A DESIGN OF THE MULTI BAND SMALL CHIP ANTENNA USING THE BRANCH STRUCTURE FOR MOBILE PHONES

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ABSTRACT

In this paper, we propose the antenna which has a wideband operation (GSM850, EGSM, DCS1800, USPCS, WCDMA). This antenna is designed by using a meander branch structure which has via and lines on FR-4(ε_r=4.4) PCB. The antenna was designed by the commercial software HFSS 3-D EM simulator. The designed antennas are manufactured by PCB processing, and measured by using the network analyzer and test chamber. The antennas with the dimension of 8mm width, 20mm height and 3.2mm thickness, are applied as internal antennas for wideband cell phones. Its size was minimized so that it can be mounted in cell-phones.

1. INTRODUCTION

In general, goals of mobile phones have been miniaturization, lightweight and low-power consumption. The application of an internal antenna becomes more important nowadays. And it brings the noticeable change in design concepts. But there are a lot of problems in applying conventional internal antennas such as PIFA which is in use. The mobile phones using PIFA are bigger than those using external antennas. Therefore, the internal antenna mobile phones have problems of high thickness.

Recently, the thickness is very important along parameters in mobile phones. The proposed antenna in this paper has a thickness of only 3.2mm, while a PIFA has a 6mm thickness in general. Moreover, the proposed antenna transmits and receives in five bands (824~960MHz, 1710~2170MHz VSWR of 3 or Return Loss -6.02dB).

This antenna has more advantages in applying it as an internal one. First, SDR applications are studied highly, and this antenna can be used to wireless communications systems which are able to be used anywhere in the world. Second, the design of this antenna need not be changed. The present conventional internal antennas have a designing problem which is making new ones in every time whenever new application offered, but this antenna don't have to be redesign. Because the proposed antenna has a wide bandwidth operation, it only needs some matching circuits for applying to mobile phones such as GSM/DCS dual band or triple band in markets now.

This paper introduces a design property of the wideband antenna, and shows performance of simulation and real products.

2. DESIGN OF THE ANTENNA

In this paper the antenna operates in five bands those are GSM850, EGSM, DCS1800, USPCS, W-CDMA. And this five bands are divided roughly into two parts (824~960 MHz, 1710~2170 MHz).

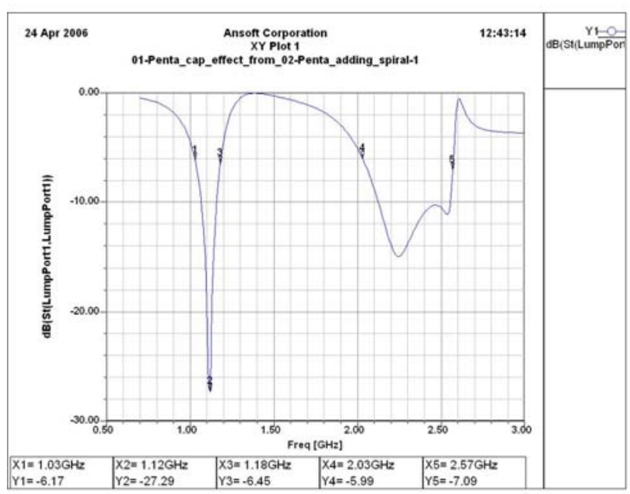

Fig. 1. Return loss of simulation result (6.02dB)

The goal of the design is to make two resonance overall. One is a resonance at 1100 MHz, the other is a sum of two resonances at 2200MHz and 2500MHz.

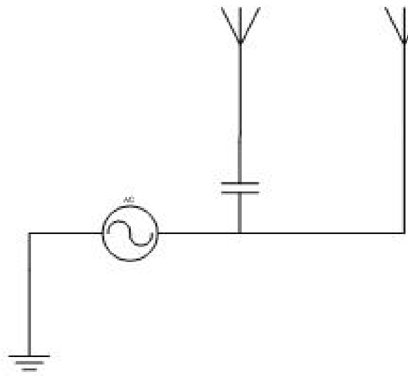

Fig. 2. Summary illustration of a branch structure

Fig.2 shows a fundamental idea about designing the antenna. This is a monopole type using λ/4 (λ: wave-length). The long part located on right side resonates at 1100 MHz, and its harmonic makes resonance at 2500 MHz. [1,2] The short part in center resonates at 2200 MHz. Especially, in order to separate two resonances well, the short wavelength branch has a capacitive component. [3]

