Figure 9 Measurement result of non–Foster reactance. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com]

TABLE 1 Negative Capacitor of NFC

Frequency	Reactance	Capacitor Value	Simulation Result
0.8 GHz	18.9Ω	−10.53pF	−10.089pF
0.9 GHz	14.18Ω	−12.47pF	−10.006pF
1 GHz	12.151Ω	−13.01pF	−9.968pF
1.2 GHz	10.653Ω	−12.45pF	−10.048pF

To explain a difference between our measurement result and the simulation result, we go back to the equation (1). We can see that the α parameter of the transistor is the main factor that makes a good negative value. Unfortunately, that factor is frequency–dependent and it is not equal to all frequencies. The frequency-dependent character was demonstrated by using the following equation:

$$\alpha = \frac{\alpha_0}{1 + j\frac{f}{f_{c\alpha}}} \quad (4)$$

Where $f_{c\alpha}$ is the cut-off frequency, α_0 is the unity alpha of the transistor and it goes from 0.98 to 0.998. Hence, when the frequency increases, α parameter is smaller and the reactance at the higher frequency is lower than what we expected.

CONCLUSION

We have proposed a novel NFC to make negative impedance from 0.8GHz to 1.2GHz. In our design, we used an RF transformer to invert the phases of input signal and we improved the Q-factor of our design by matching the real part of the NFC. The results proved that our design has a good negative impedance compared with the practical negative −10pF capacitor. In the future, we will try to apply it in RF modules or antennas to test its suitability for broadband high Q matching techniques for all applications.

ACKNOWLEDGMENTS

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REDUCTION OF THE HEAD EFFECT IN MOBILE DEVICES

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ABSTRACT: *This letter compares two types of antennas for Bluetooth applications in mobile handsets; in the presence and absence of a human head. A Planar Inverted F Antenna (PIFA) and a three dimensional loop-type antenna were designed to fully cover Bluetooth services. The antennas are designed on a Frame Retardant Type 4 (FR-4) substrate ($\varepsilon_r = 4.4$, tan $\delta = 0.02$) with the size of 140 mm × 45 mm printed circuit board (PCB) with 1 mm thickness.* © 2016 Wiley Periodicals, Inc. Microwave Opt Technol Lett 58:1806–1808, 2016; View this article online at wileyonlinelibrary.com. DOI 10.1002/mop.29908

Key words: *head effect; mobile devices; bluetooth; PIFA; three dimensional loop*

1. INTRODUCTION

Modern mobile devices currently on the market are evolving to be smart and wearable devices to enhance the quality of living. These devices are closely located to the human body and the performance of the antenna is affected by the human body. In addition to the market requirements in the past that were wide bandwidth capability and a high realized efficiency, they also require the antenna to be highly immune to the effects of the human body. Thus, it is becoming more important that the performance of the antenna is strongly immune to the effects of the human body.

It is well known from "Chu-Harrington Limit" [1–4] that the radiation quality factor of an ideally small antenna is

