A Resonant Handset Antenna that can Cover All Bands of UHF Mobile TV, GSM and CDMA without Using Matching Circuits

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I- Introduction:
Antennas for mobile digital TV are required to have a very wide frequency band. For example, UHF DVB-H is designed to work in the frequency band from 470 MHz to 862 MHz. This is a very wide bandwidth which is difficult to cover with a single resonant antenna. Therefore, matching circuits are usually used to tune the antenna for this band [1]-[3]. Matching circuits increase the complexity, the size and the costs of the antenna and also reduce its efficiency. On the other hand, the mobile TV band overlaps with the CDMA/GSM800 band (824-894 MHz) and it is also too close to the E-GSM900 band (880-960 MHz). This overlapping may cause severe interference between the antennas of these applications especially if they were placed close to each other inside the handset. A novel solution to overcome all these problems is to use only one wideband resonant antenna that can cover all bands of UHF mobile digital TV, 700 MHz WiMax (698-806 MHz), CDMA, GSM800 and E-GSM900.

In this research, a novel wideband resonant antenna that fulfils theses requirements has been developed, manufactured and tested. The new antenna covers a bandwidth of more than 68%. It is an unbalanced resonant antenna that does not need any tuning-matching circuits or any other components. It naturally resonates from 470 MHz to 960 MHz and hence it can cover all bands of the above applications. The new antenna can be used with multifunction multi-standard handsets, palmtop computers, notebook and laptop computers or any other portable communication equipment.

II- Geometry of the new resonant antenna:
Fig.1 shows the geometry of the new UHF digital mobile TV antenna. It consists of two narrow printed metallic arms connected together by a short metallic strip. The two arms can have any angle between them and they can also be parallel to each other. The length of the short arm is L_1 and its width is W_1 while the length of the long arm is L_2 and its width is W_2. The thickness of the antenna is T_a and it is fed at a distance F_a from the shorted edge. Each arm has a set of slots having different configurations. The shapes, locations and dimensions of the slots are optimized in order to maximize the bandwidth.

The new antenna is completely self-contained and it does not need an additional ground plane or any other components. Thus, the new antenna can be mounted anywhere inside or outside any handset because the antenna does not use a part of the handset as an extended ground plane as usually happens with internal antennas. Furthermore, the new antenna is made of a flexible material and it can be bent and/or folded in different forms in order to fit any available space inside or outside the handset. Actually, it can be used as an internal, external or partially internal and partially external antenna. Moreover, its overall size is very small and its manufacturing costs are very low.

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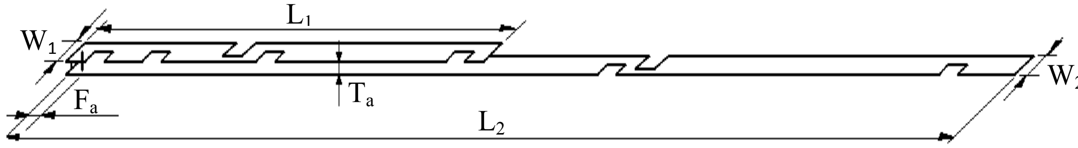


Fig.1 Geometry of the new antenna

III- Results:

Different prototypes of the new mobile TV antenna have been designed, manufactured and tested. The results of a selected sample antenna configuration will be presented. The two arms of the selected sample antenna are parallel to each other. The dimensions of the antenna are: L_1 =11.5 cm, L_2 = 25 cm, W_1 = 2.6 mm, W_2 =3.5 mm and T_a = 2 mm. Thus, the overall size of the antenna is 25 x 0.35 x 0.2 = 1.75 cm^3. It should be noted that this is the total volume of the antenna because it does not require an additional ground plane or matching circuits. The performance of the antenna is numerically calculated by a software packages that uses the moment method. It is also measured at IMST antenna labs in Germany [4]. The agreement between numerical and experimental results was acceptable and only experimental results will be presented. Fig.2 shows the measured return loss of the new antenna. The return loss is less than -5 dB from about 470 MHz to 960 MHz which is more than 68% bandwidth.

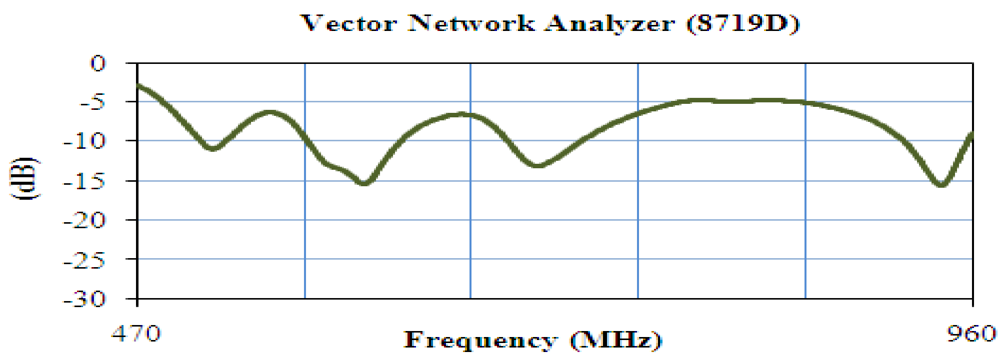


Fig.2 Measured return loss of the new antenna

Fig.3 shows the measured peak gain of the new antenna from 470 MHz to 960 MHz. The peak gain is about 0 dBi over most of the band. Thus, the peak gain of the new antenna is much higher than MBRAI specifications of the UHF mobile TV [5]. The measured efficiency of the new antenna is shown in Fig.4 from 470 MHz to 960 MHz. The average efficiency over the whole band is about 45%.

