THE BATTERY EFFECT IN MOBILE ANTENNA DESIGN

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ABSTRACT

The battery pack is a necessary component of mobile phones, and is located in close vicinity of the integrated antenna modules. The influence of the battery with different grounded points was investigated for both dual-band and tri-band integrated mobile antennas. Experimental results are presented to show this.

1. Introduction

Mobile communication handsets with internal antennas are becoming more popular each day. These integrated antennas are designed in a small volume of an arbitrary shape. The design of the antenna becomes even more critical given the need for multiband functionality as an essential feature in modern mobile phones. The planar Inverted-F antenna (PIFA) is often preferred because of its low profile characteristics [1,2] and it is often placed on the upper part of the phone. Due to space considerations on the mobile handset, the battery is often placed next to the integrated antenna. Thus the influence of the battery due to its proximity to the antenna can be rather large.

Earlier investigations [3] had been done to establish a relationship between the integrated antenna impedance bandwidth and the physical length of the mobile handset, or between the volume of an antenna and the maximum bandwidth [4]. In this paper, the influence of the battery and the location of the battery connection to the PCB’s ground will be examined using three typical inverted-F antenna designs. It hads been observed that the battery connector for mobile handsets could be placed at either the top part of the battery which is close to the antenna or at the opposite end away from the antenna. In our experiment of all the antenna designs mentioned, the battery was grounded at either of two locations, one location is close to the antenna (top ground), and the other is far away from the antenna (bottom ground).

2. Antenna configurations and results

Fig1 (a)-(c) shows the three typical designs for dual-band (GSM & DCS) and tri-band (GSM, DCS & PCS) antennas on the real mobile phone. In the first dual-band design, two connected elements were use to create a low band (900MHz) and high band (1800MHz) resonances respectively. For the second dual-band antenna design, the high band element was enclosed in low band element which is running in anti-clockwise direction (another possibility to do this is to run the low band element in clockwise direction, and it was considered the same as the case shown in Fig1 (b)). As for the tri-band antenna, one coupling parasitic element was used to widen the bandwidth in high band (DCS & PCS), as shown in Fig1 (c). These 3 designs represent

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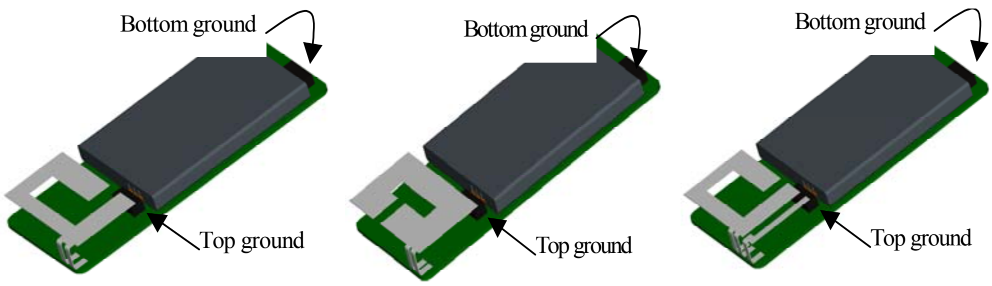
most of the current mobile handset antenna designs that are in the market. As such these experiments should be a good representation of the effect of the battery on most mobile handset.

In all cases, the battery was considered as a metallic block connected to the ground of the PCB at either top (top ground) or bottom (bottom ground). The distance between the edge of the antenna and the top of the battery pack is about 2mm. The sizes of the PCB and the battery are 95x38mm and 54x35x5mm respectively. The effect of the battery with regards to the antenna performance will be discussed for the three configurations: the battery with top ground, bottom ground, and without the battery, for each antenna design. Return loss curves of the antenna will be used to study different effects of the influence of the battery.



