A Wideband Built-in Antenna with Omni-Directional Radiation Pattern using Dual Radiators for Wireless Terminals

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Abstract: A new built-in antenna is proposed with omni directional radiation characteristics and wideband for wireless terminals. Bandwidth of built-in antenna is dependent on length and width of the chassis [1]. Radiation characteristics of built-in antenna are also very sensitive to chassis size and mounting position. When size of chassis is increased, radiation pattern characteristics of built-in antenna are more degenerative in the high frequencies (1800MHz~2200MHz) than those of antenna in the low frequency (900MHz) among current cellular services.

This paper proposes a balanced dual radiators built-in antenna with special impedance matching branch for bar-type handsets (45mm x 100mm), which built-in antenna is operating at PCS and IMT-2000 band. Using suggested technique, we improved –6dB impedance bandwidth by about 75% and also obtain the omni directional radiation pattern even though which is mounted on relatively large chassis.

Key Words: Built-in antenna, Radiation pattern, Dual radiators, Feed position, Finite Ground

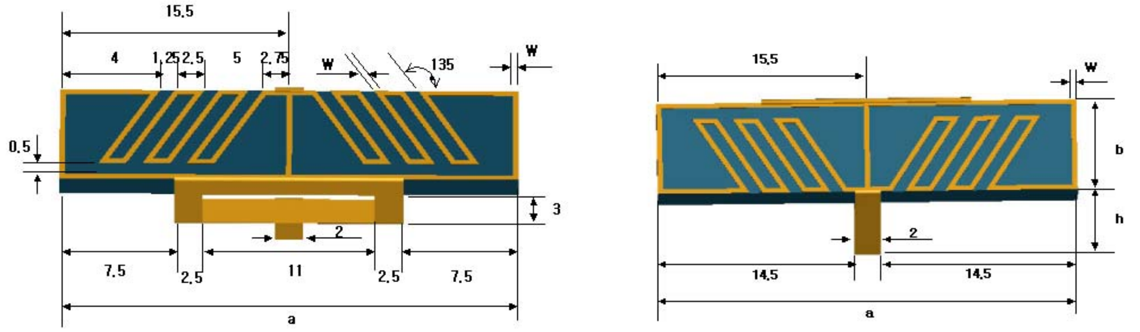
I. INTRODUCTION

The electrical characteristics of a built-in antenna depend strongly on the size of the device ground plane on which the antenna is mounted and the position of the antenna on it [1]. Previous research has focused mainly on the length effect of a handset's metal chassis on bandwidth and gain [1-3]. Generally, Bar type handset or PDA terminal has about 100mm length and 40~45mm width. This finite-sized situation is good for 900MHz band, but not in 1800MHz ~ 2200MHz [4]. Especially, the radiation pattern can be degraded severely at special azimuth angle, and maximum –6dB bandwidth of built-in antenna is at least about 10 % [1,3]. This paper presents the new wideband built-in antenna for bar type handset (100mm length). Resonant frequency of the proposed antenna is about 2000MHz to observe their performance of antenna clearly in the worst situation. The designed antenna has been simulated using Microwave Studio(MWS).

II. THE DISCRIPTION OF PROPOSED ANTENNA WITH SLOTED DUAL RADIATORS

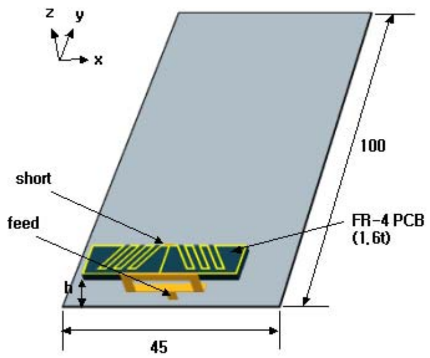
Configuration of the antenna, which consists of balanced dual radiators with diagonal slots, is shown in Fig. 1. And this diagonal slot can contribute strongly to cross-polarization of radiation pattern. We used FR-4 PCB resin (ε_r=4.2, 1.6t) for antenna material and impedance matching branch adapter for achieving wideband characteristics. FR-4 PCB substrate layer is used for miniature antenna design. The proposed antenna is fed by a coaxial cable via folded Y-shaped special branch for wideband impedance matching at center position on ground. In the experiment, a semi-rigid cable with diameter of 2mm was used. The center frequency f_0 is about 2GHz. Fig. 3 shows that the general PIFA structure with copper plate of thickness 0.2mm is fed at the edge position of chassis. Generally, the edge feeding technique is used for PIFA to obtain sufficient impedance bandwidth in finite-sized ground plane [4].

