A Design And Analysis Of Crown Slot Patch Antennas For 5g Applications

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Abstract: In this article, A highly compact (volume of only 7 x 7x1.6mm3) crown slot patch antenna, operating at 28GHz (5G mobile applications) and 34GHz (higher satellite band application) is presented. A structure of antenna is integrated with heptagon radiator and crown shaped slot on the radiating element. The proposed configuration has The antenna has S11 <-10dB bandwidth of 4.39GHz at 28 GHz and 2.36GHz at 34GHz.The obtained bandwidth can easily satisfy the requirement of millimeter 5G and higher satellite band.Which is highly compact size, overall radiation efficiency, good gain, table radiation pattern obtained at targeted 5G application.

Keywords: 5G, crown shaped slot, heptagon radiator**.**

1. Introduction

Since 1G, 2G, 3G and 4G has been advanced and gained lot of maturity, researches, specialists and remote correspondence social orders are presently focusing on millimeter wave (MMW) range groups (20-300 GHZ). The primary benefit of this MMW range activity is that it gives higher information rates.[1-2] Researchers have now focused their whole spotlight on using these MMW ranges for future 5G and satellite correspondences. As a result, the antenna architecture layout is the most dangerous assertion for Smartphone and other 5G interactive terminals. The size of the antenna must be small in order for it to be integrated with 5G devices[3-8]. A few 5G antennas have been recorded in the literature. These antennas, on the other hand, have the downside of being larger. [8-10}

An exceptionally compactantenna for 5G and higher satellite band is planned, recreated and examined in this paper. The plan design of radio wire comprises of an even rectangular radiator, metamaterial RSRR). A structure of the antenna is integrated with heptagon radiator and crown shaped slot on the radiating element and a feed line. Crown shaped slot is etched to achieve compactness and a higher satellite band (i.e. 34.6GHz), where as a symmetrical rectangular shaped radiator is used to achieve the 5G band (i.e. 28.2GHz). Parametric analyses are used to determine the antenna's operational behavior under different conditions. The proposed arrangement acquires great radiation productivity, Impedance coordinating and acquire at the particular resonance.

2. Antenna design

The basic objective of this paper is to design a very compact antenna for millimeter 5G and higher satellite bands. A symmetrical heptagon radiator and a crown shaped slot are used to achieve the previously mentioned target as shown in fig(a). The particular measurement shape of the expected layout is outlined in fig(a). A structure of the antenna is integrated with heptagon radiator and crown shaped slot on the radiating element . The antenna is outlined on low cost 7x7mm^2 FR4 substrate having a=0.02, h=1.6mm and dielectric constant =4.4. A micro strip line is used to energize the antenna in order to reach an impedance match of 50. The draw evolution of last configuration is demonstrated in fig. The antenna in association with symmetrical rectangular radiator (i.e. "stage 2" of fig) functions at 26GHz (higher 5G band in millimeter wave range) as demonstrated in fig.1

To create the antenna function at extra resonance a crown shaped is etched in the radiating segment as illustrated of fig1 b. The addition of heptagon radiator generated the narrow resonance at 34.2GHz (higher satellite band). Additionally, the introduction of the crown shaped slot constitution alters the approach field boundary criteria and therefore assists to accomplish compactness in altogether volume. The detailed dimensions of the 5G antenna as illustrated in fig1.band optimized dimensions given in Table 1.

