ULTRA-COMPACT WIDEBAND ANTENNA FOR PORTABLE DEVICE APPLICATIONS

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Key words: Compact antennas; portable device; wideband antenna.

Abstract: An ultra-compact broadband antenna easily integrable on portable devices is presented. The antenna is composed of **a printed rectangular radiating** element and a C-strip printed as the ground plane on the other side. The overall antenna occupies a compact area of 56.5 × 2 × 0.5 mm^3, yet generating two resonant modes to form 39% (850MHz) wide impedance bandwidth from 1.75 to 2.6GHz with stable omni-directional radiation pattern with low cross-polarization.

Ultra kompaktna širokopasovna antena za uporabo v prenosnih napravah

Kjučne besede: kompaktne antene, prenosne naprave, širokopasovna antena

Izvleček: Predstavljena je zelo kompaktna širokopasovna antena, ki se jo zlahka namesti v prenosne naprave. Sestavljena je iz tiskanega pravokotnega sevajočega elementa in ozemljitvijo v obliki tiskanega C-traku na drugi strani tiskanine. Celotna antena zavzema površino 56.5 × 2 × 0.5 *mm*^{3}, deluje v dveh resonančnih načinih, s pasovno širino 39% (850MHz) na frekvenčnem pasu od 1.75 do 2.6GHz s stabilnim večsmernim vzorcem sevanja in nizko navzkrižno polarizacijo.

1. Introduction

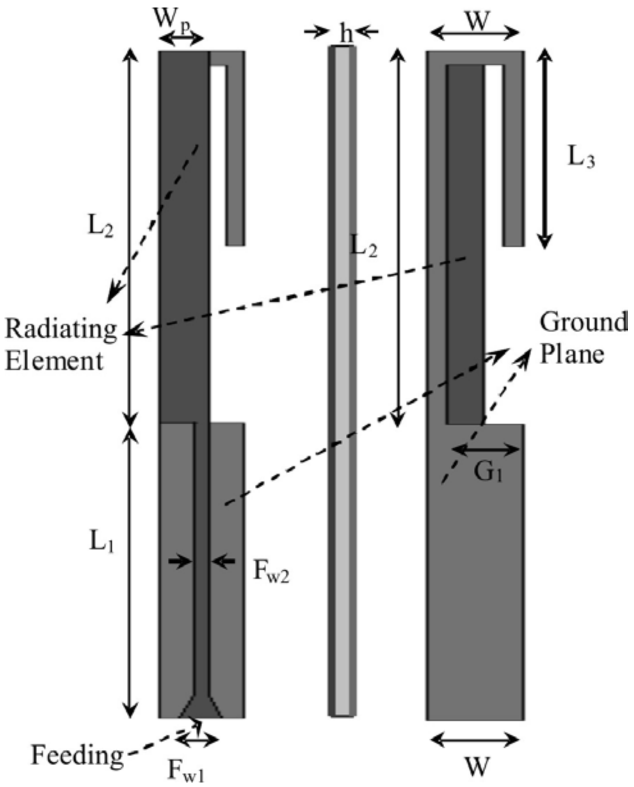
In the era of modern wireless communication systems, wideband or multi-band antennas with omni directional radiation characteristics play a vital role. Increasing demand for smaller size in portable devices results in a need for effective antenna miniaturization which is a critically challenging problem due to the inevitable trade-off between the size and the performance of the antenna due to the fact that antenna performance is bound with the fundamental limits based on the size of the antenna. This is especially true in the field of radio communications, where reducing the size of an antenna leads to smaller and light-weight systems, thereby enhancing portability and minimizing electromagnetic interference with other electronic devices. Therefore it is very desirable to miniaturize the antenna in order to scale down the system size.

