A Dual Band Balanced Planar Inverted F Antenna (PIFA) for Mobile Applications

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***Abstract*—A new low profile dual-band balanced planar inverted F antenna with meandered lines resonating in the 1800 MHz and 2100 MHz bands is proposed. The antenna size is $50 \times 12 \times 10mm^3$ allowing it to be easily housed in mobile handsets. The return loss, radiation pattern, gain and current distribution of the proposed antenna is presented. Furthermore, agreement between simulations and measurements is shown for a balanced feed with zero phase difference. Then, the design with differential feeding is simulated for various feeding phase angles and the benefits of minimized current flow on the ground plane are highlighted.**

***Index Terms*—Balanced antenna, PIFA, Electromagnetic Interference (EMI), handset antenna**

I. Introduction

Balanced antennas in wireless communications have gained popularity over recent years because of the good performance when brought in the vicinity of the human body [1], which in turn minimizes the effect of Electromagnetic Interference (EMI) between the other devices in mobile handsets that are integrated on the ground plane of antenna [2]. Unbalanced antennas, such as the planar inverted F antenna (PIFA), have been widely used in the mobile industry because of their compactness while having a drawback of narrow bandwidth at low frequencies [3],[4]. Furthermore, these designs can have performance degradation when brought in the vicinity of the human body. To overcome this effect, instead of a single structure, a symmetric structure can be used and fed with two conductors with equal current magnitude and a 180 degree phase difference. This feed technique then results in a cancellation of the current on the ground plane. This use of a balanced structure is a good technique to improve antenna performance, reduce EMI and mitigate coupling between the human body and the mobile handset [5]. In this paper, a new balanced PIFA for the 1900 MHz GSM and 2100 UMTS bands is proposed. An image of the antenna layout is shown in Fig. 1. The following sections show that the theoretical background of balanced structures having maximum current on the antenna patch and lower current on ground plane can be achieved.

II. Antenna Design Procedure and Structure

Initially, the design is started using a conventional PIFA structure with dimensions of $24mm \times 12mm$ on a Rogers TMM4 ($\epsilon_r = 4.5$) substrate with a thickness of 10 mm. The ground plane of the antenna has an overall size of $50 \times 100mm^2$ and consists of the same TMM4 substrate as the PIFA antenna element. To achieve dual band characteristics in a PIFA, meandered lines are introduced in the existing structure. This this also results in a reduction in the overall size of PIFA.

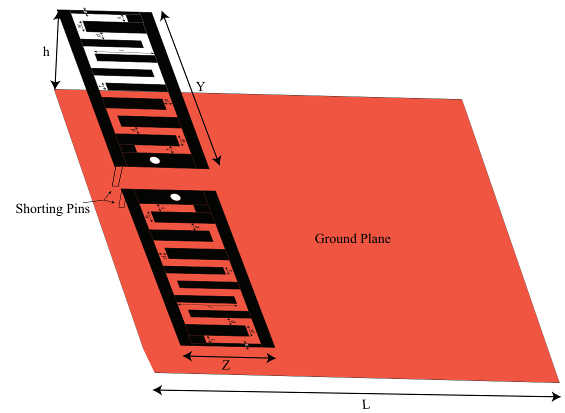

Fig. 1. Configuration of balanced PIFA with h = 10 mm, Z = 12 mm and Y = 24 mm.

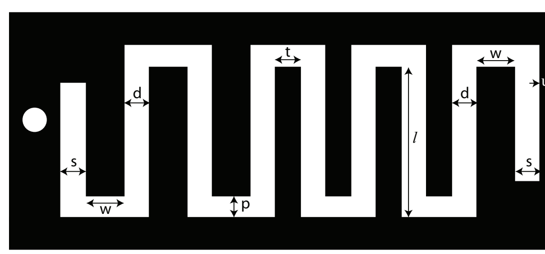

Fig. 2. Patch Layout with s = 1.6 mm, w = 1.2 mm, d = 1.5 mm, p = 0.8 mm, t = 0.8 mm, l = 6 mm, s = 1.6 mm and u = 0.4 mm.

