Quad-Band Handset Antenna for GSM900/DCS1800/PCS1900/UMTS Bands

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1. Abstract

An novel compact quadband internal planar inverted-F antenna (PIFA) for contemporary handsets covering the bands GSM-900, DCS-1800, PCS-1900 and UMTS is presented. The proposed antenna consists of a planar antenna element suspended parallel above the dielectric of a single sided PCB. By etching a section of the conducting ground plane below the radiating element, the antenna gains the merits of a planar monopole and consequently a wider bandwidth. The total volume occupied is 38mm x 25mm x 6mm and is suited as internal antenna due to its low profile, small size, wide bandwidth and multi-band behavior. The antenna structure, simulations, return loss measurements, radiation patterns and specific absorption rate (SAR) are also discussed.

2. Introduction

Competitive global marketing in the mobile phone sector has driven demand for small phone terminals capable of multi-band operation across standard mobile communication bands. These facilitate both international roaming and connectivity to local devices. There is further restriction on the antenna size due to the presence of various integrated components for different applications in contemporary handsets. The antenna should also be reasonably efficient and free from excessive radiation illuminating the user's head (low SAR value). To meet these requirements, PIFAs are widely used [1-3] as an internal antenna solution. PIFAs have desirable features such as high efficiency multi-frequency behavior, moderate bandwidth, low profile, low cost, lightweight, less prone to breakage and reduced user power absorption compared with equivalent external antennas [3]. This suggests that the electromagnetic energy absorption by the user's head (SAR) can be reduced particularly with some modification in the ground plane. The PIFA usually occupies a compact volume which can be concealed in the handset by integration onto the quarter wavelength long circuit board.

Several multi-band PIFA designs, most of them capable of quad-band operation, appear in the literature [4-6]. Unfortunately, due to excessive dimensions (heights exceeding 8mm or ground plane widths exceeding 45mm) [4-6] and complicated structures (requiring expensive sophisticated fabrication processes) many of these designs are impractical for contemporary commercial application.

The quadband PIFA suitable for a practical mobile handset covers the frequency bands with a minimum 5 dB return loss. Effect of ground plane length on antenna impedance bandwidth and resonance frequency are investigated. Efficiency, gain, return loss, bandwidth and radiation patterns of the designed antenna are investigated numerically and experimentally. The antenna structure is analysed and designed using CST MICROWAVE STUDIO™. SAR measurements are applied using a SPEAG Dosimetric Assessment System (DASY4) ™.

3. Antenna Design And Structure

The geometry of the proposed quadband PIFA is given in Figure 1. The radiating element is made of copper and is a rectangular planar plate with slots that control the surface current paths. The plate size is 25mm long x 38mm wide x 0.3mm thick and supported 6mm above a finite ground plane on a single sided PCB (FR4, $\varepsilon_r = 4$), 120mm long x 38mm wide x 1.6mm thick.

A 16mm long x 38mm wide area is etched in the ground plane underneath the antenna element to combine the advantages of a low-profile PIFA with the broad impedance bandwidth of the monopole section. The antenna is fed at the left lower corner via a feeding strip connected to a 50Ω coaxial cable and shorted to the ground plane using another vertical strip, illustrated in Figure