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Heejun Yoon
Kwangwoon University

Frances J. Harackiewicz
Southern Illinois University Carbondale, fran@engr.siu.edu

Hanphil Rhyu
Kwangwoon University

Myun Joo Park
Kwangwoon University

Byungje Lee
Kwangwoon University

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Internal Antenna for Multiband Mobile Handset Applications

Heejun Yoon[(1)*], Frances J. Harackiewicz[(2)], Hanphil Rhyu[(1)], Myun-Joo Park[(1)], and Byungje Lee[(1)]
(1) Department of Radio Science and Engineering, Kwangwoon University
447-1, Wolgye-dong, Nowon-gu, Seoul, 139-701, Korea,
(2) Department of Electrical and Computer Engineering
Southern Illinois University at Carbondale, IL62901

Abstract

Design of a multiband internal antenna for mobile handset applications is presented. Two antenna elements are formed on top and bottom of the common substrate and connected by metallic pin. Resonant frequency of each element is almost independent. Matching the impedance with the slit, a wide bandwidth is achieved so that the operating frequency bands include GSM (880-960 MHz), GPS (1575 MHz), DCS (1710-1880 MHz), USPCS (1850-1990 MHz), and UMTS (1885-2200 MHz). Radiation patterns are omni-directional for all frequency bands. Details of the proposed antenna as well as the measured results are presented.

Introduction

Internal antenna has several advantages over usual external antennas. It makes the handset look more aesthetic and compact. Mechanically, the handset is also stronger and more robust because antenna is contained and protected on the inside [1]. However, since internal antenna is an electrically small, it has narrow bandwidth due to high Q and low efficiency [2]. There have been studied for improvement of these drawbacks. PIFA is commonly used to realize an internal antenna because of its low-profile and small characteristics.

The rapid growth of wireless communications demands for mobile phones to have multiband operations. Designing the multiband internal antenna is much more difficult because of the wide bandwidth requirement. In this paper, the proposed antenna is designed to have multiband operations, and it is layered PIFA which consists of two antenna elements operating almost independently. Therefore, characteristics of one antenna element such as return loss, impedance, and bandwidth are barely changed with modifying the other antenna element. Also, the proposed antenna obtains a wide bandwidth by realizing a matching slit so that it covers the five bands of GSM, GPS, DCS, USPCS, and UMTS.

Results and Discussions

Fig. 1 shows the proposed structure with the layered patches. The antenna consists of two patches, and each patch is placed at the top and bottom of FR4 common layer. The antenna is realized within a volume of $36 \times 14 \times 7$ mm^3 and mounted on a ground plane of 40mm $\times$ 58 mm. Lower patch includes a 50Ω feeding post and a shorting post. Upper patch is connected to lower patch by a 1.5mm diameter of metallic pin. Other

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dimensions are shown in Fig. 1(b). The simulated and measured return losses are shown in Fig. 2. The impedance behavior of the antenna with/without a matching slit is present in Fig. 3. It is noticed that impedance bandwidth in high frequency band becomes wider when the antenna has a matching slit on its lower patch [3]. The antenna has a bandwidth of 44% (VSWR<3) at the center frequency of 1920MHz covering higher bands, GPS, DCS, USPCS and UMTS. From the upper patch resonating at the lower frequency band, 7.5% of impedance bandwidth (VSWR<3) at the center frequency of 920 MHz is obtained and covered for GSM band. Therefore the proposed antenna covers all five bands. Fig. 4 shows radiation patterns in H- and E-plane at each operating frequency. The radiation pattern of H-plane is omni-directional in all bands. The measured peak gains are -1.07dBi, 1.43dBi, 1.02dBi, 1.18dBi, 1.84dBi for GSM, GPS, DCS, USPCS, and UMTS band, respectively.

Conclusion

The analysis and design of a multiband internal antenna with a layered PIFA is presented. The proposed antenna has two radiating elements resonating independently each other. Thus, the impedance can be easily matched by using a matching slit for both antenna elements. The proposed antenna operates for GSM, GSP, DCS, USPCS and UMTS bands, and its performance is verified by simulated and experimental results.