The balanced structure was designed by placing a mirror image of the meandered PIFA in a symmetrical dipole manner. The meandered slots were optimized in such a way that the design covers the required bands (< -10 dB return loss) in HFSS [6]. The position of probe feed and the shorting pin were used to control the impedance matching of the antenna.

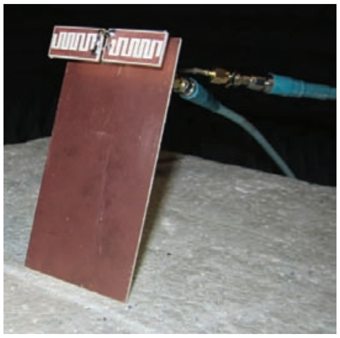

Fig. 3. Prototype antenna being measured in the anechoic chamber.

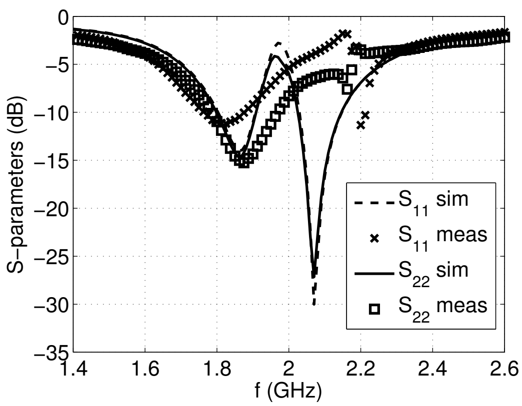

Fig. 4. Simulated and measured S-parameters of the prototype antenna.

The dimensions of the meander lines of the patch are shown in Fig. 2.

III. Simulation and Measurement Results

First, the S-parameters of the antenna were measured and compared to HFSS simulations for accuracy. A picture of the prototype antenna being measured in the anechoic chamber is shown in Fig. 3 and the measurement results are shown to agree with the simulations in Fig. 4. Next, the current distribution on the ground plane of antenna was simulated for feed currents with the same phase and a phase difference of 180 degrees. These results are shown in Figs. 5 and 6. It is shown that the currents on the ground plane in Fig. 6 are much lower for a phase difference of 180 degrees. Having a low current on the ground plane significantly helps the immunity of the antenna, especially for mobile handset applications. Finally, the 3D radiation pattern of the prototype antenna was simulated at 1800MHz and is shown in Fig. 7. It should also be mentioned that the radiation pattern was similar at 2100 MHz.

IV. Conclusion

A novel, low profile dual band Balanced PIFA antnena resonating at the GSM and UMTS bands is presented, simulated and experimentally verified. Simulations show that with the appropriate feed current, the ground plane currents can be minimized. This then minimizes the human body effects on the antenna performance, making the design very useful for mobile handset devices.

Fig. 5. Simulated ground plane current for feeding currents with the same phase at 1800 MHz (similar results were observed at 2100 MHz).

Fig. 6. Simulated ground plane current for feeding currents with a phase difference of 180 degrees at 1800 MHz (similar results were observed at 2100 MHz).

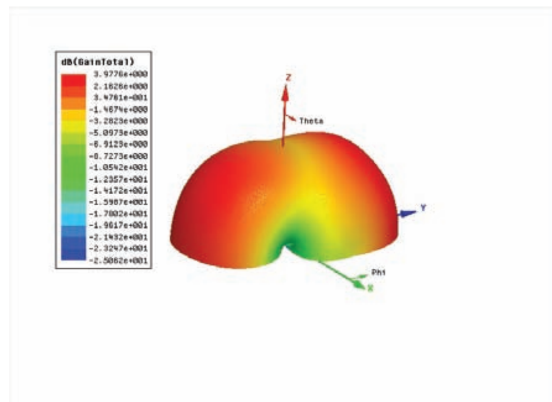

Fig. 7. Simulated 3D radiation pattern at 1800 MHz.

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