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Research Article

A 30 Ghz Slotted Bow-Tie Rectangular Patch Antenna Design For 5g Application

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Abstract:

In this work, we suggest a new rectangular microstrip patch antenna (RMPA) with a relative permittivity (ɐr) of 4.3 and a thickness (h) of 0.254 mm, and we examine its design and performance at (f).The wavelength is 28 GHz. In order to enhance the antenna radiation performance, particularly the antenna gain and bandwidth, three distinct feeding strategies are explored utilising Computer Simulation Technology (CST) and the High Frequency Structure Simulator (HFSS): microstrip inset line, coaxial probe, and proximity linked line. Although it has a bigger antenna than the other feeding options, the proximity-coupled fed still manages to produce a highly directed pattern and keep radiation performance good, according to the simulated frequency responses. The three feeding methods increase the gain from 5.50 dB to 6.83 dB. Furthermore, for f r = 28 GHz, with the reflection coefficient S11= -10 dB, the antenna bandwidth is enhanced from 0.6 GHz to 3.60 GHz. The suggested architecture is more suited to various 5G application systems than the previously developed RMPA due to its greater bandwidth, higher gain, and dependable size.

Keywords: Feed techniques, gain, broadband bandwidth, microstrip patch, 5G

Introduction

All facets of our lives have been touched by wireless apps in the last few years. Antennas necessary for 5G and millimetre wave networks must have small size, strong gain, and wide bandwidth uses of waves [1, 2]. In such cases, an RMPA, or rectangular microstrip patch antenna, might work well. Nevertheless, its narrow bandwidth and low gain are seen as its two major downsides. To get around these problems, a lot of research has been done in the literature.

Reducing substrate thickness, improving substrate permittivity, feeding strategies, and using different optimisation methods are just a few of the many approaches that have been investigated in an effort to increase the gain and bandwidth of MPAs [3]. In addition, the primary goal of the mode shift theory given in [4] was to increase the bandwidth of the dual-mode RMPA by the stimulation of two resonant modes. The antenna size was lowered while the bandwidth and efficiency were enhanced by exciting the higher mode in the RMPA.

To increase the MPA's bandwidth, two slots were carved from the microstrip patch as described in [5] to stimulate adjacent radiative modes. However, according to [6], a typical patch antenna might have its gain increased by as much as 48% by using a superstrate lens to standardise the electric field's phase distribution over the patch.

Furthermore, [7] suggested incorporating a ferrite ring into the RMPA's hybrid substrate to generate constructive interference between the incident and reflecting fields in the substrate. This would result in a 4.0 dB gain enhancement for the antenna without sacrificing bandwidth. Then, to improve the antenna's overall performance, two sets of short-circuited patches were included in [8] to excite two sets of orthogonal electric and magnetic dipole modes. The array used a

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microcontroller-controlled switchable feed network to provide the RMPA strong gain and adjustable polarisation [9].
To circumvent this, a numerical approach, dubbed the discrete mode matching technique, was laid forth in [10].
RMPA problems to be had. As stated in reference [11], an optically fed microstrip patch was accomplished by the utilisation of a vertical cavity surface-emitting laser. In a system that is optically fed, there is no longer a need for the transmission line to provide power to the radiation element in order to raise the gain of the antenna.
In contrast to the methods described above, an equal-angle triangular patch antenna was used in order to generate dual-circularly polarised radiation via the utilisation of aperture-coupled and proximity feeds [12]. The bandwidth and gain of a circular microstrip patch antenna were significantly improved by the use of hybrid-feed and coaxial probe feed techniques, as well as the incorporation of an L-shaped patch [13]. Exciting two orthogonal modes was also accomplished with the use of a square microstrip patch antenna that had two feed ports [14].
It is possible to produce both linear and circular polarisation across a certain frequency range that is appropriate for operation.
An improvement in the bandwidth of RMPA and the achievement of dual polarisation were both accomplished by cutting a bow-tie slot from a rectangular patch [15].
The purpose of this study is to describe a revolutionary RMPA architecture that includes proximity linked feed, coaxial probe feed, and microstrip inset feed. In order to do this, a FR4 dielectric substrate is used, and the proposed RMPA's return loss S11, VSWR, gain, radiation pattern, antenna size, and bandwidth are simulated by using the (HFSS) and (CST) techniques. This is done in order to explore the influence that different feeding strategies have. The results lead to the discovery of a reasonable feeding technique that is not only straightforward but also reliable in terms of radiation performance. As a result, this approach is perfect for use in 5G application systems.