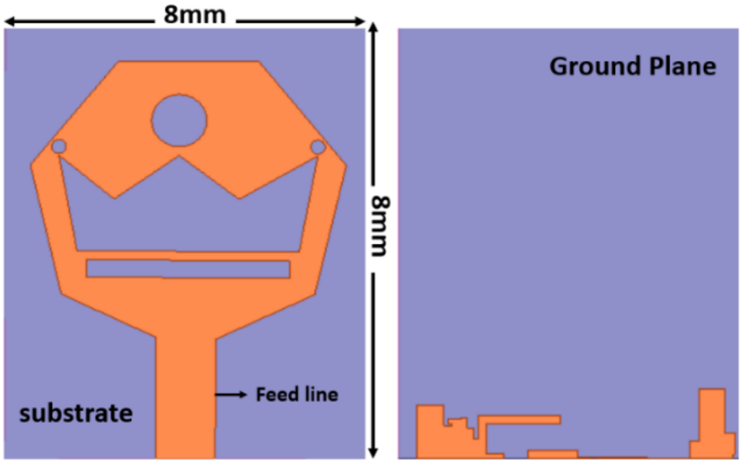
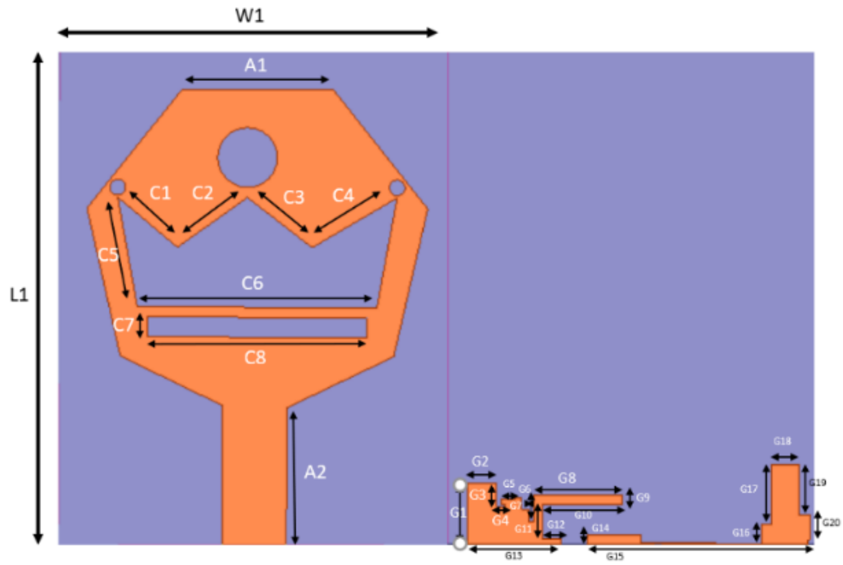


Fig. 1 (a) Proposed antenna structure (b) Proposed configuration detailed dimensions layout.

TABLE. 1: OPTIMIZED DIMENSIONS



Dimensions in mm					
L1	10	C8	4.4	G11	0.7
W1	8	G1	1.2	G12	0.4
A1	2.3	G2	0.6	G13	2
A2	2.7	G3	0.4	G14	0.2
C1	1.5	G4	0.2	G15	4.7
C2	1.7	G5	0.3	G16	0.3
C3	1.6	G6	0.1	G17	1.2
C4	1.4	G7	0.5	G18	0.6
C5	2.6	G8	1.9	G19	0.9
C6	4.8	G9	0.2	G20	0.5
C7	0.4	G10	1.7		

(b)

3. Results

The proposed configuration is simulated on HFSSv.13.0 simulator using FEM method. The S11 plot of the antenna is depicted in Fig. 2. The antenna has a total volume of only 102mm3 and operating at 28 (millimeter

5G band) and 34.2 GHz (higher satellite band). The proposed configuration has S11 <-10dB bandwidth of 4.39GHz at 28 GHz and 2.36GHz at 34GHz. The obtained bandwidth can easily satisfy the requirement of millimeter 5G and higher satellite band.The simulated VSWR of the proposed configuration is demonstrated in Fig. 3. At both the bands the VSWR lies between 1-2.

