Small Chip Antenna for PHS Band Mobile Phone Handset

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ABSTRACT

In this paper, we propose a chip type antenna for PHS band, which can be applied to actual mobile phone. The minimization of the antenna was realized by using meander structure and loop inductor, which make lower resonant frequency than general PIFA antennas at same size. This antenna has lines on FR-4 PCB of dielectric constant = 4.4 [1] [2]. The antenna characteristic is analyzed depending on tuning components, the size of supporting dielectric portion and its permittivity by using the commercial software HFSS 3-D EM simulator.

1. INTRODUCTION

Personal-Handy phone System called PHS was primarily developed in Japan and the phone called city phone, which is similar to PHS, was serviced in Korea. It makes two services possible with an equipment. People can use it as a wireless phone at home and like cellular pone by using base station installed at public phone booths or buildings in outdoor. It was not success in Korea and Japan because of its low quality. But it is popular in China because of its low price. The existing PHS phones usually used external antenna such as helical antenna and whip antenna since it had a good performance, but external antennas gave a constraint of design of phone and influenced from outside circumstance therefore the use of internal microstrip antenna is getting important. Since it takes bigger portion in the phone, we can't neglect the size of antenna which giving a restraint of design of phone. In this paper, we researched the very small built-in type PHS Band Chip antenna to solve those problems. The characteristic of in this research, variable resonance frequency antennas are achieved on one board by applying printed circuit board technology (PCB). Therefore this technology doesn't need tuning process after making antennas. The advantages of the antenna are easy process, low price, and reduction of processing time comparing to previous antennas. Another merit of this antenna is strength from outer influences and variation of the pattern, since it is a built-in type antenna.

2. The GOAL OF DESIGN

This section shows the manufacturing goal of the antenna that proposed in this paper.

2.1 Electrical spec.

Antenna type	Chip type
Application	PHS band
Frequency Range	1880MHz ~ 1930MHz
V S W R	2 : 1
Radiation Efficiency	50%

2.1 Physical spec.

Dimension	2mm, 2mm, 10mm
Weight(g)	0.1 g
connection type	SMD

3. Characteristic due to variation of physical length

Figure 1 (a), (b) show the measured return loss result which is varied by the variation of the length of pattern otherwise other parameters are fixed to see the resonance frequency result from variation of physical length of antenna.

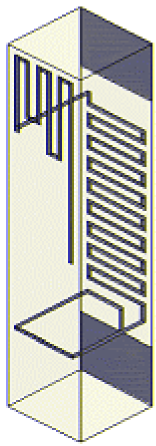

Figure 1(a)

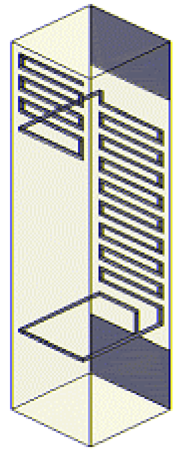

Figure 1(b)

There are loop in the bottom of the antenna shown Figure 1, it operates as an inductor that raises the imaginary part of impedance. This antenna uses first order resonance and the effect of inductor makes higher imaginary value so the antenna is able to have lower resonance frequency in the same size of antenna.

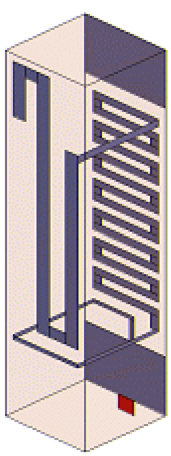

Figure 2(a)

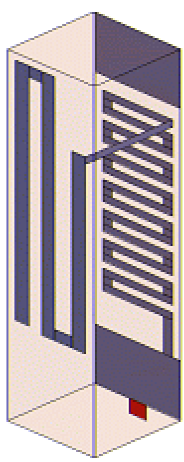

Figure 2(b)

Figure 2 (a), (b) present two antenna. The first one has the loop which acts as an inductor, and the other one doesn't.

