Conformal Shaped PIFAs for Mobile Communication Applications

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Abstract

Conformal shaped multi-band PIFAs, with a single feed, are introduced. The first antenna, semi-circular PIFA, operates in the iDEN (806 – 875 MHz) and GPS bands. The proposed semi circular PIFA exhibited peak gain of > 1 dBi in most of the iDEN band, and 1 dBi in GPS band. Two embedded antenna designs, one for AMPS/PCS dual band and the other for GSM/DCS/PCS tri-band, and their results are reported in this paper.

Introduction

Apart from extensive utility of PIFA [1] in commercial cellular communications, PIFA continues to find its usefulness in many other systems applications such as WLAN[2]. In the majority of the research papers on PIFA, the contour of the radiating element has mostly been restricted to either rectangular or square shape. One of the objectives of this paper is to consider the radiating element of the PIFA with a contour that is conformal to the communication device. In this paper, radiators of two different configurations are considered and they are (a) Semi-Circular shaped radiator for iDEN/GPS bands, and (b) Embedded PIFAs having the contour of a back-housing of a typical cellular handset and exhibiting cellular dual and tri band performance. There seems to be no work reported on semi-circular PIFAs (either single or dual band) in open literature. However, the publications[3,4] on circular microstrip antennas are of some relevance to this paper. While conventional Micro-strip antenna designs are based on half-wavelength of operation, the PIFA designs invoke the quarter-wavelength operation. The quarter wavelength of PIFA operation is due to the connection of the radiating element to the ground plane through a shorting strip or pin.

Recently there has been a requirement for a cellular handset to support dual frequency operation comprising iDEN (806 – 875 MHz) and GPS (1575. 4 MHz) bands. An easy recourse is to have two radiators with two separate feeds to achieve dual resonant frequencies. However, the problem of using two feeds is the associated poor isolation between the feed ports that significantly reduces the antenna gain in both iDEN and GPS bands. This paper extends the scope of using a single feed for dual- band semi circular PIFA design and the advantages of the proposed design are: the absence of isolation, enhanced antenna performance in each band and reduced cost in view of the avoidance of extra hard-ware for two feeds. In an alternative design configuration of dual or multi band conformal PIFAs, this paper proposes embedded PIFAs with radiators conforming to the contour of the back-housing of a typical cellular handset. One of the advantages of the embedded PIFAs is the lack of need of a separate dielectric carriage, which normally degrades the efficiency of the antenna. The proposed embedded PIFA allows its formation as an integral part of the back housing. The radiating element of the PIFA conforming to the contour of the device also enables the optimum utilization of the available volume ear marked for the internal antenna

Antenna Configuration and Results

In this dual band semi circular PIFA design (Figure 1), the feed and shorting pins, aligned along a straight line, are located at the extreme corner of the PCB. A J-shaped slot with its slot opening along a direction orthogonal to the line joining the feed and the shorting pins is formed on the radiating element. The attempted step discontinuity in the width of the J-slot at selective locations enabled to realize enhanced resonance performance of the PIFA and the resulting slot structure appears to resemble a frequency selective surface. The curved portion of the semi circular dielectric carriage is located at the top end of the PCB and the straight or flat section of the carriage lies in close proximity of the battery position. The single feed dual band semi circular PIFA designed with the above configuration has a VSWR of <3.0:1, in both iDEN and GPS bands, as shown in Figure 2. The proposed semi circular PIFA exhibited peak gain of > 1 dBi in most of the iDEN band (as shown in Figure 3a), and 1 dBi in GPS band (as shown in Figure 3b).

In the second design configuration, two different single feed embedded PIFAs - one with a AMPS/PCS dual band response (as shown in Figure 4a) and the other GSM/DCS/PCS Tri band response (as shown in Figure 4b) have been designed. The feed and shorting pins of the embedded PIFA are placed along the major axis of the radiator to get maximum performance of the antenna. The formation of a T- shaped slot with its open end in a direction perpendicular to the line connecting the feed and shorting pins realizes the quasi physical partitioning for multi band operation of the PIFA.

Conclusions

Although the proposed semi-circular PIFA design has been done for iDEN/GPS, it can be used for other frequencies of interest. Through the choice of an unconventional configurations such as J-Shaped or T shaped, the potential advantage of introducing the steps within the slot to realize non uniformity of the slot width was proposed. The resulting slot structure with non-uniform width resembles a frequency selective surface and thus enhancing the performance of the antenna. This paper demonstrates the feasibility design of an embedded single feed multi band PIFA with out necessitating a supporting dielectric carriage.