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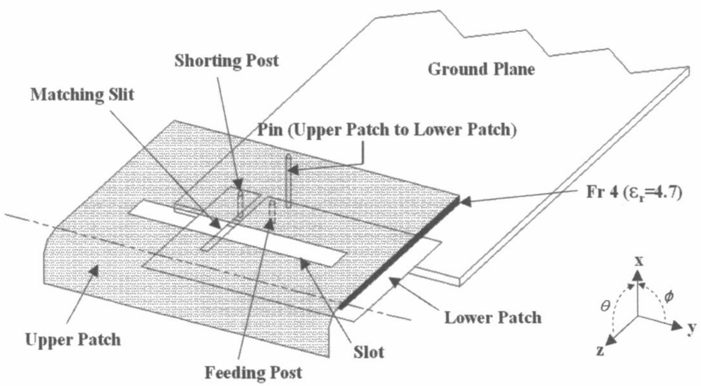
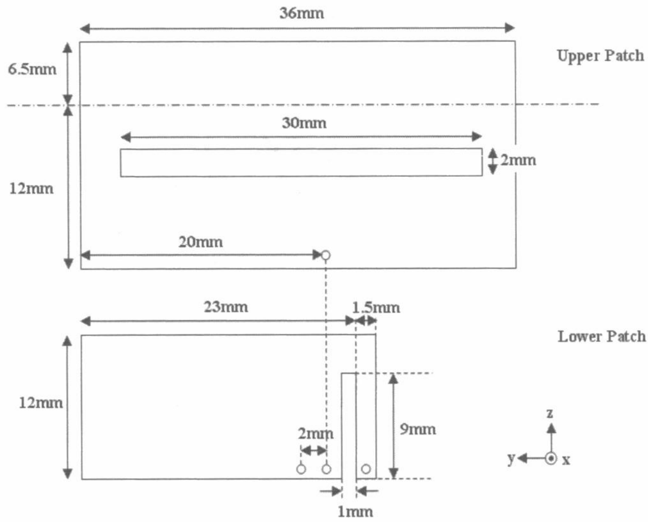


(a)



(b)

Fig. 1. Structure of the proposed antenna: (a) overall view, and (b) dimension

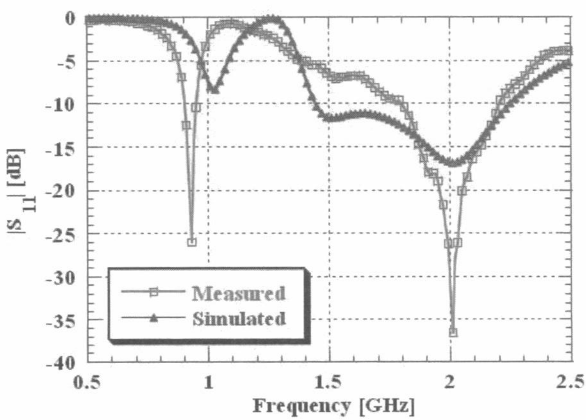


Fig. 2. Calculated and measured return loss of the proposed antenna

Fig. 3. Impedance characteristics with/without matching slit

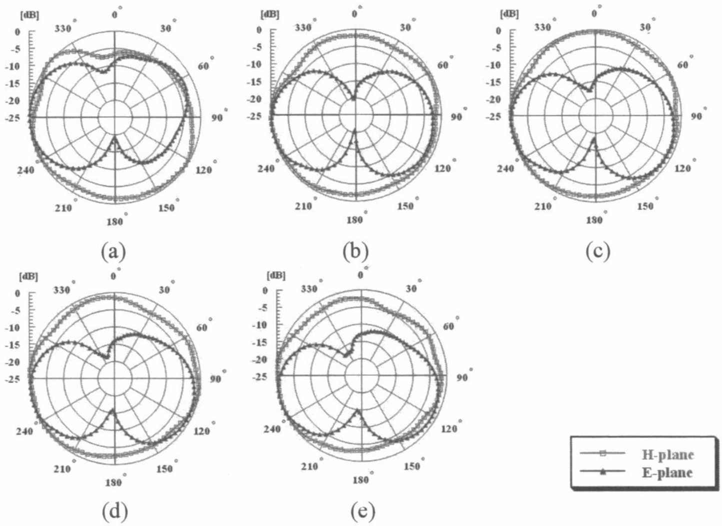


Fig. 4. Radiation patterns of the proposed antenna: (a) 920 MHz, (b) 1575 MHz, (c) 1795 MHz, (d) 1920 MHz, and (e) 2050 MHz