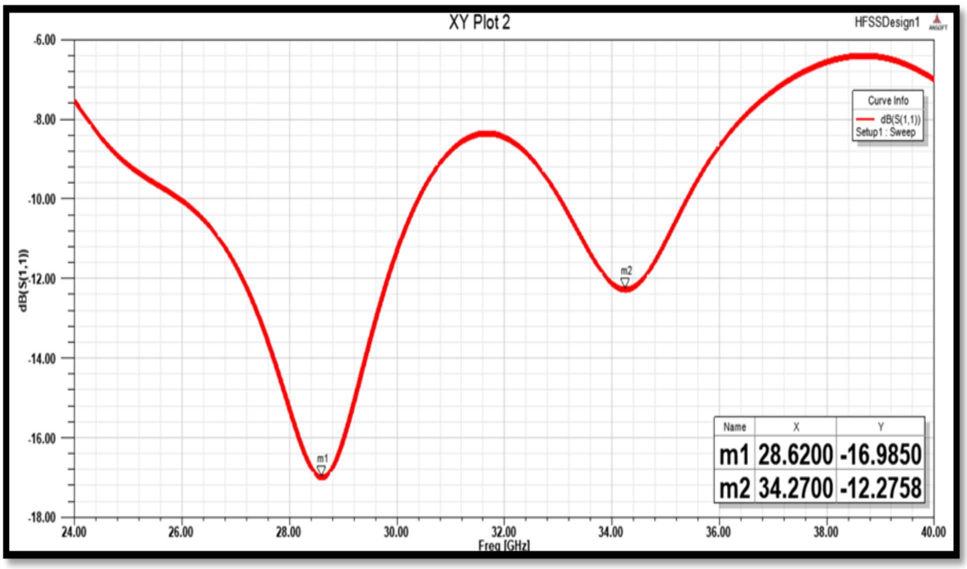


Fig. 2: S11 of the proposed Design.

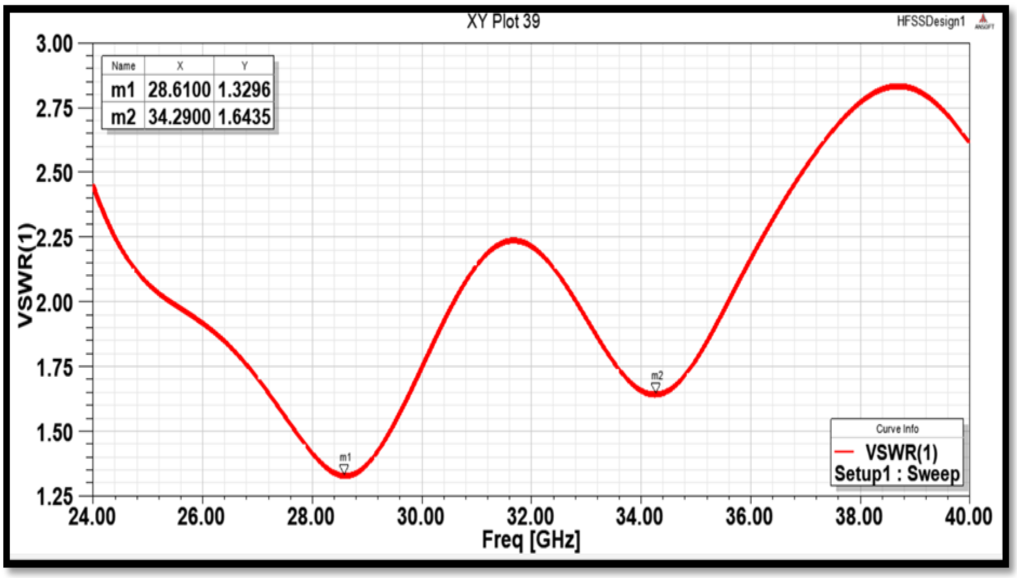
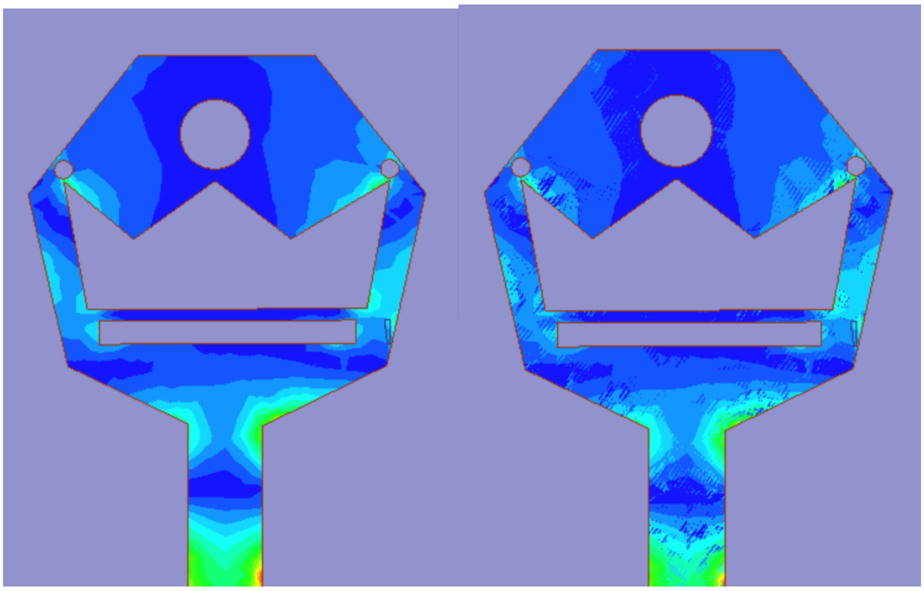