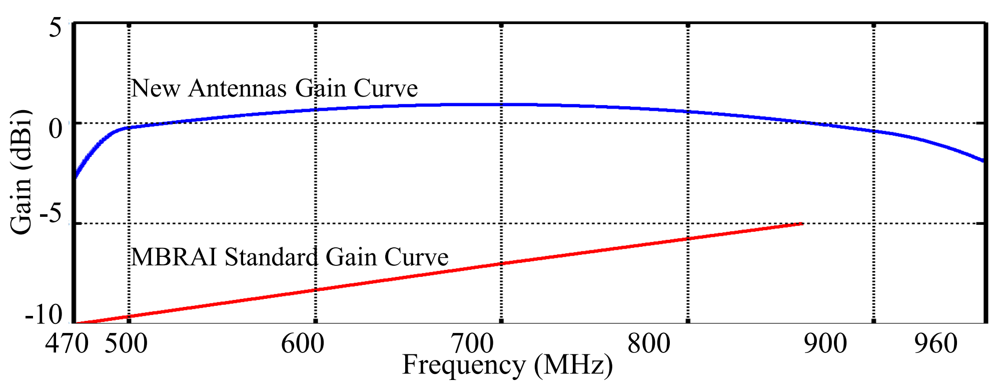


Fig.3 Peak gain of the new antenna

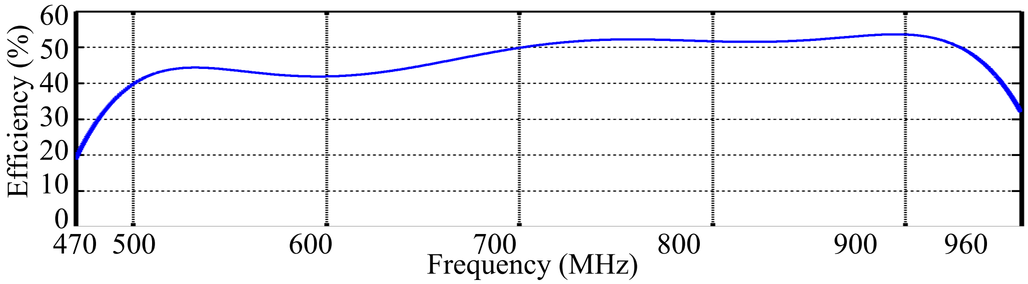


Fig.4 Efficiency of the new antenna

The antenna size can be further reduced by decreasing its width and/or its thickness. For example the width W_1 of the short arm of the above configuration is reduced from 2.6 mm to 2 mm while the width W_2 of the long arm is reduced from 3.5 mm to 2 mm. The antenna thickness T_a is also reduced from 2 mm to 1 mm. The overall size of the new antenna configuration is 25 x 0.2 x 0.1 = 0.5 cm^3. The return loss and the radiation patterns of this new configuration are also measured at IMST antenna labs in Germany and the measured return loss is shown in Fig.5. The return loss is less than -6 dB over most of the band from 470 MHz to 960 MHz. The measured peak gain of the 0.5 cm^3 antenna is still much higher than MBRAI specifications and it is not presented because of space.

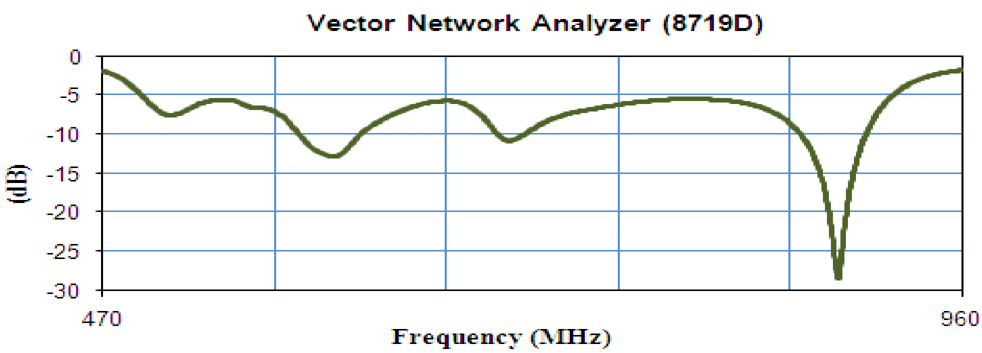


Fig.5 Measured return loss of the new antenna after reducing its overall size to 0.5 cm^3

IV – Bending and folding the antenna:

The new antenna has a very small cross-section area and it is made of a flexible printed material. Therefore, it can be easily bent and/or folded in order to fit any available space. Therefore, although the length of the antenna is 25 cm, it can be reduced in different ways. For example, the two ends of the antenna can be folded as shown in Fig.6 where the length is reduced from 25 cm to 16 cm without a significant effect on its performance. The performance of the short antenna is very close to that of the straight antenna and it is not presented because of space.