Antenna Design

Generally speaking, the literature had a variety of various approaches that might be used to feed the radiation patch of RMPA. It is important to note that the role that plays in improving the antenna input impedance and efficiency is substantial [17]. Methods of feeding that include touch and those that do not involve contact are the two that are most generally recognised. When it comes to the manner of initiating contact,
Through the use of a conducting strip, such as microstrip inset line feeding and/or a coaxial probe feeding, the electromagnetic energy that has been steered is directly delivered to the patch that is radiating. The electromagnetic energy that is steered, on the other hand, may be directed to the radiating patch under the resonance condition by the use of proximity coupling supplied.

Antenna Configuration

A demonstration of the design of the proposed RMPA is shown in Figure 1, which makes use of the CST simulator to show the presence of the three different feeding approaches. The RMPA is seen in Figure 1 on the a).in which the microstrip inset feed line is used to provide the feed. This particular line is used in order to transform the edge impedance into a merit that corresponds to the impedance characteristic of the input of the signal. In order to ensure that the impedance matching is done correctly, two slots are carved all the way around the microstrip line. From the perspective of the converted impedance value, the length of the microstrip feed line is equivalent to a quarter wavelength. This value may be calculated by using the relation

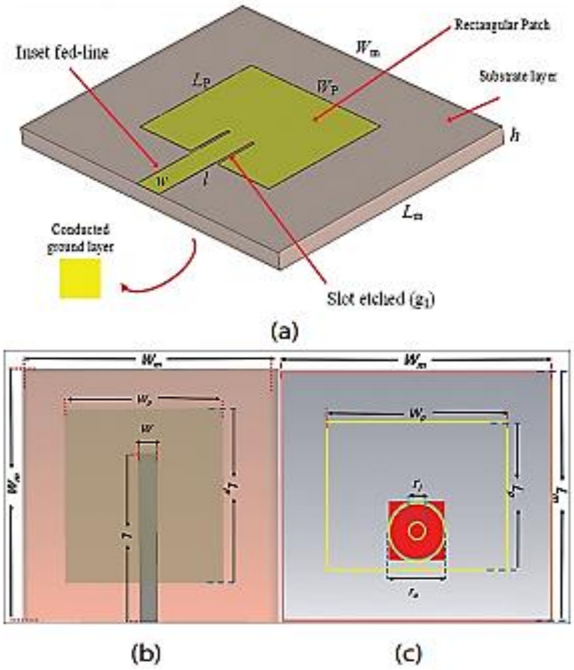

Fig. 1. Three-dimension view of the simulated RMPA with their specified layer representation for (a) microstrip line, (b) Proximity coupled and (c) Coaxial probe fed

It is essential to observe that the initial values of the dimensions labeled on the RMPA in Fig. 1 have been obtained using the relations given in section 2.1. Then, the genetic algorithm optimization method in CST has been performed on these dimensions in order to make the antenna resonate at (f r = 28 GHz). The optimized dimensions of the proposed RMPA with each mentioned feeding techniques

Conclusion

A novel configuration of RMPA that operates at 28 GHz has been suggested in this study. The microstrip inset, the coaxial probe, and the proximity coupled are the three various feeding strategies that have been used while developing this configuration.

With the use of the HFSS and CST simulators, the RMPA that was simulated has been calculated. Despite the fact that the production process for the proximity linked feed is quite complicated, it often results in superior radiation performance when compared to the other different feeding strategies that are being evaluated.

