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Design of Microstrip Patch Antenna Array for 5G Resonate at 3.6GHz

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Authors' contributions

This work was carried out in collaboration among all authors. Author KZ designed the study, performed the result analysis and wrote the first draft of the manuscript. Authors AC and MYK managed the analyses of the study and the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The paper presents design of microstrip patch antenna array with two elements radiating for 5G C-band access point application resonating at 3.6GHz. Proposed antenna is designed on Rogers RO4350(tm) substrate with 3.54mm thickness and dielectric constant ε_r =3.66. The designed antenna has three slots, two placed on each radiating elements and one on the power line. Simulated by using HFSS17.02, the gain of the designed antenna is 9dBi and his bandwidth is 200MHz.

Keywords: Microstrip patch antenna; bandwidth improvement; return loss 5G.

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1. INTRODUCTION

The fifth generation (5G) mobile communication is a technology designed to improve the capacity of the networks with better coverage. It is also deigned to provide a theorical data rate of 1GB and latency time less than 1millisecond to support the big data and internet of things [1]. To achieve these objectives, the 5G need the large bandwidth.].Microstrip patch antennas are narrowband antennas in the order of 1-5% [2,3]. Various techniques have been carried out in the last three decades to improve the bandwidth of microstrip patch antenna [4,5]. These techniques can be impedance matching networks [6,7], parasitic or multiple resonators [8,9,10], frequency selective surface [11,12], the modification geometry of the radiating element [13,14,15] and the use of high substrates of low dielectric constant or the increasing of substrate thickness [3,4,16].

In this paper the microstrip patch antenna for 5G operate at 3.6GHz is presented. The bandwidth of designed antenna is increased by using the array configuration technique and modification geometry of the radiating element. The proposed antenna is adapted with the return loss of -34.8dB, a gain of 9dBi and a bandwidth of 200MHz.In the following section design and simulation of proposed antenna are presented.

2. DESIGN AND DISCUSSION OF RESULTS

The proposed antenna is an antenna array with two rectangular microstrip patch antenna, the spacing between there is 19,71mm. Firstly, the simple microstrip antenna is designed and optimized. The dimensions of the proposed simple microstrip patch antenna seen in the Fig. 1 are obtained by using the transmission line design equation. The width is given by (1) and the actual length is gated by using (2).

$$W = \frac{v_0}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \quad (1)$$

$$L = \frac{v_0}{2\, f_r\sqrt{\epsilon_{eff}}} - 2\Delta l \quad (2)$$

Where v_0 is the free-space velocity of light.

The input resistant for inset- feed is determined by solving (3).

$$R_{in}\,(y = y_0) = R_{in}\,(y = 0)cos^2\,(\frac{\pi}{L}y_0) \quad (3)$$

The proposed structure is simulated under HFSS 17.02, the reflection coefficient is showed in the Fig. 2. The basic structure presents a low bandwidth at -10dB.In the following part two techniques have been used to increase this bandwidth.

