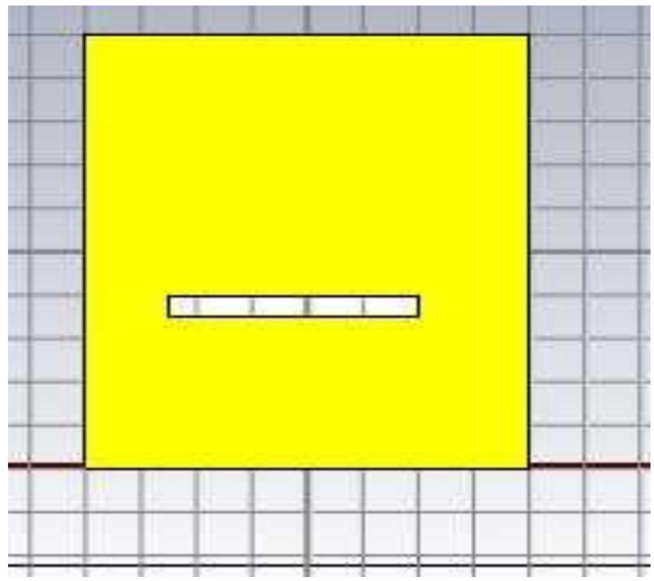


Figure 2: Back of design antenna with DGS

IV. RESULT AND ANALYSIS

The result section represents the simulated results in terms of return loss, bandwidth, VSWR, and radiation pattern. The design has been prepared in CST software and the obtained results are discussed below figure 3.

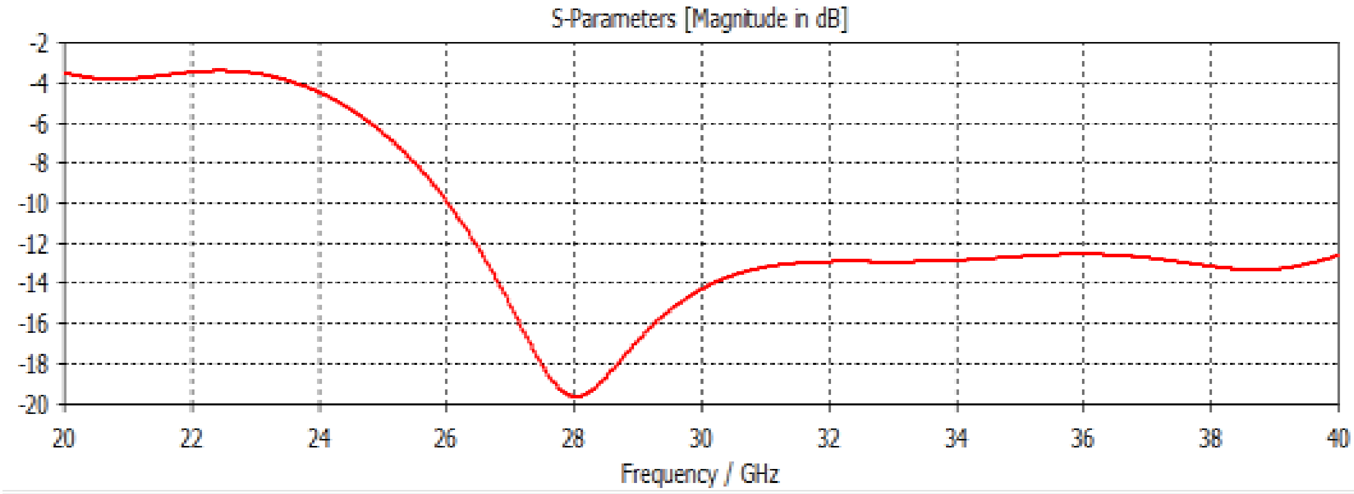


Figure 3: Return loss

Return loss is the reflection represented due to the mismatch appears between the patch and the microstrip line. Or it can be define as the ratio of reflected wave to the incident wave. The graph plotted between S parameters and frequency which is known as return loss is represented in Figure 3. From the graph it is shown that antenna is resonated at 28 GHz and covers band between 25.99 GHz to 40 GHz, which is having bandwidth of 14 GHz.

