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Folded Planar Monopole Internal Antenna for Multi-band Mobile Phones

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Abstact

A new folded planar monopole antenna is proposed for multiband operations. Measured impedance bandwidth (VSWR<3) is 20% (820~1000MHz) and 119.8% (1570~ 6270MHz) in low and high frequency, respectively. The proposed antenna can effectively cover most mobile communication bands (CDMA, GSM, GPS, DCS, PCS, and UMTS), WiBro, S-DMB and WLAN.

Introduction

With rapid growth and globalization in mobile communication systems, a mobile phone is demanded to provide a world wide roaming including the major mobile communication services (CDMA, GSM, GPS, DCS, PCS and UMTS). Also various other services such as internet and broadcasting will be realized by a mobile phone in near future. In conjunction with demanding various services of the mobile phone, an internal antenna requires the capability of not only multi-band operation but also wide bandwidth. A folded planar monopole structure has been proposed to achieve a wide impedance bandwidth [1], [2]. A pair of notches at the two upper corners of the ground plane is used to match the impedance over wide frequency bandwidth [3]. In this work, combining these methods, a new multi-band folded planar monopole antenna is proposed to cover CDMA (824~ 894 MHz), GSM(880~960 MHz), GPS(1575±5 MHz), DCS(1710~1880 MHz), PCS (1850~1990 MHz), UMTS(1920~2170 MHz), WiBro (2300~2390 MHz), S-DMB (2630~ 2655 MHz), and WLAN(2400~2483 MHz, 5150~5825 MHz) bands.

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Antenna Structure and Design

The configuration of the proposed antenna is shown in Fig. 1. The radiating element is constructed by bending a rectangular metal plate twice along four dashed lines shown in Fig. 1(b) with total dimension of 15×125 mm^2. Bending the radiating element twice makes the design of radiator more effective because the wavelength of current path at lower frequency band such as CDMA and GSM band is too long to realize within limited space. Radiating plate A-B-C-D and PCB ground plane are on the same layer. Radiating plate E-F-G-H is placed on the backside of the PCB ground plane with 2 mm gap. Radiating plate I-J-K-L is on top layer. The radiating plates are electrically connected to each other. A pair of notches (6×6 mm^2, 6×12 mm^2) is added at the two upper corners of the ground plane (dimensions of 90×40×1 mm^3). Size of each notch controls amount of the coupling between the radiator and the PCB ground plane so that it can obtain the impedance match for all operating frequency bands.

Results

Fig. 2 shows the measured VSWR for the proposed antenna. Measured bandwidth (VSWR<3) is 20% (820~1000MHz) and 119.8% (1570~6270MHz) in the low and high band, respectively. This impedance bandwidth covers the CDMA, GSM, GPS, DCS, PCS, UMTS, WiBro, S-DMB, and WLAN. The measured radiation patterns are shown in Fig. 3. Since the radiation pattern at DCS, PCS, and UMTS bands is almost the same, the measured radiation pattern at the centre frequency of CDMA, GSM, GPS, DCS/PCS/UMTS, WiBro/2.4 GHz WLAN, S-DMB, and 5GHz WLAN bands is only presented here. The measured gains are listed in Table 1.

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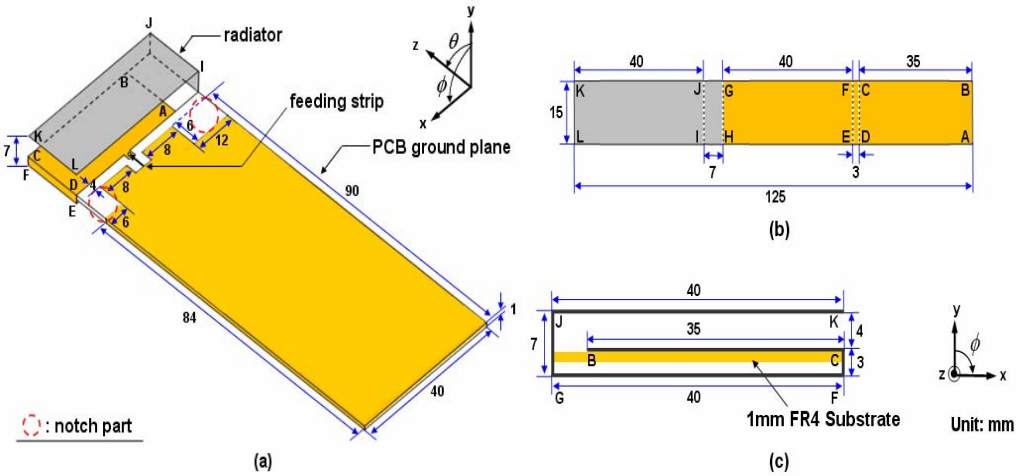

Fig. 1 Configuration of the proposed antenna: (a) 3D view, (b) unfold radiator, (c) front view