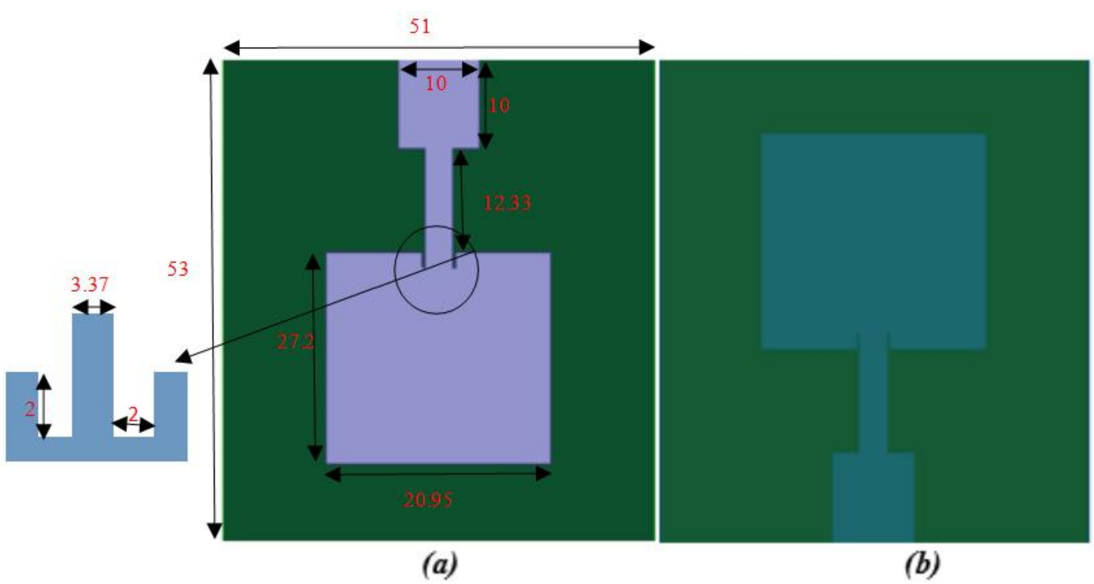


Fig. 1. Basic structure top view (a) bottom view (b)

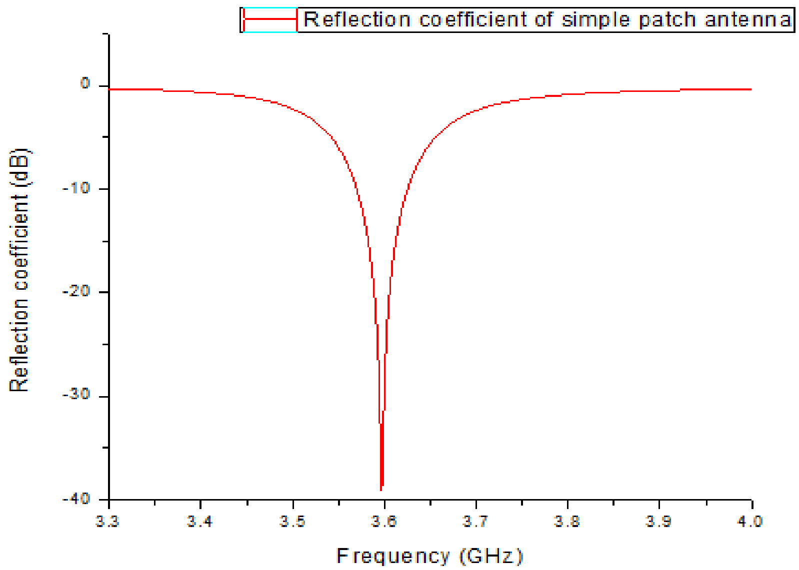


Fig. 2. Reflection coefficient for the basic structure

The last basic structure has been networked, the thickness of the substrate is increased and the slot with a dimension 10mmx2mm is placed on the line of power source. The thickness of substrate has been increased by the optimization of his gap between 1.54 to 7.54mm with a pitch of 1mm.The best result is obtained when the thickness of substrate is 3.54mm (Fig. 3) but the bandwidth is not wide to 5G in 3.4-3.8GHz band. In each radiating elements, one slot with a dimension of 22mmx2mm has been inserted. The slots are placed on each patch to create a new resonance and increase electrical length. The new resonance will be coupling with the principal resonance to increase the bandwidth.

The Fig. 4 shows the final structure antenna array and its simulation result is given by Fig. 5. The bandwidth is increased and the proposed antenna has the good reflection coefficient, it is acceptable resulted compared with the conventional antenna array.

