Ultra Wideband Built-in Antenna with Novel EM Coupling Feed for Mobile Phones

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1. Introduction

Significant growth in the wireless communication market and consumers has caused wide interests in designing wideband and multiband antennas. In addition, recent global roaming trend has increased demand for wideband antenna with shrinking the size of the mobile handset. Thus, a single handset should be able to deal with the multi-standard issue and services such as voice, data, video, broadcasting, and digital multi-media contents. As a result, the need for wireless communication handsets antenna with at least penta-band (5-band) covering GSM quad-band as well as 3G service such as WCDMA would be more popular. However, most basic PIFA elements have inherently narrow bandwidth. Especially, narrow band characteristic in low-band is a very serious problem regarding resonance-shifting due to the hand and head effects. Even though, there are the many researches based on the PIFA concepts for achieving multi-band operations, it is not easy to achieve enough bandwidth for low-band with covering penta-band or more bands simultaneously[1,2].

This paper proposes new design concepts as a miniature wideband built-in antenna with novel EM coupling feed structure which is implemented between the feed line and short line. This structure consists of the periodic distributed L-C coupling structure involving wide-band impedance matching with miniature antenna size. With this proposed novel feeding structure, a hepta-band built-in antenna with 3.8cc for covering the GSM850, GSM900, DCS, PCS, WCDMA, WIMAX2350, and Bluetooth are eventually implemented.

2. Antenna Geometry and Characteristics

The proposed new antenna in this work is shown in Fig. 1. The new hepta-band antenna was developed within a 3.8cc $(39\text{mm} \times 14\text{mm} \times 7\text{t})$ volume. The overall size of PCB with 3 layers (total thickness: 1*mm*) has a length of 100*mm* and a width of 39*mm*. The used PCB structure consists of the combination of 2 metal layers with 0.01mm thickness (1^{st} layer: bottom of PCB, 3^{rd} layer: top of PCB, beneath of antenna) and 1 dielectric layer with 0.98mm thickness. Especially, for the ground layer under the antenna area, only bottom ground layer (1^{st} layer) is remained unpeeled off except the top layer.

Figure 1 shows the detailed 3-dimensional prospective view of antenna structure. Antenna under test (AUT) consists of a metal radiator, plastic carrier, and bare PCB layer. Plastic supporter is made of ABS polymer (ε_r=3.2) and act as a role of supporting material of radiator in this structure. Such as a figure 1 (b) ~ (c), the each radiator is connected to the ground layer via two short pins (short pin 1 and short pin 2) respectively and also feed line is connected to a 50 Ω coaxial cable via a feed pin. As a low band feed mechanism of proposed antenna, the EM signal is coupled from feed line through the face-to-face comb-line structure of 0.062λ length dominantly. With the compact and high density EM coupling feed mechanism, bandwidth enhancement could be achieved in the low frequency band. Especially, for the maximized multiple L-C resonance characteristics, it is very important to optimize the stub length, width, and gap between each stub. The optimized dimensions of antenna are shown Fig. 1 (b), and the key parameters are 1.3mm for length, 0.5mm for width, and 0.5mm for gap. For the high band structure, the radiators with two different branch lengths are also extended from ground layer via short pin 2. Especially the shorter of the two branches is EM coupled structure with the feed line for making wideband matching characteristics

3. Measurement results and Discussion

Fig. 2 shows the measured and simulated return losses of the proposed antenna. The measured bandwidth according to -6dB return loss matching are 260MHz (837MHz-1097MHz) at the lower band and 890MHz (1710MHz-2600MHz) at the upper band, respectively. The measured bandwidth are about 29% at the lower band (@ 892MHz center frequency) and about 41% at the upper band (@ 2155MHz center frequency) respectively. There is a good agreement between the measured and simulated results. The measured far-field radiation patterns of the new hepta-band antenna are depicted in Figs. 3(a)-(g), respectively. It can be seen that the measured gains for all bands are within the range of -0.5dBi ~ 3.78dBi.