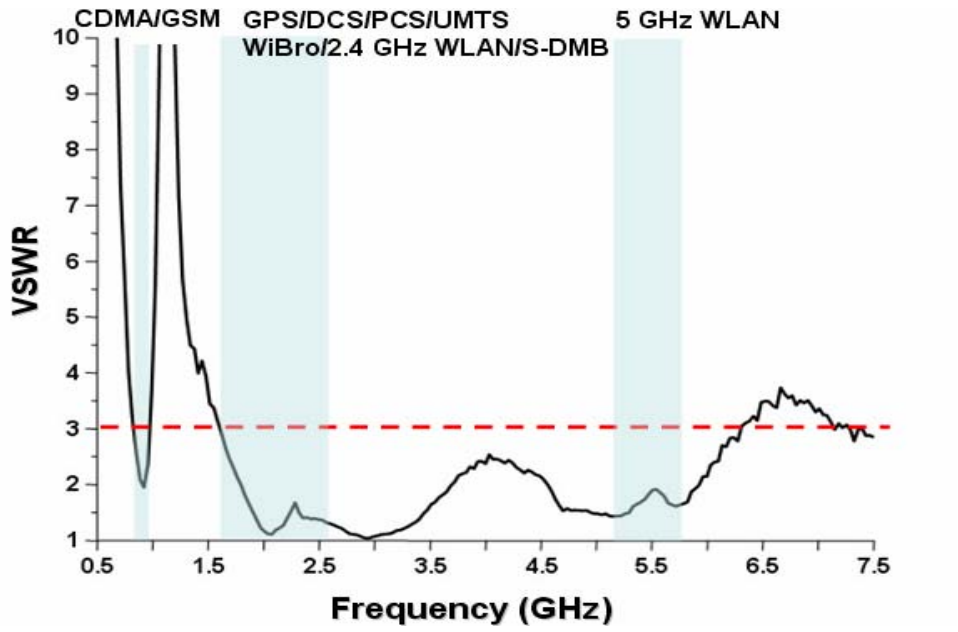

Fig. 2 Measured VSWR of the proposed antenna

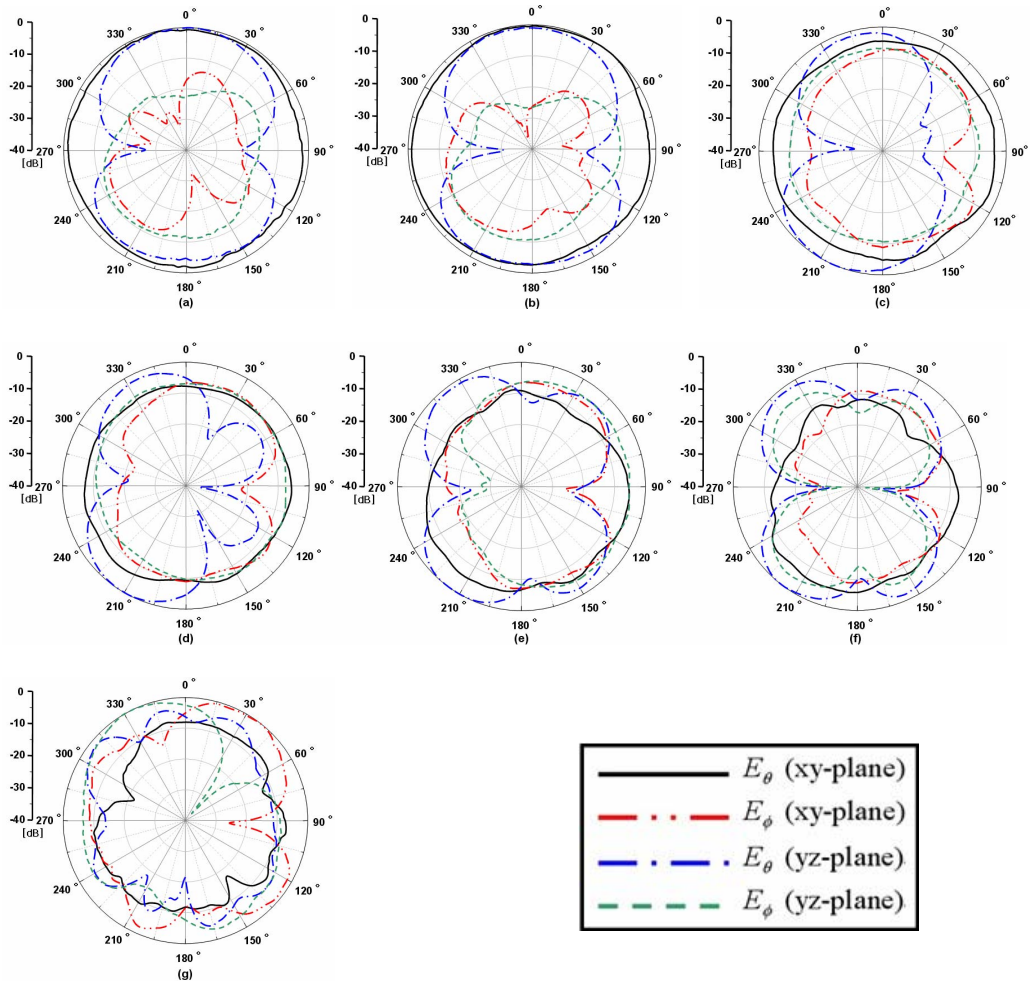

Fig. 3 Measured radiation patterns: (a) 0.859GHz for CDMA, (b) 0.92GHz for GSM, (c) 1.575GHz for GPS, (d) 1.94GHz for DCS/PCS/UMTS, (e) 2.4GHz for WiBro/2.4GHz WLAN, (f) 2.64GHz for S-DMB, (g) 5.5GHz for 5GHz WLAN

TABLE 1 Measured gains

Band	Gain(dBi)
CDMA/GSM	**0.72~2.34**
GPS	**2.44**
DCS/PCS/WCDMA	**1.33~4.37**
WiBro	**1.58~4.11**
2.4 GHz WLAN	**0.97~1.83**
S-DMB	**2.78~3.40**
5 GHz WLAN	**-2.43~0.78**