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Design of Circular Patch with Double C-Shaped Slot Microstrip Antenna for LTE 1800 MHz

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Abstract

The design of a circular patch microstrip antenna with double C-shaped for LTE 1800 MHz is presented. The antenna is designed using FR-4 with dielectric constant of ε = 4.3, with thickness of substrate that is 1.6 mm and the thickness of patch and ground are 0.025 mm, Respectively the simulation results presented that the antenna works at frequency of 1714-1889.6 MHz, and work very well at frequency of 1800 MHz with a Return loss -20.484 dB, bandwidth 175.6 MHz. Technique used for broaden the bandwidth by using double C-shaped slot. In this paper presents S-Parameters, and Gain of microstrip antenna circular patch with double C-shaped slot.

Keywords*: Microstrip Antenna, LTE, C-Shaped Slot.*

1. Introduction

The microstrip antennas are increasingly used for wireless application, because of their low cost, easily construction and fabrication [1-2]. The most commonly used microstrip antennas are rectangular and circular patch [3-4]. However, the microstrip antenna has a weakness in bandwidth. To overcome it, there are several ways to broaden the bandwidth such as by making slots and widening of the substrate [5]. In paper [6], the authors have developed the slotted Circular Microstrip Antenna. The antenna has circular polaritation and wide bandwidth. In paper [7], the authors have developed the Planar Finger-Shaped Antenna Used in Ultra-Wideband Wireless Systems, the authors proved that three slots have performed large bandwidth width dual band. The microstrip antenna has supported for LTE application, because of the advantages it has. LTE band frequency in the range of 1710–2690 MHz [8-10]. Various types of antennas have been proposed by the previous researchers, including reconfigurable phased of Antenna Array [11], Monopole Antenna [12], Loop Antenna [13], Slot Antennas [6-7], etc. This paper presented design of microstrip circular patch with double C-shaped slots antenna, with operating frequency at 1800 MHz for LTE application.

2. Antenna Design

In this paper, circular patch microstrip antenna with double C-shaped slot is designed at 1800 MHz for the circular patch, the radius a is determined by using the following Equations [14];

$$a = \frac{F}{\{1+\frac{2h}{\pi\varepsilon_r F}\left[\ln\left(\frac{\pi F}{2h}\right)+1.7726\right]\}^{1/2}} \quad (1)$$

Where,

$$F = \frac{8.791*10^9}{f_r\sqrt{\varepsilon_r}} \quad (2)$$

F = logarithmic functions radiation element
h = height substrate
ε_r = dielectric constant of substrate

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f_r = Resonant frequency

The antenna is designed and simulated by using CST Software, FR-4 with permitivity of : 4,3, and height of 1.6 mm is chosen.

Table 1. Dimensions of the proposed antenna

Parameters	W_1	L_1	W_3	h_1	D_1	h_2	W_2	L_2	D_2	D_3
Value (mm)	114	109	8	4	32	54	79.2	84.5	30	19

Table 1 and Figure 1 show the dimensions of the proposed antenna, the circular patch has a diameter of 32 mm.

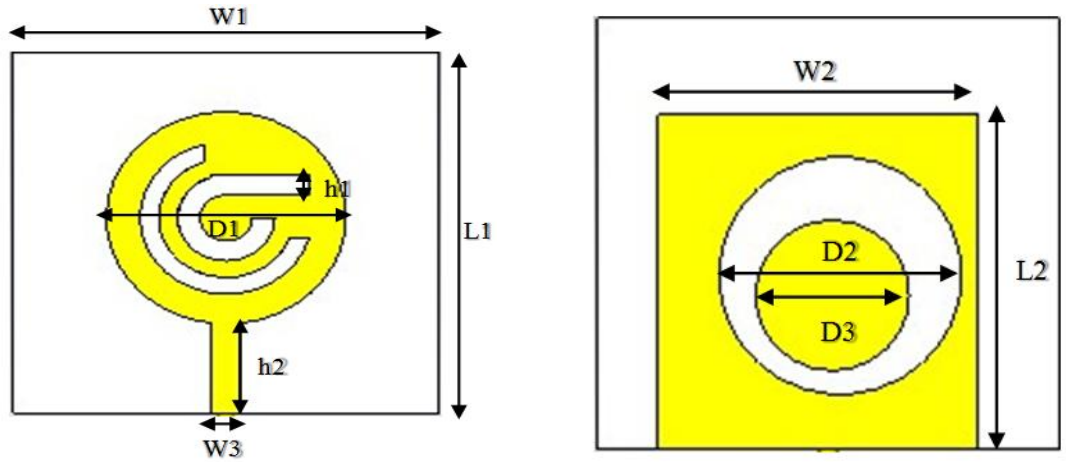


Figure 1. Dimensions of the proposed antenna (a) front view (b) back view

3. Results and Discussions

In this section, detailed simulation and experimental results of the proposed antenna are presented. Figure 2 shows the optimization result of the proposed antenna. The optimization aims to get a working frequency of 1800 MHz as well as to determine other parameters.