Given that the RMPA is able to give a gain and bandwidth on the order of 6.86 dB and 3.60 GHz, respectively, with no side and back lobes in comparison to the other feeding approaches that are being evaluated, the simulated results of the proximity coupled fed demonstrate that the RMPA is really capable of providing these benefits. Furthermore, in comparison to the previous studies that are listed in this article, the suggested design is characterised by a relatively compact size, as well as a competitive gain and bandwidth. In addition, it is important to note that the RMSAs that have been provided are suitable for implementation in wireless communication systems that are compatible with 5G.

References

[1] B. A. Rahman, S. O. Hasan, "Simulation Design of Low-Profile Equilateral Triangle Microstrip Patch Antenna Operating at 28 GHz", International Journal on Communications Antenna and Propagation, Vol. 12, 2022, pp. 74-82.

[2] A. Bansal, R. Gupta, "A review on microstrip patch antenna and feeding techniques", International Journal of Information Technology, Vol. 12, 2020, pp. 149-154.

[3] A. Bhattacharyya, J. Pal, K. Patra, B. Gupta, "Bandwidth-enhanced miniaturized patch antenna operating at higher order dual-mode resonance using modal analysis", IEEE Antennas and Wireless Propagation Letters, Vol. 20, 2020, pp. 274-278.
[4] J. Wen, D. Xie, L. Zhu, "Bandwidth-Enhanced High Gain Micros trip Patch Antenna Under TM Dual Mode Resonances", IEEE Antennas and Wireless Propagation Letters, Vol. 18, 2019, pp. 1976-1980.
[5] M. S. M. Mollaei, E. Zanganeh, M. F. Farahani, "Enhancement of patch antenna gain using cylindrical shell-shaped superstrate", IEEE Antennas and Wireless Propagation Letters, Vol. 16, 2017, pp. 2570-2573.
[6] A. Rivera-Albino, C. A. Balanis, "Gain enhancement in microstrip patch antennas using hybrid substrates", IEEE Antennas and Wireless Propagation Letters, Vol. 12, 2013, pp. 476-479.
[7] Y. Liu, Z. Yue, Y. Jia, Y. Xu, Q. Xue, "Dual-band dual circularly polarized antenna array with printed Volume 14, Number 8, 2023 839ridge gap waveguide", IEEE Transactions on Antennas and Propagation, Vol. 69, 2021, pp. 5118-5123
[8] C. Liu, Y. Li, T. Liu, Y. Han, J. Wang, S. Qu, "Polarization reconfigurable and beam-switchable array antenna using switchable feed network", IEEE Access, Vol. 10, 2022, pp. 29032-29039
[9] A. Ioffe, M. Thiel, A. Dreher, "Analysis of microstrip patch antennas on arbitrarily shaped multilayers", IEEE Transactions on Antennas and Propagation, Vol. 51, 2003, pp. 1929-1935
[10] Q. Luo, S. Gao, M. Sobhy, J. T. S. Sumantyo, J. Li, G. Wei, J. Xu, C. Wu, "Dual circularly polarized equilateral triangular patch array", IEEE Transactions on Antennas and Propagation, Vol. 64, 2016, pp. 2255- 2262
[11] S.-L. Yang, K.-M. Luk, "Design of a wide-band Lprobe patch antenna for pattern reconfiguration or diversity applications", IEEE Transactions on Antennas and Propagation, Vol. 54, 2006, pp. 433-438
[12] J.-F. Tsai, J.-S.Row, "Reconfigurable square-ring microstrip antenna, IEEE Transactions on Antennas and Propagation", Vol. 61, 2013, pp. 2857-2860.
[13] C. Deng, Y. Li, Z. Zhang, Z. Feng, "A wideband high isolated dual-polarized patch antenna using two different balun feedings", IEEE Antennas and Wireless Propagation Letters, Vol. 13, 2014, pp. 1617- 1619.