Figure 3(a), (b) shows the difference of return loss results between the antennas

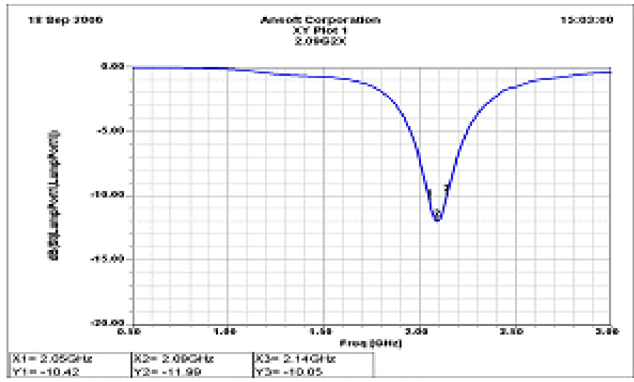

Figure 3(a) Return loss result of Figure 2(a)

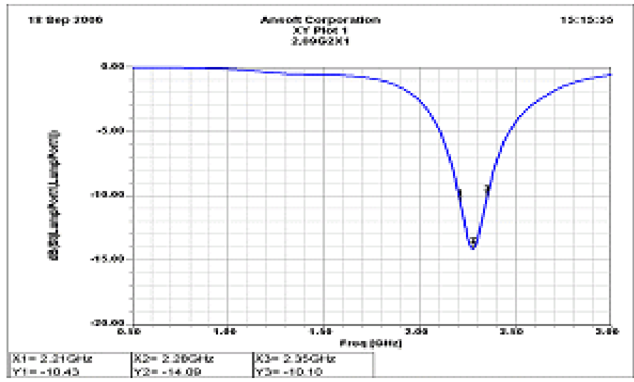

Figure 3(b) Return loss result of Figure 2(b)

From the results shown that even the antenna has same length of pattern, the one made with the loop has lower resonance frequency than the other one, since inductor raising the imaginary part of impedance.

Figure 4 shows the return loss due to the variation of physical length.

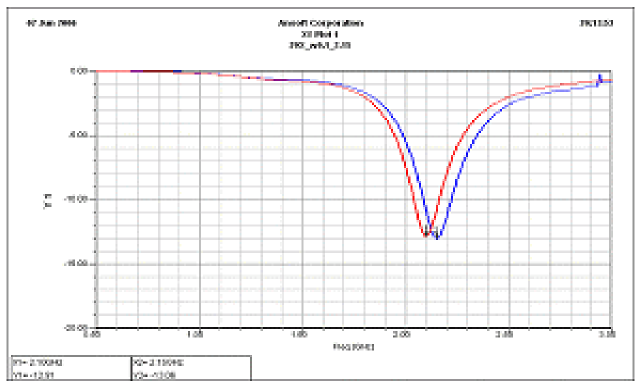

Figure 4 Return loss result of Figure 1(a), (b)

The above result presented simulated with HFSS 3-D simulator. The resonance frequency is increased by shortened the physical length of pattern.

Figure 4 shows the return loss at 2100 MHz and 2150 MHz. Each of them has bandwidth of 120 MHz and 130 MHz in VSWR 2:1.

4. MANUFACTURE AND MEASURED RESULT

The antenna is manufactured by the simulation results. Several antennas, which have different resonance frequency, can be made on one board at once by varying the physical length as shown Figure 6.
Figure 6 shows 16 different models manufactured on one board.

Figure 5 shows the real size of one antenna compared with a ruler.

