A SURFACE EDGE CUTOUT MICROSTRIP PATCH ANTENNA FOR 5G APPLICATIONS

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Abstract

With internet revolutionizing communication, to the extent that it has become a preferred medium of communication. With these huge demand for high speed cost effective networks so in order to meet these requirements 5th generation networks is required. The primary technologies include: Millimeter bands(26,28,38 and 60GHz) are 5G and offer performance as 20 gigabits per second; Massive MIMO offers performance up to ten times of current 4G networks. In this paper, we have proposed a novel surface edge cutout single patch Micro strip antenna with high gain. The antenna is fabricated on FR4 Epoxy substrate with relative permittivity 4.4 and dielectric loss tangent 0.02. The proposed antenna has compact structure of 28.9mmx28.9mmx1.6mm.The antenna resonates at 5GHz. The proposed antenna has surface edge cutout design which results in high gain and good bandwidth better radiation patters. The formulation is validated by simulation in finite element method- based software, ANSYS HFSS.

Keywords: Slotted Patch, Gain, and Radiation pattern.

I. Introduction

This Micro strip Patch Antenna is low-profile planar antennas mounted at a ground level with di-electric material in-between constitutes a micro strip or patch on the top. They are compact, less expensive and easy to fabricate antennas.

With the advance wireless technology, fast increasing internet speed the requirement for micro strip patch antenna to introduce the high standard of data transfer and low cost of fabrication is made the millimetre wave which is applicable for commercial purpose[1]. Because of the speedy development of wireless communication, the 5G (5th generation mobile networks) technology growth will be necessary to meet the large network demands. The current mobile communication systems cover the band which is below 3GHz. To meet the demands of the 5G, the spectrum from 3-300GHz has been explored [2-3]. The millimetre wave band is a powerful candidate for the next 5th generation [4], but it has the limitation of the transmission distance. Also, although the lower band from 3-6 GHz has much better propagation. An enhancing mobile network performance capability [2]-[5] is a key to facilitate the infrastructure for smart city development. Thus, simple structure antennas which provide wide bandwidth for mobiles and advanced devices will have been continuously receiving great research interests. Over the past decades, significant progress has been made in the development of wideband patch antennas. However, conventional patch antennas suffer from very narrow bandwidth, typically only about several percentages. Many techniques have been extensively investigated to enhance the operating ban [9-13] of patch antennas [6]-[10]. In this paper, we proposed a surface edge cutout design single patch antenna. This in turn validated by the simulation in FEM based general software HFSS.

II. ANTENNA DESIGN AND GEOMETRY

I Design of Simple Patch Antenna

This antenna has a simple structure of rectangular patch operating at 5GHz. The structure and design of the antenna are shown in Figure 1. The antenna has a rectangular patch of dimensions 18.52×13.76mm. In this antenna transmission line feed is used.

II Design of Simple Patch with inset feed Antenna

In this antenna, slots are introduced which has dimensions of 2.5mm × 1mm. The structure and design of the antenna is shown in Figure 2. The length and width of the patch is the same. The rectangle slots are inserted in this antenna.

III Design of Surface Edge Cutout Antenna

In this antenna, edge slots are introduced at the surface to obtain high bandwidth and high gain. The size of the rectangular patch is 18.52×13.76mm. The edge slots have dimensions of 0.8mm × 0.8mm. The structure and design of the antenna is shown in Figure 3.