References

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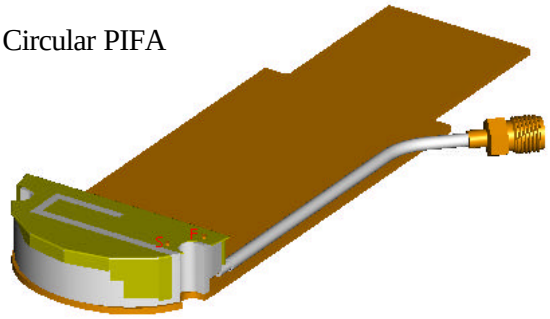
[3] Wen-Hsiu Hsu and Kin-Lu Wong**,** “A Wideband Circular Patch Antenna”, *MICROWAVE AND OPTICAL TECHNOLOGY LETTERS*, Vol. 25, No. 5, June 5 2000 pp. 328**.**

[4] K.M. Luk, Y.W. Lee, K.F. Tong, and K.F.Lee, “Experimental studies of circular patches with slots”, *IEE Proc.-Microw. Antennas Propagation*., Vol. 144, No. 6, Dec. 1997, pp. 421-424

Figure 1. Single Feed Dual Band Circular PIFA



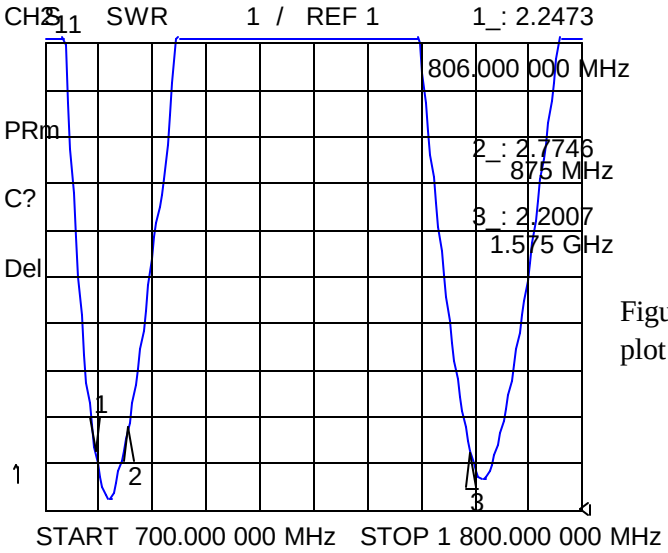


Figure 2: Associated VSWR plot of Semi-Circular PIFA

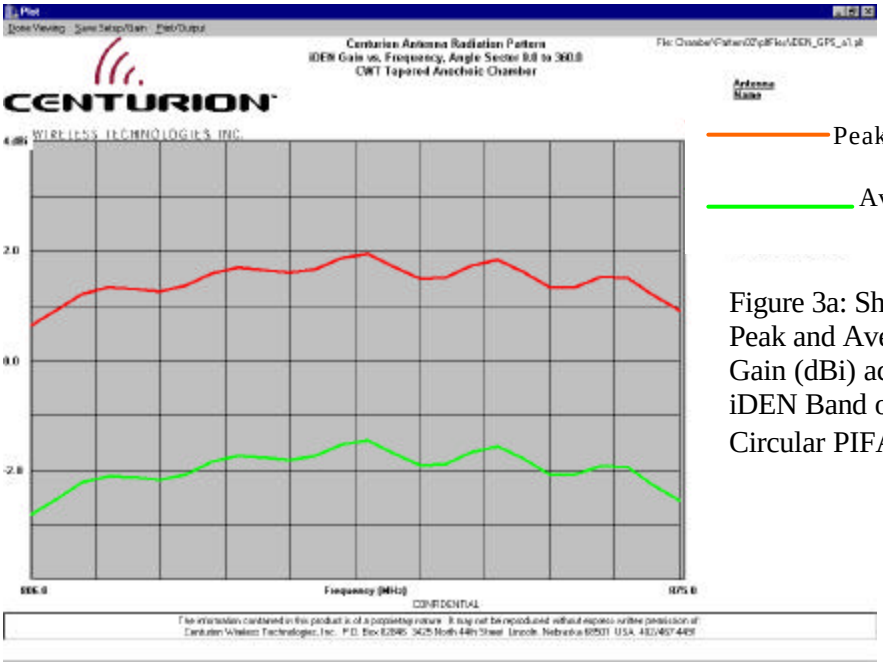


Figure 3a: Showing Peak and Average Gain (dBi) across iDEN Band of Semi-Circular PIFA