Fig. 3: VSWR of the proposed Design.

A. Current distribution

The antenna resonance behaviour is studied by the current distribution, as demonstrated in Fig. 4. From the distribution it can be analyzed that for the dual band (i.e. 28.6 GHz and 34.2 GHz) the antenna has corresponding resonant paths.

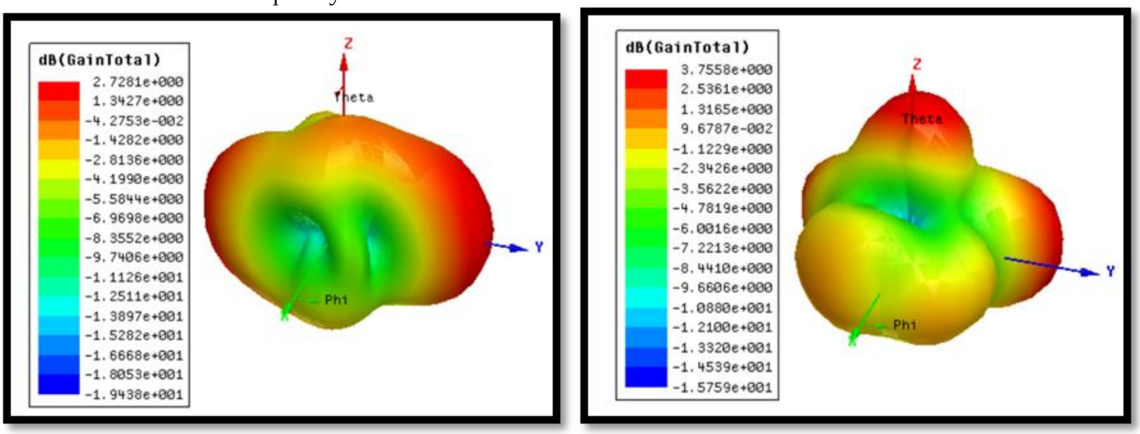


(a) (b)

Fig. 4 . current distribution plots of the proposed design at 28.6 and 34.2 GHz

B. Gain

The 3-D gain plot of the proposed configuration is depicted in Fig.5. The antenna has a gain of 2.72 and 3.373dB at the resonance frequency of 28.61 and 34.2GHz.

