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Seung Hoon Baek

Southern Illinois University Carbondale

Byungje Lee

Kwangwoon University

Frances J. Harackiewicz

Southern Illinois University Carbondale, fran@engr.siu.edu

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Multi-band Internal Loop Antenna with Inserted Concentric Rings for Mobile Terminals

Seung Hoon Baek^{1*}, Byungje Lee², and F. Harackiewicz¹

¹Department of Electrical and Computer Engineering
Southern Illinois University Carbondale Carbondale, IL 62901
Tel: 618-453-3034, E-mail:baek@engr.siu.edu

²Dept. of Wireless Communications Engineering, Kwangwoon University,
447-1, Wolgye-Dong, Nowon-Gu, Seoul, Korea 139-701

Abstract

Loop Antenna with inserted concentric rings is proposed for mobile terminals. Inserting concentric ring(s) on the loop element improves the impedance bandwidth of the proposed antenna. Measurement results show that the bandwidth includes GSM, DCS, PCS, and UMTS bands.

1. Introduction

The planar Inverted F antenna (PIFA) is very frequently used for portable wireless communication handsets. Among some advantages, compact size characteristic has a big attention for applying wireless communication handsets since the size of mobile terminal is getting small. Internal antennas' advantages are convenient to carry handset and giving opportunity for good outline handset design. Folded and bent internal loop type antenna was presented [1]. Matching technique using open stub was studied [2]. Combination of loop type and inserted stub for the impedance matching could make broad bandwidth.

The main purpose of this paper is for studying characteristics of the inserted concentric rings on the loop radiating element. Loop antenna that is designed for dual-band operation: the lower band for GSM900 (880~960MHz) and the upper band for GSM1800/DCS1800 (1770~1880MHz), PCS1900 (1850~1990MHz), and W-CDMA/UMTS (1920~2170MHz). When the concentric rings that have the different width and radius of rings are inserted, the impedance bandwidth of the loop element is improved.

2. Antenna Structure

The proposed antenna configuration is shown as Fig. 1. The size of patch and ground are 21x44mm and 44 x 65mm, respectively. The height of antenna from ground plane to patch element is 8mm. The characteristics of epoxy substrate are $\epsilon_r=4.4$ and $h=2$ mm. Detail dimension of the radiating element is described in Fig. 1(b). Design concept of the proposed antenna without ring, with 1 ring, and with 2 rings is described in Fig. 2. The shape of radiating element is loop (base) and the concentric rings are added to enhance bandwidth. The concentric rings are located to in the middle of the loop.

3. Results

The simulation results of S_{11} of three different types of the radiating elements are shown in Fig. 3. It is noticed that the impedance behavior of antenna is improved by adding a ring. The simulated S_{11} with 2 rings shows almost 60% improvement for upper band compared to without ring. There is small difference of bandwidth for lower band. The resonant frequency of lower band is slightly shifted toward the lower frequency. Fig. 4, the simulated radiation pattern with 2 rings is presented. Comparison of simulated and measured results for loop antenna with 2 rings is shown in Fig. 5. The measured bandwidth for lower band and upper band are 944~994MHz and 1.74~2.12GHz, respectively. Although the measurement result for the lower band does not cover the entire GSM band now, we will do take care of that later. The measured results show the proposed antenna covers the entire upper band (DCS, PCS, and UMTS) with S_{11} less than -10dB.

4. Conclusion

A new loop antenna with 2 rings is studied and presented by improving the impedance bandwidth for the upper band. Inserted concentric rings improve impedance bandwidth since it affects to have small locus around 50 ohm point at the smith chart. Simulated and measured results for the loop antenna with 2 rings need to be modified to cover the entire targeted frequency ranges. To obtain the entire GSM band operation, a loop path to increase wavelength will be studied and designed in future.

