A Dual-Band Chip Antenna for Handheld Cell-phones Application

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1. Introduction

Currently, the volume of wireless terminal phones has been designed smaller than before. Antenna is one of the most important elements in a communication system. In order to reduce the effects of *Electromagnetic Interference* (EMI) / *Electromagnetic Compatibility* (EMC) and the excited current of an antenna on the system ground (GND) plane, an isolated distance between an antenna and electronic components in phones is suggested not less than 7 mm [1-2]. The most internal radiators are made by using printed techniques due to such characteristics as low-profile, low-price, and easier fabrication [3-6]. Many studies on miniaturization of antennas by using dielectric materials are already reported in [7]. Decreasing the effects of the GND plane to the performances of an antenna, the type of chip configuration antenna is presented with meander lines. The presented antenna is designed in *Industrial, Scientific, and Medical* (ISM) band of 2.4 GHz and *Unlicensed National Information Infrastructure* (U-NII) - 5 GHz. The impedance bandwidth of the designed antenna between 2.3 - 2.5 GHz and 5 - 5.5 GHz is covered referring to -10 dB *Return Loss* (RL). The total volume of the antenna is 10 (L) x 10 (W) x 0.2 (H) mm^3, which is greatly reduced by 70 % comparing to generally internal radiators. The ratio of impedance bandwidth of the antenna in relation to central frequencies (2.4 and 5.2 GHz) is 8.3 % and 10 %, respectively.

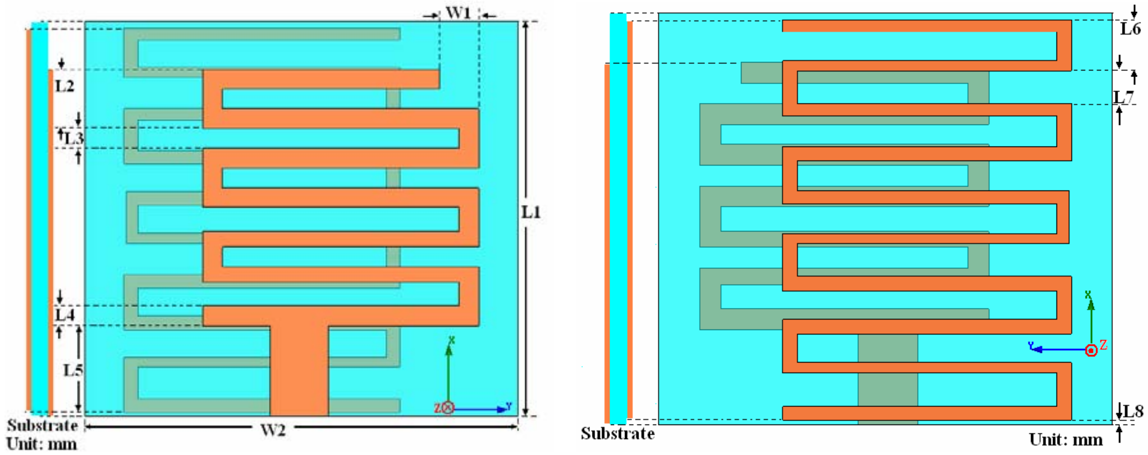
The experimental results compared to the numerical simulator *High Frequency Structure Simulator* (HFSS) can be fairly good agreement. The good characteristics of the antenna such as omni-directional far-field radiation patterns can be obtained.

2. Antenna Design

To satisfy commercial products application, this proposed antenna is actually mounted on the PCB size of a real phone according to the Dopod P100 mobile telephone specifications [8]. The material FR4 is used to be a substrate (SUB) of the antenna of which is 10 (L) x 10 (W) x 0.8 (H) mm^3. The relative permittivity of the FR4 is 4.4. The geometry of the antenna is shown in Fig. 1. The detailed dimensions of the presented antenna and the substrate are L1 = 10 mm, L2 = 1.5 mm, L3 = L4 = 0.5 mm, L5 = 2.3 mm, L6 = 0.25 mm, L7 = 0.8 mm, L8 = 0.1 mm, W1 = 1 mm, W2 = 10 mm. The radiator is mounded on the top of the SUB of which is made by using conductive metal meander lines.