In order to operate at the same center frequency, the parameters of proposed antenna are *a*=31mm, *b*=8mm, *h*=8mm, and those of the PIFA are 26mm, 10mm, and 8mm. The dimension of finite-sized ground plane has width of 45mm and length of 100mm.



(a) (b)

Fig. 1 The proposed antenna structure with Front view (a) and Back view (b)



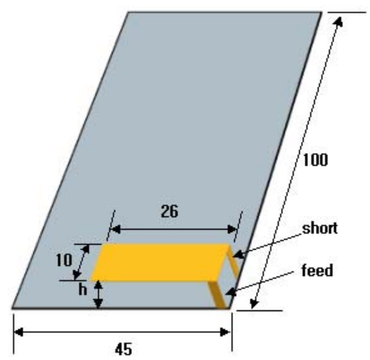


Fig. 2 Proposed antenna mounted on chassis plane Fig. 3 PIFA mounted on chassis plane

III. NUMERICAL AND EXPERIMENTAL RESULTS

To clarify the characteristic of the proposed antenna as well as PIFA, the VSWR are calculated and measured in Fig. 4. As can be seen in Fig. 4, the calculated results agree very well with the measured results for both antennas. Furthermore, Table 1 shows the relation between bandwidth and volume for both antennas. The bandwidth (VSWR 3:1) is evaluated to be approximately 16~17% for both calculated and measured results. However, we can see that measured impedance bandwidth of PIFA is 9.8%. This result has good agreement with previous research for finite-sized ground plane (100mm length) [1,4]. The bandwidth of the proposed antenna is broader than those of the PIFA even though the volume of the proposed antenna is smaller than PIFA.

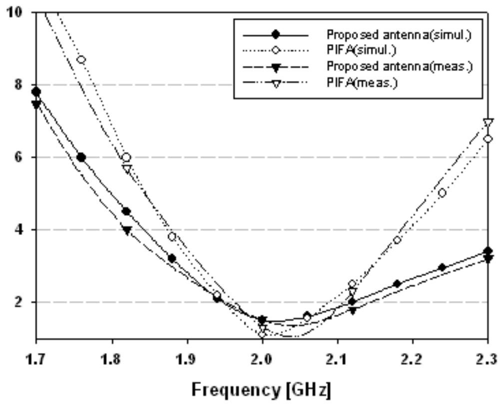
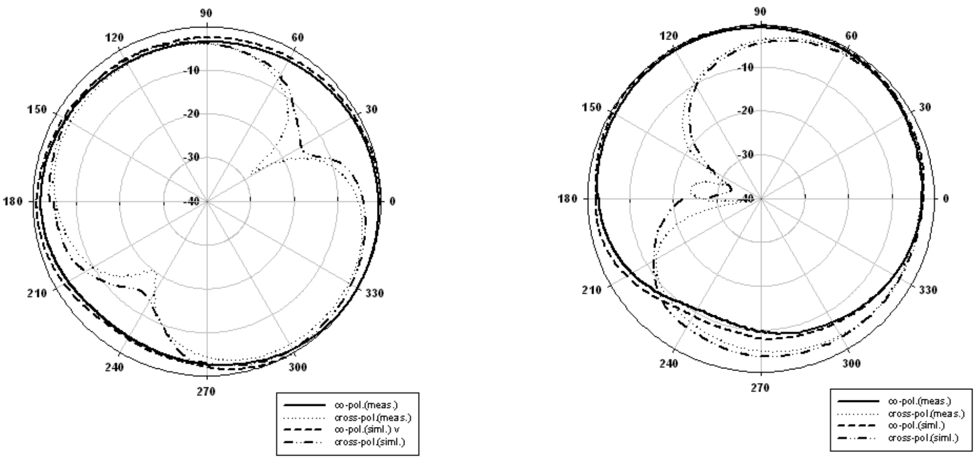