References

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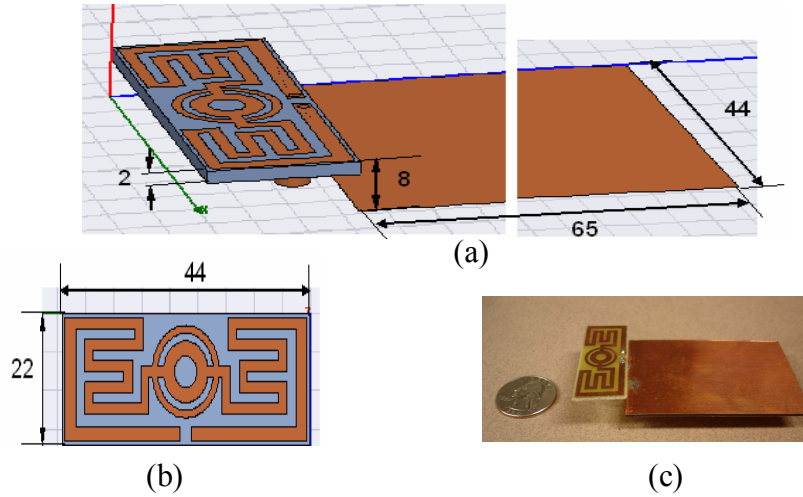


Fig. 1. The configuration of a proposed antenna. (a) 3D view, (b) Radiating element dimension (c) Actual photo.

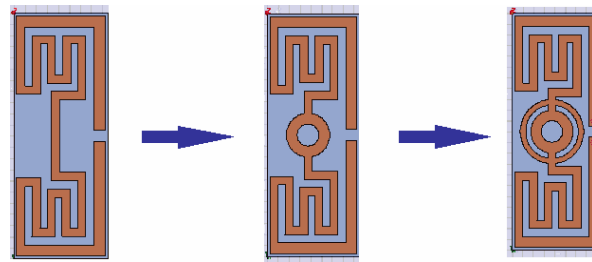


Fig. 2. Design development.