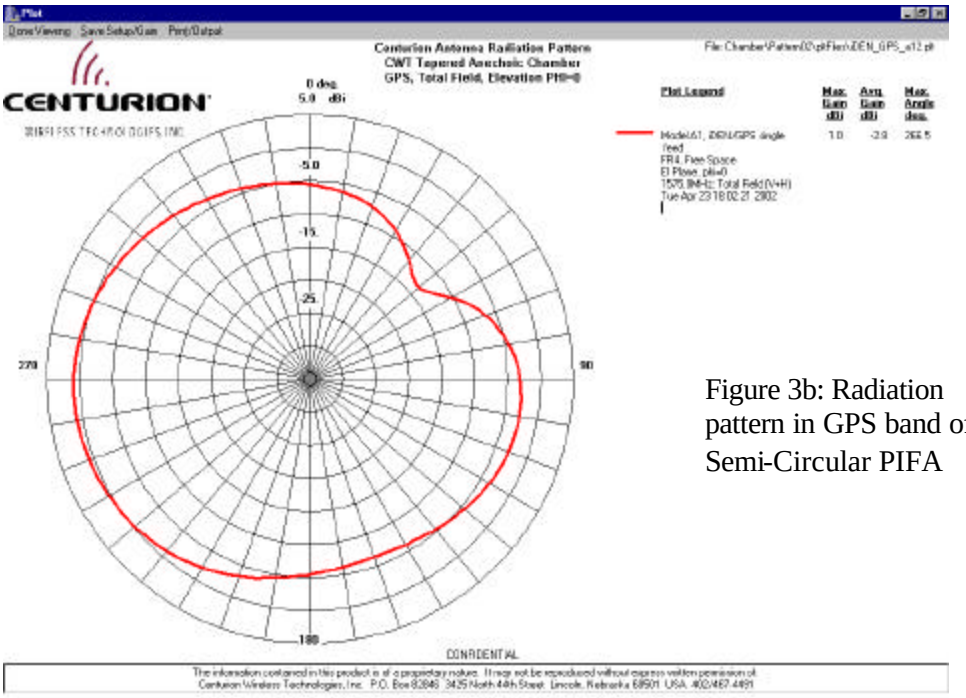


Figure 3b: Radiation pattern in GPS band of Semi-Circular PIFA

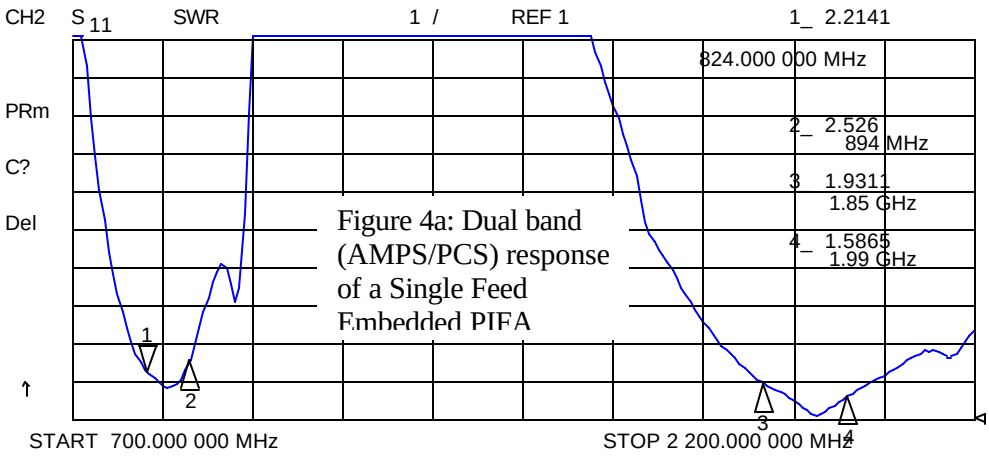


Figure 4a: Dual band (AMPS/PCS) response of a Single Feed Embedded PIFA

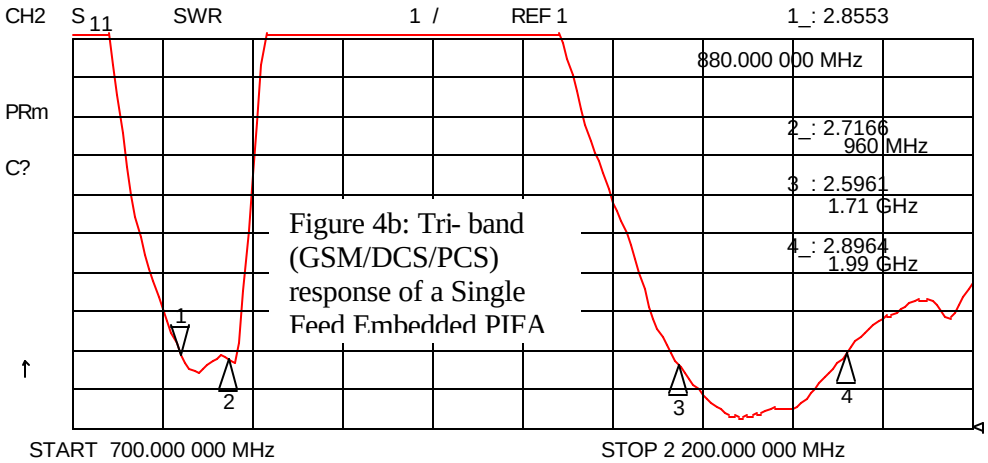


Figure 4b: Tri- band (GSM/DCS/PCS) response of a Single Feed Embedded PIFA

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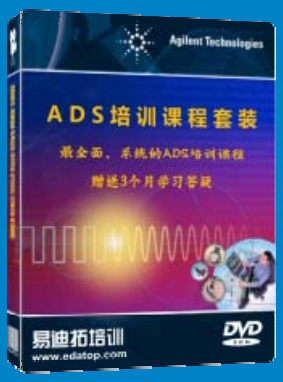

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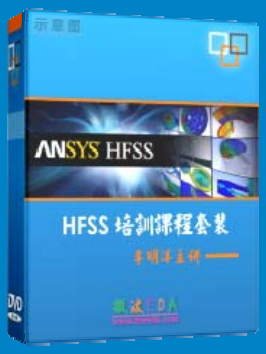

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