Small Internal Antennas for Cell-Phones Application

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1. Introduction

Small antennas are more widely used in wireless communication systems than before. The characteristics of small antennas like gain, efficiency, impedance bandwidth, and radiation patterns have been studied for application in real phones [1]. The embedded antennas are widely made due to such characteristics as low-profile, low-price, low *Specific Absorption Rate* (SAR), and easier fabrication [2-5]. However, nowadays still there is no any research organization in the world that can propose statistics proving cancer attributed to human body tissue exposed to *Electromagnetic* (EM) energy. But surely, EM radiation energy will cause the biological effects and pathological changes on the human organizations [6-7].

The presented antennas are designed in *Universal Mobile Telecommunication System* (UMTS) of 1920 - 2170 MHz and *Digital Video Broadcast–Handheld* (DVB-H^+) of 1452 - 1492 MHz. The resonant frequency of UMTS is made by using a *Planar Inverted-F Antenna* (PIFA) element; the other resonant frequency of DVB-H^+ is made by using meander-line configurations. The total volume of the antennas is greatly reduced by 65 % compared to generally internal radiators. The ratios of impedance bandwidth of the antennas related to the central frequencies 1.5 and 2.1 GHz are 20 % and 18 %, respectively.

The good characteristics of the antenna such as omni-directional far-field radiation patterns are attainable. The experimental results show fairly good agreement with the numerical data by *High Frequency Structure Simulator* (HFSS).

2. Antenna Design

To satisfy commercial applications, the proposed antennas are mounted on the top of a *Printed Circuit Board* (PCB) in a real phone according to the Dopod P100 mobile telephone specifications [8]. The material FR4 is used to be a substrate (SUB) of the antennas of which is 100 (L) x 60 (W) x 0.6 (H) mm^3 and the relative permittivity is 4.4. The geometry of the antennas is shown in Fig. 1 with the dimensions of L1 = 100 mm, L2 = 5 mm, L3 = L4 = 4 mm, L5 = 5 mm, W1 = 60 mm, W2 = 27 mm, W3 = 20 mm, W4 = W5 = 4 mm, W6 = 8 mm, W7 = 5 mm, W8 = 13 mm, W9 = 40 mm. The radius of the conductive metal single-core lines of the antennas is 0.7 mm. The 50-ohm coaxial cable with SMA is used to deliver the EM energy to the radiators.

3. Experiment Results

The far-field anechoic chamber and *Vector Network Analyzer* (VNA) HP 8720C are used to measure the electrical characteristics of the antennas. The experimental results are compared to the numerical data of HFSS. The *Return Loss* (RL) of the antennas is shown in Fig. 2. It illustrates that the measured impedance bandwidth of the antenna between 1.3 – 1.6 GHz and 1.92 – 2.3 GHz is covered referring to -10 dB RL. The ratios of impedance bandwidth of the antennas related to the central frequencies 1.5 and 2.1 GHz are 20 % and 18 %, respectively. The isolation level of the antennas is shown in Fig. 3. The far-field radiation patterns of the antennas at these resonant frequencies of 1.48, 2.0, and 2.1 GHz are shown from Fig. 4 to Fig. 6. The values of peak gain of the antennas on the azimuth (H_plane) at these resonant frequencies of 1.48, 2.0, and 2.1 GHz are 1.8, 1.7, and 2.0 dBi, respectively. The values of peak gain of the antennas on the elevation (E_plane) at these resonant frequencies of 1.48, 2.0, and 2.1 GHz are 0.7, 2.0, and 3.2 dBi, respectively.

4. Conclusions

Small internal antennas are presented for UMTS of 1920 - 2170 MHz and DVB-H$^+$ of 1452 - 1492 MHz applications. The ratios of impedance bandwidth of the antennas related to the center frequencies 1500 and 2100 MHz are 20 % and 18 %, respectively. The total volume of the antennas is greatly reduced by 65 % compared to generally internal radiators. The antennas have the good characteristics of omni-directional radiation patterns and wide impedance bandwidth. The experimental results show fairly good agreement with the numerical data of HFSS.