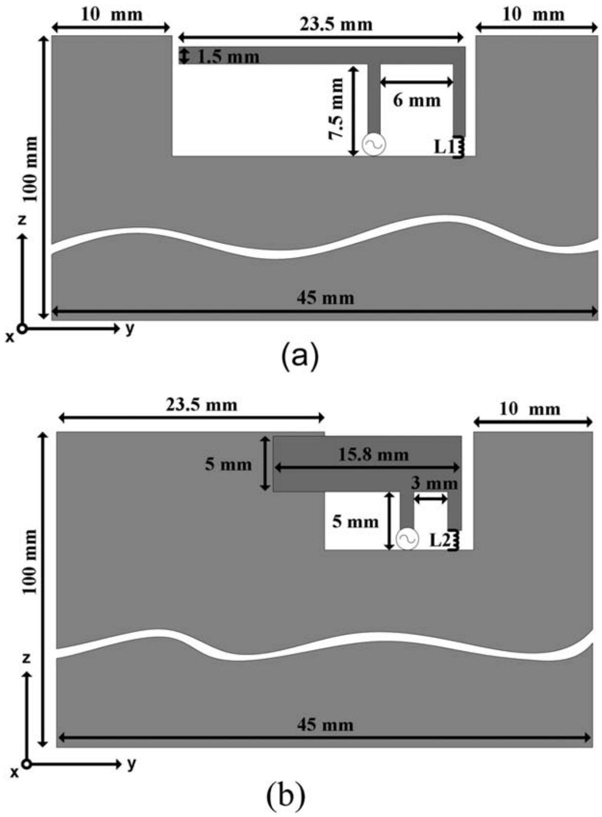

Figure 1 Geometry of the antennas (a) PIFA (b) 3D loop

approximately inversely proportional to the volume of the antenna in wavelength and its impedance bandwidth is limited by the size of the antenna. Hence, it has become a great challenge for antenna designers to develop an antenna with small size having good radiation performance. Many types of antennas has been analysed in many papers that there has to be sufficient height in the antenna to reduce the head and body effects [5–10].

In this letter, a three-dimensional loop-type antenna is proposed to reduce the size of the antenna and to reduce the head effects compared with conventional PIFA over Bluetooth band (2.4 GHz– 2.5 GHz). Measurement data were obtained using network analyser and three dimensional anechoic chamber.

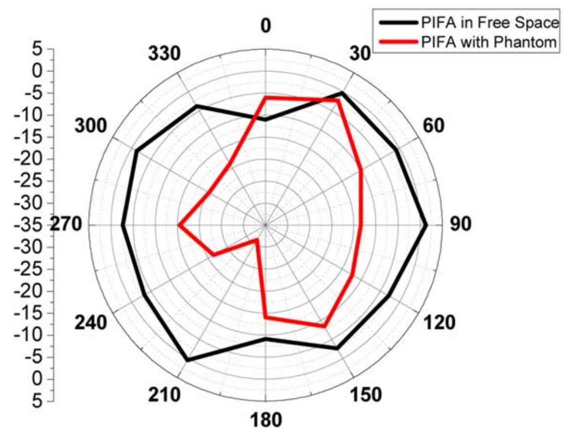

Figure 2 Measured radiation patterns of PIFA at 2.44 GHz. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com]

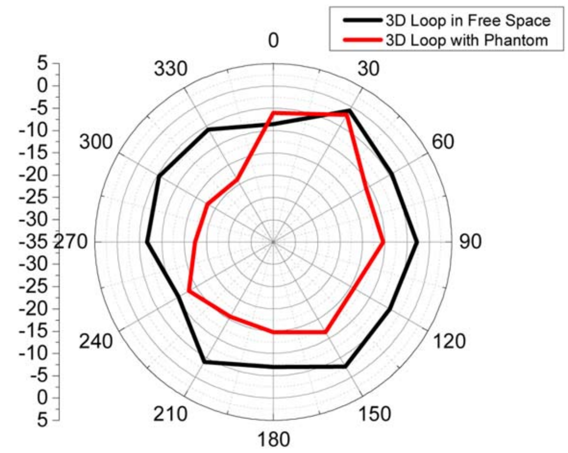

Figure 3 Measured radiation patterns of 3D loop at 2.44 GHz. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com]

2. ANTENNA DESIGN AND OPERATING MECHANISM

Two types of antennas were designed to observe the head effects on the performance of the antenna. The antennas (Figure 1) were etched on a 140 mm × 45 mm FR-4 substrate with 1 mm thickness. PIFA was designed with the width of the top radiator 1.5 mm, located 2 mm above the ground plane, and the three dimensional loop-type antenna was designed with the width of the top radiator 5 mm, located 2 mm above the ground plane. For both PIFA and three dimensional loop-type antenna, the values of the inductors used for L1 and L2 are 1 nH.

For both cases of PIFA and loop-type antenna, combination of electric and magnetic current exist. However, in the case of conventional PIFA, dominant parallel electric current (z-direction) is formed near the antenna and when it is placed close to the human head, the dominant image current in the human head is formed in the opposite direction, degrading the performance of the antenna. On the other hand, the proposed three dimensional loop-type antenna forms a dominant parallel magnetic current (z-direction) and when it is placed close to the human head, the dominant image current in the human head is formed in the same direction, and has less head effect compared to PIFA as shown in Figure 6 [11].