3. Experiment Results

The far-field anechoic chamber and *Vector Network Analyzer* (VNA) HP 8720C are used to measure the electrical characteristics of the antenna. The experimental results are compared to the numerical simulator HFSS. The *Return Lose* (RL) of the antenna is shown in Fig. 2. It illustrates that the measured impedance bandwidth of the antenna between 2.3 - 2.5 GHz and 5 - 5.5 GHz is covered referring to -10 dB RL. The ratio of impedance bandwidth of the antenna in relation to central frequencies (2.4 and 5.2 GHz) is 8.3 % and 10 %, respectively.



(a) (b)

Figure 1: Geometry of the antenna (a) top side, (b) opposite side

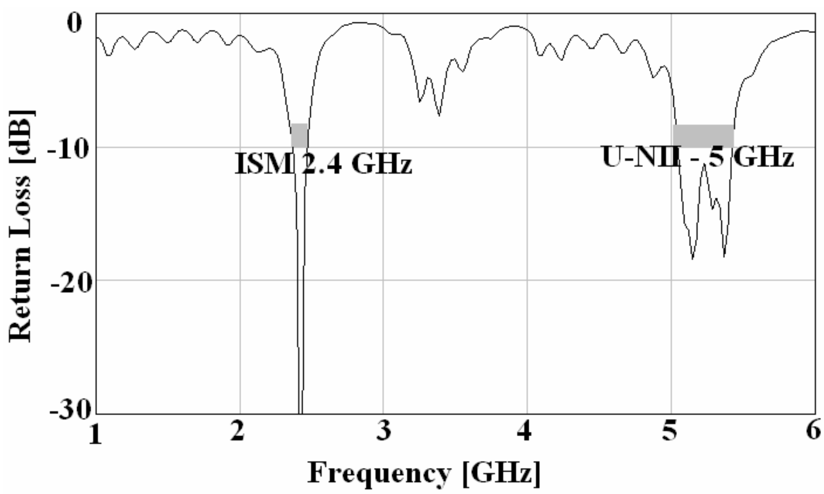


Figure 2: Return lose (RL) of the antenna

These far-field radiation patterns of the antenna at these resonant frequencies of 2.4, 5, 5.2, and 5.4 GHz are shown in Fig. 3 to Fig. 6. The values of peak gain of the antenna on the azimuth (H_plane) at these resonant frequencies of 2.4, 5, 5.2, and 5.4 GHz are -9.6, -6.0, -5.7, and -3.9 dBi, respectively. The values of peak gain of the antenna on the elevation (E_plane) at these resonant frequencies of 2.4, 5, 5.2, and 5.4 GHz are -5.8, -6.2, -6.0, and -4.0 dBi, respectively.

4. Conclusions

A small chip antenna with meander lines is presented for portable terminal phones application. It has the good characteristics of omni-directional radiation patterns. The antenna works in ISM band of 2.4 GHz and U-NII - 5 GHz band of 5 - 5.5 GHz. The total volume of the antenna is 10 (L) x 10 (W) x 0.2 (H) mm^3, which is greatly reduced by 70 % comparing to generally internal radiators. The experimental results are compared to numerical simulator HFSS can be agreement. The radiator led to compact requirement, and the manufacture is therefore quite easy.

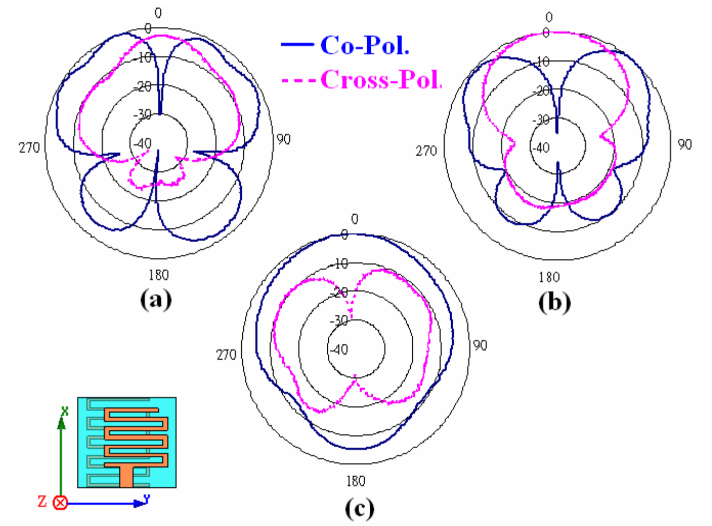


Figure 3: Measured radiation patterns of the antenna at 2.4 GHz (a) x-y, (b) z-x, and (c) y-z plane

