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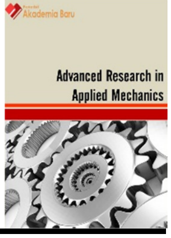

Millimetric Broadband Ankh Key Antenna for 5G Applications

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ABSTRACT

A simple design is proposed in this paper, supporting millimeter wave applications which can be used in short range wireless communications such as 5G applications. This design enhances the use of V-band and part of W-band, according to IEEE standards, as the antenna works in a range extending from 53 to 92 GHz, bandwidth of 39 GHz, with peak gain more than 7.5 dBi. The design is simulated using different numerical techniques achieving a very good agreement.

1. Introduction

The millimeter wave bands extend from 30-300 GHz providing up to multi- Gega bytes data transfer challenging researchers to work in this field. 5G technology is not available yet [6] but researchers are working on such technologies to meet their standards. FCC proposed new rules concerning the wireless broadband frequencies on October, 2015, (FCC 15-138) to be 28GHz, 37 GHz, 39 GHz, and 64-71 GHz bands [1-4]. Various researches were employed for the other millimetre wave applications but very few were done to support 5G technology.

In this paper, a new, simple, and low cost microstrip antenna design is proposed of dimensions 7.5 x 4.4 x 0.508 mm3 using two different simulators based on different numerical techniques, Hyperlynx IE3D [6], and CST Microwave Studio [7], where IE3D is using Method of moments (MOM) technique while CST is using Finite Difference Time Domain (FDTD). The results from both simulators showed a satisfying agreement to each other. The antenna is operating from below 53 GHz to 92 GHz achieving a broadside radiation pattern at the central frequency 73 GHz with a peak gain over 7.5 dBi and VSWR below 2.

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2. Single Element Design

The single element is designed to work in the V-band and part of the W-band ranges supporting 5G technology. It is a simple, low cost, and easily fabricated design with dimensions 7.5 x 4.4 x 0.508 mm^3 as shown in figure 1. The antenna is operating in the range from below 53 GHz to 92 GHz with a peak gain of 7.5 dBi.

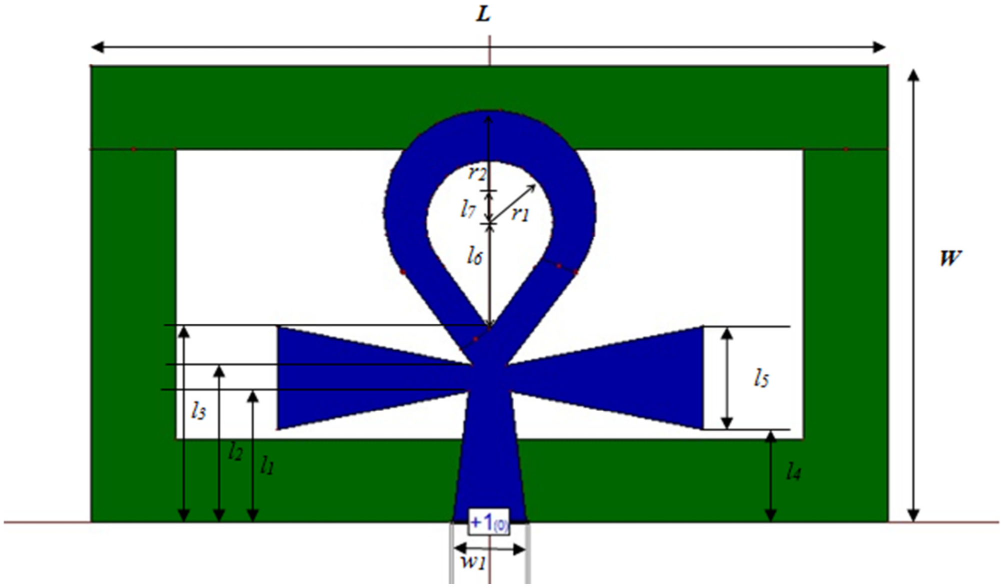

Fig. 1. Geometry of the proposed antenna

2.1 Design and Dimensions

The design is a typical pharaonic Ankh Key shape of dimensions 4 mm x 3.9875 mm and fed with 50Ω microstrip line of length l_1 = 1.2625 mm and widths of w_1 = 0.7 mm, w_2 = 0.4 mm and w_3 = 0.32 mm. The patch is designed at a height h = 0.508 mm from the rectangular ground frame of dimensions L = 7.5 mm and W = 4.4 mm. This height is a Rogers Duroid RT 5880 dielectric substrate having relative permittivity ε_r = 2.2 and loss tangent tanδ = 0.0009 which is considered in the calculations. Table I shows the parameters of the designed patch.

The achieved design is a modification of a similar patch but with different ground structure having a dimension of 7.5 x 7.5 mm^2 as shown in figure 2. This antenna can be used in a bandwidth between 60.5 GHz to 72 GHz with a peak gain of 8.3 dBi.