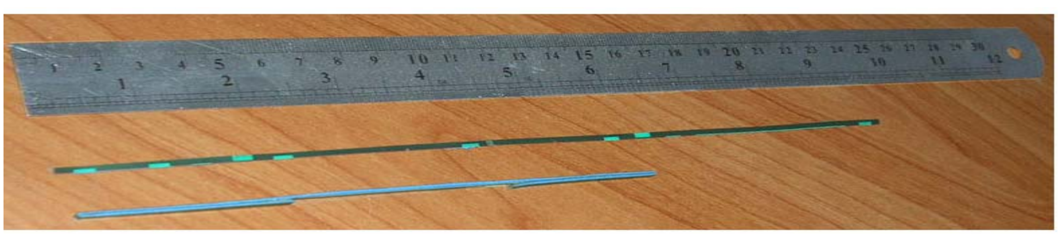
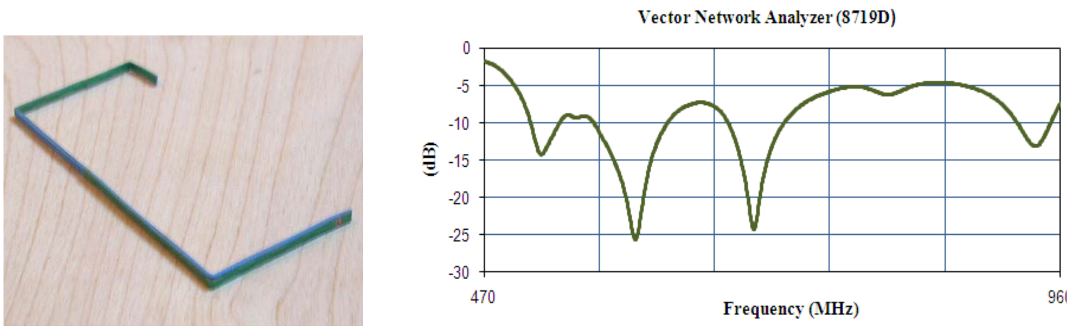


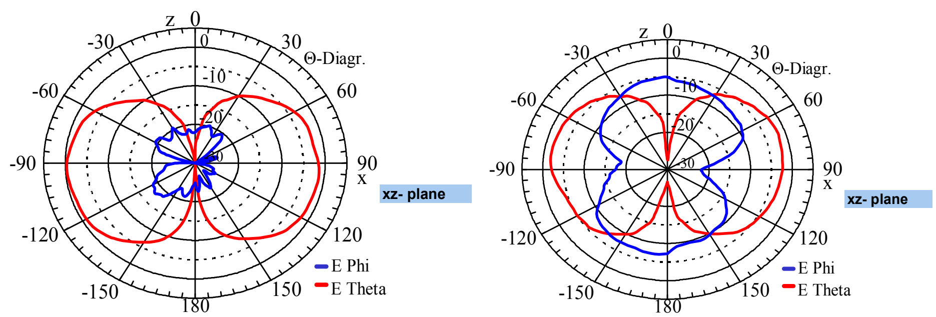
Fig.6 Straight and folded antennas

On the other hand, the new antenna can be folded in two perpendicular directions to form a rectangle or a part of a rectangle as shown in Fig.7 (a). The dimensions of this rectangle can be adjusted to fit any handset. The measured return loss of the folded antenna is shown in Fig. 7(b). The measured radiation patterns of straight and folded antennas at 700 MHz are shown in Fig.8. While the straight antenna is sensitive to only one polarization, the folded antenna is sensitive to two perpendicular polarizations. Such dual polarized antennas are very important in indoor applications where waves are randomly polarized because of multipath reflections and rotation of polarization.



(a) (b)

Fig.7 A folded antenna (a) and its measured return loss (b)



(a) (b)

Fig.8 Radiation patterns of a straight antenna (a) and a folded antenna (b)

V- Conclusions:

A novel small size resonant antenna was developed for multi-standard multifunction handsets. The new antenna covered a frequency band from 470 MHz to 960 MHz with more than 68% bandwidth. It could cover all the bands of UHF DVB-H mobile digital TV, 700 MHz WiMax, CDMA, GSM800 and E-GSM900.

References:

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[2] Fusao Sekiguchi and Kenichi Mitsugi, “Variable Tuning Antenna and Mobile Wireless Device”, US Patent No. 0197711, September 2006

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[4] http://www.imst.com/en/home.php

[5] http://www.eicta.org/index.php?id=33&id_article=152