Characteristics of a planar folded dipole antenna for Handsets with a parasitic element

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1. Introduction

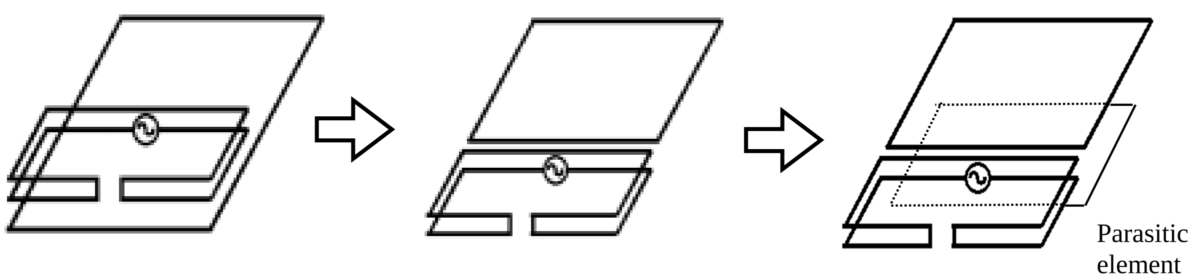
A folded loop antenna has already been introduced as one of the balance-fed antennas for handset [1]. A folded loop antenna has a self-balanced structure so that no unbalanced current flows on the ground plane (GP), even though it is fed by an unbalanced line such as a coaxial cable.. However, the antenna has a narrow bandwidth of 3% for both unbalanced and balanced feed. By changing the strip width ratio of folded loop antenna, the bandwidth is enlarged up to 45% for the balanced feed [2]. In addition, in order to make a lower profile of a folded loop antenna, built-in folded dipole antenna (BFDA), which has a structure folded loop elements sideways so that the antenna can be placed on the ground plane(GP), has been proposed. BFDA has also a self-balanced effect. The relative bandwidth is about 13% [3].

To be lower profile and smaller structure including the GP, a planar folded dipole antenna(PFDA) has been proposed[5]. PFDA consists of a folded loop element placed horizontally on the top of GP so that the antenna becomes a lower profile. However, the relative bandwidth for VSWR ≤2 is 7.0% and 13% for the balanced and unbalanced feed, respectively.

In this paper, in order to enlarge the bandwidth, a planar folded dipole antenna(PFDA) for handsets with a parasitic element placed under the antenna element is introduced and its characteristics are analyzed. In the analysis, the electromagnetic simulator based on the finite integration technique is used. The design parameters, which are useful in practical operation, are obtained. An example of a wideband antenna is designed based on these parameters and antenna characteristics such as VSWR and the radiation patterns are shown.

2. Antenna structure

The change of from BFDA to PFDA with a parasitic element is shown in Fig.1 Antenna dimensional parameters and the antenna element on the top of rectangular GP are shown in fig.2, where (a) and (b) show perspective view and side view, respectively. The antenna element is placed close to the top of the rectangular GP and on the top of a parasitic element. The antenna parameters of optimized structure are *w*1=7mm, *w*2=10mm, *w*3=4mm, *w*4=10mm, *w6*=2mm, *s*=27mm, *h*=2mm, *d*=4.5mm, *b*=3mm. The antenna element and GP are made of a copper plate with a thickness of 0.2 and 0.5mm respectively. The antenna element is fed by a semi-rigid cable with a diameter of 2mm in the experiment.



