

Multi-band Planar Inverted-F Antenna for Mobile Communication Applications

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Abstract. This paper is proposed to design mobile handset antenna for make mobile handset more compact and thin. This antenna has an advantage of performing different frequency bands by one antenna design. Design and simulations are done using CST Microwave Studio program. A Reconfigurable Antenna is designed by using the FR-4 (lossy) substrate with the dielectric constant of $\epsilon_r=4.3$ and dielectric loss tangent 0.025. The substrate thickness of $h=1.6$ [mm], length= L_{sub} , width= W_{sub} . The ground is designed by using the PEC material with $h=0.035$ [mm]. The PIFA designed by using the copper with $h=0.035$ [mm], length= l/L_{sub} . In a result, return loss was below ($|S_{11}| < -17.05$ dB at 0.9GHz, $|S_{11}| < -21.86$ dB at 2.4GHz and $|S_{11}| < -38.78$ dB at 3.6GHz band. VSWR=1.5 at 0.9GHz, VSWR=1.1 at 2.4GHz and VSWR=1.5 at 3.6GHz. In the future, this antenna design will be fabricated and used in a mobile handset system.

Keywords: Wireless system, PIFA antenna, WiMax, GSM/PDC, Antenna theory

1 Introduction

Modern wireless systems employ multifunction broadband subsystems to support multiple frequency bands. This is connected with increases technical requirements for some parts of the system, e.g filters and antennas with adaptable frequency behavior. Availability of multi-mode, multi-band, and multi-standard devices makes the simplification of RF front ends possible. [1]

Multiband internal antennas have become a necessity for the state-of-the-art multifunction "smart-phone" and wireless sensor modules for the mobile devices. but this paper is proposed to design mobile handset antenna for make mobile handset more compact and thin. This antenna has an advantage of performing different frequency bands by one antenna design. For this purpose, a varactor diode is used in antenna design. [2]

2 Planar Inverted-F Antenna Theory

Antenna designers are always looking for creative ways to improve performance. One method used in patch antenna design is to introduce shorting pins (from the patch to the ground plane) at various locations. To illustrate how this may help, two instances will be illustrated, the quarter-wavelength Patch Antenna, which leads into the Planar Inverted-F Antenna (PIFA). The Planar Inverted-F antenna (PIFA) is increasingly used in the mobile phone market. The antenna is resonant at a quarter-wavelength (thus reducing the required space needed on the phone), and also typically has good SAR properties. This antenna resembles an inverted F, which explains the PIFA name. The Planar Inverted-F Antenna is popular because it has a low profile and an omnidirectional pattern. The PIFA is shown from a side view in Figure 1.

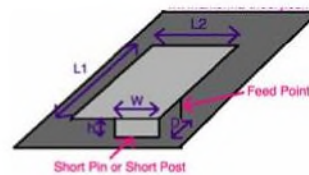
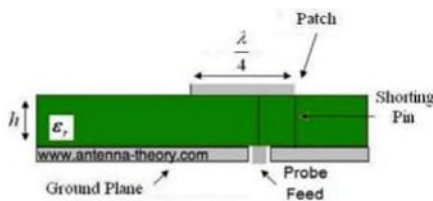


Fig. 1. Half-wavelength patch with shorting pin at the feed and PIFA antenna

3 Design of the PIFA Antenna

Fig 2 shows the geometry of our proposed antenna model. The proposed novel antenna is designed by using the FR-4 (lossy) substrate with the dielectric constant of $\epsilon_r=4.3$ and dielectric loss tangent 0.025. The substrate thickness of $h=1.6$ [mm], length= L_{sub} , width= W_{sub} . The ground is designed by using the PEC material with $h=0.035$ [mm] and length= $3/L_{sub}$. The patch designed by using the copper with $h=0.035$ [mm], length= $1/L_{sub}$.