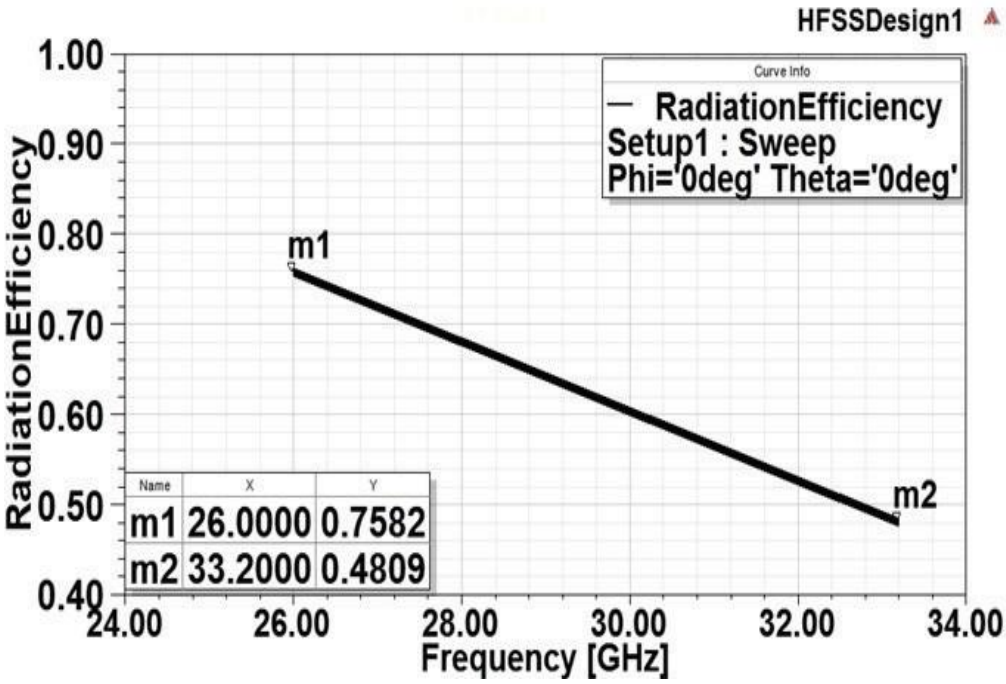


(a) (b)

Fig. 5 . 3D gain plots of the proposed design at 28.6 and 34.2 GHz

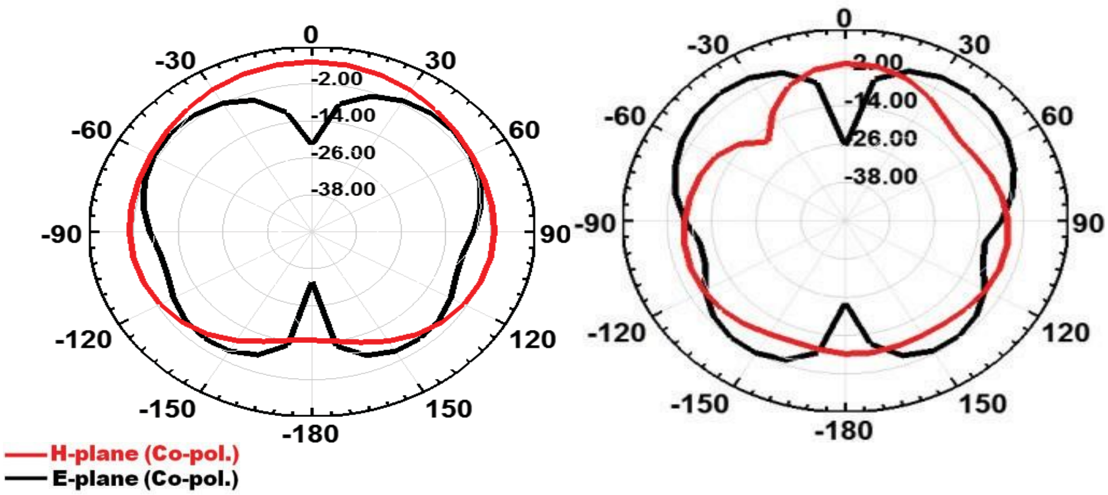
C. Radiation Efficiency

The radiation efficiency of the proposed antenna is depicted in Fig.5. The radiation efficiency of 75% and 48% are obtained for 26.and 33 GHz