(a) Dual-band (b) Dual-band (c) Tri-band

Fig 1: Different antenna designs

Fig2-4 shows the comparison of the return loss measured for both dual- and tri-band antenna designs with three different battery configurations. It is very clear that the resonant frequency for both low band and high band were shifted to a lower frequency the moment that the battery was introduced. This reason is two-fold. One, the Planar Inverted F Antenna depends very much on the ground and its environment. Secondly, due to the metallic structure of the battery, when connected, the ground of the antenna is now changed, as there is now an element of coupling with the battery. When the battery is connected using top and bottom ground, the high band resonances did not change for all the 3 antenna designs. Thus the battery top or bottom connection has little effect on the high band. The shift in frequency is about 1.2% to 4.1% to a lower frequency for the high band when the battery was added. However, the low band exhibits some differences for the different battery connections. A shift of about 1% to 3.4% was seen for the case when the bottom ground was used. A larger shift of up to 4.9% was seen for the case when the top ground was used. It is obvious that the top ground cause greater shift in resonance compared with the bottom ground. This is due to the larger amount of coupling cause with the connection at the top.

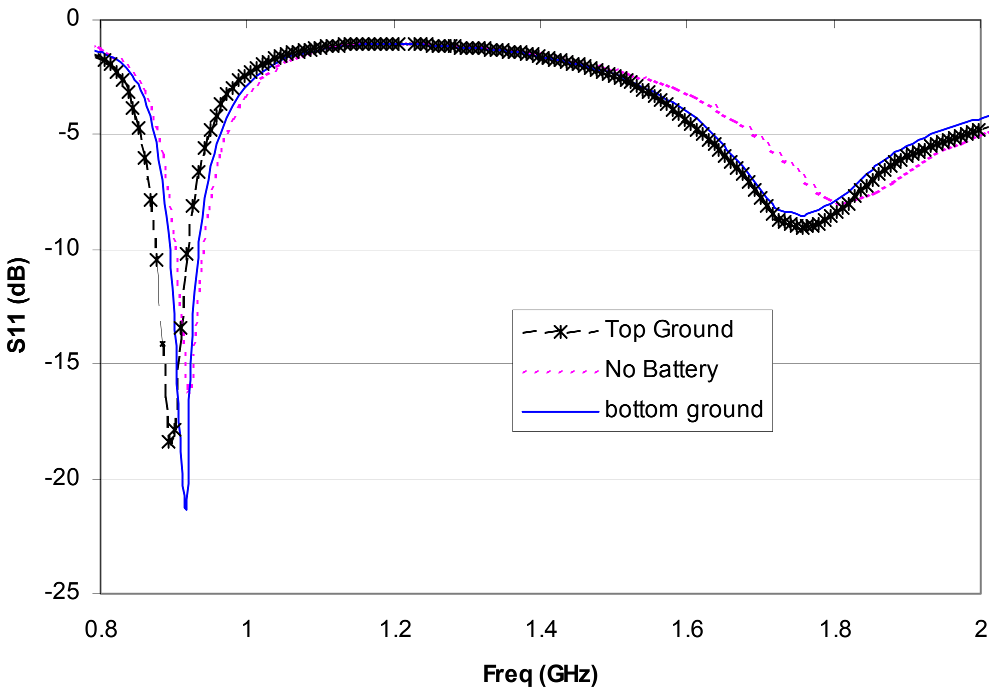


Fig 2: Measured return loss for design (a)