Fig. 4 Simulated and measured VSWR results between the proposed antenna and PIFA

Table 1: Relation between –6dB Impedance Bandwidth (VSWR 3:1) and Volume

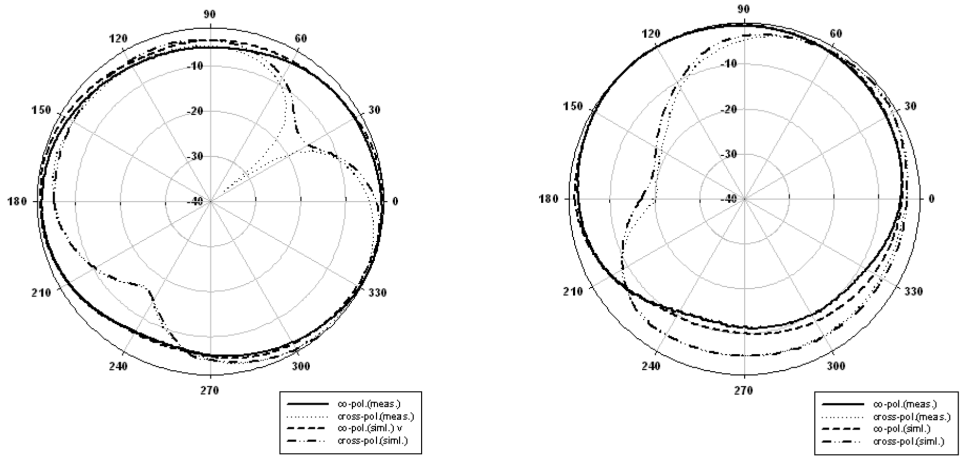
	Bandwidth [MHz]	Bandwidth [%]	Volume [%]
Proposed antenna (cal.)	320	16	90
Proposed antenna (mea.)	340	17	90
PIFA (cal.)	190	9.5	100
PIFA (mea.)	195	9.8	100

Fig. 5 and Fig. 6 shows the calculated and measured radiation patterns of the gain (dBi) around the center frequency f_0 near and at 2.0GHz and 2.05GHz, respectively. In Fig. 5(a), we can observe that the proposed antenna has an omni-directional radiation pattern in co-polarization plane. Also, cross-polarization pattern has the maximized values at +135 degrees or –45 degrees due to diagonal slotted pattern on PCB antenna. Fig. 5(b) shows the radiation pattern of general PIFA type mounted on finite-sized ground plane. However, we can clearly see that there is –10dB degradation at –90 degree in co-polarization plane. And there is –30 dB null point at 180 degrees in cross-polarization plane. As the operating frequency is higher, null depth and angle are more severely occurred. Fig. 6 illustrates the radiation patterns of two antennas at 2.05 GHz. There is almost no degradation characteristics like as in Fig. 6(a). However, as can be seen in Fig. 6(b), when the frequency is increased, the radiation characteristics of PIFA are more deteriorated through broader beam width.



(a) (b)

Fig. 5 Simulated and measured results of the radiation pattern at 2.0GHz
for the proposed antenna (a) and PIFA (b)



(a) (b)

Fig. 6 Simulated and measured results of the radiation pattern at 2.05GHz for the proposed antenna (a) and PIFA (b)

IV. CONCLUSIONS

The proposed built-in antenna with diagonal slots has an omni directional radiation pattern as well as wideband characteristics. Measured impedance bandwidth of the proposed antenna mounted on finite-sized chassis (100mm length) is about 17% (340MHz, VSWR < 3). And the radiation pattern of the proposed built-in antenna has an omni directional pattern in x-z plane (H-plane) even though PIFA has severe degradation in co-polarization plane as well as cross-polarization plane. The proposed built-in antenna has an attractive feature for mobile handset applications, because this antenna has the good radiation characteristics, which can improve the handset's radiation performances such as TRP/TIS.

V. ACKNOWLEDGMENT

This work was supported by the National Research Lab. (NRL) of Ministry of Science and Technology, Korea under contract No. M1-0203-0015.

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