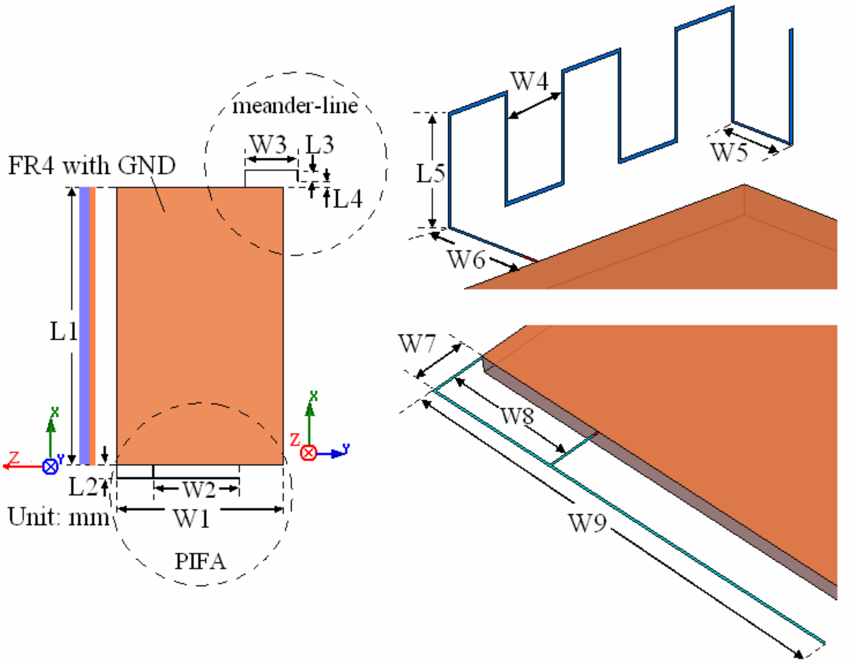

Figure 1: Geometry of the antennas

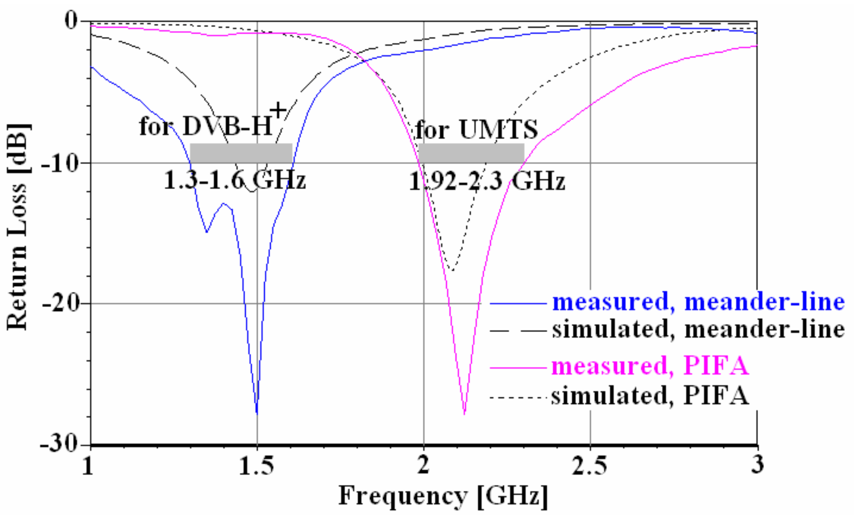

Figure 2: Return lose (RL) of the antenna

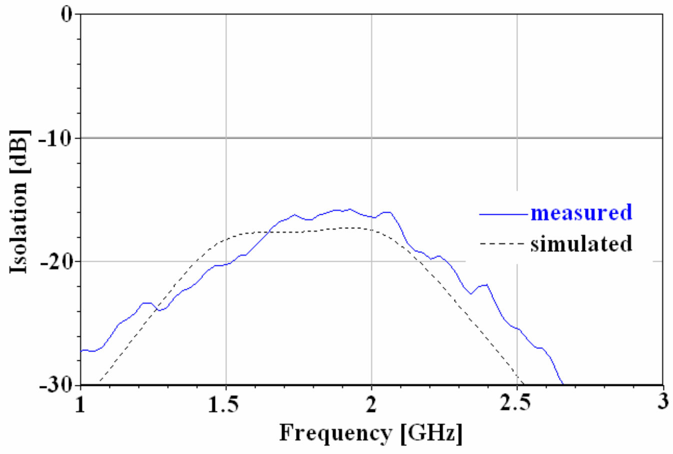

Figure 3: Isolation level of the antennas