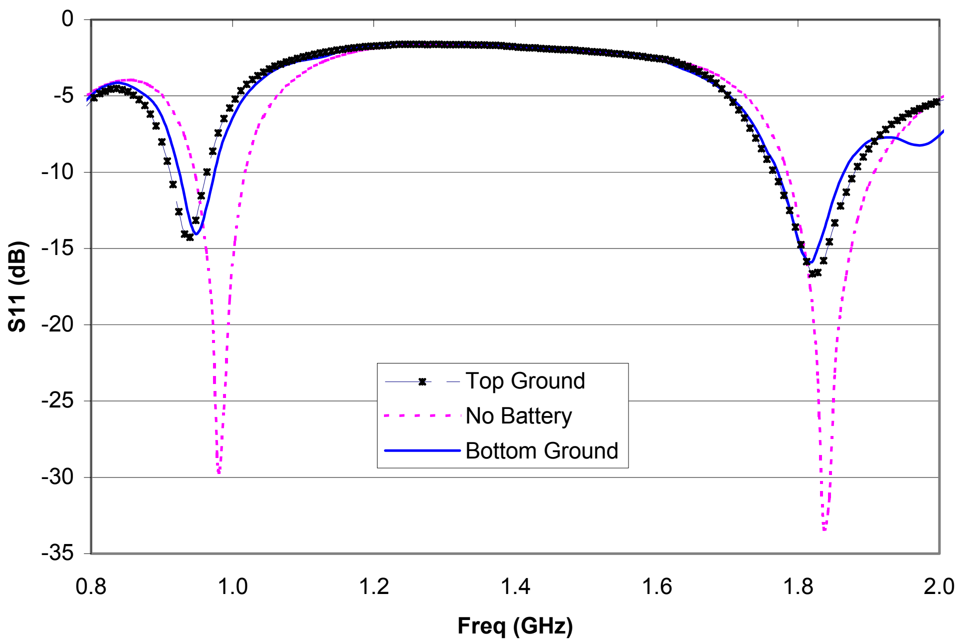


Fig 3: Measured return loss for design (b)

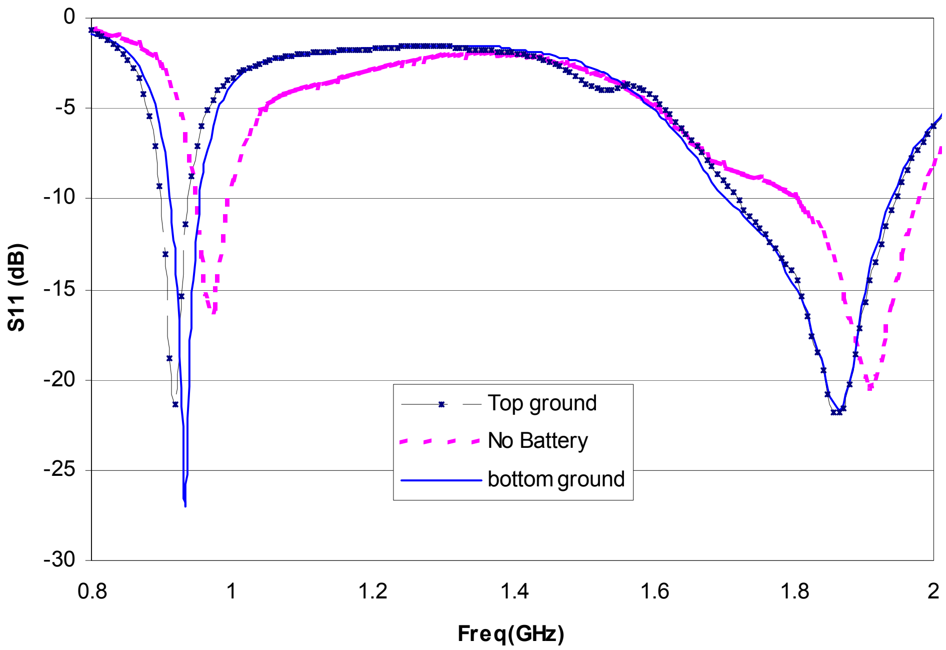


Fig 4: Measured return loss for design (c)

3. Conclusion

In conclusion, it has been shown that the battery has some effect on the antenna design of the mobile. With the addition of the battery, it shifts the resonant frequency band to lower frequencies for both low and high bands. Especially for the low band, when the battery was grounded on the top, the resonant frequency will shift down more compared with the case of the bottom grounded design. This is especially useful when mobile handsets are getting smaller and there has to be compromises in the total available volume for antenna to be designed. This down shifting of the bandwidth helps achieve a greater amount of design freedom especially in the low band of GSM850 and GSM900.

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