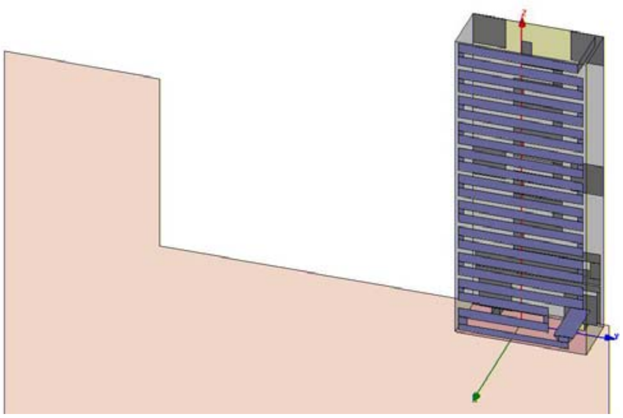

Fig. 3. Simulation design

Fig. 3 shows the design on a simulator. There are the antenna and the top of ground plane. The antenna has a distance which is 0.5mm between a bottom of the antenna and the ground plane, and the other distance is 19.5mm between a side of the antenna and the ground plane. In the antenna, the meander line on the front side resonates at 1100 MHz and 2500 MHz, the branch meandered line on the other side do at 2200 MHz. The gap located on the lower end of back side realizes the capacitive component shown in Fig. 2. The wide pattern lays solely on x-axis direction makes an approximation of 'via' which connects two sides of a PCB. This is based on this approximation. [4-7]

$$a_{eqv} = 0.25s \quad (1)$$

In equation (1), a_{eqv} is the radius of equivalent cylindrical wire, and s is the strip width.

3. MANUFACTURE AND RESULT

Fig. 4 shows the real product. Its dimension consists of 8mm width, 20mm height and 3.2mm thickness as shown in that figure.

Fig. 4. Shape of the antenna

Fig. 4 shows the real product. Its dimension consists of 8mm width, 20mm height and 3.2mm thickness as shown in Fig. 4. In order to measure the antenna performance, the jig board is used and its specific shape is like Fig. 5.

Fig. 5. Antenna mounted on the jig board

The jig board is capable of loading a SMD type antenna. Input signals are received through the 50Ω coaxial cable. The VSWR curves and 2-D gain of the antenna are measured in the condition like Fig. 5.

In Fig. 1, basic frequencies of the antenna are set on high bands which are 200 MHz higher than the bands mentioned in the introduction. Because the measurement on a jig board is lower than that of simulation. And besides, if the antenna is built in systems, it will be lower.

Fig. 6 is the result plot of HFSS, and the s1p file added. The s1p file is a result from the Agilent E8361 network analyzer.

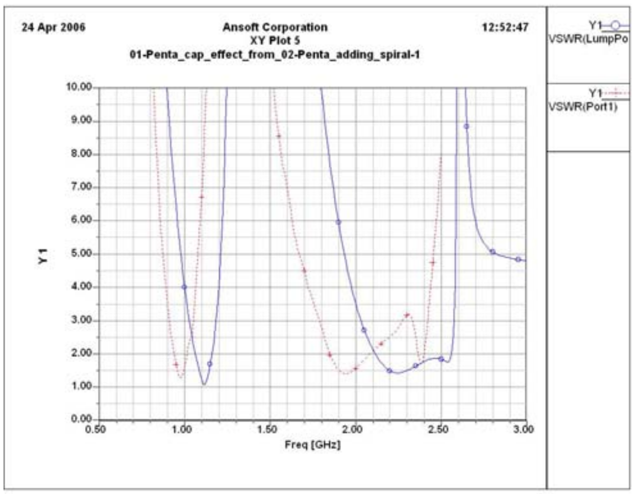

Fig. 6. VSWR curves: Simulation and measurement

In Fig. 6, the circle marked black line is simulated one, and the stick marked gray line is measured one. Fig. 6 shows that the measured frequency is lower than the simulated one about 100~ 200 MHz.

The following figures show the gains in the same condition. The A Plus Tech CTIA OTA test chamber is used to measure it.

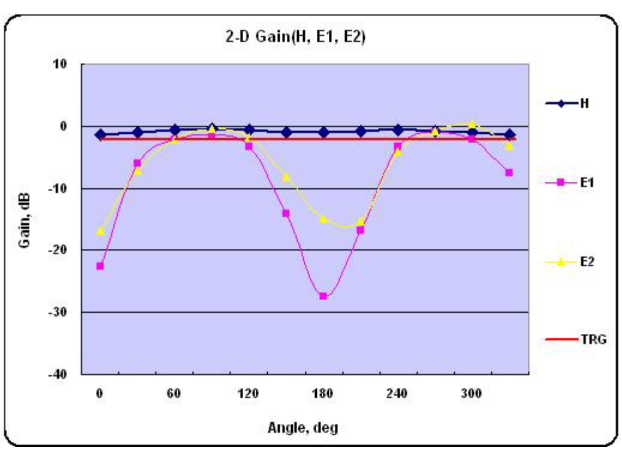

Fig. 7. 910MHz (Average: -2.079 dB)

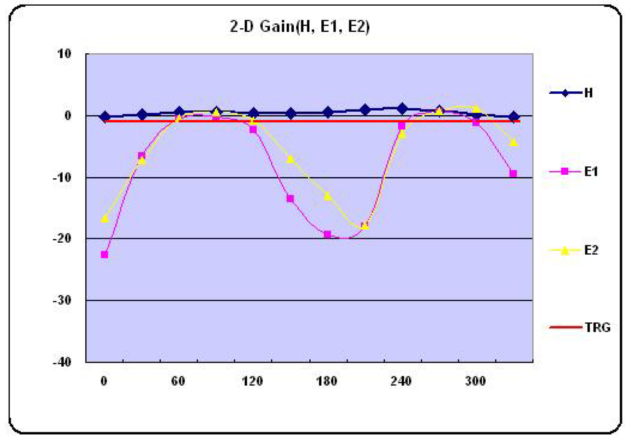

Fig. 8. 990MHz (Average: -0.946 dB)