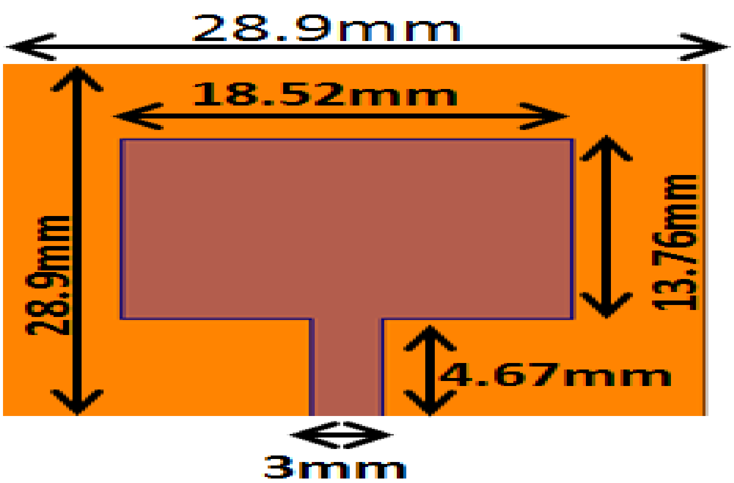

Figure 1: *Geometries proposed of the simple patch Antenna*

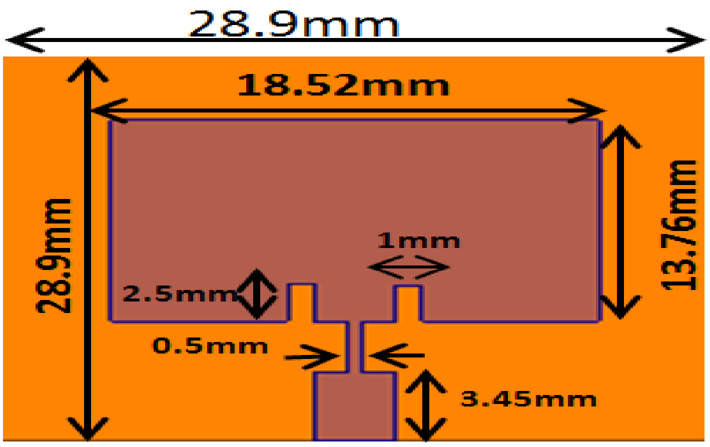

Figure 2: *Geometries proposed of the simple patch with feed Antenna*

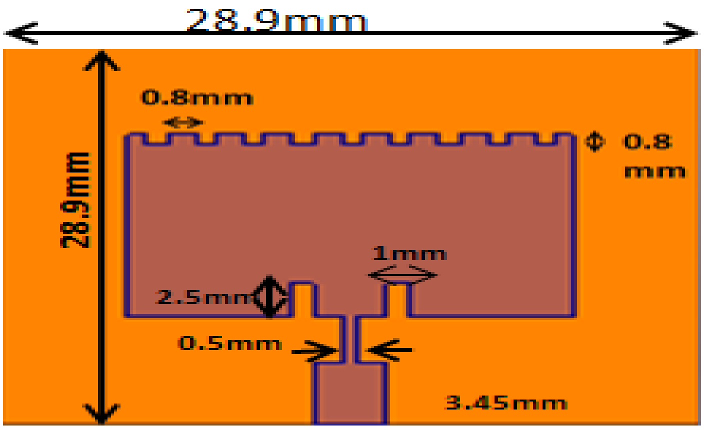

Figure 3: *Geometries proposed of the surface edge cutout Antenna*

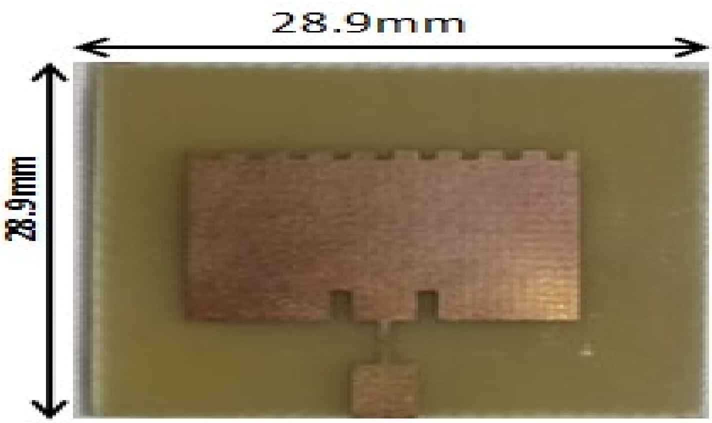

Figure 4: Surface edge cutout fabricated *Antenna*

III. Results

Table 1: *Comparative analysis of different antennas for Return loss, Range and Gain*