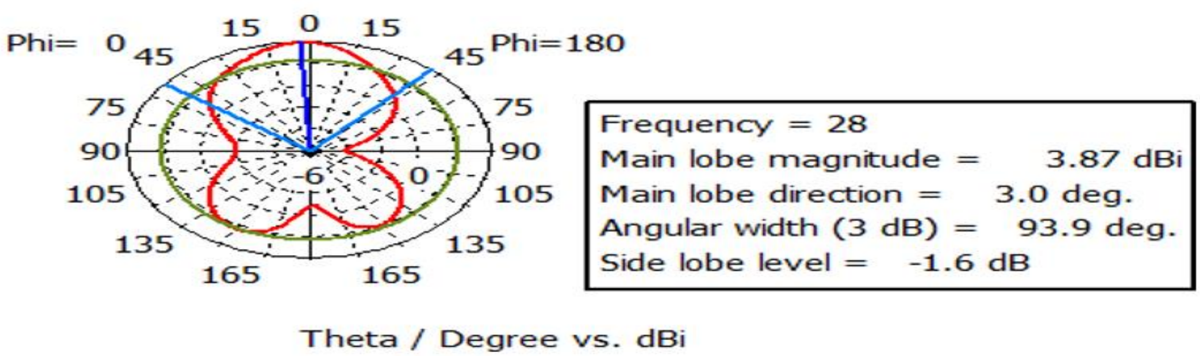
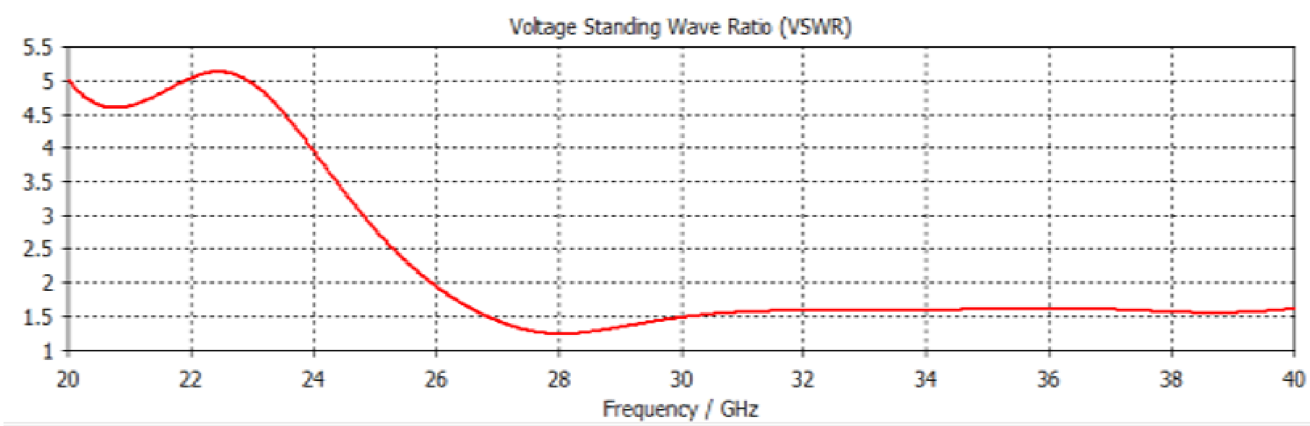


Figure 4: Radiation pattern

Far field radiation pattern is the function of theta and phi, at phi=0 radiation plot is represented in Figure 4. The graph shows that graph has major lobe along the 3 degree direction having angular width of 93.9 degree. The side lobe level of -1.6 dB is obtained that shows a unidirectional pattern.



VSWR

Figure 5: Performance of antenna is VSWR (Voltage Standing Wave Ratio)

Another parameter that is used to know the performance of antenna is VSWR (Voltage Standing Wave Ratio). It is nothing but the ratio of Vmax to Vmin. For an ideal case, VSWR is equal to 1, in this design antenna, VSWR lies between 1.23 - 1.60, which is less than 2 that indicates that antenna is matched sufficiently to 50 ohm strip line.

V. CONCLUSION

A diminutive rectangular patch antenna with DGS and using a simple microstrip feedline approach has been presented in this research. The design has been prepared in CST simulator. The design antenna has performed better in terms of VSWR i.e <2; unidirectional radiation pattern. Return loss of -20dB. The antenna offers a bandwidth of 14GHz with center frequency of 28 GHz. Today's, patch antenna is one of the recent and innovative topic, which must be continued. This is due to the very attractive features of patch antenna such as light weight, low cost etc. Therefore, one of the motive of this research is to improve electric characteristics of patch antenna such as to increase bandwidth by using simple strip technique.