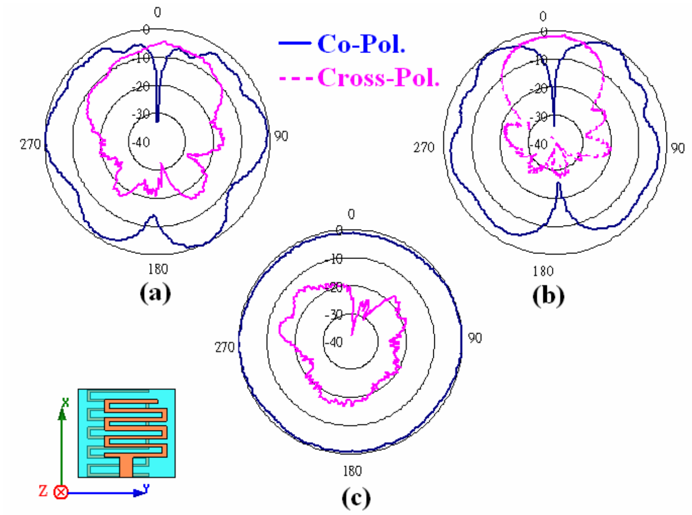


Figure 4: Measured radiation patterns of the antenna at 5.0 GHz (a) x-y, (b) z-x, and (c) y-z plane

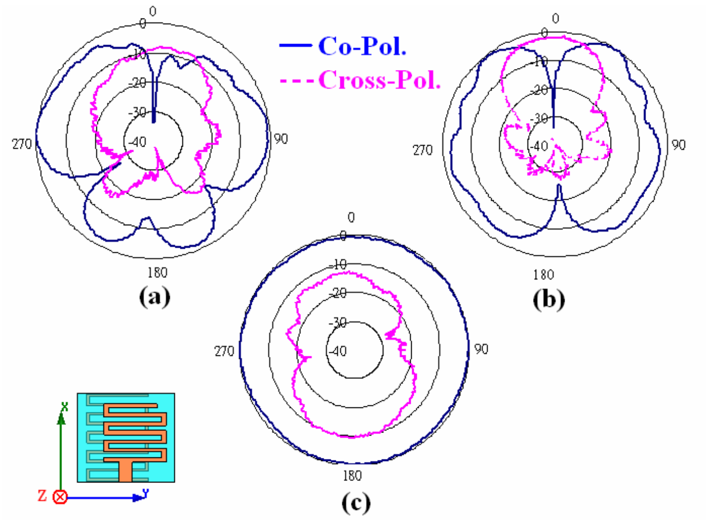


Figure 5: Measured radiation patterns of the antenna at 5.2 GHz (a) x-y, (b) z-x, and (c) y-z plane

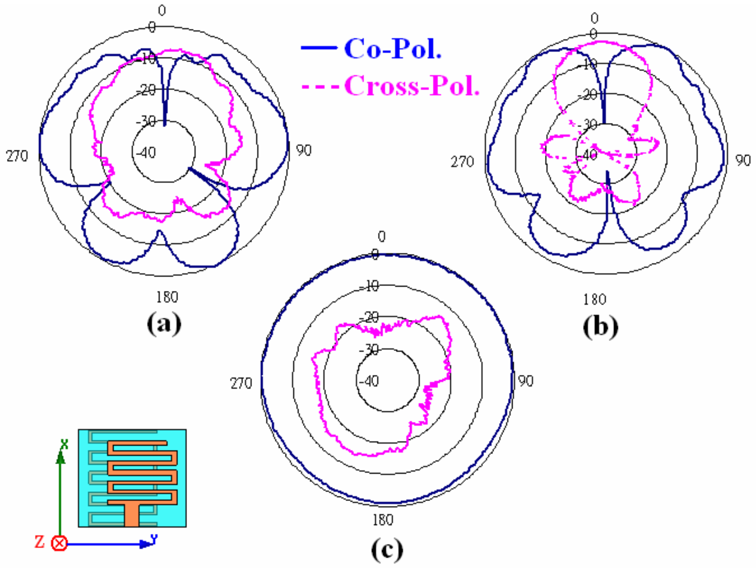


Figure 6: Measured radiation patterns of the antenna at 5.4 GHz (a) x-y, (b) z-x, and (c) y-z plane

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