Parameters	Antenna		
	Simple Patch Antenna	*Simple Patch with Inset Feed Antenna*	*Surface Edge Cutout Antenna*
Return Loss (dB)	-5.88	-11.88	-15.79
Range	-	4.93-5.04	4.81-5.18
Gain(dBi)	4.56	4.75	4.83

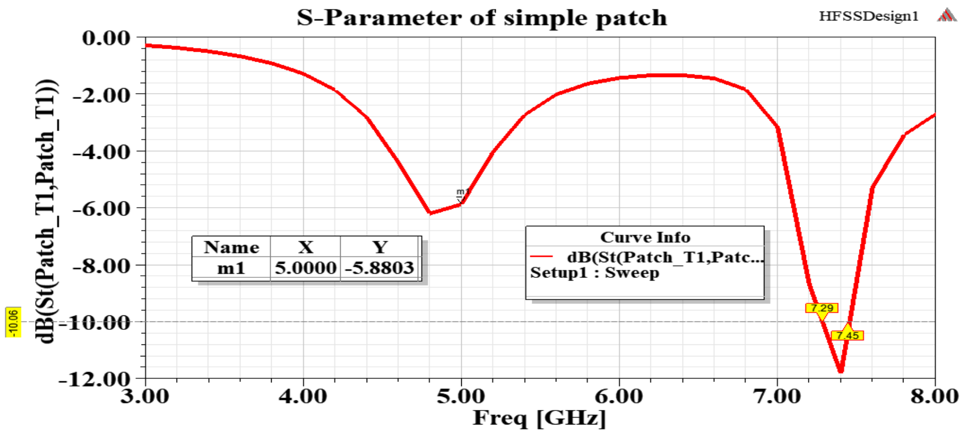

Figure 5(a): *Returen loss of the simple patch antenna*

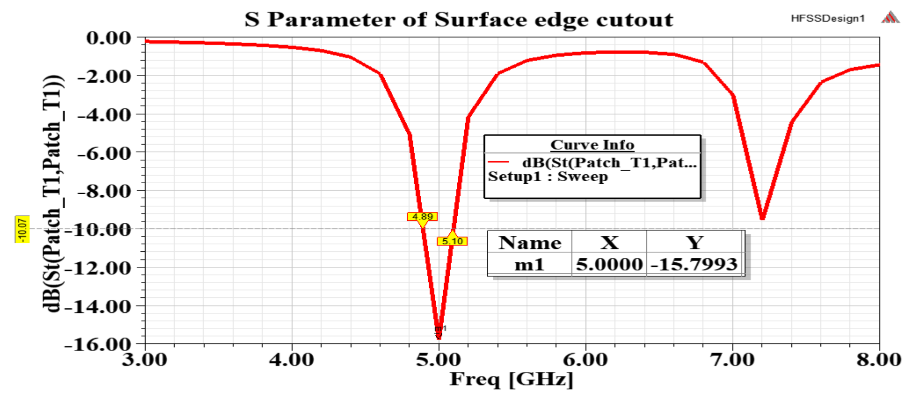

Figure 5(b): *Returen loss of the simple patch with feed antenna*

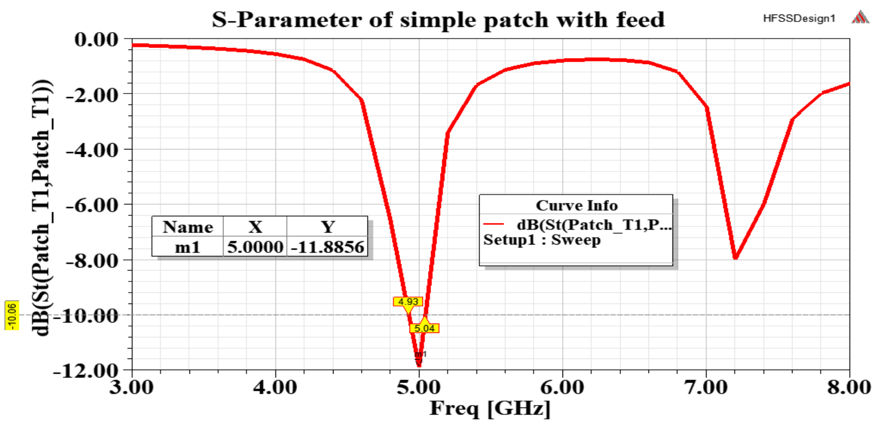

Figure 5(c): *Returen loss of the surface edge cutout antenna*

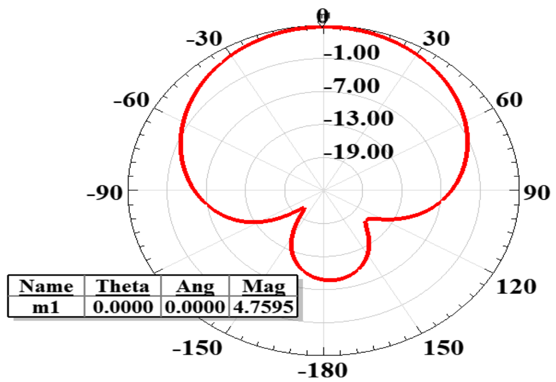

Figure 6(a): *Gain of the simple patch antenna*

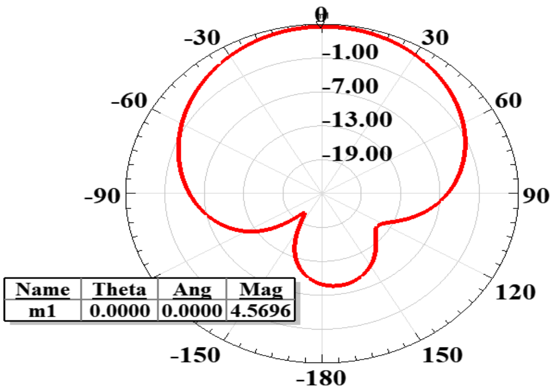

Figure 6(b): *Gain of the simple patch with feed antenna*

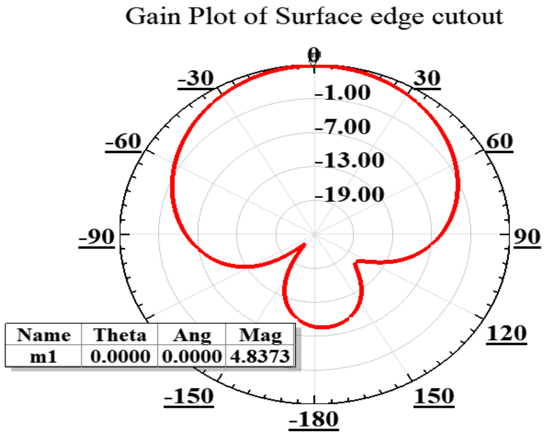

Figure 6(c): *Gain of the surface edge cutout antenna*

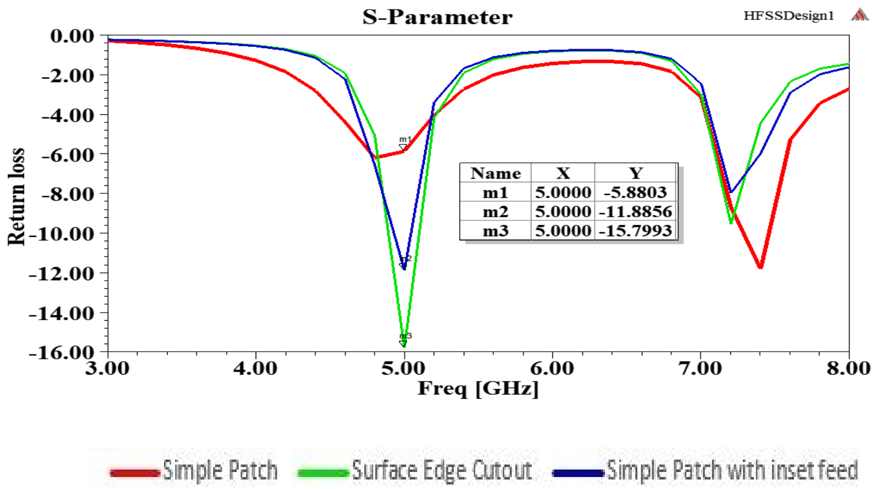

Figure 7: *Comparison of Return loss*

IV. Discussion

The simulation of the proposed antennas is carried out in HFSS software. Three antennas are designed at centre frequency 5GHz. In the simple patch antenna, the return loss obtained is -5.88dB. At -10dB, no return loss is obtained at the centre frequency. The simulated gain is 4.56dBi. In the antenna containing quarter feed with slots, the return loss is -11.88dB. The radiating frequency is 4.93GHz-5.04GHz. The gain obtained is 4.75dBi. The third antenna has the highest gain and bandwidth compared with the other two. The edge cutout at the surface of the patch increases the gain and reduces the return loss. The