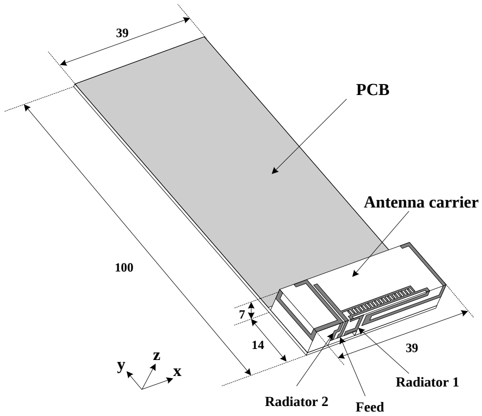
4. Conclusions

A novel built-in antenna with a compact EM coupled feed structure suitable for application in GSM850/GSM900/DCS/PCS/WCDMA/ Wibro2350/ Bluetooth hepta-band wireless terminal has been proposed. Ultra wideband impedance bandwidths are achieved through a novel face-to-face comb-line EM coupled feed between signal line and short line. In measurements, the bandwidth of proposed antenna showed about 29% at the lower band and about 41% at the upper band. The fabricated built-in antenna with the proposed novel structure has a good agreement between the measured and simulated results.

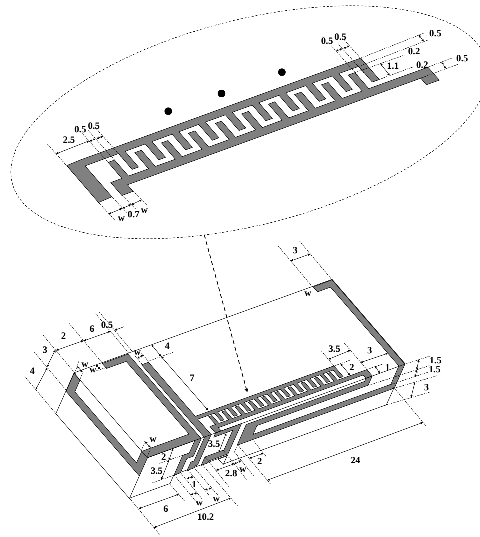
References

[1] Y.X. Guo, M. Y. W. Chia, and Z.N. Chen, “Miniature Built-in Multiband Antennas for Mobile Handsets,” *IEEE Trans. Antennas Propagat.*, vol. 52, 2004, pp. 1936-1944

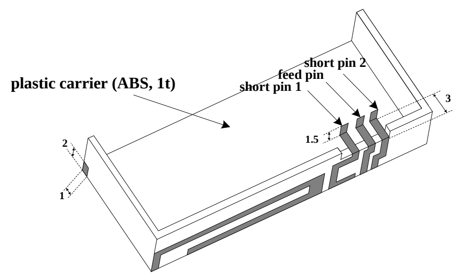
[2] Mikko K. Karkkainen, “Meandered Multiband PIFA With Coplanar Parasitic Patches,” *IEEE Microwave and Wireless Components Letters*, vol. 15, no. 10, 2005, pp. 630-632