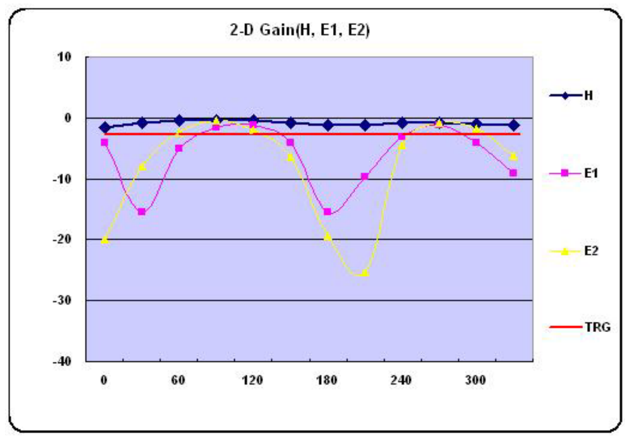

Fig. 9. 1060 MHz (Average: -2.746 dB)

Fig. 7~9 show 2-D gain results in low frequencies. The results represent that the frequencies which have VSWR value near 1 in Fig. 6 achieves high gains.

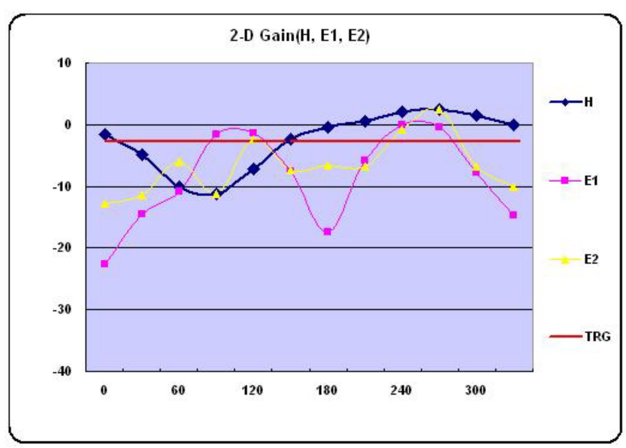

Fig. 10. 1800 MHz (Average: -2.760 dB)

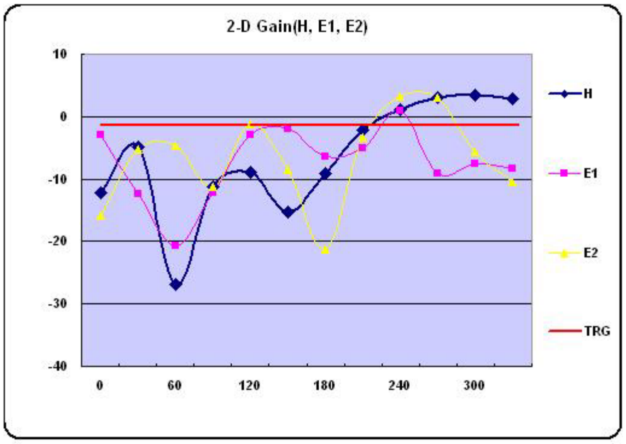

Fig. 11. 2020 MHz (Average: -1.414 dB)

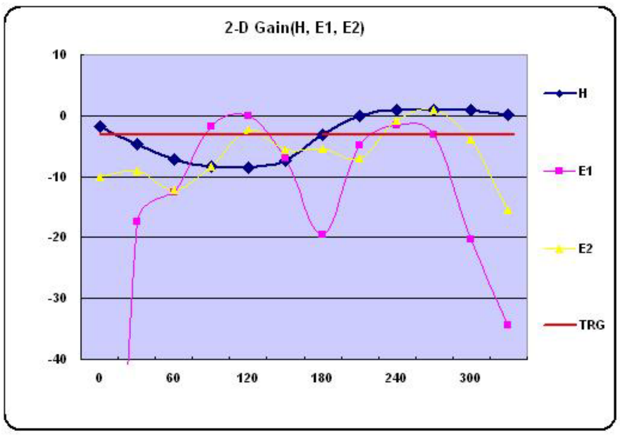

Fig. 12. 2260 MHz (Average: -3.158 dB)

Gains in high frequencies have the same property like low ones.

4. CONCLUSION

This paper introduced the wideband small chip type antenna which used a branch structure. In simulation, it was designed using meander lines while considered a expected frequency shift. The antenna was manufactured in this way, and showed VSWR and gains while it was loaded on a jig board. It operated in 910~1060MHz and 1800~2260MHz when the bandwidth criterion was the VSWR of 3. As the gains ware measured in this bandwidth, a nearly 65% radiation efficiency was achieved at the referred bandwidth.

5. ACKNOWLEDGEMENT

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