return loss and gain obtained is -15.79dB and 4.83dBi respectively. The radiating frequency is 4.81GHz-5.18GHz. The return loss in the first antenna is poor because it is a simple patch. With the introduction of inset feed and two slots in the second, antenna the return loss improves relatively to -11.88dBi and in the third antenna we have made slots of equal size with inset feed which has increased the return considerably because with feed there is an improvement in impedance matching hence the results improve. The return losses and gain of the three antennas are given in Figure 5 and Figure 6 respectively. The comparisons of the return loss of the three antennas are shown in Figure 7. The surface edge cutout antenna has the lowest return loss which is -15.79dB. The reason is because of the cutouts at the surface of the antenna which improves the performance. The other two antennas have return loss above -10dB because of the change in design of the antennas.

References

[1] 9 K. Gong, Z. N. Chen, S. Q, P. Chen and W. Hong, " substrate integrated waveguide cavity backed wide slot antenna for 60GHz band", IEEE Trans. Antennas propag., Vol.60, no.12 and pp.6023- 6026, Dec 2012

[2] 5GA_5G_Spectrum_Recommendations_2017_FINAL

[3] https://www.gsma.com/spectrum/wp- content/uploads/ 2016/06/GSMA-5G-Spectrum-PPP.pdf

[4] T. S. Rappaport et al., "Millimeter wave mobile communications for 5G cellular: It will work!" IEEE Access, vol.1, pp. 335-349, 2013.

