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A Novel Compact Microstrip Antenna for Multiband Applications in Wireless Communication Systems

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Abstract
In this paper a microstrip fed multi-band antenna is presented. The compact size of the antenna is 30 × 18 × 1.6 mm^3, which makes it pretty to mobile devices. The antenna consists of three half-ring patches. The measured return loss $S_{11} \leq$ -10 dB of multiband antenna is achieved at the frequency bands WiMAX (2500–2690 MHz), WiMAX (3400–3600 MHz), and WLAN (5.725–5.825 GHz). The measured performance of the antenna confirms its multiband operation and omnidirectional radiation pattern.
Keywords: *Microstrip antenna, WLAN/WiMAX, Multiband antenna*

1. Introduction

The quick progress in the applications of mobile communication systems means that a single handset is currently required to deal with multi-standard facilities, such as voice, data, video, broadcasting, and digital multimedia. This has led to a great demand into designing compact multiband antennas for mobile handsets [1]. The design of antennas operating in multiband allows the wireless devices to be used with only a single antenna for multiple wireless applications, and thus permits us to reduce the size of the space required for antenna on the wireless equipment. The MSA plays an important role in the development of the new generation of wireless and mobile communication systems [2]. A large number of such antennas have been proposed [3]–[4], often with sizes that may be too large to be used practically. Some compact antennas have also been proposed [5]–[6].

In this article, the design of a simple CPW fed planar antenna with a square spiral-patch structure is initially proposed for exciting multi-resonance modes. It is able to cover the WLAN, Bluetooth (2400–2480 MHz), WiMAX (2500–2690 MHz), WiMAX (3400–3600 MHz) and WLAN (5.725–5.825 GHz). Note that the total area size of the proposed antenna is only 30 × 18 mm^2, and it is printed on a thin FR4 substrate of 1.6mm. A detailed analysis of the proposed antenna and typical experimental results are presented and discussed. Its design process and parametric studies via simulation are also thoroughly studied here.

2. ANTENNA STRUCTURE AND DESIGN

Fig. 1 shows the geometry of the proposed compact multiband antenna. The proposed multiband antenna is designed on an FR4 substrate with permittivity of 4.4 and a loss tangent of 0.022. The ultimate dimensions of the proposed antenna are presented in Fig. 1. In order to achieve impedance matching between SMA port and radiating patch, feed line length is fixed on 17 mm.

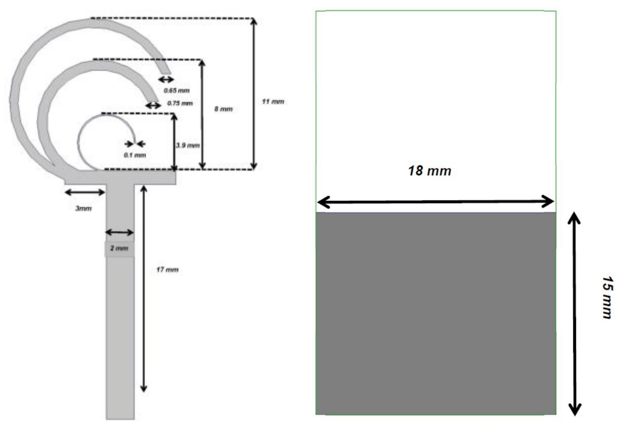

Fig. 1. Configuration of the antenna.

3. SIMULATIONS AND RESULTS

The antenna designing process for simulation is presented in Fig. 2. The proposed antenna structures are simulated using a High Frequency Structure Simulator (HFSS, ver. 13). In Fig. 3 the result of adding square spiral is discussed. Return loss specifications for four antennas presented in Fig. 2 are shown in Fig. 3. The contrast of S_{11} specifications is shown increasing number of frequency resonances. In Fig. 4 the result of S_{11} variation for different values of parameter g is discussed. As shown in Fig. 4, S_{11} response changes in resonance frequencies by using different values of parameter g, so finding the optimized value for g is important for the proposed antenna.

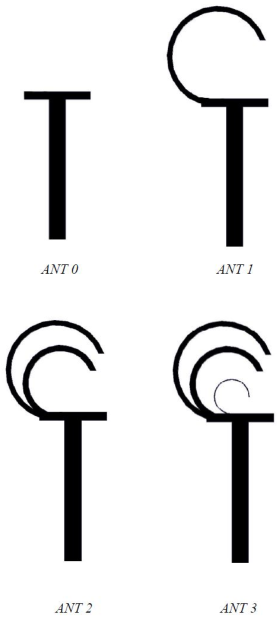

Fig. 2. The antenna designing process.

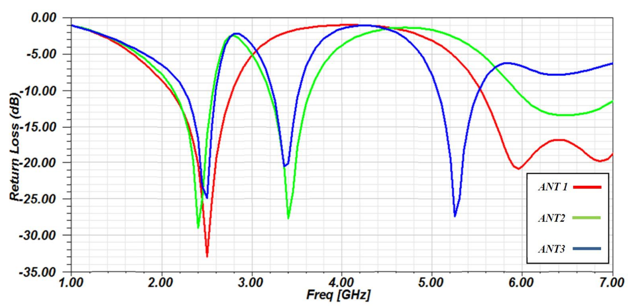

Fig. 3. Simulated S_{11} for different steps of antenna.