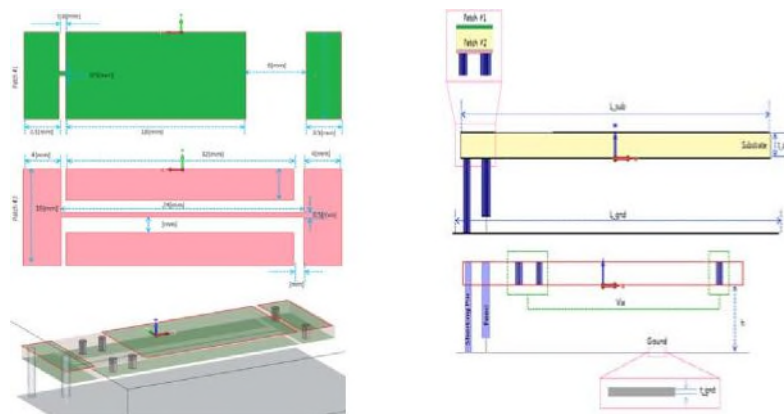


Fig. 2. The Planar Inverted-F Antenna design with short pin

4 Result

Fig. 3 shows the simulated return loss of the proposed antenna. From the obtained results, it is clearly seen the return losses of the proposed antenna can cover the required bandwidth of the $(S_{11} < -17\text{dB}$ at 0.9GHz, $S_{11} < -21\text{dB}$ at 2.4GHz and $S_{11} < -38\text{dB}$ at 3.6GHz band.

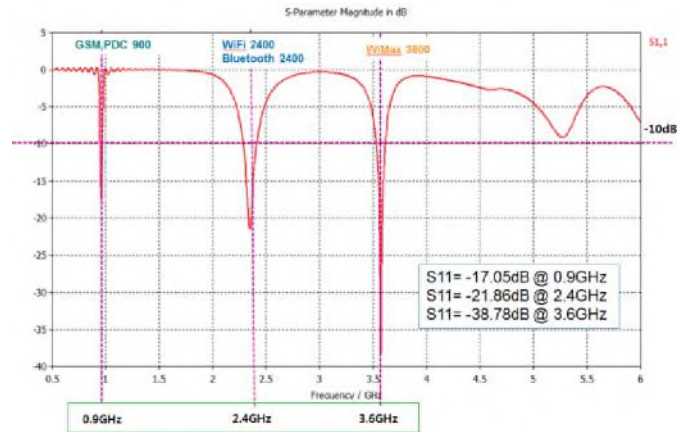


Fig. 3. S-Parameter Magnitude in dB (Return loss)

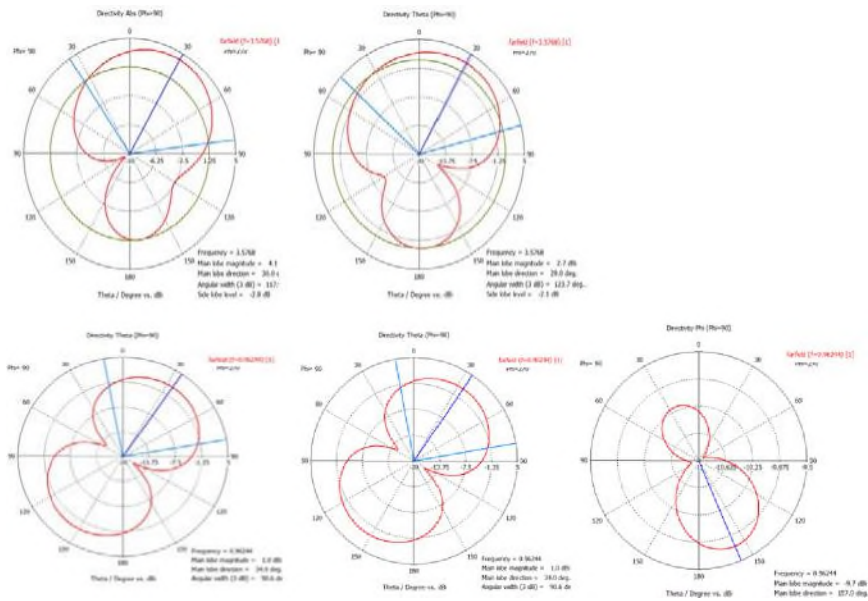


Fig. 4. E-Plane and H-Plane Radiation pattern at 0.9GHz, 2.4GHz and 3.6GHz.