[5] Holopainen, J. M. Hannula, and V. Viikari, "A study of 5G antennas in mobile terminal, 2017 11th European Conference on on Antennas and Propagation (EUCAP), Paris, Mar. 2017, pp. 3079-3081

[6] Butler, "5G spectrum challenges," 5G Radio Technology Seminar. Exploring Technical Challenges in the Emerging 5G Ecosystem,London 17 March,2015

[7] N. F. M. Aun, P. J. Soh, A. A. A. Hadi, M. F. Jamlos, and G. A. E Vandenbosch, and D. Schreurs, "Revolutionizing wearables for 5G: 5G technologies: recent developments and future perspectives for wearable devices and antennas," IEEE Microwave Magazine, vol. 18, no. 3, Apr 2017, pp. 1527-3342.

[8] Gupta, and R. K. JHA, "A survey of 5G network: architecture and emerging technologies," IEEE Access, vol. 3, Jul. 2015, pp. 1206-1232

[9] M. Luk, C. L. Mak, Y. L. Chow, and K. F. Lee, "broadband microstrip patch antenna," Electron Lett., vol. 34, no. 15, Jul. 1998, pp1442-144

[10] Y. X. Guo, C. L. Mak, K. M. Luk, and K. F. Lee "Analysis and design of L probe proximity fed patch antennas," IEEE Trans. Antennas Propagat., vol. 49, no. 2,pp 145-149

[11] H. W. Lai, and K. M. Luk, "Design and study of wideband patch antenna fed by meandering probe," IEEE Trans. Antennas Propagat., vol. 54, no 2, Feb. 2006, pp 564-571.

[12] H. W. Lai, and K. M. Luk, "Wideband stacked patch antenna fed by meandering probe," Electron. Lett ., vol. 41, no. 6, Mar. 2005

[13] L. Mak, K. F. Lee, and K. M. Luk, "Broadband patch antenna with a T-shaped probe," IEE Proc. Microw Trans. Antennas Propagat., vol. 147 , no. 2, Apr. 2000, pp 73-76.