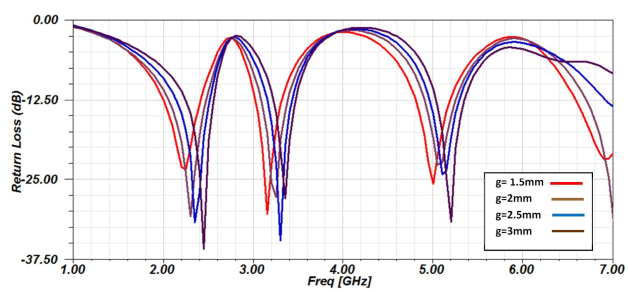

Fig. 4. Simulated S_{11} for different values of antenna with variation of g.

Fig. 5 shows normalized radiation pattern of the antenna at 2.4 GHz, 3.5 GHz and 5.5 GHz. The co and cross-polarized components of the field are different in the x–z (H-plane) and y–z (E-plane) plane. In the H-plane, the radiation pattern is Omni-directional at lower frequency and higher frequency.

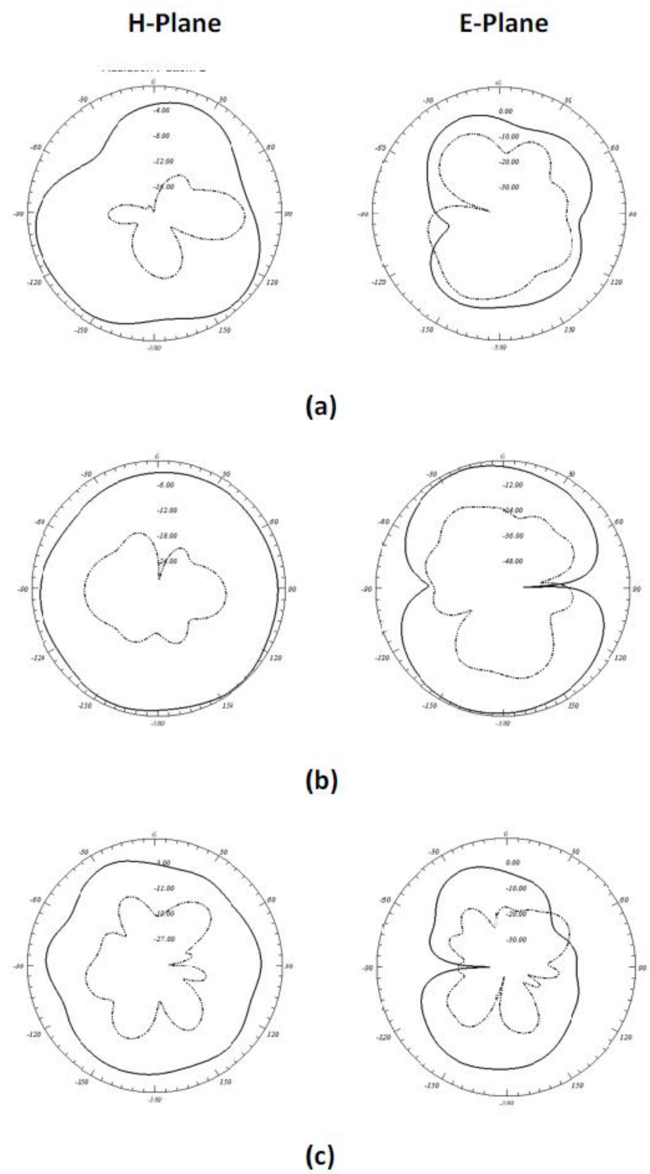

Fig. 5. Measured radiation patterns of the proposed antenna (a) 2.4 GHz (b) 3.5 GHz (c) 5.5 GHz.

The simulated current distributions of the proposed antenna are presented in Fig. 6. The surface current distributions have proposed antenna at 2.4 GHz (Fig. 6(a)), 3.5 GHz (Fig. 6(b)), and 5.5 GHz (Fig. 6(c)). The comparison of measured and simulated S_{11} plot is given in Fig. 7. The prototype of antenna is presented in Fig. 8.

Fig. 6. Simulated surface current distributions of the proposed antenna (a) at 2.6 GHz (b) at 3.5 GHz (c) at 5.8 GHz.

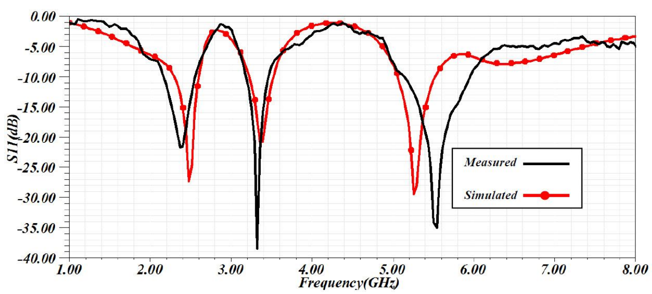

Fig. 7. Measured and simulated return loss CPW-fed antenna.

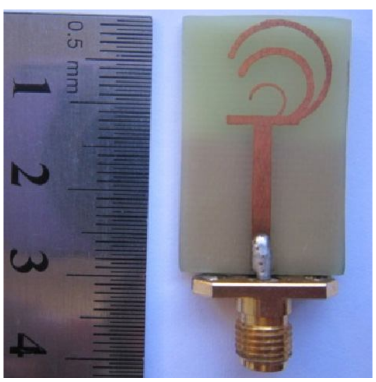

Fig. 8. Photograph of the fabricated multiband antenna.

4. Conclusions

A novel multiband antenna with three half-ring radiating patches is presented. The antenna covers WLAN and WiMAX frequency bands. By adding half-ring resonators, the numbers of frequency resonances are increasing. The result of the measured and simulated return loss are presented and discussed. The radiation pattern of antenna is satisfying.

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