BFDA **PFDA** **PFDA with a parasitic element**

Fig.1 The change of PFDA with a parasitic element

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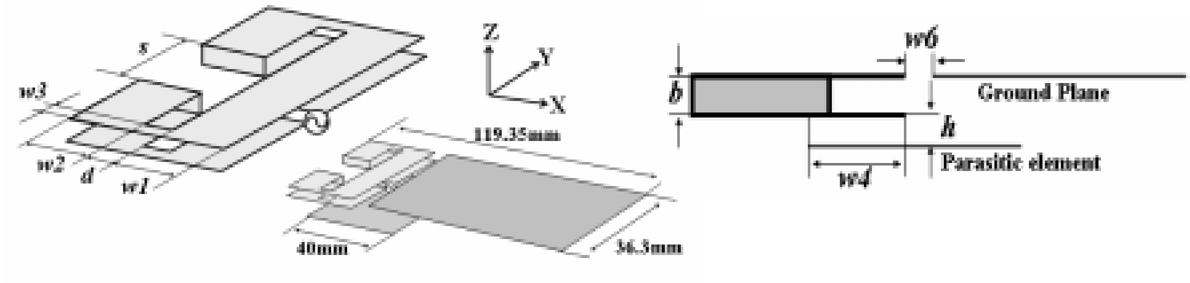


(a) Perspective view (b) side view

Fig.2 Geometry of the proposed antenna

3. Results

3-1. VSWR characteristics of PFDA with a parasitic element

The calculated and measured VSWR characteristics of proposed antenna in this paper are shown in the Fig.3. As can be seen in the figure, the calculated results