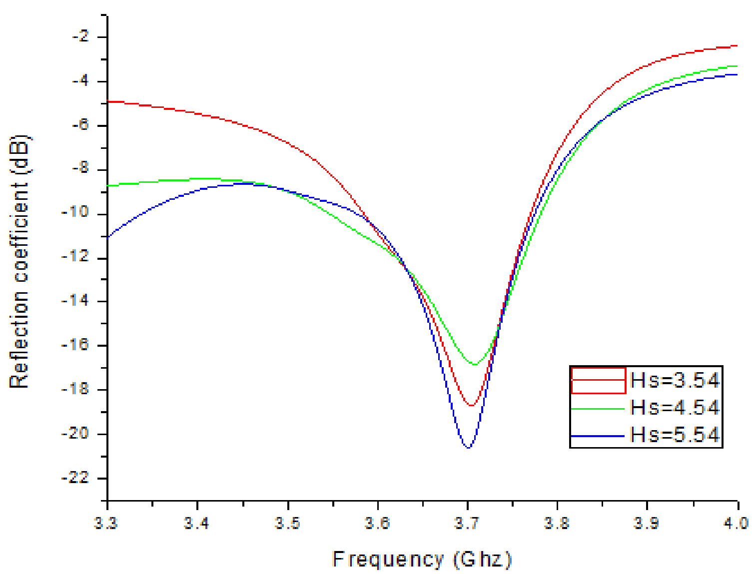


Fig. 3. Reflection coefficient for the first modification

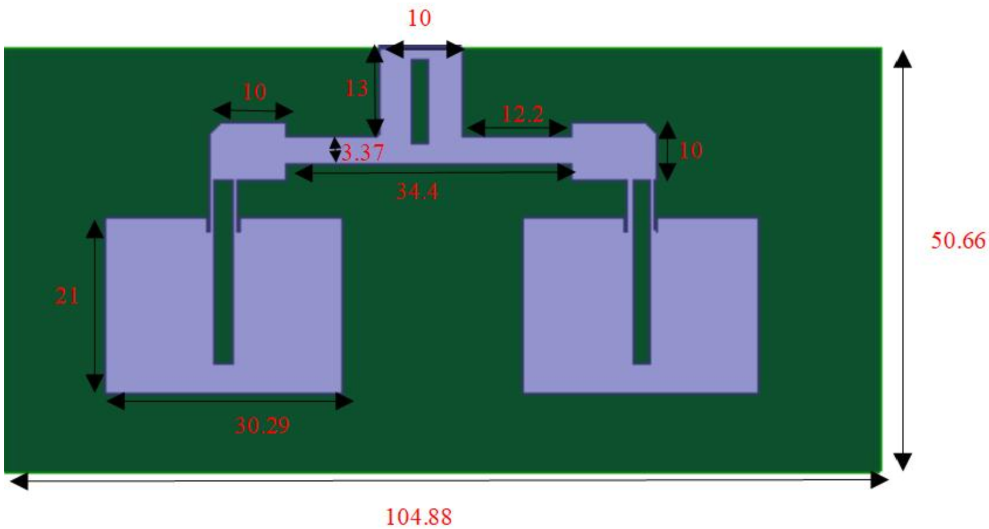


Fig. 4. Top view of proposed antenna

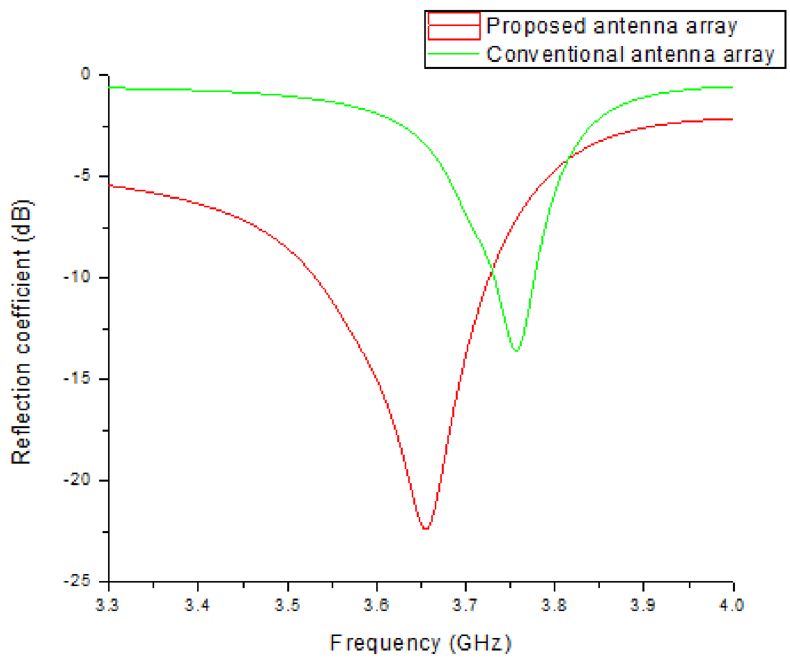


Fig. 5. Reflection coefficient for antenna array with three slots and for the conventional antenna array

The proposed antenna doesn't resonate at the theorical frequency, to bring it at the desired frequency, the length and the width of radiating elements are optimized. For patch length, parametric study is done between 19 to 22mm with a 0.25mm pitch. It is observed in the Fig. 6, the optimal length of radiating element to maintain the bandwidth at 200 MHz is 21mm. And for patch width parametric study is done between 25.29 to 35.29mm with a step of 1mm.The following Fig. 7 shows the reflection coefficient curve of this study. The better result is when the patch width is 30.29mm

The proposed antenna is antenna array with two radiating elements printed on the Roger

RO4350(tm) with thickness of 3.54mm. The gain and the radiation efficiency of the proposed antenna are acceptable. The flowing figure show these radiation Parten ant the radiation.