Conventional internal antennas for portable device applications are generally in the forms of the planar inverted-F patch antenna, very-low-profile printed or metal-plate monopole antenna, and so on [1-3]. But such internal mobile antennas usually excite large surface currents on the system ground plane of the mobile phone, which functions as an effective radiation portion. Owing to the large excited surface currents on the system ground plane, especially in the region near the internal antenna, an isolation distance of about 7*mm* or larger between the antenna and the nearby conducting elements or electronic components in the mobile phone is usually required to avoid large degradation effects on the performances of the internal antenna[4,5]. This is a big limitation for the portable devices.

To eliminate the effect of large ground plane this paper presents an ultra-compact antenna for mobile applications in DCS-1900/PCS/**PHS (1850–1990MHz), WCDMA/IMT-2000 (1920–2170MHz), wireless broadband internet (WiBro) (2.3–2.39 GHz), WLAN-IEEE 802.11b (2400–2483MHz) bands. The antenna comprises a rectangular radiating** element and a C-strip printed as the ground plane. The antenna has the advantages of microstrip feeding and lack of big ground plane makes it suitable for co-existing integration on printed circuit board (PCB). Details of the antenna design and results are presented and discussed.

2. Antenna configuration

The configuration of the compact planar antenna is illustrated in Figure 1. The design of the antenna is based on an RT/Duroid RO4350B planar substrate that has a permittivity of 3.45 and a thickness of 20mils (0.5mm). The total dimension of the antennas is 56.5 × 2 × 0.5. It is also noticed that the antenna size at the lowest frequency



(a) (b) (c)

Fig. 1: Schematic Diagrams of proposed antenna (a) top view, (b) side view

(1.75GHz) is 0.33 λ_o × 0.012 λ_o × 0.003 λ_o. In one side of the antenna the rectangular radiating patch fed by a microstrip line of 0.4mm is designed. On the other side a C-strip acting as the ground plane. The feeding microstrip line is positioned at the middle of the antenna, while the rectangular patch is fed at the lower corner, which makes it only 1.5mm wide. The compactness of the planar antenna is attributed to the slim structure of the radiation element and the folded configuration of the C-strip, while the broad band performance is a result of the mutual coupling between the rectangular radiating patch and C-strip. However the tapped pad is added to enhance the lower limit of the operating frequency. The geometrical parameters of the antenna are shown in mm in the Table 1.

Table 1: Geometrical parameters of the slot-type antenna

L_1	25	h	0.5
L_2	31.5	W	2
L_3	16.5	W_p	1.2
F_{w1}	1	F_{w2}	0.4

3. Results & discussions

Generally, a 6-dBreturn loss is acceptable for the mobile phone applications [2]. The return loss of the antenna is exhibited in Figure 2. From the curve it is apparent that the antenna achieved -6dB return loss bandwidth of 850MHz, ranging from 1.75GHz to 2.6GHz, or about 39% with respect to the centre frequency at 2.18GHz.

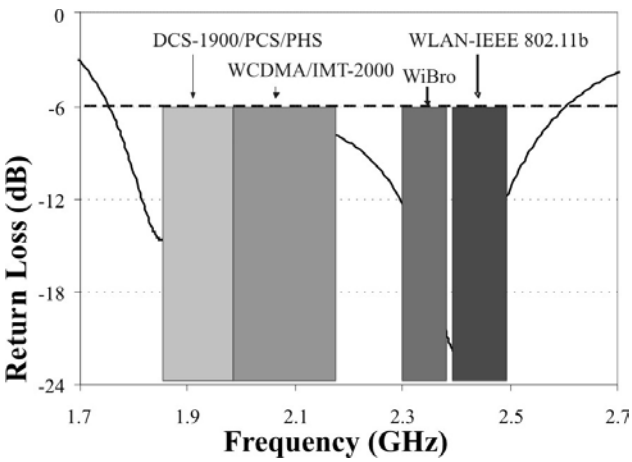
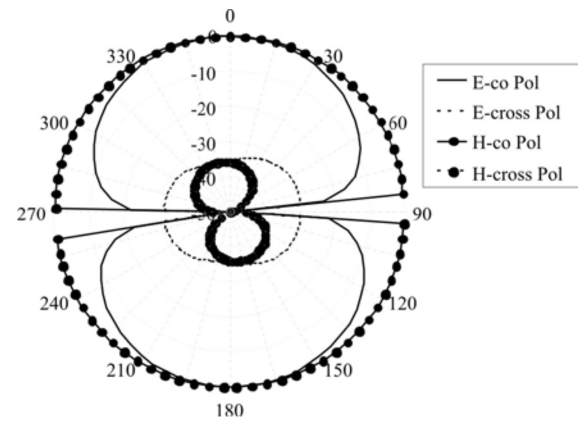