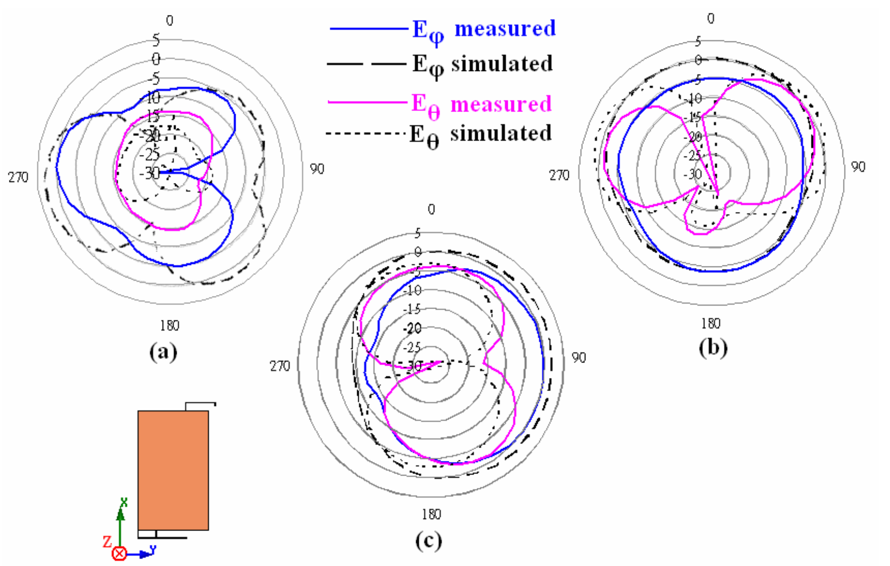

Figure 4: Measured radiation patterns of the antennas at 1.48 GHz (a) x-y, (b) z-x, and (c) y-z plane

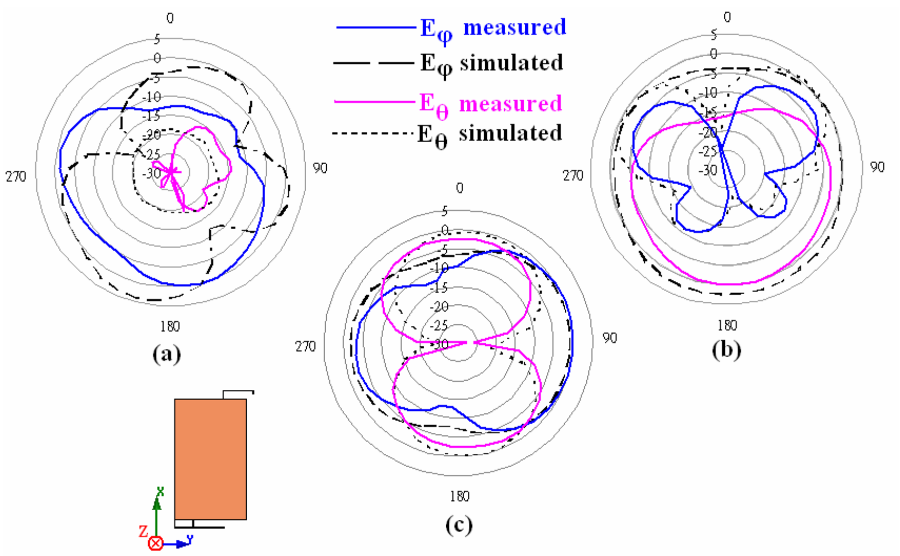

Figure 5: Measured radiation patterns of the antennas at 2.0 GHz (a) x-y, (b) z-x, and (c) y-z plane