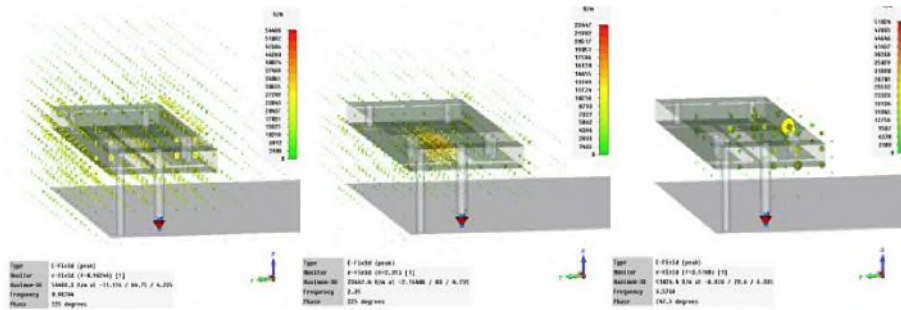


Fig. 5. The result of E-Field at 0.9GHz, 2.4GHz and 3.6GHz

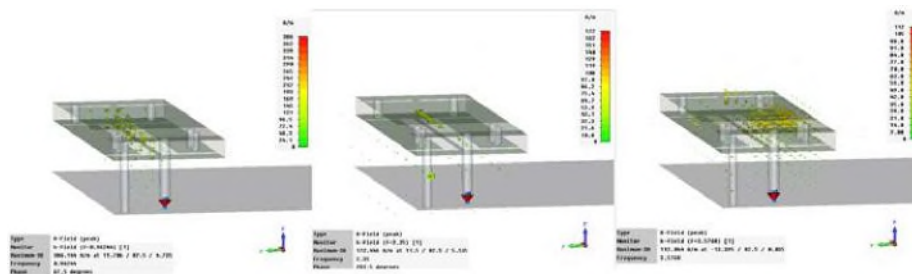


Fig. 6. The result of H-Field at 0.9GHz, 2.4GHz and 3.6GHz

5 Conclusion

Design and simulations are done using CST Microwave Studio program. Antenna is designed by using the FR-4 substrate with the dielectric constant of $\epsilon_r=4.3$ and dielectric loss tangent 0.025. The substrate thickness of $h=1.6$ [mm], length= L_{sub} , width= W_{sub} . The ground is designed by using the PEC material with $h=0.035$ [mm] and length= $3/L_{sub}$. The patch designed by using the copper with $h=0.035$ [mm], length= $1/L_{sub}$. In a result, return loss was below -17.05 dB at 0.9GHz, -21.86 dB at 2.4GHz and -38.78 dB at 3.6GHz band.

References

1. VReconfigurable Antennas: the state-of-the-art, INTL Journal of Electronics and Telecommunications,2-1-,vol.56,No.3, pp.319-326.
2. The Design and Fabrication of Compact Reconfigurable Monopole Antenna for LTE3G[.1GHz]/Wifi and Bluetooth[2.4GHz]/LTE4G[2.6GHz] Bandwidths, International Journal of Advanced Information Technology and Convergence, Vol.3, No. 1, July 31, 2013.
3. Planar Inverted-F Antenna theory.
4. The Design and Resonance Analysis of Small Antenna for Mobile Applications: 2004

5. C. R. Rowell and R. D. Murch: A compact PIFA suitable for dual frequency 900/1800-MHz operation. *IEEE Trans. Antennas Propagat.*, vol. 46, pp. 596–598, 1998.
6. Diallo, A.,Luxey, C.,Thuc, P. L.,Staraj, R., and Kossiavas, G.: Study and Reduction of the Mutual Coupling Between Two Mobile Phone PIFAs operating in the DCS1800 and UMTS Bands. *IEEE*