for both unbalanced and balanced feed agree well from 2500MHz to 4565MHz. Also, tendency of VSWR characteristics agrees between the calculated and measured results. In the balanced feed, the relative bandwidth for VSWR≤2 is about 71% at the center frequency 3680MHz. In the unbalanced feed, the calculated and measured relative bandwidths for VSWR≤2 are about 69% and 71% at the center frequency of 3680MHz, respectively.

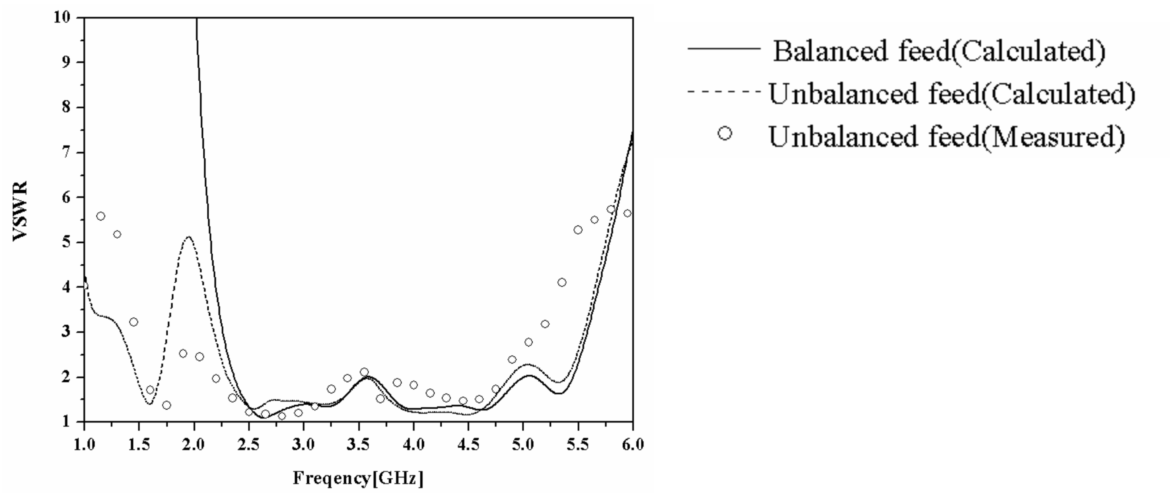
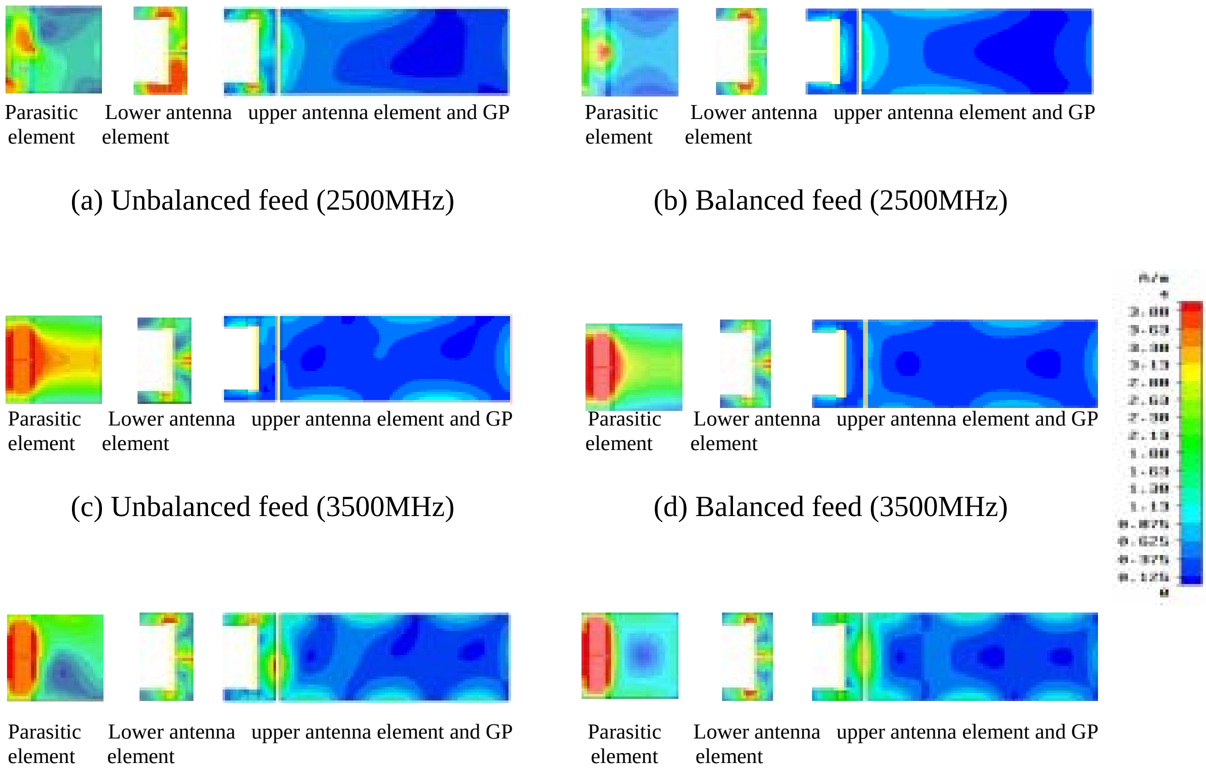