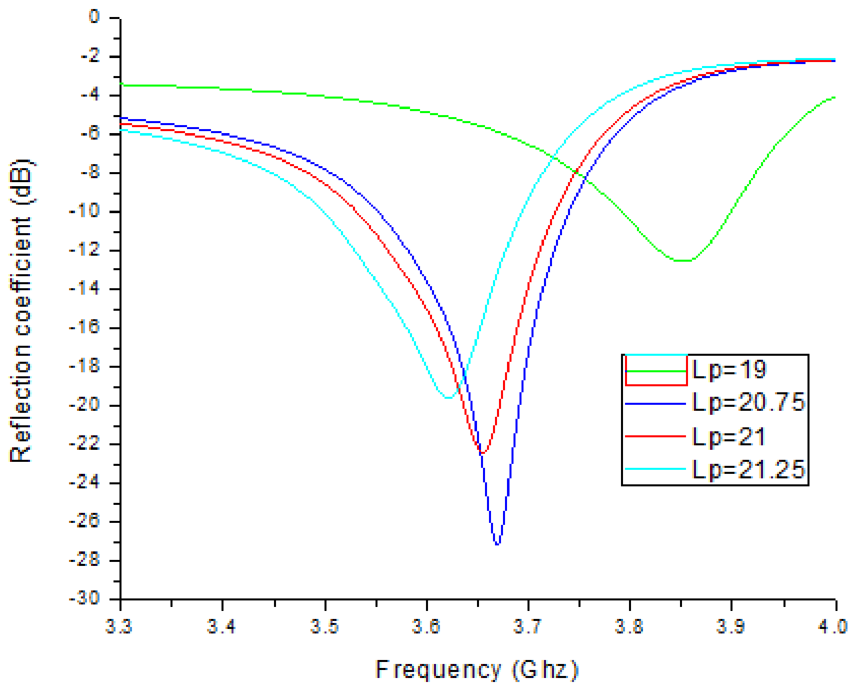


Fig. 6. Reflection coefficient for different length of patch

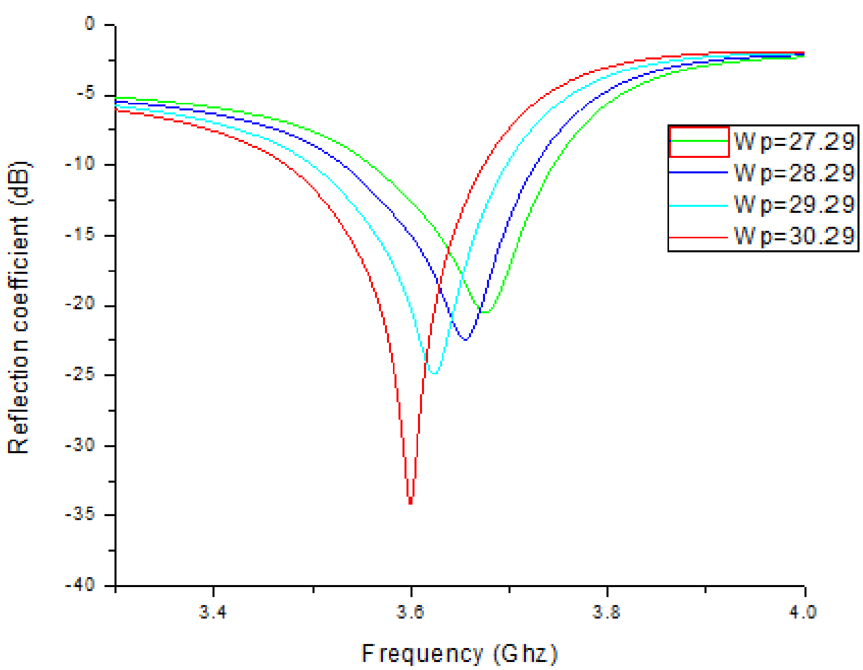
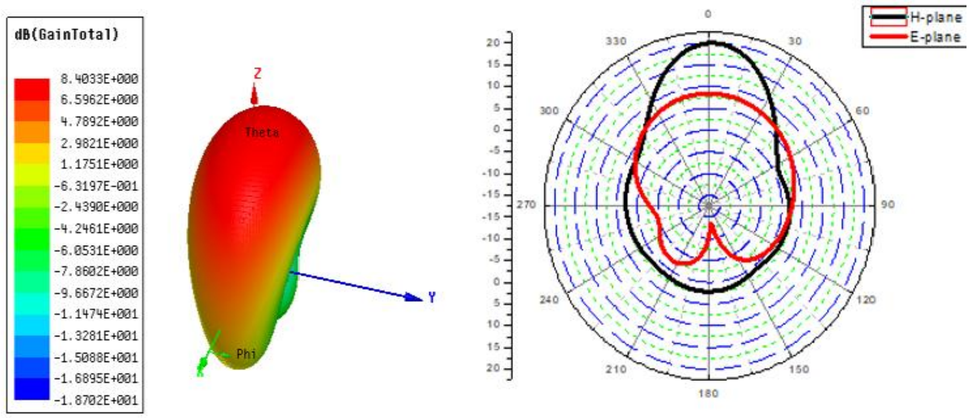
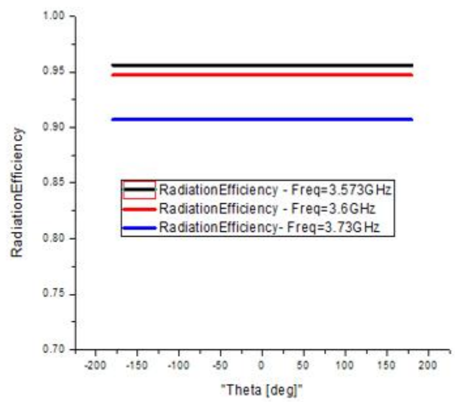


Fig. 7. Reflection coefficient for different width of patch



(a)



(b)

Fig. 6. Gain of proposed antenna (a), Radiation efficiency (b)

3. CONCLUSION

The article proposed microstrip patch antenna 5G C-band access point application resonating at 3.6GHz. The designed antenna is done by two part. Firstly, the basic microstrip antenna is designed and optimized. The basic structure antenna has a low bandwidth. This bandwidth is enhanced by networking the basic structure, increasing the substrate thickness and inserted two slots in each radiating element and one on the power line. The final proposed antenna has 200MHz of the bandwidth, gain and a good radiation efficiency.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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