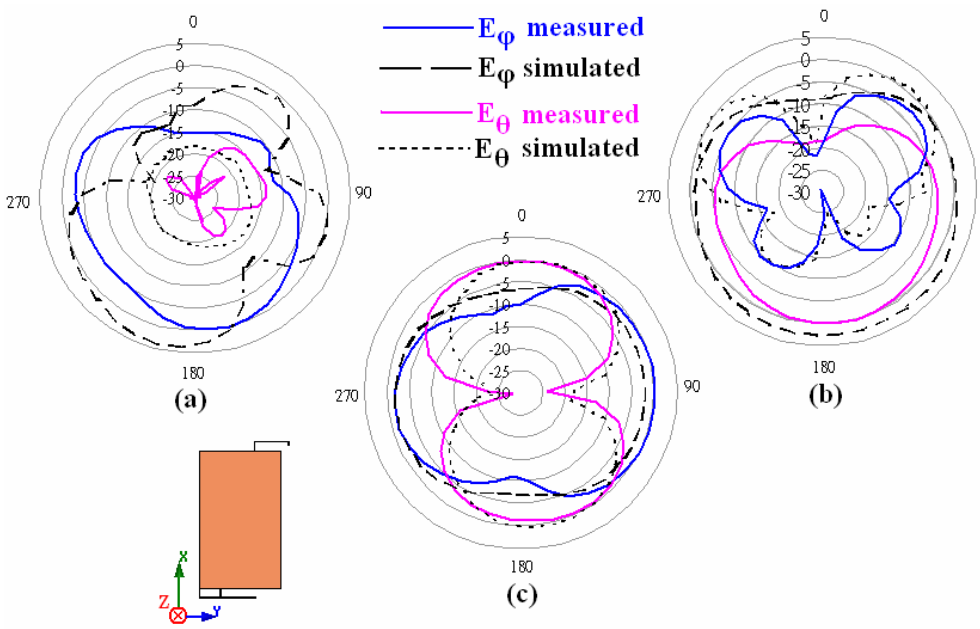

Figure 6: Measured radiation patterns of the antennas at 2.1 GHz (a) x-y, (b) z-x, and (c) y-z plane

References

[1] K. L. Wong, S. W. Su, C. L. Tang, and S. H.Yeh, "Internal shorted patch antenna for a UMTS folder-type mobile phone," IEEE Trans. on Antenna and Propagation, vol. 53, pp. 3391-3394, 2005.

[2] Benito Sanz-Izquierdo et al., "Single and Double Layer Planar Multiband PIFAs," IEEE Trans. on Antenna and Propagation, vol. 45, No. 5, pp. 1416-1422, 2006.

[3] Corbett R. Rowell and R. D. Murch, "A Compact PIFA Suitable for Dual-Frequency 900/1800-MHz Operation," IEEE Trans. on Antenna and Propagation, vol. 46, No. 4, pp. 596-598, 1998.

[4] K. Fujimoto, A. Hendenon, K. Hirasaya and J. R. James. "Small antenna." *Research Studies Press*, UK, 1987.

[5] A. Taflove, and M. E. Brodwin, "Computation of the Electromagnetic Fields and Induced Temperatures within a Model of the Microwave Irradiated Human Eye," IEEE Trans. on Microwave Theory Tech., vol. MTT-23, No. 11, pp. 888-896, 1975.

[6] ICNIRP Guideline, Guidelines for Limiting Exposure to Time-varying Electric, Magnetic, and ELectronagnetic Fields (up to 300 GHz), Health Phys., vol. 74, No. 4, 1998.

[7] D. Razansky, D. F. Soldea, and P. D. Einziger, "Generalized Transmission-line Model for Estimation of Cellular Handset Power Absorption in Biological Tissues," IEEE Trans. on Electromagnetic Compatibility., vol. 47, No. 1, pp. 61-67, 2005.

[8] Dopod, *http://www. Dopodasia, com*