Design of Dual-band Coplanar Dipole Antenna for LTE Applications

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Abstract. In this paper, we propose a simple structure of coplanar dipole antenna with a tuning stub. The antenna which exhibits dual band is designed and fabricated respectively. The influences of stub length parameter of coplanar dipole antennas on the resonant frequency, return loss and bandwidth are also discussed. We use IE3D software to design coplanar dipole antennas and choose the better stub length parameter to manufacture coplanar dipole antenna. The proposed antenna here with the size of 150mm$\times$30mm$\times$1.6mm possesses the dual-band characteristics, 692MHz-832MHz and 1451MHz-1926MHz. The fabricated antenna is suitable for long term evolution (LTE) applications at 700MHz and 1800MHz.

Introduction

Today, wireless communication devices are developed rapidly. The process with the fourth industry revolution links production and high quality service to form highly flexible production. The internet of things enables objects to exchange data with other connected devices. These devices collect useful data and flow the data between other devices. In many wireless communication devices, antenna plays an important role on transmitting and receiving data of these devices. Compact size, lower cost and easy fabrication are important factors to design antenna that can be used in wireless communication [1,2,3]. Coplanar antennas possess these attractive features. Hence, many studies about coplanar antennas have been proposed and widely used in wireless communication systems [4, 5, 6].

This research will carry on design, simulation and fabrication of coplanar dipole antenna in the range of 700MHz and 1800MHz frequency bands. This coplanar dipole antenna can be applied to the 4G wireless communication system. The stub length of the coplanar dipole antenna will be changed to design the proposed antenna. The IE3D software will be used to design and simulate the coplanar dipole antenna and find out the better stub length parameter of the coplanar dipole antenna. The implemented coplanar dipole antenna can be applied to the 700/1800MHz wireless communication system.

Antenna Design

The proposed antenna has a volume of 150mm$\times$30mm$\times$1.6mm. The proposed coplanar dipole antenna structure is printed on a single metallic layer of FR4 dielectric substrate which has permittivity of 4.4 and thickness of 1.6mm. The configuration of this proposed antenna is depicted in Fig.1. In this figure, two symmetric stubs are etched on the metallic layer to create the operating frequency bands. Points A and B are the feeding points of the coplanar dipole antenna. We adjust the stub length parameter W1 to observe the variations with respect to the resonant frequency and impedance bandwidth of the proposed antennas. The dimension parameters of the proposed antenna
shown in Fig.1 are listed below: \( L_1 = 25\text{mm}, L_2 = 3\text{mm}, L_3 = 11\text{mm}, L_4 = 5\text{mm}, G = 1\text{mm}, W_2 = 36\text{mm}, W_3 = 11.5\text{mm}, W_4 = 71.5\text{mm}, W_5 = 3\text{mm} \). The 50 ohm coaxial connector was adopted for testing.

![Figure 1. Geometry of the proposed coplanar dipole antenna.](image)

**Simulations**

The characteristics of the proposed antenna were simulated by means of using IE3D software. The simulated curves of return loss against frequency for changing \( W_1 \) shown in Fig.1 of the proposed antenna are shown in Fig.2. It can be seen that the proposed antenna with stub structure can excite the dual frequency bands.

![Figure 2. Simulated return loss of the proposed antenna with varying \( W_1 \).](image)

From this figure, it is easy to find that the lower operating frequency band of the proposed antenna is nearly unchanged with varying \( W_1 \). The upper operating frequency band and resonant frequency are shifted to lower frequency with increasing the value of \( W_1 \). Carefully adjust the stub length parameter could excite the dual frequency bands that can be used in 700/1800MHz LTE wireless communication system.

**Experimental Results and Discussion**

From the simulation results, we use the same geometric parameters to fabricate the proposed antenna. The photography of fabricated antennas is shown in Fig.3. The measured curves of return loss against frequency with varying \( W_1 \) of the fabricated antenna are illustrated in Fig4.
As shown in Fig.4, dual operating frequency bands are also obtained. The measured lower operating frequency band is nearly unchanged with varying stub length W1. The measured upper operating frequency band and resonant frequency also exhibit shifting to lower frequency with increasing stub length. The measured return losses of the fabricated antennas with W1=42.5mm and W1=40.5mm meet the requirements at 700MHz and 1800MHz bands. We choose W1=42.5mm to measure the radiation patterns of the fabricated antenna due to its larger bandwidth at 1800MHz band. The simulated and measured return losses of the proposed antenna with W1=42.5mm are shown in Fig. 5. In this figure, we observe the trend of simulated and measured results are in good agreement. The measured return loss (RL), lower side f1 and upper side f2 of operating frequency band, and bandwidth of the fabricated antenna with W1=42.5mm are listed in Table 1. The measured radiation patterns testing at the operating frequency are shown in Fig.6. The measured peak gains for testing frequencies at X-Z and Y-Z plane of the fabricated antenna with W1=42.5mm are listed in Table 2. From Fig.6, it can be observed that the radiation patterns are almost omnidirectional in the Y-Z plane. The omnidirectional antenna radiation pattern indicates that the fabricated antenna is good for mobile devices. The measured peak gains of the fabricated antenna with W1=42.5mm at 700MHz and 1800MHz are 2.654dBi and 4.104dBi, respectively. The fabricated antenna can be used for LTE 700/1800MHz applications. Therefore, carefully designed with tuning the stub length could obtain the desired resonant frequency and bandwidth.
Figure 5. Simulated and measured return losses of the proposed antenna with $W_1=42.5\text{mm}$.

Figure 6. Measured radiation patterns for $W_1=42.5\text{mm}$ of the fabricated antenna.
Table 1. Measured results of the fabricated antenna with W1=42.5mm.

<table>
<thead>
<tr>
<th>Frequency band (MHz)</th>
<th>RL(dB)</th>
<th>f1, f2 (MHz)</th>
<th>BW (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>700</td>
<td>-18.9</td>
<td>692, 832</td>
<td>140</td>
</tr>
<tr>
<td>1800</td>
<td>-24.9</td>
<td>1451, 1926</td>
<td>475</td>
</tr>
</tbody>
</table>

Table 2. Measured peak gain of the fabricated antenna with W1=42.5mm.

<table>
<thead>
<tr>
<th>Operating Frequency (MHz)</th>
<th>X-Z plane Peak gain (dBi)</th>
<th>Y-Z plane Peak gain (dBi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>700</td>
<td>2.336</td>
<td>2.654</td>
</tr>
<tr>
<td>1800</td>
<td>2.288</td>
<td>4.104</td>
</tr>
</tbody>
</table>

Summary

In this study, the fabricated coplanar dipole antenna exhibits simple planar structure. It can excite dual frequency bands that can be used in 700/1800 MHz. Therefore, carefully choose the designed length parameter of the stub would implement the suitable antenna that can be used at the desired frequency band. The fabricated antenna can be built as an on-board antenna. This will reduce the manufacturing cost of a device. The fabricated antenna with the size of 150mm×30mm×1.6mm has dual frequency bands of 700MHz and 1800MHz. The fabricated antenna possesses peak gain of 2.654dBi and 4.104dBi at 700MHz and 1800MHz, respectively. This coplanar dipole antenna is suitable for long term evolution applications at 700MHz and 1800MHz bands.

References


