Highly efficient SAR reduction using PIFA and MB antenna in mobile handsets

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Abstract - The field compensation method for creation of a weak field area near a transmitting antenna provides a generic method for reducing irradiation of mobile phone user’s body, especially his head, without distorting the antenna’s far field pattern in the horizontal plane. This method consists in adding an auxiliary antenna between the transmitting (main) antenna and the user’s head. In this work we’ve applied the field compensation method to the PIFA and the MB antenna. The former is widely used in nowadays mobile handsets, and the latter is an emerging printed antenna with promising characteristics for cellular handset applications and exhibits superior performance relative to the PIFA. The simulation results show that when antenna MB and compensation method are used instead of antenna PIFA the total SAR decreased by 15.5 dB, and the maximal local SAR by 16.9 dB. The SAR reduction ability combined with the compact size and high gain characteristics of the MB antenna make it a promising candidate for compact and safe cellular handset applications.

Keywords – Compensation method, far field, near field, MB antenna, PIFA, Mobile handsets, SAR, cellular antenna

I. INTRODUCTION

Proximity of a transmitting antenna to vulnerable devices or objects may induce damage both in terms of proper operation of such device (object) and in terms of physical damage. A particular example is mobile telephones placed close to the user’s head. Besides possible health problems, the antenna’s proximity to user’s head may distort its radiation pattern in the far region, leading to degradation of the communication link. Therefore, it is very important to ensure that when reducing irradiation on an object in the near region, the field magnitude at the far region is not changed, and hence the quality of communication link is preserved.

The new Specific Absorption Rate (SAR) reduction method, called the compensation method, permits to reduce the undesirable irradiation of the user’s head, without distorting the antenna pattern in the horizontal plane [1-5]. In accordance with this method an auxiliary antenna is placed between the user’s head and the main radiator, and excited approximately in anti-phase to it. Consequently the radiators’ fields will compensate each other at some point inside the head, and around this point an area of weak field will be created.

In this work, we apply the compensation method to different antenna types, namely PIFAs which are widely used in compact cellular handsets, and the so-called MB antenna [6], which has been recently proposed as an internal monopole for handset applications. We present comparative results based on CST simulations.

II. PIFA and MB ANTENNA

The MB antenna is a modified monopole. In contrast to the conventional monopole, it can be implemented in parallel to a ground plane. This property is achieved by creating a phase difference of 180 degrees between the current in the radiating trace of the monopole and the current in the ground plane, which is in parallel to the radiating element. In this manner the ground and the radiating element’s currents are in–phase, and theirs radiation fields add up constructively.

The main characteristics of the MB antenna, studied by CST simulations, are presented in Table 1, and compared to those of PIFA, indicating the superior performance of the MB antenna.

The input characteristics of the antenna PIFA and the MB antenna are given in Fig. 1. As seen in this figure the MB antenna exhibits three frequency bands.

Table 1- Electric characteristics of the MB antenna compared to PIFA

<table>
<thead>
<tr>
<th>Antenna type</th>
<th>Frequency, GHz</th>
<th>Total efficiency, dB</th>
<th>Gain, dB</th>
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<tbody>
<tr>
<td>MB</td>
<td>1.305</td>
<td>-0.0139</td>
<td>4.384</td>
</tr>
<tr>
<td>PIFA</td>
<td>0.9</td>
<td>-2.094</td>
<td>1.92</td>
</tr>
</tbody>
</table>

III. SIMULATION RESULTS AND DISCUSSION

The SAR values for the MB antenna and PIFA were calculated by CST. Fig. 2 presents the simulation results for the far fields of both antennas, and Fig. 3 shows the simulation results for the antennas’ gains. In Fig. 4 the simulation models for SAR evaluation are shown for the
cases of the MB antenna and PIFA when two similar antennas are used as required by the compensation method.

Fig. 1 Input characteristics of the MB antenna (a) and the PIFA (b)

Fig. 2 The simulation results for the far fields of the MB antenna (a) and the PIFA (b)

Fig. 3 The simulation results for the gains of the antenna MB (a) and the antenna PIFA (b)

Fig. 4 The simulation models for SAR evaluation for the cases of the MB antenna (a) and PIFA (b)
The simulation results of the MB antenna in three frequency regions are presented in Fig. 5.

![Simulation results of MB antenna in three frequency regions](image)

Fig. 5 MB antenna simulation in three frequency regions

The SAR reduction ability of the antennas is evaluated by comparing the local and total SAR values when the compensation method is applied (two antennas) compared to the single antenna case. The results are shown in Table 2, which presents the maximum field strength $E_{\text{max}}$ at a distance of 5 m, and the near field value $E$.

Table 3 compares the SAR reduction performance of the compensation method in the cases of the MB antenna and PIFA. As it can be seen from this table, the MB antenna allows for a substantial reduction of the SAR value in the user head. This result combined with small size and high gain of the MB antenna make it very attractive for use in compact handsets.

### IV. Conclusions

In conclusion we have applied the field compensation method the MB antenna and PIFA. Simulation results show that the field compensation method yields efficient SAR reduction in both cases. However, in the case of the MB antenna the SAR reduction efficiency is higher by about 10dB, in terms of total SAR value, compared to PIFA. In addition, as a printed monopole, the MB antenna lends itself well for utilization in cellular handsets, when the compensation method is applied. Based on these results and other radiation characteristics of the MB antenna, such as its high gain, it seems as a promising antenna for cellular handsets.

### References