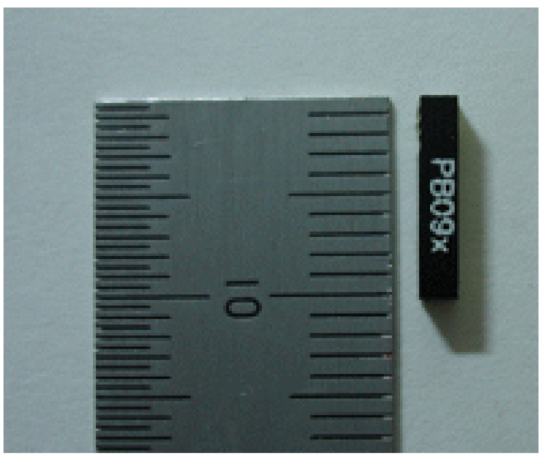

Figure 5 Size of an antenna

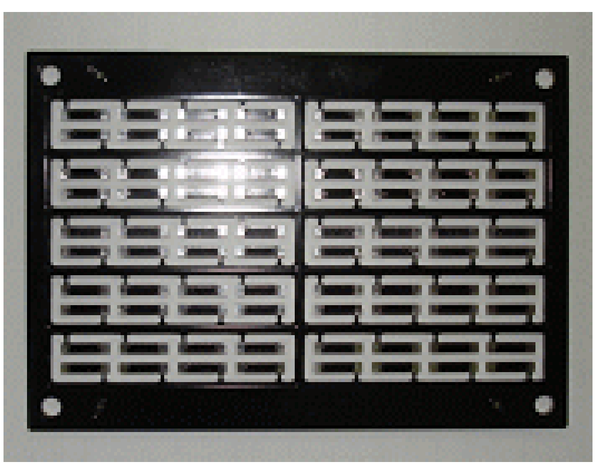

Figure 6 Manufactured antennas on one board

There is an antenna installed on the jig for test in figure 7.

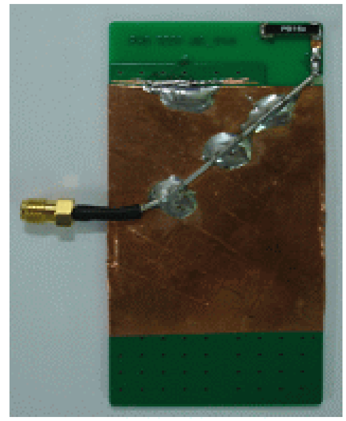

Figure 7 Installed antenna on the jig

Figure 8 shows the VSWR results measured by using Agilent E8361 Network analyzer.

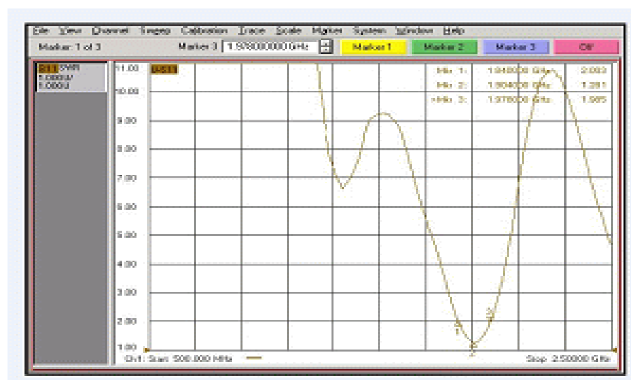

Figure 8 VSWR result

From the previous result, the antenna acts from 1840 MHz to 1978 MHz in VSWR 2:1, it satisfies PHS band enough.

Table 1 shows the results of the radiation efficient measured in A Plus Tech CTIA OTA Test Chamber.

Table 1 Radiation efficiency result

	1	2	3
Frequency(MHz)	**1895**	**1905**	**1918**
Efficiency(dB)	-2.88	-3.12	-2.86
Efficiency(%)	51.57	48.74	51.72

It shows the radiation efficiency over 50% in PHS band (1890MHz ~ 1920MHz)

5. RESULT

In this paper, the PHS band small chip antenna which is able to be applied to an actual handy phone. To making antenna by using PCB technology, which has different resonance frequencies without tuning process, is available. The advantages of this technology are easy process, low price, reduced processing time comparing previous antennas. It also solves the designing problem by using dielectric, meander type pattern, and loop inductor. It is also very strong from outer influences and variation of the pattern, since it is a built-in type antenna. The return loss is satisfied in PHS band in VSWR 2:1(return loss -10dB).

The remarkable point in this research is that several resonance frequency antennas are achieved easily by changing physical length on simulation. It means that antennas having other mobile communication bands can be manufactured on one board at once. Especially smaller size of antenna is available at higher frequency band than PHS band.

6. REFERENCES

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