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Design of a Dual-Band PIFA for Handset Devices and it SAR Evaluation

Diseño de una PIFA doble banda para dispositivos móviles y su evaluación de SAR

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Abstract

PIFA antenna (*Planar Inverted F Antenna*) is one of the most used in mobile devices, fundamentally for it reduced size. Because of the convergence of wireless services in one mobile device, it is convenient that it can operate in different frequencies, leading to multiband antenna design. Nonetheless, besides technical consideration, it is necessary the evaluation of antenna radiation impact in the user. Therefore, in this work a dual-band PIFA antenna for GSM 900 and GSM 1800 is presented and its interaction with a model of user hand and head is analyzed and evaluated by means of SAR (*Specific Absorption Rate*) parameter in a simulated manner. The dual-band characteristic is obtained by means of an insertion of an L-shaped slot, which will use to tune the operation frequencies.

Keywords:

- antenna
- PIFA
- SAR
- mobile device
- dual-band

Resumen

Las antenas PIFA (planar Inverted F Antenna) son una de las más empleadas en los dispositivos móviles, fundamentalmente por su tamaño reducido. Debido a la convergencia de los servicios inalámbricos en un solo dispositivo móvil, es conveniente que este pueda operar en diferentes frecuencias, lo que ha conducido al diseño de antenas multibanda. Sin embargo, además de consideraciones técnicas, es necesaria la evaluación de los efectos de la radiación de la antena en el usuario. Es por ello que en este trabajo se presenta una antena PIFA doble banda para GSM 900 y GSM 1800, y se analiza y evalúa su interacción con un modelo de mano y cabeza humanas por medio del parámetro SAR (Razón de Absorción Específica) de manera simulada. La característica de doble banda se obtiene por medio de una inserción de una ranura en forma de L, que será empleada para sintonizar las frecuencias de operación.

Descriptores:

- *antena*
- *PIFA*
- *SAR*
- *dispositivo móvil*
- *doble banda*

Introduction

The vertiginous growth of the mobile wireless communications has leaded the development of small antennas with multiband behavior. In this moment, a terminal often integrates several wireless systems, and the antennas play a fundamental role in the best design of these. An appropriate design and an integrated radiator, not only permit a reliable connection, independently of the orientation of the terminal, but also it helps to foresee an excessive consumption of the battery, improving the efficiency. In addition, the design of the antenna must take into account the effects of the housing and antenna radiation interaction with the human body, with the objective to select the best design and location of the radiator in the terminal.

The implementation of an antenna is schematized in (Balanis, 2008) as a cyclical process where intervene four stages, as it is shown in Figure 1: antenna design, multiple antenna analysis, human interaction study, and housing effects; and it stops when the desired electromagnetic parameters are met. The present work will take into account mainly two stages: the design of the antenna and its interaction with a representative model of user (SAM, *Specific Anthropomorphic Mannequin*).

The studies and reports that have been carried out analyzing the impact of SAR are diverse, however do not exist data for all conditions that can be given. In (Firoozy & Shirazi, 2011) is presented a dual band PIFA antenna (1800 and 2442 MHz), and is analyzed the SAR by means of CST MICROWAVE STUDIO (CST MWS) software simulation. In (SOH, VANDENBOSCH, OOI, & NURUL, 2011) a study of the behavior of PIFA antennas in a human body model was carried out, evaluating SAR in different parts of the user (chest and back).

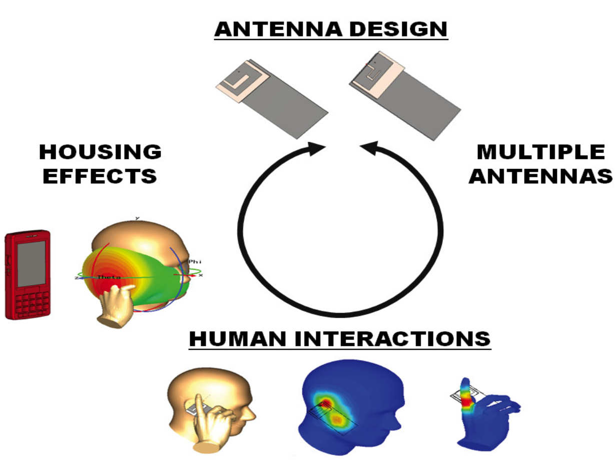

Figure 1. Schematic process for mobile handset antenna implementation

This work also evaluates the impact of the type of material to use as antenna. The multiband behavior is obtained with a U-shaped slot. In (Vehovský *et al*., 2014) a PIFA for the two bands of GSM with an L-shaped slot is presented, and it was built and tested a hand model for SAR evaluation. In (Liu & Zhao, 2014) a multiband antenna for a wide rank of frequencies of GSM900/1800/1900, UMTS2100 and LTE2300/2500 was designed, and was evaluated the SAR in the presence of a hand and head model. In (Lee & Sung, 2014) are also analyzed the values of SAR with a SAM model.

Based on the previous information, the paper presents the design of a dual-band PIFA antenna for the GSM900 (876-960MHz) and GSM1800 (1710-1889 MHz) bands. The second resonant frequency and the dual-band behavior are obtained by means of the insertion of an L-shaped slot. This technique has been used in (Cabedo *et al*., 2009) and (Vehovský *et al*., 2014). The proposed design has as main advantage that the fine tune of the structure will be realized varying the width of the L-shaped slot inserted in the patch, rather than the patch dimension. For the PIFA design several criteria have been taken into account: confine the antenna in an extreme of the structure, and maintain as low as possible the height (vertical dimension). Moreover, the evaluation of the radiation influence in a model of user hand and head is carried out in a simulated manner. CST MWS software is used for the simulations.

Dual band PIFA antenna with L-shaped slot

To obtain good radiation characteristics, the antenna must be resonant and it size must be comparable with the wavelength. That is the reason for the introduction of several techniques directed to reduce the dimensions of the structure. The use of a PIFA antenna permits a reduction of at least the half of the size with respect to a basic microstrip antenna. This is successfully achieved by means of a shorting wall, and if its thickness is reduced a decreasing in frequency can be obtained. Some advantages of the PIFA antennas are compact size, low profile, easy construction and a good electric behavior.

The fundamental parameters to adjust the PIFA design are the longitude of the patch (L and W), the height of the structure h, the width of the shorting wall w, and the distance from the feeding to the wall. The dimensions of the L, W and the h are chosen to achieve a certain resonant frequency as follow (García, 2007)

$$(L+h)\sqrt{\varepsilon_r} \cong \frac{\lambda}{4} \tag{1}$$