Table 1
Parameters of the proposed antenna

Parameter	l_2	l_3	l_4	l_5	l_6	l_7	r_1	r_2
Dimension (mm)	1.5125	1.8675	0.8875	1	1.025	0.095	0.6	1

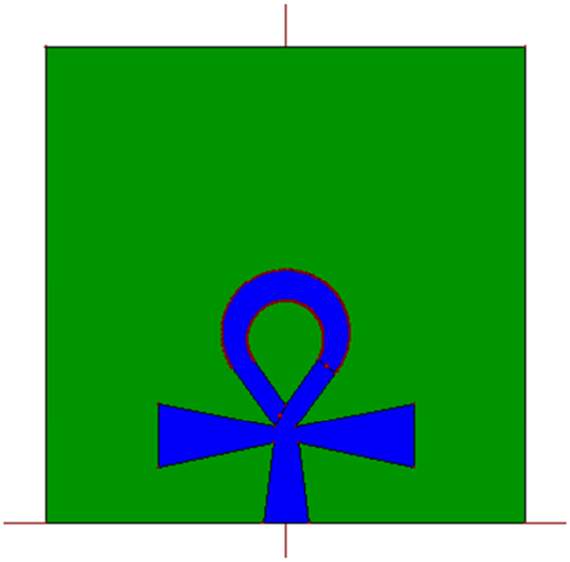

Fig. 2. Referenced design

2.2 Results

Figures 3 and 4 show a comparison result between the FDTD (CST) and MOM (IE3D) results for return loss, S_{11}, and peak gain respectively. The bandwidth of FDTD is 36.5 GHz starting from 55.5-92 GHz, while of MOM is 39 GHz starting from 53-92 GHz. Although the results can have slight differences, but these differences are accepted as they both have almost the same range results. These differences can be due to the different solving numerical techniques as MOM technique is faster but less accurate than FDTD, thus taking this as an advantage for faster optimizations. It can be observed that maximum gain in both simulators reached almost the same results of 7.5 dBi at 57GHz and 6 dBi at 63GHz as shown in figure 3.

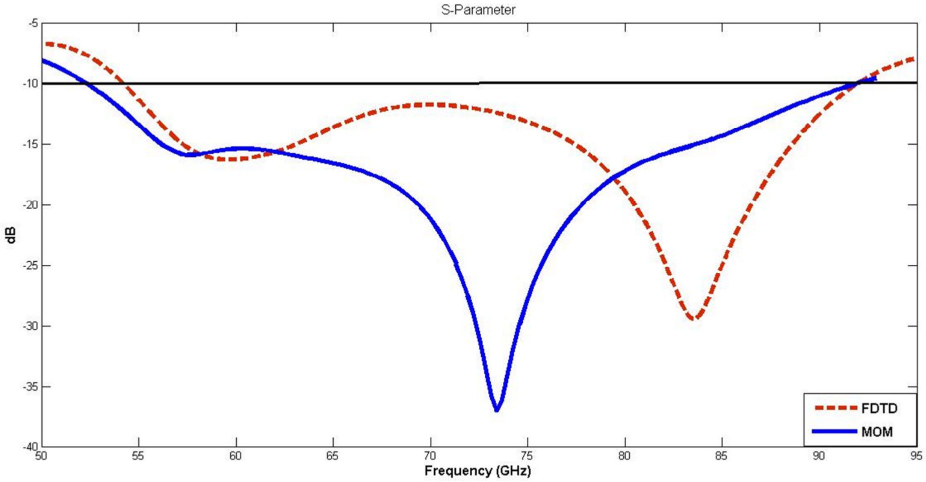

Fig. 3. Simulated return loss, S_{11}, for single element

Figures 5 shows the 3D radiation pattern geometry, *E-plane* and *H-plane* respectively, at different frequencies; 59 GHz, 65 GHz, 73 GHz, 80 GHz, and 87 GHz observing some changes by changing the frequency where the main lobe is reflected 180° for frequencies above 70 GHz.

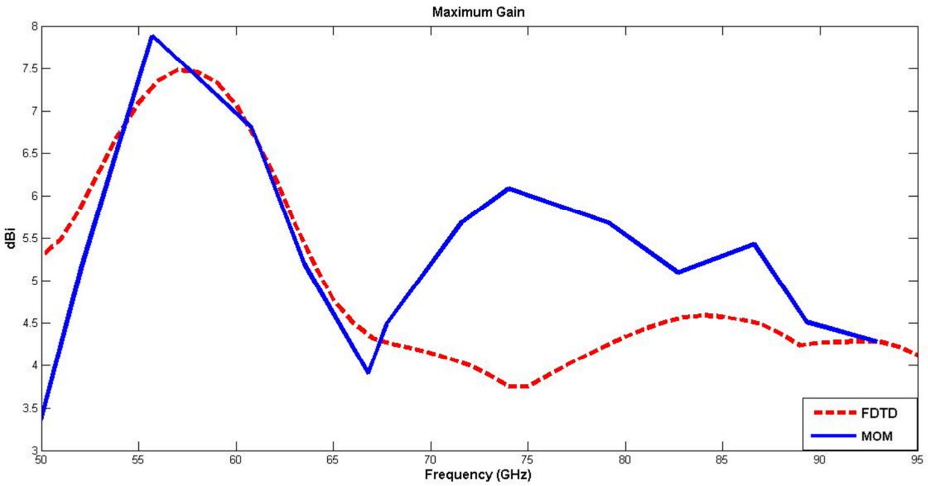

Fig. 4. Simulated peak gain for single element

3. Conclusion

In this paper, a small microstrip antenna design is proposed of dimensions 7.5 x 4.4 x 0.508 mm^3 enhancing the use of V-Band and part of W-band, specifically 5G technology, having a bandwidth of 39 GHz extending from 53 GHz to 92 GHz and peak gain above 7.5 dBi showing a very good radiation pattern in both E-plane and H-plane.

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