Fig.3 VSWR characteristic of optimized antenna

3-2. Current distribution

The calculated current distribution on the antenna element, GP and a parasitic element are shown in Fig.4, where they are shown at 2500MHz, 3500MHz and 4500MHz for both unbalanced and balanced feed. In these figures, a slight difference is seen around parasitic element and antenna element between balanced and unbalanced feed. However, the current flows on the GP is also reduced for both feed



(a) Unbalanced feed (2500MHz)

(b) Balanced feed (2500MHz)

(c) Unbalanced feed (3500MHz)

(d) Balanced feed (3500MHz)

(e) Unbalanced feed (4500MHz)

(f) Balanced feed (4500MHz)

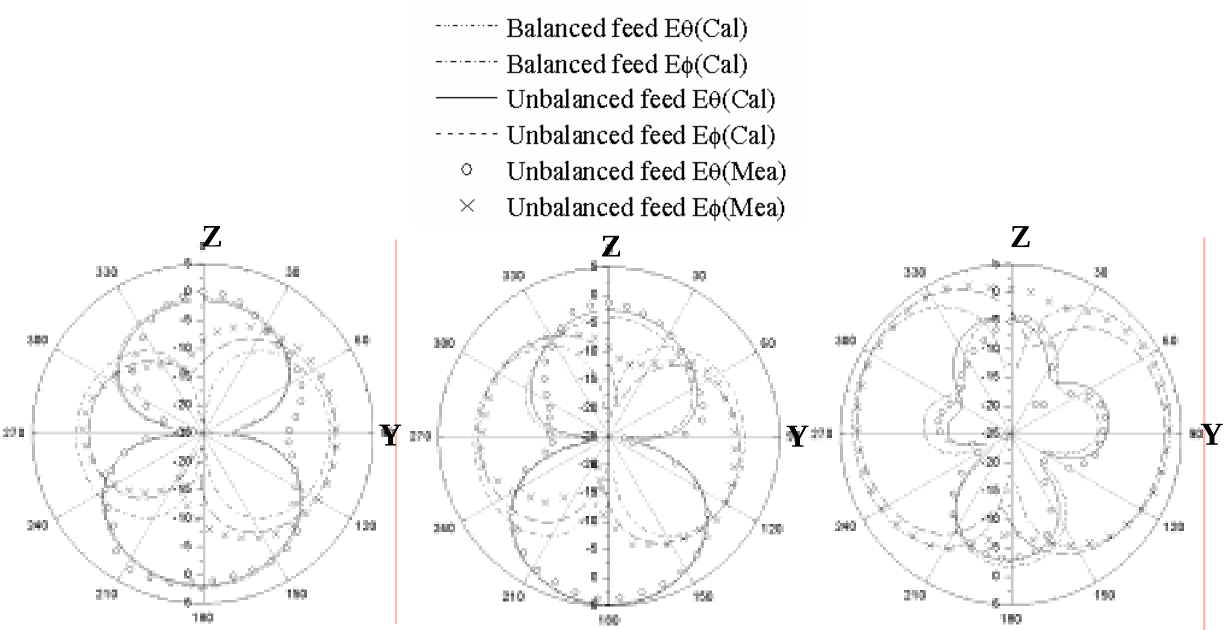
Fig.4 Current distribution

3-3. Radiation patterns

The calculated and measured radiation patterns in the YZ plane are shown in fig.5, where they are shown at 2500MHz, 3500MHz and 4500MHz. The radiation patterns are expressed by the power gain [dBi]. As can be seen in these figures, the calculated radiation patterns in both feeds are similar to each other at above three frequencies. A slight difference is shown between measured and calculated results. The reasons can be considered to be influence of cable and sensitiveness of antenna in the measurement. However the tendency of radiation pattern agrees between the calculated and measured results at above three frequencies. The radiation is enhanced toward –Z direction. It can be considered that the parasitic element is operated as a part of radiator.

4. Conclusion

In this paper, one of the methods enlarging bandwidth by using the parasitic element for a planar folded dipole antenna (PFDA) is introduced and its characteristics are analyzed. In the balanced feed, the relative bandwidth for VSWR≤2 is about 71% at the center frequency 3680MHz. In the unbalanced feed, the calculated and measured relative bandwidths for VSWR≤2 are about 69% and 71% at the center frequency of 3680MHz, respectively. The analyses considering design frequency is the next subject to be studied.



(a) 2.5GHz (b) 3.5GHz (c) 4.5GHz

Fig.5 Radiation patterns (YZ plane)

Reference

[1] Y. Kim, H. Morishita, Y, Koyanagi, and K, Fujimoto, "A Folded loop antenna system for handsets developed and based on the advanced design concept", IECE Trans. Communication, Vol. E84-B, No. 9,pp. 2468-2475 (Sep. 2001)

[2] S. Hayashida, H. Morishita, and K. Fujimoto, "A Wideband Folded Loop Antenna", IECE Trans., Vol. 86-B, No. 9,pp. 1799-1805 (Sep 2003)

[3] T. Tanaka, S. Hayashida, H. Morishita, Y. Koyanagi, and K. Fujimoto, "Built-in folded dipole antenna for handset s," IEEE AP-S Proc., vol.1, pp.451-454, Jun. 2003.

[4] A. Skrivervik, J-F. Zurcher, O. Stanb, and J. R. Mosing, "PCS Antenna Design", The Challege of Miniaturization, IEEE Antennas and Propagation Magazine, vol. 43, no. 4, pp.12-26, Aug. 2001

[5] D. Sasaki, S. Hayashida, K. Imamura H. Morishita M. Usami, "A Planar Folded Antenna for Handset", IWAT`05, S6.3, March, 2005