(a) 3-demensional prospective view of the designed antenna and PCB board



(b) top view



(c) rear view

Fig. 1 Detailed geometries of the designed antenna

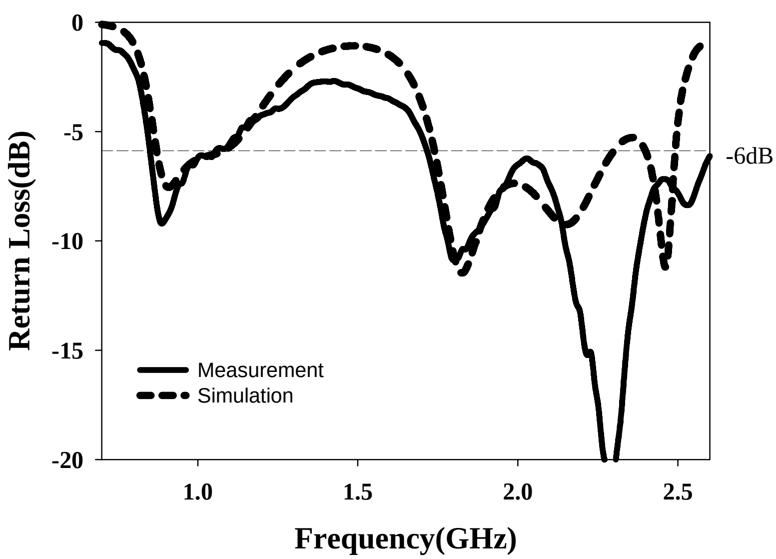
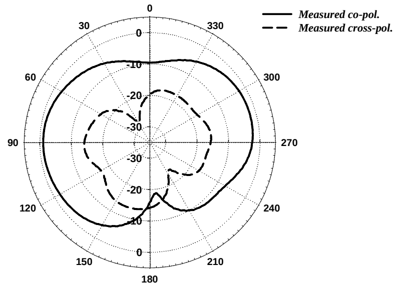
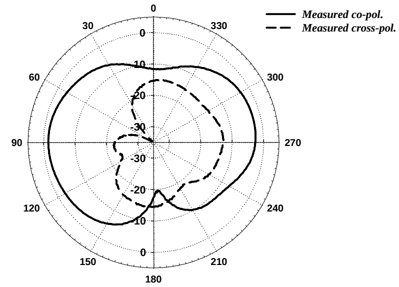


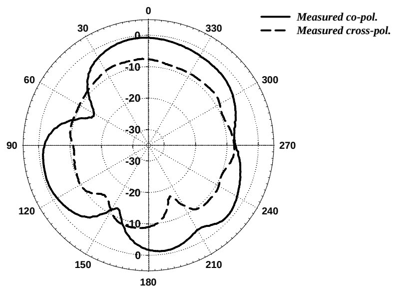
Fig. 2 Return loss characteristics of the designed antenna



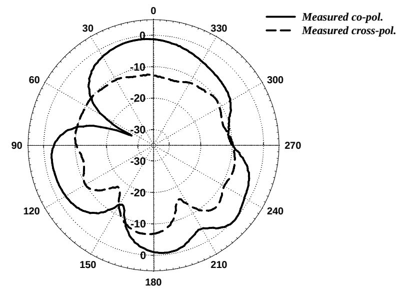
(a) 869MHz



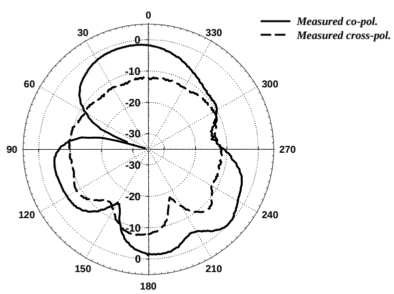
(b) 935MHz



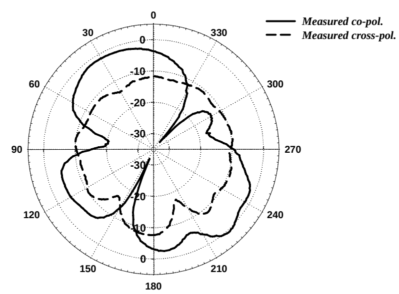
(c) 1805MHz



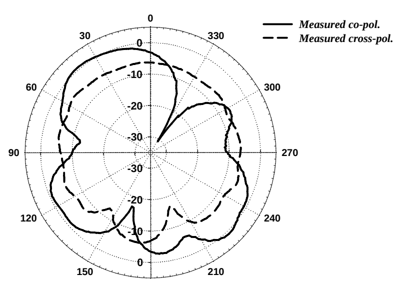
(d) 1930MHz



(e) 2110MHz



(f) 2350MHz



(g) 2450MHz

Fig. 3 Measured radiation patterns in-y-z plane