REFERENCES

[1]. Aliakbari, H., Abdipour, A., Mirzavand, R., Costanzo, A., & Mousavi, P. (2016, April). A single feed dual-band circularly polarized millimeter-wave antenna for 5G communication. In 2016 10th European conference on antennas and propagation (EuCAP) (pp. 1-5). IEEE.

[2]. Hasan, M. N., Bashir, S., & Chu, S. (2019). Dual band omnidirectional millimeter wave antenna for 5G communications. Journal of Electromagnetic Waves and Applications, 33(12), 1581-1590.

[3]. Wagih, M., Weddell, A. S., & Beeby, S. (2020). Millimeter-wave power harvesting: A review. IEEE Open Journal of Antennas and Propagation.

[4]. Zhang, J., Ge, X., Li, Q., Guizani, M., & Zhang, Y. (2016). 5G millimeter-wave antenna array: Design and challenges. IEEE Wireless communications, 24(2), 106-112.

[5]. Matin, M. A. (2016). Review on millimeter wave antennas-potential candidate for 5G enabled applications. Advanced Electromagnetics, 5(3), 98-105.

[6]. Roy, P., Vishwakarma, R. K., Jain, A., & Singh, R. (2016, March). Multiband millimeter wave antenna array for 5G communication. In 2016 International Conference on Emerging Trends in Electrical Electronics & Sustainable Energy Systems (ICETEESES) (pp. 102-105). IEEE.

[7]. Elkashlan, M., Duong, T. Q., & Chen, H. H. (2014). Millimeter-wave communications for 5G: fundamentals: Part I [Guest Editorial]. IEEE Communications Magazine, 52(9), 52-54.

[8]. Seker, C., Güneser, M. T., & Ozturk, T. (2018, October). A review of millimeter wave communication for 5G. In 2018 2nd International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT) (pp. 1-5). Ieee.

[9]. Mungur, D., & Duraikannan, S. (2018). Microstrip patch antenna at 28 GHz for 5G applications. Journal of Science Technology Engineering and Management-Advanced Research & Innovation, 1(1), 20-22.

[10]. Lee, S., Kim, S., & Choi, J. (2019, March). Dual-band dual-polarized proximity fed patch antenna for 28 GHz/39 GHz 5G millimeter-wave communications. In 2019 13th European Conference on Antennas and Propagation (EuCAP) (pp. 1-5). IEEE.

[11]. Noor, S. K., Ramli, N., Sahar, N. M., & Khalifa, T. (2021, May). Compact and Wide Bandwidth Microstrip Patch Antenna for 5G Millimeter Wave Technology: Design and Analysis. In Journal of Physics: Conference Series (Vol. 1878, No. 1, p. 012008). IOP Publishing.

[12]. Abdelaziz, A., & Hamad, E. K. (2019). Design of a compact high gain microstrip patch antenna for tri-band 5 G wireless communication. Frequenz, 73(1-2), 45-52.

[13]. Colaco, J., & Lohani, R. (2020, June). Design and Implementation of microstrip patch antenna for 5G applications. In 2020 5th International Conference on Communication and Electronics Systems (ICCES) (pp. 682-685). IEEE.

[14]. Imran, D., Farooqi, M. M., Khattak, M. I., Ullah, Z., Khan, M. I., Khattak, M. A., & Dar, H. (2018, February). Millimeter wave microstrip patch antenna for 5G mobile communication. In 2018 International Conference on Engineering and Emerging Technologies (ICEET) (pp. 1-6). IEEE.

[15] Bhat, F.Y ; Mehra, M(2021,Nov)" Microstrip Patch Antenna for MIMO based WLAN Application: A Review" ADBU Journal of Electrical and Electronics Engineering (AJEEE) | Volume 4, Issue 2 |

[16] Mehra,M; Singh,R.P "A Review Paper on 5G Research Activities" Journal of Emerging Technologies and Innovative Research , ISSN: 2349-5162 , Volume 5, Issue 9, September 2018.