D. Radiation pattern

The polar pattern of the proposed configuration is illustrated in Fig. 9. For H-plane (red line) antenna exhibits omnidirectional pattern for the resonating frequency (i.e. 28.61and 34.2 GHz). For E-plane (black line) the antenna shows 8-shaped (bi-directational) pattern at both the operating frequency. Moreover, the pattern are broad and stable thus, favors the usuage of antenna for 5 G and higher satelliteoperations.



(a) (b)

Fig.5 Radiation pattern plots of the proposed design at 28.6 and 34.2 GHz

4. Conclusion

A Profoundly minimal double band slot patchantenna for 5G and higher satellite band is planned. The radio wire has the benefit of straight forward construction, satisfactory increase and great radiation effectiveness. The antenna has S11 <-10dB bandwidth of 4.39GHz at 28 GHz and 2.36GHz at 34GHz.The obtained bandwidth can easily satisfy the requirement of millimeter 5G and higher satellite band Profoundly minimal size and stable radiation attributes make the proposed arrangement a serious contender for the previously mentioned remote applications.

References

1. Subhash BK, Prasad KD, Biradar RC. A Dual band Metamaterial Antenna for 5G and Higher Satellite band Applications. In2018 4th International Conference for Convergence in Technology (I2CT) 2018 Oct 27 (pp. 1-4). IEEE.
2. Raj, Saurabh, et aI. “A Compact Design of Circularly Polarized Fractal Patch Antenna for 5G Application.” 2018 IEEE MTT-S International Microwave and RF Conference (IMaRC). IEEE, 2018.
3. Raj, S., Kishore, N., Upadhyay, G., Tripathi, S., & Tripathi, V. S. (2018, November). A Compact Design of Circularly Polarized Fractal Patch Antenna for 5G Application. In 2018 IEEE MTT-S International Microwave and RF Conference (IMaRC) (pp. 1-4). IEEE.
4. Pitiphunpong, C., & Theeradejvanichkul, T. (2019, March). A Wideband Multilayered FSS Based on 2nd-Iteration Hex flake Fractal Patch and Minkowski Ring Slot for Radome Application. In 2019 International Workshop on Antenna Technology (iWAT) (pp. 139-142). IEEE.Chicago
5. Hamdy, Salah, et aI. “A new fractal-like tree structure of circular patch antennas for 5G multi-band and wide-band applications.” 2016 Progress in Electromagnetic Research Symposium (PIERS). IEEE, 2016.
6. Goel, T., & Patnaik, A. (2019, December). Fractal DGS based Novel Wideband Antenna for 5G Applications. In 2019 IEEE Indian Conference on Antennas and Propagation (InCAP) (pp. 1-4). IEEE.
7. Kumar, S., Dixit, A. S., Malekar, R. R., Raut, H. D., & Shevada, L. K. (2020). Fifth Generation Antennas: A Comprehensive Review of Design and performance Enhancement Techniques. IEEE Access, 8, 163568-163593.
8. Structural And Mechanical Properties Of Thorium Oxide , Nilesh Dhurve, Neetu Paliwal, International Journal Of Advance Research In Science And Engineering http://www.ijarse.com IJARSE, Volume No. 09, Issue No. 09, September 2020 ISSN-2319-8354(E).
9. Patnaik A. Fractal DGS based Novel wideband Antenna for 5G Applications. In2019 IEEE Indian Conference on Antennas and Propagation (InCAP) 2019 Dec 19 (pp.1-4). IEEE.