3. EXPERIMENTAL RESULTS

The proposed antennas have been successfully simulated and constructed. The proposed antennas were simulated and

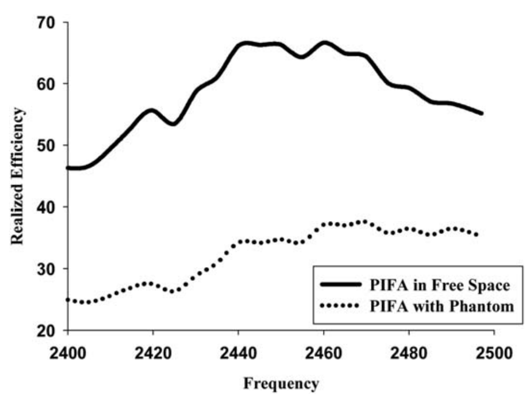

Figure 4 Measured realized efficiency of PIFA

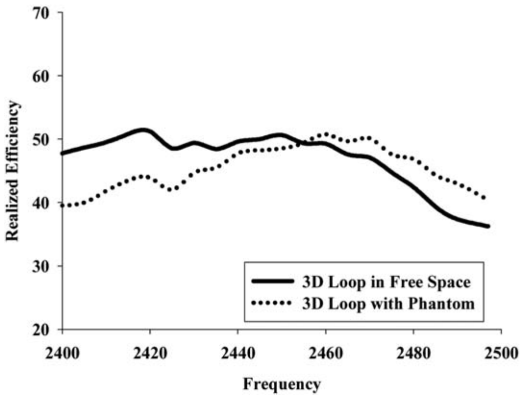

Figure 5 Measured realized efficiency of 3D loop

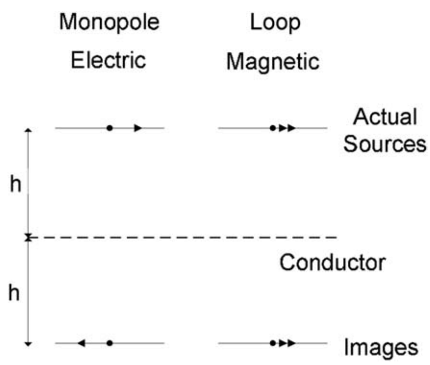

Figure 6 Concept of PIFA and 3D loop

measured. It can be seen from Figures 2 and 3 that the proposed three dimensional loop-type antenna has less head effect than PIFA. The overall efficiency at 2400–2500 MHz of PIFA has dropped from 58.57% to 32.23% in the presence of a human head whereas three-dimensional loop-type antenna has dropped from 46.91% to 45.38% having less head effect (Figures 4-6).

4. CONCLUSION

The proposed antenna was designed and achieves sufficient gain in the direction of a human head to operate at Bluetooth band. Three-dimensional loop-type antenna not only occupies a smaller space but also achieves better radiation performance in the presence of a human head. In order to reduce the head effect, it is important to place the magnetic current parallel to the human head.

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MINIATURE LOW PROFILE UWB ANTENNA: NEW TECHNIQUES FOR BANDWIDTH ENHANCEMENT AND RADIATION PATTERN STABILITY

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ABSTRACT: *A miniature (30 × 10 mm²) efficient planar monopole antenna with stable radiation pattern for UWB applications (3.1–10.6 GHz) is proposed in this paper. These characteristics, wide bandwidth and radiation stability, are achieved by using original design solutions with maintaining a small size and good efficiency of the system. Based on modified ground plane and loop feeding structure, the first design solution consist to propose a simple technique which not requires any discrete additional elements or circuits and does not affect the overall dimensions of the basic structure. This technique enhances the (−6 dB) bandwidth of the planar monopole antenna by approximately 50% compared to the basic structure while maintaining the same dimension (30 × 10 mm²). The optimized proposed antenna presents a large bandwidth, good radiation stability, total efficiency higher than 70% over the entire band and small size (30 × 10 mm²) which will enable to use it in different UWB applications. In the second step, two L slots are added in the printed circuit board of the proposed UWB antenna to reach a good stability of the radiation pattern on the overall desired band.* © 2016 Wiley Periodicals, Inc. Microwave Opt Technol Lett 58:1808–1813, 2016; View this article online at wileyonlinelibrary.com. DOI 10.1002/mop.29907

Key words: *bandwidth enhancement technique; planar monopole antenna; ultrawideband antenna; radiation pattern stability*

1. INTRODUCTION

The need for high data transmission rates using miniature communication systems is one of the important requirements of the users over the past decade. To answer these requirements, wireless communication technology has been the subject of extensive investigation in recent years, and several wireless systems and standards have been created, [1].