Fig. 2: Return loss of the designed antenna

The E and H plane radiation patterns of the proposed antenna at 1.85GHz and 2.4GHz has been shown in Figure 3. It can be realized that the antenna produces omni-directional symmetrical radiation pattern in both the resonating frequencies. Moreover, a 30dB cross-polarization is observed in both E-and H-planes.

(a)



(b)

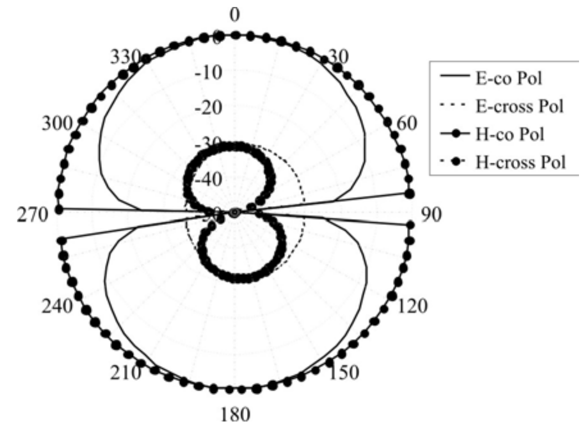


Fig. 3: Simulated radiation pattern of the proposed antenna at a) 1.85GHz, b) 2.4GHz

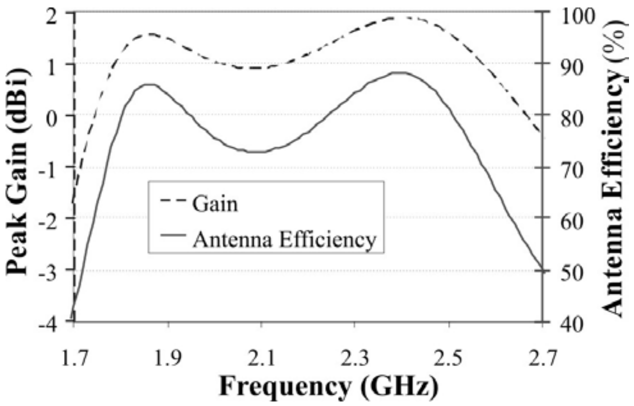


Fig. 4: Antenna gain of the proposed antenna (a) lower band and (b) upper band

Figure 4 depicts the peak gain and antenna efficiency of the proposed antenna. With a maximum gain of 1.9dBi, the antenna provides >0dBi over the whole resonating band of the antenna. The antenna efficiency takes into account the reflection losses, that is to say $\eta_a = \eta_r \times (1-|S_{11}|^2)$, where η_r is the radiation efficiency. A conductivity of $\sigma = 5.8 \times 10^7$ S/m for copper and a loss tangent of $\tan\delta = 0.0036$ for the low loss Duroide dielectric substrate were used in the simulation. A good antenna efficiency of 80% over operating band is observed for the antenna

4. Conclusion

The design of a low-profile microstrip-fed printed antenna with extremely small width, operating in the DCS-1900/ PCS/**PHS, WCDMA/IMT-2000, WiBro, WLAN-IEEE 802.11b** bands, has been proposed in this paper. The design is simple and compact with very few design parameters. The proposed antenna has small dimensions of 56.5 × 2 × 0.5 mm^3 suitable for integration with application specific circuits. The present design stands out as a potential candidate for portable applications.

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Prispelo: 07.09.2010 *Sprejeto: 23.08.2011*