Table 2. Optimization Result of the proposed antenna

Number optimization	1	2	3	4	5
L (mm)	84.5	84.5	84.5	84.5	**84.5**
W (mm)	77	82	78	70	**79.2**

Table 2 shows that W_2 size of the ground of antenna may effect the value of the frequency range, bandwidth and returnloss. The optimization result is shown in Figure 2, which is performed of 5 times. The optimization has been done for W_2 sizes of ground plane. For the first optimization with size W_2 of 77 mm, the S-1,1 result of -20,375 dB at 1812.8 MHz, the second optimization with size W_2 of 82 mm, the S-1,1 result of -20,657 dB at 1802.4 MHz, the third optimization with size W_2 of 78 mm, the S-1,1 result of -20,929 dB at 1799.5 MHz, the fourth optimization with size W_2 of 70 mm, the S-1,1 result of -20,675 dB at 1788 MHz, and last the fifth optimization with size W_2 of 79.2 mm, the S-1,1 result -20,485 dB at 1800 MHz figure [2].

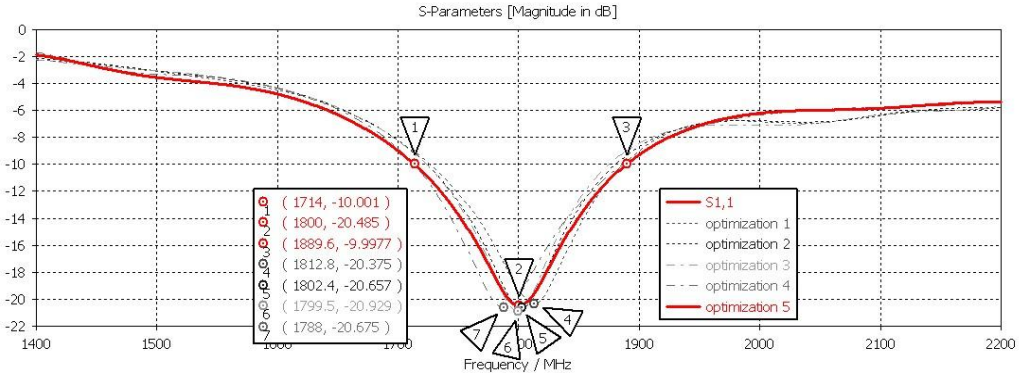
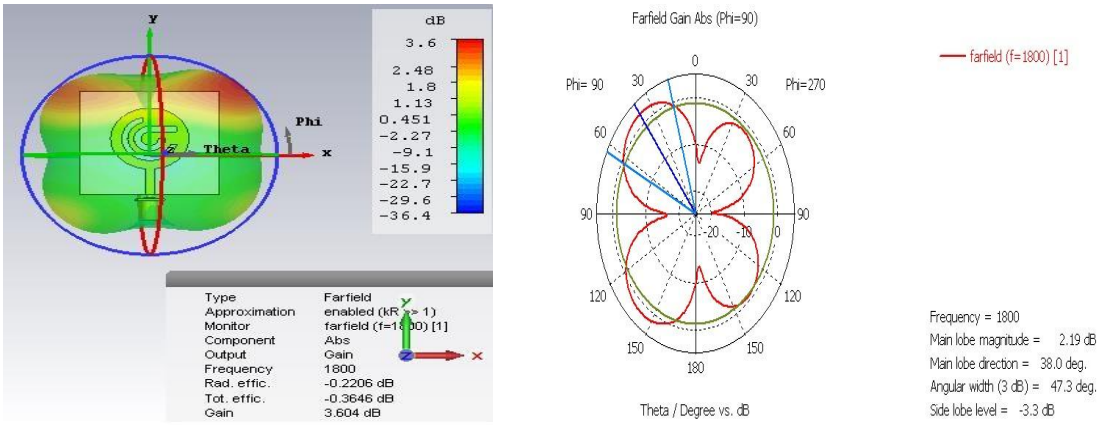


Figure 2. Optimization Result of the proposed antenna

From the 5 times optimization, the best result is proved by the fifth optimization 5, with Return loss of -20, 485 dB at 1800 MHz, and bandwidth 175.6 MHz.



(a) (b)

Figure 3. Radiation pattern of the proposed antenna (a) Radiation Pattern 3D (b) Radiation Pattern Polar

Figure 3 shows the gain of the antenna. From the simulation result, the gain obtained is 3.504 dB, with radiation pattern is nearly omni-directional.

4. Conclusion

According to the antenna design, analysis and simulation have successfully designed microstrip antennas working on an LTE channel with a frequency range of 1714-1889.6 MHz. The simulation results obtained antenna works well at a frequency 1800 MHz with a return loss -20. 485 dB, the bandwidth value is 157.6 MHz and the gain value is 3.504 dB. The radiation pattern of the proposed antenna is nearly omni-directional.

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