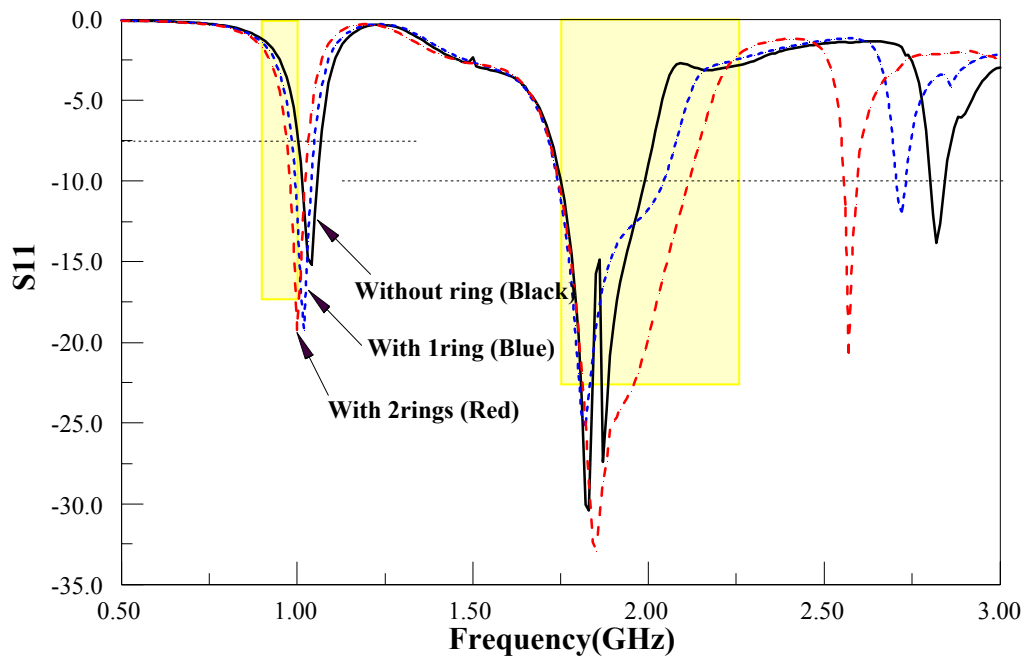


Fig. 3. The simulated S11 results

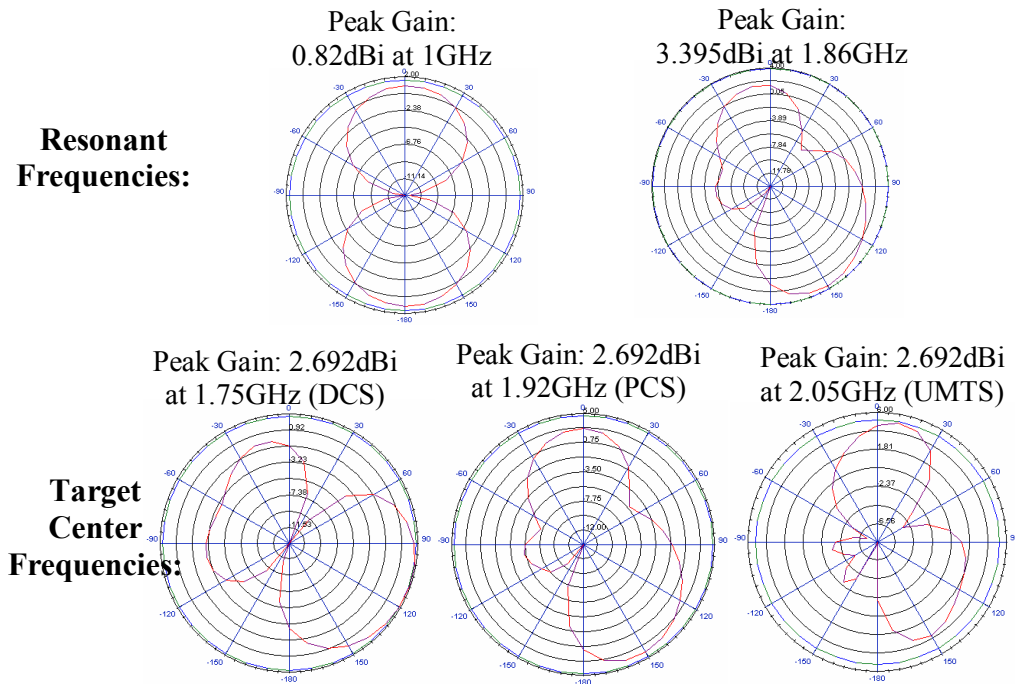


Fig. 4. The simulated radiation pattern with two concentric rings

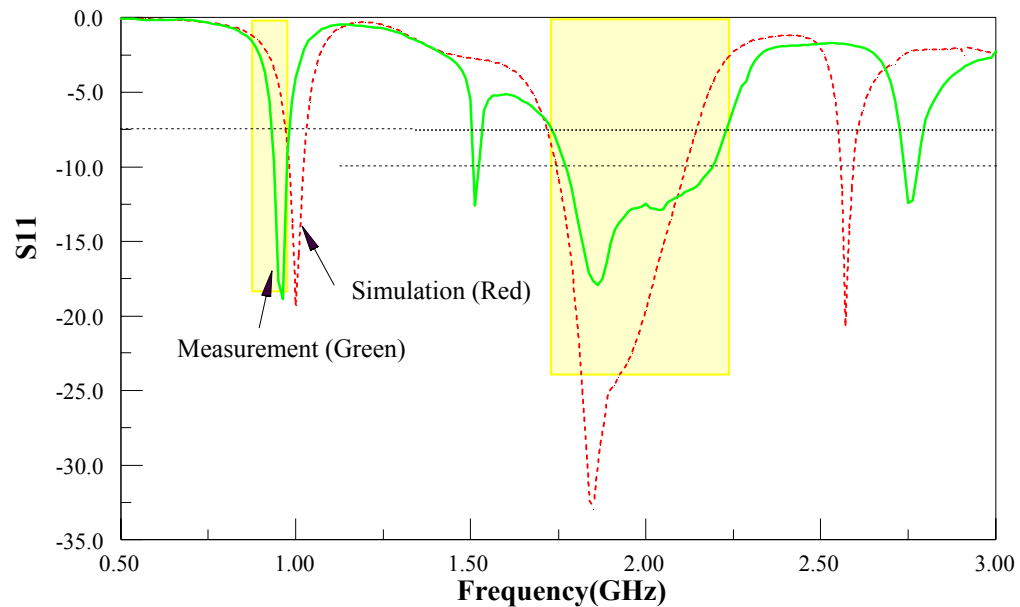


Fig. 5. The simulated and measured results with 2 concentric rings of S11.